FCC SAR TEST REPORT

Report No.:	SET2015-18821
Product:	Digital camera
Brand Name:	Sioeye
Model No.:	IRIS4G
FCC ID:	2AE44IRIS4G
Applicant:	Sioeye, Inc.
Address:	1518 First Avenue S. Suite 200 Seattle Washington United States
Issued by:	CCIC-SET
Lab Location:	Electronic Testing Building, Shahe Road，Xili, Nanshan District, Shenzhen, 518055, P. R. China
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Test Report

Product. ……………….:	Digital camera
Model No. ……………..:	IRIS4G
Brand Name…………..:	Sioeye
FCC ID…………………..:	2AE44IRIS4G
Applicant………………..:	Sioeye, Inc.
Applicant Address…….:	1518 First Avenue S. Suite 200 Seattle Washington United States
Manufacturer…………:	CK Telecom Limited
Manufacturer Address:	Technology Road.High-Tech Development Zone. Heyuan, Guangdong,P.R.China.
Test Standards……….:	**47CFR § 2.1093-** Radiofrequency Radiation Exposure Evaluation: Portable Devices; **ANSI C95.1–1992:** Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz – 300 GHz.(IEEE Std C95.1-1991) **IEEE 1528–2013:** IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communications Devices: Experimental Techniques;
Test Result……………:	Pass

Tested by …………..: Mei Chun 2015-12-20

Chun Mei, Test Engineer

Reviewed by………….: Shuangwen Zhang 2015-12-20

Shuangwen Zhang,Senior Egineer

Approved by……………: Wu Li'an 2015-12-20

Wu Li'an , Manager

Contents

1. GENERAL CONDITIONS

1.1 This report only refers to the item that has undergone the test.

1.2 This report standalone does not constitute or imply by its own an approval of the product by the certification Bodies or competent Authorities.

1.3 This document is only valid if complete; no partial reproduction can be made without written approval of CCIC-SET

1.4 This report cannot be used partially or in full for publicity and/or promotional purposes without previous written approval of CCIC-SET and the Accreditation Bodies, if it applies.

2. Administrative Date

2.1. Identification of the Responsible Testing Laboratory

Company Name:	CCIC-SET
Department:	EMC & RF Department
Address:	Electronic Testing Building, Shahe Road, Nanshan District, ShenZhen, P. R. China
Telephone:	+86-755-26629676
Fax:	+86-755-26627238
Responsible Test Lab Managers:	Mr. Wu Li'an

2.2. Identification of the Responsible Testing Location(s)

Company Name:	CCIC-SET
Address:	Electronic Testing Building, Shahe Road, Nanshan District, Shenzhen, P. R. China

2.3. Organization Item

CCIC-SET Report No.:	SET2015-18821
CCIC-SET Project Leader:	Mr. Li Sixiong
CCIC-SET Responsible for accreditation scope:	Mr. Wu Li'an
Start of Testing:	2015-11-17
End of Testing:	2015-11-19

2.4. Identification of Applicant

Company Name:	Sioeye, Inc.
Address:	1518 First Avenue S. Suite 200 Seattle Washington United States

2.5. Identification of Manufacture

Company Name:	CK Telecom Limited
Address:	Technology Road.High-Tech Development Zone. Heyuan, Guangdong,P.R.China.

Notes: This data is based on the information by the applicant.

3. Equipment Under Test (EUT)

3.1. Identification of the Equipment under Test

Sample Name:	Digital camera	
Model Name:	IRIS4G	
Brand Name:	Sioeye	
General description:	Support Band	WCDMA 850MHz/ 1900MHz, LTE Band2/4/5/7/17,WIFI, BT
	Test Band	WCDMA 850MHz/ 1900MHz, LTE Band 2/4/5/7/17,WIFI 802.11b
	Development Stage	Identical Prototype
	Accessories	Power Supply
	Battery type	4.2V 1160mAh
	Antenna type	Internal/External Antenna
	Operation mode	WCDMA/ LTE /WIFI
	Modulation mode	UMTS(QPSK),LTE(QPSK,16QAM), WIFI(OFDM/DSSS)
	Max. RF Power	23.56dBm
	Max. SAR Value	Body support: 0.85 W/kg;

NOTE:

a. The above EUT's information was declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.

4 SAR SUMMARY

Highest Standalone SAR Summary

Exposure Position	Frequency Band	Scaled 1g-SAR(W/kg)	Highest Scaled 1g-SAR(W/kg)
Body-Support (5mm Gap)	WCDMA Band Ⅴ	0.14	0.85
	WCDMA Band II	0.85	
	LTE Band 2	0.81	
	LTE Band 4	0.08	
	LTE Band 5	0.14	
	LTE Band 7	0.23	
	LTE Band 17	0.13	
	WIFI	0.19	

Highest Simultaneous SAR Summary

Exposure Position	Frequency Band	Scaled 1g-SAR(W/kg)	Highest Scaled 1g-SAR(W/kg)
Body-Support (5mm Gap)	WCDMA Band II &WIFI	0.85+0.19	1.04

5 Specific Absorption Rate (SAR)

5.1 Introduction

SAR is related to the rate at which energy is absorbed per unit mass in an object exposed to a radio field. The SAR distribution in a biological body is complicated and is usually carried out by experimental techniques or numerical modeling. The standard recommends limits for two tiers of groups, occupational/controlled and general population/uncontrolled, based on a person's awareness and ability to exercise control over his or her exposure. In general, occupational/controlled exposure limits are higher than the limits for general population/uncontrolled.

5.2 SAR Definition

The SAR definition is the time derivative (rate) of the incremental energy (dW) absorbed by (dissipated in) an incremental mass (dm) contained in a volume element (dv) of a given density (). The equation description is as below:

$$\mathrm{SAR} = \frac{d}{dt}\left(\frac{dW}{dm}\right) = \frac{d}{dt}\left(\frac{dW}{\rho dv}\right)$$

SAR is expressed in units of Watts per kilogram (W/kg)

SAR measurement can be either related to the temperature elevation in tissue by

$$\mathrm{SAR} = C\frac{\delta T}{\delta t}$$

where C is the specific head capacity, δT is the temperature rise and δt the exposure duration, or related to the electrical field in the tissue by

$$\mathrm{SAR} = \frac{\sigma |E|^2}{\rho}$$

where σ is the conductivity of the tissue, ρ is the mass density of the tissue and E is the rms electrical field strength.

However for evaluating SAR of low power transmitter, electrical field measurement is typically applied.

5.3 Phantoms

The phantom used for all tests i.e. for both system checks and device testing, was the twin-headed "SAM Phantom", manufactured by SATIMO. The SAM twin phantom is a fiberglass shell phantom with 2mm shell thickness (except the ear region, where shell thickness increases to 6mm).

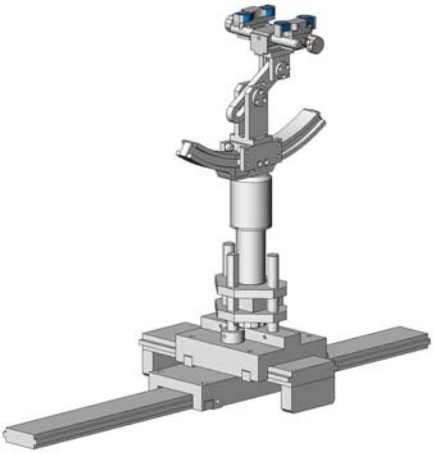
System checking was performed using the flat section, whilst Head SAR tests used the left and right head profile sections. Body SAR testing also used the flat section between the head profiles.

SAM Twin Phantom

5.4 Device Holder

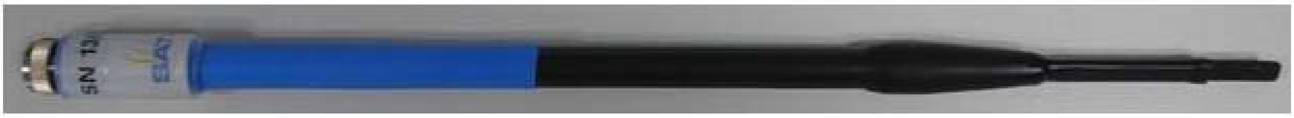
The device was placed in the device holder (illustrated below) that is supplied by SATIMO as an integral part of the COMOSAR test system.

The device holder is designed to cope with the different positions given in the standard. It has two scales for device rotation (with respect to the body axis) and device inclination (with respect to the line between the ear reference points). The rotation centers for both scales is the ear reference point (ERP). Thus the device needs no repositioning when changing the angles.



Device holder

5.5 Probe Specification

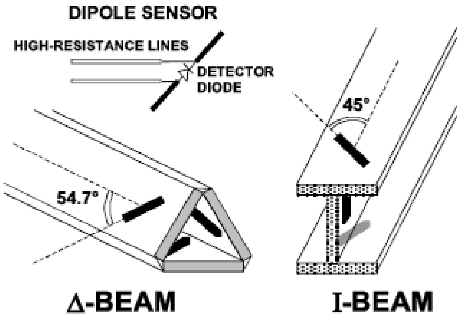


Construction	Symmetrical design with triangular core Interleaved sensors Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)
Calibration	ISO/IEC 17025 calibration service available.
Frequency	700 MHz to 3 GHz; Linearity: ± 0.5 dB (700 MHz to 3 GHz)
Directivity	± 0.25 dB in HSL (rotation around probe axis) ± 0.5 dB in tissue material (rotation normal to probe axis)
Dynamic Range	1.5 μW/g to 100 mW/g; Linearity: ± 0.5 dB
Dimensions	Overall length: 330 mm (Tip: 20 mm) Tip diameter: 5 mm Distance from probe tip to dipole centers: <2.7 mm
Application	General dosimetry up to 3 GHz Dosimetry in strong gradient fields Compliance tests of mobile phones
Compatibility	COMOSAR

Isotropic E-Field Probe

The isotropic E-Field probe has been fully calibrated and assessed for isotropicity, and boundary effect within a controlled environment. Depending on the frequency for which the probe is calibrated the method utilized for calibration will change.

The E-Field probe utilizes a triangular sensor arrangement as detailed in the diagram below:



6 OPERATIONAL CONDITIONS DURING TEST

6.1 Schematic Test Configuration

During SAR test, EUT was operating in Traffic Mode (Channel Allocated) at Normal Voltage Condition. A communication link is set up with a System Simulator (SS) by air link, and a call is established.The EUT was commanded to operate at maximum transmitting power.

The EUT should use its internal transmitter. The antenna(s), battery and accessories shall be those specified by the manufacturer. The EUT battery must be fully charged and checked periodically during the test to ascertain uniform power output. If a wireless link was used, the antenna connected to the output of the base station simulator shall be placed at least 50 cm away from the handset.

The signal transmitted by the simulator to the antenna feeding point should be lower than the output power level of the handset by at least 35 dB

6.2 SAR Measurement System

The SAR measurement system being used is the SATIMO system, the system is controlled remotely from a PC, which contains the software to control the robot and data acquisition equipment. The software also displays the data obtained from test scans.

In operation, the system first does an area (2D) scan at a fixed depth within the liquid from the inside wall of the phantom. When the maximum SAR point has been found, the system will then carry out a 3D scan centred at that point to determine volume averaged SAR level.

6.2.1 Tissue Dielectric Parameters for Head and Body Phantoms

The head tissue dielectric parameters recommended by the IEEE SCC-34/SC-2 in P1528 have been incorporated in the following table. These head parameters are derived from planar layer models simulating the highest expected SAR for the dielectric properties and tissue thickness Power drifts in a human head. Other head and body tissue parameters that have not been specified in P1528 are derived from the tissue dielectric parameters computed from the 4-Cole-Cole equations described in Reference [12] and extrapolated according to the head parameters specified in P1528.

Table 1: Recommended Dielectric Performance of Tissue

Ingredients (% by weight)	Frequency (MHz)											
	450		835		915		1900		2450		2600	
Tissue Type	Head	Body	Head	Body	Head	Body	Head	Body	Head	Body	Head	Body
Water	38.56	51.16	41.46	52.4	41.05	56.0	54.9	40.4	62.7	73.2	55.24	64.49
Salt (Nacl)	3.95	1.49	1.45	1.4	1.35	0.76	0.18	0.5	0.5	0.04	0.5	0.024
Sugar	56.32	46.78	56.0	45.0	56.5	41.76	0.0	58.0	0.0	0.0	0.0	0.0

HEC	0.98	0.52	1.0	1.0	1.0	1.21	0.0	1.0	0.0	0.0	0.0	0.0
Bactericide	0.19	0.05	0.1	0.1	0.1	0.27	0.0	0.1	0.0	0.0	0.0	0.0
Triton x-100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	36.8	0.0	44.45	32.25
DGBE	0.0	0.0	0.0	0.0	0.0	0.0	44.92	0.0	0.0	26.7	0.0	26.7
Dielectric Constant	43.42	58.0	42.54	56.1	42.0	56.8	39.9	54.0	39.8	52.5	39.0	52.5
Conductivity (s/m)	0.85	0.83	0.91	0.95	1.0	1.07	1.42	1.45	1.88	1.78	1.96	2.16

MSL/HSL750 (Body and Head liquid for 700 – 800 MHz)

Item	Head Tissue Simulation Liquid HSL750 Muscle(body)Tissue Simulation Liquid MSL750			
H2O	Water, 35 – 58%			
Sucrese	Sugar, white, refined, 40-60%			
NaCl	Sodium Chloride, 0-6%			
Hydroxyethel-cellulsoe	Medium Viscosity (CAS# 9004-62-0), <0.3%			
Preventol-D7	Preservative: aqueous preparation, (CAS# 55965-84-9), containing 5-chloro-2-methyl-3(2H)-isothiazolone and 2-methyyl-3(2H)-isothiazolone, 0.1-0.7%			
Frequency (MHz)	Head εr	Head σ(S/m)	Body εr	Bodyσ(S/m)
750	41.9	0.89	55.2	0.97

Note: The liquid of 700MHz&2600MHz typical liquid composition is provided by SATIMO.

Table 2 Recommended Tissue Dielectric Parameters

Frequency (MHz)	Head Tissue		Body Tissue	
	ε_r	σ(S/m)	ε_r	σ(S/m)
150	52.3	0.76	61.9	0.80
300	45.3	0.87	58.2	0.92
450	43.5	0.87	56.7	0.94
835	41.5	0.90	55.2	0.97
900	41.5	0.97	55.0	1.05
915	41.5	0.98	55.0	1.06
1450	40.5	1.20	54.0	1.30
1610	40.3	1.29	53.8	1.40
1800-2000	40.0	1.40	53.3	1.52
2450	39.2	1.80	52.7	1.95
3000	38.5	2.40	52.0	2.73
5800	35.3	5.27	48.2	6.00

6.2.2 Stimulate liquid

For measurements against the phantom head, the “cheek” and “tilt” position on both the left hand and the right hand sides of the phantom. For body-worn measurements, the EUT was tested against flat phantom representing the user body. The EUT was put on in the belt holder. Stimulate liquid that are used for testing at frequencies of GSM 850MHz/1900MHz, WCDMA850MHz/1900MHz, LTE Band2/4/7/17 and Wi-Fi 2.4GHz, which are made mainly of sugar, salt and water solutions may be left in the phantoms.

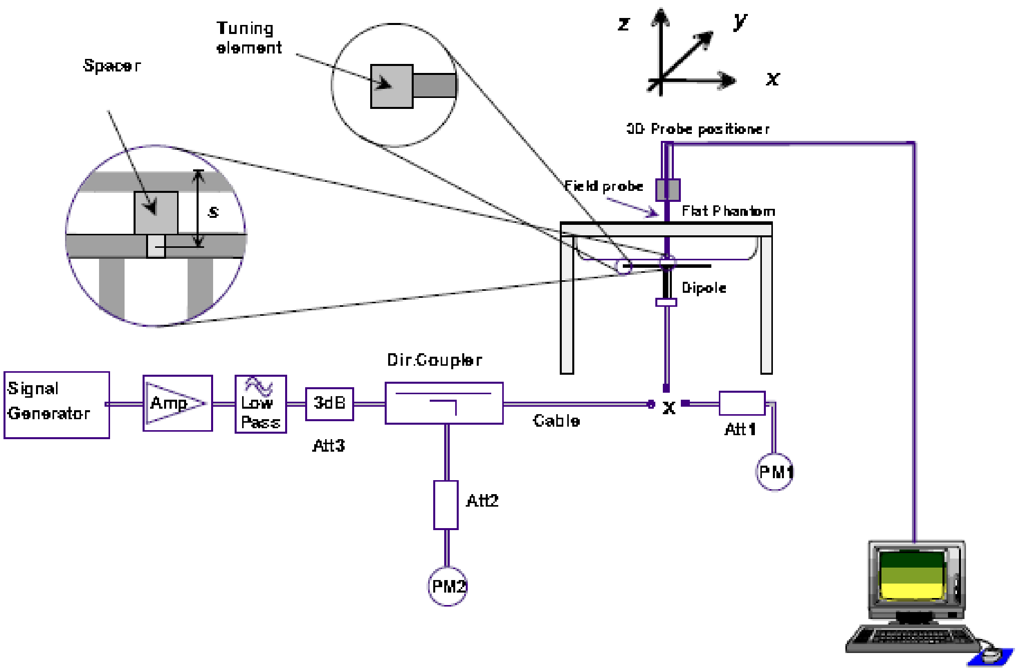
Table 3: Dielectric Performance of Body Tissue Simulating Liquid

Temperature: 23.2°C; Humidity: 64%;			
/	Frequency	Permittivity ε	Conductivity σ (S/m)
Target value	750MHz	55.2±5%	0.97±5%
Validation value (Nov. 17th, 2015)	750MHz	55.01	0.95
Target value	850MHz	55.2±5%	0.97±5%
Validation value (Nov. 17th, 2015)	850MHz	55.32	0.95
Target value	1800 MHz	53.3±5%	1.52±5%
Validation value (Nov. 18th, 2015)	1800 MHz	53.37	1.50
Target value	1900MHz	53.3±5%	1.52±5%
Validation value (Nov. 18th, 2015)	1900MHz	53.14	1.52
Target value	2450MHz	52.7±5%	1.95±5%
Validation value (Nov. 19th, 2015)	2450MHz	52.53	1.94
Target value	2600MHz	52.5±5%	2.16±5%
Validation value (Nov. 19th, 2015)	2600MHz	52.56	2.15

6.3 Results of validation testing

Prior to the assessment, the system validation kit was used to test whether the system was operating within its specifications of ±10%. The validation results are tabulated below. And also the corresponding SAR plot is attached as well in the SAR plots files.

The following procedure, recommended for performing validation tests using box phantoms is based on the procedures described in the IEEE standard P1528. Setup according to the setup diagram below :



With the SG and Amp and with directional coupler in place, set up the source signal at the relevant frequency and use a power meter to measure the power at the end of the SMA cable that you intend to connect to the balanced dipole. Adjust the SG to make this, say, 0.25W (24dBm). If this level is too high to read directly with the power meter sensor, insert a calibrated attenuator (e.g. 10 or 20 dB) and make a suitable correction to the power meter reading.

Note 1: In this method, the directional coupler is used for monitoring rather than setting the exact feed power level. If, however, the directional coupler is used for power measurement, you should check the frequency range and power rating of the coupler and measure the coupling factor (referred to output) at the test frequency using a VNA.

Note 2: Remember that the use of a 3dB attenuator (as shown in Figure 8.1 of P1528) means that you need an RF amplifier of 2 times greater power for the same feed power. The other issue is the cable length. You might get up to 1dB of loss per meter of cable, so the cable length after the coupler needs to be quite short.

Note 3: For the validation testing done using CW signals, most power meters are suitable. However, if you are measuring the output of a modulated signal from either a signal generator or a handset, you must ensure that the power meter correctly reads the modulated signals.

