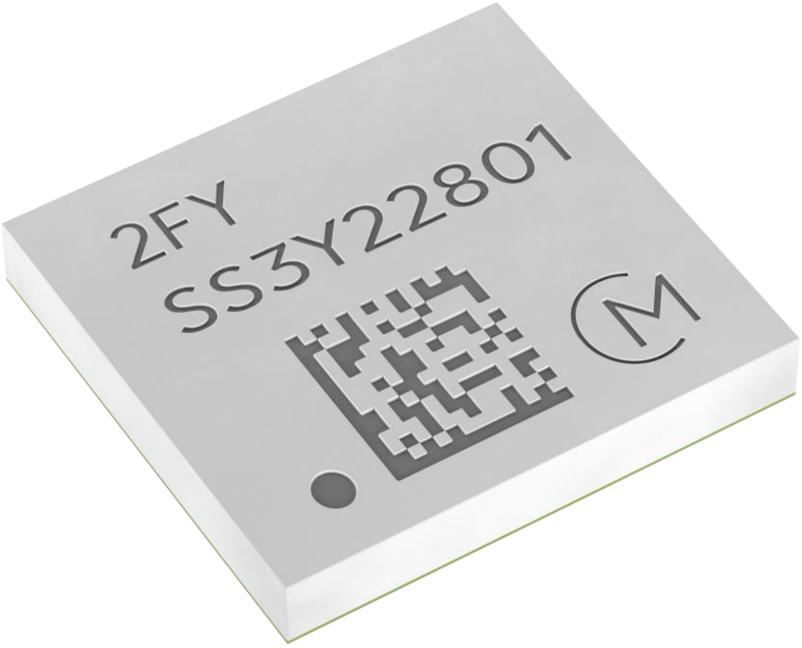
Datasheet

INNOVATOR IN ELECTRONICS

Type 2FY Wi-Fi™ + Bluetooth® Module

Infineon CYW55513 Chipset for 802.11a/b/g/n/ac/ax + Bluetooth 5.4 Datasheet - Rev. 11

- Design Name: Type 2FY
- Module P/N: LBEE5HY2FY-922



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About This Document

Type 2FY is a small and high-performance module based on IFX CYW55513 combo chipset, supporting IEEE 802.11a/b/g/n/ac/ax + Bluetooth 5.4 BR/EDR/LE. This datasheet describes Type 2FY 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; specifically 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.
ℹ	**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**: Murata ↗ 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 is applied to the IEEE802.11a/b/g/n/ac/ax + Bluetooth 5.4 BR/EDR/LE combo module.

2 Key Feature

- Infineon/CYW55513 inside
- Supports IEEE 802.11a/b/g/n/ac/ax: Tri band 2.4 GHz, 5 GHz, and 6 GHz
- 1x1 SISO with 20MHz channels
- Up to MCS11 data rates (143 Mbps)
- Supports Bluetooth specification version 5.4
- For supported Bluetooth functions, refer to Bluetooth SIG site
- WLAN interface: SDIO 3.0/2.0
- Bluetooth interface: HCI UART, and PCM
- Temperature Range: -40 °C to 85 °C
- Dimensions 7.9 x 7.3 x 1.1(Max) mm
- Weight: 170 mg
- MSL: 3
- Surface-mount type
- RoHS compliant
- Total Fit: 406

3 Ordering Information

The ordering information is shown in **Table 2.**

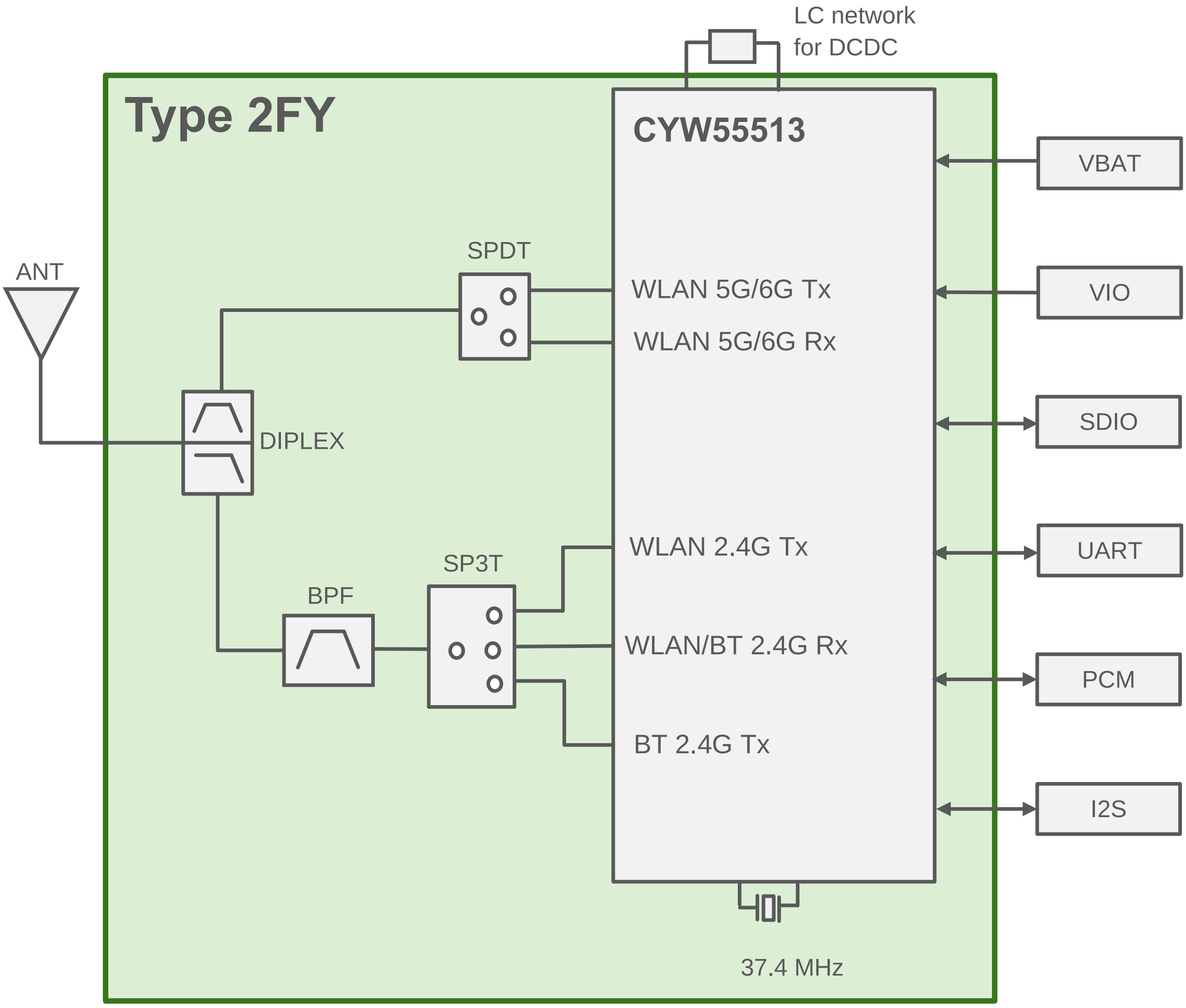
Table 2: Ordering Information

Ordering Part Number	Description
LBEE5HY2FY-922	Module Order
LBEE5HY2FY-SMP	Sample module order (If module samples are not available through distribution, contact Murata referencing this part number)
EAR00511	Embedded Artists Type 2FY M.2 EVB (default EVB available through distribution)

4 Block Diagram

Figure 1 shows the block diagram.

Figure 1: Block Diagram



5 Certification Information

This section has information about radio and Bluetooth certification.

5.1 Radio Certification

Table 3 describes the radio certification information.

Table 3: Radio Certification

Country	ID	Country Code
USA (FCC)	VPYLBEE5HY2FY	US
Canada (ISED)	772C-LBEE5HY2FY	CA
Europe	EN300328, EN301893, EN300440, EN303687 The conducted test reports are prepared.	DE
Japan (MIC)	Japanese type certification is prepared. 🅁 007-AN0125	JP

Each country code is defined by Murata’s clm Blob file.
You can get Murata’s clm Blob file at Murata GitHub

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 【Regulatory Information】：Type 2FY Radio Law Approval Application Note for Radio Law Certification user manual.

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

Please be sure to check the document.

5.3 Bluetooth Qualification

- QDID : 241038
- DN: Q301434
- For supported Bluetooth functions, refer to Bluetooth SIG site.

6 Dimensions, Markings, and Terminal Configurations

This section has information on dimensions, markings, and terminal configurations for Type 2FY as shown in **Figure 2**. **Table 4** describes the markings shown in **Figure 2**. **Table 5** describes the dimensions.

Figure 2: Dimensions, Markings and Terminal Configurations

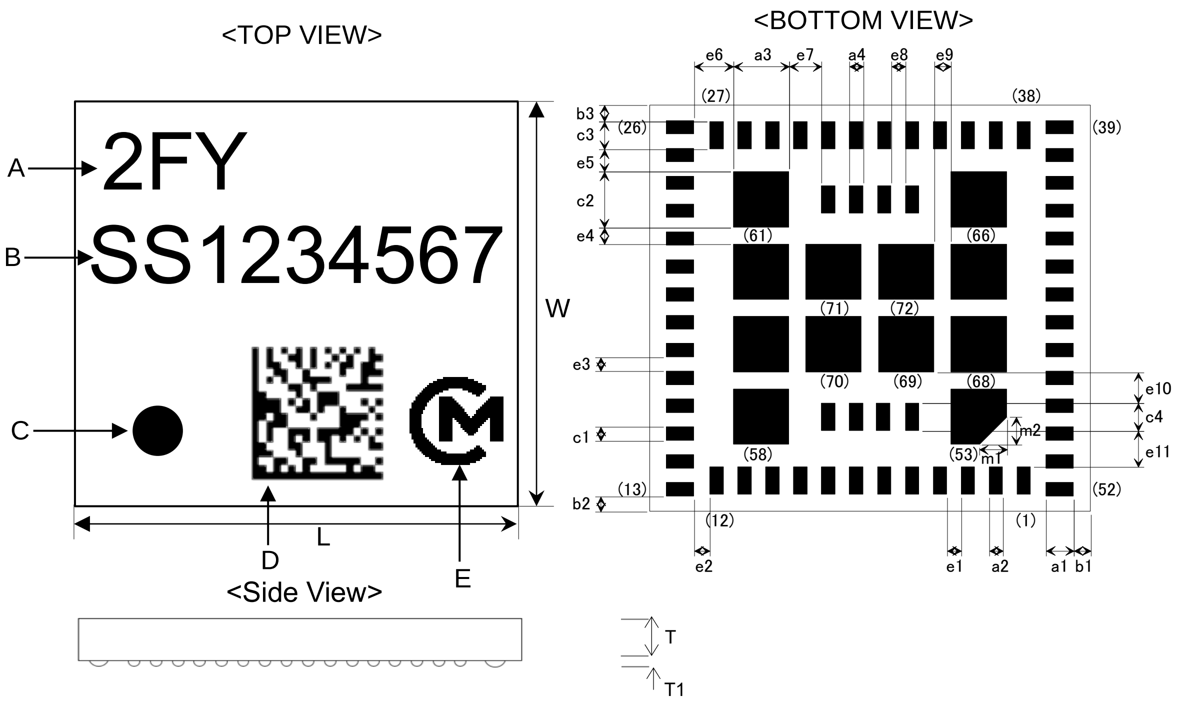


Table 4 and **Table 5** describe the markings and dimensions shown in **Figure 2**.

Table 4: Markings

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

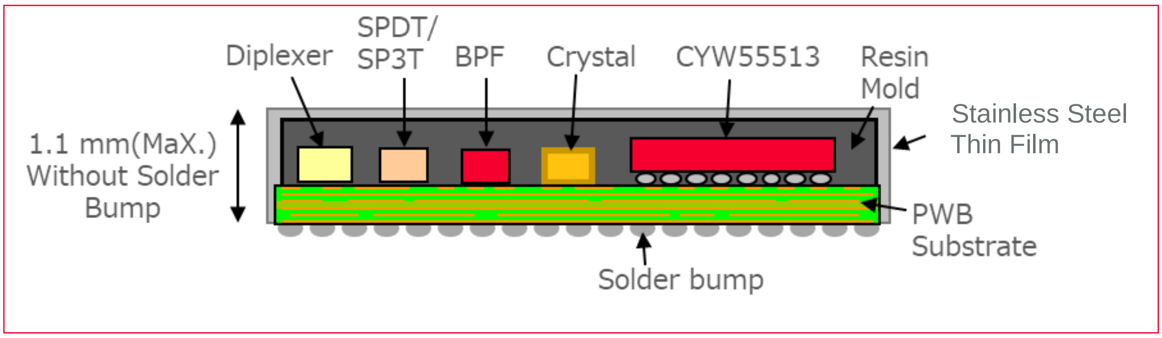
Table 5: Dimensions (Unit: Millimeters)

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

Mark	Dimensions (mm)	Mark	Dimensions (mm)	Mark	Dimensions (mm)
e11	0.65 +/- 0.1	m1	0.5 +/- 0.1	m2	0.5 +/- 0.1
T1	0.04 Typ.				

Figure 3 shows the Type 2FY structure.

Figure 3: Structure



The sides of the module are GND shielded. In order to avoid contact between the GND shield and the electrodes on the mother board, please carefully evaluate the standoff before use the module.

7 Module Pin Descriptions

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

7.1 Module Pin Layout

The pin assignment (top view) layout is shown in **Figure 4**.

Figure 4: Pin Layout - Top View

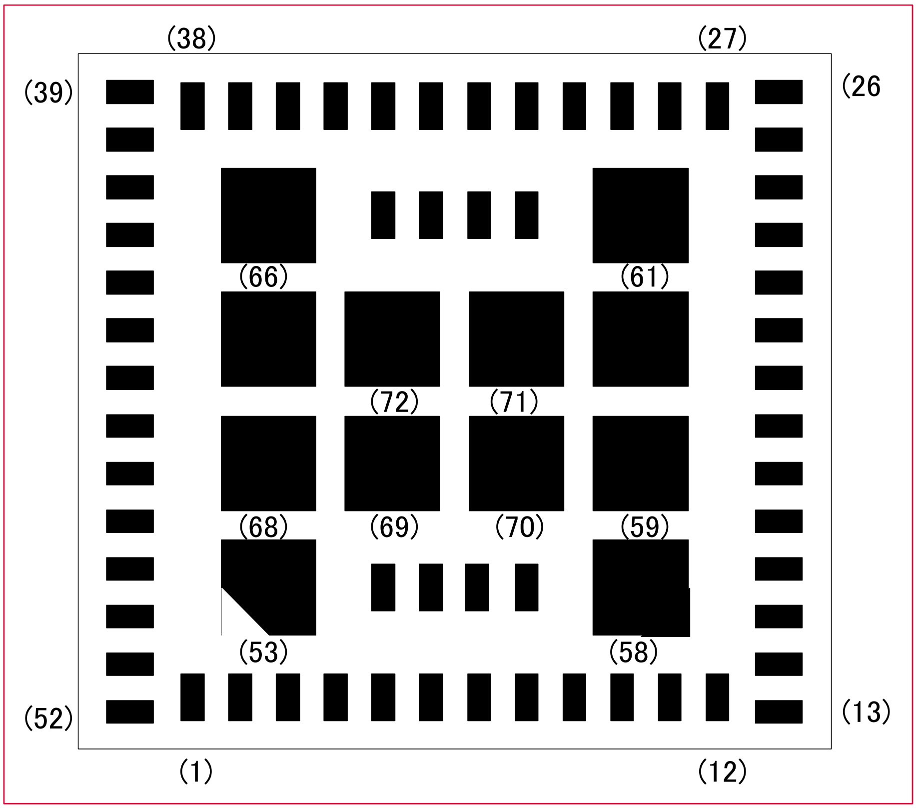


Table 6 illustrates the terminal configurations.

