

# 1. MAXIMUM PERMISSIBLE EXPOSURE (MPE)

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## 1.1 General Information

### Client Information

Applicant: Shenzhen Inrico Electronics Co., LTD  
Address of applicant: 3/F, Building NO.118, High Tech Industrial Park, 72 Guowei Road, Luohu District, Shenzhen, China

Manufacturer: Shenzhen Inrico Electronics Co., LTD  
Address of manufacturer: 3/F, Building NO.118, High Tech Industrial Park, 72 Guowei Road, Luohu District, Shenzhen, China

### General Description of EUT:

Product Name: Mobile Network Radio  
Trade Name: /  
Model No.: TM-7PLUS  
Adding Model(s): /  
FCC ID: 2AIV6-TM-7PLUS  
Rated Voltage: DC12-36V  
Battery Capacity: /

| Technical Characteristics of EUT: |                                                                              |
|-----------------------------------|------------------------------------------------------------------------------|
| <b>2G</b>                         |                                                                              |
| Support Networks:                 | GSM, GPRS, EDGE                                                              |
| Support Band:                     | GSM850/PCS1900                                                               |
| Uplink Frequency:                 | GSM/GPRS/EDGE 850: 824~849MHz<br>GSM/GPRS/EDGE 1900: 1850~1910MHz            |
| Downlink Frequency:               | GSM/GPRS/EDGE 850: 869~894MHz<br>GSM/GPRS/EDGE 1900: 1930~1990MHz            |
| Max RF Output Power:              | GSM850: 32.72dBm, GSM1900: 29.75dBm<br>EDGE850: 31.97dBm, EDGE1900: 27.55dBm |
| Type of Emission:                 | GSM850: 250KGXW, GSM1900: 251KGXW<br>EDGE850: 289KG7W, EDGE1900: 247KG7W     |
| Type of Modulation:               | GMSK, 8PSK                                                                   |
| Type of Antenna:                  | Integral Antenna                                                             |
| Antenna Gain:                     | GSM850: -1.19dBi; GSM1900: -1.12dBi                                          |
| GPRS/EDGE Class:                  | Class 12                                                                     |
| <b>3G</b>                         |                                                                              |
| Support Networks:                 | WCDMA, HSDPA, HSUPA                                                          |
| Support Band:                     | WCDMA Band 2, WCDMA Band 4, WCDMA Band 5                                     |
| Uplink Frequency:                 | WCDMA Band 2: 1850~1910MHz<br>WCDMA Band 4: 1710~1755MHz                     |

|                     |                                                                                                                                                                                                                                                           |
|---------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                     | WCDMA Band 5: 824~849MHz                                                                                                                                                                                                                                  |
| Downlink Frequency: | WCDMA Band 2: 1930~1990MHz<br>WCDMA Band 4: 2110~2155MHz<br>WCDMA Band 5: 869~894MHz                                                                                                                                                                      |
| RF Output Power:    | WCDMA Band 2: 22.30dBm,<br>WCDMA Band 4: 23.65dBm<br>WCDMA Band 5: 23.11dBm                                                                                                                                                                               |
| Type of Emission:   | WCDMA Band 2: 4M25F9W<br>WCDMA Band 4: 4M24F9W<br>WCDMA Band 5: 4M24F9W                                                                                                                                                                                   |
| Type of Modulation: | BPSK,QPSK                                                                                                                                                                                                                                                 |
| Antenna Type:       | Integral Antenna                                                                                                                                                                                                                                          |
| Antenna Gain:       | WCDMA Band 2: -1.12dBi,<br>WCDMA Band 4: 0.22dBi,<br>WCDMA Band 5: -1.19dBi                                                                                                                                                                               |
| <b>4G</b>           |                                                                                                                                                                                                                                                           |
| Support Networks:   | FDD-LTE                                                                                                                                                                                                                                                   |
| Support Band:       | FDD-LTE Band 2, 4, 5, 7, 12, 13, 17                                                                                                                                                                                                                       |
| Uplink Frequency:   | FDD-LTE Band 2: Tx: 1850-1910MHz,<br>FDD-LTE Band 4: Tx: 1710-1755MHz,<br>FDD-LTE Band 5: Tx: 824-849MHz,<br>FDD-LTE Band 7: Tx: 2500-2570MHz,<br>FDD-LTE Band 12: Tx: 699-716MHz,<br>FDD-LTE Band 13: Tx: 777-787MHz,<br>FDD-LTE Band 17: Tx: 704-716MHz |
| Downlink Frequency: | FDD-LTE Band 2: Rx: 1930-1990MHz,<br>FDD-LTE Band 4: Rx: 2110-2155MHz,<br>FDD-LTE Band 5: Rx: 869-894MHz,<br>FDD-LTE Band 7: Rx: 2620-2690MHz,<br>FDD-LTE Band 12: Rx: 729-746MHz,<br>FDD-LTE Band 13: Rx: 746-756MHz,<br>FDD-LTE Band 17: Rx: 734-746MHz |
| RF Output Power:    | FDD-LTE Band 2: 23.2dBm,<br>FDD-LTE Band 4: 23.68 dBm,<br>FDD-LTE Band 5: 23.07dBm,<br>FDD-LTE Band 7: 23.28dBm,<br>FDD-LTE Band 12: 23.58dBm,<br>FDD-LTE Band 13: 23.96dBm,<br>FDD-LTE Band 17: 23.49dBm                                                 |
| Type of Emission:   | FDD-LTE Band 2: 17M9G7D, 17M9W7D<br>FDD-LTE Band 4: 17M9G7D, 17M9W7D<br>FDD-LTE Band 5: 8M97G7D, 8M95W7D<br>FDD-LTE Band 7: 17M9G7D, 17M9W7D<br>FDD-LTE Band 12: 8M95G7D, 8M95W7D                                                                         |