The measured 1-gram averaged SAR values of the device against the phantom are provided in Tables 5 and Table 6. The humidity and ambient temperature of test facility were 64% and 23.2°C respectively. The body phantom were full of the body tissue simulating liquid. The EUT was supplied with full-charged battery for each measurement.

The distance between the back of the EUT and the bottom of the flat phantom is 10 mm (taking into account of the IEEE 1528 and the place of the antenna).

Table 4: Body SAR system validation (1g)

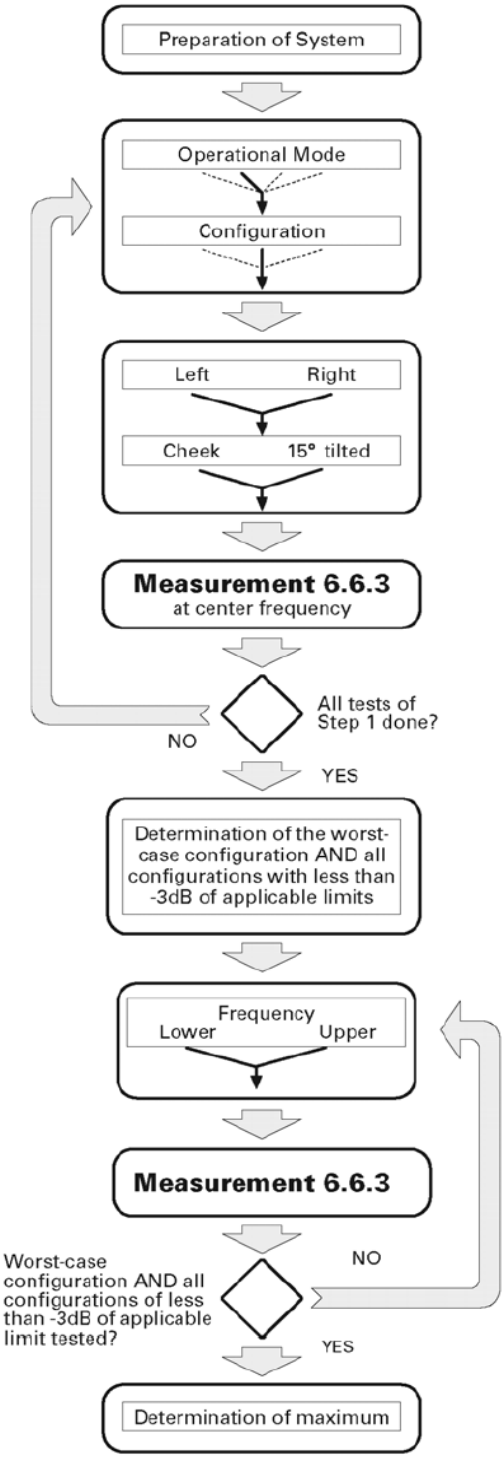
Frequency	Duty cycle	Target value（W/kg）	Test value (W/kg)	
			250 mW	1W
750MHz(Nov. 17th, 2015)	1:1	8.43±10%	2.01	8.04
835MHz(Nov. 17th, 2015)	1:1	10.31±10%	2.52	10.08
1800MHz(Nov. 18th, 2015)	1:1	40.07±10%	9.83	39.32
1900MHz(Nov. 18th, 2015)	1:1	40.81±10%	10.11	40.44
2450MHz(Nov. 19th, 2015)	1:1	52.66±10%	13.06	52.24
2600MHz((Nov. 19th, 2015)	1:1	57.55±10%	14.03	56.12

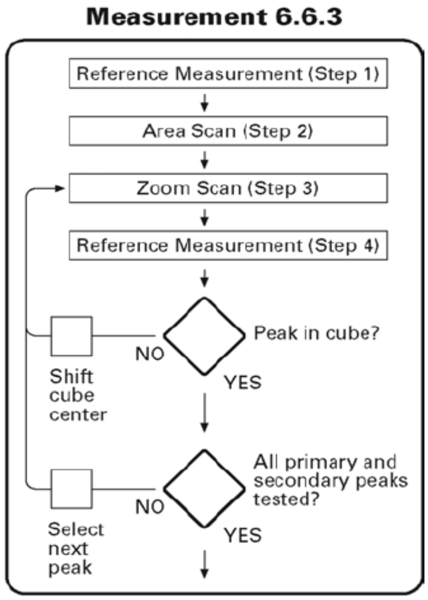
* Note: Target value was referring to the measured value in the calibration certificate of reference dipole.

Note: All SAR values are normalized to 1W forward power.

6.4 SAR measurement procedure

The SAR test against the head phantom was carried out as follow:





Establish a call with the maximum output power with a base station simulator, the connection between the EUT and the base station simulator is established via air interface.

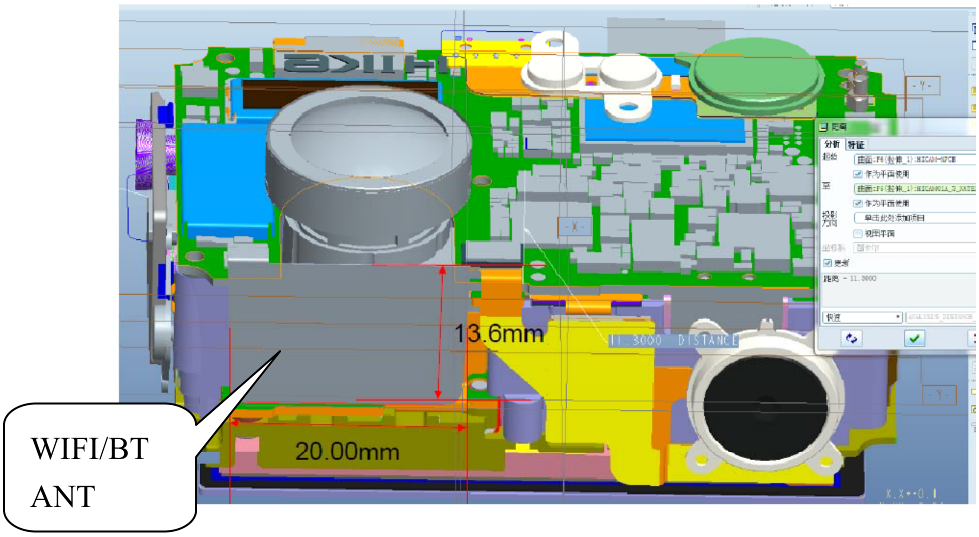
After an area scan has been done at a fixed distance of 2mm from the surface of the phantom on the source side, a 3D scan is set up around the location of the maximum spot SAR. First, a point within the scan area is visited by the probe and a SAR reading taken at the start of testing. At the end of testing, the probe is returned to the same point and a second reading is taken. Comparison between these start and end readings enables the power drift during measurement to be assessed.

Above is the scanning procedure flow chart and table from the IEEEp1528 standard. This is the procedure for which all compliant testing should be carried out to ensure that all variations of the device position and transmission behavior are tested.

For body-worn measurement, the EUT was tested under two position: face upward and back upward.

6.5 Transmitting antenna information

The WIFI&BT antennas inside the EUT.



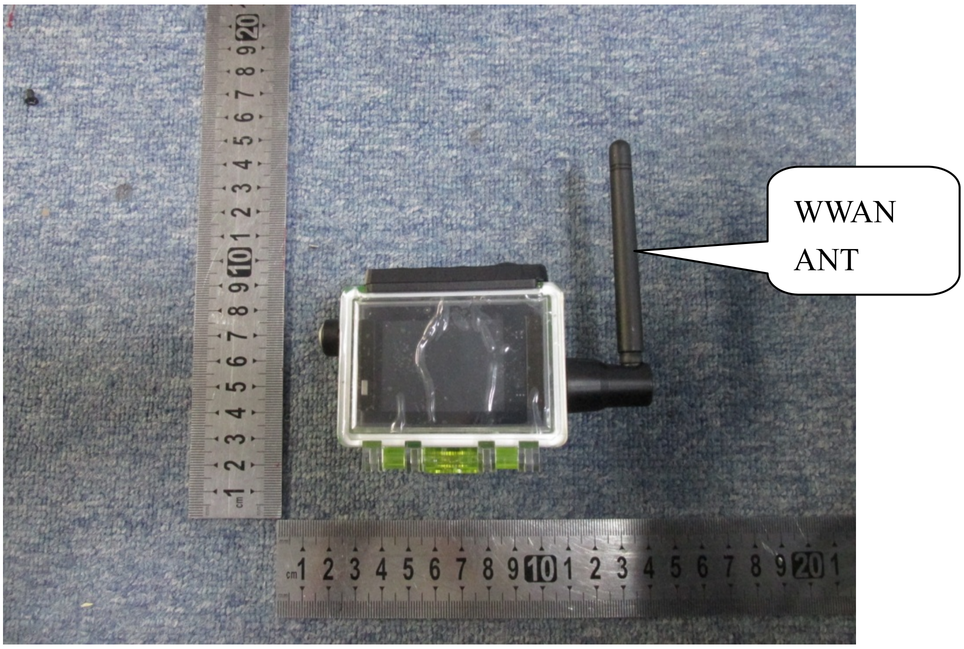


Fig. 3 Position of the antennas

7 CHARACTERISTICS OF THE TEST

7.1 Applicable Limit Regulations

47CFR §2.1093- Radiofrequency Radiation Exposure Evaluation: Portable Devices;

ANSI C95.1–1992: Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz – 300 GHz.(IEEE Std C95.1-1991)

IEEE 1528–2013: IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communications Devices: Experimental Techniques;

It specifies the maximum exposure limit of **1.6 W/kg** as averaged over any 1 gram of tissue for portable devices being used within 20 cm of the user in the uncontrolled environment.

7.2 Applicable Measurement Standards

The Specific Absorption Rate (SAR) testing specification, method, and procedure for this is in accordance with the following standards:

FCC 47 CFR Part2 (2.1093)
ANSI/IEEE C95.1-1992
IEEE 1528-2013
FCC KDB 248227 D01 802.11 Wi-Fi SAR v02r02
FCC KDB 447498 D01 v06 General RF Exposure Guidance
FCC KDB 865664 D01 v01r04 SAR Measurement 100MHz to 6GHz
FCC KDB 865664 D02 v01r02 SAR Exposure Reporting
FCC KDB 941225 D01 v03r01 3G SAR Procedures
FCC KDB 941225 D05 v02r04 SAR for LTE Devices

8 LABORATORY ENVIRONMENT

The Ambient Conditions during SAR Test

Temperature	Min. = 22 ℃, Max. = 25 ℃
Atmospheric pressure	Min.=86 kPa, Max.=106 kPa
Relative humidity	Min. = 45%, Max. = 75%
Ground system resistance	< 0.5 Ω
Ambient noise is checked and found very low and in compliance with requirement of standards. Reflection of surrounding objects is minimized and in compliance with requirement of standards.	

9.Conducted RF Output Power

9.1 WCDMA Conducted output Power

WCDMA conducted output power

Item	band	WCDMA 850			WCDMA 1900		
	ARFCN	4132	4183	4233	9262	9400	9538
	subtest	dBm			dBm		
RMC 12.2kbps	non	22.84	22.76	22.61	22.63	22.86	22.79
HSDPA	1	22.41	22.08	22.18	22.18	22.08	22.08
	2	22.19	22.01	22.09	22.07	22.01	22.00
	3	21.68	21.91	21.78	21.85	21.89	21.95
	4	21.79	21.54	21.61	21.77	21.94	21.83
HSUPA	1	22.04	22.07	22.17	22.14	22.07	21.97
	2	21.99	22.14	22.21	22.03	21.89	21.74
	3	21.86	22.09	22.08	22.17	22.01	22.08
	4	22..05	22.04	22.33	21.99	21.51	21.74
	5	22.23	22.16	22.11	22.05	22.25	22.08
HSPA+	1	22.23	22.18	22.25	22.01	22.05	22.07
Note:	The Conducted RF Output Power test of WCDMA /HSDPA /HSUPA were tested by power meter.						

Note:

1. WCDMA SAR was tested under PMC 12.2kbps with HSPA Inactive per KDB Publication 941225 D01.HSPA SAR was not requires since the average output power of the HSPA subtests was not more than 0.25dB higher than the RMC level and SAR was less than 1.2W/kg.
2. It is expected by the manufacturer that MPR for some HSPA subtests may be up to 2dB more than specified by 3GPP, but also as low as 0dB according to the chipset implementation in this model.

9.3 LTE Conducted Output Power

LTE Test Configurations

The CMW500 WideBand Radio Communication Tester was used for LTE output power measurements and SAR testing. Closed loop power control was used so the UE transmits with maximum output power during SAR testing. SAR test were performed with the same number of RB and RB offsets transmitting on all frames.

1)Spectrum Plots for RB configurations

A properly configured base station simulator was used for LTE output power measurements and SAR testing. Therefore, spectrum plots for RB configurations were not required to be included in this report.

2)MPR

When MPR is implemented permanently within the UE, regardless of network requirements, only those RB configurations allowed by 3GPP for the channel banwidth and modulation conbinations may be tested with MPR active. Configurations with RB allocations less than the RB thresholds required by 3GPP must be tested without MPR.

The allowed Maximum Power Reduction(MPR) for the maximum output power due to higher order modulation and transmit bandwidth configuration (resource blocks) is specified in Table 6.2.3-1 of the 3GPP TS36.101:

Table 6.2.3-1: Maximum Power Reduction (MPR) for Power Class 3

Modulation	Channel bandwidth / Transmission bandwidth configuration [RB]						MPR (dB)
	1.4 MHz	3.0 MHz	5 MHz	10 MHz	15 MHz	20 MHz	
QPSK	> 5	> 4	> 8	> 12	> 16	> 18	≤ 1
16 QAM	≤ 5	≤ 4	≤ 8	≤ 12	≤ 16	≤ 18	≤ 1
16 QAM	> 5	> 4	> 8	> 12	> 16	> 18	≤ 2

3)A-MPR LTE procedures for SAR testing

A-MPR(Additional MPR) has been disabled for all SAR tests by using Network Signalling Value of “NS_01” on the base station simulator.

4)LTE procedures for SAR testing

A) Largest channel bandwidth standalone SAR test

requirements i) QPSK with 1 RB allocation

Start with the largest channel bandwidth and measure SAR for QPSK with 1 RB allocation, using the RB offset and required test channel combination with the highest maximum output power for RB offsets at the upper edge, middle and lower edge of each required test channel. When the reported SAR is ≤ 0.8W/kg, testing of the remaining RB offset configurations and required test channels is not required for 1RB allocation; otherwise, SAR is required for the remaining required test channels and only for the RB offset configuration with the highest output power for that channel. When the reported SAR of a required test channel is > 1.45 W/kg, SAR is required for all three RB offset configurations for that required test channel.

ii) QPSK with 50% RB allocation

The procedures required for 1 RB allocation in i) are applied to measure the SAR for QPSK with 50% RB allocation.

iii) QPSK with 100% RB allocation

For QPSK with 100% RB allocation, SAR is not required when the highest maximum output power for 100 % RB allocation is less than the highest maximum output power in 50% and 1 RB allocations and the highest reported SAR for 1 RB and 50% RB allocation in i) and ii) are ≤ 0.8 W/kg. Otherwise, SAR is measured for the highest output power channel and if the reported SAR is > 1.45 W/kg, the remaining required test channels must also be tested.

iv) Higher order modulations

For each modulation besides QPSK; e.g., 16-QAM, 64-QAM, apply the QPSK procedures in above sections to determine the QAM configurations that may need SAR measurement. For each configuration identified as required for testing, SAR is required only when the highest maximum output power for the configuration in the higher order modulation is > ½ dB higher than the same configuration in QPSK or when the reported SAR for the QPSK configuration is > 1.45 W/kg.

B) Other channel bandwidth standalone SAR test requirements

For the other channel bandwidths used by the device in a frequency band, apply all the procedures required for the largest channel bandwidth in section A) to determine the channels and RB configurations that need SAR testing and only measure SAR when the highest maximum output power of a configuration requiring testing in the smaller channel bandwidth is > ½ dB higher than the equivalent channel configurations in the largest channel bandwidth configuration or the reported SAR of a configuration for the largest channel bandwidth is > 1.45 W/kg.

1. LTE Band 2 Conducted Power Test Verdict:

BW(MHz)	Modulation	RB Size	RB Offset	Power(dBm) Low Ch./Freq.	Power(dBm) Middle Ch./Freq.	Power(dBm) High Ch./Freq.
Channel				18700	18900	19100
Frequency(MHz)				1860	1880	1900
20	QPSK	1	0	23.24	23.31	**23.35**
20	QPSK	1	49	23.22	23.19	23.28
20	QPSK	1	99	23.12	23.24	23.21
20	QPSK	50	0	22.64	22.55	22.53
20	QPSK	50	24	22.57	22.59	22.44
20	QPSK	50	49	22.54	22.45	22.41
20	QPSK	100	0	22.35	22.31	22.27
20	16QAM	1	0	21.58	21.61	21.55
20	16QAM	1	49	21.44	21.45	21.53
20	16QAM	1	99	21.47	21.60	21.57
20	16QAM	50	0	20.77	20.74	20.76
20	16QAM	50	24	20.75	20.67	20.78
20	16QAM	50	49	20.62	20.58	20.61
20	16QAM	100	0	20.59	20.65	20.73
Channel				18675	18900	19125
Frequency(MHz)				1857.5	1880	1902.5
15	QPSK	1	0	23.31	23.30	23.26
15	QPSK	1	37	23.27	23.24	23.31
15	QPSK	1	74	23.11	23.16	23.20
15	QPSK	36	0	22.61	22.58	22.64
15	QPSK	36	18	22.55	22.51	22.52
15	QPSK	36	37	22.43	22.45	22.47
15	QPSK	75	0	22.61	22.58	22.60
15	16QAM	1	0	21.59	21.55	21.54
15	16QAM	1	37	21.36	21.37	21.42
15	16QAM	1	74	21.27	21.22	21.35
15	16QAM	36	0	20.67	20.71	20.75
15	16QAM	36	18	20.66	20.61	20.59
15	16QAM	36	37	20.71	20.64	20.75
15	16QAM	75	0	20.69	20.72	20.73

BW(MHz)	Modulation	RB Size	RB Offset	Power(dBm) Low Ch./Freq.	Power(dBm) Middle Ch./Freq.	Power(dBm) High Ch./Freq.
Channel				18650	18900	19150
Frequency(MHz)				1855	1880	1905
10	QPSK	1	0	23.33	23.24	23.30
10	QPSK	1	24	23.22	23.21	23.29
10	QPSK	1	49	23.15	23.19	23.20
10	QPSK	25	0	22.67	22.71	22.73
10	QPSK	25	12	22.58	22.65	22.57
10	QPSK	25	24	22.69	22.70	22.65
10	QPSK	50	0	22.65	22.62	22.67
10	16QAM	1	0	21.67	21.55	21.51
10	16QAM	1	24	21.46	21.49	21.41
10	16QAM	1	49	21.35	21.32	21.38
10	16QAM	25	0	20.68	20.70	20.76
10	16QAM	25	12	20.65	20.68	20.72
10	16QAM	25	24	20.54	20.57	20.64
10	16QAM	50	0	20.81	20.77	20.82
Channel				18625	18900	19175
Frequency(MHz)				1852.5	1880	1907.5
5	QPSK	1	0	23.31	23.28	23.30
5	QPSK	1	12	23.22	23.27	23.25
5	QPSK	1	24	23.21	23.15	23.21
5	QPSK	12	0	22.67	22.69	22.72
5	QPSK	12	6	22.62	22.54	22.59
5	QPSK	12	11	22.71	22.64	22.57
5	QPSK	25	0	22.61	22.71	22.62
5	16QAM	1	0	21.69	21.74	21.71
5	16QAM	1	12	21.62	21.51	21.58
5	16QAM	1	24	21.51	21.60	21.59
5	16QAM	12	0	20.76	20.74	20.71
5	16QAM	12	6	20.67	20.75	20.73
5	16QAM	12	11	20.64	20.71	20.65
5	16QAM	25	0	20.76	20.81	20.78

