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FCC Maximum Permissible Exposure(MPE) Estimation Report

Product Name: LTE CPE

Model: B315s-519

Report No.: SYBH(Z-SAR)008012017-2

FCC ID: QISB315S-519B

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REV.	DESCRIPTION	ISSUED DATE	REMARK
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Table of Contents

1	EUT Description	6
1.1	General Description.....	7
2	Test specification(s).....	8
3	Testing laboratory.....	8
4	Applicant and Manufacturer	8
5	Application details.....	8
6	Ambient Condition	8
7	RF Exposure Requirements	9
7.1	FCC MPE Limits	10
8	RF Exposure Evaluation(FCC).....	11
8.1	Operation in GSM850.....	11
8.2	Operation in GSM1900.....	12
8.3	Operation in UMTS Band II	13
8.4	Operation in UMTS Band V	13
8.5	Operation in LTE Band II.....	14
8.6	Operation in LTE Band IV	14
8.7	Operation in LTE Band V	15
8.8	Operation in LTE Band XIII	15
8.9	Operation in LTE Band XVII.....	16
8.10	Operation in WLAN 2.4G.....	16
9	Exposure calculations for multiple sources(FCC)	17
9.1	Estimation for WLAN2.4G MIMO	18
9.2	Estimation for GSM850& WLAN2.4G	18
9.3	Estimation for GSM1900& WLAN2.4G	18
9.4	Estimation for UMTS Band II & WLAN2.4G	18
9.5	Estimation for UMTS Band V & WLAN2.4G.....	19
9.6	Estimation for LTE Band II & WLAN2.4G.....	19

9.7	Estimation for LTE Band IV & WLAN2.4G	19
9.8	Estimation for LTE Band V & WLAN2.4G	19
9.9	Estimation for LTE Band XIII & WLAN2.4G	20
9.10	Estimation for LTE Band XVII & WLAN2.4G.....	20

1 EUT Description

Device Information:				
Product Name :	LTE CPE			
Model :	B315s-519			
FCC ID:	QISB315S-519B			
Device Type :	Mobile Device			
Device Phase:	Identical Prototype			
Exposure Category:	Uncontrolled environment/general population			
Hardware Version :	WL1B310I			
Software Version :	V100R001			
Antenna Type :	Internal Antenna & External Antenna			
Device Operating Configurations:				
Supporting Mode(s)	GSM850/1900,UMTS Band II / V, LTE band II / IV / V / XIII / XVII,WiFi 2.4G			
Test Modulation	GSM(GMSK/8PSK),UMTS(QPSK),LTE(QPSK/16QAM), WiFi(DSSS/OFDM)			
Operating 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 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 XIII	777-787	746-756
		LTE Band XVII	704-716	734-746
		WiFi 2.4G	2400-2483.5	2400-2483.5

1.1 General Description

B315s-519 LTE/DC-HSDPA/WCDMA/EDGE/GPRS/GSM mutli-mode LTE CPE is subscriber equipment in the LTE/UMTS/GSM system and support WLAN 802.11/b/g/n. B315s-519 implement such functions as RF signal receiving/transmitting, LTE/HSPA/WCDMA and EDGE/GPRS/GSM protocol processing, data service etc. It provides USIM card interface, RJ45/RJ11 Ethernet interface, USB port and two 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
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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	2017-02-08
End Date of test	2017-02-08

