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FCC Maximum Permissible Exposure(MPE) Estimation Report

Product Name: LTE CPE

Model: B612s-51d

Report No.: SYBH(Z-SAR)013022017-2

FCC ID: QISB612S-51D

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REV.	DESCRIPTION	ISSUED DATE	REMARK
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1 EUT Description

Device Information:				
Product Name :		LTE CPE		
Model :		B612s-51d		
FCC ID:		QISB612S-51D		
Device Type :		Mobile Device		
Device Phase:		Identical Prototype		
Exposure Category:		Uncontrolled environment/general population		
Hardware Version :		WL1B612SW		
Software Version :		11.187.01.01.00		
Antenna Type :		Internal Antenna &External Antenna		
Device Operating Configurations:				
Supporting Mode(s)		GSM850/1900,UMTS Band II / IV / V, LTE band II / IV / V / VII / XXXVIII / XLI ,WiFi 2.4G		
Test Modulation		GSM(GMSK/8PSK),UMTS(QPSK),LTE(QPSK/16QAM),Wi Fi(DSSS/OFDM)		
Operating Frequency Range(s)*	Frequency	Band	Tx (MHz)	Rx (MHz)
		GSM850	824-849	869-894
		GSM1900	1850-1910	1930-1990
		UMTS Band II	1850-1910	1930-1990
		UMTS Band IV	1710-1755	2110-2155
		UMTS Band V	824-849	869-894
		LTE Band II	1850-1910	1930-1990
		LTE Band IV	1710-1755	2110-2155
		LTE Band V	824-849	869-894
		LTE Band VII	2500-2570	2620-2690
		LTE Band XXXVIII	2570-2620	2570-2620
		LTE Band XLI	2545-2655	2545-2655
		WiFi 2.4G	2412-2462	2412-2462

Note: * The device only supports downlink LTE CA. The maximum tune-up power and antenna gain when downlink carrier aggregation is active are the same as those when downlink carrier aggregation is inactive. So additional MPE evaluation for downlink LTE CA is not required.

1.1 General Description

B612s-51d LTE/DC-HSPA+/WCDMA/EDGE/GPRS/GSM multi-mode LTE CPE is subscriber equipment in the LTE/UMTS/GSM system and support WLAN 802.11a/b/g/n/ac. B612s-51d implement such functions as RF signal receiving/transmitting, LTE/DC-HSPA+/WCDMA and EDGE/GPRS/GSM protocol processing, data service etc. It provides USIM card interface, RJ45/RJ11 Ethernet interface, USB port and external antenna interfaces.

2 Test specification(s)

ANSI Std C95.1-1992	Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz – 300 GHz.(IEEE Std C95.1-1991)
KDB 447498 D01	General RF Exposure Guidance v06

3 Testing laboratory

Test Site	The Reliability Laboratory of Huawei Technologies Co., Ltd.
Test Location	Section G1,Huawei Base Bantian, Longgang District, Shenzhen 518129, P.R. China
Telephone	+86 755 28780808
Fax	+86 755 89652518
State of accreditation	The Test laboratory (area of testing) is accredited according to ISO/IEC 17025. CNAS Registration number: L0310 A2LA TESTING CERT #2174.01 & 2174.02 & 2174.03

4 Applicant and Manufacturer

Company Name	HUAWEI TECHNOLOGIES CO., LTD
Address	Administration Building, Headquarters of Huawei Technologies Co., Ltd., Bantian, Longgang District, Shenzhen, 518129, P.R.C

5 Application details

Start Date of test	2017-03-03
End Date of test	2017-03-03

6 Ambient Condition

Ambient temperature	20°C – 24°C
Relative Humidity	30% – 70%

7 RF Exposure Requirements

An estimation of MPE in this application for product is used to ensure if it complies to the rules of the standard in the regulation list above.

Maximum permissible exposure (MPE) refers to the RF energy that is acceptable for human exposure. It is broken down into two categories, Occupational/controlled and General population/uncontrolled.

Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.

General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or can not exercise control over their exposure.

A rough estimation of the expected exposure in power flux density on a given point can be made with the following equation:

$$S = \frac{P \times G}{4 \times \pi \times R^2}$$

Where:

S = power density

P = power input to the antenna

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

R= distance to the centre of radiation of the antenna

EIRP = P*G

The antenna of the product, under normal use condition is at least 20 cm away from the

body of the user. Warning statement to the user for keeping at least 20cm separation distance and the prohibition of operating to a person has been printed on the user's manual. Therefore, the S of the device is calculated with R=20cm, and if it is below the limit S, then we can conclude the device complies with the rules.

7.1 FCC MPE Limits

We analysis if it comply with the limits for General population/uncontrolled exposure. The FCC MPE limits for field strength and power density are given in 47CFR 1.1310(Table below).These limits are generally based on recommended exposure guidelines published by the National Council on Radiation Protection and Measurements (NCRP), and also partly based on guidelines recommended by the American National Standards Institute (ANSI) in Section 4.1 of ANSI/IEEE C95.1.

Table: Limits For Maximum Permissible Exposure (MPE)

(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 ²)	Averaging Time (minute) E ² , H ² or S
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
(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 ²)	Averaging Time (minute) E ² , H ² or S
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
1500-100,000	/	/	1.0	30
f=frequency in MHz			*Plane-wave equivalent power density	

8 RF Exposure Evaluation

8.1 Operation in GSM850

(uplink: 824-849MHz, downlink: 869-894MHz)

Antenna	Mode	Tune-up limit (dBm)	Gain (dBi)	EIRP* (dBm)	EIRP (mW)	R(cm)	S (mW/cm ²)	MPE Limit (mW/cm ²)	Conclusion
Internal Antenna	GSM CS	35.00	1.50	36.50	558.35	20	0.111	0.549	PASS
	1TS*(1/8)	35.00	1.50	36.50	558.35	20	0.111	0.549	PASS
	2TS*(2/8)	35.00	1.50	36.50	1116.71	20	0.222	0.549	PASS
	3TS*(3/8)	33.20	1.50	34.70	1106.70	20	0.220	0.549	PASS
	4TS*(4/8)	32.00	1.50	33.50	1119.36	20	0.223	0.549	PASS
External Antenna	GSM CS	35.00	3.00	38.00	788.70	20	0.157	0.549	PASS
	1TS*(1/8)	35.00	3.00	38.00	788.70	20	0.157	0.549	PASS
	2TS*(2/8)	35.00	3.00	38.00	1577.39	20	0.314	0.549	PASS
	3TS*(3/8)	33.20	3.00	36.20	1563.26	20	0.311	0.549	PASS
	4TS*(4/8)	32.00	3.00	35.00	1581.14	20	0.315	0.549	PASS

Note:*- based on the maximum tune-up tolerance limit declared by manufacturer.

According to the Table, we can conclude the max power density level at 20 cm is 0.315mW/cm², which is below the uncontrolled exposure limit, so we can conclude it is into compliance.

8.2 Operation in GSM1900

(uplink: 1850-1910MHz, downlink: 1930-1990MHz)

Antenna	Mode	Tune-up limit (dBm)	Gain (dBi)	EIRP* (dBm)	EIRP (mW)	R(cm)	S (mW/cm ²)	MPE Limit (mW/cm ²)	Conclusion
Internal Antenna	GSM CS	32.00	3.50	35.50	443.52	20	0.088	1.000	PASS
	1TS*(1/8)	32.00	3.50	35.50	443.52	20	0.088	1.000	PASS
	2TS*(2/8)	32.00	3.50	35.50	887.03	20	0.177	1.000	PASS
	3TS*(3/8)	30.20	3.50	33.70	879.09	20	0.175	1.000	PASS
	4TS*(4/8)	29.00	3.50	32.50	889.14	20	0.177	1.000	PASS
External Antenna	GSM CS	32.00	3.00	35.00	395.28	20	0.079	1.000	PASS
	1TS*(1/8)	32.00	3.00	35.00	395.28	20	0.079	1.000	PASS
	2TS*(2/8)	32.00	3.00	35.00	790.57	20	0.157	1.000	PASS
	3TS*(3/8)	30.20	3.00	33.20	783.49	20	0.156	1.000	PASS
	4TS*(4/8)	29.00	3.00	32.00	792.45	20	0.158	1.000	PASS

