

WiFi+Bluetooth Combo Module Data Sheet

NXP 88W9098 Chipset
for 802.11a/b/g/n/ac/ax 2x2 MIMO + Bluetooth 5.3

Design Name: Type1XL
P/N : LBEE5ZZ1XL-774

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

Revision History

Rev Code	Date	Description	Comments
-	Nov. 20 2020	First Issue	
A	Mar. 15 2021	5. Dimensions, Marking and Terminal Configurations 6.1. Pin Assignments	-Changed module size and pin function information.
B	Mar. 29 2021	5. Dimensions, Marking and Terminal Configurations 6.2. Pin Descriptions	-Changed module height and pin function information.
C	Apr. 5 2021	5. Dimensions, Marking and Terminal Configurations	-Corrected e5 value from 1.09 to 1.10mm.
D	Apr. 28 2021	5. Dimensions, Marking and Terminal Configurations 12. Reference Circuit	-Added Marking information. -Added reference circuit.
E	May 5 2021	6.2. Pin Descriptions	-Corrected pin description
F	Jun. 14, 2021	5. Dimensions, Marking and Terminal Configurations	-Modified Marking information.
G	Oct.18, 2021	1. Scope 2. Key Features 3. Part Number 6. Dimensions, Marking and Terminal Configurations 7.1 Pin Assignments 7.2 Pin Descriptions 7.3 Configuration Pins 7.4 Pin State 7.5 SDIO Pin Descriptions 12. Land patterns	-Updated Bluetooth version -Added a new section -Added MP part number -Updated terminal size and dimensions. -Updated a diagram and Pin 235-238 -Updated Pin 235-238 and Pin 68 -Added a new section -Added a new section -Added a new section -Added Land patter figure
H	Feb. 01, 2022	4. Block Diagram 9.1 Operating Conditions 7.4 Pin States 13. Reference Circuit	-Removed sleep clock input -Defined IO Current -Added PDn -Applied change of Pin 235-238 and Pin 68.
I	Apr. 01, 2022	5.1 Radio Certification 5.2 Bluetooth Qualification 6. Dimensions, Marking and Terminal Configurations 9.1 Operating conditions 9.2 Digital I/O Requirements 9.3 Package thermal conditions 11. Host Interface Specification 12.14. DC/RF Characteristics for Bluetooth 12.15. DC/RF Characteristics for Bluetooth	-Added certification number -Added qualification number -Added module structure, Defined T1. -Added Junction temperature -Added this section -Added this section -Added this section -Added test method -Added test method
J	May. 09, 2022	6. Dimensions, Marking and Terminal Configurations 9.1 Operating conditions 12.DC/RF Characteristics	-Modified b3 measurement -Defined max values of peak current. -Defined current consumption and max input level
K	May. 31, 2022	7.2 Pin Descriptions 7.4 Pin States 14. Reference circuit	-Updated supply voltage level of IO pins (Power domain) -Updated supply voltage level of IO pins (Power domain) -Connect Pin 82 to GND. Added comment on GPIO22/23.
L	Aug.26,2022	7.2 Pin Descriptions 9.1 Operating Condition 9.3 Package Thermal Conditions 14 Reference Circuit	-Corrected descriptions of Pin 56, Pin 65 and Pin76 -Added Notes. -Corrected value. -Corrected connection of Pin 20 and 21.

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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 IEEE802.11 a/b/g/n/ac/ax + Bluetooth 5.3 module.

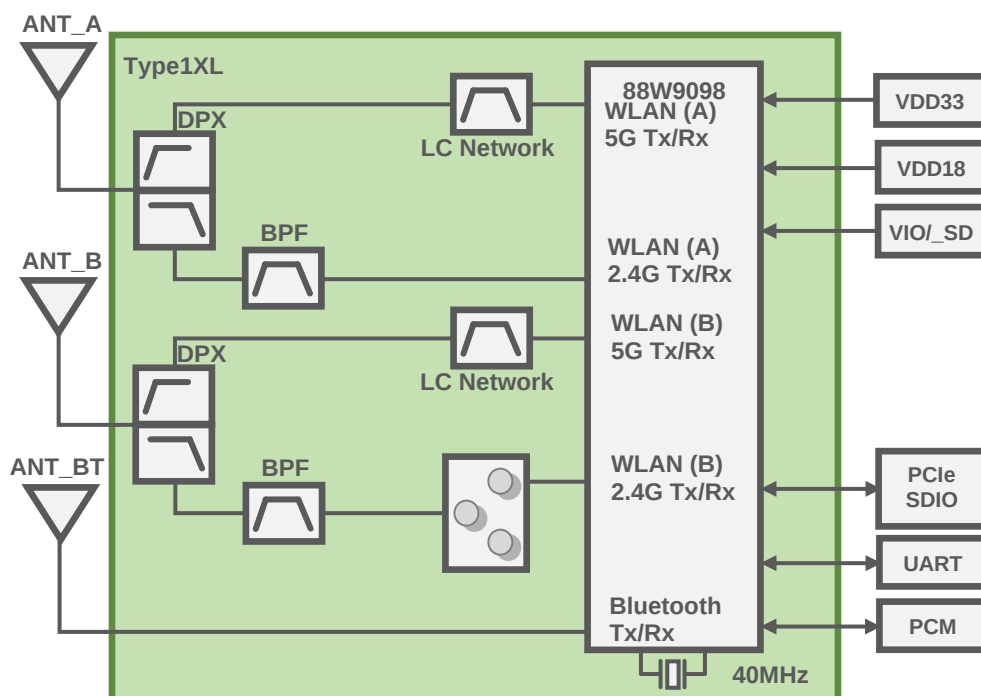
2. Key Features

- Module Size : 19.1(typ.) x 16.5(typ.) x 2.1(max.) mm
- Host Interface
 - WLAN : PCIe / SDIO
 - Bluetooth : UART
- IC P/N : NXP 88W9098
- Reference Clock : Reference clock embedded
- Weight : 1355 mg
- MSL : 3
- RoHS : This component can meet with RoHS compliance.

3. Part Number

Ordering Part Number	Description
LBEE5ZZ1XL-774	MP order
LBEE5ZZ1XL-SMP	In case of sample order

4. Block Diagram



5. Certification Information

5.1. Radio Certification

USA

FCC ID: VPYLBEE5ZZ1XL

Country Code: US

Canada

IC: 772C-LBEE5ZZ1XL

Country Code: CA

Europe

EN300328/301893, EN300440 conducted test report is prepared.

Country Code: DE

Japan

Japanese type certification is prepared.

Ⓡ 001-P01770

Country Code: JP

The each country code are defined by Murata's DB.txt file.
Please ask your contact person from Murata.

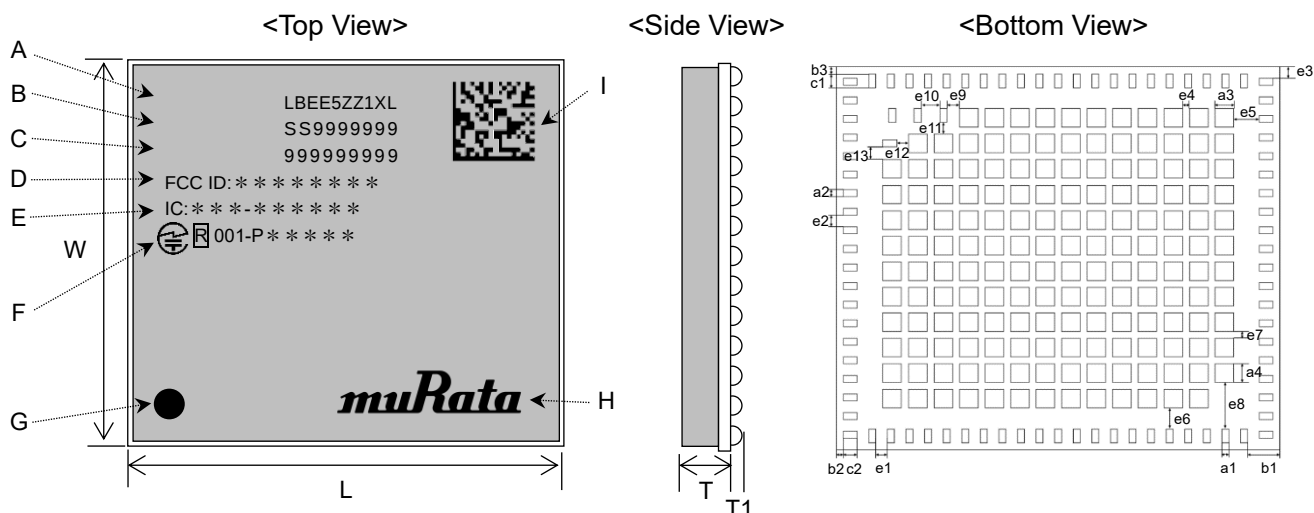
5.2. Bluetooth Qualification

QDID: 184816

*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

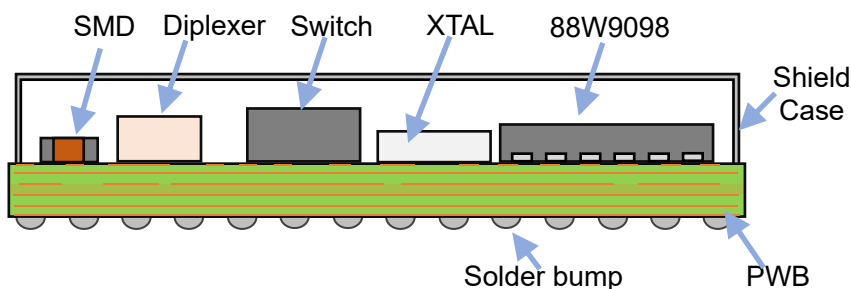


Marking	Meaning
A	Module Type
B	Production Process Number
C	Serial Number
D	FCC ID
E	ISED ID
F	Japan certification mark & ID
G	Pin-1 Marking
H	Murata Logo
I	2D code

Mark	Dimensions	Mark	Dimensions	Mark	Dimensions
L	19.1 +/- 0.2	W	16.5 +/- 0.2	T	2.1 max
T1	0.45 typ.	a1	0.3 +/- 0.1	a2	0.3 +/- 0.1
a3	0.8 +/- 0.1	a4	0.8 +/- 0.1	b1	1.4 +/- 0.2
b2	0.3 +/- 0.2	b3	0.3 +/- 0.2	c1	0.6 +/- 0.1
c2	0.6 +/- 0.1	e1	0.5 +/- 0.1	e2	0.5 +/- 0.1
e3	0.5 +/- 0.2	e4	0.3 +/- 0.1	e5	1.1 +/- 0.1
e6	0.9 +/- 0.1	e7	0.3 +/- 0.1	e8	2.0 +/- 0.1
e9	0.5 +/- 0.1	e10	0.8 +/- 0.1	e11	0.5 +/- 0.1
e12	0.5 +/- 0.1	e13	0.55 +/- 0.1	—	—

(unit : mm)

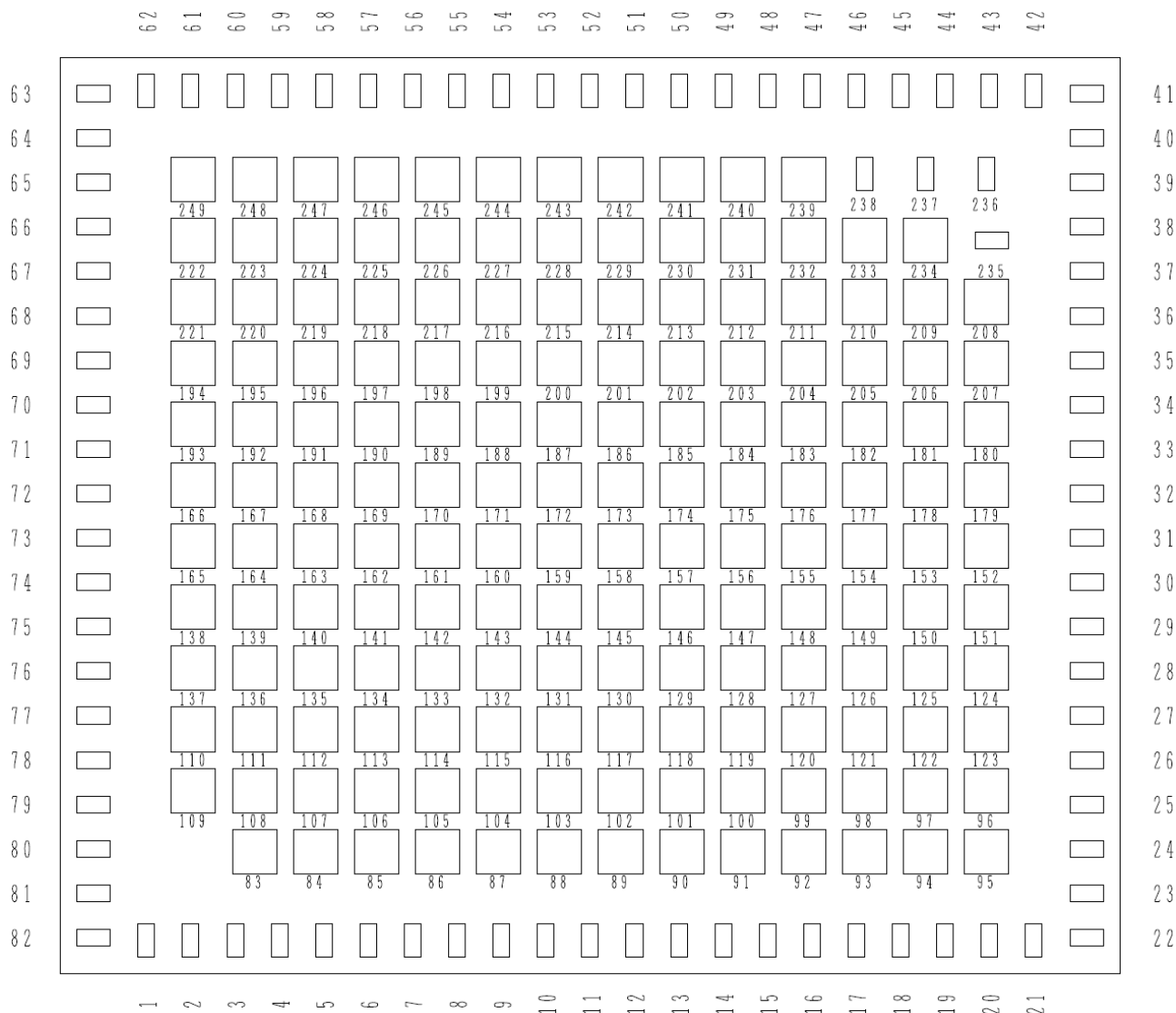
Structure



7. Module Pin Descriptions

7.1. Pin Assignments

<Top View>



No.	Terminal Name	No.	Terminal Name	No.	Terminal Name
1	GND	31	GND	61	GPIO[26]
2	GND	32	NC	62	GPIO[27]
3	CONFIG_HOST[0]	33	NC	63	GND
4	CONFIG_HOST[1]	34	GND	64	GND
5	CONFIG_HOST[2]	35	VIO_SD	65	BT_RF_OUT
6	GPIO[1]	36	SD_CLK	66	GND
7	GPIO[0]	37	SD_CMD	67	GND
8	GPIO[14]	38	SD_D[0]	68	NC
9	GPIO[4]	39	SD_D[1]	69	GND
10	GPIO[6]	40	SD_D[2]	70	GPIO[22]
11	GPIO[5]	41	GND	71	GPIO[23]
12	GPIO[7]	42	SD_D[3]	72	GPIO[19]
13	GPIO[16]	43	PCIE_PERST_N	73	GPIO[18]
14	GPIO[15]	44	PCIE_CLKREQ_N	74	GPIO[17]
15	PDn	45	PCIE_WAKE_N	75	GND
16	GND	46	W_DISABLE1N	76	WL_B_ANT/ WL B BT ANT
17	VDD33	47	GPIO[31]	77	GND
18	VDD33	48	GPIO[29]	78	GND
19	VIO	49	GPIO[30]	79	GND
20	VDD18	50	GPIO[28]	80	WL_A_ANT
21	VDD18	51	GPIO[3]	81	GND
22	GND	52	GPIO[2]	82	GND
23	PCIE_CLK_N	53	GPIO[11]	83-234	GND
24	PCIE_CLK_P	54	GPIO[10]	235	RF_CNTL0_N
25	GND	55	GPIO[9]	236	RF_CNTL3_P
26	PCIE_TX_P	56	GPIO[8]	237	RF_CNTL2_N
27	PCIE_TX_N	57	GPIO[12]	238	RF_CNTL1_P
28	GND	58	GPIO[13]	239-248	GND
29	PCIE_RX_N	59	GPIO[24]	249	NC
30	PCIE_RX_P	60	GPIO[25]	-	-

