

W-LAN+Bluetooth Combo Module Data Sheet

NXP IW416 Chipset
for 802.11a/b/g/n + Bluetooth 5.2

Design Name: Type1XK
Tentative P/N : LBEE5CJ1XK-SMP

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


Revision History

Revision Code	Date	Description	Comments
-	2020.12.16	First Issue	
A	2021.03.23	Top page 4. Block Diagram 9. Operating Conditions 11.2 High-speed UART specifications 12. DC/RF Characteristics	- Removed "ac" - Updated - Updated operating temperature. - Added default baud rate information. - Added 802.11n 40MHz in 2.4GHz. - Added Tx power values.
B	2021.03.31	14. Reference Circuit 15. Tape and Reel Packing	- Added circuit for dedicated BT antenna. - Added
C	2021.04.05	2. Key feature & 5.2 Bluetooth Qualification 7.1 Pin Assignments 7.2 Pin Descriptions	- Added a comment on supported Bluetooth functions - Corrected pin number - Corrected pin number
D	2021.04.14	14. Reference Circuit	- Corrected circuit for dedicated BT antenna
E	2021.05.19	2. Key Features 7.5 Pin States 14. Reference Circuit 12.8 DC/RF Characteristics for Bluetooth 12.9 DC/RF Characteristics for Bluetooth Low Energy	- Added Weight - Added Internal pull values - Corrected circuit for Shard BT antenna - Updated Output Power - Updated Output Power

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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 WLAN + Bluetooth® 5.2 combo module.

2. Key Features

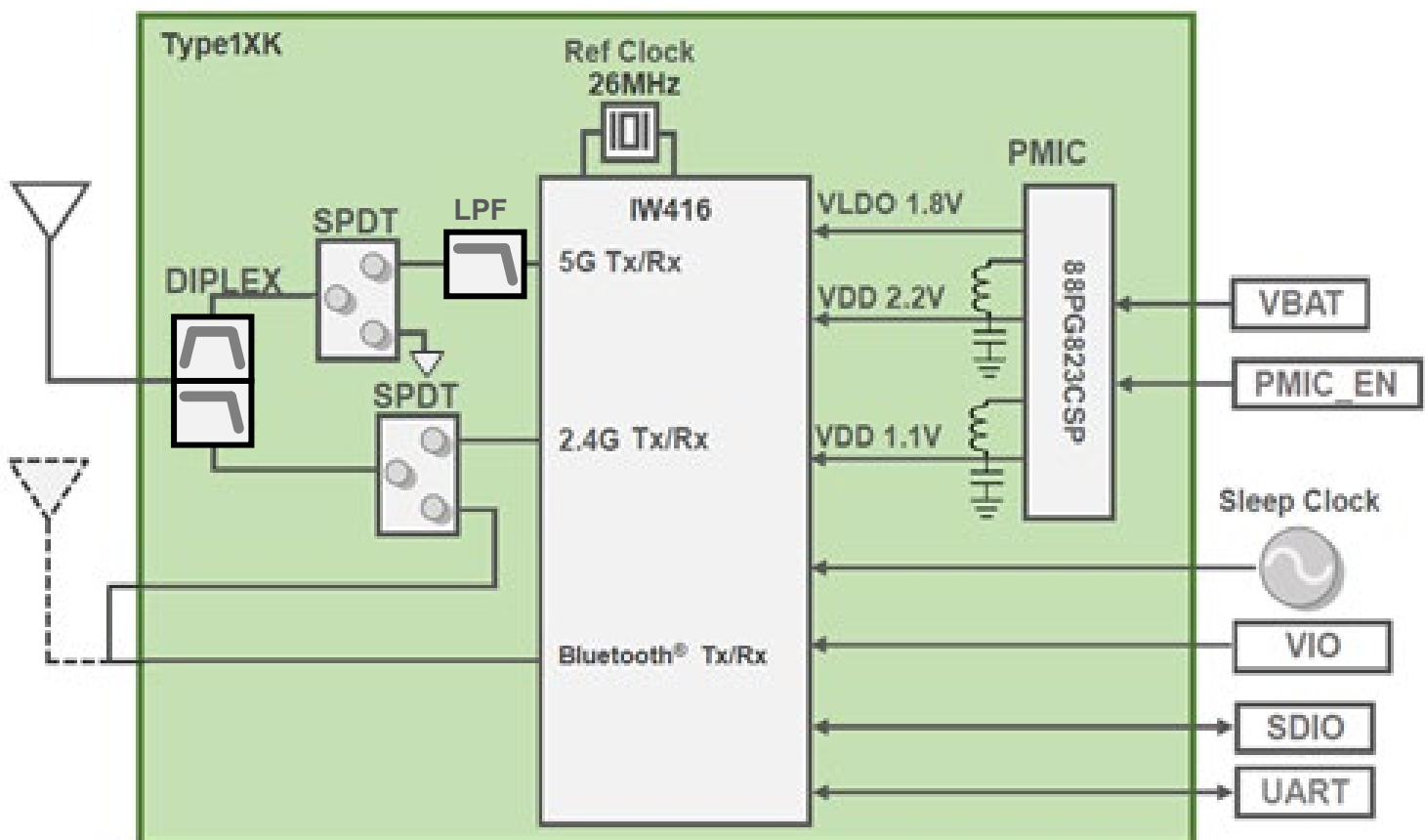
- NXP IW416 inside
- Compliant with IEEE802.11a/b/g/n, SISO
- Compliant with Bluetooth® specification v5.2 (See PIC for supported Bluetooth functions on Bluetooth SIG site)
- Supports standard SDIO3.0 interface for WLAN
- UART / SDIO3.0 interfaces support for Bluetooth is Host Controller Interface (HCI)
- Surface mount type 9.1 x 8.3 mm(Typical), H = 1.3 mm(Max.)
- Weight :268.8 mg
- MSL : TBD
- RoHS compliant

3. Ordering Information

Ordering Part Number	Description
LBEE5CJ1XK-SMP	In case of sample order
LBEE5CJ1XK-EVB	EVB

“LBEE5CJ1XK” is used in certification test report.

4. Block Diagram



5. Certification Information

5.1. Radio Certification

TBD

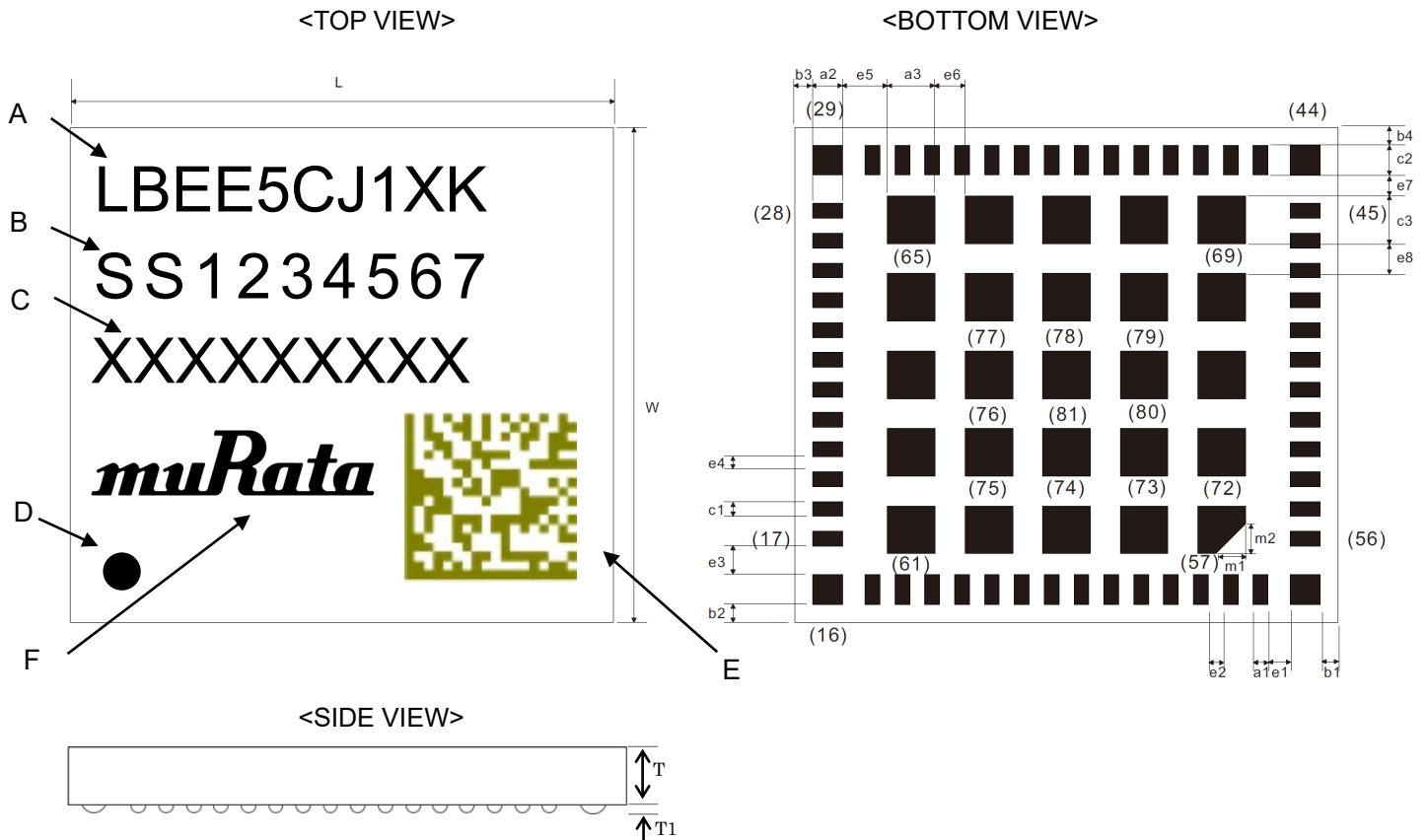
5.2. Bluetooth Qualification

TBD

*Set Bluetooth Tx Power to Class1 by using "bt_power_config_1.sh".

**See PICS for supported Bluetooth functions on Bluetooth SIG site

6. Dimensions, Marking and Terminal Configurations



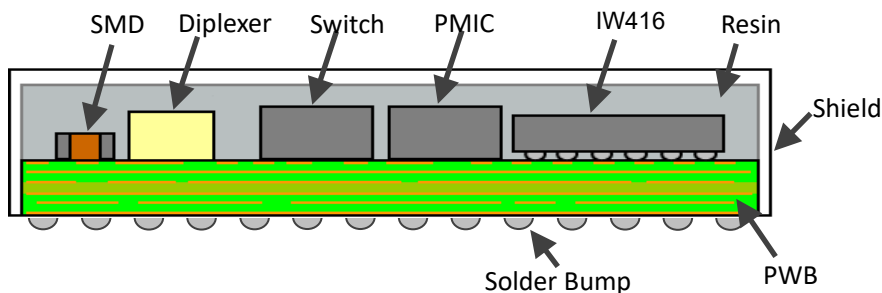
Marking	Meaning
A	Module Type
B	Inspection Number
C	Serial Number
D	Pin 1 Marking
E	2D code
F	Murata Logo

(unit : mm)

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

* T dimension does not include height of solder bumps.

