# Maximum Permissible Exposure Report

## 1. Product Information

| | |
|---|---|
| FCC ID | 2AVLJGC388082 |
| Name of EUT | Mobile Radio |
| Test Model | W2PLUS |
| Additional Model No.: | W1plus, F8, F8plus, M-7700, W5plus, W8plus, M-9900, A18plus. |
| Model Declaration | PCB board, structure and internal of these model(s) are the same, so no additional models were tested. |
| Modulation Type | GMSK for GSM/GPRS; 8-PSK for EDGE; QPSK for UMTS; QPSK, 16QAM for LTE |
| Antenna Gain | 2.0dBi (max.) For GSM 850; 2.0dBi (max.) For GSM 900;<br>2.0dBi (max.) For DCS 1800; 2.0dBi (max.) For PCS 1900;<br>2.0dBi for WCDMA Band I; 2.0dBi for WCDMA Band II;<br>2.0dBi for WCDMA Band IV; 2.0dBi for WCDMA Band V;<br>2.0dBi for WCDMA Band VIII;<br>3.0dBi for LTE Band 2; 3.0dBi for LTE Band 4;<br>3.0dBi for LTE Band 5; 3.0dBi for LTE Band 7;<br>3.0dBi for LTE Band 12; 3.0dBi for LTE Band 13;<br>3.0dBi for LTE Band 17;<br>2.0dBi (max.) For BT and WLAN |
| Hardware version | MRA58K release-keys |
| Software version | MT6737N_Android 7.0 |
| GSM/EDGE/GPRS Operation Frequency Band | GSM850/PCS1900/GPRS850/GPRS1900/EDGE850/EDGE1900 |
| UMTS Operation Frequency Band | UMTS FDD Band II/IV/V |
| LTE Operation Frequency Band | LTE FDD band 2, 4, 5, 7, 12, 13, 17 |
| GSM/EDGE/GPRS | Supported GSM/GPRS/EDGE |
| GSM Release Version | R99 |
| GSM/EDGE/GPRS Power Class | GSM850:Power Class 4/ PCS1900:Power Class 1 |
| GPRS/EDGE Multislot Class | GPRS/EDGE: Multi-slot Class 12 |
| GPRS operation mode | Class B |
| WCDMA Release Version | R8 |
| HSDPA Release Version | Release 8 |
| HSUPA Release Version | Release 6 |
| DC-HSUPA Release Version | Not Supported |
| LTE Release Version | R9 |
| LTE/UMTS Power Class | Class 3 |
| WLAN FCC Modulation Type | IEEE 802.11b: DSSS(CCK,DQPSK,DBPSK)<br>IEEE 802.11g/n: OFDM(64QAM, 16QAM, QPSK, BPSK) |
| WLAN FCC Operation frequency | IEEE 802.11b:2412-2462MHz<br>IEEE 802.11g/n20:2412-2462MHz<br>IEEE 802.11n40:2422-2452MHz |
| Antenna Type | Wifi: Internal antenna<br>BT: Internal antenna<br>GSM: External antenna<br>WCDMA: External antenna<br>LTE: QPSK, External antenna |
| BT Modulation Type | GFSK, π/4-DQPSK, 8-DPSK (BT V4.0) |
| Extreme temp. Tolerance | -30°C to +75°C |
| GPS function | Support and only RX |
| NFC Function | Not Supported |
| Extreme vol. Limits | 10VDC to 24VDC (nominal: 12VDC) |
| Name of EUT | Mobile Radio |
| Exposure category | General population/uncontrolled environment |
| EUT Type | Production Unit |
| Device Type | Mobile 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 C95.1–1999: IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz 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/Controlled 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

ES-D4 can only use antennas certificated as follows provided by manufacturer;

| Antenna type and antenna number | Operate frequency band | Maximum antenna gain | Notes |
|---|---|---|---|
| Internal Antenna | 2000 MHz – 2500 MHz | 2.0 dBi | BT/ WLAN Antenna |
| External Antenna | 600 MHz – 3000 MHz | 3.0 dBi | GSM/WCDMA/LTE Antenna |

