

SAR TEST REPORT
For
NJY Science & Technology Co., Ltd
Smart Watch
Model No.: G3
Additional Model No.: G4, G5, G6, D5, D6, D7, D8, Q7, S6

Prepared for	:	NJY Science & Technology Co., Ltd
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Date of receipt of test sample	:	May 20, 2016
Number of tested samples	:	1
Serial number	:	Prototype
Date of Test	:	May 20, 2016–May 30, 2016
Date of Report	:	May 30, 2016

SAR TEST REPORT**Report Reference No.....: LCS1605252317E**

Date Of Issue.....: May 30, 2016

Testing Laboratory Name: Shenzhen LCS Compliance Testing Laboratory Ltd.

Address.....: 1/F., Xingyuan Industrial Park, Tongda Road, Bao'an Avenue, Bao'an District, Shenzhen, Guangdong, China

Testing Location/ Procedure: Full application of Harmonised standards Partial application of Harmonised standards Other standard testing method **Applicant's Name**: NJY Science & Technology Co., Ltd

Address.....: 1788, Block A, Modern Window, NO.1050 Huaqiang North Road, Futian District

Test Specification:Standard: IEEE 1528:2013/KDB865664
47CFR §2.1093

Test Report Form No.: LCSEMC-1.0

TRF Originator.....: Shenzhen LCS Compliance Testing Laboratory Ltd.

Master TRF: Dated 2014-09

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Test Item Description.....: Smart Watch

Trade Mark.....: N/A

Model/Type Reference.....: G3

Operation Frequency.....: GSM 850/PCS1900, Bluetooth4.0

Modulation Type.....: GSM(GMSK,8PSK), Bluetooth(GFSK,8DPSK, $\pi/4$ -DQPSK)

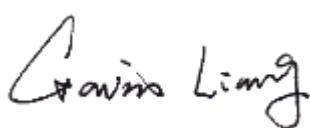
Ratings: DC 3.7V by Lithium ion polymer battery(380mAh)

Result: Positive**Compiled by:**

Linda He/ File administrators

Supervised by:

Glin Lu/ Technique principal

Approved by:

Gavin Liang/ Manager

SAR -- TEST REPORT

Test Report No. : LCS1605252317E	<u>May 30, 2016</u> Date of issue
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Type / Model..... : G3

EUT..... : Smart Watch

Applicant..... : NJY Science & Technology Co., Ltd

Address..... : 1788, Block A, Modern Window, NO.1050 Huaqiang North Road, Futian District

Telephone..... : /

Fax..... : /

Manufacturer..... : Bao'an Branch of NJY Science & Technology Co., Ltd

Address..... : 43 Shajiang Road, 4th floor 1st building Wenfeng Industrial Park, Bao'an District, Shenzhen China

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Fax..... : /

Factory..... : Bao'an Branch of NJY Science & Technology Co., Ltd

Address..... : 43 Shajiang Road, 4th floor 1st building Wenfeng Industrial Park, Bao'an District, Shenzhen China

Telephone..... : /

Fax..... : /

Test Result	Positive
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The test report merely corresponds to the test sample.

It is not permitted to copy extracts of these test result without the written permission of the test laboratory.

Revision History

Revision	Issue Date	Revisions	Revised By
00	2016-05-30	Initial Issue	Gavin Liang

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1. TEST STANDARDS AND TEST DESCRIPTION

1.1. Test Standards

[IEEE Std C95.1, 2005](#): IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 KHz to 300 GHz. 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.

[IEEE Std 1528™-2013](#): IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques.

[FCC Part 2.1093 Radiofrequency Radiation Exposure Evaluation](#): Portable Devices

[KDB447498 D01 General RF Exposure Guidance v06](#) : Mobile and Portable Device RF Exposure Procedures and Equipment Authorization Policies

[KDB648474 D04, Handset SAR v01r03](#): SAR Evaluation Considerations for Wireless Handsets

[KDB865664 D01 SAR Measurement 100 MHz to 6 GHz v01r04](#) : SAR Measurement Requirements for 100 MHz to 6 GHz

[KDB865664 D02 RF Exposure Reporting v01r02](#): RF Exposure Compliance Reporting and Documentation Considerations

1.2. Test Description

The EUT battery must be fully charged and checked periodically during the test to ascertain uniform power . And Test device is identical prototype.

1.3. General Remarks

Date of receipt of test sample	:	May 20, 2016
Testing commenced on	:	May 20, 2016
Testing concluded on	:	May 30, 2016

1.4. Product Description

The **NJY Science & Technology Co., Ltd's** Model: G3 or the “EUT” as referred to in this report; more general information as follows, for more details, refer to the user's manual of the EUT.

General Description	
Product Name:	Smart Watch
Trade Mark:	N/A
Model/Type reference:	G3
Listed Model(s):	G3, G4, G5, G6, D5, D6, D7, D8, Q7, S6
Modulation Type:	GSM(GMSK,8PSK), Bluetooth(GFSK,8DPSK, $\pi/4$ -DQPSK)
Device category:	Common mobile Device
Exposure category:	General population/uncontrolled environment
EUT Type:	Prototype
Hardware Version	V3.1
Software Version:	G3_B_V1_16040
Power supply:	DC 3.7V by Lithium ion polymer battery(380mAh)
<i>The EUT is GSM, smart watch. the smart watch is intended for speech and Multimedia Message Service (MMS) transmission. It is equipped with GPRS/EDGE class 12 for GSM850, PCS1900, and Bluetooth functions. For more information see the following datasheet</i>	

Technical Characteristics	
GSM	
Support Networks	GSM, GPRS, EGPRS
Support Band	GSM850, PCS1900
Frequency	GSM850: 824.2~848.8MHz GSM1900: 1850.2~1909.8MHz
Power Class:	GSM850:Power Class 5 PCS1900:Power Class 0
Modulation Type:	GMSK for GSM/GPRS
GSM Release Version	R97
GPRS Multislot Class	12
EGPRS Multislot Class	12
DTM Mode	Not Supported
Antenna Description	PIFA Antenna, -3.2dBi(Max.) for GSM850; PIFA Antenna, -4.0dBi(max.) for GSM1900
Bluetooth	
Bluetooth Version:	V3.0+4.0
Modulation:	GFSK(1Mbps) , π /4-DQPSK(2Mbps) , 8-DPSK(3Mbps)
Operation frequency:	2402MHz~2480MHz
Channel number:	40/79
Channel separation:	1MHz/2MHz
Antenna Description	PIFA Antenna, 1.55dBi(Max.)

1.5. Statement of Compliance

The maximum of results of SAR found during testing for G3 are follows:

<Highest Reported standalone SAR Summary>

Exposure Configuration	Technology Band	Highest Measured SAR (W/Kg)	limit
Next to mouth 1-g SAR (Separation Distance 10mm)	GSM850	0.064	1.6 1g(W/Kg)
	PCS1900	0.127	
Wrist-worn 10-g SAR (Separation Distance 0mm)	GSM850	0.404	4.0 10g(W/Kg)
	GPRS850	0.299	
	PCS1900	0.157	
	GPRS1900	0.098	

This device is in compliance with Specific Absorption Rate (SAR) for general population/uncontrolled exposure limits (1.6 W/kg) specified in FCC 47 CFR part 2 (2.1093) and ANSI/IEEE C95.1-2005, and had been tested in accordance with the measurement methods and procedures specified in IEEE 1528-2013.

For body worn operation, this device has been tested and meets FCC RF exposure guidelines when used with any accessory that contains no metal and which provides a minimum separation distance of 0mm between this device and the body of the user. Use of other accessories may not ensure compliance with FCC RF exposure guidelines.

