



FCC RF Exposure Evaluation

1. Product Information

FCC ID	: 2ABRU-BW335P2
Product name	: BDE Dual-band (2.4 and 5GHz) Wi-Fi 6 & BLE Combo Module
Test Model	: BDE-BW3351NP2
Additional Model No.	: BDE-BW3351NP2-IN, BDE-BW3351UP2, BDE-BW3351UP2-IN, BDE-BW3350NP2, BDE-BW3350NP2-IN, BDE-BW3350UP2, BDE-BW3350UP2-IN
Model Declaration	: In BDE-BW335P2 series, the difference between BDE-BW3351NP2 and BDE-BW3351UP2 is the antenna lead-in connector: BDE-BW3351NP2 is the bottom pad lead-in, which can be connected to an external antenna, and BDE-BW3351UP2 is the U.FL connector on the board, which can be connected to an external antenna; The difference between the BDE-BW3351NP2-IN and BDE-BW3351UP2-IN models and the previous two models is that the models with -IN suffix can work in the temperature range of -40° ~ 105°, and the models without -IN suffix can work in the temperature range of -40° ~ 85°; BDE-BW3350NP2, BDE-BW3350UP2, BDE-BW3350NP2-IN, BDE-BW3350UP2-IN differ from the previous four models by their names, and are mainly distinguished from the previous four models by the silk-screening on the shielding cover.
Ratings	: Input: DC 3.3V
Hardware Version	: V1
Software Version	: 1.7.0.50
Bluetooth	:
Frequency Range	: 2402MHz~2480MHz 2404MHz ~ 2478MHz
Channel Number	: 40 channels for Bluetooth V5.4 (DTS) 37 channels for Bluetooth V5.4 (DTS)
Channel Spacing	: 2MHz for Bluetooth V5.4 (DTS)
Modulation Type	: GFSK for Bluetooth V5.4 (DTS)
Bluetooth Version	: V5.4
Antenna Description	: FPC Antenna, 1.5dBi(Max.) Ceramic Antenna1, 1.0dBi(Max.) PCB Antenna, 0.78dBi(Max.) Dipole Antenna, 2.7dBi(Max.) Ceramic Antenna2, 2.2dBi(Max.)
WIFI(2.4G Band)	:
Frequency Range	: 2412MHz~2462MHz
Channel Spacing	: 5MHz
Channel Number	: 11 Channels for 20MHz bandwidth (2412~2462MHz)
Modulation Type	: IEEE 802.11b: DSSS (CCK, DQPSK, DBPSK)



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	:	IEEE 802.11g: OFDM (64QAM, 16QAM, QPSK, BPSK) IEEE 802.11n: OFDM (64QAM, 16QAM, QPSK, BPSK) IEEE 802.11ax: OFDMA (1024QAM, 256QAM, 64QAM, 16QAM, QPSK, BPSK)
Antenna Description	:	Antenna0: FPC Antenna0, 1.5dBi(Max.) Antenna0: FPC Antenna1, 1.5dBi(Max.) Antenna0: Ceramic Antenna0, 1.0dBi(Max.) Antenna0: Ceramic Antenna1, 1.0dBi(Max.) Antenna0: PCB Antenna0, 0.78dBi(Max.) Antenna0: PCB Antenna1, 0.78dBi(Max.) Antenna0: Dipole Antenna0, 2.7dBi(Max.) Antenna0: Dipole Antenna1, 2.7dBi(Max.) Antenna1: Ceramic Antenna0, 2.2dBi(Max.) Antenna1: Ceramic Antenna1, 2.2dBi(Max.)
5.2G WLAN	:	
Frequency Range	:	5180MHz~5240MHz
Channel Number	:	4 channels for 20MHz bandwidth(5180MHz~5240MHz)
Modulation Type	:	IEEE 802.11a/n: OFDM (64QAM, 16QAM, QPSK, BPSK) IEEE 802.11ac: OFDM (256QAM, 64QAM, 16QAM, QPSK, BPSK) IEEE 802.11ax: OFDMA (1024QAM, 256QAM, 64QAM, 16QAM, QPSK, BPSK)
Antenna Description	:	Antenna0: FPC Antenna0, 2.9dBi(Max.) Antenna0: FPC Antenna1, 2.9dBi(Max.) Antenna0: Ceramic Antenna0, 2.6dBi(Max.) Antenna0: Ceramic Antenna1, 2.6dBi(Max.) Antenna0: PCB Antenna0, 1.41dBi(Max.) Antenna0: PCB Antenna1, 1.41dBi(Max.) Antenna0: Dipole Antenna0, 2.3dBi(Max.) Antenna0: Dipole Antenna1, 2.3dBi(Max.) Antenna1: Ceramic Antenna0, 5.2dBi(Max.) Antenna1: Ceramic Antenna1, 5.2dBi(Max.)
5.8G WLAN	:	
Frequency Range	:	5725MHz~5850MHz
Channel Number	:	5 channels for 20MHz bandwidth(5745MHz~5825MHz)
Modulation Type	:	IEEE 802.11a/n: OFDM (64QAM, 16QAM, QPSK, BPSK) IEEE 802.11ac: OFDM (256QAM, 64QAM, 16QAM, QPSK, BPSK) IEEE 802.11ax: OFDMA (1024QAM, 256QAM, 64QAM, 16QAM, QPSK, BPSK)
Antenna Description	:	Antenna0: FPC Antenna0, 2.9dBi(Max.) Antenna0: FPC Antenna1, 2.9dBi(Max.) Antenna0: Ceramic Antenna0, 2.6dBi(Max.) Antenna0: Ceramic Antenna1, 2.6dBi(Max.) Antenna0: PCB Antenna0, 1.41dBi(Max.) Antenna0: PCB Antenna1, 1.41dBi(Max.)



