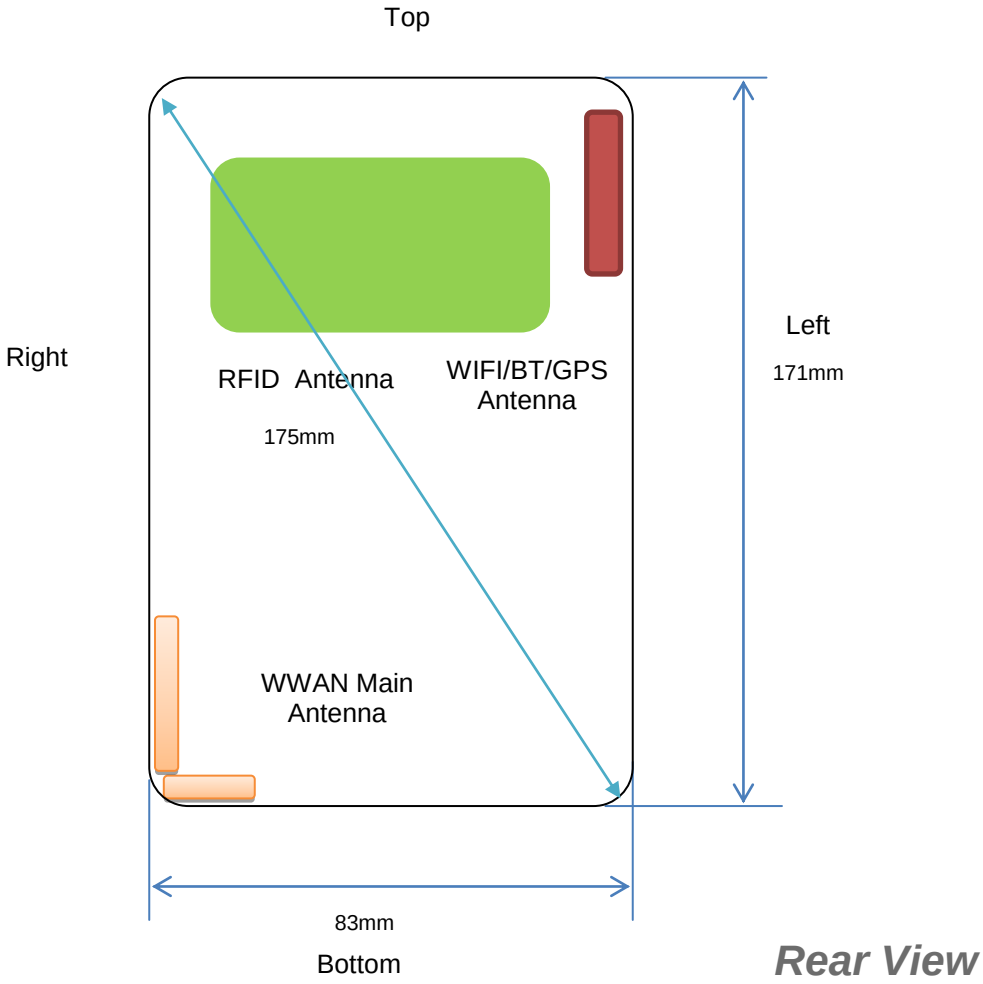
4.3. Transmit Antennas and SAR Measurement Position



Antenna information:

WWAN Main Antenna	GSM/UMTS TX/RX
WLAN/GPS/BT Antenna	WLAN/BT TX/RX

Note:
1). Per KDB648474 D04, because the overall diagonal distance of this devices is 175mm>160mm, it is considered as “Phablet“ device.
2). Per KDB648474 D04, 10-g extremity SAR is not required when Body-Worn mode 1-g reported SAR < 1.2 W/Kg.
3). According to the KDB941225 D06 Hot Spot SAR v02, the edges with less than 25 mm distance to the antennas need to be tested for SAR.

Distance of The Antenna to the EUT surface and edge (mm)						
Antennas	**Front**	**Back**	**Top Side**	**Bottom Side**	**Left Side**	**Right Side**
WWAN	<5	<5	136	<5	42	<5
BT/WLAN	<5	<5	24	121	<5	73

Positions for SAR tests; Hotspot mode						
Antennas	**Front**	**Back**	**Top Side**	**Bottom Side**	**Left Side**	**Right Side**
WWAN	Yes	Yes	No	Yes	No	Yes
BT/WLAN	Yes	Yes	Yes	No	Yes	No

General Note: Referring to KDB 941225 D06 v02, When the overall device length and width are ≥9cm*5cm, the test distance is 10mm, SAR must be measured for all sides and surfaces with a transmitting antenna located with 25mm from that surface or edge.

4.4. SAR Measurement Results

The calculated SAR is obtained by the following formula:

Reported SAR=Measured SAR*$10^{(Ptarget-Pmeasured))/10}$

Scaling factor=$10^{(Ptarget-Pmeasured))/10}$

Reported SAR= Measured SAR* Scaling factor

Where

P_{target} is the power of manufacturing upper limit;

$P_{measured}$ is the measured power;

Measured SAR is measured SAR at measured power which including power drift)

Reported SAR which including Power Drift and Scaling factor

Duty Cycle

Test Mode	Duty Cycle
Speech for GSM850/1900	1:8
GPRS850	1:2.67
GPRS1900	1:2.67
UMTS	1:1
WLAN2450	1:1

4.4.1 SAR Results

SAR Values [GSM 850]

Ch.	*Freq. (MHz)*	*Time slots*	*Test Position*	*Conducted Power (dBm)*	*Maximum Allowed Power (dBm)*	*Power Drift (%)*	*Scaling Factor*	*SAR_{1-g} results(W/kg)*		*Graph Results*
								Measured	*Reported*	
measured / reported SAR numbers –Head<SIM1>										
128	824.2	Voice	Left Cheek	32.17	32.50	0.00	1.079	0.018	0.019	
128	824.2	Voice	Left Tilt	32.17	32.50	-2.01	1.079	0.013	0.014	
128	824.2	Voice	Right Cheek	32.17	32.50	4.33	1.079	**0.033**	**0.036**	Plot 1
128	824.2	Voice	Right Tilt	32.17	32.50	2.30	1.079	0.022	0.024	
measured / reported SAR numbers - Body (hotspot open, distance 10mm)<SIM1>										
251	848.8	3Txslots	Front	29.41	29.50	-2.59	1.021	**0.098**	**0.100**	Plot 2
251	848.8	3Txslots	Rear	29.41	29.50	-1.61	1.021	0.070	0.071	
251	848.8	3Txslots	Right	29.41	29.50	2.69	1.021	0.051	0.052	
251	848.8	3Txslots	Bottom	29.41	29.50	1.75	1.021	0.033	0.034	

Remark:

1. The value with block color is the maximum SAR Value of each test band.

2. The frame average of GPRS (3Tx slots) higher than GSM and sample can support VoIP function.

3. Per FCC KDB Publication 447498 D01, if the reported (scaled) SAR measured at the middle channel or highest output power channel for each test configuration is ≤ 0.8 W/kg then testing at the other channels is optional for such test configuration(s).

SAR Values [GSM 1900]

Ch.	*Freq. (MHz)*	*time slots*	*Test Position*	*Conducted Power (dBm)*	*Maximum Allowed Power (dBm)*	*Power Drift (%)*	*Scaling Factor*	*SAR_{1-g} results(W/kg)*		*Graph Results*
								Measured	*Reported*	
measured / reported SAR numbers –Head<SIM1>										
810	1909.8	Voice	Left Cheek	29.38	29.50	-1.62	1.028	0.049	0.050	
810	1909.8	Voice	Left Tilt	29.38	29.50	-2.02	1.028	0.032	0.033	
810	1909.8	Voice	Right Cheek	29.38	29.50	0.04	1.028	**0.151**	**0.155**	Plot 3
810	1909.8	Voice	Right Tilt	29.38	29.50	2.93	1.028	0.105	0.108	
measured / reported SAR numbers – Body (hotspot open, distance 10mm)<SIM1>										
810	1909.8	3Txslots	Front	26.53	27.00	-1.36	1.114	0.155	0.173	
810	1909.8	3Txslots	Rear	26.53	27.00	-4.30	1.114	**0.177**	**0.197**	Plot 4
810	1909.8	3Txslots	Right	26.53	27.00	2.73	1.114	0.083	0.092	
810	1909.8	3Txslots	Bottom	26.53	27.00	1.44	1.114	0.047	0.052	

Remark:

1. The value with block color is the maximum SAR Value of each test band.

2. The frame average of GPRS (3Tx slots) higher than GSM and sample can support VoIP function.

3. Per FCC KDB Publication 447498 D01, if the reported (scaled) SAR measured at the middle channel or highest output power channel for each test configuration is ≤ 0.8 W/kg then testing at the other channels is optional for such test configuration(s).

SAR Values [WCDMA Band V]

Ch.	Freq. (MHz)	Channel Type	Test Position	Conducted Power (dBm)	Maximum Allowed Power (dBm)	Power Drift (%)	Scaling Factor	SAR_{1-g} results(W/kg)		Graph Results
								Measured	Reported	
measured / reported SAR numbers –Head<SIM1>										
4132	826.4	RMC*	Left Cheek	23.53	24.00	-0.33	1.114	0.021	0.023	
4132	826.4	RMC*	Left Tilt	23.53	24.00	3.11	1.114	0.015	0.017	
4132	826.4	RMC*	Right Cheek	23.53	24.00	1.92	1.114	**0.037**	**0.041**	Plot 5
4132	826.4	RMC*	Right Tilt	23.53	24.00	2.01	1.114	0.020	0.022	
measured / reported SAR numbers - Body (hotspot open, distance 10mm)<SIM1>										
4233	846.6	RMC*	Front	23.53	24.00	-0.20	1.114	**0.114**	**0.127**	Plot 6
4233	846.6	RMC*	Rear	23.53	24.00	-0.12	1.114	0.085	0.095	
4233	846.6	RMC*	Right	23.53	24.00	2.16	1.114	0.055	0.061	
4233	846.6	RMC*	Bottom	23.53	24.00	-3.46	1.114	0.029	0.032	

Remark:
1. The value with block color is the maximum SAR Value of each test band.
2. Per FCC KDB Publication 447498 D01, if the reported (scaled) SAR measured at the middle channel or highest output power channel for each test configuration is ≤ 0.8 W/kg then testing at the other channels is optional for such test configuration(s).
3. RMC - RMC 12.2kbps mode;*

SAR Values [WCDMA Band II]

Ch.	Freq. (MHz)	Channel Type	Test Position	Conducted Power (dBm)	Maximum Allowed Power (dBm)	Power Drift (%)	Scaling Factor	SAR_{1-g} results(W/kg)		Graph Results
								Measured	Reported	
measured / reported SAR numbers –Head<SIM1>										
9662	1852.4	RMC	Left Cheek	23.73	24.00	1.59	1.064	0.085	0.090	
9662	1852.4	RMC	Left Tilt	23.73	24.00	1.42	1.064	0.072	0.077	
9662	1852.4	RMC	Right Cheek	23.73	24.00	2.09	1.064	**0.263**	**0.280**	Plot 7
9662	1852.4	RMC	Right Tilt	23.73	24.00	-3.95	1.064	0.132	0.140	
measured / reported SAR numbers - Body (hotspot open, distance 10mm)<SIM1>										
9400	1880.0	RMC	Front	23.73	24.00	-0.65	1.064	**0.339**	**0.361**	Plot 8
9400	1880.0	RMC	Rear	23.73	24.00	-0.11	1.064	0.316	0.336	
9400	1880.0	RMC	Right	23.73	24.00	-2.01	1.064	0.153	0.163	
9400	1880.0	RMC	Bottom	23.73	24.00	0.07	1.064	0.101	0.107	

Remark:
1. The value with block color is the maximum SAR Value of each test band.
2. Per FCC KDB Publication 447498 D01, if the reported (scaled) SAR measured at the middle channel or highest output power channel for each test configuration is ≤ 0.8 W/kg then testing at the other channels is optional for such test configuration(s).
3. RMC - RMC 12.2kbps mode;*

SAR Values [WIFI2.4G]

Ch.	Freq. (MHz)	Service	Test Position	Conducted Power (dBm)	Maximum Allowed Power (dBm)	Power Drift (%)	Scaling Factor	SAR1-g results(W/kg)		Graph Results
								Measured	Reported	
measured / reported SAR numbers –Head<SIM1>										
6	2437	DSSS	Left Cheek	15.63	16.00	2.24	1.089	0.023	0.025	
6	2437	DSSS	Left Tilt	15.63	16.00	-2.46	1.089	0.017	0.019	
6	2437	DSSS	Right Cheek	15.63	16.00	-0.45	1.089	**0.043**	**0.047**	Plot 9
6	2437	DSSS	Right Tilt	15.63	16.00	0.02	1.089	0.021	0.023	
measured / reported SAR numbers - Body (hotspot open, distance 10mm)<SIM1>										
6	2437	DSSS	Front	15.63	16.00	1.02	1.089	**0.052**	**0.057**	Plot 10
6	2437	DSSS	Rear	15.63	16.00	-0.38	1.089	0.024	0.026	
6	2437	DSSS	Left	15.63	16.00	-2.01	1.089	0.019	0.021	
6	2437	DSSS	Top	15.63	16.00	-3.44	1.089	0.010	0.011	

Remark:

1. The value with blue color is the maximum SAR Value of each test band.
2. Per FCC KDB Publication 447498 D01, if the reported (scaled) SAR measured at the middle channel or highest output power channel for each test configuration is ≤ 0.8 W/kg then testing at the other channels is optional for such test configuration(s).
3. SAR is not required for the following 2.4 GHz OFDM conditions as the highest reported SAR for DSSS is adjusted by the ratio of OFDM to DSSS specified maximum output power and the adjusted SAR is 0.045[0.057(31.62/39.81)] ≤ 1.2 W/kg.*

4.4.2 Standalone SAR Test Exclusion Considerations and Estimated SAR

Per KDB447498 requires when the standalone SAR test exclusion of section 4.3.1 is applied to an antenna that transmits simultaneously with other antennas, the standalone SAR must be estimated according to the following to determine simultaneous transmission SAR test exclusion;

● (max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)] • [√ f(GHz)/x] W/kg for test separation distances ≤ 50 mm;

where x = 7.5 for 1-g SAR, and x = 18.75 for 10-g SAR.