## 6. Conducted Power

[BT Max Conducted Power]

| Mode | Channel | Frequency(MHz) | Max Conducted Power (dBm) |
|---|---|---|---|
| GFSK BT LE | 0 | 2402 | -0.205 |
| | 19 | 2440 | -2.201 |
| | 39 | 2480 | -0.894 |
| GFSK | 0 | 2402 | -0.121 |
| | 39 | 2441 | -2.088 |
| | 78 | 2480 | -0.750 |
| π/4DQPSK | 0 | 2402 | -0.849 |
| | 39 | 2441 | -2.650 |
| | 78 | 2480 | -1.544 |
| 8DPSK | 0 | 2402 | -0.623 |
| | 39 | 2441 | -2.477 |
| | 78 | 2480 | -1.293 |

[2.4GWLAN Max Conducted Power]

| Mode | Channel | Frequency(MHz) | Max Conducted Power (dBm) |
|---|---|---|---|
| IEEE 802.11b | 1 | 2412 | 10.67 |
| | 6 | 2437 | 10.49 |
| | 11 | 2462 | 10.94 |
| IEEE 802.11g | 1 | 2412 | 13.64 |
| | 6 | 2437 | 13.64 |
| | 11 | 2462 | 13.86 |
| IEEE 802.11n HT20 | 1 | 2412 | 11.68 |
| | 6 | 2437 | 11.63 |
| | 11 | 2462 | 12.03 |
| IEEE 802.11n HT40 | 3 | 2422 | 11.73 |
| | 6 | 2437 | 11.89 |
| | 9 | 2452 | 12.04 |

[GSM Max Average Power]

| Test Mode | Channel | Frequency (MHz) | Max Average Power (dBm) |
|---|---|---|---|
| GSM 850 | Low | 824.2 | 32.16 |
| | Middle | 836.6 | 32.25 |
| | High | 848.8 | 32.18 |
| GSM 1900 | Low | 1850.2 | 29.36 |
| | Middle | 1880.0 | 29.55 |
| | High | 1909.8 | 29.31 |

[WCDMA Max Average Power]

| Test Mode | Channel | Frequency (MHz) | Max Average Power (dBm) |
|---|---|---|---|
| WCDMA Band II | Low | 1852.4 | 23.31 |
| | Middle | 1880 | 23.38 |
| | High | 1907.6 | 23.23 |
| WCDMA Band IV | Low | 1712.4 | 23.14 |
| | Middle | 1732.6 | 23.27 |
| | High | 1752.6 | 23.23 |
| WCDMA Band V | Low | 826.4 | 23.25 |
| | Middle | 836.4 | 23.50 |
| | High | 846.6 | 23.41 |

[LTE Max Average Power]

| Test Mode | | Channel | Max Average Power (dBm) |
|---|---|---|---|
| LTE | Band 2 | LCH | 23.43 |
| | | MCH | 22.93 |
| | | HCH | 22.70 |
| | Band 4 | LCH | 22.96 |
| | | MCH | 22.44 |
| | | HCH | 23.00 |
| | Band 5 | LCH | 23.40 |
| | | MCH | 22.83 |
| | | HCH | 23.40 |
| | Band 7 | LCH | 23.08 |
| | | MCH | 23.66 |
| | | HCH | 22.63 |
| | Band 12 | LCH | 23.47 |
| | | MCH | 23.55 |
| | | HCH | 23.57 |
| | Band 13 | LCH | 23.22 |
| | | MCH | 23.25 |
| | | HCH | 23.16 |
| | Band 17 | LCH | 23.59 |
| | | MCH | 23.77 |
| | | HCH | 23.64 |

## 7. Manufacturing Tolerance

[BT Max Conducted Power]

| Test Mode | Channel | Max Conducted Power (dBm) | ANT Max. Tune Up Power (dBm) |
|---|---|---|---|
| GFSK BT LE | LCH | -0.205 | -1.0±1.0 |
| | MCH | -2.201 | -2.0±1.0 |
| | HCH | -0.894 | -1.0±1.0 |
| GFSK | LCH | -0.121 | -1.0±1.0 |
| | MCH | -2.088 | -2.0±1.0 |
| | HCH | -0.750 | -1.0±1.0 |
| π/4DQPSK | LCH | -0.849 | -1.0±1.0 |
| | MCH | -2.650 | -2.0±1.0 |
| | HCH | -1.544 | -1.0±1.0 |
| 8DPSK | LCH | -0.623 | -1.0±1.0 |
| | MCH | -2.477 | -2.0±1.0 |
| | HCH | -1.293 | -1.0±1.0 |