Table 6: Terminal Configurations

No.	Terminal Name	No.	Terminal Name	No.	Terminal Name
1	GPIO_6	25	ABUCK_1P12_IN	49	GND
2	GPIO_0	26	PVSSA	50	ANT
3	GPIO_3	27	PVSSA	51	GND
4	GPIO_5	28	ABUCK_1P12_OUT	52	GND
5	LHL_GPIO_1	29	GND	53	GND
6	GPIO_4	30	LPO_IN	54	NC
7	GPIO_2	31	TDM2_MCK	55	GND
8	BT_REG_ON	32	BT_PCM_IN	56	GND
9	WL_REG_ON	33	BT_PCM_SYNC	57	JTAG_SEL
10	GND	34	BT_PCM_OUT	58	GND
11	VDDIO	35	BT_PCM_CLK	59	GND
12	GND	36	I2S_DO	60	GND
13	GND	37	I2S_CLK	61	GND
14	SDIO_DATA0	38	I2S_WS	62	BT_GPIO_4
15	SDIO_CMD	39	GND	63	BT_GPIO_3
16	SDIO_DATA1	40	LHL_GPIO_0	64	BT_GPIO_2
17	SDIO_DATA2	41	BT_HOST_WAKE	65	BT_GPIO_5
18	SDIO_DATA3	42	I2S_DI	66	GND
19	GND	43	TDM1_MCK	67	GND
20	SDIO_CLK	44	GND	68	GND
21	GND	45	BT_UART_RXD	69	GND
22	VBAT_SR	46	BT_UART_TXD	70	GND
23	VBAT_SR	47	BT_UART_RTS_N	71	GND
24	PVSSA	48	BT_UART_CTS_N	72	GND

7.2 Pin Descriptions

The following notations shown under Type indicate pin directions, and characteristics, if any.

- **I/O**: Bidirectional
- **I**: Input
- **O**: Output
- **PWR**: Power
- **GND**: Ground
- **OD**: Open-Drain
- **RF**: RF terminal

Table 7 describes Type 2FY Pins.

Table 7: Pin Descriptions

No.	Pin name	Type	System	Connection to IC Pin Name	Description
1	GPIO_6	I/O	WL	WL_JTAG_TRST	WLAN General Purpose I/O
2	GPIO_0	I/O	WL	WL_HOST_WAKE	WLAN General Purpose I/O
3	GPIO_3	I/O	WL	WL_JTAG_TMS	WLAN General Purpose I/O
4	GPIO_5	I/O	WL	WL_TAG_TDO	WLAN General Purpose I/O
5	LHL_GPIO_1	I/O	WL	WL_DEV_WAKE	WLAN General Purpose I/O
6	GPIO_4	I/O	WL	WL_JTAG_TDI	WLAN General Purpose I/O
7	GPIO_2	I/O	WL	WL_JTAG_TCK	WLAN General Purpose I/O
8	BT_REG_ON	I	BT	BT_REG_ON	Used by the PMU to power up or power down the internal CYW55513 regulators used by the Bluetooth® section. When deasserted, this pin holds the Bluetooth® section in reset. This pin has an internal 50 kΩ pull-down resistor that is auto enabled/disabled by programming
9	WL_REG_ON	I	WL	WL_REG_ON	Used by the PMU to power up or power down the internal CYW55513 regulators used by the WLAN section. When deasserted, this pin holds the WLAN section in reset. This pin has an internal 50 KΩ pull down resistor that is auto enabled/disabled by programming
10	GND				-
11	VDDIO	PWR			Supply 1.8V for WLAN, BT, PMU, WLAN GPIO
12	GND				-
13	GND				-
14	SDIO_DATA0	I/O	WL	SDIO_DATA_0	SDIO data line 0
15	SDIO_CMD	I/O	WL	SDIO_CMD	SDIO command line
16	SDIO_DATA1	I/O	WL	SDIO_DATA_1	SDIO data line 1
17	SDIO_DATA2	I/O	WL	SDIO_DATA_2	SDIO data line 2
18	SDIO_DATA3	I/O	WL	SDIO_DATA_3	SDIO data line 3
19	GND				
20	SDIO_CLK	I	WL	SDIO_CLK	SDIO clock input
21	GND				
22	VBAT_SR	PWR		VBAT_SR	Power supply
23	VBAT_SR	PWR		VBAT_SR	Power supply

No.	Pin name	Type	System	Connection to IC Pin Name	Description
24	PVSSA	PWR		PVSSA	Ground input of ASR power stage
25	ABUCK_1P12_IN	PWR		ABuck_1P12_IN	Se Sense or feedback input of ASR power stage
26	PVSSA	PWR		PVSSA	Ground input of ASR power stage
27	PVSSA			PVSSA	Ground input of ASR power stage
28	ABUCK_1P12_OUT	PWR		ABuck_1P12_OUT	ASR power stage output to inductor
29	GND				
30	LPO_IN	I		LPO_IN	As an external 32 kHz clock source input
31	TDM2_MCK	I/O	WL	TDM2_MCK	TDM2 Interface Master Clock
32	BT_PCM_IN	I	BT	BT_PCM_IN/TDM2_DI	TDM2 Interface Data In.
33	BT_PCM_SYNC	I/O	BT	BT_PCM_SYNC/TDM2_WS	TDM2 Interface WordSelect
34	BT_PCM_OUT	O	BT	BT_PCM_OUT/TDM2_DO	TDM2 Interface Data Out
35	BT_PCM_CLK	I/O	BT	BT_PCM_CLK/TDM2_SCK	TDM2 Interface Slave Clock
36	I2S_DO	I/O	BT	I2S_DO/TDM1_DO	Bluetooth® TDM1 Interface Data Out
37	I2S_CLK	I/O	BT	I2S_CLK/TDM1_SCK	TDM1 Interface Slave Clock
38	I2S_WS	I/O	BT	I2S_WS/TDM1_WS	TDM1 Interface WordSelect
39	GND	-	-	-	-
40	LHL_GPIO_0	I	BT	BT_DEV_WAKE	Bluetooth DEV_WAKE
41	BT_HOST_WAKE	O	BT	BT_HOST_WAKE	Bluetooth HOST_WAKE
42	I2S_DI	I/O	BT	I2S_DI/TDM1_DI	TDM1 Interface Data In
43	TDM1_MCK	-	-	TDM1_MCK	TDM1 Interface Master Clock
44	GND	-	-	-	-
45	BT_UART_RXD	I	BT	BT_UART_RXD	UART serial input. Serial data input for the HCI UART interface.
46	BT_UART_TXD	O	BT	BT_UART_TXD	UART serial output. Serial data output for the HCI UART interface.
47	BT_UART_RTS_N	O	BT	BT_UART_RTS_N	UART request – to - send. Active - low request - to-send signal for the HCI UART interface.
48	BT_UART_CTS_N	I	BT	BT_UART_CTS_N	UART clear – to - send. Active - low clear – to - send signal for the HCI UART interface.
49	GND				
50	ANT	RF		RF_ANT	
51	GND				
52	GND				
53	GND				
54	NC			NC	
55	GND				
56	GND				
57	JTAG_SEL	I/O		JTAG_SEL	JTAG select input: Pull high to select the JTAG interface. If the JTAG interface is not used this pin should be connected to ground.
58	GND				
59	GND				
60	GND				

No.	Pin name	Type	System	Connection to IC Pin Name	Description
61	GND				
62	BT_GPIO_4	I/O	BT	BT_GPIO_4	Bluetooth general-purpose I/O.
63	BT_GPIO_3	I/O	BT	BT_GPIO_3	Bluetooth general-purpose I/O.
64	BT_GPIO_2	I/O	BT	BT_GPIO_2	Bluetooth general-purpose I/O.
65	BT_GPIO_5	I/O	BT	BT_GPIO_5	Bluetooth general-purpose I/O.
66-72	GND				

8 Absolute Maximum Ratings

The absolute and maximum ratings are shown in **Table 8.**

Table 8: Absolute Maximum Ratings

Parameter		Minimum	Maximum	Unit
Storage Temperature		-40	+85	^{0}C
Supply Voltage	VBAT	-0.5	6.0	V
	VDDIO	-0.5	2.2	V

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

9 Operating Condition

The operating conditions are shown in **Table 9**.

Table 9: Operating Conditions

Parameter		Minimum	Typical	Maximum	Unit
Operating Temperature		-40	+25	+85	°C
Specification Temperature		-30	+25	+85	°C
Operating Voltage	VBAT	3.0	3.3	4.8	V
	VDDIO	1.71	1.8	1.89	V
Peak current	VBAT=3.3V	-	-	720	mA

Functionality is guaranteed but the specifications require the derating at over-temperatures, over-voltage condition.

10 External LPO_IN Signal Requirement

External LPO requirements are shown in **Table 10**.

Table 10: External LPO_IN Signal Requirement

Parameter	External LPO_IN Clock	Unit
Nominal input frequency	32.768	kHz
Frequency accuracy	±250	ppm
Duty cycle	30 - 70	%
Input signal amplitude	200-1800	mV, p-p
Signal type	Square-wave or sinewave	
Input impedance	> 100k	Ω
	< 5	pF
Clock jitter (during initial start-up)	< 10,000	ppm

Input impedance condition is when power is applied or switch off.

11 I/O State

The following notations are used in I/O State Table.

- **I**: Input signal
- **O**: Output signal
- **I/O**: Input/Output signal
- **PU:** Pulled up
- **PD:** Pulled down
- **NoPull:** Neither pulled up nor pulled down

Where applicable, the default value is shown in brackets (for example, [default value]).

Table 11 describes the I/O state table.

Table 11: I/O State Table

Name	I/O	Keeper	Active Mode	Low-Power State/Sleep (All Power Present)	Power-down (BT_REG_ON and WL_REG_ON Held Low)	Out-of-Reset: Before SW Download (BT_REG_ON High; WL_REG_ON High)	(WL_REG_ON High and BT_REG_ON = 0) and VDDIOs are Present	Power Rail
WL_REG_ON BT_REG_ON	I	N	I: PD Pull down auto disabled	I: PD Pull down auto disabled	I: PD (of 50K)	I: PD (of 50K)	I: PD (of 50K)	-
GPIO_0	I/O	Y	I/O: PU, PD, NoPull Programmable [PD]	I/O: PU, PD, NoPull Programmable [PD]	High-Z, NoPull	High-Z, NoPull	High-Z, NoPull	VDDIO
GPIO_2	I/O	Y	I/O: PU, PD, NoPull Programmable [NoPull]	I/O: PU, PD, NoPull Programmable [NoPull]	High-Z, NoPull	I:PU	I:PU	VDDIO
GPIO_3	I/O	Y	I/O: PU, PD, NoPull Programmable [NoPull]	I/O: PU, PD, NoPull Programmable [NoPull]	High-Z, NoPull	I:PU	I:PU	VDDIO
GPIO_4	I/O	Y	I/O: PU, PD, NoPull Programmable [NoPull]	I/O: PU, PD, NoPull Programmable [NoPull]	High-Z, NoPull	I:PU	I:PU	VDDIO
GPIO_5	I/O	Y	I/O: PU, PD, NoPull Programmable [NoPull]	I/O: PU, PD, NoPull Programmable [NoPull]	High-Z, NoPull	I: NoPull[13]	I: NoPull[13]	VDDIO
GPIO_6	I/O	Y	I/O: PU, PD, NoPull Programmable [NoPull]	I/O: PU, PD, NoPull Programmable [NoPull]	High-Z, NoPull	I:PU	I:PU	VDDIO

When JTAG is not enabled on the GPIO

12 Power-On Sequence

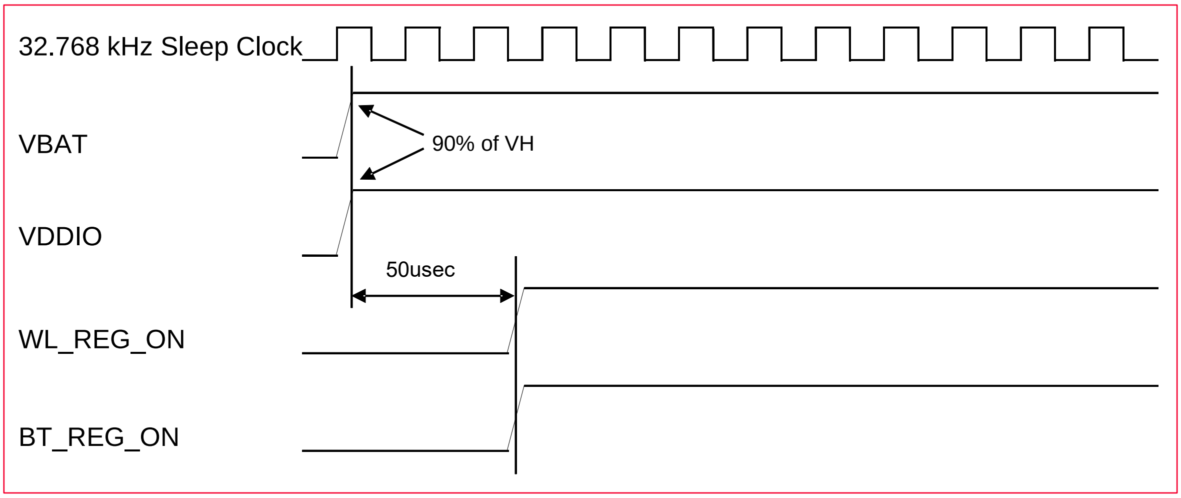
This section describes the power sequences along with their parameters.

- VBAT and VDDIO should not rise 10%-90% faster than 40 microseconds.
- VBAT should be up before or at the same time as VDDIO. VDDIO should NOT be present fast or be held high before VBAT is high.

12.1 Power-On Sequence for WLAN ON and BT ON

Figure 5 shows the power-on sequence diagram for WLAN ON and BT ON.