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		Antenna0: Dipole Antenna0, 2.3dBi(Max.) Antenna0: Dipole Antenna1, 2.3dBi(Max.) Antenna1: Ceramic Antenna0, 5.2dBi(Max.) Antenna1: Ceramic Antenna1, 5.2dBi(Max.)
Exposure category	:	General population/uncontrolled environment
EUT Type	:	Production Unit
Device Type	:	Moblie Device

2. Evaluation Method

Systems operating under the provisions of FCC 47 CFR section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy level in excess of the Commission's guidelines.

In accordance with 47 CFR FCC Part 2 Subpart J, section 2.1091 this device has been defined as mobile device whereby a distance of 0.2m normally can be maintained between the user and the device, and below RF Permissible Exposure limit shall comply with.

In accordance with KDB447498D01 for Simultaneous transmission MPE test exclusion applies when the sum of the MPE ratios for all simultaneous transmitting antennas incorporated in a host device, based on the calculated/estimated, numerically modelled or measured field strengths or power density, is ≤ 1.0 . The MPE ratio of each antenna is determined at the minimum test separation distance required by the operating configurations and exposure conditions of the host device, according to the ratio of field strengths or power density to MPE limit, at the test frequency. Either the maximum peak or spatially averaged results from measurements or numerical simulations may be used to determine the MPE ratios. Spatial averaging does not apply when MPE is estimated using simple calculations based on far-field plane-wave equivalent conditions. The antenna installation and operating requirements for the host device must meet the minimum test separation distances required by all antennas, in both standalone and simultaneous transmission operations, to satisfy compliance.

3. Limit

3. 1 Refer Evaluation Method

[ANSI C95.1-2019](#): IEEE Standard for Safety Levels with Respect to Human Exposure to Electric, Magnetic, and Electromagnetic Fields, 0 Hz to 300 GHz

[FCC KDB publication 447498 D01 General 1 RF Exposure Guidance v06](#): Mobile and Portable Devices RF Exposure Procedures and Equipment Authorization Policies.

[FCC CFR 47 part1 1.1310](#): Radiofrequency radiation exposure limits.

[FCC CFR 47 part2 2.1091](#): Radiofrequency radiation exposure evaluation: mobile devices.