●0.4 W/kg for 1-g SAR and 1.0 W/kg for 10-g SAR, when the test separation distances is > 50 mm

Per FCC KD B447498 D01,simultaneous transmission SAR test exclusion may be applied when the sum of the 1-g SAR for all the transmitting antenna in a specific a physical test configuration is ≤1.6 W/Kg.When the sum is greater than the SAR limit,SAR test exclusion is determined by the SAR to peak location separation ratio.

$$\text{Ratio}=\frac{(SAR_1+SAR_2)^{1.5}}{(\text{peak location separation,mm})}<0.04$$

Estimated stand alone SAR					
Communication system	Frequency (MHz)	Configuration	Maximum Power (dBm)	Separation Distance (mm)	Estimated SAR_{1-g} (W/kg)
Bluetooth*	2450	Head	2.00	5	0.066
Bluetooth*	2450	Hotspot	2.00	10	0.033
Bluetooth*	2450	Body-worn	2.00	10	0.033

Remark:

1. *Bluetooth*- Including Lower power Bluetooth*
2. *Maximum average power including tune-up tolerance;*
3. *When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion*
4. *Body as body use distance is 10mm from manufacturer declaration of user manual*

4.5. Simultaneous TX SAR Considerations

4.5.1 Introduction

The following procedures adopted from “FCC SAR Considerations for Cell Phones with Multiple Transmitters” are applicable to handsets with built-in unlicensed transmitters such as 802.11 a/b/g/n and Bluetooth devices which may simultaneously transmit with the licensed transmitter.

For the DUT,the BT and WiFi modules sharing same antenna,GSM, WCDMA modules sharing a single antenna; BT/WLAN and GSM/UMTS can simultaneous transmit;

Application Simultaneous Transmission information:

Air-Interface	Band (MHz)	Type	Simultaneous Transmissions	Voice over Digital Transport(Data)
GSM	850	VO	Yes,WLAN or BT	N/A
	1900	VO		
	GPRS/EDGE	DT	Yes,WLAN or BT	N/A
WCDMA	Band II/BandV	DT	Yes,WLAN or BT	N/A
WLAN	2450	DT	Yes,GSM,GPRS,EDGE,UMTS	Yes
BT	2450	DT	Yes,GSM,GPRS,EDGE,UMTS	N/A
Note:VO-Voice Service only;DT-Digital Transport				

Note:

BT and WLAN can be active at the same time, but only with interleaving of packages switched on board level. That means that they don’t transmit at the same time.

BT- Classical Bluetooth;

4.5.2 Evaluation of Simultaneous SAR

Head Exposure Conditions

Simultaneous transmission SAR for WiFi and GSM

Test Position	GSM850 Reported SAR_{1-g} (W/kg)	GSM1900 Reported SAR_{1-g} (W/kg)	WiFi2.4G Reported SAR_{1-g} (W/kg)	MAX. ΣSAR_{1-g} (W/kg)	SAR_{1-g} Limit (W/kg)	Peak location separation ratio	Simut Meas. Required
Left Cheek	0.019	0.050	0.025	0.075	1.6	no	no
Left Tilt	0.014	0.033	0.019	0.052	1.6	no	no
Right Cheek	**0.036**	**0.155**	**0.047**	**0.202**	1.6	no	no
Right Tilt	0.024	0.108	0.023	0.131	1.6	no	no

Simultaneous transmission SAR for WiFi and UMTS

Test Position	UMTS Band V Reported SAR_{1-g} (W/kg)	UMTS Band II Reported SAR_{1-g} (W/kg)	WiFi2.4G Reported SAR1-g (W/kg)	MAX. ΣSAR_{1-g} (W/kg)	SAR_{1-g} Limit (W/kg)	Peak location separation ratio	Simut Meas. Required
Left Cheek	0.023	0.090	0.025	0.115	1.6	no	no
Left Tilt	0.017	0.077	0.019	0.096	1.6	no	no
Right Cheek	**0.041**	**0.280**	**0.047**	**0.327**	1.6	no	no
Right Tilt	0.022	0.140	0.023	0.163	1.6	no	no

Simultaneous transmission SAR for BT and GSM

Test Position	GSM850 Reported SAR_{1-g} (W/kg)	GSM1900 Reported SAR_{1-g} (W/kg)	BT Estimated SAR_{1-g} (W/kg)	MAX. ΣSAR_{1-g} (W/kg)	SAR_{1-g} Limit (W/kg)	Peak location separation ratio	Simut Meas. Required
Left Cheek	0.019	0.050	0.066	0.116	1.6	no	no
LeftTilt	0.014	0.033	0.066	0.099	1.6	no	no
Right Cheek	**0.036**	**0.155**	0.066	**0.221**	1.6	no	no
Right Tilt	0.024	0.108	0.066	0.174	1.6	no	no

Simultaneous transmission SAR forBT and UMTS

Test Position	UMTS Band V Reported SAR_{1-g} (W/kg)	UMTS Band II Reported SAR_{1-g} (W/kg)	BT Estimated SAR_{1-g} (W/kg)	MAX. ΣSAR_{1-g} (W/kg)	SAR_{1-g} Limit (W/kg)	Peak location separation ratio	Simut Meas. Required
Left Cheek	0.023	0.090	0.066	0.156	1.6	no	no
LeftTilt	0.017	0.077	0.066	0.143	1.6	no	no
RightChek	**0.041**	**0.280**	0.066	**0.346**	1.6	no	no
Right Tilt	0.022	0.140	0.066	0.206	1.6	no	no

BodyHotspot Exposure Conditions

Simultaneous transmission SAR for WiFi and GSM

Test Position	GSM850 Reported SAR_{1-g} (W/kg)	GSM1900 Reported SAR_{1-g} (W/kg)	WiFi2.4G Reported SAR_{1-g} (W/kg)	MAX. ΣSAR_{1-g} (W/kg)	SAR_{1-g} Limit (W/kg)	Peak location separation ratio	Simut Meas. Required
Front	**0.100**	0.173	**0.057**	**0.230**	1.6	no	no
Rear	0.071	**0.197**	0.026	0.223	1.6	no	no
Left	/	/	/	/	1.6	no	no
Right	0.052	0.092	0.021	0.113	1.6	no	no
Bottom	0.034	0.052	**/**	0.052	1.6	no	no
Top	/	/	0.011	0.011	1.6	no	no

Simultaneous transmission SAR for WiFi and UMTS

Test Position	UMTS Band V Reported SAR_{1-g} (W/kg)	UMTS Band II Reported SAR_{1-g} (W/kg)	WiFi2.4G Reported SAR1-g (W/kg)	MAX. ΣSAR_{1-g} (W/kg)	SAR_{1-g} Limit (W/kg)	Peak location separation ratio	Simut Meas. Required
Front	**0.127**	**0.361**	**0.057**	**0.418**	1.6	no	no
Rear	0.095	0.336	0.026	0.362	1.6	no	no
Left	/	/	/	/	1.6	no	no
Right	0.061	0.163	0.021	0.184	1.6	no	no
Bottom	0.032	0.107	**/**	0.107	1.6	no	no
Top	/	/	0.011	0.011	1.6	no	no

Simultaneous transmission SAR for BT and GSM

Test Position	GSM850 Reported SAR_{1-g} (W/kg)	GSM1900 Reported SAR_{1-g} (W/kg)	BT Estimated SAR_{1-g} (W/kg)	MAX. ΣSAR_{1-g} (W/kg)	SAR_{1-g} Limit (W/kg)	Peak location separation ratio	Simut Meas. Required
Front	**0.100**	0.173	0.033	0.206	1.6	no	no
Rear	0.071	**0.197**	0.033	**0.230**	1.6	no	no
Left	/	/	/	/	1.6	no	no
Right	0.052	0.092	0.033	0.125	1.6	no	no
Bottom	0.034	0.052	/	0.052	1.6	no	no
Top	/	/	0.033	0.033	1.6	no	no

Simultaneous transmission SAR for BT and UMTS

Test Position	UMTS Band V Reported SAR_{1-g} (W/kg)	UMTS Band II Reported SAR_{1-g} (W/kg)	BT Estimated SAR_{1-g} (W/kg)	MAX. ΣSAR_{1-g} (W/kg)	SAR_{1-g} Limit (W/kg)	Peak location separation ratio	Simut Meas. Required
Front	**0.127**	**0.361**	0.033	**0.394**	1.6	no	no
Rear	0.095	0.336	0.033	0.369	1.6	no	no
Left	/	/	/	/	1.6	no	no
Right	0.061	0.163	0.033	0.196	1.6	no	no
Bottom	0.032	0.107	/	0.107	1.6	no	no
Top	/	/	0.033	0.033	1.6	no	no

Note:
1. The WiFi and BT share same antenna, so cannot transmit at same time.
2. The value with **block** color is the maximum values of standalone
3. The value with blue color is the maximum values of $\sum SAR_{1-g}$

4.6. SAR Measurement Variability

According to KDB865664, Repeated measurements are required only when the measured SAR is ≥ 0.80 W/kg. If the measured SAR value of the initial repeated measurement is < 1.45 W/kg with ≤ 20% variation, only one repeated measurement is required to reaffirm that the results are not expected to have substantial variations, which may introduce significant compliance concerns. A second repeated measurement is required only if the measured result for the initial repeated measurement is within 10% of the SAR limit and vary by more than 20%, which are often related to device and measurement setup difficulties. The following procedures are applied to determine if repeated measurements are required. The same procedures should be adapted for measurements according to extremity and occupational exposure limits by applying a factor of 2.5 for extremity exposure and a factor of 5 for occupational exposure to the corresponding SAR thresholds.19 The repeated measurement results must be clearly identified in the SAR report. All measured SAR, including the repeated results, must be considered to determine compliance and for reporting according to KDB 690783.Repeated measurement is not required when the original highest measured SAR is < 0.80 W/kg; steps 2) through 4) do not apply.

3) When the original highest measured SAR is ≥ 0.80 W/kg, repeat that measurement once.
4) Perform a second repeated measurement only if the ratio of largest to smallest SAR for the original and first repeated measurements is > 1.20 or when the original or repeated measurement is ≥ 1.45 W/kg (~ 10% from the 1-g SAR limit).
5) Perform a third repeated measurement only if the original, first or second repeated measurement is ≥ 1.5 W/kg and the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 1.20.
6) Perform a third repeated measurement only if the original, first or second repeated measurement is ≥ 1.5 W/kg and the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 1.20

Frequency Band (MHz)	Air Interface	RF Exposure Configuration	Test Position	Repeated SAR (yes/no)	Highest Measured SAR_{1-g} (W/Kg)	First Repeated	
						Measued SAR_{1-g} (W/Kg)	Largest to Smallest SAR Ratio
850	GSM850	Standalone	Body-Front	no	0.098	n/a	n/a
	WCDMA Band V	Standalone	Body-Front	no	0.114	n/a	n/a
1900	GSM1900	Standalone	Body-Rear	no	0.177	n/a	n/a
	WCDMA Band II	Standalone	Body-Front	no	0.339	n/a	n/a
2450	2.4GWLAN	Standalone	Body-Front	no	0.052	n/a	n/a

Remark:

1. *Second Repeated Measurement is not required since the ratio of the largest to smallest SAR for the orignal and first repeated measurement is not > 1.20 or 3 (1-g or 10-g respectively)*

4.7. General description of test procedures

1. The DUT is tested using CMU 200 communications testers as controller unit to set test channels and maximum output power to the DUT, as well as for measuring the conducted peak power.
2. Test positions as described in the tables above are in accordance with the specified test standard.
3. Tests in body position were performed in that configuration, which generates the highest time based averaged output power (see conducted power results).
4. Tests in head position with GSM were performed in voice mode with 1 timeslot unless GPRS/EGPRS/DTM function allows parallel voice and data traffic on 2 or more timeslots.
5. UMTS was tested in RMC mode with 12.2 kbit/s and TPC bits set to ‘all 1’.
6. WiFi was tested in 802.11b/g/n mode with 1 Mbit/s and 6 Mbit/s. According to KDB 248227 the SAR testing for 802.11g/n is not required since When the highest reported SAR for DSSS is adjusted by the ratio of OFDM to DSSS specified maximum output power and the adjusted SAR is ≤ 1.2 W/kg.
7. Required WiFi test channels were selected according to KDB 248227
8. According to FCC KDB pub 248227 D01,When there are multiple test channels with the same measured maximum output power, the channel closest to mid-band frequency is selected for SAR measurement and when there are multiple test channels with the same measured maximum output power and equal separation from mid-band frequency; for example, high and low channels or two mid-band channels, the higher frequency (number) channel is selected for SAR measurement.
9. According to FCC KDB pub 941225 D06 this device has been tested with 10 mm distance to the phantom for operation in WiFi hot spot mode.
10. Per FCC KDB pub 941225 D06 the edges with antennas within 2.5 cm are required to be evaluated for SAR to cover WiFi hot spot function.
11. According to IEEE 1528 the SAR test shall be performed at middle channel. Testing of top and bottom channel is optional.
12. According to KDB 447498 D01 testing of other required channels within the operating mode of a frequency band is not required when the reported 1-g or 10-g SAR for the mid-band or highest output power channel is:

