



FCC RF Exposure Evaluation

1. Product Information

FCC ID	:	2ABRU-BW335P1
Product name	:	BDE Dual-band (2.4 and 5GHz) Wi-Fi 6 & BLE Combo Module
Test Model	:	BDE-BW3351NP1
Additional Model No.	:	BDE-BW3351NP1-IN, BDE-BW3351AP1, BDE-BW3351AP1-IN, BDE-BW3351UP1, BDE-BW3351UP1-IN, BDE-BW3350NP1, BDE-BW3350NP1-IN, BDE-BW3350AP1, BDE-BW3350AP1-IN, BDE-BW3350UP1, BDE-BW3350UP1-IN
Model Declaration	:	BDE-BW3351NP1, BDE-BW3351AP1, BDE-BW3351UP1 models differ only from the antenna, and the test is measured in the worst mode according to the maximum antenna gain. BDE-BW3351NP1-IN, BDE-BW3351AP1-IN, BDE-BW3351UP1-IN models differ only in operating temperature. BDE-BW3350NP1, BDE-BW3350NP1-IN, BDE-BW3350AP1, BDE-BW3350AP1-IN, BDE-BW3350UP1, BDE-BW3350UP1-IN only the model name is different.
Power supply	:	Input: DC 3.3V
Hardware Version	:	V1
Software Version	:	1.7.0.50
Bluetooth	:	
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) GFSK for Bluetooth V5.4 (DTS)
Bluetooth Version	:	V5.4
Antenna Description	:	PCB Antenna, -2.2dBi(Max.) Ceramic Antenna, 1.0dBi(Max.) FPC Antenna, 1.5dBi(Max.) Dipole Antenna, 2.7dBi(Max.)
WIFI(2.4G Band)	:	
Frequency Range	:	2412MHz~2462MHz
Channel Number	:	11 Channels for 20MHz bandwidth(2412~2462MHz)
Channel Spacing	:	5MHz
Modulation Type	:	IEEE 802.11b: DSSS (CCK, DQPSK, DBPSK) IEEE 802.11g: OFDM (64QAM, 16QAM, QPSK, BPSK) IEEE 802.11n: OFDM (64QAM, 16QAM,QPSK,BPSK) IEEE 802.11ax: OFDM (1024QAM, 256QAM, 64QAM, 16QAM, QPSK, BPSK)





Antenna Description	:	PCB Antenna, -2.2dBi(Max.) Ceramic Antenna, 1.0dBi(Max.) FPC Antenna, 1.5dBi(Max.) Dipole Antenna, 2.7dBi(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: OFDM (1024QAM, 256QAM, 64QAM, 16QAM, QPSK, BPSK)
Antenna Description	:	PCB Antenna, 0.7dBi(Max.) Ceramic Antenna, 2.6dBi(Max.) FPC Antenna, 2.9dBi(Max.) Dipole Antenna, 2.3dBi(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: OFDM (1024QAM, 256QAM, 64QAM, 16QAM, QPSK, BPSK)
Antenna Description	:	PCB Antenna, 0.7dBi(Max.) Ceramic Antenna, 2.6dBi(Max.) FPC Antenna, 2.9dBi(Max.) Dipole Antenna, 2.3dBi(Max.)
Exposure category	:	General population/uncontrolled environment
EUT Type	:	Production Unit
Device Type	:	Moblle 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

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
External	Dipole Antenna	2400-6000 MHz	BT/2.4G WIFI: 2.7dBi 5.2G WIFI: 2.3dBi 5.8G WIFI: 2.3dBi	Bluetooth/2.4GWIFI /5G WIFI Antenna
External	FPC Antenna	2400-6000 MHz	BT/2.4G WIFI: 1.5dBi 5.2G WIFI: 2.9dBi 5.8G WIFI: 2.9dBi	Bluetooth/2.4GWIFI /5G WIFI Antenna
Internal	PCB Antenna	2400-6000 MHz	BT/2.4G WIFI: -2.2dBi 5.2G WIFI: 0.7dBi 5.8G WIFI: 0.7dBi	Bluetooth/2.4GWIFI /5G WIFI Antenna
External	Ceramic Antenna	2400-6000 MHz	BT/2.4G WIFI: 1.0dBi 5.2G WIFI: 2.6dBi 5.8G WIFI: 2.6dBi	Bluetooth/2.4GWIFI /5G WIFI Antenna

6. Conducted Power Results

[BLE]

Mode	Channel	Frequency (MHz)	Peak Conducted Output Power (dBm)
BLE_1M	0	2402	16.89
	19	2440	16.94
	39	2480	17.29

