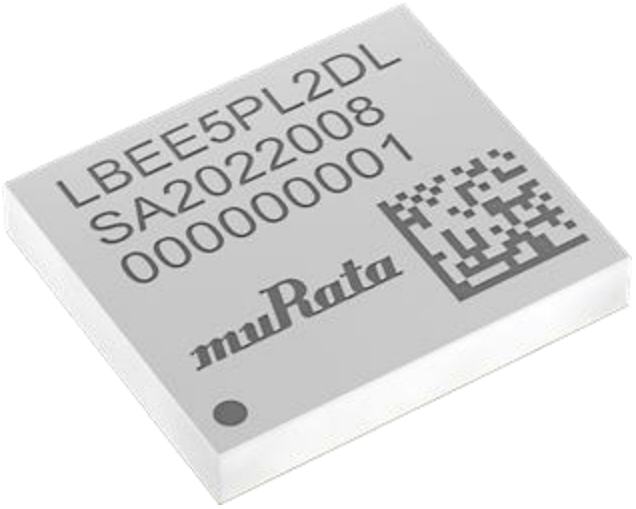
Datasheet

Type 2DL Wi-Fi® + Bluetooth® Module

NXP IW611 Chipset for 802.11a/b/g/n/ac/ax + Bluetooth 5.3
Datasheet - Rev. C

- Design Name: Type 2DL
- P/N: LBEE5PL2DL-921



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About This Document

Murata's Type 2DL is a small and high-performance module based on NXP's IW611 combo chipset, supporting IEEE 802.11a/b/g/n/ac/ax + Bluetooth 5.3 BR/EDR/LE. This datasheet describes Type 2DL module in detail.

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

Audience & Purpose

Intended audience includes any customer looking to integrate this module into their product. In particular, RF, hardware, software, and systems engineers.

Document Conventions

Table 1 describes the document conventions.

Table 1: Document Conventions

Conventions	Description
	Warning Note Indicates very important note. Users are strongly recommended to review.
	Info Note Intended for informational purposes. Users should review.
	Menu Reference Indicates menu navigation instructions. **Example**: Insert➔Tables➔Quick Tables➔Save Selection to Gallery
	External Hyperlink This symbol indicates a hyperlink to an external document or website. **Example**: Embedded Artists AB Click on the text to open the external link.
	Internal Hyperlink This symbol indicates a hyperlink within the document. **Example**: Scope Click on the text to open the link.
`Console input/output or code snippet`	**Console I/O or Code Snippet** This text ***Style*** denotes console input/output or a code snippet.
`# Console I/O comment` `// Code snippet comment`	**Console I/O or Code Snippet Comment** This text ***Style*** denotes a console input/output or code snippet comment. • Console I/O comment (preceded by "#") is for informational purposes only and does not denote actual console input/output. • Code Snippet comment (preceded by "//") may exist in the original code.

1 Scope

This specification characterizes the IEEE 802.11a/b/g/n/ac/ax WLAN + Bluetooth 5.3 BR/EDR/LE combo module.

2 Key Features

- NXP IW611 inside
- Supports IEEE 802.11a/b/g/n/ac/ax specifications: Dual band 2.4 GHz and 5 GHz
- SISO with 20, 40 and 80 MHz channels
- Up to MCS11 data rates (601 Mbps)
- Supports Bluetooth specification version 5.3
- For supported Bluetooth functions, refer to Bluetooth SIG site
- WLAN interface: SDIO 3.0
- Bluetooth interface: HCI UART
- Temperature Range: - 40 °C to 85 °C
- Dimensions: 8.8 x 7.7 x 1.3 mm
- Weight: 0.22 g
- MSL: 3
- Surface-mount type
- RoHS compliant
- Total Fit : 54

3 Ordering Information

The part number and associated ordering information is shown in **Table 2**.

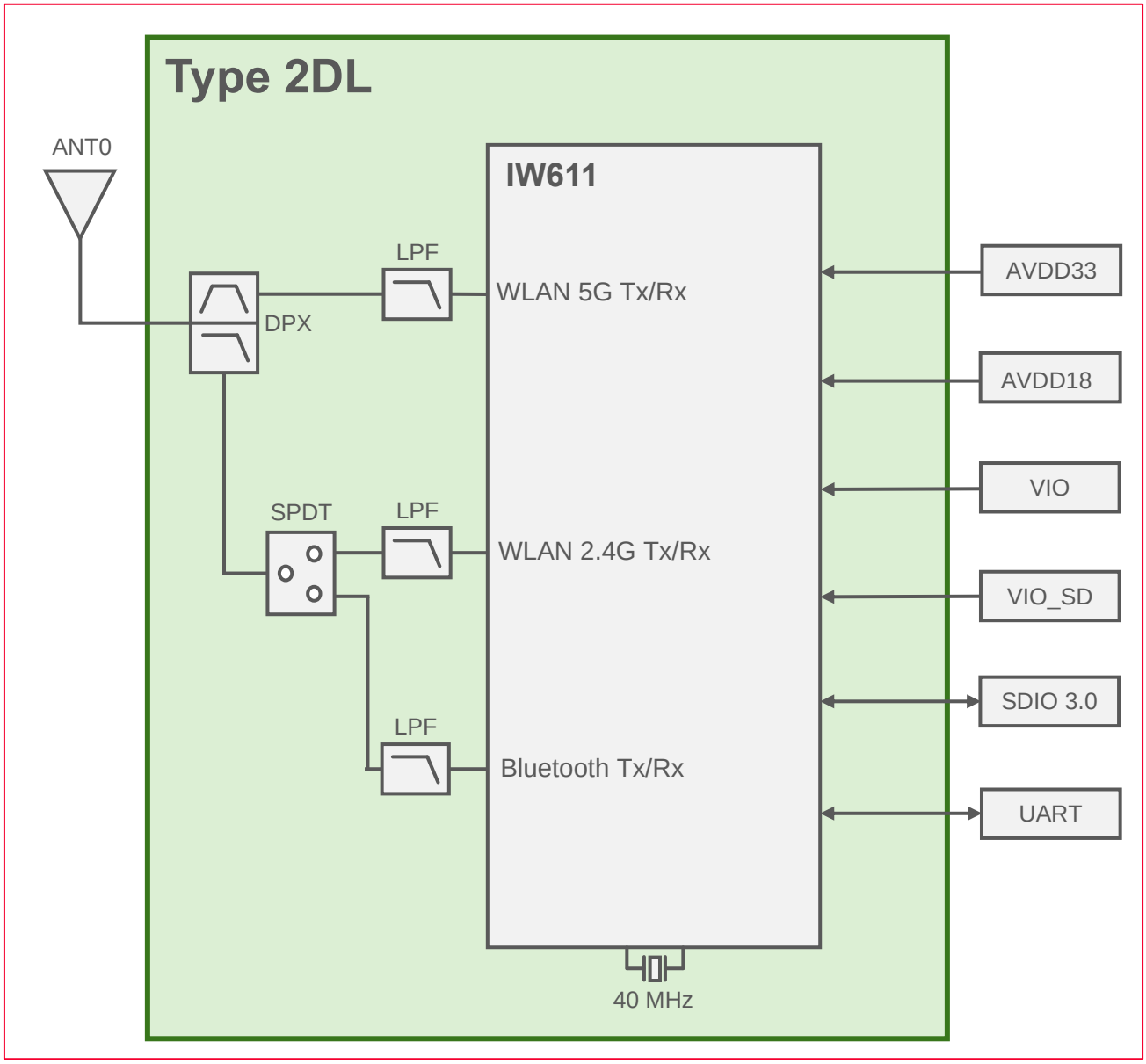
Table 2: Ordering Information

Ordering Part Number	Description
LBEE5PL2DL-921	Module order
LBEE5PL2DL-SMP	Sample module order (If module samples are not available through distribution, contact Murata referencing this part number)
LBEE5PL2DL-EVB	Murata Type 2DL M.2 EVB (contact Murata as this is special order item)

4 Block Diagram

Figure 1 shows the block diagram.

Figure 1: Block Diagram



5 Certification Information

This section describes the radio and Bluetooth qualification.

5.1 Radio Certification

Table 3 describes the certification information.

Table 3: Certification Information

Country	ID	Country Code	Tx Power Limit File	
			Linux	FreeRTOS
USA (FCC)	VPYLBES5PL2EL	US	txpower_US.bin	TBD
Canada (IC)	722C-LBES5PL2EL	CA	txpower_CA.bin	TBD
Europe	EN300328/301893, EN300440 conducted test report is prepared.	DE	txpower_EU.bin	TBD
Japan	Japanese type certification is prepared. Ⓡ 001-P02019	JP	txpower_JP.bin	TBD

5.2 Radio Regulatory Certification by Country

Murata have prepared the document about Radio Regulatory Certification separately.

This document is designed to ensure that module manufacturers correctly communicate the necessary information to host manufacturers that incorporate their modules.

Refer to Type 2DL Radio Law Approval Application Note for Radio Law Certification user manual.

If you don't follow the rule written in Type 2DL Radio Law Approval Application Note, there is a risk of conflict Radio Law Certification.

Please be sure to check the documents.

5.3 Bluetooth Qualification

- QDID: 202018
- Set Bluetooth Tx Power to Class 1 by using bt_power_config_1.sh.
- For supported Bluetooth functions, refer to Bluetooth SIG site.

6 Dimensions, Marking, and Terminal Configurations

The dimensions, marking, and terminal configurations are labelled in **Figure 2**.

Figure 2: Dimensions and Terminal Configurations Markings

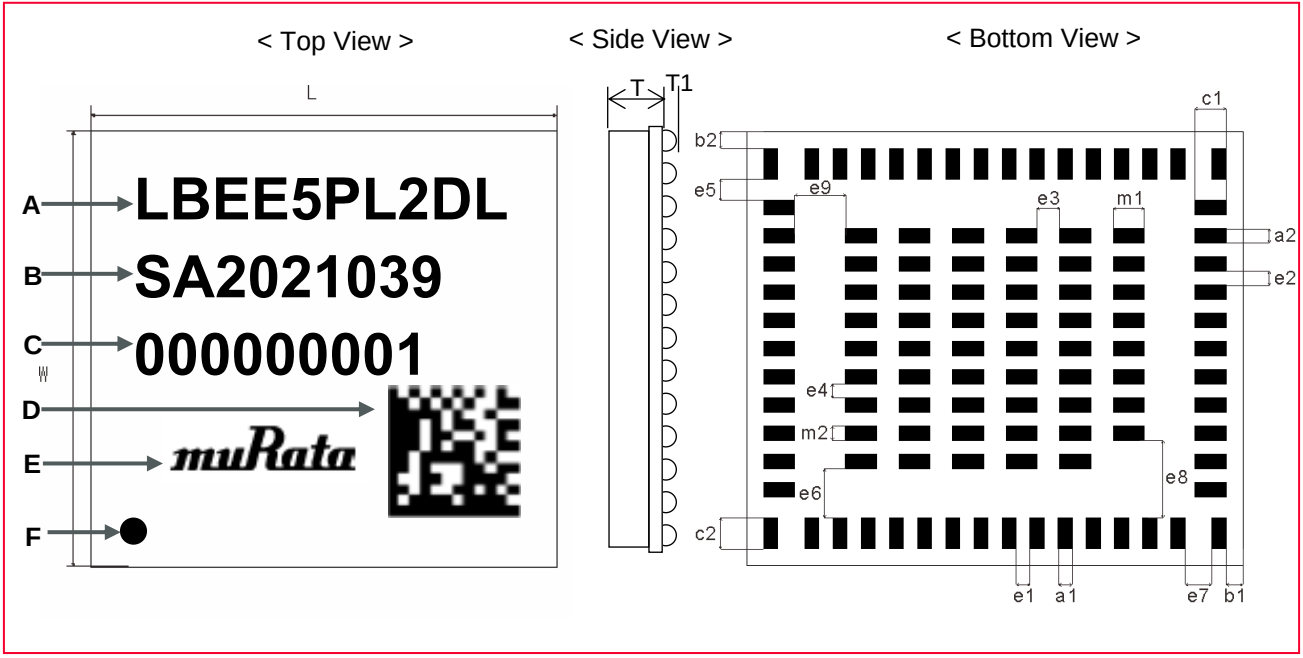


Table 4 and **Table 5** describes the marking labels for the top and bottom view as shown in **Figure 2**.

Table 4: Markings (Top View)

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

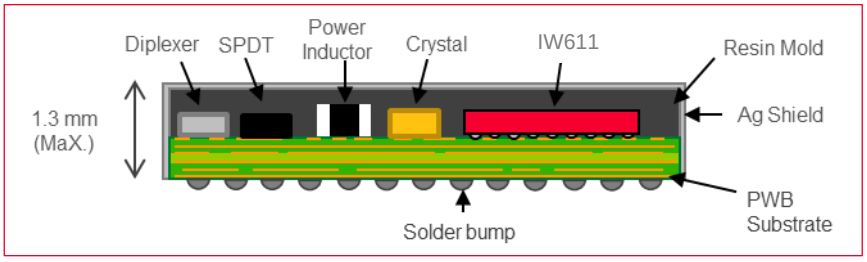
Table 5: Dimensions

Mark	Dimensions (mm)	Mark	Dimensions (mm)	Mark	Dimensions (mm)
L	8.8 +/- 0.2	W	7.7 +/- 0.2		
T	1.3 maximum	T1	0.04 typical (Bump)		
a1	0.25 +/- 0.1	a2	0.25 +/- 0.1	b1	0.3 +/- 0.2
b2	0.3 +/- 0.2	c1	0.55 +/- 0.1	c2	0.55 +/- 0.1
e1	0.25 +/- 0.1	e2	0.25 +/- 0.1	e3	0.4 +/- 0.1

e4	0.25 +/- 0.1	e5	0.375 +/- 0.1	e6	0.875 +/- 0.1
e7	0.475 +/- 0.1	e8	1.375 +/- 0.1	e9	0.9 +/- 0.1
m1	0.55 +/- 0.1	m2	0.25 +/- 0.1		

Figure 3 shows the Type 2DL structure.

Figure 3: Structure



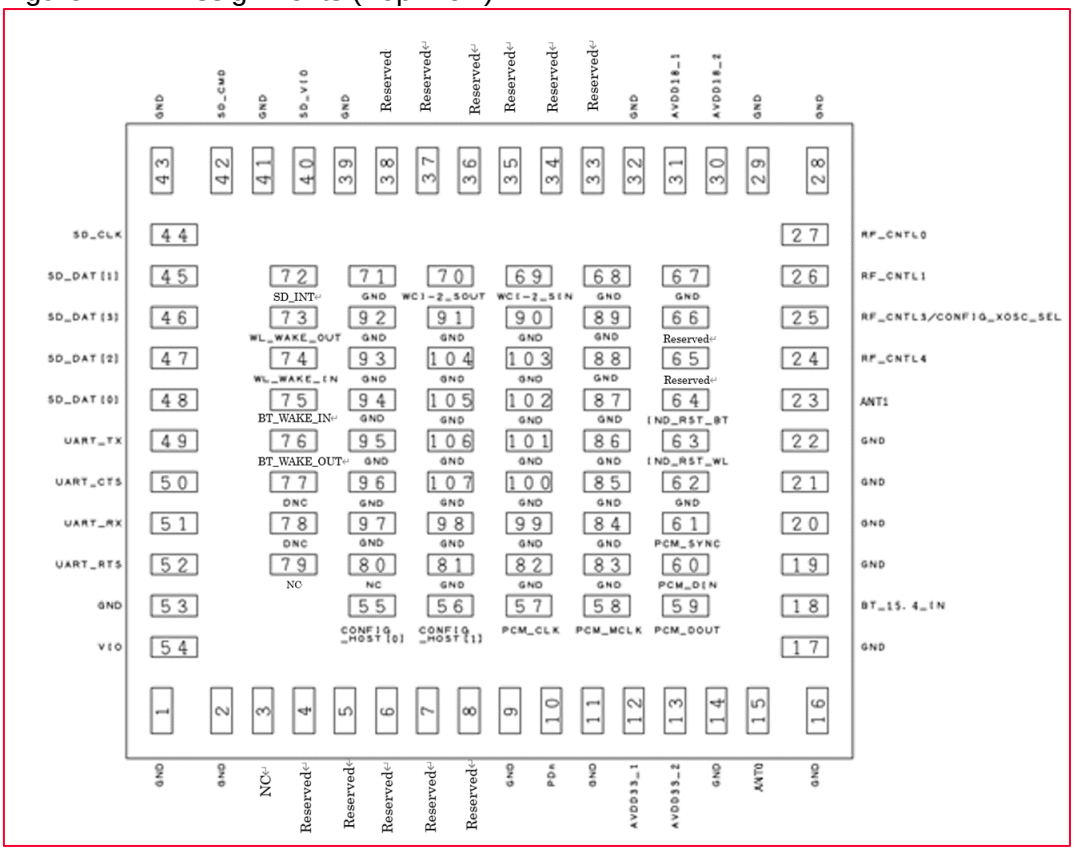
7 Module Pin Description

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

7.1 Pin Assignments

Type 2DL pin-assignment top view is presented in **Figure 4**.

Figure 4: Pin Assignments (Top View)



The terminal names are listed in **Table 6**.

Table 6: Terminal Names

No.	Terminal Name	No.	Terminal Name	No.	Terminal Name
1	GND	29	GND	57	PCM_CLK
2	GND	30	AVDD18_2	58	PCM_MCLK
3	NC	31	AVDD18_1	59	PCM_DOUT
4	Reserved	32	GND	60	PCM_DIN
5	Reserved	33	Reserved	61	PCM_SYNC
6	Reserved	34	Reserved	62	GND
7	Reserved	35	Reserved	63	IND_RST_WL
8	Reserved	36	Reserved	64	IND_RST_BT
9	GND	37	Reserved	65	Reserved
10	PDn	38	Reserved	66	Reserved
11	GND	39	GND	67	GND
12	AVDD33_1	40	SD_VIO	68	GND
13	AVDD33_2	41	GND	69	WCI-2_SIN
14	GND	42	SD_CMD	70	WCI-2_SOUT
15	ANT0	43	GND	71	GND
16	GND	44	SD_CLK	72	SD_INT
17	GND	45	SD_DAT[1]	73	WL_WAKE_OUT
18	BT_IN	46	SD_DAT[3]	74	WL_WAKE_IN
19	GND	47	SD_DAT[2]	75	BT_WAKE_IN
20	GND	48	SD_DAT[0]	76	BT_WAKE_OUT
21	GND	49	UART_TX	77	NC
22	GND	50	UART_CTS	78	NC
23	ANT1	51	UART_RX	79	NC
24	RF_CNTL4	52	UART_RTS	80	NC
25	RF_CNTL3/CONFIG_XOSC_SEL	53	GND	81 - 107	GND
26	RF_CNTL1	54	VIO		
27	RF_CNTL0	55	CONFIG_HOST[0]		
28	GND	56	CONFIG_HOST[1]		

7.2 Pin Descriptions

Table 7 lists the pin descriptions of Type 2DL.

Table 7: Pin Descriptions

No.	Terminal name	Type	Connection to IC Terminal	Description
1	GND			Ground
2	GND			Ground
3	NC		NC	Not Connected
4	Reserved	I/O	GPIO[20]	Multi-functional pin: GPIO[20]. Input/output NC when not in use.
5	Reserved	I/O	GPIO[14]	Multi-functional pin: GPIO[14]. Input/output NC when not in use.
6	Reserved	I/O	GPIO[15]	Multi-functional pin: GPIO[15]. Input/output NC when not in use.
7	Reserved	I/O	GPIO[12]	Multi-functional pin: GPIO[12]. Input/output NC when not in use.

