

W-LAN+Bluetooth Combo Module Data Sheet

Infineon Chipset
for 802.11a/b/g/n/ac + Bluetooth 5.0

Tentative P/N : LBEE5HY1MW-TEMP

The revision history of the product specification

Revised No.	Revised Date	Note
-	2016.10.03	Initial Release
A	2017.04.26	Changed BT version 1.SCOPE 2.KEY FEATURE 10.7.DC/RF Characteristics for Bluetooth 10.8. DC/RF Characteristics for Bluetooth (LE)
B	2017.05.19	2. Key Feature : Changed IC vendor name 4. Operating condition : corrected 8. Digital I/O Requirements : Added 10.Electrical characteristics : Corrected 12. Reference Circuit : Added
C	2017.08.02	Modify Bluetooth Specification Version
D	2017.08.04	10. Finalize WLAN TBD Spec value
E	2017.08.17	12. Corrected Reference circuit
F	2017.09.04	10.2.1. Low Rate Condition for IEEE802.11g - 2.4GHz Corrected Power Levels
G	2018.01.10	4. Operating condition : Changed VBAT min voltage 10.Electrical characteristic : Changed output power setting
H	2018.04.17	10.Electrical characteristic : Updated
I	2018.04.23	10.Electrical characteristic : Corrected
J	2018.06.13	3. Certification information : Added APPENDIX : Added
K	2018.11.29	Modify Bluetooth Specification Version : 4.2 to 5.0
L	2018.12.28	Revised 12. REFERENCE CIRCUIT/14.5. Soldering conditions/14.6. Cleaning
M	2019.02.28	Corrected 3.2 Europe certification information
N	2019.05.16	3.2 Bluetooth® Qualification: Added 16. PRECONDITION TO USE OUR PRODUCTS: Updated Appendix : Added User manual for Japan certification
O	2020.03.19	5.OPERATING CONDITION : uploaded Temperature Range to "-30~85"
P	2020.06/25	3.1. Radio Certification Added Canada's country code information.
Q	2022.06.10	Silicon manufacturer name is revised

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Preliminary

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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.

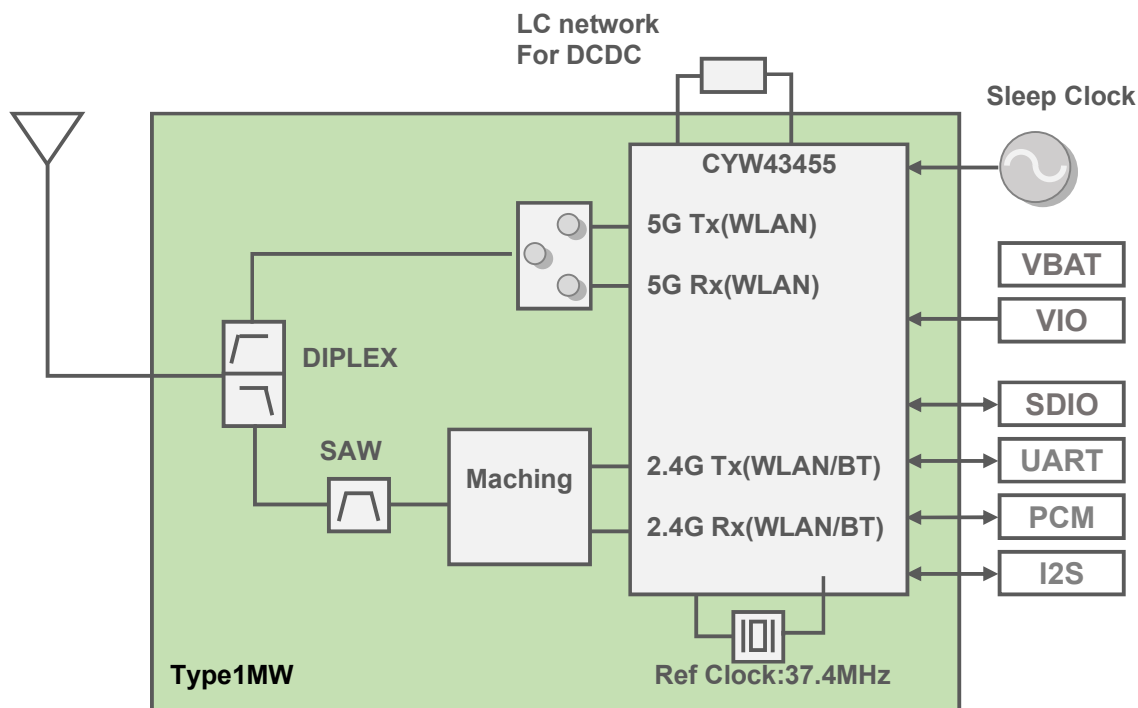
1. SCOPE

This specification is applied to the IEEE802.11a/b/g/n/ac W-LAN + Bluetooth 5.0 combo module.

2. KEY FEATURE

- Infineon/CYW43455 inside
- Compliant with IEEE802.11a/b/g/n/ac
- Compliant with Bluetooth specification v5.0
- SAW filter inside
- SDIO interface for W-LAN
- Interface support for Bluetooth is Host Controller Interface (HCI)
- Surface mount type 7.9 x 7.3 mm (Typical), H = 1.1 mm (Max)
- Weight : 0.15g
- MSL : 3

2.1. Block Diagram



2.2. Ordering Information

Ordering Part Number	Description
LBEE5HY1MW-TEMP	In case of sample order
LBEE5HY1MW-TEMP-D	EVK

2.3. RoHS Compliance

This module is compliant with the RoHS directive.

3. Certification Information

3.1. Radio Certification

USA

FCC ID: VPYLBEE5HY1MW

Country Code: US/0

*Please follow user/installation manual of Appendix

Canada

IC: 772C-LBEE5HY1MW

Country Code: CA/0

*Please follow user/installation manual of Appendix

Europe

EN300328/301893 v2.1.1, EN300440 v2.2.0 conducted test report is prepared.

Country Code: DE/0

Japan

Japanese type certification is prepared.

 001-P01220

Country Code: JP/0

*Please follow user manual of Appendix

The each country code are defined by Murata Blob file.

Please ask your contact person from Murata.

3.2. Bluetooth® Qualification

QDID: 118271

4. ABSOLUTE MAXIMUM RATINGS

Parameter		min.	max.	Unit
Storage Temperature		-40	85	deg.C
Supply Voltage	VBAT	0	5.0	V
	VIO	0	3.9	V

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

5. OPERATING CONDITION

Parameter		min.	typ.	max.	unit
Operating Temperature*1		-30	25	+85	deg.C
Supply Voltage	VBAT	3.2	-	4.2	V
	VIO 1.8V/3.3V	1.62	-	3.63	V

*1 Functionality is guaranteed but specifications require derating at extreme temperatures.

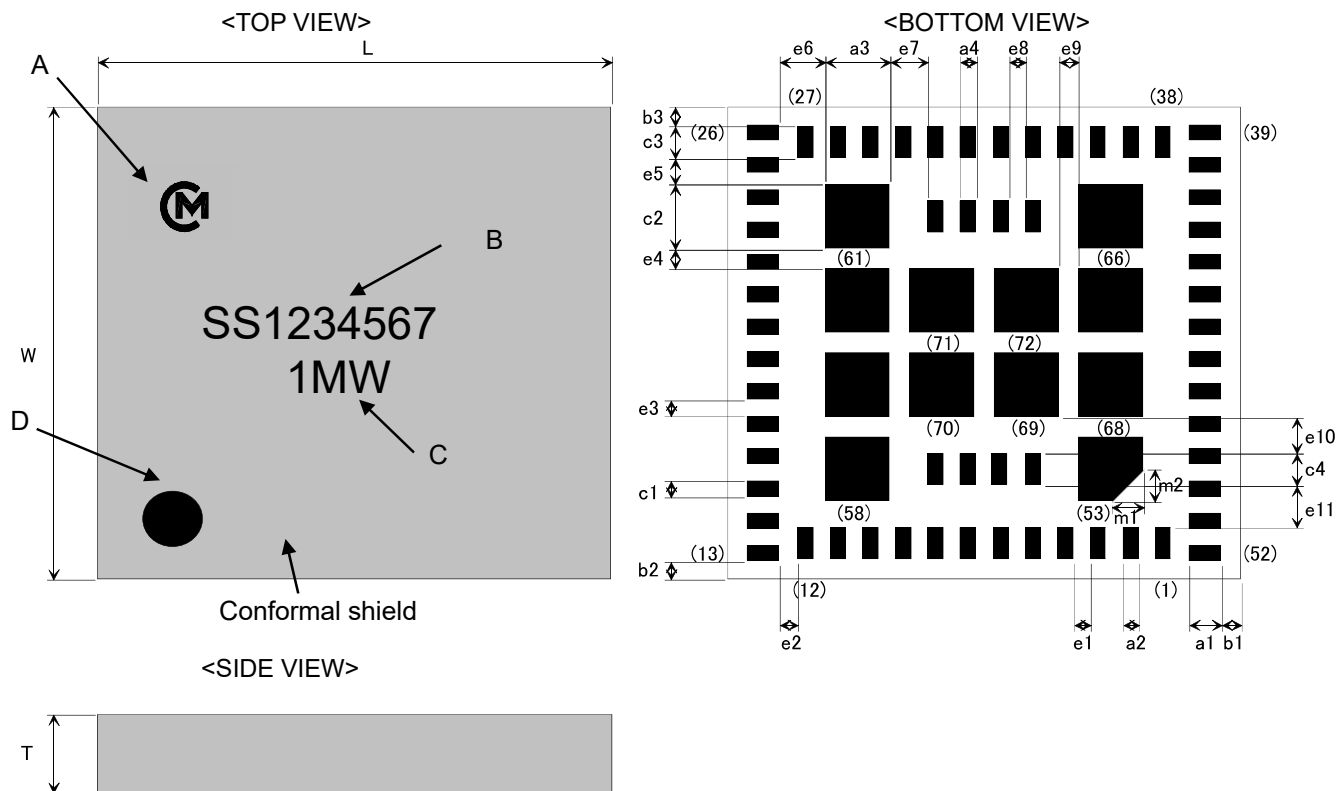
6. External LPO Signal Requirement

Parameter	External LPO Clock	Unit
Nominal input frequency	32.768	kHz
Frequency accuracy	+/-200	ppm
Duty cycle	30-70	%
Input signal amplitude	200 - 3300	mVp-p
Signal type	Square-wave or sine-wave	-
Input impedance* ^a	> 100k	ohm
	< 5	pF
Clock jitter (during initial start-up)	<10,000	ppm

a)When power is applied or switch off.

7. DIMENSIONS, MARKING AND TERMINAL CONFIGURATIONS

7.1. Dimensions



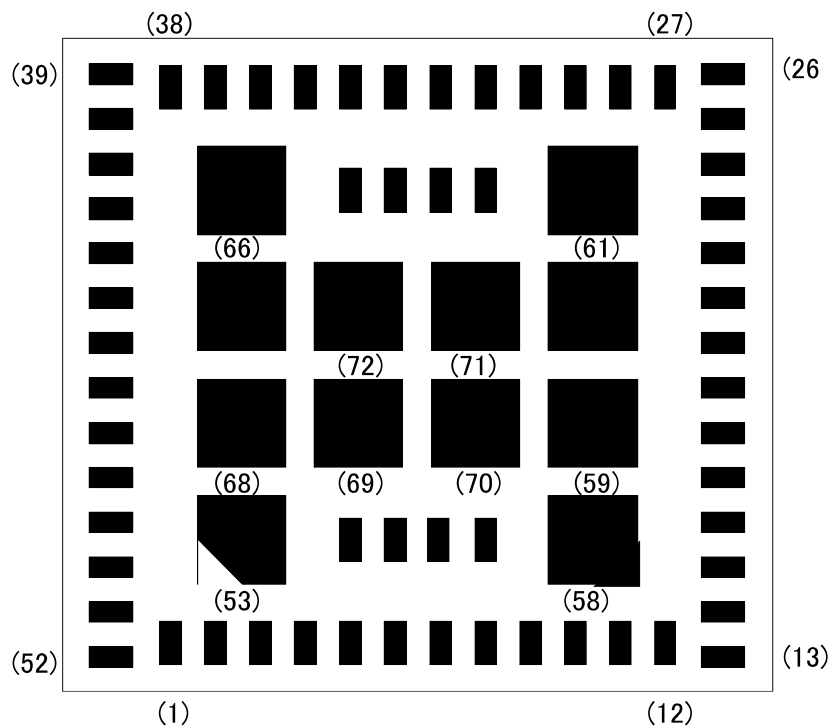
Marking	Meaning
A	Murata Logo
B	Inspection Number
C	Module Type
D	Pin 1 Marking

(unit : mm)

Mark	Dimensions	Mark	Dimensions	Mark	Dimensions
L	7.9 +/- 0.1	W	7.3 +/- 0.1	T	1.1 max.
a1	0.5 +/- 0.1	a2	0.25 +/- 0.1	a3	1.0 +/- 0.1
a4	0.25 +/- 0.1	b1	0.3 +/- 0.1	b2	0.275 +/- 0.1
b3	0.3 +/- 0.1	c1	0.25 +/- 0.1	c2	1.0 +/- 0.1
c3	0.5 +/- 0.1	c4	0.5 +/- 0.1	e1	0.25 +/- 0.1
e2	0.275 +/- 0.1	e3	0.25 +/- 0.1	e4	0.3 +/- 0.1
e5	0.4 +/- 0.1	e6	0.7 +/- 0.1	e7	0.575 +/- 0.1
e8	0.25 +/- 0.1	e9	0.3 +/- 0.1	e10	0.55 +/- 0.1
e11	0.65 +/- 0.1	m1	0.5 +/- 0.1	m2	0.5 +/- 0.1

7.2. Pin Layout

Top View



Pin No.	Description	Pin No.	Description	Pin No.	Description	Pin No.	Description
1	GPIO_6	19	GND	37	I2S_CLK	55	GND
2	GPIO_0	20	SDIO_CLK	38	I2S_WS	56	GND
3	GPIO_3	21	GND	39	GND	57	JTAG_SEL
4	GPIO_5	22	VBAT_LDO	40	BT_DEV_WAKE	58	GND
5	GPIO_1	23	VBAT_SR	41	BT_HOST_WAKE	59	GND
6	GPIO_4	24	SR_PVSS	42	I2S_DI	60	GND
7	GPIO_2	25	VIN_LDO	43	NC	61	GND
8	BT_REG_ON	26	SR_PVSS	44	GND	62	BT_GPIO_4
9	WL_REG_ON	27	SR_PVSS	45	BT_UART_RXD	63	BT_GPIO_3
10	GND	28	SR_VLX	46	BT_UART_TXD	64	BT_GPIO_2
11	VIO	29	GND	47	BT_UART_RTS_N	65	BT_GPIO_5
12	GND	30	LPO_IN	48	BT_UART_CTS_N	66	GND
13	GND	31	GPIO_7	49	GND	67	GND
14	SDIO_DATA0	32	BT_PCM_IN	50	ANT	68	GND
15	SDIO_CMD	33	BT_PCM_SYNC	51	GND	69	GND
16	SDIO_DATA1	34	BT_PCM_OUT	52	GND	70	GND
17	SDIO_DATA2	35	BT_PCM_CLK	53	GND	71	GND
18	SDIO_DATA3	36	I2S_DO	54	NC	72	GND