3.2 Limit

Limits for Maximum Permissible Exposure (MPE)/Controlled Exposure

Frequency Range(MHz)	Electric Field Strength(V/m)	Magnetic Field Strength(A/m)	Power Density (mW/cm ²)	Averaging Time (minute)
Limits for Occupational/Controlled Exposure				
0.3 – 3.0	614	1.63	(100) *	6
3.0 – 30	1842/f	4.89/f	(900/f ²)*	6
30 – 300	61.4	0.163	1.0	6
300 – 1500	/	/	f/300	6
1500 – 100,000	/	/	5	6

Limits for Maximum Permissible Exposure (MPE)/Uncontrolled Exposure

Frequency Range(MHz)	Electric Field Strength(V/m)	Magnetic Field Strength(A/m)	Power Density (mW/cm ²)	Averaging Time (minute)
Limits for Occupational/Uncontrolled Exposure				
0.3 – 3.0	614	1.63	(100) *	30
3.0 – 30	824/f	2.19/f	(180/f ²)*	30
30 – 300	27.5	0.073	0.2	30
300 – 1500	/	/	f/1500	30
1500 – 100,000	/	/	1.0	30

F=frequency in MHz

*=Plane-wave equivalent power density

4. MPE Calculation Method

Predication of MPE limit at a given distance

Equation from page 18 of OET Bulletin 65, Edition 97-01

$$S=PG/4\pi R^2$$

Where: S=power density

P=power input to antenna

G=power gain of the antenna in the direction of interest relative to an isotropic radiator

R=distance to the center of radiation of the antenna



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5. Antenna Information

EUT can only use antennas certificated as follows provided by manufacturer;

Internal/External Identification	Antenna type and antenna number	Operate frequency band	Maximum antenna gain	Notes
Antenna 1:	FPC Antenna	2402-2480 MHz 2404-2478 MHz	BT: 1.5dBi	Bluetooth Antenna
Antenna 1:	Ceramic Antenna 0	2402-2480 MHz 2404-2478 MHz	BT: 1.0dBi	Bluetooth Antenna
Antenna 1:	PCB Antenna	2402-2480 MHz 2404-2478 MHz	BT: 0.78dBi	Bluetooth Antenna
Antenna 1:	Dipole Antenna	2402-2480 MHz 2404-2478 MHz	BT: 2.7dBi	Bluetooth Antenna
Antenna 1:	Ceramic Antenna 1	2402-2480 MHz 2404-2478 MHz	BT: 2.2dBi	Bluetooth Antenna
Antenna 0: Antenna 1:	FPC Antenna	2412-2462 MHz 5180-5240 MHz 5725-5850 MHz	2.4G WIFI: 1.5dBi 5.2G WIFI: 2.9dBi 5.8G WIFI: 2.9dBi	2.4GWIFI /5G WIFI Antenna
Antenna 0: Antenna 1:	Ceramic Antenna 0	2412-2462 MHz 5180-5240 MHz 5725-5850 MHz	2.4G WIFI: 1.0dBi 5.2G WIFI: 2.6dBi 5.8G WIFI: 2.6dBi	2.4GWIFI /5G WIFI Antenna
Antenna 0: Antenna 1:	PCB Antenna	2412-2462 MHz 5180-5240 MHz 5725-5850 MHz	2.4G WIFI: 0.78dBi 5.2G WIFI: 1.41dBi 5.8G WIFI: 1.41dBi	2.4GWIFI /5G WIFI Antenna
Antenna 0: Antenna 1:	Dipole Antenna	2412-2462 MHz 5180-5240 MHz 5725-5850 MHz	2.4G WIFI: 2.7dBi 5.2G WIFI: 2.3dBi 5.8G WIFI: 2.3dBi	2.4GWIFI /5G WIFI Antenna
Antenna 0: Antenna 1:	Ceramic Antenna 1	2412-2462 MHz 5180-5240 MHz 5725-5850 MHz	2.4G WIFI: 2.2dBi 5.2G WIFI: 5.2dBi 5.8G WIFI: 5.2dBi	2.4GWIFI /5G WIFI Antenna

6. Conducted Power Results

[BLE]

Mode	Channel	Frequency (MHz)	Peak Conducted Output Power (dBm)
BLE_1M	0	2402	16.13
	19	2440	16.17
	39	2480	15.66

Mode	Channel	Frequency (MHz)	Peak Conducted Output Power (dBm)
BLE_2M	0	2404	15.41
	17	2440	15.48
	36	2478	14.83





[2.4G WIFI]

