

## RF Exposure evaluation

FCC ID: 2A54Y-X3BAI

### 1. Reference

According to §1.1307(b)(1), systems operating under the provisions of this 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.

According to §1.1310 and §2.1091 RF exposure is calculated.

KDB447498 D01: Mobile and Portable Devices RF Exposure Procedures and Equipment Authorization Policies

### 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 <sup>2</sup> ) | 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 <sup>2</sup> )*              | 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 <sup>2</sup> ) | Averaging Time (minute) |
|---------------------------------------------|------------------------------|------------------------------|-------------------------------------|-------------------------|
| Limits for Occupational/Controlled Exposure |                              |                              |                                     |                         |
| 0.3 – 3.0                                   | 614                          | 1.63                         | (100) *                             | 30                      |
| 3.0 – 30                                    | 824/f                        | 2.19/f                       | (180/f <sup>2</sup> )*              | 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

### 3. 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

### 4. Antenna Information

X3 can only use antennas certificated as follows provided by manufacturer;

| Antenna No. | Model No. of antenna: | Type of antenna: | Gain of the antenna (Max.)                                         | Frequency range: |
|-------------|-----------------------|------------------|--------------------------------------------------------------------|------------------|
| BT          | /                     | PCB ANT          | 2.54dBi for 2400-2500MHz                                           |                  |
| 2.4GWIFI    | /                     | FPC ANT          | Ant 1: 1.67dBi for 2400-2500MHz<br>Ant 2: 1.90dBi for 2400-2500MHz |                  |
| 5GWIFI      | /                     | FPC ANT          | Ant 1: 4.12dBi for 5150-5250MHz<br>Ant 2: 4.90dBi for 5150-5250MHz |                  |
|             |                       |                  | Ant 1: 2.90dBi for 5725-5875MHz<br>Ant 2: 2.96dBi for 5725-5875MHz |                  |

### 5. Manufacturing Tolerance

BLE(Peak)

| BLE             |            |            |            |
|-----------------|------------|------------|------------|
| Channel         | Channel 00 | Channel 19 | Channel 39 |
| Target (dBm)    | 4.0        | 4.0        | 4.0        |
| Tolerance ±(dB) | 1.0        | 1.0        | 1.0        |

BR/EDR(Peak)

| GFSK            |            |            |            |
|-----------------|------------|------------|------------|
| Channel         | Channel 00 | Channel 39 | Channel 78 |
| Target (dBm)    | 6.0        | 6.0        | 6.0        |
| Tolerance ±(dB) | 1.0        | 1.0        | 1.0        |
| π/4QPSK         |            |            |            |
| Channel         | Channel 00 | Channel 39 | Channel 78 |
| Target (dBm)    | 8.0        | 8.0        | 8.0        |
| Tolerance ±(dB) | 1.0        | 1.0        | 1.0        |
| 8DPSK           |            |            |            |
| Channel         | Channel 00 | Channel 39 | Channel 78 |
| Target (dBm)    | 8.0        | 8.0        | 8.0        |
| Tolerance ±(dB) | 1.0        | 1.0        | 1.0        |

For ANT1

2.4GWIFI(Peak)

| 802.11b              |            |           |            |
|----------------------|------------|-----------|------------|
| Channel              | Channel 01 | Channel 6 | Channel 11 |
| Target (dBm)         | 14.0       | 14.0      | 14.0       |
| Tolerance $\pm$ (dB) | 1.0        | 1.0       | 1.0        |
| 802.11g              |            |           |            |
| Channel              | Channel 01 | Channel 6 | Channel 11 |
| Target (dBm)         | 15.0       | 15.0      | 15.0       |
| Tolerance $\pm$ (dB) | 1.0        | 1.0       | 1.0        |
| 802.11n(HT20)        |            |           |            |
| Channel              | Channel 01 | Channel 6 | Channel 11 |
| Target (dBm)         | 15.0       | 15.0      | 15.0       |
| Tolerance $\pm$ (dB) | 1.0        | 1.0       | 1.0        |
| 802.11n(HT40)        |            |           |            |
| Channel              | Channel 01 | Channel 6 | Channel 11 |
| Target (dBm)         | 16.0       | 16.0      | 16.0       |
| Tolerance $\pm$ (dB) | 1.0        | 1.0       | 1.0        |