7.3. Module PIN Descriptions

No.	Pin name	Type	System	Connection to IC pin name	Description
1	GPIO_6	I/O	WL	GPIO_6	Programmable GPIO Pin
2	GPIO_0	I/O	WL	GPIO_0	Programmable GPIO Pin
3	GPIO_3	I/O	WL	GPIO_3	Programmable GPIO Pin
4	GPIO_5	I/O	WL	GPIO_5	Programmable GPIO Pin
5	GPIO_1	I/O	WL	GPIO_1	Programmable GPIO Pin
6	GPIO_4	I/O	WL	GPIO_4	Programmable GPIO Pin
7	GPIO_2	I/O	WL	GPIO_2	Programmable GPIO Pin
8	BT_REG_ON	I	BT	BT_REG_ON	Used by PMU to power up or power down the internal CYW43455 regulators used by the BT section. Also, when deasserted, this pin holds the BT section in reset. This pin has an internal 200k ohm pull-down resistor that is enabled by default. It can be disabled through programming.
9	WL_REG_ON	I	WL	WL_REG_ON	Used by PMU to power up or power down the internal CYW43455 regulators used by the WLAN section. Also, when deasserted, this pin holds the WLAN section in reset. This pin has an internal 200k ohm pull-down resistor that is enabled by default. It can be disabled through programming.
10	GND	-	-	-	-
11	VIO	I	-	VDDIO, VDDIO_SD, BT_VDDO	Supply for PMU, BT, WLAN, SDIO.
12	GND	-	-	-	-
13	GND	-	-	-	-
14	SDIO_DATA0	I/O	WL	SDIO_DATA0	SDIO data line 0
15	SDIO_CMD	I/O	WL	SDIO_CMD	SDIO command line
16	SDIO_DATA1	I/O	WL	SDIO_DATA1	SDIO data line 1
17	SDIO_DATA2	I/O	WL	SDIO_DATA2	SDIO data line 2
18	SDIO_DATA3	I/O	WL	SDIO_DATA3	SDIO data line 3
19	GND	-	-	-	-
20	SDIO_CLK	I	WL	SDIO_CLK	SDIO clock input
21	GND	-	-	-	-
22	VBAT_LDO	I	-	LDO_VDDBAT5V	Power supply
23	VBAT_SR	I	-	SR_VDDBAT5V	Power supply
24	SR_PVSS	-	-	-	Connect to GND
25	VIN_LDO	I	-	LDO_VDD1P5	LDO input
26	SR_PVSS	-	-	-	Connect to GND
27					
28	SR_VLX	O	-	SR_VLX	CBuck switching regulator output.
29	GND	-	-	-	-
30	LPO_IN	I	-	LPO_IN	External Sleep clock input(32.768kHz)
31	GPIO_7	I/O	WL	GPIO_7	Strapping option for SDIO I/F voltage 1=1.8V (NC) 0=3.3V (Pull down with 10k ohm resister)
32	BT_PCM_IN	I	BT	BT_PCM_IN	PCM data input or SLIMbus transport sensing.

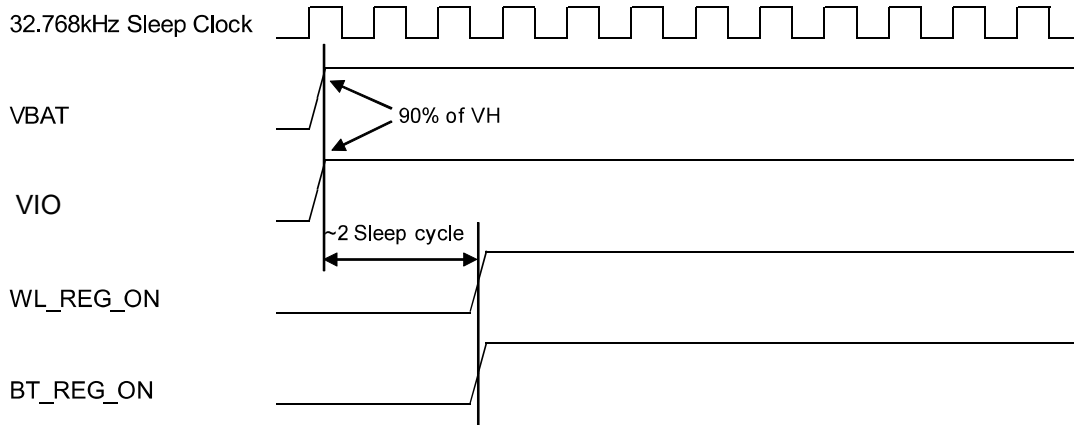
33	BT_PCM_SYNC	I/O	BT	BT_PCM_SYNC	PCM sync; can be master(output) or slave(input), or SLIMbus data.
34	BT_PCM_OUT	O	BT	BT_PCM_OUT	PCM data output
35	BT_PCM_CLK	I/O	BT	BT_PCM_CLK	PCM or SLIMbus clock; can be master(output) or slave(input).
36	I2S_DO	I/O	BT	BT_I2S_DO	I2S data output
37	I2S_CLK	I/O	BT	BT_I2S_CLK	I2S clock, can be master (output) or slave (input).
38	I2S_WS	I/O	BT	BT_I2S_WS	I2S WS; can be master (output) or slave (input).
39	GND	-	-	-	-
40	BT_DEV_WAKE	I	BT	BT_DEV_WAKE	Bluetooth DEV_WAKE
41	BT_HOST_WAKE	O	BT	BT_HOST_WAKE	Bluetooth HOST_WAKE
42	I2S_DI	I/O	BT	BT_I2S_DI	I2S data input
43	NC	-	-	-	-
44	GND	-	-	-	-
45	BT_UART_RXD	I	BT	BT_UART_RXD	UART serial input. Serial data input for the HCI UART interface.
46	BT_UART_TXD	O	BT	BT_UART_TXD	UART serial output. Serial data output for the HCI UART interface.
47	BT_UART_RTS_N	O	BT	BT_UART_RTS_N	UART request – to - send. Active - low request - to-send signal for the HCI UART interface.
48	BT_UART_CTS_N	I	BT	BT_UART_CTS_N	UART clear – to - send. Active - low clear – to - send signal for the HCI UART interface.
49	GND	-	-	-	-
50	ANT	I/O	-	-	-
51	GND	-	-	-	-
52	GND	-	-	-	-
53	GND	-	-	-	-
54	NC	-	-	-	-
55	GND	-	-	-	-
56	GND	-	-	-	-
57	JTAG_SEL	I/O	-	JTAG_SEL	JTAG select. This pin must be connected to ground if the JTAG/SWD interface is not used. It must be high to select SWD OR JTAG. When JTAG_SEL=1: •GPIO_2 is TCK/SWCLK •GPIO_3 is TMS/SWDIO •GPIO_4 is TDIO •GPIO_5 is TDO •GPIO_6 is TRST_L
58	GND	-	-	-	-
59	GND	-	-	-	-
60	GND	-	-	-	-
61	GND	-	-	-	-
62	BT_GPIO_4	I/O	BT	BT_GPIO_4	Bluetooth general-purpose I/O.
63	BT_GPIO_3	I/O	BT	BT_GPIO_3	Bluetooth general-purpose I/O.
64	BT_GPIO_2	I/O	BT	BT_GPIO_2	Bluetooth general-purpose I/O.
65	BT_GPIO_5	I/O	BT	BT_GPIO_5	Bluetooth general-purpose I/O.
66-72	GND	-	-	-	-

8. POWER ON SEQUENCE

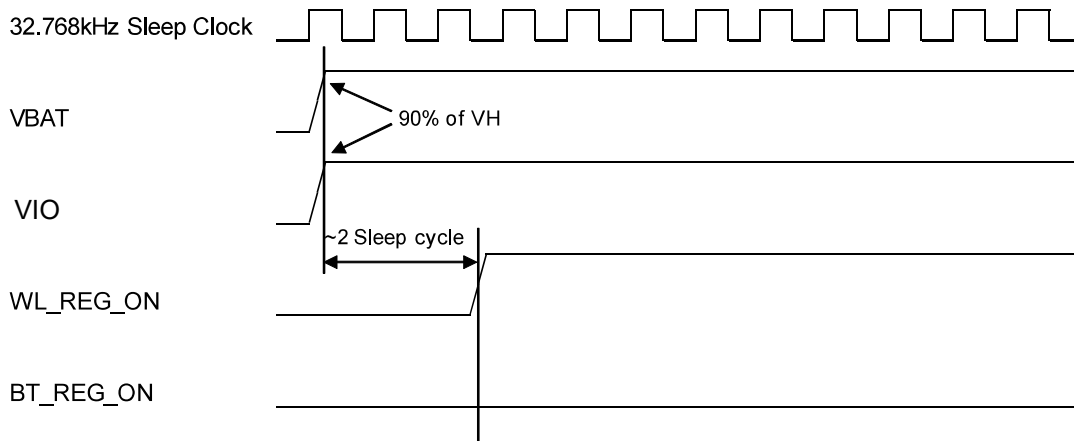
-VBAT should not rise 10%-90% faster than 40 microsecond.

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

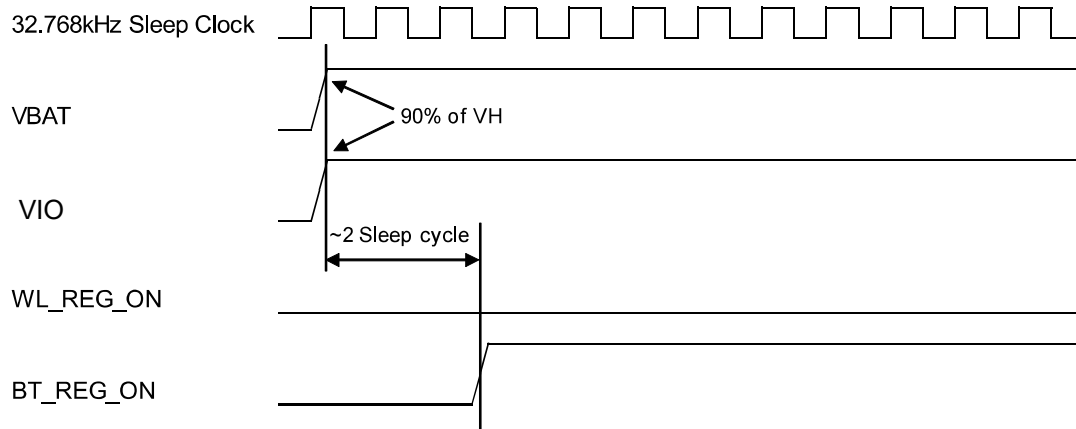
8.1. Power On Sequence for WLAN ON and BT ON



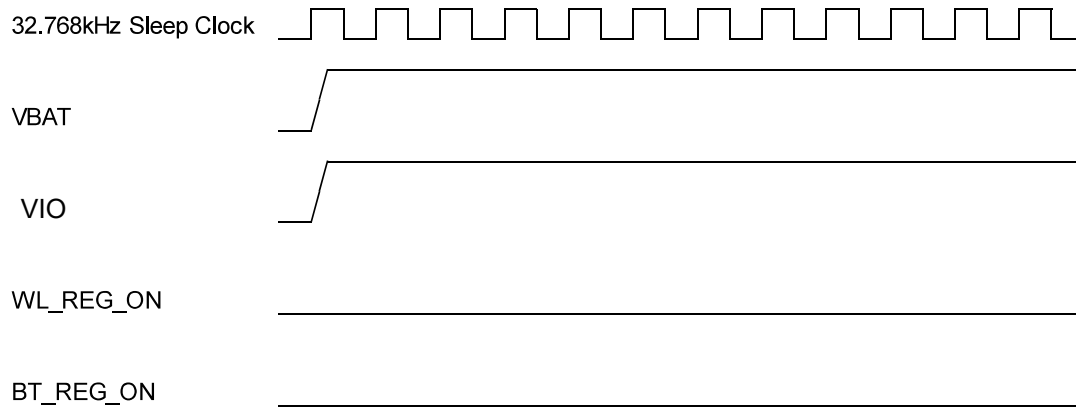
8.2. Power On Sequence for WLAN ON and BT Off



8.3. Power On Sequence for WLAN OFF and BT ON



8.4. Power On Sequence for WLAN OFF and BT OFF

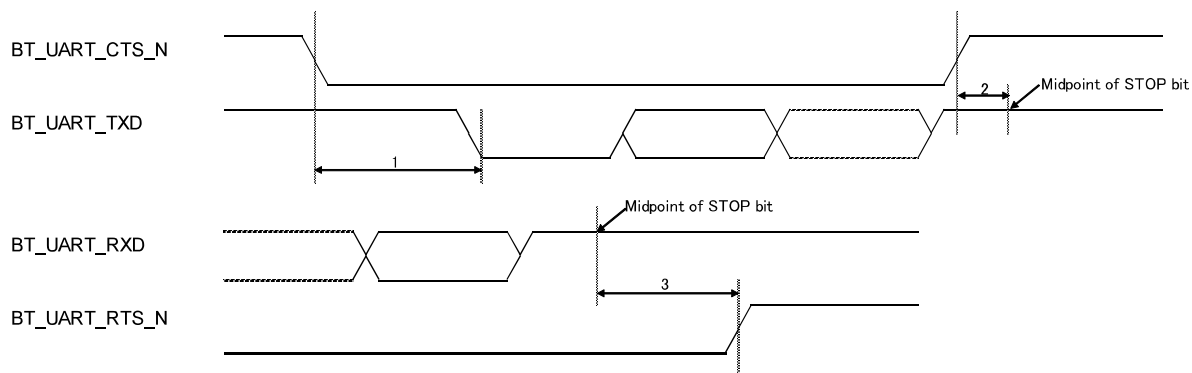


9. Digital I/O Requirements

Digital I/O Pins	Sym	min.	typ.	max.	unit
For VIO=1.8V:					
Input high voltage	VIH	0.65xVIO	-	-	V
Input low voltage	VIL	-	-	0.35xVIO	V
Output high voltage@2mA	VOH	VIO-0.45	-	-	V
Output low voltage@2mA	VOL	-	-	0.45	V
For VIO=3.3V:					
Input high voltage	VIH	2.00	-	-	V
Input low voltage	VIL	-	-	0.80	V
Output high voltage@2mA	VOH	VIO-0.4	-	-	V
Output low voltage@2mA	VOL	-	-	0.40	V

10. INTERFACE TIMING AND AC CHARACTERISTICS

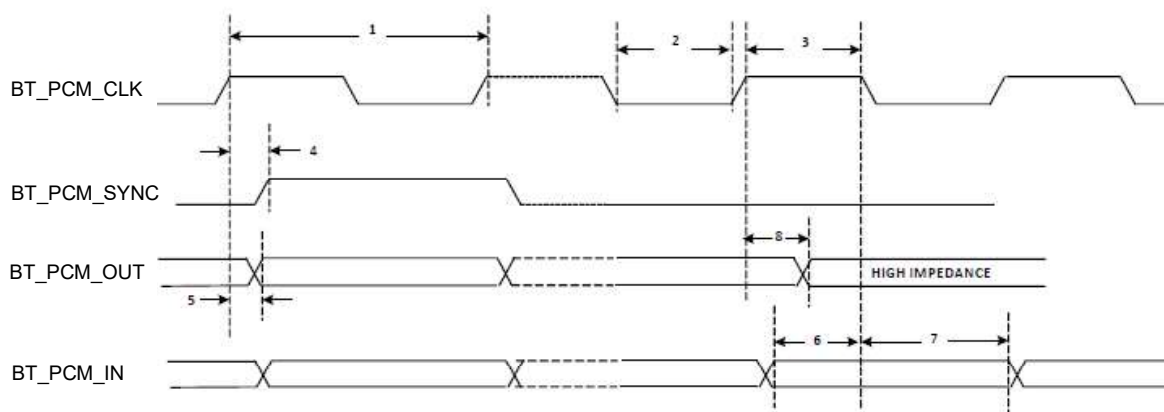
10.1. Bluetooth UART Timing



Reference	Description	Min	Typ	Max	Unit
1	Delay time, BT_UART_CTS_N low to BT_UART_TXD valid	-	-	1.5	Bit periods
2	Setup time, BT_UART_CTS_N high before midpoint of stop bit	-	-	0.5	Bit periods
3	Delay time, midpoint of stop bit to BT_UART_RTS_N high	-	-	0.5	Bit periods