Mode	Channel	Frequency (MHz)	Ant0 Peak Conducted Output Power (dBm)	Ant1 Peak Conducted Output Power (dBm)
11B	1	2412	17.28	16.98
	6	2437	17.35	17.38
	11	2462	17.38	17.85
11G	1	2412	14.72	14.79
	6	2437	17.8	18.92
	11	2462	15.45	15.51
11N20 SISO	1	2412	15.18	15
	6	2437	17.31	18.84
	11	2462	17.6	17.4
11AX20 SISO	1	2412	16.51	16.36
	6	2437	20.22	21.06
	11	2462	17.13	16.9

[5.2G WLAN]

Mode	Channel	Frequency (MHz)	Ant0 Peak Conducted Output Power (dBm)	Ant1 Peak Conducted Output Power (dBm)
11A	36	5180	10.95	10.90
	40	5200	11.55	11.58
	48	5240	10.28	9.90
11N20 SISO	36	5180	10.64	10.19
	40	5200	11.12	10.29
	48	5240	10.00	9.35
11AC20 SISO	36	5180	10.72	10.09
	40	5200	11.57	10.41
	48	5240	10.20	9.41
11AX20 SISO	36	5180	9.35	8.92
	40	5200	11.33	10.77
	48	5240	11.07	9.99

[5.8G WLAN]

Mode	Channel	Frequency (MHz)	Ant0 Peak Conducted Output Power (dBm)	Ant1 Peak Conducted Output Power (dBm)
11A	149	5745	9.08	9.37
	157	5785	11.19	11.18
	165	5825	10.25	9.83
11N20 SISO	149	5745	10.62	11.12
	157	5785	10.26	10.42
	165	5825	9.99	9.55
11AC20 SISO	149	5745	10.78	10.99
	157	5785	10.72	10.69
	165	5825	9.76	9.74
11AX20 SISO	149	5745	11.63	11.43
	157	5785	10.30	12.06
	165	5825	9.79	10.64



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7.Manufacturing Tolerance

[BLE]

BT LE (Peak)			
Channel	Channel 0	Channel 19	Channel 39
Target (dBm)	16.0	16.0	5.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0

BT 2LE (Peak)			
Channel	Channel 0	Channel 17	Channel 36
Target (dBm)	16.0	16.0	5.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0

[2.4G WIFI Ant0]

11B (Peak)			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	17.0	17.0	17.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
11G (Peak)			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	14.0	17.0	14.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
11N20(Peak)			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	14.0	17.0	17.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
11AX20(Peak)			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	15.0	20.0	11.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0

[2.4G WIFI Ant1]

11B (Peak)			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	16.0	17.0	17.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
11G (Peak)			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	15.0	18.0	14.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
11N20(Peak)			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	13.0	18.0	16.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0





11AX20(Peak)			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	16.0	21.0	14.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0

[5.2G WIFI Ant0]

11A(Average)			
Channel	Channel 36	Channel 40	Channel 48
Target (dBm)	10.0	11.0	10.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
11N20(Average)			
Channel	Channel 36	Channel 40	Channel 48
Target (dBm)	10.0	11.0	10.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
11AC20(Average)			
Channel	Channel 36	Channel 40	Channel 48
Target (dBm)	10.0	11.0	10.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
11AX20(Average)			
Channel	Channel 36	Channel 40	Channel 48
Target (dBm)	19.0	11.0	11.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0

[5.2G WIFI Ant1]

11A(Average)			
Channel	Channel 36	Channel 40	Channel 48
Target (dBm)	10.0	11.0	9.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
11N20(Average)			
Channel	Channel 36	Channel 40	Channel 48
Target (dBm)	10.0	10.0	9.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
11AC20(Average)			
Channel	Channel 36	Channel 40	Channel 48
Target (dBm)	10.0	10.0	9.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
11AX20(Average)			
Channel	Channel 36	Channel 40	Channel 48
Target (dBm)	8.0	10.0	9.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0



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[5.8G WIFI Ant0]

11A (Average)			
Channel	Channel 149	Channel 157	Channel 165
Target (dBm)	9.0	11.0	10.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
11N20(Average)			
Channel	Channel 149	Channel 157	Channel 165
Target (dBm)	10.0	10.0	9.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
11AC20(Average)			
Channel	Channel 149	Channel 157	Channel 165
Target (dBm)	10.0	10.0	9.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
11AX20(Average)			
Channel	Channel 149	Channel 157	Channel 165
Target (dBm)	11.0	10.0	9.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0