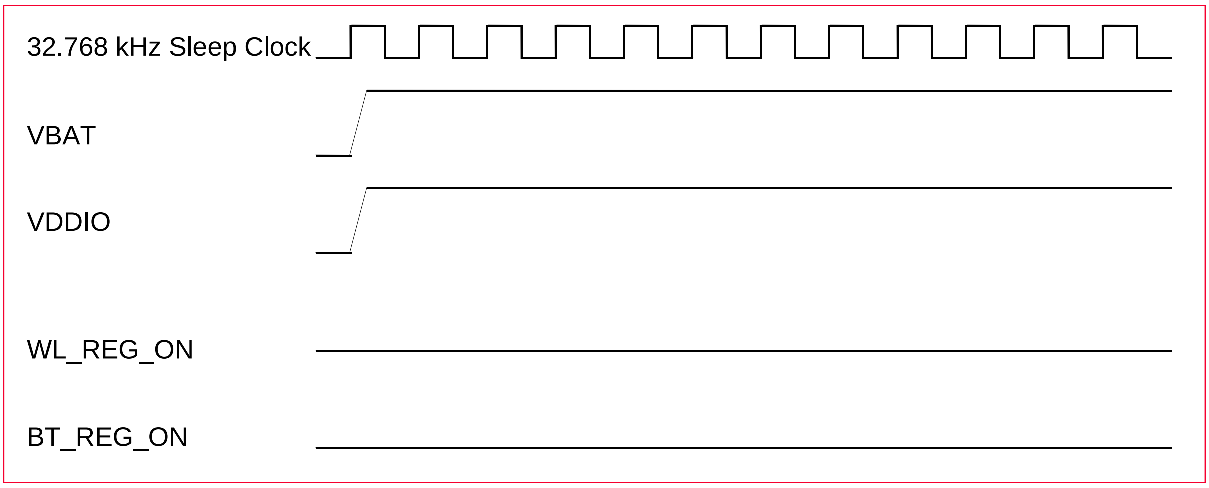
Figure 5: Power-On Sequence - WLAN ON and BT ON



12.2 Power-On Sequence for WLAN OFF and BT OFF

Figure 6 shows the power-on sequence diagram for WLAN OFF and BT OFF.

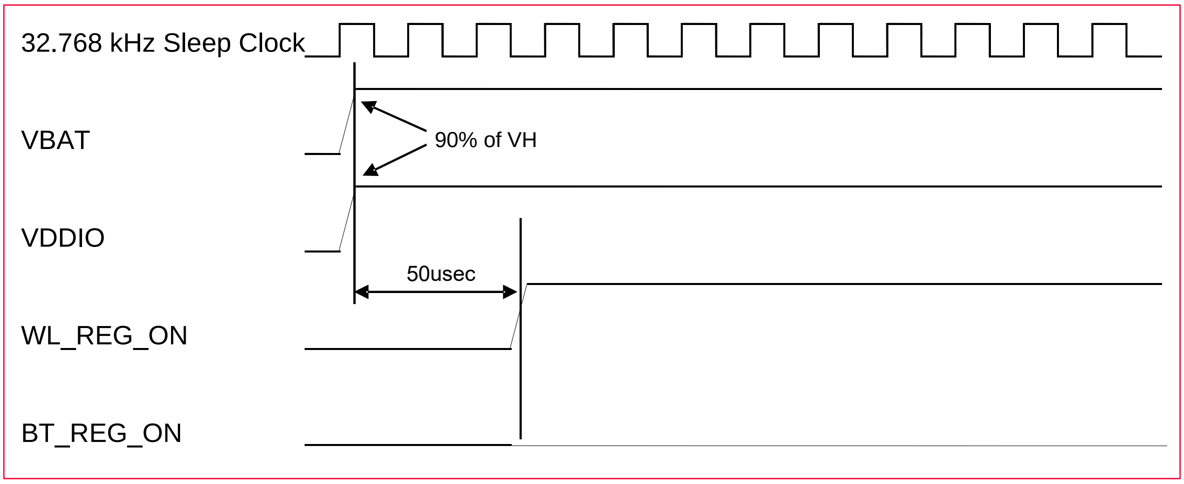
Figure 6: Power-On Sequence - WLAN OFF and BT OFF



12.3 Power-On Sequence for WLAN ON and BT OFF

Figure 7 shows the power-on sequence diagram for WLAN ON and BT OFF.

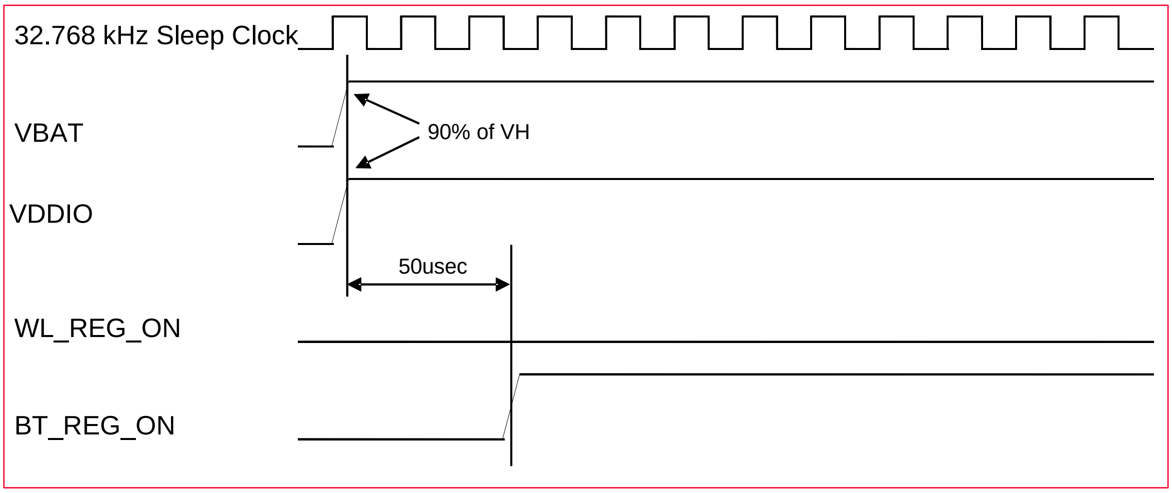
Figure 7: Power-On Sequence - WLAN ON and BT OFF



12.4 Power-On Sequence for WLAN OFF and BT ON

Figure 8 shows the power-on sequence diagram for WLAN OFF and BT ON.

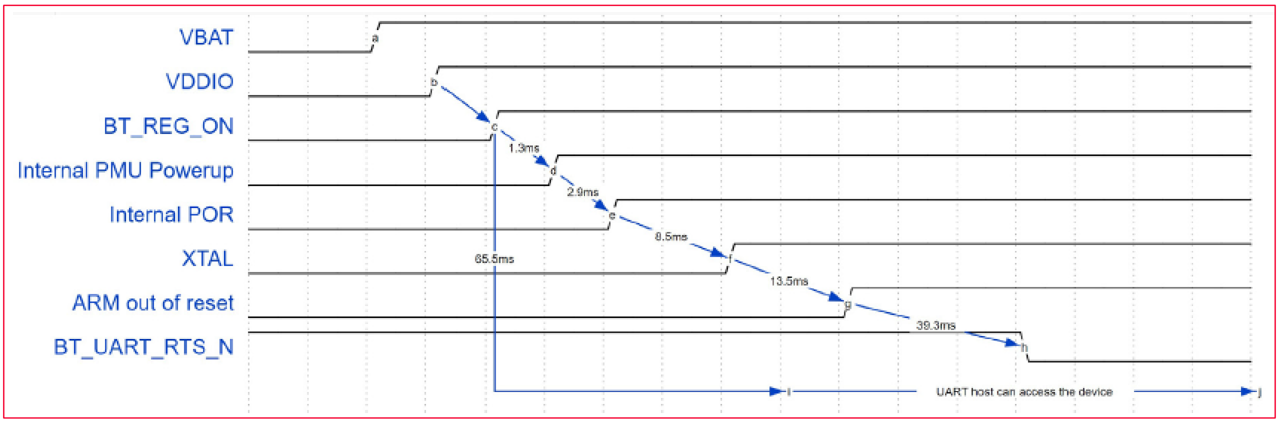
Figure 8: Power-On Sequence - WLAN OFF and BT ON



12.5 Bluetooth Subsystem Bootup Sequence

Figure 9 shows the power-on sequence diagram for Bluetooth subsystem.

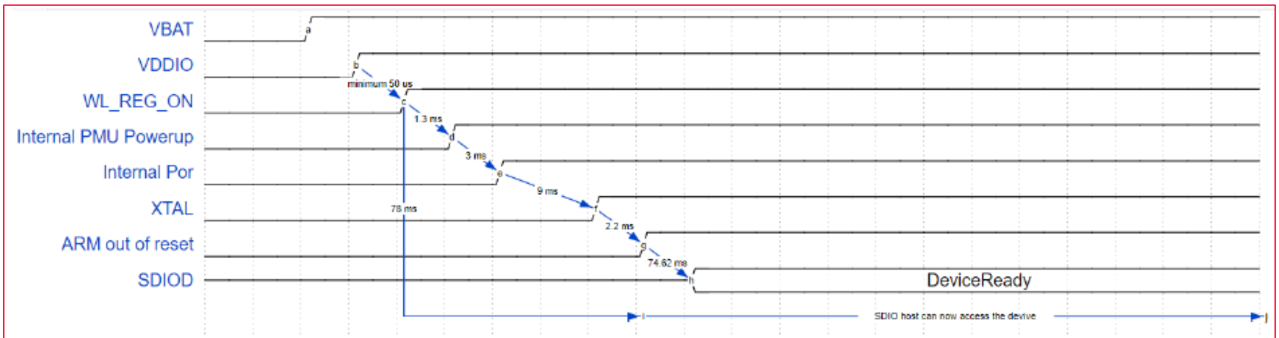
Figure 9: Bluetooth Subsystem Bootup Sequence



12.6 WLAN Boot-up Sequence for SDIO Host

Figure 10 shows the power-on sequence diagram for WLAN.

Figure 10: WLAN Boot-Up sequence for SDIO Host



SDIO host can access device after 78ms from assertion WL_REG_ON

13 Digital I/O Requirements

The requirements are described in **Table 12.**

Table 12: Digital I/O Requirements

Digital I/O Pins	System	Minimum	Typical	Maximum	Unit
For VDDIO, VDDIO_SD, BT_VDDO, BT_VDDIO_SMIF = 1.8 V:					
Input high voltage	VIH	0.65xVDDIO			V
Input low voltage	VIL			0.35xVDDIO	V
Output high voltage@2mA	VOH	VDDIO-0.40			V
Output low voltage@2mA	VOL			0.45	V

14 Interface Timing and AC Characteristics

This section describes the interface timing for SDIO, Bluetooth, and PCM, their speed modes, related parameters and graphs.

14.1 Bluetooth UART Timing

Figure 11 and **Table 13** show the Bluetooth UART timing diagram and related parameters.

Figure 11: Bluetooth UART Timing Diagram

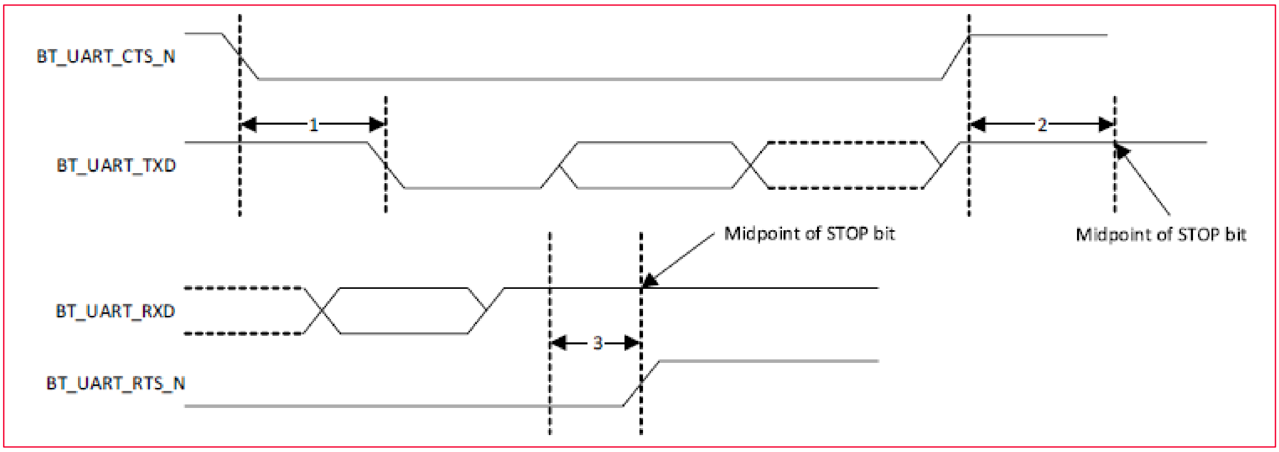


Table 13: Bluetooth UART Timing Parameters

Reference	Description	Minimum	Typical	Maximum	Unit
1	Delay time, BT_UART_CTS_N low to BT_UART_TXD valid			1.5	Bit periods
2	Setup time, BT_UART_CTS_N high before midpoint of stop bit			0.5	Bit periods
3	Delay time, midpoint of stop bit to BT_UART_RTS_N high			0.5	Bit periods

14.2 Bluetooth PCM Interface Timing

This section describes the Bluetooth PCM Interface Timing and its data formatting and widespread speed support that includes short frame sync and long frame sync at master and slave modes.

14.2.1 Data Formatting

The IC may be configured to generate and accept several different data formats. For a conventional Narrowband Speech mode, CYW5551x uses 13 of the 16 bits in each PCM frame. The location and order of these 13 bits can be configured to support various data formats on the PCM interface. The remaining three bits are ignored on the input and may be filled with 0s, 1s, a sign bit, or a programmed value on the output. The default format is 13-bit 2's complement data, left justified, and clocked most significant bit (MSb) first.

14.2.2 Wideband Speech Support

When the host encodes wideband speech (WBS) packets in transparent mode, the encoded packets are transferred over the PCM bus for an eSCO voice connection. In this mode, the PCM bus is typically configured in master mode for a 4 KHz sync rate with 16-bit samples, resulting in a 64-kbps bit rate. The IC also supports slave transparent mode using a proprietary rate-matching scheme. IN SBC-code mode, linear 16-bit data at 16 KHz (256 kbps rate) is transferred over the PCM bus.

14.2.3 Short Frame Sync - Master Mode

Figure 12 and **Table 14** show the short frame sync signal and its parameters in master mode.