No.	Terminal name	Type	Connection to IC Terminal	Description
8	Reserved	I/O	GPIO[13]	Multi-functional pin: GPIO[13]. Input/output NC when not in use.
9	GND			Ground
10	PDn	I	PDn	Full Power-down (input) (active low) 0 = full power-down mode 1 = normal mode PDn can accept an input of 1.8V to 4.5V PDn may be driven by the host. PDn must be high for normal operation. No internal pull-up on this pin. This pin has an always-on internal weak pull-down.
11	GND			Ground
12	AVDD33_1	Power	AVDD33	Power supply
13	AVDD33_2	Power	AVDD33	Power supply
14	GND			Ground
15	ANT0	I/O		ANT0 is WLAN output and it's also used for BT output when SANT mode.
16	GND			Ground
17	GND			Ground
18	BT_IN	I		BT in (Feedback)
19	GND			Ground
20	GND			Ground
21	GND			Ground
22	GND			Ground
23	ANT1	O		ANT1 is BT output, and it should be connected to BT_IN when SANT mode.
24	RF_CNTL4	I/O	RF_CNTL4	RF control line 4
25	RF_CNTL3/ CONFIG_XOSC_SEL	I/O	F_CNTL3/ CONFIG_ XOSC_SEL	Reference clock frequency select 1=40 MHz RF control line 3
26	RF_CNTL1	O		RF control line 1
27	RF_CNTL0	O		RF control line 0
28	GND			Ground
29	GND			Ground
30	AVDD18_2	Power		Power supply
31	AVDD18_1	Power		Power supply
32	GND			Ground
33	Reserved	I/O	GPIO[31]/JTAG_TDO	Programable GPIO Pin. (JTAG_TDO)[1]
34	Reserved	I/O	GPIO[29]/JTAG_TMS	Programable GPIO Pin. (JTAG_TMS)[1]
35	Reserved	I/O	GPIO[28]/JTAG_TCK	Programable GPIO Pin. (JTAG_TCK)[1]
36	Reserved	I/O	GPIO[30]/JTAG_TDI	Programable GPIO Pin. (JTAG_TDI)[1]
37	Reserved	I/O	GPIO[22]	Programable GPIO Pin. NC when not in use.
38	Reserved	I/O	GPIO[24]	Multi-functional pin: GPIO[24] input/output NC when not in use.
39	GND			Ground
40	SD_VIO	Power		Power supply
41	GND			Ground

[1] NXP internal use only

No.	Terminal name	Type	Connection to IC Terminal	Description
42	SD_CMD	I/O	SD_CMD	SDIO 4-bit mode: Command/response (input/output) SDIO 1-bit mode: Command line (input/output)
43	GND			Ground
44	SD_CLK	I	SD_CLK	SDIO 4-bit mode: Clock input SDIO 1-bit mode: Clock input
45	SD_DAT[1]	I/O	SD_DAT[1]	SDIO 4-bit mode: Data line bit [1] SDIO 1-bit mode: Interrupt
46	SD_DAT[3]	I/O	SD_DAT[3]	SDIO 4-bit mode: Data line bit [3] SDIO 1-bit mode: Reserved
47	SD_DAT[2]	I/O	SD_DAT[2]	SDIO 4-bit mode: Data line bit[2] or read wait (optional) SDIO 1-bit mode: Read wait (optional)
48	SD_DAT[0]	I/O	SD_DAT[0]	SDIO 4-bit mode: Data line bit[0] SDIO 1-bit mode: Interrupt.
49	UART_TX	I/O	UART_TX	UART serial output signal
50	UART_CTS	I/O	UART_CTS	UART clear-to-send input signal.
51	UART_RX	I/O	UART_RX	UART serial input signal
52	UART_RTS	I/O	UART_RTS	UART request-to-send output signal
53	GND			Ground
54	VIO	Power		Power supply.
55	CONFIG_HOST[0]	I	CONFIG_HOST[0]	Firmware Boot Option Refer to Section 7.3.
56	CONFIG_HOST[1]	I	CONFIG_HOST[1]	Firmware Boot Option Refer to Section 7.3.
57	PCM_CLK	I/O	GPIO[4]/PCM_CLK	GPIO[4] input/output PCM clock signal. · Central mode: output · Peripheral mode: input I2S audio bit clock. . Central mode: output . Peripheral mode: input
58	PCM_MCLK	I/O	GPIO[3]/PCM_MCLK	GPIO[3] input/output PCM codec main clock signal (optional). Optional clock used for some codecs. Derived from PCM_CLK. I2S clock output signal O ptional clock used for some codecs. Derived from I2S_BCLK.
59	PCM_DOUT	I/O	GPIO[5]/PCM_DOUT	GPIO[5] input/output PCM transmit data signal (output). *Connect to PCM audio codec input data (for playback). I2S_DOUT - I2S transmit data signal (output). I2S audio codec input data (for playback).
60	PCM_DIN	I/O	GPIO[6]/PCM_DIN	GPIO[6] input/output PCM transmit data signal (input). *Connect to PCM audio codec output data (for recording). I2S_DIN - I2S receive data signal (input). PCM audio codec output data (for recording).

No.	Terminal name	Type	Connection to IC Terminal	Description
61	PCM_SYNC	I/O	GPIO[7]/PCM_SYNC	GPIO[7] input/output PCM sync pulse signal (output if master, input if slave). · Central mode: output · Peripheral mode: input I2S_LRCLK - I2S left/right clock (output if master, input if slave). · Central mode: output · Peripheral mode: input
62	GND			Ground.
63	IND_RST_WL	I/O	GPIO[1]/ IND_RST_WL	Independent software reset for Wi-Fi Multi-functional pin: GPIO[1] input/output.
64	IND_RST_BT	I/O	GPIO[2]/ IND_RST_BT	Independent software reset for Bluetooth[2]. Multi-functional pin: GPIO[2] input/output.
65	Reserved	I/O	GPIO[27]	Programable GPIO Pin[3]
66	Reserved	I/O	GPIO[23]	Programable GPIO Pin[3]
67	GND			Ground
68	GND			Ground
69	WCI-2_SIN	I/O	GPIO[25]/ WCI-2_SIN	Output signal to external radio. Multi-functional pin: GPIO[26] input/output External radio coexistence interface
70	WCI-2_SOUT	I/O	GPIO[26]/ WCI-2_SOUT	Output signal to external radio. Multi-functional pin: GPIO[26] input/output
71	GND			Ground
72	SD_INT	I/O	GPIO[21]/SD_INT	Out-of-band SDIO interface interrupt signal output. Multi-functional pin: GPIO[21] input/output.
73	WL_WAKE_OUT	I/O	GPIO[17]/ WL_WAKE_OUT	Wi-Fi radio wake-up output signal. **Multi-functional pin:** GPIO[17] input/output.
74	WL_WAKE_IN	I/O	GPIO[16]/ WL_WAKE_IN	Wi-Fi radio wake-up input signal. **Multi-functional pin:** GPIO[16] input/output.
75	BT_WAKE_IN	I/O	GPIO[18]/ BT_WAKE_IN	Bluetooth radio wake-up input signal. **Multi-functional pin:** GPIO[18] input/output.
76	BT_WAKE_OUT	I/O	GPIO[19]/ BT_WAKE_OUT	Bluetooth radio wake-up output signal. **Multi-functional pin:** GPIO[19] input/output
77	NC		NC	Not connected
78	NC		NC	Not connected
79	NC		NC	Not connected
80	NC		NC	Not connected
81-107	GND			Ground

[2] The request to reset either Bluetooth radio leads to reinitialization of both radios.
[3] NC when not in use.

7.3 Configuration Pins

Table 8 describes the configuration pins.

Table 8: Configuration Pins

CONFIG_HOST[0]	CONFIG_HOST[1]	WLAN	Bluetooth/ Bluetooth LE	Remarks
1	1	SDIO	UART	Default
Others	Others	Reserved	Reserved	Reserved

7.4 Pin States

Pin states information for the tables below include:

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

Table 9 describes the pin states.

Table 9: Pin States

Pin Name	Supply	No Pad Power State	Reset State	HW State	PD State	PD Prog	Internal PU/PD	Internal Pull Value
GPIO[13]	VIO	tristate	input	input	drive high	yes	nominal PU	90kΩ
GPIO[20]	VIO	tristate	input	input	Drive low	yes	nominal PU	90kΩ
GPIO[14]	VIO	tristate	input	input	tristate	yes	nominal PU	90kΩ
GPIO[15]	VIO	tristate	output low	output low	drive low	yes	nominal PU	90kΩ
GPIO[12]	VIO	tristate	input	input	tristate	yes	nominal PU	90kΩ
GPIO[22]	VIO	tristate	output high	output low	tristate	yes	nominal PU	90kΩ
UART_TX	VIO	tristate	output high	output high	drive low	yes	nominal PU	90kΩ
UART_CTS	VIO	tristate	input	input	tristate	yes	nominal PU	90kΩ
UART_RX	VIO	tristate	input	input	tristate	yes	nominal PU	90kΩ
UART_RTS	VIO	tristate	output high	output high	drive high	yes	nominal PU	90kΩ
PCM_CLK	VIO	tristate	input	input	tristate	yes	weak PU	800kΩ
PCM_MCLK	VIO	tristate	input	input	tristate	yes	nominal PU	90kΩ
PCM_DOUT	VIO	tristate	input	input	tristate	yes	weak PU	800kΩ
PCM_DIN	VIO	tristate	input	input	tristate	yes	weak PU	800kΩ
PCM_SYNC	VIO	tristate	input	input	tristate	yes	nominal PU	90kΩ

Pin Name	Supply	No Pad Power State	Reset State	HW State	PD State	PD Prog	Internal PU/PD	Internal Pull Value
IND_RST_WL	VIO	tristate	input	input	tristate	yes	nominal PU	90kΩ
IND_RST_BT	VIO	tristate	input	input	tristate	yes	nominal PU	90kΩ
GPIO[27]	VIO	tristate	input	input	tristate	yes	weak PU	800kΩ
GPIO[23]	VIO	tristate	input	input	tristate	yes	nominal PU	90kΩ
WCI-2_SIN	VIO	tristate	input	input	tristate	yes	nominal PU	90kΩ
WCI-2_SOUT	VIO	tristate	input	input	tristate	yes	nominal PU	90kΩ
SD_INT	VIO	tristate	output high	output low	drive low	yes	nominal PU	90kΩ
WL_WAKE_OUT	VIO	tristate	input	input	drive low	yes	nominal PU	90kΩ
WL_WAKE_IN	VIO	tristate	input	input	tristate	yes	weak PU	800kΩ
BT_WAKE_IN	VIO	tristate	input	input	tristate	yes	weak PU	800kΩ
BT_WAKE_OUT	VIO	tristate	input	input	drive low	yes	nominal PU	90kΩ
XOSC_EN	VIO	tristate	input	input	drive low	yes	nominal PU	90kΩ
RF_CNTL4	VIO	tristate	input	input	drive low	yes	weak PU	800kΩ
RF_CNTL3/CONFIG_XOSC_SEL	VIO	tristate	input	input	drive high	yes	weak PU	800kΩ
RF_CNTL1	VIO	tristate	output high	output high	drive high	yes	weak PU	800kΩ
RF_CNTL0	VIO	tristate	output low	output low	drive low	yes	nominal PU	90kΩ
SD_CMD	VIO_SD	tristate	input	input	tristate	yes	nominal PU	90kΩ
SD_CLK	VIO_SD	tristate	input	input	tristate	yes	nominal PU	90kΩ
SD_DAT[1]	VIO_SD	tristate	input	input	tristate	yes	nominal PU	90kΩ
SD_DAT[3]	VIO_SD	tristate	input	input	tristate	yes	nominal PU	90kΩ
SD_DAT[2]	VIO_SD	tristate	input	input	tristate	yes	nominal PU	90kΩ
SD_DAT[0]	VIO_SD	tristate	Input	Input	Tristate	yes	nominal PU	90kΩ
CONFIG_HOST[0]	AVDD18	tristate	Input	Input	Tristate	no	weak PU	800kΩ
CONFIG_HOST[1]	AVDD18	tristate	Input	Input	Tristate	no	weak PU	800kΩ
PDn	AVDD33						weak PD	51kΩ

7.5 SDIO Pin Descriptions

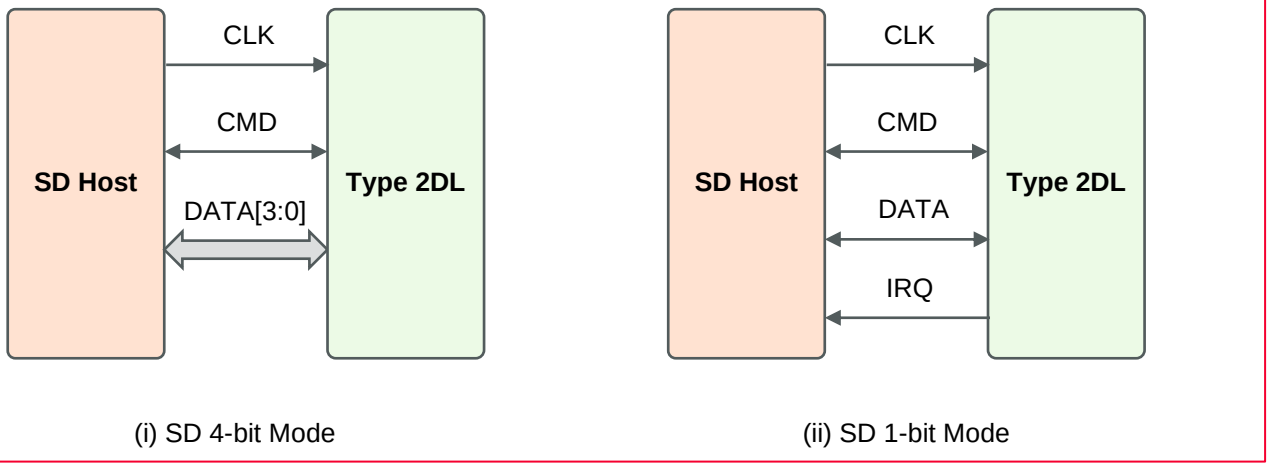
SDIO pins are described in **Table 10**.

Table 10: SDIO Pin Descriptions

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

Figure 5 shows the SDIO Pin Modes.

Figure 5: SDIO Pin Modes



8 Absolute Maximum Ratings

Table 11 Shows the absolute maximum rating values.

Table 11: Absolute Maximum Ratings

Parameter		Minimum	Maximum	Unit
Storage Temperature		-50	+85	ºC
Supply Voltage	AVDD33		3.96	V
	AVDD18		2.16	V
	SD_VIO 1.8V/3.3V		2.16	V
			3.96	V
	VIO 1.8V/3.3V		2.16	V
			3.96	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

Table 12 shows the operating conditions for Type 2DL.

Table 12: Operating conditions

Parameter		Minimum	Typical	Maximum	Unit
Operating Temperature		-40	25	+85	ºC
Supply Voltage	AVDD33	3.14	3.3	3.46	V

Parameter		Minimum	Typical	Maximum	Unit
	AVDD18	1.71	1.8	1.89	V
	SD_VIO/VIO = 1.8V	1.71	1.8	1.89	V
	SD_VIO/VIO = 3.3V	3.14	3.3	3.46	V
Peak Current	AVDD33			420	mA
	AVDD18			1009	mA

Operation beyond the recommended operating conditions is neither recommended nor guaranteed. Peak current is happened during DPD calibration when the firmware is downloaded.

9.2 Digital I/O Requirement

Table 13 describes the digital input and output requirements.

Table 13: Digital I/O Requirements

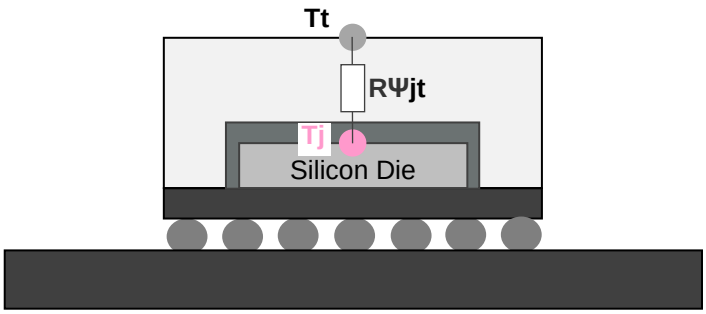
Symbol	Parameter	Condition	Minimum	Typical	Maximum	Unit
V_{IO}	I/O pad supply voltage		1.71	1.8	1.89	V
V_{IH}	Input high voltage		0.7*VIO		VIO+0.4	V
V_{IL}	Input low voltage		-0.4		0.3*VIO	V
V_{HYS}	Input hysteresis		100			mV
V_{OH}	Output high voltage		VIO-0.4			V
V_{OL}	Output low voltage				0.4	V

9.3 Package Thermal Conditions

- RΨjt：3.12 ℃/W
- RΨjt = (Tj - Tt)/P

Tj: Junction temperature (℃), Tt: Top temperature (℃), P: Total Power Consumption (W)

Figure 6: Package Thermal Conditions



10 Power Sequence

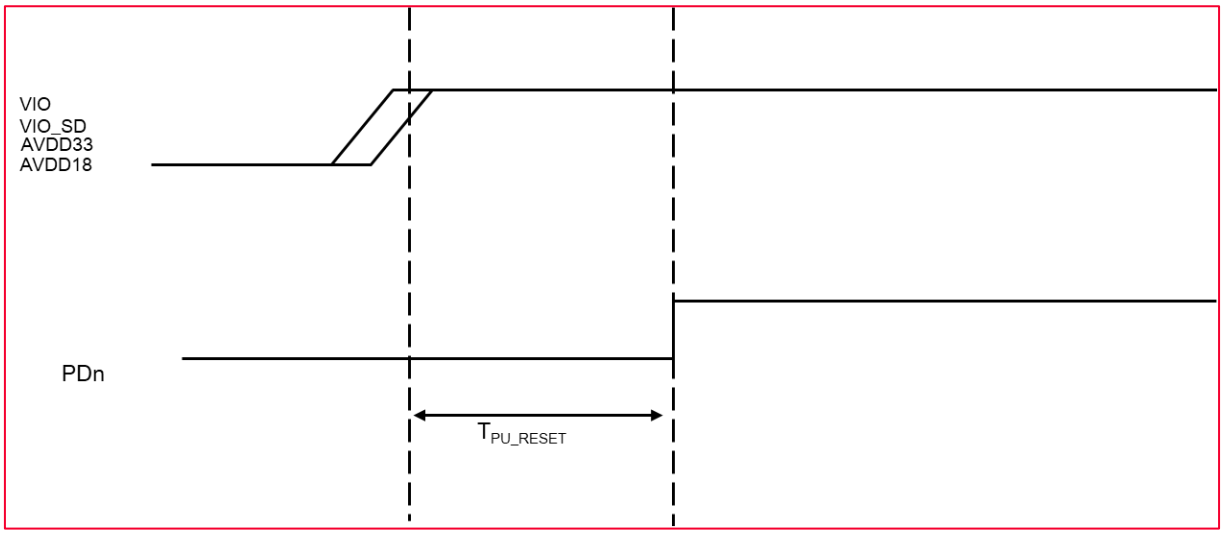
This section describes the power on and power off sequences and host rest sequence.

10.1 Power-On Sequence

VIO, VIO_SD, AVDD33, and AVDD18 can be power upped with 0 second minimum. The PDn signal when it is asserted (low) while all power supplies to the devices are high.

The power-on sequence is shown in **Figure 7**.

Figure 7: Power-On Sequence



PDn pin (power-off) specifications - Power remains high at PDn assertion.

The power-on sequence parameters is described in **Table 14**.

Table 14: Power-On Sequence Parameters

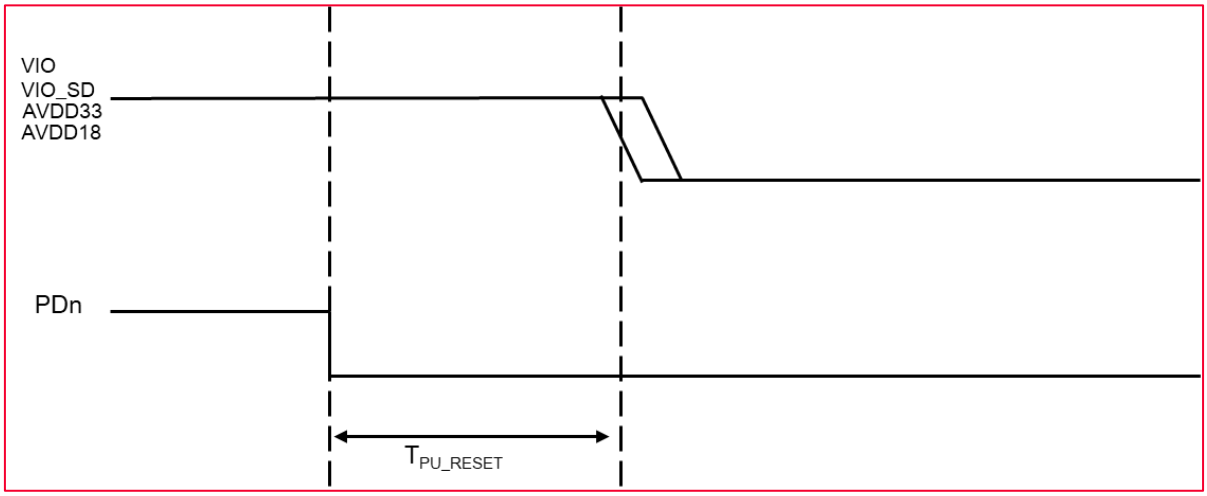
Symbol	Parameter	Condition	Minimum	Typical	Maximum	Unit
T_{VIO_AVDD}	Power up timing of VIO, VIO_SD, AVDD33, and VIO18		0			ms
T_{PU_RESET}	Valid power to PDn de-asserted		0			ms
V_{IH}	Input high voltage		1.4		4.5	V
V_{IL}	Input low voltage		-0.4		0.5	V

Minimum value guaranteed for a valid rest. Smaller values may put the device in an undefined state.

10.2 Power-Off Sequence

The power-off sequence is shown in **Figure 8**.

Figure 8: Power-Off Sequence



The power-off sequence parameters is described in **Table 15**.