[5.8G WIFI Ant1]

11A (Average)			
Channel	Channel 149	Channel 157	Channel 165
Target (dBm)	9.0	11.0	9.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
11N20(Average)			
Channel	Channel 149	Channel 157	Channel 165
Target (dBm)	11.0	10.0	9.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
11AC20(Average)			
Channel	Channel 149	Channel 157	Channel 165
Target (dBm)	10.0	10.0	9.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
11AX20(Average)			
Channel	Channel 149	Channel 157	Channel 165
Target (dBm)	11.0	12.0	10.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0



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8. Evaluation Results

As declared by the Applicant, the EUT is a wireless device used in a fix application, at least 20 cm from any body part of the user or nearby persons; from the maximum EUT RF output power, the minimum separation distance, $r=20\text{cm}$, as well as the gain of the used antenna refer to antenna information, the RF power density can be obtained.

[BT LE]

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW				
BLE 1M	17.0	50.1187	2.7	1.8621	0.0186	1.0000
BLE 2M	17.0	50.1187	2.7	1.8621	0.0186	1.0000

[2.4G WIFI Ant0]

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW				
IEEE 802.11b	18.0	63.0957	2.7	1.8621	0.0234	1.0000
IEEE 802.11g	18.0	63.0957	2.7	1.8621	0.0234	1.0000
IEEE 802.11n HT20	18.0	63.0957	2.7	1.8621	0.0234	1.0000
IEEE 802.11ax HEW20	21.0	125.8925	2.7	1.8621	0.0467	1.0000

[2.4G WIFI Ant1]

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW				
IEEE 802.11b	18.0	63.0957	2.7	1.8621	0.0234	1.0000
IEEE 802.11g	19.0	79.4328	2.7	1.8621	0.0294	1.0000
IEEE 802.11n HT20	19.0	79.4328	2.7	1.8621	0.0294	1.0000
IEEE 802.11ax HEW20	21.0	125.8925	2.7	1.8621	0.0467	1.0000

[5.2G WIFI Ant0]

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW				
IEEE 802.11a	12.0	15.8489	2.9	1.9498	0.0062	1.0000
IEEE 802.11n HT20	12.0	15.8489	2.9	1.9498	0.0062	1.0000
IEEE 802.11ac VHT20	12.0	15.8489	2.9	1.9498	0.0062	1.0000
IEEE 802.11ax HEW20	12.0	15.8489	2.9	1.9498	0.0062	1.0000





[5.2G WIFI Ant1]

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW				
IEEE 802.11a	12.0	15.8489	2.9	1.9498	0.0062	1.0000
IEEE 802.11n HT20	11.0	12.5893	2.9	1.9498	0.0049	1.0000
IEEE 802.11ac VHT20	11.0	12.5893	2.9	1.9498	0.0049	1.0000
IEEE 802.11ax HEW20	11.0	12.5893	2.9	1.9498	0.0049	1.0000

[5.8G WIFI Ant0]

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW				
IEEE 802.11a	12.0	15.8489	2.9	1.9498	0.0062	1.0000
IEEE 802.11n HT20	11.0	12.5893	2.9	1.9498	0.0049	1.0000
IEEE 802.11ac VHT20	11.0	12.5893	2.9	1.9498	0.0049	1.0000
IEEE 802.11ax HEW20	12.0	15.8489	2.9	1.9498	0.0062	1.0000

[5.8G WIFI Ant1]

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW				
IEEE 802.11a	12.0	15.8489	2.9	1.9498	0.0062	1.0000
IEEE 802.11n HT20	12.0	15.8489	2.9	1.9498	0.0062	1.0000
IEEE 802.11ac VHT20	11.0	12.5893	2.9	1.9498	0.0049	1.0000
IEEE 802.11ax HEW20	13.0	19.9526	2.9	1.9498	0.0077	1.0000

Remark:

1. Output power including tune-up tolerance;
2. Output power was adjust to duty cycle at 100% if measured duty cycle less than 98%;
3. MPE evaluate distance is 20cm from user manual provide by manufacturer.

9. Conclusion

The measurement results comply with the FCC Limit per 47 CFR 2.1091 for the uncontrolled RF Exposure of mobile device.

-----THE END OF REPORT-----