●≤ 0.8 W/kg or 2.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≤ 100 MHz
●≤ 0.6 W/kg or 1.5 W/kg, for 1-g or 10-g respectively, when the transmission band is between 100 MHz and 200 MHz
●≤ 0.4 W/kg or 1.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≥ 200 MHz

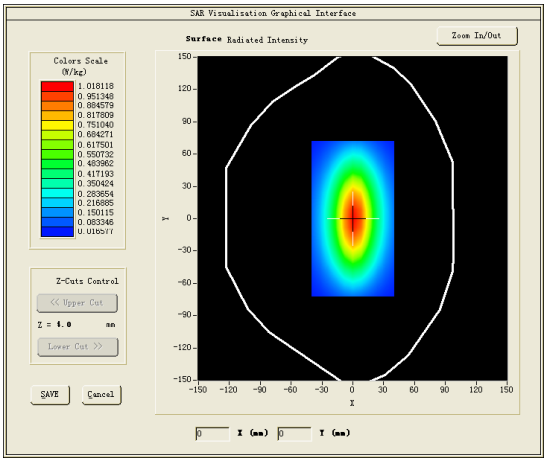
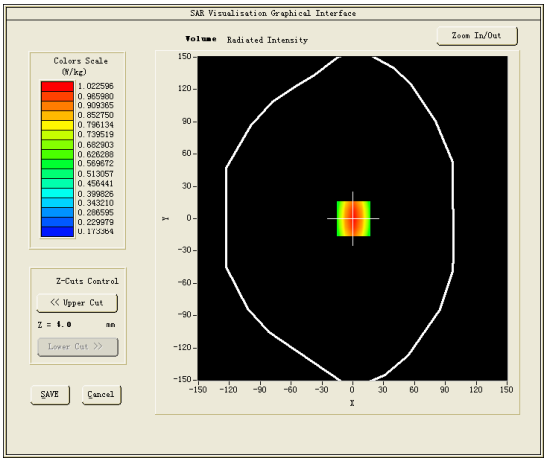
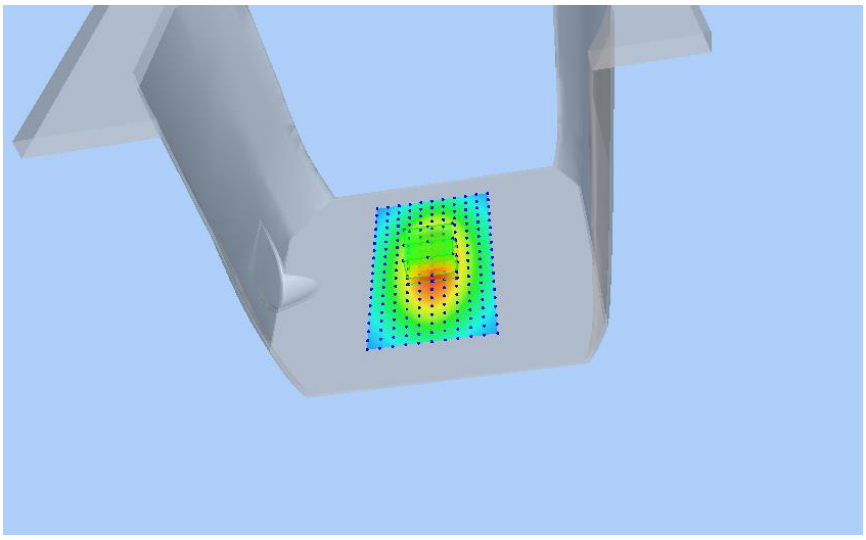
13. IEEE 1528-2003 require the middle channel to be tested first. This generally applies to wireless devices that are designed to operate in technologies with tight tolerances for maximum output power variations across channels in the band.
14. Per KDB648474 D04 require when the reported SAR for a body-worn accessory, measured without a headset connected to the handset, is < 1.2 W/kg.
15. Per KDB648474 D04 require when the separation distance required for body-worn accessory testing is larger than or equal to that tested for hotspot mode, using the same wireless mode test configuration for voice and data, such as UMTS and Wi-Fi, and for the same surface of the phone, the hotspot mode SAR data may be used to support body-worn accessory SAR compliance for that particular configuration (surface)
16. 10-g extremity SAR is required only for the surfaces and edges with hotspot mode 1-g SAR > 1.2 W/kg.
17. Per KDB648474 D04 require for phablet SAR test considerations，For Mobile Phones with a display diagonal dimension > 15.0 cm or an overall diagonal dimension > 16.0 cm, When hotspot mode applies, 10-g extremity SAR is required only for the surfaces and edges with hotspot mode 1-g reported SAR > 1.2 W/kg.
18. 10-g extremity SAR is required only for the surfaces and edges with hotspot mode 1-g SAR > 1.2 W/kg.

4.8. Measurement Uncertainty (450MHz-6GHz)

Not required as SAR measurement uncertainty analysis is required in SAR reports only when the highest measured SAR in a frequency band is ≥ 1.5 W/kg for 1-g SAR accoridng to KDB865664D01.

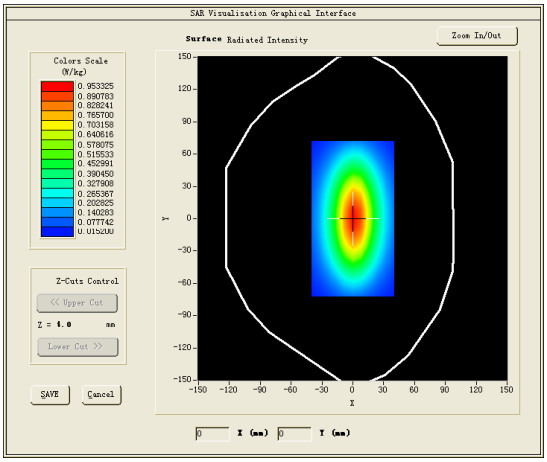
4.9. System Check Results

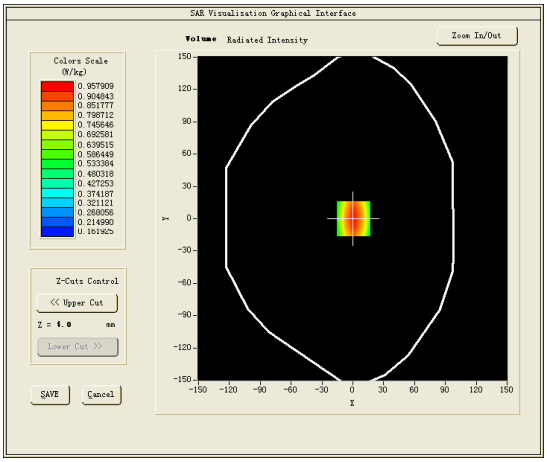
Test mode:835MHz(Head)
Product Description:Validation
Model:Dipole SID835
E-Field Probe:SSE2(SN 45/15 EPGO281)
Test Date:April 03, 2019

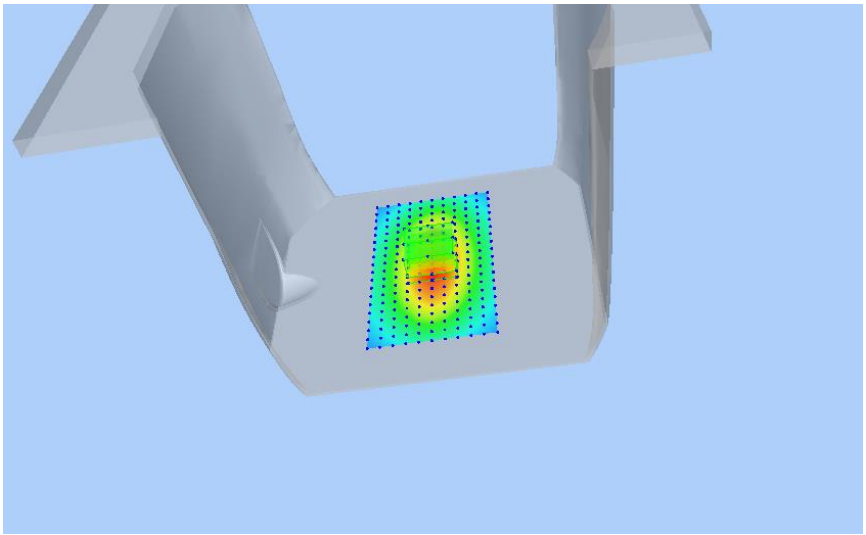
Medium(liquid type)	HSL_850
Frequency (MHz)	835.0000
Relative permittivity (real part)	39.89
Conductivity (S/m)	0.87
Input power	100mW
Crest Factor	1.0
Conversion Factor	2.04
Variation (%)	-0.760000
SAR 10g (W/Kg)	0.636193
SAR 1g (W/Kg)	0.981009
SURFACE SAR	**VOLUME SAR**
	
	

Test mode:835MHz(Body)
Product Description:Validation
Model:Dipole SID835
E-Field Probe:SSE2(SN 45/15 EPGO281)
Test Date:April 04, 2019

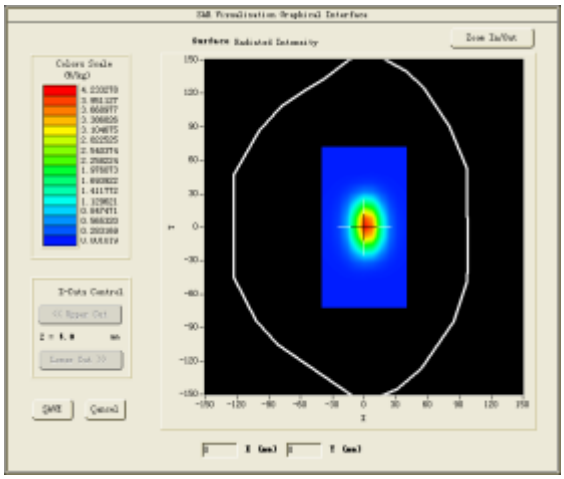
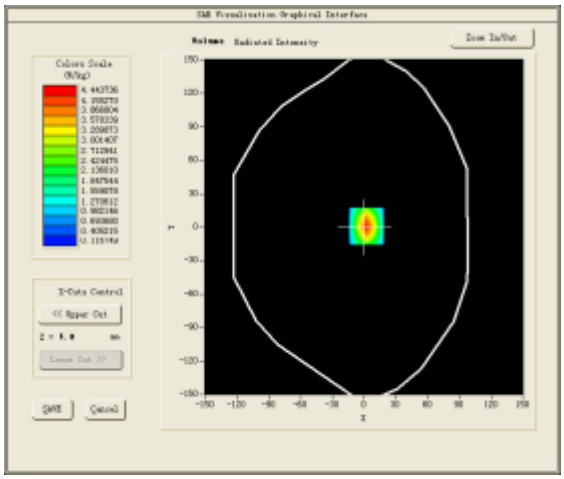
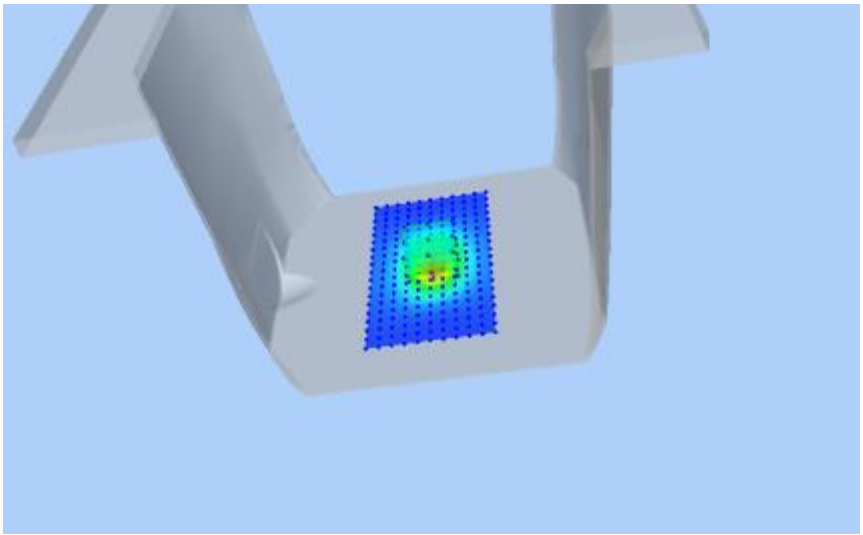
Medium(liquid type)	MSL_850
Frequency (MHz)	835.0000
Relative permittivity (real part)	53.77
Conductivity (S/m)	0.99
Input power	100mW
Crest Factor	1.0
Conversion Factor	1.85
Variation (%)	2.110000
SAR 10g (W/Kg)	0.633429
SAR 1g (W/Kg)	0.972163
SURFACE SAR	**VOLUME SAR**