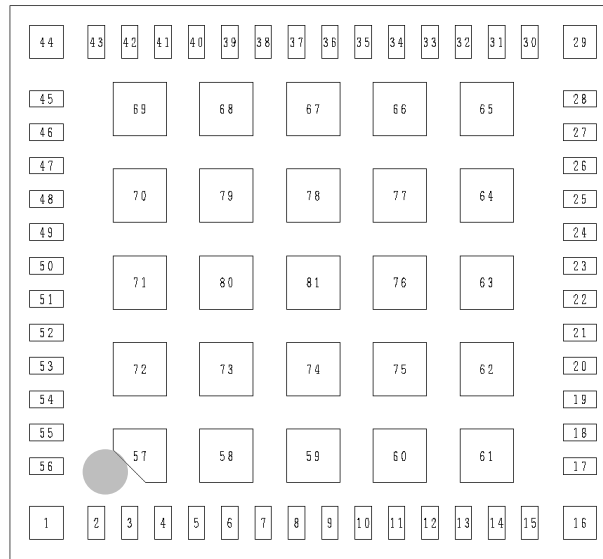
Structure



7. Module Pin Descriptions

7.1. Pin Assignments

<TOP VIEW>



No.	Terminal Name	No.	Terminal Name	No.	Terminal Name
1	GND	20	GPIO(3) TDO	39	GND
2	VIO	21	GND	40	GND
3	SD_D2	22	VBAT	41	GND
4	SD_CLK	23	VBAT	42	RF_CONTL2_N
5	SD_D0	24	GND	43	RF_CONTL3_P
6	SD_CMD	25	GND	44	GND
7	GPIO(9) UART_RXD	26	GND	45	BT_ANT SHARED
8	GPIO(6)	27	GND	46	GND
9	GPIO(7)	28	GND	47	BT_ANT DEDICATED
10	NC	29	GND	48	GND
11	GPIO(4)	30	GND	49	GND
12	GPIO(1)	31	PMIC_EN	50	GND
13	GPIO(15) TMS	32	WCI_SOUT	51	GPIO(11) UART_RTS
14	GPIO(5)	33	WCI_SIN	52	GPIO(0)
15	GPIO(8) UART_CTS	34	GPIO(12)	53	GPIO(13)
16	GND	35	RF_CONTL1_P	54	GPIO(10) UART_TXD
17	GPIO(14) TCK	36	RF_CONTL0_N	55	SD_D3
18	GPIO(2) TDI	37	GND	56	SD_D1
19	SLP_CLK_IN	38	RF_ANT	57-81	GND

7.2. Pin Descriptions

No.	Pin name	Type	Connection to	Description
			IC pin name	
1	GND	-	-	Ground
2	VIO	P	VIO VIO_RF VIO_SD	Power supply
3	SD_D2	I	SD_DAT[2]	SDIO 4-bit mode: Data line Bit[2] or read wait (optional) SDIO 1-bit mode: Read wait (optional)
4	SD_CLK	I	SD_CLK	SDIO Clock input
5	SD_D0	I	SD_DAT[0]	SDIO 4-bit mode: Data line Bit[0] SDIO 1-bit mode: Data line
6	SD_CMD	I/O	SD_CMD	SDIO 4-bit mode: Command/response (input/output) SDIO 1-bit mode: Command line
7	GPIO(9) UART_RXD	I/O	GPIO[9]	GPIO mode: GPIO[9] (input/output) UART mode: UART_SIN (input)
8	GPIO(6)	I/O	GPIO[6]	GPIO mode: GPIO[6] (input/output) PCM mode: PCM_CLK (input/output) • Output if master • Input if slave I2S mode: I2S_BCLK (input/output) • Output if master • Input if slave
9	GPIO(7)	I/O	GPIO[7]	GPIO mode: GPIO[7] (input/output) PCM mode: PCM_SYNC (input/output) • Output if master • Input if master I2S mode: I2S_LRCLK (input/output) • Output if master • Input if master
10	NC	-	-	NC
11	GPIO(4)	I/O	GPIO[4]	GPIO mode: GPIO[4] (input/output) PCM mode: PCM_DOUT/PCM_DIN (depending on the configuration. If GPIO[5] is configured as PCM_DIN, then GPIO[4] is set as PCM_DOUT, and vice-versa) I2S mode: I2S_DOUT/I2S_DIN (depending on the configuration. If GPIO[5] is configured as I2S_DIN, then GPIO[4] is set as I2S_DOUT, and vice-versa)
12	GPIO(1)	I/O	GPIO[1]	GPIO mode: GPIO[1] (input/output) This pin is used as a configuration pin: CON[9] (input) Do not drive this signal during boot-up SDU mode: Host_int (output)
13	GPIO(15) TMS	I/O	GPIO[15]	GPIO mode: GPIO[15] (input/output) JTAG mode: JTAG_TMS, JTAG controller select (input) Host wake mode: Host-to-Chip wakeup Reset recovery mode: Host-to-Bluetooth reset recovery
14	GPIO(5)	I/O	GPIO[5]	GPIO mode: GPIO[5] (input/output) PCM mode: PCM_DOUT/PCM_DIN (depending on the configuration, used with GPIO[4]) I2S mode: I2S_DOUT/I2S_DIN (depending on the configuration)
15	GPIO(8) UART_CTS	I/O	GPIO[8]	GPIO mode: GPIO[8] (input/output) This pin is used as a configuration pin: CON7 (input) Do not drive this signal during boot-up UART mode: UART_CTSn (input, active low)
16	GND	-	-	Ground
17	GPIO(14) TCK	I/O	GPIO[14]	GPIO mode: GPIO[14] (input/output) JTAG mode: JTAG_TCK, JTAG test clock (input) Host wake mode: Host-to-Chip wakeup Reset recovery mode: Host-to-Wi-Fi reset recovery (if GPIO[14] is used for wakeup, then use GPIO[13] for Wi-Fi reset recovery)
18	GPIO(2) TDI	I/O	GPIO[2]	

19	SLP_CLK_IN	I	SLP_CLK_IN	Sleep Clock Input (optional) Used for lower power operation in sleep mode. • An external sleep clock of 32.768 kHz can be used for lowest current consumption in sleep mode. • An external sleep clock is required if automatic reference clock frequency detection is used. • If no external sleep clock is used, leave this pin floating (DNC).
20	GPIO(3) TDO	I/O	GPIO[3]	GPIO mode: GPIO[3] (input/output) Power management mode: DVSC[1], Digital voltage scaling control (output) JTAG mode: JTAG_TDO, JTAG test data (output) PCM mode: PCM_MCLK (output) - PCM clock signal (output, optional) I2S mode: I2S_CCLK (Output)
21	GND	-	-	Ground
22	VBAT	P	PVIN(PMIC)	Power supply
23	VBAT	P	PVIN(PMIC)	Power supply
24	GND	-	-	Ground
25	GND	-	-	Ground
26	GND	-	-	Ground
27	GND	-	-	Ground
28	GND	-	-	Ground
29	GND	-	-	Ground
30	GND	-	-	Ground
31	PMIC_EN	I	EN(PMIC)	Enable build-in PMIC. Logic high enables internal regulators and internal hardware reset is de-asserted. Logic low disables regulators and internal hardware reset is asserted. • Do not float this pin
32	WCI_SOUT			TBD
33	WCI_SIN			TBD
34	GPIO(12)	I/O	GPIO[12]	GPIO mode: GPIO[12] (input/output) UART mode: UART_DSRn (input) (active low) Host wake mode: Host-to-Chip (Bluetooth) wakeup
35	RF_CONTL1_P	O	RF_CNTL1_P	Reserved Set to 1.
36	RF_CONTL0_N	O	RF_CNTL0_N	RF Control 0—RF Control Output Low (output) This pin is used as a configuration pin: CON[0] (input). See 7.3 Configuration Pins
37	GND	-	-	Ground
38	RF_ANT			
39	GND	-	-	Ground
40	GND	-	-	Ground
41	GND	-	-	Ground
42	RF_CONTL2_N	O	RF_CNTL2_N	Reserved Set to 1
43	RF_CONTL3_P	O	RF_CNTL3_P	Reserved
44	GND	-	-	Ground
45	BT_ANT SHARED	I	-	BT in(Feedback)
46	GND	-	-	Ground
47	BT_ANT DEDICATED	O	-	BT output
48	GND	-	-	Ground
49	GND	-	-	Ground
50	GND	-	-	Ground
51	GPIO(11) UART_RTS	I/O	GPIO[11]	GPIO mode: GPIO[11] (input/output) This pin is used as a configuration pin: CON[8] (input) Do not drive this signal during boot-up UART mode: UART_RTSn (output) (active low)
52	GPIO(0)	I/O	GPIO[0]	GPIO mode: GPIO[0] (input/output) Oscillator enable mode: XOSC_EN (output) (active high) 0 = disable external oscillator 1 = enable external oscillator

53	GPIO(13)	I/O	GPIO[13]	GPIO mode: GPIO[13] (input/output) UART mode: UART_DTRn (output) Reset recovery mode: Host-to-Wi-Fi reset recovery (secondary option if GPIO[14] is being used for other purposes)
54	GPIO(10) UART_TXD	I/O	GPIO[10]	GPIO mode: GPIO[10] (input/output) UART mode: UART_SOUT (output)
55	SD_D3	I	SD_DAT[3]	SDIO 4-bit mode: Data line Bit[3] SDIO 1-bit mode: Reserved
56	SD_D1	I	SD_DAT[1]	SDIO 4-bit mode: Data line Bit[1] SDIO 1-bit mode: Interrupt
57-81	GND	-	-	Ground

* () of "pin name" is BSP configuration of NXP iMX8.