Table 15: Power-Off Sequence Parameters

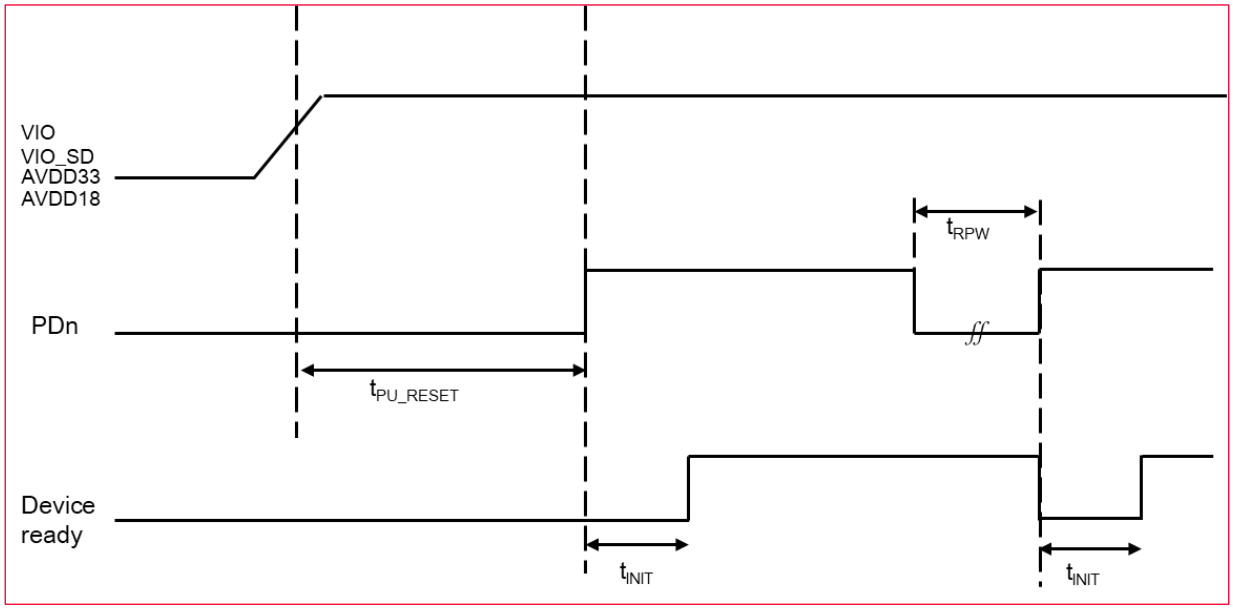
Symbol	Parameter	Condition	Minimum	Typical	Maximum	Unit
T_{VIO_AVDD}	Power up timing of VIO, VIO_SD, AVDD33, and VIO18		0			ms
T_{PU_RESET}	Valid power to PDn de-asserted		0			ms
V_{IH}	Input high voltage		1.4		4.5	V
V_{IL}	Input low voltage		-0.4		0.5	V

Minimum value guaranteed for a valid rest. Smaller values may put the device in an undefined state.

10.3 Hot Reset Sequence

Figure 9 shows the hot reset sequence.

Figure 9: Hot Reset Sequence



The hot sequence parameters are described in **Table 16**.

Table 16: Hot Reset Sequence Parameters

Symbol	Parameter	Condition	Minimum	Typical	Maximum	Unit
t_{PU_RESET}	Valid power to PDn de-asserted		0			ms
t_{PRW}	PDn pulse width		1[4]			µs
t_{INIT}	From PDn de-assertion to device ready (SDIO bus enumeration)		20			ms
V_{IH}	Input high voltage		1.4		4.5	V
V_{IL}	Input low voltage		-0.4		0.5	V

[4] Minimum value guaranteed for a valid rest. Smaller values may put the device in an undefined state.

11 Interface Timing

This section describes interface timings:

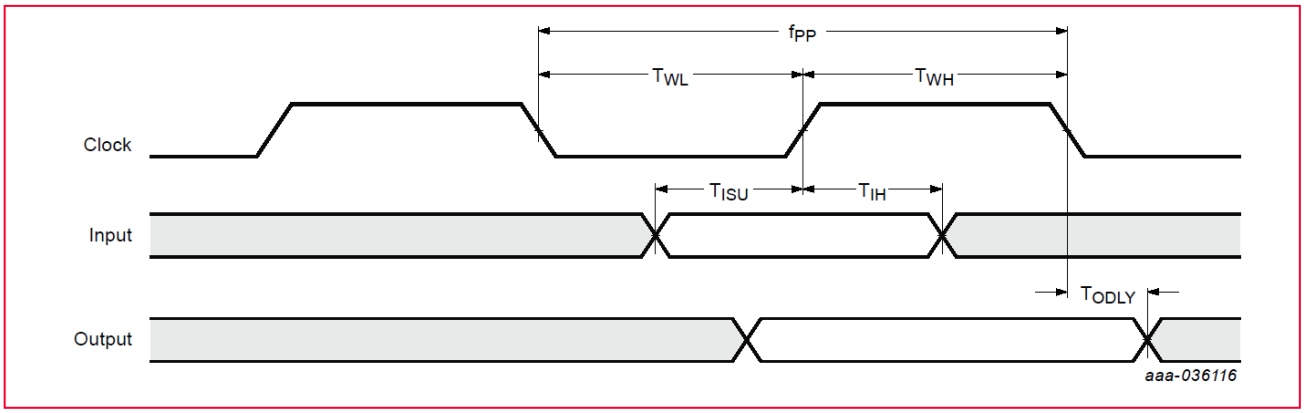
- SDIO timing (default and high-speed modes)
- SDIO protocol timings
- UART timing (default mode)
- Bluetooth PCM timing (master and slave mode)

11.1 SDIO Timing (Default Speed Mode)

11.1.1 Default Speed Mode

This section describes the SDIO protocol timing diagram in default speed mode. The sequence is shown in **Figure 10**.

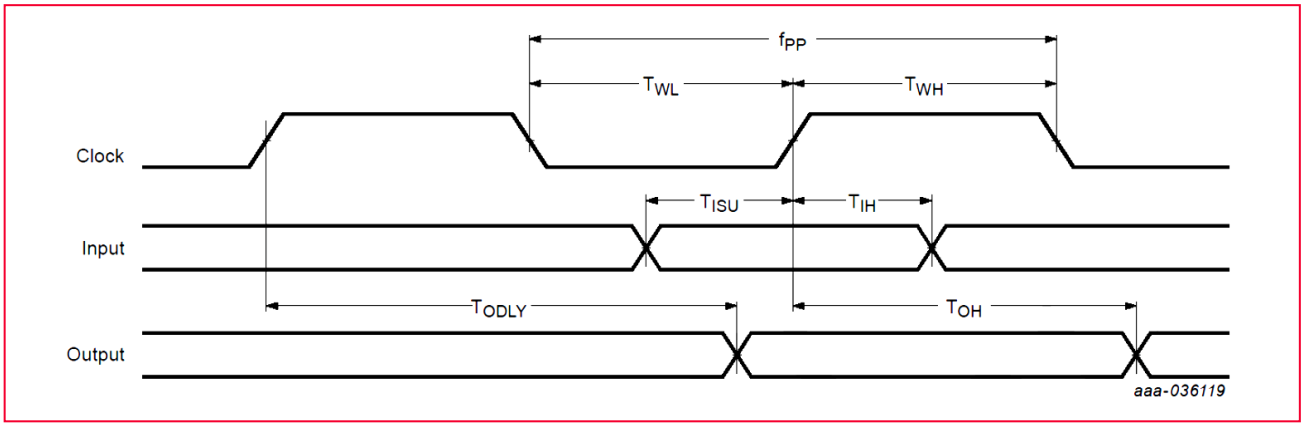
Figure 10: SDIO Protocol Timing Diagram - Default Speed Mode



11.1.2 High Speed Mode

Figure 11 describes the SDIO protocol timing diagram - high speed mode parameters.

Figure 11: SDIO Protocol Timing Diagram - High Speed Mode



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

Table 17 describes the SDIO protocol high speed mode parameters.

Table 17: SDIO Protocol Timing High Speed Mode Parameters

Symbol	Parameter	Condition	Minimum	Typical	Maximum	Unit
f_{PP}	Clock frequency	Normal	0		25	MHz
		High-speed	0		50	MHz
T_{WL}	Clock low time	Normal	10			ns
		High-speed	7			ns
T_{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 put hold time	High-speed	2.5			ns

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

Figure 12 shows the SDR12, SDR25, and SDR50 modes at 1.8V (up to 100 MHz).

Figure 12: SDR12, SDR25, and SDR50 modes at 1.8V (up to 100 MHz)

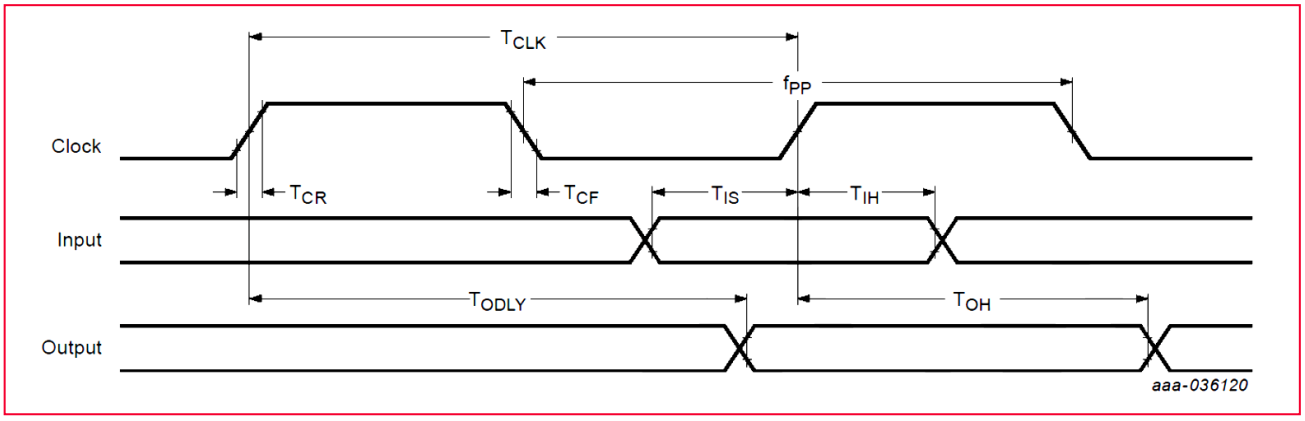


Table 18 describes the SDR12, SDR25, and SDR50 parameters.

Table 18: Parameters for SDR12, SDR25, and SDR50 Modes at 1.8V (up to 100 MHz)

Symbol	Parameter	Condition	Minimum	Typical	Maximum	Unit
f_{PP}	Clock frequency	SDR12/25/50	25		100	MHz
T_{IS}	Input setup time	SDR12/25/50	3			MHz
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 (maximum) at 100 MHz C_{CARD} = 10 pF	SDR12/25/50			0.2*T_{CLK}	ns
T_{OLDY}	Output delay time CL ≤ 15 pF	SDR12/25/50			7.5	ns
T_{OH}	Input setup time	SDR12/25/50	1.5			ns

11.1.4 SDR104 mode (208 MHz) (1.8V)

Figure 13: shows SDIO protocol timing diagram for SDR104 Mode (up to 208 MHz) at 1.8V.

Figure 13: SDR104 mode at 1.8V (208 MHz)

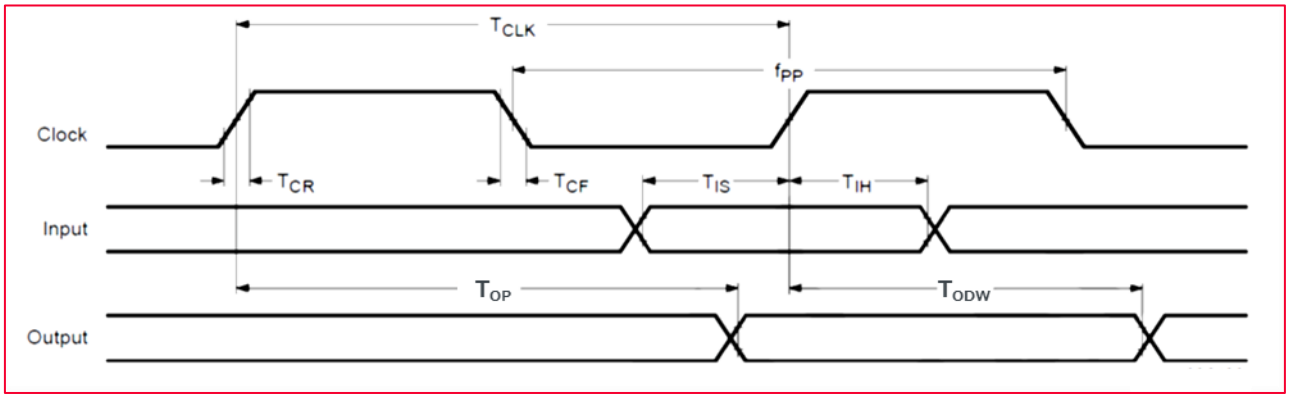


Table 19: SDIO Protocol Timing Parameters - SDR104 ModeTable 18 describes SDIO protocol timing data for SDR104 Mode (up to 208 MHz) at 1.8V.

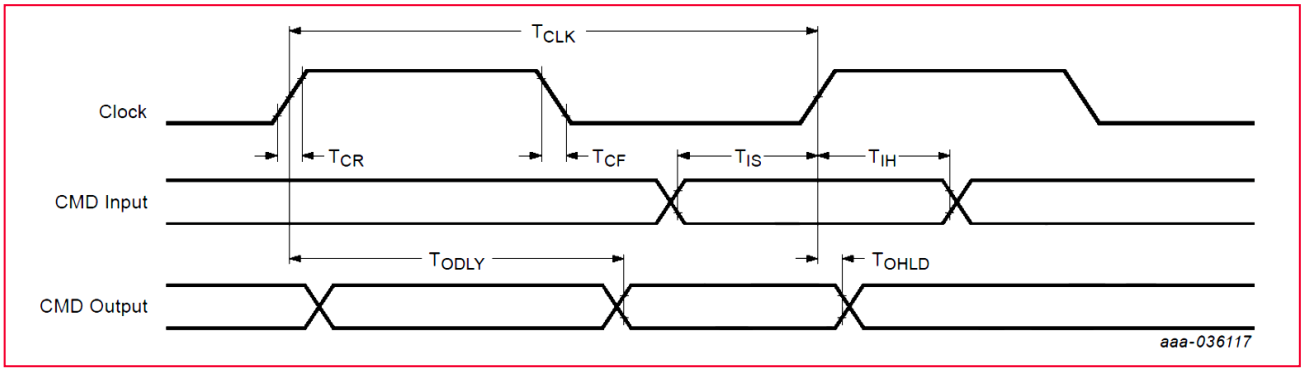
Table 19: SDIO Protocol Timing Parameters - SDR104 Mode

Symbol	Parameter	Condition	Minimum	Typical	Maximum	Unit
f_{PP}	Clock frequency	SDR104	0		208	MHz
T_{IS}	Input setup time	SDR104	1.4			MHz
T_{IH}	Input hold time	SDR104	0.8			ns
T_{CLK}	Clock time	SDR104	4.8			ns
T_{CR}, T_{CF}	Rise time, fall time T_{CR}, T_{CF} < 0.96 ns (maximum) at 208 MHz C_{CARD} = 10 pF	SDR104			0.2*T_{CLK}	ns
T_{OP}	Card output phase	SDR104			2	ns
T_{ODW}	Output timing of variable data window	SDR104	2.88			ns

11.1.5 DDR50 Mode at 1.8V (50 MHz)

Figure 14 shows DDR50 mode at 1.8V (50 MHz).

Figure 14: DDR50 Mode at 1.8V (50 MHz)



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

Figure 15 shows the SDIO DATA timing diagram - DDR50 mode.

Figure 15: SDIO DATA Timing Diagram - DDR50 Mode

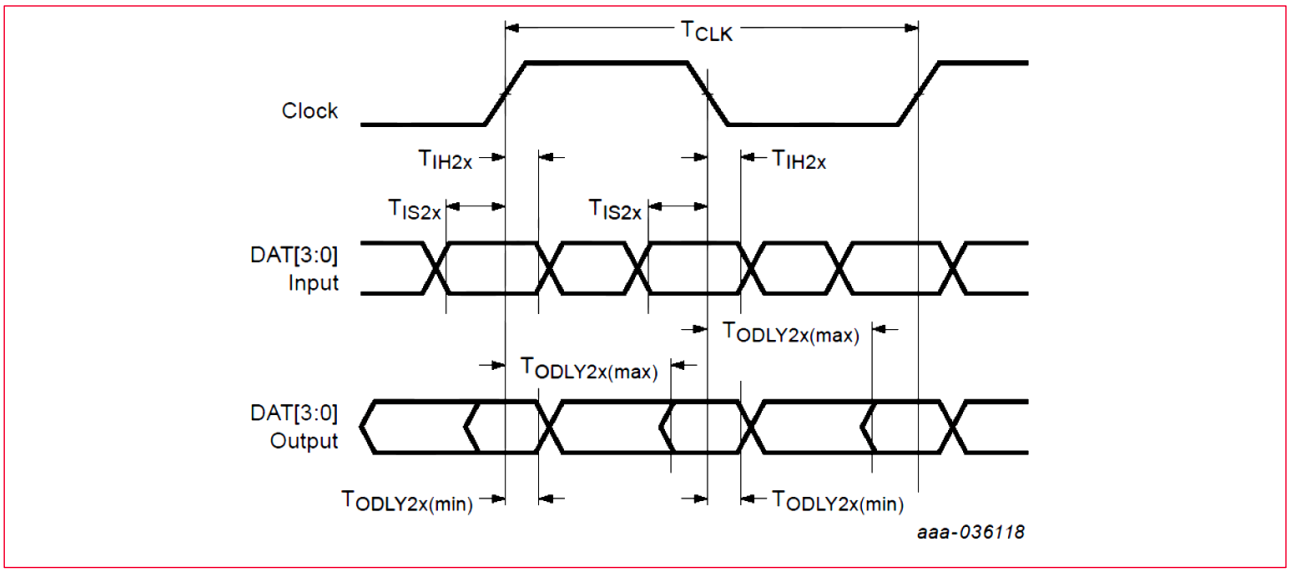


Table 20 describes the parameters for DDR50 mode at 1.8V (50 MHz).

Table 20: Parameters for DDR50 Mode at 1.8V (50 MHz)

Symbol	Parameter	Condition	Minimum	Typical	Maximum	Unit
Clock						
T_{CLK}	Clock time 50 MHz (maximum) between rising edge	DDR50	20			ns
T_{CR}, T_{CF}	Rise time, fall time. T_{CR}, T_{CF} < 4.00 ms (maximum) at 50 MHz	DDR50	3		0.2*T_{CLK}	ns
		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 CL ≤ 30 pF (1card)	DDR50			13.7	ns
T_{OHLD}	Output hold time CL ≤ 30 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_{OLD2x} (maxi)	Output delay time during data transfer mode CL ≤ 25 pF (1 card)	DDR50			7.0	ns
T_{OLDY2x} (min)	Output hold time CL ≤ 15 pF (1 card)	DDR50	1.5			ns

11.2 UART Timing (Default Mode)

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

Figure 16 shows the UART timing default mode signals.

Figure 16: UART Timing Default Mode Signals

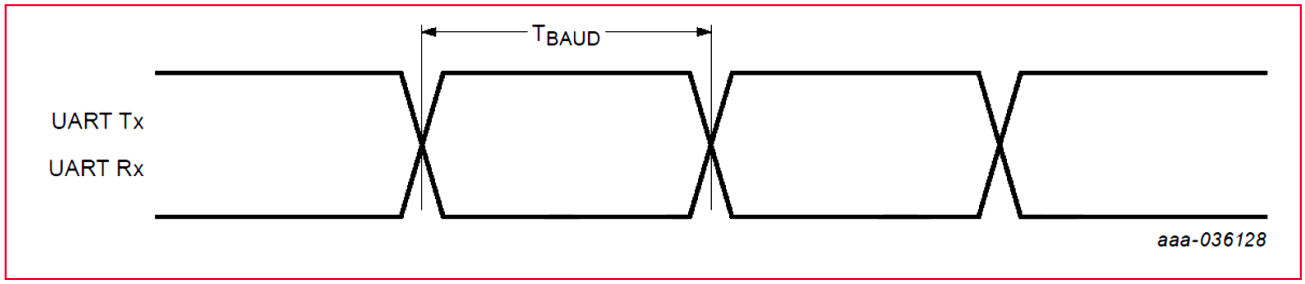


Table 21 describes the UART timing default mode parameters.

Table 21: UART Timing Default Mode Parameters

Symbol	Parameter	Condition	Minimum	Typical	Maximum	Unit
TBAUD	Baud rate	38.4 MHz	250			ns

11.3 Bluetooth PCM Timing

This section describes the Bluetooth PCM timing master mode and slave mode data signals and PCM_SYNC signals.