Mode	Channel	Frequency (MHz)	Peak Conducted Output Power (dBm)
BLE_2M	0	2404	16.91
	17	2440	17.22
	36	2478	17.26





[2.4G WIFI]

Mode	Channel	Frequency (MHz)	Max Conducted Power(dBm)
11B	1	2412	17.93
	6	2437	18.1
	11	2462	18.23
11G	1	2412	15.33
	6	2437	18.47
	11	2462	15.47
11N20 SISO	1	2412	14.18
	6	2437	18.72
	11	2462	16
11AX20 SISO	1	2412	15.64
	6	2437	21.09
	11	2462	16.15

[5.2G WLAN]

Mode	Channel	Frequency (MHz)	Peak Conducted Output Power (dBm)
11A	36	5180	15.21
	40	5200	14.95
	48	5240	14.58
11N20 SISO	36	5180	14.62
	40	5200	15.02
	48	5240	14.20
11AC20 SISO	36	5180	14.41
	40	5200	14.67
	48	5240	13.86
11AX20 SISO	36	5180	14.02
	40	5200	15.40
	48	5240	14.21





[5.8G WLAN]

Mode	Channel	Frequency (MHz)	Peak Conducted Output Power (dBm)
11A	149	5745	15.31
	157	5785	14.37
	165	5825	13.93
11N20 SISO	149	5745	14.30
	157	5785	13.90
	165	5825	12.92
11AC20 SISO	149	5745	13.82
	157	5785	13.95
	165	5825	13.79
11AX20 SISO	149	5745	15.22
	157	5785	13.98
	165	5825	13.43





7.Manufacturing Tolerance

[BLE]

BT LE (Peak)			
Channel	Channel 0	Channel 19	Channel 39
Target (dBm)	16.0	16.0	6.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0

BT 2LE (Peak)			
Channel	Channel 0	Channel 17	Channel 36
Target (dBm)	16.0	17.0	7.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0

[2.4G WIFI]

11B (Peak)			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	17.0	18.0	18.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
11G (Peak)			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	15.0	18.0	15.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
11N20(Peak)			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	14.0	18.0	16.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
11AX20(Peak)			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	15.0	21.0	16.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0





[5.2G WIFI]

11A(Average)			
Channel	Channel 36	Channel 40	Channel 48
Target (dBm)	15.0	14.0	14.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
11N20(Average)			
Channel	Channel 36	Channel 40	Channel 48
Target (dBm)	14.0	15.0	14.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
11AC20(Average)			
Channel	Channel 36	Channel 40	Channel 48
Target (dBm)	14.0	14.0	13.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
11AX20(Average)			
Channel	Channel 36	Channel 40	Channel 48
Target (dBm)	14.0	15.0	14.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0

[5.8G WIFI]

11A (Average)			
Channel	Channel 149	Channel 157	Channel 165
Target (dBm)	15.0	14.0	13.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
11N20(Average)			
Channel	Channel 149	Channel 157	Channel 165
Target (dBm)	14.0	13.0	12.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
11AC20(Average)			
Channel	Channel 149	Channel 157	Channel 165
Target (dBm)	13.0	13.0	13.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
11AX20(Average)			
Channel	Channel 149	Channel 157	Channel 165
Target (dBm)	15.0	13.0	13.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0





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	18.0	63.0957	2.7	1.8621	0.0234	1.0000

[2.4G WIFI]

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW				
IEEE 802.11b	19.0	79.4328	2.7	1.8621	0.0294	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	22.0	158.4893	2.7	1.8621	0.0587	1.0000

[5.2G WIFI]

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW				
IEEE 802.11a	16.0	39.8107	2.9	1.9498	0.0155	1.0000
IEEE 802.11n HT20	16.0	39.8107	2.9	1.9498	0.0155	1.0000
IEEE 802.11ac VHT20	15.0	31.6228	2.9	1.9498	0.0123	1.0000
IEEE 802.11ax HEW20	16.0	39.8107	2.9	1.9498	0.0155	1.0000

[5.8G WIFI]

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW				
IEEE 802.11a	16.0	39.8107	2.9	1.9498	0.0155	1.0000
IEEE 802.11n HT20	15.0	31.6228	2.9	1.9498	0.0123	1.0000
IEEE 802.11ac VHT20	14.0	25.1189	2.9	1.9498	0.0097	1.0000
IEEE 802.11ax HEW20	16.0	39.8107	2.9	1.9498	0.0155	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-----