7.2. Pin Descriptions

No.	Terminal Name	Type	Power Supply	Description
(1)	GND	GND	-	Ground
(2)	GND	GND	-	Ground
(3)	CONFIG_HOST[0]	I	VDD18	Host configuration options. Selects the host interface used for Wi-Fi and Bluetooth. See section 7.3. Internal pull-up
(4)	CONFIG_HOST[1]	I	VDD18	Host configuration options. Selects the host interface used for Wi-Fi and Bluetooth. See section 7.3. Internal pull-up
(5)	CONFIG_HOST[2]	I	VDD18	Host configuration options. Selects the host interface used for Wi-Fi and Bluetooth. See section 7.3. Internal pull-down(51k ohm) on this pin
(6)	GPIO[1]	I/O	VIO	GPIO[1]
(7)	GPIO[0]	I/O	VIO	GPIO[0]
(8)	GPIO[14]	I/O	VIO	CONFIG_AUTO_REF_DET GPIO[14] Internal pull-down(51k ohm) on this pin Keep open or input level high until finished power up sequence.
(9)	GPIO[4]	I/O	VIO	PCM Mode: Receive PCM input. I2S Mode: Receive I2S input. GPIO[4]
(10)	GPIO[6]	I/O	VIO	PCM Mode: PCM Clock I2S Mode: I2S bit clock. - Output if master - Input if slave GPIO[6]
(11)	GPIO[5]	I/O	VIO	PCM Mode: Transmit PCM output. I2S Mode: Transmit I2S output. GPIO[5]
(12)	GPIO[7]	I/O	VIO	PCM Mode: PCM frame sync. I2S Mode: I2S left-right clock. - Output if master - Input if slave GPIO[7]
(13)	GPIO[16]	I/O	VIO	GPIO[16] Keep open or input level high until finished power up sequence.
(14)	GPIO[15]	I/O	VIO	GPIO[15] Keep open or input level high until finished power up sequence.
(15)	PDn	I	VDD18	Full power-down (input) (active low) · 0 = full power-down mode · 1 = normal operation 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. Connect to power down pin (GPIO) of host or tie to power rail. External host required to drive this pin high for normal operation mode.
(16)	GND	GND	-	Ground
(17)	VDD33	P	-	3.3V Voltage Input
(18)	VDD33	P	-	3.3V Voltage Input
(19)	VIO	P	-	1.8V/3.3V Digital I/O Power Supply
(20)	VDD18	P	-	1.8V Voltage Input
(21)	VDD18	P	-	1.8V Voltage Input
(22)	GND	GND	-	Ground
(23)	PCIE_CLK_N	I	VDD18	PCI Express Differential Clock Input—Negative
(24)	PCIE_CLK_P	I	VDD18	PCI Express Differential Clock Input—Positive
(25)	GND	GND	-	Ground
(26)	PCIE_TX_P	O	VDD18	PCI Express Transmit Data—Positive
(27)	PCIE_TX_N	O	VDD18	PCI Express Transmit Data—Negative
(28)	GND	GND	-	Ground
(29)	PCIE_RX_N	I	VDD18	PCI Express Receive Data—Negative

(30)	PCIE_RX_P	I	VDD18	PCI Express Receive Data—Positive
(31)	GND	GND	-	Ground
(32)	NC	-	-	No Connection
(33)	NC	-	-	No Connection
(34)	GND	GND	-	Ground
(35)	VIO_SD	P	-	1.8V/3.3V Digital I/O SDIO power supply • For SDIO ultra-high speed mode (25 to 208 MHz), VIO_SD must be 1.8V. • For SDIO default mode (up to 25 MHz) and high-speed mode (up to 50 MHz), VIO_SD must be 1.8V or 3.3V.
(36)	SD_CLK	I	VIO_SD	SDIO 4-bit Mode: Clock input SDIO 1-bit Mode: Clock input Internal pull-up
(37)	SD_CMD	I/O	VIO_SD	SDIO 4-bit Mode: Command/response (input/output) SDIO 1-bit Mode: Command line Internal pull-up
(38)	SD_D[0]	I/O	VIO_SD	SDIO 4-bit Mode: Data line Bit[0] SDIO 1-bit Mode: Data line Internal pull-up
(39)	SD_D[1]	I/O	VIO_SD	SDIO 4-bit Mode: Data line Bit[1] SDIO 1-bit Mode: Interrupt Internal pull-up
(40)	SD_D[2]	I/O	VIO_SD	SDIO 4-bit Mode: Data line Bit[2] or read wait (optional) SDIO 1-bit Mode: Read wait (optional) Internal pull-up
(41)	GND	GND	-	Ground
(42)	SD_D[3]	I/O	VIO_SD	SDIO 4-bit Mode: Data line Bit[3] SDIO 1-bit Mode: Reserved Internal pull-up
(43)	PCIE_PERST_N	I	VIO	PCIe host indication to reset the device (input)(active low) Note: Muxed with GPIO[20].(input/output) Internal pull-up
(44)	PCIE_CLKREQ_N	I/O	VIO	PCIe clock request (input/output) (active low) Note: An external pull-up (on host side) is required.
(45)	PCIE_WAKE_N	I/O	VIO	PCIe wake signal (input/output) (active low) Note: An external pull-up (on host side) is required.
(46)	W_DISABLE1N	I	VIO	GPIO Mode: GPIO[21] (input/output) Default Mode: W_DISABLE1n (input) (active low) Host indication to disable the Wi-Fi function of the device. See GPIO[12] for W_DISABLE2n (input) (active low).
(47)	GPIO[31]	I/O	VIO	GPIO Mode: GPIO[31] (input/output) JTAG Mode: JTAG_TDO, JTAG test data (output) Coexistence Mode: UART_LTE_SOUT (LTE coexistence data output signal)
(48)	GPIO[29]	I/O	VIO	GPIO Mode: GPIO[29] (input/output) JTAG Mode: JTAG_TMS, JTAG controller select (input)
(49)	GPIO[30]	I/O	VIO	GPIO Mode: GPIO[30] (input/output) JTAG Mode: JTAG_TDI, JTAG test data (input) Coexistence Mode: UART_LTE_SIN (LTE coexistence data input signal)
(50)	GPIO[28]	I/O	VIO	GPIO Mode: GPIO[28] (input/output) JTAG Mode: JTAG_TCK, JTAG test clock (input)
(51)	GPIO[3]	I/O	VIO	GPIO Mode: GPIO[3] (input/output) LED Mode: LED_OUT_BT (output) I2S Mode: I2S_CCLK (output, optional) PCM Mode: PCM_MCLK (output, optional)
(52)	GPIO[2]	I/O	VIO	GPIO Mode: GPIO[2] (input/output) LED Mode: LED_OUT_WLAN (output)
(53)	GPIO[11]	I/O	VIO	GPIO Mode: GPIO[11] (input/output) UART Mode: UART_RTSn (output) (active low)
(54)	GPIO[10]	I/O	VIO	GPIO Mode: GPIO[10] (input/output) UART Mode: UART_CTSn (input) (active low)
(55)	GPIO[9]	I/O	VIO	GPIO Mode: GPIO[9] (input/output) UART Mode: UART_SIN (input)
(56)	GPIO[8]	I/O	VIO	GPIO Mode: GPIO[8] (input/output) UART Mode: UART_SOUT (output)
(57)	GPIO[12]	I/O	VIO	GPIO Mode: GPIO[12] (input/output) UART Mode: UART_DSRRn (input) (active low) Default Mode: W_DISABLE2n (input) (active low) Host indication to disable the Wi-Fi function of the device. See GPIO[21] for W_DISABLE1n (input) (active low).
(58)	GPIO[13]	I/O	VIO	GPIO Mode: GPIO[13] (input/output) UART Mode: UART_DTRn (output) (active low)
(59)	GPIO[24]	I/O	VIO	GPIO Mode: GPIO[24] (input/output)
(60)	GPIO[25]	I/O	VIO	GPIO Mode: GPIO[25] (input/output)

(61)	GPIO[26]	I/O	VIO	GPIO Mode: GPIO[26] (input/output)
(62)	GPIO[27]	I/O	VIO	GPIO Mode: GPIO[27] (input/output)
(63)	GND	GND	-	Ground
(64)	GND	GND	-	Ground
(65)	BT_RF_OUT	RF	-	Bluetooth Transmit/Receive
(66)	GND	GND	-	Ground
(67)	GND	GND	-	Ground
(68)	NC	NC	-	NC
(69)	GND	GND	-	Ground
(70)	GPIO[22]	I/O	VDD33	GPIO[22]
(71)	GPIO[23]	I/O	VDD33	GPIO[23]
(72)	GPIO[19]	I/O	VIO	GPIO[19]
(73)	GPIO[18]	I/O	VIO	GPIO[18]
(74)	GPIO[17]	I/O	VIO	GPIO[17]
(75)	GND	GND	-	Ground
(76)	WL_B_ANT	RF	-	WLAN Transmit/Receive - Path B
(77)	GND	GND	-	Ground
(78)	GND	GND	-	Ground
(79)	GND	GND	-	Ground
(80)	WL_A_ANT	RF		WLAN Transmit/Receive – Path A
(81)	GND	GND	-	Ground
(82)	GND	GND	-	Ground
(83)-(234)	GND	GND	-	Ground
(235)	RF_CNTL0_N	O	VDD33	RF Control 0—RF Control Output Low (output)
(236)	RF_CNTL3_P	O	VDD33	RF Control 3—RF Control Output High (output)
(237)	RF_CNTL2_N	O	VDD33	RF Control 2—RF Control Output Low (output)
(238)	RF_CNTL1_P	O	VDD33	RF Control 1—RF Control Output High (output)
(239)-(248)	GND	GND	-	Ground
(249)	NC	GND	-	No Connection

7.3. Configuration Pins

Strap Value			WLAN	Bluetooth/LE
CONFIG_HOST[2]	CONFIG_HOST[1]	CONFIG_HOST[0]		
0	0	0	SDIO	UART
0	0	1	reserved	reserved
0	1	0	reserved	reserved
0	1	1	PCIe	UART
1	0	0	reserved	reserved
1	0	1	reserved	reserved
1	1	0	reserved	reserved
1	1	1	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.

I/O State Table

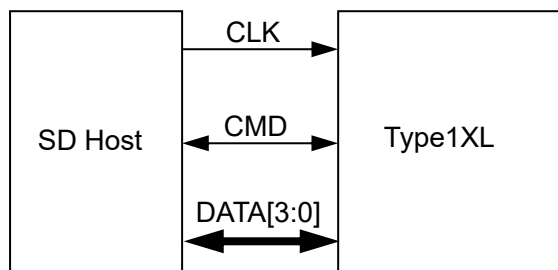
Pin Name	Supply	No Pad Power State ^[1]	Reset State	HW State	PD State	PD Prog	Internal PU/PD	Int'l Pull Value[Ω]
GPIO[0]	VIO	tristate	output	output	drive low	yes	nominal PU	100K
GPIO[1]	VIO	tristate	input	input	tristate	yes	weak PU	800K
GPIO[2]	VIO	tristate	input	input	tristate	yes	nominal PU	100K
GPIO[3]	VIO	tristate	input	input	tristate	yes	nominal PU	100K
GPIO[4]	VIO	tristate	input	input	tristate	yes	weak PU	800K
GPIO[5]	VIO	tristate	input	input	tristate	yes	weak PU	800K
GPIO[6]	VIO	tristate	input	input	tristate	yes	weak PU	800K
GPIO[7]	VIO	tristate	input	input	tristate	yes	nominal PU	100K
GPIO[8]	VIO	tristate	input	input	drive low	yes	nominal PU	100K
GPIO[9]	VIO	tristate	input	input	tristate	yes	nominal PU	100K
GPIO[10]	VIO	tristate	input	input	tristate	yes	nominal PU	100K
GPIO[11]	VIO	tristate	input	input	drive high	yes	nominal PU	100K
GPIO[12]	VIO	tristate	input	input	tristate	yes	nominal PD	100K
GPIO[13]	VIO	tristate	input	input	drive high	yes	nominal PU	100K
GPIO[14]	VIO	tristate	input	input	tristate	yes	weak PU	800K
GPIO[15]	VIO	tristate	input	input	drive high	yes	weak PU	800K
GPIO[16]	VIO	tristate	input	input	tristate	yes	weak PD	800K
GPIO[17]	VIO	tristate	input	input	tristate	yes	weak PD	800K
GPIO[18]	VIO	tristate	input	input	tristate	yes	weak PD	800K
GPIO[19]	VIO	tristate	input	input	tristate	yes	weak PU	800K
GPIO[20]	VIO	tristate	input	input	drive high	yes	nominal PU	100K
GPIO[21]	VIO	tristate	input	input	tristate	yes	nominal PU	100K
GPIO[22]	VDD33	tristate	input	input	drive high	yes	weak PU	800K
GPIO[23]	VDD33	tristate	input	input	drive low	yes	weak PU	800K
GPIO[24]	VIO	tristate	input	input	tristate	yes	nominal PU	100K
GPIO[25]	VIO	tristate	input	input	drive high	yes	nominal PU	100K
GPIO[26]	VIO	tristate	input	input	tristate	yes	nominal PU	100K
GPIO[27]	VIO	tristate	input	input	tristate	yes	nominal PU	100K
GPIO[28]	VIO	tristate	input	input	tristate	yes	nominal PU	100K
GPIO[29]	VIO	tristate	input	input	tristate	yes	nominal PD	100K
GPIO[30]	VIO	tristate	input	input	tristate	yes	nominal PU	100K
GPIO[31]	VIO	tristate	input	input	tristate	yes	nominal PU	100K
SD_CLK	VIO	tristate	input	input	tristate	no	nominal PU	100K
SD_CMD	VIO	tristate	input	input	tristate	no	nominal PU	100K
SD_D[0]	VIO	tristate	input	input	tristate	no	nominal PU	100K
SD_D[1]	VIO	tristate	input	input	tristate	no	nominal PU	100K
SD_D[2]	VIO	tristate	input	input	tristate	no	nominal PU	100K

SD_D[3]	VIO	tristate	input	input	tristate	no	nominal PU	100K
PCIE_CLKP	AVDD18	-	-	-	-	-	-	-
PCIE_CLKN	AVDD18	-	-	-	-	-	-	-
PCIE_TXP	AVDD18	-	-	-	-	-	-	-
PCIE_TXN	AVDD18	-	-	-	-	-	-	-
PCIE_RXP	AVDD18	-	-	-	-	-	-	-
PCIE_RXN	AVDD18	-	-	-	-	-	-	-
PCIE_WAKE_N	VIO	tristate	input	output	n/a	n/a	n/a	-
PCIE_CLKREQ_N	VIO	tristate	input	output	n/a	n/a	n/a	-
PCIE_PERST_N	VIO	tristate	input	input	drive high	yes	nominal PU	100K
CONFIG_HOST[0]	AVDD18	tristate	input	input	tristate	no	weak PU	800K
CONFIG_HOST[1]	AVDD18	tristate	input	input	tristate	no	weak PU	800K
CONFIG_HOST[2]	AVDD18	tristate	input	input	tristate	no	weak PU	800K
RF_CNTL0_N	VDD33	tristate	input	output	drive low	yes	nominal PU	100K
RF_CNTL1_P	VDD33	tristate	input	output	drive low	yes	weak PU	800K
RF_CNTL2_N	VDD33	tristate	input	output	drive low	yes	weak PU	800K
RF_CNTL3_P	VDD33	tristate	input	output	drive low	yes	weak PU	800K
PDn	AVDD18	-	-	-	-	-	-	-

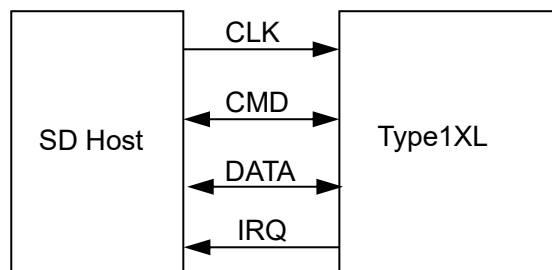
[1] Maximum input voltage is 0.4V when VIO has no power (or in uncertain situations).

7.5. SDIO Pin Descriptions

No.	Pin Name	(i) SD 4-bit Mode		(ii) SD 1-bit Mode	
55	SD_CLK	CLK	Clock	CLK	Clock
59	SD_D[0]	DATA0	Data line 0	DATA	Data line
61	SD_D[1]	DATA1	Data line 1 /Interrupt	IRQ	Interrupt
63	SD_D[2]	DATA2	Data line 2	NC	Not used
65	SD_D[3]	DATA3	Data line 3	NC	Not used
57	SD_CMD	CMD	Command line	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	VDD33	-	3.63	V
	VDD18	-	2.16	V
	VIO (1.8V)	-	1.98	V
	VIO(3.3V)	-	3.63	V
	VIO_SD(1.8V)	-	1.98	V
	VIO_SD(3.3V)	-	3.63	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 Condition

9.1. Operating Condition

Parameter		Min	Typ	Max	Unit
Operating Temperature Range ¹	Ta	-40	+25	+85	deg.C
	Tj	-	-	+125	deg.C
Supply Voltage	VDD33	3.14	3.3	3.46	V
	VDD18	1.71	1.8	1.89	V
	VIO	1.71	1.8	1.89	V
		3.14	3.3	3.46	V
	VIO_SD	1.71	1.8	1.89	V
		3.14	3.3	3.46	V
IO Current	VIO&VIO_SD	-	0.1	0.5	mA
Peak current*	VDD33	-	1150	1200	mA
	VDD18	-	1873	2000	mA

Note) Operation beyond the recommended operating conditions is neither recommended nor guaranteed.

*Peak current of VDD33 and VDD18 is happen during DPD calibration when the firmware is downloaded.