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	34.00	1.00	35.00	395.28	20	0.079	0.549	PASS
	1TS*(1/8)	34.00	1.00	35.00	395.28	20	0.079	0.549	PASS
	2TS*(2/8)	32.50	1.00	33.50	559.68	20	0.111	0.549	PASS
	3TS*(3/8)	30.50	1.00	31.50	529.70	20	0.105	0.549	PASS
	4TS*(4/8)	28.50	1.00	29.50	445.63	20	0.089	0.549	PASS
External Antenna 1	GSM CS	34.00	1.00	35.00	395.28	20	0.079	0.549	PASS
	1TS*(1/8)	34.00	1.00	35.00	395.28	20	0.079	0.549	PASS
	2TS*(2/8)	32.50	1.00	33.50	559.68	20	0.111	0.549	PASS
	3TS*(3/8)	30.50	1.00	31.50	529.70	20	0.105	0.549	PASS
	4TS*(4/8)	28.50	1.00	29.50	445.63	20	0.089	0.549	PASS
External Antenna2	GSM CS	34.00	3.00	37.0	626.48	20	0.125	0.549	PASS
	1TS*(1/8)	34.00	3.00	37.0	626.48	20	0.125	0.549	PASS
	2TS*(2/8)	32.50	3.00	35.5	887.03	20	0.177	0.549	PASS
	3TS*(3/8)	30.50	3.00	33.5	839.52	20	0.167	0.549	PASS
	4TS*(4/8)	28.50	3.00	31.5	706.27	20	0.141	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 0.177mW/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	31.50	1.50	33.00	249.41	20	0.050	1.000	PASS
	1TS*(1/8)	31.50	1.50	33.00	249.41	20	0.050	1.000	PASS
	2TS*(2/8)	30.00	1.50	31.50	353.13	20	0.070	1.000	PASS
	3TS*(3/8)	28.00	1.50	29.50	334.22	20	0.067	1.000	PASS
	4TS*(4/8)	26.00	1.50	27.50	281.17	20	0.056	1.000	PASS
External Antenna 1	GSM CS	31.50	1.00	32.50	222.28	20	0.044	1.000	PASS
	1TS*(1/8)	31.50	1.00	32.50	222.28	20	0.044	1.000	PASS
	2TS*(2/8)	30.00	1.00	31.00	314.73	20	0.063	1.000	PASS
	3TS*(3/8)	28.00	1.00	29.00	297.87	20	0.059	1.000	PASS
	4TS*(4/8)	26.00	1.00	27.00	250.59	20	0.050	1.000	PASS
External Antenna 2	GSM CS	31.50	3.00	34.50	352.30	20	0.070	1.000	PASS
	1TS*(1/8)	31.50	3.00	34.50	352.30	20	0.070	1.000	PASS
	2TS*(2/8)	30.00	3.00	33.00	498.82	20	0.099	1.000	PASS
	3TS*(3/8)	28.00	3.00	31.00	472.10	20	0.094	1.000	PASS
	4TS*(4/8)	26.00	3.00	29.00	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 0.099 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	1.50	27.20	524.80	20	0.104	1.000	PASS
External Antenna 1	25.70	1.00	26.7	467.7	20	0.093	1.000	PASS
External Antenna 2	25.70	3.00	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 0.148mW/cm², which is below the uncontrolled exposure limit, so we can conclude it is into compliance.

8.4 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	1.00	26.7	467.7	20	0.093	0.549	PASS
External Antenna 1	25.70	1.00	26.7	467.7	20	0.093	0.549	PASS
External Antenna 2	25.70	3.00	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.

8.5 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	1.50	27.20	524.8	20	0.104	1.000	PASS
External Antenna 1	25.70	1.00	26.7	467.7	20	0.093	1.000	PASS
External Antenna 2	25.70	3.00	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 0.148 mW/cm², which is below the uncontrolled exposure limit, so we can conclude it is into compliance.

8.6 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	1.50	27.20	524.8	20	0.104	1.000	PASS
External Antenna 1	25.70	1.00	26.70	467.7	20	0.093	1.000	PASS
External Antenna 2	25.70	3.00	28.70	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 0.148mW/cm², which is below the uncontrolled exposure limit, so we can conclude it is into compliance.

8.7 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	1.00	26.70	467.7	20	0.093	0.549	PASS
External Antenna 1	25.70	1.00	26.70	467.7	20	0.093	0.549	PASS
External Antenna 2	25.70	3.00	28.70	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.