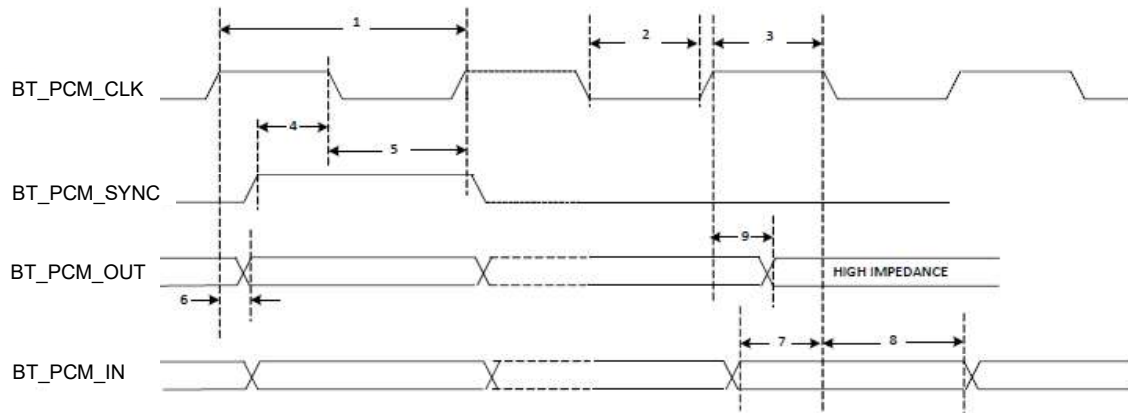
10.2. Bluetooth PCM Interface Timing

10.2.1. Short Frame Sync, Master Mode



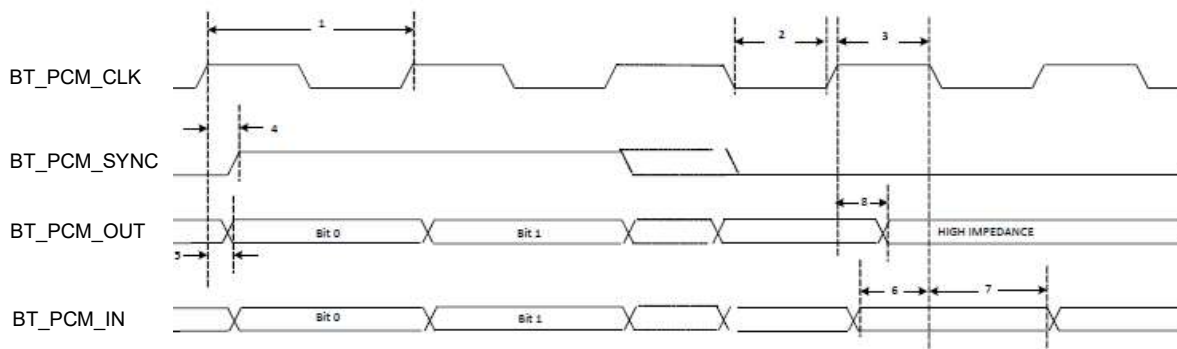
Reference	Description	Min	Typ	Max	Unit
1	PCM bit clock frequency	-	-	12	MHz
2	PCM bit clock High	41	-	-	ns
3	PCM bit clock Low	41	-	-	ns
4	BT_PCM_SYNC delay	0	-	25	ns
5	BT_PCM_OUT delay	0	-	25	ns
6	BT_PCM_IN setup	8	-	-	ns
7	BT_PCM_IN hold	8	-	-	ns
8	Delay from rising edge of BT_PCM_CLK during last bit period to BT_PCM_OUT becoming high impedance	0	-	25	ns

10.2.2. Short Frame Sync, Slave Mode



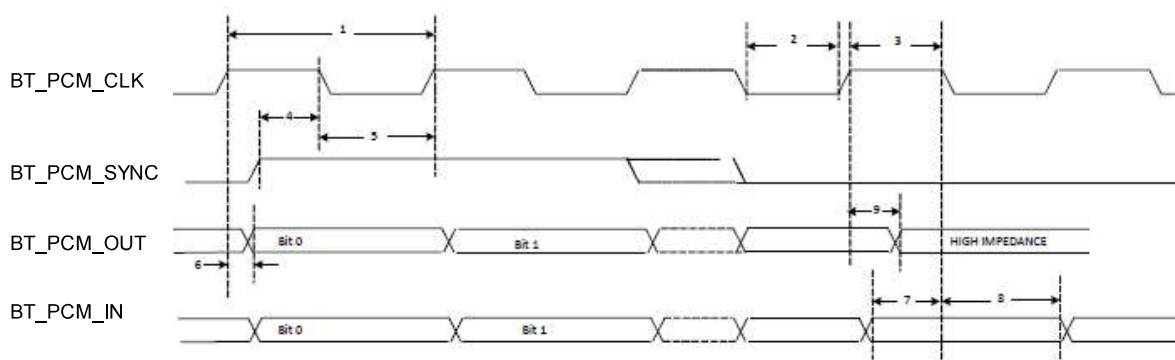
Reference	Description	Min	Typ	Max	Unit
1	PCM bit clock frequency	-	-	12	MHz
2	PCM bit clock High	41	-	-	ns
3	PCM bit clock Low	41	-	-	ns
4	BT_PCM_SYNC setup	8	-	-	ns
5	BT_PCM_SYNC hold	8	-	-	ns
6	BT_PCM_OUT delay	0	-	25	ns
7	BT_PCM_IN setup	8	-	-	ns
8	BT_PCM_IN hold	8	-	-	ns
9	Delay from rising edge of BT_PCM_CLK during last bit period to BT_PCM_OUT becoming high impedance	0	-	25	ns

10.2.3. Long Frame Sync, Master Mode



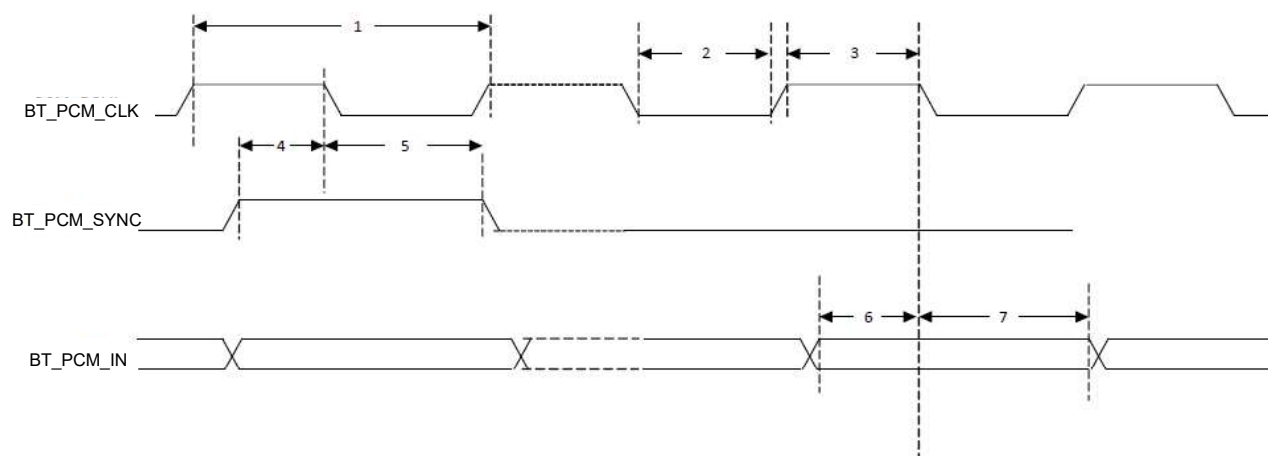
Reference	Description	Min	Typ	Max	Unit
1	PCM bit clock frequency	-	-	12	MHz
2	PCM bit clock High	41	-	-	ns
3	PCM bit clock Low	41	-	-	ns
4	BT_PCM_SYNC delay	0	-	25	ns
5	BT_PCM_OUT delay	0	-	25	ns
6	BT_PCM_IN setup	8	-	-	ns
7	BT_PCM_IN hold	8	-	-	ns
8	Delay from rising edge of BT_PCM_CLK during last bit period to BT_PCM_OUT becoming high impedance	0	-	25	ns

10.2.4. Long Frame Sync, Slave Mode



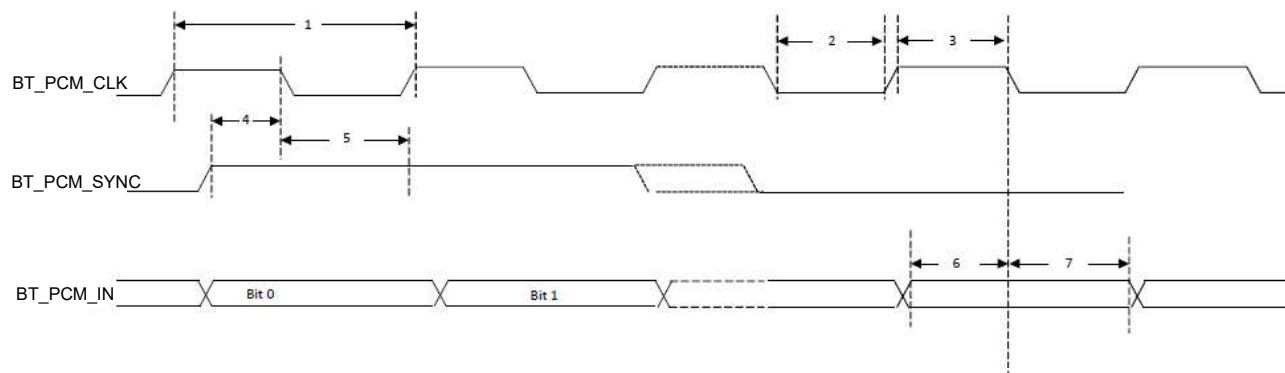
Reference	Description	Min	Typ	Max	Unit
1	PCM bit clock frequency	-	-	12	MHz
2	PCM bit clock High	41	-	-	ns
3	PCM bit clock Low	41	-	-	ns
4	BT_PCM_SYNC setup	8	-	-	ns
5	BT_PCM_SYNC hold	8	-	-	ns
6	BT_PCM_OUT delay	0	-	25	ns
7	BT_PCM_IN setup	8	-	-	ns
8	BT_PCM_IN hold	8	-	-	ns
9	Delay from rising edge of BT_PCM_CLK during last bit period to BT_PCM_OUT becoming high impedance	0	-	25	ns

10.2.5. Short Frame Sync. Burst Mode



Reference	Description	Min	Typ	Max	Unit
1	PCM bit clock frequency	-	-	24	MHz
2	PCM bit clock Low	20.8	-	-	ns
3	PCM bit clock High	20.8	-	-	ns
4	BT_PCM_SYNC setup	8	-	-	ns
5	BT_PCM_SYNC hold	8	-	-	ns
6	BT_PCM_IN setup	8	-	-	ns
7	BT_PCM_IN hold	8	-	-	ns

10.2.6. Long Frame Sync, Burst Mode



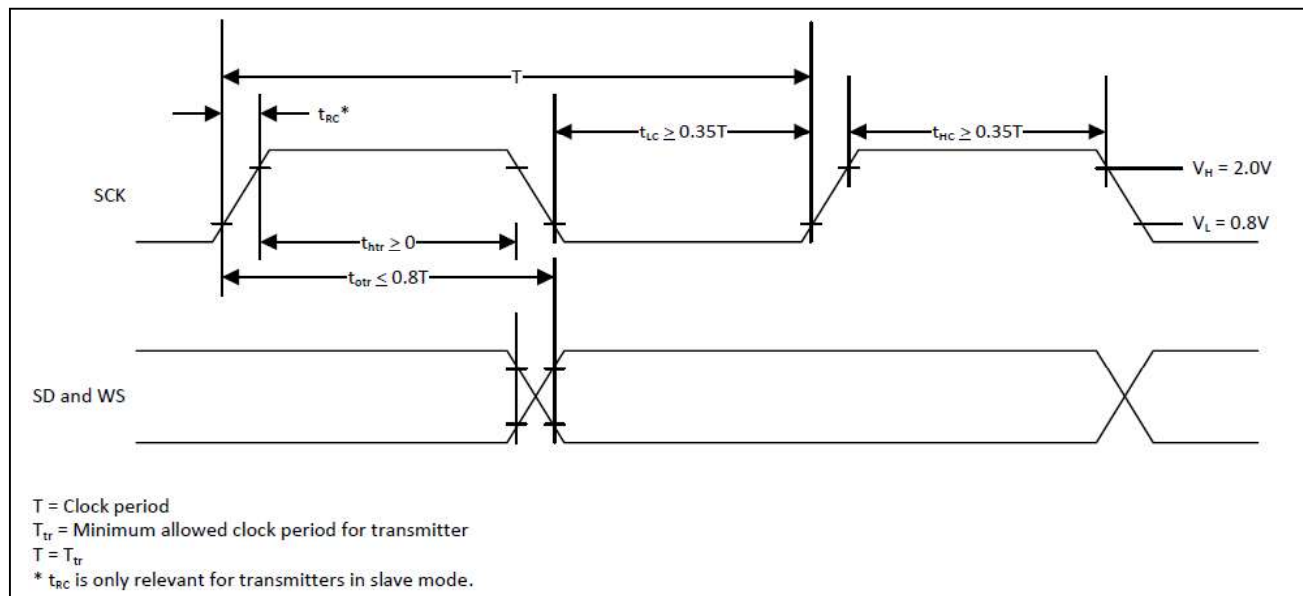
Reference	Description	Min	Typ	Max	Unit
1	PCM bit clock frequency	-	-	24	MHz
2	PCM bit clock Low	20.8	-	-	ns
3	PCM bit clock High	20.8	-	-	ns
4	BT_PCM_SYNC setup	8	-	-	ns
5	BT_PCM_SYNC hold	8	-	-	ns
6	BT_PCM_IN setup	8	-	-	ns
7	BT_PCM_IN hold	8	-	-	ns

10.3. I²S Timing

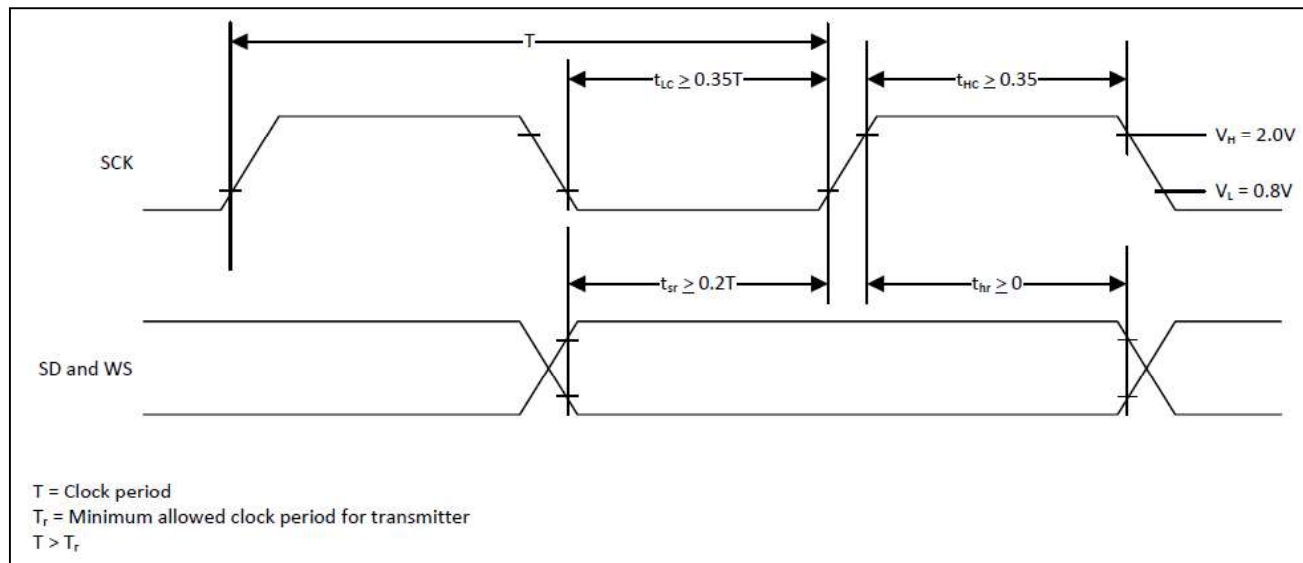
	Transmitter				Receiver				
	Lower Limit		Upper Limit		Lower Limit		Upper Limit		Notes
	Min	Max	Min	Max	Min	Max	Min	Max	
Clock Period T	T_{tr}	-	-	-	T_{tr}	-	-	-	a
Master Mode: Clock generated by transmitter or receiver									
HIGH t_{HC}	$0.35T_{tr}$	-	-	-	$0.35T_{tr}$	-	-	-	b
LOW t_{LC}	$0.35T_{tr}$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