7.3. Configuration Pins

Configuration Bits	Pin Name	Configuration Function
CON[1]	RF_CNTL2_N	Firmware Boot Options No hardware impact. Software reads and boots accordingly. See the table below. Note: Boot code needs to use this host boot strap status to decide the correct boot sequence.
CON[0]	RF_CNTL0_N	

7.4. Firmware boot options

CON[1]	CON[0]	Wi-Fi	Bluetooth/LE	Number of SDIO Functions
1	0	SDIO	UART	1 (Wi-Fi)
1	1	SDIO	SDIO	2 (Wi-Fi, Bluetooth)

7.5. Pin States

Pin states information for the tables below include:

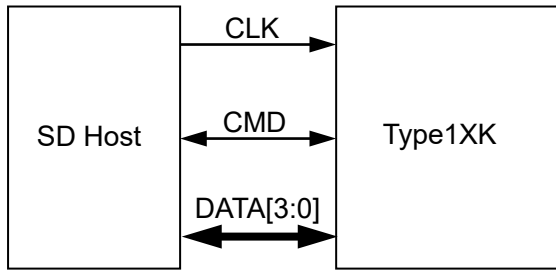
- After firmware is downloaded, the pads (GPIO, Serial interface, RF control) are programmed in functional mode per the functionality of the pins.
- For SDIO, once the command is received from the host, the pads are configured accordingly.
- Pull-up and pull-down are only effective when the pad is in 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

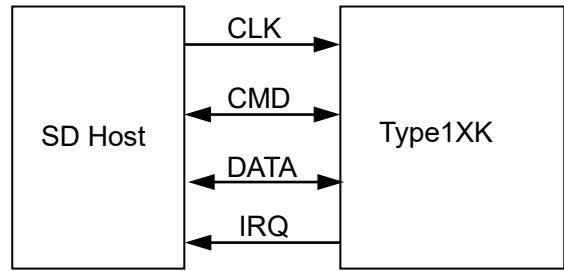
Pin Name	Supply	No Pad Power State	Reset State	HW State	PD State	PD Prog	Internal PU/PD	Int'l Pull Value[Ω]
GPIO0	VIO	tristate	output	output	drive low	yes	nominal PU	90K
GPIO1	VIO	tristate	input	input	tristate	yes	weak PU	800K
GPIO2	VIO	tristate	input	input	tristate	yes	weak PU	800K
GPIO3	VIO	tristate	input	input	tristate	yes	weak PU	800K
GPIO4	VIO	tristate	output	input	tristate	yes	nominal PU	90K
GPIO5	VIO	tristate	input	input	tristate	yes	weak PU	800K
GPIO6	VIO	tristate	input	input	tristate	yes	nominal PU	90K
GPIO7	VIO	tristate	input	input	tristate	yes	nominal PU	90K
GPIO8	VIO	tristate	input	input	drive low	yes	weak PU	800K
GPIO9	VIO	tristate	output	input	tristate	yes	nominal PU	90K
GPIO10	VIO	tristate	input	input	tristate	yes	nominal PU	90K
GPIO11	VIO	tristate	output	input	drive high	yes	weak PU	800K
GPIO12	VIO	tristate	input	input	tristate	yes	nominal PU	90K
GPIO13	VIO	tristate	input	input	drive high	yes	nominal PU	90K
SD_CLK	VIO_SD	tristate	input	Input	tristate	no	nominal PD	90K
SD_CMD	VIO_SD	tristate	input	Input	tristate	no	nominal PD	90K
SD_D0	VIO_SD	tristate	input	Input	tristate	no	nominal PD	90K
SD_D1	VIO_SD	tristate	input	Input	tristate	no	nominal PD	90K
SD_D2	VIO_SD	tristate	input	Input	tristate	no	nominal PD	90K
SD_D3	VIO_SD	tristate	input	Input	tristate	no	nominal PD	90K
RF_CNTL0_N	VIO_RF	tristate	input	output	drive low	yes	weak PU	800K
RF_CNTL1_P	VIO_RF	tristate	input	output	drive high	yes	weak PU	800K
RF_CNTL2_N	VIO_RF	tristate	input	output	drive low	yes	weak PU	800K
RF_CNTL3_P	VIO_RF	tristate	input	output	drive high	yes	weak PU	800K

SDIO Pin Descriptions

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



(i) SD 4-bit Mode



(ii) SD 1-bit Mode

8. Absolute Maximum Ratings

Parameter		min.	max.	Unit
Storage Temperature		-40	85	deg.C
Supply Voltage	V _{BAT}	-0.3	6.0	V
	V _{IO}	-	4.0	V

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

9. Operating Conditions

9.1. Operating conditions

Parameter		min.	typ.	max.	unit
Operating Temperature		-40	25	+85	deg.C
Supply Voltage	V _{BAT}	2.7	-	5.5	V
	V _{IO}	1.62	1.8	1.98	V
		2.97	3.3	3.47	
Peak current	V _{BAT}	—	TBD	TBD	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. External Sleep Clock Requirements

Symbol	Parameter	Min	Typ	Max	Unit
CLK	Clock frequency range/accuracy CMOS input clock signal type ±250 ppm (initial , aging, temperature)	-	32.768	-	kHz
PN	Phase Noise Requirement (@ 100kHz)	-	-125	-	dBc/Hz
J _c	Cycle jitter	-	1.5	-	ns(RMS)
SR	Slew rate limit (10-90%)	-	-	100	ns
DC	Duty cycle tolerance	20	-	80	%

9.3. Digital I/O Requirements

Symbol	Parameter	Condition	Min	Typ	Max	Unit
V _{IH}	Input high voltage	-	0.7*V _{IO}	-	V _{IO} +0.4	V
V _{IL}	Input low voltage	-	-0.4	-	0.3*V _{IO}	V
V _{HYS}	Input hysteresis	-	100	-	-	mV
V _{OH}	Output high voltage	-	V _{IO} -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

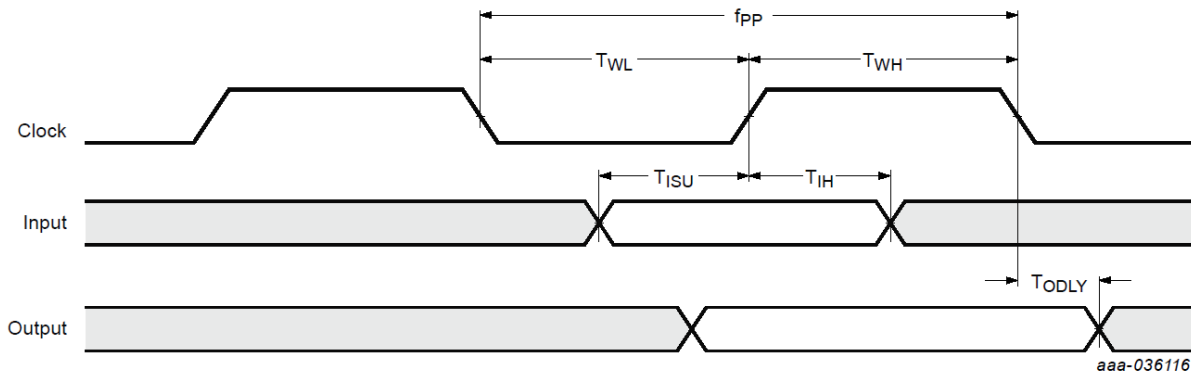


11. Interface Timing

11.1. SDIO Timing

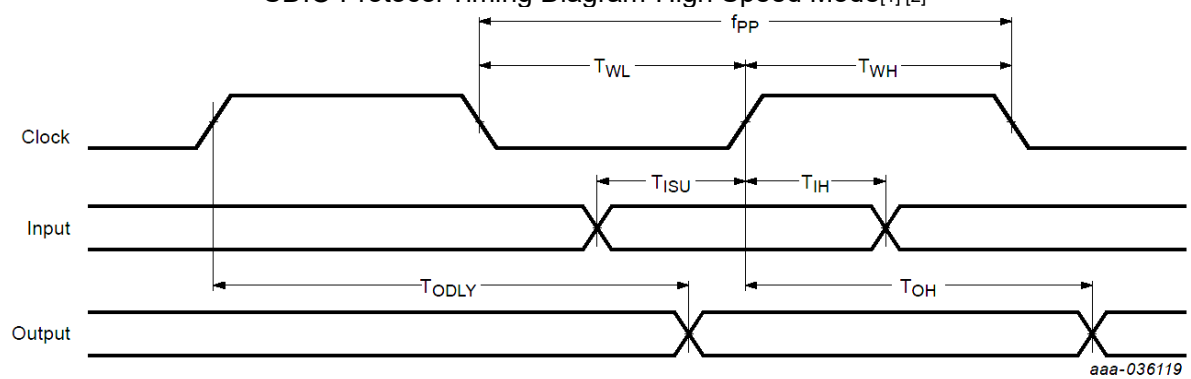
11.1.1. Default Speed Mode

SDIO Protocol Timing Diagram-Default Speed Mode



11.1.2. High Speed Mode

SDIO Protocol Timing Diagram-High Speed Mode^{[1] [2]}

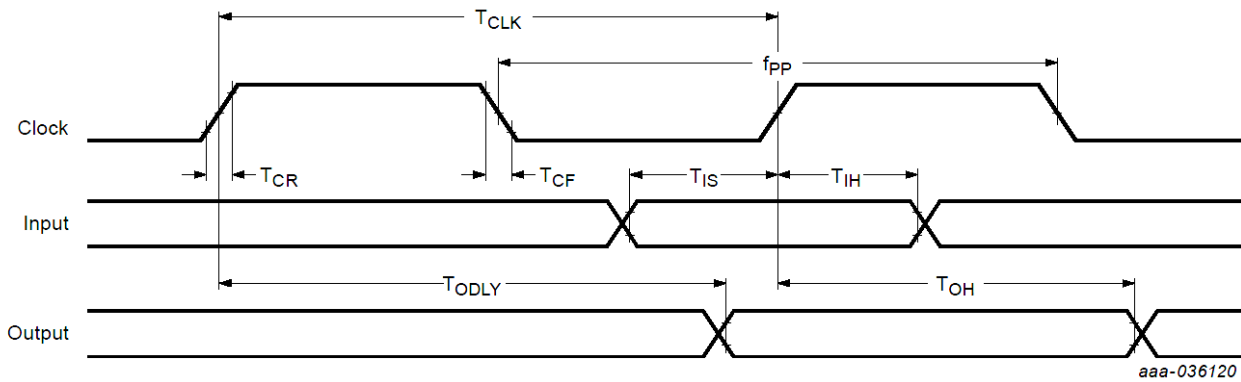


Symbol	Parameter	Condition	Min	Typ	Max	Unit
f_{PP}	Clock frequency	Normal	0	--	25	MHz
		High-speed	0	--	50	MHz
T_{WL}	Clock low time	Normal	10	--	--	ns
		High-speed	7	--	--	ns
T_{WH}	Clock high time	Normal	10	--	--	ns
		High-speed	7	--	--	ns
T_{ISU}	Input setup time	Normal	5	--	--	ns
		High-speed	6	--	--	ns
T_{IH}	Input hold time	Normal	5	--	--	ns
		High-speed	2	--	--	ns
T_{ODLY}	Output delay time	Normal	--	--	14	ns
	CL ≤ 40 pF (1 card)	High-speed	--	--	14	ns
T_{OH}	Output hold time	High-speed	2.5	--	--	ns

[2] For SDIO 2.0 running at 25 MHz clock frequency, VIO_SD must be 3.3V.

