General Description

Note: Images are for illustrative purposes only; actual products may differ.

BDE-BW3351xP2 is a 2.4-GHz & 5-GHz dual-band Wi-Fi 6 and Bluetooth Low Energy 5.4 combo wireless module series based on TI's CC3351 with antenna diversity feature (Antenna diversity feature is not supported in BLE). This module series is ideal for cost-sensitive embedded applications with a Linux or RTOS host running TCP/IP, where the peak application throughput requirement is a maximum of 50 Mbps and also has requirement for BLE connectivity. The BDE-BW3351xP2 module series is an excellent choice for bringing the efficiency of Wi-Fi 6 to embedded device applications, featuring a small PCB footprint and a highly optimized bill of materials for lower costs. Additionally, the module is backward compatible with Wi-Fi 4 (802.11 b/g/n) and Wi-Fi 5 (802.11 ac).

In order to fulfil different integration requirements, BDE offers various variants. They are listed in Table 1.

Table 1. Module Variants

Series Name	Orderable Part Number	Connectivity	Antenna Options	Operating Temperature
BDE-BW335P2	BDE-BW3351NP2	2.4-GHz & 5-GHz Wi-Fi 6 SISO & BLE 5.4	ANT pin	-40 °C to +85 °C
	BDE-BW3351UP2		U.FL connector	
	BDE-BW3351NP2-IN		ANT pin	-40 °C to +105 °C
	BDE-BW3351UP2-IN		U.FL connector	

Key Features

- Highly optimized Wi-Fi 6 (802.11 ax) and Bluetooth Low Energy 5.4 system for low cost embedded IoT applications
- Seamless integration with any processor or MCU host capable of running a TCP/IP stack
- Integrated 2.4-GHz and 5-GHz PA for complete wireless solution with up to +20 dBm output power
- Application throughput up to 50 Mbps
- Wi-Fi 6
  - 2.4 GHz and 5 GHz, 20 MHz, single spatial stream
  - MAC, baseband, and RF transceiver with support for IEEE 802.11 b/g/n/ax
  - Target wake time (TWT), OFDMA, MU-MIMO (Downlink), Basic Service Set Coloring, and trigger frame for improved efficiency
  - Hardware-based encryption and decryption supporting WPA2 and WPA3
  - Excellent interoperability
  - Support for 4 bit SDIO or SPI host interfaces
- Bluetooth Low Energy 5.4
  - LE Coded PHYs (Long Range), LE 2M PHY (High Speed) and Advertising Extension
  - Host Controller Interface (HCI) transport with option for UART or shared SDIO
- Enhanced Security
  - Secured host interface
  - Firmware authentication
  - Anti-rollback protection
- Multirole support (for example, concurrent STA and AP) to connect with Wi-Fi devices on different RF channels (Wi-Fi networks)
- 3-wire or 1-wire PTA for external coexistence with additional 2.4-GHz radios (for example, Thread or Zigbee)
- Operating temperature: -40°C to +85°C or -40°C to +105°C
- Power Management
  - VDD_1V8: 1.62 V - 1.98 V
  - VDD_3V3: 3 V – 3.6V
- Clock Source
  - On-board 40 MHz XTAL fast clock

  - Internal slow clock or external 32.768-kHz slow clock
- Antenna Options
  - Dual antenna with antenna diversity
  - ANT pin for external antenna
  - U.FL connector for external antenna
- Package
  - LGA-64, 13.3-mm x 13.4-mm x 2-mm
  - LGA-64, 13.3-mm x 18.4-mm x 2-mm
  - Pin to Pin Compatible with TI's WL1837MOD (-N variants)
  - Pin to Pin Compatible with BDE's BDE-BW2837 (-N variants)
- Qualification and Regulatory Compliance
  - Bluetooth SIG, DID/DN: D067335
  - FCC ID: 2ABRU-BW335P2
  - IC: 25657-BW335P2
  - MIC: 219-248334
  - CE-RED

Applications

- Grid Infrastructure
  - Electricity Meter
  - String Inverter
  - Micro Inverter
  - Energy Storage Power Conversion System (PCS)
  - EV Charging Infrastructure
- Building and Home Automation
  - HVAC Controller
  - HVAC Gateway
  - Thermostat
  - Building Security Gateway
  - Garage Door System
  - IP Network Camera/Video Doorbell
  - Wireless Security Camera
- Appliances
  - Refrigerator & Freezer
  - Oven
  - Washer & Dryer
  - Residential Water Heater & Heating System
  - Air Purifier & Humidifier
  - Coffee Machine
  - Air Conditioner Indoor Unit
  - Vacuum Robot
  - Robotic Lawn Mower
- Medical
  - Infusion Pump
  - Electronic Hospital Bed & Bed Control
  - Multiparameter Patient Monitor
  - Blood Pressure Monitor
  - CPAP Machine
  - Telehealth Systems
  - Ultrasound Scanner
  - Ultrasound Smart Probe
  - Electric Toothbrush
- Retail Automation and Payment
- Printers

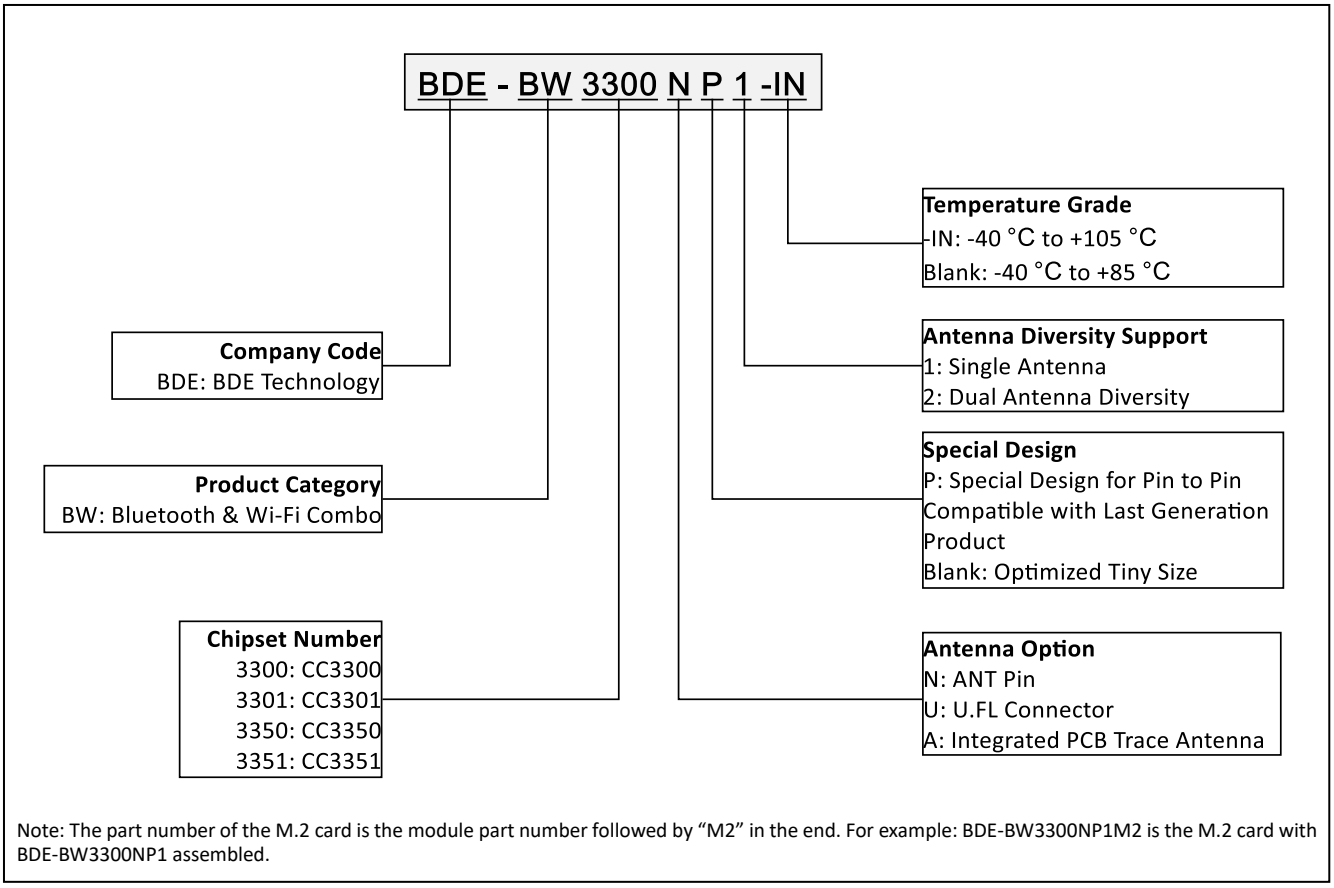
Module Family

Table 2. Module Family

Product Type & Series Name	Orderable Part Number	Chipset	Connectivity	Antenna Options	Antenna Diversity Support	Operating Temperature (°C)	Size (mm)
Module BDE-BW330P1	BDE-BW3301NP1	CC3301	2.4-GHz Wi-Fi 6 SISO & BLE 5.4	ANT pin	Not supported	-40 to +85	13.3 x 13.4 x 2
	BDE-BW3301UP1			U.FL connector			13.3 x 18.4 x 2
	BDE-BW3301AP1			PCB trace antenna			13.3 x 18.4 x 2
	BDE-BW3301NP1-IN			ANT pin		-40 to +105	13.3 x 13.4 x 2
	BDE-BW3301UP1-IN			U.FL connector			13.3 x 18.4 x 2
	BDE-BW3301AP1-IN			PCB trace antenna			13.3 x 18.4 x 2
	BDE-BW3300NP1	CC3300	2.4-GHz Wi-Fi 6 SISO	ANT pin	Not supported	-40 to +85	13.3 x 13.4 x 2
	BDE-BW3300UP1			U.FL connector			13.3 x 18.4 x 2
	BDE-BW3300AP1			PCB trace antenna			13.3 x 18.4 x 2
	BDE-BW3300NP1-IN			ANT pin		-40 to +105	13.3 x 13.4 x 2
	BDE-BW3300UP1-IN			U.FL connector			13.3 x 18.4 x 2
	BDE-BW3300AP1-IN			PCB trace antenna			13.3 x 18.4 x 2
Module BDE-BW335P1	BDE-BW3351NP1	CC3351	2.4-GHz & 5-GHz Wi-Fi 6 SISO & BLE 5.4	ANT pin	Not supported	-40 to +85	13.3 x 13.4 x 2
	BDE-BW3351UP1			U.FL connector			13.3 x 18.4 x 2
	BDE-BW3351AP1			PCB trace antenna			13.3 x 18.4 x 2
	BDE-BW3351NP1-IN			ANT pin		-40 to +105	13.3 x 13.4 x 2
	BDE-BW3351UP1-IN			U.FL connector			13.3 x 18.4 x 2
	BDE-BW3351AP1-IN			PCB trace antenna			13.3 x 18.4 x 2
	BDE-BW3350NP1	CC3350	2.4-GHz & 5-GHz Wi-Fi 6 SISO	ANT pin	Not supported	-40 to +85	13.3 x 13.4 x 2
	BDE-BW3350UP1			U.FL connector			13.3 x 18.4 x 2
	BDE-BW3350AP1			PCB trace antenna			13.3 x 18.4 x 2
	BDE-BW3350NP1-IN			ANT pin		-40 to +105	13.3 x 13.4 x 2
	BDE-BW3350UP1-IN			U.FL connector			13.3 x 18.4 x 2
	BDE-BW3350AP1-IN			PCB trace antenna			13.3 x 18.4 x 2
Module BDE-BW330P2	BDE-BW3301NP2	CC3301	2.4-GHz Wi-Fi 6 SISO & BLE 5.4	ANT pin	Supported, Dual Antenna	-40 to +85	13.3 x 13.4 x 2
	BDE-BW3301UP2			U.FL connector			13.3 x 18.4 x 2
	BDE-BW3301NP2-IN			ANT pin		-40 to +105	13.3 x 13.4 x 2
	BDE-BW3301UP2-IN			U.FL connector			13.3 x 18.4 x 2
	BDE-BW3300NP2	CC3300	2.4-GHz Wi-Fi 6 SISO	ANT pin	Supported, Dual Antenna	-40 to +85	13.3 x 13.4 x 2
	BDE-BW3300UP2			U.FL connector			13.3 x 18.4 x 2
	BDE-BW3300NP2-IN			ANT pin		-40 to +105	13.3 x 13.4 x 2
	BDE-BW3300UP2-IN			U.FL connector			13.3 x 18.4 x 2
Module BDE-BW335P2	BDE-BW3351NP2	CC3351	2.4-GHz & 5-GHz Wi-Fi 6 SISO & BLE 5.4	ANT pin	Supported, Dual Antenna	-40 to +85	13.3 x 13.4 x 2
	BDE-BW3351UP2			U.FL connector			13.3 x 18.4 x 2
	BDE-BW3351NP2-IN			ANT pin		-40 to +105	13.3 x 13.4 x 2
	BDE-BW3351UP2-IN			U.FL connector			13.3 x 18.4 x 2
	BDE-BW3350NP2	CC3350	2.4-GHz & 5-GHz Wi-Fi 6 SISO	ANT pin	Supported, Dual Antenna	-40 to +85	13.3 x 13.4 x 2
	BDE-BW3350UP2			U.FL connector			13.3 x 18.4 x 2
	BDE-BW3350NP2-IN			ANT pin		-40 to +105	13.3 x 13.4 x 2
	BDE-BW3350UP2-IN			U.FL connector			13.3 x 18.4 x 2

Product Type & Series Name	Orderable Part Number	Chipset	Connectivity	Antenna Options	Antenna Diversity Support	Operating Temperature (°C)	Size (mm)
Module BDE-BW330S	BDE-BW3301N1	CC3301	2.4-GHz Wi-Fi 6 SISO & BLE 5.4	ANT pin	Not supported	-40 to +85	11 x 11 x 2
	BDE-BW3301U1			U.FL connector			11 x 15 x 2
	BDE-BW3301A1			PCB trace antenna			11 x 15 x 2
	BDE-BW3301N1-IN			ANT pin		-40 to +105	11 x 11 x 2
	BDE-BW3301U1-IN			U.FL connector			11 x 15 x 2
	BDE-BW3301A1-IN			PCB trace antenna			11 x 15 x 2
	BDE-BW3300N1	CC3300	2.4-GHz Wi-Fi 6 SISO	ANT pin	Not supported	-40 to +85	11 x 11 x 2
	BDE-BW3300U1			U.FL connector			11 x 15 x 2
	BDE-BW3300A1			PCB trace antenna			11 x 15 x 2
	BDE-BW3300N1-IN			ANT pin		-40 to +105	11 x 11 x 2
	BDE-BW3300U1-IN			U.FL connector			11 x 15 x 2
	BDE-BW3300A1-IN			PCB trace antenna			11 x 15 x 2
Module BDE-BW335S	BDE-BW3351N1	CC3351	2.4-GHz & 5-GHz Wi-Fi 6 SISO & BLE 5.4	ANT pin	Not supported	-40 to +85	11 x 11 x 2
	BDE-BW3351U1			U.FL connector			11 x 15 x 2
	BDE-BW3351A1			PCB trace antenna			11 x 15 x 2
	BDE-BW3351N1-IN			ANT pin		-40 to +105	11 x 11 x 2
	BDE-BW3351U1-IN			U.FL connector			11 x 15 x 2
	BDE-BW3351A1-IN			PCB trace antenna			11 x 15 x 2
	BDE-BW3350N1	CC3350	2.4-GHz & 5-GHz Wi-Fi 6 SISO	ANT pin	Not supported	-40 to +85	11 x 11 x 2
	BDE-BW3350U1			U.FL connector			11 x 15 x 2
	BDE-BW3350A1			PCB trace antenna			11 x 15 x 2
	BDE-BW3350N1-IN			ANT pin		-40 to +105	11 x 11 x 2
	BDE-BW3350U1-IN			U.FL connector			11 x 15 x 2
	BDE-BW3350A1-IN			PCB trace antenna			11 x 15 x 2
M.2 Card	BDE-BW3301NP1M2	CC3301	Wi-Fi 6 SISO & BLE 5.4	U.FL connector	Not supported	-40 to +85	22 x 30 x 28
	BDE-BW3301NP2M2				Supported		
	BDE-BW3300NP1M2	CC3300	2.4-GHz Wi-Fi 6 SISO		Not supported		
	BDE-BW3300NP2M2				Supported		
	BDE-BW3351NP1M2	CC3351	2.4-GHz & 5-GHz Wi-Fi 6 SISO & BLE 5.4		Not supported		
	BDE-BW3351NP2M2				Supported		
	BDE-BW3350NP1M2	CC3350	2.4-GHz & 5-GHz Wi-Fi 6 SISO		Not supported		
	BDE-BW3350NP2M2				Supported		

Naming Convention



Note: The part number of the M.2 card is the module part number followed by "M2" in the end. For example: BDE-BW3300NP1M2 is the M.2 card with BDE-BW3300NP1 assembled.