11.3.1 Master Mode

Figure 17 shows the master mode data signals.

Figure 17: Data Signals (Master Mode)

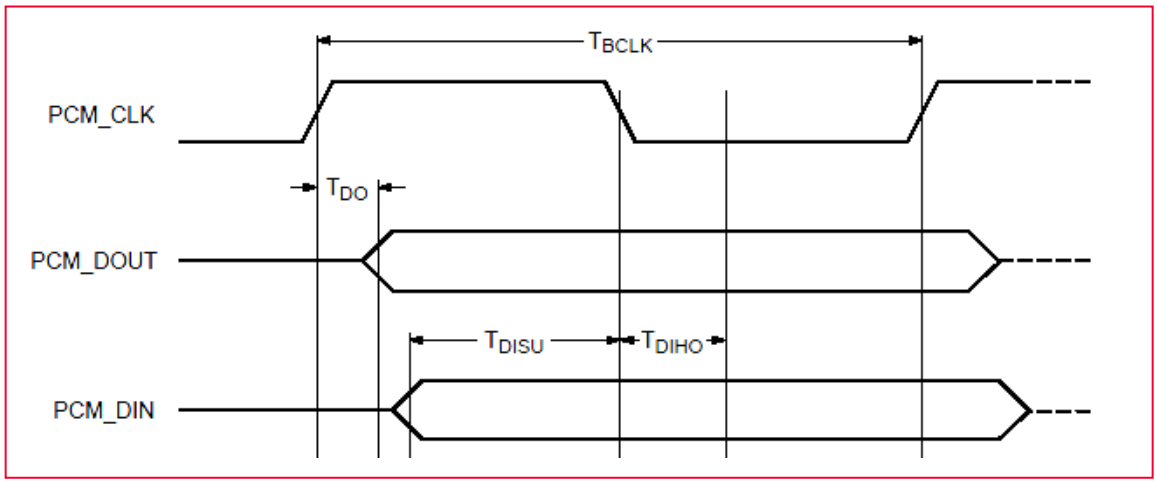


Figure 18 shows the PCM_SYNC signals on master mode.

Figure 18: PCM_SYNC Signals (Master Mode)

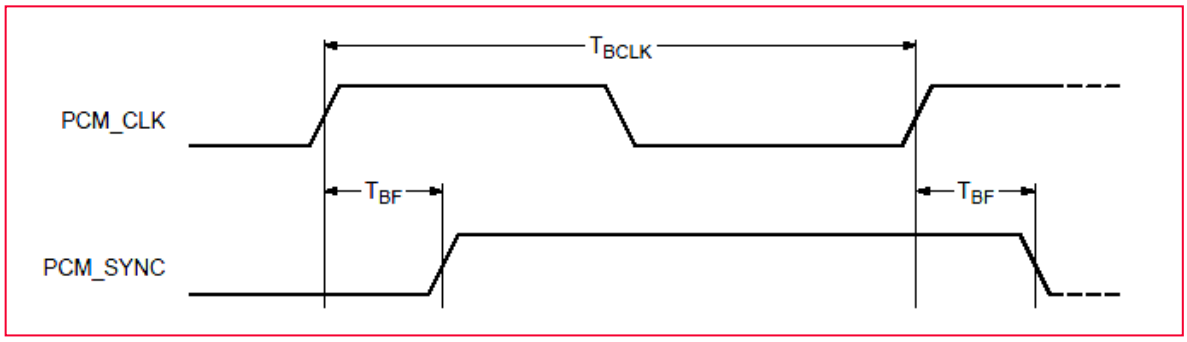


Table 22 describes the Bluetooth PCM timing master mode parameters.

Table 22: Master Mode Parameters

Symbol	Parameter	Condition	Minimum	Typical	Maximum	Unit
F_{BCLK}	Bit clock frequency			2/2.048		MHz
Duty $Cycle_{BCLK}$	Bit clock duty cycle		0.4	0.5	0.6	
$T_{BCLK\ rise/fall}$	PCM_CLK rise/fall time.			3		ns
T_{DO}	Delay from PCM_CLK rising edge to PCM_DOUT rising edge.				15	ns
T_{DISU}	Setup time for PCM_DIN before PCM_CLK falling edge.		20			ns
T_{DIHO}	Hold time for PCM_DIN after PCM_CLK falling edge.		15			ns
T_{BF}	Delay from PCM_CLK rising edge to PCM_SYNC rising edge				15	ns

11.3.2 Slave Mode

Figure 19 shows the slave mode data signals.

Figure 19: Data Signals (Slave Mode)

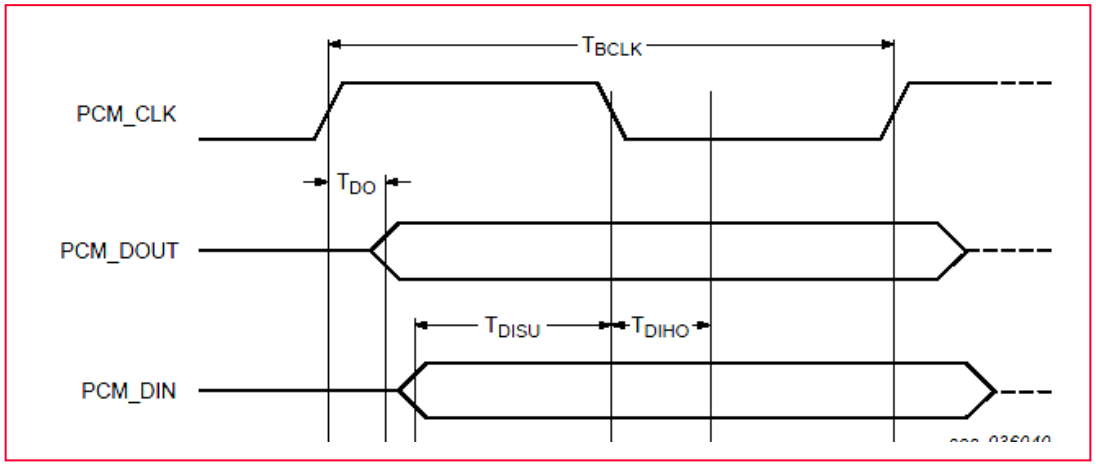


Figure 20 shows PCM_SYNC signal at slave mode.

Figure 20: PCM_SYNC Signals (Slave Mode)

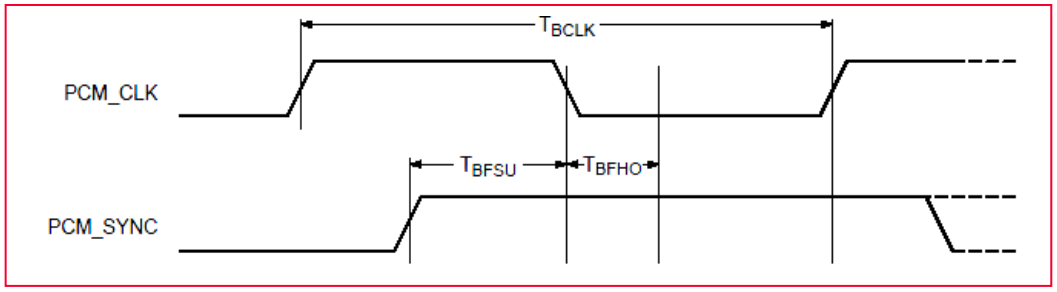


Table 23 describes the slave mode parameters.

Table 23: Slave Mode Parameters

Symbol	Parameter	Condition	Minimum	Typical	Maximum	Unit
F_{BCLK}	Bit clock frequency			2/2.048		MHz
Duty $Cycle_{BCLK}$	Bit clock duty cycle		0.4	0.5	0.6	
$T_{BCLK\ rise/fall}$	PCM_CLK rise/fall time.			3		ns
T_{DO}	Delay from PCM_CLK rising edge to PCM_DOUT rising edge.				30	ns
T_{DISU}	Setup time for PCM_DIN before PCM_CLK falling edge.		15			ns
T_{DIHO}	Hold time for PCM_DIN after PCM_CLK falling edge.		10			ns
T_{BFSU}	Setup time for PCM_SYNC before PCM_CLK falling edge.		15			ns
T_{BFHO}	Hold time for PCM_SYNC after PCM_CLK falling edge		10			ns

12 DC/RF Characteristics

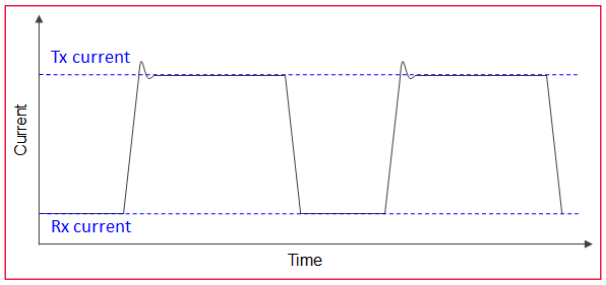
ALL DC/RF characteristics are defined by following files.

Table 24: DC/RF Characteristics and Files

DC R/F Characteristics	Value
WLAN Tx Power	TBD
WLAN Regulatory Limit	TBD
Energy Detect	TBD
Bluetooth Power	TBD

Burst current definition is shown in **Figure 21**.

Figure 21: Burst Current Definition



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

Table 25: DC/RF Characteristics for IEEE 802.11b - 2.4 GHz

Characteristics	Value
Specification	IEEE 802.11b
Mode	DSSS / CCK
Channel Frequency	2412 - 2472 MHz
Data rate	1, 2, 5.5, 11 Mbps

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

Conditions: 25 ºC, VBAT = 3.3V, VIO = 1.8V, Output power setting = 18 dBm at module pad, 11 Mbps mode.

Table 26: High-Rate Condition for IEEE 802.11b - 2.4 GHz

Items	Contents			
DC characteristics	Minimum	Typical	Maximum	Unit
DC Current				
• Tx mode Current 1.8V		148	180	mA
• Tx mode Current 3.3V		234	290	mA
• Rx mode Current 1.8V		101	130	mA
• Rx mode Current 3.3V		0.2	10	mA
Tx Characteristics	Minimum	Typical	Maximum	Unit
Output Power	16	18	20	dBm
Spectrum Mask Margin				
• 1st side lobes	0			dB
• 2nd side lobes	0			dB
Power-on/off ramp			2.0	µs
RF Carrier Suppression	15			dB
Modulation Accuracy			35	%
Frequency Tolerance	-20		20	ppm
Spurious Emissions				
• 30-47 MHz (BW = 100 kHz)			-36	dBm
• 47-74 MHz (BW = 100 kHz)			-54	dBm
• 74-87.5 MHz (BW = 100 kHz)			-36	dBm
• 87.5-118 MHz (BW = 100 kHz)			-54	dBm
• 118-174 MHz (BW = 100 kHz)			-36	dBm
• 174-230 MHz (BW = 100 kHz)			-54	dBm
• 230-470 MHz (BW = 100 kHz)			-36	dBm
• 470-862 MHz (BW = 100 kHz)			-54	dBm
• 862-1000 MHz (BW = 100 kHz)			-36	dBm
• 1000-12750 MHz (BW = 1 MHz)			-30	dBm
Rx Characteristics	Minimum	Typical	Maximum	Unit
Minimum Input Level (FER ≤ 8%)			-76	dBm

Items	Contents			
Maximum Input Level (FER ≤ 8%)	-10			dBm
Adjacent Channel Rejection (FER ≤ 8%)	35			dB

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

Conditions: 25 ºC, VBAT =3.3V, VIO = 1.8V, Output power setting = 18 dBm at module pad, 1 Mbps mode.

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

Items	Contents			
DC characteristics	Minimum	Typical	Maximum	Unit
DC Current				
• Tx mode Current 1.8V		146	180	mA
• Tx mode Current 3.3V		225	270	mA
• Rx mode Current 1.8V		101	130	mA
• Rx mode Current 3.3V		0.2	10	mA
Tx Characteristics	Minimum	Typical	Maximum	Unit
Output Power	16	18	20	dBm
Spectrum Mask Margin				
• 1st side lobes	0			dB
• 2nd side lobes	0			dB
Power-on/off ramp			2.0	µs
RF Carrier Suppression	15			dB
Modulation Accuracy			35	%
Frequency Tolerance	-20		20	-ppm
Spurious Emissions				
• 30 - 47MHz (BW=100kHz)			-36	dBm
• 47 - 74MHz (BW=100kHz)			-54	dBm
• 74 - 87.5MHz (BW=100kHz)			-36	dBm
• 87.5 - 118MHz (BW=100kHz)			-54	dBm
• 118 - 174MHz (BW=100kHz)			-36	dBm
• 174 - 230MHz (BW=100kHz)			-54	dBm
• 230 - 470MHz (BW=100kHz)			-36	dBm
• 470 - 862MHz (BW=100kHz)			-54	dBm
• 862 - 1000MHz (BW=100kHz)			-36	dBm
• 1000 - 12750MHz (BW=1MHz)			-30	dBm
Rx Characteristics	Minimum	Typical	Maximum	Unit
Minimum Input Level (FER ≤ 8%)			-80	dBm
Maximum Input Level (FER ≤ 8%)	-4			dBm
Adjacent Channel Rejection (FER ≤ 8%)	35			dB

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

Table 28: DC/RF Characteristics for IEEE 802.11g - 2.4 GHz

Characteristics	Value
Specification	IEEE 802.11g
Mode	OFDM
Channel Frequency	2412 - 2472 MHz
Data rate	6, 9, 12, 18, 24, 36, 48, 54 Mbps

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

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

Table 29: High-Rate Condition for IEEE 802.11g - 2.4 GHz

Items	Contents			
DC characteristics	Minimum	Typical	Maximum	Unit
DC Current				
• Tx mode Current 1.8V		163	200	mA
• Tx mode Current 3.3V		197	240	mA
• Rx mode Current 1.8V		102	130	mA
• Rx mode Current 3.3V		0.2	10	mA
Tx Characteristics	Minimum	Typical	Maximum	Unit
Output Power	14	16	18	dBm
Spectrum Mask Margin				
• 9 MHz to 11 MHz (0~ -20 dBr)	0			dB
• 11 MHz to 20 MHz (-20~ -28 dBr)	0			dB
• 20 MHz to 30 MHz (-28~ -40 dBr)	0			dB
• 30 MHz to 33 MHz (-40 dBr)	0			dB
Constellation Error (EVM)			-25	dB
Frequency Tolerance	-20		20	ppm
Spurious Emissions				
• 30 - 47 MHz			-36	dBm
• 47 - 74 MHz			-54	dBm
• 74 - 87.5 MHz			-36	dBm
• 87.5 - 118 MHz			-54	dBm
• 118 - 174 MHz			-36	dBm
• 174 - 230 MHz			-54	dBm
• 230 - 470 MHz			-36	dBm
• 470 - 862 MHz			-54	dBm
• 862 - 1000 MHz			-36	dBm
• 1000-12750 MHz (BW = 1 MHz)			-30	dBm
Rx Characteristics	Minimum	Typical	Maximum	Unit
Minimum Input Level (FER < 10%)			-65	dBm
Maximum Input Level (FER < 10%)	-20			dBm
Adjacent Channel Rejection (FER < 10%)	-1			dB

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

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

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

Items	Contents			
DC characteristics	Minimum	Typical	Maximum	Unit
DC Current				
• Tx mode Current 1.8V		164	200	mA
• Tx mode Current 3.3V		201	260	mA
• Rx mode Current 1.8V		102	130	mA
• Rx mode Current 3.3V		0.2	10	mA
Tx Characteristics	Minimum	Typical	Maximum	Unit
Output Power	14	16	18	dBm
Spectrum Mask Margin				
1. 9 MHz to 11 MHz (0~ -20 dBr)	0			dB
2. 11 MHz to 20 MHz (-20~ -28 dBr)	0			dB
3. 20 MHz to 30 MHz (-28~ -40 dBr)	0			dB
4. 30 MHz to 33 MHz (-40 dBr)	0			dB
Constellation Error (EVM)			-25	dB
Frequency Tolerance	-20		20	ppm
Spurious Emissions				
• 30 - 47 MHz (BW = 100 kHz)			-36	dBm
• 47 - 74 MHz (BW = 100 kHz)			-54	dBm
• 74 - 87.5 MHz (BW = 100 kHz)			-36	dBm
• 87.5 - 11 8 MHz (BW = 10 kHz)			-54	dBm
• 118 - 174 MHz (BW = 100 kHz)			-36	dBm
• 174 - 230 MHz (BW = 100 kHz)			-54	dBm
• 230 - 470 MHz (BW = 100 kHz)			-36	dBm
• 470 - 862 MHz (BW = 100 kHz)			-54	dBm
• 862 - 1000 MHz (BW = 100 kHz)			-36	dBm
• 1000 - 12750 MHz (BW = 1 MHz)			-30	dBm
Rx Characteristics	Minimum	Typical	Maximum	Unit
Minimum Input Level (PER < 10%)			-82	dBm
Maximum Input Level (PER < 10%)	-20			dBm
Adjacent Channel Rejection (PER < 10%)	-1			dB

12.3 DC/RF Characteristics for IEEE 802.11n - 2.4 GHz

Table 31: DC/RF Characteristics for IEEE 802.11n - 2.4 GHz

Characteristics	Value
Specification	IEEE 802.11n
Mode	OFDM
Channel Frequency	2412 - 2472 MHz
Data rate	MCS0-MCS7

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

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

Table 32: High-Rate Condition for IEEE 802.11n - 2.4 GHz

Items	Contents			
DC characteristics	Minimum	Typical	Maximum	Unit
DC Current				
• Tx mode Current 1.8V		164	200	mA
• Tx mode Current 3.3V		188	230	mA
• Rx mode Current 1.8V		102	130	mA
• Rx mode Current 3.3V		0.2	10	mA
Tx Characteristics	Minimum	Typical	Maximum	Unit
Output Power	13	15	17	dBm
Spectrum Mask Margin				
• 9 MHz to 11 MHz (0~ -20 dBr)	0			dB
• 11 MHz to 20 MHz (-20~ -28 dBr)	0			dB
• 20 MHz to 30 MHz (-28~ -45 dBr)	0			dB
• 30 MHz to 33 MHz (-45 dBr)	0			dB
Constellation Error (EVM) (Measured at enhanced mode)			-27	dB
Frequency Tolerance	-20		20	ppm
Spurious Emissions				
• 30 - 47 MHz (BW = 100 kHz)			-36	dBm
• 47 - 74 MHz (BW = 100 kHz)			-54	dBm
• 74 - 87.5 MHz (BW = 100 kHz)			-36	dBm
• 87.5 - 118 MHz (BW = 100 kHz)			-54	dBm
• 118 - 174 MHz (BW = 100 kHz)			-36	dBm
• 174 - 230 MHz (BW = 100 kHz)			-54	dBm
• 230 - 470 MHz (BW = 100 kHz)			-36	dBm
• 470 - 862 MHz (BW = 100 kHz)			-54	dBm
• 862 - 1000 MHz (BW = 100 kHz)			-36	dBm
• 1000 - 12750 MHz (BW = 1 MHz)			-30	dBm
Rx Characteristics	Minimum	Typical	Maximum	Unit
Minimum Input Level (PER ≤ 10%)			-64	dBm
Maximum Input Level (PER < 10%)	-20			dBm
Adjacent Channel Rejection (PER ≤ 10%)	-2			dB

12.3.2 Low-Rate Condition for IEEE 802.11n - 2.4 GHz

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

Table 33: Low-Rate Condition for IEEE 802.11n - 2.4 GHz

Items	Contents			
DC characteristics	Minimum	Typical	Maximum	Unit
DC Current				
• Tx mode Current 1.8V		164	200	mA
• Tx mode Current 3.3V		188	230	mA
• Rx mode Current 1.8V		102	130	mA
• Rx mode Current 3.3V		0.2	10	mA
Tx Characteristics	Minimum	Typical	Maximum	Unit
Output Power	13	15	17	dBm
Spectrum Mask Margin				
• 9 MHz to 11 MHz (0~ -20 dBr)	0			dB
• 11 MHz to 20 MHz (-20~ -28 dBr)	0			dB
• 20 MHz to 30 MHz (-28~ -45 dBr)	0			dB
• 30 MHz to 33 MHz (-45 dBr)	0			dB
Constellation Error (EVM) (Measured at enhanced mode)			-27	dB
Frequency Tolerance	-20		20	ppm
Spurious Emissions				
• 30 - 47 MHz (BW = 100kHz)			-36	dBm
• 47 - 74 MHz (BW = 100kHz)			-54	dBm
• 74 - 87.5 MHz (BW = 100kHz)			-36	dBm
• 87.5 - 118 MHz (BW = 100kHz)			-54	dBm
• 118 - 174 MHz (BW = 100kHz)			-36	dBm
• 174 - 230 MHz (BW = 100kHz)			-54	dBm
• 230 - 470 MHz (BW = 100kHz)			-36	dBm
• 470 - 862 MHz (BW = 100kHz)			-54	dBm
• 862 - 1000 MHz (BW = 100kHz)			-36	dBm
• 1000 - 12750 MHz (BW = 1 MHz)			-30	dBm
Rx Characteristics	Minimum	Typical	Maximum	Unit
Minimum Input Level (PER < 10%)			-82	dBm
Maximum Input Level (PER < 10%)	-20			dBm
Adjacent Channel Rejection (PER < 10%)	-2			dB

12.4 DC/RF Characteristics for IEEE 802.11ax (HE20) - 2.4 GHz

Table 34: DC/RF Characteristics for IEEE 802.11ax (HE20) - 2.4 GHz

Characteristics	Value
Specification	IEEE 802.11ax
Mode	OFDM
Channel Frequency	2412 - 2472 MHz
Data rate	MCS0 - MCS11

12.4.1 High-Rate Condition for IEEE 802.11ax (HE20) - 2.4 GHz

Conditions: 25ºC, VBAT = 3.3V, VIO = 1.8V, Output power setting = 13 dBm at module pad, MCS11 mode.