Figure 12: Short Frame Sync Signal - Master Mode

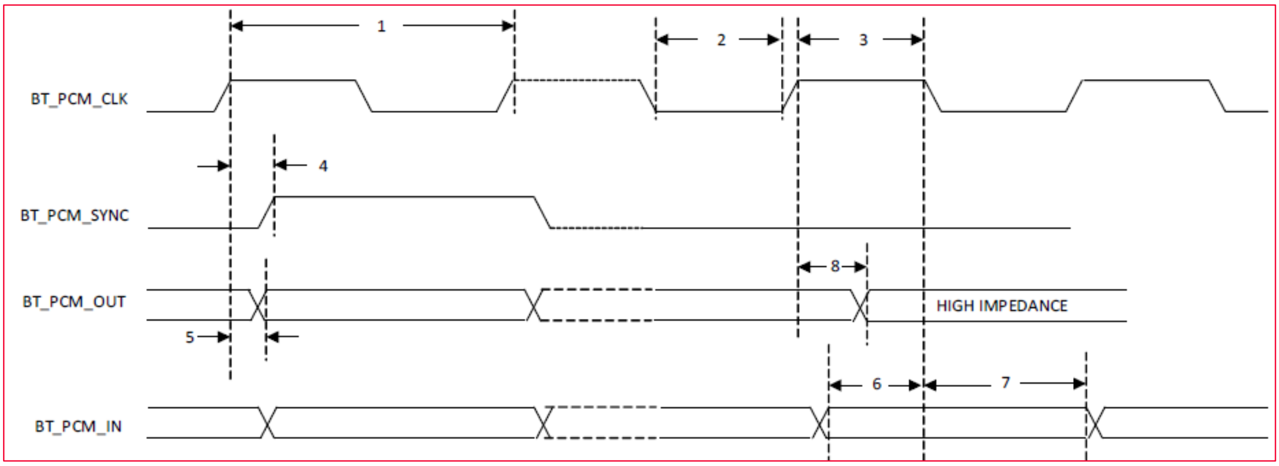


Table 14: Short Frame Sync Signal Parameters - Master Mode

Reference	Description	Minimum	Typical	Maximum	Unit
1	PCM bit clock frequency			12.0	MHz
2	PCM bit clock LOW	41.0			ns
3	PCM bit clock HIGH	41.0			ns
4	BT PCM SYNC delay	0		25.0	ns
5	BT_PCM_OUT delay	0		25.0	ns

Reference	Description	Minimum	Typical	Maximum	Unit
6	BT PCM IN setup	8.0			ns
7	BT PCM IN hold	8.0			ns
8	Delay from rising edge of BT_PCM_CLK during last bit period to BT_PCM_OUT becoming high impedance.	0		25.0	ns

14.2.4 Short Frame Sync - Slave Mode

Figure 13 and **Table 15**: Short Frame Sync Signal Parameters - Slave Mode show the short frame sync signal and its parameters in slave mode.

Figure 13: Short Frame Sync Signal - Slave Mode

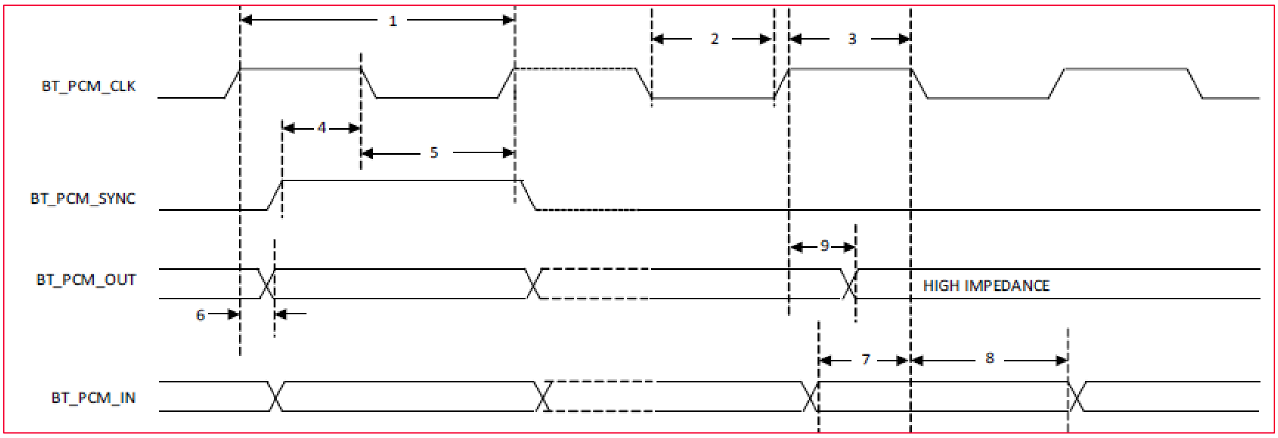


Table 15: Short Frame Sync Signal Parameters - Slave Mode

Reference	Description	Minimum	Typical	Maximum	Unit
1	PCM bit clock frequency			12.0	MHz
2	PCM bit clock Low	41.0			ns
3	PCM bit clock High	41.0			ns
4	BT_PCM_SYNC setup	8.0			ns
5	BT_PCM_SYNC hold	8.0			ns
6	BT_PCM_OUT delay	0		25.0	ns
7	BT_PCM_IN setup	8.0			ns
8	BT_PCM_IN hold	8.0			ns
9	Delay from rising edge of BT_PCM_CLK during last bit period to BT_PCM_OUT becoming high impedance.	0		25.0	ns

14.3 WLAN SDIO Timing

This section describes the SDIO timings for different modes.

14.3.1 SDIO Timing - Default Mode

Figure 14 and **Table 16** show the SDIO default timing diagram and its data.

Figure 14: SDIO Timing Diagram - Default Mode

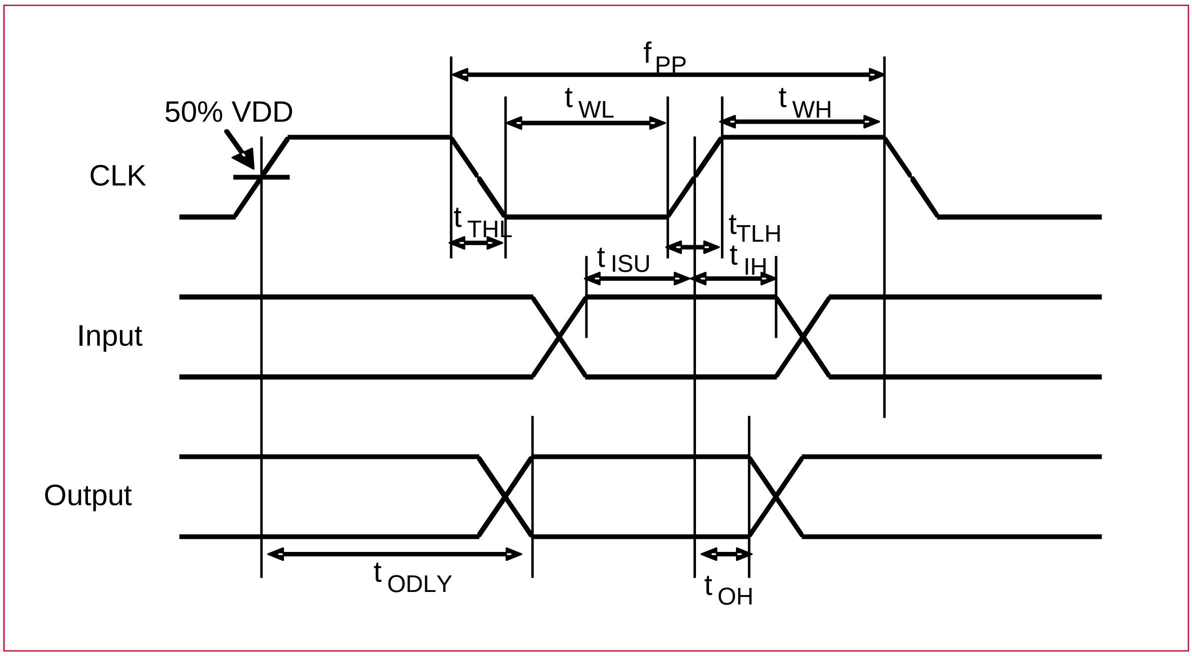


Table 16: SDIO Timing Data - Default Mode

Parameter	Symbol	Minimum	Typical	Maximum	Unit
SDIO CLK (All values are referred to minimum VIH and maximum VIL)					
Frequency-Data Transfer Mode	f_{PP}	0		25	MHz
Frequency-Identification Mode	f_{OD}	0		400	kHz
Clock Low Time	t_{WL}	10			ns
Clock High Time	t_{WH}	10			ns
Clock Rise Time	t_{TLH}			10	ns
Clock Fall Time	t_{THL}			10	ns
Inputs: CMD, DAT (referenced to CLK)					
Input Setup Time	t_{ISU}	5			ns
Input Hold Time	t_{IH}	5			ns
Outputs: CMD, DAT (referenced to CLK)					
Output Delay Time-Data Transfer Mode	t_{ODLY}	0		14	ns
Output Delay Time-Identification Mode	t_{ODLY}	0		50	ns

- Timing is based on CL < 40 pF load on CMD and Data.
- Minimum (Vih) = 0.7*VDDIO and maximum (Vil) = 0.2*VDDIO.

14.3.2 SDIO Timing - High-Speed Mode

Figure 15 and **Table 17** show the SDIO high speed timing diagram and its data.

Figure 15: **SDIO Timing Diagram - High-Speed Mode**

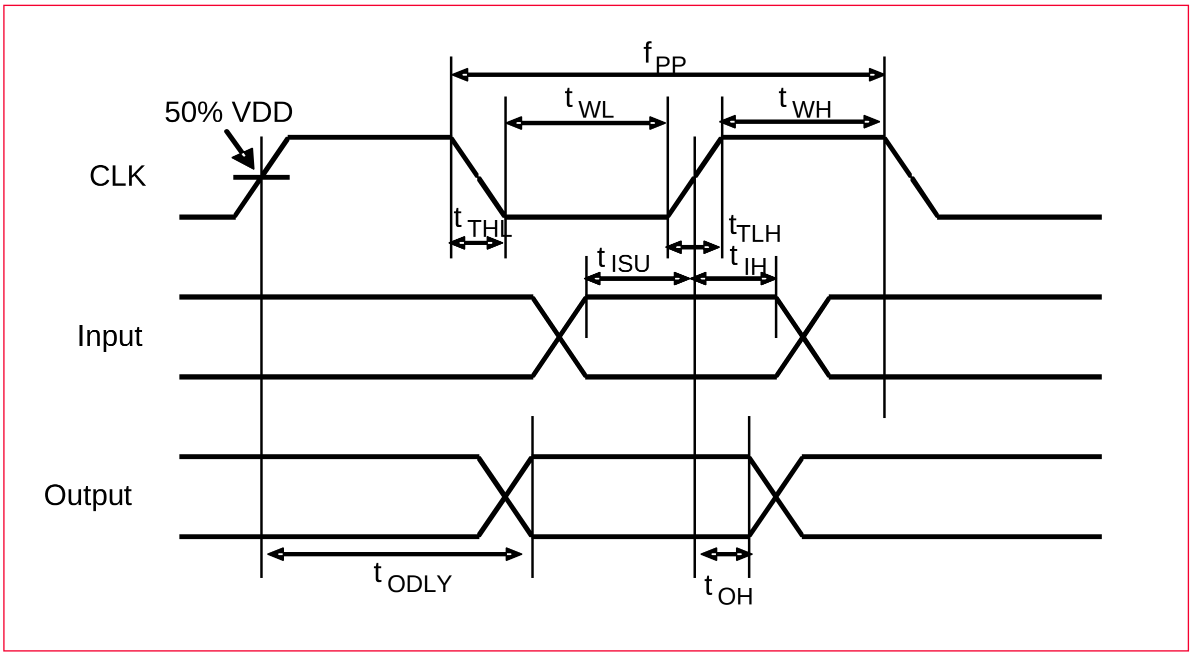


Table 17: SDIO Timing Data - High-Speed Mode

Parameter	Symbol	Minimum	Typical	Maximum	Unit
Clock CLK (All values are referred to minimum VIH and maximum VIL)					
Frequency-Data Transfer Mode	f_{PP}	0		50	MHz
Frequency-Identification Mode	f_{OD}	0		400	kHz
Clock Low Time	t_{WL}	7			ns
Clock High Time	t_{WH}	7			ns
Clock Rise Time	t_{TLH}			3	ns
Clock Fall Time	t_{THL}			3	ns
Inputs: CMD, DAT (referenced to CLK)					
Input Setup Time	t_{ISU}	6			ns
Input Hold Time	t_{IH}	2			ns
Outputs: CMD, DAT (referenced to CLK)					
Output Delay Time-Data Transfer Mode	t_{ODLY}			14	ns
Output Hold time	t_{OH}	2.5			ns
Total System Capacitance (each line)	CL			40	pF

- Timing is based on CL < 40 pF load on CMD and Data.
- Minimum (Vih) = 0.7*VDDIO and maximum (Vil) = 0.2*VDDIO.

14.3.3 SDIO BUS Timing Specifications in SDR Modes

This section describes the SDIO BUS timing specifications in SDR Mode.

14.3.3.1 Clock Timing

Figure 16 and **Table 18** show the clock timing diagram and its parameters in SDR mode.

Figure 16: Clock Timing Diagram – SDR Mode

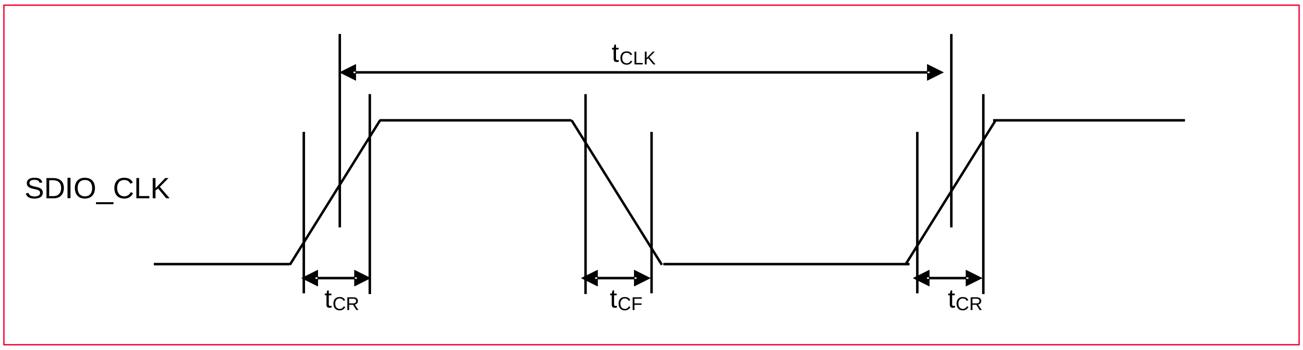


Table 18: Clock Timing Parameters - SDR Mode

Parameter	Symbol	Minimum	Maximum	Unit	Comments
	t_{CLK}	40		ns	SDR12 mode
		20		ns	SDR25 mode
		12.5		ns	SDR50 mode
	t_{CR}, t_{CF}		0.2 * t_{CLK}	ns	t_{CR}, t_{CF} < 2.00 ns (maximum) @ 100 MHz, C_{CARD} = 10 pF t_{CR}, t_{CF} < 0.96 ns (maximum) @ 208 MHz, C_{CARD} = 10 pF
Clock duty Cycle		30	70	%	

14.3.3.2 Device Input Timing

Figure 17 and **Table 19** show the device input timing diagram and its parameters in SDR mode.