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

10.3.1. I²S Transmitter Timing

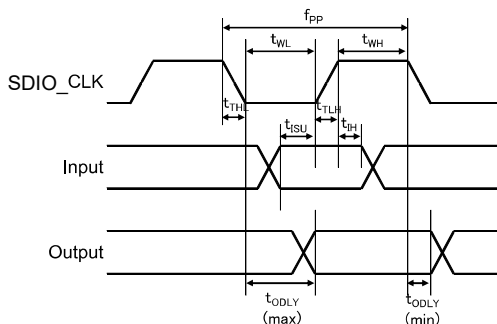


10.3.2. I²S Receiver Timing



10.5. WLAN SDIO Timing

10.5.1. SDIO Default Mode Timing



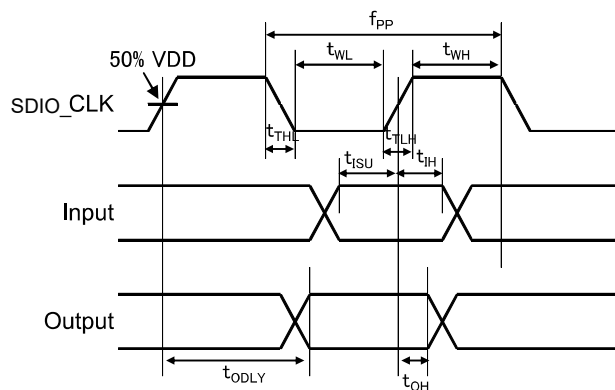
SDIO Bus Timing^(a) parameters (default Mode)

Parameter	Symbol	Min	Typ	Max	Unit
SDIO CLK (All values are referred to minimum VIH and maximum VIL ^(b))					
Frequency-Data Transfer Mode	fPP	0	-	25	MHz
Frequency-Identification Mode	fOD	0	-	400	kHz
Clock Low Time	tWL	10	-	-	ns
Clock High Time	tWH	10	-	-	ns
Clock Rise Time	tTLH	-	-	10	ns
Clock low Time	tTHL	-	-	10	ns
Inputs: CMD, DAT (referenced to CLK)					
Input Setup Time	tISU	5	-	-	ns
Input Hold Time	tIH	5	-	-	ns
Outputs: CMD, DAT (referenced to CLK)					
Output Delay time-Data Transfer Mode	tODLY	0	-	14	ns
Output Delay time-Identification Mode	tODLY	0	-	50	ns

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

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

10.5.2. SDIO High-Speed Mode Timing



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

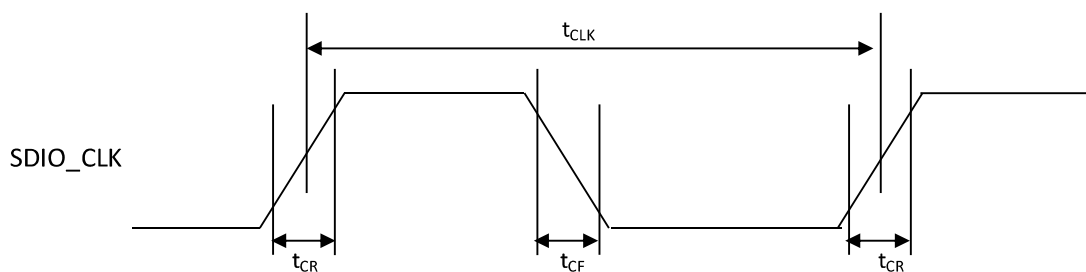
Parameter	Symbol	Min	Typ	Max	Unit
SDIO CLK (All values are referred to minimum VIH and maximum VIL ^(b))					
Frequency-Data Transfer Mode	fPP	0	-	50	MHz
Frequency-Identification Mode	fOD	0	-	400	kHz
Clock Low Time	tWL	7	-	-	ns
Clock High Time	tWH	7	-	-	ns
Clock Rise Time	tTLH	-	-	3	ns
Clock low Time	tTHL	-	-	3	ns
Inputs: CMD, DAT (referenced to CLK)					
Input Setup Time	tISU	6	-	-	ns
Input Hold Time	tIH	2	-	-	ns
Outputs: CMD, DAT (referenced to CLK)					
Output Delay time-Data Transfer Mode	tODLY	-	-	14	ns
Output Hold time	tOH	2.5	-	-	ns
Total System Capacitance (each line)	CL	-	-	40	pF

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

(b). Min (Vih) = $0.7 \cdot V_{IO}$ and max (Vil) = $0.2 \cdot V_{IO}$

10.5.3. SDIO BUS Timing Specifications in SDR Modes

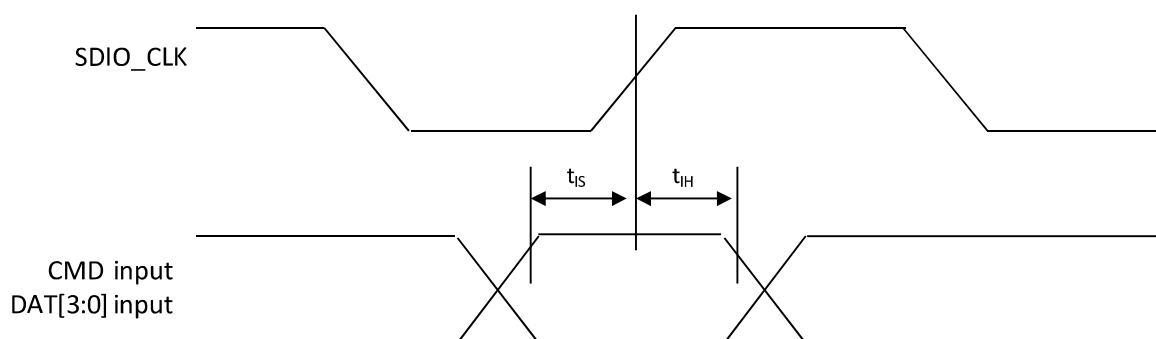
Clock Timing



SDIO Bus Clock Timing Parameters (SDR Modes)

Parameter	Symbol	Min	Max	Unit	Comments
-	tCLK	40	-	ns	SDR12 mode
		20	-	ns	SDR25 mode
		10	-	ns	SDR50 mode
		4.8	-	ns	SDR104 mode
-	tCR,tCF	-	0.2 x tCLK	ns	tCR,tCF<2.00ns(max)@100MHz,cCARD=10pF tCR,tCF<0.96ns(max)@208MHz,cCARD=10pF
Clock duty cycle	-	30	70	%	-

Card Input Timing

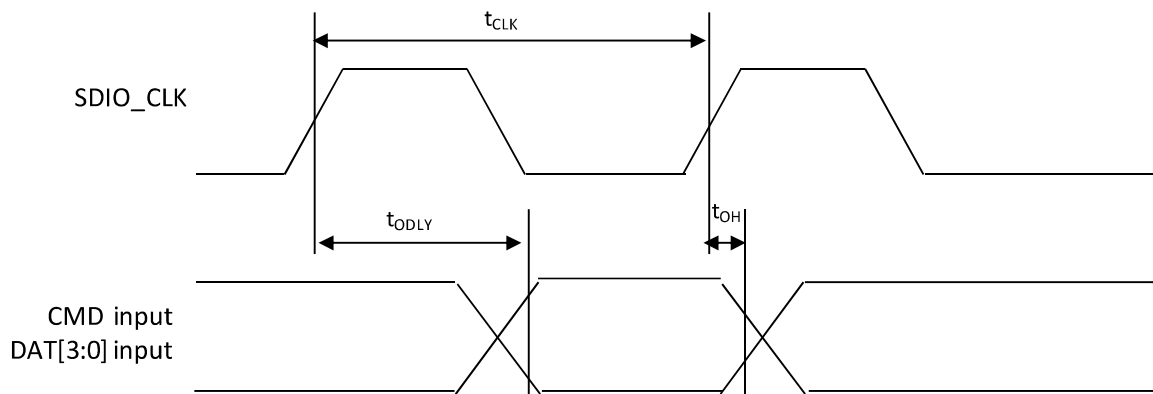


SDIO Bus Input Timing Parameters (SDR Modes)

Symbol	Min	Max	Unit	Comments
SDR104 Mode				
tIS	1.4	-	ns	cCARD = 10pF,VCT = 0.975V
tIH	0.8	-	ns	cCARD = 5pF,VCT = 0.975V
SDR50 Mode				
tIS	3.0	-	ns	cCARD = 10pF,VCT = 0.975V
tIH	0.8	-	ns	cCARD = 5pF,VCT = 0.975V

Card Output Timing

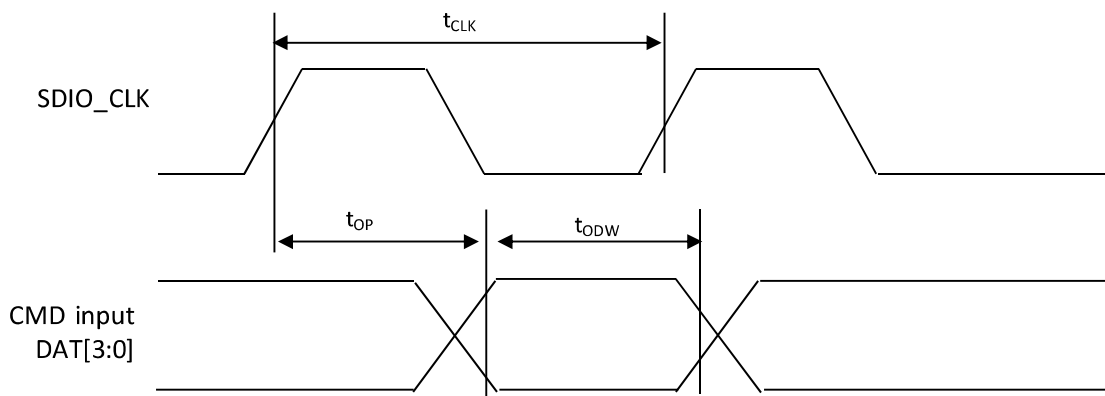
SDIO Bus Output Timing (SDR Modes up to 100MHz)



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

Symbol	Min	Max	Unit	Comments
t _{ODLY}	-	7.5	ns	t _{CLK} ≥ 10ns CL = 30pF using driver type B for SDR50
t _{ODLY}	-	14.0	ns	t _{CLK} ≥ 20ns CL = 40pF using for SDR12,SDR25
t _{OH}	1.5	-	ns	Hold time at the t _{ODLY} (min) CL = 15pF

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

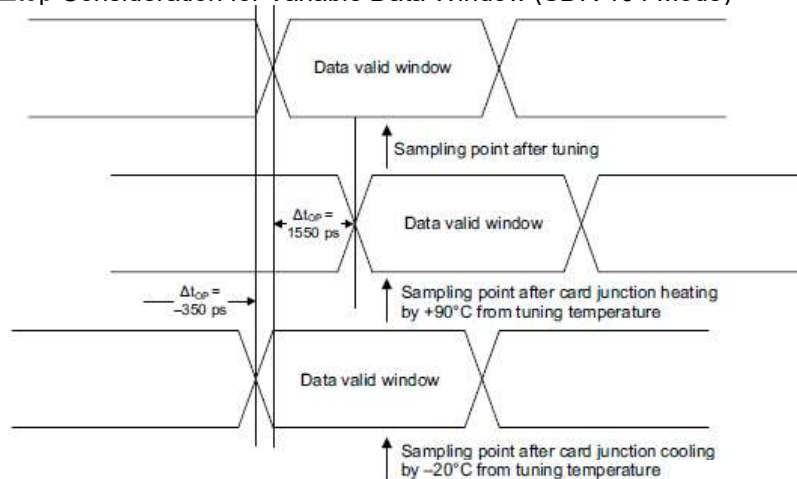


SDIO Bus Output Timing Parameters (SDR Modes 100MHz to 208MHz)

Symbol	Min	Max	Unit	Comments
t _{OP}	0	2	UI	Card output phase
Δ t _{OP}	-350	+1550	ps	Delay variation due to temp change after tuning
t _{ODW}	0.60	-	UI	t _{ODW} = 2.88ns @208MHz

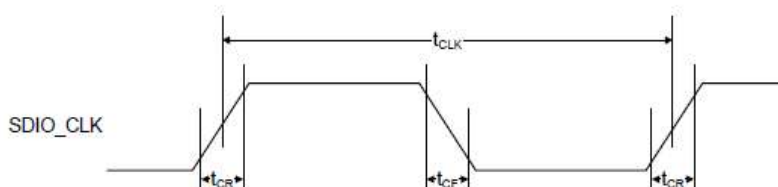
- $\Delta t_{op}=+1550\text{ps}$ for junction temperature of $\Delta t_{op}=90^{\circ}\text{C}$ during operation.
- $\Delta t_{op}=-350\text{ps}$ for junction temperature of $\Delta t_{op}=-20^{\circ}\text{C}$ during operation.
- $\Delta t_{op}=+2600\text{ps}$ for junction temperature of $\Delta t_{op}=-20^{\circ}\text{C}$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

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



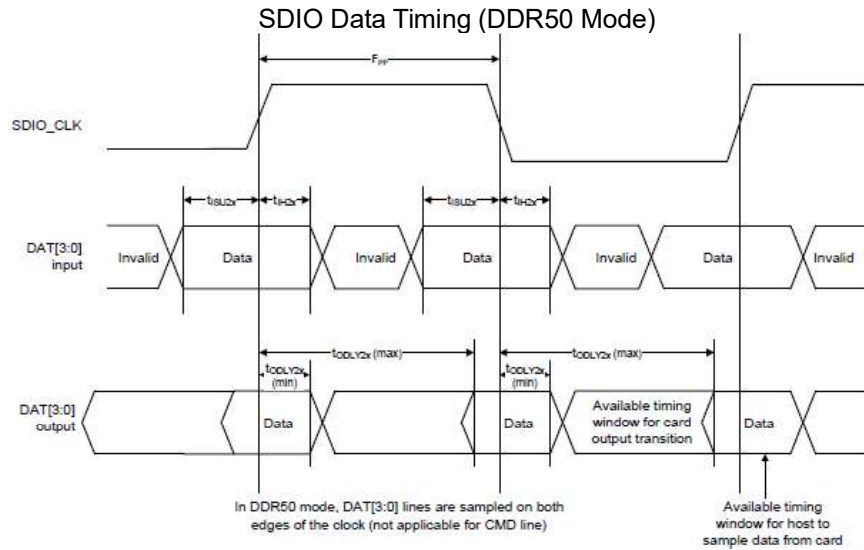
10.5.4. SDIO Timing Specifications in DDR50 Mode

SDIO Clock Timing (DDR50 Mode)



SDIO Bus Clock Timing Parameters (DDR50 Mode)

Parameter	Symbol	Min	Max	Unit	Comments
-	t_{CLK}	20	-	ns	DDr50 mode
-	t_{CR}, t_{CF}	-	$0.2 \times t_{CLK}$	ns	$t_{CR}, t_{CF} < 4.00\text{ns}(\text{max})@50\text{MHz}$, $c_{Card}=10\text{pF}$
Clock duty cycle	-	45	55	%	-



SDIO Bus Timing parameters (DDR50 Mode)

Parameter	Symbol	Min	Max	Unit	Comments
Input CMD					
Input setup time	tISU	6	-	ns	Ccard<10pF (1 card)
Input hold time	tIH	0.8	-	ns	Ccard<10pF (1 card)
Output CMD					
Output delay time	tODLY	-	13.7	ns	Ccard<30pF (1 card)
Output hold time	tOH	1.5	-	ns	Ccard<15pF (1 card)
Input DAT					
Input setup time	tISU2x	3	-	ns	Ccard<10pF (1 card)
Input hold time	tIH2x	0.8	-	ns	Ccard<10pF (1 card)
Output DAT					
Output delay time	tODLY2x	-	7.5	ns	Ccard<25pF (1 card)
Output hold time	tOH2x	1.5	-	ns	Ccard<15pF (1 card)

11. ELECTRICAL CHARACTERISTICS

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

Specification	IEEE802.11b
Mode	DSSS / CCK
Frequency	2400 - 2483.5MHz
Data rate	1, 2, 5.5, 11Mbps

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

Normal Condition : 25deg.C, VBAT=3.3V. Output power setting=17dBm, **11Mbps**.