9.2. Digital I/O Requirements

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

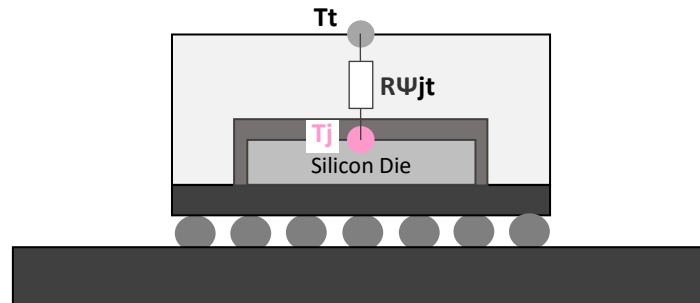
¹ Functionality is guaranteed but specifications require derating at extreme temperatures

9.3. Package Thermal Conditions

$R\psi_{jt} : 3.6^{\circ}\text{C/W}$

$R\psi_{jt} = (T_j - T_t)/P$

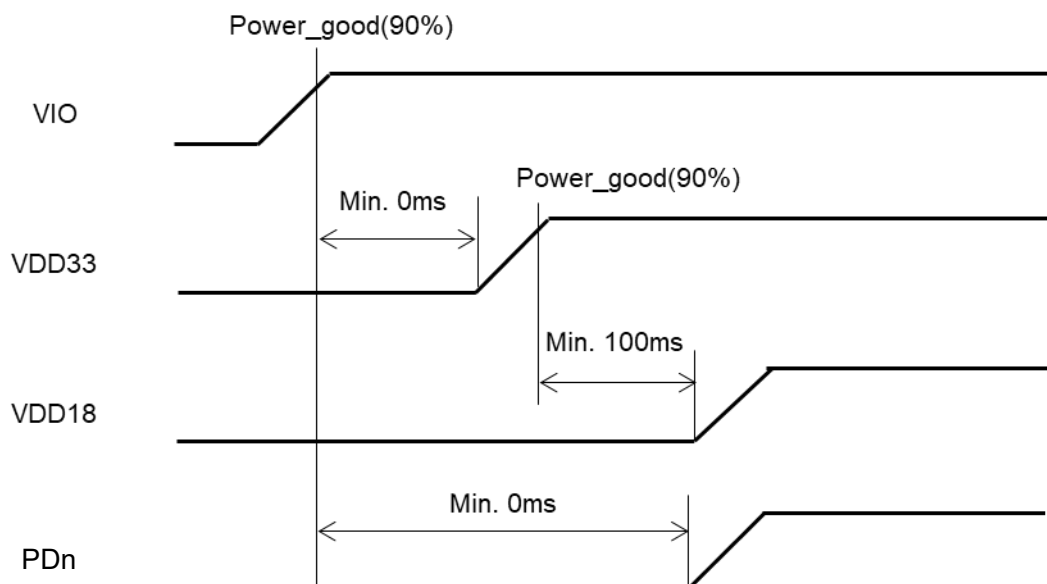
* T_j : Junction temperature($^{\circ}\text{C}$), T_t : Top temperature($^{\circ}\text{C}$), P: Total Power Consumption (W)



10. Power-Up / Power-Down Sequence

10.1. Power-Up Sequence

(1) VIO=3.3V

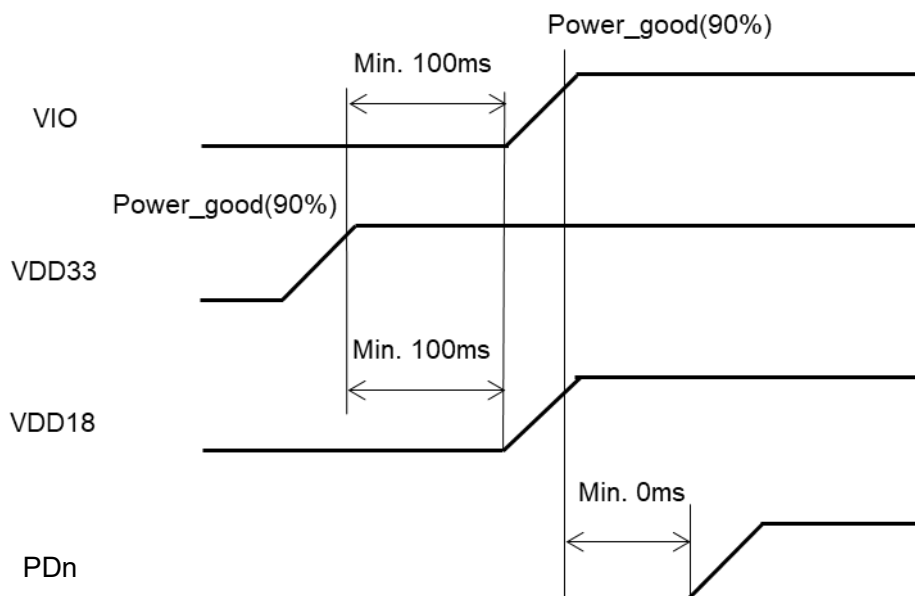


Ramp-up time of VIO must be <100ms.

Ramp-up time of VDD33 must be <100ms.

Ramp-up time of VDD18 must be <100ms.

(2) VIO=1.8V



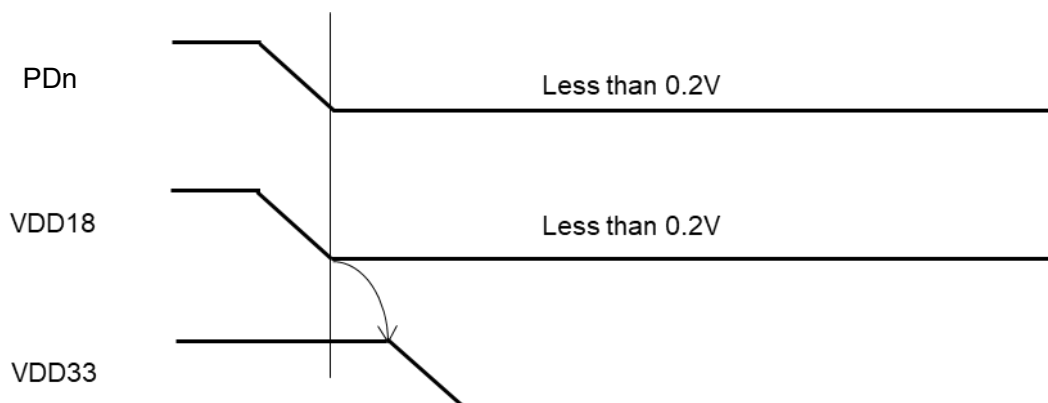
Ramp-up time of VIO must be <100ms.

Ramp-up time of VDD33 must be <100ms.

Ramp-up time of VDD18 must be <100ms.

VIO should be the same as VDD18 or earlier. After power_good state of VDD33, then VIO can ramp up. At that time VDD18 can be the same or later than VIO.

10.2. Power-Down Sequence



To reduce leakage, ramp down VDD18 before VDD33 when powering down the SoC. It is not required specific timing for VIO for its power-down.

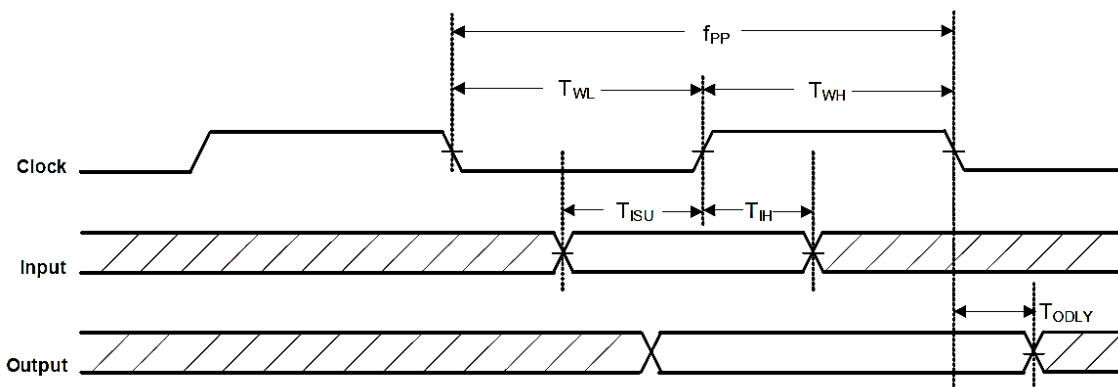
11. Host Interface Specification

11.1. SDIO Specifications

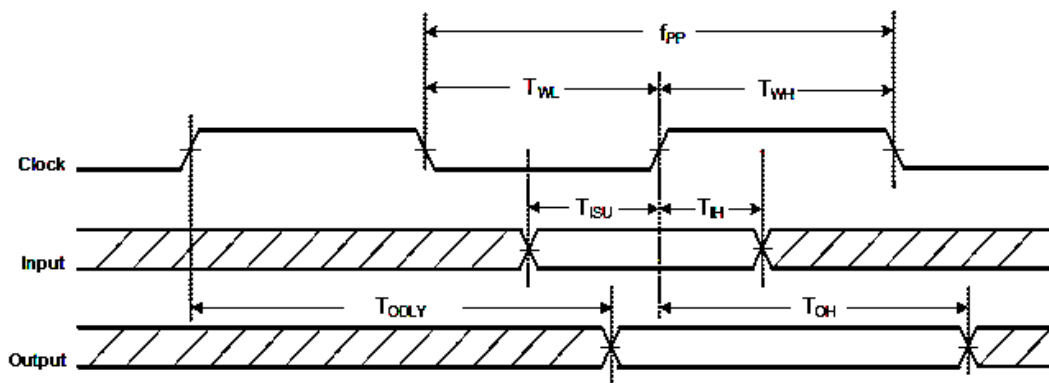
The SDIO host interface pins are powered from the VIO_SD voltage supply.
The SDIO electrical specifications are identical for 4-bit SDIO and 1-bit SDIO transfer modes.

11.1.1. Default Speed, High-Speed Modes

SDIO Protocol Timing Diagram—Default Speed Mode (3.3V)



SDIO Protocol Timing Diagram—High Speed Mode (3.3V)



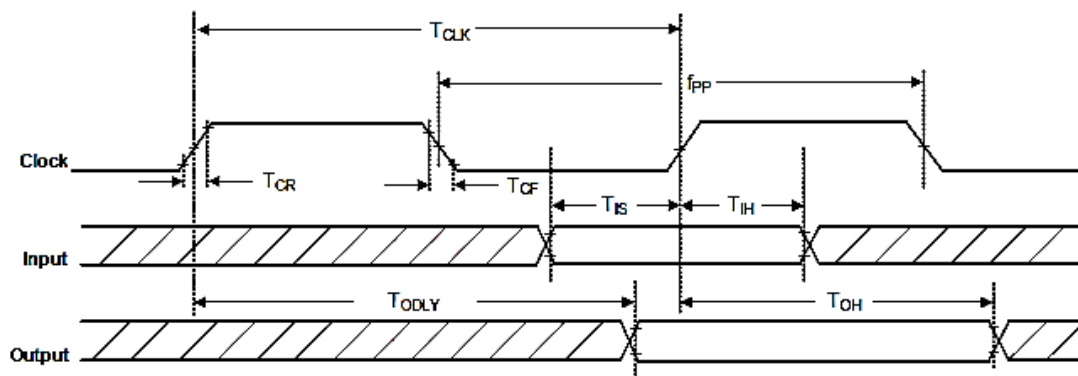
SDIO Timing Data—Default Speed, High-Speed Modes (3.3V)

Note: Over full range of values specified in the Recommended Operating Conditions unless otherwise specified.

Symbol	Parameter	Condition	Min	Typ	Max	Units
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

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

SDIO protocol Timing Diagram—SDR12, SDR25, SDR50 Modes (up to 100 MHz) (1.8 V)



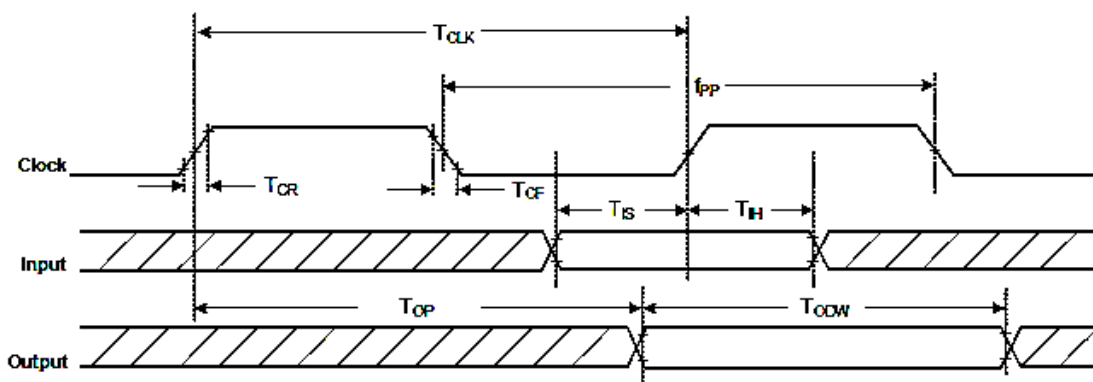
SDIO Timing Data—SDR12, SDR25, SDR50 Modes (up to 100 MHz) (1.8 V)

Note: Over full range of values specified in the Recommended Operating Conditions unless otherwise specified.

Symbol	Parameter	Condition	Min	Typ	Max	Units
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 $T_{CR}, T_{CF} < 2\text{ns}(\text{max})$ at 100 MHz CCARD=10 pF	SDR12/25/50	-	-	$0.2 \cdot T_{CLK}$	ns
T_{ODLY}	Output decay time $CL \leq 30\text{pF}$	SDR12/25/50	-	-	7.5	ns
T_{OH}	Output hold time $CL=15\text{ pF}$	SDR12/25/50	1.5	-	-	ns

11.1.3. SDR104 Mode (208 MHz) (1.8 V)

SDIO Protocol Timing Diagram—SDR104 Mode (208 MHz)



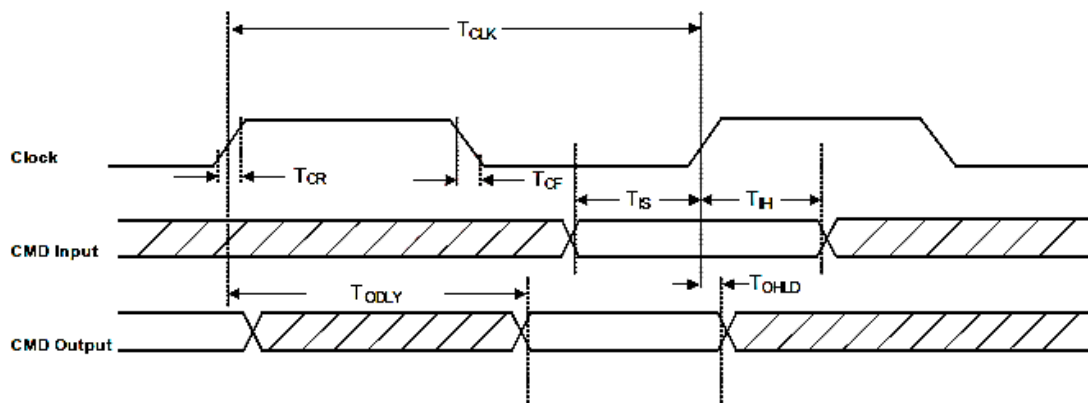
SDIO Timing Data—SDR104 Mode (208 MHz)

Note: Over full range of values specified in the Recommended Operating Conditions unless otherwise specified.