The EUT battery must be fully charged and checked periodically during the test to ascertain uniform power output

2. TEST ENVIRONMENT

2.1. Test Facility

The test facility is recognized, certified, or accredited by the following organizations:

Site Description

EMC Lab.

- : CNAS Registration Number. is L4595.
- FCC Registration Number. is 899208.
- Industry Canada Registration Number. is 9642A-1.
- VCCI Registration Number. is C-4260 and R-3804.
- ESMD Registration Number. is ARCB0108.
- UL Registration Number. is 100571-492.
- TUV SUD Registration Number. is SCN1081.
- TUV RH Registration Number. is UA 50296516-001.

2.2. Environmental conditions

During the measurement the environmental conditions were within the listed ranges:

Temperature:	18-25 ° C
Humidity:	40-65 %
Atmospheric pressure:	950-1050mbar

2.3. SAR Limits

FCC Limit (1g Tissue)

EXPOSURE LIMITS	SAR (W/kg)	
	(General Population / Uncontrolled Exposure Environment)	(Occupational / Controlled Exposure Environment)
Spatial Average(averaged over the whole body)	0.08	0.4
Spatial Peak(averaged over any 1 g of tissue)	1.6	8.0
Spatial Peak(hands/wrists/feet/anklesaveraged over 10 g)	4.0	20.0

Population/Uncontrolled Environments are defined as locations where there is the exposure of individual who have no knowledge or control of their exposure.

Occupational/Controlled Environments are defined as locations where there is exposure that may be incurred by people who are aware of the potential for exposure (i.e. as a result of employment or occupation).

2.4. Equipments Used during the Test

Test Equipment	Manufacturer	Type/Model	Serial Number	Calibration	
				Calibration Date	Calibration Due
PC	Lenovo	G5005	MY42081102	N/A	N/A
Signal Generator	Agilent	E4438C	MY42081396	09/25/2015	09/24/2016
Multimeter	Keithley	MiltiMeter 2000	4059164	10/01/2015	09/30/2016
S-parameter Network Analyzer	Agilent	8753ES	US38432944	09/25/2015	09/24/2016
Wireless Communication Test Set	R & S	CMU200	105988	09/25/2015	09/24/2016
Power Meter	Agilent	E4407B	MY41440754	09/25/2015	09/24/2016
Power Meter	R & S	NRVS	100469	09/25/2015	09/24/2016
Power Sensor	R & S	NRV-Z51	100458	06/18/2015	06/17/2016
Power Sensor	R & S	NRV-Z32	10057	06/18/2015	06/17/2016
E-Field PROBE	SATIMO	SSE5	SN 17/14 EP220	10/01/2015	09/30/2016
E-Field PROBE	SATIMO	SSE5	SN 17/14 EP221	09/01/2015	08/31/2016
DIPOLE 835	SATIMO	SID 835	SN 07/14 DIP 0G835-303	10/01/2015	09/30/2016
DIPOLE 1900	SATIMO	SID 1900	SN 30/14 DIP 1G900-333	09/01/2015	08/31/2016
COMOSAR OPEN Coaxial Probe	SATIMO	OCPG 68	SN 40/14 OCPG68	10/01/2015	09/30/2016
Communication Antenna	SATIMO	ANTA57	SN 39/14 ANTA57	10/01/2015	09/30/2016
Mobile Phone POSITIONING DEVICE	SATIMO	MSH98	SN 40/14 MSH98	N/A	N/A
DUMMY PROBE	SATIMO	DP60	SN 03/14 DP60	N/A	N/A
SAM PHANTOM	SATIMO	SAM117	SN 40/14 SAM117	N/A	N/A
Simulated Tissue 900 MHz Body and Head	SATIMO	SAM-9-H	SN 21/14 HLD438	Each Time	N/A
Simulated Tissue 1900 MHz For Head	SATIMO	SAM-18-H	SN 21/14 HLF439	Each Time	N/A
Simulated Tissue 2450 MHz Body and Head	SATIMO	SAM-24-H	SN 21/14 HLJ445	Each Time	N/A
PHANTOM TABLE	SATIMO	TABP98	SN 40/14 TABP98	N/A	N/A
6 AXIS ROBOT	KUKA	KR6-R900	501217	N/A	N/A
High Power Solid State Amplifier (80MHz~1000MHz)	Instruments for Industry	CMC150	M631-0627	09/25/2015	09/24/2016
Medium Power Solid State Amplifier (0.8~4.2GHz)	Instruments for Industry	S41-25	M629-0539	09/25/2015	09/24/2016

Note:

- 1) Per KDB865664D01 requirements for dipole calibration, the test laboratory has adopted three year extended calibration interval. Each measured dipole is expected to evaluate with following criteria at least on annual interval.
 - a) There is no physical damage on the dipole;
 - b) System check with specific dipole is within 10% of calibrated values;
 - c) The most recent return-loss results, measured at least annually, deviates by no more than 20% from the previous measurement;
 - d) The most recent measurement of the real or imaginary parts of the impedance, measured at least annually is within 5Ω from the previous measurement.
- 2) Network analyzer probe calibration against air, distilled water and a shorting block performed before measuring liquid parameters.

3. SAR MEASUREMENTS SYSTEM CONFIGURATION

3.1. SAR Measurement Set-up

The OPENSAR system for performing compliance tests consist of the following items:

A standard high precision 6-axis robot (KUKA) with controller and software.

KUKA Control Panel (KCP)

A dosimetric probe, i.e., an isotropic E-field probe optimized and calibrated for usage in tissue simulating liquid. The probe is equipped with a Video Positioning System(VPS).

The stress sensor is composed with mechanical and electronic when the electronic part detects a change on the electro-mechanical switch, It sends an “Emergency signal” to the robot controller that to stop robot’s moves

A computer operating Windows XP.

OPENSAR software

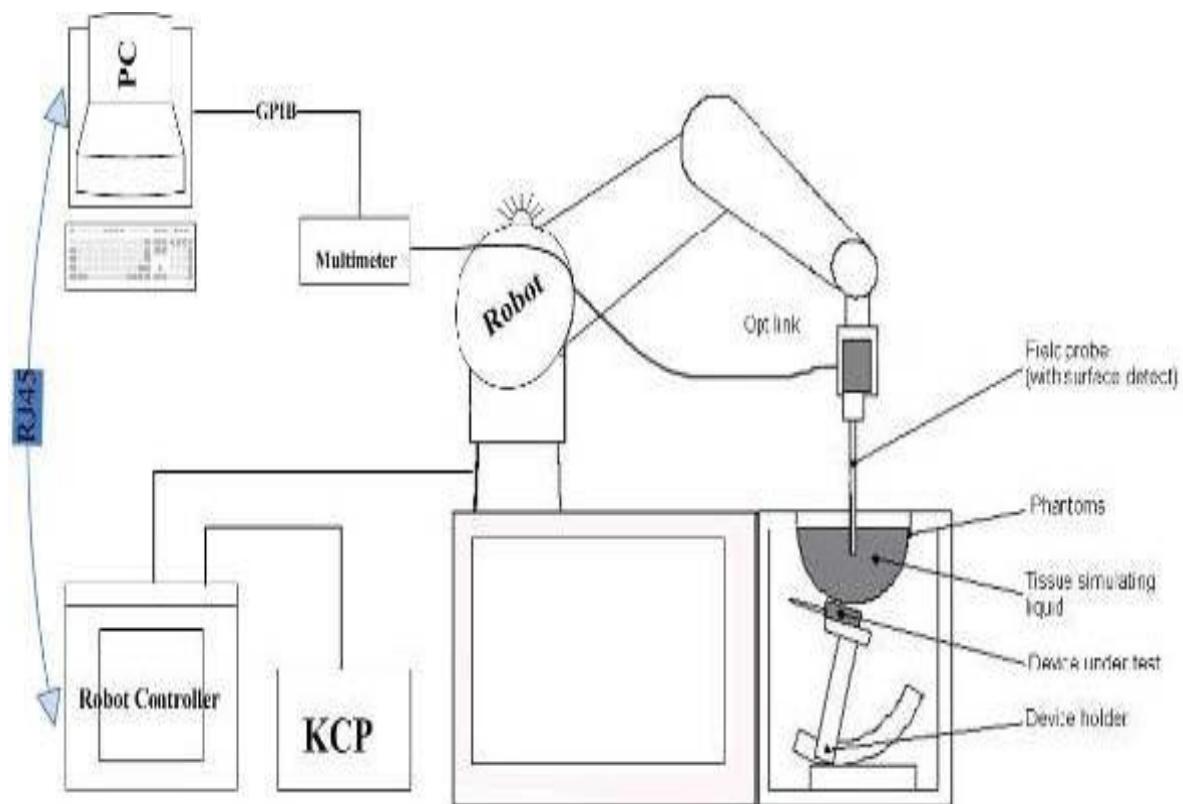
Remote control with teaches pendant and additional circuitry for robot safety such as warning lamps, etc.