Items	Contents			
- DC Characteristics -	Min.	Typ.	Max.	Unit
1. DC current				
1) Tx mode (1024byte, 20usec interval)*2	-	-	420	mA
2) Rx mode	-	-	80	mA
- Tx Characteristics *2 -	Min.	Typ.	Max.	Unit
2. Output Power	14.5	17	19.5	dBm
3. Spectrum Mask Margin				
1) 1st side lobes(-30dBr)	0	-	-	dB
2) 2nd side lobes(-50dBr)	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 (BW=100kHz)				
1) 30-1000MHz	-	-	-36	dBm
2) 1000-12750MHz	-	-	-30	dBm
3) 1800-1900MHz	-	-	-47	dBm
4) 5150-5300MHz	-	-	-47	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

*2: Defined when output power setting is 17dBm at Murata module antenna pad

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

Normal Condition : 25deg.C, VBAT=3.3V. Output power setting=17dBm, **1Mbps**.

Items	Contents			
- DC Characteristics -	Min.	Typ.	Max.	Unit
2. DC current				
2) Tx mode (1024byte, 20usec interval)*3	-	-	430	mA
2) Rx mode	-	-	80	mA
- Tx Characteristics *3 -	Min.	Typ.	Max.	Unit
2. Output Power	14.5	17	19.5	dBm
3. Spectrum Mask Margin				
1) 1st side lobes(-30dBr)	0	-	-	dB
2) 2nd side lobes(-50dBr)	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 (BW=100kHz)				
1) 30-1000MHz	-	-	-36	dBm
2) 1000-12750MHz	-	-	-30	dBm
3) 1800-1900MHz	-	-	-47	dBm
4) 5150-5300MHz	-	-	-47	dBm
- Rx Characteristics -	Min.	Typ.	Max.	Unit
9. Minimum Input Level (FER≤ 8%)	-	-	-76	dBm
10. Maximum Input Level (FER≤ 8%)	-4	-	-	dBm
11. Adjacent Channel Rejection (FER≤ 8%)	35	-	-	dB

*3: Defined when output power setting is 17dBm at Murata module antenna pad

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

Specification	IEEE802.11g
Mode	OFDM
Frequency	2400 - 2483.5MHz
Data rate	6, 9, 12, 18, 24, 36, 48, 54Mbps

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

Normal Condition : 25deg.C, VBAT=3.3V. Output power setting=13dBm, **54Mbps**.

Items	Contents			
- DC Characteristics -	Min.	Typ.	Max.	Unit
1. DC current				
1) Tx mode (1024byte, 20usec interval)*4	-	-	370	mA
2) Rx mode	-	-	80	mA
- Tx Characteristics*4 -	Min.	Typ.	Max.	unit
2. Output Power	10.5	13.0	15.5	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. Outband Spurious Emissions				
1) 30MHz to 1GHz (BW=100kHz)	-	-	-36	dBm
2) 1GHz to 12.75GHz (BW=100kHz)	-	-	-30	dBm
3) 1.8GHz to 1.9GHz (BW=100kHz)	-	-	-47	dBm
4) 5.15GHz to 5.3GHz (BW=100kHz)	-	-	-47	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

*4: Defined when output power setting is 13dBm at Murata module antenna pad

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

Normal Condition : 25deg.C, VBAT=3.3V. Output power setting=16dBm, **6Mbps**.

Items	Contents			
- DC Characteristics -	Min.	Typ.	Max.	Unit
1. DC current				
2) Tx mode (1024byte, 20usec interval)*5	-	-	420	mA
2) Rx mode	-	-	80	mA
- Tx Characteristics*5 -	Min.	Typ.	Max.	unit
2. Output Power	13.5	16.0	18.5	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. Outband Spurious Emissions				
1) 30MHz to 1GHz (BW=100kHz)	-	-	-36	dBm
2) 1GHz to 12.75GHz (BW=100kHz)	-	-	-30	dBm
3) 1.8GHz to 1.9GHz (BW=100kHz)	-	-	-47	dBm
4) 5.15GHz to 5.3GHz (BW=100kHz)	-	-	-47	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%)	16	-	-	dB

*5: Defined when output power setting is 16dBm at Murata module antenna pad

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

Specification	IEEE802.11n
Mode	OFDM
Frequency	2400 - 2483.5MHz
Data rate	6.5, 13, 19.5, 26, 39, 52, 58.5, 65Mbps

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

Normal Condition : 25deg.C, VBAT=3.3V. Output power setting=12dBm, **65Mbps(MCS7)**.

Items	Contents			
- DC Characteristics -	Min.	Typ.	Max.	Unit
1. DC current				
3) Tx mode (1024byte, 20usec interval)*6	-	-	360	mA
2) Rx mode	-	-	80	mA
- Tx Characteristics*6 -	Min.	Typ.	Max.	unit
2. Output Power	9.5	12.0	14.5	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)	-	-	-27	dB
5. Frequency tolerance	-20		20	ppm
6. Outband Spurious Emissions				
1) 30MHz to 1GHz (BW=100kHz)	-	-	-36	dBm
2) 1GHz to 12.75GHz (BW=100kHz)	-	-	-30	dBm
3) 1.8GHz to 1.9GHz (BW=100kHz)	-	-	-47	dBm
4) 5.15GHz to 5.3GHz (BW=100kHz)	-	-	-47	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

*6: Defined when output power setting is 12dBm at Murata module antenna pad

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

Normal Condition : 25deg.C, VBAT=3.3V. Output power setting=14dBm, **6.5Mbps(MCS0)**.

Items	Contents			
- DC Characteristics -	Min.	Typ.	Max.	Unit
1. DC current				
4) Tx mode (1024byte, 20usec interval)*7	-	-	410	mA
2) Rx mode	-	-	80	mA
- Tx Characteristics*7 -	Min.	Typ.	Max.	unit
2. Output Power	11.5	14.0	16.5	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)	-	-	-5	dB
5. Frequency tolerance	-20		20	ppm
6. Outband Spurious Emissions				
1) 30MHz to 1GHz (BW=100kHz)	-	-	-36	dBm
2) 1GHz to 12.75GHz (BW=100kHz)	-	-	-30	dBm
3) 1.8GHz to 1.9GHz (BW=100kHz)	-	-	-47	dBm
4) 5.15GHz to 5.3GHz (BW=100kHz)	-	-	-47	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%)	16	-	-	dB

*7: Defined when output power setting is 14dBm at Murata module antenna pad

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

Specification	IEEE802.11a
Mode	OFDM
Frequency	5180 - 5825MHz
Data rate	6, 9, 12, 18, 24, 36, 48, 54Mbps

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

Normal Condition : 25deg.C, VBAT=3.3V. Output power setting=13dBm, **54Mbps**.

Items	Contents			
- DC Characteristics -	Min.	Typ.	Max.	Unit
1. DC current				
5) Tx mode (1024byte, 20usec interval)*8	-	-	330	mA
2) Rx mode	-	-	100	mA
- Tx Characteristics*8 -	Min.	Typ.	Max.	unit
2. Output Power	11.0	13.0	15.0	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. Outband Spurious Emissions				
1) 30MHz to 1GHz (BW=100kHz)	-	-	-36	dBm
2) 1GHz to 12.75GHz (BW=100kHz)	-	-	-30	dBm
3) 1.8GHz to 1.9GHz (BW=100kHz)	-	-	-47	dBm
4) 5.15GHz to 5.3GHz (BW=100kHz)	-	-	-47	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

*8: Defined when output power setting is 13dBm at Murata module antenna pad

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

Normal Condition : 25deg.C, VBAT=3.3V. Output power setting=15dBm, **6Mbps**.

Items	Contents			
- DC Characteristics -	Min.	Typ.	Max.	Unit
1. DC current				
1) Tx mode (1024byte, 20usec interval)*9	-	-	360	mA
2) Rx mode	-	-	100	mA
- Tx Characteristics*9 -	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~ -40dBr)	0	-	-	dB
4) 30MHz to 33MHz (-40dBr)	0	-	-	dB
4. Constellation Error (EVM)	-	-	-5	dB
5. Frequency tolerance	-20		20	ppm
6. Outband Spurious Emissions				
1) 30MHz to 1GHz (BW=100kHz)	-	-	-36	dBm
2) 1GHz to 12.75GHz (BW=100kHz)	-	-	-30	dBm
3) 1.8GHz to 1.9GHz (BW=100kHz)	-	-	-47	dBm
4) 5.15GHz to 5.3GHz (BW=100kHz)	-	-	-47	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%)	16	-	-	dB

*9: Defined when output power setting is 15dBm at Murata module antenna pad

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

Specification	IEEE802.11n(HT40)
Mode	OFDM
Frequency	5190 - 5795MHz
Data rate	13.5, 27, 40.5, 54, 81, 108, 121.5, 135Mbps

11.5.1. High Rate Condition for IEEE802.11n(HT 40MHz) – 5GHz

Normal Condition : 25deg.C, VBAT=3.3V. Output power setting=13dBm, **135Mbps(MCS7)**.

Items	Contents			
- DC Characteristics -	min.	typ.	max.	unit
1. DC current				
1) Tx mode (1024byte, 20usec interval)*10	-	-	310	mA
2) Rx mode	-	-	110	mA
- Tx Characteristics*10 -	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)	-	-	-27	dB
5. Frequency tolerance	-20		20	ppm
- Rx Characteristics -	min.	typ.	max.	unit
6. Minimum Input Level (PER ≤ 10%)	-	-	-61	dBm
7. Maximum Input Level (PER ≤ 10%)	-30	-	-	dBm
7. Adjacent Channel Rejection (PER ≤ 10%)	-2	-	-	dB

*10: Defined when output power setting is 13.0dBm at Murata module antenna pad

11.5.2. Low Rate Condition for IEEE802.11n(HT 40MHz) – 5GHz

Normal Condition : 25deg.C, VBAT=3.3V. Output power setting=15dBm, **13.5Mbps(MCS0)**.

Items	Contents			
- DC Characteristics -	min.	typ.	max.	unit
1. DC current				
2) Tx mode (1024byte, 20usec interval)*11	-	-	370	mA
2) Rx mode	-	-	110	mA
- Tx Characteristics*11 -	min.	typ.	max.	unit
2. Output Power	13.0	15.0	17.0	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)	-	-	-5	dB
5. Frequency tolerance	-20		20	ppm
- Rx Characteristics -	min.	typ.	max.	unit
6. Minimum Input Level (PER ≤ 10%)	-	-	-79	dBm
7. Maximum Input Level (PER ≤ 10%)	-30	-	-	dBm
8. Adjacent Channel Rejection (PER ≤ 10%)	16	-	-	dB

*11: Defined when output power setting is 15.0dBm at Murata module antenna pad

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

Specification	IEEE802.11ac(VHT80)
Mode	OFDM
Frequency	5210 - 5775MHz
Data rate	29.3,58.5,87.8,117,175.5,234,263.3,292.5,351,390Mbps

11.6.1. High Rate Condition for IEEE802.11ac(VHT 80MHz) – 5GHz

Normal Condition : 25deg.C, VBAT=3.3V. Output power setting=10dBm, **390Mbps(MCS9)**.

- DC Characteristics -	min.	typ.	max.	unit
1. DC current				
1) Tx mode (1024byte, 20usec interval)*12	-	-	340	mA
2) Rx mode	-	-	130	mA
- Tx Characteristics*12 -	min.	typ.	max.	unit
2. Output Power	8.0	10.0	12.0	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)	-	-	-32	dB
5. Frequency tolerance	-20		20	ppm
- Rx Characteristics -	min.	typ.	max.	unit
6. Minimum Input Level (PER ≤ 10%)	-	-	-51	dBm
7. Maximum Input Level (PER ≤ 10%)	-30	-	-	dBm
8. Adjacent Channel Rejection (PER ≤ 10%)	-9	-	-	dB

*12: Defined when output power setting is 10dBm at Murata module antenna pad

11.6.2. Low Rate Condition for IEEE802.11ac(VHT 80MHz) – 5GHz

 Normal Condition : 25deg.C, VBAT=3.3V. Output power setting=12dBm, **29.3Mbps(MCS0)**.

- DC Characteristics -	min.	typ.	max.	unit
1. DC current				
2) Tx mode (1024byte, 20usec interval)*13	-	-	380	mA
2) Rx mode	-	-	130	mA
- Tx Characteristics*13 -	min.	typ.	max.	unit
2. Output Power	10.0	12.0	14.0	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)	-	-	-5	dB
5. Frequency tolerance	-20		20	ppm
- 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%)	16	-	-	dB

*13: Defined when output power setting is 12dBm at Murata module antenna pad

11.7. DC/RF Characteristics for Bluetooth

Normal conditions : 25 deg.C, VBAT = 3.3V

Items		Contents			
Bluetooth specification (power class)		Version 5.0 (Class1)			
Channel frequency (spacing)		2402 to 2480 MHz (1MHz)			
Transmitter		Min.	Typ.	Max.	Unit
Output Power	BDR	3.0		10.5	dBm
	EDR	-1.5		6.0	dBm
Frequency range		2400	-	2483.5	MHz
20dB bandwidth		-		1	MHz
Modulation characteristics					
(a) Modulation Δf_{1avg}		140	-	175	kHz
(b) Modulation Δf_{2max}		115		-	kHz
(c) Modulation $\Delta f_{2avg} / \Delta f_{1avg}$		0.8	-	-	
Carrier Frequency Drift					
(a) 1slot		-25	-	+25	kHz
(b) 3slot / 5slot		-40	-	+40	kHz
(c) Maximum drift rate		-20	-	+20	kHz/50us
EDR Relative Power		-4	-	+1	dB
EDR Carrier Frequency Stability and Modulation Accuracy					
(a) ω_i		-75	-	+75	kHz
(b) $\omega_i + \omega_o$		-75	-	+75	kHz
(c) ω_o		-10	-	+10	kHz
(d) RMS DEVM ($\pi/4$ DQPSK)		-	-	20	%
(e) Peak DEVM ($\pi/4$ DQPSK)		-	-	35	%
(f) 99% DEVM ($\pi/4$ DQPSK)		-	-	30	%
(g) RMS DEVM (8DPSK)		-	-	13	%
(h) Peak DEVM (8DPSK)		-	-	25	%
(i) 99% DEVM (8DPSK)		-	-	20	%
Spurious Emissions (BW=100kHz)					
(a) $10\text{MHz} \leq f < 2387\text{MHz}$		-	-	-36	dBm
(b) $2387\text{MHz} \leq f < 2400\text{MHz}$		-	-	-30	dBm
(c) $2483.5\text{MHz} < f \leq 2496.5\text{MHz}$		-	-	-47	dBm
(d) $2496.5\text{MHz} < f \leq 8\text{GHz}$		-	-	-47	dBm
Receiver		Min.	Typ.	Max.	Unit
Sensitivity (BER<0.1%)		-	-	-80	dBm
Maximum Input Level (BER<0.1%)		-20	-	-	dBm
EDR Sensitivity (BER<0.007%)					
(a) 8DPSK		-	-	-77	dBm