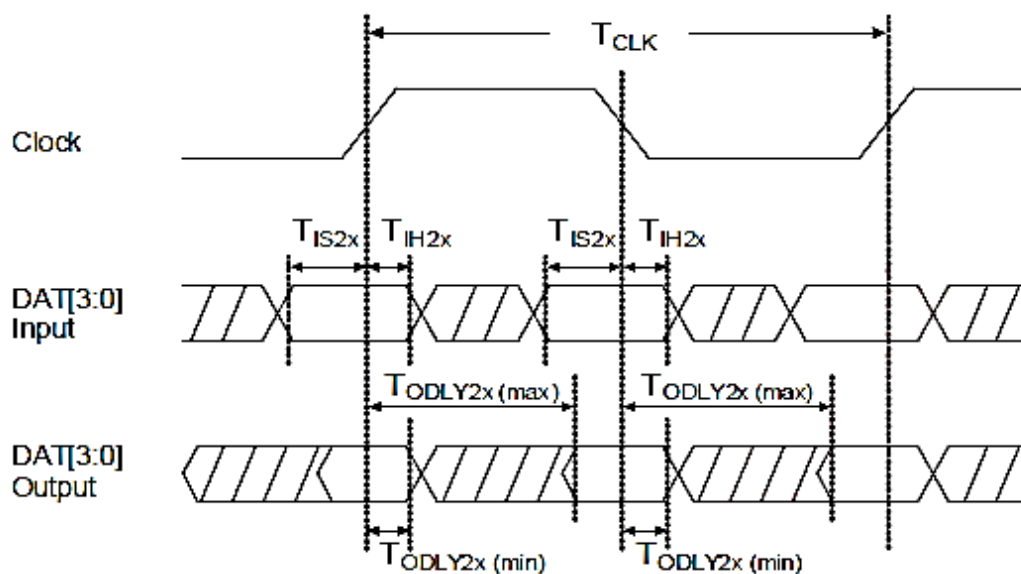
Symbol	Parameter	Condition	Min	Typ	Max	Units
f_{PP}	Clock frequency	SDR104	0	-	208	MHz
T_{IS}	Input setup time	SDR104	1.4	-	-	ns
T_{IH}	Input hold time	SDR104	0.8	-	-	ns
T_{CLK}	Clock time	SDR104	4.8	-	-	ns
T_{CR}, T_{CF}	Rise time, fall time $T_{CR}, T_{CF} < 0.96$ ns(max) at 208 MHz CCARD=10 pF	SDR104	-	-	$0.2 \cdot T_{CLK}$	ns
T_{OP}	Card output phase	SDR104	0	-	10	ns
T_{ODW}	Output timing of variable data window	SDR104	2.88	-	-	ns

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

SDIO CMD Timing Diagram—DDR50 Mode (50 MHz)



SDIO DAT[3:0] Timing Diagram—DDR50 Mode (50 MHz)



SDIO Timing Data—DDR50 Mode (50 MHz)

Note: Over full range of values specified in the Recommended Operating Conditions unless otherwise specified

Symbol	Parameter	Condition	Min	Typ	Max	Units
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	-	-	$0.2 \cdot T_{CLK}$	ns
Clock Duty	-	DDR50	45	-	55	%
CMD Input (referenced to clock rising edge)						
T_{IS}	Input setup time $C_{CARD} \leq 10$ pF (1 card)	DDR50	6	-	-	ns
T_{IH}	Input hold time $C_{CARD} \leq 10$ pF (1 card)	DDR50	0.8	-	-	ns
CMD Output (referenced to clock rising edge)						
T_{ODLY}	Output delay time during data transfer mode $C_L \leq 30$ pF (1 card)	DDR50	-	-	13.7	ns
T_{OHLD}	Output hold time $C_L \geq 15$ pF (1 card)	DDR50	1.5	-	-	ns
DAT[3:0] Input (referenced to clock rising and falling edges)						
T_{IS2x}	Input setup time $C_{CARD} \leq 10$ pF (1 card)	DDR50	3	-	-	ns
T_{IH2x}	Input hold time $C_{CARD} \leq 10$ pF (1 card)	DDR50	0.8	-	-	ns
DAT[3:0] Output (referenced to clock rising and falling edges)						
$T_{ODLY2x}(\text{max})$	Output delay time during data transfer mode $C_L \leq 25$ pF (1 card)	DDR50	-	-	7.0	ns
$T_{ODLY2x}(\text{min})$	Output hold time $C_L \geq 15$ pF (1 card)	DDR50	1.5	-	-	ns

11.2. PCI Express Specifications

The PCI Express host interface pins are powered from the AVDD18 voltage supply.

11.2.1. Differential Tx Output Electricals

PCI Express Tx Output Specifications Data—2.5 GT/s

Note: In accordance with PCI Express Base Specification, Revision 2.1 March 4. 2009.

Symbol	Parameter	Min	Typ	Max	Units
UI	Unit Interval (UI) The specified UI is equivalent to a tolerance of ± 300 ppm for each Refclk source. Period does not account for SSC induced variations.	399.88	--	400.12	ps
$V_{TX-DIFF-PP}$	Differential peak-to-peak Tx voltage swing $V_{TX-DIFF-PP} = 2 * V_{TXD+} - V_{TXD-} $	0.8	--	1.2	V
$V_{TX-DIFF-PP-LOW}$	Low power differential peak-to-peak tTx voltage swing $V_{TX-DIFF-PP} = 2 * V_{TXD+} - V_{TXD-} $	0.4	--	1.2	V
$V_{TX-DE-RATIO-3.5dB}$	Tx de-emphasis level ratio (3.5 dB)	3.0	--	4.0	dB
T_{TX-EYE}	Tx eye including all jitter sources	0.75	--	--	UI
$T_{TX-EYE-MEDIAN-to-MAX-JITTER}$	Maximum time between jitter median and maximum deviation from median	--	--	0.125	UI
$T_{TX-RISE-FALL}$	Tx rise/fall time Measured differentially from 20% to 80% of swing.	0.125	--	--	UI
$RL_{TX-DIFF}$	Tx package plus Si differential return loss	10	--	--	dB
RL_{TX-CM}	Tx package plus Si common mode return loss	6	--	--	dB
$V_{TX-CM-AC-P}$	Tx AC common mode voltage	--	20	--	mV
$I_{TX-SHORT}$	Tx short circuit current limit	--	--	90	mA
$V_{TX-DC-CM}$	Tx DC common mode voltage	0	--	3.6	V
$V_{TX-CM-DC-ACTIVE-IDLE-DELTA}$	Absolute delta of DC common mode voltage during L0 and electrical idle	0	--	100	mV
$V_{TX-IDLE-DIFF-AC-p}$	Electrical idle differential peak output voltage	0	--	20	mV
$V_{TX-RCV-DETECT}$	Voltage change allowed during receiver detection	--	--	600	mV
$T_{TX-IDLE-MIN}$	Minimum time spent in electrical idle	20	--	--	ns
$T_{TX-IDLE-SET-TO-IDLE}$	Maximum time to transition to a valid electrical idle after sending an electrical idle ordered set	--	--	8	ns
$T_{TX-IDLE-TO-DIFF-DATA}$	Maximum time to transition to valid diff signaling after leaving electrical idle	--	--	8	ns
$T_{CROSSLINK}$	Crosslink random timeout	--	--	1.0	ms
C_{TX}	AC coupling capacitor	75	--	200	nF

PCI Express Tx Output Specifications Data—5 GT/s

Note: In accordance with PCI Express Base Specification, Revision 2.1 March 4, 2009.

Symbol	Parameter	Min	Typ	Max	Units
UI	Unit Interval (UI) The specified UI is equivalent to a tolerance of ± 300 ppm for each Refclk source. Period does not account for SSC induced variations.	199.94	--	200.06	ps
$V_{TX-DIFFpp}$	Differential peak-to-peak Tx voltage swing $V_{TX-DIFFpp} = 2 * V_{TXD+} - V_{TXD-} $	0.8	--	1.2	V
$V_{TX-DIFFpp-LOW}$	Low power differential peak-to-peak Tx voltage swing $V_{TX-DIFFpp} = 2 * V_{TXD+} - V_{TXD-} $	0.4	--	1.2	V
$V_{TX-DE-RATIO-3.5dB}$	Tx de-emphasis level ratio (3.5 dB)	3.0	--	4.0	dB
$V_{TX-DE-RATIO-6dB}$	Tx de-emphasis level ratio (6 dB)	5.5	--	6.5	dB
$T_{MIN-PULSE}$	Instantaneous lone pulse width Measured relative to rising/falling pulse.	0.9	--	--	UI
T_{TX-EYE}	Tx eye including all jitter sources	0.75	--	--	UI
$T_{TX-HF-DJ-DD}$	Tx deterministic jitter > 1.5 MHz Deterministic jitter only.	--	--	0.15	UI
$T_{TX-LF-RMS}$	Tx RMS jitter < 1.5 MHz Total energy measured over a 10 kHz—1.5 MHz range.	--	3.0	--	Ps RMS
$T_{TX-RISE-FALL}$	Tx rise/fall time Measured differentially from 20% to 80% of swing.	0.15	--	--	UI
$RL_{TX-DIFF}$	Tx package plus Si differential return loss (1.25-2.5 GHz)	10	--	--	dB
	Tx package plus Si differential return loss (0.05-1.25 GHz)	8	--	--	
RL_{TX-CM}	Tx package plus Si common mode return loss	6	--	--	dB
$V_{TX-CM-AC-PP}$	Tx AC common mode voltage	--	--	100	mVPP
$I_{TX-SHORT}$	Tx short circuit current limit	--	--	90	mA
$V_{TX-DC-CM}$	Tx DC common mode voltage	0	--	3.6	V
$V_{TX-CM-DC-ACTIVE-IDLE-DELTA}$	Absolute delta of DC common mode voltage during L0 and electrical idle	0	--	100	mV
$V_{TX-IDLE-DIFF-AC-p}$	Electrical idle differential peak output voltage $V_{TX-IDLE-DIFF-DC} = V_{TX-IDLE-D+} - V_{TX-IDLE-D-} \leq 20$ mV	0	--	20	mV
$V_{TX-IDLE-DIFF-DC}$	DC Electrical idle differential peak output voltage $V_{TX-IDLE-DIFF-DC} = V_{TX-IDLE-D+} - V_{TX-IDLE-D-} \leq 5$ mV	0	--	5	mV
$V_{TX-RCV-DETECT}$	Voltage change allowed during receiver detection	--	--	600	mV
$T_{TX-IDLE-MIN}$	Minimum time spent in electrical idle	20	--	--	ns
$T_{TX-IDLE-SET-TO-IDLE}$	Maximum time to transition to a valid electrical idle after sending an electrical idle ordered set	--	--	8	ns
$T_{TX-IDLE-TO-DIFF-DATA}$	Maximum time to transition to valid differential signaling after leaving electrical idle	--	--	8	ns
$T_{CROSSLINK}$	Crosslink random timeout	--	--	1.0	ms
C_{TX}	AC coupling capacitor	75	--	200	nF

11.2.2. Differential Rx Input Electricals

PCI Express Rx Input Specifications Data—2.5 GT/s

Note: In accordance with PCI Express Base Specification, Revision 2.1 March 4, 2009.

Symbol	Parameter	Min	Typ	Max	Units
UI	Unit Interval (UI) UI does not account for SSC induced variations.	399.88	--	400.12	ps
V _{RX-DIFF-PP-CC}	Differential Rx peak-to-peak voltage for common Refclk Rx architecture	0.175	--	1.2	V
V _{RX-DIFF-PP-DC}	Differential Rx peak-to-peak voltage for data clocked Rx architecture	0.175	--	1.2	V
T _{RX-EYE}	Rx eye time opening Minimum eye time at Rx pins to yield a 10 ⁻¹² BER.	0.40	--	--	UI
T _{RX-EYE-MEDIAN-to-MAX-JITTER}	Maximum time delta between median and deviation from median	--	--	0.3	UI
V _{RX-CM-ACp}	AC peak common mode input voltage	--	--	150	mV
RL _{RX-DIFF}	Differential return loss	15	--	--	dB
RL _{RX-CM}	Common mode return loss	0	--	3.6	dB
Z _{RX-DIFF-DC}	DC differential input impedance	80	100	120	W
Z _{RX-DC}	DC input impedance	40	50	60	W
Z _{RX-HIGH-IMP-DC}	Powered down DC input impedance	200	--	--	kΩ
V _{RX-IDLE-DET-DIFF-p-p}	Electrical idle detect threshold	65	--	175	mV
T _{RX-IDLE-DET-DIFF-ENTERTIME}	Unexpected electrical idle enter detect threshold integration time	--	--	10	ms
L _{RX-SKEW}	Total skew	--	--	20	ns

PCI Express Rx Input Specifications Data—5 GT/s

Note: In accordance with PCI Express Base Specification, Revision 2.1 March 4, 2009.

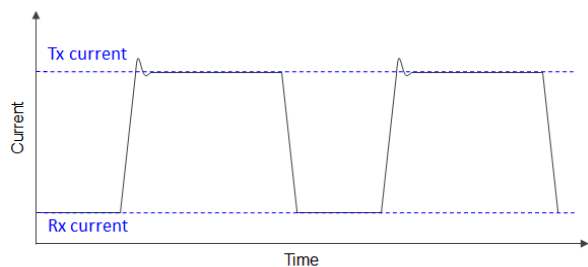
Symbol	Parameter	Min	Typ	Max	Units
UI	Unit Interval (UI) UI does not account for SSC induced variations.	199.94	--	200.06	ps
V _{RX-DIFF-PP-CC}	Differential Rx peak-to-peak voltage for common Refclk Rx architecture	0.120	--	1.2	V
V _{RX-DIFF-PP-DC}	Differential Rx peak-to-peak voltage for data clocked Rx architecture	0.100	--	1.2	V
T _{RX-TJ-CC}	Maximum Rx inherent total timing error for common Refclk Rx architecture	--	--	0.40	UI
T _{RX-TJ-DC}	Maximum Rx inherent total timing error for data clocked Rx architecture	--	--	0.34	UI
T _{RX-DJ-DD-CC}	Maximum Rx inherent deterministic timing error for common Refclk Rx architecture		--	0.30	UI
T _{RX-DJ-DD-DC}	Maximum Rx inherent deterministic timing error for data clocked Rx architecture		--	0.24	UI
T _{RX-MIN-PLISE}	Minimum width pulse at Rx Measured to account for worst Tj at 10 ⁻¹² BER.	0.6	--	--	UI
V _{RX-CM-ACp}	AC peak common mode input voltage	--	--	150	mV
RL _{RX-DIFF}	Differential return loss	15	--	--	dB
RL _{RX-CM}	Common mode return loss	0	--	3.6	dB
Z _{RX-DIFF-DC}	DC differential input impedance	80	100	120	W
Z _{RX-DC}	DC input impedance	40	50	60	W
Z _{RX-HIGH-IMP-DC}	Powered down DC input impedance	200	--	--	kΩ
V _{RX-IDLE-DET-DIFF-p-p}	Electrical idle detect threshold	65	--	175	mV
T _{RX-IDLE-DET-DIFF-ENTERTIME}	Unexpected electrical idle enter detect threshold integration time	--	--	10	ms
L _{RX-SKEW}	Total skew	--	--	20	ns

12. DC / RF Characteristics

- ALL DC/RF characteristics are defined by following file.

WLAN Tx Power	txpower_US.bin, txpower_CA.bin, txpower_EU.bin, txpower_JP.bin
WLAN Regulatory Limit	db.txt
Energy Detect	ed_mac.bin
Bluetooth Power	bt_power_config_1.sh (Class1)

- Burst current definition



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

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

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

Conditions : 25deg.C, VDD33=3.3V, VDD18=1.8V VIO=1.8V, Output power setting=18dBm, 11Mbps mode

Items		Contents			
- DC Characteristics -		Min.	Typ.	Max.	Unit
1. DC current					
1) Tx mode	VDD18	-	280	-	mA
	VDD33	-	220	-	mA
	VDD18(MIMO)	-	370	-	mA
	VDD33(MIMO)	-	450	-	mA
2) Rx mode	VDD18	-	280	-	mA
	VDD33	-	0.2	-	mA
	VDD18(MIMO)	-	300	-	mA
	VDD33(MIMO)	-	0.2	-	mA
- Tx Characteristics -		Min.	Typ.	Max.	Unit
2. Output Power		16	18	20	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, VDD33=3.3V, VDD18=1.8V VIO=1.8V, Output power setting=18dBm, 1Mbps mode

Items		Contents			
- DC Characteristics -		Min.	Typ.	Max.	Unit
1. DC current					
1) Tx mode	VDD18	-	280	-	mA
	VDD33	-	210	-	mA
	VDD18(MIMO)	-	370	-	mA
	VDD33(MIMO)	-	450	-	mA
2) Rx mode	VDD18	-	280	-	mA
	VDD33	-	0.2	-	mA
	VDD18(MIMO)	-	300	-	mA
	VDD33(MIMO)	-	0.2	-	mA
- Tx Characteristics -		Min.	Typ.	Max.	Unit
2. Output Power		16	18	20	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%)		-	-	-80	dBm
10. Maximum Input Level (FER ≤ 8%)		-10	-	-	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, VDD33=3.3V, VDD18=1.8V VIO=1.8V, Output power setting=16dBm, 54Mbps mode

Items		Contents			
- DC Characteristics -		Min.	Typ.	Max.	Unit
1. DC current					
1) Tx mode	VDD18	-	300	-	mA
	VDD33	-	180	-	mA
	VDD18(MIMO)	-	410	-	mA
	VDD33(MIMO)	-	370	-	mA
2) Rx mode	VDD18	-	280	-	mA
	VDD33	-	0.2	-	mA
	VDD18(MIMO)	-	300	-	mA
	VDD33(MIMO)	-	0.2	-	mA
- Tx Characteristics -		Min.	Typ.	Max.	Unit
2. Output Power		14	16	18	dBm
3. Spectrum Mask Margin					
1) 9MHz to 11MHz (0~ -20dBr)		0	-	-	dB
2) 11MHz to 20MHz (-20~ -28dBr)		0	-	-	dB
3) 20MHz to 30MHz (-28~ -40dBr)		0	-	-	dB
4) 30MHz to 33MHz (-40dBr)		0	-	-	dB
4. Constellation Error(EVM)		-	-	-25	dB
5. Frequency tolerance		-20		20	ppm
6. Spurious Emissions					
1) 30-47MHz (BW=100kHz)		-	-	-36	dBm
2) 47-74MHz (BW=100kHz)		-	-	-54	dBm
3) 74-87.5MHz (BW=100kHz)		-	-	-36	dBm
4) 87.5-118MHz (BW=100kHz)		-	-	-54	dBm
5) 118-174MHz (BW=100kHz)		-	-	-36	dBm
6) 174-230MHz (BW=100kHz)		-	-	-54	dBm
7) 230-470MHz (BW=100kHz)		-	-	-36	dBm
8) 470-862MHz (BW=100kHz)		-	-	-54	dBm
9) 862-1000MHz (BW=100kHz)		-	-	-36	dBm
10) 1000-12750MHz (BW=1MHz)		-	-	-30	dBm
- Rx Characteristics -		Min.	Typ.	Max.	Unit
7. Minimum Input Level (PER < 10%)		-	-	-65	dBm
8. Maximum Input Level (PER < 10%)		-20	-	-	dBm
9. Adjacent Channel Rejection(PER< 10%)		-1	-	-	dB

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

Conditions : 25deg.C, VDD33=3.3V, VDD18=1.8V VIO=1.8V, Output power setting=17dBm, 6Mbps mode