[2.4GWLAN Max Conducted Power]

| Test Mode | Channel | Max Conducted Power (dBm) | ANT Max. Tune Up Power (dBm) |
|---|---|---|---|
| IEEE 802.11b | LCH | 10.67 | 10.0±1.0 |
| | MCH | 10.49 | 10.0±1.0 |
| | HCH | 10.94 | 10.0±1.0 |
| IEEE 802.11g | LCH | 13.64 | 13.0±1.0 |
| | MCH | 13.64 | 13.0±1.0 |
| | HCH | 13.86 | 13.0±1.0 |
| IEEE 802.11n HT20 | LCH | 11.68 | 12.0±1.0 |
| | MCH | 11.63 | 12.0±1.0 |
| | HCH | 12.03 | 12.0±1.0 |
| IEEE 802.11n HT40 | LCH | 11.73 | 12.0±1.0 |
| | MCH | 11.89 | 12.0±1.0 |
| | HCH | 12.04 | 12.0±1.0 |

[GSM Max Average Power]

| Test Mode | Channel | Max Average Power (dBm) | ANT Max. Tune Up Power (dBm) |
|---|---|---|---|
| GSM 850 | LCH | 32.16 | 31.3±1.0 |
| | MCH | 32.25 | 31.4±1.0 |
| | HCH | 32.18 | 31.4±1.0 |
| GSM 1900 | LCH | 29.36 | 29.0±1.0 |
| | MCH | 29.55 | 29.0±1.0 |
| | HCH | 29.31 | 29.0±1.0 |

[WCDMA Max Average Power]

| Test Mode | | Channel | Max Average Power (dBm) | ANT Max. Tune Up Power (dBm) |
|---|---|---|---|---|
| WCDMA | Band II | LCH | 23.31 | 23.0±1.0 |
| | | MCH | 23.38 | 23.0±1.0 |
| | | HCH | 23.23 | 23.0±1.0 |
| | Band IV | Low | 23.14 | 23.0±1.0 |
| | | Middle | 23.27 | 23.0±1.0 |
| | | High | 23.23 | 23.0±1.0 |

| | | | | |
|---|---|---|---|---|
| | Band V | LCH | 23.25 | 23.0±1.0 |
| | | MCH | 23.50 | 23.0±1.0 |
| | | HCH | 23.41 | 23.0±1.0 |

**<LTE Max Average Power>**

| Test Mode | | Channel | Max Average Power (dBm) | ANT Max. Tune Up Power (dBm) |
|---|---|---|---|---|
| LTE | Band 2 | LCH | 23.43 | 23.0±1.0 |
| | | MCH | 22.93 | 23.0±1.0 |
| | | HCH | 22.70 | 23.0±1.0 |
| | Band 4 | LCH | 22.96 | 23.0±1.0 |
| | | MCH | 22.44 | 23.0±1.0 |
| | | HCH | 23.00 | 23.0±1.0 |
| | Band 5 | LCH | 23.40 | 23.0±1.0 |
| | | MCH | 22.83 | 23.0±1.0 |
| | | HCH | 23.40 | 23.0±1.0 |
| | Band 7 | LCH | 23.08 | 23.0±1.0 |
| | | MCH | 23.66 | 23.0±1.0 |
| | | HCH | 22.63 | 23.0±1.0 |
| | Band 12 | LCH | 23.47 | 23.0±1.0 |
| | | MCH | 23.55 | 23.0±1.0 |
| | | HCH | 23.57 | 23.0±1.0 |
| | Band 13 | LCH | 23.22 | 23.0±1.0 |
| | | MCH | 23.25 | 23.0±1.0 |
| | | HCH | 23.16 | 23.0±1.0 |
| | Band 17 | LCH | 23.59 | 23.0±1.0 |
| | | MCH | 23.77 | 23.0±1.0 |
| | | HCH | 23.64 | 23.0±1.0 |