Figure 17: Device Input Timing Diagram - SDR Mode

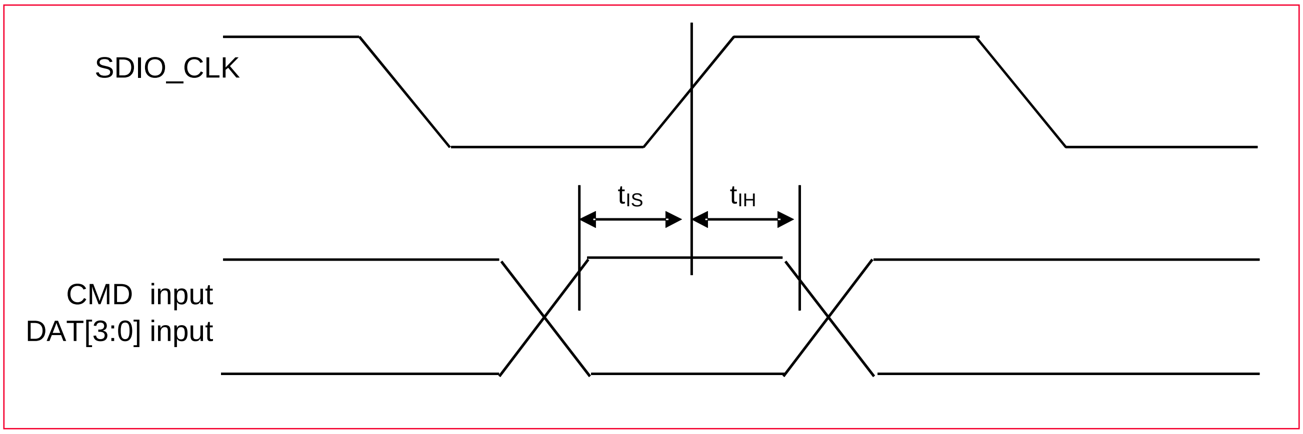


Table 19: SDIO Bus Input Timing Parameters - SDR Mode

Symbol	Minimum	Maximum	Unit	Comments
SDR50 Mode				
t_{IS}	3.0		ns	C_{CARD} = 10 pF, VCT = 0.975V
t_{IH}	0.8		ns	C_{CARD} = 5 pF, VCT = 0.975V

14.3.3.3 Device Output Timing

Figure 18 and **Table 20** show the device output timing diagram and its parameters in SDR modes up to 80 MHz.

Figure 18: Device Output Timing Diagram - SDR Modes up to 80 MHz

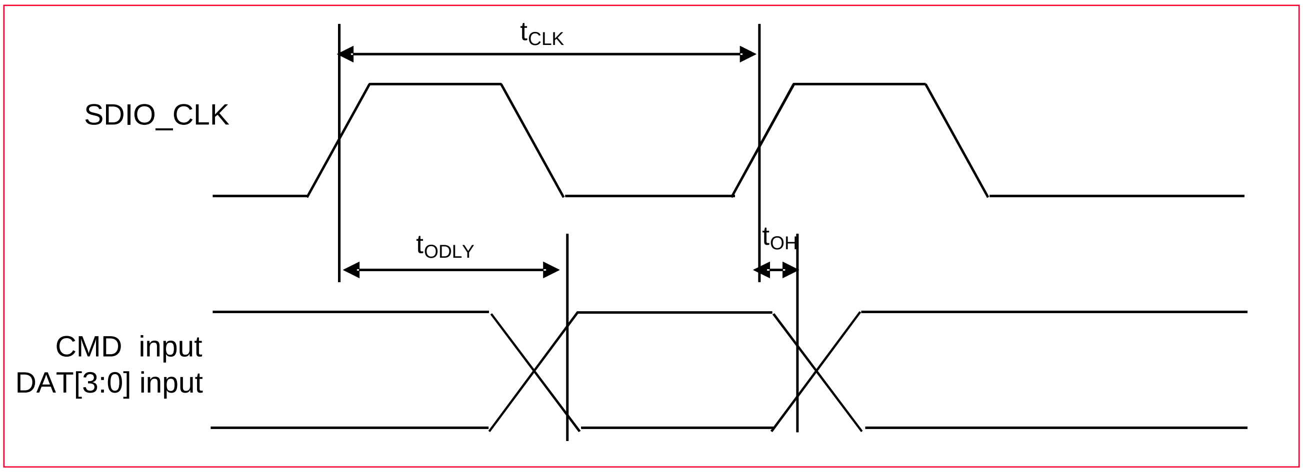


Table 20: SDIO Bus Output Timing Parameters - SDR Modes up to 80 MHz

Symbol	Minimum	Maximum	Unit	Comments
t_{ODLY}		7.5	ns	$t_{CLK} \geq 10$ ns $C_L = 30$ pF using driver type B for SDR50
t_{ODLY}		14.0	ns	$t_{CLK} \geq 20$ ns $C_L = 40$ pF using for SDR12, SDR25
t_{OH}	1.5		ns	Hold time at the t_{ODLY}(min) $C_L = 15$ pF

14.3.4 SDIO Timing Specifications in DDR50 Mode

This section describes the SDIO clock and SDIO data.

14.3.4.1 SDIO Clock Timing

Figure 19 and **Table 21** show the SDIO clock timing diagram and parameters in DDR50 mode.

Figure 19**: SDIO Clock Timing Diagram - DDR50 Mode**

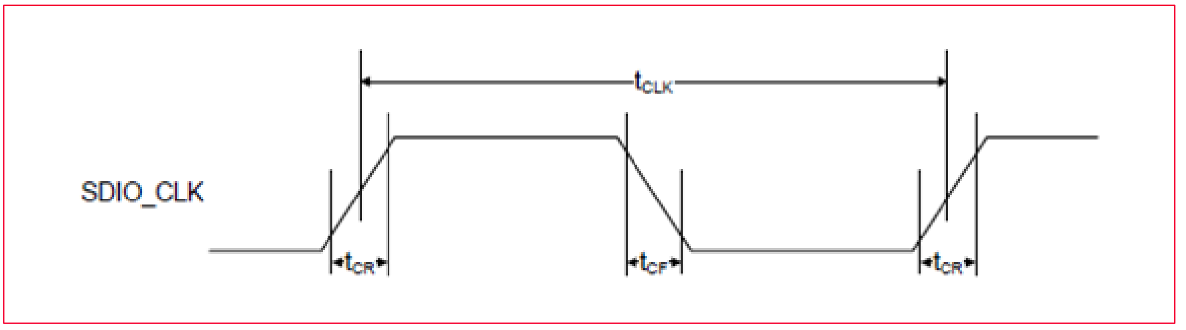


Table 21: SDIO Clock Timing Parameters - DDR50 Mode

Parameter	Symbol	Minimum	Maximum	Unit	Comments
	t_{CLK}	25		ns	DDR50 mode
	t_{CR}, t_{CF}		0.2 * t_{CLK}	ns	t_{CR}, t_{CF}<4.00 ns (maximum) at 50MHz, C_{CARD} = 10pF
Clock duty cycle		45	55	%	

14.3.4.2 SDIO Data Timing

Figure 20 and **Table 22** show the SDIO data timing diagram and its parameters in DDR50 mode.

Figure 20**: SDIO Data Timing Diagram - DDR50 Mode**

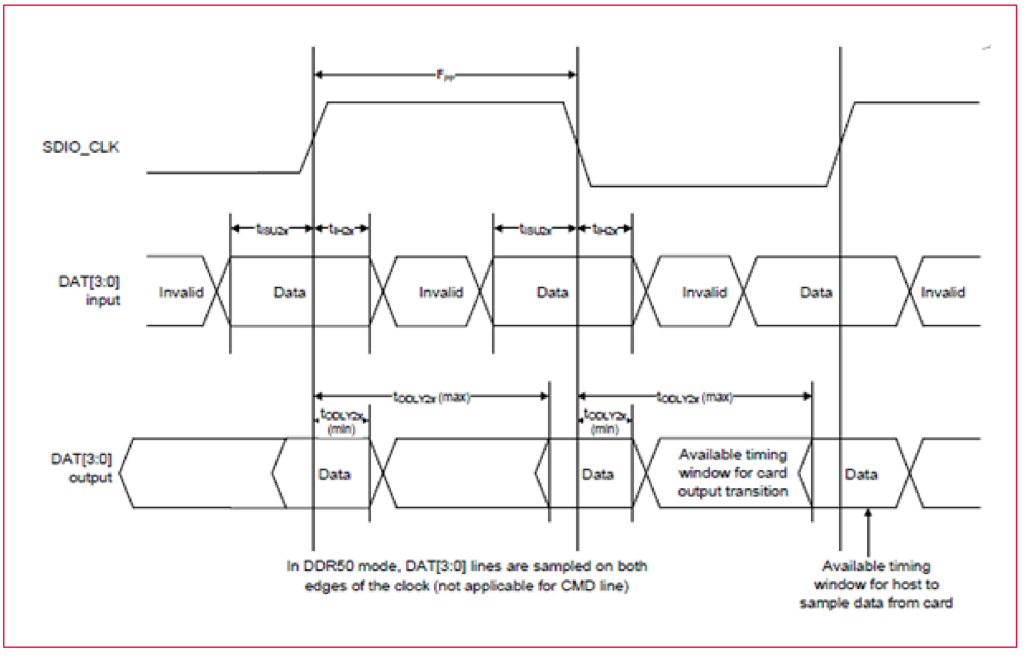


Table 22: SDIO Data Timing Parameters - DDR50 Mode

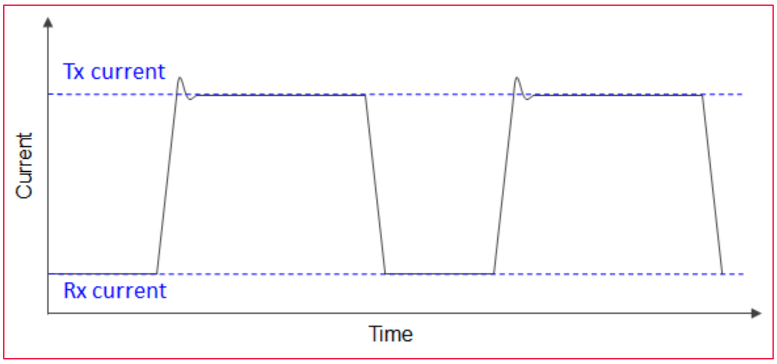
Parameter	Symbol	Minimum	Maximum	Unit	Comments
Input CMD					
Input setup time	t_{ISU}	6		ns	Ccard < 10 pF (1 card)
Input hold time	t_{IH}	0.8		ns	Ccard < 10 pF (1 card)
Output CMD					
Output delay time	t_{ODLY}		13.7	ns	Ccard < 30 pF (1 card)
Output hold time	t_{OH}	1.5		ns	Ccard < 15 pF (1 card)
Input DAT					
Input setup time	t_{ISU2x}	3		ns	Ccard < 10 pF (1 card)
Input hold time	t_{IH2x}	0.8		ns	Ccard < 10 pF (1 card)
Output DAT					
Output delay time	t_{ODLY2x}		7.5	ns	Ccard < 25 pF (1 card)
Output hold time	t_{OH2x}	1.5		ns	Ccard < 15 pF (1 card)

15 DC/RF Characteristics

This section describes the electrical characteristics of the Type 2FY module.

Burst current definition is shown in Figure 21

Figure 21: Burst Current Definition



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

Table 23: Characteristics Values for IEEE 802.11b - 2.4 GHz

Items	Contents
Specification	IEEE 802.11b
Mode	DSSS / CCK
Channel Frequency	2412 - 2472 MHz
Data Rate	1, 2, 5.5, 11 Mbps

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

Conditions: 25 °C, VBAT = 3.3V, VDDIO = 1.8V, 11 Mbps mode

Table 24: High-Rate Condition for IEEE 802.11b - 2.4 GHz

Items	Contents			
Current Consumption	**Minimum**	**Typical**	**Maximum**	**Unit**
• Tx mode (Power setting: 19 dBm)		280	390	mA
• Rx mode		40		mA
Tx Characteristics	**Minimum**	**Typical**	**Maximum**	**Unit**
Output Power	16.5	19	21.5	dBm
Spectrum Mask Margin				
• 1st side lobes (-30 dBr)	0			dB
• 2nd side lobes (-50 dBr)	0			dB
Power-on and Power-down ramp			2.0	µs
RF Carrier Suppression	15			dB
Modulation Accuracy (EVM)			35	%
Frequency Tolerance	-20		20	ppm
Out band 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 Sensitivity		-89	-76	dBm
Maximum Input Level (FER ≤ 8%)	-10			dBm
Adjacent Channel Rejection (FER ≤ 8%)	35			dB

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

Conditions: 25 °C, VBAT = 3.3V, VDDIO = 1.8V, 1 Mbps mode

Table 25: Low-Rate Condition for IEEE 802.11b - 2.4 GHz

Items	Contents			
Current Consumption	**Minimum**	**Typical**	**Maximum**	**Unit**
• Tx mode (Power setting: 20 dBm)		290	400	mA
• Rx mode		40		mA
Tx Characteristics	**Minimum**	**Typical**	**Maximum**	**Unit**
Output Power	17.5	20	22.5	dBm
Spectrum Mask Margin				
• 1st side lobes (-30 dBr)	0			dB
• 2nd side lobes (-50 dBr)	0			dB
Power-on and Power-down Ramp			2.0	µs
RF Carrier Suppression	15			dB
Modulation Accuracy (EVM)			35	%
Frequency Tolerance	-20		20	ppm
Out band 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 Sensitivity			-76	dBm
Maximum Input Level (FER ≤ 8%)	-10			dBm
Adjacent Channel Rejection (FER ≤ 8%)	35			dB

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

Table 26: Characteristics Values for IEEE 802.11g - 2.4 GHz

Items	Contents
Specification	IEEE 802.11g
Mode	OFDM
Channel Frequency	2412 - 2472 MHz
Data Rate	6, 9, 12, 18, 24, 36, 48, 54 Mbps

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

Conditions: 25 °C, VBAT = 3.3V, VDDIO = 1.8V, 54 Mbps mode

Table 27: High-Rate Condition for IEEE 802.11g - 2.4 GHz

Items	Contents			
Current Consumption	**Minimum**	**Typical**	**Maximum**	**Unit**
• Tx mode (Power setting: 17 dBm)		230	300	mA
• Rx mode		40		mA
Tx Characteristics	**Minimum**	**Typical**	**Maximum**	**Unit**
Output Power	14.5	17	19.5	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
Out Band 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 Sensitivity		-76	-65	dBm
Maximum Input Level (PER ≤ 10%)	-20			dBm
Adjacent Channel Rejection (PER ≤ 10%)	-1			dB

15.2.2 Low-Rate Condition for IEEE 802.11g – 2.4 GHz

Conditions: 25 °C, VBAT = 3.3V, VDDIO = 1.8V, 6 Mbps mode

Table 28: Low-Rate Condition for IEEE 802.11g - 2.4 GHz

Items	Contents			
Current Consumption	**Minimum**	**Typical**	**Maximum**	**Unit**
- Tx mode (Power setting: 17 dBm)		260	340	mA
- Rx mode		40		mA
Tx Characteristics	**Minimum**	**Typical**	**Maximum**	**Unit**
Output Power	14.5	17	19.5	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)			-5	dB
Frequency Tolerance	-20		20	ppm
Out Band 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 Sensitivity			-82	dBm
Maximum Input Level (PER ≤ 10%)	-20			dBm
Adjacent Channel Rejection (PER ≤ 10%)	16			dB

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

Table 29: Characteristics Values for IEEE 802.11n - 2.4 GHz

Items	Contents
Specification	IEEE 802.11n
Mode	OFDM
Channel Frequency	2412 - 2472 MHz
Data Rate	MCS0 - MCS7

