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FCC Maximum Permissible Exposure(MPE) Estimation Report

Product Name: LTE CPE

Model: B612s-52d

Report No.: SYBH(Z-SAR)20180423013001-2

FCC ID: QISB612S-52D

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DATE	2018-05-25	2018-05-25

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REV.	DESCRIPTION	ISSUED DATE	REMARK
Rev.1.0	Initial Test Report Release	2018-05-25	He Renqiang

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1 EUT Description

Device Information:			
Product Name :	LTE CPE		
Model :	B612s-52d		
FCC ID:	QISB612S-52D		
Device Type :	Mobile Device		
Device Phase:	Identical Prototype		
Exposure Category:	Uncontrolled environment/general population		
Hardware Version :	WL1B612M04		
Software Version :	B612_UPDATE_11.196.00.00.00		
Antenna Type :	Internal Antenna/External Antenna		
Device Operating Configurations:			
Supporting Mode(s)	GSM850/1900, UMTS Band 2/4/5, LTE Band 2/4/5/7/38/41, WiFi 2.4G		
Test Modulation	GSM(GMSK/8PSK),UMTS(QPSK), LTE(QPSK/16QAM),WiFi(DSSS/OFDM)		
HSDPA UE Category	14		
HSUPA UE Category	6		
DC-HSDPA UE Category	24		
Operating Frequency Range(s)	Band	Tx (MHz)	Rx (MHz)
	GSM850	824-849	869-894
	GSM1900	1850-1910	1930-1990
	UMTS Band 2	1850-1910	1930-1990
	UMTS Band 4	1710-1755	2110-2115
	UMTS Band 5	824-849	869-894
	LTE Band 2	1850-1910	1930-1990
	LTE Band 4	1710-1755	2110-2115
	LTE Band 5	824-849	869-894
	LTE Band 7	2500-2570	2620-2690
	LTE Band 38	2570-2620	2570-2620
	LTE Band 41	2545-2655	2545-2655
	WiFi 2.4G	2432-2462	2432-2462

1.1 General Description

The LTE CPE B612s-52d is a Long Term Evolution (LTE) wireless gateway for multiple users in household or small office environments. It enables users to access the Internet, supports 3GPP Release 11 with UE downlink/uplink category 6. Working band: LTE: B2/4/5/7/38/41 (B41:2545~2655MHz), WCDMA: B2/4/5, GSM: B2/B5, Wi-Fi: 2.4 GHz 802.11b/g/n up to 300Mbps, Downlink 4x4MIMO B4/7/38/41.

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	2018-05-25
End Date of test	2018-05-25

6 Ambient Condition

Ambient temperature	18°C – 25°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 cannot 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	1TS*(1/8)	35	1.5	36.5	558.35	20	0.111	0.549	Pass
	2TS*(2/8)	33	1.5	34.5	704.60	20	0.140	0.549	Pass
	3TS*(3/8)	31	1.5	32.5	666.85	20	0.133	0.549	Pass
	4TS*(4/8)	29	1.5	30.5	561.01	20	0.112	0.549	Pass
External Antenna	1TS*(1/8)	35	3.0	38.0	788.70	20	0.157	0.549	Pass
	2TS*(2/8)	33	3.0	36.0	995.27	20	0.198	0.549	Pass
	3TS*(3/8)	31	3.0	34.0	941.96	20	0.187	0.549	Pass
	4TS*(4/8)	29	3.0	32.0	792.45	20	0.158	0.549	Pass

Note:*- based on the maximum tune-up tolerance limit declared by manufacturer
For GSM bands, the time-based average power considering the duty cycle should be used in MPE evaluation. To average the power, the division factor is as follows:

1Tx slot = 1 transmit time slot out of 8 time slots => power divided by (1/8) = > - 9.03dB

2Tx slots = 2 transmit time slot out of 8 time slots=> power divided by (2/8) = > - 6.02dB

3Tx slots = 3 transmit time slot out of 8 time slots=> power divided by (3/8) = > - 4.26dB

4Tx slots = 4 transmit time slot out of 8 time slots=> power divided by (4/8) = > - 3.01dB