## 8. Measurement Results

### 8.1 Standalone MPE Evaluation

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.

| Modulation Type | Output power | | Antenna Gain (dBi) | Antenna Gain (linear) | MPE ($mW/cm^2$) | MPE Limits ($mW/cm^2$) |
|---|---|---|---|---|---|---|
| | dBm | mW | | | | |
| GFSK BT LE | 0 | 1.00 | 2.0 | 1.585 | 0.0003 | 1.0 |
| GFSK | 0 | 1.00 | 2.0 | 1.585 | 0.0003 | 1.0 |
| π/4DQPSK | 0 | 1.00 | 2.0 | 1.585 | 0.0003 | 1.0 |
| 8DPSK | 0 | 1.00 | 2.0 | 1.585 | 0.0003 | 1.0 |
| IEEE 802.11b | 11.0 | 12.59 | 2.0 | 1.585 | 0.0040 | 1.0 |
| IEEE 802.11g | 14.0 | 25.12 | 2.0 | 1.585 | 0.0079 | 1.0 |
| IEEE 802.11n HT20 | 13.0 | 19.95 | 2.0 | 1.585 | 0.0063 | 1.0 |
| IEEE 802.11n HT40 | 13.0 | 19.95 | 2.0 | 1.585 | 0.0063 | 1.0 |

| Modulation Type | Output power | | Antenna Gain (dBi) | Antenna Gain (linear) | MPE (mW/cm2) | MPE Limits (mW/cm2) |
|---|---|---|---|---|---|---|
| | dBm | mW | | | | |
| GSM 850 | 32.3 | 1698.24 | 2.0 | 1.585 | 0.5355 | 1.0 |
| GSM 1900 | 30.0 | 1000.00 | 2.0 | 1.585 | 0.3155 | 1.0 |
| WCDMA Band II | 24.0 | 251.19 | 2.0 | 1.585 | 0.0792 | 1.0 |
| WCDMA Band V | 24.0 | 251.19 | 2.0 | 1.585 | 0.0792 | 1.0 |
| LTE Band 2 | 24.0 | 251.19 | 3.0 | 1.995 | 0.0997 | 1.0 |

| | | | | | | |
|---|---|---|---|---|---|---|
| LTE Band 4 | 24.0 | 251.19 | 3.0 | 1.995 | 0.0997 | 1.0 |
| LTE Band 5 | 24.0 | 251.19 | 3.0 | 1.995 | 0.0997 | 1.0 |
| LTE Band 7 | 24.0 | 251.19 | 3.0 | 1.995 | 0.0997 | 1.0 |
| LTE Band 12 | 24.0 | 251.19 | 3.0 | 1.995 | 0.0997 | 1.0 |
| LTE Band 13 | 24.0 | 251.19 | 3.0 | 1.995 | 0.0997 | 1.0 |
| LTE Band 17 | 24.0 | 251.19 | 3.0 | 1.995 | 0.0997 | 1.0 |

*Remark:*
*1. Output power including turn-up tolerance;*
*2. Output power is burst average power;*
*3. MPE evaluate distance is 20cm from user manual provide by manufacturer;*
*4. MPE values = $PG/4\pi R^2$*

**8.2 Simultaneous Transmission MPE**

The sample support one BT&2.4GWLAN and another one LTE&WCDMA&GSM transmit antenna, so need consider simultaneous transmission;
Simultaneous transmission MPE
According to KDB447498 for Transmitters used in mobile exposure conditions for simultaneous transmission operations;
$\sum\sum$ of MPE ratios ≤ 1.0

| Mode | ∑ MPE max ratios | Limit | Results |
|---|---|---|---|
| BT + GSM | 0.5358 | 1.0 | Pass |
| BT + WCDMA | 0.0795 | 1.0 | Pass |
| BT + LTE | 0.10 | 1.0 | Pass |
| 2.4G WIFI + GSM | 0.5434 | 1.0 | Pass |
| 2.4G WIFI + WCDMA | 0.0871 | 1.0 | Pass |
| 2.4G WIFI + LTE | 0.1076 | 1.0 | Pass |

## 9. Conclusion

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

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