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

Conditions: 25 °C, VBAT = 3.3V, VDDIO = 1.8V, MCS7

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

Items	Contents			
Current Consumption	**Minimum**	**Typical**	**Maximum**	**Unit**
• Tx mode (Power setting: 16 dBm)		220	290	mA
• Rx mode		40		mA
Tx Characteristics	**Minimum**	**Typical**	**Maximum**	**Unit**
Output Power	13.5	16	18.5	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)			-27	dB
Frequency Tolerance	-20		20	ppm
Out band 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 Sensitivity		-76	-64	dBm
Maximum Input Level (PER ≤ 10%)	-20			dBm
Adjacent Channel Rejection (PER ≤ 10%)	-2			dB

15.3.2 Low-Rate Condition for IEEE 802.11n – 2.4 GHz

Conditions: 25 °C, VBAT = 3.3V, VDDIO = 1.8V, MCS0

Table 31: Low-Rate Condition for IEEE 802.11n - 2.4 GHz

Items	Contents			
Current Consumption	**Minimum**	**Typical**	**Maximum**	**Unit**
• Tx mode (Power setting: 17 dBm)		250	340	mA
• Rx mode		40		mA
Tx Characteristics	**Minimum**	**Typical**	**Maximum**	**Unit**
Output Power	14.5	17	19.5	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)			-5	dB
Frequency Tolerance	-20		20	ppm
Out band 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 Sensitivity			-82	dBm
Maximum Input Level (PER ≤ 10%)	-20			dBm
Adjacent Channel Rejection (PER ≤ 10%)	16			dB

15.4 DC/RF Characteristics for IEEE 802.11ax - 2.4 GHz

Table 32: Characteristics Values for IEEE 802.11ax - 2.4 GHz

Items	Contents
Specification	IEEE 802.11ax
Mode	OFDM (OFDMA)
Channel Frequency	2412 - 2472 MHz
Data Rate	MCS0 - MCS11

15.4.1 High-Rate Condition for IEEE 802.11ax - 2.4 GHz

Conditions: 25 °C, VBAT = 3.3V, VDDIO = 1.8V, MCS11

Table 33: High-Rate Condition for IEEE 802.11ax - 2.4 GHz

Items	Contents			
Current Consumption	**Minimum**	**Typical**	**Maximum**	**Unit**
• Tx mode (Power setting: 14 dBm)		220	300	mA
• Rx mode		40		mA
Tx Characteristics	**Minimum**	**Typical**	**Maximum**	**Unit**
Output Power	11.5	14	16.5	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)			-35	dB
Frequency Tolerance	-20		20	ppm
Out band 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 Sensitivity		-63	-52	dBm
Maximum Input Level (PER ≤ 10%)	-20			dBm
Adjacent Channel Rejection (PER ≤ 10%)	-2			dB

15.4.2 Low-Rate Condition for IEEE 802.11ax – 2.4 GHz

Conditions: 25 °C, VBAT = 3.3V, VDDIO = 1.8V, MCS0

Table 34: Low-Rate Condition for IEEE 802.11ax - 2.4 GHz

Items	Contents			
Current Consumption	**Minimum**	**Typical**	**Maximum**	**Unit**
• Tx mode (Power setting: 17 dBm)		250	340	mA
• Rx mode		40		mA
Tx Characteristics	**Minimum**	**Typical**	**Maximum**	**Unit**
Output Power	14.5	17	19.5	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)			-5	dB
Frequency Tolerance	-20		20	ppm
Out band 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 Sensitivity			-82	dBm
Maximum Input Level (PER ≤ 10%)	-20			dBm
Adjacent Channel Rejection (PER ≤ 10%)	16			dB

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

Table 35: Characteristics Values for IEEE 802.11a - 5 GHz

Items	Contents
Specification	IEEE 802.11a
Mode	OFDM
Channel Frequency	5180 to 5320 MHz, 5500 to 5720 MHz, 5745 to 5825 MHz
Data Rate	6, 9, 12, 18, 24, 36, 48, 54 Mbps

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

Conditions: 25 °C, VBAT = 3.3V, VDDIO = 1.8V, 54 Mbps

Table 36: High-Rate Condition for IEEE 802.11a - 5 GHz

Items	Contents			
Current Consumption	**Minimum**	**Typical**	**Maximum**	**Unit**
• Tx mode (Power setting: 16 dBm)		360	480	mA
• Rx mode		50		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 (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 Sensitivity		-74	-65	dBm
Maximum Input Level (PER < 10%)	-30			dBm
Adjacent Channel Rejection (PER ≤ 10%)	-1			dB

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

Conditions: 25 °C, VBAT = 3.3V, VDDIO = 1.8V, 6 Mbps

Table 37: Low-Rate Condition for IEEE 802.11a - 5 GHz

Items	Contents			
Current Consumption	**Minimum**	**Typical**	**Maximum**	**Unit**
• Tx mode (Power setting: 16 dBm)		360	480	mA
• Rx mode		50		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)			-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**
Minimum Input Level Sensitivity			-82	dBm
Maximum Input Level (PER < 10%)	-30			dBm
Adjacent Channel Rejection (PER ≤ 10%)	16			dB

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

Table 38: Characteristics Values for IEEE 802.11n (HT20) - 5 GHz

Items	Contents
Specification	IEEE 802.11n
Mode	OFDM
Channel Frequency	5180 to 5320 MHz, 5500 to 5720 MHz, 5745 to 5825 MHz
Data Rate	MCS0 - MCS7

15.6.1 High-Rate Condition for IEEE 802.11n (HT20) - 5 GHz

Conditions: 25 °C, VBAT = 3.3V, VDDIO = 1.8V, Output power setting = 14 dBm, MCS7

Table 39: High-Rate Condition for IEEE 802.11n (HT20) - 5 GHz

Items	Contents			
Current Consumption	**Minimum**	**Typical**	**Maximum**	**Unit**
• Tx mode (Power setting: 14 dBm)		320	420	mA
• Rx mode		50		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 ~ -40 dBr)	0			dB
• 30 MHz to 33 MHz (-40 dBr)	0			dB
Constellation Error (EVM)			-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**

Minimum Input Level Sensitivity		-74	-64	dBm
Maximum Input Level (PER < 10%)	-30			dBm
Adjacent Channel Rejection (PER ≤ 10%)	-2			dB

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

Conditions: 25 °C, VBAT = 3.3V, VDDIO = 1.8V, Output power setting = 16 dBm, MCS0

Table 40: Low-Rate Condition for IEEE 802.11n (HT20) - 5 GHz

Items	Contents			
Current Consumption	**Minimum**	**Typical**	**Maximum**	**Unit**
• Tx mode (Power setting: 16 dBm)		360	480	mA
• Rx mode		50		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)			-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**
Minimum Input Level Sensitivity			-82	dBm
Maximum Input Level (PER < 10%)	-30			dBm
Adjacent Channel Rejection (PER ≤ 10%)	16			dB

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

Table 41: Characteristics Values for IEEE 802.11ac (VHT20) - 5 GHz

Items	Contents
Specification	IEEE 802.11ac
Mode	OFDM
Channel Frequency	5180 to 5320 MHz, 5500 to 5720 MHz, 5745 to 5825 MHz
Data Rate	MCS0 - MCS8

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

Conditions: 25 °C, VBAT = 3.3V, VDDIO = 1.8V, Output power setting = 13 dBm, MCS8

Table 42: High-Rate Condition for IEEE 802.11ac (VHT20) - 5 GHz

Items	Contents			
Current Consumption	**Minimum**	**Typical**	**Maximum**	**Unit**
• Tx mode (Power setting: 13 dBm)		300	410	mA
• Rx mode		50		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 ~ -40 dBr)	0			dB
• 30 MHz to 33 MHz (-40 dBr)	0			dB
Constellation Error (EVM)			-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
• 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 Sensitivity		-70	-59	dBm

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

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

Conditions: 25 °C, VBAT = 3.3V, VDDIO = 1.8V, MCS0

Table 43: Low-Rate Condition for IEEE 802.11ac (VHT20) - 5 GHz

Items	Contents			
Current Consumption	**Minimum**	**Typical**	**Maximum**	**Unit**
• Tx mode (Power setting: 16 dBm)		360	480	mA
• Rx mode		50		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)			-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**
Minimum Input Level Sensitivity			-82	dBm
Maximum Input Level (PER < 10%)	-30			dBm
Adjacent Channel Rejection (PER ≤ 10%)	16			dB

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

Table 44: Characteristics Values for IEEE 802.11ax (HE20) - 5 GHz

Items	Contents
Specification	IEEE 802.11ax
Mode	OFDM (OFDMA)
Channel Frequency	5180 to 5320 MHz, 5500 to 5720 MHz, 5745 to 5825 MHz
Data Rate	MCS0 - MCS11

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

Conditions: 25 °C, VBAT = 3.3V, VDDIO = 1.8V, MCS11

Table 45: High-Rate Condition for IEEE 802.11ax (HE20) - 5 GHz

Items	Contents			
Current Consumption	**Minimum**	**Typical**	**Maximum**	**Unit**
• Tx mode (Power setting: 10 dBm)		270	360	mA
• Rx mode		50		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 ~ -40 dBr)	0			dB
• 30 MHz to 33 MHz (-40 dBr)	0			dB
Constellation Error (EVM)			-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**
Minimum Input Level Sensitivity		-59	-52	dBm

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

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

Conditions: 25 °C, VBAT = 3.3V, VDDIO = 1.8V, MCS0

Table 46: Low-Rate Condition for IEEE 802.11ax (HE20) - 5 GHz

Items	Contents			
Current Consumption	**Minimum**	**Typical**	**Maximum**	**Unit**
• Tx mode (Power setting: 16 dBm)		360	480	mA
• Rx mode		50		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)			-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**
Minimum Input Level Sensitivity			-82	dBm
Maximum Input Level (PER < 10%)	-30			dBm
Adjacent Channel Rejection (PER ≤ 10%)	16			dB

15.9 DC/RF Characteristics for IEEE 802.11a - 6 GHz

Table 47: DC/RF Characteristics for IEEE 802.11a - 6 GHz

Items	Contents
Specification	IEEE 802.11a - 6 GHz
Mode	OFDM
Channel Frequency (Spacing)	5955 to 7095 MHz (20 MHz)
Data Rate	6, 9, 12, 18, 24 Mbps

15.9.1 High-Rate Condition for IEEE 802.11a - 6 GHz

Conditions: 25 °C, VBAT = 3.3V, VDDIO = 1.8V, 24 Mbps

Table 48: High-Rate Condition for IEEE 802.11a - 6 GHz

Items	Contents			
Current Consumption	**Minimum**	**Typical**	**Maximum**	**Unit**
• Tx Mode (Power setting: 16 dBm)		380	490	mA
• Rx Mode		50		mA
Tx Characteristics	**Minimum**	**Typical**	**Maximum**	**Unit**
Output Power	13.5	16	18.5	dBm
Spectrum Mask Margin				
• 9 MHz to 11 MHz (0 ~ -20 dBr)	0			dBr
• 11 MHz to 20 MHz (-20 ~ -28 dBr)	0			dBr
• 20 MHz to 30 MHz (-28 ~ -40 dBr)	0			dBr
• 30 MHz to 33 MHz (-40 dBr)	0			dBr
Constellation Error (EVM)			-16	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 Sensitivity		-82	-74	dBm
Maximum Input Level (PER ≤ 10%)	-30			dBm
Adjacent Channel Rejection (PER ≤ 10%)	8			dB

15.9.2 Low-Rate Condition for IEEE 802.11a - 6 GHz

Conditions: 25 °C, VBAT = 3.3V, VDDIO = 1.8V, 6 Mbps

Table 49: Low-Rate Condition for IEEE 802.11a - 6 GHz

Items	Contents			
Current Consumption	**Minimum**	**Typical**	**Maximum**	**Unit**
• Tx Mode (Power setting: 16 dBm)		380	490	mA
• Rx Mode		50		mA
Tx Characteristics	**Minimum**	**Typical**	**Maximum**	**Unit**
Output Power	13.5	16	18.5	dBm
Spectrum Mask Margin				
• 9 MHz to 11 MHz (0 ~ -20 dBr)	0			dBr
• 11 MHz to 20 MHz (-20 ~ -28 dBr)	0			dBr
• 20 MHz to 30 MHz (-28 ~ -40 dBr)	0			dBr
• 30 MHz to 33 MHz (-40 dBr)	0			dBr
Constellation Error (EVM)			-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**
Minimum Input Level Sensitivity			-82	dBm
Maximum Input Level (PER ≤ 10%)	-30			dBm
Adjacent Channel Rejection (PER ≤ 10%)	16			dB

15.10 DC/RF Characteristics for IEEE 802.11ax (HE20) - 6 GHz

Table 50: DC/RF Characteristics for IEEE 802.11ax (HE20) - 6 GHz

Items	Contents
Specification	IEEE 802.11ax - 6 GHz
Mode	OFDM
Channel Frequency (Spacing)	5955 to 7095 MHz (20 MHz)
Data Rate	MCS0 – MCS11

15.10.1 High-Rate Condition for IEEE 802.11ax (HE20) - 6 GHz

Conditions: 25 °C, VBAT = 3.3V, VDDIO = 1.8V, Output power setting = 10 dBm, MCS11

Table 51: High-Rate Condition for IEEE 802.11ax (HE20) - 6 GHz

Items	Contents			
Current Consumption	**Minimum**	**Typical**	**Maximum**	**Unit**
• Tx Mode (Power setting: 10 dBm)		270	360	mA
• Rx Mode		50		mA
Tx Characteristics	**Minimum**	**Typical**	**Maximum**	**Unit**
Output Power	7.5	10	12.5	dBm
Spectrum Mask Margin				
• 9 MHz to 11 MHz (0 ~ -20 dBr)	0			dBr
• 11 MHz to 20 MHz (-20 ~ -28 dBr)	0			dBr
• 20 MHz to 30 MHz (-28 ~ -40 dBr)	0			dBr
• 30 MHz to 33 MHz (-40 dBr)	0			dBr
Constellation Error (EVM)			-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
Minimum Input Level Sensitivity		-58	-52	dBm
Maximum Input Level (PER ≤ 10%)	-30			dBm
Adjacent Channel Rejection (PER ≤ 10%)	-14			dB

15.10.2 Low-Rate Condition for IEEE 802.11ax (HE20) - 6 GHz

Conditions: 25 °C, VBAT = 3.3V, VDDIO = 1.8V, Output power setting = 16 dBm, MCS0

Table 52: Low-Rate Condition for IEEE 802.11ax (HE20) - 6 GHz

Items	Contents			
Current Consumption	**Minimum**	**Typical**	**Maximum**	**Unit**
• Tx Mode (Power setting: 16 dBm)		380	490	mA
• Rx Mode		50		mA
Tx Characteristics	**Minimum**	**Typical**	**Maximum**	**Unit**
Output Power	13.5	16	18.5	dBm
Spectrum Mask Margin				
• 9 MHz to 11 MHz (0 ~ -20 dBr)	0			dBr
• 11 MHz to 20 MHz (-20 ~ -28 dBr)	0			dBr
• 20 MHz to 30 MHz (-28 ~ -40 dBr)	0			dBr
• 30 MHz to 33 MHz (-40 dBr)	0			dBr
Constellation Error (EVM)			-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**
Minimum Input Level Sensitivity			-82	dBm
Maximum Input Level (PER ≤ 10%)	-30			dBm
Adjacent Channel Rejection (PER ≤ 10%)	16			dB