Figure 1. Module Naming Convention

Contents

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References

1. CC3351 resources: https://www.ti.com/product/CC3351;

1. System Overview

1.1. Block Diagram

BDE-BW3351xP2 module series is based on the TI's 10th generation connectivity combo chip CC3351. The module series, as seen in below diagrams, depending on different configurations, is comprised of:

- 40-MHz XTAL
- Bandpass filter
- Decoupling capacitors
- U.FL connector (U.FL variants)

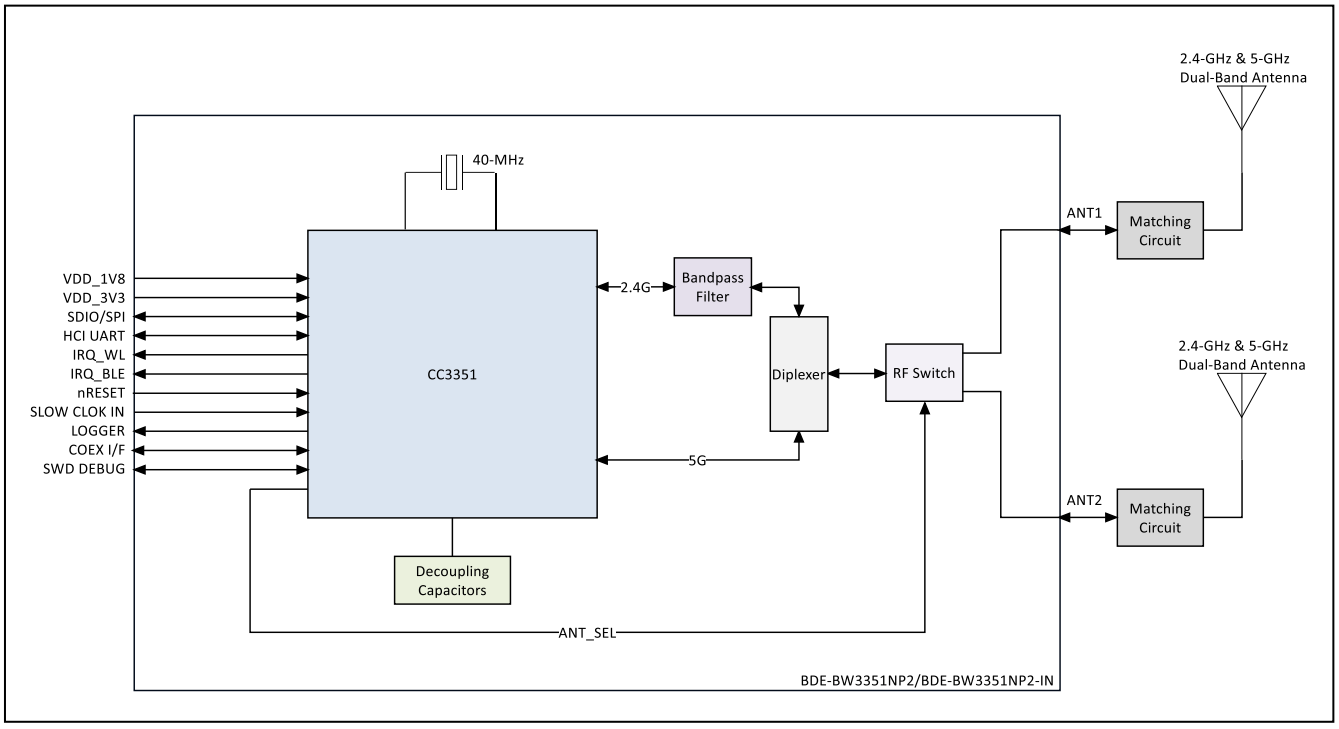


Figure 2. The Block Diagram of BDE-BW3351NP2 and BDE-BW3351NP2-IN

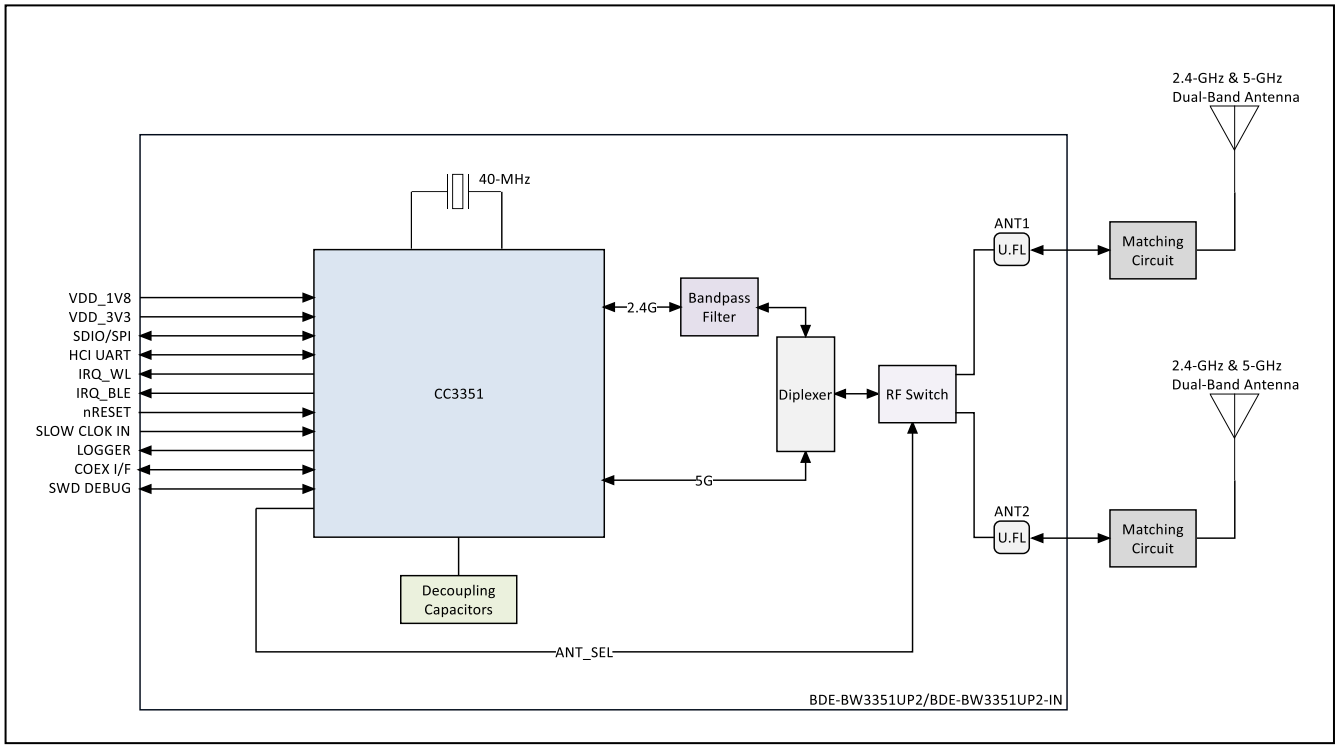


Figure 3. The Block Diagram of BDE-BW3351UP2 and BDE-BW3351UP2-IN

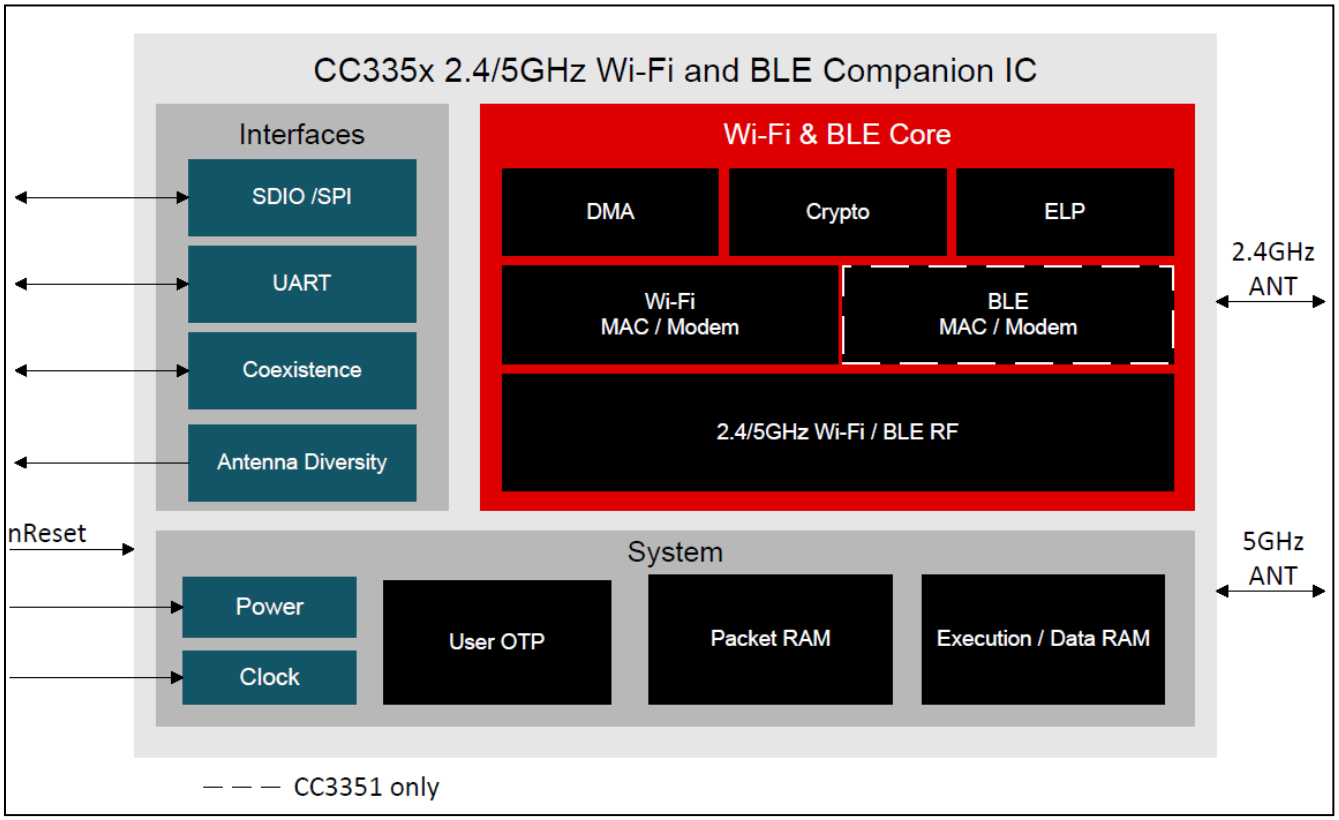


Figure 4. The Block Diagram of CC335x (Adopted form CC335x Datasheet)

2. Pinout Functions

2.1. Pin Diagram

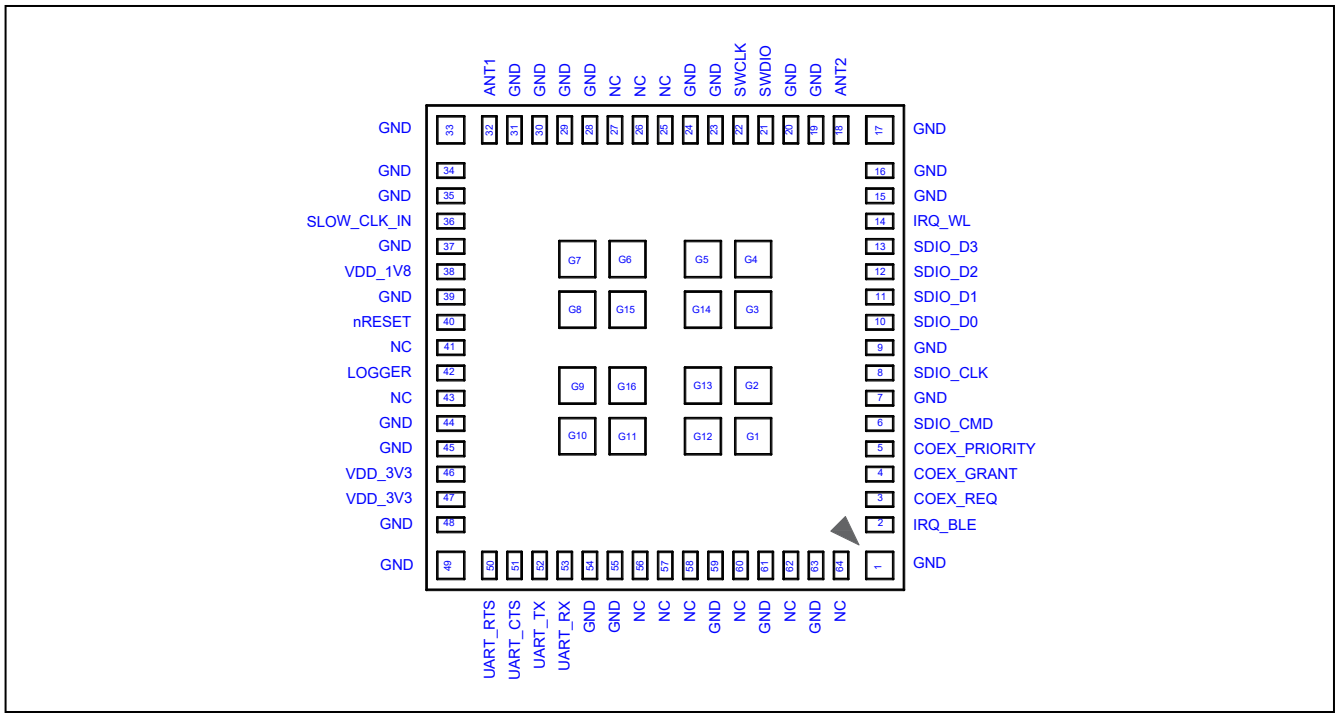


Figure 5. Pin Diagram of BDE-BW3351NP2 (Top View)

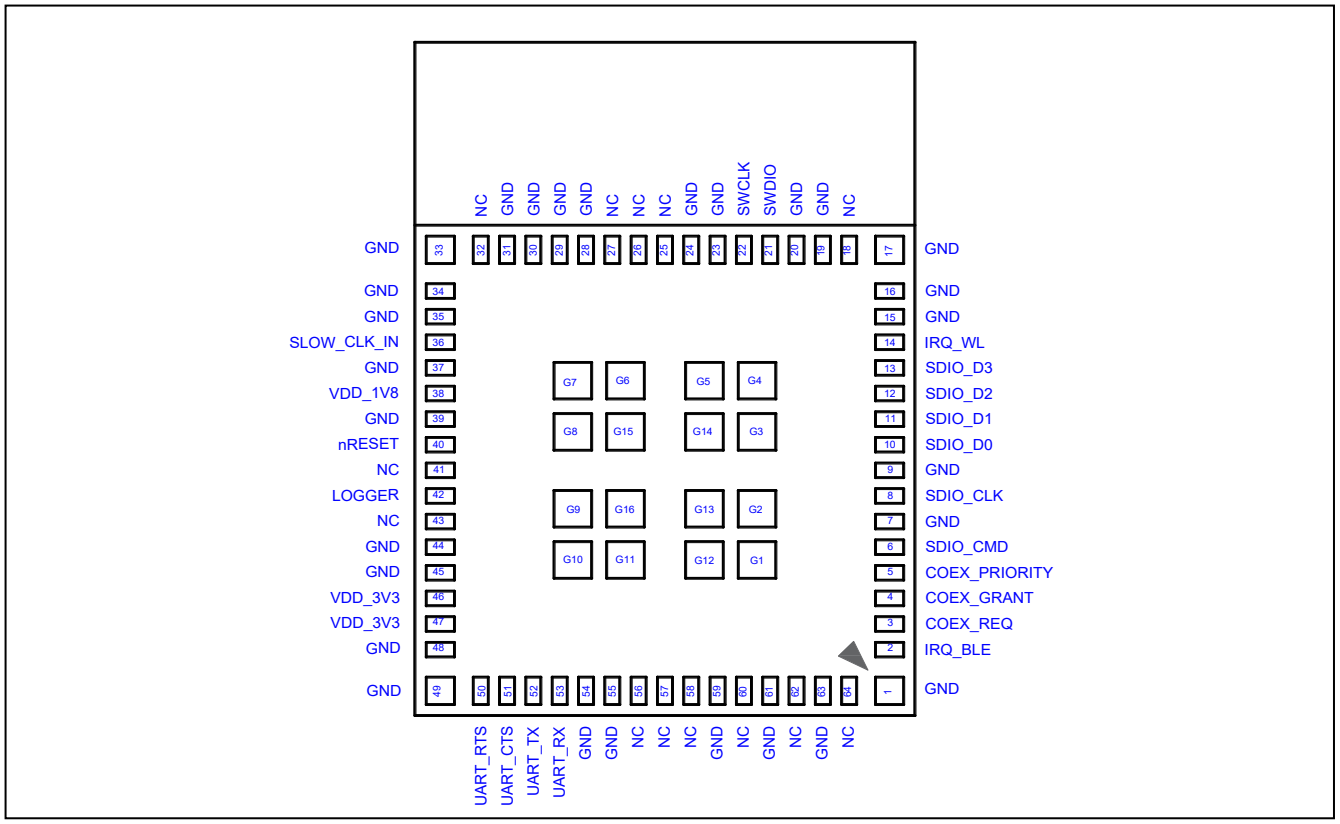


Figure 6. Pin Diagram of BDE-BW3351UP2 (Top View)

2.2. Pinout Description

Table 3. Pinout Description

Module Pin #	Pin Name	Type	Voltage Level	Shutdown State (1)	State After Power-up (1)	Description
1	GND	Ground	-	-	-	Power ground
2	IRQ_BLE (2)	O	VDD_1V8	PD	PD	Interrupt request to host for BLE (in shared SDIO mode)
3	COEX_REQ	I	VDD_1V8	PU	PU	External coexistence interface – request
4	COEX_GRANT	O	VDD_1V8	PD	PD	External coexistence interface – grant
5	COEX_PRIORITY	I	VDD_1V8	PU	PU	External coexistence interface – priority
6	SDIO_CMD	I/O	VDD_1V8	Hi-Z	Hi-Z	SDIO command or SPI PICO
7	GND	Ground	-	-	-	Power ground
8	SDIO_CLK	I	VDD_1V8	Hi-Z	Hi-Z	SDIO clock or SPI clock
9	GND	Ground	-	-	-	Power ground
10	SDIO_D0	I/O	VDD_1V8	Hi-Z	Hi-Z	SDIO data D0 or SPI POCI
11	SDIO_D1	I/O	VDD_1V8	Hi-Z	Hi-Z	SDIO data D1
12	SDIO_D2	I/O	VDD_1V8	Hi-Z	Hi-Z	SDIO data D2
13	SDIO_D3	I/O	VDD_1V8	Hi-Z	PU	SDIO data D3 or SPI CS
14	IRQ_WL (2)	O	VDD_1V8	PD	PD	Interrupt request to host for WLAN
15	GND	Ground	-	-	-	Power ground
16	GND	Ground	-	-	-	Power ground
17	GND	Ground	-	-	-	Power ground
18	ANT2	RF	-	-	-	WLAN 2.4-GHz secondary antenna port
	NC	-				No connect for BDE-BW3351UP2
19	GND	Ground	-	-	-	Power ground
20	GND	Ground	-	-	-	Power ground
21	SWDIO	I/O	VDD_1V8	PU	PU	Serial wire debug I/O
22	SWCLK	I	VDD_1V8	PD	PD	Serial wire debug clock
23	GND	Ground	-	-	-	Power ground
24	GND	Ground	-	-	-	Power ground
25	NC	-	-	-	-	No connect. Leve floating
26	NC	-	-	-	-	No connect. Leve floating
27	NC	-	-	-	-	No connect. Leve floating
28	GND	Ground	-	-	-	Power ground
29	GND	Ground	-	-	-	Power ground
30	GND	Ground	-	-	-	Power ground
31	GND	Ground	-	-	-	Power ground
32	ANT1	RF	-	-	-	Bluetooth Low Energy antenna port and WLAN 2.4-GHz primary antenna port
	NC	NC				No connect for BDE-BW3351UP2
33	GND	Ground	-	-	-	Power ground
34	GND	Ground	-	-	-	Power ground
35	GND	Ground	-	-	-	Power ground
36	SLOW_CLK_IN	I	VDD_1V8	PD	PD	32.768-KHz RTC clock input
37	GND	Ground	-	-	-	Power ground
38	VDD_1V8	Power	-	-	-	1.8V power supply for SRAM, digital, analog, I/O, and programming
39	GND	Ground	-	-	-	Power ground
40	nRESET	I	VDD_1V8	PU	PU	Reset line for enabling or disabling device (active low)
41	NC	-	-	-	-	No connect. Leve floating
42	LOGGER (2)	O	VDD_1V8	PU	PU	Tracer (UART TX debug logger)
43	NC	-	-	-	-	No connect. Leve floating
44	GND	Ground	-	-	-	Power ground
45	GND	Ground	-	-	-	Power ground
46	VDD_3V3	Power	-	-	-	3.3V power supply for PA
47						
48	GND	Ground	-	-	-	Power ground
49	GND	Ground	-	-	-	Power ground
50	UART_RTS	O	VDD_1V8	PU	PU	UART RTS signal - flow control for BLE HCI
51	UART_CTS	I	VDD_1V8	PU	PU	UART CTS signal - flow control for BLE HCI
52	UART_TX	O	VDD_1V8	PU	PU	UART TX for BLE HCI
53	UART_RX	I	VDD_1V8	PU	PU	UART RX for BLE HCI
54	GND	Ground	-	-	-	Power ground
55	GND	Ground	-	-	-	Power ground
56	NC	-	-	-	-	No connect. Leve floating
57	NC	-	-	-	-	No connect. Leve floating
58	NC	-	-	-	-	No connect. Leve floating
59	GND	Ground	-	-	-	Power ground