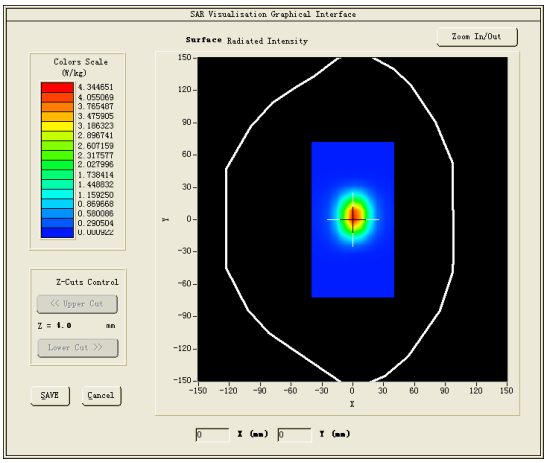
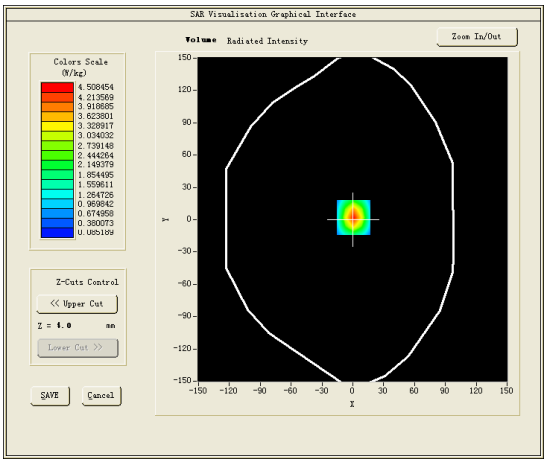
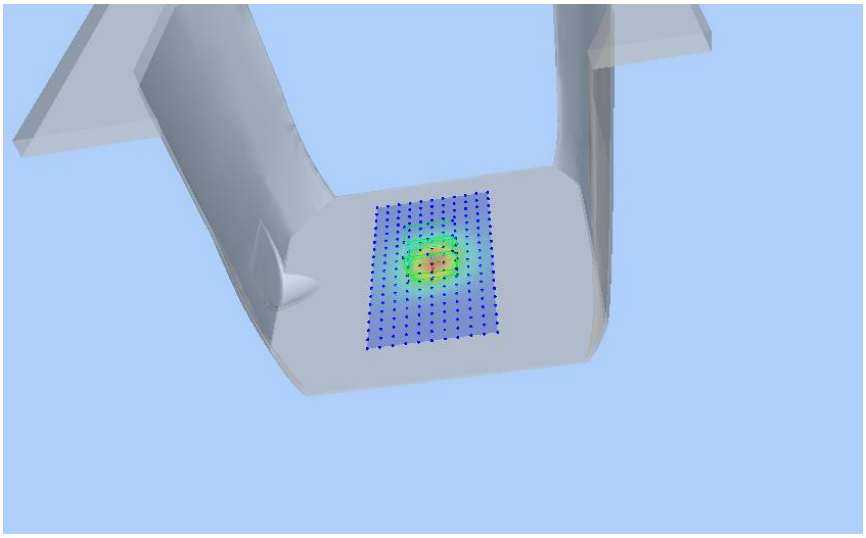




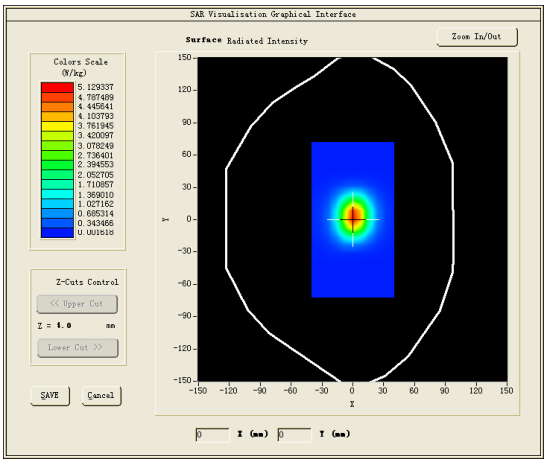
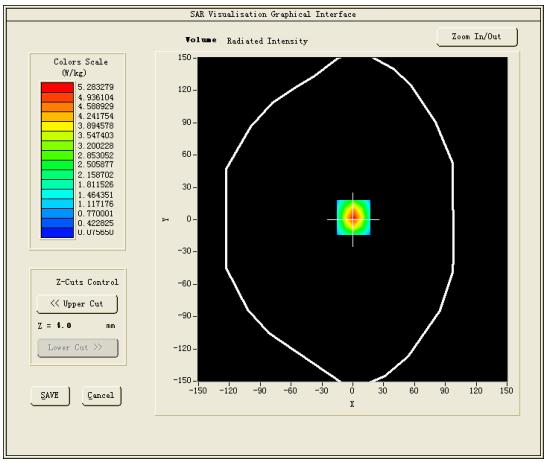
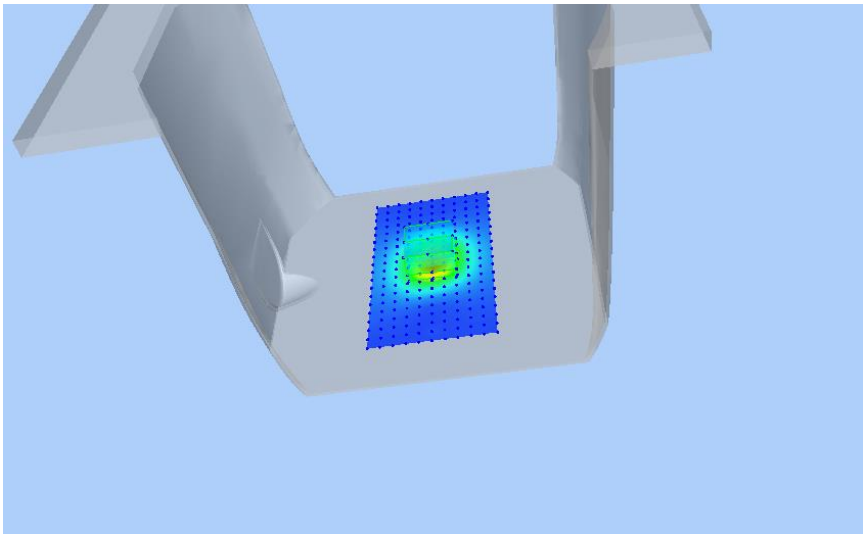
Test mode:1900MHz(Head)
Product Description:Validation
Model :Dipole SID1900
E-Field Probe:SSE2(SN 45/15 EPGO281)
Test Date:April 08, 2019

Medium(liquid type)	HSL_1900
Frequency (MHz)	1900.0000
Relative permittivity (real part)	41.52
Conductivity (S/m)	1.37
Input power	100mW
Crest Factor	1.0
Conversion Factor	2.10
Variation (%)	3.470000
SAR 10g (W/Kg)	2.000032
SAR 1g (W/Kg)	3.933465
SURFACE SAR	**VOLUME SAR**
	
	

Test mode:1900MHz(Body)
Product Description:Validation
Model :Dipole SID1900
E-Field Probe:SSE2(SN 45/15 EPGO281)
Test Date:April 15, 2019

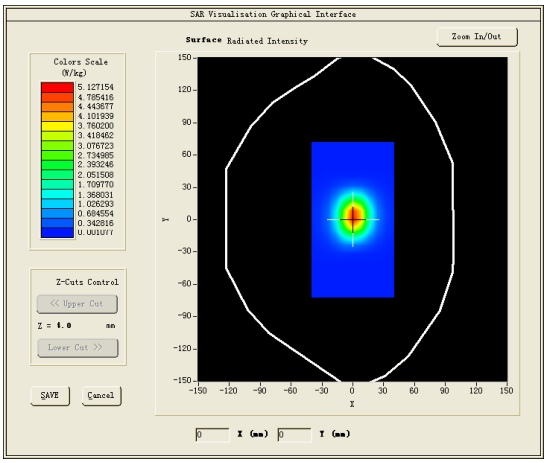
Medium(liquid type)	MSL_1900
Frequency (MHz)	1900.0000
Relative permittivity (real part)	53.63
Conductivity (S/m)	1.51
Input power	100mW
Crest Factor	1.0
Conversion Factor	2.16
Variation (%)	-1.430000
SAR 10g (W/Kg)	2.055463
SAR 1g (W/Kg)	4.212260
SURFACE SAR	**VOLUME SAR**
	
	

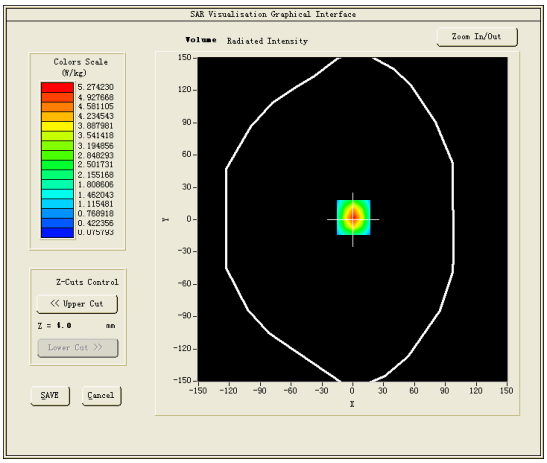
Test mode:2450MHz(Head)
Product Description:Validation
Model:Dipole SID2450
E-Field Probe:SSE2(SN 45/15 EPGO281)
Test Date:April 16, 2019

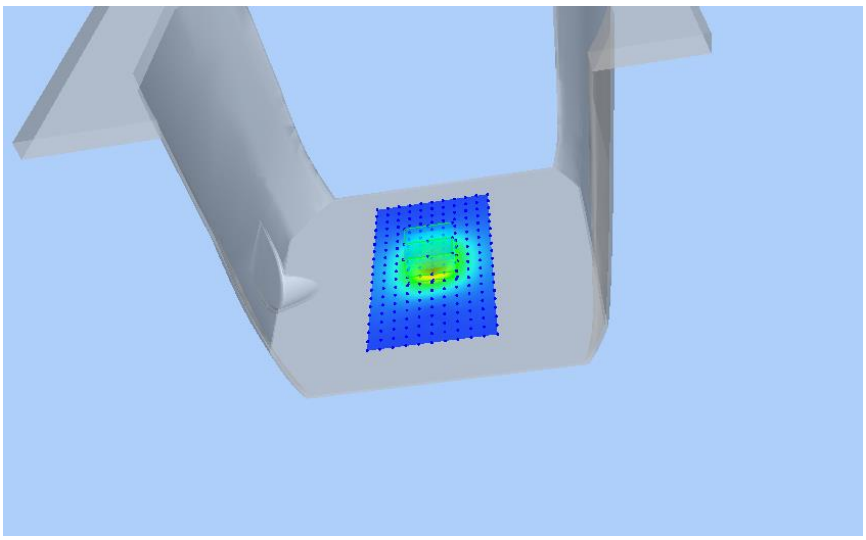
Medium(liquid type)	HSL_2450
Frequency (MHz)	2450.0000
Relative permittivity (real part)	39.95
Conductivity (S/m)	1.83
Input power	100mW
Crest Factor	1.0
Conversion Factor	2.21
Variation (%)	-2.790000
SAR 10g (W/Kg)	2.386920
SAR 1g (W/Kg)	5.257832
SURFACE SAR	**VOLUME SAR**
	
	

Test mode:2450MHz(Body)
Product Description:Validation
Model:Dipole SID2450
E-Field Probe:SSE2(SN 45/15 EPGO281)
Test Date:April 19, 2019

Medium(liquid type)	MSL_2450
Frequency (MHz)	2450.0000
Relative permittivity (real part)	53.60
Conductivity (S/m)	1.90
Input power	100mW
Crest Factor	1.0
Conversion Factor	2.28
Variation (%)	0.460000
SAR 10g (W/Kg)	2.382263
SAR 1g (W/Kg)	5.244452
SURFACE SAR	**VOLUME SAR**







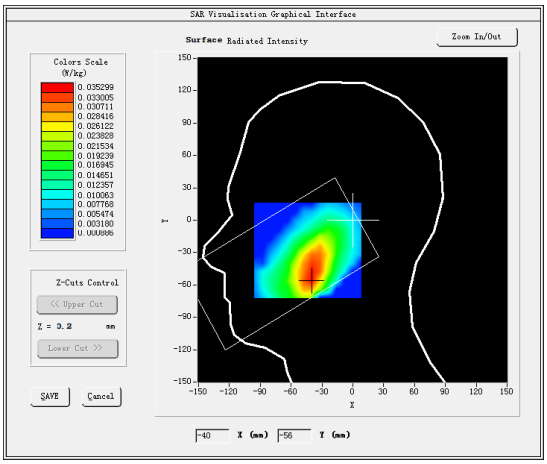
4.10SAR Test Graph Results

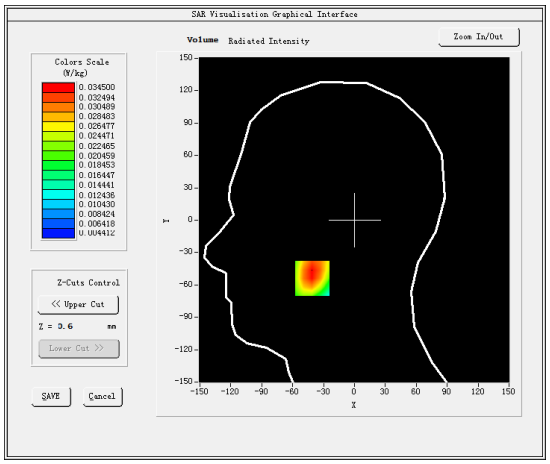
SAR plots for the highest measured SAR in each exposure configuration, wireless mode and frequency band combination according to FCC KDB 865664 D02;