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

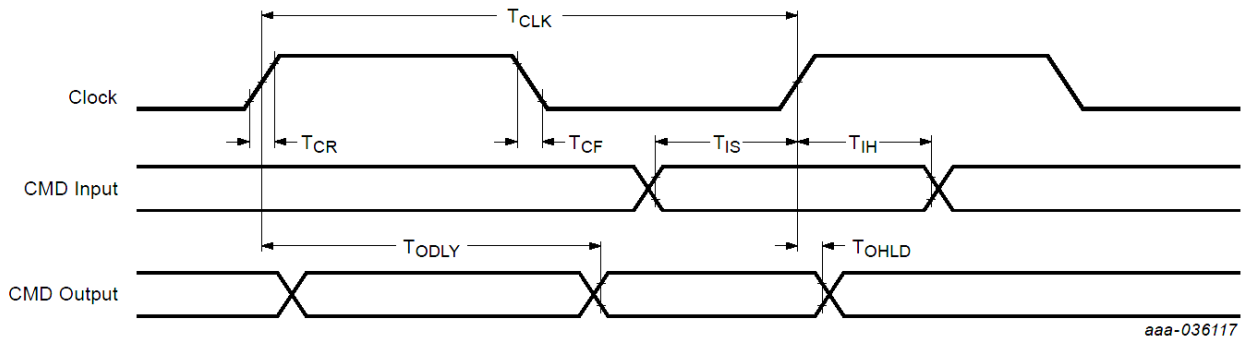
SDIO Protocol Timing Diagram-SDR12,SDR25,SDR50 Mode(up to 100MHz)(1.8V)



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 $T_{CR}, T_{CF} < 2$ ns (max) at 100 MHz $C_{CARD} = 10$ pF	SDR12/25/50	--	--	$0.2 * T_{CLK}$	ns
T_{ODLY}	Output delay time $C_L \leq 30$ pF	SDR12/25/50	--	--	7.5	ns
T_{OH}	Output hold time $C_L = 15$ pF	SDR12/25/50	1.5	--	--	ns

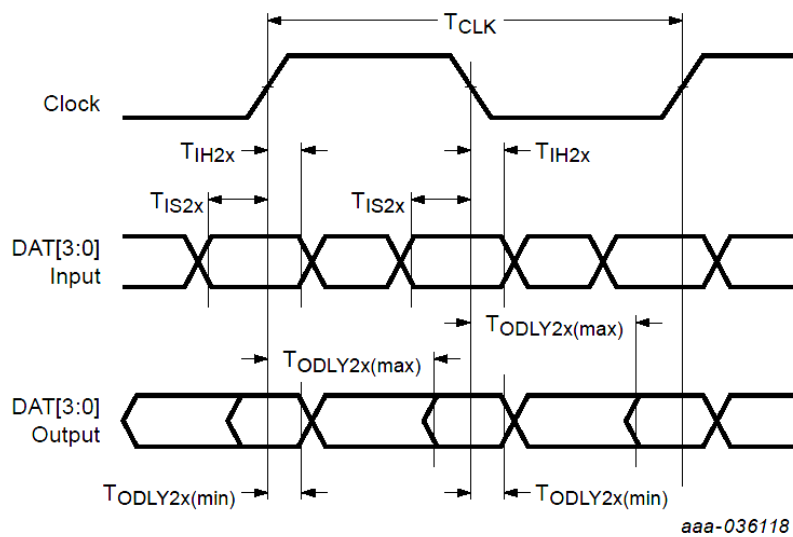
11.1.4. DDR50 Mode(50MHz)(1.8V)

SDIO CMD Timing Diagram-DDR50 Mode (50MHz)



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

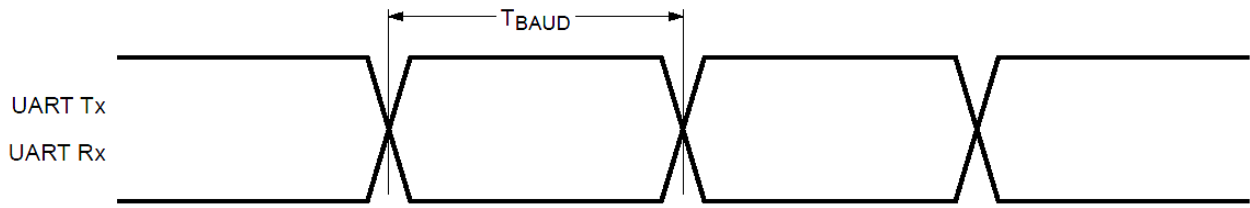
SDIO DATA Timing Diagram-DDR50 Mode



Symbol	Parameter	Condition	Min	Typ	Max	Unit
Clock						
T _{CLK}	Clock time 50 MHz (max) between rising edges	DDR50	20	--	--	ns
T _{CR} , T _{CF}	Rise time, fall time T _{CR} , T _{CF} < 4.00 ns (max) at 50 MHz C _{CARD} = 10 pF	DDR50	--	--	0.2*T _{CLK}	ns
Clock Duty	--	DDR50	45	--	55	%
CMD Input (referenced to clock rising edge)						
T _{IS}	Input setup time C _{CARD} ≤ 10 pF (1 card)	DDR50	6	--	--	ns
T _{IH}	Input hold time C _{CARD} ≤ 10 pF (1 card)	DDR50	0.8	--	--	ns
CMD Output (referenced to clock rising edge)						
T _{ODLY}	Output delay time during data transfer mode C _L ≤ 30 pF (1 card)	DDR50	--	--	13.7	ns
T _{OHLd}	Output hold time C _L ≥ 15 pF (1 card)	DDR50	1.5	--	--	ns
DAT[3:0] Input (referenced to clock rising and falling edges)						
T _{IS2x}	Input setup time C _{CARD} ≤ 10 pF (1 card)	DDR50	3	--	--	ns
T _{IH2x}	Input hold time C _{CARD} ≤ 10 pF (1 card)	DDR50	0.8	--	--	ns
DAT[3:0] Output (referenced to clock rising and falling edges)						
T _{ODLY2x (max)}	Output delay time during data transfer mode C _L ≤ 25 pF (1 card)	DDR50	--	--	7.0	ns
T _{ODLY2x (min)}	Output hold time C _L ≥ 15 pF (1 card)	DDR50	1.5	--	--	ns

11.2. UART Timing (Default Mode)

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



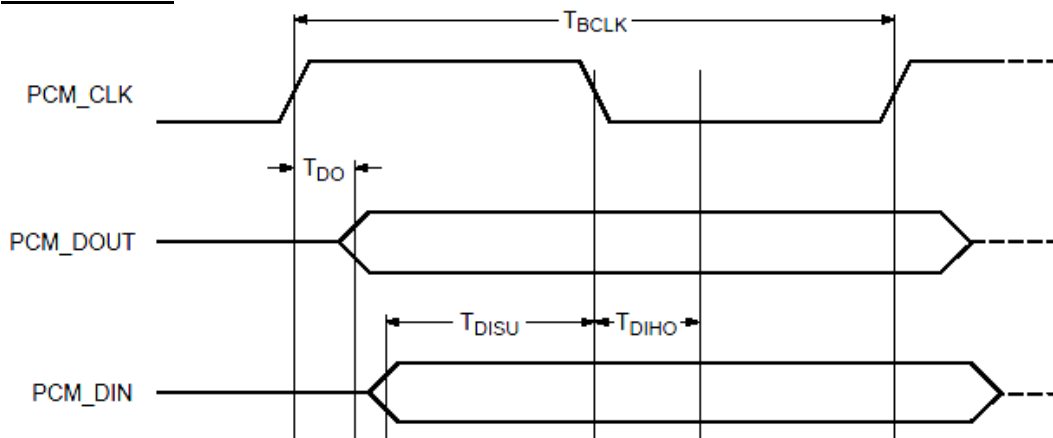
aaa-036128

Symbol	Parameter	Condition	Min	Typ	Max	Unit
T_{BAUD}	Baud rate	38.4MHz	250	-	-	ns

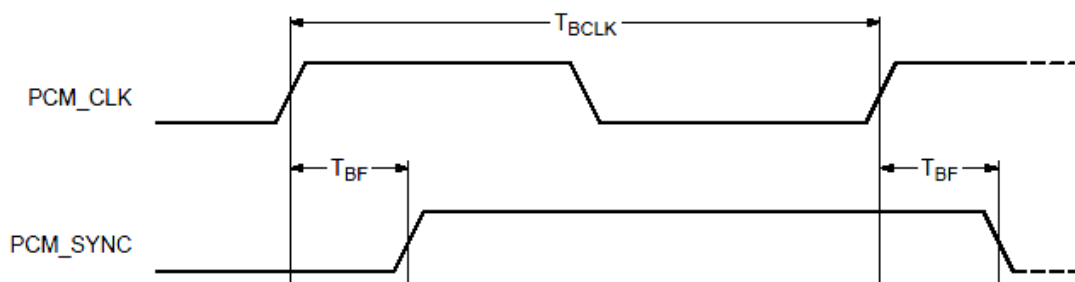
* The acceptable deviation from the UART Rx target baud rate is $\pm 3\%$.

11.3. Bluetooth PCM Timing

11.3.1. Master mode



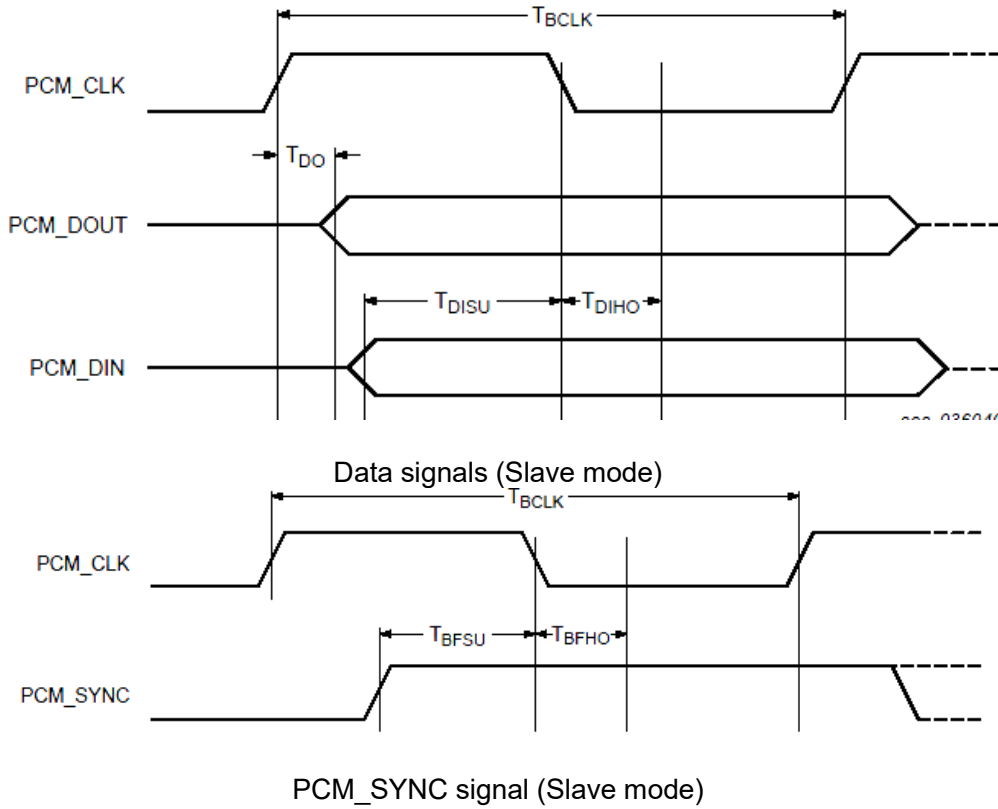
Data signals (Master mode)