The SAM phantom enabling testing left-hand right-hand and body usage.

The Position device for handheld EUT

Tissue simulating liquid mixed according to the given recipes .

System validation dipoles to validate the proper functioning of the system.



3.2. OPENSAR E-field Probe System

The SAR measurements were conducted with the dosimetric probe EP220 (manufactured by SATIMO), designed in the classical triangular configuration and optimized for dosimetric evaluation.

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.

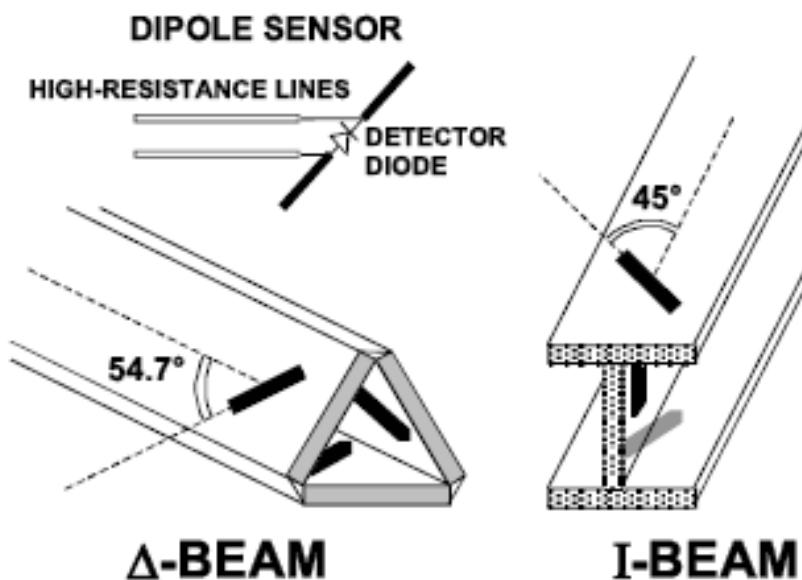
Frequency	700 MHz to 3 GHz; Linearity: 0.25dB (700 MHz to 3GHz)
Directivity	0.25 dB in HSL (rotation around probe axis) 0.5 dB in tissue material (rotation normal to probe axis)
Dynamic Range	0.01W/kg to > 100 W/kg; Linearity: 0.25 dB
Dimensions	Overall length: 330 mm (Tip: 16mm) Tip diameter: 5 mm (Body: 8 mm) Distance from probe tip to sensor centers: 2.5 mm
Application	General dosimetry up to 3 GHz Dosimetry in strong gradient fields Compliance tests of Mobile Phones



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.

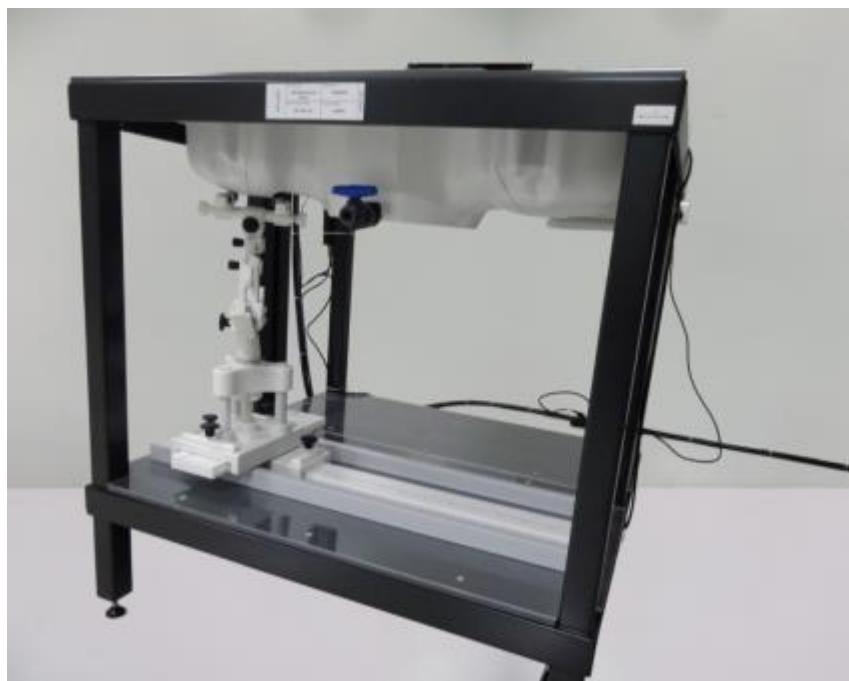
The E-Field probe utilizes a triangular sensor arrangement as detailed in the diagram below:



3.3. Phantoms

The SAM Phantom SAM117 is constructed of a fiberglass shell integrated in a wooden table. The shape of the shell is in compliance with the specification set in IEEE P1528 and CENELEC EN62209-1, EN62209-2:2010. The phantom enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region. A cover prevents the evaporation of the liquid. Reference markings on the Phantom allow the complete setup of all predefined phantom positions and measurement grids by manually teaching three points in the robot.

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

3.4. Device Holder

In combination with the Generic Twin Phantom SAM117, the Mounting Device enables the rotation of the mounted transmitter in spherical coordinates whereby the rotation points is the ear opening. The devices can be easily, accurately, and repeatedly positioned according to the FCC and CENELEC specifications. The device holder can be locked at different phantom locations (left head, right head, flat phantom).



Device holder supplied by SATIMO

3.5. Scanning Procedure

The procedure for assessing the peak spatial-average SAR value consists of the following steps

Power Reference Measurement

The reference and drift jobs are useful jobs for monitoring the power drift of the device under test in the batch process. Both jobs measure the field at a specified reference position, at a selectable distance from the phantom surface. The reference position can be either the selected section's grid reference point or a user point in this section. The reference job projects the selected point onto the phantom surface, orients the probe perpendicularly to the surface, and approaches the surface using the selected detection method.

Area Scan

The Area Scan is used as a fast scan in two dimensions to find the area of high field values before running a detailed measurement around the hot spot. Before starting the area scan a grid spacing of 15 mm x 15 mm is set. During the scan the distance of the probe to the phantom remains unchanged. After finishing area scan, the field maxima within a range of 2 dB will be ascertained.