BW(MHz)	Modulation	RB Size	RB Offset	Power(dBm) Low Ch./Freq.	Power(dBm) Middle Ch./Freq.	Power(dBm) High Ch./Freq.
Channel				18615	18900	19185
Frequency(MHz)				1851.5	1880	1908.5
3	QPSK	1	0	23.28	23.29	23.27
3	QPSK	1	7	23.27	23.31	23.25
3	QPSK	1	14	23.14	23.17	23.22
3	QPSK	8	0	22.75	22.67	22.79
3	QPSK	8	4	22.68	22.75	22.73
3	QPSK	8	7	22.64	22.68	22.75
3	QPSK	15	0	22.71	22.79	22.83
3	16QAM	1	0	21.61	21.55	21.62
3	16QAM	1	7	21.72	21.68	21.70
3	16QAM	1	14	21.64	21.57	21.62
3	16QAM	8	0	20.92	20.89	20.87
3	16QAM	8	4	20.85	20.77	20.92
3	16QAM	8	7	20.84	20.79	20.89
3	16QAM	15	0	20.67	20.72	20.70
Channel				18607	18900	19193
Frequency(MHz)				1850.7	1732.5	1909.3
1.4	QPSK	1	0	23.30	23.24	23.27
1.4	QPSK	1	2	23.23	23.22	23.26
1.4	QPSK	1	5	23.11	23.16	23.19
1.4	QPSK	3	0	22.70	22.75	22.72
1.4	QPSK	3	1	22.74	22.62	22.73
1.4	QPSK	3	2	22.64	22.58	22.61
1.4	QPSK	6	0	22.50	22.56	22.53
1.4	16QAM	1	0	21.67	21.72	21.75
1.4	16QAM	1	2	21.72	21.70	21.65
1.4	16QAM	1	5	21.57	21.62	21.54
1.4	16QAM	3	0	20.65	20.71	20.67
1.4	16QAM	3	1	20.74	20.83	20.75
1.4	16QAM	3	2	20.65	20.67	20.73
1.4	16QAM	6	0	20.75	20.71	20.74

2. LTE Band 4 Conducted Power Test Verdict:

BW(MHz)	Modulation	RB Size	RB Offset	Power(dBm) Low Ch./Freq.	Power(dBm) Middle Ch./Freq.	Power(dBm) High Ch./Freq.
Channel				20050	20175	20300
Frequency(MHz)				1720	1732.5	1745
20	QPSK	1	0	23.52	**23.56**	23.55
20	QPSK	1	49	23.49	23.53	23.51
20	QPSK	1	99	23.51	23.49	23.53
20	QPSK	50	0	22.75	22.86	22.85
20	QPSK	50	24	22.84	22.79	22.81
20	QPSK	50	49	22.73	22.75	22.80
20	QPSK	100	0	22.73	22.72	22.82
20	16QAM	1	0	21.63	21.67	21.64
20	16QAM	1	49	21.53	21.48	21.55
20	16QAM	1	99	21.49	21.51	21.54
20	16QAM	50	0	20.87	20.79	20.82
20	16QAM	50	24	20.79	20.77	20.80
20	16QAM	50	49	20.81	20.78	20.83
20	16QAM	100	0	20.74	20.76	20.81
Channel				20025	20175	20325
Frequency(MHz)				1717.5	1732.5	1747.5
15	QPSK	1	0	23.47	23.51	23.48
15	QPSK	1	37	23.43	23.41	23.44
15	QPSK	1	74	23.34	23.32	23.31
15	QPSK	36	0	22.86	22.79	22.78
15	QPSK	36	18	22.87	22.78	22.81
15	QPSK	36	37	22.79	22.75	22.78
15	QPSK	75	0	22.76	22.75	22.82
15	16QAM	1	0	21.56	21.51	21.53
15	16QAM	1	37	21.50	21.54	21.53
15	16QAM	1	74	21.59	21.62	21.58
15	16QAM	36	0	20.86	20.83	20.81
15	16QAM	36	18	20.79	20.76	20.78
15	16QAM	36	37	20.82	20.75	20.83
15	16QAM	75	0	20.78	20.75	20.81

BW(MHz)	Modulation	RB Size	RB Offset	Power(dBm) Low Ch./Freq.	Power(dBm) Middle Ch./Freq.	Power(dBm) High Ch./Freq.
Channel				20000	20175	20350
Frequency(MHz)				1715	1732.5	1750
10	QPSK	1	0	23.47	23.53	23.48
10	QPSK	1	24	23.49	23.43	23.51
10	QPSK	1	49	23.38	23.27	23.33
10	QPSK	25	0	22.94	22.87	22.85
10	QPSK	25	12	22.82	22.89	22.83
10	QPSK	25	24	22.78	22.80	22.85
10	QPSK	50	0	22.86	22.82	22.91
10	16QAM	1	0	21.67	21.65	21.69
10	16QAM	1	24	21.61	21.58	21.64
10	16QAM	1	49	21.61	21.62	21.56
10	16QAM	25	0	20.81	20.83	20.88
10	16QAM	25	12	20.82	20.78	20.82
10	16QAM	25	24	20.85	20.77	20.83
10	16QAM	50	0	20.80	20.74	20.79
Channel				19975	20175	20375
Frequency(MHz)				1712.5	1732.5	1752.5
5	QPSK	1	0	23.47	23.49	23.45
5	QPSK	1	12	23.45	23.48	23.50
5	QPSK	1	24	23.38	23.40	23.38
5	QPSK	12	0	22.81	22.87	22.82
5	QPSK	12	6	22.85	22.82	22.78
5	QPSK	12	11	22.83	22.73	22.77
5	QPSK	25	0	22.85	22.78	22.75
5	16QAM	1	0	21.67	21.66	21.63
5	16QAM	1	12	21.50	21.49	21.49
5	16QAM	1	24	21.54	21.58	21.51
5	16QAM	12	0	20.75	20.77	20.69
5	16QAM	12	6	20.67	20.65	20.64
5	16QAM	12	11	20.72	20.75	20.76
5	16QAM	25	0	20.78	20.72	20.75

BW(MHz)	Modulation	RB Size	RB Offset	Power(dBm) Low Ch./Freq.	Power(dBm) Middle Ch./Freq.	Power(dBm) High Ch./Freq.
Channel				19965	20175	20385
Frequency(MHz)				1711.5	1732.5	1753.5
3	QPSK	1	0	23.46	23.52	23.47
3	QPSK	1	7	23.43	23.49	23.50
3	QPSK	1	14	23.32	23.42	23.37
3	QPSK	8	0	22.77	22.71	22.76
3	QPSK	8	4	22.75	22.75	22.78
3	QPSK	8	7	22.69	22.70	22.70
3	QPSK	15	0	22.67	22.67	22.68
3	16QAM	1	0	21.51	21.45	21.49
3	16QAM	1	7	21.47	21.45	21.43
3	16QAM	1	14	21.38	21.30	21.36
3	16QAM	8	0	20.63	20.70	20.72
3	16QAM	8	4	20.64	20.68	20.68
3	16QAM	8	7	20.63	20.62	20.65
3	16QAM	15	0	20.52	20.56	20.58
Channel				19957	20175	20393
Frequency(MHz)				1710.7	1732.5	1754.3
1.4	QPSK	1	0	23.45	23.51	23.49
1.4	QPSK	1	2	23.44	23.42	23.48
1.4	QPSK	1	5	23.39	23.37	23.35
1.4	QPSK	3	0	22.73	22.68	22.72
1.4	QPSK	3	1	22.57	22.47	22.52
1.4	QPSK	3	2	22.66	22.57	22.61
1.4	QPSK	6	0	22.57	22.46	22.53
1.4	16QAM	1	0	21.72	21.77	21.61
1.4	16QAM	1	2	21.73	21.81	21.75
1.4	16QAM	1	5	21.81	21.86	21.84
1.4	16QAM	3	0	20.79	20.74	20.85
1.4	16QAM	3	1	20.62	20.73	20.67
1.4	16QAM	3	2	20.70	20.59	20.67
1.4	16QAM	6	0	20.59	20.55	20.66

3. LTE Band 5 Conducted Power Test Verdict:

BW(MHz)	Modulation	RB Size	RB Offset	Power(dBm) Low Ch./Freq.	Power(dBm) Middle Ch./Freq.	Power(dBm) High Ch./Freq.
Channel				20450	20525	20600
Frequency(MHz)				829	836.5	844
10	QPSK	1	0	**23.28**	23.25	23.23
10	QPSK	1	24	23.19	23.20	23.21
10	QPSK	1	49	23.23	23.14	23.19
10	QPSK	25	0	22.72	22.71	22.76
10	QPSK	25	12	22.67	22.76	22.72
10	QPSK	25	24	22.81	22.75	22.76
10	QPSK	50	0	22.69	22.66	22.67
10	16QAM	1	0	21.54	22.64	22.57
10	16QAM	1	24	21.60	22.51	22.53
10	16QAM	1	49	21.52	22.41	22.42
10	16QAM	25	0	20.81	20.76	20.85
10	16QAM	25	12	20.64	20.65	20.71
10	16QAM	25	24	20.82	20.74	20.76
10	16QAM	50	0	20.73	20.76	20.81
Channel				20425	20525	20625
Frequency(MHz)				826.5	836.5	846.5
5	QPSK	1	0	23.22	23.27	23.23
5	QPSK	1	12	23.19	23.23	23.16
5	QPSK	1	24	23.18	23.20	23.19
5	QPSK	12	0	22.80	22.83	22.77
5	QPSK	12	6	22.66	22.72	22.67
5	QPSK	12	11	22.76	22.81	22.79
5	QPSK	25	0	22.81	22.73	22.82
5	16QAM	1	0	21.64	21.59	21.69
5	16QAM	1	12	21.55	21.58	21.66
5	16QAM	1	24	21.53	22.47	22.44
5	16QAM	12	0	20.76	20.75	20.81
5	16QAM	12	6	20.62	20.72	20.69
5	16QAM	12	11	20.78	20.80	20.77
5	16QAM	25	0	20.71	20.82	20.74

BW(MHz)	Modulation	RB Size	RB Offset	Power(dBm) Low Ch./Freq.	Power(dBm) Middle Ch./Freq.	Power(dBm) High Ch./Freq.
Channel				20415	20525	20635
Frequency(MHz)				825.5	836.5	847.5
3	QPSK	1	0	23.24	23.25	23.23
3	QPSK	1	7	23.19	23.20	23.21
3	QPSK	1	14	23.13	23.14	23.19
3	QPSK	8	0	22.72	22.71	22.76
3	QPSK	8	4	22.67	22.76	22.82
3	QPSK	8	7	22.81	22.75	22.76
3	QPSK	15	0	22.69	22.66	22.72
3	16QAM	1	0	21.54	21.64	21.57
3	16QAM	1	7	21.60	21.51	21.53
3	16QAM	1	14	21.52	21.41	21.42
3	16QAM	8	0	20.81	20.76	20.85
3	16QAM	8	4	20.84	20.75	20.71
3	16QAM	8	7	20.82	20.74	20.76
3	16QAM	15	0	20.73	20.76	20.81
Channel				20407	20525	20643
Frequency(MHz)				824.7	836.5	848.3
1.4	QPSK	1	0	23.22	23.17	23.23
1.4	QPSK	1	2	23.19	23.23	23.26
1.4	QPSK	1	5	23.18	23.20	23.19
1.4	QPSK	3	0	22.80	22.83	22.77
1.4	QPSK	3	1	22.76	22.82	22.72
1.4	QPSK	3	2	22.64	22.66	22.62
1.4	QPSK	6	0	22.56	22.43	22.52
1.4	16QAM	1	0	21.64	21.69	21.71
1.4	16QAM	1	2	21.65	21.58	21.66
1.4	16QAM	1	5	21.53	21.47	21.54
1.4	16QAM	3	0	20.70	20.75	20.85
1.4	16QAM	3	1	20.62	20.75	20.69
1.4	16QAM	3	2	20.78	20.80	20.77
1.4	16QAM	6	0	20.71	20.82	20.74

4. LTE Band 7 Conducted Power Test Verdict:

BW(MHz)	Modulation	RB Size	RB Offset	Power(dBm) Low Ch./Freq.	Power(dBm) Middle Ch./Freq.	Power(dBm) High Ch./Freq.
Channel				20850	21100	21350
Frequency(MHz)				2510	2535	2560
20	QPSK	1	0	23.32	**23.34**	23.27
20	QPSK	1	49	23.28	23.27	23.33
20	QPSK	1	99	23.31	23.22	23.25
20	QPSK	50	0	22.62	22.75	22.67
20	QPSK	50	24	22.77	22.75	22.71
20	QPSK	50	49	22.64	22.62	22.65
20	QPSK	100	0	22.62	22.55	22.60
20	16QAM	1	0	21.30	21.31	21.35
20	16QAM	1	49	21.34	21.25	21.33
20	16QAM	1	99	21.28	21.30	21.24
20	16QAM	50	0	20.67	20.75	20.72
20	16QAM	50	24	20.59	20.67	20.70
20	16QAM	50	49	20.61	20.51	20.56
20	16QAM	100	0	20.70	20.65	20.71
Channel				20825	21100	21375
Frequency(MHz)				2507.5	2535	2562.5
15	QPSK	1	0	23.26	23.32	23.27
15	QPSK	1	37	23.31	23.25	23.28
15	QPSK	1	74	23.25	23.27	23.21
15	QPSK	36	0	22.77	22.75	22.72
15	QPSK	36	18	22.72	22.75	22.68
15	QPSK	36	37	22.64	22.62	22.65
15	QPSK	75	0	22.61	22.65	22.67
15	16QAM	1	0	21.70	21.67	21.73
15	16QAM	1	37	21.64	21.68	21.70
15	16QAM	1	74	21.67	21.60	21.66
15	16QAM	36	0	20.63	20.55	20.58
15	16QAM	36	18	20.69	20.67	20.72
15	16QAM	36	37	20.58	20.61	20.56
15	16QAM	75	0	20.74	20.69	20.71

BW(MHz)	Modulation	RB Size	RB Offset	Power(dBm) Low Ch./Freq.	Power(dBm) Middle Ch./Freq.	Power(dBm) High Ch./Freq.
Channel				20800	21100	21400
Frequency(MHz)				2505	2535	2565
10	QPSK	1	0	23.31	23.32	23.30
10	QPSK	1	24	23.24	23.25	23.24
10	QPSK	1	49	23.21	23.28	23.25
10	QPSK	25	0	22.67	22.72	22.66
10	QPSK	25	12	22.72	22.74	22.76
10	QPSK	25	24	22.69	22.62	22.65
10	QPSK	50	0	22.77	22.75	22.71
10	16QAM	1	0	21.60	21.71	21.65
10	16QAM	1	24	21.64	21.69	21.73
10	16QAM	1	49	21.54	21.50	21.48
10	16QAM	25	0	20.67	20.75	20.68
10	16QAM	25	12	20.69	20.67	20.70
10	16QAM	25	24	20.61	20.71	20.66
10	16QAM	50	0	20.84	20.75	20.81
Channel				20775	21100	21425
Frequency(MHz)				2502.5	2535	2567.5
5	QPSK	1	0	23.27	23.33	23.31
5	QPSK	1	12	23.26	23.21	23.27
5	QPSK	1	24	23.31	23.23	23.25
5	QPSK	12	0	22.74	22.77	22.68
5	QPSK	12	6	22.70	22.65	22.62
5	QPSK	12	11	22.64	22.68	22.65
5	QPSK	25	0	22.61	22.58	22.55
5	16QAM	1	0	21.60	21.51	21.57
5	16QAM	1	12	21.54	21.45	21.51
5	16QAM	1	24	21.39	21.42	21.44
5	16QAM	12	0	20.53	20.65	20.58
5	16QAM	12	6	20.79	20.77	20.80
5	16QAM	12	11	20.68	20.74	20.72
5	16QAM	25	0	20.76	20.84	20.81

5. LTE Band 17 Conducted Power Test Verdict:

BW(MHz)	Modulation	RB Size	RB Offset	Power(dBm) Low Ch./Freq.	Power(dBm) Middle Ch./Freq.	Power(dBm) High Ch./Freq.
Channel				23780	23790	23800
Frequency(MHz)				709	710	711
10	QPSK	1	0	23.38	23.35	**23.44**
10	QPSK	1	24	23.42	23.39	23.41
10	QPSK	1	49	23.28	23.33	23.21
10	QPSK	25	0	22.75	22.79	22.77
10	QPSK	25	12	22.76	22.77	22.72
10	QPSK	25	24	22.65	22.63	22.55
10	QPSK	50	0	22.73	22.77	22.70
10	16QAM	1	0	21.83	21.74	21.81
10	16QAM	1	24	21.71	21.70	21.73
10	16QAM	1	49	21.63	21.63	21.70
10	16QAM	25	0	20.86	20.71	20.77
10	16QAM	25	12	20.69	20.67	20.57
10	16QAM	25	24	20.55	20.57	20.63
10	16QAM	50	0	20.61	20.59	20.56
Channel				23755	23790	23825
Frequency(MHz)				706.5	710	713.5
5	QPSK	1	0	23.33	23.34	23.39
5	QPSK	1	12	23.41	23.37	23.34
5	QPSK	1	24	23.35	23.31	23.35
5	QPSK	12	0	22.74	22.83	22.79
5	QPSK	12	6	22.82	22.78	22.69
5	QPSK	12	11	22.64	22.72	22.75
5	QPSK	25	0	22.80	22.75	22.71
5	16QAM	1	0	21.74	21.70	21.81
5	16QAM	1	12	21.75	21.69	21.74
5	16QAM	1	24	21.65	21.58	21.59
5	16QAM	12	0	20.74	20.73	20.77
5	16QAM	12	6	20.69	20.58	20.71
5	16QAM	12	11	20.72	20.82	20.79
5	16QAM	25	0	20.63	20.60	20.74

WLAN 2.4GHz Band Conducted Power

Channel/Freq.(MHz)	Peak Power (dBm) for Data Rates (Mbps)		
	802.11b	802.11g	802.11n(HT20)
1(2412)	16.88	16.40	16.01
6(2437)	17.20	16.63	16.21
11(2462)	16.94	16.51	16.10
Channel	802.11n(HT40)		
3(2422)	15.70		
6(2437)	15.77		
9(2452)	15.62		

Bluetooth Conducted Power

Channel	Frequency (MHz)	BT3.0 Output Power(dBm)		
		GFSK	π /4-DQPSK	8-DPSK
CH 0	2402	6.29	5.67	5.70
CH 39	2441	6.79	6.20	6.16
CH 78	2480	7.34	6.66	6.47
Channel	Frequency (MHz)	BT4.0 Output Power(dBm)		
		GFSK		
CH 0	2402	0.94		
CH 20	2442	1.24		
CH 39	2480	0.97		

Note:

1. Per KDB248227 D01 v02r02, choose the highest output power channel to test SAR and determine further SAR exclusion
2. For each frequency band, testing at higher data rates and higher order modulations is not required when the maximum average output power for each of these configurations is less than 1/4dB higher than those measured at lowest data rate
3. Per KDB248227 D01 v02r02, 802.11g /11n-HT20/11n-HT40 is not required. . 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 ≤1.2W/Kg. Thus the SAR can be excluded.