Items		Contents			
- DC Characteristics -		Min.	Typ.	Max.	Unit
1. DC current					
1) Tx mode	VDD18	-	300	-	mA
	VDD33	-	200	-	mA
	VDD18(MIMO)	-	410	-	mA
	VDD33(MIMO)	-	420	-	mA
2) Rx mode	VDD18	-	280	-	mA
	VDD33	-	0.2	-	mA
	VDD18(MIMO)	-	300	-	mA
	VDD33(MIMO)	-	0.2	-	mA
- Tx Characteristics -		Min.	Typ.	Max.	Unit
2. Output Power		15	17	19	dBm
3. Spectrum Mask Margin					
1) 9MHz to 11MHz (0~ -20dBr)		0	-	-	dB
2) 11MHz to 20MHz (-20~ -28dBr)		0	-	-	dB
3) 20MHz to 30MHz (-28~ -40dBr)		0	-	-	dB
4) 30MHz to 33MHz (-40dBr)		0	-	-	dB
4. Constellation Error(EVM)		-	-	-25	dB
5. Frequency tolerance		-20		20	ppm
6. Spurious Emissions					
1) 30-47MHz (BW=100kHz)		-	-	-36	dBm
2) 47-74MHz (BW=100kHz)		-	-	-54	dBm
3) 74-87.5MHz (BW=100kHz)		-	-	-36	dBm
4) 87.5-118MHz (BW=100kHz)		-	-	-54	dBm
5) 118-174MHz (BW=100kHz)		-	-	-36	dBm
6) 174-230MHz (BW=100kHz)		-	-	-54	dBm
7) 230-470MHz (BW=100kHz)		-	-	-36	dBm
8) 470-862MHz (BW=100kHz)		-	-	-54	dBm
9) 862-1000MHz (BW=100kHz)		-	-	-36	dBm
10) 1000-12750MHz (BW=1MHz)		-	-	-30	dBm
- Rx Characteristics -		Min.	Typ.	Max.	Unit
7. Minimum Input Level (PER < 10%)		-	-	-82	dBm
8. Maximum Input Level (PER < 10%)		-20	-	-	dBm
9. Adjacent Channel Rejection(PER< 10%)		-1	-	-	dB

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

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

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

Conditions : 25deg.C, VDD33=3.3V, VDD18=1.8V VIO=1.8V, Output power setting=15dBm, MCS7 mode

Items		Contents			
- DC Characteristics -		Min.	Typ.	Max.	Unit
1. DC current					
1) Tx mode	VDD18	-	300	-	mA
	VDD33	-	170	-	mA
	VDD18(MIMO)	-	410	-	mA
	VDD33(MIMO)	-	330	-	mA
2) Rx mode	VDD18	-	280	-	mA
	VDD33	-	0.2	-	mA
	VDD18(MIMO)	-	300	-	mA
	VDD33(MIMO)	-	0.2	-	mA
- Tx Characteristics -		Min.	Typ.	Max.	Unit
2. Output Power		13	15	17	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 – 2.4GHz

Conditions : 25deg.C, VDD33=3.3V, VDD18=1.8V VIO=1.8V, Output power setting=16dBm, MCS0 mode

Items		Contents			
- DC Characteristics -		Min.	Typ.	Max.	Unit
1. DC current					
1) Tx mode	VDD18	-	300	-	mA
	VDD33	-	190	-	mA
	VDD18(MIMO)	-	410	-	mA
	VDD33(MIMO)	-	380	-	mA
2) Rx mode	VDD18	-	280	-	mA
	VDD33	-	0.2	-	mA
	VDD18(MIMO)	-	300	-	mA
	VDD33(MIMO)	-	0.2	-	mA
- Tx Characteristics -		Min.	Typ.	Max.	Unit
2. Output Power		14	16	18	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%)		-	-	-82	dBm
8. Maximum Input Level (PER < 10%)		-20	-	-	dBm
9. Adjacent Channel Rejection(PER≤ 10%)		-2	-	-	dB

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

Specification	IEEE802.11ax
Mode	OFDM
Channel Frequency	2412 - 2472MHz
Data rate	MCS0-MCS11

12.4.1. High Rate Condition for IEEE802.11ax – 2.4GHz

Conditions : 25deg.C, VDD33=3.3V, VDD18=1.8V VIO=1.8V, Output power setting=13dBm, MCS11 mode

Items		Contents			
- DC Characteristics -		Min.	Typ.	Max.	Unit
1. DC current					
1) Tx mode	VDD18	-	300	-	mA
	VDD33	-	150	-	mA
	VDD18(MIMO)	-	410	-	mA
	VDD33(MIMO)	-	300	-	mA
2) Rx mode	VDD18	-	280	-	mA
	VDD33	-	0.2	-	mA
	VDD18(MIMO)	-	300	-	mA
	VDD33(MIMO)	-	0.2	-	mA
- Tx Characteristics -		Min.	Typ.	Max.	Unit
2. Output Power		11	13	15	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)		-	-	-35	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%)		-	-	-69	dBm
8. Maximum Input Level (PER < 10%)		-20	-	-	dBm
9. Adjacent Channel Rejection(PER≤ 10%)		-2	-	-	dB

12.4.2. Low Rate Condition for IEEE802.11ax – 2.4GHz

Conditions : 25deg.C, VDD33=3.3V, VDD18=1.8V VIO=1.8V, Output power setting=16dBm, MCS0 mode

Items		Contents			
- DC Characteristics -		Min.	Typ.	Max.	Unit
1. DC current					
1) Tx mode	VDD18	-	300	-	mA
	VDD33	-	190	-	mA
	VDD18(MIMO)	-	420	-	mA
	VDD33(MIMO)	-	390	-	mA
2) Rx mode	VDD18	-	280	-	mA
	VDD33	-	0.2	-	mA
	VDD18(MIMO)	-	300	-	mA
	VDD33(MIMO)	-	0.2	-	mA
- Tx Characteristics -		Min.	Typ.	Max.	Unit
2. Output Power		14	16	18	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)		-	-	-19	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%)		-	-	-69	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, VDD33=3.3V, VDD18=1.8V VIO=1.8V, Output power setting=16dBm, 54Mbps mode

Items		Contents			
- DC Characteristics -		min.	Typ.	Max.	Unit
1. DC current					
1) Tx mode	VDD18	-	400	-	mA
	VDD33	-	230	-	mA
	VDD18(MIMO)	-	620	-	mA
	VDD33(MIMO)	-	460	-	mA
2) Rx mode	VDD18	-	320	-	mA
	VDD33	-	0.2	-	mA
	VDD18(MIMO)	-	320	-	mA
	VDD33(MIMO)	-	0.2	-	mA
- Tx Characteristics -		min.	Typ.	Max.	Unit
2. Output Power		14	16	18	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, VDD33=3.3V, VDD18=1.8V VIO=1.8V, Output power setting=17dBm, 6Mbps mode

Items		Contents			
- DC Characteristics -		min.	Typ.	Max.	Unit
1. DC current					
1) Tx mode*	VDD18	-	430	-	mA
	VDD33	-	260	-	mA
	VDD18(MIMO)	-	610	-	mA
	VDD33(MIMO)	-	510	-	mA
2) Rx mode	VDD18	-	320	-	mA
	VDD33	-	0.2	-	mA
	VDD18(MIMO)	-	320	-	mA
	VDD33(MIMO)	-	0.2	-	mA
- Tx Characteristics -		min.	Typ.	Max.	Unit
2. Output Power		15	17	19	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%)		-	-	-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, VDD33=3.3V, VDD18=1.8V VIO=1.8V, Output power setting=16dBm, MCS7 mode

Items		Contents			
- DC Characteristics -		min.	Typ.	Max.	Unit
1. DC current					
1) Tx mode	VDD18	-	400	-	mA
	VDD33	-	240	-	mA
	VDD18(MIMO)	-	620	-	mA
	VDD33(MIMO)	-	450	-	mA
2) Rx mode	VDD18	-	320	-	mA
	VDD33	-	0.2	-	mA
	VDD18(MIMO)	-	320	-	mA
	VDD33(MIMO)	-	0.2	-	mA
- Tx Characteristics -		min.	Typ.	Max.	Unit
2. Output Power		14	16	18	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, VDD33=3.3V, VDD18=1.8V VIO=1.8V, Output power setting=16dBm, MCS0 mode

Items		Contents			
- DC Characteristics -		min.	Typ.	Max.	Unit
1. DC current					
1) Tx mode	VDD18	-	400	-	mA
	VDD33	-	250	-	mA
	VDD18(MIMO)	-	630	-	mA
	VDD33(MIMO)	-	470	-	mA
2) Rx mode	VDD18	-	320	-	mA
	VDD33	-	0.2	-	mA
	VDD18(MIMO)	-	320	-	mA
	VDD33(MIMO)	-	0.2	-	mA
- Tx Characteristics -		min.	Typ.	Max.	Unit
2. Output Power		14	16	18	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%)		-	-	-82	dBm
8. Maximum Input Level (PER < 10%)		-30	-	-	dBm
9. Adjacent Channel Rejection (PER ≤ 10%)		-2	-	-	dB

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

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

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

Conditions : 25deg.C, VDD33=3.3V, VDD18=1.8V VIO=1.8V, Output power setting=15dBm, MCS8 mode

Items		Contents			
- DC Characteristics -		min.	Typ.	Max.	Unit
1. DC current					
1) Tx mode	VDD18	-	370	-	mA
	VDD33	-	220	-	mA
	VDD18(MIMO)	-	560	-	mA
	VDD33(MIMO)	-	420	-	mA
2) Rx mode	VDD18	-	320	-	mA
	VDD33	-	0.2	-	mA
	VDD18(MIMO)	-	320	-	mA
	VDD33(MIMO)	-	0.2	-	mA
- Tx Characteristics -		min.	Typ.	Max.	Unit
2. Output Power		13	15	17	dBm
3. Spectrum Mask Margin					
1) 9MHz to 11MHz (0~ -20dBr)		0	-	-	dB
2) 11MHz to 20MHz (-20~ -28dBr)		0	-	-	dB
3) 20MHz to 30MHz (-28~ -45dBr)		0	-	-	dB
4) 30MHz to 33MHz (-45dBr)		0	-	-	dB
4. Constellation Error (EVM) (measured at enhanced mode)		-	-	-30	dB
5. Frequency tolerance		-20		20	ppm
6. Spurious Emissions					
1) 30-47MHz (BW=100kHz)		-	-	-36	dBm
2) 47-74MHz (BW=100kHz)		-	-	-54	dBm
3) 74-87.5MHz (BW=100kHz)		-	-	-36	dBm
4) 87.5-118MHz (BW=100kHz)		-	-	-54	dBm
5) 118-174MHz (BW=100kHz)		-	-	-36	dBm
6) 174-230MHz (BW=100kHz)		-	-	-54	dBm
7) 230-470MHz (BW=100kHz)		-	-	-36	dBm
8) 470-862MHz (BW=100kHz)		-	-	-54	dBm
9) 862-1000MHz (BW=100kHz)		-	-	-36	dBm
10) 1000-5150MHz (BW=1MHz)		-	-	-30	dBm
11) 5350-5470MHz (BW=1MHz)		-	-	-30	dBm
12) 5725-26000MHz (BW=1MHz)		-	-	-30	dBm
- Rx Characteristics -		Min.	Typ.	Max.	Unit
7. Minimum Input Level (PER < 10%)		-	-	-59	dBm
8. Maximum Input Level (PER < 10%)		-30	-	-	dBm
9. Adjacent Channel Rejection (PER ≤ 10%)		-7	-	-	dB

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

Conditions : 25deg.C, VDD33=3.3V, VDD18=1.8V VIO=1.8V, Output power setting=16dBm, MCS0 mode

Items		Contents			
- DC Characteristics -		min.	Typ.	Max.	Unit
1. DC current					
1) Tx mode	VDD18	-	400	-	mA
	VDD33	-	250	-	mA
	VDD18(MIMO)	-	640	-	mA
	VDD33(MIMO)	-	470	-	mA
2) Rx mode	VDD18	-	320	-	mA
	VDD33	-	0.2	-	mA
	VDD18(MIMO)	-	320	-	mA
	VDD33(MIMO)	-	0.2	-	mA
- Tx Characteristics -		min.	Typ.	Max.	Unit
2. Output Power		14	16	18	dBm
3. Spectrum Mask Margin					
1) 9MHz to 11MHz (0~ -20dBr)		0	-	-	dB
2) 11MHz to 20MHz (-20~ -28dBr)		0	-	-	dB
3) 20MHz to 30MHz (-28~ -45dBr)		0	-	-	dB
4) 30MHz to 33MHz (-45dBr)		0	-	-	dB
4. Constellation Error (EVM) (measured at enhanced mode)		-	-	-30	dB
5. Frequency tolerance		-20		20	ppm
6. Spurious Emissions					
1) 30-47MHz (BW=100kHz)		-	-	-36	dBm
2) 47-74MHz (BW=100kHz)		-	-	-54	dBm
3) 74-87.5MHz (BW=100kHz)		-	-	-36	dBm
4) 87.5-118MHz (BW=100kHz)		-	-	-54	dBm
5) 118-174MHz (BW=100kHz)		-	-	-36	dBm
6) 174-230MHz (BW=100kHz)		-	-	-54	dBm
7) 230-470MHz (BW=100kHz)		-	-	-36	dBm
8) 470-862MHz (BW=100kHz)		-	-	-54	dBm
9) 862-1000MHz (BW=100kHz)		-	-	-36	dBm
10) 1000-5150MHz (BW=1MHz)		-	-	-30	dBm
11) 5350-5470MHz (BW=1MHz)		-	-	-30	dBm
12) 5725-26000MHz (BW=1MHz)		-	-	-30	dBm
- Rx Characteristics -		Min.	Typ.	Max.	Unit
7. Minimum Input Level (PER ≤ 10%)		-	-	-82	dBm
8. Maximum Input Level (PER < 10%)		-30	-	-	dBm
9. Adjacent Channel Rejection (PER ≤ 10%)		-7	-	-	dB

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

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

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

Conditions : 25deg.C, VDD33=3.3V, VDD18=1.8V VIO=1.8V, Output power setting=16dBm, MCS7 mode

Items		Contents			
- DC Characteristics -		min.	Typ.	Max.	Unit
1. DC current					
1) Tx mode	VDD18	-	410	-	mA
	VDD33	-	240	-	mA
	VDD18(MIMO)	-	630	-	mA
	VDD33(MIMO)	-	440	-	mA
2) Rx mode	VDD18	-	320	-	mA
	VDD33	-	0.2	-	mA
	VDD18(MIMO)	-	350	-	mA
	VDD33(MIMO)	-	0.2	-	mA
- Tx Characteristics -		min.	Typ.	Max.	Unit
2. Output Power		14	16	18	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

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

Conditions : 25deg.C, VDD33=3.3V, VDD18=1.8V VIO=1.8V, Output power setting=16dBm, MCS0 mode

Items		Contents			
- DC Characteristics -		min.	Typ.	Max.	Unit
1. DC current					
1) Tx mode	VDD18	-	410	-	mA
	VDD33	-	250	-	mA
	VDD18(MIMO)	-	650	-	mA
	VDD33(MIMO)	-	470	-	mA
2) Rx mode	VDD18	-	320	-	mA
	VDD33	-	0.2	-	mA
	VDD18(MIMO)	-	350	-	mA
	VDD33(MIMO)	-	0.2	-	mA
- Tx Characteristics -		min.	Typ.	Max.	Unit
2. Output Power		14	16	18	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%)		-	-	-79	dBm
8. Maximum Input Level (PER ≤ 10%)		-30	-	-	dBm
9. Adjacent Channel Rejection (PER ≤ 10%)		-2	-	-	dB

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

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

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

Conditions : 25deg.C, VDD33=3.3V, VDD18=1.8V VIO=1.8V, Output power setting=15, MCS9 mode

Items		Contents			
- DC Characteristics -		min.	Typ.	Max.	Unit
1. DC current					
1) Tx mode	VDD18	-	380	-	mA
	VDD33	-	210	-	mA
	VDD18(MIMO)	-	570	-	mA
	VDD33(MIMO)	-	410	-	mA
2) Rx mode	VDD18	-	320	-	mA
	VDD33	-	0.2	-	mA
	VDD18(MIMO)	-	350	-	mA
	VDD33(MIMO)	-	0.2	-	mA
- Tx Characteristics -		min.	Typ.	Max.	Unit
2. Output Power		13	15	17	dBm
3. Spectrum Mask Margin					
1) 19MHz to 21MHz (0~ -20dBr)		0	-	-	dB
2) 21MHz to 40MHz (-20~ -28dBr)		0	-	-	dB
3) 40MHz to 60MHz (-28~ -45dBr)		0	-	-	dB
4) 60MHz to 80MHz (-45dBr)		0	-	-	dB
4. Constellation Error (EVM) (measured at enhanced mode)		-	-	-32	dB
5. Frequency tolerance		-20		20	ppm
6. Spurious Emissions					
1) 30-47MHz (BW=100kHz)		-	-	-36	dBm
2) 47-74MHz (BW=100kHz)		-	-	-54	dBm
3) 74-87.5MHz (BW=100kHz)		-	-	-36	dBm
4) 87.5-118MHz (BW=100kHz)		-	-	-54	dBm
5) 118-174MHz (BW=100kHz)		-	-	-36	dBm
6) 174-230MHz (BW=100kHz)		-	-	-54	dBm
7) 230-470MHz (BW=100kHz)		-	-	-36	dBm
8) 470-862MHz (BW=100kHz)		-	-	-54	dBm
9) 862-1000MHz (BW=100kHz)		-	-	-36	dBm
10) 1000-5150MHz (BW=1MHz)		-	-	-30	dBm
11) 5350-5470MHz (BW=1MHz)		-	-	-30	dBm
12) 5725-26000MHz (BW=1MHz)		-	-	-30	dBm
- Rx Characteristics -		Min.	Typ.	Max.	Unit
7. Minimum Input Level (PER ≤ 10%)		-	-	-54	dBm
8. Maximum Input Level (PER ≤ 10%)		-30	-	-	dBm
9. Adjacent Channel Rejection (PER ≤ 10%)		-9	-	-	dB