11.8. DC/RF Characteristics for Bluetooth (LE)

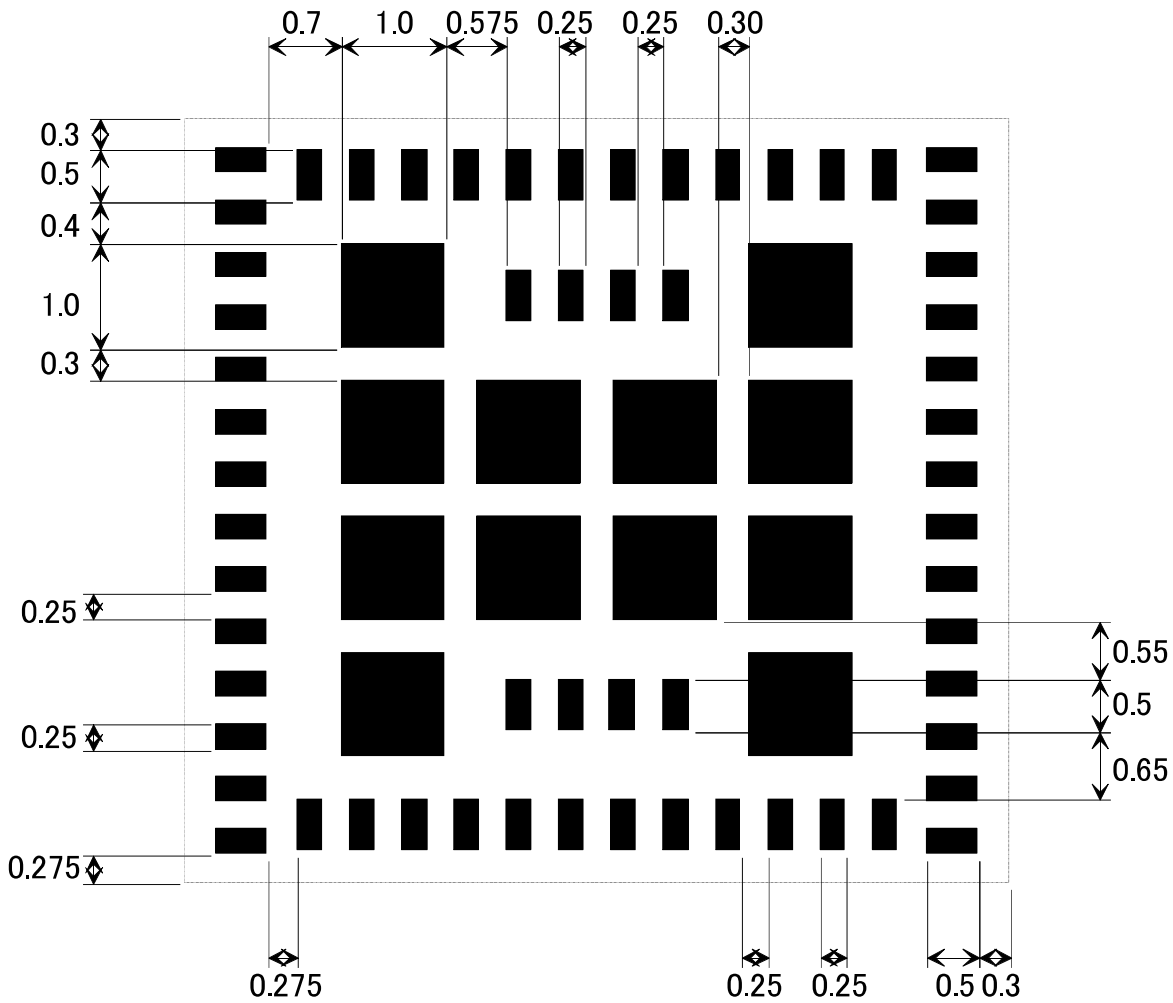
Normal conditions : 25 deg.C, VBAT = 3.3V

Items	Contents			
Bluetooth specification (power class)	Version 5.0 (LE)			
Channel frequency (spacing)	2402 to 2480 MHz (2MHz)			
Number of RF Channel	40			
Item / Condition	Min.	Typ.	Max.	Unit
Center Frequency	2402	-	2480	MHz
Channel Spacing	-	2	-	MHz
Number of RF channel	-	40	-	-
Output power	1.5	-	9.0	dBm
Modulation Characteristics				
1) $\Delta f_{1\text{avg}}$	225	-	275	kHz
2) $\Delta f_{2\text{max}}$ (at 99.9%)	185	-	-	kHz
3) $\Delta f_{2\text{avg}} / \Delta f_{1\text{avg}}$	0.8	-	-	-
Carrier frequency offset and drift				
1) Frequency offset	-150	-	150	kHz
2) Frequency drift	-	-	50	kHz
3) Drift rate	-	-	20	kHz
Receiver sensitivity (PER < 30.8%)	-	-	-70	dBm
Maximum input signal level (PER < 30.8%)	-10	-	-	dBm
PER Report Integrity (-30dBm input)	50	-	65.4	%

Note

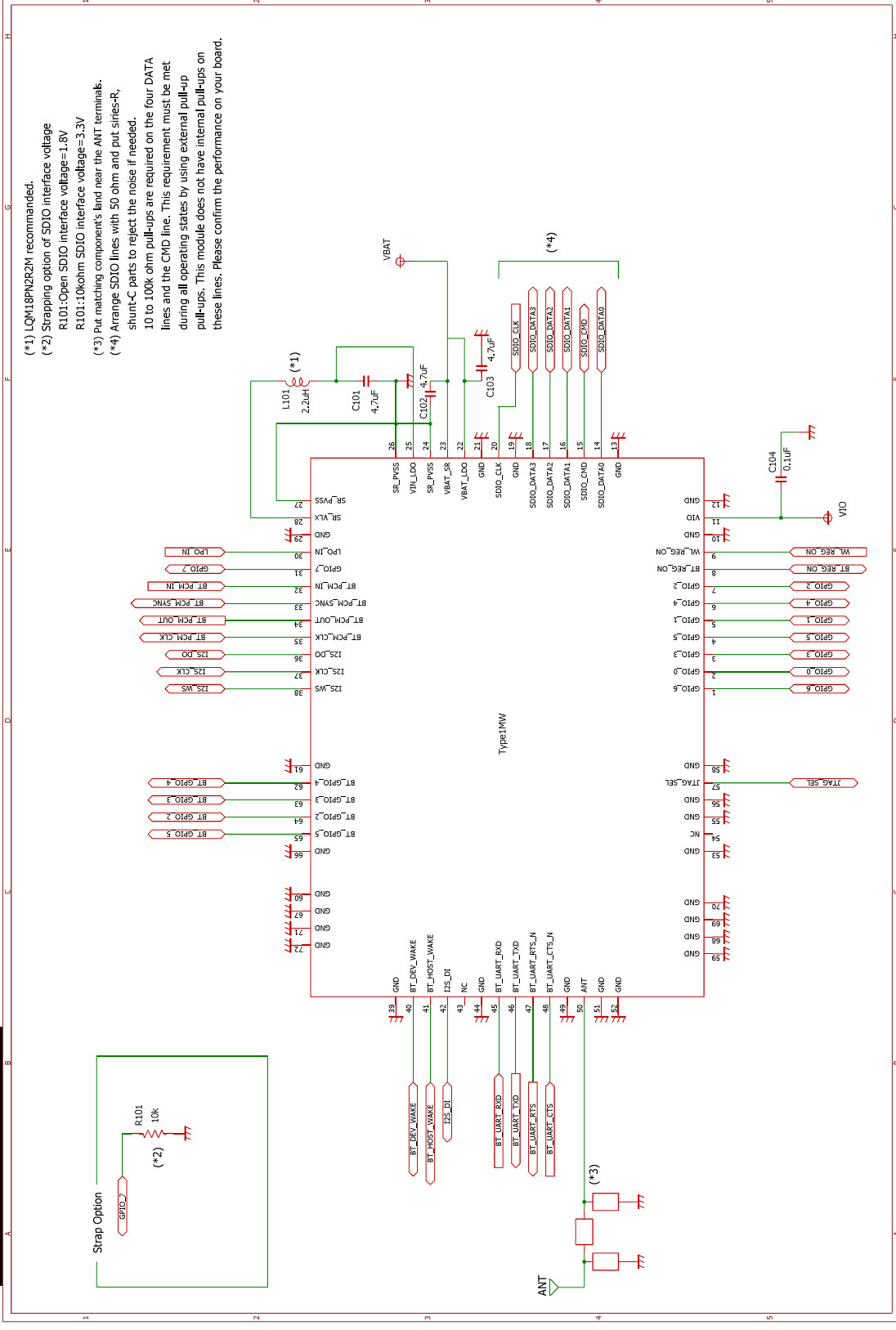
The above mentioned values have been obtained according to our own measuring methods and may very depend on the circuit, in which the component is actually incorporated. Therefore, you are kindly requested to test the performance of the component actually in your set.

12. LAND PATTERN (TOP VIEW)



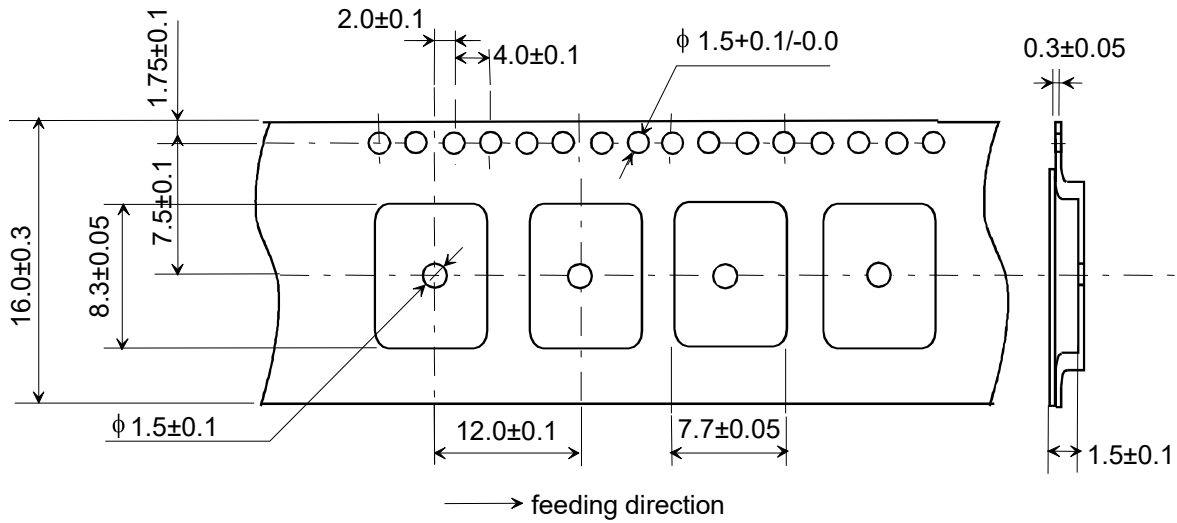
* To avoid the short-circuit between the side shielding and a solder on the module land after the reflow, please locate the module land at 0.2mm away from module outline as above figure.

13. REFERENCE CIRCUIT

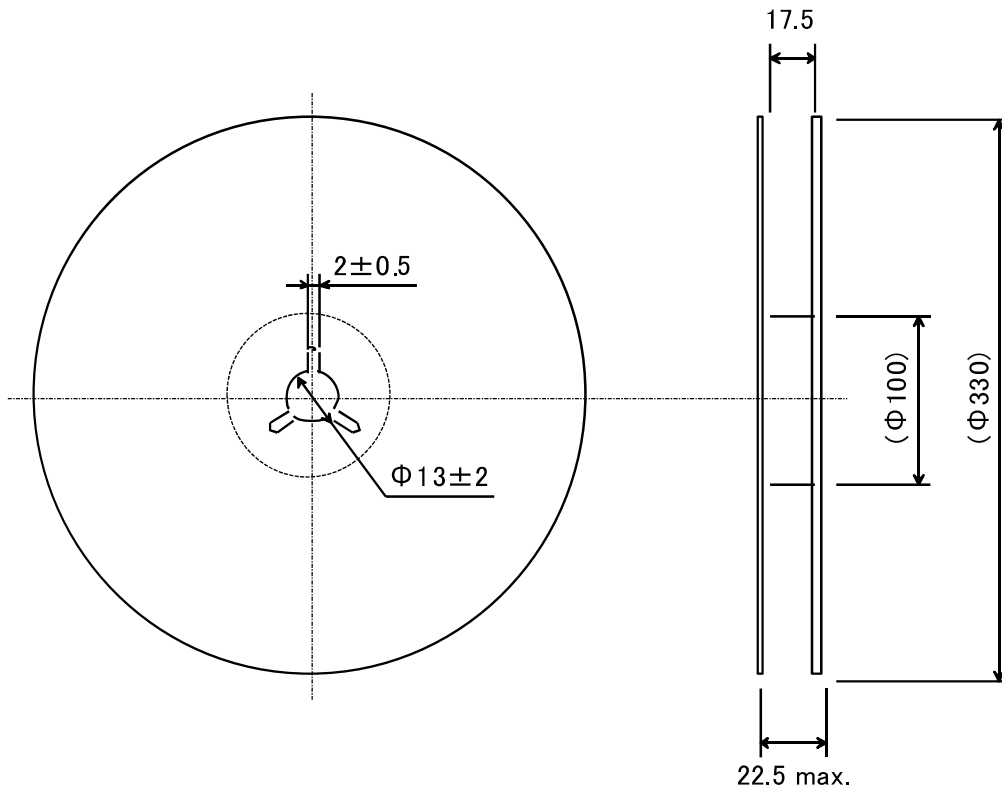


14. TAPE AND REEL PACKING

(1) Dimensions of Tape (Plastic tape)