PCM_SYNC signal (Master mode)

Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
F_{BCLK}	Bit clock frequency	--	--	2/2.048	--	MHz
Duty Cycle $_{BCLK}$	Bit clock duty cycle	--	0.4	0.5	0.6	--
$T_{BCLK\ rise/fall}$	PCM_CLK rise/fall time	--	--	3	--	ns
T_{DO}	Delay from PCM_CLK rising edge to PCM_DOUT rising edge	--	--	--	15	ns
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



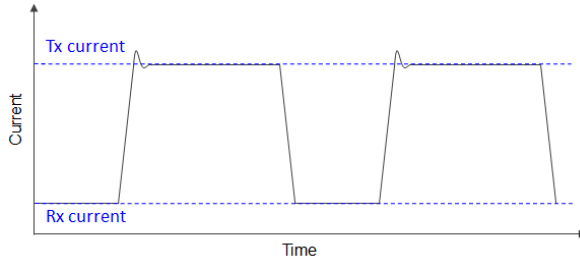
Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
F_{BCLK}	Bit clock frequency	--	--	2/2.048	--	MHz
Duty Cycle $_{BCLK}$	Bit clock duty cycle	--	0.4	0.5	0.6	--
$T_{BCLK\ rise/fall}$	PCM_CLK rise/fall time	--	--	3	--	ns
T_{Do}	Delay from PCM_CLK rising edge to PCM_DOUT rising edge	--	--	--	30	ns
T_{DISU}	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	TBD
WLAN Regulatory Limit	TBD
Energy Detect	TBD
Bluetooth Power	TBD

- 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			
	Min.	Typ.	Max.	Unit
- DC Characteristics -				
1. DC current				
1) Tx mode	-	TBD	TBD	mA
2) Rx mode	-	TBD	TBD	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			
	Min.	Typ.	Max.	Unit
- DC Characteristics -				
1. DC current				
1) Tx mode	-	TBD	TBD	mA
2) Rx mode	-	TBD	TBD	mA
- Tx Characteristics -				
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 -				
9. Minimum Input Level (FER _≤ 8%)	-		-80	dBm
10. Maximum Input Level (FER _≤ 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			
	Min.	Typ.	Max.	Unit
- DC Characteristics -				
1. DC current				
1) Tx mode	-	TBD	TBD	mA
2) Rx mode	-	TBD	TBD	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~ -20dB)	0	-	-	dB
2) 11MHz to 20MHz (-20~ -28dB)	0	-	-	dB
3) 20MHz to 30MHz (-28~ -40dB)	0	-	-	dB
4) 30MHz to 33MHz (-40dB)	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			
	Min.	Typ.	Max.	Unit
- DC Characteristics -				
1. DC current				
1) Tx mode	-	TBD	TBD	mA
2) Rx mode	-	TBD	TBD	mA
- Tx Characteristics -				
2. Output Power	Min.	Typ.	Max.	Unit
	15.0	17.0	19.0	dBm
3. Spectrum Mask Margin				
1) 9MHz to 11MHz (0~ -20dB)	0	-	-	dB
2) 11MHz to 20MHz (-20~ -28dB)	0	-	-	dB
3) 20MHz to 30MHz (-28~ -40dB)	0	-	-	dB
4) 30MHz to 33MHz (-40dB)	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 -				
7. Minimum Input Level (PER < 10%)	Min.	Typ.	Max.	Unit
	-	-	-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 20MHz BW
Mode	OFDM
Channel Frequency	2412 - 2472MHz
Data rate	MCS0-MCS7

12.3.1. High Rate Condition for IEEE802.11n 20MHz BW – 2.4GHz

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

Items	Contents			
	Min.	Typ.	Max.	Unit
- DC Characteristics -				
1. DC current				
1) Tx mode	-	TBD	TBD	mA
2) Rx mode	-	TBD	TBD	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

12.3.2. Low Rate Condition for IEEE802.11n 20MHz BW – 2.4GHz

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

Items	Contents			
	Min.	Typ.	Max.	Unit
- DC Characteristics -				
1. DC current				
1) Tx mode	-	TBD	TBD	mA
2) Rx mode	-	TBD	TBD	mA
- Tx Characteristics -				
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) <small>(measured at enhanced mode)</small>	-	-	-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 -				
7. Minimum Input Level (PER ≤ 10%)	-	-	-82	dBm
8. Maximum Input Level (PER < 10%)	-20	-	-	dBm
9. Adjacent Channel Rejection (PER ≤ 10%)	-2	-	-	dB

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

Specification	IEEE802.11n 40MHz BW
Mode	OFDM
Channel Frequency	2412 - 2462MHz
Data rate	MCS0-MCS7

12.4.1. High Rate Condition for IEEE802.11n 40MHz BW – 2.4GHz

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

Items	Contents			
	Min.	Typ.	Max.	Unit
- DC Characteristics -				
1. DC current				
1) Tx mode	-	TBD	TBD	mA
2) Rx mode	-	TBD	TBD	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) 1000-12750MHz (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

12.4.2. Low Rate Condition for IEEE802.11n 40MHz BW – 2.4GHz

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

Items	Contents			
	Min.	Typ.	Max.	Unit
- DC Characteristics -				
1. DC current				
1) Tx mode	-	TBD	TBD	mA
2) Rx mode	-	TBD	TBD	mA
- Tx Characteristics -				
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) <small>(measured at enhanced mode)</small>	-	-	-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 -				
7. Minimum Input Level (PER ≤ 10%)	-	-	-82	dBm
8. Maximum Input Level (PER < 10%)	-20	-	-	dBm
9. Adjacent Channel Rejection (PER ≤ 10%)	-2	-	-	dB

12.5. 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

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

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

Items	Contents			
	min.	Typ.	Max.	Unit
- DC Characteristics -				
1. DC current				
1) Tx mode	-	TBD	TBD	mA
2) Rx mode	-	TBD	TBD	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)	-	-	-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

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

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

Items	Contents			
	min.	Typ.	Max.	Unit
- DC Characteristics -				
1. DC current				
1) Tx mode	-	TBD	TBD	mA
2) Rx mode	-	TBD	TBD	mA
- Tx Characteristics -				
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) <small>(measured at enhanced mode)</small>	-	-	-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 -				
7. Minimum Input Level (PER ≤ 10%)	-	-	-82	dBm
8. Maximum Input Level (PER < 10%)	-30	-	-	dBm
9. Adjacent Channel Rejection (PER ≤ 10%)	-1	-	-	dB

12.6. 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

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

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

Items	Contents			
	min.	Typ.	Max.	Unit
- DC Characteristics -				
1. DC current				
1) Tx mode	-	TBD	TBD	mA
2) Rx mode	-	TBD	TBD	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) 1000-5150MHz (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

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

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

Items	Contents			
	min.	Typ.	Max.	Unit
- DC Characteristics -				
1. DC current				
1) Tx mode	-	TBD	TBD	mA
2) Rx mode	-	TBD	TBD	mA
- Tx Characteristics -				
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) <small>(measured at enhanced mode)</small>	-	-	-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 -				
7. Minimum Input Level (PER ≤ 10%)	-	-	-82	dBm
8. Maximum Input Level (PER < 10%)	-30	-	-	dBm
9. Adjacent Channel Rejection (PER ≤ 10%)	-2	-	-	dB

12.7. 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			
	min.	Typ.	Max.	Unit
- DC Characteristics -				
1. DC current				
1) Tx mode	-	TBD	TBD	mA
2) Rx mode	-	TBD	TBD	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 ≤ 10%)	-	-	-61	dBm
8. Maximum Input Level (PER ≤ 10%)	-30	-	-	dBm
9. Adjacent Channel Rejection (PER ≤ 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			
	min.	Typ.	Max.	Unit
- DC Characteristics -				
1. DC current				
1) Tx mode	-	TBD	TBD	mA
2) Rx mode	-	TBD	TBD	mA
- Tx Characteristics -				
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) <small>(measured at enhanced mode)</small>	-	-	-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 -				
7. Minimum Input Level (PER ≤ 10%)	-	-	-79	dBm
8. Maximum Input Level (PER ≤ 10%)	-30	-	-	dBm
9. Adjacent Channel Rejection (PER ≤ 10%)	-2	-	-	dB

12.8. DC/RF Characteristics for Bluetooth

Items	Contents
Bluetooth specification (power class)	Version 5.2 (Class1)
Channel frequency (spacing)	2402 to 2480 MHz (1MHz)
Number of RF Channel	79

12.8.1. Basic Data Rate Condition

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

Items	Contents			
	Min.	Typ.	Max.	Unit
Current Consumption				
1) Tx mode DH5	-	TBD	TBD	mA
2) Rx mode DH5	-	TBD	TBD	mA
- Tx Characteristics -	Min.	Typ.	Max.	Unit
Output Power@DH5	0	3.0	6.3	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%)	-	TBD	-70	dBm
Maximum Input Level (BER≤0.1%)	-20	-	-	dBm

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

12.8.2. Enhanced Data Rate Condition

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

Items	Contents			
	Min.	Typ.	Max.	Unit
Current Consumption				
1) Tx mode 2DH5	-	TBD	TBD	mA
2) Rx mode 2DH5	-	TBD	TBD	mA
3) Tx mode 3DH5	-	TBD	TBD	mA
4) Rx mode 3DH5	-	TBD	TBD	mA
- Tx Characteristics -	Min.	Typ.	Max.	Unit
Output Power@2DH5/3DH5	-3.0	0	3.3	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) ω_i	-75	-	75	kHz
2) $\omega_i + \omega_o$	-75	-	75	kHz
3) ω_o	-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	-	TBD	-70	dBm
Maximum Input Level (BER≤0.1%)	-20	-	-	dBm

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

12.9. DC/RF Characteristics for Bluetooth Low Energy

Items	Contents
Bluetooth specification (power class)	Version 5.2 (Class1.5)
Channel frequency (spacing)	2402 to 2480 MHz (2MHz)
Number of RF Channel	40