|                       |                                                                                                                                                                                                           |
|-----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                       | FDD-LTE Band 13: 8M96G7D, 8M96W7D<br>FDD-LTE Band 17: 8M93G7D, 8M94W7D                                                                                                                                    |
| Type of Modulation:   | QPSK, 16QAM                                                                                                                                                                                               |
| Antenna Type:         | Integral Antenna                                                                                                                                                                                          |
| Antenna Gain:         | FDD-LTE Band 2: -1.12dBi,<br>FDD-LTE Band 4: 0.21dBi,<br>FDD-LTE Band 5: -1.19dBi,<br>FDD-LTE Band 7: -0.78dBi,<br>FDD-LTE Band 12: -3.26dBi,<br>FDD-LTE Band 13: -3.54dBi,<br>FDD-LTE Band 17: -3.26dBi, |
| <b>Wi-Fi</b>          |                                                                                                                                                                                                           |
| Support Standards:    | 802.11b, 802.11g, 802.11n                                                                                                                                                                                 |
| Frequency Range:      | 2412-2462MHz for 802.11b/g/n-HT20<br>2422-2452MHz for 802.11n-HT40                                                                                                                                        |
| RF Output Power:      | 12.02dBm (Conducted)                                                                                                                                                                                      |
| Type of Modulation:   | CCK, OFDM, QPSK, BPSK, 16QAM, 64QAM                                                                                                                                                                       |
| Data Rate:            | 1-11Mbps, 6-54Mbps, up to 150Mbps                                                                                                                                                                         |
| Quantity of Channels: | 11 for 802.11b/g/n-HT20<br>7 for 802.11n-HT40                                                                                                                                                             |
| Channel Separation:   | 5MHz                                                                                                                                                                                                      |
| Type of Antenna:      | Integral Antenna                                                                                                                                                                                          |
| Antenna Gain:         | 0.46dBi                                                                                                                                                                                                   |
| GPRS/EDGE Class:      | Class 12                                                                                                                                                                                                  |
| <b>BT</b>             |                                                                                                                                                                                                           |
| Bluetooth Version:    | V4.0 (BDR/EDR mode)                                                                                                                                                                                       |
| Frequency Range:      | 2402-2480MHz                                                                                                                                                                                              |
| RF Output Power:      | -0.82dBm (Conducted)                                                                                                                                                                                      |
| Data Rate:            | 1Mbps, 2Mbps, 3Mbps                                                                                                                                                                                       |
| Modulation:           | GFSK, Pi/4 QDPSK, 8DPSK                                                                                                                                                                                   |
| Quantity of Channels: | 79/40                                                                                                                                                                                                     |
| Channel Separation:   | 1MHz/2MHz                                                                                                                                                                                                 |
| Type of Antenna:      | Integral Antenna                                                                                                                                                                                          |
| Antenna Gain:         | 0.46dBi                                                                                                                                                                                                   |

## 1.2 Standard Applicable

According to § 1.1307(b)(1) and KDB 447498 D01 General RF Exposure Guidance v06, system operating under the provisions of this section shall be operating in a manner that the public is not exposed to radio frequency energy level in excess limit for maximum permissible exposure.