Note:*- based on the maximum tune-up tolerance limit declared by manufacturer.

According to the Table, we can conclude the max power density level at 20 cm is 0.177 mW/cm², which is below the uncontrolled exposure limit, so we can conclude it is into compliance.

8.3 Operation in UMTS Band II

(uplink: 1850-1910MHz, downlink: 1930-1990MHz)

Antenna	Tune-up limit (dBm)	Gain (dBi)	EIRP* (dBm)	EIRP (mW)	R(cm)	S (mW/cm ²)	MPE Limit (mW/cm ²)	Conclusion
Internal Antenna	25.70	3.50	29.20	831.76	20	0.166	1.000	PASS
External Antenna	25.70	3.00	28.70	741.31	20	0.148	1.000	PASS

Note:*- based on the maximum tune-up tolerance limit declared by manufacturer.

According to the Table, we can conclude the max power density level at 20 cm is 0.166mW/cm², which is below the uncontrolled exposure limit, so we can conclude it is into compliance.

8.4 Operation in UMTS Band IV

(uplink: 1710-1755MHz, downlink: 2110-2155MHz)

Antenna	Tune-up limit (dBm)	Gain (dBi)	EIRP* (dBm)	EIRP (mW)	R(cm)	S (mW/cm ²)	MPE Limit (mW/cm ²)	Conclusion
Internal Antenna	25.70	3.50	29.20	831.76	20	0.166	1.000	PASS
External Antenna	25.70	3.00	28.70	741.31	20	0.148	1.000	PASS

Note:*- based on the maximum tune-up tolerance limit declared by manufacturer.

According to the Table, we can conclude the max power density level at 20 cm is 0.166mW/cm², which is below the uncontrolled exposure limit, so we can conclude it is into compliance.

8.5 Operation in UMTS Band V

(uplink: 824-849MHz, downlink: 869-894MHz)

Antenna	Tune-up limit (dBm)	Gain (dBi)	EIRP* (dBm)	EIRP (mW)	R(cm)	S (mW/cm ²)	MPE Limit (mW/cm ²)	Conclusion
Internal Antenna	25.70	1.50	27.20	524.81	20	0.104	0.549	PASS
External Antenna	25.70	3.00	28.70	741.31	20	0.148	0.549	PASS

Note:*- based on the maximum tune-up tolerance limit declared by manufacturer.

According to the Table, we can conclude the max power density level at 20 cm is 0.148mW/cm², which is below the uncontrolled exposure limit, so we can conclude it is into compliance.

8.6 Operation in LTE Band II

(uplink: 1850-1910MHz, downlink: 1930-1990MHz)

Antenna	Tune-up limit (dBm)	Gain (dBi)	EIRP* (dBm)	EIRP (mW)	R(cm)	S (mW/cm ²)	MPE Limit (mW/cm ²)	Conclusion
Internal Antenna	25.70	3.50	29.20	831.76	20	0.166	1.000	PASS
External Antenna	25.70	3.00	28.70	741.31	20	0.148	1.000	PASS

Note:*- based on the maximum tune-up tolerance limit declared by manufacturer.

According to the Table, we can conclude the max power density level at 20 cm is 0.166 mW/cm², which is below the uncontrolled exposure limit, so we can conclude it is into compliance.