Table 35: High-Rate Condition for IEEE 802.11ax (HE20) - 2.4 GHz

Items	Contents			
DC characteristics	Minimum	Typical	Maximum	Unit
DC Current				
• Tx mode Current 1.8V		165	200	mA
• Tx mode Current 3.3V		170	210	mA
• Rx mode Current 1.8V		102	130	mA
• Rx mode Current 3.3V		0.2	10	mA
Tx Characteristics	Minimum	Typical	Maximum	Unit
Output Power	11	13	15	dBm
Spectrum Mask Margin				
• 9 MHz to 11 MHz (0~ -20 dBr)	0			dB
• 11 MHz to 20 MHz (-20~ -28 dBr)	0			dB
• 20 MHz to 30 MHz (-28~ -45 dBr)	0			dB
• 30 MHz to 33 MHz (-45 dBr)	0			dB
Constellation Error (EVM) (Measured at enhanced mode)			-35	dB
Frequency Tolerance	-20		20	ppm
Spurious Emissions				
• 30 - 47 MHz (BW = 100 kHz)			-36	dBm
• 47 - 74 MHz (BW = 100 kHz)			-54	dBm
• 74 - 87.5 MHz (BW = 100 kHz)			-36	dBm
• 87.5 - 118 MHz (BW = 100 kHz)			-54	dBm
• 118 - 174 MHz (BW = 100 kHz)			-36	dBm
• 174 - 230 MHz (BW = 100 kHz)			-54	dBm
• 230 - 470 MHz (BW = 100 kHz)			-36	dBm
• 470 - 862 MHz (BW = 100 kHz)			-54	dBm
• 862 - 1000 MHz (BW = 100 kHz)			-36	dBm
• 1000 - 5150 MHz (BW = 1 MHz)			-30	dBm
• 5350 - 5470 MHz (BW = 1 MHz)			-30	dBm
• 5725 - 26000 MHz (BW = 1 MHz)			-30	dBm
Rx Characteristics	Minimum	Typical	Maximum	Unit

Items	Contents			
Minimum Input Level (PER ≤ 10%)			-59	dBm
Maximum Input Level (PER < 10%)	-30			dBm
Adjacent Channel Rejection (PER ≤ 10%)	-7			dB

12.4.2 Low-Rate Condition for IEEE 802.11ax (HE20) - 2.4 GHz

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

Table 36: Low-Rate Condition for IEEE 802.11ax (HE20) - 2.4 GHz

Items	Contents			
DC characteristics	Minimum	Typical	Maximum	Unit
DC Current				
• Tx mode Current 1.8V		164	200	mA
• Tx mode Current 3.3V		192	240	mA
• Rx mode Current 1.8V		102	130	mA
• Rx mode Current 3.3V		0.2	10	mA
Tx Characteristics	Minimum	Typical	Maximum	Unit
Output Power	13	15	17	dBm
Spectrum Mask Margin				
• 9 MHz to 11 MHz (0~ -20 dBr)	0			dB
• 11 MHz to 20 MHz (-20~ -28 dBr)	0			dB
• 20 MHz to 30 MHz (-28~ -45 dBr)	0			dB
• 30 MHz to 33 MHz (-45 dBr)	0			dB
Constellation Error (EVM) (Measured at enhanced mode)			-5	dB
Frequency Tolerance	-20		20	ppm
Spurious Emissions				
• 30 - 47 MHz (BW = 100 kHz)			-36	dBm
• 47 - 74 MHz (BW = 100 kHz)			-54	dBm
• 74 - 87.5 MHz (BW = 100 kHz)			-36	dBm
• 87.5 - 118 MHz (BW = 100 kHz)			-54	dBm
• 118 - 174 MHz (BW = 100 kHz)			-36	dBm
• 174 - 230 MHz (BW = 100 kHz)			-54	dBm
• 230 - 470 MHz (BW = 100 kHz)			-36	dBm
• 470 - 862 MHz (BW = 100 kHz)			-54	dBm
• 862 - 1000 MHz (BW = 100 kHz)			-36	dBm
• 1000 - 5150 MHz (BW = 1 MHz)			-30	dBm
• 5350 - 5470 MHz (BW = 1 MHz)			-30	dBm
• 5725 - 26000 MHz (BW = 1 MHz)			-30	dBm
Rx Characteristics	Minimum	Typical	Maximum	Unit

Items	Contents			
Minimum Input Level (PER ≤ 10%)			-82	dBm
Maximum Input Level (PER < 10%)	-30			dBm
Adjacent Channel Rejection (PER ≤ 10%)	-7			dB

12.5 DC/RF Characteristics for IEEE 802.11a - 5 GHz

Table 37: DC/RF Characteristics for IEEE 802.11a - 5 GHz

Characteristics	Value
Specification	IEEE 802.11a
Mode	OFDM
Channel Frequency	5180 - 5240 MHz, 5260 - 5320 MHz, 5500 - 5720 MHz, 5745 - 5825 MHz
Data rate	6, 9, 12, 18, 24, 36, 48, 54 Mbps

12.5.1 High-Rate Condition for IEEE 802.11a - 5 GHz

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

Table 38: High-Rate Condition for IEEE 802.11a - 5 GHz

Items	Contents			
DC characteristics	Minimum	Typical	Maximum	Unit
DC Current				
• Tx mode Current 1.8V		248	300	mA
• Tx mode Current 3.3V		240	310	mA
• Rx mode Current 1.8V		122	150	mA
• Rx mode Current 3.3V		0.2	10	mA
Tx Characteristics	Minimum	Typical	Maximum	Unit
Output Power	14	16	18	dBm
Spectrum Mask Margin				
• 9 MHz to 11 MHz (0~ -20 dBr)	0			dB
• 11 MHz to 20 MHz (-20~ -28 dBr)	0			dB
• 20 MHz to 30 MHz (-28~ -45 dBr)	0			dB
• 30 MHz to 33 MHz (-45 dBr)	0			dB
Constellation Error (EVM) (Measured at enhanced mode)			-25	dB
Frequency Tolerance	-20		20	ppm
Spurious Emissions				
• 30 - 47 MHz (BW = 100 kHz)			-36	dBm
• 47 - 74 MHz (BW = 100 kHz)			-54	dBm
• 74 - 87.5 MHz (BW = 100 kHz)			-36	dBm
• 87.5 - 118 MHz (BW = 100 kHz)			-54	dBm
• 118 - 174 MHz (BW = 100 kHz)			-36	dBm
• 174 - 230 MHz (BW = 100 kHz)			-54	dBm
• 230 - 470 MHz (BW = 100 kHz)			-36	dBm
• 470 - 862 MHz (BW = 100 kHz)			-54	dBm
• 862 - 1000 MHz (BW = 100 kHz)			-36	dBm
• 1000 - 5150 MHz (BW = 1 MHz)			-30	dBm
• 5350 - 5470 MHz (BW = 1 MHz)			-30	dBm

Items	Contents			
• 5725 - 26000 MHz (BW = 1 MHz)			-30	dBm
Rx Characteristics	Minimum	Typical	Maximum	Unit
Minimum Input Level (PER ≤ 10%)			-65	dBm
Maximum Input Level (PER < 10%)	-30			dBm
Adjacent Channel Rejection (PER ≤ 10%)	-1			dB

12.5.2 Low-Rate Condition for IEEE 802.11a - 5 GHz

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

Table 39: Low-Rate Condition for IEEE 802. 11a - 5 GHz

Items	Contents			
DC characteristics	Minimum	Typical	Maximum	Unit
DC Current				
• Tx mode Current 1.8V		250	300	mA
• Tx mode Current 3.3V		245	310	mA
• Rx mode Current 1.8V		122	150	mA
• Rx mode Current 3.3V		0.2	10	mA
Tx Characteristics	Minimum	Typical	Maximum	Unit
Output Power	14	16	18	dBm
Spectrum Mask Margin				
• 9 MHz to 11 MHz (0~ -20 dBr)	0			dB
• 11 MHz to 20 MHz (-20~ -28 dBr)	0			dB
• 20 MHz to 30 MHz (-28~ -45 dBr)	0			dB
• 30 MHz to 33 MHz (-45 dBr)	0			dB
Constellation Error (EVM) (Measured at enhanced mode)			-25	dB
Frequency Tolerance	-20		20	ppm
Spurious Emissions				
• 30 - 47 MHz (BW = 100 kHz)			-36	dBm
• 47 - 74 MHz (BW = 100 kHz)			-54	dBm
• 74 - 87.5 MHz (BW = 100 kHz)			-36	dBm
• 87.5 - 118 MHz (BW = 100 kHz)			-54	dBm
• 118 - 174 MHz (BW = 100 kHz)			-36	dBm
• 174 - 230 MHz (BW = 100 kHz)			-54	dBm
• 230 - 470 MHz (BW = 100 kHz)			-36	dBm
• 470 - 862 MHz (BW = 100 kHz)			-54	dBm
• 862 - 1000 MHz (BW = 100 kHz)			-36	dBm
• 1000 - 5150 MHz (BW = 1 MHz)			-30	dBm
• 5350 - 5470 MHz (BW = 1 MHz)			-30	dBm
• 5725 - 26000 MHz (BW = 1 MHz)			-30	dBm
Rx Characteristics	Minimum	Typical	Maximum	Unit
Minimum Input Level (PER ≤ 10%)			-82	dBm

Items	Contents			
Maximum Input Level (PER < 10%)	-30			dBm
Adjacent Channel Rejection (PER ≤ 10%)	-1			dB

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

Table 40: DC/RF Characteristics for IEEE 802.11n (HT20) - 5 GHz

Characteristics	Value
Specification	IEEE 802.11n
Mode	OFDM
Channel Frequency	5180 - 5240 MHz, 5260 - 5320 MHz, 5500 - 5720 MHz, 5745 - 5825 MHz
Data rate	MCS0 - MCS7

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

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

Table 41: High-Rate Condition for IEEE 802.11n (HT20 MHz) - 5 GHz

Items	Contents			
DC characteristics	Minimum	Typical	Maximum	Unit
DC Current				
• Tx mode Current 1.8V		221	280	mA
• Tx mode Current 3.3V		209	280	mA
• Rx mode Current 1.8V		121	150	mA
• Rx mode Current 3.3V		0.2	10	mA
Tx Characteristics	Minimum	Typical	Maximum	Unit
Output Power	12	14	16	dBm
Spectrum Mask Margin				
• 9 MHz to 11 MHz (0~ -20 dBr)	0			dB
• 11 MHz to 20 MHz (-20~ -28 dBr)	0			dB
• 20 MHz to 30 MHz (-28~ -45 dBr)	0			dB
• 30 MHz to 33 MHz (-45 dBr)	0			dB
Constellation Error (EVM) (Measured at enhanced mode)			-27	dB
Frequency Tolerance	-20		20	ppm
Spurious Emissions				
• 30 - 47 MHz (BW = 100 kHz)			-36	dBm
• 47 - 74 MHz (BW = 100 kHz)			-54	dBm
• 74 - 87.5 MHz (BW = 100 kHz)			-36	dBm
• 87.5 - 118 MHz (BW = 100 kHz)			-54	dBm
• 118 - 174 MHz (BW = 100 kHz)			-36	dBm
• 174 - 230 MHz (BW = 100 kHz)			-54	dBm
• 230 - 470 MHz (BW = 100 kHz)			-36	dBm
• 470 - 862 MHz (BW = 100 kHz)			-54	dBm
• 862 - 1000 MHz (BW = 100 kHz)			-36	dBm
• 1000 - 5150 MHz (BW = 1 MHz)			-30	dBm

Items	Contents			
• 5350 - 5470 MHz (BW = 1 MHz)			-30	dBm
• 5725 - 26000 MHz (BW = 1 MHz)			-30	dBm
Rx Characteristics	Minimum	Typical	Maximum	Unit
Minimum Input Level (PER ≤ 10%)			-64	dBm
Maximum Input Level (PER < 10%)	-30			dBm
Adjacent Channel Rejection (PER ≤ 10%)	-2			dB

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

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

Table 42: Low-Rate Condition for IEEE 802. 11n (HT20) - 5 GHz

Items	Contents			
DC characteristics	Minimum	Typical	Maximum	Unit
DC Current				
• Tx mode Current 1.8V		221	280	mA
• Tx mode Current 3.3V		214	280	mA
• Rx mode Current 1.8V		121	150	mA
• Rx mode Current 3.3V		0.2	10	mA
Tx Characteristics	Minimum	Typical	Maximum	Unit
Output Power	12	14	16	dBm
Spectrum Mask Margin				
• 9 MHz to 11 MHz (0~ -20 dBr)	0			dB
• 11 MHz to 20 MHz (-20~ -28 dBr)	0			dB
• 20 MHz to 30 MHz (-28~ -45 dBr)	0			dB
• 30 MHz to 33 MHz (-45 dBr)	0			dB
Constellation Error (EVM) (Measured at enhanced mode)			-27	dB
Frequency Tolerance	-20		20	ppm
Spurious Emissions				
• 30-47 MHz (BW = 100 kHz)			-36	dBm
• 47-74 MHz (BW = 100 kHz)			-54	dBm
• 74-87.5 MHz (BW = 100 kHz)			-36	dBm
• 87.5-118 MHz (BW = 100 kHz)			-54	dBm
• 118-174 MHz (BW = 100 kHz)			-36	dBm
• 174-230 MHz (BW = 100 kHz)			-54	dBm
• 230-470 MHz (BW = 100 kHz)			-36	dBm
• 470-862 MHz (BW = 100 kHz)			-54	dBm
• 862-1000 MHz (BW = 100 kHz)			-36	dBm
• 1000-5150 MHz (BW = 1 MHz)			-30	dBm
• 5350-5470 MHz (BW = 1 MHz)			-30	dBm
• 5725-26000 MHz (BW = 1 MHz)			-30	dBm
Rx Characteristics	Minimum	Typical	Maximum	Unit

Items	Contents			
Minimum Input Level (PER ≤ 10%)			-82	dBm
Maximum Input Level (PER < 10%)	-30			dBm
Adjacent Channel Rejection (PER ≤ 10%)	-2			dBm

12.7 DC/RF Characteristics for IEEE 802.11ac (VHT20) - 5 GHz

Table 43: DC/RF Characteristics for IEEE 802.11ac (VHT20) - 5 GHz

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

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

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

Table 44: High-Rate Condition for IEEE 802.11ac (VHT20) - 5 GHz

Items	Contents			
DC characteristics	Minimum	Typical	Maximum	Unit
DC Current				
• Tx mode Current 1.8V		221	280	mA
• Tx mode Current 3.3V		209	280	mA
• Rx mode Current 1.8V		121	150	mA
• Rx mode Current 3.3V		0.2	10	mA
Tx Characteristics	Minimum	Typical	Maximum	Unit
Output Power	12	14	16	dBm
Spectrum Mask Margin				
• 9 MHz to 11 MHz (0~ -20 dBr)	0			dB
• 11 MHz to 20 MHz (-20~ -28 dBr)	0			dB
• 20 MHz to 30 MHz (-28~ -45 dBr)	0			dB
• 30 MHz to 33 MHz (-45 dBr)	0			dB
Constellation Error (EVM) (Measured at enhanced mode)			-30	dB
Frequency Tolerance	-20		20	ppm
Spurious Emissions				
• 30 - 47 MHz (BW = 100 kHz)			-36	dBm
• 47 - 74 MHz (BW = 100 kHz)			-54	dBm
• 74 - 87.5 MHz (BW = 100 kHz)			-36	dBm
• 87.5 - 118 MHz (BW = 100 kHz)			-54	dBm

Items	Contents			
• 118 - 174 MHz (BW = 100 kHz)			-36	dBm
• 174 - 230 MHz (BW = 100 kHz)			-54	dBm
• 230 - 470 MHz (BW = 100 kHz)			-36	dBm
• 470 - 862 MHz (BW = 100 kHz)			-54	dBm
• 862 - 1000 MHz (BW = 100 kHz)			-36	dBm
• 1000 - 5150 MHz (BW = 1 MHz)			-30	dBm
• 5350 - 5470 MHz (BW = 1 MHz)			-30	dBm
• 5725 - 26000 MHz (BW = 1 MHz)			-30	dBm
Rx Characteristics	Minimum	Typical	Maximum	Unit
Minimum Input Level (PER ≤ 10%)			-59	dBm
Maximum Input Level (PER < 10%)	-30			dBm
Adjacent Channel Rejection (PER ≤ 10%)	-7			dB

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

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

Table 45: Low-Rate Condition for IEEE 802.11ac (VHT20) - 5 GHz

Items	Contents			
DC characteristics	Minimum	Typical	Maximum	Unit
DC Current				
DC Current				
• Tx mode Current 1.8V		221	280	mA
• Tx mode Current 3.3V		212	280	mA
• Rx mode Current 1.8V		121	150	mA
• Rx mode Current 3.3V		0.2	10	mA
Tx Characteristics	Minimum	Typical	Maximum	Unit
Output Power	12	14	16	dBm
Spectrum Mask Margin				
• 9 MHz to 11 MHz (0~ -20 dBr)	0			dB
• 11 MHz to 20 MHz (-20~ -28 dBr)	0			dB
• 20 MHz to 30 MHz (-28~ -45 dBr)	0			dB
• 30 MHz to 33 MHz (-45 dBr)	0			dB
Constellation Error (EVM) (Measured at enhanced mode)			-30	dB
Frequency Tolerance	-20		20	ppm
Spurious Emissions				
• 30 - 47 MHz (BW = 100 kHz)			-36	dBm
• 47 - 74 MHz (BW = 100 kHz)			-54	dBm
• 74 - 87.5 MHz (BW = 100 kHz)			-36	dBm
• 87.5 - 118 MHz (BW = 100 kHz)			-54	dBm
• 118 - 174 MHz (BW = 100 kHz)			-36	dBm
• 174 - 230 MHz (BW = 100 kHz)			-54	dBm
• 230 - 470 MHz (BW = 100 kHz)			-36	dBm
• 470 - 862 MHz (BW = 100 kHz)			-54	dBm

Items	Contents			
• 862 - 1000 MHz (BW = 100 kHz)			-36	dBm
• 1000 - 5150 MHz (BW = 1 MHz)			-30	dBm
• 5350 - 5470 MHz (BW = 1 MHz)			-30	dBm
• 5725 - 26000 MHz (BW = 1 MHz)			-30	dBm
Rx Characteristics	Minimum	Typical	Maximum	Unit
Minimum Input Level (PER ≤ 10%)			-82	dBm
Maximum Input Level (PER < 10%)	-30			dBm
Adjacent Channel Rejection (PER ≤ 10%)	-7			dB

12.8 DC/RF Characteristics for IEEE 802.11ax (HE20) - 5 GHz

Table 46: DC/RF Characteristics for IEEE 802. 11ax (HE20) - 5 GHz

Characteristics	Value
Specification	IEEE 802.11ax
Mode	OFDM
Channel Frequency	5180 - 5240 MHz, 5260 - 5320 MHz, 5500 - 5720 MHz, 5745 - 5825 MHz
Data rate	MCS0 - MCS11

12.8.1 High-Rate Condition for IEEE 802.11ax (HE20) - 5 GHz

Conditions: 25ºC, VBAT = 3.3V, VIO = 1.8V, Output power setting = 10 dBm at module pad, MCS11 mode.