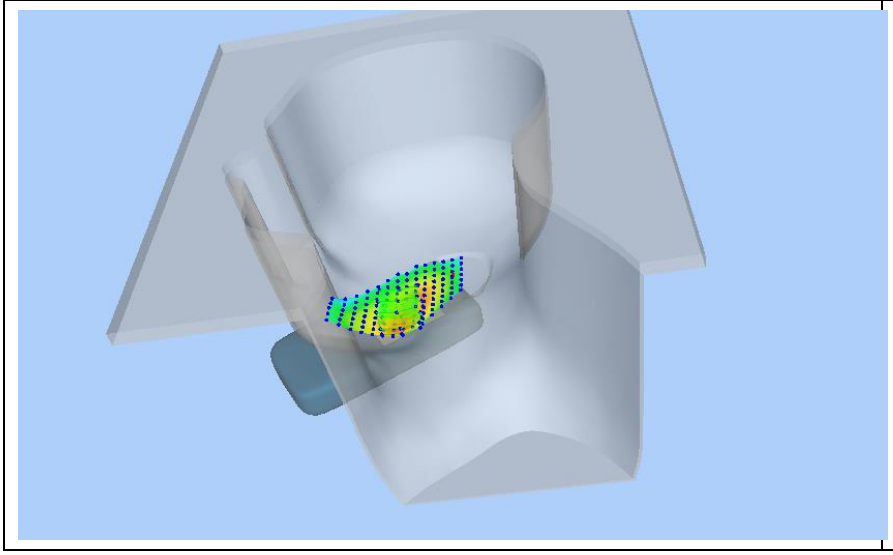
#1

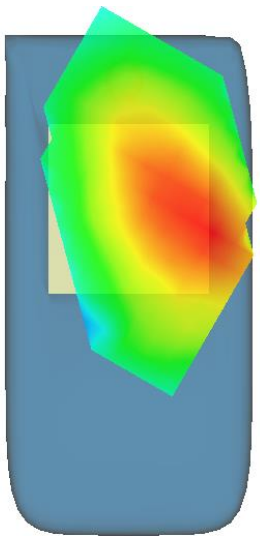
Test Mode:GSM 850MHz,Low channel(Head Right Cheek)
Product Description:Mobile Data Terminal
Model:C5000
Test Date: April 03, 2019

Medium(liquid type)	HSL_850
Frequency (MHz)	824.2000
Relative permittivity (real part)	39.89
Conductivity (S/m)	0.87
E-Field Probe	SN 45/15 EPGO281
Crest Factor	2.67
Conversion Factor	1.78
Sensor	4mm
Area Scan	dx=8mm dy=8mm
Zoom Scan	5x5x7,dx=8mm dy=8mm dz=5mm
Variation (%)	4.330000
SAR 10g (W/Kg)	0.023031
SAR 1g (W/Kg)	0.033201
SURFACE SAR	**VOLUME SAR**





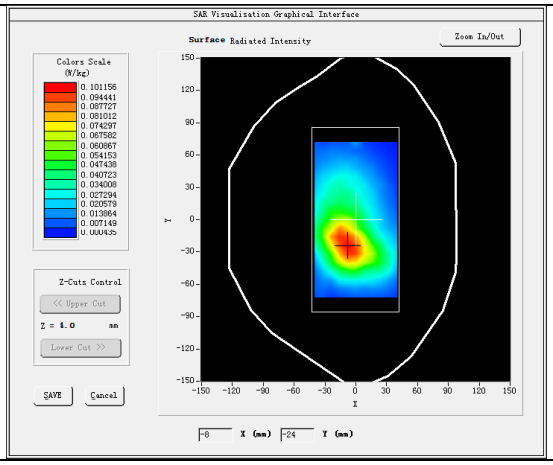


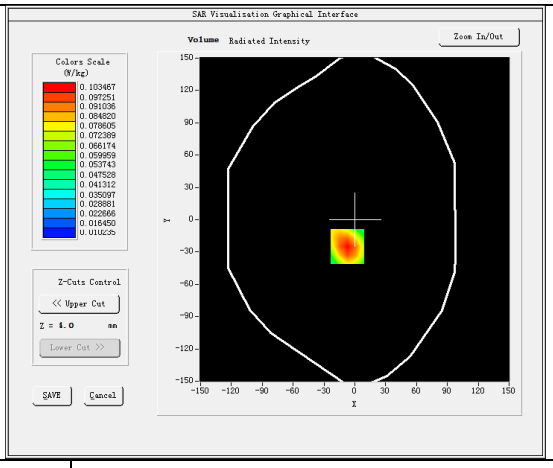


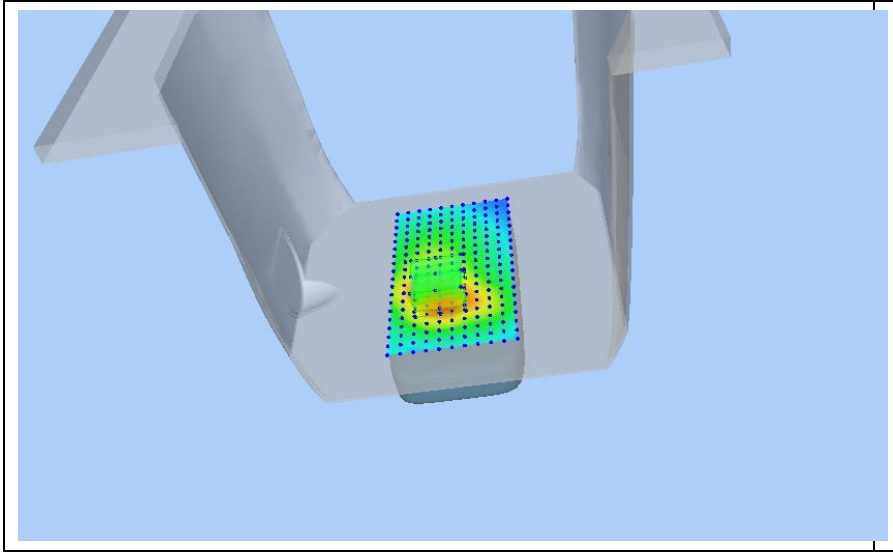
#2

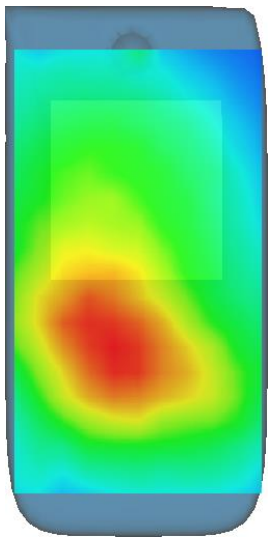
Test Mode:Hotspot GSM850MHz,High channel(Body Front Side)
Product Description:Mobile Data Terminal
Model:C5000
Test Date:April 04, 2019

Medium(liquid type)	MSL_850
Frequency (MHz)	848.8000
Relative permittivity (real part)	53.77
Conductivity (S/m)	0.99
E-Field Probe	SN 45/15 EPGO281
Crest Factor	2.67
Conversion Factor	1.85
Sensor	4mm
Area Scan	dx=8mm dy=8mm
Zoom Scan	5x5x7,dx=8mm dy=8mm dz=5mm
Variation (%)	-2.590000
SAR 10g (W/Kg)	0.060902
SAR 1g (W/Kg)	0.098367
SURFACE SAR	VOLUME SAR





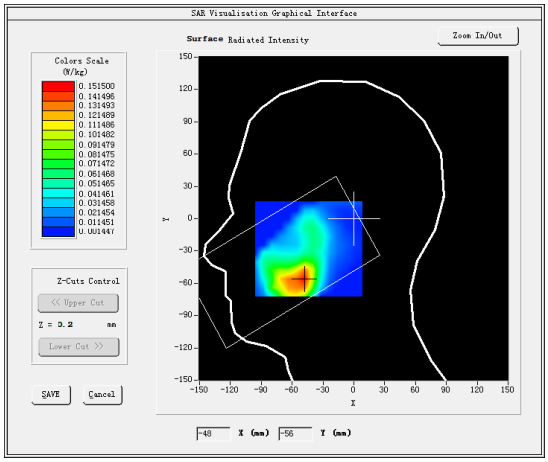


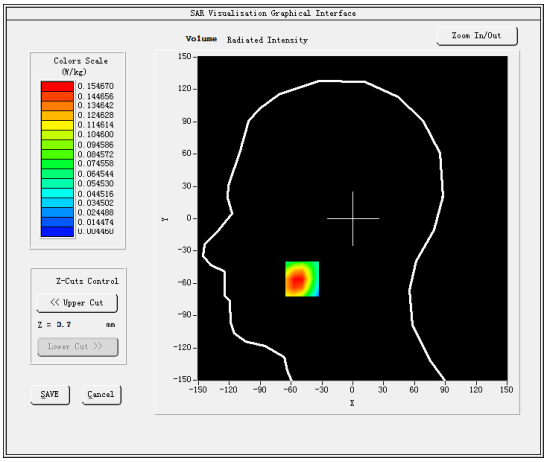


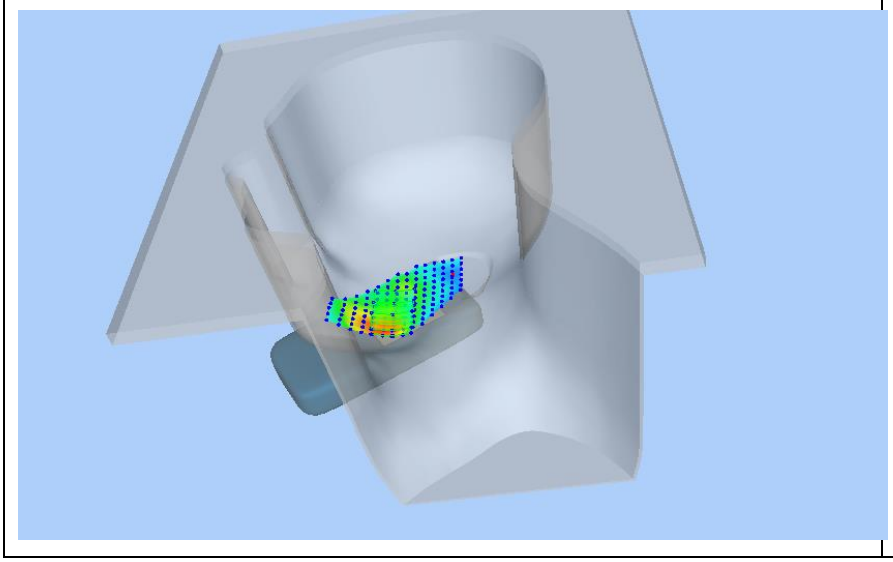
#3

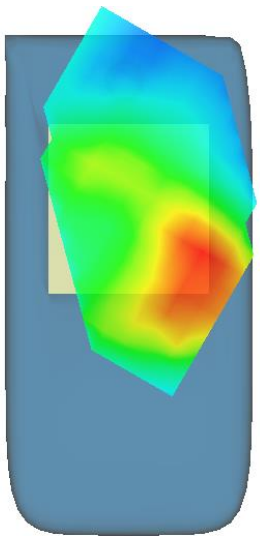
Test Mode:GSM 1900MHz,High channel(Head Right Cheek)
Product Description:Mobile Data Terminal
Model:C5000
Test Date: April 08, 2019

Medium(liquid type)	HSL_1800
Frequency (MHz)	1908.8000
Relative permittivity (real part)	41.52
Conductivity (S/m)	1.37
E-Field Probe	SN 45/15 EPGO281
Crest Factor	2.67
Conversion Factor	1.83
Sensor	4mm
Area Scan	dx=8mm dy=8mm
Zoom Scan	5x5x7,dx=8mm dy=8mm dz=5mm
Variation (%)	0.040000
SAR 10g (W/Kg)	0.090858
SAR 1g (W/Kg)	0.151354
SURFACE SAR	**VOLUME SAR**





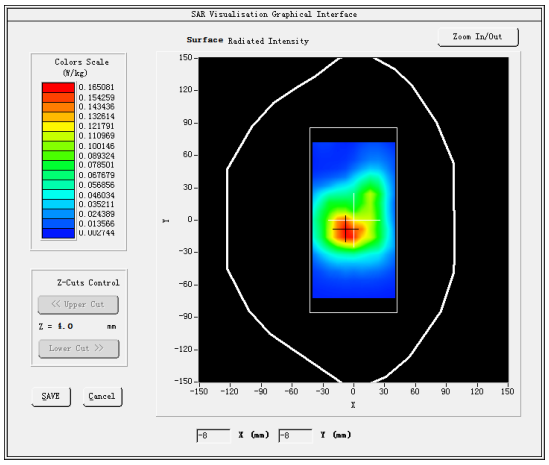


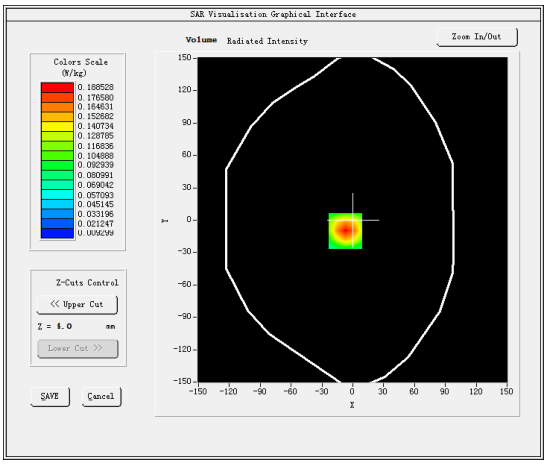


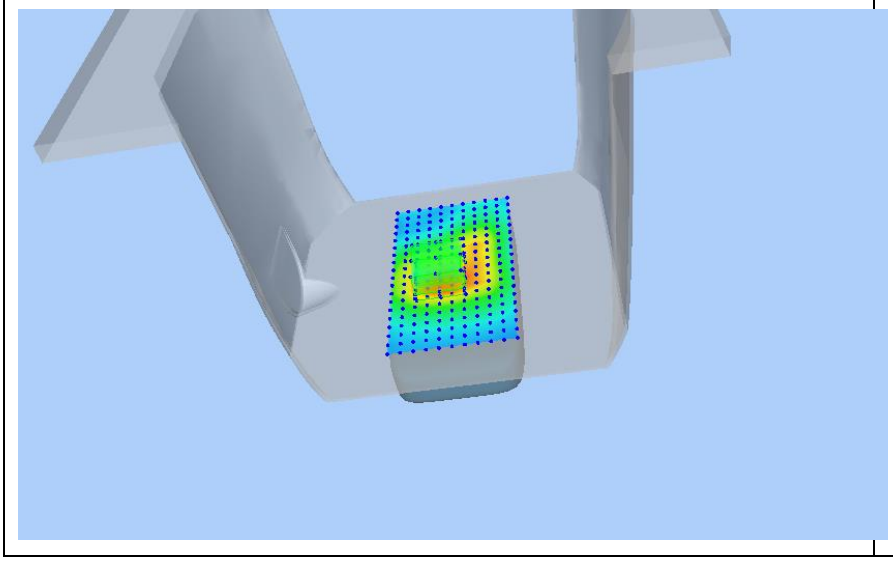
#4

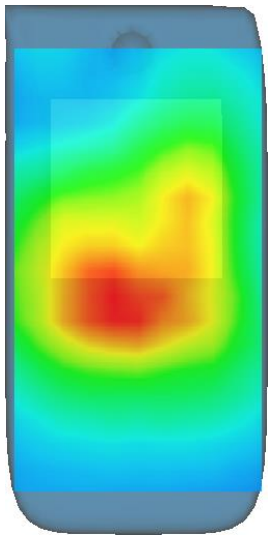
Test Mode: Hotspot GPRS1900MHz,High channel(Body Rear Side)
Product Description:Mobile Data Terminal
Model:C5000
Test Date: April 15, 2019