5GHz WLAN U-NII 1

| IEEE 802.11a         |            |            |            |
|----------------------|------------|------------|------------|
| Channel              | Channel 36 | Channel 40 | Channel 48 |
| Target (dBm)         | 14.0       | 14.0       | 14.0       |
| Tolerance $\pm$ (dB) | 1.0        | 1.0        | 1.0        |
| IEEE 802.11n HT20    |            |            |            |
| Channel              | Channel 36 | Channel 40 | Channel 48 |
| Target (dBm)         | 14.0       | 14.0       | 14.0       |
| Tolerance $\pm$ (dB) | 1.0        | 1.0        | 1.0        |
| IEEE 802.11ac VHT20  |            |            |            |
| Channel              | Channel 36 | Channel 40 | Channel 48 |
| Target (dBm)         | 11.0       | 11.0       | 11.0       |
| Tolerance $\pm$ (dB) | 1.0        | 1.0        | 1.0        |
| IEEE 802.11n HT40    |            |            |            |
| Channel              | Channel 38 | ---        | Channel 46 |
| Target (dBm)         | 14.0       | ---        | 14.0       |
| Tolerance $\pm$ (dB) | 1.0        | ---        | 1.0        |
| IEEE 802.11ac VHT40  |            |            |            |
| Channel              | Channel 38 | ---        | Channel 46 |
| Target (dBm)         | 14.0       | ---        | 14.0       |
| Tolerance $\pm$ (dB) | 1.0        | ---        | 1.0        |
| IEEE 802.11ac VHT80  |            |            |            |
| Channel              | ---        | Channel 42 | ---        |
| Target (dBm)         | ---        | 11.0       | ---        |
| Tolerance $\pm$ (dB) | ---        | 6.0        | ---        |

5GHz WLAN U-NII 3

| IEEE 802.11a         |             |             |             |
|----------------------|-------------|-------------|-------------|
| Channel              | Channel 149 | Channel 157 | Channel 165 |
| Target (dBm)         | 15.0        | 15.0        | 15.0        |
| Tolerance $\pm$ (dB) | 1.0         | 1.0         | 1.0         |
| IEEE 802.11n HT20    |             |             |             |
| Channel              | Channel 149 | Channel 157 | Channel 165 |
| Target (dBm)         | 15.0        | 15.0        | 15.0        |
| Tolerance $\pm$ (dB) | 1.0         | 1.0         | 1.0         |
| IEEE 802.11ac VHT20  |             |             |             |
| Channel              | Channel 149 | Channel 157 | Channel 165 |
| Target (dBm)         | 15.0        | 15.0        | 15.0        |
| Tolerance $\pm$ (dB) | 1.0         | 1.0         | 1.0         |
| IEEE 802.11n HT40    |             |             |             |
| Channel              | Channel 151 | ---         | Channel 159 |
| Target (dBm)         | 13.0        | ---         | 13.0        |
| Tolerance $\pm$ (dB) | 1.0         | ---         | 1.0         |
| IEEE 802.11ac VHT40  |             |             |             |
| Channel              | Channel 151 | ---         | Channel 159 |
| Target (dBm)         | 13.0        | ---         | 13.0        |
| Tolerance $\pm$ (dB) | 1.0         | ---         | 1.0         |
| IEEE 802.11ac VHT80  |             |             |             |
| Channel              | ---         | Channel 155 | ---         |
| Target (dBm)         | ---         | 9.0         | ---         |
| Tolerance $\pm$ (dB) | ---         | 1.0         | ---         |

For ANT2

2.4GWIFI(Peak)

| 802.11b              |            |           |            |
|----------------------|------------|-----------|------------|
| Channel              | Channel 01 | Channel 6 | Channel 11 |
| Target (dBm)         | 15.0       | 15.0      | 15.0       |
| Tolerance $\pm$ (dB) | 1.0        | 1.0       | 1.0        |
| 802.11g              |            |           |            |
| Channel              | Channel 01 | Channel 6 | Channel 11 |
| Target (dBm)         | 15.0       | 15.0      | 15.0       |
| Tolerance $\pm$ (dB) | 1.0        | 1.0       | 1.0        |
| 802.11n(HT20)        |            |           |            |
| Channel              | Channel 01 | Channel 6 | Channel 11 |
| Target (dBm)         | 15.0       | 15.0      | 15.0       |
| Tolerance $\pm$ (dB) | 1.0        | 1.0       | 1.0        |
| 802.11n(HT40)        |            |           |            |
| Channel              | Channel 01 | Channel 6 | Channel 11 |
| Target (dBm)         | 15.0       | 15.0      | 15.0       |
| Tolerance $\pm$ (dB) | 1.0        | 1.0       | 1.0        |

