RF Exposure Evaluation For FCC ID: UKMMRG1005

Refer user manual this device is a Multi-Service Gateway & Edge Controller, and this device was designed used in Mobile devices that the minimum distance between human's body is **20cm.** Based on the 47CFR 2.1091, this device belongs to Mobile device. The definition of the category as following:

Mobile Derives:

CFR Title 47 §2.1091(b)

(b) For purposes of this section, a mobile device is defined as a transmitting device designed to be used in other than fixed locations and to generally be used in such a way that a separation distance of at least 20 centimeters is normally maintained between the transmitter's radiating structure(s) and the body of the user or nearby persons.

FCC KDB 447498 D01 General RF Exposure Guidance v06 Limit

Devices operating in standalone mobile exposure conditions may contain a single transmitter or multiple transmitters that do not transmit simultaneously. A minimum test separation distance ≥ 20 cm is required between the antenna and radiating structures of the device and nearby persons to apply mobile device exposure limits. The distance must be fully supported by the operating and installation configurations of the transmitter and its antenna(s), according to the source-based time-averaged maximum power requirements of § 2.1091(d)(2). In cases where cable losses or other attenuations are applied to determine compliance, the most conservative operating configurations and exposure conditions must be evaluated. The minimum test separation distance required for a device to comply with mobile exposure conditions must be clearly identified in the installation and operating instructions, for all installation and exposure conditions, to enable users and installers to comply with RF exposure requirements. For mobile devices that have the potential to operate in portable device exposure conditions, similar to the configurations described in § 2.1091(d)(4), a KDB inquiry is required to determine the SAR test requirements for demonstrating compliance.

When the categorical exclusion provision of § 2.1091(c) applies, the minimum test separation distance may be estimated, when applicable, by simple calculations according to plane-wave equivalent conditions, to ensure the transmitter and its antenna(s) can operate in manners that meet or exceed the estimated distance. The source-based time-averaged maximum radiated power, according to the maximum antenna gain, must be applied to calculate the field strength and power density required to establish the minimum test separation distance. When the estimated test separation distance becomes overly conservative and does not support compliance, MPE measurement or computational modeling may be used to determine the required minimum separation distance.

According to FCC Part 1.1307, systems operating under the provisions of this section shall be operated in a manner the ensures that the public is not exposed to radio frequency energy level in excess of the commission's guidelines.

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^2)
0.3-1.34	614	1.63	(100)*
1.34-30	824/f	2.19/f	(180/f2)*
30-300	27.5	0.073	0.2
300-1500			f/1500
1500-100,000			1.0

MPE calculation formula

$$S = \frac{PG}{4\pi R^2}$$

Where:

S = power density

P = output power (mW)

G = power gain of the antenna in the direction of interest relative to an isotropic radiator

R = Separation distance between radiator and human body (cm)

Peak Power Test Data

BLUETOOTH				
Mode	BR/EDR			BLE
	GFSK	Π/4-DQPSK	8-DPSK	GFSK
Peak Power (dBm)	8.63	7.16	7.64	7.18
WIFI				
Mode	802.11b	802.11g		802.11n-20 MHz
Peak Power (dBm)	**8.99**	8.56		8.57
Note: 1. This report listed the worst case peak power value, please refer to RF test report for more details. 2. The EUT also support 2G Network GSM 850/ 1900 and 3G Network WCDMA Band 2/ 5, only 2.4G WLAN and Bluetooth were conduct for MPE assessment in this report.				

Assessment result

Evolution mode	Maximum peak output power（dBm）	Antenna Gain (typical) (dBi):	Total Power (mw)	Distance (cm)	Limit of Power Density (mW/cm²)	Power Density (mW/cm²)	Verdict
WIFI（802.11b）	8.99	4.7	23.39	20	1	0.0047	Pass
Bluetooth	8.63	4.7	21.53	20	1	0.0043	Pass

Note:

1. Multi-Service Gateway & Edge Controller work frequency range used is 2400 MHz ~ 2483.5 MHz, the result close to the limit by the above formula so, we select 2472MHz to calculate the exclusion power threshold.

2. More power list please refer to RF test report “BL-SZ1630286-601&602&603 pdf”.
3. About 2G Network GSM 850/ 1900 and 3G Network WCDMA Band 2/ 5 MPE assessment, please refer to the report “MDE_UBLOX_1519_MPEa”.

RF Exposure Evaluation for multiple transmitters

The calculation below is used to consider situations in which simultaneous exposure to fields of different frequencies occur. The calculation is performed by the sum of each relative exposure for each equipment according to the following criteria.

$$\sum_{1}^{N} \frac{S_{eqn}}{S_{Limn}} = \frac{S_{eq1}}{S_{Lim1}} + \frac{S_{eq2}}{S_{Lim2}} + \ldots + \frac{S_{eqN}}{S_{LimN}} \leq 1$$

Where:

S_{eq} is the power density of the electromagnetic field at a given distance by a specific transmitter and a defined frequency.