Medium(liquid type)	MSL_1800
Frequency (MHz)	1909.8000
Relative permittivity (real part)	53.63
Conductivity (S/m)	1.51
E-Field Probe	SN 45/15 EPGO281
Crest Factor	2.67
Conversion Factor	1.87
Sensor	4mm
Area Scan	dx=8mm dy=8mm
Zoom Scan	5x5x7,dx=8mm dy=8mm dz=5mm
Variation (%)	-4.300000
SAR 10g (W/Kg)	0.102749
SAR 1g (W/Kg)	0.176614
SURFACE SAR	**VOLUME SAR**





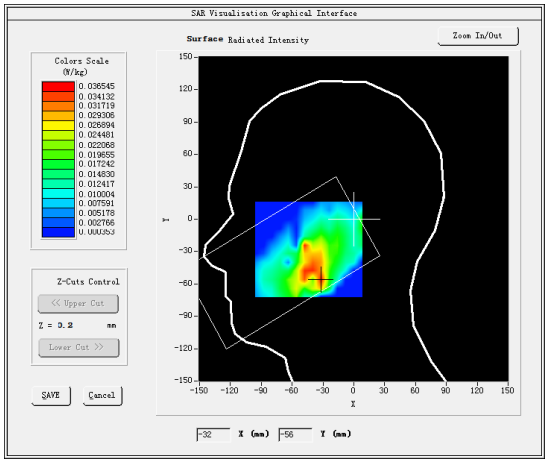


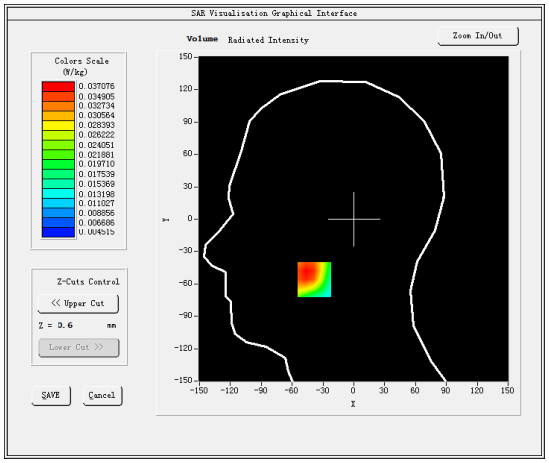


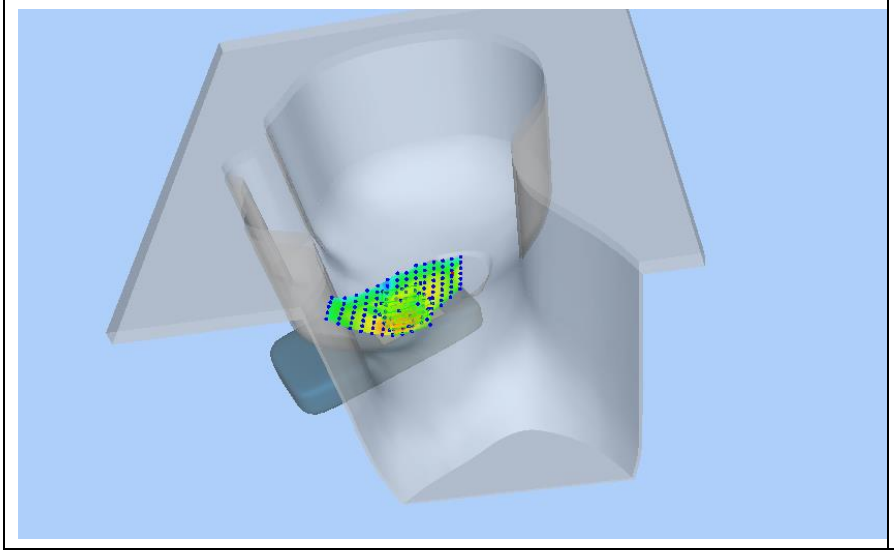
#5

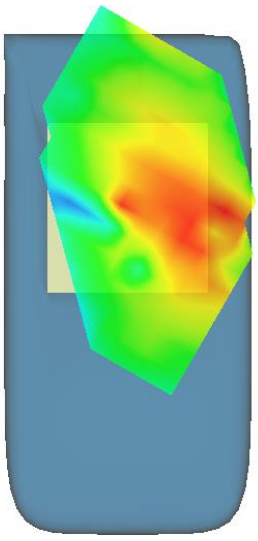
Test Mode:WCDMA Band V,Low channel(Head Right Cheek)
Product Description:Mobile Data Terminal
Model:C5000
Test Date: Oct 08, 2018

Medium(liquid type)	HSL_850
Frequency (MHz)	826.4000
Relative permittivity (real part)	39.89
Conductivity (S/m)	0.87
E-Field Probe	SN 45/15 EPGO281
Crest Factor	1.0
Conversion Factor	1.78
Sensor	4mm
Area Scan	dx=8mm dy=8mm
Zoom Scan	5x5x7,dx=8mm dy=8mm dz=5mm
Variation (%)	1.920000
SAR 10g (W/Kg)	0.025650
SAR 1g (W/Kg)	0.037008
SURFACE SAR	**VOLUME SAR**





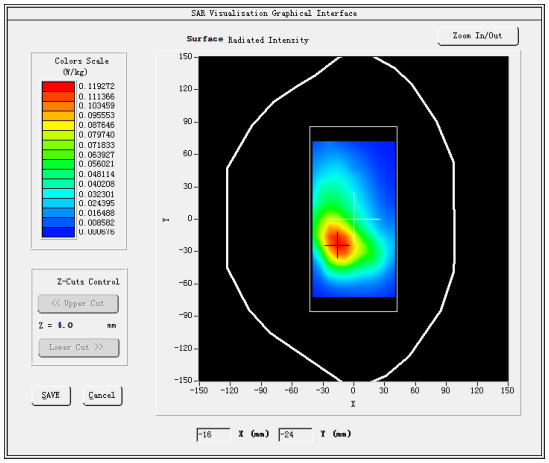


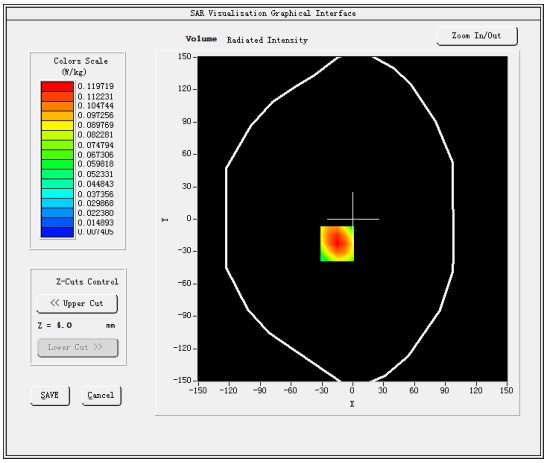


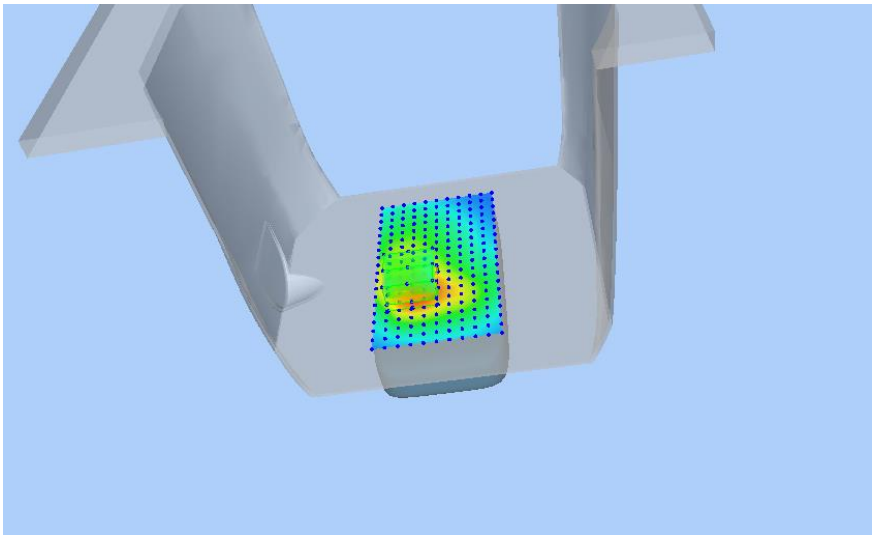
#6

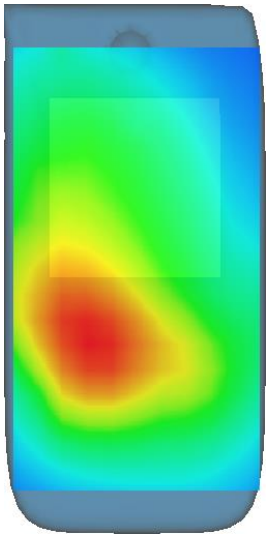
Test Mode: Hotspot WCDMA Band V,Low channel(Body Front Side)
Product Description:Mobile Data Terminal
Model:C5000
Test Date:April 04, 2019

Medium(liquid type)	MSL_850
Frequency (MHz)	826.4000
Relative permittivity (real part)	53.77
Conductivity (S/m)	0.99
E-Field Probe	SN 45/15 EPGO281
Crest Factor	1.0
Conversion Factor	1.85
Sensor	4mm
Area Scan	dx=8mm dy=8mm
Zoom Scan	5x5x7,dx=8mm dy=8mm dz=5mm
Variation (%)	-0.200000
SAR 10g (W/Kg)	0.073692
SAR 1g (W/Kg)	0.114465
SURFACE SAR	**VOLUME SAR**





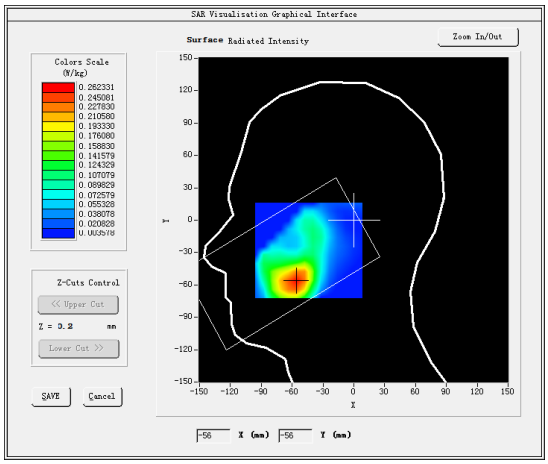


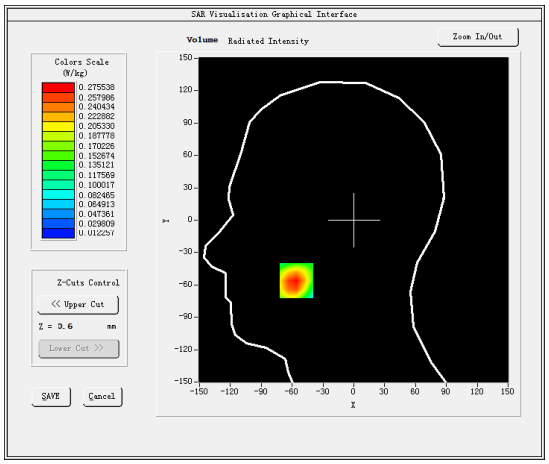


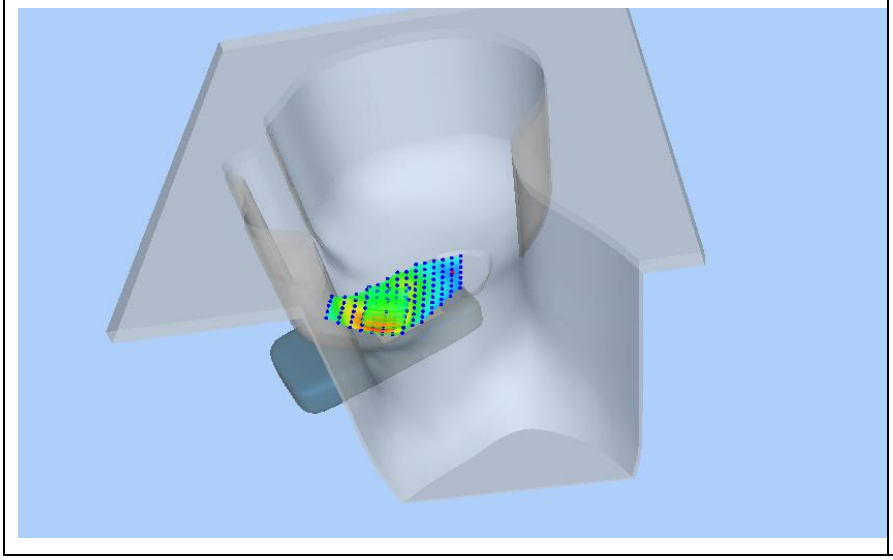
#7

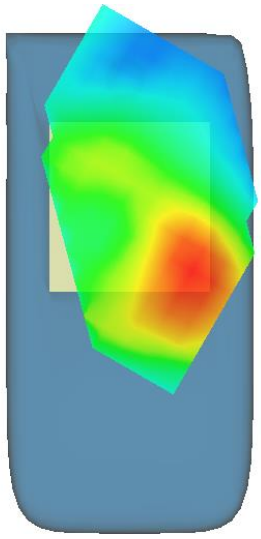
Test Mode:WCDMA Band II,Low channel(Head Right Cheek)
Product Description:Mobile Data Terminal
Model:C5000
Test Date: April 08, 2019