15.11 DC/RF Characteristics for Bluetooth

Conditions : 25 °C, VBAT = 3.3V, VDDIO = 1.8V

Table 53: DC/RF Characteristics for Bluetooth

Items	Contents			
Bluetooth Specification (power class)	Version 5.4			
Channel Frequency (spacing)	2402 to 2480 MHz (1 MHz)			
Current Consumption	**Minimum**	**Typical**	**Maximum**	**Unit**
- Tx = Rx = DH5 (fully occupied)		35	45	mA
- Tx = Rx = 2DH5 (fully occupied)		28	36	mA
- Tx = Rx = 3DH5 (fully occupied)		28	36	mA
Transmitter	**Minimum**	**Typical**	**Maximum**	**Unit**
Output Power (at DH5)	6	9	12	dBm
Output Power (at 2DH5, 3DH5)	1	4	7	dBm
Frequency range	2400		2483.5	MHz
20 dB bandwidth			1	MHz
Adjacent Channel Power				
- [M-N] = 2			-20	dBm
- [M-N] ≥ 3			-40	dBm
Modulation Characteristics	**Minimum**	**Typical**	**Maximum**	**Unit**
- Modulation $\Delta f1_{avg}$	140		175	kHz
- Modulation $\Delta f2_{max}$	115			kHz
- Modulation $\Delta f2_{avg} / \Delta f1_{avg}$	0.8			
Carrier Frequency Drift	**Minimum**	**Typical**	**Maximum**	**Unit**
- 1slot	-25		+25	kHz
- 3slot / 5slot	-40		+40	kHz
- Maximum drift rate			20	kHz/50µs
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 (8DPSK)			13	%
- Peak DEVM (8DPSK)			25	%
- 99% DEVM (8DPSK)			20	%
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 - 12750 MHz (BW = 1 MHz)			-30	dBm
Receiver	**Minimum**	**Typical**	**Maximum**	**Unit**
BDR Sensitivity (BER ≤ 0.1%)		-92	-70	dBm
EDR Sensitivity (BER ≤ 0.007%) @8DPSK		-88	-70	dBm
C/I Performance (BER ≤ 0.1%)				
• co-channel			11	dB
• 1 MHz			0	dB
• 2 MHz			-30	dB
• 3 MHz			-40	dB
• image (+4 MHz)			-9	dB
• image +/- 1 MHz			-20	dB
Maximum Input Level (BER ≤ 0.1%)	-20			dBm

Adjacent Channel Power: Up to three spurious responses within Bluetooth limits are allowed.

15.12 DC/RF Characteristics for Bluetooth Low Energy

Conditions : 25 °C, VBAT = 3.3V, VDDIO = 1.8V

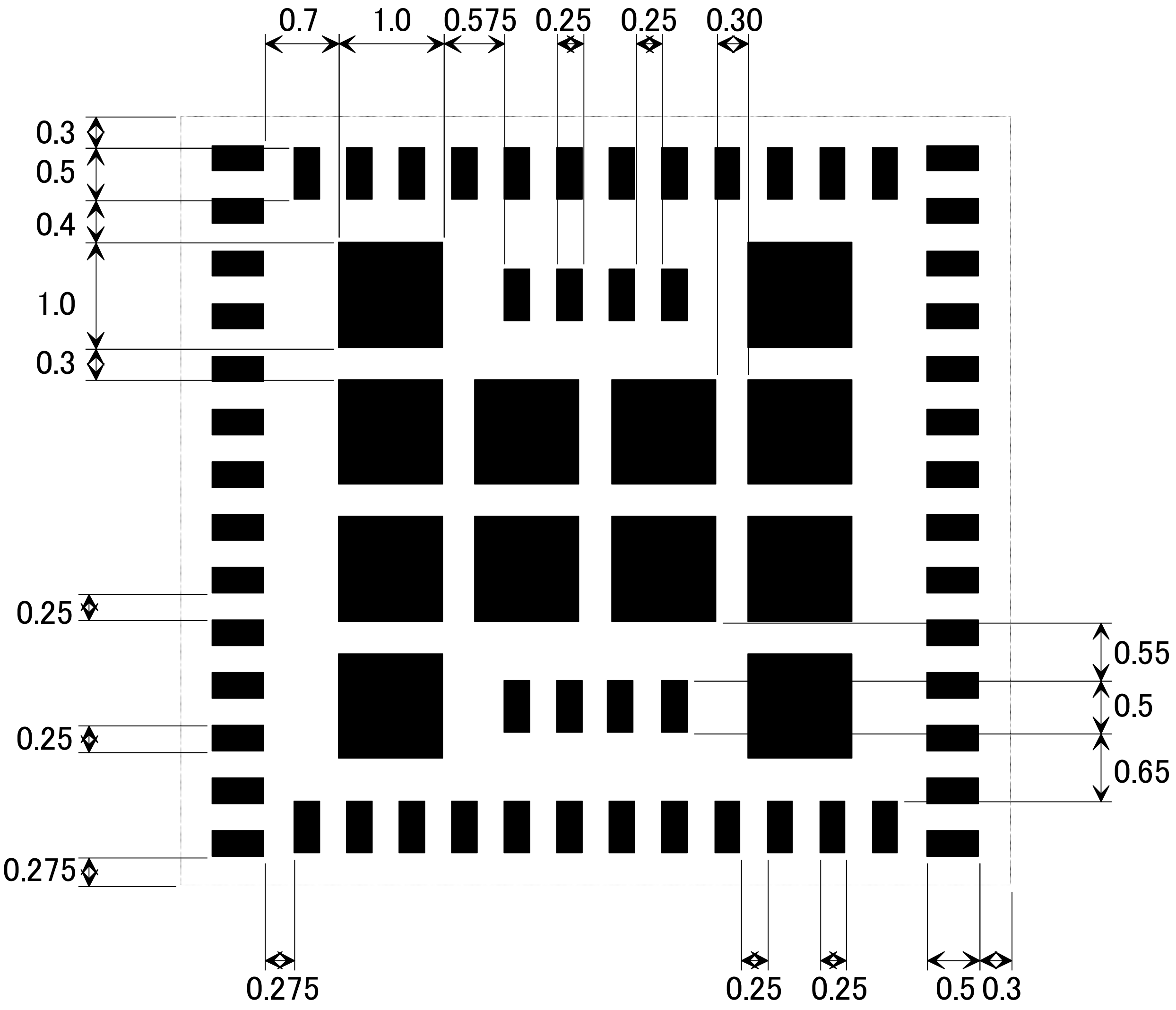
Table 54: DC/RF Characteristics for Bluetooth Low Energy

Items	Contents			
Bluetooth Specification (power class)	Version 5.4(LE)			
Channel Frequency (spacing)	2402 to 2480 MHz (2 MHz)			
Current Consumption	**Minimum**	**Typical**	**Maximum**	**Unit**
Tx Mode for US (fully occupied)		35	45	mA
Tx Mode for EU/JP (fully occupied)		25	33	mA
Rx Mode		15	18	mA
Item / Condition	**Minimum**	**Typical**	**Maximum**	**Unit**
Center Frequency	2402		2480	MHz
Channel Spacing		2		MHz
Number of RF Channel		40		
Output Power for US	6	9	12	dBm
Output Power for EU/JP	1	4	7	dBm
Modulation Characteristics				
• $\Delta f1_{avg}$	225		275	kHz
• $\Delta f2_{max}$ (at 99.9%)	185			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 ($\lvert f_0 - f_n \rvert$); n = 2, 3, 4…k			50	kHz
Drift Rate				
• $\lvert f_1 - f_0 \rvert$			23	kHz
• $\lvert f_n - f_{n-5} \rvert$; 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
Receiver	**Minimum**	**Typical**	**Maximum**	**Unit**
Receiver Sensitivity (PER < 30.8%)		-96	-70	dBm
Maximum Input Signal Level (PER < 30.8%)	-10			dBm
PER Report Integrity (-30 dBm input)	50		65.4	%

16 Land Pattern (Top View)

Figure 22 shows the land pattern for the module.

Figure 22: Land Pattern (Unit: 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 millimeter away from module outline as above figure.

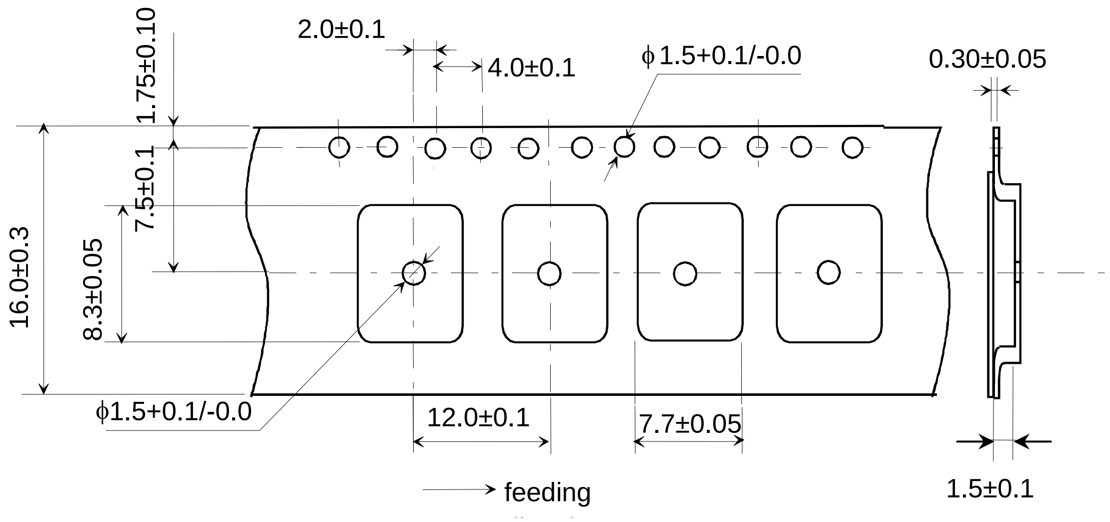
17 Tape And Reel Packing

This section describes the tape and reel packing, i.e., the dimensions of the plastic tape, reel and taping diagrams.

17.1 Dimensions of Tape (Plastic Tape)

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

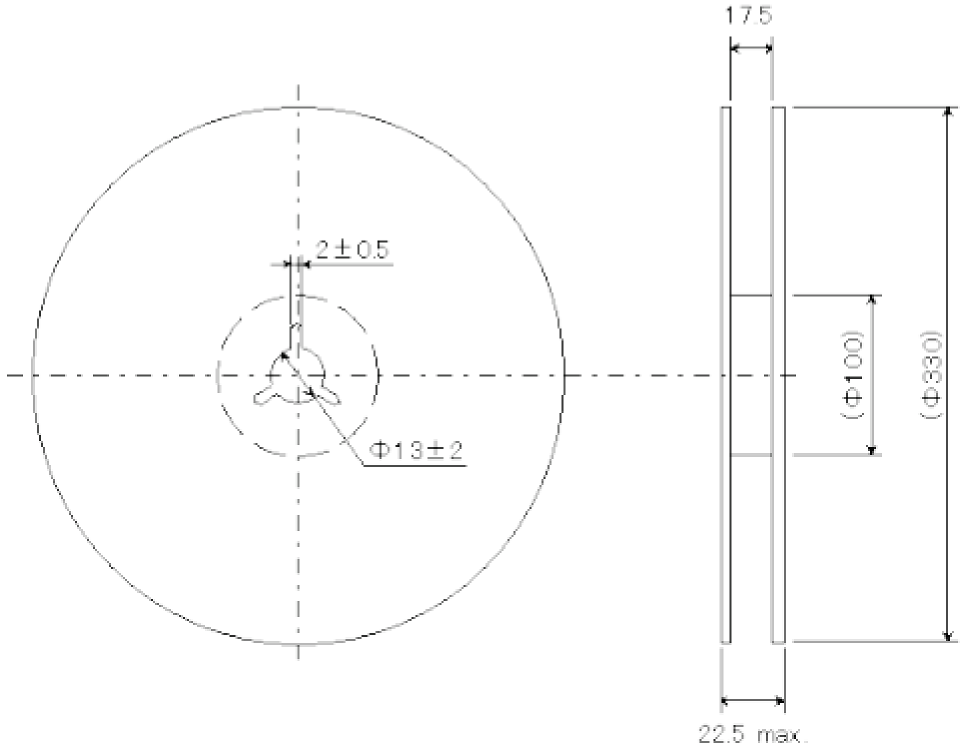
Figure 23: Dimensions of Tape (Unit: mm)



17.2 Dimensions of Reel

Figure 24 shows the dimensions of reel.

Figure 24: Dimensions of Reel (Unit: mm)



17.3 Taping Diagrams

Figure 25 shows the taping diagrams.

Figure 25: Taping Diagrams

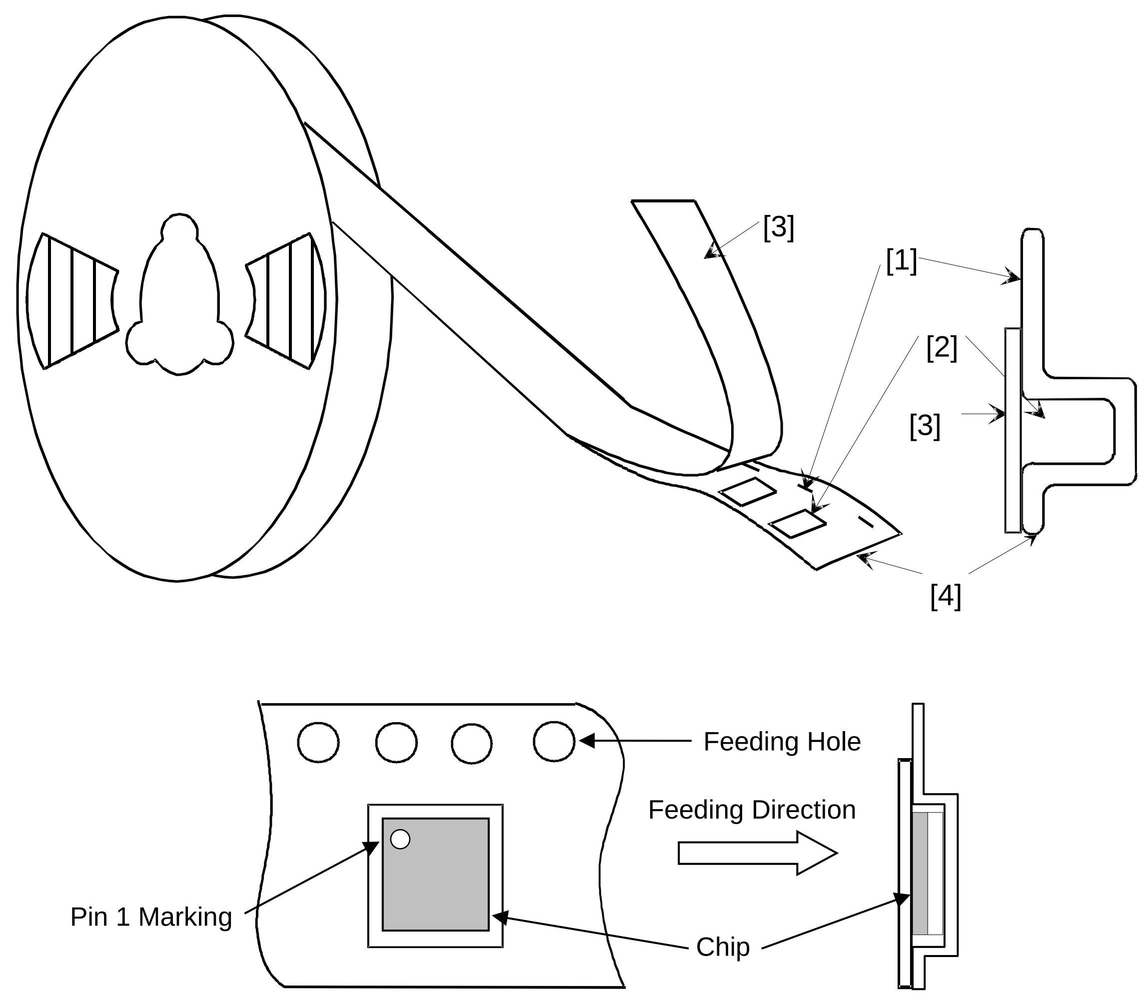


Table 55 describes the taping specifications.