Module Pin #	Pin Name	Type	Voltage Level	Shutdown State (1)	State After Power-up (1)	Description
60	NC	-	-	-	-	No connect. Leve floating
61	GND	Ground	-	-	-	Power ground
62	NC	-	-	-	-	No connect in the BDE-BW3351XP2
63	GND	Ground	-	-	-	Power ground
64	NC	-	-	-	-	No connect. Leve floating
G1 – G16	GND	Ground	-	-	-	Power ground, thermal pads

(1) All digital I/Os are with internal PU/PD according to the "shutdown state" column when the device is in shutdown mode (with the exception of SDIO signals are Hi-Z). PU means pull-up, PD means pull-down, Hi-Z means high impedance;
(2) LOGGER and IRQ_WL pins are sensed by the device during boot. They should be kept “10” state on power-up with LOGGER pin being high.

3. Characteristics

3.1. Electrical Characteristics

3.1.1. Absolute Maximum Ratings

Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. These are stress ratings only, so functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specification are not implied. Exposure to Absolute Maximum Rating conditions for extended periods may affect device reliability.

Table 4. Absolute Maximum Ratings

Parameter	MIN	MAX	Unit
VDD_3V3	-0.5	4.2	V
VDD_1V8	-0.5	2.1	V
Operating ambient temperature	-40	105	°C
Storage temperature	-40	105	°C

3.1.2. ESD Ratings

Table 5. ESD Ratings

Parameter	Description	Value	Unit	Note
Electrostatic discharge	Contact discharge	4000	V	As per EN 301-489
	Air discharge	8000	V	As per EN 301-489

3.1.3. Recommended Operating Conditions

Table 6. Recommended Operating Conditions

Parameter	MIN	TYP	MAX	Unit
VDD_3V3	3	3.3	3.6	V
VDD_1V8	1.62	1.8	1.98	V
Operating ambient temperature	-40		85	°C
Operating ambient temperature (-IN variants)	-40		105 (1)	°C

(1) -IN variants module may operate at temperature of up to 105 °C. This allows the device to be used reliably in applications that may be exposed to higher ambient temperature over certain periods of the product’s life. At temperatures higher than 85 °C, the WLAN/BLE performance may degrade.

3.1.4. I/O DC Characteristics

Table 7. I/O DC Characteristics

Parameter	Description	Test Condition	MIN	TYP	MAX	Unit
V_{IH}	High level input voltage		0.65 x VDD_1V8		VDD_1V8	V
V_{IL}	Low level input voltage		0		0.35 x VDD_1V8	V
V_{OH}	High level output voltage	At 4mA	VDD_1V8 – 0.45		VDD_1V8	V
V_{OL}	Low level output voltage	At 4mA	0		0.45	V

3.1.5. Power Consumption

Table 8. Current Consumption – WLAN 2.4-GHz Static Modes

Parameter	Test Condition		Supply	TYP	Unit
Continuous TX (1)	1 DSSS	TX power = 17.8 dBm	VDD_1V8	97	mA
			VDD_3V3	263	
	6 OFDM	TX power = 17.8 dBm	VDD_1V8	102	
			VDD_3V3	257	
	54 OFDM	TX power = 15.3 dBm	VDD_1V8	101	
			VDD_3V3	212	
	HT MCS0	TX power = 17.8 dBm	VDD_1V8	102	
			VDD_3V3	256	
	HT MCS7	TX power = 15.3 dBm	VDD_1V8	101	
			VDD_3V3	212	
	HE MCS0	TX power = 17.8 dBm	VDD_1V8	103	
			VDD_3V3	265	
	HE MCS7	TX power = 15.1 dBm	VDD_1V8	103	
			VDD_3V3	207	
Continuous RX			VDD_1V8	68	
			VDD_3V3	0	

(1) Peak current VDD_3V3 can hit 340mA during device calibration; Peak current VDD_1V8 of 185mA including peripherals and internal cortex.
(2) Highest power setting for TX power. TX power is recorded as average power.

Table 9. Current Consumption – WLAN 2.4-GHz Use Cases

Mode	Description	TYP	Unit
DTIM = 1	System with 3.3V to Ext. DC/DC at 85% efficiency WLAN beacon reception every DTIM=1 (~100ms)	637	µA
	System with 1.8V WLAN beacon reception every DTIM=1 (~100ms)	980	
DTIM = 3	System with 3.3V to Ext. DC/DC at 85% efficiency WLAN beacon reception every DTIM=3 (~300ms)	371	
	System with 1.8V WLAN beacon reception every DTIM=3 (~300ms)	570	
DTIM = 5	System with 3.3V to Ext. DC/DC at 85% efficiency WLAN beacon reception every DTIM=5 (~500ms)	319	
	System with 1.8V WLAN beacon reception every DTIM=5 (~500ms)	490	

Table 10. Current Consumption – WLAN 5-GHz Static Modes

Parameter	Test Condition		Supply	TYP	Unit
Continuous TX	6 OFDM	TX power = 16.3 dBm	VDD_1V8	169	mA
			VDD_3V3	236	
	54 OFDM	TX power = 11.8 dBm	VDD_1V8	168	
			VDD_3V3	204	
	HT MCS0	TX power = 16.3 dBm	VDD_1V8	169	
			VDD_3V3	249	
	HT MCS7	TX power = 11.8 dBm	VDD_1V8	166	
			VDD_3V3	181	
	HE MCS0	TX power = 16.1 dBm	VDD_1V8	164	
			VDD_3V3	237	
	HE MCS7	TX power = 10.7 dBm	VDD_1V8	163	
			VDD_3V3	176	
Continuous RX			VDD_1V8	108	
			VDD_3V3	0	

(1) Peak current VDD_3V3 can hit 450mA during device calibration; Peak current VDD_1V8 of 300mA including peripherals and internal cortex.

Table 11. Current Consumption –WLAN 5-GHz Use Cases

Mode	Description	TYP	Unit
DTIM = 1	System with 3.3V to Ext. DC/DC at 85% efficiency WLAN beacon reception every DTIM=1 (~100ms)	735	µA

Mode	Description	TYP	Unit
	System with 1.8V WLAN beacon reception every DTIM=1 (~100ms)	1130	
DTIM = 3	System with 3.3V to Ext. DC/DC at 85% efficiency WLAN beacon reception every DTIM=3 (~300ms)	390	
	System with 1.8V WLAN beacon reception every DTIM=3 (~300ms)	600	
DTIM = 5	System with 3.3V to Ext. DC/DC at 85% efficiency WLAN beacon reception every DTIM=5 (~500ms)	340	
	System with 1.8V WLAN beacon reception every DTIM=5 (~500ms)	520	

Table 12. Current Consumption – BLE Static Modes

Parameter	Test Condition	Supply	TYP	Unit
TX, max duty cycle	TX power = 0 dBm	VDD_1V8	98	mA
		VDD_3V3	39	
	TX power = 10 dBm	VDD_1V8	98	
		VDD_3V3	116	
	TX power = 20 dBm	VDD_1V8	98	
		VDD_3V3	259	
RX		VDD_1V8	60	
		VDD_3V3	0	

Table 13. Current Consumption – Device States

Mode	Description	Supply	TYP	Unit
Shutdown	External supplies are available, device held in reset (nRESET is low)	VDD_1V8	10	µA
		VDD_3V3	2	
Sleep	Low power mode – RAM in retention	VDD_1V8	330	
		VDD_3V3	2	

3.1.6. Fast Clock Characteristics

The fast clock running at 40-MHz for WLAN/BLE functions is included in the module. The specification is shown in below table.

Table 14. 40-MHz Crystal Oscillator (HFXT) Characteristics

Parameter	Test Condition	MIN	TYP	MAX	Unit
Crystal frequency			40		MHz
ESR, Equivalent series resistance				20	Ω
Frequency tolerance	T_A: 25°C	-10		+10	ppm
Frequency stability	T_A: -40°C ~ 85°C/105°C (1)	-30		+30	ppm
C_L, Crystal load capacitance			8		pF

(1) -IN variants can support up to 105 °C.

3.1.7. External Slow Clock Requirements

The slow clock running at 32.768-KHz for low power mode is not included in the module. The slow clock can be generated internally or externally. The external slow clock requirements are listed in below table.

Table 15. External 32.768-KHz Slow Clock Requirements

Parameter	Description	MIN	TYP	MAX	Unit
Crystal frequency	Square wave		32768		Hz
Frequency accuracy	Initial + temperature + aging	-250		+250	ppm
Input duty cycle		30	50	70	%
Rise and fall time	10% to 90% (rise) and 90% to 10% (fall) of digital signal level			100	ns
Input low level		0		0.35 x VDD_1V8	V
Input high level		0.65 x VDD_1V8		1.95	V
Input impedance		1			MΩ
Input capacitance				5	pF

3.1.8. Power Supply Sequencing

For proper operation of the module, perform the recommended power-up sequencing as follows:

1. VDD_3V3 and VDD_1V8 must be available before nRESET is released;
2. For an external slow clock, ensure that the clock is stable before nRESET is deasserted (high);
3. The nRESET pin should be held low for at least 10 us after stabilization of the external power supplies.

3.1.9. SDIO Timing Characteristics

SDIO is the main host interfaces for WLAN, and it supports a maximum clock rate of 52-MHz. The module also supports shared SDIO interface for both BLE and WLAN.

The timing diagram for default speed and high speed SDIO are as follows:

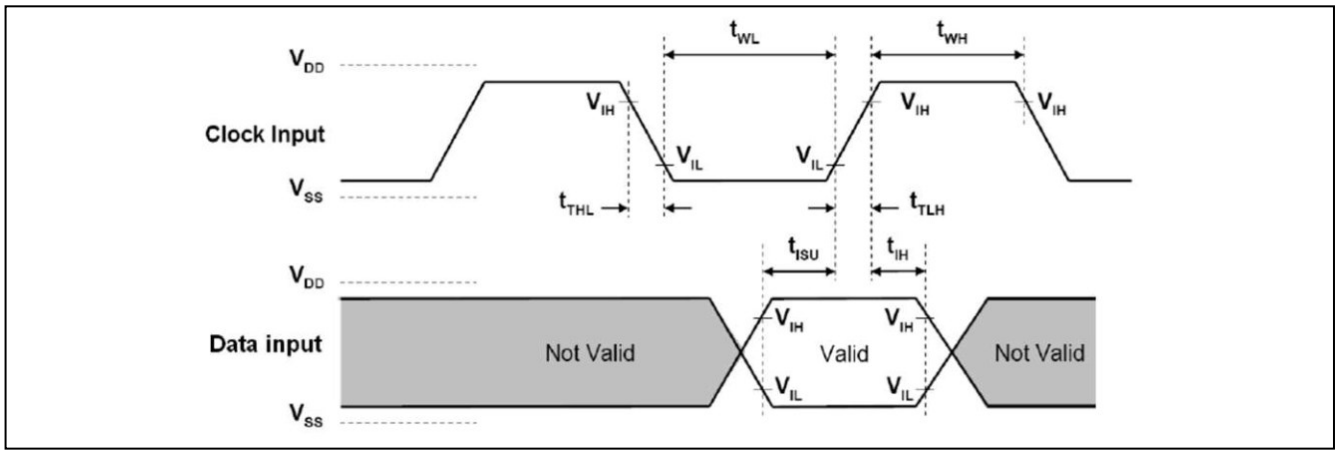


Figure 7. SDIO Default Input Timing

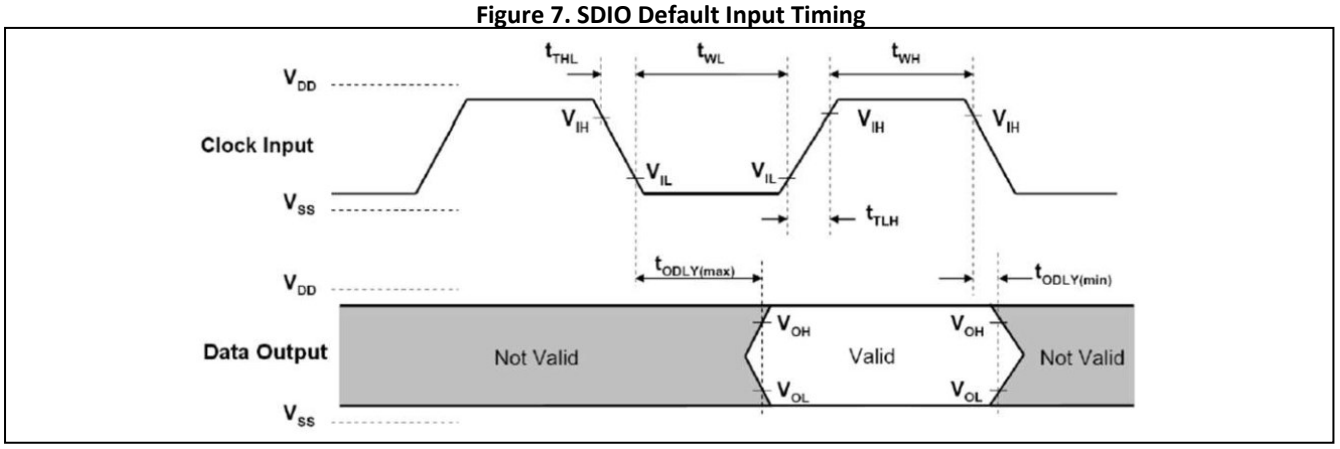


Figure 8. SDIO Default Output Timing

Table 16. SDIO Timing Parameters - Default Speed

Parameter	Description	MIN	MAX	Unit
f_{clock}	Clock frequency, CLK		26	MHz
t_{High}	High period	10		ns
t_{Low}	Low period	10		
t_{TLH}	Rise time, CLK		10	
t_{THL}	Fall time, CLK		10	
t_{ISU}	Setup time, input valid before CLK ↑	5		
t_{IH}	Hold time, input valid after CLK ↑	5		
t_{ODLY}	Delay time, CLK ↓ to output valid	2	14	
C_L	Capacitive load on outputs	15	40	pF

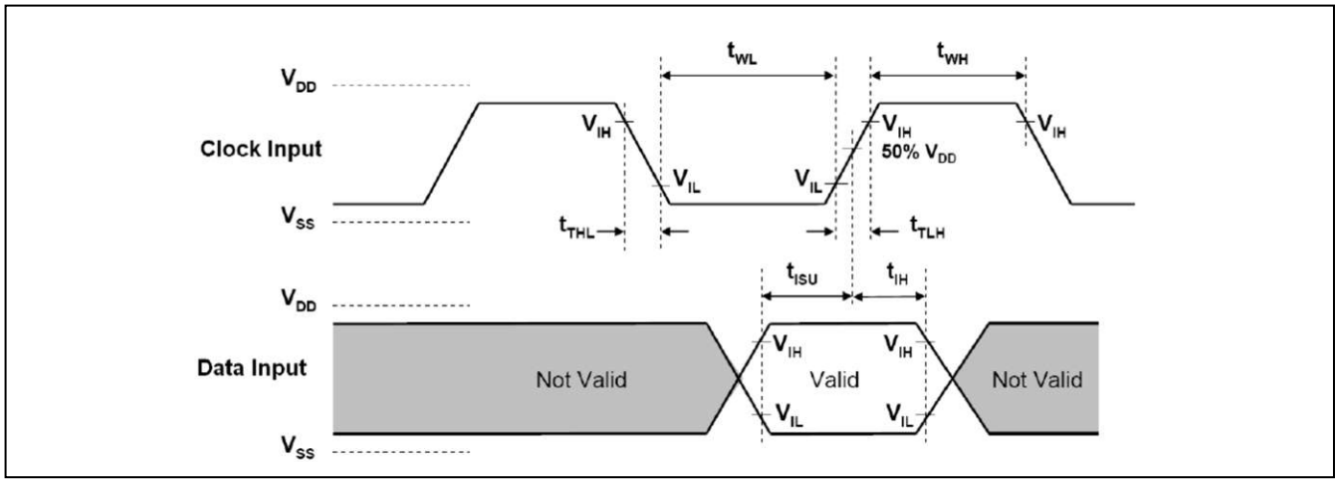


Figure 9. SDIO High Speed Input Timing

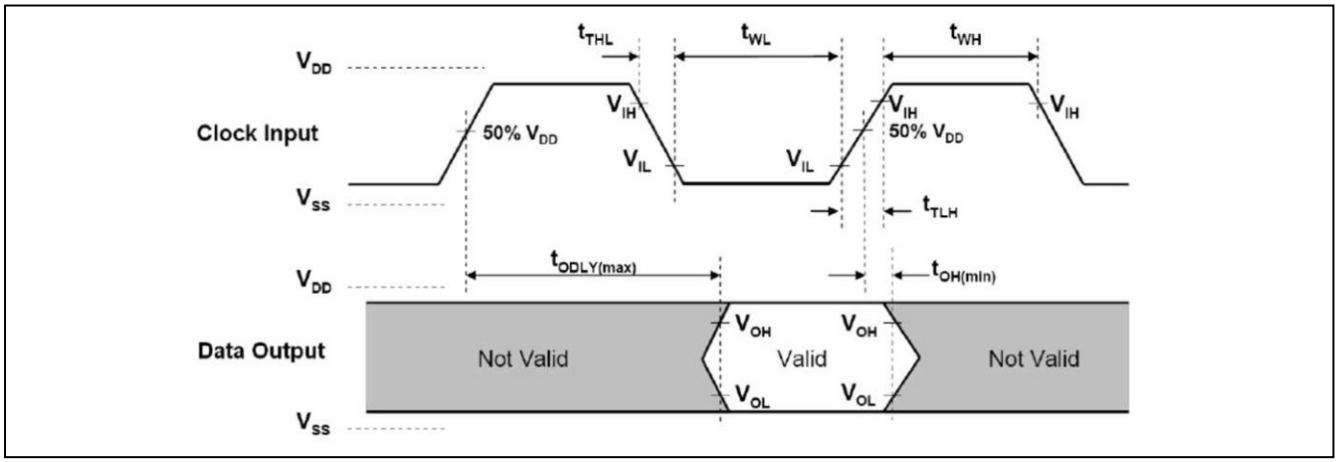


Figure 10. SDIO High Speed Output Timing

Table 17. SDIO Timing Parameters - High Speed

Parameter	Description	MIN	MAX	Unit
f_{clock}	Clock frequency, CLK		52	MHz
t_{High}	High period	7		ns
t_{Low}	Low period	7		
t_{TLH}	Rise time, CLK		3	
t_{THL}	Fall time, CLK		3	
t_{ISU}	Setup time, input valid before CLK ↑	6		
t_{IH}	Hold time, input valid after CLK ↑	2		
t_{ODLY}	Delay time, CLK ↓ to output valid	2	14	
C_L	Capacitive load on outputs	15	40	pF