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

Conditions : 25deg.C, VDD33=3.3V, VDD18=1.8V VIO=1.8V, Output power setting=16dBm, MCS0 mode

Items		Contents			
- DC Characteristics -		min.	Typ.	Max.	Unit
1. DC current					
1) Tx mode	VDD18	-	410	-	mA
	VDD33	-	250	-	mA
	VDD18(MIMO)	-	650	-	mA
	VDD33(MIMO)	-	470	-	mA
2) Rx mode	VDD18	-	320	-	mA
	VDD33	-	0.2	-	mA
	VDD18(MIMO)	-	350	-	mA
	VDD33(MIMO)	-	0.2	-	mA
- Tx Characteristics -		min.	Typ.	Max.	Unit
2. Output Power		14	16	18	dBm
3. Spectrum Mask Margin					
1) 19MHz to 21MHz (0~ -20dBr)		0	-	-	dB
2) 21MHz to 40MHz (-20~ -28dBr)		0	-	-	dB
3) 40MHz to 60MHz (-28~ -45dBr)		0	-	-	dB
4) 60MHz to 80MHz (-45dBr)		0	-	-	dB
4. Constellation Error (EVM) (measured at enhanced mode)		-	-	-32	dB
5. Frequency tolerance		-20		20	ppm
6. Spurious Emissions					
1) 30-47MHz (BW=100kHz)		-	-	-36	dBm
2) 47-74MHz (BW=100kHz)		-	-	-54	dBm
3) 74-87.5MHz (BW=100kHz)		-	-	-36	dBm
4) 87.5-118MHz (BW=100kHz)		-	-	-54	dBm
5) 118-174MHz (BW=100kHz)		-	-	-36	dBm
6) 174-230MHz (BW=100kHz)		-	-	-54	dBm
7) 230-470MHz (BW=100kHz)		-	-	-36	dBm
8) 470-862MHz (BW=100kHz)		-	-	-54	dBm
9) 862-1000MHz (BW=100kHz)		-	-	-36	dBm
10) 1000-5150MHz (BW=1MHz)		-	-	-30	dBm
11) 5350-5470MHz (BW=1MHz)		-	-	-30	dBm
12) 5725-26000MHz (BW=1MHz)		-	-	-30	dBm
- Rx Characteristics -		Min.	Typ.	Max.	Unit
7. Minimum Input Level (PER ≤ 10%)		-	-	-79	dBm
8. Maximum Input Level (PER ≤ 10%)		-30	-	-	dBm
9. Adjacent Channel Rejection (PER ≤ 10%)		-9	-	-	dB

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

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

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

Conditions : 25deg.C, VDD33=3.3V, VDD18=1.8V VIO=1.8V, Output power setting=14dBm, MCS9 mode

Items		Contents			
- DC Characteristics -		min.	Typ.	Max.	Unit
1. DC current					
1) Tx mode	VDD18	-	400	-	mA
	VDD33	-	200	-	mA
	VDD18(MIMO)	-	600	-	mA
	VDD33(MIMO)	-	380	-	mA
2) Rx mode	VDD18	-	350	-	mA
	VDD33	-	0.2	-	mA
	VDD18(MIMO)	-	420	-	mA
	VDD33(MIMO)	-	0.2	-	mA
- Tx Characteristics -		min.	Typ.	Max.	Unit
2. Output Power		12	14	16	dBm
3. Spectrum Mask Margin					
1) 39MHz to 41MHz (0~ -20dBr)		0	-	-	dB
2) 41MHz to 80MHz (-20~ -28dBr)		0	-	-	dB
3) 80MHz to 120MHz (-28~ -40dBr)		0	-	-	dB
4) 120MHz to 140MHz (-40dBr)		0	-	-	dB
4. Constellation Error (EVM) (measured at enhanced mode)		-	-	-32	dB
5. Frequency tolerance		-20		20	ppm
6. Spurious Emissions					
1) 30-47MHz (BW=100kHz)		-	-	-36	dBm
2) 47-74MHz (BW=100kHz)		-	-	-54	dBm
3) 74-87.5MHz (BW=100kHz)		-	-	-36	dBm
4) 87.5-118MHz (BW=100kHz)		-	-	-54	dBm
5) 118-174MHz (BW=100kHz)		-	-	-36	dBm
6) 174-230MHz (BW=100kHz)		-	-	-54	dBm
7) 230-470MHz (BW=100kHz)		-	-	-36	dBm
8) 470-862MHz (BW=100kHz)		-	-	-54	dBm
9) 862-1000MHz (BW=100kHz)		-	-	-36	dBm
10) 1000-5150MHz (BW=1MHz)		-	-	-30	dBm
11) 5350-5470MHz (BW=1MHz)		-	-	-30	dBm
12) 5725-26000MHz (BW=1MHz)		-	-	-30	dBm
- Rx Characteristics -		Min.	Typ.	Max.	Unit
6. Minimum Input Level (PER ≤ 10%)		-	-	-51	dBm
7. Maximum Input Level (PER ≤ 10%)		-30	-	-	dBm
8. Adjacent Channel Rejection (PER ≤ 10%)		-9	-	-	dB

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

Conditions : 25deg.C, VDD33=3.3V, VDD18=1.8V VIO=1.8V, Output power setting=15dBm, MCS0 mode

Items		Contents			
- DC Characteristics -		min.	Typ.	Max.	Unit
1. DC current					
1) Tx mode	VDD18	-	400	-	mA
	VDD33	-	230	-	mA
	VDD18(MIMO)	-	630	-	mA
	VDD33(MIMO)	-	440	-	mA
2) Rx mode	VDD18	-	350	-	mA
	VDD33	-	0.2	-	mA
	VDD18(MIMO)	-	420	-	mA
	VDD33(MIMO)	-	0.2	-	mA
- Tx Characteristics -		min.	Typ.	Max.	Unit
2. Output Power		13	15	17	dBm
3. Spectrum Mask Margin					
1) 39MHz to 41MHz (0~ -20dBr)		0	-	-	dB
2) 41MHz to 80MHz (-20~ -28dBr)		0	-	-	dB
3) 80MHz to 120MHz (-28~ -40dBr)		0	-	-	dB
4) 120MHz to 140MHz (-40dBr)		0	-	-	dB
4. Constellation Error (EVM) (measured at enhanced mode)		-	-	-19	dB
5. Frequency tolerance		-20		20	ppm
6. Spurious Emissions					
1) 30-47MHz (BW=100kHz)		-	-	-36	dBm
2) 47-74MHz (BW=100kHz)		-	-	-54	dBm
3) 74-87.5MHz (BW=100kHz)		-	-	-36	dBm
4) 87.5-118MHz (BW=100kHz)		-	-	-54	dBm
5) 118-174MHz (BW=100kHz)		-	-	-36	dBm
6) 174-230MHz (BW=100kHz)		-	-	-54	dBm
7) 230-470MHz (BW=100kHz)		-	-	-36	dBm
8) 470-862MHz (BW=100kHz)		-	-	-54	dBm
9) 862-1000MHz (BW=100kHz)		-	-	-36	dBm
10) 1000-5150MHz (BW=1MHz)		-	-	-30	dBm
11) 5350-5470MHz (BW=1MHz)		-	-	-30	dBm
12) 5725-26000MHz (BW=1MHz)		-	-	-30	dBm
- Rx Characteristics -		Min.	Typ.	Max.	Unit
6. Minimum Input Level (PER ≤ 10%)		-	-	-76	dBm
7. Maximum Input Level (PER ≤ 10%)		-30	-	-	dBm
8. Adjacent Channel Rejection (PER ≤ 10%)		-9	-	-	dB

12.11. DC/RF Characteristics for IEEE802.11ax(HE 20MHz)-5GHz

Specification	IEEE802.11ax
Mode	OFDM
Channel Frequency	5180 to 5240MHz, 5260 to 5320MHz, 5500 to 5720MHz, 5745 to 5825MHz
Data rate	MCS0-MCS11

12.11.1. High Rate Condition for IEEE802.11ax(HE20) – 5GHz

Conditions : 25deg.C, VDD33=3.3V, VDD18=1.8V VIO=1.8V, Output power setting=14dBm, MCS11 mode

Items		Contents			
- DC Characteristics -		min.	Typ.	Max.	Unit
1. DC current					
1) Tx mode	VDD18	-	380	-	mA
	VDD33	-	210	-	mA
	VDD18(MIMO)	-	560	-	mA
	VDD33(MIMO)	-	400	-	mA
2) Rx mode	VDD18	-	320	-	mA
	VDD33	-	0.2	-	mA
	VDD18(MIMO)	-	320	-	mA
	VDD33(MIMO)	-	0.2	-	mA
- Tx Characteristics -		min.	Typ.	Max.	Unit
2. Output Power		12	14	16	dBm
3. Spectrum Mask Margin					
1) 39MHz to 41MHz (0~ -20dBr)		0	-	-	dB
2) 41MHz to 80MHz (-20~ -28dBr)		0	-	-	dB
3) 80MHz to 120MHz (-28~ -40dBr)		0	-	-	dB
4) 120MHz to 140MHz (-40dBr)		0	-	-	dB
4. Constellation Error (EVM) (measured at enhanced mode)		-	-	-32	dB
5. Frequency tolerance		-20		20	ppm
6. Spurious Emissions					
1) 30-47MHz (BW=100kHz)		-	-	-36	dBm
2) 47-74MHz (BW=100kHz)		-	-	-54	dBm
3) 74-87.5MHz (BW=100kHz)		-	-	-36	dBm
4) 87.5-118MHz (BW=100kHz)		-	-	-54	dBm
5) 118-174MHz (BW=100kHz)		-	-	-36	dBm
6) 174-230MHz (BW=100kHz)		-	-	-54	dBm
7) 230-470MHz (BW=100kHz)		-	-	-36	dBm
8) 470-862MHz (BW=100kHz)		-	-	-54	dBm
9) 862-1000MHz (BW=100kHz)		-	-	-36	dBm
10) 1000-5150MHz (BW=1MHz)		-	-	-30	dBm
11) 5350-5470MHz (BW=1MHz)		-	-	-30	dBm
12) 5725-26000MHz (BW=1MHz)		-	-	-30	dBm
- Rx Characteristics -		Min.	Typ.	Max.	Unit
6. Minimum Input Level (PER ≤ 10%)		-	-	-51	dBm
7. Maximum Input Level (PER ≤ 10%)		-30	-	-	dBm
8. Adjacent Channel Rejection (PER ≤ 10%)		-9	-	-	dB

12.11.2. Low Rate Condition for IEEE802.11ax(HE20) – 5GHz

Conditions : 25deg.C, VDD33=3.3V, VDD18=1.8V VIO=1.8V, Output power setting=16dBm, MCS0 mode

Items		Contents			
- DC Characteristics -		min.	Typ.	Max.	Unit
1. DC current					
1) Tx mode	VDD18	-	400	-	mA
	VDD33	-	250	-	mA
	VDD18(MIMO)	-	640	-	mA
	VDD33(MIMO)	-	480	-	mA
2) Rx mode	VDD18	-	320	-	mA
	VDD33	-	0.2	-	mA
	VDD18(MIMO)	-	320	-	mA
	VDD33(MIMO)	-	0.2	-	mA
- Tx Characteristics -		min.	Typ.	Max.	Unit
2. Output Power		14	16	18	dBm
3. Spectrum Mask Margin					
1) 39MHz to 41MHz (0~ -20dBr)		0	-	-	dB
2) 41MHz to 80MHz (-20~ -28dBr)		0	-	-	dB
3) 80MHz to 120MHz (-28~ -40dBr)		0	-	-	dB
4) 120MHz to 140MHz (-40dBr)		0	-	-	dB
4. Constellation Error (EVM) (measured at enhanced mode)		-	-	-19	dB
5. Frequency tolerance		-20		20	ppm
6. Spurious Emissions					
1) 30-47MHz (BW=100kHz)		-	-	-36	dBm
2) 47-74MHz (BW=100kHz)		-	-	-54	dBm
3) 74-87.5MHz (BW=100kHz)		-	-	-36	dBm
4) 87.5-118MHz (BW=100kHz)		-	-	-54	dBm
5) 118-174MHz (BW=100kHz)		-	-	-36	dBm
6) 174-230MHz (BW=100kHz)		-	-	-54	dBm
7) 230-470MHz (BW=100kHz)		-	-	-36	dBm
8) 470-862MHz (BW=100kHz)		-	-	-54	dBm
9) 862-1000MHz (BW=100kHz)		-	-	-36	dBm
10) 1000-5150MHz (BW=1MHz)		-	-	-30	dBm
11) 5350-5470MHz (BW=1MHz)		-	-	-30	dBm
12) 5725-26000MHz (BW=1MHz)		-	-	-30	dBm
- Rx Characteristics -		Min.	Typ.	Max.	Unit
6. Minimum Input Level (PER ≤ 10%)		-	-	-76	dBm
7. Maximum Input Level (PER ≤ 10%)		-30	-	-	dBm
8. Adjacent Channel Rejection (PER ≤ 10%)		-9	-	-	dB

12.12. DC/RF Characteristics for IEEE802.11ax(HE 40MHz)-5GHz

Specification	IEEE802.11ax
Mode	OFDM
Channel Frequency	5210 - 5775MHz
Data rate	MCS0-MCS11

12.12.1. High Rate Condition for IEEE802.11ax(HE40) – 5GHz

Conditions : 25deg.C, VDD33=3.3V, VDD18=1.8V VIO=1.8V, Output power setting=14dBm, MCS11 mode

Items		Contents			
- DC Characteristics -		min.	Typ.	Max.	Unit
1. DC current					
1) Tx mode	VDD18	-	390	-	mA
	VDD33	-	210	-	mA
	VDD18(MIMO)	-	560	-	mA
	VDD33(MIMO)	-	400	-	mA
2) Rx mode	VDD18	-	320	-	mA
	VDD33	-	0.2	-	mA
	VDD18(MIMO)	-	350	-	mA
	VDD33(MIMO)	-	0.2	-	mA
- Tx Characteristics -		min.	Typ.	Max.	Unit
2. Output Power		12	14	16	dBm
3. Spectrum Mask Margin					
1) 39MHz to 41MHz (0~ -20dBr)		0	-	-	dB
2) 41MHz to 80MHz (-20~ -28dBr)		0	-	-	dB
3) 80MHz to 120MHz (-28~ -40dBr)		0	-	-	dB
4) 120MHz to 140MHz (-40dBr)		0	-	-	dB
4. Constellation Error (EVM) (measured at enhanced mode)		-	-	-32	dB
5. Frequency tolerance		-20		20	ppm
6. Spurious Emissions					
1) 30-47MHz (BW=100kHz)		-	-	-36	dBm
2) 47-74MHz (BW=100kHz)		-	-	-54	dBm
3) 74-87.5MHz (BW=100kHz)		-	-	-36	dBm
4) 87.5-118MHz (BW=100kHz)		-	-	-54	dBm
5) 118-174MHz (BW=100kHz)		-	-	-36	dBm
6) 174-230MHz (BW=100kHz)		-	-	-54	dBm
7) 230-470MHz (BW=100kHz)		-	-	-36	dBm
8) 470-862MHz (BW=100kHz)		-	-	-54	dBm
9) 862-1000MHz (BW=100kHz)		-	-	-36	dBm
10) 1000-5150MHz (BW=1MHz)		-	-	-30	dBm
11) 5350-5470MHz (BW=1MHz)		-	-	-30	dBm
12) 5725-26000MHz (BW=1MHz)		-	-	-30	dBm
- Rx Characteristics -		Min.	Typ.	Max.	Unit
6. Minimum Input Level (PER ≤ 10%)		-	-	-51	dBm
7. Maximum Input Level (PER ≤ 10%)		-30	-	-	dBm
8. Adjacent Channel Rejection (PER ≤ 10%)		-9	-	-	dB

12.12.2. Low Rate Condition for IEEE802.11ax(HE40) – 5GHz

Conditions : 25deg.C, VDD33=3.3V, VDD18=1.8V VIO=1.8V, Output power setting=16dBm, MCS0 mode