8.7 Operation in LTE Band IV

(uplink: 1710-1755MHz, downlink: 2110-2155MHz)

Antenna	Tune-up limit (dBm)	Gain (dBi)	EIRP* (dBm)	EIRP (mW)	R(cm)	S (mW/cm ²)	MPE Limit (mW/cm ²)	Conclusion
Internal Antenna	25.70	3.50	29.20	831.76	20	0.166	1.000	PASS
External Antenna	25.70	3.00	28.70	741.31	20	0.148	1.000	PASS

Note:*- based on the maximum tune-up tolerance limit declared by manufacturer.

According to the Table, we can conclude the max power density level at 20 cm is 0.166 mW/cm², which is below the uncontrolled exposure limit, so we can conclude it is into compliance.

8.8 Operation in LTE Band V

(uplink: 824-849MHz, downlink: 869-894MHz)

Antenna	Tune-up limit (dBm)	Gain (dBi)	EIRP* (dBm)	EIRP (mW)	R(cm)	S (mW/cm ²)	MPE Limit (mW/cm ²)	Conclusion
Internal Antenna	25.70	1.50	27.20	524.81	20	0.104	0.549	PASS
External Antenna	25.70	3.00	28.70	741.31	20	0.148	0.549	PASS

Note:*- based on the maximum tune-up tolerance limit declared by manufacturer.

According to the Table, we can conclude the max power density level at 20 cm is 0.148mW/cm², which is below the uncontrolled exposure limit, so we can conclude it is into compliance.

8.9 Operation in LTE Band VII

(uplink: 2500-2570MHz, downlink: 2620-2690MHz)

Antenna	Tune-up limit (dBm)	Gain (dBi)	EIRP* (dBm)	EIRP (mW)	R(cm)	S (mW/cm ²)	MPE Limit (mW/cm ²)	Conclusion
Internal Antenna	25.70	3.50	29.20	831.76	20	0.166	1.000	PASS
External Antenna	25.70	3.00	28.70	741.31	20	0.148	1.000	PASS

Note:*- based on the maximum tune-up tolerance limit declared by manufacturer.

According to the Table, we can conclude the max power density level at 20 cm is 0.166mW/cm², which is below the uncontrolled exposure limit, so we can conclude it is into compliance.

8.10 Operation in LTE Band XXXVIII

(uplink: 2570-2620MHz, downlink: 2570-2620MHz)

Antenna	Tune-up limit (dBm)	Gain (dBi)	EIRP* (dBm)	EIRP (mW)	R(cm)	S (mW/cm ²)	MPE Limit (mW/cm ²)	Conclusion
Internal Antenna	25.70	3.50	29.20	831.76	20	0.166	1.000	PASS
External Antenna 1	25.70	3.00	28.70	741.31	20	0.148	1.000	PASS

Note:*- based on the maximum tune-up tolerance limit declared by manufacturer.

According to the Table, we can conclude the max power density level at 20 cm is 0.166mW/cm², which is below the uncontrolled exposure limit, so we can conclude it is into compliance.

8.11 Operation in LTE Band XLI

(uplink: 2545-2655MHz, downlink: 2545-2655MHz)

Antenna	Tune-up limit (dBm)	Gain (dBi)	EIRP* (dBm)	EIRP (mW)	R(cm)	S (mW/cm ²)	MPE Limit (mW/cm ²)	Conclusion
Internal Antenna	25.70	3.50	29.20	831.80	20	0.166	1.000	PASS
External Antenna	25.70	3.00	28.70	741.31	20	0.148	1.000	PASS

Note:*- based on the maximum tune-up tolerance limit declared by manufacturer.

According to the Table, we can conclude the max power density level at 20 cm is 0.166mW/cm², which is below the uncontrolled exposure limit, so we can conclude it is into compliance.