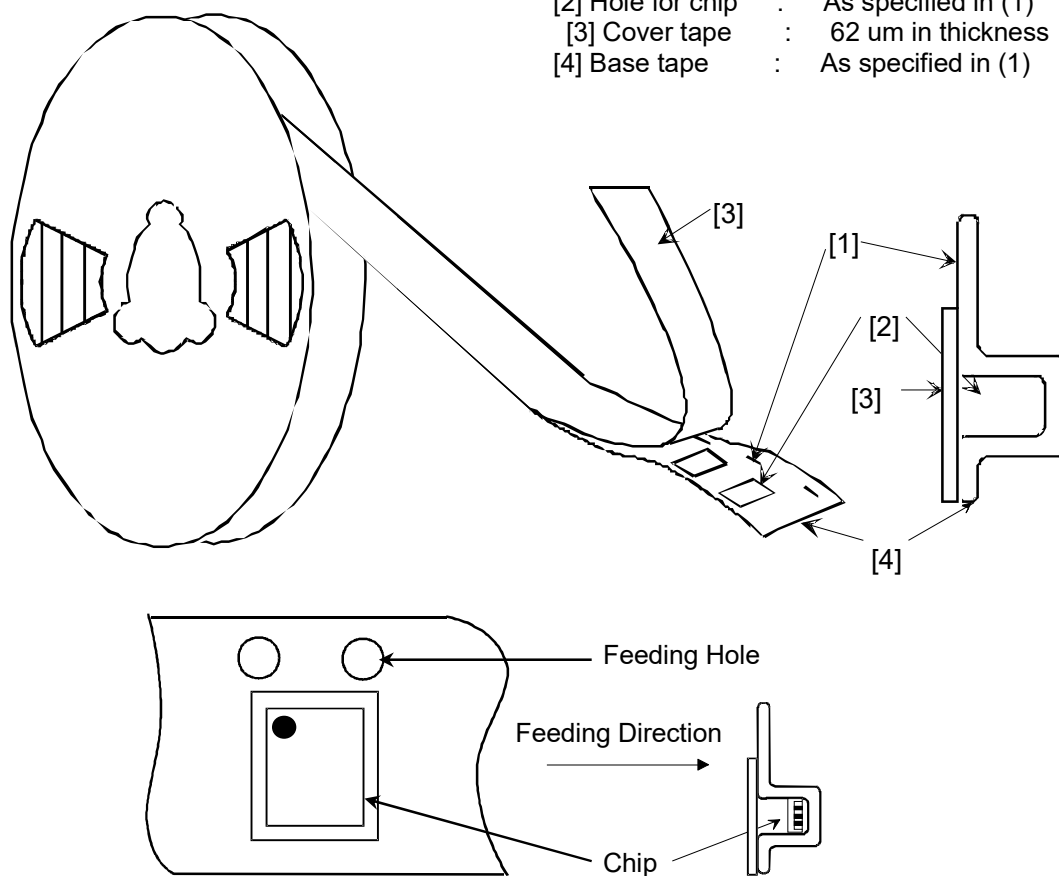


(2) Dimensions of Reel

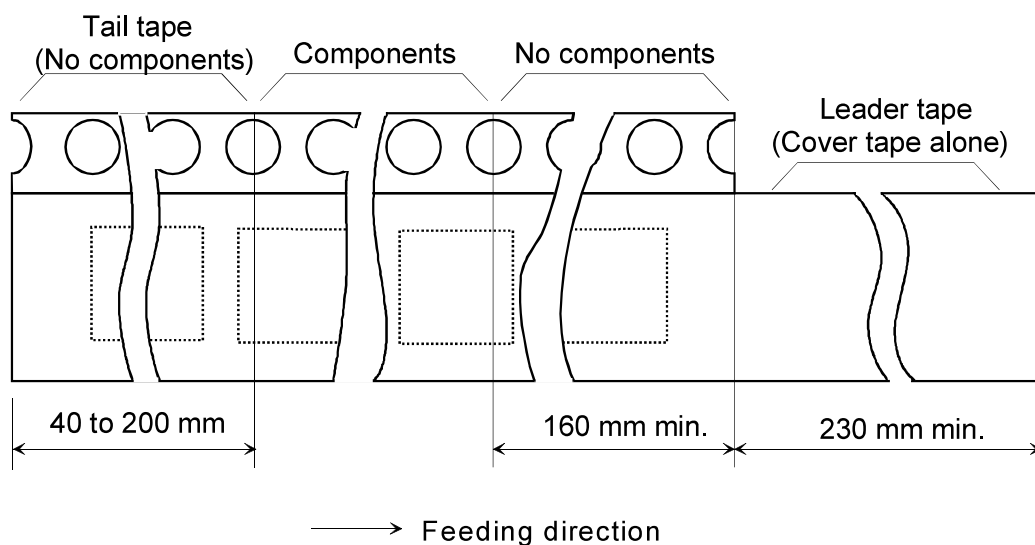


(3) Taping Diagrams

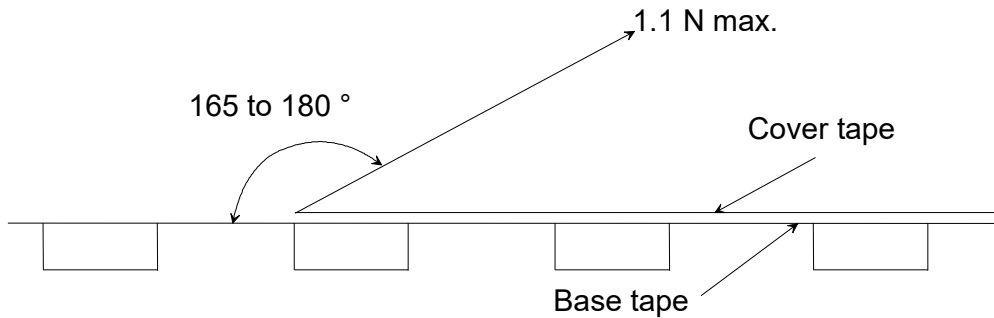
- [1] Feeding Hole : As specified in (1)
- [2] Hole for chip : As specified in (1)
- [3] Cover tape : 62 μ m in thickness
- [4] Base tape : As specified in (1)



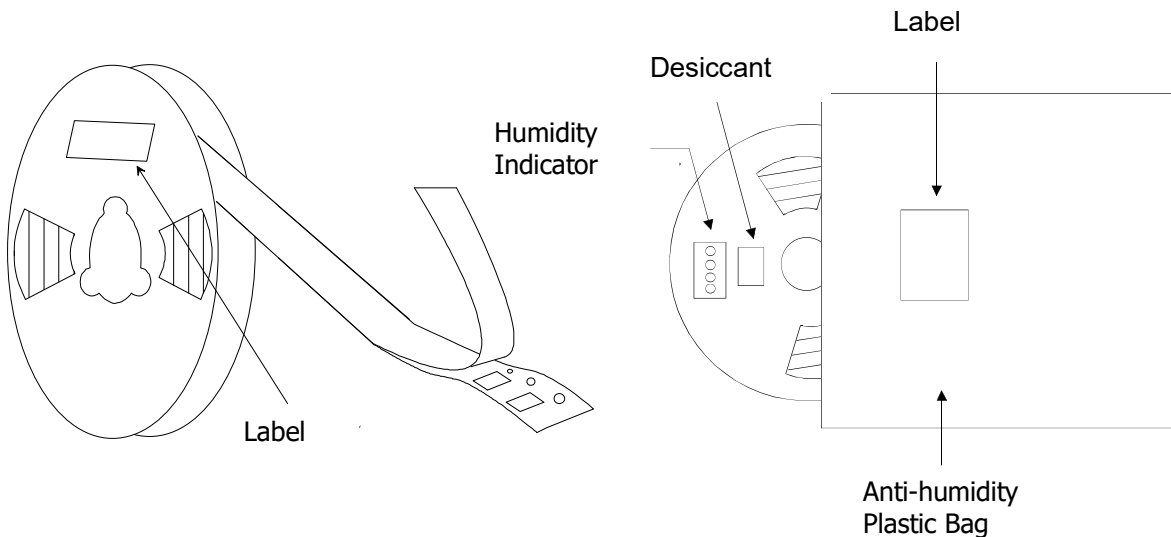
(4) Leader and Tail tape



- The tape for chips are wound clockwise, the feeding holes to the right side as the tape is pulled toward the user.
- The cover tape and base tape are not adhered at no components area for 250 mm min.
- Tear off strength against pulling of cover tape: 5 N min.
- Packaging unit: 1,000 pcs/ reel
- Material: Base tape: Plastic
Reel : Plastic
Cover tape, cavity tape and reel are made the anti-static processing.
- Peeling of force: 1.1 N max. in the direction of peeling as shown below.



- PACKAGE (Humidity proof packing)



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

15. NOTICE

15.1. Storage Conditions:

Please use this product within 6month after receipt.

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

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

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

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

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

This product is applicable to MSL3 (Based on JEDEC Standard J-STD-020)

- After the packing opened, the product shall be stored at ≤30deg.C / ≤60%RH and the product shall be used within 168hours.

- When the color of the indicator in the packing changed, the product shall be baked before soldering.

Baking condition: 125+5/-0deg.C, 24hours, 1time

The products shall be baked on the heat-resistant tray because the material (Base Tape, Reel Tape and Cover Tape) are not heat-resistant.

15.2. Handling Conditions:

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

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

15.3. 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.

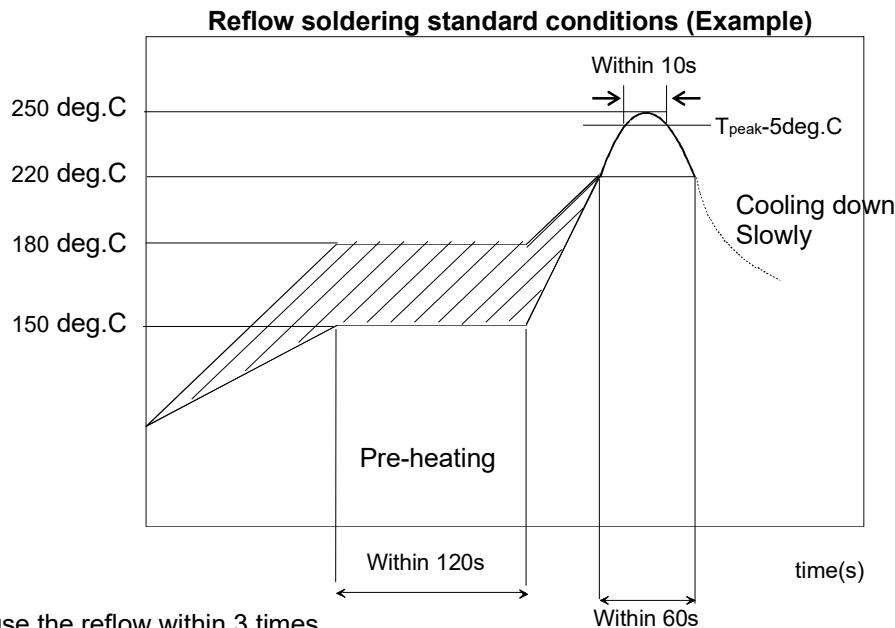
The recommended land pattern and dimensions is as Murata's standard. The characteristics of products may vary depending on the pattern drawing method, grounding method, land dimensions, land forming method of the NC terminals and the PCB material and thickness. Therefore, be sure to verify the characteristics in the actual set. When using non-standard lands, contact Murata beforehand.

15.4. 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.

15.5. 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.



Please use the reflow within 3 times.

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

15.6. 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.

15.7. Operational Environment Conditions:

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

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

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

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.

15.8. Input Power Capacity:

Products shall be used in the input power capacity as specified in this specifications.
Inform Murata beforehand, in case that the components are used beyond such input power capacity range.

16. PRECONDITION TO USE OUR PRODUCTS

PLEASE READ THIS NOTICE BEFORE USING OUR PRODUCTS.

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

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

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

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

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

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

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

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

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

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

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

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

We disclaim any liability for consequential and incidental damages.

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

Preliminary

< Specification may be changed by Murata without notice >
Murata Manufacturing Co., Ltd.

APPENDIX

1MW Installation Manual

FCC ID of this product is as follows.
 FCC ID: VPYLBEE5HY1MW

IC No. of this product is as follows.
 IC: 772C-LBEE5HY1MW

Contents

1. Theory of Operation-Channel List
2. Antenna

1. Theory of Operation-Channel List

Theory of Operation-Software Security and Channel List

Frequency of operation			Scan	Ad-hoc mode
2.4GHz	11b/g/n (HT20)	2412-2462MHz	Active	Yes
	BT	2402-2480MHz	N/A	N/A
	BLE	2402-2480MHz	N/A	N/A
W52	11a/n/ac ((V)HT20)	5180-5240MHz	Active	Yes
	11n/ac ((V)HT40)	5190-5230MHz	Active	Yes
	11ac (VHT80)	5210MHz	Active	Yes
W53	11a/n/ac ((V)HT20)	5260-5320MHz	Passive	No
	11n/ac ((V)HT40)	5270-5310MHz	Passive	No
	11ac (VHT80)	5290MHz	Passive	No
W56	11a/n/ac ((V)HT20)	5500-5720MHz *	Passive	No
	11n/ac ((V)HT40)	5510-5710MHz *	Passive	No
	11ac (VHT80)	5530-5690MHz *	Passive	No
W58	11a/n/ac ((V)HT20)	5745-5825MHz	Active	Yes
	11n/ac ((V)HT40)	5755-5795MHz	Active	Yes
	11ac (VHT80)	5775MHz	Active	Yes

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

Notes: End users cannot modify the software because F/W & driver are installed in device.

2. Antenna

■ Please perform the antenna design that followed the specifications of the antenna.

■ About the signal line between an antenna and a module

It is a 50-ohm line design.

Fine tuning of return loss etc. can be performed using a matching network.

However, it is required to check "Class1 change" and "Class2 change" which the authorities define then.

The concrete contents of a check are the following three points.

- 1) It is the same type as the antenna type of antenna specifications.
- 2) An antenna gain is lower than a gain given in antenna specifications.
- 3) The emission level is not getting worse.

■ 50-ohm line(microstrip line length)

	Antenna
Antenna type	Monopole pattern antenna
50-ohm feed line length	We test it at 0mm as a representative

LBEE5HY1MW User Manual for FCC

■ Regarding FCC modular approval of LBEE5HY1MW

Model Name: LBEE5HY1MW

FCC ID: VPYLBEE5HY1MW

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.

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

Contains Transmitter Module FCC ID: VPYLBEE5HY1MW

or

Contains FCC ID: VPYLBEE5HY1MW

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 cannot be described on the host product, it must be listed on both the host product manual and on the host product package or removable label.

● 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.

Compliance with FCC requirement 15.407(c)

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

Frequency Tolerance: ± 20 ppm

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

- 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 20cm or more away from person's body.

- 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. LBEE5HY1MW 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 V5.0 (BDR/EDR/LE)).

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.

LBEE5HY1MW User Manual for ISED

PMN: LBEE5HY1MW
HVIN: LBEE5HY1MW
IC Number: 772C-LBEE5HY1MW

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

Contains IC: 772C-LBEE5HY1MW

- 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.

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.

*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".

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-LBEE5HY1MW) 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.

: 2.4GHz	Monopole Gain: +0.1 dBi
: 5GHz	Monopole Gain: -0.4 dBi

Le présent émetteur radio (IC Number: 772C-LBEE5HY1MW) 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

: 2.4GHz	Monopole Gain: +0.1 dBi
: 5GHz	Monopole Gain: -0.4 dBi

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

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

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

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

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

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.

● 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 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.