Table 47: High-Rate Condition for IEEE 802.11ax (HE20) - 5 GHz

Items	Contents			
DC characteristics	Minimum	Typical	Maximum	Unit
DC Current				
• Tx mode Current 1.8V		207	280	mA
• Tx mode Current 3.3V		169	230	mA
• Rx mode Current 1.8V		121	150	mA
• Rx mode Current 3.3V		0.2	10	mA
Tx Characteristics	Minimum	Typical	Maximum	Unit
Output Power	8	10	12	dBm
Spectrum Mask Margin				
• 9 MHz to 11 MHz (0~ -20 dBr)	0			dB
• 11 MHz to 20 MHz (-20~ -28 dBr)	0			dB
• 20 MHz to 30 MHz (-28~ -45 dBr)	0			dB
• 30 MHz to 33 MHz (-45 dBr)	0			dB
Constellation Error (EVM) (Measured at enhanced mode)			-35	dB

Items	Contents			
Frequency Tolerance	-20		20	ppm
Spurious Emissions				
• 30 - 47 MHz (BW = 100 KHz)			-36	dBm
• 47 - 74 MHz (BW = 100 KHz)			-54	dBm
• 74 - 87.5 MHz (BW = 100 KHz)			-36	dBm
• 87.5 - 118 MHz (BW = 100 KHz)			-54	dBm
• 118 - 174 MHz (BW = 100 KHz)			-36	dBm
• 174 - 230 MHz (BW = 100 KHz)			-54	dBm
• 230 - 470 MHz (BW = 100 KHz)			-36	dBm
• 470 - 862 MHz (BW = 100 KHz)			-54	dBm
• 862 - 1000 MHz (BW = 100 KHz)			-36	dBm
• 1000 - 5150 MHz (BW = 1 MHz)			-30	dBm
• 5350 - 5470 MHz (BW = 1 MHz)			-30	dBm
• 5725 - 26000 MHz (BW = 1 MHz)			-30	dBm
Rx Characteristics	Minimum	Typical	Maximum	Unit
Minimum Input Level (PER ≤ 10%)			-59	dBm
Maximum Input Level (PER < 10%)	-30			dBm
Adjacent Channel Rejection (PER ≤ 10%)	-7			dB

12.8.2 Low-Rate Condition for IEEE 802.11ax (HE20) - 5 GHz

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

Table 48: Low-Rate Condition for IEEE 802.11n (HT20) - 5 GHz

Items	Contents			
DC characteristics	Minimum	Typical	Maximum	Unit
DC Current				
• Tx mode Current 1.8V		222	280	mA
• Tx mode Current 3.3V		216	280	mA
• Rx mode Current 1.8V		121	150	mA
• Rx mode Current 3.3V		0.2	10	mA
Tx Characteristics	Minimum	Typical	Maximum	Unit
Output Power	12	14	16	dBm
Spectrum Mask Margin				
• 9 MHz to 11 MHz (0~ -20 dBr)	0			dB
• 11 MHz to 20 MHz (-20~ -28 dBr)	0			dB
• 20 MHz to 30 MHz (-28~ -45 dBr)	0			dB
• 30 MHz to 33 MHz (-45 dBr)	0			dB
Constellation Error (EVM) (Measured at enhanced mode)			-5	dB
Frequency Tolerance	-20		20	ppm
Spurious Emissions				
• 30 - 47 MHz (BW = 100 KHz)			-36	dBm
• 47 - 74 MHz (BW = 100 KHz)			-54	dBm
• 74 - 87.5 MHz (BW = 100 KHz)			-36	dBm

Items	Contents			
• 87.5 - 118 MHz (BW = 100 KHz)			-54	dBm
• 118 - 174 MHz (BW = 100 KHz)			-36	dBm
• 174 - 230 MHz (BW = 100 KHz)			-54	dBm
• 230 - 470 MHz (BW = 100 KHz)			-36	dBm
• 470 - 862 MHz (BW = 100 KHz)			-54	dBm
• 862 - 1000 MHz (BW = 100 KHz)			-36	dBm
• 1000 - 5150 MHz (BW = 1 MHz)			-30	dBm
• 5350 - 5470 MHz (BW = 1 MHz)			-30	dBm
• 5725 - 26000 MHz (BW = 1 MHz)			-30	dBm
Rx Characteristics	Minimum	Typical	Maximum	Unit
Minimum Input Level (PER ≤ 10%)			-82	dBm
Maximum Input Level (PER < 10%)	-30			dBm
Adjacent Channel Rejection (PER ≤ 10%)	-7			dB

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

Table 49: DC/RF Characteristics for IEEE 802.11n (HT40) - 5 GHz

Characteristics	Value
Specification	IEEE 802.11n
Mode	OFDM
Channel Frequency	5190 - 5795 MHz
Data rate	MCS0 - MCS7

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

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

Table 50: High-Rate Condition for IEEE 802.11n (HT40) - 5 GHz

Items	Contents			
DC characteristics	Minimum	Typical	Maximum	Unit
DC Current				
• Tx mode Current 1.8V		231	290	mA
• Tx mode Current 3.3V		203	280	mA
• Rx mode Current 1.8V		140	170	mA
• Rx mode Current 3.3V		0.2	10	mA
Tx Characteristics	Minimum	Typical	Maximum	Unit
Output Power	12	14	16	dBm
Spectrum Mask Margin				
• 19 MHz to 21 MHz (0~ -20 dBr)	0			dB
• 21 MHz to 40 MHz (-20~ -28 dBr)	0			dB
• 40 MHz to 60 MHz (-28~ -45 dBr)	0			dB
• 60 MHz to 80 MHz (-45 dBr)	0			dB
Constellation Error (EVM) (Measured at enhanced mode)			-27	dB

Items	Contents			
Frequency Tolerance	-20		20	ppm
Spurious Emissions				
• 30 - 47 MHz (BW = 100 KHz)			-36	dBm
• 47 - 74 MHz (BW = 100 KHz)			-54	dBm
• 74 - 87.5 MHz (BW = 100 KHz)			-36	dBm
• 87.5 - 118 MHz (BW = 100 KHz)			-54	dBm
• 118 - 174 MHz (BW = 100 KHz)			-36	dBm
• 174 - 230 MHz (BW = 100 KHz)			-54	dBm
• 230 - 470 MHz (BW = 100 KHz)			-36	dBm
• 470 - 862 MHz (BW = 100 KHz)			-54	dBm
• 862 - 1000 MHz (BW = 100 KHz)			-36	dBm
• 1000 - 5150 MHz (BW = 1 MHz)			-30	dBm
• 5350 - 5470 MHz (BW = 1 MHz)			-30	dBm
• 5725 - 26000 MHz (BW = 1 MHz)			-30	dBm
Rx Characteristics	Minimum	Typical	Maximum	Unit
Minimum Input Level (PER ≤ 10%)			-61	dBm
Maximum Input Level (PER < 10%)	-30			dBm
Adjacent Channel Rejection (PER ≤ 10%)	-2			dB

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

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

Table 51: Low-Rate Condition for IEEE 802.11n (HT40) - 5 GHz

Items	Contents			
DC characteristics	Minimum	Typical	Maximum	Unit
DC Current				
• Tx mode Current 1.8V		232	290	mA
• Tx mode Current 3.3V		205	280	mA
• Rx mode Current 1.8V		140	170	mA
• Rx mode Current 3.3V		0.2	10	mA
Tx Characteristics	Minimum	Typical	Maximum	Unit
Output Power	12	14	16	dBm
Spectrum Mask Margin				
• 19 MHz to 21 MHz (0~ -20 dBr)	0			dB
• 21 MHz to 40 MHz (-20~ -28 dBr)	0			dB
• 40 MHz to 60 MHz (-28~ -45 dBr)	0			dB
• 60 MHz to 80 MHz (-45 dBr)	0			dB
Constellation Error (EVM) (Measured at enhanced mode)			-27	dB
Frequency Tolerance	-20		20	ppm
Spurious Emissions				
• 30 - 47 MHz (BW = 100 KHz)			-36	dBm
• 47 - 74 MHz (BW = 100 KHz)			-54	dBm

Items	Contents			
• 74 - 87.5 MHz (BW = 100 KHz)			-36	dBm
• 87.5 - 118 MHz (BW = 100 KHz)			-54	dBm
• 118 - 174 MHz (BW = 100 KHz)			-36	dBm
• 174 - 230 MHz (BW = 100 KHz)			-54	dBm
• 230 - 470 MHz (BW = 100 KHz)			-36	dBm
• 470 - 862 MHz (BW = 100 KHz)			-54	dBm
• 862 - 1000 MHz (BW = 100 KHz)			-36	dBm
• 1000 - 5150 MHz (BW = 1 MHz)			-30	dBm
• 5350 - 5470 MHz (BW = 1 MHz)			-30	dBm
• 5725 - 26000 MHz (BW = 1 MHz)			-30	dBm
Rx Characteristics	Minimum	Typical	Maximum	Unit
Minimum Input Level (PER ≤ 10%)			-79	dBm
Maximum Input Level (PER < 10%)	-30			dBm
Adjacent Channel Rejection (PER ≤ 10%)	-2			dB

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

Table 52: DC/RF Characteristics for IEEE 802.11ac (VHT40) - 5 GHz

Characteristics	Value
Specification	IEEE 802.11ac
Mode	OFDM
Channel Frequency	5190 - 5795 MHz
Data rate	MCS0 - MCS9

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

Conditions: 25 ºC, VBAT = 3.3V, VIO = 1.8V, Output power setting = 12 dBm at module pad, MCS9 mode.

Table 53: High-Rate Condition for IEEE 802.11 ac (VHT40) - 5 GHz

Items	Contents			
DC characteristics	Minimum	Typical	Maximum	Unit
DC Current				
• Tx mode Current 1.8V		225	290	mA
• Tx mode Current 3.3V		179	250	mA
• Rx mode Current 1.8V		141	170	mA
• Rx mode Current 3.3V		0.2	10	mA
Tx Characteristics	Minimum	Typical	Maximum	Unit
Output Power	10	12	14	dBm
Spectrum Mask Margin				
• 19 MHz to 21 MHz (0~ -20 dBr)	0			dB
• 21 MHz to 40 MHz (-20~ -28 dBr)	0			dB
• 40 MHz to 60 MHz (-28~ -45 dBr)	0			dB
• 60 MHz to 80 MHz (-45 dBr)	0			dB
Constellation Error (EVM) (Measured at enhanced mode)			-32	dB
Frequency Tolerance	-20		20	ppm
Spurious Emissions				
• 30 - 47 MHz (BW = 100 KHz)			-36	dBm
• 47 - 74 MHz (BW = 100 KHz)			-54	dBm
• 74 - 87.5 MHz (BW = 100 KHz)			-36	dBm
• 87.5 - 118 MHz (BW = 100 KHz)			-54	dBm
• 118 - 174 MHz (BW = 100 KHz)			-36	dBm
• 174 - 230 MHz (BW = 100 KHz)			-54	dBm
• 230 - 470 MHz (BW = 100 KHz)			-36	dBm
• 470 - 862 MHz (BW = 100 KHz)			-54	dBm
• 862 - 1000 MHz (BW = 100 KHz)			-36	dBm
• 1000 - 5150 MHz (BW = 1 MHz)			-30	dBm
• 5350 - 5470 MHz (BW = 1 MHz)			-30	dBm
• 5725 - 26000 MHz (BW = 1 MHz)			-30	dBm
Rx Characteristics	Minimum	Typical	Maximum	Unit
Minimum Input Level (PER ≤ 10%)			-54	dBm

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

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

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

Table 54: Low-Rate Condition for IEEE 802.11 ac (VHT40) - 5 GHz

Items	Contents			
DC characteristics	Minimum	Typical	Maximum	Unit
DC Current				
• Tx mode Current 1.8V		232	290	mA
• Tx mode Current 3.3V		206	280	mA
• Rx mode Current 1.8V		141	170	mA
• Rx mode Current 3.3V		0.2	10	mA
Tx Characteristics	Minimum	Typical	Maximum	Unit
Output Power	12	14	16	dBm
Spectrum Mask Margin				
• 19 MHz to 21 MHz (0~ -20 dBr)	0			dB
• 21MHz to 40 MHz (-20~ -28 dBr)	0			dB
• 40 MHz to 60 MHz (-28~ -45 dBr)	0			dB
• 60 MHz to 80 MHz (-45 dBr)	0			dB
Constellation Error (EVM) (Measured at enhanced mode)			-32	dB
Frequency Tolerance	-20		20	ppm
Spurious Emissions				
• 30 - 47 MHz (BW = 100 KHz)			-36	dBm
• 47 - 74 MHz (BW = 100 KHz)			-54	dBm
• 74 - 87.5 MHz (BW = 100 KHz)			-36	dBm
• 87.5 - 118 MHz (BW = 100 KHz)			-54	dBm
• 118 - 174 MHz (BW = 100 KHz)			-36	dBm
• 174 - 230 MHz (BW = 100 KHz)			-54	dBm
• 230 - 470 MHz (BW = 100 KHz)			-36	dBm
• 470 - 862 MHz (BW = 100 KHz)			-54	dBm
• 862 - 1000 MHz (BW = 100 KHz)			-36	dBm
• 1000 - 5150 MHz (BW = 1 MHz)			-30	dBm
• 5350 - 5470 MHz (BW = 1 MHz)			-30	dBm
• 5725 - 26000 MHz (BW = 1 MHz)			-30	dBm
Rx Characteristics	Minimum	Typical	Maximum	Unit
Minimum Input Level (PER ≤ 10%)			-79	dBm

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

12.11 DC/RF Characteristics for IEEE 802.11ax (HE40) - 5 GHz

Table 55: DC/RF Characteristics for IEEE 802.11ax (HE40) - 5 GHz

Characteristics	Value
Specification	IEEE 802.11ax
Mode	OFDM
Channel Frequency	5190 - 5795 MHz
Data rate	MCS0 - MCS11

12.11.1 High-Rate Condition for IEEE 802.11ax (HE40) - 5 GHz

Conditions: 25 ºC, VBAT = 3.3V, VIO = 1.8V, Output power setting = 10 dBm at module pad, MCS11 mode.

Table 56: High-Rate Condition for IEEE802.11ax (HE40) - 5 GHz

Items	Contents			
DC characteristics	Minimum	Typical	Maximum	Unit
DC Current				
• Tx mode Current 1.8V		217	290	mA
• Tx mode Current 3.3V		162	230	mA
• Rx mode Current 1.8V		141	170	mA
• Rx mode Current 3.3V		0.2	10	mA
Tx Characteristics	Minimum	Typical	Maximum	Unit
Output Power	8	10	12	dBm
Spectrum Mask Margin				
• 19 MHz to 21 MHz (0~ -20 dBr)	0			dB
• 21 MHz to 40 MHz (-20~ -28 dBr)	0			dB
• 40 MHz to 60 MHz (-28~ -45 dBr)	0			dB
• 60 MHz to 80 MHz (-45 dBr)	0			dB
Constellation Error (EVM) (Measured at enhanced mode)			-32	dB
Frequency Tolerance	-20		20	ppm
Spurious Emissions				
• 30 - 47 MHz (BW = 100 KHz)			-36	dBm
• 47 - 74 MHz (BW = 100 KHz)			-54	dBm
• 74 - 87.5 MHz (BW = 100 KHz)			-36	dBm
• 87.5 - 118 MHz (BW = 100 KHz)			-54	dBm
• 118 - 174 MHz (BW = 100 KHz)			-36	dBm
• 174 - 230 MHz (BW = 100 KHz)			-54	dBm
• 230 - 470 MHz (BW = 100 KHz)			-36	dBm

Items	Contents			
• 470 - 862 MHz (BW = 100 KHz)			-54	dBm
• 862 - 1000 MHz (BW = 100 KHz)			-36	dBm
• 1000 - 5150 MHz (BW = 1 MHz)			-30	dBm
• 5350 - 5470 MHz (BW = 1 MHz)			-30	dBm
• 5725 - 26000 MHz (BW = 1 MHz)			-30	dBm
Rx Characteristics	Minimum	Typical	Maximum	Unit
Minimum Input Level (PER ≤ 10%)			-54	dBm
Maximum Input Level (PER < 10%)	-30			dBm
Adjacent Channel Rejection (PER ≤ 10%)	-9			dB

12.11.2 Low-Rate Condition for IEEE802.11ax (HE40) - 5 GHz

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

Table 57: Low-Rate Condition for IEEE802.11ax (HE40) - 5 GHz

Items	Contents			
DC characteristics	Minimum	Typical	Maximum	Unit
DC Current				
• Tx mode Current 1.8V		234	290	mA
• Tx mode Current 3.3V		212	280	mA
• Rx mode Current 1.8V		141	170	mA
• Rx mode Current 3.3V		0.2	10	mA
Tx Characteristics	Minimum	Typical	Maximum	Unit
Output Power	12	14	16	dBm
Spectrum Mask Margin				
• 19 MHz to 21 MHz (0~ -20 dBr)	0			dB
• 21 MHz to 40 MHz (-20~ -28 dBr)	0			dB
• 40 MHz to 60 MHz (-28~ -45 dBr)	0			dB
• 60 MHz to 80 MHz (-45 dBr)	0			dB
Constellation Error (EVM) (Measured at enhanced mode)			-32	dB
Frequency Tolerance	-20		20	ppm
Spurious Emissions				
• 30 - 47 MHz (BW = 100 KHz)			-36	dBm
• 47 - 74 MHz (BW = 100 KHz)			-54	dBm
• 74 - 87.5 MHz (BW = 100 KHz)			-36	dBm
• 87.5 - 118 MHz (BW = 100 KHz)			-54	dBm
• 118 - 174 MHz (BW = 100 KHz)			-36	dBm
• 174 - 230 MHz (BW = 100 KHz)			-54	dBm
• 230 - 470 MHz (BW = 100 KHz)			-36	dBm
• 470 - 862 MHz (BW = 100 KHz)			-54	dBm
• 862 - 1000 MHz (BW = 100 KHz)			-36	dBm

Items	Contents			
• 1000 - 5150 MHz (BW = 1 MHz)			-30	dBm
• 5350 - 5470 MHz (BW = 1 MHz)			-30	dBm
• 5725 - 26000 MHz (BW = 1 MHz)			-30	dBm
Rx Characteristics	Minimum	Typical	Maximum	Unit
Minimum Input Level (PER ≤ 10%)			-79	dBm
Maximum Input Level (PER < 10%)	-30			dBm
Adjacent Channel Rejection (PER ≤ 10%)	-9			dB

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

Table 58: DC/RF Characteristics for IEEE 802.11ac (VHT80) - 5 GHz

Characteristics	Value
Specification	IEEE 802.11ac
Mode	OFDM
Channel Frequency	5210 - 5775 MHz
Data rate	MCS0-MCS9

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

Conditions: 25 ºC, VBAT = 3.3V, VIO = 1.8V, Output power setting = 12 dBm at module pad, MCS9 mode.

Table 59: High-Rate Condition for IEEE 802.11ac (VHT80) - 5 GHz

Items	Contents			
DC characteristics	Minimum	Typical	Maximum	Unit
DC Current				
• Tx mode Current 1.8V		243	310	mA
• Tx mode Current 3.3V		177	250	mA
• Rx mode Current 1.8V		172	200	mA
• Rx mode Current 3.3V		0.2	10	mA
Tx Characteristics	Minimum	Typical	Maximum	Unit
Output Power	10	12	14	dBm
Spectrum Mask Margin				
• 39 MHz to 41 MHz (0~ -20 dBr)	0			dB
• 41 MHz to 80 MHz (-20~ -28 dBr)	0			dB
• 80 MHz to 120 MHz (-28~ -40 dBr)	0			dB
• 120 MHz to 140 MHz (-40 dBr)	0			dB
Constellation Error (EVM) (Measured at enhanced mode)			-32	dB
Frequency Tolerance	-20		20	ppm
Spurious Emissions				
• 30 - 47 MHz (BW = 100 KHz)			-36	dBm
• 47 - 74 MHz (BW = 100 KHz)			-54	dBm
• 74 - 87.5 MHz (BW = 100 KHz)			-36	dBm
• 87.5 - 118 MHz (BW = 100 KHz)			-54	dBm
• 118 - 174 MHz (BW = 100 KHz)			-36	dBm
• 174 - 230 MHz (BW = 100 KHz)			-54	dBm
• 230 - 470 MHz (BW = 100 KHz)			-36	dBm
• 470 - 862 MHz (BW = 100 KHz)			-54	dBm
• 862 - 1000 MHz (BW = 100 KHz)			-36	dBm
• 1000 - 5150 MHz (BW = 1 MHz)			-30	dBm
• 5350 - 5470 MHz (BW = 1 MHz)			-30	dBm
• 5725 - 26000 MHz (BW = 1 MHz)			-30	dBm
Rx Characteristics	Minimum	Typical	Maximum	Unit
Minimum Input Level (PER ≤ 10%)			-51	dBm

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

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

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

Table 60: Low-Rate Condition for IEEE 802.11ac (VHT80) - 5 GHz

Items	Contents			
DC characteristics	Minimum	Typical	Maximum	Unit
DC Current				
• Tx mode Current 1.8V		250	310	mA
• Tx mode Current 3.3V		208	290	mA
• Rx mode Current 1.8V		172	200	mA
• Rx mode Current 3.3V		0.2	10	mA
Tx Characteristics	Minimum	Typical	Maximum	Unit
Output Power	12	14	16	dBm
Spectrum Mask Margin				
• 39 MHz to 41 MHz (0~ -20 dBr)	0			dB
• 41 MHz to 80 MHz (-20~ -28 dBr)	0			dB
• 80 MHz to 120 MHz (-28~ -40 dBr)	0			dB
• 120 MHz to 140 MHz (-40 dBr)	0			dB
Constellation Error (EVM) (Measured at enhanced mode)			-32	dB
Frequency Tolerance	-20		20	ppm
Spurious Emissions				
• 30 - 47 MHz (BW = 100 KHz)			-36	dBm
• 47 - 74 MHz (BW = 100 KHz)			-54	dBm
• 74 - 87.5 MHz (BW = 100 KHz)			-36	dBm
• 87.5 - 118 MHz (BW = 100 KHz)			-54	dBm
• 118 - 174 MHz (BW = 100 KHz)			-36	dBm
• 174 - 230 MHz (BW = 100 KHz)			-54	dBm
• 230 - 470 MHz (BW = 100 KHz)			-36	dBm
• 470 - 862 MHz (BW = 100 KHz)			-54	dBm
• 862 - 1000 MHz (BW = 100 KHz)			-36	dBm
• 1000 - 5150 MHz (BW = 1 MHz)			-30	dBm
• 5350 - 5470 MHz (BW = 1 MHz)			-30	dBm
• 5725 - 26000 MHz (BW = 1 MHz)			-30	dBm
Rx Characteristics	Minimum	Typical	Maximum	Unit
Minimum Input Level (PER ≤ 10%)			-76	dBm

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

12.13 DC/RF Characteristics for IEEE 802.11ax (HE80) - 5 GHz

Table 61: DC/RF Characteristics for IEEE 802.11ac (HE80) - 5 GHz

Characteristics	Value
Specification	IEEE 802.11ax
Mode	OFDM
Channel Frequency	5210 - 5775 MHz
Data rate	MCS0 - MCS9

12.13.1 High-Rate Condition for IEEE 802.11ax (HE80) - 5 GHz

Conditions: 25 ºC, VBAT = 3.3V, VIO = 1.8V, Output power setting = 10 dBm at module pad, MCS11 mode.