S_{lin} is the MPE limit for the frequency being evaluated.

Output Power Test Data

GSM & WCDMA				
Band	GSM 850	GSM 1900	WCDMA 850	WCDMA 1900
Frequency range	836.2-848.8	1850.2-1909.8	1850-1907.6	824-846.6
Frequency of highest power	836.6	1907.6	1852.4	826.4
Maximum Conducted Output Power (dBm)	33.5	32	25	25
Note: More power list about 2G Network GSM 850/ 1900 and 3G Network WCDMA Band 2/ 5, please refer to the report “MDE_UBLOX_1519_MPEa”.				

Evolution mode	Duty Cycle	Frequency (MHz)	Maximum peak output power（dBm）	Maximum Conducted output power (mW)	Equivalent conducted output power (mW)	Distance (cm)	MPE Limit (mW/cm²)	Maximum antenna gain to meet MPE Limit (dBi)
GSM 850	50%	836.6	33.5	2238.72	1119.44	20	0.5577	4.0
GSM 1900	50%	1907.6	32	1584.89	792.50	20	1.0000	8.0
WCDMA 1900	100%	1852.4	25	316.23	316.23	20	1.0000	12.0
WCDMA 850	100%	826.4	25	316.23	316.23	20	0.5509	9.4
Note: About 2G Network GSM 850/ 1900 and 3G Network WCDMA Band 2/ 5 MPE assessment, please refer to the report “MDE_UBLOX_1519_MPEa”.								

Antenna Specification					
Band	AMPS	GSM	DCS	PCS	UMTS
Frequency range (MHz)	824 - 896	880 - 960	1710 - 1880	1850 - 1990	1710 - 2170
Average g(dBi)	2.1	3.9	4.1	3.2	3.2
Note: About 2G Network GSM 850/ 1900 and 3G Network WCDMA Band 2/ 5 Antenna gain, please refer to the Antenna report “GSA-8821 I-Bar Penta band GSM Antenna pdf”.					

Evolution mode	Duty Cycle	Frequency (MHz)	Maximum peak output power （dBm）	Equivalent conducted output power (mW)	MPE Limit (mW/cm²)	Distance (cm)	MPE Value using max gain	Verdict
GSM 850	50%	836.6	33.5	1119.44	0.5577	20	0.4986	Pass
GSM 1900	50%	1907.6	32	792.50	1.0000	20	0.3530	Pass
WCDMA 1900	100%	1852.4	25	316.23	1.0000	20	0.7564	Pass
WCDMA 850	100%	826.4	25	316.23	0.5509	20	0.4883	Pass
Note: About 2G Network GSM 850/ 1900 and 3G Network WCDMA Band 2/ 5 MPE assessment, please refer to the report “MDE_UBLOX_1519_MPEa”.								

Relative exposure for Primary Transmitter

Evolution mode	Frequency (MHz)	output power （dBm）	S_{eq} (mW/cm²)	S_{lin} (mW/cm²)	S_{eq}/S_{lin}	Verdict
GSM 850	836.6	1119.44	0.4986	0.5577	0.89393082	Pass
GSM 1900	1907.6	792.50	0.3530	1.0000	0.35296408	Pass
WCDMA 1900	1852.4	316.23	0.7564	1.0000	0.756363411	Pass
WCDMA 850	826.4	316.23	0.4883	0.5509	0.8864035	Pass
WIFI（802.11b）	2472	23.39	0.0047	1.0000	0.00465329	Pass
Bluetooth	2441	21.53	0.0043	1.0000	0.004283261	Pass

Simultaneous exposure of Primary and Secondary transmitter Assessment

Evolution mode	Transmitter	Frequency (MHz)	Maximum S_{eq}/S_{lin}	Maximum $S_{eq}/S_{lin\ pri} + S_{eq}/S_{lin\ Sec}$	Verdict Maximum $S_{eq}/S_{lin\ pri} + S_{eq}/S_{lin\ Sec} < 1$
1	WIFI（802.11b）	2472	0.0047	0.8986	Pass
	GSM 850	836.6	0.8939		
2	WIFI（802.11b）	2472	0.0047	0.3577	Pass
	GSM 1900	1907.6	0.3530		
3	WIFI（802.11b）	2472	0.0047	0.7611	Pass
	WCDMA 1900	1852.4	0.7564		

4	WIFI（802.11b）	2472	0.0047	0.8911	Pass
	WCDMA 850	826.4	0.8864		
5	Bluetooth	2441	0.0043	0.8982	Pass
	GSM 850	836.6	0.8939		
6	Bluetooth	2441	0.0043	0.3573	Pass
	GSM 1900	1907.6	0.3530		
7	Bluetooth	2441	0.0043	0.7607	Pass
	WCDMA 1900	1852.4	0.7564		
8	Bluetooth	2441	0.0043	0.8907	Pass
	WCDMA 850	826.4	0.8864		