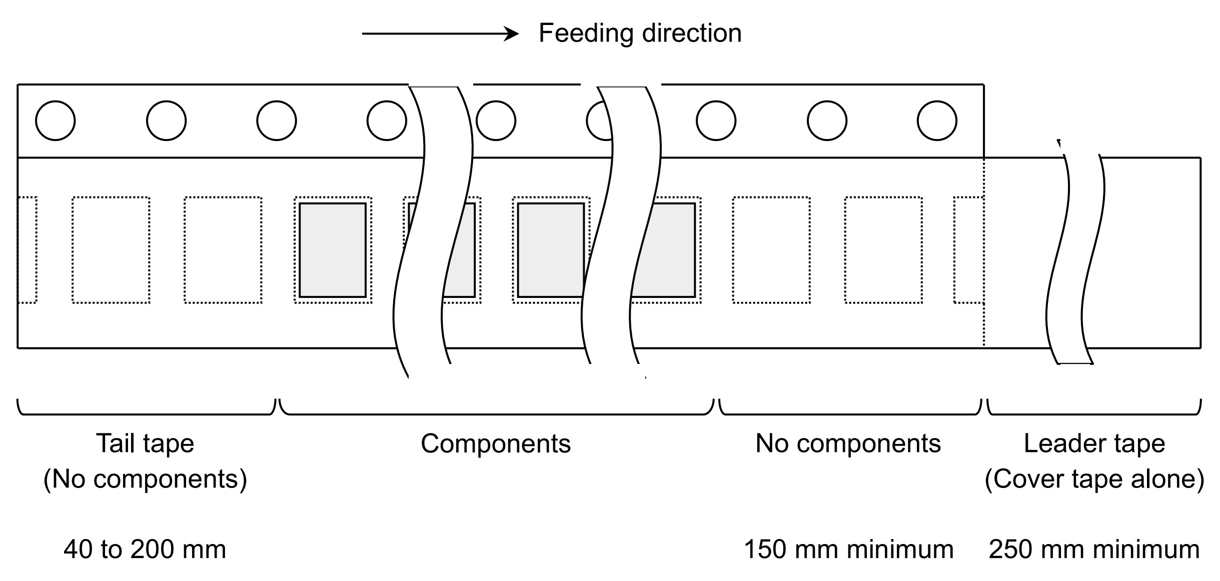
Table 55: Taping Specifications

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)

17.4 Leader and Tail Tape

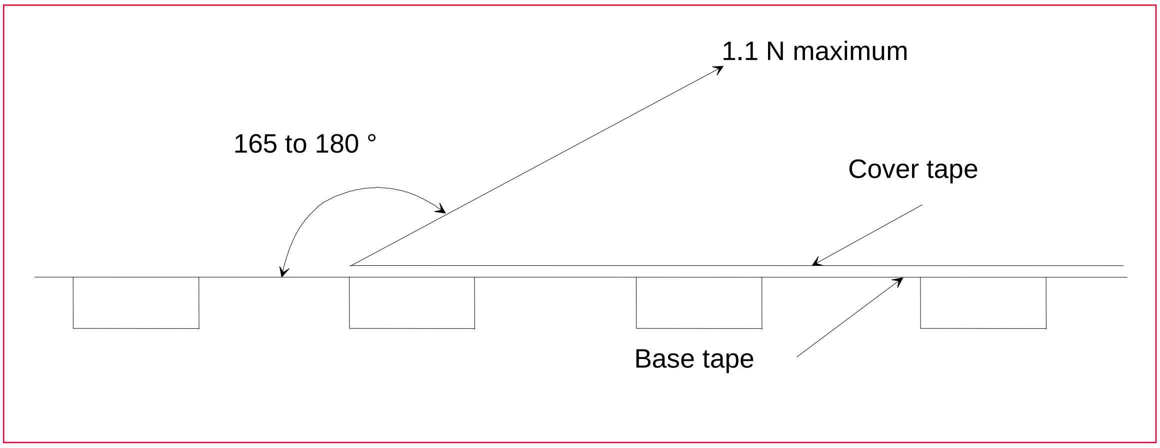
Figure 26 shows the leader and tail tape.

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
  - Reel: Plastic
- Cover tape, cavity tape and reel are made the anti-static processing.
- Peeling of force: 1.1 N maximum in the direction of peeling as shown in **Figure 27**.

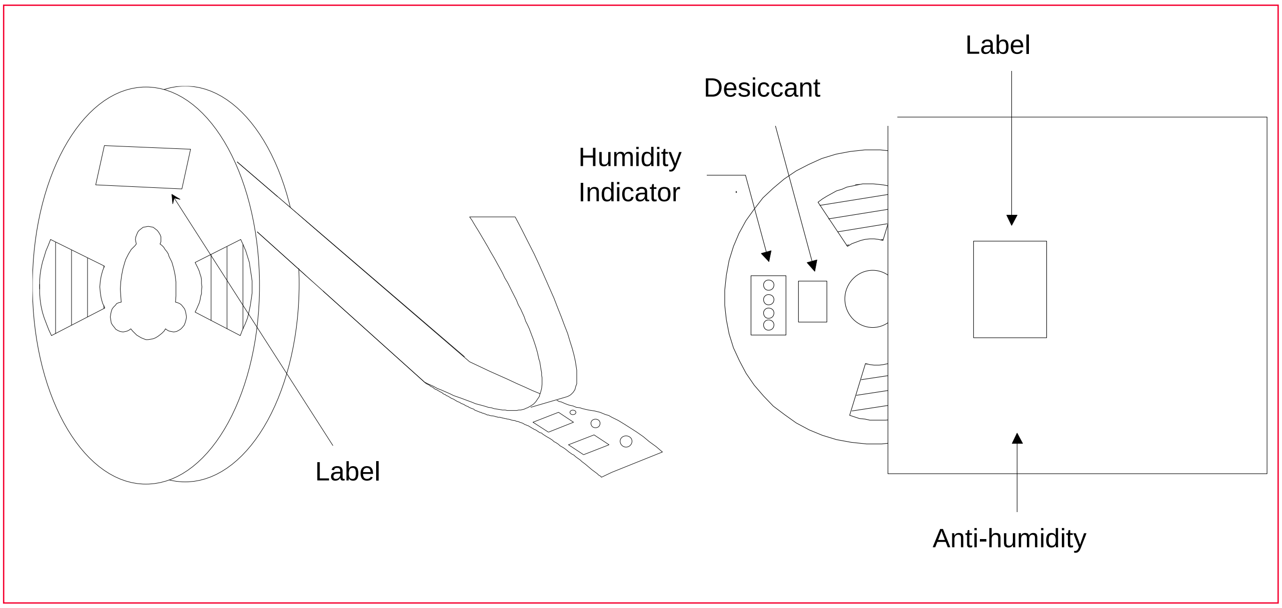
Figure 27: Peeling Off Force



17.5 Humidity Proof Packing

Figure 28 shows the humidity proof packaging.

Figure 28: Humidity Proof Packaging



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

18 Notice

18.1 Storage Conditions

Please use this product within 6 months after receipt.

- The product must 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 solderability of the product left idle for more than 6 months after receipt needs to be confirmed before it is used.
- The product must 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, must not be applied as that will damage the packing materials.

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

- After the packing is opened, the product must be stored at <30 °C / <60 %RH and the product *should be* used within 168 hours after opening.
- When the color of the indicator in the packing is changed, the product *should be* baked before soldering.
  - **Baking condition:** 125 +5/-0 °C, 24 hours, 1 time

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

18.2 Handling Conditions

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

Handle with care if you suspect that 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 as that may cause poor solderability and cause damage by static electrical charge.

18.3 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 should be as per 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 in advance.

18.4 Notice for Chip Placer

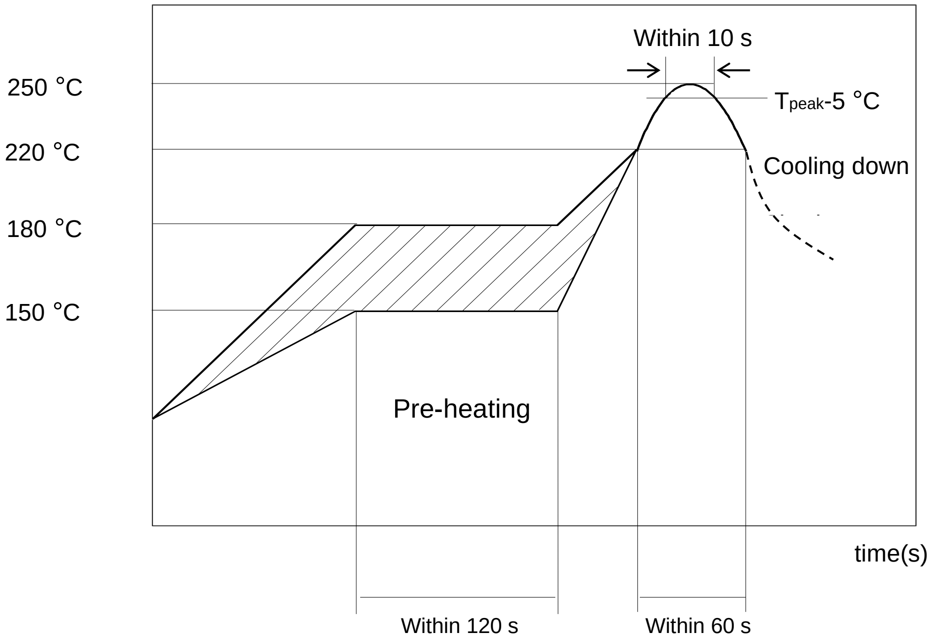
When placing products on the PCB, products may be stressed and broken by uneven forces from a worn-out chucking locating claw or a suction nozzle. To prevent products from damages, be sure to follow the specifications for the maintenance of the chip placer being used. For the positioning of products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

18.5 Soldering Conditions

The recommendation conditions of soldering are as in Figure 29

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

18.6 Cleaning

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

18.7 Operational Environment Conditions

Murata products are designed to work for electronic products under normal environmental conditions (ambient temperature, humidity, and pressure). Therefore, there is no problem in using the products under the above-mentioned conditions. However, using the products under the following circumstances may damage products and cause electricity leakage and abnormal temperature may occur:

- In atmosphere containing corrosive gas (Cl_2, NH_3, SO_X, NO_X etc.).
- In atmosphere containing combustible and volatile gases.
- Dusty place.
- Direct sunlight place.
- Water splashing place.
- Humid place where water condenses.
- Freezing place.

If there is any chance of using the products under the conditions listed above, consult with Murata before actual use.

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

18.8 Input Power Capacity

Products shall be used in the input power capacity as specified in this specification.

Inform Murata beforehand, in case that the components are used beyond such input power capacity range.

19 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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- Power plant control equipment.
- Medical equipment.
- Traffic signal equipment.

- Burning / explosion control equipment.
- Disaster prevention / crime prevention equipment.
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- Application of similar complexity and/ or reliability requirements to the applications listed in the above.
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Revision History

Revision Code	Date	Changed Item	Comment
	2023.04.17	Initial Release	
1 (A)	2023.06.09	Add Reference circuit	
2 (B)	2023.10.11	Updated VBAT/VDDIO	
3 (C)	2023.12.12	Update Datasheet Format	
4 (D)	2024.05.28	4. Block diagram P.8 9. Operating temperature range P.14 10. External LPO_IN Signal Requirement P.15 15. Update RF specification P.26~ P.47	• Revise 5G to 5G/6G for RF path • Change operating temperature range from -30~85 to -40~85, add specification temperature range. • Revise External LPO_IN signal input signal amplitude from 200~3300 to 200~1800 • Change the out band Spurious Emissions to TBD of 2.4G.
5 (E)	2024.09.06	2. Key Feature P.7 5.2. Bluetooth Qualification P.9 6. Dimensions, Markings, and Terminal Configurations P.10 9. Operating Condition P.14	• Update the weight the information from 0.15g to 0.2g and MSL level • Update the Bluetooth Qualification ID • Update module side view and Bump height information T1= 0.04 Typ. • Update module operating voltage VBAT from 3.13~3.5 to 3.0~4.8 V
6 (F)	2024.10.30	5.1 Radio Certification 8. Absolute Maximum Ratings 15. DC/RF characteristics 18. Tape and Reel packing 20. Preconditions to Use Our Products	• Update Radio certification ID • Add Peak current information. • Update RF performance, such as TX power, TX current, RX current, Sensitivity level • Update Tape and Reel information • Update Preconditions
7 (G)	2024.11.25	15. DC/RF characteristics	• Update RF performance, such as low data rate TX power, TX current
8 (2.0)	2025.02.18	Remove Preliminary 2. Key Feature 4. Block Diagram 5.1 Radio Certification 6. Dimensions, Markings, and Terminal Configurations 14.2 PCM interface Timing 14.3 WLAN SDIO Timing 15.12 DC/RF characteristics 17. Reference circuit	Refer to IC DS rev I • Update key feature information • Block Diagram was revised. • Move FCC/CE/IC/JRL ID to certification note • “Figure 3: Structure” was added. • Remove below timing title: ○ 14.2.3 Long Frame Sync, Master Mode ○ 14.2.4 Long Frame Sync, Slave Mode ○ 14.2.5 Short Frame Sync, Burst Mode ○ 14.2.6 Long Frame Sync, Burst Mode • Revised SDIO Timing of Default Mode • Update format • Move to HW app note

Revision Code	Date	Changed Item	Comment
9	2025.06.09	2. Key Feature 5 Certification Information 11. IO State 12 Power-On Sequence 15 DC/RF Characteristics 18.5 Soldering Conditions	• Update FIT information. • Add certification information • Remove RF_SW_CTRL_CTRL_X info • Add Power-On Sequence • Format changed, add BT/BLE Power max/min value • Updated • Updated (Base IC datasheet revision: I)
10	2025.10.27	5 Certification Information	• Revise Certification FCC/IC ID • Revise the description for CE part.
11	2025.11.5	6 Structure	• Revise Ag Shield to Stainless Steel Thin Film