	≤ 3 GHz	> 3 GHz
Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface	$5 \text{ mm} \pm 1 \text{ mm}$	$\frac{1}{2} \cdot \delta \cdot \ln(2) \text{ mm} \pm 0.5 \text{ mm}$
Maximum probe angle from probe axis to phantom surface normal at the measurement location	$30^\circ \pm 1^\circ$	$20^\circ \pm 1^\circ$
	$\leq 2 \text{ GHz: } \leq 15 \text{ mm}$ $2 - 3 \text{ GHz: } \leq 12 \text{ mm}$	$3 - 4 \text{ GHz: } \leq 12 \text{ mm}$ $4 - 6 \text{ GHz: } \leq 10 \text{ mm}$
Maximum area scan spatial resolution: $\Delta x_{\text{Area}}, \Delta y_{\text{Area}}$	When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be \leq the corresponding x or y dimension of the test device with at least one measurement point on the test device.	

Zoom Scan

Zoom Scans are used to estimate the peak spatial SAR values within a cubic averaging volume containing 1 g and 10 g of simulated tissue. The default Zoom Scan is done by 7x7x7 points within a cube whose base is centered around the maxima found in the preceding area scan.

Maximum zoom scan spatial resolution: $\Delta x_{\text{Zoom}}, \Delta y_{\text{Zoom}}$		$\leq 2 \text{ GHz: } \leq 8 \text{ mm}$ $2 - 3 \text{ GHz: } \leq 5 \text{ mm}^*$	$3 - 4 \text{ GHz: } \leq 5 \text{ mm}^*$ $4 - 6 \text{ GHz: } \leq 4 \text{ mm}^*$
	uniform grid: $\Delta z_{\text{Zoom}}(n)$	$\leq 5 \text{ mm}$	$3 - 4 \text{ GHz: } \leq 4 \text{ mm}$ $4 - 5 \text{ GHz: } \leq 3 \text{ mm}$ $5 - 6 \text{ GHz: } \leq 2 \text{ mm}$
Maximum zoom scan spatial resolution, normal to phantom surface	graded grid	$\Delta z_{\text{Zoom}}(1): \text{ between } 1^{\text{st}} \text{ two points closest to phantom surface}$	$3 - 4 \text{ GHz: } \leq 3 \text{ mm}$ $4 - 5 \text{ GHz: } \leq 2.5 \text{ mm}$ $5 - 6 \text{ GHz: } \leq 2 \text{ mm}$
		$\Delta z_{\text{Zoom}}(n>1): \text{ between subsequent points}$	$\leq 1.5 \cdot \Delta z_{\text{Zoom}}(n-1) \text{ mm}$
Minimum zoom scan volume	X, y, z	$\geq 30 \text{ mm}$	$3 - 4 \text{ GHz: } \geq 28 \text{ mm}$ $4 - 5 \text{ GHz: } \geq 25 \text{ mm}$ $5 - 6 \text{ GHz: } \geq 22 \text{ mm}$

Note: δ is the penetration depth of a plane-wave at normal incidence to the tissue medium; see IEEE Std 1528-2013 for details.

* When zoom scan is required and the *reported* SAR from the *area scan based 1-g SAR estimation* procedures of KDB Publication 447498 is $\leq 1.4 \text{ W/kg}$, $\leq 8 \text{ mm}$, $\leq 7 \text{ mm}$ and $\leq 5 \text{ mm}$ zoom scan resolution may be applied, respectively, for 2 GHz to 3 GHz, 3 GHz to 4 GHz and 4 GHz to 6 GHz.

Power Drift measurement

The drift job measures the field at the same location as the most recent reference job within the same procedure, and with the same settings. The drift measurement gives the field difference in dB from the reading conducted within the last reference measurement. Several drift measurements are possible for one reference measurement. This allows a user to monitor the power drift of the device under test within a batch process. In the properties of the Drift job, the user can specify a limit for the drift and have OPENSAR software stop the measurements if this limit is exceeded.

3.6. Data Storage and Evaluation

Data Storage

The OPENSAR software stores the acquired data from the data acquisition electronics as raw data (in microvolt readings from the probe sensors), together with all necessary software parameters for the data evaluation (probe calibration data, liquid parameters and device frequency and modulation data) in measurement files. The software evaluates the desired unit and format for output each time the data is visualized or exported. This allows verification of the complete software setup even after the measurement and allows correction of incorrect parameter settings. For example, if a measurement has been performed with a wrong crest factor parameter in the device setup, the parameter can be corrected afterwards and the data can be re-evaluated.

The measured data can be visualized or exported in different units or formats, depending on the selected probe type ([V/m], [A/m], [°C], [mW/g], [mW/cm²], [dBrel], etc.). Some of these units are not available in certain situations or show meaningless results, e.g., a SAR output in a lossless media will always be zero. Raw data can also be exported to perform the evaluation with other software packages.

Data Evaluation

The OPENSAR software automatically executes the following procedures to calculate the field units from the microvolt readings at the probe connector. The parameters used in the evaluation are stored in the configuration modules of the software:

Probe parameters:	- Sensitivity	Normi, ai0, ai1, ai2
	- Conversion factor	ConvFi
	- Diode compression point	Dcp <i>i</i>
Device parameters:	- Frequency	f
	- Crest factor	cf
Media parameters:	- Conductivity	σ
	- Density	ρ

These parameters must be set correctly in the software. They can be found in the component documents or they can be imported into the software from the configuration files issued for the OPENSAR components. In the direct measuring mode of the multimeter option, the parameters of the actual system setup are used. In the scan visualization and export modes, the parameters stored in the corresponding document files are used.

The first step of the evaluation is a linearization of the filtered input signal to account for the compression characteristics of the detector diode. The compensation depends on the input signal, the diode type and the DC-transmission factor from the diode to the evaluation electronics. If the exciting field is pulsed, the crest factor of the signal must be known to correctly compensate for peak power. The formula for each channel can be given as:

$$V_i = U_i + U_i^2 \cdot \frac{cf}{dcpi}$$

With V_i = compensated signal of channel i ($i = x, y, z$)

U_i = input signal of channel i ($i = x, y, z$)

cf = crest factor of exciting field

$dcpi$ = diode compression point

From the compensated input signals the primary field data for each channel can be evaluated:

$$E - \text{fieldprobes} : \quad E_i = \sqrt{\frac{V_i}{Norm_i \cdot ConvF}}$$

$$H - \text{fieldprobes} : \quad H_i = \sqrt{V_i} \cdot \frac{a_{i0} + a_{i1}f + a_{i2}f^2}{f}$$

With V_i = compensated signal of channel i ($i = x, y, z$)

$Norm_i$ = sensor sensitivity of channel i ($i = x, y, z$)

[mV/(V/m)2] for E-field Probes

$ConvF$ = sensitivity enhancement in solution

a_{ij} = sensor sensitivity factors for H-field probes
 f = carrier frequency [GHz]
 E_i = electric field strength of channel i in V/m
 H_i = magnetic field strength of channel i in A/m

The RSS value of the field components gives the total field strength (Hermitian magnitude):

$$E_{tot} = \sqrt{E_x^2 + E_y^2 + E_z^2}$$

The primary field data are used to calculate the derived field units.

$$SAR = E_{tot}^2 \cdot \frac{\sigma}{\rho \cdot 1'000}$$

with SAR = local specific absorption rate in mW/g
 E_{tot} = total field strength in V/m
 σ = conductivity in [mho/m] or [Siemens/m]
 ρ = equivalent tissue density in g/cm³

Note that the density is normally set to 1 (or 1.06), to account for actual brain density rather than the density of the simulation liquid.

3.7. Position of the wireless device in relation to the phantom

General considerations

This standard specifies two handset test positions against the head phantom – the “cheek” position and the “tilt” position.