Medium(liquid type)	HSL_1800
Frequency (MHz)	1852.4000
Relative permittivity (real part)	41.52
Conductivity (S/m)	1.37
E-Field Probe	SN 45/15 EPGO281
Crest Factor	1.0
Conversion Factor	1.83
Sensor	4mm
Area Scan	dx=8mm dy=8mm
Zoom Scan	5x5x7,dx=8mm dy=8mm dz=5mm
Variation (%)	2.090000
SAR 10g (W/Kg)	0.159322
SAR 1g (W/Kg)	0.263019
SURFACE SAR	**VOLUME SAR**





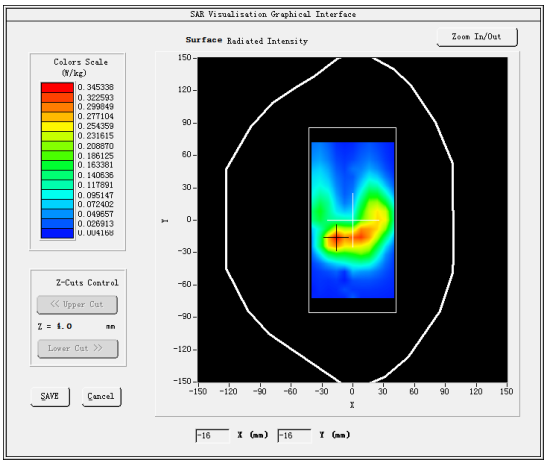


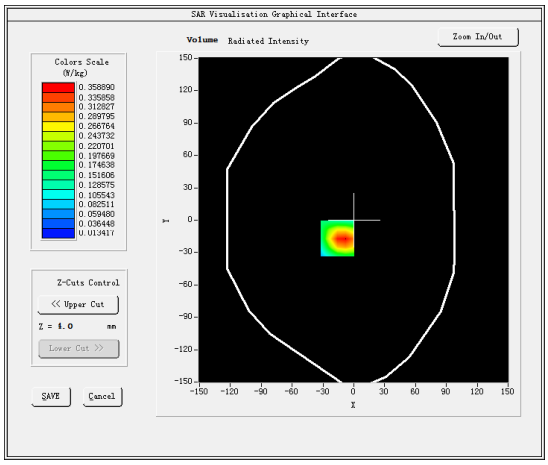


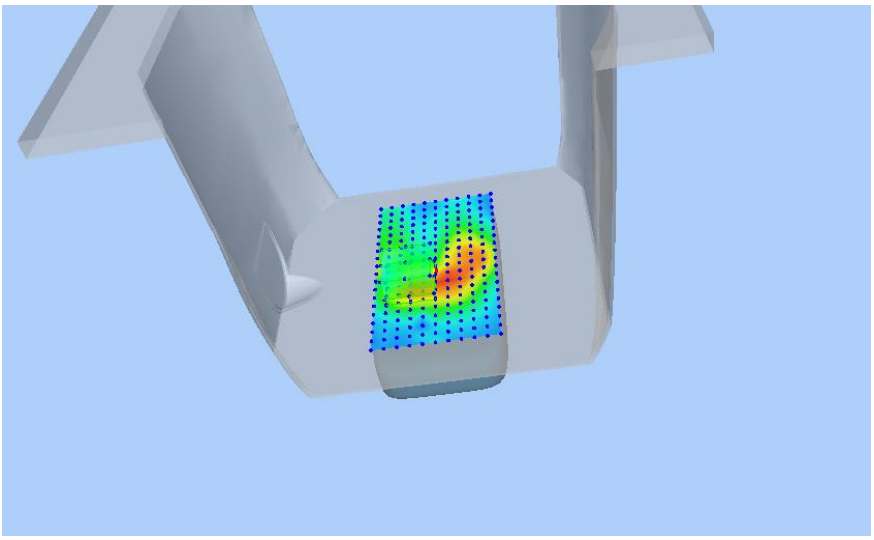
#8

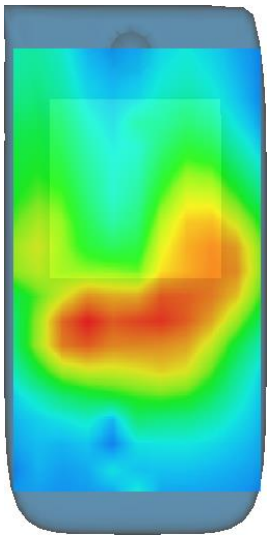
Test Mode: Hotspot WCDMA Band II,Low channel(Body Front Side)
Product Description:Mobile Data Terminal
Model:C5000
Test Date: April 15, 2019

Medium(liquid type)	MSL_1800
Frequency (MHz)	1852.4000
Relative permittivity (real part)	53.63
Conductivity (S/m)	1.51
E-Field Probe	SN 45/15 EPGO281
Crest Factor	1.0
Conversion Factor	1.87
Sensor	4mm
Area Scan	dx=8mm dy=8mm
Zoom Scan	5x5x7,dx=8mm dy=8mm dz=5mm
Variation (%)	-0.650000
SAR 10g (W/Kg)	0.192518
SAR 1g (W/Kg)	0.338525
SURFACE SAR	**VOLUME SAR**



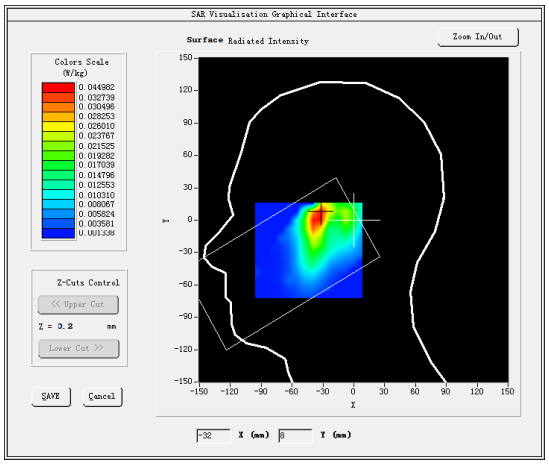
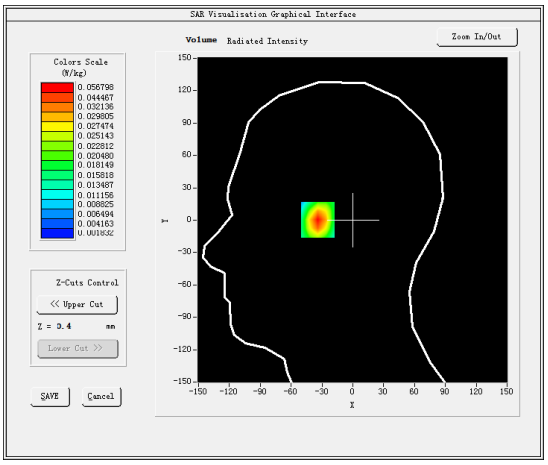
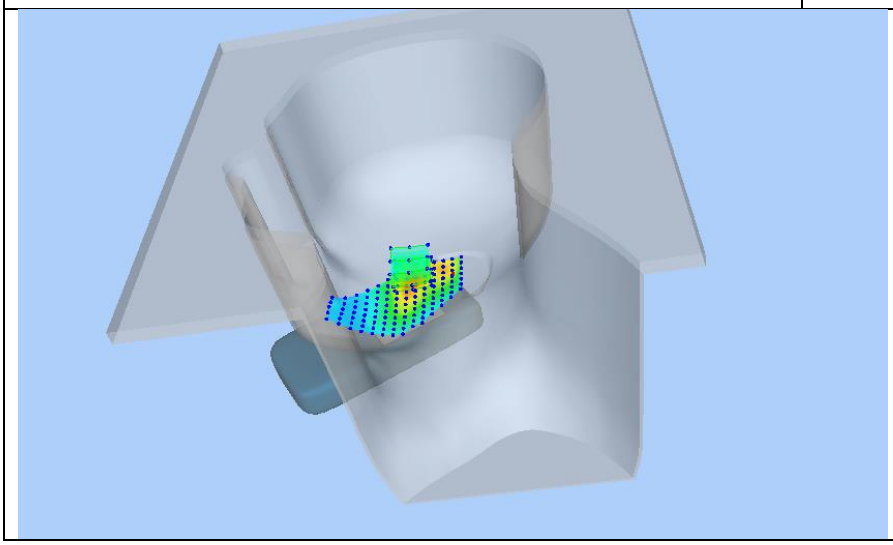
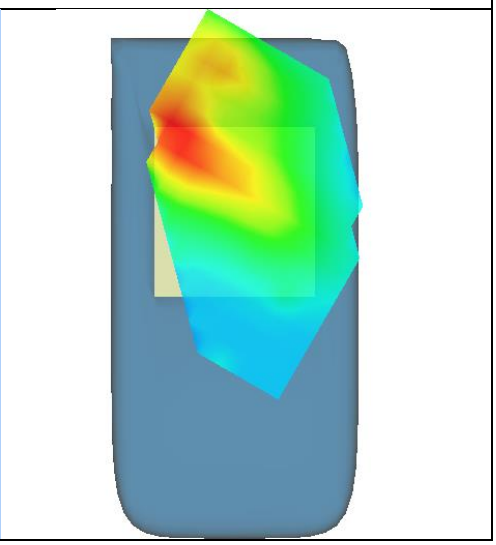






#9

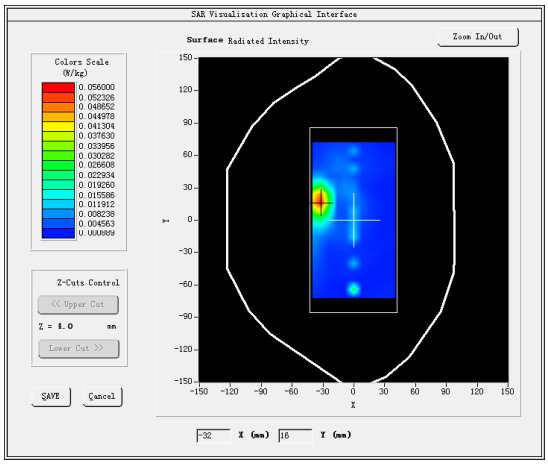
Test Mode:802.11b(WiFi2.4G),Middle channel(Head Right Cheek)
Product Description:Mobile Data Terminal
Model:C5000
Test Date:April 16, 2019

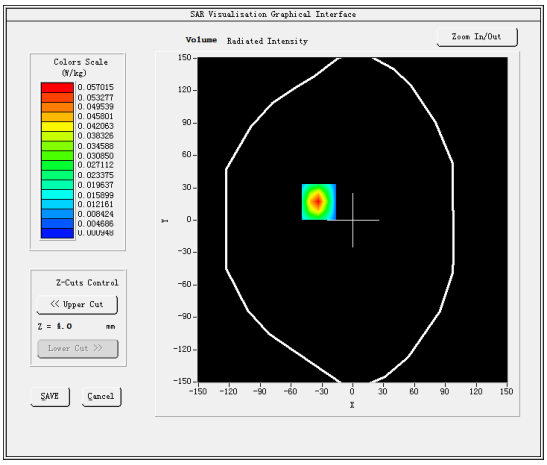
Medium(liquid type)	HSL_2450
Frequency (MHz)	2437.0000
Relative permittivity (real part)	39.95
Conductivity (S/m)	1.83
E-Field Probe	SN 45/15 EPGO281
Crest Factor	1.0
Conversion Factor	2.21
Sensor	4mm
Area Scan	dx=8mm dy=8mm
Zoom Scan	5x5x7,dx=8mm dy=8mm dz=5mm
Variation (%)	-0.450000
SAR 10g (W/Kg)	0.020094
SAR 1g (W/Kg)	0.042705
SURFACE SAR	**VOLUME SAR**
	
	