Stand alone SAR Exclusion &Estimated SAR valuation

1. Per KDB 447498 D01v06, the 1-g and 10-g SAR test exclusion thresholds for 100MHz to 6GHz at test separation distances ≤ 50mm are determined by:[(max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)] • [$\sqrt{f}$ (GHz)] ≤3.0 for 1-g SAR and ≤7.5 for 10-g extremity SAR
   (1) f(GHz) is the RF channel transmit frequency in GHz
   (2) Power and distance are round to the nearest mW and mm before calculation
   (3) The result is rounded to one decimal place for comparison
   (4) If the test separation distance(antenna-user) is < 5mm, 5mm is used for excluded SAR calculation

Bluetooth Max Tune up Power (dBm)	mW	Test Distance (mm)	Frequency(Ghz)	Calculation result	Exclusion Thresholds
7.5	5.62	5	2.4	1.76	3.0

2. Estimated SAR

(*max. power of channel, including tune-up tolerance, mW*)/(*min. test separation distance, mm*)]·[$\sqrt{f_{(GHz)}}/x$] W/kg for *test separation distances* ≤ 50 mm;

Bluetooth Max Tune up Power (dBm)	mW	Test Distance (mm)	Frequency(Ghz)	BT Estimated SAR(W/kg)
7.5	5.62	5	2.4	0.23

The estimated SAR value is used for simultaneous transmission analysis.

General Note:

1. Per KDB 447498 D01v06, the reported SAR is the measured SAR value adjusted for maximum tune-up tolerance.
2. Per KDB447498 D01v06, 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≤ 100MHz. When the maximum output power variation across the required test channels is > ½ dB, instead of the middle channel, the highest output power channel must be used.
3. Per KDB 865664 D01v01r04,for each frequency band, repeated SAR measurement is required only when the measured SAR is ≥0.8W/Kg; if the deviation among the repeated measurement is ≤20%,and the measured SAR <1.45W/Kg,only one repeated measurement is required.
4. Per KDB865664 D02 v01r02, SAR plot is only required for the highest measured SAR in each exposure configuration, wireless mode and frequency band combination; Plots are also required when the measured SAR is > 1.5 W/kg, or > 7.0 W/kg for occupational exposure. The published RF exposure KDB procedures may require additional plots; for example, to support SAR to peak location separation ratio test exclusion and/or volume scan post-processing(Refer to appendix D for details).
5. Per KDB941225 D01 v03r01, when the maximum output power and tune-up tolerance specified for production units in a secondary mode is ≤ ¼ dB higher than the primary mode or when the highest reported SAR of the primary mode is scaled by the ratio of specified maximum output power and tune-up tolerance of secondary to primary mode and the adjusted SAR is ≤ 1.2 W/kg, SAR measurement is not required for the secondary mode.
6. Per KDB248227 D01 v02r02, 802.11g /11n-HT20/11n-HT40 is not required. 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 ≤1.2W/Kg. Thus the SAR can be excluded.

9.3. Scaling Factor calculation

Operation Mode	Channel	Output Power(dBm)	Tune up Power in tolerance(dBm)	Scaling Factor
WCDMA850	4132	**22.84**	22.5 ± 1.0	1.164
	4183	22.76	22.5 ± 1.0	1.186
	4233	22.61	22.5 ± 1.0	1.227
WCDMA1900	9262	22.63	22.5 ± 1.0	1.221
	9400	**22.86**	22.5 ± 1.0	1.159
	9538	22.79	22.5 ± 1.0	1.178
LTE B2 20MHz 1RB#49	18700	23.24	23.0 ± 1.0	1.191
	18900	23.31	23.0 ± 1.0	1.172
	19100	**23.35**	23.0 ± 1.0	1.161
LTE B2 20MHz 50RB#0	18700	**22.64**	22.5 ± 1.0	1.219
	18900	22.55	22.5 ± 1.0	1.245
	19100	22.53	22.5 ± 1.0	1.250
LTE B4 20MHz 1RB#0	20050	23.52	23.0 ± 1.0	1.117
	20175	**23.56**	23.0 ± 1.0	1.107
	20300	23.55	23.0 ± 1.0	1.109
LTE B4 20MHz 50RB#0	20050	22.75	22.5 ± 1.0	1.189
	20175	**22.86**	22.5 ± 1.0	1.159
	20300	22.85	22.5 ± 1.0	1.161
LTE B5 20MHz 1RB#0	20450	**23.28**	23.0 ± 1.0	1.180
	20525	23.25	23.0 ± 1.0	1.189
	20600	23.23	23.0 ± 1.0	1.194
LTE B5 20MHz 25RB#0	20450	22.72	22.5 ± 1.0	1.196
	20525	22.71	22.5 ± 1.0	1.199
	20600	**22.76**	22.5 ± 1.0	1.186
LTE B7 20MHz 1RB#49	20850	23.32	23.0 ± 1.0	1.169
	21100	**23.34**	23.0 ± 1.0	1.164
	21350	23.27	23.0 ± 1.0	1.183
LTE B7 20MHz 50RB#0	20850	22.62	22.5 ± 1.0	1.225
	21100	**22.75**	22.5 ± 1.0	1.189
	21350	22.67	22.5 ± 1.0	1.211
LTE B17 10MHz 1RB#49	23780	23.38	23.0 ± 1.0	1.153
	23790	23.38	23.0 ± 1.0	1.153
	23800	23.44	23.0 ± 1.0	1.137

LTE B17 10MHz 25RB#0	23780	22.76	22.5 ± 1.0	1.186
	23790	**22.77**	22.5 ± 1.0	1.183
	23800	22.72	22.5 ± 1.0	1.197
WIFI 802.11b	1	16.88	16.5 ± 1.0	1.153
	6	17.20	16.5 ± 1.0	1.072
	11	16.94	16.5 ± 1.0	1.138
BT	78	7.34	6.5 ± 1.0	1.038

Note: for LTE power tolerance, only QPSK modulation mode was provide here.

10 TEST RESULTS

10.1 Summary of SAR Measurement Results

Note: 1. wifi SAR was performed at 6 Edge position with 5mm separation distance without the external shell. WWAN SAR testing was performed with external shell

Table 5: SAR Values of WCDMA850

Temperature: 23.0~23.5°C, humidity: 62~64%.						
Test Positions		Channel /Frequency (MHz)	SAR(W/Kg), 1.6 (1g average)			Plot No.
			SAR(W/Kg), 1g	Scaled Factor	Scaled SAR(W/Kg),1 g	
Body-Support (5mm Separation)	EUT with shell(External)	4132/824.6	**0.118**	1.164	**0.14**	1
		4183/836.6	0.109	1.186	0.13	**-**
		4233/846.6	0.098	1.227	0.12	-

Table 6: SAR Values of WCDMA1900

Temperature: 23.0~23.5°C, humidity: 62~64%.						
Test Positions		Channel /Frequency (MHz)	SAR(W/Kg), 1.6 (1g average)			Plot No.
			SAR(W/Kg), 1g	Scaled Factor	Scaled SAR(W/Kg),1 g	
Body-Support (5mm Separation)	EUT with shell(External)	9262/1852.4	0.620	1.221	0.76	--
		9400/1880	**0.733**	1.159	**0.85**	2
		9538/1907.6	0.700	1.178	0.82	

Table 7: SAR Values of LTE Band 2, 20MHz, QPSK

Temperature: 23.0~23.5°C, humidity: 62~64%.						
Test Positions		Channel /Frequency (MHz)	SAR(W/Kg), 1.6 (1g average)			Plot No.
			SAR(W/Kg),1g	Scaled Factor	Scaled SAR(W/Kg),1 g	
1RB #49						
Body-Support (5mm Separation)	EUT with shell(External)	18700/1860	0.608	1.191	0.72	--
		18900/1880	0.642	1.172	075	--
		19100/1900	**0.701**	1.161	**0.81**	3
50%RB #0						
Body-Support (5mm Separation)	EUT with shell(External)	18700/1860	0.568	1.219	0.69	--
		18700/1880	0.581	1.245	0.72	--
		18700/1900	0.608	1.250	0.76	--

Table 8: SAR Values of LTE Band 4, 20MHz, QPSK

Temperature: 23.0~23.5°C, humidity: 62~64%.						
Test Positions		Channel /Frequency (MHz)	SAR(W/Kg), 1.6 (1g average)			Plot No.
			SAR(W/Kg),1g	Scaled Factor	Scaled SAR(W/Kg),1g	
1RB #49						
Body-Support (5mm Separation)	EUT with shell(External)	20050/1720	0.051	1.117	0.06	--
		20175/1732.5	**0.074**	1.107	**0.08**	4
		20300/1745	0.066	1.109	0.07	--
50%RB #0						
Body-Support (5mm Separation)	EUT with shell(External)	20050/1720	0.049	1.189	0.06	--
		20175/1732.5	0.066	1.159	0.08	--
		20300/1745	0.048	1.161	0.06	--

Table 9: SAR Values of LTE Band 5 , 20MHz, QPSK

Temperature: 23.0~23.5°C, humidity: 62~64%.						
Test Positions		Channel /Frequency (MHz)	SAR(W/Kg), 1.6 (1g average)			Plot No.
			SAR(W/Kg),1g	Scaled Factor	Scaled SAR(W/Kg),1g	
1RB #49						
Body-Support (5mm Separation)	EUT with shell(External)	20450/829	**0.121**	1.180	**0.14**	5
		20525/836.5	0.069	1.189	0.08	--
		20600/844	0.056	1.194	0.07	--
50%RB #0						
Body-Support (5mm Separation)	EUT with shell(External)	20450/829	0.041	1.196	0.05	--
		20525/836.5	0.055	1.199	0.07	--
		20600/844	0.101	1.186	0.12	--

Table 10: SAR Values of LTE Band 7,20MHz, QPSK

Temperature: 23.0~23.5°C, humidity: 62~64%.						
Test Positions		Channel /Frequency (MHz)	SAR(W/Kg), 1.6 (1g average)			Plot No.
			SAR(W/Kg), 1g	Scaled Factor	Scaled SAR(W/Kg),1g	
1RB #49						
Body-Support (5mm Separation)	EUT with shell(External)	20850/2510	0.158	1.169	0.18	--
		21100/2535	**0.201**	1.164	**0.23**	6
		21350/2560	0.179	1.183	0.21	--
50%RB #0						
Body-Support (5mm Separation)	EUT with shell(External)	20850/2510	0.111	1.225	0.14	--
		21100/2535	0.159	1.189	0.19	--
		21350/2560	0.081	1.211	0.10	--

Table 11: SAR Values of LTE Band 17,10MHz, QPSK

Temperature: 23.0~23.5°C, humidity: 62~64%.						
Test Positions		Channel /Frequency (MHz)	SAR(W/Kg), 1.6 (1g average)			Plot No.
			SAR(W/Kg),1 g	Scaled Factor	Scaled SAR(W/Kg),1 g	
1RB #49						
Body-Support (5mm Separation)	EUT with shell(External)	23780/709	0.093	1.153	0.11	--
		23790/710	0.089	1.153	0.10	--
		23800/711	**0.116**	1.137	**0.13**	7
50%RB #0						
Body-Support (5mm Separation)	EUT with shell(External)	23780/709	0.101	1.186	0.12	--
		23790/710	0.086	1.183	0.10	--
		23800/711	0.088	1.197	0.11	--

Table 12: SAR Values of Wi-Fi 802.11b

Test Positions		Channel /Frequency (MHz)	SAR(W/Kg), 1.6 (1g average)			Plot No.
			SAR(W/Kg1g Peak)	Scaled Factor	Scaled SAR(W/Kg), 1g	
Body-Support (5mm Separation)	Face Upward	6/2437	0.021	1.072	0.02	--
	Back Upward	6/2437	0.034	1.072	0.04	--
	Edge A	6/2437	0.126	1.072	0.14	--
	Edge B	6/2437	0.016	1.072	0.02	--
	Edge C	6/2437	0.011	1.072	0.01	--
	Edge D	6/2437	**0.176**	1.072	**0.19**	8
	Edge D (with shell)	6/2437	0.028	1.072	0.03	--

Note: When the 1-g SAR for the mid-band channel or the channel with the Highest output power satisfy the following conditions, testing of the other channels in the band is not required.(Per KDB 447498 D01 General RF Exposure Guidance v06)

• ≤ 0.8 W/kg, when the transmission band is ≤ 100 MHz
• ≤ 0.6 W/kg, when the transmission band is between 100 MHz and 200 MHz
• ≤ 0.4 W/kg, when the transmission band is ≥ 200 MHz

10.2 Simultaneous SAR Evaluation

Localized Specific Absorption Rate (SAR) of this portable wireless device has been measured in all cases requested by the relevant standards cited in Clause 6 of this report. Maximum localized SAR is **below** exposure limits specified in the relevant standards.

Simultaneous Transmission analysis:

No.	Transmitter Combinations	Scenario Supported or not
1	WCDMA(Data) +wifi	Yes
2	LTE(Data)+wifi	Yes
3	LTE(Data)+WCDMA(Data)	No
4	WIFI+BT	No
5	WCDMA(Data) +wifi+BT	No
6	LTE(Data)+wifi+BT	No

Simultaneous SAR Calculation

Test Position		body
Body-Support 5mm separation MAX 1-g SAR(W/Kg)	WCDMA850	0.14
	WCDMA1900	0.85
	LTE Band2	0.81
	LTE Band4	0.08
	LTE Band5	0.14
	LTE Band7	0.23
	LTE Band17	0.13
	WIFI 802.11b	0.19
	BT	0.23
Simultaneous BT ∑1-g SAR(W/Kg)		1.08
Simultaneous WiFi ∑1-g SAR(W/Kg)		1.04

Simultaneous Tx Combination of GSM/WCDMA/LTE and BT/WIFI (Body).

The estimated SAR value with * Signal

SAR to Peak Location Separation Ratio (SPLSR)

As the Sum of the SAR is not greater than 1.6 W/kg SPLSR assessment is not required

11 Measurement Uncertainty

No.	Uncertainty Component	Type	Uncertainty Value (%)	Probability Distribution	k	ci	Standard Uncertainty (%) ui(%)	Degree of freedom Veff or vi
	Measurement System							
1	– Probe Calibration	B	5.8	N	1	1	5.8	∞
2	– Axial isotropy	B	3.5	R	$\sqrt{3}$	0.5	1.43	∞
3	– Hemispherical Isotropy	B	5.9	R	$\sqrt{3}$	0.5	2.41	∞
4	– Boundary Effect	B	1	R	$\sqrt{3}$	1	0.58	∞
5	– Linearity	B	4.7	R	$\sqrt{3}$	1	2.71	∞
6	– System Detection Limits	B	1.0	R	$\sqrt{3}$	1	0.58	∞
7	Modulation response	B	3	N	1	1	3.00	
8	– Readout Electronics	B	0.5	N	1	1	0.50	∞
9	– Response Time	B	1.4	R	$\sqrt{3}$	1	0.81	∞
10	– Integration Time	B	3.0	R	$\sqrt{3}$	1	1.73	∞
11	– RF Ambient Conditions	B	3.0	R	$\sqrt{3}$	1	1.73	∞
12	– Probe Position Mechanical tolerance	B	1.4	R	$\sqrt{3}$	1	0.81	∞
13	– Probe Position with respect to Phantom Shell	B	1.4	R	$\sqrt{3}$	1	0.81	∞
14	– Extrapolation, Interpolation and Integration Algorithms for Max. SAR evaluation	B	2.3	R	$\sqrt{3}$	1	1.33	∞
	Uncertainties of the DUT							
15	– Position of the DUT	A	2.6	N	$\sqrt{3}$	1	2.6	5
16	– Holder of the DUT	A	3	N	$\sqrt{3}$	1	3.0	5

17	– Output Power Variation –SAR drift measurement	B	5.0	R	$\sqrt{3}$	1	2.89	∞
Phantom and Tissue Parameters								
18	– Phantom Uncertainty(shape and thickness tolerances)	B	4	R	$\sqrt{3}$	1	2.31	∞
19	Uncertainty in SAR correction for deviation(in permittivity and conductivity)	B	2	N	1	1	2.00	
20	– Liquid Conductivity Target –tolerance	B	2.5	R	$\sqrt{3}$	0.6	1.95	∞
21	– Liquid Conductivity –measurement Uncertainty)	B	4	N	$\sqrt{3}$	1	0.92	9
22	– Liquid Permittivity Target tolerance	B	2.5	R	$\sqrt{3}$	0.6	1.95	∞
23	– Liquid Permittivity –measurement uncertainty	B	5	N	$\sqrt{3}$	1	1.15	∞
Combined Standard Uncertainty				RSS			10.63	
Expanded uncertainty (Confidence interval of 95 %)				K=2			21.26	

System Check Uncertainty

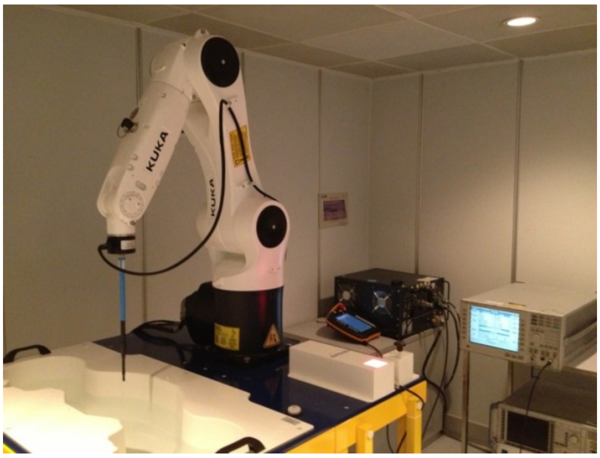
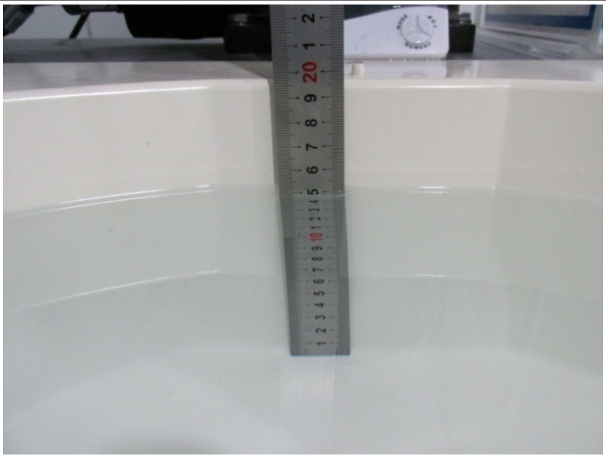
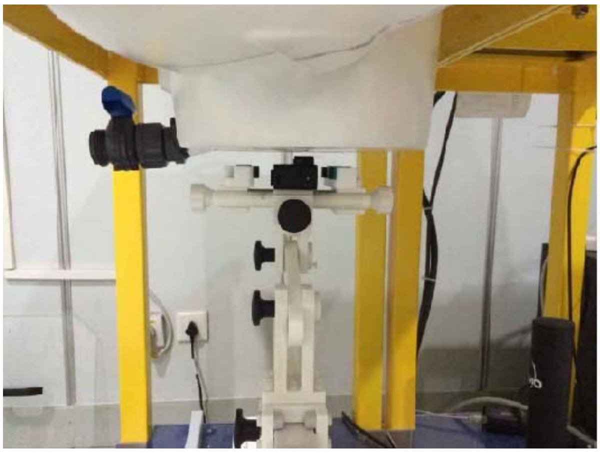
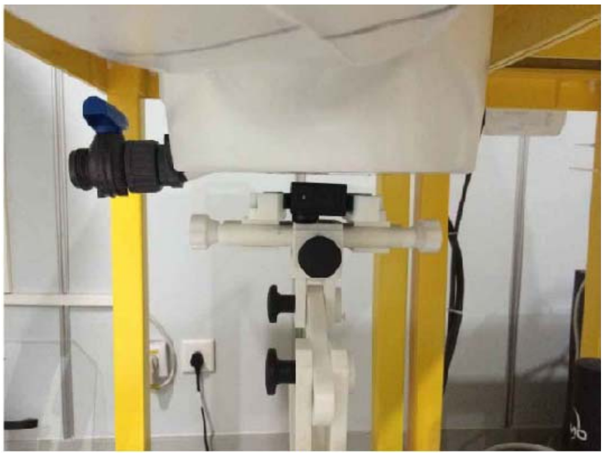
No.	Uncertainty Component	Type	Uncertainty Value (%)	Probability Distribution	k	ci	Standard Uncertainty (%) ui(%)	Degree of freedom Veff or vi
	Measurement System							
1	– Probe Calibration	B	5.8	N	1	1	5.8	∞
2	– Axial isotropy	B	3.5	R	$\sqrt{3}$	0.5	1.43	∞
3	—Hemispherical Isotropy	B	5.9	R	$\sqrt{3}$	0.5	2.41	∞
4	– Boundary Effect	B	1	R	$\sqrt{3}$	1	0.58	∞
5	– Linearity	B	4.7	R	$\sqrt{3}$	1	2.71	∞
6	– System Detection Limits	B	1	R	$\sqrt{3}$	1	0.58	∞
7	Modulation response	B	0	N	1	1	0.00	