### (a) Limits for Occupational / Controlled Exposure

| Frequency range (MHz) | Electric Field Strength (E) (V/m) | Magnetic Field Strength (H) (A/m) | Power Density (S) (mW/cm <sup>2</sup> ) | Averaging Times   E   <sup>2</sup> ,   H   <sup>2</sup> or S (minutes) |
|-----------------------|-----------------------------------|-----------------------------------|-----------------------------------------|------------------------------------------------------------------------|
| 0.3-3.0               | 614                               | 1.63                              | (100)*                                  | 6                                                                      |
| 3.0-30                | 1842/f                            | 4.89/f                            | (900/f)*                                | 6                                                                      |
| 30-300                | 61.4                              | 0.163                             | 1.0                                     | 6                                                                      |
| 300-1500              | /                                 | /                                 | F/300                                   | 6                                                                      |
| 1500-100000           | /                                 | /                                 | 5                                       | 6                                                                      |

### (b) Limits for General Population / Uncontrolled Exposure

| Frequency range (MHz) | Electric Field Strength (E) (V/m) | Magnetic Field Strength (H) (A/m) | Power Density (S) (mW/cm <sup>2</sup> ) | Averaging Times   E   <sup>2</sup> ,   H   <sup>2</sup> or S (minutes) |
|-----------------------|-----------------------------------|-----------------------------------|-----------------------------------------|------------------------------------------------------------------------|
| 0.3-1.34              | 614                               | 1.63                              | (100)*                                  | 30                                                                     |
| 1.34-30               | 824/f                             | 2.19/f                            | (180/f)*                                | 30                                                                     |
| 30-300                | 27.5                              | 0.073                             | 0.2                                     | 30                                                                     |
| 300-1500              | /                                 | /                                 | F/1500                                  | 30                                                                     |
| 1500-100000           | /                                 | /                                 | 1                                       | 30                                                                     |

Note: f = frequency in MHz: \* = Plane-wave equivalents power density

## 1.3 MPE Calculation Method

$$S = (30 * P * G) / (377 * R^2)$$

S = power density (in appropriate units, e.g., mw/cm<sup>2</sup>)

P = power input to the antenna (in appropriate units, e.g., mw)

G = power gain of the antenna in the direction of interest relative to an isotropic radiator, the power gain factor is normally numeric gain.

R = distance to the center of radiation of the antenna (in appropriate units, e.g., cm)

## 1.4 MPE Calculation Result

### GSM850:

Maximum Tune-Up output power: 33.0 (dBm)

Maximum peak output power at antenna input terminal: 1995.26 (mW)

Prediction distance: >20(cm)

Prediction frequency: 824.4 (MHz)

Antenna gain: -1.19 (dBi)

Directional gain (numeric gain): 0.76

The worst case is power density at prediction frequency at 20cm: 0.302 (mw/cm<sup>2</sup>)

MPE limit for general population exposure at prediction frequency: 0.55 (mw/cm<sup>2</sup>)

### GSM1900:

Maximum Tune-Up output power: 30.0 (dBm)

Maximum peak output power at antenna input terminal: 1000 (mW)

Prediction distance: >20(cm)

Prediction frequency: 1852.4(MHz)

Antenna gain: -1.12 (dBi)

Directional gain (numeric gain): 0.77

The worst case is power density at prediction frequency at 20cm: 0.153 (mw/cm<sup>2</sup>)

MPE limit for general population exposure at prediction frequency: 1.0 (mw/cm<sup>2</sup>)

### WCDMA Band 2:

Maximum Tune-Up output power: 22.5 (dBm)

Maximum peak output power at antenna input terminal: 177.83 (mW)