8.12 Operation in WLAN 2.4G

(uplink: 2412-2462MHz, downlink: 2412-2462MHz)

Antenna	Tune-up limit (dBm)	Gain (dBi)	EIRP* (dBm)	EIRP (mW)	R(cm)	S (mW/cm ²)	MPE Limit (mW/cm ²)	Conclusion
Antenna 1	18.00	1.00	19.00	79.43	20	0.016	1.000	PASS
Antenna 2	18.00	1.00	19.00	79.43	20	0.016	1.000	PASS

Note:* - based on the maximum tune-up tolerance limit declared by manufacturer.

According to the Table, we can conclude the max power density level at 20 cm is 0.016mW/cm², which is below the uncontrolled exposure limit, so we can conclude it is into compliance.

9 Exposure calculations for multiple sources

When a number of sources at different frequencies, and/or broadband sources, contribute to the total exposure, it becomes necessary to weigh each contribution relative to the MPE in accordance with the provisions of Table(A) and Table(B). To comply with the MPE, the fraction of the MPE in terms of E^2 , H^2 (or power density) incurred within each frequency interval should be determined and the sum of all such fractions should not exceed unity.

In order to ensure compliance with the MPE for a controlled environment, the sum of the ratios of the power density to the corresponding MPE should not exceed unity. That is

$$\sum_{i=1}^n \frac{S_i}{MPE_i} \leq 1$$

The product also has multiple transmitters The Simultaneous Transmission Possibilities are as below:

Simultaneous Tx Combination	Configuration
1	WLAN 2.4G MIMO
2	GSM/UMTS/LTE +WLAN SISO/MIMO

Note:

- 1) The device has one GSM/UMTS/LTE Internal antenna, one GSM/UMTS/LTE External antenna and two WLAN antennas.
- 2) The GSM/UMTS/LTE Internal antenna and GSM/UMTS/LTE External antenna cannot transmit simultaneously.
- 3) The two WLAN antennas support 2*2 MIMO.

9.1 Estimation for WLAN2.4G MIMO

Antenna	Tune-up limit (dBm)	Gain (dBi)	EIRP* (dBm)	EIRP (mW)	R(cm)	S (mW/cm ²)	MPE Limit (mW/cm ²)	Calculation result	Conclusion
Antenna 1	16.00	1.00	17.00	50.10	20	0.010	1.000	0.014	PASS
Antenna 2	16.00	1.00	17.00	50.10	20	0.010	1.000		

Note: *- based on the maximum tune-up tolerance limit declared by manufacturer

9.2 Estimation for GSM850& WLAN2.4G

No.	Mode	S (mW/cm ²)	MPE Limit (mW/cm ²)	Calculation result	Conclusion
1	GSM850	0.315	0.549	0.590	PASS
	WLAN 2.4G SISO	0.016	1.000		
2	GSM850	0.315	0.549	0.594	PASS
	WLAN MIMO with Antenna 1	0.010	1.000		
	WLAN MIMO with Antenna 2	0.010	1.000		

9.3 Estimation for GSM1900& WLAN2.4G

No.	Mode	S (mW/cm ²)	MPE Limit (mW/cm ²)	Calculation result	Conclusion
1	GSM1900	0.177	1.000	0.193	PASS
	WLAN SISO	0.016	1.000		
2	GSM1900	0.177	1.000	0.197	PASS
	WLAN MIMO with Antenna 1	0.010	1.000		
	WLAN MIMO with Antenna 2	0.010	1.000		

9.4 Estimation for UMTS Band II & WLAN2.4G

No.	Mode	S (mW/cm ²)	MPE Limit (mW/cm ²)	Calculation result	Conclusion
1	UMTS Band II	0.166	1.000	0.182	PASS
	WLAN SISO	0.016	1.000		
2	UMTS Band II	0.166	1.000	0.186	PASS
	WLAN MIMO with Antenna 1	0.010	1.000		
	WLAN MIMO with Antenna 2	0.010	1.000		