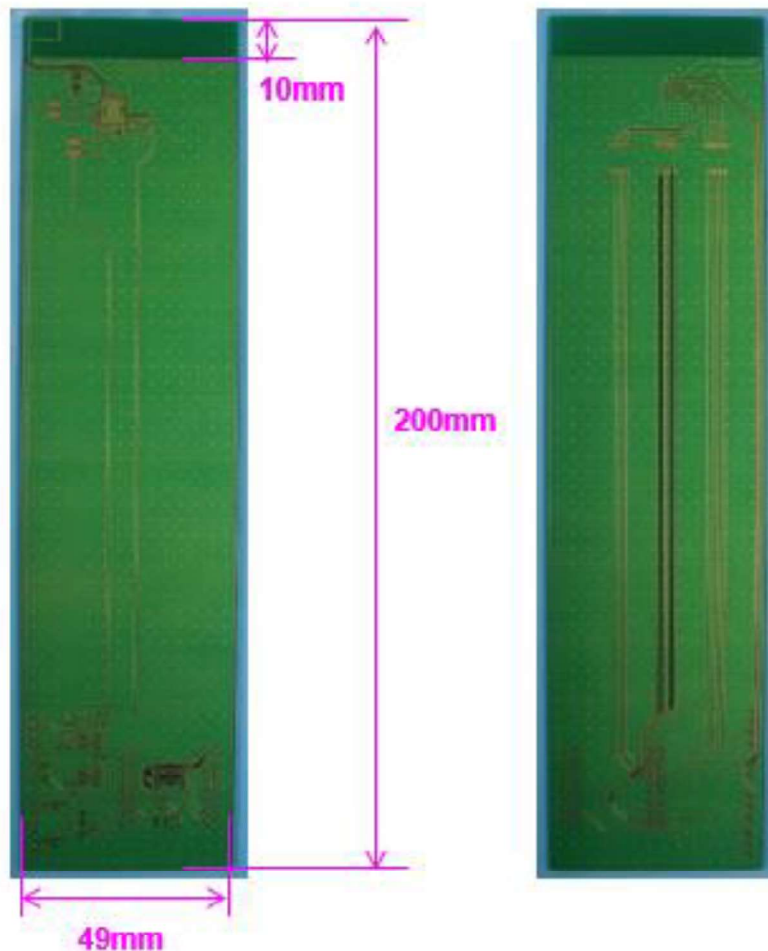
●Antenna

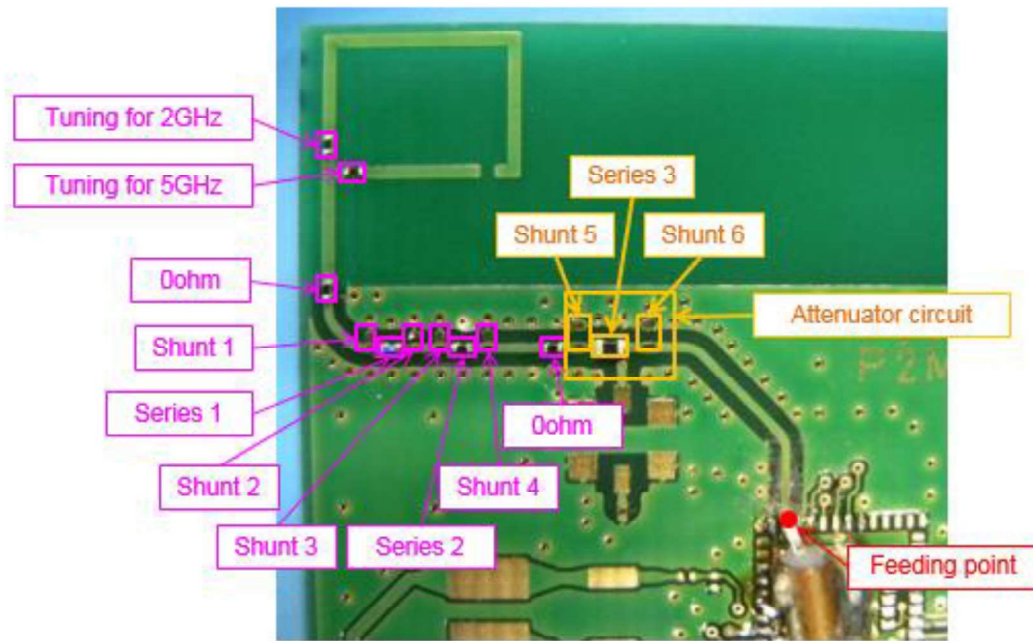
Please refer to the Antenna Specification or please contact Murata for the detail designation of how to design the Antenna trace.

Model name LBEE5HY1MW

- Antenna Model Name : Type1MW-Antenna
- Antenna type : Monopole pattern antenna
- Antenna manufacture : Murata Manufacturing Co.,Ltd.
- Antenna gain : +0.1 dBi @2442MHz
- 0.4 dBi @5150MHz
- Frequency : 2400-2483.5MHz, 5150-5850MHz

Appearance

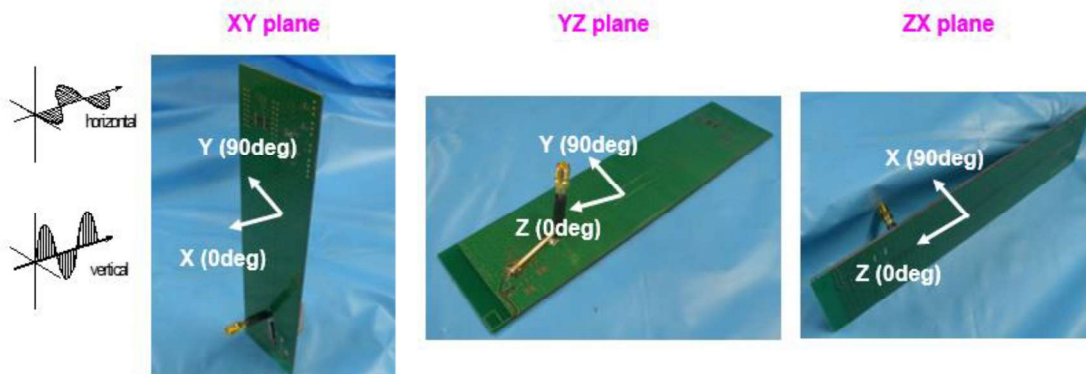


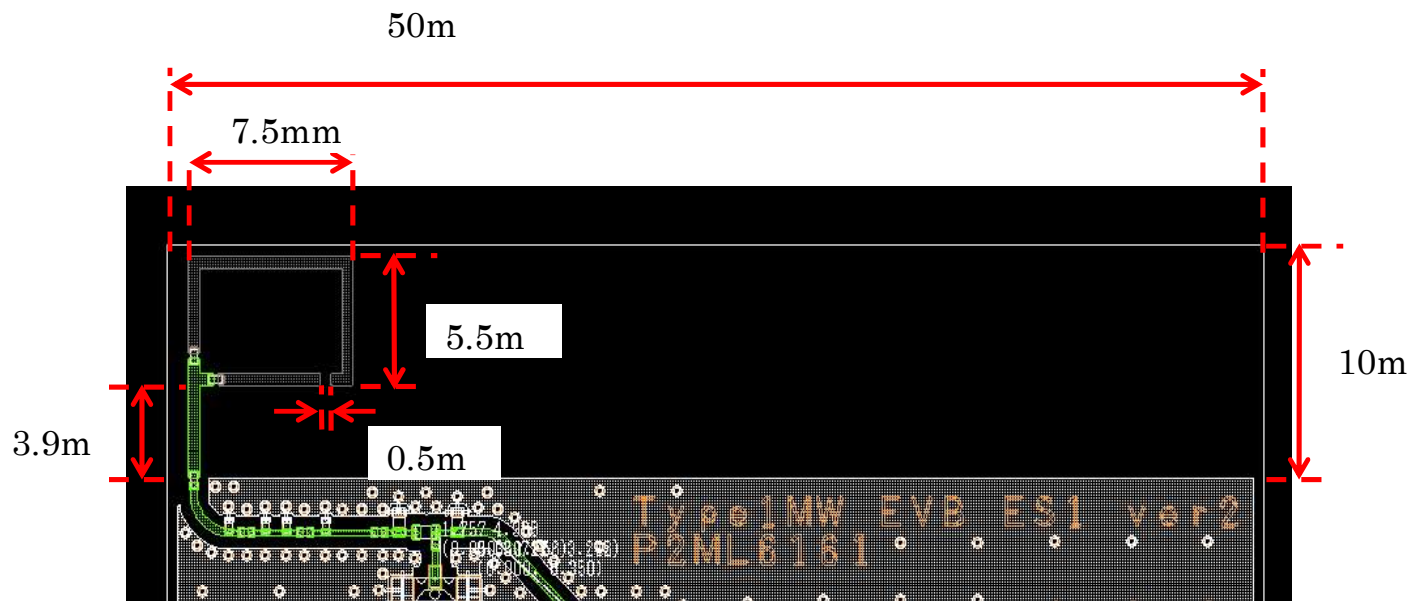
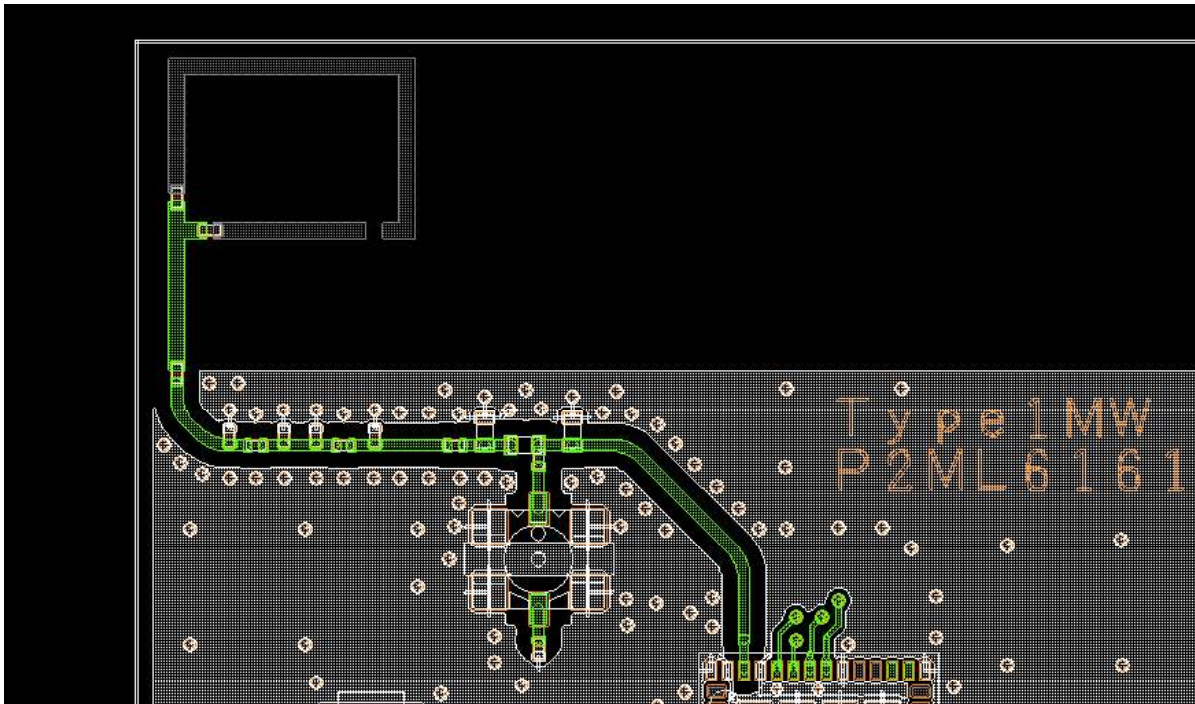


Tuning for 2GHz	Tuning for 5GHz-1	Matching circuit	Attenuator circuit
0ohm	0ohm	Shunt 1: None, Series 1: 1.4nH, Shunt 2: None, Shunt 3: None, Series 2: 0ohm, Shunt 4: 270ohm	Shunt 5: 270ohm, Series 3: 20ohm, Shunt 6: 270ohm

*1005 size component is applied to attenuator circuit

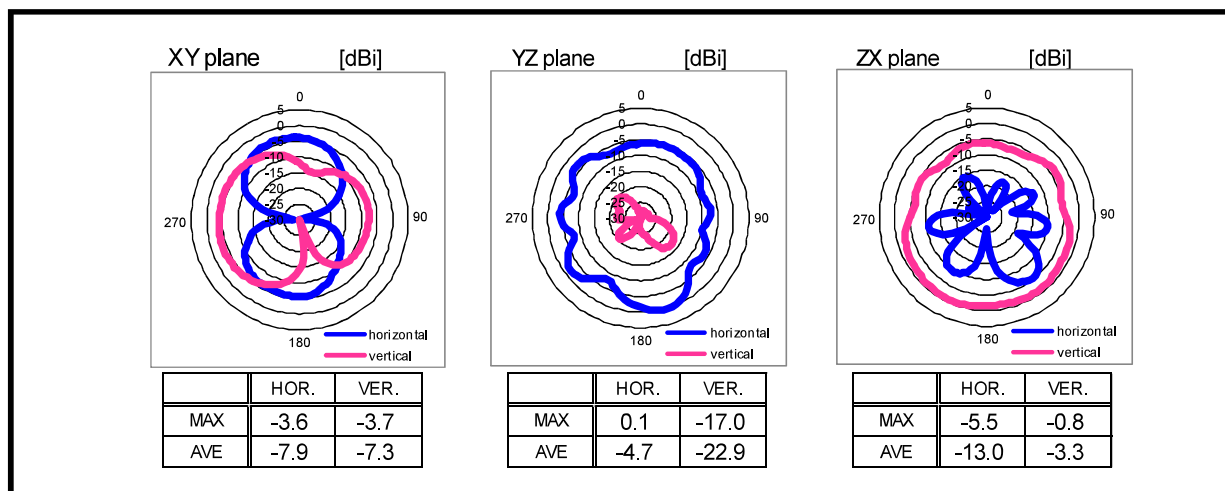
Measurement direction



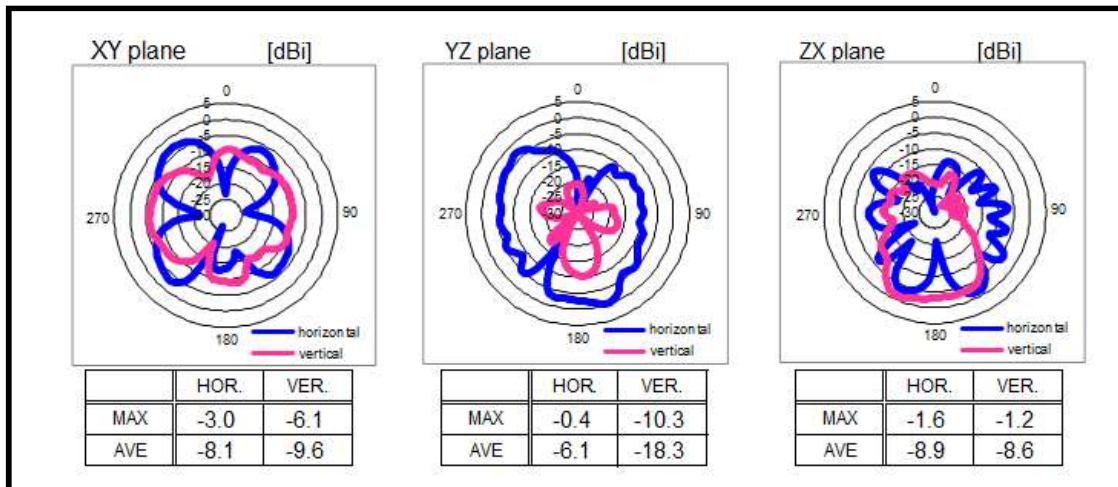


Antenna trace width 0.5mm

		[dBi]						[dB]
LINEAR POLARIZATION		XY-plane		YZ-plane		ZX-plane		Total Efficiency
		hor.	ver.	hor.	ver.	hor.	ver.	
2400 MHz	MAX.	-3.8	-4.0	-0.1	-18.5	-6.0	-1.2	-4.3
	AVE.	-8.1	-7.7	-5.1	-24.0	-13.3	-3.6	
2442 MHz	MAX.	-3.6	-3.7	0.1	-17.0	-5.5	-0.8	-3.9
	AVE.	-7.9	-7.3	-4.7	-22.9	-13.0	-3.3	
2484 MHz	MAX.	-3.3	-3.6	0.0	-16.5	-5.5	-0.6	-3.8
	AVE.	-7.8	-7.1	-4.6	-22.8	-12.8	-3.1	

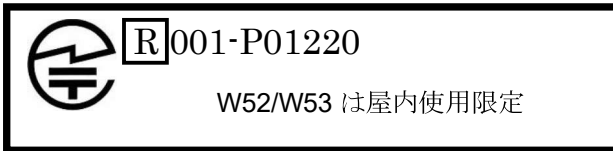


		[dBi]						[dB]
LINEAR POLARIZATION		XY-plane		YZ-plane		ZX-plane		Total Efficiency
		hor.	ver.	hor.	ver.	hor.	ver.	
5150 MHz	MAX.	-3.0	-6.1	-0.4	-10.3	-1.6	-1.2	-5.6
	AVE.	-8.1	-9.6	-6.1	-18.3	-8.9	-8.6	
5500 MHz	MAX.	-2.4	-4.9	-0.6	-10.8	-0.7	-2.9	-5.2
	AVE.	-7.6	-8.6	-5.7	-19.0	-9.0	-10.0	
5850 MHz	MAX.	-1.8	-4.0	-1.3	-10.7	-0.9	-5.1	-5.4
	AVE.	-7.6	-8.0	-6.2	-18.4	-8.6	-11.8	



LBEE5HY1MW User Manual for Japan

■ Regarding Japan Certificate of Construction Type of LBEE5HY1MW



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-P01220) 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.]