# 5GHz WLAN U-NII 1

| IEEE 802.11a         |            |            |            |
|----------------------|------------|------------|------------|
| Channel              | Channel 36 | Channel 40 | Channel 48 |
| Target (dBm)         | 13.0       | 13.0       | 13.0       |
| Tolerance $\pm$ (dB) | 1.0        | 1.0        | 1.0        |
| IEEE 802.11n HT20    |            |            |            |
| Channel              | Channel 36 | Channel 40 | Channel 48 |
| Target (dBm)         | 13.0       | 13.0       | 13.0       |
| Tolerance $\pm$ (dB) | 1.0        | 1.0        | 1.0        |
| IEEE 802.11ac VHT20  |            |            |            |
| Channel              | Channel 36 | Channel 40 | Channel 48 |
| Target (dBm)         | 13.0       | 13.0       | 13.0       |
| Tolerance $\pm$ (dB) | 1.0        | 1.0        | 1.0        |
| IEEE 802.11n HT40    |            |            |            |
| Channel              | Channel 38 | ---        | Channel 46 |
| Target (dBm)         | 13.0       | ---        | 13.0       |
| Tolerance $\pm$ (dB) | 1.0        | ---        | 1.0        |
| IEEE 802.11ac VHT40  |            |            |            |
| Channel              | Channel 38 | ---        | Channel 46 |
| Target (dBm)         | 13.0       | ---        | 13.0       |
| Tolerance $\pm$ (dB) | 1.0        | ---        | 1.0        |
| IEEE 802.11ac VHT80  |            |            |            |
| Channel              | ---        | Channel 42 | ---        |
| Target (dBm)         | ---        | 5.0        | ---        |
| Tolerance $\pm$ (dB) | ---        | 1.0        | ---        |

# 5GHz WLAN U-NII 3

| IEEE 802.11a         |             |             |             |
|----------------------|-------------|-------------|-------------|
| Channel              | Channel 149 | Channel 157 | Channel 165 |
| Target (dBm)         | 15.0        | 15.0        | 15.0        |
| Tolerance $\pm$ (dB) | 1.0         | 1.0         | 1.0         |
| IEEE 802.11n HT20    |             |             |             |
| Channel              | Channel 149 | Channel 157 | Channel 165 |
| Target (dBm)         | 15.0        | 15.0        | 15.0        |
| Tolerance $\pm$ (dB) | 1.0         | 1.0         | 1.0         |
| IEEE 802.11ac VHT20  |             |             |             |
| Channel              | Channel 149 | Channel 157 | Channel 165 |
| Target (dBm)         | 15.0        | 15.0        | 15.0        |
| Tolerance $\pm$ (dB) | 1.0         | 1.0         | 1.0         |
| IEEE 802.11n HT40    |             |             |             |
| Channel              | Channel 151 | ---         | Channel 159 |
| Target (dBm)         | 15.0        | ---         | 15.0        |
| Tolerance $\pm$ (dB) | 1.0         | ---         | 1.0         |
| IEEE 802.11ac VHT40  |             |             |             |

|                      |             |             |             |
|----------------------|-------------|-------------|-------------|
| Channel              | Channel 151 | ---         | Channel 159 |
| Target (dBm)         | 15.0        | ---         | 15.0        |
| Tolerance $\pm$ (dB) | 1.0         | ---         | 1.0         |
| IEEE 802.11ac VHT80  |             |             |             |
| Channel              | ---         | Channel 155 | ---         |
| Target (dBm)         | ---         | 7.0         | ---         |
| Tolerance $\pm$ (dB) | ---         | 1.0         | ---         |

For MIMO:

#### 2.4GWIFI

|                      |            |           |            |
|----------------------|------------|-----------|------------|
| 802.11n(HT20)        |            |           |            |
| Channel              | Channel 01 | Channel 6 | Channel 11 |
| Target (dBm)         | 18.0       | 18.0      | 18.0       |
| Tolerance $\pm$ (dB) | 1.0        | 1.0       | 1.0        |
| 802.11n(HT40)        |            |           |            |
| Channel              | Channel 01 | Channel 6 | Channel 11 |
| Target (dBm)         | 18.0       | 18.0      | 18.0       |
| Tolerance $\pm$ (dB) | 1.0        | 1.0       | 1.0        |