Table 62: High-Rate Condition for IEEE 802.11ax (HE80) - 5 GHz

Items	Contents			
DC characteristics	Minimum	Typical	Maximum	Unit
DC Current				
• Tx mode Current 1.8V		236	310	mA
• Tx mode Current 3.3V		161	220	mA
• Rx mode Current 1.8V		172	200	mA
• Rx mode Current 3.3V		0.2	10	mA
Tx Characteristics	Minimum	Typical	Maximum	Unit
Output Power	8	10	12	dBm
Spectrum Mask Margin				
• 39 MHz to 41 MHz (0~ -20 dBr)	0			dB
• 41 MHz to 80 MHz (-20~ -28 dBr)	0			dB
• 80 MHz to 120 MHz (-28~ -40 dBr)	0			dB
• 120 MHz to 140 MHz (-40 dBr)	0			dB
Constellation Error (EVM) (Measured at enhanced mode)			-32	dB
Frequency Tolerance	-20		20	ppm
Spurious Emissions				
• 30 - 47 MHz (BW = 100kHz)			-36	dBm
• 47 - 74 MHz (BW = 100kHz)			-54	dBm
• 74 - 87.5 MHz (BW = 100kHz)			-36	dBm
• 87.5 - 118 MHz (BW = 100kHz)			-54	dBm
• 118 - 174 MHz (BW = 100kHz)			-36	dBm
• 174 - 230 MHz (BW = 100kHz)			-54	dBm
• 230 - 470 MHz (BW = 100kHz)			-36	dBm
• 470 - 862 MHz (BW = 100kHz)			-54	dBm
• 862 - 1000 MHz (BW = 100kHz)			-36	dBm
• 1000 - 5150 MHz (BW = 1MHz)			-30	dBm
• 5350 - 5470 MHz (BW = 1MHz)			-30	dBm
• 5725 - 26000 MHz (BW = 1MHz)			-30	dBm
Rx Characteristics	Minimum	Typical	Maximum	Unit
Minimum Input Level (PER ≤ 10%)			-51	dBm

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

12.13.2 Low-Rate Condition for IEEE 802.11ax (HE80) - 5 GHz

Normal Condition: 25 ºC, VBAT = 3.3V. MCS0 mode unless otherwise specified.

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

Table 63: Low-Rate Condition for IEEE 802.11ax (HE80) - 5 GHz

Items	Contents			
DC characteristics	Minimum	Typical	Maximum	Unit
DC Current				
• Tx mode Current 1.8V		254	310	mA
• Tx mode Current 3.3V		211	290	mA
• Rx mode Current 1.8V		172	200	mA
• Rx mode Current 3.3V		0.2	10	mA
Tx Characteristics	Minimum	Typical	Maximum	Unit
Output Power	12	14	16	dBm
Spectrum Mask Margin				
• 39 MHz to 41 MHz (0~ -20 dBr)	0			dB
• 41 MHz to 80 MHz (-20~ -28 dBr)	0			dB
• 80 MHz to 120 MHz (-28~ -40 dBr)	0			dB
• 120 MHz to 140 MHz (-40 dBr)	0			dB
Constellation Error (EVM) (Measured at enhanced mode)			-32	dB
Frequency Tolerance	-20		20	ppm
Spurious Emissions				
• 30 - 47 MHz			-36	dBm
• 47 - 74 MHz			-54	dBm
• 74 - 87.5 MHz			-36	dBm
• 87.5 - 118 MHz			-54	dBm
• 118 - 174 MHz			-36	dBm
• 174 - 230 MHz			-54	dBm
• 230 - 470 MHz			-36	dBm
• 470 - 862 MHz			-54	dBm
• 862 - 1000 MHz			-36	dBm
• 1000 - 5150 MHz (BW = 1 MHz)			-30	dBm
• 5350 - 5470 MHz (BW = 1 MHz)			-30	dBm
• 5725 - 26000 MHz (BW = 1 MHz)			-30	dBm
Rx Characteristics	Minimum	Typical	Maximum	Unit

Items	Contents			
Minimum Input Level (PER ≤ 10%)			-76	dBm
Maximum Input Level (PER < 10%)	-30			dBm
Adjacent Channel Rejection (PER ≤ 10%)	-9			dB

12.14 DC/RF Characteristics for Bluetooth

Table 64: DC/RF Characteristics for Bluetooth

Characteristics	Value
Bluetooth specification (power class)	Version 5.3 (Class1)
Channel frequency (spacing)	2402 - 2480 MHz (1 MHz)
Number of RF Channel	79

12.14.1 Basic Data Rate Conditions

Conditions: 25 ºC, VBAT = 3.3V, VIO = 1.8V.

Table 65: Basic Data Rate Conditions

Items		Contents		
Current Consumption	Minimum	Typical	Maximum	Unit
• Tx mode DH5 Current 1.8V		323	390	mA
• Tx mode DH5 Current 3.3V		0.2	3	mA
• Rx mode DH5 Current 1.8V		123	150	mA
• Rx mode DH5 Current 3.3V		0.2	3	mA
Tx Characteristics	Minimum	Typical	Maximum	Unit
Output Power@DH5	2	5	8	dBm
Frequency Range	2400		2483.5	MHz
20 dB Bandwidth			1	MHz
Adjacent Channel Power[5]				
• [M-N] = 2			-20	dBm
• [M-N] ≥ 3			-40	dBm
Modulation Characteristics				
• Modulation $\Delta f1_{avg}$	140	151	175	kHz
• Modulation $\Delta f2_{max}$	115			kHz
• Modulation $\Delta f2_{avg}$ / $\Delta f1_{avg}$	0.8	1		
Carrier Frequency Drift				
• 1 slot	-25		25	kHz
• 3 slot / 5 slot	-40		40	kHz
• Maximum Drift Rate			20	kHz/50µs
Rx Characteristics	Minimum	Typical	Maximum	Unit
BR Sensitivity (BER ≤ 0.1%)		-96	-70	dBm
Maximum Input Level (BER ≤ 0.1%)	-20			dBm

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

12.14.2 Enhanced Data Rate Conditions

Conditions: 25 ºC, VBAT=3.3V, VIO=1.8V

Table 66: Enhanced Data Rate Conditions

Items	Contents			
Current Consumption	Minimum	Typical	Maximum	Unit
• Tx mode 2DH5 Current 1.8V		192	240	mA
• Tx mode 2DH5 Current 3.3V		0.2	3	mA
• Rx mode 2DH5 Current 1.8V		123	150	mA
• Rx mode 2DH5 Current 3.3V		0.2	3	mA
• Tx mode 3DH5 Current 1.8V		191	240	mA
• Tx mode 3DH5 Current 3.3V		0.2	3	mA
• Rx mode 3DH5 Current 1.8V		123	150	mA
• Rx mode 3DH5 Current 3.3V		0.2	3	mA
Tx Characteristics	Minimum	Typical	Maximum	Unit
Output Power@2DH5/3DH5	2	5	8	dBm
Frequency Range	2400		2483.5	MHz
20 dB Bandwidth			1	MHz
Adjacent Channel Power[6]				
• [M-N] =2			-20	dBm
• [M-N] ≥3			-40	dBm
EDR Relative Power	-4		1	dB
EDR Carrier Frequency Stability and Modulation Accuracy				
• ωi	-75		75	kHz
• ωi+ωo	-75		75	kHz
• ωo	-10		10	kHz
• RMS DEVM (DQPSK)			20	%
• Peak DEVM (DQPSK)			35	%
• 99% DEVM (DQPSK)			30	%
• RMS DEVM (8 DPSK)			13	%
• Peak DEVM (8 DPSK)			25	%
• 99% DEVM (8 DPSK)			20	%
Spurious Emissions				
• 30-47 MHz			-36	dBm
• 47-74 MHz			-54	dBm
• 74-87.5 MHz			-36	dBm
• 87.5-118 MHz			-54	dBm
• 118-174 MHz			-36	dBm
• 174-230 MHz			-54	dBm
• 230-470 MHz			-36	dBm
• 470-862 MHz			-54	dBm
• 862-1000 MHz			-36	dBm

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

Items	Contents			
• 1000-12750 MHz (BW = 1 MHz)			-30	dBm
Rx Characteristics	Minimum	Typical	Maximum	Unit
EDR Sensitivity (BER ≤ 0.007%) @ 8DPSK		-88	-70	dBm
Maximum Input Level (BER ≤ 0.1%)	-20			dBm

12.15 DC/RF Characteristics for Bluetooth Low Energy

Table 67: DC/RF Characteristics for Bluetooth Low Energy

Characteristics	Value
Bluetooth specification (power class)	Version 5.3 (Class1.5)
Channel frequency (spacing)	2402 - 2480 MHz (2 MHz)
Number of RF Channel	40

12.15.1 1 Mbps PHY Conditions

Conditions: 25 ºC, VBAT = 3.3V, VIO = 1.8V

Table 68: 1 Mbps PHY Conditions

Items	Contents			
Current Consumption	Minimum	Typical	Maximum	Unit
• Tx mode Current 1.8V		325	390	mA
• Tx mode Current 3.3V		0.2	3	
• Rx mode Current 1.8V		123	150	mA
• Rx mode Current 3.3V		0.2	3	
Tx Characteristics	Minimum	Typical	Maximum	Unit
Center Frequency	2402		2480	MHz
Channel Spacing		2		MHz
Number of RF Channel		40		
Output Power	10	13	16	dBm
In-band Emission				
• f_{TX}+/-2 MHz			-20	dBm
• f_{TX}+/-[3+n] MHz; n=0,1,2…			-30	dBm
Modulation Characteristics				
• $\Delta f1_{avg}$	225		275	kHz
• $\Delta f2_{max}$ (at 99.9%)	185			kHz
• $\Delta f2_{avg}$ / Δf1avg	0.8			
Stable Modulation Characteristics				
• $\Delta f1_{avg}$	247.5		252.5	kHz
• $\Delta f2_{max}$ (at 99.9%)	185			kHz
• $\Delta f2_{avg}$ / $\Delta f1_{avg}$	0.8			

Items	Contents			
Carrier Frequency Offset and Drift				
• Frequency offset (f_n); n = 0,1,2,3…k	-150		150	kHz
• Frequency drift ($\|f_0-f_n\|$); n = 2,3,4…k			50	kHz
Drift Rate				
• $\|f_1-f_0\|$			23	KHz
• $\|f_n-f_n-5\|$; n=6,7,8,…k			20	KHz
Spurious Emissions				
• 30 - 47 MHz (BW = 100 KHz)			-36	dBm
• 47 - 74 MHz (BW = 100 KHz)			-54	dBm
• 74 - 87.5 MHz (BW = 100 KHz)			-36	dBm
• 87.5 - 118 MHz (BW = 100 KHz)			-54	dBm
• 118 - 174 MHz (BW = 100 KHz)			-36	dBm
• 174 - 230 MHz (BW = 100 KHz)			-54	dBm
• 230 - 470 MHz (BW = 100 KHz)			-36	dBm
• 470 - 862 MHz (BW = 100 KHz)			-54	dBm
• 862 - 1000 MHz (BW = 100 KHz)			-36	dBm
• 1000 - 12750 MHz (BW = 1 MHz)			-30	dBm
Rx Characteristics	Minimum	Typical	Maximum	Unit
Receiver sensitivity (PER < 30.8%)		-97	-70	dBm
Maximum input signal level (PER < 30.8%)	-10			dBm
PER Report Integrity (-30 dBm input)	50		65.4	%

12.15.2 2 Mbps PHY Conditions

Conditions: 25 ºC, VBAT = 3.3V, VIO = 1.8V

Table 69: 2 Mbps PHY Conditions

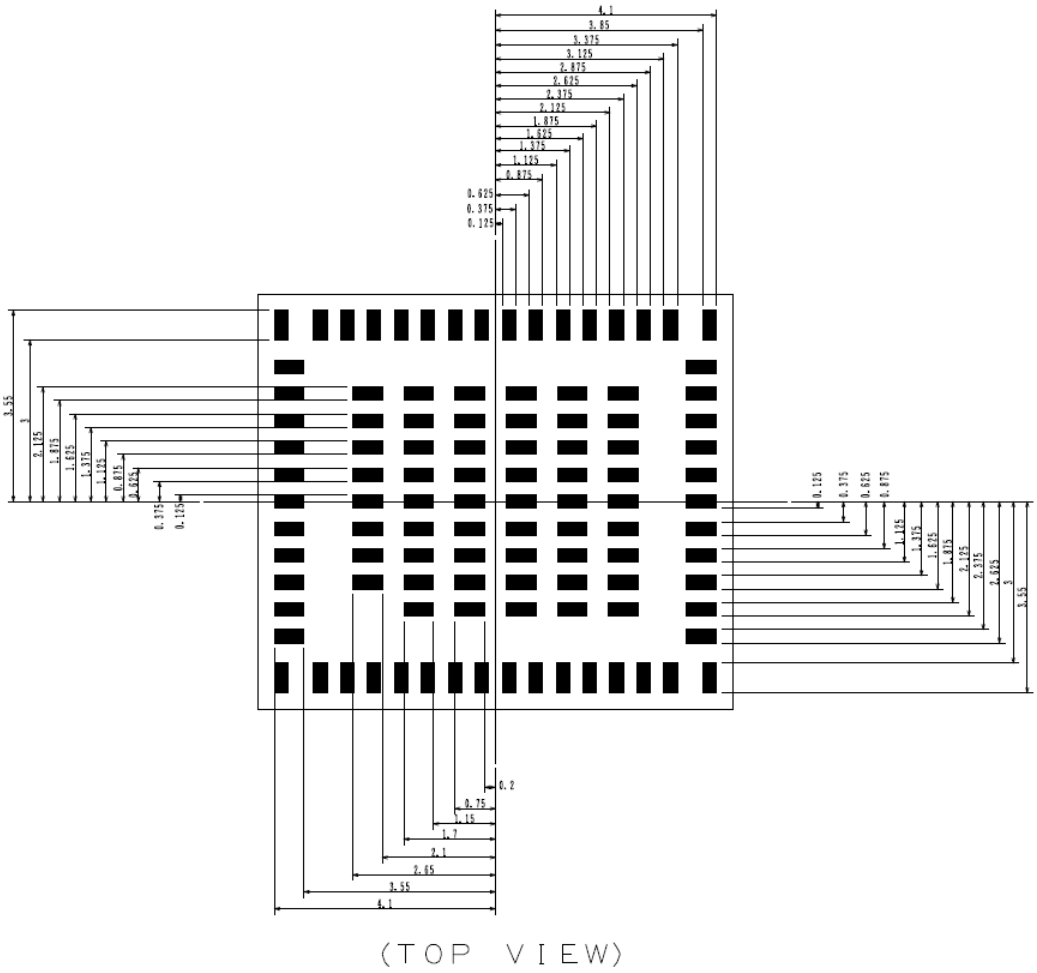
Items	Contents			
Current Consumption	Minimum	Typical	Maximum	Unit
• Tx mode Current 1.8V		344	390	mA
• Tx mode Current 3.3V		0.2	3	mA
• Rx mode Current 1.8V		123	150	mA
• Rx mode Current 3.3V		0.2	3	mA
Tx Characteristics	Minimum	Typical	Maximum	Unit
Center Frequency	2402		2480	MHz
Channel Spacing		2		MHz
Number of RF Channel		40		
Output Power	10	13	16	dBm
In-band Emission				

Items	Contents			
• f_{TX}+/-4 MHz			-20	dBm
• f_{TX}+/-5 MHz			-20	dBm
• f_{TX}+/-[6+n] MHz; n=0,1,2…			-30	dBm
Modulation Characteristics				
• $\Delta f1_{avg}$	450		550	kHz
• $\Delta f2_{max}$ (at 99.9%)	370			kHz
• $\Delta f2_{avg}$ / Δf1avg	0.8			
Stable Modulation Characteristics				
• $\Delta f1_{avg}$	495		505	kHz
• $\Delta f2_{max}$ (at 99.9%)	370			kHz
• $\Delta f2_{avg}$ / $\Delta f1_{avg}$	0.8			
Carrier Frequency Offset and Drift				
• Frequency offset (f_n); n = 0,1,2,3…k	-150		150	kHz
• Frequency drift ($\|f_0-f_n\|$); n = 2,3,4…k			50	kHz
Drift Rate				
• $\|f_1-f_0\|$			23	kHz
• $\|f_n-f_n-5\|$; n=6,7,8,…k			20	kHz
Spurious Emissions				
• 30 - 47 MHz (BW = 100 KHz)			-36	dBm
• 47 - 74 MHz (BW = 100 KHz)			-54	dBm
• 74 - 87.5 MHz (BW = 100 KHz)			-36	dBm
• 87.5 - 118 MHz (BW = 100 KHz)			-54	dBm
• 118 - 174 MHz (BW = 100 KHz)			-36	dBm
• 174 - 230 MHz (BW = 100 KHz)			-54	dBm
• 230 - 470 MHz (BW = 100 KHz)			-36	dBm
• 470 - 862 MHz (BW = 100 KHz)			-54	dBm
• 862 - 1000 MHz (BW = 100 KHz)			-36	dBm
• 1000 - 12750 MHz (BW = 1 MHz)			-30	dBm
Rx Characteristics	Minimum	Typical	Maximum	Unit
Receiver sensitivity (PER < 30.8%)		-97	-70	dBm
Maximum input signal level (PER < 30.8%)	-10			dBm
PER Report Integrity (-30 dBm input)	50		65.4	%

13 Land Pattern

Figure 22 shows the land pattern of Type 2DL.

Figure 22: Land Pattern (in mm)



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 0.2 mm away from module outline as above figure.

14 Tape and Reel Packing

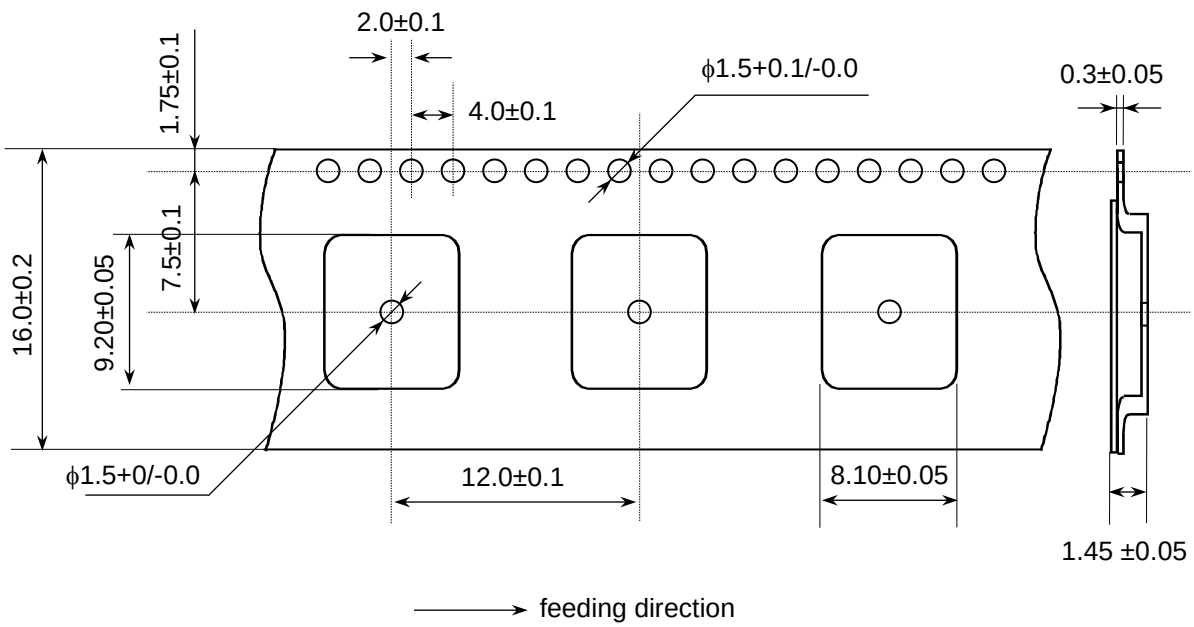
This section provides the general specifications for tape and reel packing.