8.8 Operation in LTE Band XIII

(uplink: 777-787MHz, downlink: 746-756MHz)

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	1.00	26.70	467.7	20	0.093	0.518	PASS
External Antenna 1	25.70	1.00	26.70	467.7	20	0.093	0.518	PASS
External Antenna 2	25.70	3.00	28.70	741.3	20	0.148	0.518	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 XVII

(uplink: 704-716MHz, downlink: 734-746MHz)

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	27.2	524.8	20	0.104	0.469	PASS
External Antenna 1	25.70	1.00	26.7	467.7	20	0.093	0.469	PASS
External Antenna 2	25.70	3.00	28.7	741.3	20	0.148	0.469	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.

8.10 Operation in WLAN 2.4G

(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	18.00	1.00	19.00	79.40	20	0.016	1.000	PASS
Antenna 2	18.00	1.00	19.00	79.40	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 0.016 mW/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: The GSM/UMTS/LTE Internal antenna and GSM/UMTS/LTE External antennas cannot transmit simultaneously.

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	14.50	1.00	15.5	35.5	20	0.007	1.000	0.014	PASS
Antenna 2	14.50	1.00	15.5	35.5	20	0.007	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	0.177	0.549	0.338	PASS
	WLAN 2.4G SISO	0.016	1.000		
2	GSM850	0.177	0.549	0.336	PASS
	WLAN MIMO with Antenna 1	0.007	1.000		
	WLAN MIMO with Antenna 2	0.007	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	0.099	1.000	0.115	PASS
	WLAN SISO	0.016	1.000		
2	GSM1900	0.099	1.000	0.113	PASS
	WLAN MIMO with Antenna 1	0.007	1.000		
	WLAN MIMO with Antenna 2	0.007	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	0.148	1.000	0.164	PASS
	WLAN SISO	0.016	1.000		
2	UMTS Band II	0.148	1.000	0.162	PASS
	WLAN MIMO with Antenna 1	0.007	1.000		
	WLAN MIMO with Antenna 2	0.007	1.000		

9.5 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	0.284	PASS
	WLAN MIMO with Antenna 1	0.007	1.000		
	WLAN MIMO with Antenna 2	0.007	1.000		

9.6 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	0.148	1.000	0.164	PASS
	WLAN SISO	0.016	1.000		
2	LTE Band II	0.148	1.000	0.162	PASS
	WLAN MIMO with Antenna 1	0.007	1.000		
	WLAN MIMO with Antenna 2	0.007	1.000		

9.7 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	0.148	1.000	0.164	PASS
	WLAN SISO	0.016	1.000		
2	LTE Band IV	0.148	1.000	0.162	PASS
	WLAN MIMO with Antenna 1	0.007	1.000		
	WLAN MIMO with Antenna 2	0.007	1.000		

9.8 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	0.284	PASS
	WLAN MIMO with Antenna 1	0.007	1.000		
	WLAN MIMO with Antenna 2	0.007	1.000		

9.9 Estimation for LTE Band XIII & WLAN2.4G

No.	Mode	S (mW/cm ²)	MPE Limit (mW/cm ²)	Calculation result	Conclusion
1	LTE Band VII	0.148	0.518	0.302	PASS
	WLAN SISO	0.016	1.000		
2	LTE Band VII	0.148	0.518	0.300	PASS
	WLAN MIMO with Antenna 1	0.007	1.000		
	WLAN MIMO with Antenna 2	0.007	1.000		

9.10 Estimation for LTE Band XVII & WLAN2.4G

No.	Mode	S (mW/cm ²)	MPE Limit (mW/cm ²)	Calculation result	Conclusion
1	LTE Band VII	0.148	0.469	0.332	PASS
	WLAN SISO	0.016	1.000		
2	LTE Band VII	0.148	0.469	0.330	PASS
	WLAN MIMO with Antenna 1	0.007	1.000		
	WLAN MIMO with Antenna 2	0.007	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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