3.1.10. SPI Timing Characteristics

SPI is another host interface for WLAN. The module also supports shared SPI interface for both BLE and WLAN.
The timing diagram for SPI is as follows:

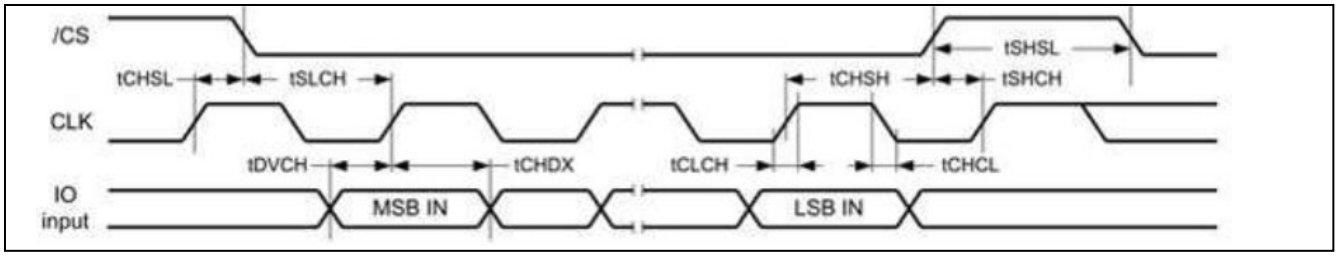


Figure 11. SPI Default Input Timing

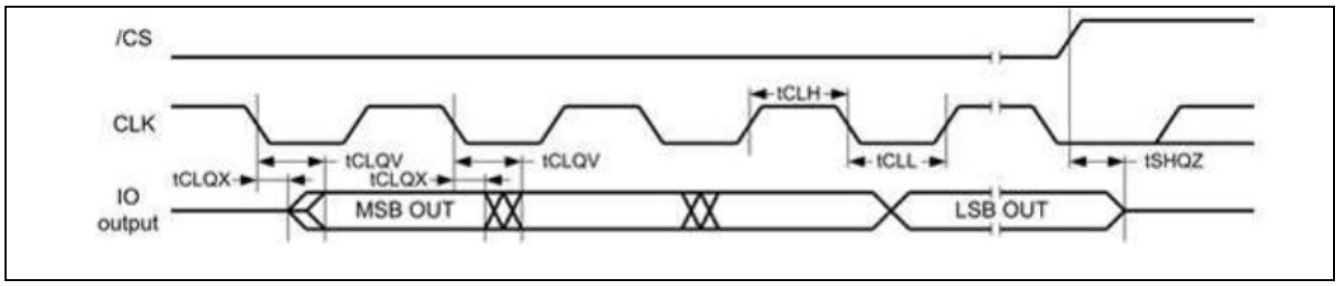


Figure 12. SPI Default Output Timing

Table 18. SPI Timing Parameters

Parameter	Description	MIN	MAX	Unit
f_{clock}	Clock frequency, CLK		26	MHz
t_{High}	High period	10		ns
t_{Low}	Low period	10		
t_{TLH}	Rise time, CLK		3	
t_{THL}	Fall time, CLK		3	
t_{CSU}	CS setup time, CS valid before CLK ↑	3		
t_{ISU}	PICO, input valid before CLK ↑	3		
t_{IH}	PICO Hold time, input valid after CLK ↑	3		
t_{Dr}, t_{Df} - Active	Delay time, CLK ↑ / ↓ to output valid	2	10	
t_{Dr}, t_{Df} - Sleep	Delay time, CLK ↑ / ↓ to output valid		12	
C_L	Capacitive load on outputs	15	40	pF

3.1.11. UART 4-Wire Interface

UART is the main host interface for BLE, which supports host controller interface (HCI) transport layer.

Table 19. UART Timing Parameters

Parameter	Description	MIN	TYP	MAX	Unit
Baud rate	Clock frequency, CLK	37.5		4364	kbps
Baud rate accuracy per byte	Receive/Transmit	-2.5		+1.5	%
Baud rate accuracy per bit	Receive/Transmit	-12.5		+12.5	%
CTS low to TX_DATA on		0	2		ms
CTS high to TX_DATA off	Hardware flow control			1	Byte
CTS high pulse width		1			bit
RTS low to RX_DATA on		0	2		ms
RTS high to RX_DATA off	Interrupt set to 1/4 FIFO			16	Byte

3.2. RF Characteristics

Below RF data is applicable to both ANT1 and ANT2 ports. ANT2 port is not available for BLE.

3.2.1. WLAN Performance: 2.4-GHz Receiver Characteristics

Table 20. WLAN Performance: 2.4-GHz Receiver Characteristics(1)

Parameter	Test Condition	MIN	TYP	MAX	Unit
Operational frequency range		2412		2472	MHz
Sensitivity: 8% PER for 11b rates, 10% PER for 11g/n/ax rates	1 DSSS		-95		dBm
	2 DSSS		-92		
	11 DSSS		-87		
	6 OFDM		-90		
	54 OFDM		-72		
	HT MCS0 MM 4K		-90		
	HT MCS7 MM 4K		-68.5		
	HE MCS0 4K		-89.5		
	HE MCS7 4K		-69.5		
Maximum input level: 8% PER for 11b rates, 10% PER for 11g/n/ax rates	1 DSSS		0		dBm
	6 OFDM, HT MCS0, HE MCS0		0		
	54 OFDM, HT MCS7, HE MCS7		-9		

Parameter	Test Condition	MIN	TYP	MAX	Unit
Adjacent channel rejection	1 DSSS		45		dB
	2 DSSS		39		
	11 DSSS		20		
	6 OFDM		3		
	54 OFDM		20		
	HT MCS0 MM 4K		3		
	HT MCS7 MM 4K		16		
	HE MCS0 4K		-1		
RSSI accuracy	-90 dBm to -30 dBm	-3		3	dB

(1) Data was measured at channel 6 – 2437MHz. Measurements on other channels may show a variance of 1 to 2 dB.

3.2.2. WLAN Performance: 2.4-GHz Transmitter Characteristics

Table 21. WLAN Performance: 2.4-GHz Transmitter Power

Parameter	Test Condition	MIN	TYP	MAX	Unit
Operational frequency range		2412		2472	MHz
Output power at VDD_3V3 = 3.3 V	1 DSSS		17.8		dBm
	6 OFDM		17.8		
	54 OFDM		15.3		
	HT MCS0 MM 4K		17.8		
	HT MCS7 MM 4K		15.3		
	HE MCS0 4K		17.8		
	HE MCS7 4K		15.1		

(1) Data was measured at channel 6 – 2437MHz. Measurements on other channels may show a variance of 1 to 2 dB. Typical power was recorded as average power, peak power can reach 20 dBm. TX power on each channel might be limited by the regulatory requirement.

3.2.3. WLAN Performance: 5-GHz Receiver Characteristics

Table 22. WLAN Performance: 5-GHz Receiver Characteristics

Parameter	Test Condition	MIN	TYP	MAX	Unit
Operational frequency range		5180		5845	MHz
Sensitivity: 10% PER for 11g/n/ax rates	6 OFDM		-90.5		
	54 OFDM		-73		
	HT MCS0 MM 4K		-90.5		
	HT MCS7 MM 4K		-71		
	HE MCS0 4K		-89.5		
	HE MCS7 4K		-69.5		
Maximum input level: 10% PER for 11g/n/ax rates	6 OFDM, HT MCS0, HE MCS0		-23		dBm
	54 OFDM, HT MCS7, HE MCS7		-24		
Adjacent channel rejection	6 OFDM		20		dB
	54 OFDM		3		
	HT MCS0		18		
	HT MCS7		0		
	HE MCS0		16		
	HE MCS7		-1		
RSSI accuracy	-90 dBm to -30 dBm	-3		3	dB

3.2.4. WLAN Performance: 5-GHz Transmitter Characteristics

Table 23. WLAN Performance: 5-GHz Transmitter Power

Parameter	Test Condition	MIN	TYP	MAX	Unit
Operational frequency range		5180		5845	MHz
Output power at VDD_3V3 = 3.3 V	6 OFDM		16.4		dBm
	54 OFDM		11.7		
	HT MCS0		16.4		
	HT MCS7		11.7		
	HE MCS0		16.5		
	HE MCS7		10.6		

(1) The output power is measured at frequency 5580MHz. Measurements on other channels may show a variance of 1 to 2 dB. Typical power was recorded as average power, peak power can reach 20 dBm. TX power on each channel might be limited by the regulatory requirement.

3.2.5. BLE Performance: Receiver Characteristics

Table 24. BLE Performance: 2.4-GHz Receiver Characteristics

Parameter	Test Condition	MIN	TYP	MAX	Unit
BLE 125Kbps (LE Coded) Receiver Characteristics					
Receiver sensitivity	PER <30.8%		-100		dBm
Receiver saturation	PER <30.8%		0		
Co-channel rejection (1)	Wanted signal at -79 dBm, modulated interferer in channel		10		dB
Selectivity, ±1 MHz (1)	Wanted signal at -79 dBm, modulated interferer at ±1 MHz		0 / 0 (2)		
Selectivity, ±2 MHz (1)	Wanted signal at -79 dBm, modulated interferer at ±2 MHz		-37 / -30 (2)		
Selectivity, ±3 MHz (1)	Wanted signal at -79 dBm, modulated interferer at ±3 MHz		-39 / -36 (2)		
Selectivity, ±4 MHz (1)	Wanted signal at -79 dBm, modulated interferer at ±4MHz		-45 / -41 (2)		
RSSI accuracy	-90 dBm to -20 dBm	-4		4	
BLE 500Kbps (LE Coded) Receiver Characteristics					
Receiver sensitivity	PER <30.8%		-97.5		dBm
Receiver saturation	PER <30.8%		0		
Co-channel rejection (1)	Wanted signal at -72 dBm, modulated interferer in channel		10		dB
Selectivity, ±1 MHz (1)	Wanted signal at -72 dBm, modulated interferer at ±1 MHz		0 / 0 (2)		
Selectivity, ±2 MHz (1)	Wanted signal at -72 dBm, modulated interferer at ±2 MHz		-35 / -25 (2)		
Selectivity, ±3 MHz (1)	Wanted signal at -72 dBm, modulated interferer at ±3 MHz		-40 / -37 (2)		
Selectivity, ±4 MHz (1)	Wanted signal at -72 dBm, modulated interferer at ±4MHz		-45 / -40 (2)		
RSSI accuracy	-90 dBm to -20 dBm	-4		4	
BLE 1Mbps (LE 1M) Receiver Characteristics					
Receiver sensitivity	PER <30.8%, 37-byte packets		-95.5		dBm
Receiver sensitivity	PER <30.8%, 255-byte packets		-95		
Receiver saturation	PER <30.8%		0		
Co-channel rejection (1)	Wanted signal at -67 dBm, modulated interferer in channel		10		dB
Selectivity, ±1 MHz (1)	Wanted signal at -67 dBm, modulated interferer at ±1 MHz		0 / 0 (2)		
Selectivity, ±2 MHz (1)	Wanted signal at -67 dBm, modulated interferer at ±2 MHz		-35 / -28 (2)		
Selectivity, ±3 MHz (1)	Wanted signal at -67 dBm, modulated interferer at ±3 MHz		-38 / -32 (2)		
Selectivity, ±4 MHz (1)	Wanted signal at -67 dBm, modulated interferer at ±4MHz		-45 / -40 (2)		
Out-of-band blocking	30 MHz to 2000 MHz, wanted signal at -67 dBm		-23		dBm
Out-of-band blocking	2003 MHz to 2399 MHz, wanted signal at -67 dBm		-30		
Out-of-band blocking	2484 MHz to 2997 MHz, wanted signal at -67 dBm		-30		
Out-of-band blocking	3000 MHz to 6 GHz, wanted signal at -67 dBm		-21		
Intermodulation	Wanted signal at 2402 MHz, -64 dBm, two interferers at 2405 and 2408 MHz respectively, at the given power level		-40		
RSSI accuracy	-90 dBm to -20 dBm	-4		4	dB
BLE 2Mbps (LE 2M) Receiver Characteristics					
Receiver sensitivity	PER <30.8%, 37-byte packets		-93		dBm
Receiver saturation	PER <30.8%		0		
Co-channel rejection (1)	Wanted signal at -67 dBm, modulated interferer in channel		10		dB
Selectivity, ±2 MHz (1)	Wanted signal at -67 dBm, modulated interferer at ±1 MHz		0 / 0 (2)		
Selectivity, ±4 MHz (1)	Wanted signal at -67 dBm, modulated interferer at ±2 MHz		-35 / -28 (2)		
Selectivity, ±6 MHz (1)	Wanted signal at -67 dBm, modulated interferer at ±3 MHz		-35 / -28 (2)		
Alternate channel rejection, ±8 MHz (1)	Wanted signal at -67 dBm, modulated interferer at ±8MHz		-37 / -32 (2)		
Out-of-band blocking	30 MHz to 2000 MHz, wanted signal at -67 dBm		-23		dBm
Out-of-band blocking	2003 MHz to 2399 MHz, wanted signal at -67 dBm		-30		
Out-of-band blocking	2484 MHz to 2997 MHz, wanted signal at -67 dBm		-30		
Out-of-band blocking	3000 MHz to 6 GHz, wanted signal at -67 dBm		-21		
Intermodulation	Wanted signal at 2402 MHz, -64 dBm, two interferers at 2405 and 2408 MHz respectively, at the given power level		-44		
RSSI accuracy	-90 dBm to -20 dBm	-4		4	dB

(1) Numbers given as C/I dB;
(2) X / Y, where X is +N MHz and Y is –N MHz;

3.2.6. BLE Performance: Transmitter Characteristics

Table 25. BLE Performance: Transmitter Characteristics

Parameter	Test Condition	MIN	TYP	MAX	Unit
Operational frequency range		2402		2480	MHz
Output power	Highest setting		17.6		dBm

(1) Data was measured at channel 6 – 2440MHz. Measurements on other channels may show a variance of 1 to 2 dB. TX power might be limited by the regulatory requirement.

3.3. Antenna Characteristics

BDE provides a reference PCB trace antenna to work with BDE-BW3351NP2 module. This reference antenna is certified with the module. Customer can refer to the reference layout to achieve similar performance while integrating the module to the system. The following data was measured with the module assembled to a reference board. The module placement and the dimension of the reference board is shown in below figure.