According to the Table, we can conclude the max power density level at 20 cm is 0.198mW/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	1TS*(1/8)	32	3.5	35.5	443.52	20	0.088	1.000	Pass
	2TS*(2/8)	30	3.5	33.5	559.68	20	0.111	1.000	Pass
	3TS*(3/8)	28	3.5	31.5	529.70	20	0.105	1.000	Pass
	4TS*(4/8)	26	3.5	29.5	445.63	20	0.089	1.000	Pass
External Antenna	1TS*(1/8)	32	3.0	35.0	395.28	20	0.079	1.000	Pass
	2TS*(2/8)	30	3.0	33.0	498.82	20	0.099	1.000	Pass
	3TS*(3/8)	28	3.0	31.0	472.10	20	0.094	1.000	Pass
	4TS*(4/8)	26	3.0	29.0	397.16	20	0.079	1.000	Pass

Note: *- based on the maximum tune-up tolerance limit declared by manufacturer
 For GSM bands, the time-based average power considering the duty cycle should be used in MPE evaluation. To average the power, the division factor is as follows:
 1Tx slot = 1 transmit time slot out of 8 time slots => power divided by (1/8) = > - 9.03dB
 2Tx slots = 2 transmit time slot out of 8 time slots=> power divided by (2/8) = > - 6.02dB
 3Tx slots = 3 transmit time slot out of 8 time slots=> power divided by (3/8) = > - 4.26dB
 4Tx slots = 4 transmit time slot out of 8 time slots=> power divided by (4/8) = > - 3.01dB

According to the Table, we can conclude the max power density level at 20 cm is 0.111mW/cm², which is below the uncontrolled exposure limit, so we can conclude it is into compliance.

8.3 Operation in UMTS Band 2

(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	25.7	3.5	29.2	831.8	20	0.166	1.000	Pass
External Antenna	25.7	3.0	28.7	741.3	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 4

(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	25.7	3.5	29.2	831.8	20	0.166	1.000	Pass
External Antenna	25.7	3.0	28.7	741.3	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 5

(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	25.7	1.5	27.2	524.8	20	0.104	0.549	Pass
External Antenna	25.7	3.0	28.7	741.3	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 2

(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	25.7	3.5	29.2	831.8	20	0.166	1.000	Pass
External Antenna	25.7	3.0	28.7	741.3	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.

8.7 Operation in LTE Band 4

(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	25.7	3.5	29.2	831.8	20	0.166	1.000	Pass
External Antenna	25.7	3.0	28.7	741.3	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.

8.8 Operation in LTE Band 5

(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	25.7	1.5	27.2	524.8	20	0.104	0.549	Pass
External Antenna	25.7	3.0	28.7	741.3	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 7

(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	25.7	3.5	29.2	831.8	20	0.166	1.000	Pass
External Antenna	25.7	3.0	28.7	741.3	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 38

(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	25.7	3.5	29.2	831.8	20	0.166	1.000	Pass
External Antenna	25.7	3.0	28.7	741.3	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 41

(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	25.7	3.5	29.2	831.8	20	0.166	1.000	Pass
External Antenna	25.7	3.0	28.7	741.3	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 WiFi 2.4G SISO

(uplink: 2432-2462MHz, downlink: 2432-2462MHz)

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 SISO	15.0	3.2	18.2	66.1	20	0.013	1.000	Pass
Antenna 2 SISO	15.0	4.6	19.6	91.2	20	0.018	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 0.018mW/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	WiFi 2.4G MIMO
2	GSM/UMTS/LTE +WiFi 2.4G SISO/MIMO

Note: The GSM/UMTS//LTE Internal antenna and GSM/UMTS/LTE External antenna cannot transmit simultaneously.

9.1 Estimation for WiFi 2.4G 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
Antenna 1 & Antenna 2	12.0	1.1	13.1	20.4	20	0.004	1.000	PASS

9.2 Estimation for GSM850 & WiFi 2.4G

No.	Mode	S (mW/cm ²)	MPE Limit (mW/cm ²)	Calculation result	Conclusion
1	GSM850	0.198	0.549	0.379	PASS
	WiFi 2.4G SISO	0.018	1.000		
2	GSM850	0.198	0.549	0.365	PASS
	WiFi 2.4G MIMO	0.004	1.000		