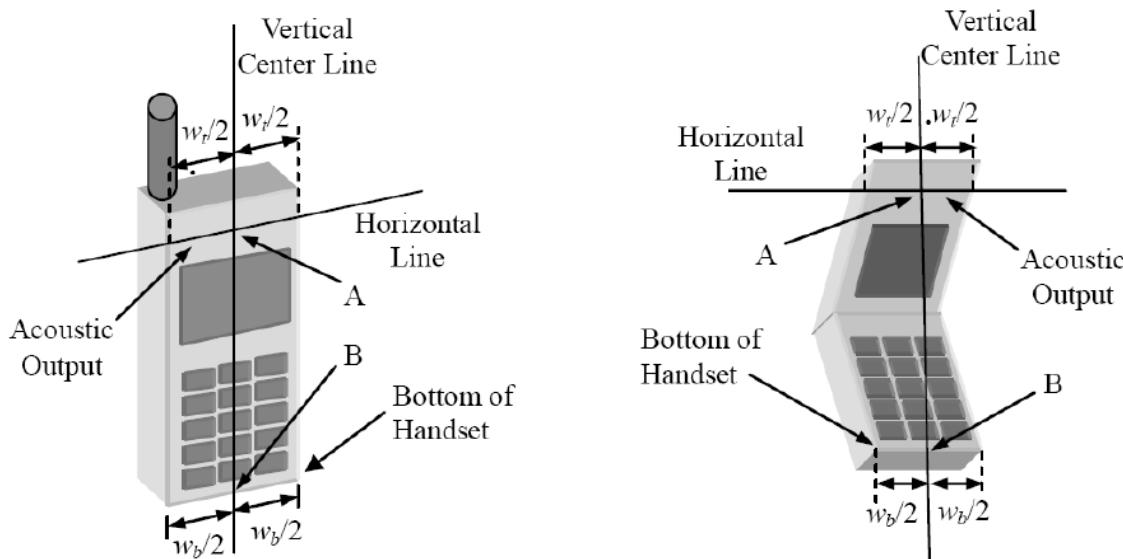
The power flow density is calculated assuming the excitation field as a free space field

$$P_{(pwe)} = \frac{E_{tot}^2}{3770} \text{ or } P_{(pwe)} = H_{tot}^2 \cdot 37.7$$

Where P_{pwe} =Equivalent power density of a plane wave in mW/cm²

E_{tot} =total electric field strength in V/m

H_{tot} =total magnetic field strength in A/m



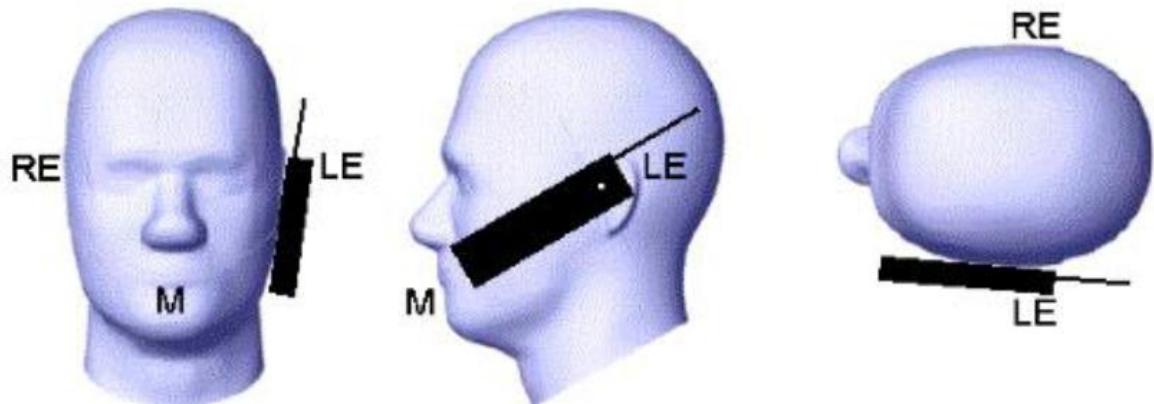
W_t Width of the handset at the level of the acoustic

W_b Width of the bottom of the handset

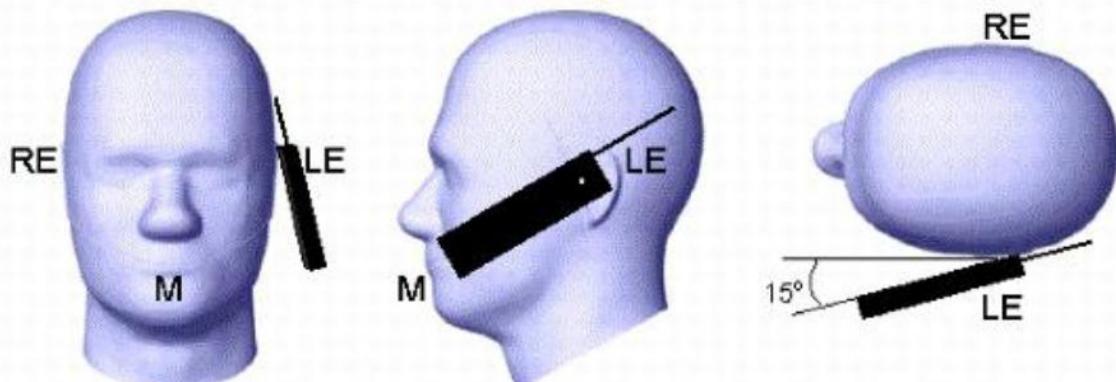
A Midpoint of the width w_t of the handset at the level of the acoustic output

B Midpoint of the width w_b of the bottom of the handset

Picture 1-a Typical “fixed” case handset Picture 1-b Typical “clam-shell” case handset



Picture 2 Cheek position of the wireless device on the left side of SAM



Picture 3 Tilt position of the wireless device on the left side of SAM

For body SAR test we applied to FCC KDB447498 D01v06.

3.8. Tissue Dielectric Parameters for Head and Body Phantoms

The liquid is consisted of water, salt, Glycol, Sugar, Preventol and Cellulose. The liquid has previously been proven to be suited for worst-case. It's satisfying the latest tissue dielectric parameters requirements proposed by the KDB865664.

The composition of the tissue simulating liquid

Frequency (MHz)	Bactericide	DGBE	HEC	NaCl	Sucrose	1,2-Propanediol	X100	Water	Conductivity	Permittivity
	%	%	%	%	%	%	%	%	σ	ϵ_r
750	/	/	/	0.79	/	64.81	/	34.40	0.97	41.8
835	/	/	/	0.79	/	64.81	/	34.40	0.97	41.8
900	/	/	/	0.79	/	64.81	/	34.40	0.97	41.8
1800	/	13.84	/	0.35	/	/	30.45	55.36	1.38	41.0
1900	/	13.84	/	0.35	/	/	30.45	55.36	1.38	41.0
2000	/	7.99	/	0.16	/	/	19.97	71.88	1.55	41.1
2450	/	7.99	/	0.16	/	/	19.97	71.88	1.88	40.3
2600	/	7.99	/	0.16	/	/	19.97	71.88	1.88	40.3

Target Frequency (MHz)	Head		Body	
	ϵ_r	$\sigma(S/m)$	ϵ_r	$\sigma(S/m)$
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
2600	39.0	1.96	52.5	2.16
3000	38.5	2.40	52.0	2.73
5800	35.3	5.27	48.2	6.00