Items		Contents			
- DC Characteristics -		min.	Typ.	Max.	Unit
1. DC current					
1) Tx mode	VDD18	-	420	-	mA
	VDD33	-	250	-	mA
	VDD18(MIMO)	-	660	-	mA
	VDD33(MIMO)	-	480	-	mA
2) Rx mode	VDD18	-	320	-	mA
	VDD33	-	0.2	-	mA
	VDD18(MIMO)	-	350	-	mA
	VDD33(MIMO)	-	0.2	-	mA
- Tx Characteristics -		min.	Typ.	Max.	Unit
2. Output Power		14	16	18	dBm
3. Spectrum Mask Margin					
1) 39MHz to 41MHz (0~ -20dBr)		0	-	-	dB
2) 41MHz to 80MHz (-20~ -28dBr)		0	-	-	dB
3) 80MHz to 120MHz (-28~ -40dBr)		0	-	-	dB
4) 120MHz to 140MHz (-40dBr)		0	-	-	dB
4. Constellation Error (EVM) (measured at enhanced mode)		-	-	-32	dB
5. Frequency tolerance		-20		20	ppm
6. Spurious Emissions					
1) 30-47MHz (BW=100kHz)		-	-	-36	dBm
2) 47-74MHz (BW=100kHz)		-	-	-54	dBm
3) 74-87.5MHz (BW=100kHz)		-	-	-36	dBm
4) 87.5-118MHz (BW=100kHz)		-	-	-54	dBm
5) 118-174MHz (BW=100kHz)		-	-	-36	dBm
6) 174-230MHz (BW=100kHz)		-	-	-54	dBm
7) 230-470MHz (BW=100kHz)		-	-	-36	dBm
8) 470-862MHz (BW=100kHz)		-	-	-54	dBm
9) 862-1000MHz (BW=100kHz)		-	-	-36	dBm
10) 1000-5150MHz (BW=1MHz)		-	-	-30	dBm
11) 5350-5470MHz (BW=1MHz)		-	-	-30	dBm
12) 5725-26000MHz (BW=1MHz)		-	-	-30	dBm
- Rx Characteristics -		Min.	Typ.	Max.	Unit
6. Minimum Input Level (PER ≤ 10%)		-	-	-76	dBm
7. Maximum Input Level (PER ≤ 10%)		-30	-	-	dBm
8. Adjacent Channel Rejection (PER ≤ 10%)		-9	-	-	dB

12.13. DC/RF Characteristics for IEEE802.11ax(HE 80MHz)-5GHz

Specification	IEEE802.11ax
Mode	OFDM
Channel Frequency	5210 - 5775MHz
Data rate	MCS0-MCS11

12.13.1. High Rate Condition for IEEE802.11ax(HE80) – 5GHz

Conditions : 25deg.C, VDD33=3.3V, VDD18=1.8V VIO=1.8V, Output power setting=14dBm, MCS11 mode

Items		Contents			
- DC Characteristics -		min.	Typ.	Max.	Unit
1. DC current					
1) Tx mode	VDD18	-	400	-	mA
	VDD33	-	200	-	mA
	VDD18(MIMO)	-	600	-	mA
	VDD33(MIMO)	-	400	-	mA
2) Rx mode	VDD18	-	350	-	mA
	VDD33	-	0.2	-	mA
	VDD18(MIMO)	-	420	-	mA
	VDD33(MIMO)	-	0.2	-	mA
- Tx Characteristics -		min.	Typ.	Max.	Unit
2. Output Power		12	14	16	dBm
3. Spectrum Mask Margin					
1) 39MHz to 41MHz (0~ -20dB)		0	-	-	dB
2) 41MHz to 80MHz (-20~ -28dB)		0	-	-	dB
3) 80MHz to 120MHz (-28~ -40dB)		0	-	-	dB
4) 120MHz to 140MHz (-40dB)		0	-	-	dB
4. Constellation Error (EVM) (measured at enhanced mode)		-	-	-32	dB
5. Frequency tolerance		-20		20	ppm
6. Spurious Emissions					
1) 30-47MHz (BW=100kHz)		-	-	-36	dBm
2) 47-74MHz (BW=100kHz)		-	-	-54	dBm
3) 74-87.5MHz (BW=100kHz)		-	-	-36	dBm
4) 87.5-118MHz (BW=100kHz)		-	-	-54	dBm
5) 118-174MHz (BW=100kHz)		-	-	-36	dBm
6) 174-230MHz (BW=100kHz)		-	-	-54	dBm
7) 230-470MHz (BW=100kHz)		-	-	-36	dBm
8) 470-862MHz (BW=100kHz)		-	-	-54	dBm
9) 862-1000MHz (BW=100kHz)		-	-	-36	dBm
10) 1000-5150MHz (BW=1MHz)		-	-	-30	dBm
11) 5350-5470MHz (BW=1MHz)		-	-	-30	dBm
12) 5725-26000MHz (BW=1MHz)		-	-	-30	dBm
- Rx Characteristics -		Min.	Typ.	Max.	Unit
6. Minimum Input Level (PER ≤ 10%)		-	-	-51	dBm
7. Maximum Input Level (PER ≤ 10%)		-30	-	-	dBm
8. Adjacent Channel Rejection (PER ≤ 10%)		-9	-	-	dB

12.13.2. Low Rate Condition for IEEE802.11ax(HE80) – 5GHz

Conditions : 25deg.C, VDD33=3.3V, VDD18=1.8V VIO=1.8V, Output power setting=15dBm, MCS0 mode

Items		Contents			
- DC Characteristics -		min.	Typ.	Max.	Unit
1. DC current					
1) Tx mode	VDD18	-	400	-	mA
	VDD33	-	230	-	mA
	VDD18(MIMO)	-	640	-	mA
	VDD33(MIMO)	-	440	-	mA
2) Rx mode	VDD18	-	350	-	mA
	VDD33	-	0.2	-	mA
	VDD18(MIMO)	-	420	-	mA
	VDD33(MIMO)	-	0.2	-	mA
- Tx Characteristics -		min.	Typ.	Max.	Unit
2. Output Power		13	15	17	dBm
3. Spectrum Mask Margin					
1) 39MHz to 41MHz (0~ -20dBr)		0	-	-	dB
2) 41MHz to 80MHz (-20~ -28dBr)		0	-	-	dB
3) 80MHz to 120MHz (-28~ -40dBr)		0	-	-	dB
4) 120MHz to 140MHz (-40dBr)		0	-	-	dB
4. Constellation Error (EVM) (measured at enhanced mode)		-	-	-32	dB
5. Frequency tolerance		-20		20	ppm
6. Spurious Emissions					
1) 30-47MHz (BW=100kHz)		-	-	-36	dBm
2) 47-74MHz (BW=100kHz)		-	-	-54	dBm
3) 74-87.5MHz (BW=100kHz)		-	-	-36	dBm
4) 87.5-118MHz (BW=100kHz)		-	-	-54	dBm
5) 118-174MHz (BW=100kHz)		-	-	-36	dBm
6) 174-230MHz (BW=100kHz)		-	-	-54	dBm
7) 230-470MHz (BW=100kHz)		-	-	-36	dBm
8) 470-862MHz (BW=100kHz)		-	-	-54	dBm
9) 862-1000MHz (BW=100kHz)		-	-	-36	dBm
10) 1000-5150MHz (BW=1MHz)		-	-	-30	dBm
11) 5350-5470MHz (BW=1MHz)		-	-	-30	dBm
12) 5725-26000MHz (BW=1MHz)		-	-	-30	dBm
- Rx Characteristics -		Min.	Typ.	Max.	Unit
6. Minimum Input Level (PER ≤ 10%)		-	-	-76	dBm
7. Maximum Input Level (PER ≤ 10%)		-30	-	-	dBm
8. Adjacent Channel Rejection (PER ≤ 10%)		-9	-	-	dB

12.14. DC/RF Characteristics for Bluetooth

12.14.1. Basic Data Rate Condition

Conditions : 25deg.C, VDD33=3.3V, VDD18=1.8V VIO=1.8V,

Items		Contents			
Bluetooth specification (power class)		Version 5.3			
Channel frequency (spacing)		2402 to 2480 MHz (1MHz)			
Current Consumption		Min.	Typ.	Max.	unit
1) Tx mode DH5	VDD18	-	45	-	mA
	VDD33	-	0.2	-	
2) Rx mode DH5	VDD18	-	20	-	mA
	VDD33	-	0.2	-	
- Tx Characteristics -		Min.	Typ.	Max.	Unit
Output Power@DH5		0	3	6	dBm
Frequency range		2400	-	2483.5	MHz
20dB bandwidth		-		1	MHz
Adjacent Channel Power *1					
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
BDR Sensitivity (BER≤0.1%)		-	-91	-86	dBm
C/I Performance (BER≤0.1%) *2					
1) co-channel		-	-	11	dB
2) 1MHz		-	-	0	dB
3) 2MHz		-	-	-30	dB
4) 3MHz		-	-	-40	dB
5) image (+4MHz)		-	-	-9	dB
6) image +/- 1MHz		-	-	-20	dB
Maximum Input Level (BER≤0.1%)		-20	-	-	dBm

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

*2: Up to five spurious responses within Bluetooth limits are allowed.

12.14.2. Enhanced Data Rate Condition

Conditions : 25deg.C, VDD33=3.3V, VDD18=1.8V VIO=1.8V,

Items		Contents			
Bluetooth specification (power class)		Version 5.3			
Channel frequency (spacing)		2402 to 2480 MHz (1MHz)			
Current Consumption		Min.	Typ.	Max.	unit
1) Tx mode 2DH5	VDD18	-	45	-	mA
	VDD33	-	0.2	-	
2) Rx mode 2DH5	VDD18	-	20	-	mA
	VDD33	-	0.2	-	
3) Tx mode 3DH5	VDD18	-	45	-	mA
	VDD33	-	0.2	-	
4) Rx mode 3DH5	VDD18	-	20	-	mA
	VDD33	-	0.2	-	
- Tx Characteristics -		Min.	Typ.	Max.	Unit
Output Power@2DH5/3DH5		-3	0	3	dBm
Frequency range		2400	-	2483.5	MHz
20dB bandwidth		-		1	MHz
Adjacent Channel Power *1					
1) [M-N] =2		-	-	-20	dBm
2) [M-N] ≥3		-	-	-40	dBm
EDR Relative Power		-4	-	1	dB
EDR Carrier Frequency Stability and Modulation Accuracy					
1) ωi		-75	-	75	kHz
2) ωi+ωo		-75	-	75	kHz
3) ωo		-10	-	10	kHz
4) RMS DEVM (DQPSK)		-	-	20	%
5) Peak DEVM (DQPSK)		-	-	35	%
6) 99% DEVM (DQPSK)		-	-	30	%
7) RMS DEVM (8DPSK)		-	-	13	%
8) Peak DEVM (8DPSK)		-	-	25	%
9) 99% DEVM (8DPSK)		-	-	20	%
Spurious Emissions					
1) 30-47MHz (BW=100kHz)		-	-	-36	dBm
2) 47-74MHz (BW=100kHz)		-	-	-54	dBm
3) 74-87.5MHz (BW=100kHz)		-	-	-36	dBm
4) 87.5-118MHz (BW=100kHz)		-	-	-54	dBm
5) 118-174MHz (BW=100kHz)		-	-	-36	dBm
6) 174-230MHz (BW=100kHz)		-	-	-54	dBm
7) 230-470MHz (BW=100kHz)		-	-	-36	dBm
8) 470-862MHz (BW=100kHz)		-	-	-54	dBm
9) 862-1000MHz (BW=100kHz)		-	-	-36	dBm
10) 1000-12750MHz (BW=1MHz)		-	-	-30	dBm
- Rx Characteristics -		Min.	Typ.	Max.	unit
EDR Sensitivity (BER≤0.007%)@8DPSK		-	-88	-82	dBm
C/I Performance (BER≤0.1%) *2					
1) co-channel		-	-	11	dB
2) 1MHz		-	-	0	dB
3) 2MHz		-	-	-30	dB
4) 3MHz		-	-	-40	dB
5) image (+4MHz)		-	-	-9	dB
6) image +/- 1MHz		-	-	-20	dB
Maximum Input Level (BER≤0.1%)		-20	-	-	dBm

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

*2: Up to five spurious responses within Bluetooth limits are allowed.

12.15. DC/RF Characteristics for Bluetooth Low Energy

12.15.1. 1Mbps PHY Condition

Conditions : 25deg.C, VDD33=3.3V, VDD18=1.8V VIO=1.8V,

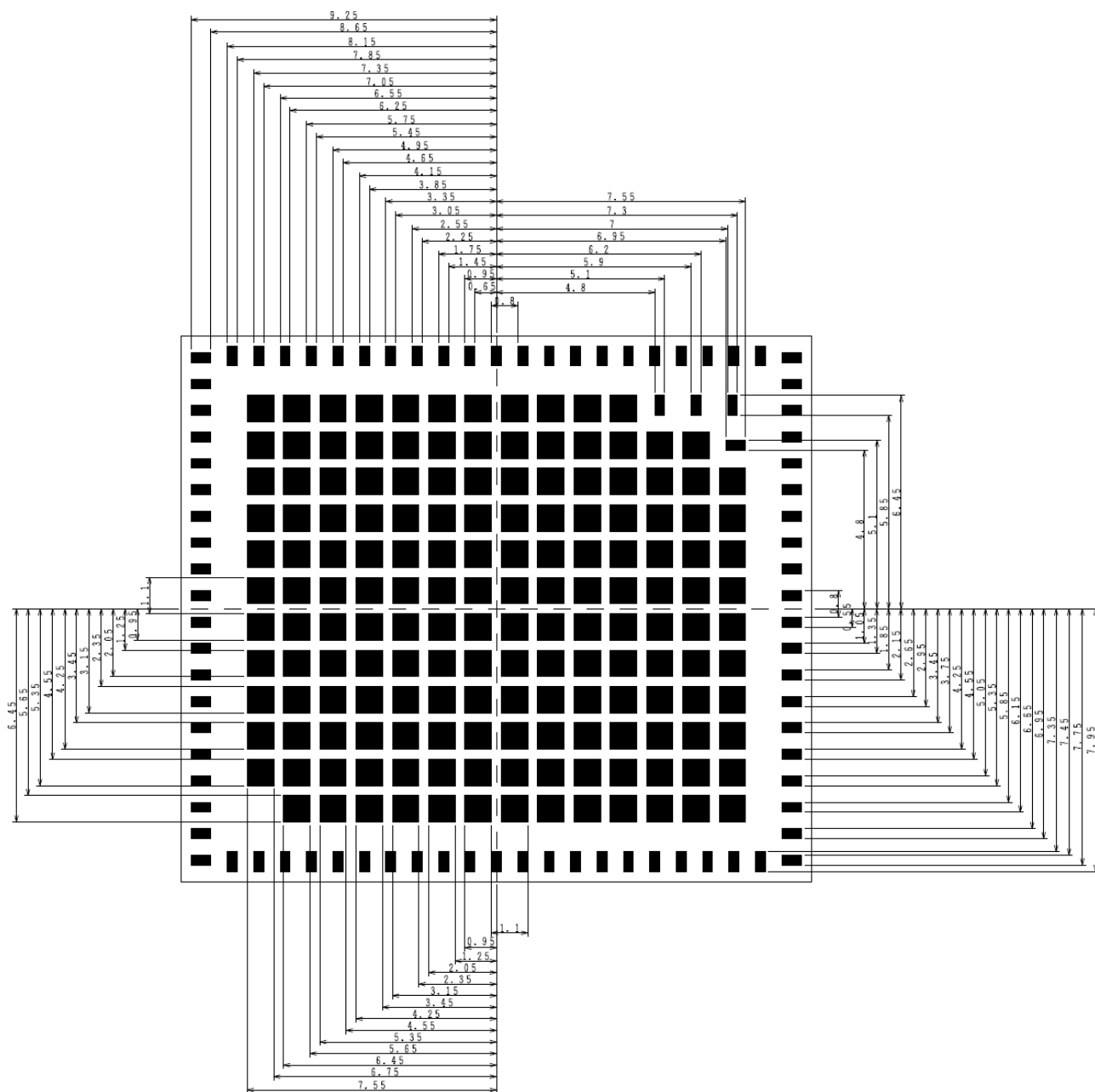
Items		Contents			
Bluetooth specification (power class)		Version 5.3			
Channel frequency (spacing)		2402 to 2480 MHz (2MHz)			
Number of RF Channel		40			
Current Consumption		Min.	Typ.	Max.	Unit
1) Tx mode	VDD18	-	60	-	mA
	VDD33	-	0.2	-	
2) Rx mode	VDD18	-	20	-	mA
	VDD33	-	0.2	-	
- Tx Characteristics -		Min.	Typ.	Max.	Unit
Center Frequency		2402	-	2480	MHz
Channel Spacing		-	2	-	MHz
Number of RF channel		-	40	-	-
Output power		0	3	6	dBm
Modulation Characteristics					
1) $\Delta f_{1\text{avg}}$		225	-	275	kHz
2) $\Delta f_{2\text{max}}$ (at 99.9%)		185	-	-	kHz
3) $\Delta f_{2\text{avg}} / \Delta f_{1\text{avg}}$		0.8	-	-	-
Carrier frequency offset and drift					
1) Frequency offset		-	-	150	kHz
2) Frequency drift		-	-	50	kHz
3) Drift rate		-	-	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%)		-	-95	-90	dBm
Maximum input signal level (PER < 30.8%)		-10	-	-	dBm
PER Report Integrity (-30dBm input)		50	-	65.4	%