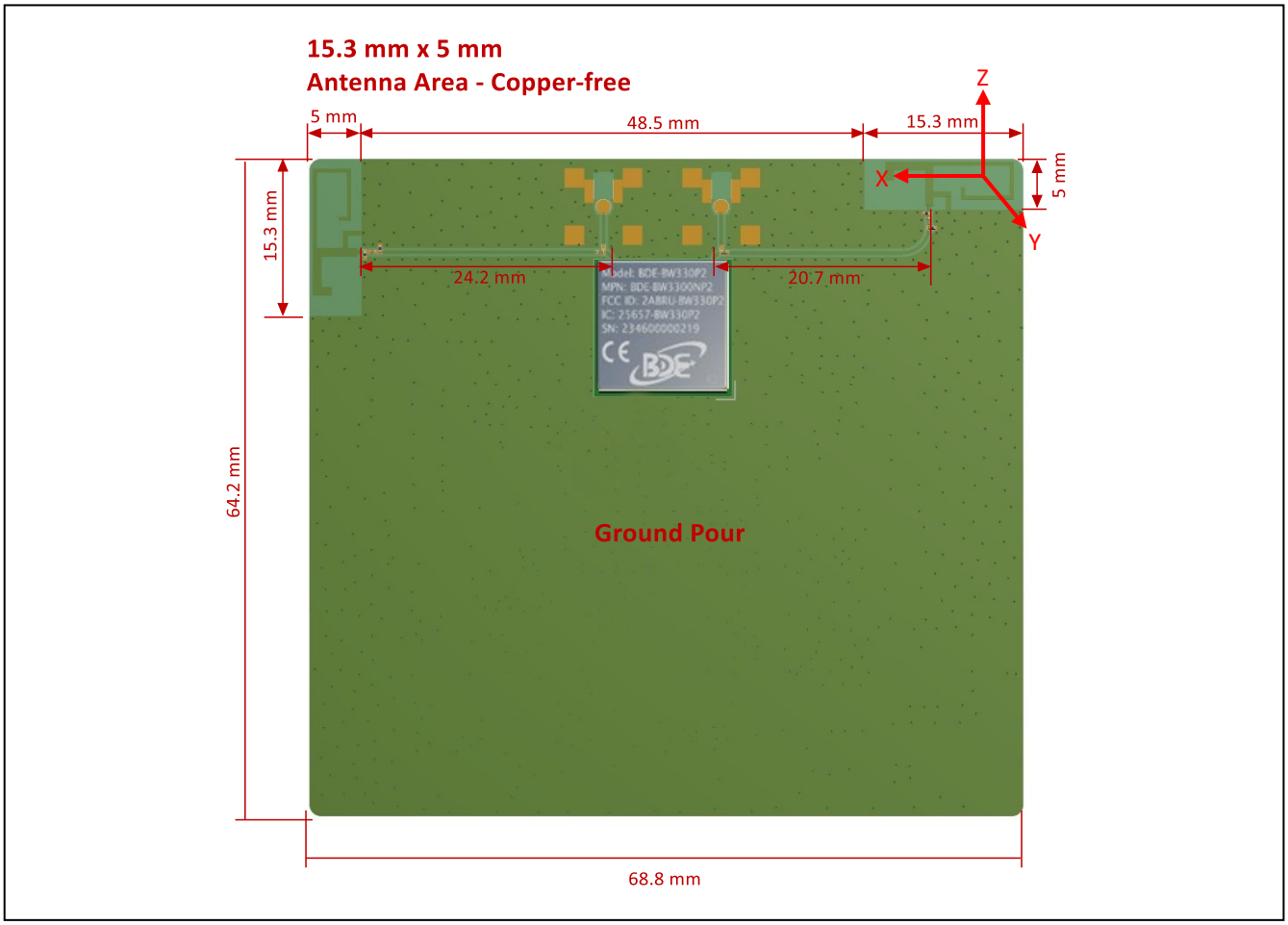


Figure 13. Antenna Placement and Reference Board

3.3.1. Antenna Gain

Table 26. Gain of Integrated PCB Trace Antenna – 2.4G

Frequency (MHz)	Gain (dBi)
2410	0.06
2420	-0.10
2430	-0.02
2440	0.27
2450	0.50
2460	0.56
2470	0.57
2480	0.71

Table 27. Gain of Integrated PCB Trace Antenna – 5G

Frequency (MHz)	Gain (dBi)
5150	1.34
5250	0.45
5350	0.43
5450	0.12
5550	1.41

Frequency (MHz)	Gain (dBi)
5650	0.60
5750	0.58
5850	-0.63

3.3.2. Antenna Radiation Pattern

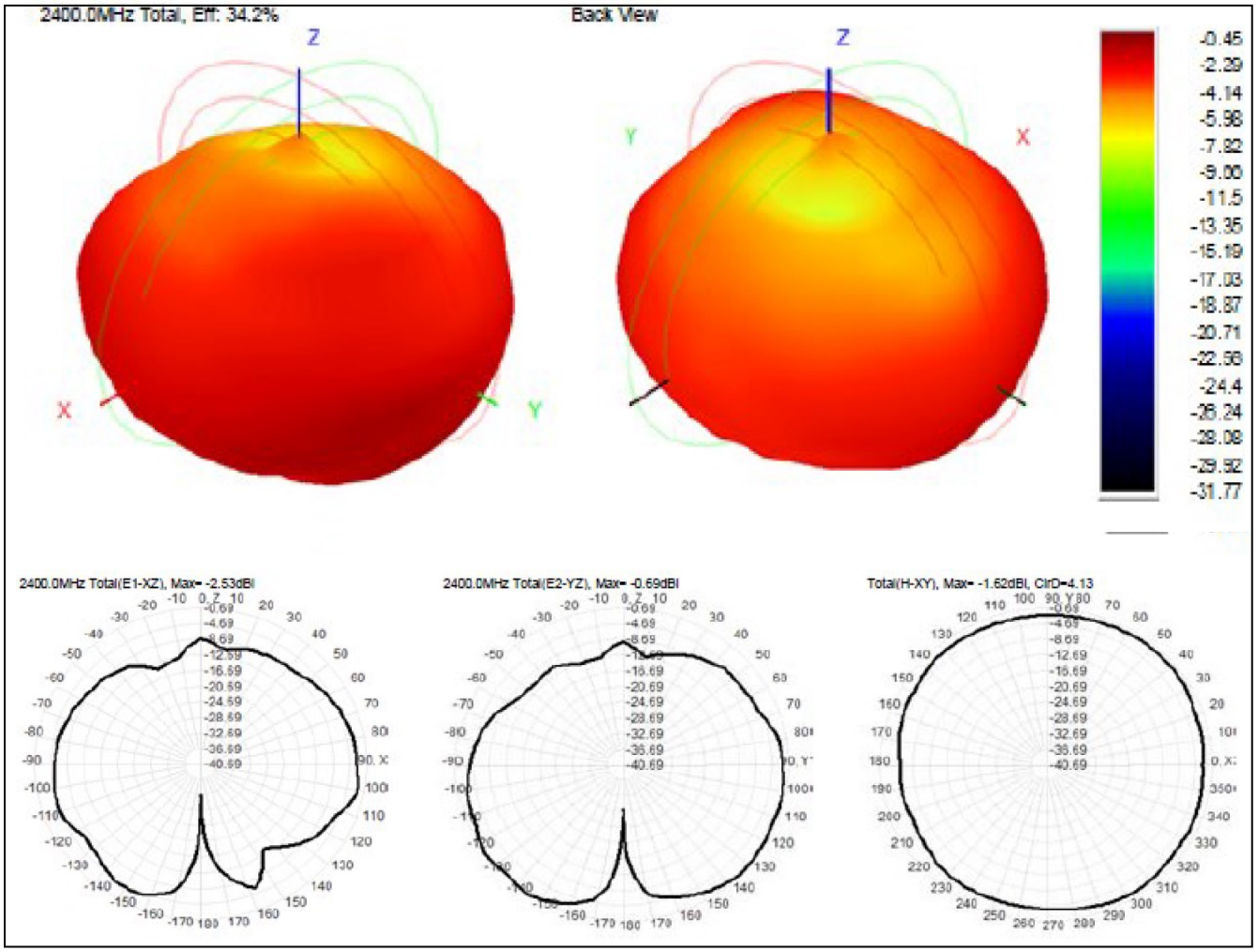


Figure 13. Radiation Pattern of the Integrated PCB Trace Antenna at 2440MHz

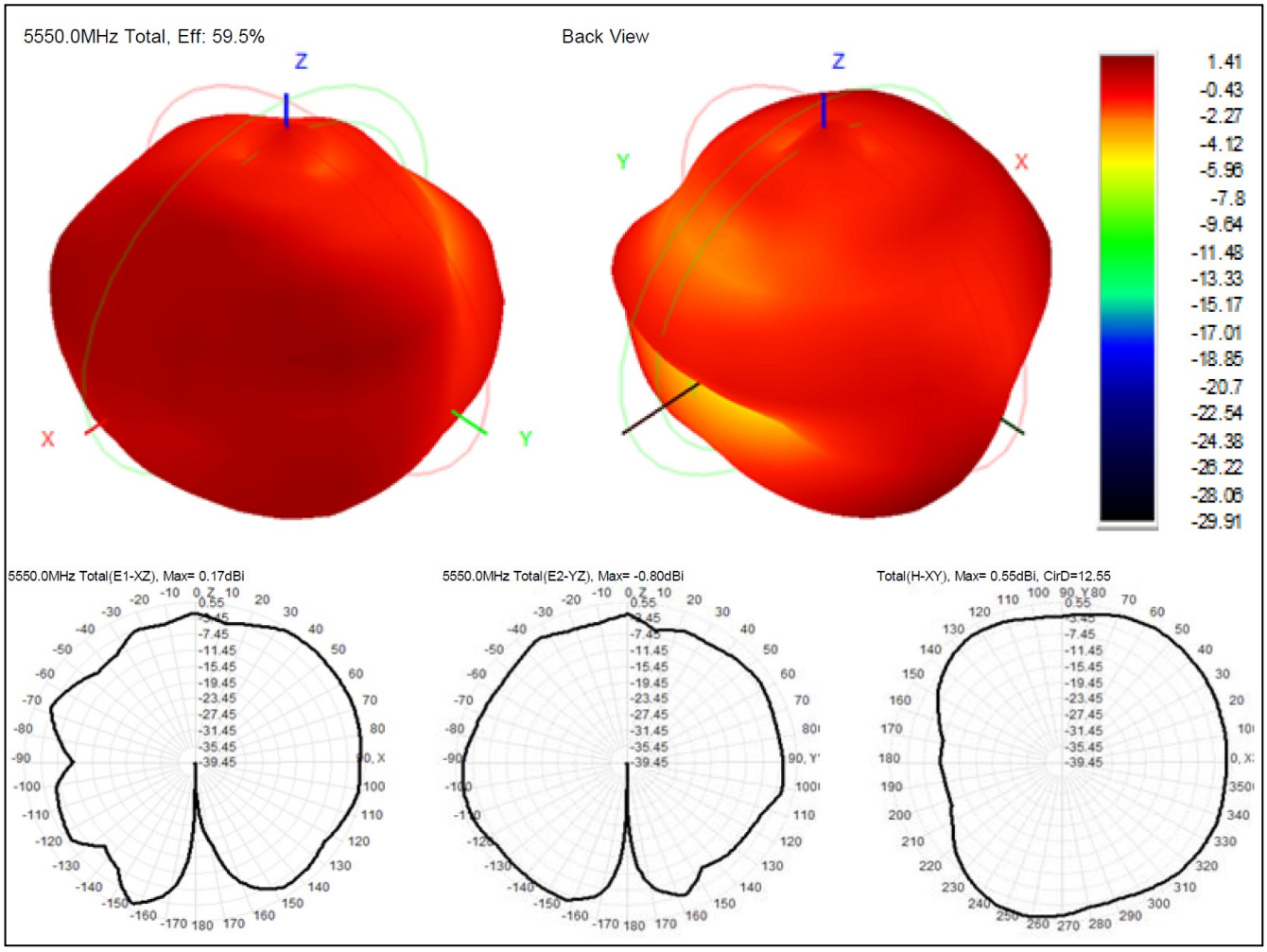


Figure 13. Radiation Pattern of the Reference PCB Trace Antenna at 5550MHz

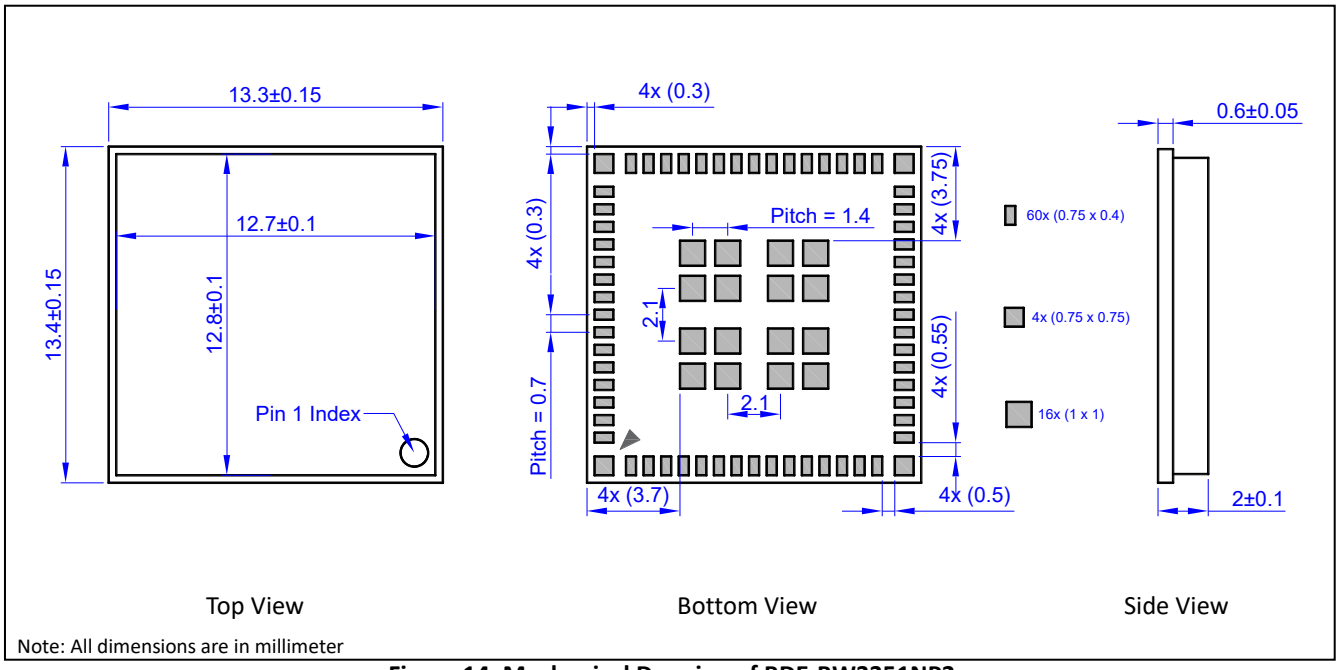
3.3.3. Other Certified Antennas

For other certified antennas, please refer to Table 33.

4. Mechanical Specifications

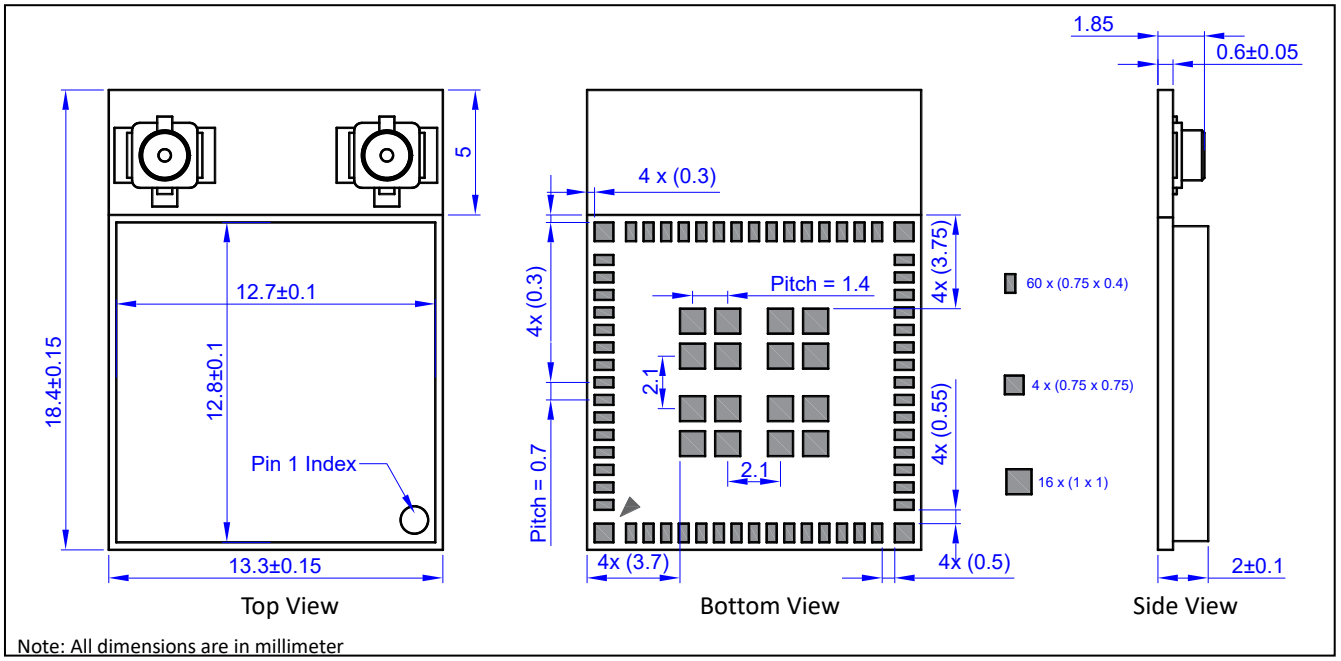
4.1. Module Dimensions

The module dimensions ae shown in following figures:



Note: All dimensions are in millimeter

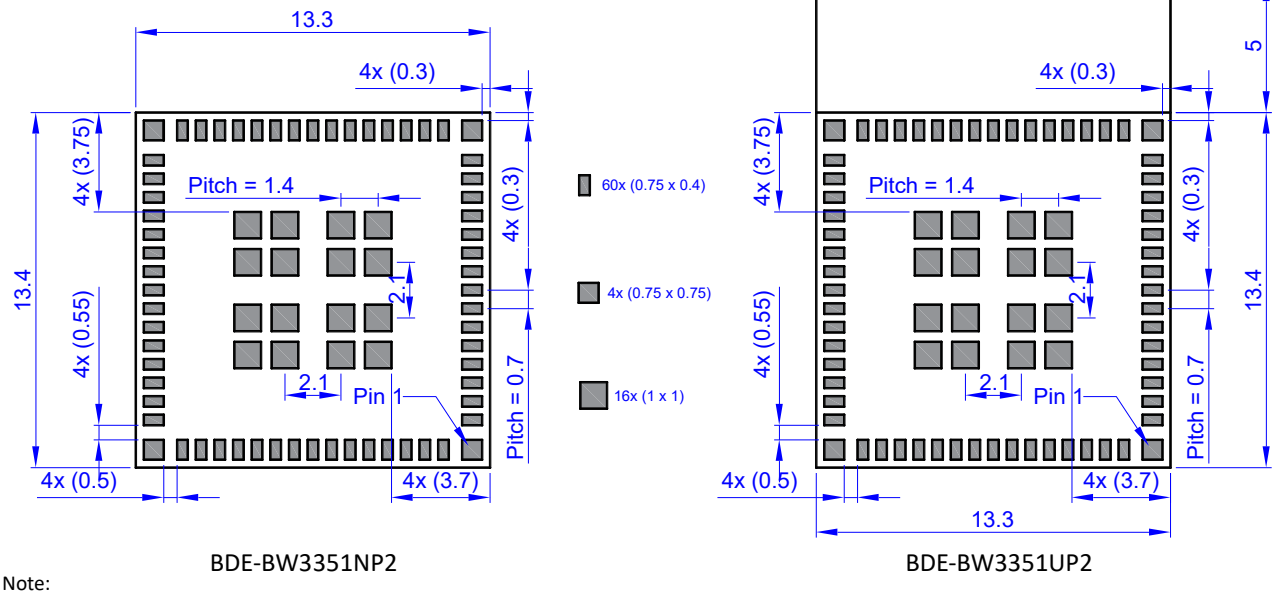
Figure 14. Mechanical Drawing of BDE-BW3351NP2