3.9. Tissue equivalent liquid properties

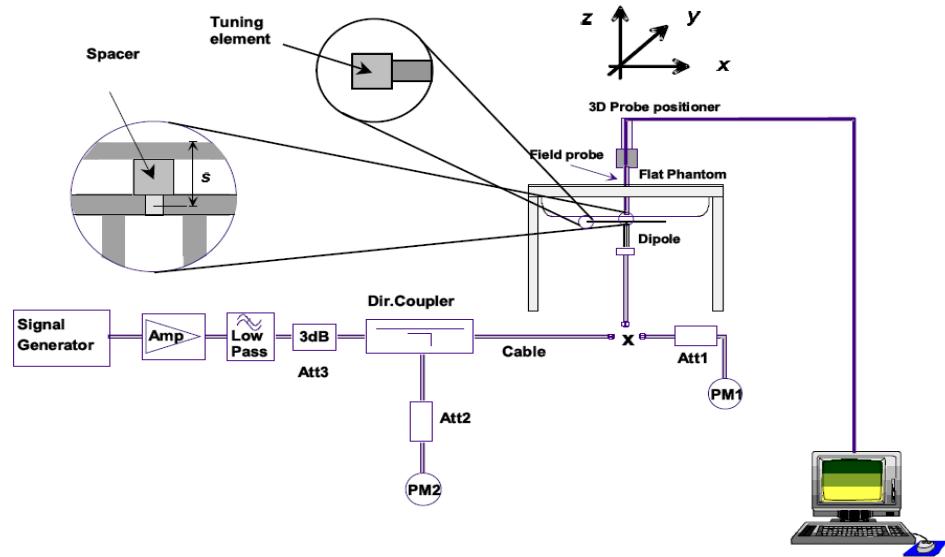
Dielectric Performance of Head and Body Tissue Simulating Liquid

Tissue Type	Measured Frequency (MHz)	Target Tissue		Measured Tissue			Liquid Temp.	Test Data	
		ϵ_r	σ	ϵ_r	Dev.	σ	Dev.		
835H	835	0.89	42.81	0.91	2.25%	42.63	-0.42%	21.5	24/05/2016
1900H	1900	1.42	41.09	1.44	1.41%	41.25	0.39%	21.5	25/05/2016
835B	835	0.96	53.46	0.99	3.13%	53.20	-0.49%	21.5	24/05/2016
1900B	1900	1.54	54.20	1.53	-0.65%	54.41	2.14%	21.5	25/05/2016

3.10. System Check

The purpose of the system check is to verify that the system operates within its specifications at the device test frequency. The system check is simple check of repeatability to make sure that the system works correctly at the time of the compliance test;

System check results have to be equal or near the values determined during dipole calibration with the relevant liquids and test system ($\pm 10\%$).



The output power on dipole port must be calibrated to 20 dBm (100mW) before dipole is connected.



Photo of Dipole Setup

Mixtue Type	Frequen cy (MHz)	Power	SAR _{1g} (W/Kg)	SAR _{10g} (W/Kg)	Drift (%)	1W Target		Difference percentage		Liquid Temp	Date
			SAR _{1g} (W/Kg)	SAR _{10g} (W/Kg)		SAR _{1g} (W/Kg)	SAR _{10g} (W/Kg)	1g	10g		
		Normalize to 1 Watt	8.78	5.71							
Head	835	100 mW	0.952	0.625	0.95	9.60	6.20	-0.83%	0.81%	21.0	24/05/ 2016
		Normalize to 1 Watt	9.52	6.25							
Body	835	100 mW	0.984	0.637	-0.24	9.90	6.39	-0.61%	-0.31%	21.0	24/05/ 2016
		Normalize to 1 Watt	9.84	6.37							
		Normalize to 1 Watt	38.92	20.51							
Head	1900	100 mW	3.973	2.010	-2.07	39.84	20.20	-0.28%	-0.50%	21.0	25/05/ 2016
		Normalize to 1 Watt	39.73	20.10							
Body	1900	100 mW	4.332	2.149	-0.09	43.33	21.59	-0.02%	-0.46%	21.0	25/05/ 2016
		Normalize to 1 Watt	43.32	21.49							

3.11. SAR measurement procedure

The measurement procedures are as follows:

3.11.1 Conducted power measurement

- a. For WWAN power measurement, use base station simulator connection with RF cable, at maximum power in each supported wireless interface and frequency band.
- b. Read the WWAN RF power level from the base station simulator.
- c. For WLAN/BT power measurement, use engineering software to configure EUT WLAN/BT continuously Transmission, at maximum RF power in each supported wireless interface and frequency band.
- d. Connect EUT RF port through RF cable to the power meter, and measure WLAN/BT output power.

3.11.2 GSM Test Configuration

SAR tests for GSM 850 and GSM 1900, a communication link is set up with a System Simulator (SS) by air link. Using CMU200 the power level is set to "5" for GSM 850, set to "0" for GSM 1900. Since the GPRS class is 12 for this EUT, it has at most 4 timeslots in uplink and at most 4 timeslots in downlink, the maximum total timeslots is 5. the EGPRS class is 12 for this EUT, it has at most 4 timeslots in uplink and at most 4 timeslots in downlink, the maximum total timeslots is 5.

SAR test reduction for GPRS and EDGE modes is determined by the source-based time-averaged output power specified for production units, including tune-up tolerance. The data mode with highest specified time-averaged output power should be tested for SAR compliance in the applicable exposure conditions. For modes with the same specified maximum output power and tolerance, the higher number time-slot configuration should be tested. GSM voice and GPRS data use GMSK, which is a constant amplitude modulation with minimal peak to average power difference within the time-slot burst. For EDGE, GMSK is used for MCS 1 – MCS 4 and 8-PSK is used for MCS 5 – MCS 9; where 8-PSK has an inherently higher peak-to-average power ratio. The GMSK and 8-PSK EDGE configurations are considered separately for SAR compliance. The GMSK EDGE configurations are grouped with GPRS and considered with respect to time-averaged maximum output power to determine compliance. The 3G SAR test reduction procedure is applied to 8-PSK EDGE with GMSK GPRS/EDGE as the primary mode.

4. TEST CONDITIONS AND RESULTS

4.1. Conducted Power Results

Max Conducted power measurement results and power drift from tune-up tolerance provide by manufacturer:

Conducted power measurement results for GSM850/PCS1900

GSM 850		Burst Conducted power (dBm)			/	Average power (dBm)			
		Channel/Frequency(MHz)				Channel/Frequency(MHz)			
		128/824.2	190/836.6	251/848.8		128/824.2	190/836.6	251/848.8	
GSM		33.26	33.14	33.12	-9.03dB	24.23	24.11	24.09	
GPRS (GMSK)	1TX slot	33.08	33.15	33.24	-9.03dB	24.05	24.12	24.21	
	2TX slot	33.16	33.09	33.11	-6.02dB	27.14	27.07	27.09	
	3TX slot	33.24	32.89	32.98	-4.26dB	28.98	28.63	28.72	
	4TX slot	32.65	32.46	32.95	-3.01dB	29.64	29.45	29.94	
EGPRS (8PSK)	1TX slot	32.96	32.75	32.64	-9.03dB	23.93	23.72	23.61	
	2TX slot	32.35	32.46	32.54	-6.02dB	26.33	26.44	26.52	
	3TX slot	33.05	32.97	32.69	-4.26dB	28.79	28.71	28.43	
	4TX slot	32.46	32.24	32.86	-3.01dB	29.45	29.23	29.85	
GSM 1900		Burst Conducted power (dBm)			/	Average power (dBm)			
		Channel/Frequency(MHz)				Channel/Frequency(MHz)			
		512/ 1850.2	661/ 1880	810/ 1909.8		512/ 1850.2	661/ 1880	810/ 1909.8	
		GSM	28.59	28.39	28.29	-9.03dB	19.56	19.36	19.26
GPRS (GMSK)	1TX slot	28.12	28.05	28.31	-9.03dB	19.09	19.02	19.28	
	2TX slot	28.13	28.21	28.14	-6.02dB	22.11	22.19	22.12	
	3TX slot	28.09	28.13	28.24	-4.26dB	23.83	23.87	23.98	
	4TX slot	28.42	28.41	28.32	-3.01dB	25.41	25.40	25.31	
EGPRS (8PSK)	1TX slot	28.51	28.33	28.28	-9.03dB	19.48	19.30	19.25	
	2TX slot	28.15	28.06	28.17	-6.02dB	22.13	22.04	22.15	
	3TX slot	28.22	28.16	28.15	-4.26dB	23.96	23.90	23.89	
	4TX slot	28.35	28.26	28.19	-3.01dB	25.34	25.25	25.18	

