

RF Exposure Report

FCC ID: 2APRD-ULTRASHORT

RF Exposure Measurement

The limit for Maximum Permissible Exposure (MPE) specified in FCC 1.1310 is followed. The gain of the antennas used in the product is extracted from the Antenna data sheets provided and also the maximum total power input to the antenna is measured. Through the Friis transmission formula and the maximum gain of the antenna, we can calculate the distance, away from the product, where the limit of MPE is reached.

Although the Friis Transmission formula is far field assumption, the calculated result of that is an over-prediction for near field power density. It is taken as worst case to specify the safety range.

RF Exposure Limit

According to FCC 1.1310: The criteria listed in the following table shall be used to evaluate the environmental impact of the human exposure to radio-frequency (RF) radiation as specified in 1.1307 (b)

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm ²)
Limits for Occupational / controlled Exposures			
300 - 1500	--	--	F/300
1500 – 100000	--	--	5.0
Limits for General population / Uncontrolled Exposure			
300 - 1500	--	--	F/1500
1500 – 100000	--	--	1.0

Limits for Maximum Permissible Exposure (MPE)

F= Frequency in MHz

Friss Formula

Friss Transmission Formula: $P_d = (P_{out} * G) / (4 * \pi * r^2)$

Where

P_d = power density in mW/cm²

P_{out} = output power to antenna in mW

G = gain of antenna in linear scale

π = 3.1416

R = Distance between observation point and the center of radiator in cm

If we know the maximum gain of the antenna and the total output power to the antenna, through calculation, we will know MPE value at distance 20cm.

EUT Operation condition

EUT was enabled to transmit and receive at lowest, middle and highest channels.

Classification

The antenna of this product, under normal use condition, is at least 20cm away from the body of the user. Warning statement to the user for keeping at least 20cm or more separation distance from the antenna should be included in the User manual. So, this device is classified as Mobile device.

BT5.0+EDR

Mode	2402-2480MHz
Detector	PEAK
GFSK	8±1dBm
$\pi/4$ -DQPSK	7±1dBm
8DPSK	8±1dBm

ANT Gain (G)

Antenna gain : -2.3dBi (gain of antenna in linear scale=0.59)

Protocol	ANT Gain(gain of antenna in linear scale)	Channel Frequency (MHz)	Output Power to Antenna (dBm)	Output Power to Antenna (mW)	Power Density (mW/cm ²)	Limit (mW/cm ²)
GFSK	0.59	2480	9	7.9433	0.00093	1
$\pi/4$ -DQPSK	0.59	2480	8	6.3096	0.00074	1
8DPSK	0.59	2480	9	7.9433	0.00093	1

2.4G WIFI

Mode	802.11b/g/n20:2412-2462MHz 802.11n40:2422-2452MHz
Detector	PEAK
802.11b	15±1dBm
802.11g	17±1dBm
802.11n20	17±1dBm
802.11n40	15±1dBm

ANT Gain (G)

Antenna gain : -2.5dBi (gain of antenna in linear scale=0.56)

Protocol	ANT Gain(gain of antenna in linear scale)	Channel Frequency (MHz)	Output Power to Antenna (dBm)	Output Power to Antenna (mW)	Power Density (mW/cm ²)	Limit (mW/cm ²)
802.11 b	0.56	2412	16	39.8107	0.00444	1
802.11 g	0.56	2462	18	63.0957	0.00703	1
802.11 n20	0.56	2462	18	63.0957	0.00703	1
802.11 n40	0.56	2452	16	39.8107	0.00444	1

GSM

Mode	GSM: GPRS 850: 824 ~ 849 MHz(TX) 869 ~ 894 MHz (Rx) GPRS1900: 1850 ~ 1910 MHz(TX) 1930 ~ 1990 MHz(Rx)
Detector	PEAK
Band 850	30±1dBm
Band 1900	27±1dBm

ANT Gain (G)

GSM 850: Antenna gain : -1.1dBi (gain of antenna in linear scale=0.78)

GSM 1900: Antenna gain : -2.0dBi (gain of antenna in linear scale=0.63)

Protocol	ANT Gain(gain of antenna in linear scale)	Channel Frequency (MHz)	Output Power to Antenna (dBm)	Output Power to Antenna (mW)	Power Density (mW/cm ²)	Limit (mW/cm ²)
Band 850	0.78	824.2	31	1258.9254	0.19545	0.549466667
Band 1900	0.63	1850.2	28	630.9573	0.09796	1

eMTC

Mode	CAT-M Band 2:1850~1910MHz (TX), 1930 ~1990MHz (RX) CAT-M Band 4:1710~1755MHz (TX), 2110~2155MHz (RX) CAT-M Band 5:824~849MHz (TX), 869~894MHz (RX) CAT-M Band 12:699~716MHz (TX), 729~746MHz (RX) CAT-M Band 13:777~787MHz (TX), 746~756MHz (RX) CAT-M Band 26:814~849MHz(TX), 859~894MHz(RX)
Detector	PEAK
LTE Band 2	22±1dBm
LTE Band 4	21±1dBm
LTE Band 5	22±1dBm
LTE Band 12	22±1dBm
LTE Band 13	22±1dBm
LTE Band 26(Part 22)	22±1dBm
LTE Band 26(Part 90)	22±1dBm