12.15.2. 2Mbps PHY Condition

Conditions : 25deg.C, VDD33=3.3V, VDD18=1.8V VIO=1.8V,

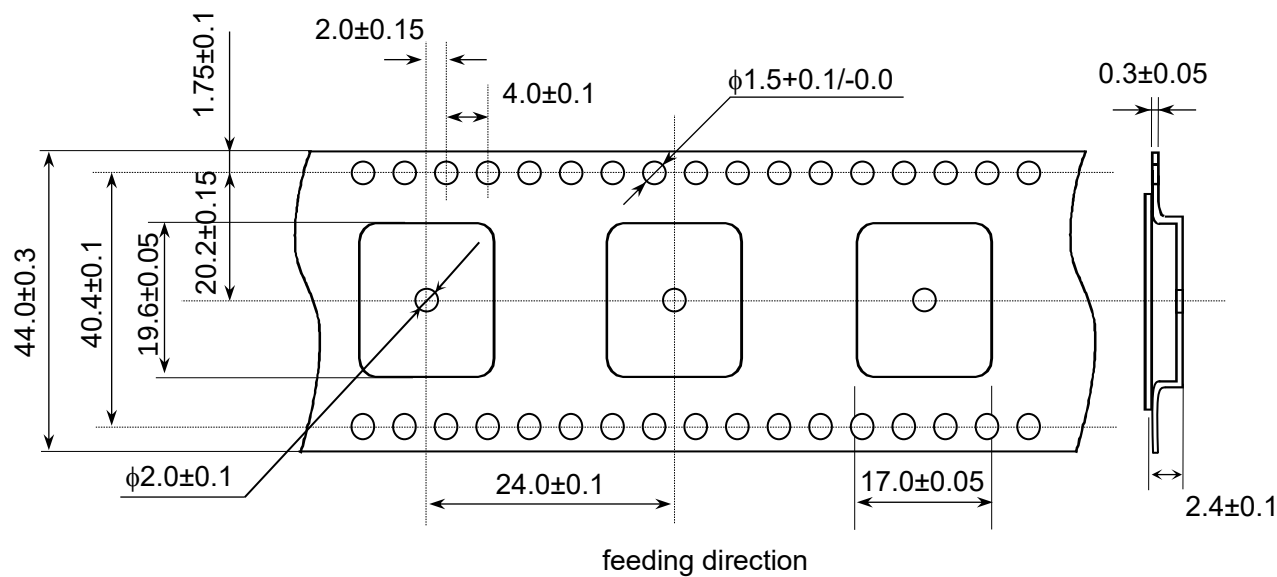
Items		Contents			
Bluetooth specification (power class)		Version 5.3			
Channel frequency (spacing)		2402 to 2480 MHz (2MHz)			
Number of RF Channel		40			
Current Consumption		Min.	Typ.	Max.	Unit
1) Tx mode	VDD18	-	60	-	mA
	VDD33	-	0.2	-	
2) Rx mode	VDD18	-	20	-	mA
	VDD33	-	0.2	-	
- Tx Characteristics -		Min.	Typ.	Max.	Unit
Center Frequency		2402	-	2480	MHz
Channel Spacing		-	2	-	MHz
Number of RF channel		-	40	-	-
Output power		0	3	6	dBm
Modulation Characteristics					
1) $\Delta f_{1\text{avg}}$		225	-	275	kHz
2) $\Delta f_{2\text{max}}$ (at 99.9%)		185	-	-	kHz
3) $\Delta f_{2\text{avg}} / \Delta f_{1\text{avg}}$		0.8	-	-	-
Carrier frequency offset and drift					
1) Frequency offset		-	-	150	kHz
2) Frequency drift		-	-	50	kHz
3) Drift rate		-	-	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%)		-	-95	-90	dBm
Maximum input signal level (PER < 30.8%)		-10	-	-	dBm
PER Report Integrity (-30dBm input)		50	-	65.4	%

13. Land Patterns

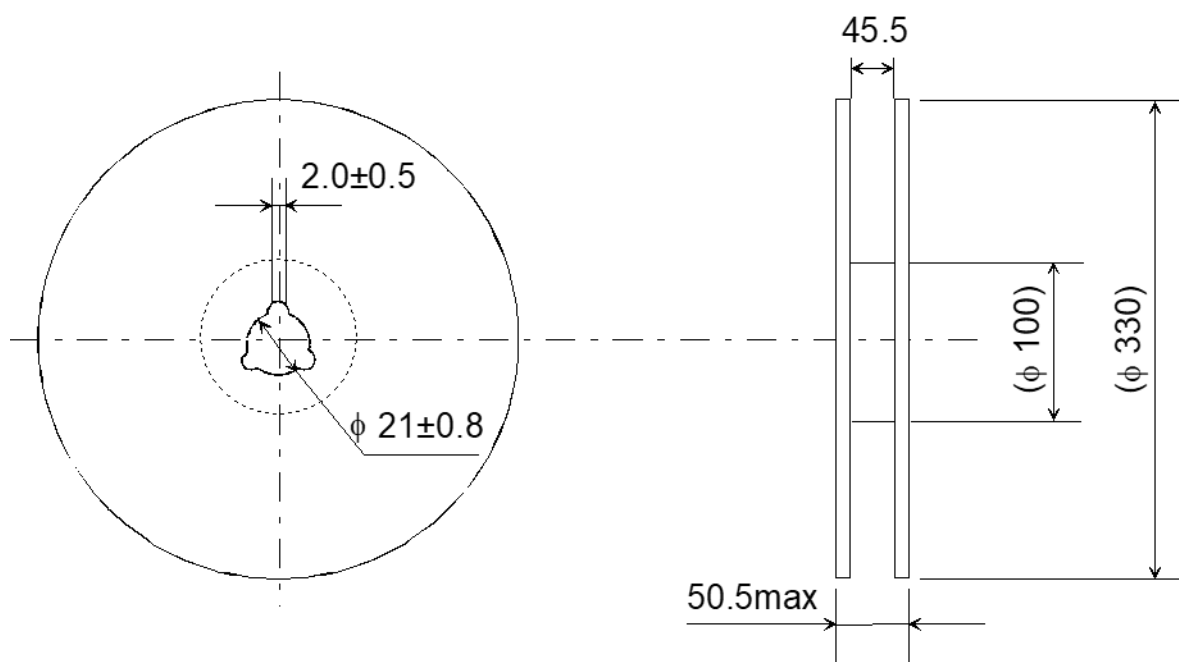


15. Tape and Reel Packing

(1) Dimensions of Tape (Plastic tape)



(2) Dimensions of Reel



(unit : mm)

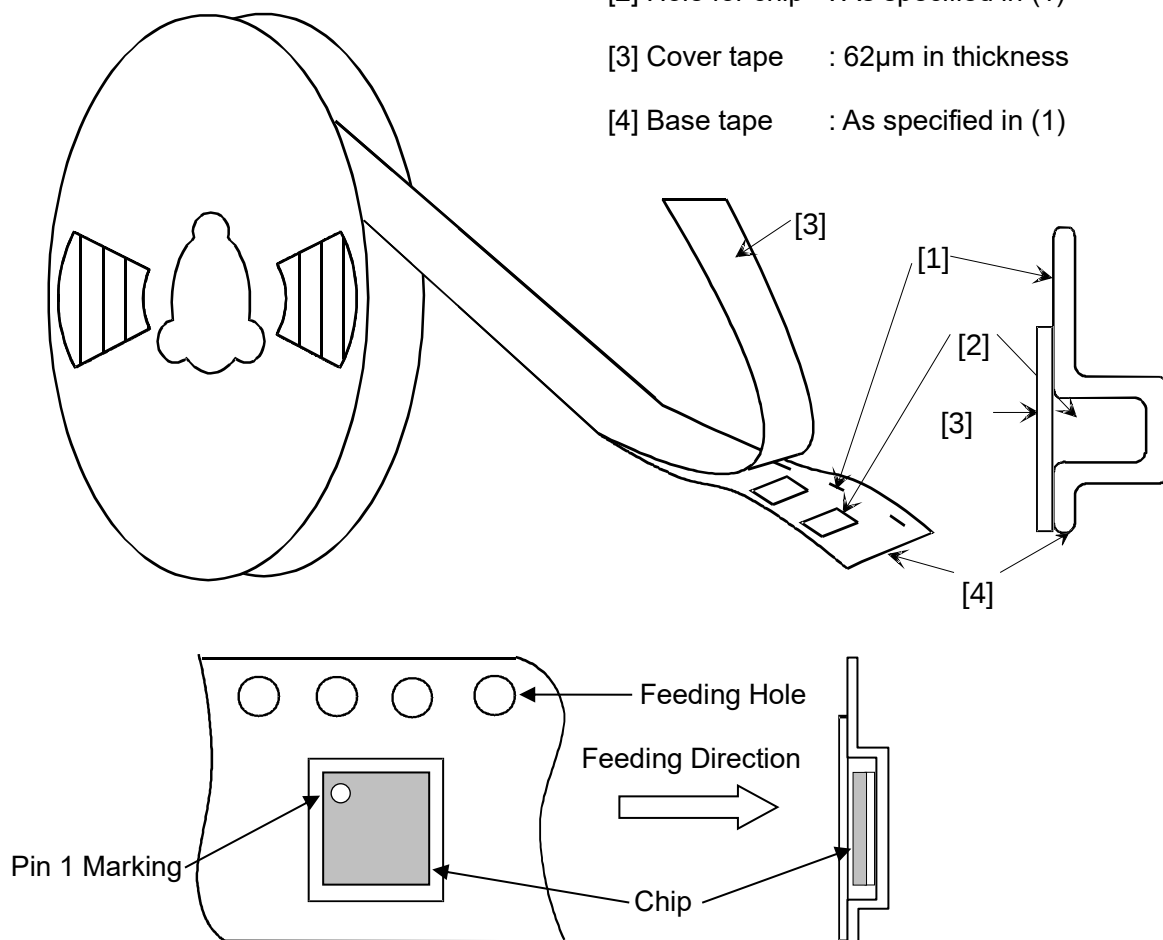
(3) Taping Diagrams

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

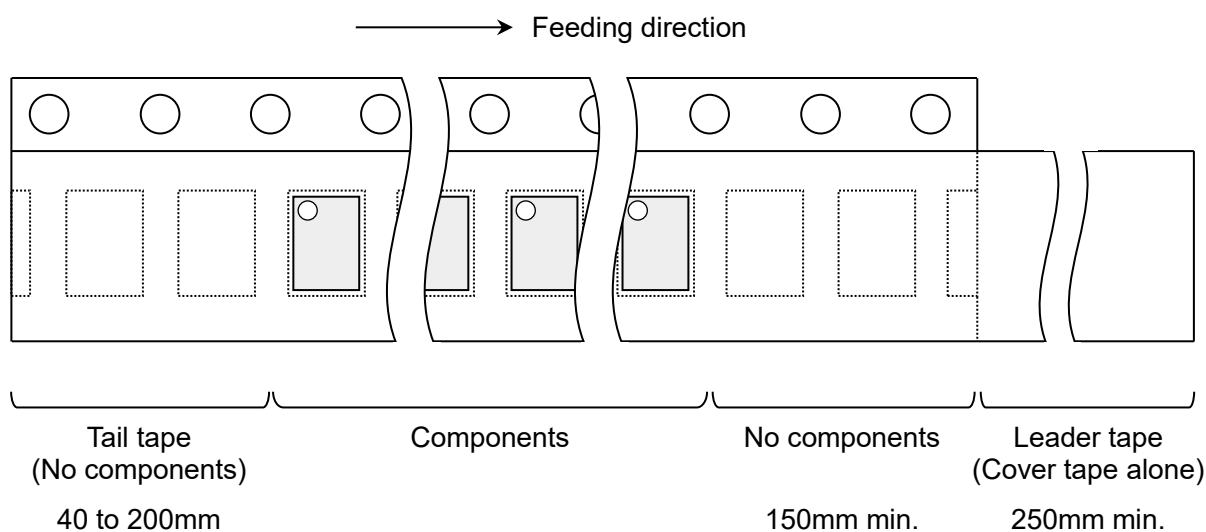
[2] Hole for chip : As specified in (1)

[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.

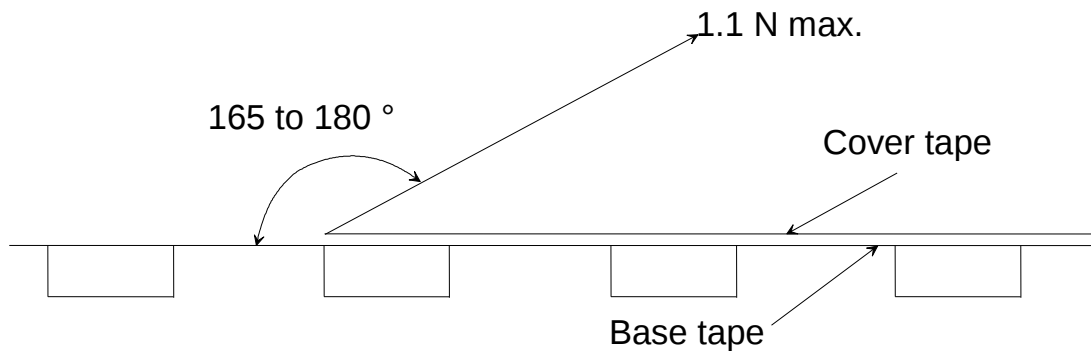
(8) Packaging unit : 500 pcs./ reel

(9) material : Base tape : Plastic

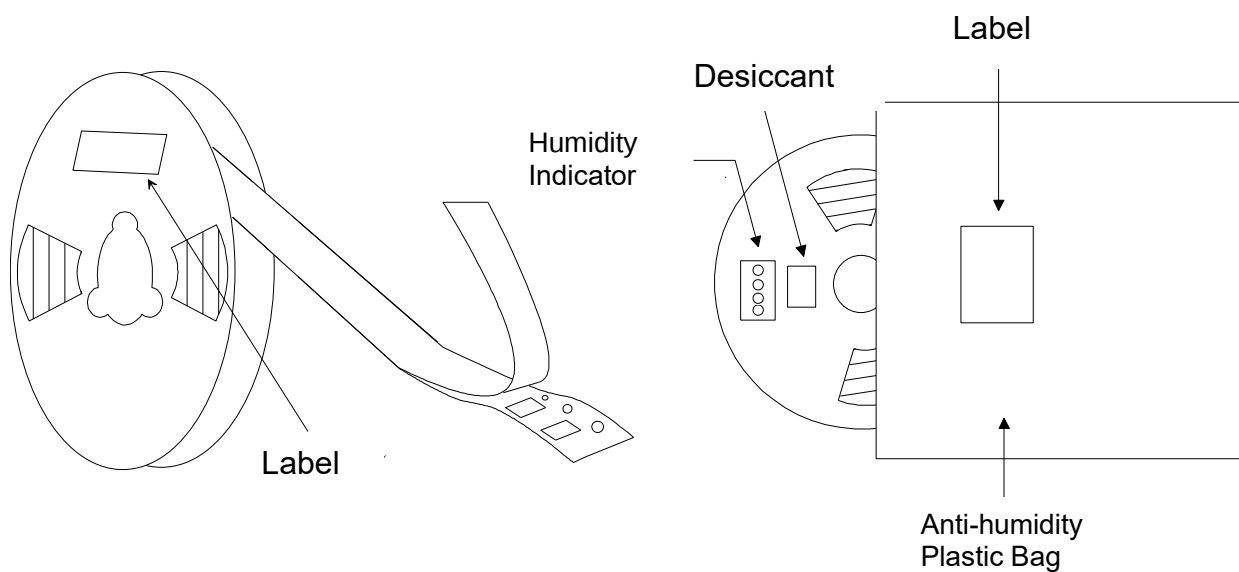
Real : Plastic

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.

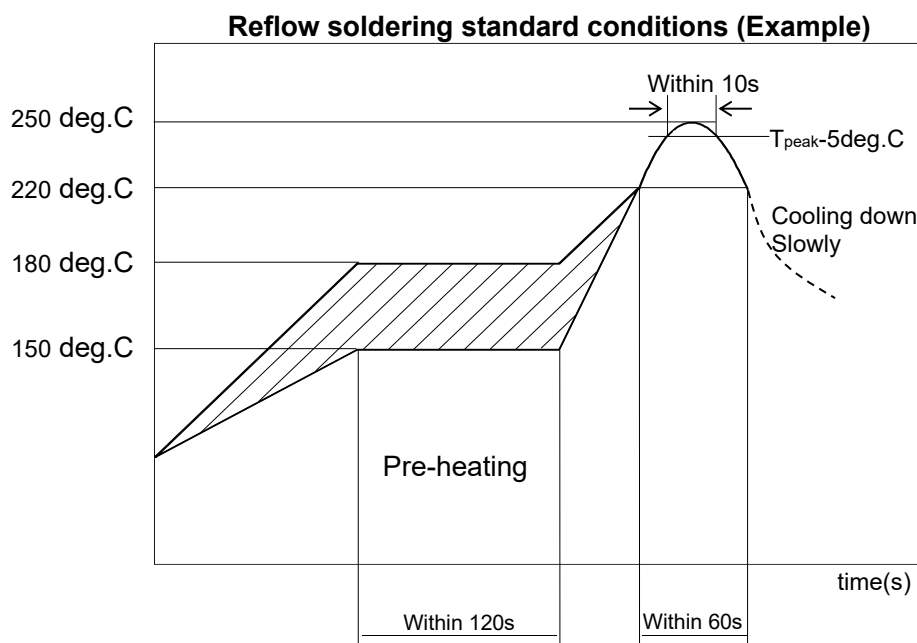
16.4. Notice for Chip Placer:

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 (Cl_2 , NH_3 , SO_x , NO_x etc.).
- In an atmosphere containing combustible and volatile gases.
- Dusty place.
- Direct sunlight place.
- Water splashing place.
- Humid place where water condenses.
- Freezing place.

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

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

17. Precondition to use our products**PLEASE READ THIS NOTICE BEFORE USING OUR PRODUCTS.**

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

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

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

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

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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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