Notes:

1. Division Factors

To average the power, the division factor is as follows:

1TX-slot = 1 transmit time slot out of 8 time slots=> conducted power divided by (8/1) => -9.00dB

2TX-slots = 2 transmit time slots out of 8 time slots=> conducted power divided by (8/2) => -6.00dB

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

4TX-slots = 4 transmit time slots out of 8 time slots=> conducted power divided by (8/4) => -3.00dB

2. According to the conducted power as above, the GPRS measurements are performed with 3Txslot for GPRS850 and 3Txslot GPRS1900.

The conducted power measurement results for Bluetooth V3.0+4.0

Mode	Channel	Frequency (MHz)	Conducted Output Average Power
			(dBm)
BLE	0	2402	4.515
	19	2440	4.393
	39	2480	4.35
GFSK	00	2402	3.255
	39	2441	2.211
	78	2480	4.72
8DPSK	00	2402	2.19
	39	2441	1.3
	78	2480	0.737
$\pi/4$ -DQPSK	00	2402	2.566
	39	2441	1.556
	78	2480	1.014

Per KDB 447498 D01v05r02, the 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances \leq 50 mm are determined by:

$[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}] \leq 3.0$ for 1-g SAR and ≤ 7.5 for 10-g extremity SAR

- $f(\text{GHz})$ is the RF channel transmit frequency in GHz
- Power and distance are rounded to the nearest mW and mm before calculation
- The result is rounded to one decimal place for comparison

Bluetooth Turn up Power (dBm)	Separation Distance (mm)	Frequency (GHz)	Exclusion Thresholds
5.0	5	2.45	0.99

Per KDB 447498 D01v05r02, when the minimum test separation distance is $<$ 5 mm, a distance of 5 mm is applied to determine SAR test exclusion. The test exclusion threshold is 0.99 which is $<$ 3, SAR testing is not required.

4.2. Manufacturing tolerance

GSM Speech

GSM 850 (GMSK) (Burst Average Power)

Channel	Channel 128	Channel 190	Channel 251
Target (dBm)	32.5	32.5	32.5
Tolerance \pm (dB)	1.0	1.0	1.0

GSM 1900 (GMSK) (Burst Average Power)

Channel	Channel 512	Channel 661	Channel 810
Target (dBm)	28.0	28.0	28.0
Tolerance \pm (dB)	1.0	1.0	1.0

GSM 850 GPRS (GMSK) (Burst Average Power)

Channel	128	190	251
1 Txslot	Target (dBm)	32.5	32.5
	Tolerance \pm (dB)	1.0	1.0
2 Txslot	Target (dBm)	32.5	32.5
	Tolerance \pm (dB)	1.0	1.0
3 Txslot	Target (dBm)	32.5	32.5
	Tolerance \pm (dB)	1.0	1.0
4 Txslot	Target (dBm)	32.5	32.5
	Tolerance \pm (dB)	1.0	1.0

GSM 850 EDGE (8PSK) (Burst Average Power)

Channel	128	190	251
1 Txslot	Target (dBm)	32.0	32.0
	Tolerance \pm (dB)	1.0	1.0
2 Txslot	Target (dBm)	32.0	32.0
	Tolerance \pm (dB)	1.0	1.0
3 Txslot	Target (dBm)	32.5	32.5
	Tolerance \pm (dB)	1.0	1.0
4 Txslot	Target (dBm)	32.0	32.0
	Tolerance \pm (dB)	1.0	1.0

GSM 1900 GPRS (GMSK) (Burst Average Power)

Channel	512	661	810
1 Txslot	Target (dBm)	27.5	27.5
	Tolerance \pm (dB)	1.0	1.0
2 Txslot	Target (dBm)	27.5	27.5
	Tolerance \pm (dB)	1.0	1.0
3 Txslot	Target (dBm)	27.5	27.5
	Tolerance \pm (dB)	1.0	1.0
4 Txslot	Target (dBm)	27.5	27.5
	Tolerance \pm (dB)	1.0	1.0

GSM 1900 EDGE (8PSK) (Burst Average Power)

Channel	512	661	810
1 Txslot	Target (dBm)	28.0	28.0
	Tolerance \pm (dB)	1.0	1.0
2 Txslot	Target (dBm)	27.5	27.5
	Tolerance \pm (dB)	1.0	1.0
3 Txslot	Target (dBm)	27.5	27.5
	Tolerance \pm (dB)	1.0	1.0
4 Txslot	Target (dBm)	27.5	27.5
	Tolerance \pm (dB)	1.0	1.0

Bluetooth V4.0**BLE(Average)**

Channel	Channel 0	Channel 19	Channel 39
Target (dBm)	4.0	4.0	4.0
Tolerance \pm (dB)	1.0	1.0	1.0

GFSK (Average)

Channel	Channel 0	Channel 39	Channel 78
Target (dBm)	4.0	4.0	4.0
Tolerance \pm (dB)	1.0	1.0	1.0

8DPSK (Average)

Channel	Channel 0	Channel 39	Channel 78
Target (dBm)	1.5	1.5	1.5
Tolerance \pm (dB)	1.0	1.0	1.0

 $\pi/4$ DQPSK (Average)

Channel	Channel 0	Channel 39	Channel 78
Target (dBm)	2.0	2.0	2.0
Tolerance \pm (dB)	1.0	1.0	1.0

4.3. SAR Measurement Results

The calculated SAR is obtained by the following formula:

$$\text{Reported SAR} = \text{Measured SAR} \times 10^{(\text{P}_{\text{target}} - \text{P}_{\text{measured}})/10}$$

$$\text{Scaling factor} = 10^{(\text{P}_{\text{target}} - \text{P}_{\text{measured}})/10}$$

$$\text{Reported SAR} = \text{Measured SAR} \times \text{Scaling factor}$$

Where

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

P_{measured} is the measured power;

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

Reported SAR which including Power Drift and Scaling factor

The product with 2 SIMs and 2 SIMs(SIM1 and SIM2) can not used Simultaneous, we tested 2 SIMs(SIM1 and SIM2) and recorded worst case at SIM 1

Duty Cycle

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

5.3.1 SAR Results

GSM Next to Mouth SAR

Ch.	Freq. (MHz)	Time slots	Test Position	Conducted Power (dBm)	Maximum Allowed Power (dBm)	Power Drift (%)	Scaling Factor	SAR _{1-g} results(W/kg)		Graph Results
								Measured	Reported	
190	836.6	Voice	Front	33.26	33.50	4.19	1.06	0.061	0.064	Plot 1
661	1880.0	Voice	Front	28.59	29.00	-1.23	1.10	0.116	0.127	Plot 2

GSM Wrist-Worn SAR

Ch.	Freq. (MHz)	time slots	Test Position	Conducted Power (dBm)	Maximum Allowed Power (dBm)	Power Drift (%)	Scaling Factor	SAR _{10-g} results(W/kg)		Graph Results
								Measured	Reported	
190	836.6	Voice	Back	33.26	33.50	3.34	1.06	0.382	0.404	Plot 3
190	836.6	4Txslots	Back	32.95	33.50	2.27	1.14	0.263	0.299	Plot 4
661	1880.0	Voice	Back	28.59	29.00	0.51	1.10	0.143	0.157	Plot 5
661	1880.0	4Txslots	Back	28.42	28.50	-0.45	1.02	0.096	0.098	Plot 6

