# 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.<br>BDE-BW3351NP1-IN, BDE-BW3351AP1-IN, BDE-BW3351UP1-IN models differ only in operating temperature.<br>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<br>2404MHz ~ 2478MHz |
| Channel Number | : | 40 channels for Bluetooth V5.4 (DTS)<br>37 channels for Bluetooth V5.4 (DTS) |
| Channel Spacing | : | 2MHz for Bluetooth V5.4(DTS) |
| Modulation Type | : | GFSK for Bluetooth V5.4 (DTS)<br>GFSK for Bluetooth V5.4 (DTS) |
| Bluetooth Version | : | V5.4 |
| Antenna Description | : | PCB Antenna, -2.2dBi(Max.)<br>Ceramic Antenna, 1.0dBi(Max.)<br>FPC Antenna, 1.5dBi(Max.)<br>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)<br>IEEE 802.11g: OFDM (64QAM, 16QAM, QPSK, BPSK)<br>IEEE 802.11n: OFDM (64QAM, 16QAM,QPSK,BPSK)<br>IEEE 802.11ax: OFDM (1024QAM, 256QAM, 64QAM, 16QAM, QPSK, BPSK) |

| | | |
|---|---|---|
| Antenna Description | : | PCB Antenna, -2.2dBi(Max.)<br>Ceramic Antenna, 1.0dBi(Max.)<br>FPC Antenna, 1.5dBi(Max.)<br>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)<br>IEEE 802.11ac: OFDM (256QAM, 64QAM, 16QAM, QPSK, BPSK)<br>IEEE 802.11ax: OFDM (1024QAM, 256QAM, 64QAM, 16QAM, QPSK, BPSK) |
| Antenna Description | : | PCB Antenna, 0.7dBi(Max.)<br>Ceramic Antenna, 2.6dBi(Max.)<br>FPC Antenna, 2.9dBi(Max.)<br>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)<br>IEEE 802.11ac: OFDM (256QAM, 64QAM, 16QAM, QPSK, BPSK)<br>IEEE 802.11ax: OFDM (1024QAM, 256QAM, 64QAM, 16QAM, QPSK,BPSK) |
| Antenna Description | : | PCB Antenna, 0.7dBi(Max.)<br>Ceramic Antenna, 2.6dBi(Max.)<br>FPC Antenna, 2.9dBi(Max.)<br>Dipole Antenna, 2.3dBi(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

## 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<br>5.2G WIFI: 2.3dBi<br>5.8G WIFI: 2.3dBi | Bluetooth/2.4GWIFI /5G WIFI Antenna |
| External | FPC Antenna | 2400-6000 MHz | BT/2.4G WIFI:1.5dBi<br>5.2G WIFI: 2.9dBi<br>5.8G WIFI: 2.9dBi | Bluetooth/2.4GWIFI /5G WIFI Antenna |
| Internal | PCB Antenna | 2400-6000 MHz | BT/2.4G WIFI:-2.2dBi<br>5.2G WIFI: 0.7dBi<br>5.8G WIFI: 0.7dBi | Bluetooth/2.4GWIFI /5G WIFI Antenna |
| External | Ceramic Antenna | 2400-6000 MHz | BT/2.4G WIFI:1.0dBi<br>5.2G WIFI: 2.6dBi<br>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 ±(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 ±(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 ±(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 ±(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 ±(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 ±(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 ±(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 ±(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 ±(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 ±(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 ±(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 ±(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 ±(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 ±(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 =20cm, 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/cm2) | MPE Limits (mW/cm2) |
|---|---|---|---|---|---|---|
| | 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/cm2) | MPE Limits (mW/cm2) |
|---|---|---|---|---|---|---|
| | 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/cm2) | MPE Limits (mW/cm2) |
|---|---|---|---|---|---|---|
| | 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----------