Prediction distance: >20(cm)

Prediction frequency: 1852.4(MHz)

Antenna gain: -1.12 (dBi)

Directional gain (numeric gain): 0.77

The worst case is power density at prediction frequency at 20cm: 0.027 (mw/cm<sup>2</sup>)

MPE limit for general population exposure at prediction frequency: 1.0 (mw/cm<sup>2</sup>)

### WCDMA Band 4:

Maximum Tune-Up output power: 24.0 (dBm)

Maximum peak output power at antenna input terminal: 251.19 (mW)

Prediction distance: >20(cm)

Prediction frequency: 1732.6(MHz)

Antenna gain: 0.22(dBi)

Directional gain (numeric gain): 1.05

The worst case is power density at prediction frequency at 20cm: 0.052 (mw/cm<sup>2</sup>)

MPE limit for general population exposure at prediction frequency: 1.0 (mw/cm<sup>2</sup>)

### WCDMA Band 5:

Maximum Tune-Up output power: 23.5 (dBm)

Maximum peak output power at antenna input terminal: 223.87 (mW)  
Prediction distance: >20(cm)  
Prediction frequency: 826.4 (MHz)  
Antenna gain: -1.19 (dBi)  
Directional gain (numeric gain): 0.76  
The worst case is power density at prediction frequency at 20cm: 0.034 (mw/cm<sup>2</sup>)  
MPE limit for general population exposure at prediction frequency: 0.55 (mw/cm<sup>2</sup>)

#### **FDD-LTE Band 2:**

Maximum Tune-Up output power: 23.5 (dBm)  
Maximum peak output power at antenna input terminal: 223.87 (mW)  
Prediction distance: >20(cm)  
Prediction frequency: 1905(MHz)  
Antenna gain: -1.12(dBi)  
Directional gain (numeric gain): 0.77  
The worst case is power density at prediction frequency at 20cm: 0.034 (mw/cm<sup>2</sup>)  
MPE limit for general population exposure at prediction frequency: 1 (mw/cm<sup>2</sup>)

#### **FDD-LTE Band 4:**

Maximum Tune-Up output power: 24.0 (dBm)  
Maximum peak output power at antenna input terminal: 251.19 (mW)  
Prediction distance: >20(cm)  
Prediction frequency: 1747.5(MHz)  
Antenna gain: 0.22(dBi)  
Directional gain (numeric gain): 1.05  
The worst case is power density at prediction frequency at 20cm: 0.052(mw/cm<sup>2</sup>)  
MPE limit for general population exposure at prediction frequency: 1.0 (mw/cm<sup>2</sup>)

#### **FDD-LTE Band 5:**

Maximum Tune-Up output power: 23.5 (dBm)  
Maximum peak output power at antenna input terminal: 223.87 (mW)  
Prediction distance: >20(cm)  
Prediction frequency: 824.7 (MHz)  
Antenna gain: -1.19 (dBi)  
Directional gain (numeric gain): 0.76  
The worst case is power density at prediction frequency at 20cm: 0.034 (mw/cm<sup>2</sup>)  
MPE limit for general population exposure at prediction frequency: 0.55 (mw/cm<sup>2</sup>)

#### **FDD-LTE Band 7:**

Maximum Tune-Up output power: 23.5 (dBm)  
Maximum peak output power at antenna input terminal: 223.87 (mW)  
Prediction distance: >20(cm)  
Prediction frequency: 2502.5(MHz)  
Antenna gain: -0.78(dBi)

Directional gain (numeric gain): 0.84

The worst case is power density at prediction frequency at 20cm: 0.037 (mw/cm<sup>2</sup>)

MPE limit for general population exposure at prediction frequency: 1.0 (mw/cm<sup>2</sup>)

#### **FDD-LTE Band 12:**

Maximum Tune-Up output power: 24.5 (dBm)

Maximum peak output power at antenna input terminal: 281.84 (mW)

Prediction distance: >20(cm)

Prediction frequency: 699.7(MHz)

Antenna gain: -3.26(dBi)

Directional gain (numeric gain): 0.47

The worst case is power density at prediction frequency at 20cm: 0.026 (mw/cm<sup>2</sup>)