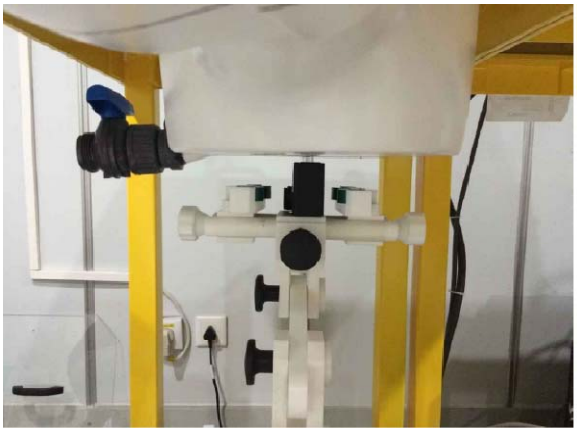
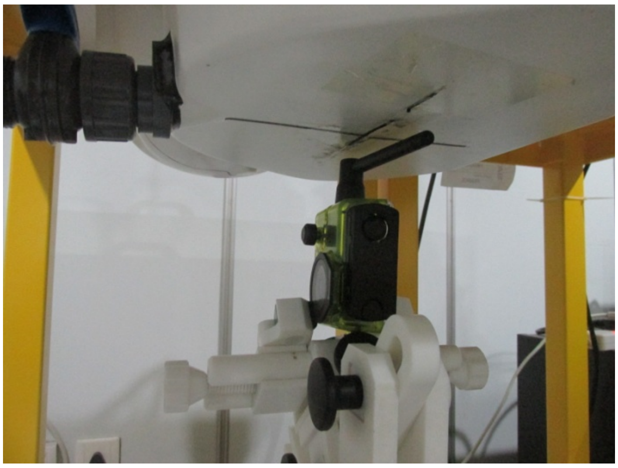
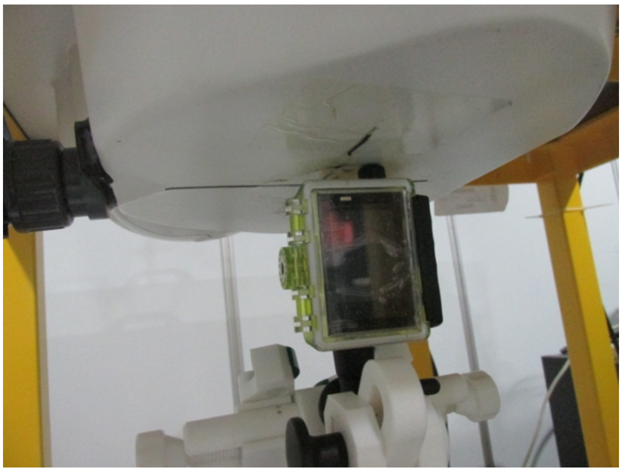
8	– Readout Electronics	B	0.5	N	1	1	0.50	∞
9	– Response Time	B	0.00	R	$\sqrt{3}$	1	0.00	∞
10	– Integration Time	B	1.4	R	$\sqrt{3}$	1	0.81	∞
11	– RF Ambient Conditions	B	3.0	R	$\sqrt{3}$	1	1.73	∞
12	– Probe Position Mechanical tolerance	B	1.4	R	$\sqrt{3}$	1	0.81	∞
13	– Probe Position with respect to Phantom Shell	B	1.4	R	$\sqrt{3}$	1	0.81	∞
14	– Extrapolation, Interpolation and Integration Algorithms for Max. SAR evaluation	B	2.3	R	$\sqrt{3}$	1	1.33	∞
	Uncertainties of the DUT							
15	Deviation of experimental source from numberical source	A	4	N	1	1	4.00	5
16	Input Power and SAR drift measurement	A	5	R	$\sqrt{3}$	1	2.89	5
17	Dipole Axis to Liquid Distance	B	2	R	$\sqrt{3}$	1	1.2	∞
Phantom and Tissue Parameters								
18	– Phantom Uncertainty(shape and thickness tolerances)	B	4	R	$\sqrt{3}$	1	2.31	∞
19	Uncertainty in SAR correction for deviation(in permittivity and conductivity)	B	2	N	1	1	2.00	
20	– Liquid Conductivity Target –tolerance	B	2.5	R	$\sqrt{3}$	0.6	1.95	∞
21	– Liquid Conductivity –measurement Uncertainty)	B	4	N	$\sqrt{3}$	1	0.92	9
22	– Liquid Permittivity Target tolerance	B	2.5	R	$\sqrt{3}$	0.6	1.95	∞
23	– Liquid Permittivity –measurement uncertainty	B	5	N	$\sqrt{3}$	1	1.15	∞
Combined Standard Uncertainty				RSS			10.15	
Expanded uncertainty (Confidence interval of 95 %)				K=2			20.29	

12 MAIN TEST INSTRUMENTS

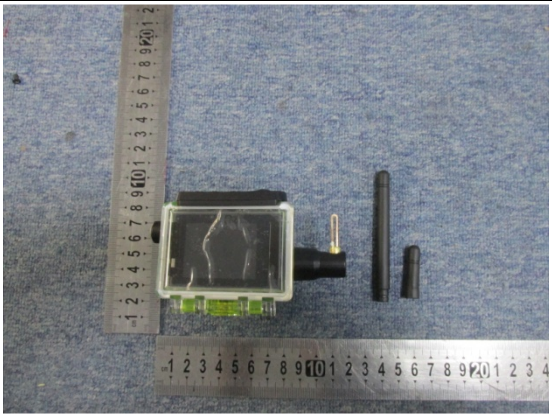
EQUIPMENT	TYPE	Series No.	Calibration Date	calibration period
System Simulator	E5515C	GB 47200710	2015/06/10	1 Year
System Simulator	CMW500	130805	2015/08/10	1 Year
SAR Probe	SATIMO	SN_0413_EP166	2015/08/10	1 Year
SAR Probe	SATIMO	SN09/13 EP169	2015/05/04	1 Year
Dipole	SID750	SN23/15 DIP0G750-378	2015/06/01	1 Year
Dipole	SID835	SN09/13 DIP0G835-217	2014/08/28	2 Year
Dipole	SID1800	SN09/13 DIP1G800-216	2014/08/28	2 Year
Dipole	SID1900	SN09/13 DIP1G900-218	2014/08/28	2 Year
Dipole	SID2450	SN09/13 DIP2G450-220	2014/08/28	2 Year
Dipole	SID2600	SN32/14 DIP2G600-338	2014/08/12	2 Year
Vector Network Analyzer	ZVB8	A0802530	2015/06/08	1 Year
Signal Generator	SMR27	A0304219	2015/06/08	1 Year
Power Meter	ML2495A	1421017	2015/06/02	1 Year
Power Sensor	MA2411B	1417208	2015/06/02	1 Year
Amplifier	Nucletudes	143060	2015/03/27	1 Year
Directional Coupler	DC6180A	305827	2015/03/27	1 Year
Multimeter	Keithley-2000	4014020	2015/03/27	1 Year

ANNEX A TEST SETUP

	
SAR Test System	**Liquid deep(15cm)**
	
Body Back Upward(5mm)	**Body Face Upward(5mm)**
	
Body Edge D(5mm)	**Body Edge C(5mm)**

	
Body Edge B(5mm)	**Body Edge A (5mm)**
	
With shell (external antenna)	**Body Edge D(with external shell) 5mm**

ANNEX B EUT Photos



ANNEX C SYSTEM CHECK

System Performance Check (Body, 750MHz)

Type: Validation measurement

Area scan resolution: dx=8mm,dy=8mm

Zoom scan resolution: dx=8mm, dy=8mm, dz=5mm

Date of measurement: 17/11/2015

Measurement duration: 20 minutes 12 seconds

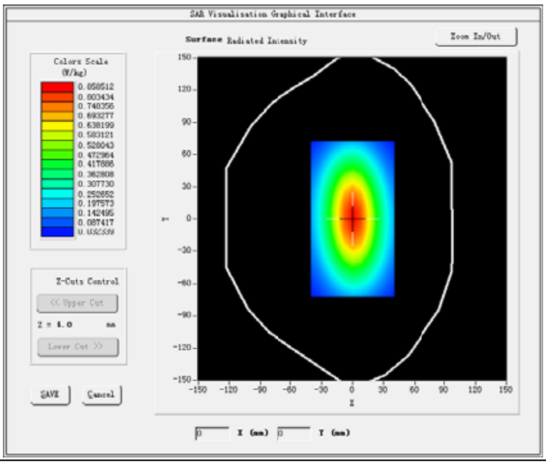
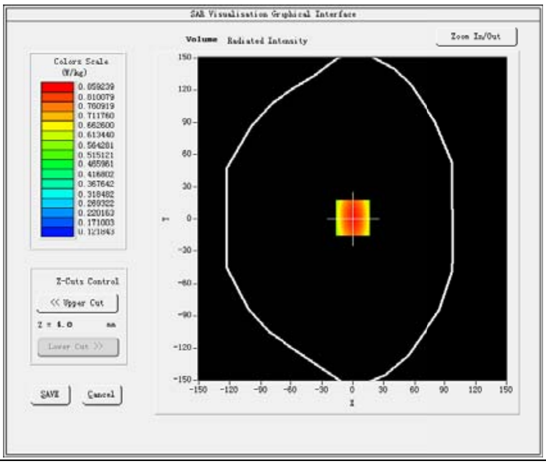
A. Experimental conditions.

Phantom File	dx=8mm dy=8mm
Phantom	5x5x7,dx=8mm dy=8mm dz=5mm
Device Position	Dipole
Band	750MHz
Signal	CW

B. SAR Measurement Results

Band SAR

E-Field Probe	SATIMO SN_09/13_EP169
Frequency (MHz)	750
Relative permittivity (real part)	55.01
Relative permittivity	22.80
Conductivity (S/m)	0.95
Power drift (%)	-3.08
Ambient Temperature:	22.2°C
Liquid Temperature:	22.5°C
ConvF:	5.41
Duty factor:	1:1

SURFACE SAR	VOLUME SAR
	

Maximum location: X=0.00, Y=1.00

SAR 10g (W/Kg)	0.996423
SAR 1g (W/Kg)	2.012576

System Performance Check (Body, 850MHz)

Type: Validation measurement

Area scan resolution: dx=8mm,dy=8mm

Zoom scan resolution: dx=8mm, dy=8mm, dz=5mm

Date of measurement: 17/11/2015

Measurement duration: 20 minutes 12 seconds

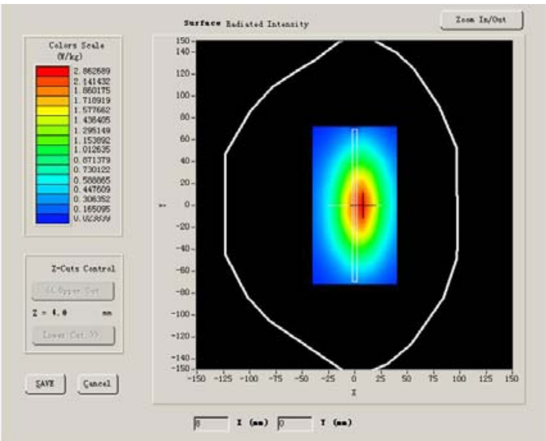
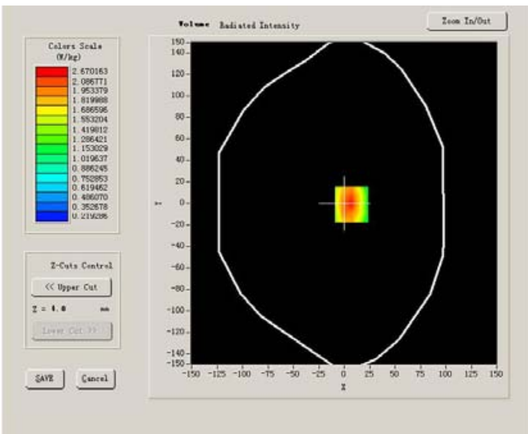
A. Experimental conditions.

Phantom File	dx=8mm dy=8mm
Phantom	5x5x7,dx=8mm dy=8mm dz=5mm
Device Position	Dipole
Band	835MHz
Channels	
Signal	CW

B. SAR Measurement Results

Band SAR

E-Field Probe	SATIMO SN_04/13_EP166
Frequency (MHz)	850
Relative permittivity (real part)	55.32
Relative permittivity	20.12
Conductivity (S/m)	0.95
Power drift (%)	-0.31
Ambient Temperature:	22.2°C
Liquid Temperature:	22.5°C
ConvF:	5.82
Duty factor:	1:1

SURFACE SAR	VOLUME SAR
	

Maximum location: X=7.00, Y=-1.00

SAR 10g (W/Kg)	1.631452
SAR 1g (W/Kg)	2.523687

System Performance Check (Body, 1800MHz)

Type: Phone measurement

Area scan resolution: dx=8mm,dy=8mm

Zoom scan resolution: dx=8mm, dy=8mm, dz=5mm

Date of measurement: 18/11/2015

Measurement duration: 20 minutes 06 seconds

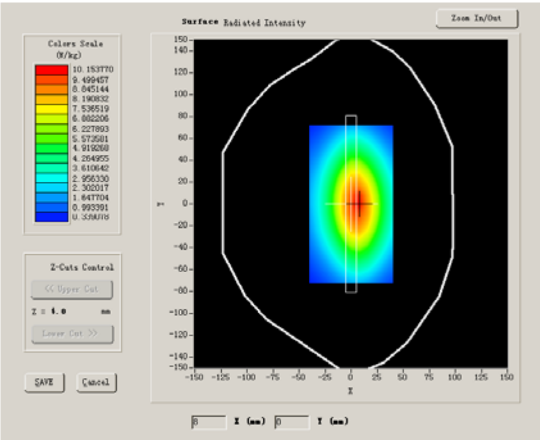
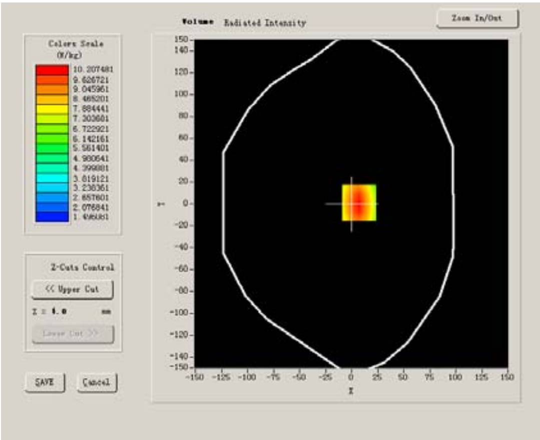
A. Experimental conditions.

Phantom File	dx=8mm dy=8mm
Phantom	5x5x7,dx=8mm dy=8mm dz=5mm
Device Position	Dipole
Band	1800MHz
Channels	
Signal	CW

B. SAR Measurement Results

Band SAR

E-Field Probe	SATIMO SN_04/13_EP166
Frequency (MHz)	1800
Relative permittivity (real part)	53.37
Relative permittivity	15.00
Conductivity (S/m)	1.50
Power drift (%)	-0.39
Ambient Temperature:	22.2°C
Liquid Temperature:	22.6°C
ConvF:	4.96
Crest factor:	1:1

SURFACE SAR	VOLUME SAR
	

Maximum location: X=7.00, Y=1.00

SAR 10g (W/Kg)	5.020572
SAR 1g (W/Kg)	9.831277

System Performance Check (Body, 1900MHz)

Type: Validation measurement

Area scan resolution: dx=8mm,dy=8mm

Zoom scan resolution: dx=8mm, dy=8mm, dz=5mm

Date of measurement: 18/11/2015

Measurement duration: 21 minutes 34 seconds

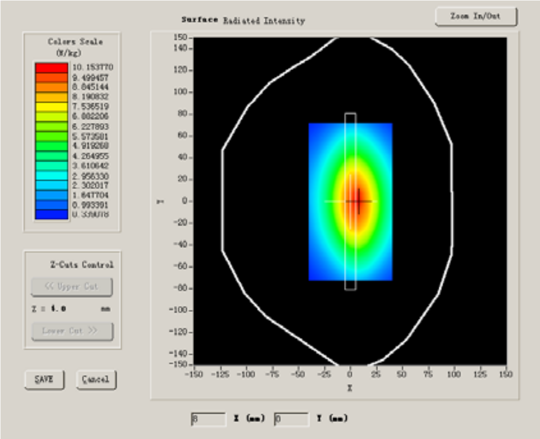
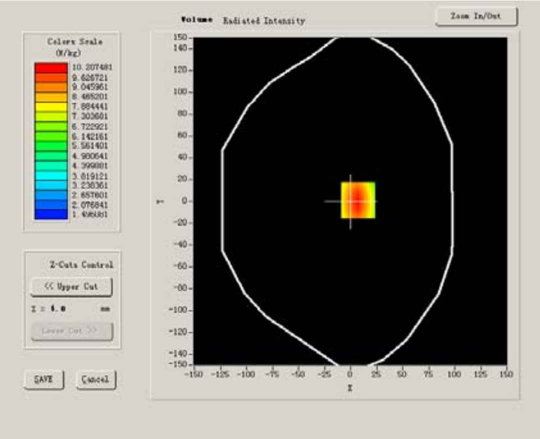
A. Experimental conditions.