Note: All dimensions are in millimeter

Figure 15. Mechanical Drawing of BDE-BW3351UP2

4.2. PCB Footprints



BDE-BW3351NP2 BDE-BW3351UP2

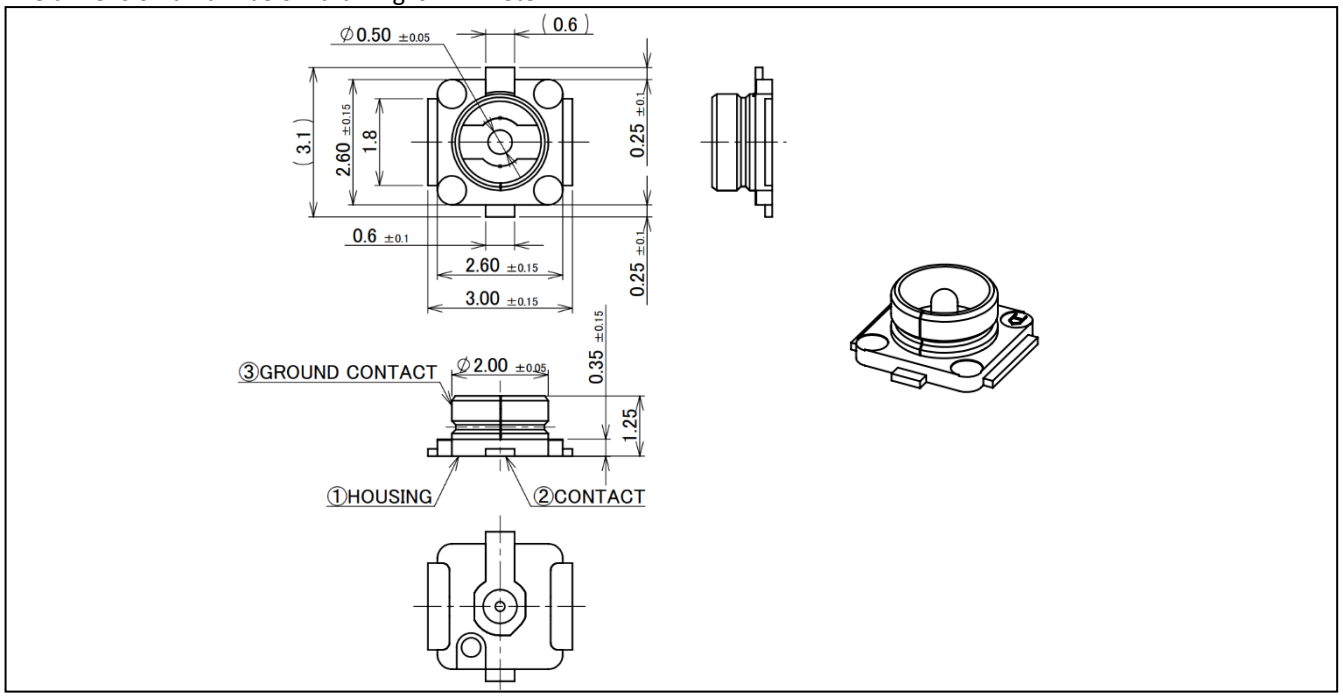
Note:
(1) All dimensions are in millimeter;
(2) Solder mask should be the same or 5% larger than the dimension of the pad;
(3) Solder paste must be the same as the pin for all peripheral pads. For thermal pads, make the solder paste 20% smaller than the pad;
(4) Customers can modify the land pattern dimensions based on their manufacturing experience.

Figure 16. Recommended Footprint Drawings

4.3. U.FL Connector Specification

The drawing and specification of the U.FL connector utilized in the module is as below for reference.

The dimension unit in below drawing is millimeter.

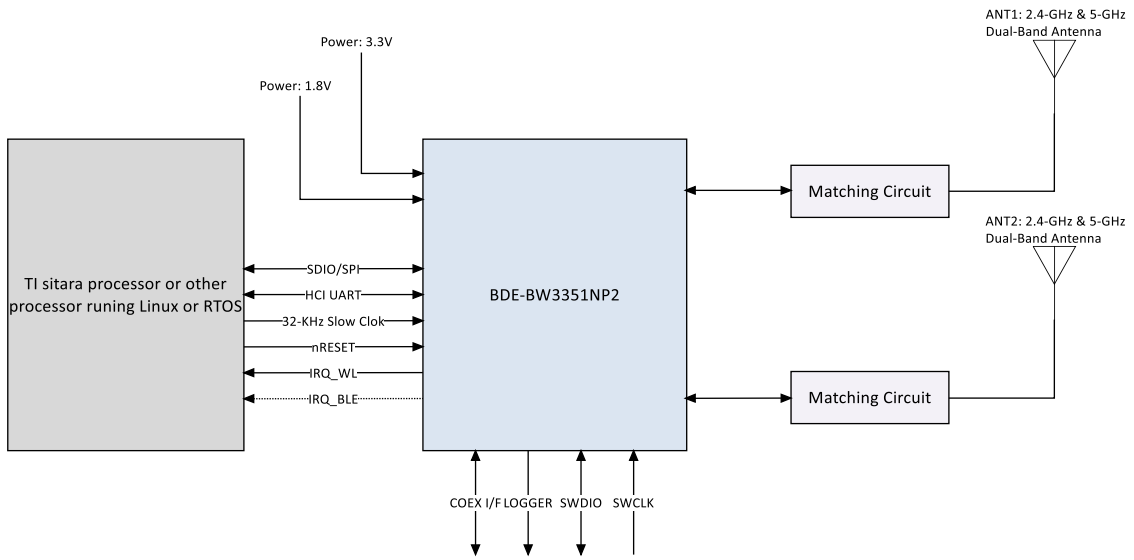


RATING VOLTAGE	60 V AC (R.M.S)	
RATING FREQUENCY	DC～9GHz	
OPERATING TEMPERATURE	233～363K (-40℃～+90℃)	
VSWR	RECEPTACLE: 1.3 MAX. AT 0.1～3 GHz, 1.4 MAX. AT 3～6 GHz, 1.8 MAX. AT 6～9 GHz	
MAIN CONTACT RESISTANCE	INITIAL: 20 mohm MAX. / AFTER TEST: ⊿R 20 mohm MAX.	
GROUND CONTACT RESISTANCE	INITIAL: 20 mohm MAX. / AFTER TEST: ⊿R 100 mohm MAX.	
INSULATION RESISTANCE	INITIAL: 500 Mohm MIN. / AFTER TEST: 100 Mohm MIN.	
DIELECTRIC WITHSTANDING VOLTAGE	200 V AC, 1 MINUTE	
DURABILITY	30 CYCLES	
UNMATING FORCE (INITIAL / AFTER TEST)	INITIAL: 5 N MIN. AFTER TEST: 3 N MIN.	INITIAL: 4 N MIN. AFTER TEST: 2 N MIN.

Figure 17. U.FL Connector Drawing and Specification

5. Integration Guideline

5.1. System Diagram



Note:
(1) Proper decoupling capacitors are recommended to be placed close to the power pins of the module;
(2) Pin IRQ_WL and Logger are assigned as the SoP mode pins, the default SoP mode is "01", which is IRQ_WL pin being pulled down and Logger pin being pulled up by default;
(3) SWDIO and SWCLK is for RF testing using TI's SimpleLink Wi-Fi ToolBox, recommended to be exposed to the test points or headers;
(4) LOGGER is for logs output, recommended to be exposed to a test point or hearder;
(5) SDIO/SPI can be used for Linux; SPI is used by default for RTOS system;
(6) COEX I/F is the coexistence interface;
(7) For BDE-BW3300UP1, antenna is attached to the module through U.FL connector;
(8) ANT1 and ANT2 should be placed apart, refer to Section 5.2 for placement;
(9) ANT2 is not available for BLE.

Figure 18. High-Level System Block Diagram

5.2. Module Placement

The placement of the module in the base board is critical in your design. Improper placement can lead to poor antenna performance. BDE recommends following below practical placement to achieve acceptable antenna performance.

Any form of proximity to the metal or other material will change/degrade the antenna performance. Keep the antenna area as far as possible to the metal material in any direction. If metal materials cannot be avoided in your design for example the

design with metal enclosure, we recommend keep the antenna area at least 40mm distance to the enclosure in all directions. Customers should verify the communication range with the mock-up or real product prototype on their own.

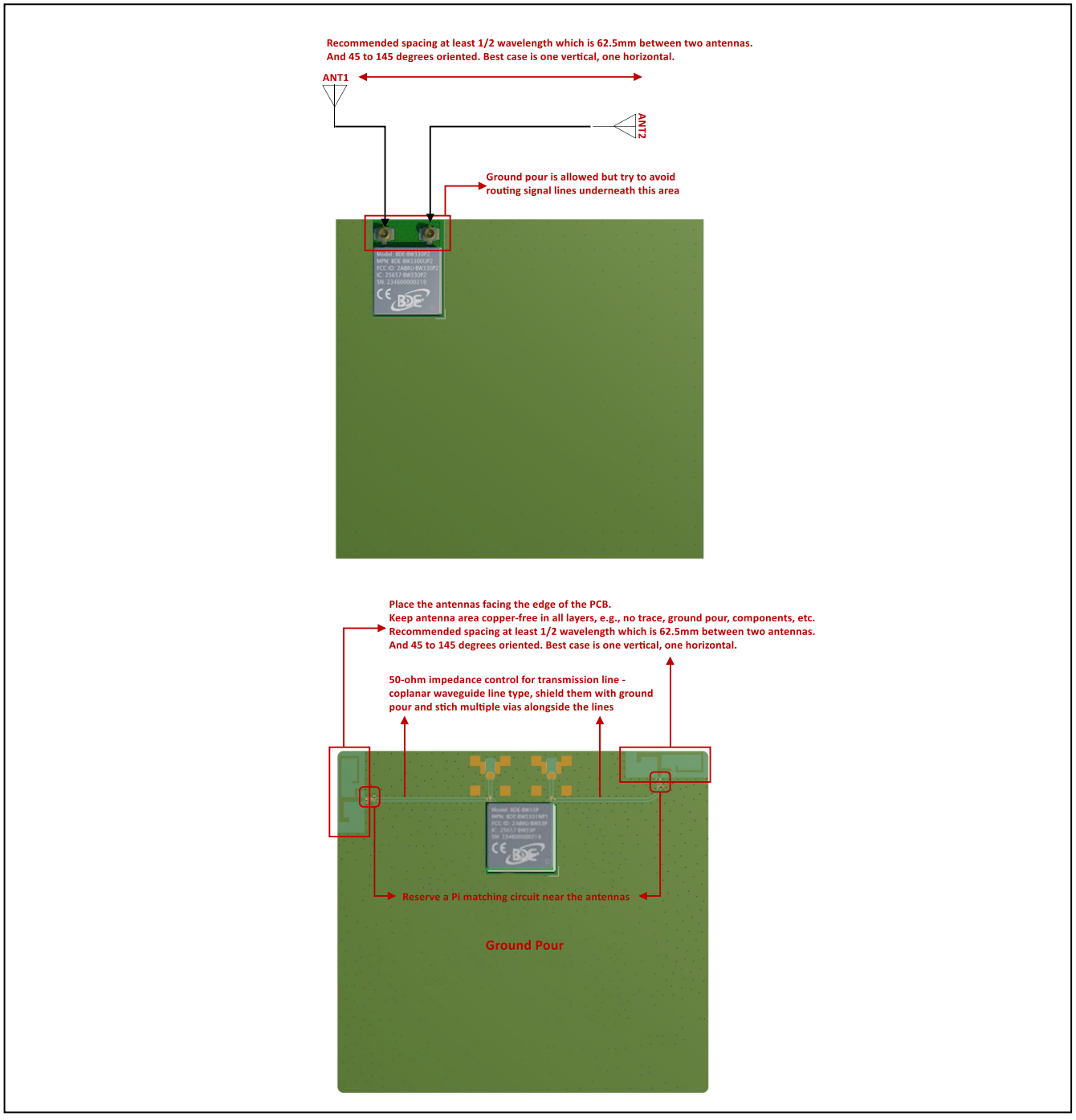


Figure 19. Recommended Module Placement

5.3. Other Design Considerations

Table 28. Other Design Considerations

	Thermal
1	The proximity of ground vias must be close to each ground pad of the module.
2	Signal traces must not be run underneath the module on the layer where the module is mounted.
3	Have a complete ground pour in layer 2 for thermal dissipation.
4	Have a solid ground plane and ground vias under the module for stable system and thermal dissipation.
5	Increase the ground pour in the first layer and have all of the traces from the first layer on the inner layers, if possible.

6	Signal traces can be run on a third layer under the solid ground layer, which is below the module mounting layer.
RF Trace and Antenna Routing	
7	The RF trace antenna feed must be as short as possible beyond the ground reference. At this point, the trace starts to radiate.
8	The RF trace bends must be gradual with an approximate maximum bend of 45° with trace mitered. RF traces must not have sharp corners.
9	RF traces must have via stitching on the ground plane beside the RF trace on both sides.
10	RF traces must have constant impedance (50-ohm Coplanar or microstrip transmission line).
11	For best results, the RF trace ground layer must be the ground layer immediately below the RF trace. The ground layer must be solid.
12	There must be no traces or ground under the antenna section.
13	RF traces must be as short as possible. The antenna, RF traces, and modules must be on the edge of the PCB product. The proximity of the antenna to the enclosure and the enclosure material must also be considered.
14	BDE recommends using double-shielded coaxial RF cable to connect with the U.FL connector with antenna if the U.FL variants are selected.
15	Do not place or run the RF cable right above or below the module.
16	If there are some other radios besides this module in the system, try to place them apart as far as possible. And ensure there is at least 25 dB isolation between the antenna port of every radio.
Supply and Interface	
17	The power trace for VDD_3V3 is recommended to be at least 20-mil wide.
18	The VDD_1V8 trace is recommended to be at least 20-mil wide.
19	Make VDD_3V3 and VDD_1V8 traces as wide as possible to ensure reduced inductance and trace resistance.
20	If possible, shield 3V3 and 1V8 traces with ground above, below, and beside the traces.
21	SDIO signals traces (CLK, CMD, D0, 01, 02, and 03) must be routed in parallel to each other and as short as possible (less than 12 cm). In addition, every trace length must be the same as the others. There should be enough space between traces- greater than 1.5 times the trace width to ensure signal quality, especially for the SDIO_CLK trace. Remember to keep these traces away from the other digital or analog signal traces. It is recommended adding ground shielding around these buses.
22	SDIO and digital clock signals are a source of noise. Keep the traces of these signals as short as possible. If possible, maintain a clearance around them.

5.4. Development Resources

Each module will have a breakout board for its own and it can be interfaced with the plug-in evaluation module BDE-BW33-EM. The module also comes with the M.2 Key E form factor that can work with any evaluation board of the processor that supports the standard M.2 Key E interface.

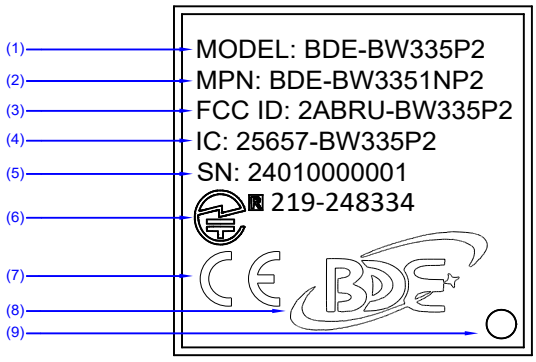
For more information on the development kits, please visit the product page on bdecomm.com or refer to the **Module User Guide**.

6. Handling Instructions

The module is the surface mount module with LGA footprint. It is designed to conform to the major manufacturing guidelines, including the commercial, industrial manufacturing process.

In this section, we will cover the basic shipping information, including the module markings, packaging, labeling, etc. And also, the instructions on how to handle the module in terms of storage, assembly and so on.