12.9.1. 1Mbps PHY Condition

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

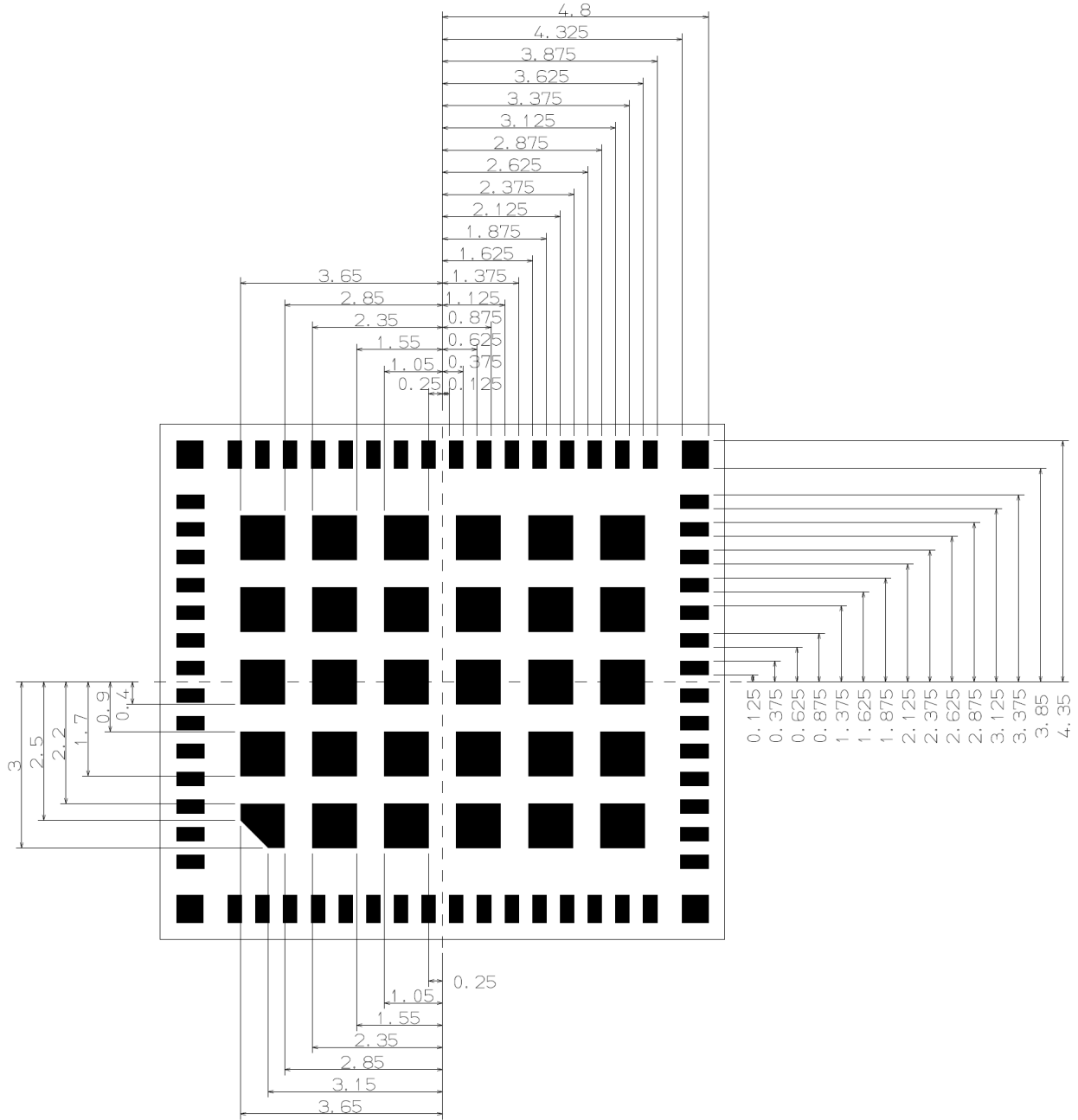
Items	Contents			
	Min.	Typ.	Max.	Unit
Current Consumption				
1) Tx mode	-	TBD	TBD	mA
2) Rx mode	-	TBD	TBD	mA
- Tx Characteristics -	Min.	Typ.	Max.	Unit
Center Frequency	2402	-	2480	MHz
Channel Spacing	-	2	-	MHz
Number of RF channel	-	40	-	-
Output power	0	3.0	6.3	dBm
In-band emission				
1) $f_{TX} \pm 2\text{MHz}$	-	-	-20	dBm
2) $f_{TX} \pm [3+n]\text{MHz}; n=0,1,2,\dots$	-	-	-30	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	-	-	-
Stable Modulation Characteristics				
1) $\Delta f_{1\text{avg}}$	247.5	-	252.5	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 (f_n); $n=0,1,2,3,\dots,k$	-150	-	150	kHz
2) Frequency drift ($ f_0 - f_n $); $n=2,3,4,\dots,k$	-	-	50	kHz
3) Drift rate				
a) $ f_1 - f_0 $	-	-	23	kHz
b) $ f_n - f_{n-5} $; $n=6,7,8,\dots,k$	-	-	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%)	-	TBD	-70	dBm
Maximum input signal level (PER < 30.8%)	-10	-	-	dBm
PER Report Integrity (-30dBm input)	50	-	65.4	%

12.9.2. 2Mbps PHY Condition

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

Items	Contents			
	Min.	Typ.	Max.	Unit
Current Consumption				
1) Tx mode	-	TBD	TBD	mA
2) Rx mode	-	TBD	TBD	mA
- Tx Characteristics -	Min.	Typ.	Max.	Unit
Center Frequency	2402	-	2480	MHz
Channel Spacing	-	2	-	MHz
Number of RF channel	-	40	-	-
Output power	0	3.0	6.3	dBm
In-band emission				
1) $f_{TX} \pm 4\text{MHz}$	-	-	-20	dBm
2) $f_{TX} \pm 5\text{MHz}$	-	-	-20	dBm
2) $f_{TX} \pm [6+n]\text{MHz}; n=0,1,2,\dots$	-	-	-30	dBm
Modulation Characteristics				
1) $\Delta f_{1\text{avg}}$	450	-	550	kHz
2) $\Delta f_{2\text{max}}$ (at 99.9%)	370	-	-	kHz
3) $\Delta f_{2\text{avg}} / \Delta f_{1\text{avg}}$	0.8	-	-	-
Stable Modulation Characteristics				
1) $\Delta f_{1\text{avg}}$	495	-	505	kHz
2) $\Delta f_{2\text{max}}$ (at 99.9%)	370	-	-	kHz
3) $\Delta f_{2\text{avg}} / \Delta f_{1\text{avg}}$	0.8	-	-	-
Carrier frequency offset and drift				
1) Frequency offset (f_n); $n=0,1,2,3,\dots,k$	-150	-	150	kHz
2) Frequency drift ($ f_0-f_n $); $n=2,3,4,\dots,k$	-	-	50	kHz
3) Drift rate				
a) $ f_1-f_0 $	-	-	23	kHz
b) $ f_n-f_{n-5} $; $n=6,7,8,\dots,k$	-	-	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%)	-	TBD	-70	dBm
Maximum input signal level (PER < 30.8%)	-10	-	-	dBm
PER Report Integrity (-30dBm input)	50	-	65.4	%

