



FCC Maximum Permissible Exposure(MPE) Estimation Report

Product Name: LTE CPE

Model: B593s-516

Report No.: SYBH(Z-SAR)020072013-2

FCC ID: QISB593S-516

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DATE	2013-08-07	2013-08-07

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※ ※ Modified History ※ ※

REV.	DESCRIPTION	ISSUED DATE	REMARK
Rev.1.0	Initial Test Report Release	2013-07-26	Sun Shaobin
Rev.1.1	1) Remove the DC battery calculation and information on page 11&12; 2) Update the turn up limit for Wi-Fi to 19dBm according to turn up procedure on page 15&17, and the tables 9.1-9.10 is updated accordingly.	2013-08-07	Sun Shaobin

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1 EUT Description

Device Information:			
DUT Name:		LTE CPE	
Type Identification:		B593s-516	
Device Type :		Mobile	
FCC ID:		QISB593S-516	
Device Phase:		Identical Prototype	
Exposure Category:		Uncontrolled environment/general population	
Hardware Version :		Router Board: CL1B593SR Modem Board: CL1E5172M	
Software Version :		V200R001	
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,WiFi 2.4G(Tested)	
Test Modulation		GMSK/8PSK/QPSK/16QAM/BPSK	
Operating Frequency Range(s)	Band	Tx (MHz)	Rx (MHz)
	GSM850	824-849	869-894
	GSM1900	1850-1910	1930-1990
	UTMS Band II	1850-1910	1930-1990
	UTMS Band IV	1710-1755	2110-2155
	UTMS 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
	WiFi 2.4G	2412-2462	2412-2462



1.1 General Description

B593s-516 LTE/WCDMA/GSM three mode 13 bands CPE is subscriber equipment in the LTE/UMTS/GSM system and support Wi-Fi 802.11b/g/n. But only GSM 850 、 1900,WCDMA 850、 1900、 AWS and LTE Band II、 AWS、 V、 Band VII testing results in this report.B593s-516 implement such functions as RF signal receiving/transmitting, LTE/WCDMA/GSM protocol processing, data service etc. Externally it provides USIM card interface, RJ45 Ethernet interface and RJ11 telephone interface. B593-516 has two external antennas and four internal antennas. Two internal antennas are used for WiFi, while the external antennas and other two internal antennas are used for LTE/WCDMA/GSM. For the LTE/WCDMA/GSM internal antennas, only one was used for transmission and both for reception.



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)
RSS-102	Radio Frequency Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands (Issue 4 of March 2010))
KDB 447498 D01	General RF Exposure Guidance v05r01

3 Testing laboratory

Test Site	The Reliability Laboratory of Huawei Technologies Co., Ltd.
Test Location	Zone K3,Huawei Industrial Base, Bantian Industry Area, Longgang District, Shenzhen, Guangdong, 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

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	2013-07-26
End Date of test	2013-07-26

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.

We analysis if it comply with the limits for General population/uncontrolled exposure. The FCC's 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	

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

$$\text{EIRP} = P * G$$

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.



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	1TS*(1/8)	33.0	0.32	33.32	268.48	20	0.053	0.549	PASS
	2TS*(2/8)	31.0	0.32	31.32	338.80	20	0.067	0.549	PASS
	3TS*(3/8)	29.0	0.32	29.32	320.65	20	0.064	0.549	PASS
	4TS*(4/8)	27.0	0.32	27.32	269.76	20	0.054	0.549	PASS
External	1TS*(1/8)	33.0	-1.37	31.63	181.93	20	0.036	0.549	PASS
	2TS*(2/8)	31.0	-1.37	29.63	229.58	20	0.046	0.549	PASS
	3TS*(3/8)	29.0	-1.37	27.63	217.29	20	0.043	0.549	PASS
	4TS*(4/8)	27.0	-1.37	25.63	182.80	20	0.036	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 0.067mW/cm², which is below the uncontrolled exposure limit of 0.549mW/cm² at 824MHz, 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	1TS*(1/8)	30.0	2.83	32.83	239.83	20	0.048	1.000	PASS
	2TS*(2/8)	28.0	2.83	30.83	302.65	20	0.060	1.000	PASS
	3TS*(3/8)	26.0	2.83	28.83	286.44	20	0.057	1.000	PASS
	4TS*(4/8)	24.0	2.83	26.83	240.97	20	0.048	1.000	PASS
External	1TS*(1/8)	30.0	-0.64	29.36	107.87	20	0.021	1.000	PASS
	2TS*(2/8)	28.0	-0.64	27.36	136.13	20	0.027	1.000	PASS
	3TS*(3/8)	26.0	-0.64	25.36	128.83	20	0.026	1.000	PASS
	4TS*(4/8)	24.0	-0.64	23.36	108.39	20	0.022	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 0.060mW/cm², which is below the uncontrolled exposure limit of 1.0mW/cm² at 1850MHz, 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	23.5	2.83	26.33	429.54	20	0.085	1.000	PASS
External	23.5	-0.64	22.86	193.20	20	0.038	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 0.085mW/cm², which is below the uncontrolled exposure limit of 1.0mW/cm² at 1850MHz, 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	23.5	2.79	26.29	425.60	20	0.085	1.000	PASS
External	23.5	-0.40	23.10	204.17	20	0.041	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 0.085mW/cm², which is below the uncontrolled exposure limit of 1.000mW/cm² at 1710MHz, 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	24.0	0.32	24.32	270.40	20	0.054	0.549	PASS
External	24.0	-1.37	22.63	183.23	20	0.036	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 0.054mW/cm², which is below the uncontrolled exposure limit of 0.549mW/cm² at 824MHz, 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	23.0	2.83	25.83	382.82	20	0.076	1.000	PASS
External	23.0	-0.64	22.36	172.19	20	0.034	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 0.076mW/cm², which is below the uncontrolled exposure limit of 1.0mW/cm² at 1850MHz, 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	23.5	2.79	26.29	425.60	20	0.085	1.000	PASS
External	23.5	-0.40	23.10	204.17	20	0.041	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 0.085mW/cm², which is below the uncontrolled exposure limit of 1.000mW/cm² at 1710MHz, 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	23.3	0.32	23.62	230.14	20	0.046	0.549	PASS
External	23.3	-1.37	21.93	155.96	20	0.031	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 0.046mW/cm², which is below the uncontrolled exposure limit of 0.549mW/cm² at 824MHz, 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	22.5	1.42	23.92	246.60	20	0.049	1.000	PASS
External	22.5	-0.89	21.61	144.88	20	0.029	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 0.049mW/cm², which is below the uncontrolled exposure limit of 1.000mW/cm² at 2500MHz, so we can conclude it is into compliance.