6.1. Module Marking

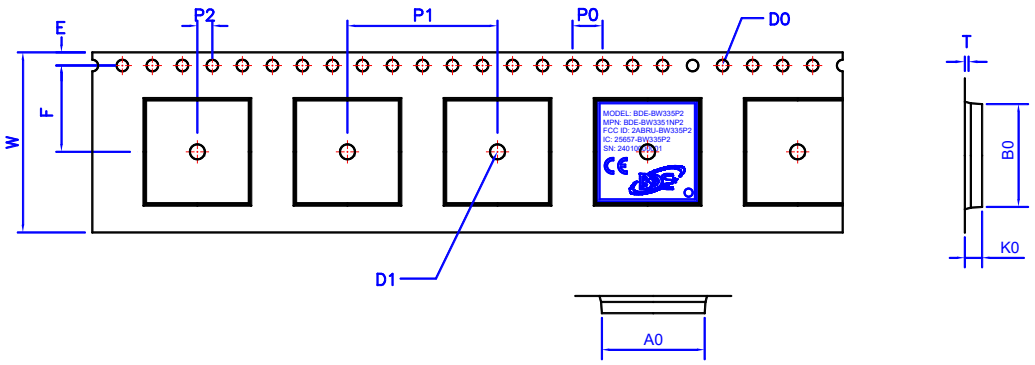


(1) Model series number;
(2) Orderable Manufacturer Part Number. Refer to Table 1;
(3) FCC ID;
(4) IC ID;
(5) Serial number for traceability;
(6) GITEKI mark and MIC number;
(7) CE mark;
(8) BDE logo.
(9) Pin 1 index;

Figure 20. Module Marking

6.2. Packaging Information

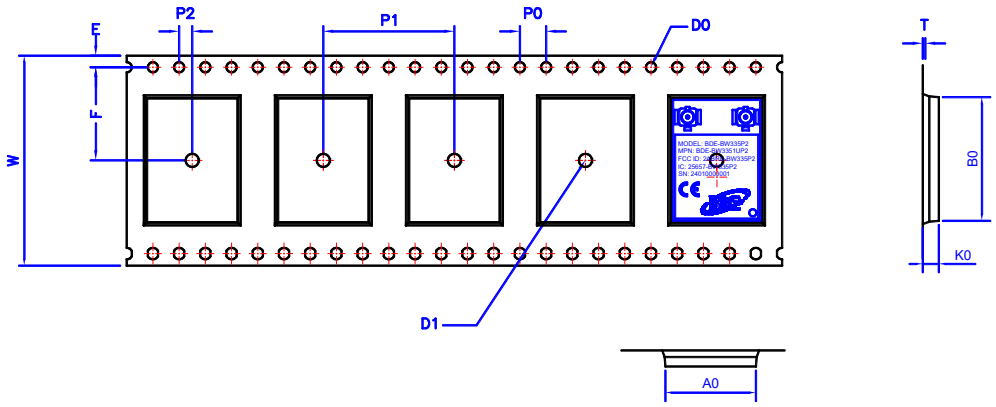
6.2.1. Tape and Reel Package Information



W	A_0	B_0	K_0	P_1	F	E	D_0	D_1	P_0	P_2	T
$24.00^{+0.30}_{-0.10}$	$13.70^{+0.10}_{-0.10}$	$13.70^{+0.10}_{-0.10}$	$2.30^{+0.10}_{-0.10}$	$20.00^{+0.10}_{-0.10}$	$11.50^{+0.10}_{-0.10}$	$1.75^{+0.10}_{-0.10}$	$1.50^{+0.10}_{-0.00}$	$2.00^{+0.10}_{-0.00}$	$4.00^{+0.10}_{-0.10}$	$2.00^{+0.10}_{-0.10}$	$0.35^{+0.05}_{-0.05}$

Note:
(1) Cumulative tolerance for every 10 sprockets pitch is ±0.2mm;
(2) Carrier camber not to exceed 1mm in every 100mm;
(3) All dimensions are in millimeter and meets EIA-481-C requirements;
(4) Material: PS Black polystyrene;
(5) Thickness: 0.35±0.05mm;
(6) Packing length per 13"reel: 20.7 meters;
(7) Component load per 13"reel: 1000+30pcs (15 voids each to the head and tail);
(8) RoHS compliance;
(9) Anti-static coefficient of $10^{6\text{-}11}\Omega$.

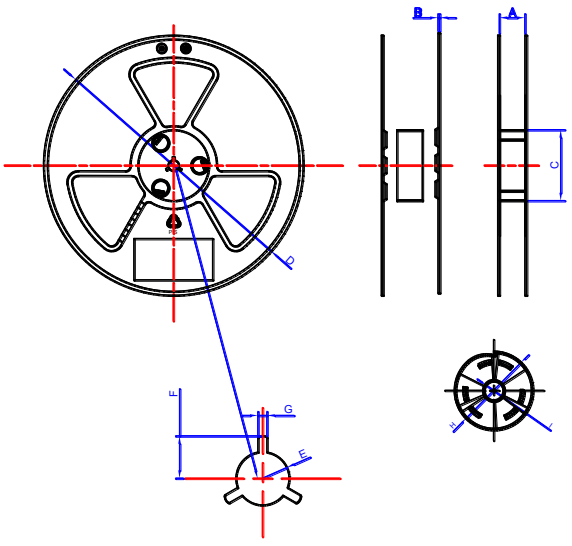
Figure 21. Carrier Tape Drawing for BDE-BW3351NP2 Variants



W	A_0	B_0	K_0	P_1	F	E	D_0	D_1	P_0	P_2	T
$32.00^{+0.30}_{-0.10}$	$13.80^{+0.10}_{-0.10}$	$18.85^{+0.10}_{-0.10}$	$2.30^{+0.10}_{-0.10}$	$20.00^{+0.10}_{-0.10}$	$14.20^{+0.10}_{-0.10}$	$1.75^{+0.10}_{-0.10}$	$1.50^{+0.10}_{-0.00}$	$2.00^{+0.10}_{-0.00}$	$4.00^{+0.10}_{-0.10}$	$2.00^{+0.10}_{-0.10}$	$0.35^{+0.05}_{-0.05}$

Note:
(1) Cumulative tolerance for every 10 sprockets pitch is ±0.2mm;
(2) Carrier camber not to exceed 1mm in every 100mm;
(3) All dimensions are in millimeter and meets EIA-481-C requirements;
(4) Material: PS Black polystyrene;
(5) Thickness: 0.35±0.05mm;
(6) Packing length per 13"reel: 20.7 meters;
(7) Component load per 13"reel: 1000+30pcs (15 voids each to the head and tail);
(8) RoHS compliance;
(9) Anti-static coefficient of $10^{6-11}\Omega$.

Figure 22. Carrier Tape Drawing for BDE-BW3351UP2 Variants



A	B	C	D	E	F	G	H	I
24.5 / 32.5	2	100	330	6.75	0.85	2.5	100	24

Note:
(1) All dimensions are in millimeter;
(2) Material: PS blue polystyrene;
(3) Dimension A is 24.5mm for BDE-BW3300NP2 variants and 32.5mm for BDE-BW3300UP2 variants.

Figure 23. 13-Inch Reel Drawing

6.2.2. Carton Information and Labeling

6.2.2.1. Carton Information

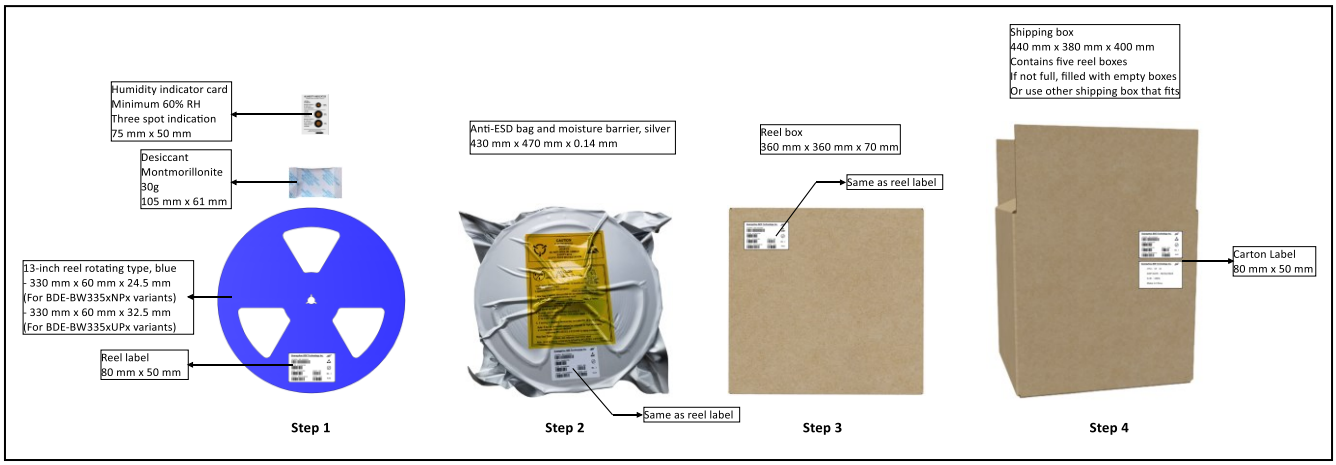


Figure 24. Carton Information

6.2.2.2. Reel Label

The reel label will be affixed onto the reel, Anti-ESD bag and reel box. It mainly shows the MPN (Manufacturer Part Number), CPN (Customer Part Number), PO (Purchase Order Number), LOT number, QTY (Quantity), DC (Date Code) and MSL (Moisture Sensitivity Level). Sometimes, it also shows other information, such as the regulatory information.

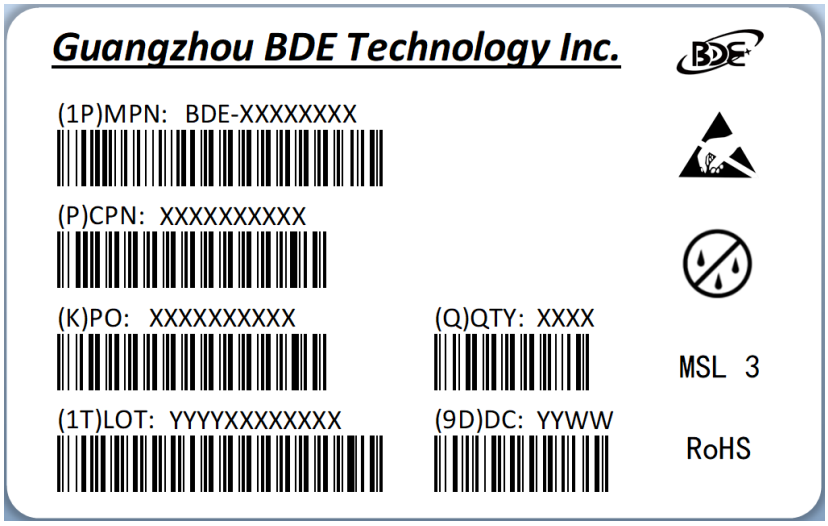


Figure 25. Reel Label Information

6.2.2.3. Carton Label

The carton label will be affixed onto the surface of the carton. If the carton contains different Part Numbers or POs, there will be different labels representing different Part Numbers, different POs and Quantity.

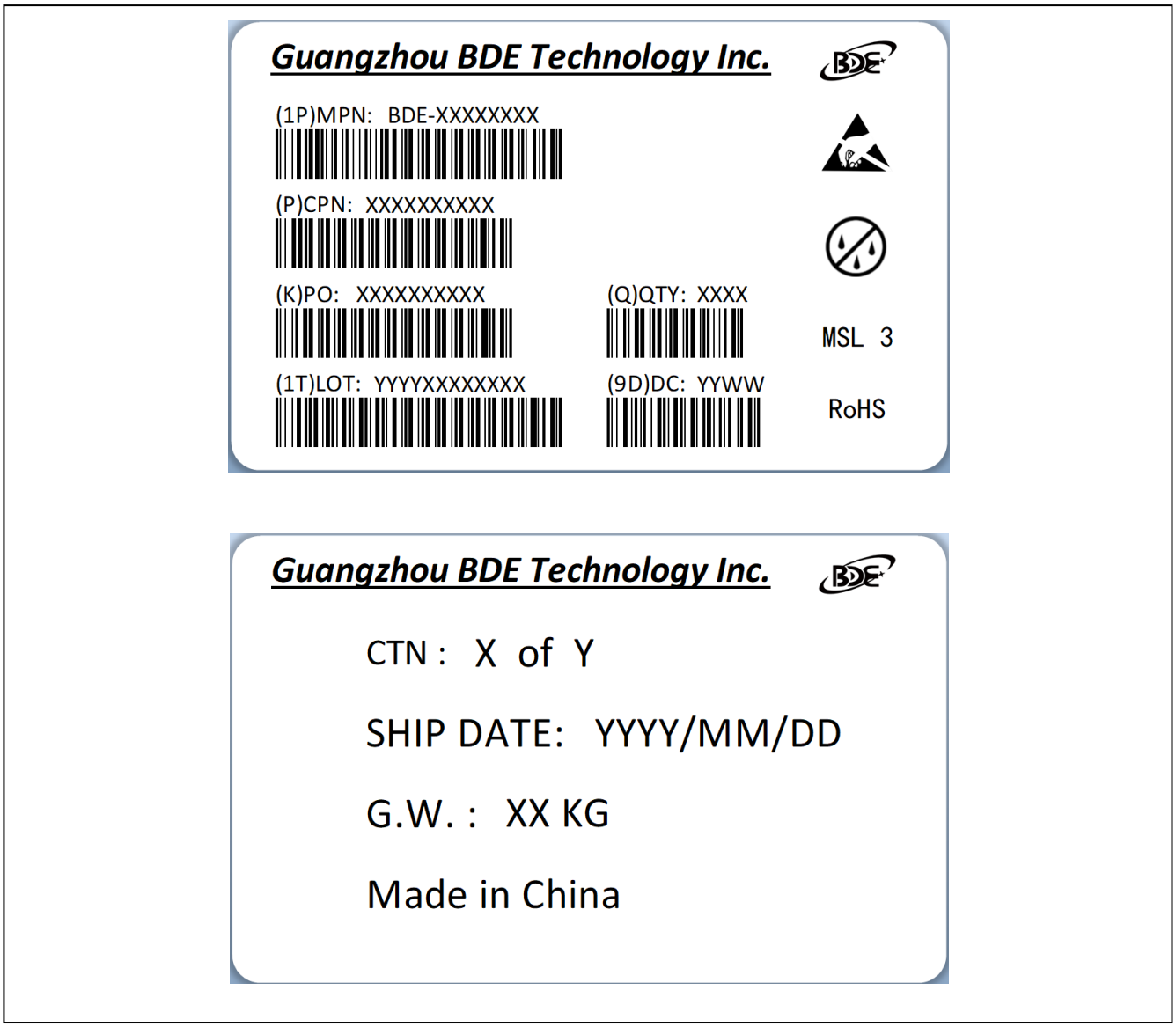


Figure 26. Carton Label Information

6.3. Assembly Instruction

6.3.1. Moisture Sensitive Level

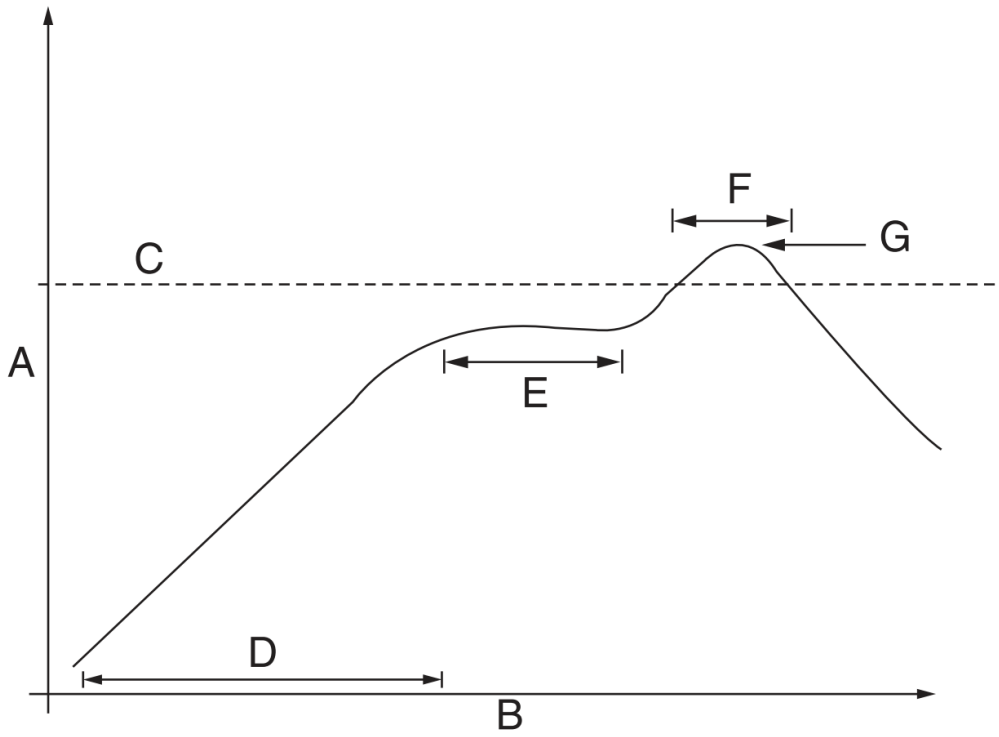
The MSL (Moisture Sensitive Level) of the module is MSL-3. Handling guidelines are listed as below:

(1) The floor life for MSL-3 device is 168 hours in ambient environment 30°C/60%RH. Before assembly, make sure to check if the modules are packaged with desiccate and humidity indicator card;

(2) After the bag is opened, make sure to mount the modules within 168 hours at factory conditions (< 30°C/60% RH) or stored at <10% RH. Repackage is needed with new desiccate and humidity indicator card if the modules are not mounted before exceeding floor life;

(3) If the card reads >10%, or the modules have been exposed for over 168 hours, the modules need to be baked before mounted. Recommended baking condition is 125℃ for 8 hours.

6.3.2. Reflow Profile



Note:
A – Temperature
B – Time
C – Alloy liquidus temperature
D – Preheat slope = temperature ramp rate
E – Preheat dwell = soak time
F – Time above liquidus
G – Peak temperature = maximum assembly temperature

Figure 27. Thermal Profile Schematic

Table 29. Reflow Profile Parameters (1) (2)

Item	Temperature Range	Ramp Rate / Time
D, preheat zone	30°C ~ 175°C	2°C ~ 4°C per second
E, soak zone	150°C ~ 200°C	60 ~ 120 seconds
C, Alloy liquidus temperature	217°C ~ 220°C	-
F, reflow zone	230°C ~ 245°C	60 ~ 90 seconds
G, target maximum reflow temperature	250°C	-
Absolute peak temperature (3)	260°C	-

(1) This is for Pb-free (SAC 305) paste. Different pastes require different profiles for optimum performance, so it is important to consult the paste manufacturer before developing the solder profile;
(2) It is recommended that the modules do not go through the reflow process more than one time;
(3) Exceed the absolute peak temperature for certain period, e.g. 20s might damage the device or affect the reliability.

6.3.3. Other Consideration

(1) Ultrasonic cleaning process is not recommended for the modules as the process might damage the module permanently, especially for the crystal oscillator in the module.
(2) Conformal coating is not allowed to this module. It will impact the reliability of the module once the coating flooded into the shield.

7. Certification

7.1. Bluetooth Qualification

7.1.1. Controller Subsystem Qualification Information

The module series is listed on the Bluetooth SIG website as a qualified Controller Subsystem The detail information can be found in below table.

Table 30. Controller Subsystem Qualification Information

DID/DN	QDID	Link
D067335	229129	https://qualification.bluetooth.com/ListingDetails/208038

7.1.2. Host Subsystem Qualification Information

The module can be integrated into either Linux or RTOS systems. In Linux, where the host is typically an MPU, the host stack used is BlueZ, while in RTOS, where the host is usually an MCU, the host stack is NimBLE.