14.1 Dimensions of Tape (Plastic Tape)

Cumulative tolerance of maximum 40.0 ± 0.15 every 10 pitches.

Figure 23 is a graphical representation of the tape dimension (plastic tape).

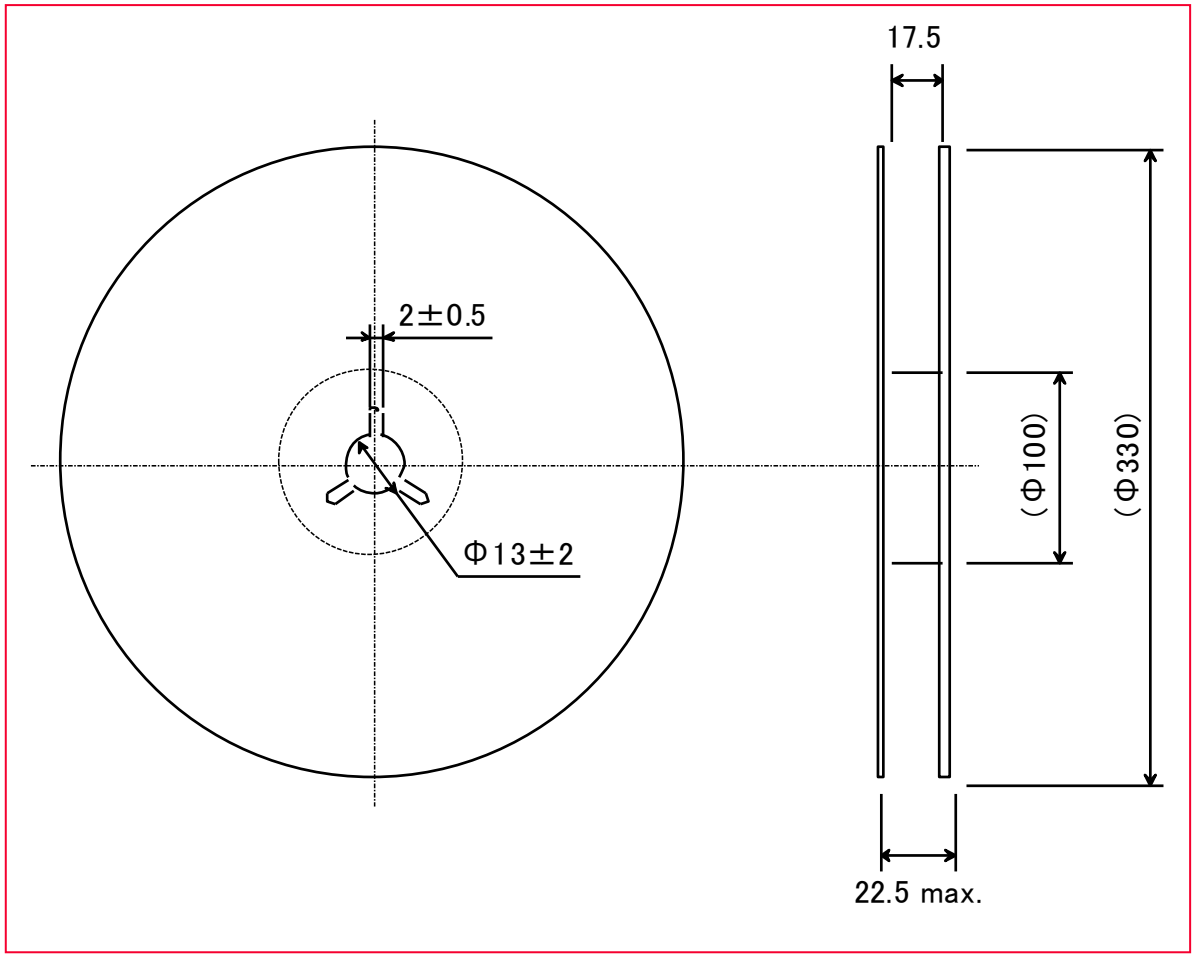
Figure 23: Dimensions of Tape (Plastic Tape)



14.2 Dimensions of Reel

Figure 24 shows the reel dimensions.

Figure 24: Dimensions of Reel (Unit: mm)



14.3 Taping Diagrams

Figure 25 shows the taping diagrams.

Figure 25: Taping Diagrams

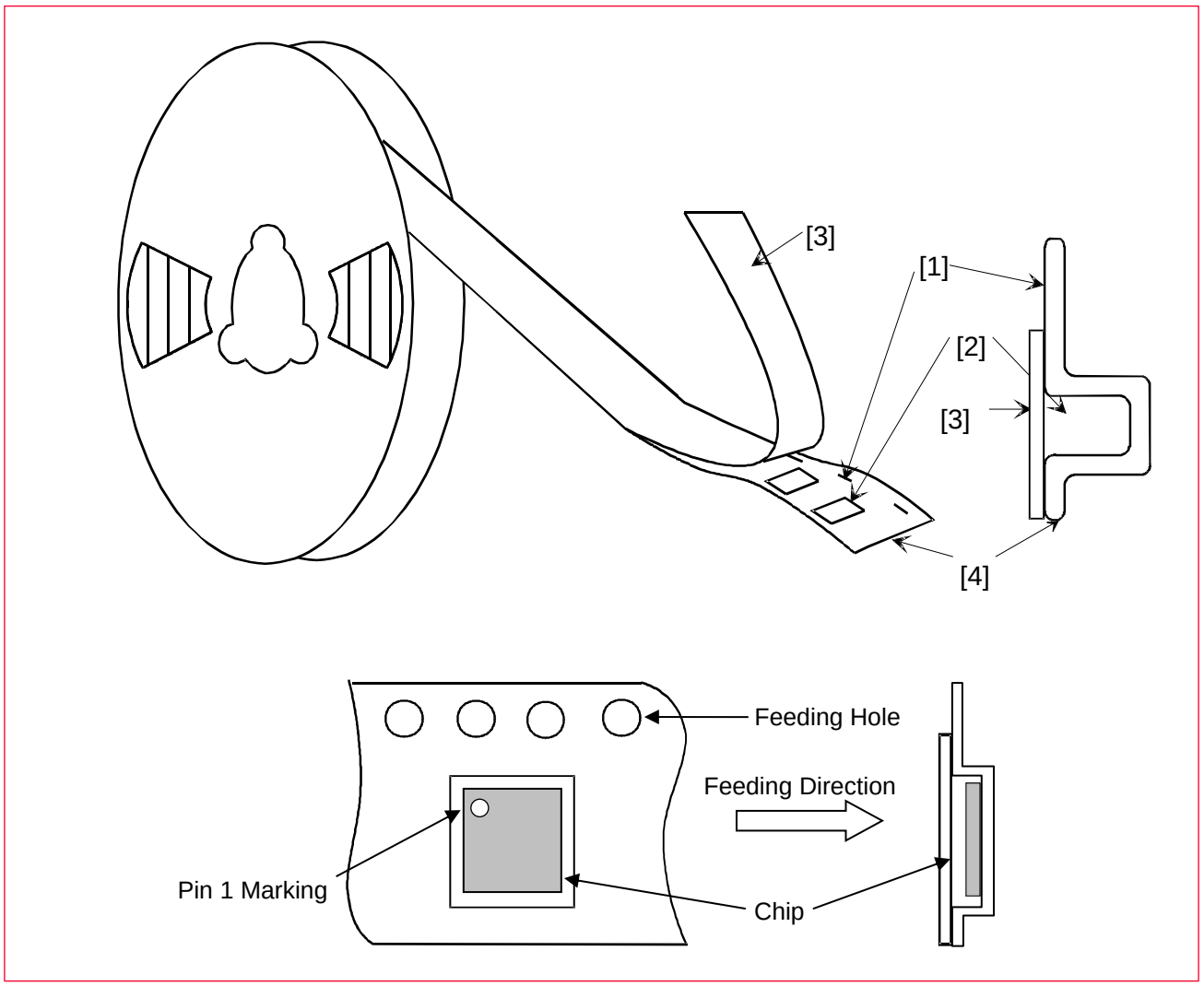


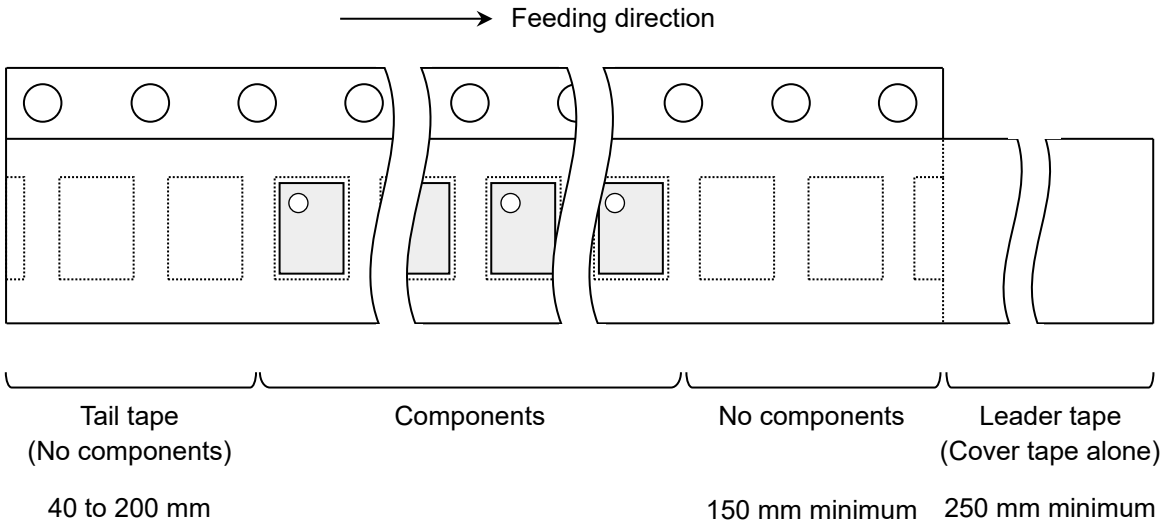
Table 70: Taping Specifications

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

14.4 Leader and Tail Tape

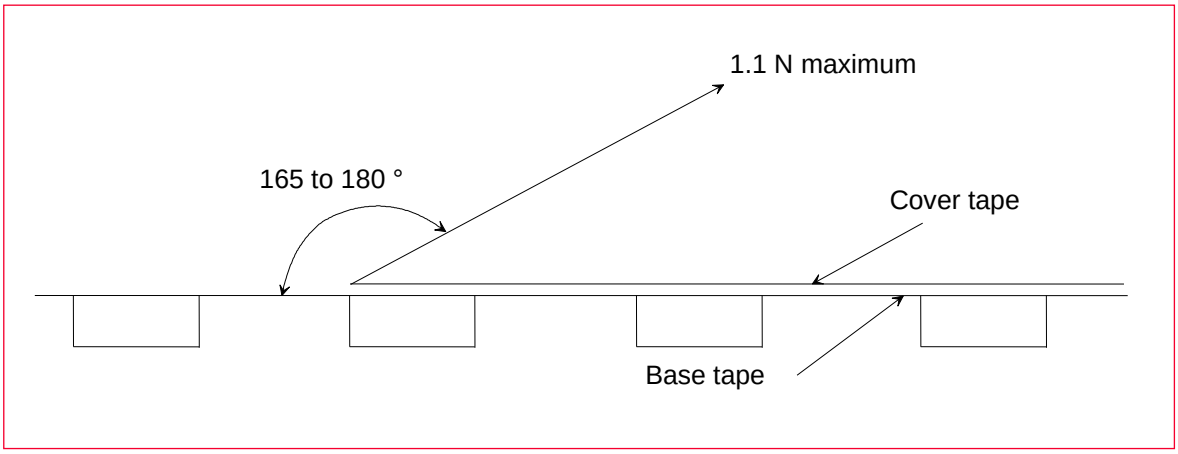
The leader and tail tape are shown in **Figure 26**

Figure 26: Leader and Tail Tape



- The tape for chips is wound clockwise, the feeding holes to the right side as the tape is pulled toward the user.
- The cover tape and base tape are not adhered at no components area for 250 mm minimum.
- Tear off strength against pulling of cover tape: 5 N minimum.
- Packaging unit: 1000 pcs./ reel
- Material
  - Base tape: Plastic
  - Real: Plastic
  - Cover tape, cavity tape and reel are made the anti-static processing.
- Peeling off force: 1.1 N maximum. in the direction of peeling as shown in **Figure 27**

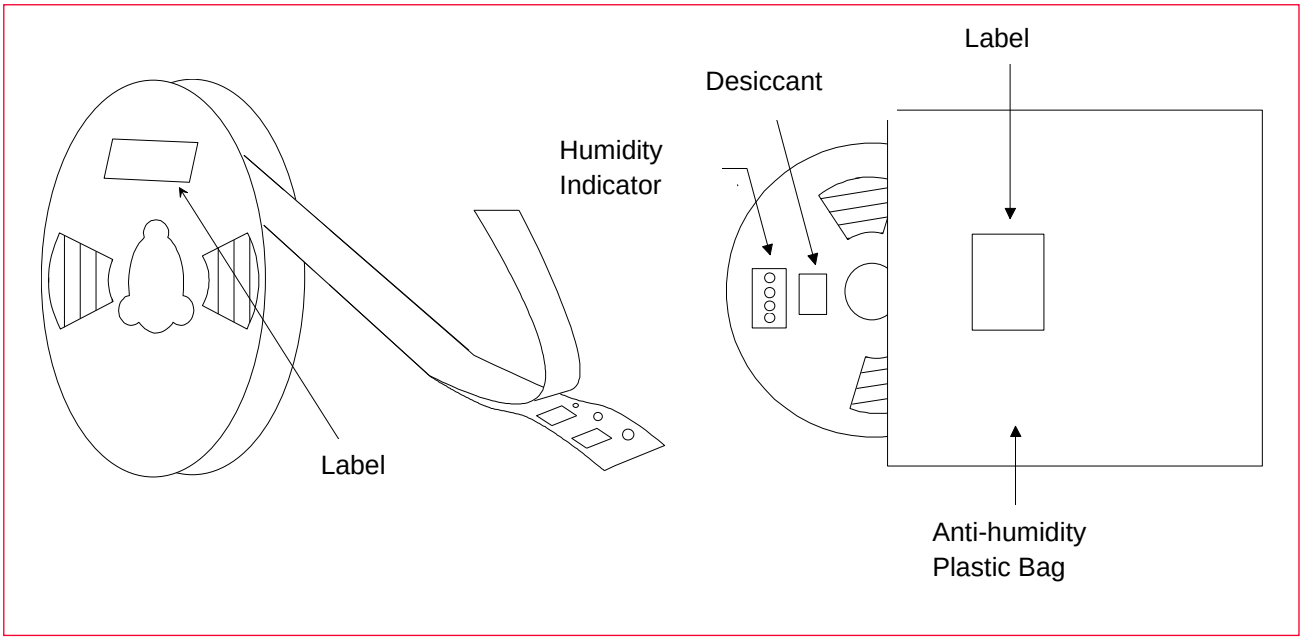
Figure 27: Peeling Force



14.5 Packaging (Humidity Proof Packing)

The packaging is shown in **Figure 28**

Figure 28: 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 6 months after receipt.
- The product shall be stored without opening the packing under the ambient temperature from 5 to 35 °C and humidity from 20 ~ 70 %RH (Packing materials, in particular, may be deformed at the temperature over 40 °C).
- The product left more than 6 months after reception; it needs to be confirmed the solderability before used.
- The product shall be stored in noncorrosive gas (Cl_2, NH_3, SO_2, NO_X, etc.).
- Any excess mechanical shock including, but not limited to, sticking the packing materials by sharp object, and dropping the product, shall not be applied in order not to damage the packing materials.
- This product is applicable to MSL3 (Based on IPC/JEDEC J-STD-020)
- After the packing opened, the product shall be stored at <30 °C / <60 %RH and the product shall be used within 168 hours.
- When the color of the indicator in the packing changed, the product shall be baked before soldering.
- Baking condition: 125 +5/-0 °C, 24 hours, 1 time
- The products shall be baked on the heat-resistant tray because the materials (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. If there is any such damage, the characteristics of products may change. Do not touch products with bare hands that may result in poor solder ability and destroy by static electrical charge.

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

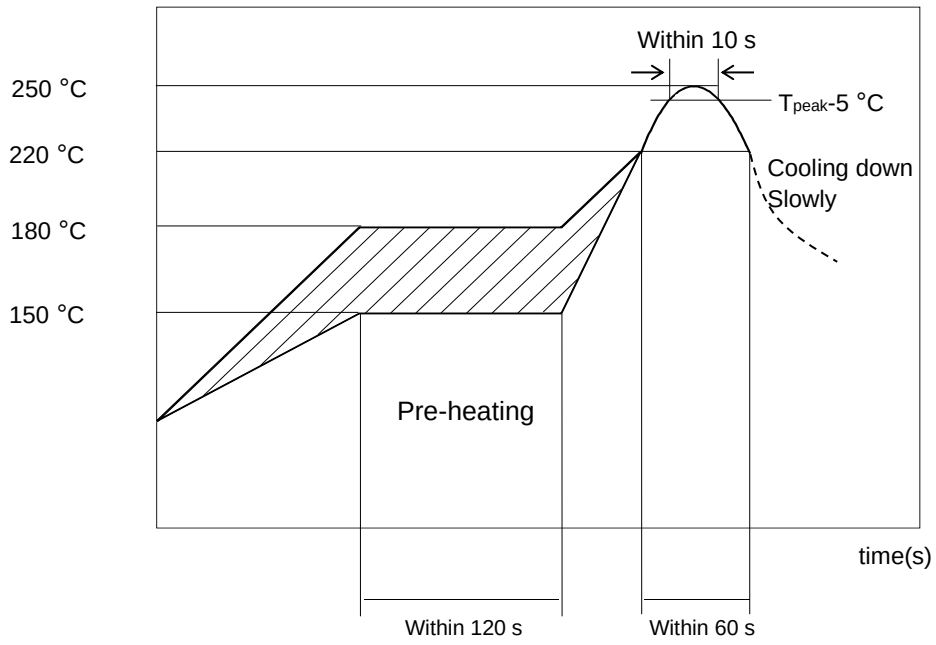
When placing products on the PCB, products may be stressed and broken by uneven forces from a worn-out chucking locating claw or a suction nozzle. To prevent products from damages, be sure to follow the specifications for the maintenance of the chip placer being used. For the positioning of products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

15.5 Soldering Conditions

The recommendation conditions of soldering are shown in **Figure 29**.

Soldering must be carried out by the above-mentioned conditions to prevent products from damage. Set up the highest temperature of reflow within 260 °C. Contact Murata before use if concerning other soldering conditions.

Figure 29: Reflow soldering standard conditions (Example)



Please use the reflow within 2 times.
Use rosin type flux or weakly active flux with a chlorine content of 0.2 wt. % or less.

15.6 Cleaning

This product is moisture sensitive; therefore, any cleaning is not recommended. If any cleaning process is done the customer is responsible for any issues or failures caused by the cleaning process.

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, SOX, NOX etc.).
- In an atmosphere containing combustible and volatile gases.
- Dusty place.
- Direct sunlight place.
- Water splashing place.
- Humid place where water condenses.
- Freezing place.

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

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

16 Precondition to Use Our Products

PLEASE READ THIS NOTICE BEFORE USING OUR PRODUCTS.

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Revision History

Revision	Date	Change	Change Description
	2023.1.27		Initial Release
A	2023.3.29		Converted to new template
B	2023.5.22	2 Key Features 5.1 Radio Certification 9.1 External Sleep Clock Requirements 10.1 10 Power On/ Power Off Sequence 11.1.4 SDR104 mode 12 DC/RF Characteristics	• Add Fit value • Update ID • Remove External Sleep Clock Requirements • Revise figure • Update SDR104 mode • Add Characteristics
C	2023.10.11	4 Block Diagram 5.1 Radio Certification 5.2 Radio Regulatory Certification by Country 6 Dimensions, Markings and Terminal Configurations 7.1 Pin Assignments 7.2 Pin Descriptions 9.3 Package Thermal Conditions	• Revise figure • Update Japan certification ID • Add new information • Revise figure • Revise figure • Revise list • Add new information

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