#### 5GHz WLAN U-NII 1

|                      |            |            |            |
|----------------------|------------|------------|------------|
| IEEE 802.11n HT20    |            |            |            |
| Channel              | Channel 36 | Channel 40 | Channel 48 |
| Target (dBm)         | 16.0       | 16.0       | 16.0       |
| Tolerance $\pm$ (dB) | 1.0        | 1.0        | 1.0        |
| IEEE 802.11ac VHT20  |            |            |            |
| Channel              | Channel 36 | Channel 40 | Channel 48 |
| Target (dBm)         | 16.0       | 16.0       | 16.0       |
| Tolerance $\pm$ (dB) | 1.0        | 1.0        | 1.0        |
| IEEE 802.11n HT40    |            |            |            |
| Channel              | Channel 38 | ---        | Channel 46 |
| Target (dBm)         | 16.0       |            | 16.0       |
| Tolerance $\pm$ (dB) | 1.0        | ---        | 1.0        |
| IEEE 802.11ac VHT40  |            |            |            |
| Channel              | Channel 38 | ---        | Channel 46 |
| Target (dBm)         | 16.0       |            | 16.0       |
| Tolerance $\pm$ (dB) | 1.0        | ---        | 1.0        |
| IEEE 802.11ac VHT80  |            |            |            |
| Channel              | ---        | Channel 42 | ---        |
| Target (dBm)         | ---        | 9.0        | ---        |
| Tolerance $\pm$ (dB) | ---        | 1.0        | ---        |

### 5GHz WLAN U-NII 3

| IEEE 802.11n HT20    |             |             |             |
|----------------------|-------------|-------------|-------------|
| Channel              | Channel 149 | Channel 157 | Channel 165 |
| Target (dBm)         | 19.0        | 19.0        | 19.0        |
| Tolerance $\pm$ (dB) | 1.0         | 1.0         | 1.0         |
| IEEE 802.11ac VHT20  |             |             |             |
| Channel              | Channel 149 | Channel 157 | Channel 165 |
| Target (dBm)         | 19.0        | 19.0        | 19.0        |
| Tolerance $\pm$ (dB) | 1.0         | 1.0         | 1.0         |
| IEEE 802.11n HT40    |             |             |             |
| Channel              | Channel 151 | ---         | Channel 159 |
| Target (dBm)         | 17.0        | ---         | 17.0        |
| Tolerance $\pm$ (dB) | 1.0         | ---         | 1.0         |
| IEEE 802.11ac VHT40  |             |             |             |
| Channel              | Channel 151 | ---         | Channel 159 |
| Target (dBm)         | 17.0        | ---         | 17.0        |
| Tolerance $\pm$ (dB) | 1.0         | ---         | 1.0         |
| IEEE 802.11ac VHT80  |             |             |             |
| Channel              | ---         | Channel 155 | ---         |
| Target (dBm)         | ---         | 11.0        | ---         |
| Tolerance $\pm$ (dB) | ---         | 1.0         | ---         |

## 6. Standalone MPE Result

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.

| Modulation Type      | Output power |         | Antenna Gain (dBi) | Antenna Gain (linear) | MPE (mW/cm <sup>2</sup> ) | MPE Limits (mW/cm <sup>2</sup> ) |
|----------------------|--------------|---------|--------------------|-----------------------|---------------------------|----------------------------------|
|                      | dBm          | mW      |                    |                       |                           |                                  |
| BT                   | 9.0          | 7.9433  | 2.54               | 1.7947                | 0.0028                    | 1.0000                           |
| BLE                  | 5.0          | 3.1623  | 2.54               | 1.7947                | 0.0012                    | 1.0000                           |
| 2.4GWIFI ANT 1       | 17.0         | 50.1187 | 1.67               | 1.4689                | 0.0146                    | 1.0000                           |
| 2.4GWIFI ANT 2       | 16.0         | 39.8107 | 1.90               | 1.5488                | 0.0123                    | 1.0000                           |
| 5GWIFI U-NII 1 ANT 1 | 15.0         | 31.6228 | 4.12               | 2.5823                | 0.0162                    | 1.0000                           |
| 5GWIFI U-NII 1 ANT 2 | 14.0         | 25.1189 | 4.90               | 3.0903                | 0.0154                    | 1.0000                           |
| 5GWIFI U-NII 3 ANT 1 | 16.0         | 39.8107 | 2.90               | 1.9498                | 0.0154                    | 1.0000                           |
| 5GWIFI U-NII 3 ANT 2 | 16.0         | 39.8107 | 2.96               | 1.9770                | 0.0157                    | 1.0000                           |

*Remark:*

1. Output power (Peak) including turn-up tolerance;
2. MPE evaluate distance is 20cm from user manual provide by manufacturer.

### **Simultaneous Evaluation**

| Bluetooth<br>MPE<br>(mW/cm <sup>2</sup> ) | WIFI ANT 1 MPE<br>(mW/cm <sup>2</sup> ) | WIFI ANT 2 MPE<br>(mW/cm <sup>2</sup> ) | MPE    | MPE<br>Limits |
|-------------------------------------------|-----------------------------------------|-----------------------------------------|--------|---------------|
| 0.0028                                    | 0.0162                                  | 0.0157                                  | 0.0347 | 1.0000        |

## **7. 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-----