Phantom File	dx=8mm dy=8mm
Phantom	5x5x7,dx=8mm dy=8mm dz=5mm
Device Position	Dipole
Band	1900MHz
Channels	
Signal	CW

B. SAR Measurement Results

Band SAR

E-Field Probe	SATIMO SN_04/13_EP166
Frequency (MHz)	1900
Relative permittivity (real part)	53.14
Relative permittivity	14.40
Conductivity (S/m)	1.52
Power Drift (%)	-0.68
Ambient Temperature:	22.1°C
Liquid Temperature:	22.6°C
ConvF:	5.43
Duty factor:	1:1

SURFACE SAR	VOLUME SAR
	

Maximum location: X=1.00, Y=6.00

SAR 10g (W/Kg)	5.268423
SAR 1g (W/Kg)	10.108358

System Performance Check (Body, 2450MHz)

Type: Phone measurement

Area scan resolution: dx=8mm,dy=8mm

Zoom scan resolution: dx=5mm, dy=5mm, dz=4mm

Date of measurement: 19/11/2015

Measurement duration: 22 minutes 21 seconds

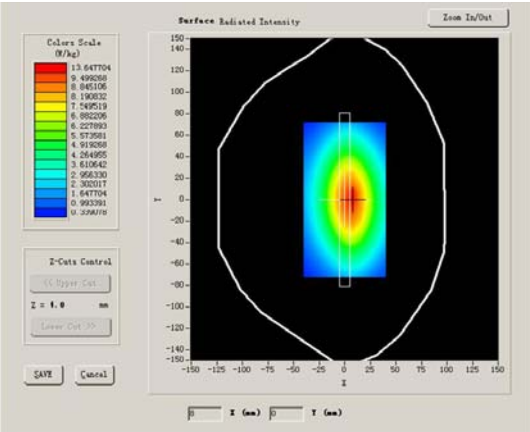
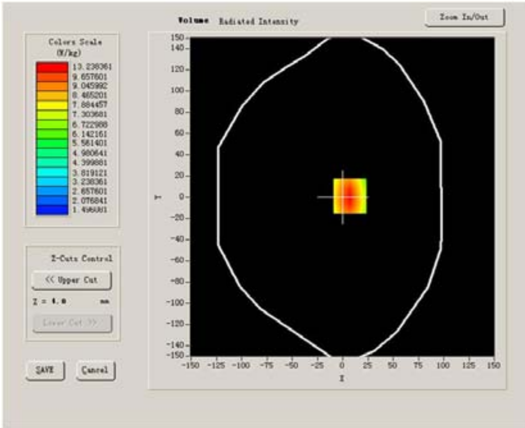
A. Experimental conditions.

Phantom File	dx=8mm dy=8mm
Phantom	7x7x8,dx=5mm dy=5mm dz=4mm
Device Position	Dipole
Band	2450MHz
Channels	
Signal	CW

B. SAR Measurement Results

Band SAR

E-Field Probe	SATIMO SN_04/13_EP166
Frequency (MHz)	2450
Relative permittivity (real part)	52.53
Relative permittivity	14.25
Conductivity (S/m)	1.94
Power Drift (%)	-0.31
Duty factor:	1:1
ConvF:	5.09

SURFACE SAR	VOLUME SAR
	

Maximum location: X=0.00, Y=8.00

SAR 10g (W/Kg)	6.050681
SAR 1g (W/Kg)	13.064876

System Performance Check (Body, 2600MHz)

Type: Phone measurement

Area scan resolution: dx=8mm,dy=8mm

Zoom scan resolution: dx=5mm, dy=5mm, dz=4mm

Date of measurement: 19/11/2015

Measurement duration: 22 minutes 24 seconds

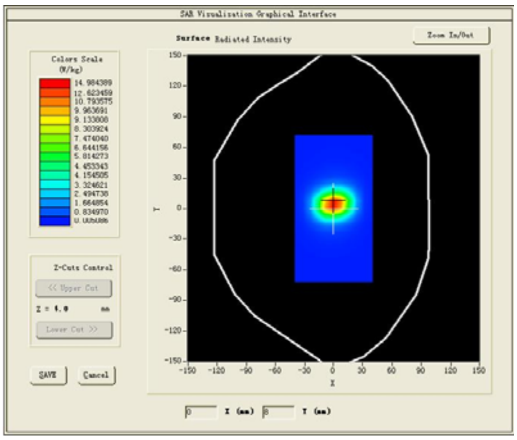
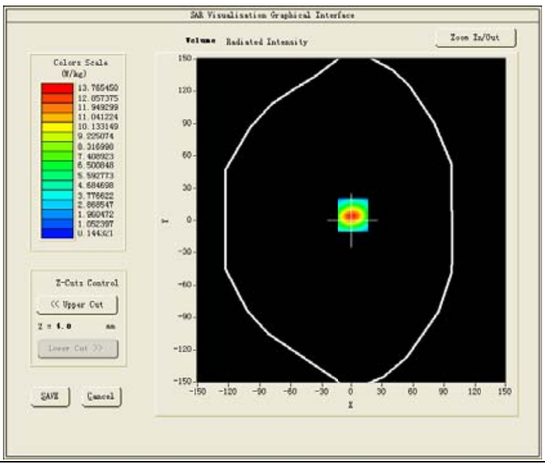
A. Experimental conditions.

Phantom File	dx=8mm dy=8mm
Phantom	7x7x8,dx=5mm dy=5mm dz=4mm
Device Position	Dipole
Band	2600MHz
Channels	
Signal	CW

B. SAR Measurement Results

Band SAR

E-Field Probe	SATIMO SN_04/13_EP166
Frequency (MHz)	2600
Relative permittivity (real part)	52.56
Relative permittivity	14.88
Conductivity (S/m)	2.15
Power drift (%)	1.35
Ambient Temperature:	22.2°C
Liquid Temperature:	22.5°C
Crest factor:	1:1
ConvF:	5.22

SURFACE SAR	VOLUME SAR
	

Maximum location: X=1.00, Y=4.00

SAR 10g (W/Kg)	5.987241
SAR 1g (W/Kg)	14.032842

Plot 1: WCDMA850, Body-Support , low

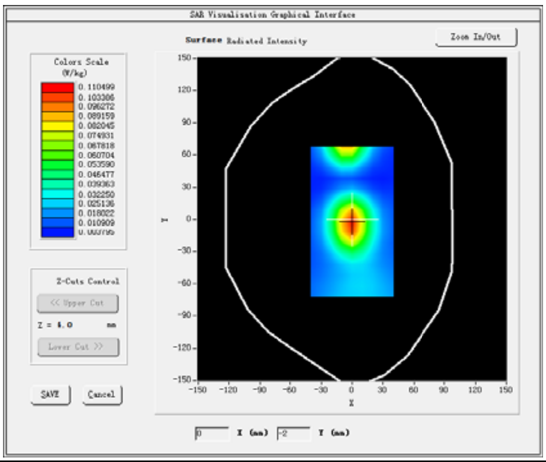
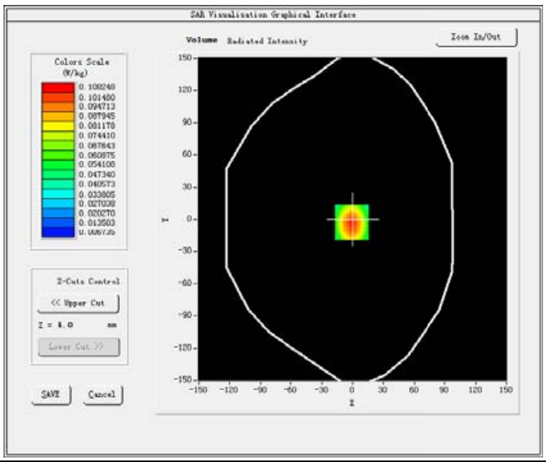
Type: Phone measurement
Date of measurement:17/11/2015
Measurement duration: 7 minutes 19 seconds
Mobile Phone IMEI number: --

A. Experimental conditions.

Area Scan	dx=8mm dy=8mm
ZoomScan	5x5x7,dx=8mm dy=8mm dz=5mm
Phantom	Validation plane
Device Position	
Band	Band5_WCDMA850
Channels	4132
Signal	WCDMA (Duty cycle: 1:1)

B. SAR Measurement Results

E-Field Probe	SATIMO SN_04/13_EP166
Frequency (MHz)	824.6
Relative permittivity (real part)	55.32
Relative permittivity (imaginary part)	20.12
Conductivity (S/m)	0.95
Variation (%)	-0.37
ConvF:	5.82

SURFACE SAR	VOLUME SAR
	

Maximum location: X=-1.00, Y=-3.00
SAR Peak: 0.15 W/kg

SAR 10g (W/Kg)	**0.06048**
SAR 1g (W/Kg)	**0.11854**

Plot 2: WCDMA1900, Body-Support, mid

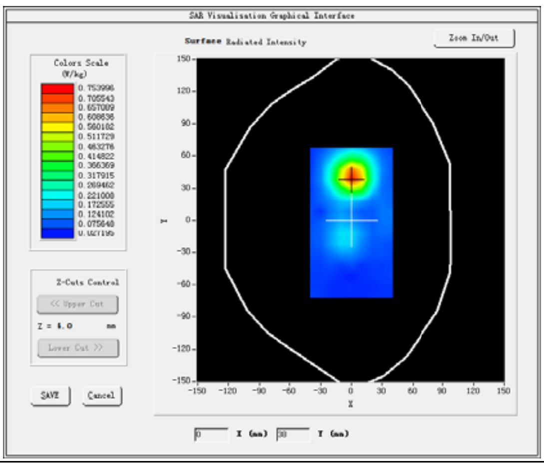
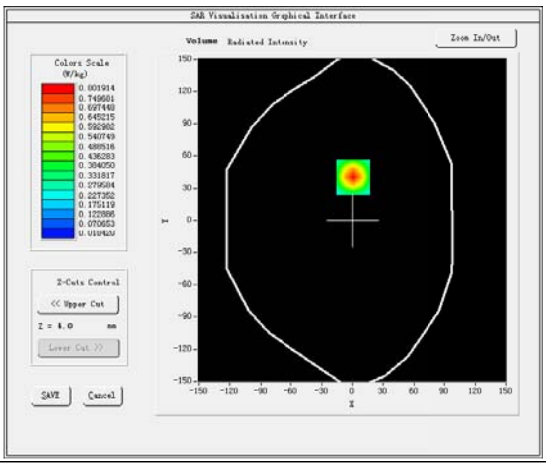
Type: Phone measurement
Date of measurement: 18/11/2015
Measurement duration: 7 minutes 14 seconds
Mobile Phone IMEI number: --

A. Experimental conditions.

Area Scan	dx=8mm dy=8mm
ZoomScan	5x5x7,dx=8mm dy=8mm dz=5mm
Phantom	Validation plane
Device Position	Back
Band	Band2_WCDMA1900
Channels	9400
Signal	WCDMA (Duty cycle: 1:1)

B. SAR Measurement Results

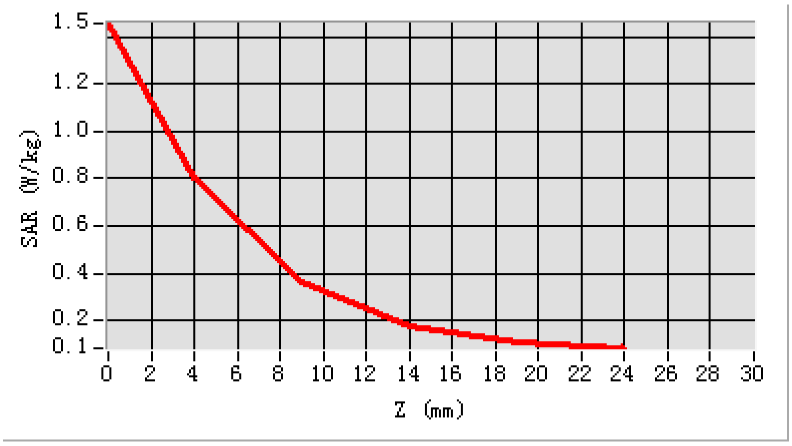
E-Field Probe	SATIMO SN_04/13_EP166
Frequency (MHz)	1880
Relative permittivity (real part)	53.14
Relative permittivity (imaginary	14.40
Conductivity (S/m)	1.52
Variation (%)	-4.51
ConvF:	5.43

SURFACE SAR	VOLUME SAR
	

Maximum location: X=-1.00, Y=40.00
SAR Peak: 1.46W/kg

SAR 10g (W/Kg)	0.36484
SAR 1g (W/Kg)	0.73359

Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	1.4581	0.8019	0.3618	0.1744	0.1077



Plot 3: LTE Band2, 20MHz, Body-Support, high

Type: Phone measurement

Date of measurement: 18/11/2015

Measurement duration: 7 minutes 13 seconds

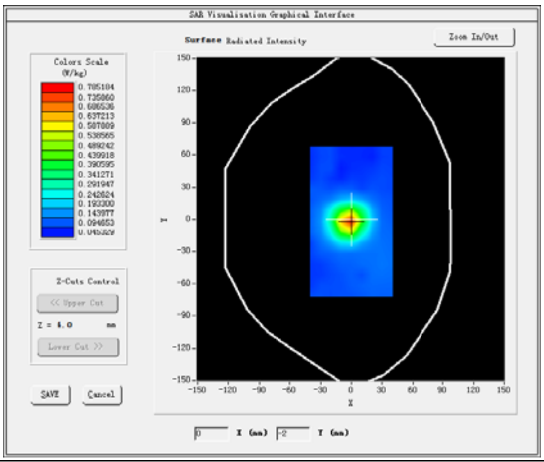
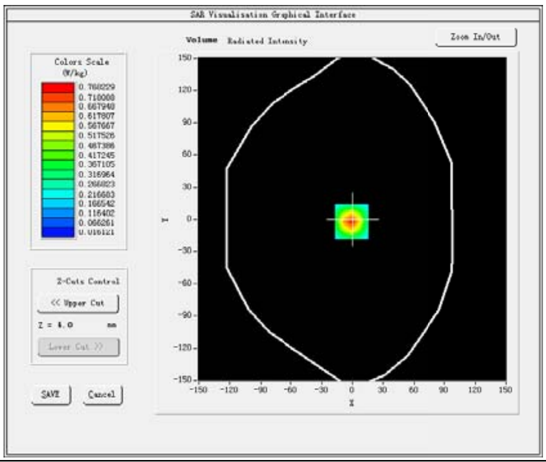
Mobile Phone IMEI number: --

A. Experimental conditions.

Area Scan	dx=8mm dy=8mm
ZoomScan	5x5x7,dx=8mm dy=8mm dz=5mm
Phantom	Validation plane
Device Position	Back
Band	LTE Band2
Channels	19100
Signal	Duty cycle: 1:1

B. SAR Measurement Results

E-Field Probe	SATIMO SN_04/13_EP166
Frequency (MHz)	1900
Relative permittivity (real part)	53.14
Relative permittivity (imaginary	14.40
Conductivity (S/m)	1.52
Variation (%)	-4.16
ConvF:	5.43

SURFACE SAR	VOLUME SAR
	

Maximum location: X=-1.00, Y=-2.00

SAR Peak: 1.38W/kg

SAR 10g (W/Kg)	0.33613
SAR 1g (W/Kg)	0.70105

Plot 4: LTE Band4, 20MHz, Body-Support , mid

Type: Phone measurement

Date of measurement: 17/7/2015

Measurement duration: 7 minutes 15 seconds

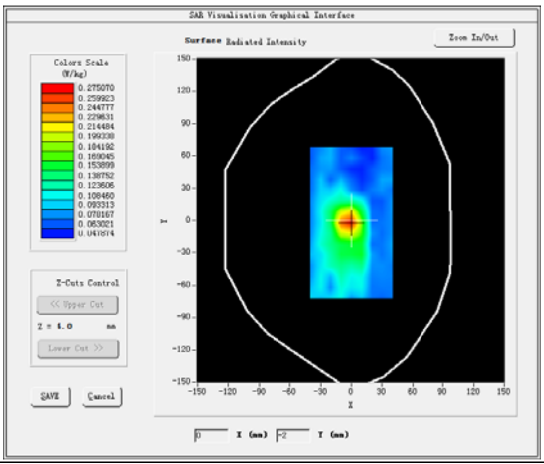
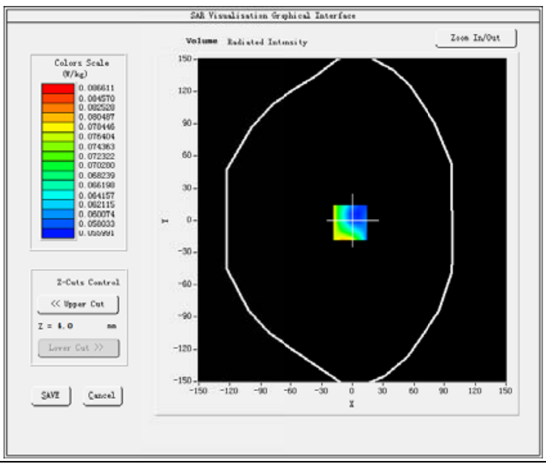
Mobile Phone IMEI number: --

A. Experimental conditions.

Area Scan	dx=8mm dy=8mm
ZoomScan	5x5x7,dx=8mm dy=8mm dz=5mm
Phantom	Validation plane
Device Position	
Band	LTE Band 4
Channels	20175
Signal	LTE (Duty cycle: 1:1)

B. SAR Measurement Results

E-Field Probe	SATIMO SN_04/13_EP166
Frequency (MHz)	1732.5
Relative permittivity (real part)	53.37
Relative permittivity (imaginary	15.00
Conductivity (S/m)	1.50
Variation (%)	4.70
ConvF:	4.96

SURFACE SAR	VOLUME SAR
	

Maximum location: X=2.00, Y=-2.00

SAR Peak: 0.08W/kg

SAR 10g (W/Kg)	0.07301
SAR 1g (W/Kg)	0.07432

Plot 5: LTE Band5, 20MHz, Body-Support, low

Type: Phone measurement

Date of measurement: 17/7/2015

Measurement duration: 7 minutes 17 seconds

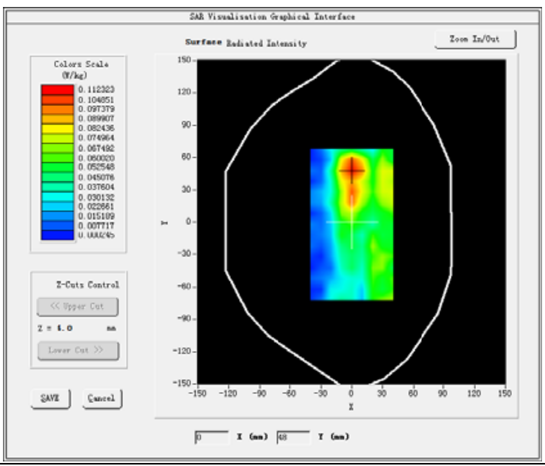
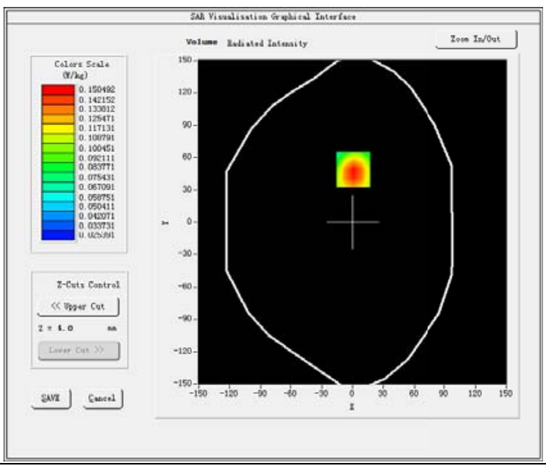
Mobile Phone IMEI number: --

A. Experimental conditions.

Area Scan	dx=8mm dy=8mm
ZoomScan	5x5x7,dx=8mm dy=8mm dz=5mm
Phantom	Validation plane
Device Position	Back
Band	LTE Band 5
Channels	20450
Signal	LTE (Duty cycle: 1:1)

B. SAR Measurement Results

E-Field Probe	SATIMO SN_04/13_EP166
Frequency (MHz)	829
Relative permittivity (real part)	55.32
Relative permittivity (imaginary	20.12
Conductivity (S/m)	0.95
Variation (%)	-0.42
ConvF:	5.82