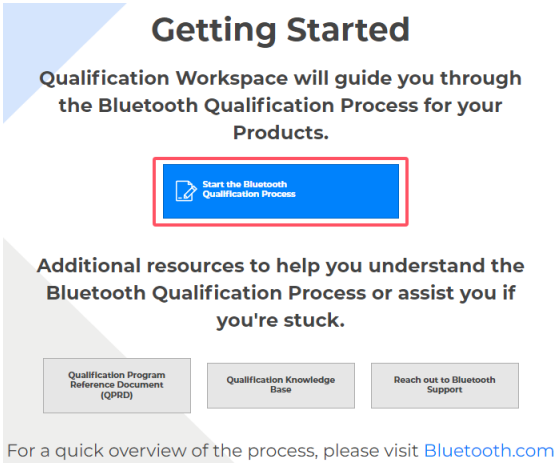
The Host Controller Subsystem qualification information is as below table.

Table 31. Host Subsystem Qualification Information

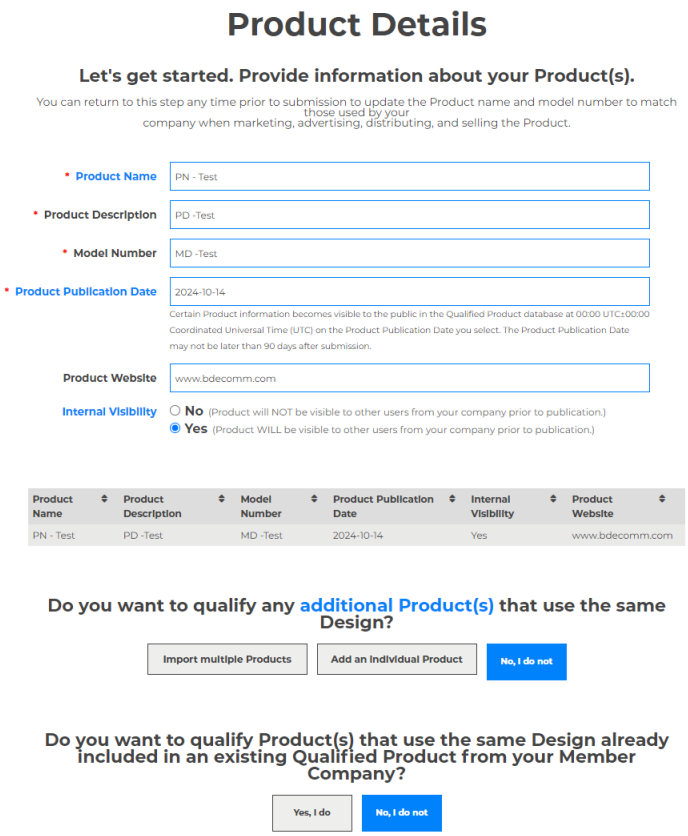
Host Stack	DN	Link
BlueZ	Q302134	https://qualification.bluetooth.com/ListingDetails/221965
NimBLE	Q344986	https://qualification.bluetooth.com/ListingDetails/273971

7.1.3. Bluetooth Qualification Process

Below Bluetooth qualification process is provided for customers when they are listing their end product referencing BDE module.
(1) Go to https://launchstudio.bluetooth.com/ and log in;
(2) Select **Start the Bluetooth Qualification Process**;

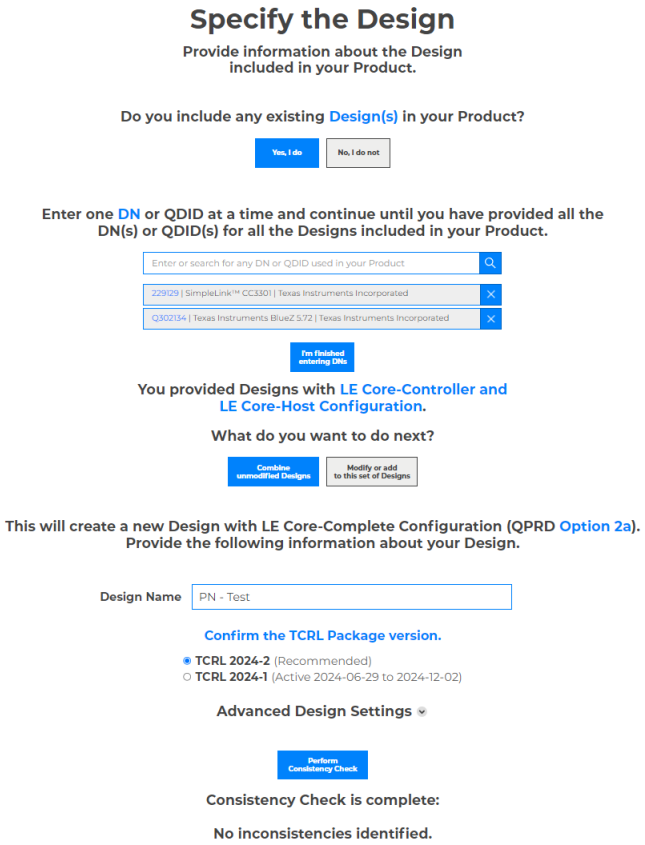


(3) Product Details:
- (a) Enter the Project Name, it can be the product name or the product series name;
- (b) Enter the Product Description;
- (c) Enter the Model Number;
- (d) Enter the Product Publication Date, the date that you want your product publicly listed on Bluetooth website;
- (e) Enter the Product Website;
- (f) Decide Internal Visibility options;
- (g) Decide whether to qualify any additional Product(s) that use the same Design. No in this example;
- (h) Decide whether to qualify Product(s) that use the same Design already included in an existing Qualified Product from your Member Company. No in this example.



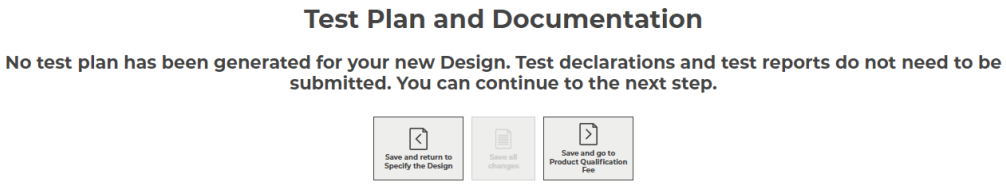
(4) Specify the Design:
- (a) Decide whether to include any existing Design(s) in your Product. Yes in this example;
- (b) Enter Controller Subsystem QDID 229129 and select. Enter Host Subsystem QDID Q302134 and select;
- (c) Click “I’m finished entering DNs”;
- (d) Click “Combine unmodified Designs”;

(e) Select “TCRL 2024-2(Recommended)”;
(f) Perform Consistency Check.



(5) Test Plan and Documentation. There would be no test plan generated and no other documentations needed to be submitted.

PN - Test



(6) Product Qualification Fee.
  (a) Select a DID. If you don’t have one, you need to purchase a DID for your product by clicking Pay Product Qualification Fee.
(7) Submission:
  (a) Review all information that you have entered and make sure no mistakes;
  (b) Tick all check boxes if you confirmed above information and add your name to the signature page;
  (c) Complete the Submission.
(8) The qualification will be done immediately and your product will be listed to the Bluetooth SIG website as per your required listed date in step (3).

For more information about listing your product to Bluetooth SIG, please visit below webpage:
https://www.bluetooth.com/develop-with-bluetooth/qualification-listing/

7.2. Regulatory Compliance

The module is certified for FCC, IC/ISED, ETSI/CE-RED and MIC as listed in below table. More regions can be covered by request.

Table 32. Certification Information

Regulatory Body / Region	Standards	ID	MPN
FCC (USA)	FCC CFR 47 PART 15 C (15.247) FCC CFR 47 PART 15 E (15.407)	2ABUR-BW335P2	BDE-BW3351NP2 BDE-BW3351UP2 BDE-BW3351NP2-IN BDE-BW3351UP2-IN
IC/ISED (Canada)	RSS-247 Issue 3 RSS-Gen Issue 5 ANSI C63.10: 2013	25657-BW335P2	
ETSI/CE-RED (Europe)	ETSI EN 301 489-1 V2.2.3 (2019-11) ETSI EN 301 489-3 V2.3.2 (2023-01) ETSI EN 301 489-17 V3.3.1 (2024-09) EN 55032:2015/A11:2020 EN 55035:2017/A11:2020 ETSI EN 300 328 V2.2.2 (2019-07) ETSI EN 301 893 V2.1.1 (2017-05) ETSI EN 300 440 V2.2.1 (2018-07) EN IEC 62311: 2020 EN IEC 62368-1:2020+A11:2020	NA	
TELEC (Japan)	MIC Notice No.88 Appendix No.43 MIC Notice No.88 Article 2, paragraph 1, item 19-3	219-248334	

7.2.1. Certified Antennas

The module series has been tested and certified with below antennas listed in Table 33.

Table 33. Certified Antenna List

Antenna Type	Manufacturer	MPN	Peak Gain (dBi)		Note
			2.4G	5G	
PCB trace antenna	BDE	NA	0.71	1.41	External, reference
Chip antenna	Ethertronics	M830520	1.0	2.6	External
Chip antenna	Pulse	W3006	2.2	5.2	External
FPC antenna	BDE	BDE-FPC25-4017-120F1	1.5	2.9	External
Whip antenna	BDE	BDE-W25-17010-HRP	2.7	2.3	External

Customers are encouraged to use the certified antennas in the case of external antenna options to reduce certification testing effort and risk of failing. If customer want to choose another antenna that fits their product, there are some scenarios that need to be considered.

If the external antenna is of the same antenna type and of equal or less gain compared to the ones listed in above table, and with similar in-band and out-of-band characteristic, then the antenna can be used with the module in USA and Canada where modular approval is applicable, as long as the spot-check testing of the new antenna with host is performed to verified that it will not change the performance. However, in countries such as EU countries applying the ETSI standards where the modular approval is not applicable, the radiated emissions are always tested with the end product with any antennas.

If the external antenna is of a different type or with non-similar in-band and out-of-band characteristic, but still has equal gain or less gain compared to the above listed antennas. The new antenna can be added to the existing modular grant/certificate by filing a permissive change, C2PC (Class II Permissive Change) in case of FCC and ISED. The radiated emission testing is needed, but re-certification is not required.

In the case of the external antenna with higher gain than the peak gain listed in above table are very likely to require a full new end product certification. However, we recommended that you consult with your certification house to understand the correct approaches for your product case by case.

For the case where customer choose the certified antenna with BDE-BW3351NP2 through the dedicated ANT pin of the module, the customer must copy the design exactly as the one that tested in the certification to comply with the requirement.

7.2.2. FCC Compliance

7.2.2.1. FCC Statement

This device complies with part 15 of the FCC rules. Operation is subject to the following two conditions:
(1) This device may not cause harmful interference, and,
(2) This device must accept any interference received, including interference that may cause undesired operation.

7.2.2.2. FCC Caution

Any changes or modifications to this unit not expressly approved by BDE for compliance could void the user's authority to operate the equipment. The integrator will be responsible to satisfy SAR/RF Exposure requirements, when the module is integrated into the host device.

7.2.2.3. Integration Instructions

List of applicable FCC rules
FCC Part 15.247

Specific operational use conditions
This transmitter/module and its antenna(s) must not be co-located or operating in conjunction with any transmitter. This information also extends to the host manufacturer's instruction manual.

Limited module procedures
Not applicable

Trace antenna designs
Not applicable

RF exposure considerations
This equipment complies with FCC RF radiation exposure limits set forth for an uncontrolled environment. This compliance to FCC radiation exposure limits for an uncontrolled environment, and minimum of 20cm separation between antenna and body. The host product manufacturer would provide the above information to end users in their end-product manuals.

Antennas
Refer to Table 33

Label and compliance information
The end product must carry a physical label or shall use e-labeling followed KDB784748D01 and KDB784748 stating "Contains Transmitter Module FCC ID: 2ABRU-BW335P2".

Information on test modes and additional testing requirements
Contact BDE for more information.

Additional testing, Part 15 Subpart B disclaimer
The modular transmitter is only FCC authorized for the specific rule parts (FCC Part 15.247) listed on the grant, and that the host product manufacturer is responsible for compliance to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification. The final host product still requires Part 15 Subpart B compliance testing with the modular transmitter installed when contains digital circuity.

(OEM) Integrator has to assure compliance of the entire end-product that includes the module. For 15 B (§15.107 and if applicable §15.109) compliance, the host manufacturer is required to show compliance with 15 while the module is installed and operating.

Furthermore, the module should be transmitting and the evaluation should confirm that the module's intentional emissions (15C) are compliant (fundamental / out-of-band). Finally, the integrator has to apply the appropriate equipment authorization (e.g. Verification) for the new host device per definition in §15.101. Integrator is reminded to assure that these installation instructions will not be made available to the end-user of the final host device.

7.2.3. IC/ISED Compliance

7.2.3.1. IC Statement

This device contains license-exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada's license-exempt RSS(s). Operation is subject to the following two conditions:
(1) This device may not cause interference, and,
(2) This device must accept any interference, including interference that may cause undesired operation of the device.

L'émetteur/récepteur exempt de licencecontenudans le présentappareilestconforme aux CNR d'Innovation, Sciences et Développementéconomique Canada applicables aux appareils radio exempts de licence. L'exploitationestautorisée aux deux conditions suivantes :
(1) L' appareil ne doit pas produire de brouillage;
(2) L' appareildoit accepter tout brouillageradioélectriquesubi, mêmesi le brouillageest susceptible d' encompromettre le fonctionnement.

7.2.3.2. IC Caution

Any changes or modifications to this unit not expressly approved by BDE for compliance could void the user's authority to operate the equipment. The integrator will be responsible to satisfy SAR/RF Exposure requirements, when the module integrated into the host device.

7.2.3.3. Integration Instructions

Label and compliance information
The final host device, into which this RF module is integrated has to be labeled with an auxiliary label stating the IC of the RF module, such as "Contains transmitter module IC: 25657-BW335P2" or "Contains transmitter module IC: 25657-BW335P2".

Informations sur l'étiquette et la conformité
Le périphériquehôte final, danslequelce module RF estintégré "doitêtreétiqueté avec uneétiquetteauxiliaireindiquant le CI du module RF, tel que "Contient le module émetteur IC: 25657-BW335P2".

Radio Frequency Exposure Statement for IC
The device has been evaluated to meet general RF exposure requirements. The device can be used in mobile exposure conditions. The min separation distance is 20cm.

Déclaration d'exposition aux radiofréquences pour IC
L'appareil a été évalué pour répondre aux exigences générales en matière d'exposition aux RF. L'appareil peut être utilisé dans des conditions d'exposition mobiles. La distance de séparation minimale est de 20 cm.

This radio transmitter [IC: 25657-BW335P2] has been approved by Innovation, Science and Economic Development Canada to operate with the antenna types listed in Table 33, with the maximum permissible gain indicated. Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device.

Cet émetteur radio [IC: 25657-BW335P2] a été approuvé par Innovation, Sciences et Développement économique Canada pour fonctionner avec les types d'antenne énumérés ci-dessous, avec le gain maximal admissible indiqué. Les types

d'antenne non inclus dans cette liste qui ont un gain supérieur au gain maximum indiqué pour tout type répertorié sont strictement interdits pour une utilisation avec cet appareil.

7.2.4. ETSI/CE Compliance

The module series is certified with required EU radio and EMC directives. See Table 32 for detailed standards the module complies with, or refer to UK Declaration of Conformity.

7.2.5. MIC Compliance

The module series is certified by MIC (Japan) with the certification number of 219-248271.

It is the end-product manufacturer's responsibility to ensure that the module is configured to conform with the compliance limit documented in the test reports of the module when integrating the module to their product.

When integrating the module into an end product, specific labeling requirements must be adhered to in order to remain compliant with Japanese regulations. These requirements include the following:

(1) Retention of MIC Certification Mark and ID. Refer to Figure 20 for module marking information.
- The MIC certification mark and certification number assigned to the radio module must be retained and clearly visible on the module.
- If the module is installed in a way that the original label is not visible (e.g., inside an enclosure), the same information must be duplicated on the exterior of the host device.

(2) Japanese Language Statement
Some products require an additional Japanese language statement specifying compliance with MIC regulations. This might read:

"本製品は技術基準適合証明または工事設計認証を受けた特定無線設備を装備しています。"

Translation: "This product is equipped with specified radio equipment that has obtained technical standard conformity certification or construction design certification.

(3) Host Product Identification
The label should also include identification of the host product, such as the product name or model number, alongside the MIC certification details if necessary.

(4) Documentation Requirements
User manuals or product documentation must include information about the integrated radio module, its MIC certification, and any operational limitations or conditions.

(5) Consultation with MIC or Certification Body
If the integration of the module changes its intended use, functionality, or emission characteristics, additional testing or re-certification may be required. Consultation with an MIC certification body is recommended in such cases.

8. Ordering Information

Table 34. Ordering Information

Orderable Part Number	Description	Size (mm)	Core Chip	Shipping Form	MOQ
BDE-BW3351NP2	2.4-GHz & 5-GHz Dual-Band Wi-Fi 6 SISO & BLE 5.4, Dual Antenna Port with Antenna Diversity with ANT Pin, -40 °C to +85 °C	13.3 x 13.4 x 2	CC3351	Tape & Reel	1K
BDE-BW3351UP2	2.4-GHz & 5-GHz Dual-Band Wi-Fi 6 SISO & BLE 5.4, Dual Antenna Port with Antenna Diversity with U.FL Connector, -40 °C to +85 °C	13.3 x 18.4 x 2	CC3351	Tape & Reel	1K
BDE-BW3351NP2-IN	2.4-GHz & 5-GHz Dual-Band Wi-Fi 6 SISO & BLE 5.4, Dual Antenna Port with Antenna Diversity with ANT Pin, -40 °C to +105 °C	13.3 x 13.4 x 2	CC3351	Tape & Reel	1K
BDE-BW3351UP2-IN	22.4-GHz & 5-GHz Dual-Band Wi-Fi 6 SISO & BLE 5.4, Dual Antenna Port with Antenna Diversity with U.FL Connector, -40 °C to +105 °C	13.3 x 18.4 x 2	CC3351	Tape & Reel	1K

9. Revision History

Table 35. Revision History

Revision	Date	Description
V0.1	2022/12/16	Preliminary, draft
V0.2	2023/2/13	Updated pinout, added reference design
V0.3	2023/3/29	Added more information
V0.4	2023/7/14	Corrected some editorial mistakes, updated reference design
V0.5	2024/1/30	Added detailed information
V0.6	2024/6/25	Updated some data, corrected some mistakes
V1.0	2025/2/17	Production version

You can find the latest datasheet on the product page at bdecomm.com.

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