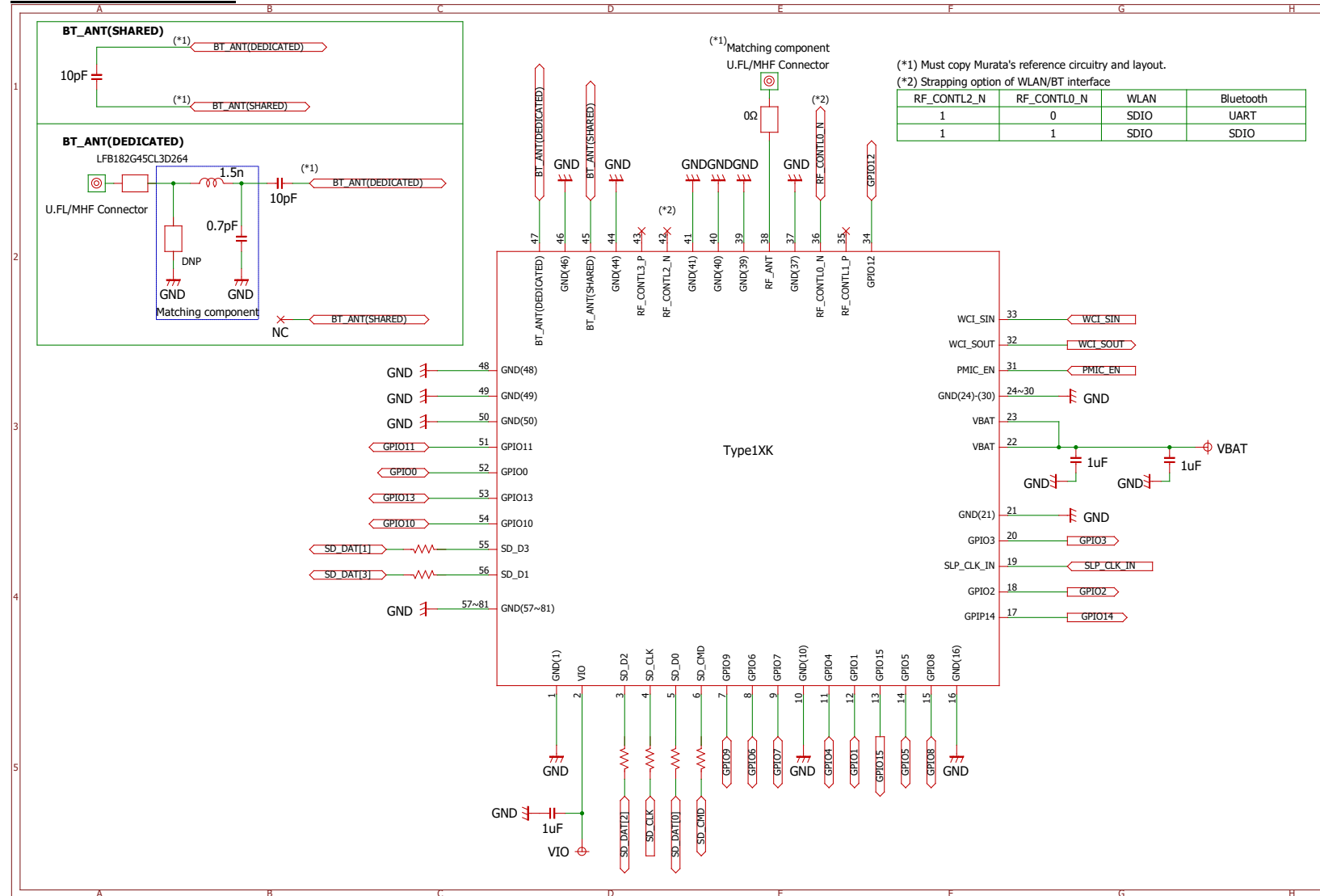
13. Land Patterns



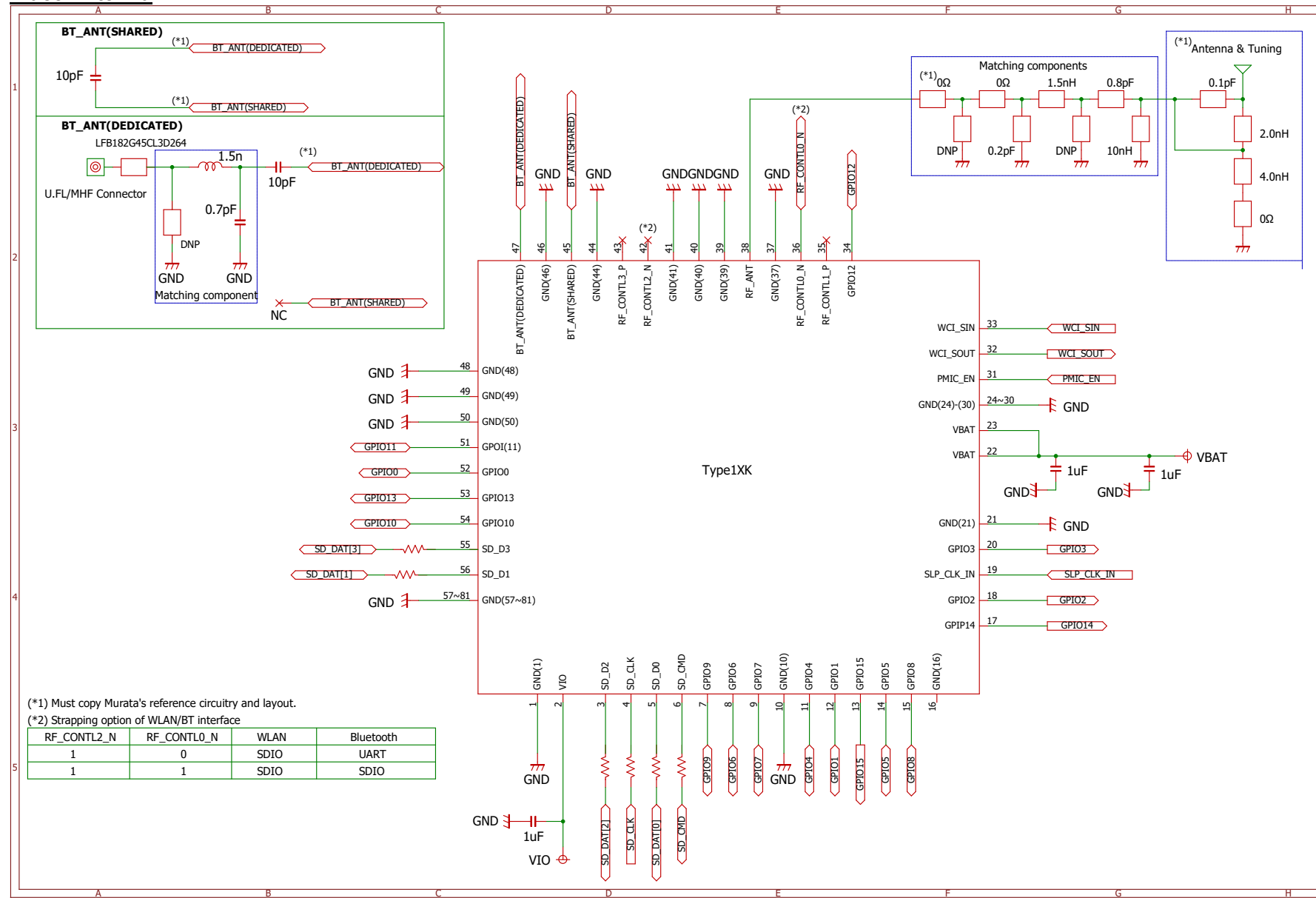
* To avoid the short-circuit between the side shielding and a solder on the module land after the reflow, please locate the module land at 0.2mm away from module outline as above figure.

14. Reference Circuit

U.FL/MHF Connector



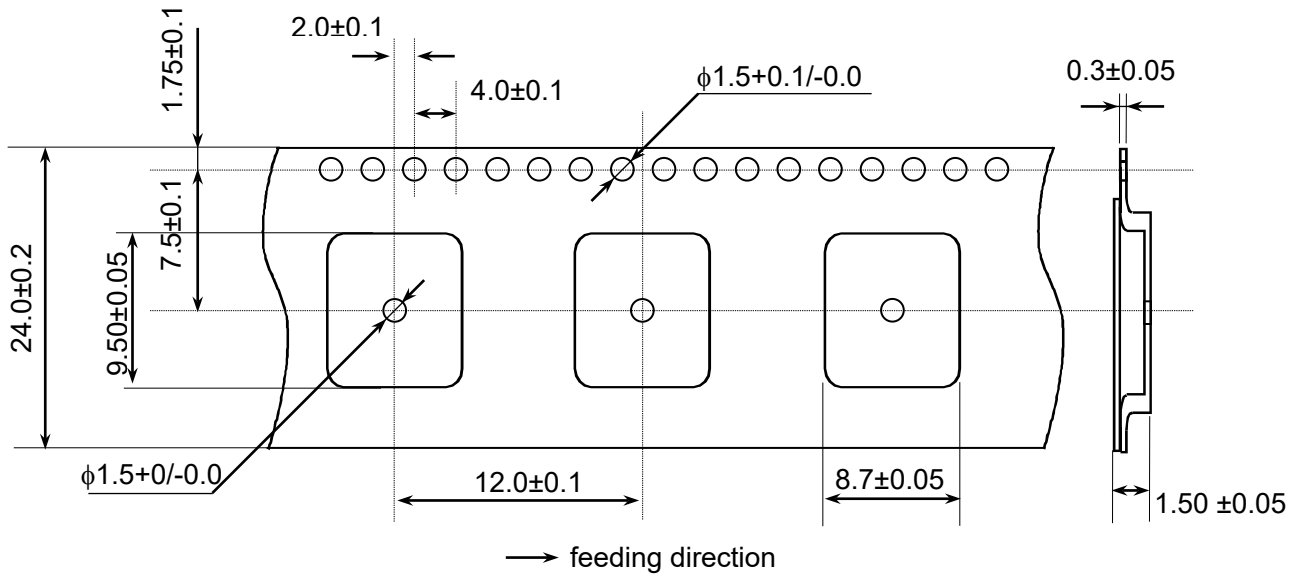
Trace Antenna



15. Tape and Reel Packing

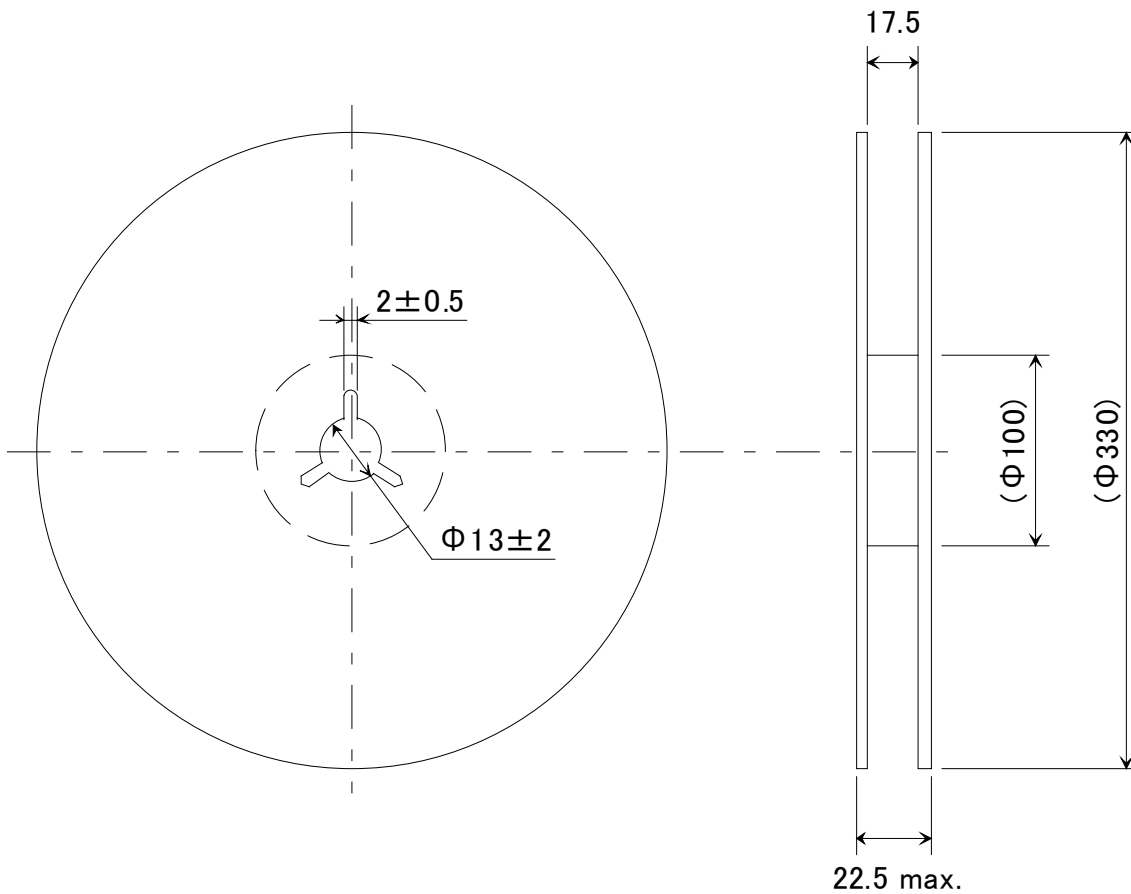
(1) Dimensions of Tape (Plastic tape)

*1. Cumulative tolerance of max. 40.0 ± 0.15 every 10 pitches



(Unit : mm)

(2) Dimensions of Reel



(unit : mm)