SURFACE SAR	VOLUME SAR
	

Maximum location: X=0.00, Y=-10.00
SAR Peak: 0.22 W/kg

SAR 10g (W/Kg)	0.083845
SAR 1g (W/Kg)	0.141271

Plot 6: LTE Band 7, 20MHz, Body-Support, mid

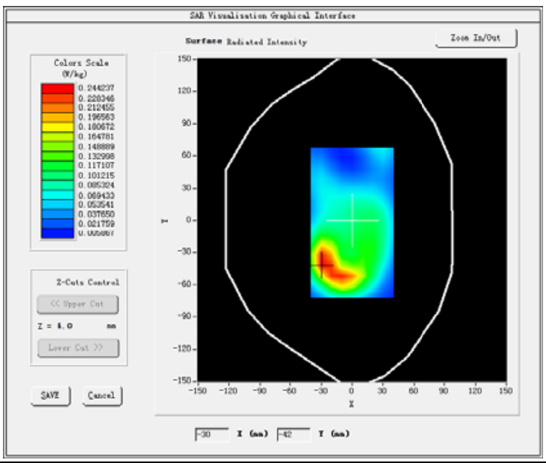
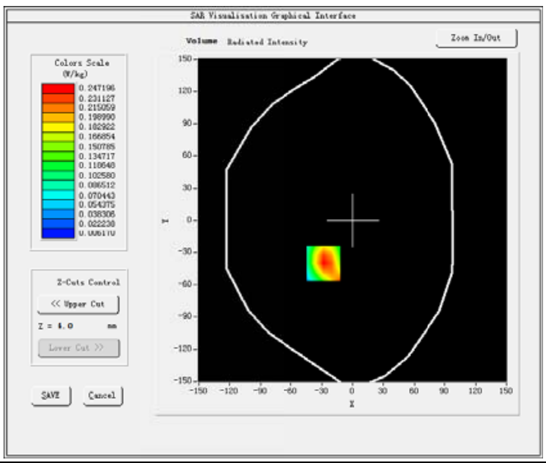
Type: Phone measurement
Date of measurement:19/11/2015
Measurement duration: 7 minutes 32 seconds
Mobile Phone IMEI number: --

A. Experimental conditions.

Area Scan	dx=8mm dy=8mm
ZoomScan	5x5x7,dx=8mm dy=8mm dz=5mm
Phantom	Validation plane
Device Position	Back
Band	LTE Band 7
Channels	2110
Signal	LTE (Duty cycle: 1:1)

B. SAR Measurement Results

E-Field Probe	SATIMO SN_04/13_EP166
Frequency (MHz)	2535
Relative permittivity (real part)	52.56
Relative permittivity (imaginary part)	14.88
Conductivity (S/m)	2.15
Variation (%)	-3.09
ConvF:	5.22

SURFACE SAR	VOLUME SAR
	

Maximum location: X=-28.00, Y=-40.00
SAR Peak: 0.37 W/kg

SAR 10g (W/Kg)	0.12101
SAR 1g (W/Kg)	0.20131

Plot 7: LTE Band 17, 10MHz, Body-Support , high

Type: Phone measurement

Date of measurement:17/11/2015

Measurement duration: 7 minutes 29 seconds

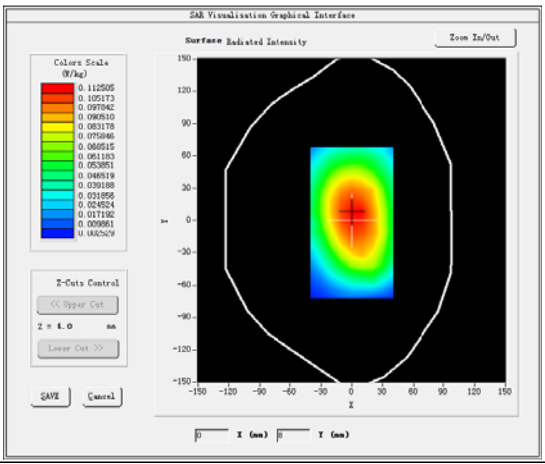
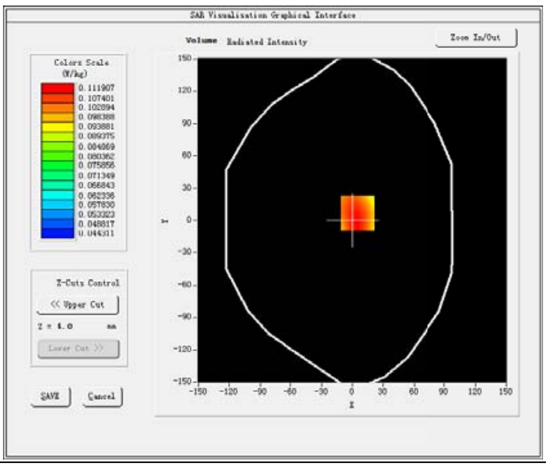
Mobile Phone IMEI number: --

A. Experimental conditions.

Area Scan	dx=8mm dy=8mm
ZoomScan	5x5x7,dx=8mm dy=8mm dz=5mm
Phantom	Validation plane
Device Position	Back
Band	LTE Band 17
Channels	23800
Signal	LTE (Duty cycle: 1:1)

B. SAR Measurement Results

E-Field Probe	SATIMO SN_09/13_EP169
Frequency (MHz)	711
Relative permittivity (real part)	55.01
Relative permittivity (imaginary part)	22.80
Conductivity (S/m)	0.95
Variation (%)	-0.59
ConvF:	5.41

SURFACE SAR	VOLUME SAR
	

Maximum location: X=5.00, Y=7.00

SAR 10g (W/Kg)	0.094251
SAR 1g (W/Kg)	0.116264

Plot 8:Wi-Fi 802.11b , Body-Support Edge D

Type: Phone measurement

Date of measurement: 19/11/2015

Measurement duration: 07 minutes 05 seconds

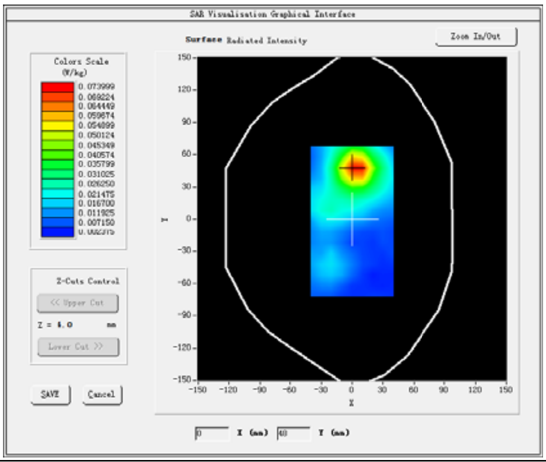
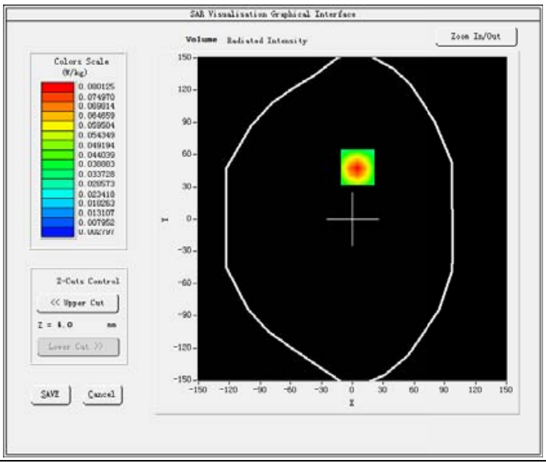
Mobile Phone IMEI number: --

A. Experimental conditions.

Area Scan	dx=8mm dy=8mm
ZoomScan	7x7x8,dx=5mm dy=5mm dz=4mm
Phantom	Validation plane
Device Position	Edge D
Band	IEEE 802.11b
Channels	6
Signal	DSSS (Crest factor: 1:1)

B. SAR Measurement Results

E-Field Probe	SATIMO SN_04/13_EP166
Frequency (MHz)	2437
Relative permittivity (real part)	52.53
Relative permittivity (imaginary part)	14.25
Conductivity (S/m)	1.94
Variation (%)	3.50
ConvF:	5.09

SURFACE SAR	VOLUME SAR
	

Maximum location: X=5.00, Y=48.00

SAR Peak: 0.13 W/kg

SAR 10g (W/Kg)	0.03907
SAR 1g (W/Kg)	0.07617

ANNEX D Calibration Certificate of Probe and Dipoles

COMOSAR E-Field Probe Calibration Report

Ref : ACR.227.15.14.SATU.A

CCIC SOUTHERN ELECTRONIC PRODUCT TESTING (SHENZHEN) CO., LTD
ELECTRONIC TESTING BUILDING, SHAHE ROAD, XILI TOWN
SHENZHEN, P.R. CHINA (POST CODE:518055)
SATIMO COMOSAR DOSIMETRIC E-FIELD PROBE
SERIAL NO.: SN 04/13 EP166

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

08/10/2015

Summary:

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

	Name	Function	Date	Signature
Prepared by :	Jérôme LUC	Product Manager	8/11/2015	JS
Checked by :	Jérôme LUC	Product Manager	8/11/2015	JS
Approved by :	Kim RUTKOWSKI	Quality Manager	8/11/2015	Kim Rutkowski

	Customer Name
Distribution :	CCIC SOUTHERN ELECTRONIC PRODUCT TESTING (SHENZHEN) Co., Ltd

Issue	Date	Modifications
A	8/11/2015	Initial release

TABLE OF CONTENTS

1 DEVICE UNDER TEST

Device Under Test	
Device Type	COMOSAR DOSIMETRIC E FIELD PROBE
Manufacturer	Satimo
Model	SSE5
Serial Number	SN 04/13 EP166
Product Condition (new / used)	Used
Frequency Range of Probe	0.7 GHz-3 GHz
Resistance of Three Dipoles at Connector	Dipole 1: R1=0.231 MΩ Dipole 2: R2=0.225 MΩ Dipole 3: R3=0.228 MΩ

A yearly calibration interval is recommended.

2 PRODUCT DESCRIPTION

2.1 GENERAL INFORMATION

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

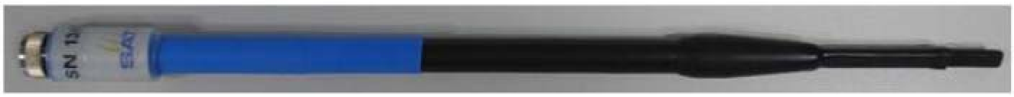


Figure 1 – *Satimo COMOSAR Dosimetric E field Dipole*

Probe Length	330 mm
Length of Individual Dipoles	4.5 mm
Maximum external diameter	8 mm
Probe Tip External Diameter	5 mm
Distance between dipoles / probe extremity	2.7 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 %

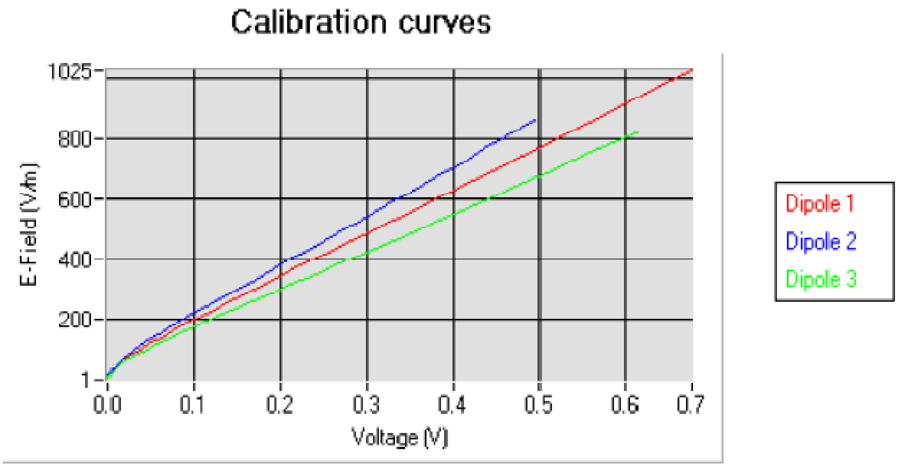
5.1 SENSITIVITY IN AIR

Normx dipole 1 ($\mu V/(V/m)^2$)	Normy dipole 2 ($\mu V/(V/m)^2$)	Normz dipole 3 ($\mu V/(V/m)^2$)
8.57	4.83	7.15

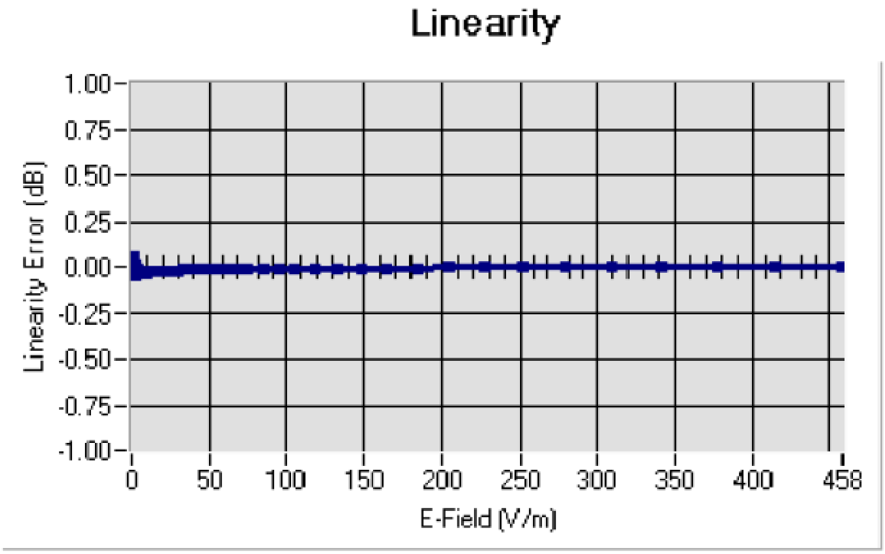
DCP dipole 1 (mV)	DCP dipole 2 (mV)	DCP dipole 3 (mV)
92	90	95

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:+/-1.55% (+/-0.07dB)

5.3 SENSITIVITY IN LIQUID

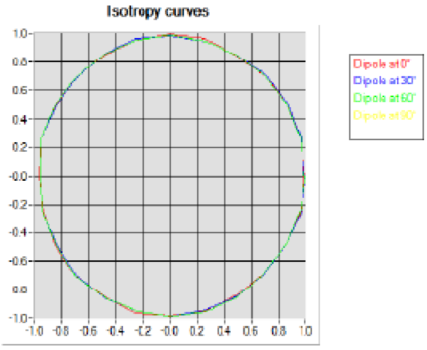
Liquid	Frequency (MHz +/- 100MHz)	Permittivity	Epsilon (S/m)	ConvF
HL850	835	42.80	0.89	5.69
BL850	835	53.45	0.96	5.82
HL900	900	42.47	0.96	5.34
BL900	900	56.68	1.08	5.55
HL1800	1800	41.30	1.38	4.75
BL1800	1800	53.27	1.51	4.96
HL1900	1900	41.09	1.42	5.25
BL1900	1900	54.20	1.54	5.43
HL2000	2000	39.72	1.43	4.81
BL2000	2000	53.90	1.53	4.95
HL2450	2450	39.05	1.77	4.93
BL2450	2450	52.98	1.93	5.09
HL2600	2600	38.35	1.92	5.08
BL2600	2600	51.82	2.19	5.22

LOWER DETECTION LIMIT: 7mW/kg

5.4 ISOTROPY

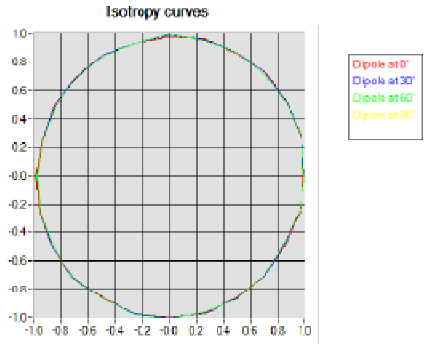
HL900 MHz

- Axial isotropy: 0.04 dB
- Hemispherical isotropy: 0.07 dB



HL1800 MHz

- Axial isotropy: 0.05 dB
- Hemispherical isotropy: 0.07 dB



6 LIST OF EQUIPMENT

Equipment Summary Sheet				
Equipment Description	**Manufacturer / Model**	**Identification No.**	**Current Calibration Date**	**Next Calibration Date**
Flat Phantom	Satimo	SN-20/09-SAM71	Validated. No cal required.	Validated. No cal required.
COMOSAR Test Bench	Version 3	NA	Validated. No cal required.	Validated. No cal required.
Network Analyzer	Rhode & Schwarz ZVA	SN100132	02/2013	02/2016
Reference Probe	Satimo	EP 94 SN 37/08	10/2014	10/2015
Multimeter	Keithley 2000	1188656	12/2013	12/2016
Signal Generator	Agilent E4438C	MY49070581	12/2013	12/2016
Amplifier	Aethercomm	SN 046	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Power Meter	HP E4418A	US38261498	12/2013	12/2016
Power Sensor	HP ECP-E26A	US37181460	12/2013	12/2016
Directional Coupler	Narda 4216-20	01386	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Waveguide	Mega Industries	069Y7-158-13-712	Validated. No cal required.	Validated. No cal required.
Waveguide Transition	Mega Industries	069Y7-158-13-701	Validated. No cal required.	Validated. No cal required.
Waveguide Termination	Mega Industries	069Y7-158-13-701	Validated. No cal required.	Validated. No cal required.
Temperature / Humidity Sensor	Control Company	11-661-9	8/2013	8/2016

COMOSAR E-Field Probe Calibration Report

Ref : ACR.125.1.15.SATU.A

CCIC SOUTHERN ELECTRONIC PRODUCT TESTING (SHENZHEN) CO., LTD
ELECTRONIC TESTING BUILDING, SHAHE ROAD, XILI TOWN
SHENZHEN, P.R. CHINA (POST CODE:518055)
MVG COMOSAR DOSIMETRIC E-FIELD PROBE
SERIAL NO.: SN 09/13 EP169

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

05/05/15

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.

	Name	*Function*	*Date*	*Signature*
Prepared by :	Jérôme LUC	Product Manager	5/5/2015	
Checked by :	Jérôme LUC	Product Manager	5/5/2015	
Approved by :	Kim RUTKOWSKI	Quality Manager	5/5/2015	Kim Rutkowski

	Customer Name
Distribution :	CCIC SOUTHERN ELECTRONIC PRODUCT TESTING (SHENZHEN) Co., Ltd

Issue	*Date*	*Modifications*
A	5/5/2015	Initial release

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1 DEVICE UNDER TEST

Device Under Test	
Device Type	COMOSAR DOSIMETRIC E FIELD PROBE
Manufacturer	MVG
Model	SSE5
Serial Number	SN 09/13 EP169
Product Condition (new / used)	Used
Frequency Range of Probe	0.7 GHz-3GHz
Resistance of Three Dipoles at Connector	Dipole 1: R1=0.222 MΩ Dipole 2: R2=0.232 MΩ Dipole 3: R3=0.221 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.