MPE limit for general population exposure at prediction frequency: 0.47 (mw/cm<sup>2</sup>)

#### **FDD-LTE Band 13:**

Maximum Tune-Up output power: 24.0 (dBm)

Maximum peak output power at antenna input terminal: 251.19 (mW)

Prediction distance: >20(cm)

Prediction frequency: 779.5(MHz)

Antenna gain: -3.54(dBi)

Directional gain (numeric gain): 0.44

The worst case is power density at prediction frequency at 20cm: 0.022 (mw/cm<sup>2</sup>)

MPE limit for general population exposure at prediction frequency: 0.52 (mw/cm<sup>2</sup>)

#### **FDD-LTE Band 17:**

Maximum Tune-Up output power: 24.0 (dBm)

Maximum peak output power at antenna input terminal: 251.19 (mW)

Prediction distance: >20(cm)

Prediction frequency: 706.5(MHz)

Antenna gain: -3.26(dBi)

Directional gain (numeric gain): 0.47

The worst case is power density at prediction frequency at 20cm: 0.023 (mw/cm<sup>2</sup>)

MPE limit for general population exposure at prediction frequency: 0.47 (mw/cm<sup>2</sup>)

#### **Wi-Fi:**

Maximum Tune-Up output power: 12.5 (dBm)

Maximum peak output power at antenna input terminal: 17.78 (mW)

Prediction distance: >20(cm)

Prediction frequency: 2412(MHz)

Antenna gain: 0.46(dBi)

Directional gain (numeric gain): 1.11

The worst case is power density at prediction frequency at 20cm: 0.004 (mw/cm<sup>2</sup>)

MPE limit for general population exposure at prediction frequency: 1.0 (mw/cm<sup>2</sup>)

**BT:**

Maximum Tune-Up output power: 0 (dBm)

Maximum peak output power at antenna input terminal: 1 (mW)

Prediction distance: >20(cm)

Prediction frequency: 2402(MHz)

Antenna gain: 0.46(dBi)

Directional gain (numeric gain): 1.11

The worst case is power density at prediction frequency at 20cm: 0.0002 (mw/cm<sup>2</sup>)

MPE limit for general population exposure at prediction frequency: 1.0 (mw/cm<sup>2</sup>)

**Simultaneous Multi-band Transmission**

GSM850+Wi-Fi:  $0.302+0.004=0.306$

GSM850+BT:  $0.302+0.0002=0.3022$

GSM1900+Wi-Fi:  $0.153+0.004=0.157$

GSM1900+BT:  $0.153+0.0002=0.1532$

WCDMA B2+Wi-Fi:  $0.027+0.004=0.031$

WCDMA B2+BT:  $0.027+0.0002=0.0272$

WCDMA B4+Wi-Fi:  $0.052+0.004=0.056$

WCDMA B4+BT:  $0.052+0.0002=0.0522$

WCDMA B5+Wi-Fi:  $0.034+0.004=0.038$

WCDMA B5+BT:  $0.034+0.0002=0.0342$

FDD LTE B2+Wi-Fi:  $0.034+0.004=0.038$

FDD LTE B2+BT:  $0.034+0.0002=0.0342$

FDD LTE B4+Wi-Fi:  $0.052+0.004=0.056$

FDD LTE B4+BT:  $0.052+0.0002=0.0522$

FDD LTE B5+Wi-Fi:  $0.034+0.004=0.038$

FDD LTE B5+ BT:  $0.034+0.0002=0.0342$

FDD LTE B7+Wi-Fi:  $0.037+0.004=0.041$

FDD LTE B7+BT:  $0.037+0.0002=0.0372$

FDD LTE B12+Wi-Fi:  $0.026+0.004=0.030$

FDD LTE B12+BT:  $0.026+0.0002=0.0262$

FDD LTE B13+Wi-Fi:  $0.022+0.004=0.026$

FDD LTE B13+BT:  $0.022+0.0002=0.0222$

FDD LTE B17+Wi-Fi:  $0.023+0.004=0.026$

FDD LTE B17+BT:  $0.023+0.0002=0.0232$

NOTE: WCDMA and LTE share the same antenna, and cannot transmit simultaneously. Wi-Fi and BT share the same antenna, and cannot transmit simultaneously.

Result: Pass