8.10 Operation in WLAN 2.4G

(uplink: 2400-2483.5MHz, downlink: 2400-2483.5MHz)

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 1	19.0	1.01	20.01	100.23	20	0.020	1.000	PASS
Internal Antenna 2	19.0	1.01	20.01	100.23	20	0.020	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 0.020mW/cm², which is below the uncontrolled exposure limit of 1.000mW/cm² at 2400MHz, 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(Internal antenna) +WLAN 2.4G SISO
3	GSM/UMTS/LTE(External antenna) +WLAN 2.4G SISO
4	GSM/UMTS/LTE(Internal antenna) +WLAN 2.4G MIMO
5	GSM/UMTS/LTE(External antenna) +WLAN 2.4G MIMO

Note: The GSM/UMTS/LTE Internal antenna and GSM/UMTS/LTE External antenna 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
Internal Antenna 1	19.0	1.01	20.01	100.23	20	0.020	1.000	0.040	PASS
Internal Antenna 2	19.0	1.01	20.01	100.23	20	0.020	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	0.067	0.549	0.142	PASS
	WLAN 2.4G SISO	0.020	1.000		
2	GSM850	0.067	0.549	0.162	PASS
	WLAN MIMO with Antenna 1	0.020	1.000		
	WLAN MIMO with Antenna 2	0.020	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	0.060	1.000	0.080	PASS
	WLAN SISO	0.020	1.000		
2	GSM1900	0.060	1.000	0.100	PASS
	WLAN MIMO with Antenna 1	0.020	1.000		
	WLAN MIMO with Antenna 2	0.020	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	0.085	1.000	0.105	PASS
	WLAN SISO	0.020	1.000		
2	UMTS Band II	0.085	1.000	0.125	PASS
	WLAN MIMO with Antenna 1	0.020	1.000		
	WLAN MIMO with Antenna 2	0.020	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	0.085	1.000	0.105	PASS
	WLAN SISO	0.020	1.000		
2	UMTS Band IV	0.085	1.000	0.125	PASS
	WLAN MIMO with Antenna 1	0.020	1.000		
	WLAN MIMO with Antenna 2	0.020	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	0.054	0.549	0.118	PASS
	WLAN SISO	0.020	1.000		
2	UMTS Band V	0.054	0.549	0.138	PASS
	WLAN MIMO with Antenna 1	0.020	1.000		
	WLAN MIMO with Antenna 2	0.020	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	0.076	1.000	0.096	PASS
	WLAN SISO	0.020	1.000		
2	LTE Band II	0.076	1.000	0.116	PASS
	WLAN MIMO with Antenna 1	0.020	1.000		
	WLAN MIMO with Antenna 2	0.020	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	0.085	1.000	0.105	PASS
	WLAN SISO	0.020	1.000		
2	LTE Band IV	0.085	1.000	0.125	PASS
	WLAN MIMO with Antenna 1	0.020	1.000		
	WLAN MIMO with Antenna 2	0.020	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	0.046	0.549	0.104	PASS
	WLAN SISO	0.020	1.000		
2	LTE Band V	0.046	0.549	0.124	PASS
	WLAN MIMO with Antenna 1	0.020	1.000		
	WLAN MIMO with Antenna 2	0.020	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	0.049	1.000	0.069	PASS
	WLAN SISO	0.020	1.000		
2	LTE Band VII	0.049	1.000	0.089	PASS
	WLAN MIMO with Antenna 1	0.020	1.000		
	WLAN MIMO with Antenna 2	0.020	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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