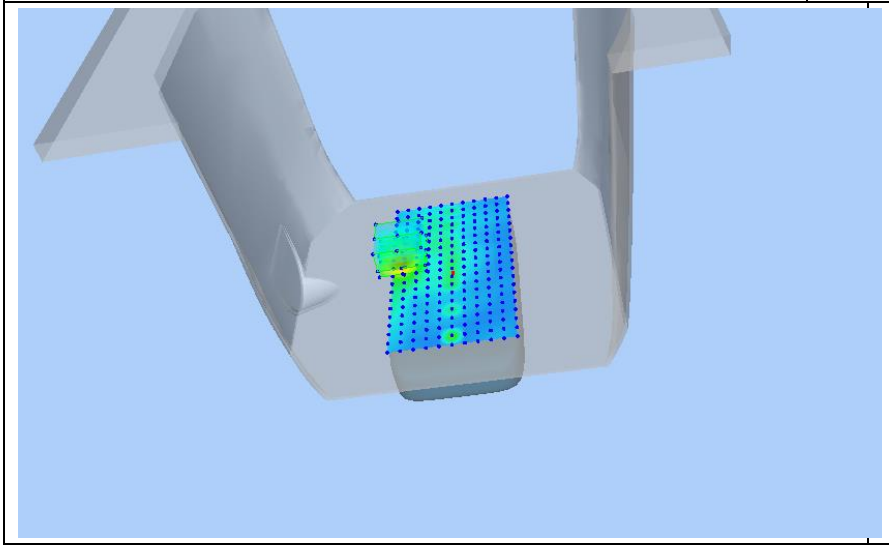
#10

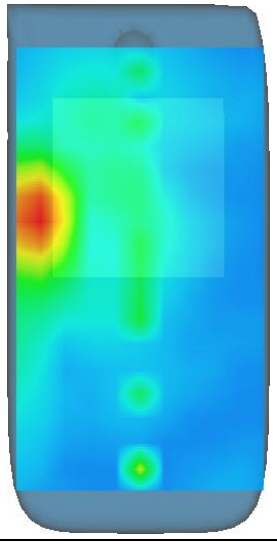
Test Mode: Hotspot 802.11b(WiFi2.4G),Middle channel(Body Front Side)
Product Description:Mobile Data Terminal
Model:C5000
Test Date:April 19, 2019

Medium(liquid type)	MSL_2450
Frequency (MHz)	2437.0000
Relative permittivity (real part)	53.60
Conductivity (S/m)	1.90
E-Field Probe	SN 45/15 EPGO281
Crest Factor	1.0
Conversion Factor	2.28
Sensor	4mm
Area Scan	dx=8mm dy=8mm
Zoom Scan	5x5x7,dx=8mm dy=8mm dz=5mm
Variation (%)	1.020000
SAR 10g (W/Kg)	0.023436
SAR 1g (W/Kg)	0.052432
SURFACE SAR	**VOLUME SAR**









5. CALIBRATION CERTIFICATES

5.1 Probe-EPGO281 Calibration Certificate

COMOSAR E-Field Probe Calibration Report

Ref : ACR.348.1.15.SATU.A

SHENZHEN STS TEST SERVICES CO., LTD.
1/F., BUILDING B, ZHUOKE SCIENCE PARK, No.190,
CHONGQING ROAD,FUYONG STREET
BAO'AN DISTRICT,SHENZHEN,GUANGDONG,CHINA

MVG COMOSAR DOSIMETRIC E-FIELD PROBE
SERIAL NO.: SN 45/15 EPGO281

Calibrated at MVG US
2105 Barrett Park Dr. - Kennesaw, GA 30144

ACCREDITED
Calibration CERT #2246-02

Calibration Date: 02/04/2018

Summary:

This document presents the method and results from an accredited COMOSAR Dosimetric E-Field Probe calibration performed in MVG USA using the CALISAR / CALIBAIR test bench, for use with a COMOSAR system only. All calibration results are traceable to national metrology institutions.

COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.348.1.15.SATU.A

	Name	*Function*	*Date*	*Signature*
Prepared by :	Jérôme LUC	Product Manager	02/08/2018	
Checked by :	Jérôme LUC	Product Manager	02/08/2018	
Approved by :	Kim RUTKOWSKI	Quality Manager	02/08/2018	

	Customer Name
Distribution :	Shenzhen STS Test Services Co., Ltd.

Issue	*Date*	*Modifications*
A	02/08/2018	Initial release

TABLE OF CONTENTS

1 DEVICE UNDER TEST

Device Under Test	
Device Type	COMOSAR DOSIMETRIC E FIELD PROBE
Manufacturer	MVG
Model	SSE2
Serial Number	SN 45/15 EPGO281
Product Condition (new / used)	New
Frequency Range of Probe	0.45 GHz-6GHz
Resistance of Three Dipoles at Connector	Dipole 1: R1=0.186 MΩ Dipole 2: R2=0.194 MΩ Dipole 3: R3=0.191 MΩ

A yearly calibration interval is recommended.

2 PRODUCT DESCRIPTION

2.1 GENERAL INFORMATION

MVG's COMOSAR E field Probes are built in accordance to the IEEE 1528, OET 65 Bulletin C and CEI/IEC 62209 standards.

Figure 1 – *MVG COMOSAR Dosimetric E field Dipole*

Probe Length	330 mm
Length of Individual Dipoles	2 mm
Maximum external diameter	8 mm
Probe Tip External Diameter	2.5 mm
Distance between dipoles / probe extremity	1 mm

3 MEASUREMENT METHOD

The IEEE 1528, OET 65 Bulletin C, CENELEC EN50361 and CEI/IEC 62209 standards provide recommended practices for the probe calibrations, including the performance characteristics of interest and methods by which to assess their affect. All calibrations / measurements performed meet the fore mentioned standards.

3.1 LINEARITY

The evaluation of the linearity was done in free space using the waveguide, performing a power sweep to cover the SAR range 0.01W/kg to 100W/kg.

3.2 SENSITIVITY

The sensitivity factors of the three dipoles were determined using a two step calibration method (air and tissue simulating liquid) using waveguides as outlined in the standards.

3.3 LOWER DETECTION LIMIT

The lower detection limit was assessed using the same measurement set up as used for the linearity measurement. The required lower detection limit is 10 mW/kg.

3.4 ISOTROPY

The axial isotropy was evaluated by exposing the probe to a reference wave from a standard dipole with the dipole mounted under the flat phantom in the test configuration suggested for system validations and checks. The probe was rotated along its main axis from 0 - 360 degrees in 15 degree steps. The hemispherical isotropy is determined by inserting the probe in a thin plastic box filled with tissue-equivalent liquid, with the plastic box illuminated with the fields from a half wave dipole. The dipole is rotated about its axis (0°–180°) in 15° increments. At each step the probe is rotated about its axis (0°–360°).

3.5 BOUNDARY EFFECT

The boundary effect is defined as the deviation between the SAR measured data and the expected exponential decay in the liquid when the probe is oriented normal to the interface. To evaluate this effect, the liquid filled flat phantom is exposed to fields from either a reference dipole or waveguide. With the probe normal to the phantom surface, the peak spatial average SAR is measured and compared to the analytical value at the surface.

4 MEASUREMENT UNCERTAINTY

The guidelines outlined in the IEEE 1528, OET 65 Bulletin C, CENELEC EN50361 and CEI/IEC 62209 standards were followed to generate the measurement uncertainty associated with an E-field probe calibration using the waveguide technique. All uncertainties listed below represent an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2, traceable to the Internationally Accepted Guides to Measurement Uncertainty.

Uncertainty analysis of the probe calibration in waveguide					
ERROR SOURCES	**Uncertainty value (%)**	**Probability Distribution**	**Divisor**	**ci**	**Standard Uncertainty (%)**
Incident or forward power	3.00%	Rectangular	$\sqrt{3}$	1	1.732%
Reflected power	3.00%	Rectangular	$\sqrt{3}$	1	1.732%
Liquid conductivity	5.00%	Rectangular	$\sqrt{3}$	1	2.887%
Liquid permittivity	4.00%	Rectangular	$\sqrt{3}$	1	2.309%
Field homogeneity	3.00%	Rectangular	$\sqrt{3}$	1	1.732%
Field probe positioning	5.00%	Rectangular	$\sqrt{3}$	1	2.887%

Field probe linearity	3.00%	Rectangular	$\sqrt{3}$	1	1.732%
Combined standard uncertainty					5.831%
Expanded uncertainty 95 % confidence level k = 2					12.0%

5 CALIBRATION MEASUREMENT RESULTS

Calibration Parameters	
Liquid Temperature	21 °C
Lab Temperature	21 °C
Lab Humidity	45 %

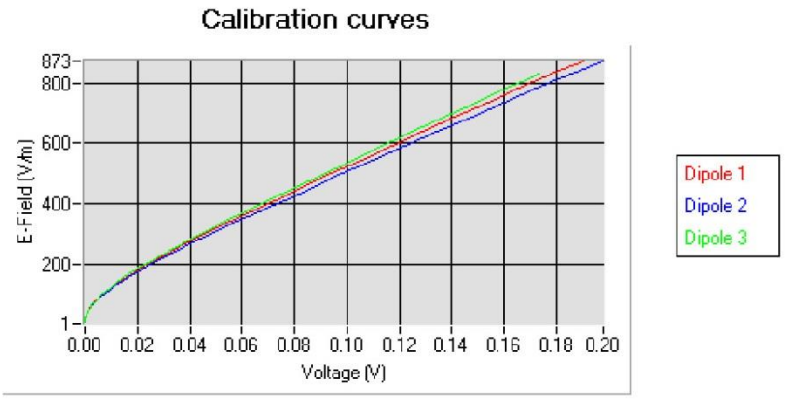
5.1 SENSITIVITY IN AIR

Normx dipole 1 (μV/(V/m)²)	Normy dipole 2 (μV/(V/m)²)	Normz dipole 3 (μV/(V/m)²)
0.77	0.83	0.67

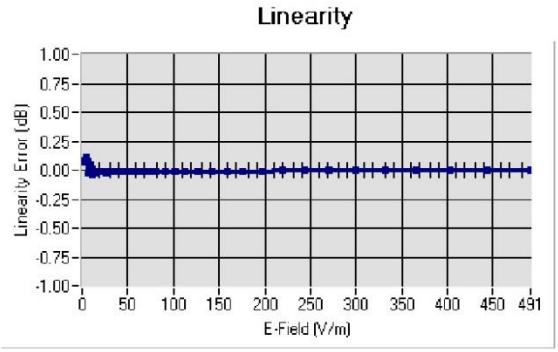
DCP dipole 1 (mV)	DCP dipole 2 (mV)	DCP dipole 3 (mV)
91	90	95

Calibration curves ei=f(V) (i=1,2,3) allow to obtain H-field value using the formula:

$$E = \sqrt{E_1^{\,2} + E_2^{\,2} + E_3^{\,2}}$$



5.2 LINEARITY



Linearity: ±2.60% (±0.11dB)

5.3 SENSITIVITY IN LIQUID

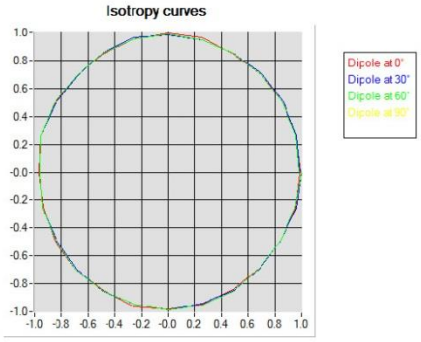
Liquid	Frequency (MHz +/- 100MHz)	Permittivity	Epsilon (S/m)	ConvF
HL450	450	44.12	0.88	1.76
BL450	450	58.92	1.00	1.81
HL750	750	42.24	0.90	1.53
BL750	750	56.85	0.99	1.59
HL850	835	43.02	0.90	1.78
BL850	835	53.72	0.98	1.85
HL900	900	42.47	0.99	1.62
BL900	900	56.97	1.09	1.67
HL1800	1800	42.24	1.40	1.83
BL1800	1800	53.53	1.53	1.87
HL1900	1900	40.79	1.42	2.10
BL1900	1900	54.47	1.57	2.16
HL2000	2000	40.52	1.44	2.01
BL2000	2000	54.18	1.56	2.09
HL2450	2450	38.73	1.81	2.21
BL2450	2450	53.23	1.96	2.28
HL2600	2600	38.54	1.95	2.32
BL2600	2600	52.07	2.23	2.38
HL5200	5200	36.80	4.84	2.46
BL5200	5200	51.21	5.16	2.52
HL5400	5400	36.35	4.96	2.70
BL5400	5400	50.51	5.70	2.79
HL5600	5600	35.57	5.23	2.74
BL5600	5600	49.83	5.91	2.83
HL5800	5800	35.30	5.47	2.53
BL5800	5800	49.03	6.28	2.60

LOWER DETECTION LIMIT: 9mW/kg

5.4 ISOTROPY

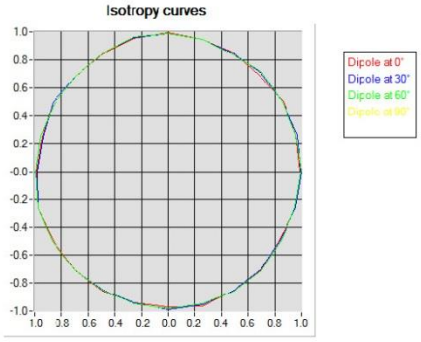
HL900 MHz

- Axial isotropy: 0.04 dB
- Hemispherical isotropy: 0.06 dB



HL1800 MHz

- Axial isotropy: 0.04 dB
- Hemispherical isotropy: 0.08 dB



HL5600 MHz

- Axial isotropy: 0.06 dB
- Hemispherical isotropy: 0.08 dB