9.5 Estimation for UMTS Band IV & WLAN2.4G

No.	Mode	S (mW/cm ²)	MPE Limit (mW/cm ²)	Calculation result	Conclusion
1	UMTS Band IV	0.166	1.000	0.182	PASS
	WLAN SISO	0.016	1.000		
2	UMTS Band IV	0.166	1.000	0.186	PASS
	WLAN MIMO with Antenna 1	0.010	1.000		
	WLAN MIMO with Antenna 2	0.010	1.000		

9.6 Estimation for UMTS Band V & WLAN2.4G

No.	Mode	S (mW/cm ²)	MPE Limit (mW/cm ²)	Calculation result	Conclusion
1	UMTS Band V	0.148	0.549	0.286	PASS
	WLAN SISO	0.016	1.000		
2	UMTS Band V	0.148	0.549	0.290	PASS
	WLAN MIMO with Antenna 1	0.010	1.000		
	WLAN MIMO with Antenna 2	0.010	1.000		

9.7 Estimation for LTE Band II & WLAN2.4G

No.	Mode	S (mW/cm ²)	MPE Limit (mW/cm ²)	Calculation result	Conclusion
1	LTE Band II	0.166	1.000	0.182	PASS
	WLAN SISO	0.016	1.000		
2	LTE Band II	0.166	1.000	0.186	PASS
	WLAN MIMO with Antenna 1	0.010	1.000		
	WLAN MIMO with Antenna 2	0.010	1.000		

9.8 Estimation for LTE Band IV & WLAN2.4G

No.	Mode	S (mW/cm ²)	MPE Limit (mW/cm ²)	Calculation result	Conclusion
1	LTE Band IV	0.166	1.000	0.182	PASS
	WLAN SISO	0.016	1.000		
2	LTE Band IV	0.166	1.000	0.186	PASS
	WLAN MIMO with Antenna 1	0.010	1.000		
	WLAN MIMO with Antenna 2	0.010	1.000		

9.9 Estimation for LTE Band V & WLAN2.4G

No.	Mode	S (mW/cm ²)	MPE Limit (mW/cm ²)	Calculation result	Conclusion
1	LTE Band V	0.148	0.549	0.286	PASS
	WLAN SISO	0.016	1.000		
2	LTE Band V	0.148	0.549	0.290	PASS
	WLAN MIMO with Antenna 1	0.010	1.000		
	WLAN MIMO with Antenna 2	0.010	1.000		

9.10 Estimation for LTE Band VII & WLAN2.4G

No.	Mode	S (mW/cm ²)	MPE Limit (mW/cm ²)	Calculation result	Conclusion
1	LTE Band VII	0.166	1.000	0.182	PASS
	WLAN SISO	0.016	1.000		
2	LTE Band VII	0.166	1.000	0.186	PASS
	WLAN MIMO with Antenna 1	0.010	1.000		
	WLAN MIMO with Antenna 2	0.010	1.000		

9.11 Estimation for LTE Band XXXVIII & WLAN2.4G

No.	Mode	S (mW/cm ²)	MPE Limit (mW/cm ²)	Calculation result	Conclusion
1	LTE Band XXXVIII	0.166	1.000	0.182	PASS
	WLAN SISO	0.016	1.000		
2	LTE Band XXXVIII	0.166	1.000	0.186	PASS
	WLAN MIMO with Antenna 1	0.010	1.000		
	WLAN MIMO with Antenna 2	0.010	1.000		

9.12 Estimation for LTE Band XLI & WLAN2.4G

No.	Mode	S (mW/cm ²)	MPE Limit (mW/cm ²)	Calculation result	Conclusion
1	LTE Band XLI	0.166	1.000	0.182	PASS
	WLAN SISO	0.016	1.000		
2	LTE Band XLI	0.166	1.000	0.186	PASS
	WLAN MIMO with Antenna 1	0.010	1.000		
	WLAN MIMO with Antenna 2	0.010	1.000		

According to the Table above, we can conclude that the calculation results of all simultaneous transmission possibilities are less than 1, so it is into compliance.

Therefore the product also meets the requirements under multiple sources condition.

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