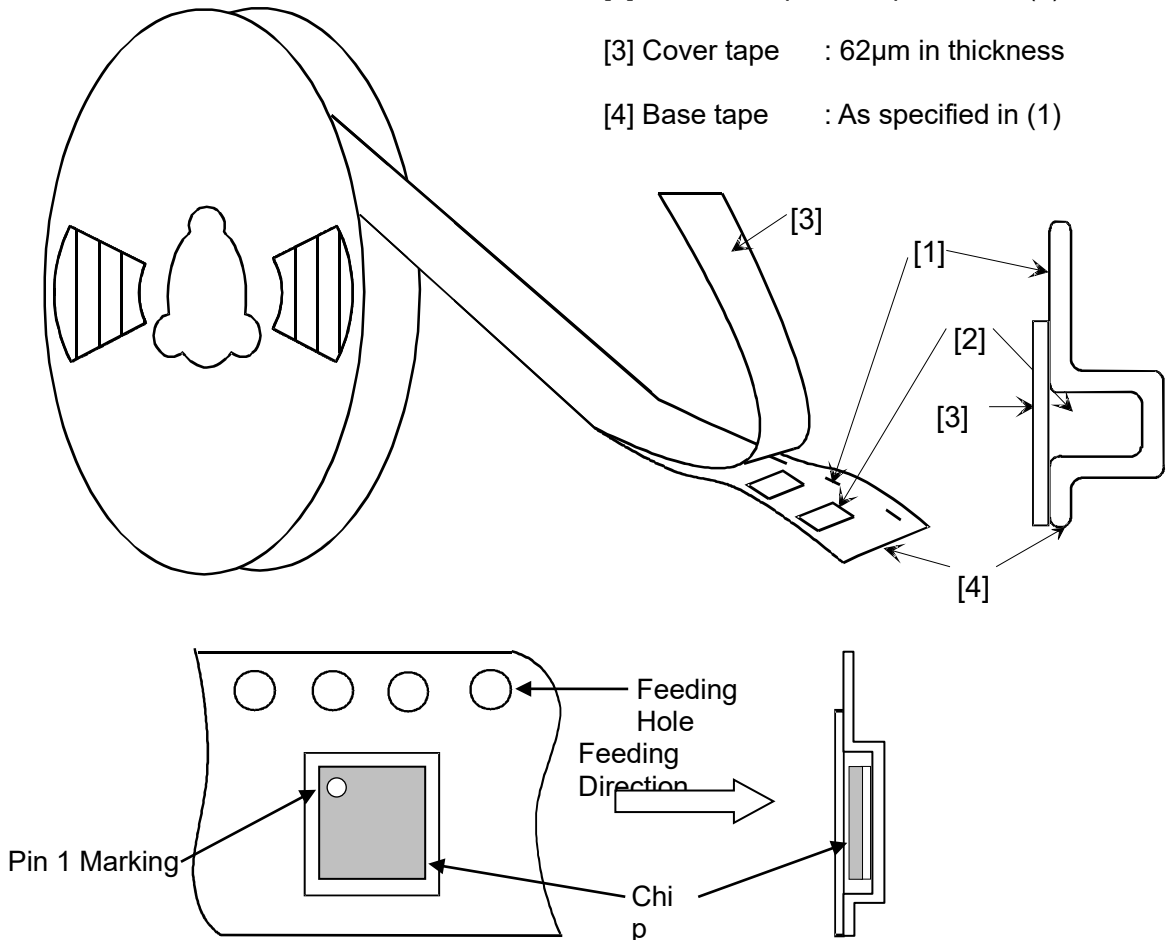
(3) Taping Diagrams

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

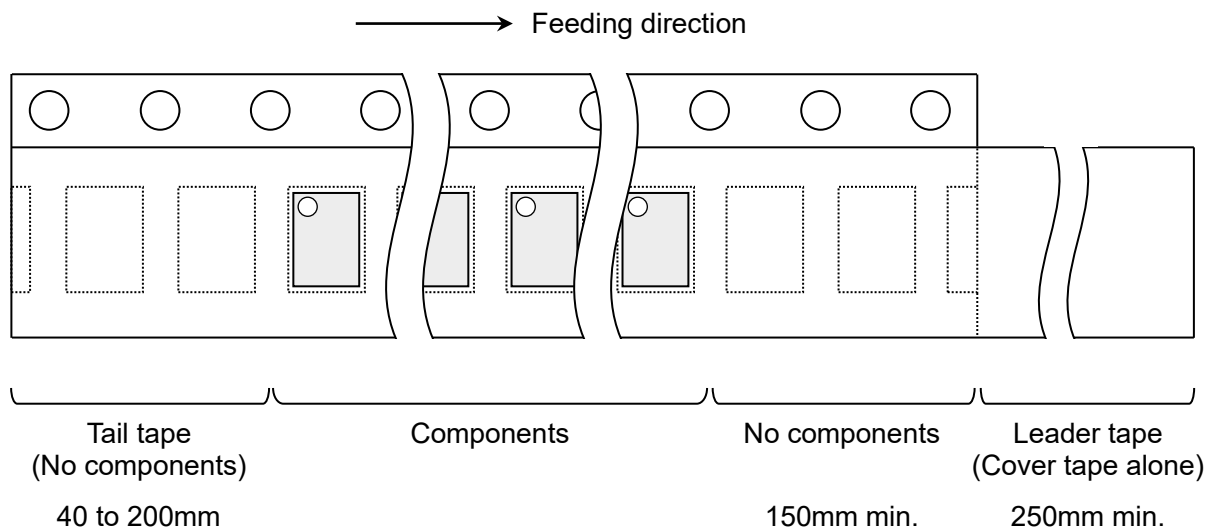
[2] Hole for chip : As specified in (1)

[3] Cover tape : 62μm in thickness

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

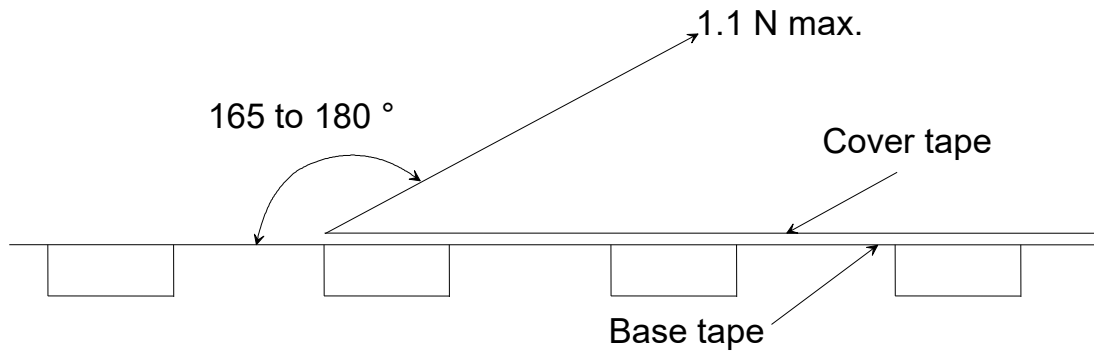


(4) Leader and Tail tape

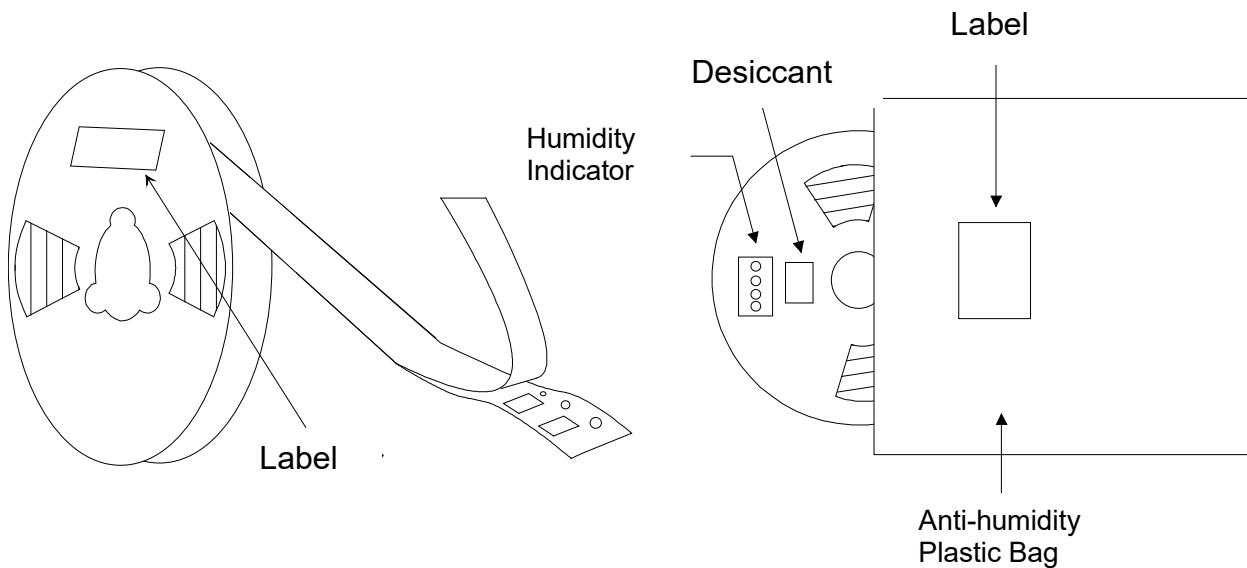


(5) The tape for chips are wound clockwise, the feeding holes to the right side as the tape is pulled toward the user.

- (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.



- (11) Packaging (Humidity proof Packing)



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.

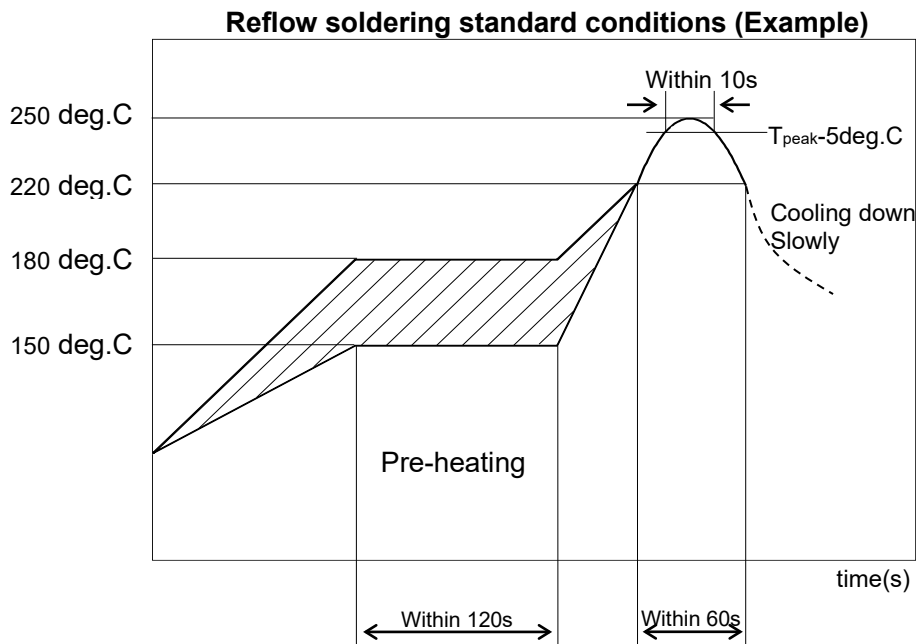
16.4. Notice for Chip Placer:

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.



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 (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.

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

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