9.3 Estimation for GSM1900 & WiFi 2.4G

No.	Mode	S (mW/cm ²)	MPE Limit (mW/cm ²)	Calculation result	Conclusion
1	GSM1900	0.111	1.000	0.129	PASS
	WiFi 2.4G SISO	0.018	1.000		
2	GSM1900	0.111	1.000	0.115	PASS
	WiFi 2.4G MIMO	0.004	1.000		

9.4 Estimation for UMTS Band 2 & WiFi 2.4G

No.	Mode	S (mW/cm ²)	MPE Limit (mW/cm ²)	Calculation result	Conclusion
1	UMTS Band 2	0.166	1.000	0.184	PASS
	WiFi 2.4G SISO	0.018	1.000		
2	UMTS Band 2	0.166	1.000	0.170	PASS
	WiFi 2.4G MIMO	0.004	1.000		

9.5 Estimation for UMTS Band 4 & WiFi 2.4G

No.	Mode	S (mW/cm ²)	MPE Limit (mW/cm ²)	Calculation result	Conclusion
1	UMTS Band 4	0.166	1.000	0.184	PASS
	WiFi 2.4G SISO	0.018	1.000		
2	UMTS Band 4	0.166	1.000	0.170	PASS
	WiFi 2.4G MIMO	0.004	1.000		

9.6 Estimation for UMTS Band 5 & WiFi 2.4G

No.	Mode	S (mW/cm ²)	MPE Limit (mW/cm ²)	Calculation result	Conclusion
1	UMTS Band 5	0.148	0.549	0.288	PASS
	WiFi 2.4G SISO	0.018	1.000		
2	UMTS Band 5	0.148	0.549	0.274	PASS
	WiFi 2.4G MIMO	0.004	1.000		

9.7 Estimation for LTE Band 2 & WiFi 2.4G

No.	Mode	S (mW/cm ²)	MPE Limit (mW/cm ²)	Calculation result	Conclusion
1	LTE Band 2	0.166	1.000	0.184	PASS
	WiFi 2.4G SISO	0.018	1.000		
2	LTE Band 2	0.166	1.000	0.170	PASS
	WiFi 2.4G MIMO	0.004	1.000		

9.8 Estimation for LTE Band 4 & WiFi 2.4G

No.	Mode	S (mW/cm ²)	MPE Limit (mW/cm ²)	Calculation result	Conclusion
1	LTE Band 4	0.166	1.000	0.184	PASS
	WiFi 2.4G SISO	0.018	1.000		
2	LTE Band 4	0.166	1.000	0.170	PASS
	WiFi 2.4G MIMO	0.004	1.000		

9.9 Estimation for LTE Band 5 & WiFi 2.4G

No.	Mode	S (mW/cm ²)	MPE Limit (mW/cm ²)	Calculation result	Conclusion
1	LTE Band 5	0.148	0.549	0.288	PASS
	WiFi 2.4G SISO	0.018	1.000		
2	LTE Band 5	0.148	0.549	0.274	PASS
	WiFi 2.4G MIMO	0.004	1.000		

9.10 Estimation for LTE Band 7 & WiFi 2.4G

No.	Mode	S (mW/cm ²)	MPE Limit (mW/cm ²)	Calculation result	Conclusion
1	LTE Band 7	0.166	1.000	0.184	PASS
	WiFi 2.4G SISO	0.018	1.000		
2	LTE Band 7	0.166	1.000	0.170	PASS
	WiFi 2.4G MIMO	0.004	1.000		

9.11 Estimation for LTE Band 38 & WiFi 2.4G

No.	Mode	S (mW/cm ²)	MPE Limit (mW/cm ²)	Calculation result	Conclusion
1	LTE Band 38	0.166	1.000	0.184	PASS
	WiFi 2.4G SISO	0.018	1.000		
2	LTE Band 38	0.166	1.000	0.170	PASS
	WiFi 2.4G MIMO	0.004	1.000		

9.12 Estimation for LTE Band 41 & WiFi 2.4G

No.	Mode	S (mW/cm ²)	MPE Limit (mW/cm ²)	Calculation result	Conclusion
1	LTE Band 41	0.166	1.000	0.184	PASS
	WiFi 2.4G SISO	0.018	1.000		
2	LTE Band 41	0.166	1.000	0.170	PASS
	WiFi 2.4G MIMO	0.004	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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