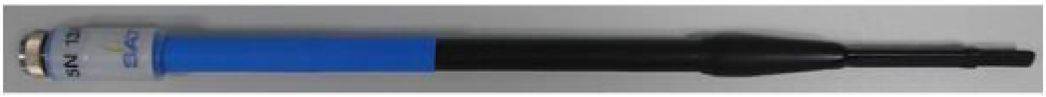


Figure 1 – *MVG COMOSAR Dosimetric E field Dipole*

Probe Length	330 mm
Length of Individual Dipoles	4.5 mm
Maximum external diameter	8 mm
Probe Tip External Diameter	5 mm
Distance between dipoles / probe extremity	2.7 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 %

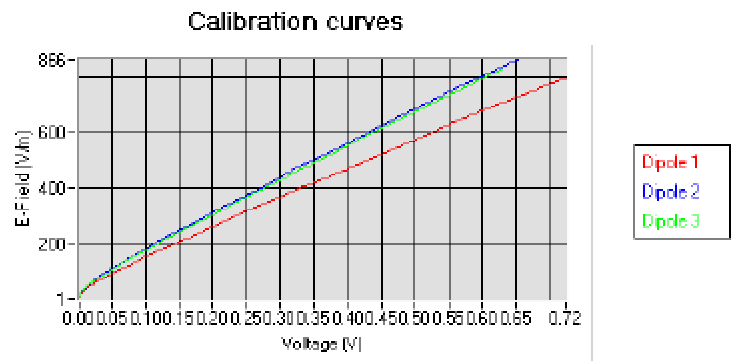
5.1 SENSITIVITY IN AIR

Normx dipole 1 ($\mu V/(V/m)^2$)	Normy dipole 2 ($\mu V/(V/m)^2$)	Normz dipole 3 ($\mu V/(V/m)^2$)
7.16	6.11	5.85

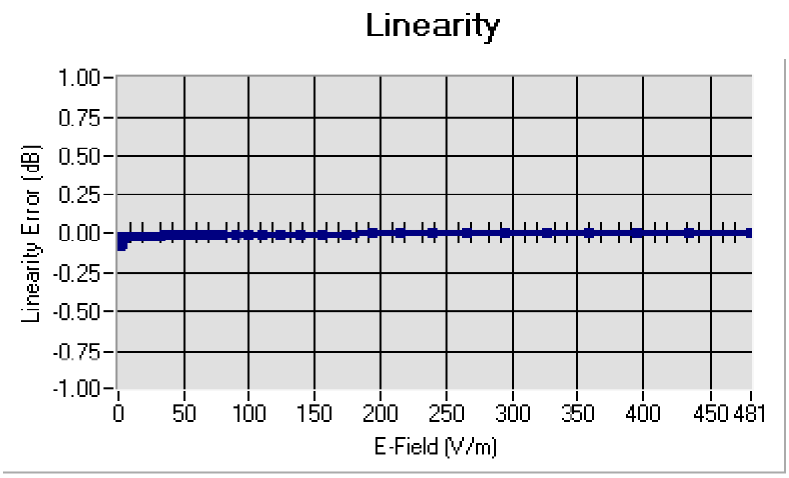
DCP dipole 1 (mV)	DCP dipole 2 (mV)	DCP dipole 3 (mV)
95	96	91

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:+/-1.83% (+/-0.08dB)

5.3 SENSITIVITY IN LIQUID

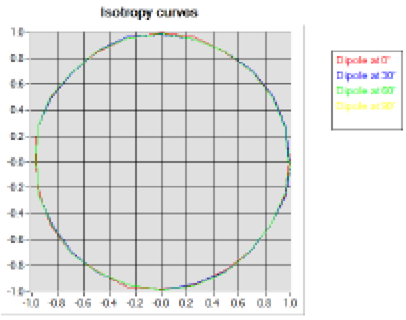
Liquid	Frequency (MHz +/- 100MHz)	Permittivity	Epsilon (S/m)	ConvF
HL750	750	41.85	0.90	5.26
BL750	750	56.28	0.98	5.41
HL2300	2300	38.75	1.64	4.75
BL2300	2300	51.66	1.77	4.93

LOWER DETECTION LIMIT: 7mW/kg

5.4 ISOTROPY

HL 750 MHz

- Axial isotropy: 0.04 dB
- Hemispherical isotropy: 0.07 dB



6 LIST OF EQUIPMENT

Equipment Summary Sheet				
Equipment Description	**Manufacturer / Model**	**Identification No.**	**Current Calibration Date**	**Next Calibration Date**
Flat Phantom	MVG	SN-20/09-SAM71	Validated. No cal required.	Validated. No cal required.
COMOSAR Test Bench	Version 3	NA	Validated. No cal required.	Validated. No cal required.
Network Analyzer	Rhode & Schwarz ZVA	SN100132	02/2013	02/2016
Reference Probe	MVG	EP 94 SN 37/08	10/2014	10/2015
Multimeter	Keithley 2000	1188656	12/2013	12/2016
Signal Generator	Agilent E4438C	MY49070581	12/2013	12/2016
Amplifier	Aethercomm	SN 046	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Power Meter	HP E4418A	US38261498	12/2013	12/2016
Power Sensor	HP ECP-E26A	US37181460	12/2013	12/2016
Directional Coupler	Narda 4216-20	01386	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Waveguide	Mega Industries	069Y7-158-13-712	Validated. No cal required.	Validated. No cal required.
Waveguide Transition	Mega Industries	069Y7-158-13-701	Validated. No cal required.	Validated. No cal required.
Waveguide Termination	Mega Industries	069Y7-158-13-701	Validated. No cal required.	Validated. No cal required.
Temperature / Humidity Sensor	Control Company	11-661-9	8/2012	8/2015

SID750 Dipole Calibration Certificate

SAR Reference Dipole Calibration Report

Ref : ACR.154.1.15.SATU.A

CCIC SOUTHERN ELECTRONIC PRODUCT TESTING (SHENZHEN) CO., LTD
ELECTRONIC TESTING BUILDING, SHAHE ROAD, XILI TOWN
SHENZHEN, P.R. CHINA (POST CODE:518055)
MVG COMOSAR REFERENCE DIPOLE
FREQUENCY: 750 MHZ
SERIAL NO.: SN 23/15 DIP 0G750-378

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

ACCREDITED
Calibration CERT #2246-02

06/01/15

Summary:

This document presents the method and results from an accredited SAR reference dipole calibration performed in MVG USA using the COMOSAR test bench. All calibration results are traceable to national metrology institutions.

	Name	*Function*	*Date*	*Signature*
Prepared by :	Jérôme LUC	Product Manager	6/3/2015	JS
Checked by :	Jérôme LUC	Product Manager	6/3/2015	JS
Approved by :	Kim RUTKOWSKI	Quality Manager	6/3/2015	Kim Rutkowski

	Customer Name
Distribution :	CCIC SOUTHERN ELECTRONIC PRODUCT TESTING (SHENZHEN) Co., Ltd

Issue	*Date*	*Modifications*
A	6/3/2015	Initial release

TABLE OF CONTENTS

1 INTRODUCTION

This document contains a summary of the requirements set forth by the IEEE 1528, FCC KDBs and CEI/IEC 62209 standards for reference dipoles used for SAR measurement system validations and the measurements that were performed to verify that the product complies with the fore mentioned standards.

2 DEVICE UNDER TEST

Device Under Test	
Device Type	COMOSAR 750 MHz REFERENCE DIPOLE
Manufacturer	MVG
Model	SID750
Serial Number	SN 23/15 DIP 0G750-378
Product Condition (new / used)	New

A yearly calibration interval is recommended.

3 PRODUCT DESCRIPTION

3.1 GENERAL INFORMATION

MVG's COMOSAR Validation Dipoles are built in accordance to the IEEE 1528, FCC KDBs and CEI/IEC 62209 standards. The product is designed for use with the COMOSAR test bench only.

Figure 1 – *MVG COMOSAR Validation Dipole*

4 MEASUREMENT METHOD

The IEEE 1528, FCC KDBs and CEI/IEC 62209 standards provide requirements for reference dipoles used for system validation measurements. The following measurements were performed to verify that the product complies with the fore mentioned standards.

4.1 RETURN LOSS REQUIREMENTS

The dipole used for SAR system validation measurements and checks must have a return loss of -20 dB or better. The return loss measurement shall be performed against a liquid filled flat phantom, with the phantom constucted as outlined in the fore mentioned standards.

4.2 MECHANICAL REQUIREMENTS

The IEEE Std. 1528 and CEI/IEC 62209 standards specify the mechanical components and dimensions of the validation dipoles, with the dimensions frequency and phantom shell thickness dependent. The COMOSAR test bench employs a 2 mm phantom shell thickness therefore the dipoles sold for use with the COMOSAR test bench comply with the requirements set forth for a 2 mm phantom shell thickness.

5 MEASUREMENT UNCERTAINTY

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.

5.1 RETURN LOSS

The following uncertainties apply to the return loss measurement:

Frequency band	Expanded Uncertainty on Return Loss
400-6000MHz	0.1 dB

5.2 DIMENSION MEASUREMENT

The following uncertainties apply to the dimension measurements:

Length (mm)	Expanded Uncertainty on Length
3 - 300	0.05 mm

5.3 VALIDATION MEASUREMENT

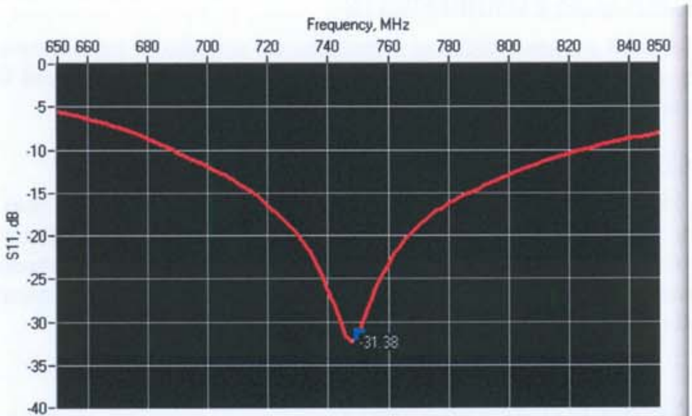
The guidelines outlined in the IEEE 1528, FCC KDBs, CENELEC EN50361 and CEI/IEC 62209 standards were followed to generate the measurement uncertainty for validation measurements.

Scan Volume	Expanded Uncertainty
1 g	20.3 %

10 g	20.1 %

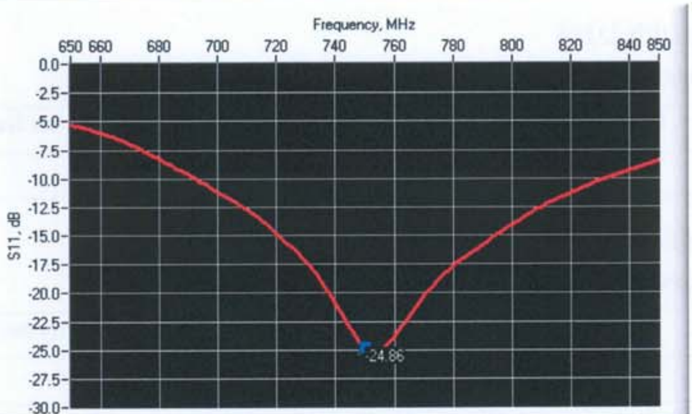
6 CALIBRATION MEASUREMENT RESULTS

6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
750	-31.38	-20	51.9 Ω + 1.9 jΩ

6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
750	-24.86	-20	49.3 Ω + 5.7 jΩ

6.3 MECHANICAL DIMENSIONS

Frequency MHz	L mm		h mm		d mm	
	required	measured	required	measured	required	measured
300	420.0 ±1 %.		250.0 ±1 %.		6.35 ±1 %.	

450	290.0 ±1 %.		166.7 ±1 %.		6.35 ±1 %.	
750	176.0 ±1 %.	PASS	100.0 ±1 %.	PASS	6.35 ±1 %.	PASS
835	161.0 ±1 %.		89.8 ±1 %.		3.6 ±1 %.	
900	149.0 ±1 %.		83.3 ±1 %.		3.6 ±1 %.	
1450	89.1 ±1 %.		51.7 ±1 %.		3.6 ±1 %.	
1500	80.5 ±1 %.		50.0 ±1 %.		3.6 ±1 %.	
1640	79.0 ±1 %.		45.7 ±1 %.		3.6 ±1 %.	
1750	75.2 ±1 %.		42.9 ±1 %.		3.6 ±1 %.	
1800	72.0 ±1 %.		41.7 ±1 %.		3.6 ±1 %.	
1900	68.0 ±1 %.		39.5 ±1 %.		3.6 ±1 %.	
1950	66.3 ±1 %.		38.5 ±1 %.		3.6 ±1 %.	
2000	64.5 ±1 %.		37.5 ±1 %.		3.6 ±1 %.	
2100	61.0 ±1 %.		35.7 ±1 %.		3.6 ±1 %.	
2300	55.5 ±1 %.		32.6 ±1 %.		3.6 ±1 %.	
2450	51.5 ±1 %.		30.4 ±1 %.		3.6 ±1 %.	
2600	48.5 ±1 %.		28.8 ±1 %.		3.6 ±1 %.	
3000	41.5 ±1 %.		25.0 ±1 %.		3.6 ±1 %.	
3500	37.0±1 %.		26.4 ±1 %.		3.6 ±1 %.	
3700	34.7±1 %.		26.4 ±1 %.		3.6 ±1 %.	

7 VALIDATION MEASUREMENT

The IEEE Std. 1528, FCC KDBs and CEI/IEC 62209 standards state that the system validation measurements must be performed using a reference dipole meeting the fore mentioned return loss and mechanical dimension requirements. The validation measurement must be performed against a liquid filled flat phantom, with the phantom constructed as outlined in the fore mentioned standards. Per the standards, the dipole shall be positioned below the bottom of the phantom, with the dipole length centered and parallel to the longest dimension of the flat phantom, with the top surface of the dipole at the described distance from the bottom surface of the phantom.

7.1 HEAD LIQUID MEASUREMENT

Frequency MHz	Relative permittivity (ε_r')		Conductivity (σ) S/m	
	required	measured	required	measured
300	45.3 ±5 %		0.87 ±5 %	
450	43.5 ±5 %		0.87 ±5 %	
750	41.9 ±5 %	PASS	0.89 ±5 %	PASS
835	41.5 ±5 %		0.90 ±5 %	
900	41.5 ±5 %		0.97 ±5 %	
1450	40.5 ±5 %		1.20 ±5 %	
1500	40.4 ±5 %		1.23 ±5 %	
1640	40.2 ±5 %		1.31 ±5 %	
1750	40.1 ±5 %		1.37 ±5 %	

1800	40.0 ±5 %		1.40 ±5 %	
1900	40.0 ±5 %		1.40 ±5 %	
1950	40.0 ±5 %		1.40 ±5 %	
2000	40.0 ±5 %		1.40 ±5 %	
2100	39.8 ±5 %		1.49 ±5 %	
2300	39.5 ±5 %		1.67 ±5 %	
2450	39.2 ±5 %		1.80 ±5 %	
2600	39.0 ±5 %		1.96 ±5 %	
3000	38.5 ±5 %		2.40 ±5 %	
3500	37.9 ±5 %		2.91 ±5 %	

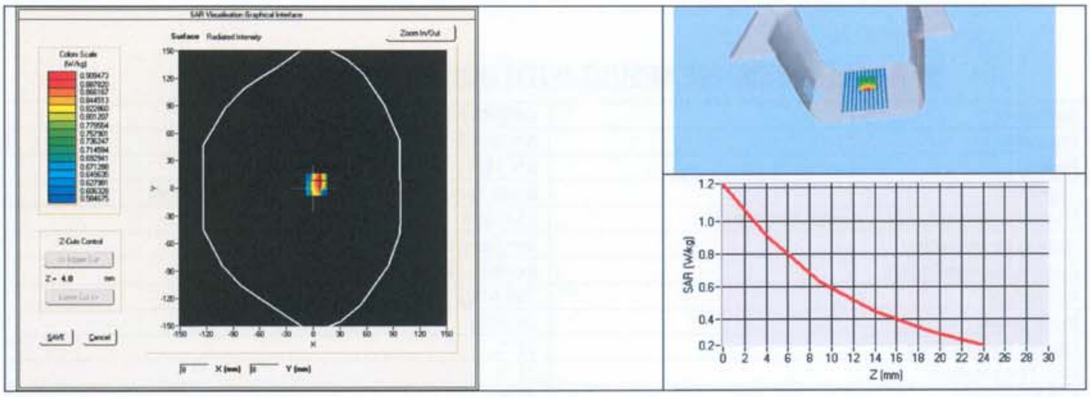
7.2 SAR MEASUREMENT RESULT WITH HEAD LIQUID

The IEEE Std. 1528 and CEI/IEC 62209 standards state that the system validation measurements should produce the SAR values shown below (for phantom thickness of 2 mm), within the uncertainty for the system validation. All SAR values are normalized to 1 W forward power. In bracket, the measured SAR is given with the used input power.

Software	OPENSAR V4
Phantom	SN 20/09 SAM71
Probe	SN 18/11 EPG122
Liquid	Head Liquid Values: eps' : 41.8 sigma : 0.90
Distance between dipole center and liquid	15.0 mm
Area scan resolution	dx=8mm/dy=8mm
Zoon Scan Resolution	dx=8mm/dy=8mm/dz=5mm
Frequency	750 MHz
Input power	20 dBm
Liquid Temperature	21 °C
Lab Temperature	21 °C
Lab Humidity	45 %

Frequency MHz	1 g SAR (W/kg/W)		10 g SAR (W/kg/W)	
	required	measured	required	measured
300	2.85		1.94	
450	4.58		3.06	
750	8.49	8.67 (0.87)	5.55	5.73 (0.57)
835	9.56		6.22	
900	10.9		6.99	
1450	29		16	
1500	30.5		16.8	
1640	34.2		18.4	
1750	36.4		19.3	
1800	38.4		20.1	

1900	39.7		20.5	
1950	40.5		20.9	
2000	41.1		21.1	
2100	43.6		21.9	
2300	48.7		23.3	
2450	52.4		24	
2600	55.3		24.6	
3000	63.8		25.7	
3500	67.1		25	



7.3 BODY LIQUID MEASUREMENT

Frequency MHz	Relative permittivity (ε_r')		Conductivity (σ) S/m	
	required	measured	required	measured
150	61.9 ±5 %		0.80 ±5 %	
300	58.2 ±5 %		0.92 ±5 %	
450	56.7 ±5 %		0.94 ±5 %	
750	55.5 ±5 %	PASS	0.96 ±5 %	PASS
835	55.2 ±5 %		0.97 ±5 %	
900	55.0 ±5 %		1.05 ±5 %	
915	55.0 ±5 %		1.06 ±5 %	
1450	54.0 ±5 %		1.30 ±5 %	
1610	53.8 ±5 %		1.40 ±5 %	
1800	53.3 ±5 %		1.52 ±5 %	
1900	53.3 ±5 %		1.52 ±5 %	
2000	53.3 ±5 %		1.52 ±5 %	
2100	53.2 ±5 %		1.62 ±5 %	
2450	52.7 ±5 %		1.95 ±5 %	

2600	52.5 ±5 %		2.16 ±5 %	
3000	52.0 ±5 %		2.73 ±5 %	
3500	51.3 ±5 %		3.31 ±5 %	
5200	49.0 ±10 %		5.30 ±10 %	
5300	48.9 ±10 %		5.42 ±10 %	
5400	48.7 ±10 %		5.53 ±10 %	
5500	48.6 ±10 %		5.65 ±10 %	
5600	48.5 ±10 %		5.77 ±10 %	
5800	48.2 ±10 %		6.00 ±10 %	

7.4 SAR MEASUREMENT RESULT WITH BODY LIQUID

Software	OPENSAR V4
Phantom	SN 20/09 SAM71
Probe	SN 18/11 EPG122
Liquid	Body Liquid Values: eps' : 56.3 sigma : 0.98
Distance between dipole center and liquid	15.0 mm
Area scan resolution	dx=8mm/dy=8mm
Zoon Scan Resolution	dx=8mm/dy=8mm/dz=5mm
Frequency	750 MHz
Input power	20 dBm
Liquid Temperature	21 °C
Lab Temperature	21 °C
Lab Humidity	45 %

Frequency MHz	1 g SAR (W/kg/W)	10 g SAR (W/kg/W)
	measured	measured
750	8.43 (0.84)	5.63 (0.56)