ANT Gain (G)

Band 2: Antenna gain : 3.50dBi (gain of antenna in linear scale=2.24)

Band 4: Antenna gain : 3.50dBi (gain of antenna in linear scale=2.24)

Band 5: Antenna gain : 1.60dBi (gain of antenna in linear scale=1.45)

Band 12: Antenna gain : 0.40dBi (gain of antenna in linear scale=1.10)

Band 13: Antenna gain : 0.40dBi (gain of antenna in linear scale=1.10)

Band 26: Antenna gain : 1.60dBi (gain of antenna in linear scale=1.45)

Protocol	ANT Gain(gain of antenna in linear scale)	Channel Frequency (MHz)	Output Power to Antenna (dBm)	Output Power to Antenna (mW)	Power Density (mW/cm ²)	Limit (mW/cm ²)
LTE Band 2	2.24	1850	23	199.5262	0.08896	1
LTE Band 4	2.24	1710	22	158.4893	0.07066	1
LTE Band 5	1.45	824	23	199.5262	0.05759	0.549333333
LTE Band 12	1.1	699	23	199.5262	0.04369	0.466
LTE Band 13	1.1	777	23	199.5262	0.04369	0.518
LTE Band 26(Part 22)	1.45	824	23	199.5262	0.05759	0.549333333
LTE Band 26(Part 90)	1.45	814	23	199.5262	0.05759	0.542666667

NB-IoT

Mode	NB-IoT Band 2:1850.1~1909.9MHz(TX), 1930.1 ~1989.9MHz(RX) NB-IoT Band 4:1710.1~1754.9MHz(TX), 2110.1~2154.9MHz(RX) NB-IoT Band 5:824.1~848.9MHz(TX), 869.1~893.9MHz(RX) NB-IoT Band 12:699.1~715.9MHz(TX), 729.1~745.9MHz(RX) NB-IoT Band 13:777.1~786.9MHz(TX), 746.1~755.9MHz(RX)
Detector	PEAK
LTE Band 2	19±1dBm
LTE Band 4	18±1dBm
LTE Band 5	20±1dBm
LTE Band 12	20±1dBm
LTE Band 13	19±1dBm

ANT Gain (G)

Band 2: Antenna gain : 3.50dBi (gain of antenna in linear scale=2.24)

Band 4: Antenna gain : 3.50dBi (gain of antenna in linear scale=2.24)

Band 5: Antenna gain : 1.60dBi (gain of antenna in linear scale=1.45)

Band 12: Antenna gain : 0.40dBi (gain of antenna in linear scale=1.10)

Band 13: Antenna gain : 0.40dBi (gain of antenna in linear scale=1.10)

Protocol	ANT Gain(gain of antenna in linear scale)	Channel Frequency (MHz)	Output Power to Antenna (dBm)	Output Power to Antenna (mW)	Power Density (mW/cm ²)	Limit (mW/cm ²)
LTE Band 2	2.24	1850	20	100.0000	0.04459	1
LTE Band 4	2.24	1710	19	79.4328	0.03542	1
LTE Band 5	1.45	824.2	21	125.8925	0.03633	0.549466667
LTE Band 12	1.1	699.1	21	125.8925	0.02756	0.466066667
LTE Band 13	1.1	777.1	20	100.0000	0.02189	0.518066667

Multiple Evaluation

$$BT/1+GSM/0.55=(0.00093/1) + (0.19549/0.55)=0.3564$$

$$BT/1+ eMTC /1=(0.00093/1)+ (0.05759/0.55)=0.1058$$

$$BT/1+ NB-IoT /1=(0.00093/1)+ (0.03633/0.55)=0.06698$$

$$WIFI/1+GSM/0.55=0.00703/1+(0.19549/0.55)=0.3625$$

$$WIFI/1+ eMTC /1=0.00703/1+(0.05759/0.55)=0.1119$$

$$WIFI/1+ NB-IoT /1=0.00703/1+(0.03633/0.55)=0.07308$$

According to the maximum gain of the antenna and the total output power to the antenna, through calculation, we will know max MPE value 0.3625 at distance 20cm. This is less than the limit 1, So Compliance the RF exposure requirement.