Note:

1. The value with black color is the maximum Reported SAR Value of each test band.
2. Per FCC KDB Publication 447498 D01, if the reported (scaled) SAR measured at the middle channel or highest output power channel for each test configuration is $\leq 0.8 \text{ W/kg}$ then testing at the other channels is optional for such test configuration(s).
3. Per KDB 941225 D02, RMC 12.2kbps setting is used to evaluate SAR. If HSDPA/HSUPA output power is $< 0.25 \text{ dB}$ higher than RMC, or reported SAR with RMC 12.2kbps setting is $\leq 1.2 \text{ W/kg}$, HSDPA/HSUPA SAR evaluation can be excluded.
4. Per KDB 248227- 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 $\leq 1.2 \text{ W/kg}$. So OFDM SAR test is not required.
5. Per KDB 648474 D04, when the reported SAR for a body-worn accessory measured without a headset connected to the handset is $\leq 1.2 \text{ W/kg}$, SAR testing with a headset connected to the handset is not required.

5.3.3 Standalone SAR Test Exclusion Considerations and Estimated SAR

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

- $(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm}) \cdot [\sqrt{f(\text{GHz})/x}] \text{ W/kg}$ for test separation distances $\leq 50 \text{ mm}$;
where $x = 7.5$ for 1-g SAR, and $x = 18.75$ for 10-g SAR.

- 0.4 W/kg for 1-g SAR and 1.0 W/kg for 10-g SAR, when the test separation distances is $> 50 \text{ mm}$

Per FCC KDB 648474 D01, simultaneous transmission SAR test exclusion may be applied when the sum of the 1-g SAR for all the transmitting antenna in a specific physical test configuration is $\leq 1.6 \text{ W/kg}$. When the sum is greater than the SAR limit, SAR test exclusion is determined by the SAR to peak location separation ratio.

$$\text{Ratio} = \frac{(\text{SAR}_1 + \text{SAR}_2)^{1.5}}{(\text{peak location separation, mm})} < 0.04$$

Estimated stand alone SAR					
Communication system	Frequency (MHz)	Configuration	Maximum Power (including tune-up tolerance) (dBm)	Separation Distance (mm)	Estimated SAR _{1-g} (W/kg)
Bluetooth*	2450	Body	5.0	5	0.131

Bluetooth*- Including Lower power Bluetooth

4.4. Simultaneous TX SAR Considerations

4.4.1 Introduction

The following procedures adopted from "FCC SAR Considerations for Cell Phones with Multiple Transmitters" are applicable to handsets with built-in unlicensed transmitters such as Bluetooth devices which may simultaneously transmit with the licensed transmitter.

For the DUT, the BT modules is a single antenna, GSM modules is a single antenna;
Application Simultaneous Transmission information:

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

Note: VO-Voice Service only; DT-Digital Transport

Note: BLE-Bluetooth low energy;

BT- Classical Bluetooth

4.4.2 Evaluation of Simultaneous SAR

Front of face SAR Data

1-g SAR:

Simultaneous transmission SAR for BT and GSM

Test Position	GSM850 Reported SAR _{1-g} (W/Kg)	GSM1900 Reported SAR _{1-g} (W/Kg)	BT Estimated SAR _{1-g} (W/Kg)	MAX. Σ SAR _{1-g} (W/Kg)	SAR _{1-g} Limit (W/Kg)	Peak location separation ratio	Simut Meas. Required
Front	0.064	0.127	0.131	0.258	1.6	no	no

Wrist-Worn SAR Data

10-g SAR :

GSM & BT Mode

Test Position	GSM850 Reported SAR _{1-g} (W/Kg)	GSM1900 Reported SAR _{1-g} (W/Kg)	BT Estimated SAR _{1-g} (W/Kg)	MAX. Σ SAR _{1-g} (W/Kg)	SAR _{10-g} Limit (W/Kg)	Peak location separation ratio	Simut Meas. Required
Back-voice	0.404	0.157	0.131	0.535	4	no	no
Back-4slots	0.299	0.098	0.131	0.430	4	no	no

4.5. SAR Measurement Variability

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

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

4.6. General description of test procedures

1. The DUT is tested using CMU 200 communications testers as controller unit to set test channels and maximum output power to the DUT, as well as for measuring the conducted peak power.
2. Test positions as described in the tables above are in accordance with the specified test standard.
3. Tests in body position were performed in that configuration, which generates the highest time based averaged output power (see conducted power results).
4. Tests in head position with GSM were performed in voice mode with 1 timeslot unless GPRS/EGPRS/DTM function allows parallel voice and data traffic on 2 or more timeslots.
5. UMTS was tested in RMC mode with 12.2 kbit/s and TPC bits set to 'all 1'.
6. WiFi was tested in 802.11b/g/n mode with 1 Mbit/s and 6 Mbit/s. According to KDB 248227 the SAR testing for 802.11g/n is not required since When the highest reported SAR for DSSS is adjusted by the ratio of OFDM to DSSS specified maximum output power and the adjusted SAR is ≤ 1.2 W/kg.
7. Required WiFi test channels were selected according to KDB 248227
8. According to FCC KDB pub 248227 D01, Channels with measured maximum output power within $\frac{1}{4}$ dB of each other are considered to have the same maximum output, When there are multiple test channels with the same measured maximum output power, the channel closest to mid-band frequency is selected for SAR measurement and when there are multiple test channels with the same measured maximum output power and equal separation from mid-band frequency; for example, high and low channels or two mid-band channels, the higher frequency (number) channel is selected for SAR measurement.
9. According to FCC KDB pub 941225 D06 this device has been tested with 10 mm distance to the phantom for operation in WiFi hot spot mode.
10. Per FCC KDB pub 941225 D06 the edges with antennas within 2.5 cm are required to be evaluated for SAR to cover WiFi hot spot function.
11. According to IEEE 1528 the SAR test shall be performed at middle channel. Testing of top and bottom channel is optional.
12. According to KDB 447498 D01 testing of other required channels within the operating mode of a frequency band is not required when the reported 1-g or 10-g SAR for the mid-band or highest output power channel is:
 - ≤ 0.8 W/kg or 2.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≤ 100 MHz
 - ≤ 0.6 W/kg or 1.5 W/kg, for 1-g or 10-g respectively, when the transmission band is between 100 MHz and 200 MHz
 - ≤ 0.4 W/kg or 1.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≥ 200 MHz
13. IEEE 1528-2013 require the middle channel to be tested first. This generally applies to wireless devices that are designed to operate in technologies with tight tolerances for maximum output power variations across channels in the band. When the maximum output power variation across the required test channels is $> \frac{1}{2}$ dB, instead of the middle channel, the highest output power channel must be used.
14. Per KDB648474 D04 require when the reported SAR for a body-worn accessory, measured without a headset connected to the handset, is < 1.2 W/kg.

15. Per KDB648474 D04 require when the separation distance required for body-worn accessory testing is larger than or equal to that tested for hotspot mode, using the same wireless mode test configuration for voice and data, such as UMTS, LTE and Wi-Fi, and for the same surface of the phone, the hotspot mode SAR data may be used to support body-worn accessory SAR compliance for that particular configuration (surface)
16. 10-g extremity SAR is required only for the surfaces and edges with hotspot mode 1-g SAR $> 1.2 \text{ W/kg}$.
17. Per KDB648474 D04 require for phablet SAR test considerations, For smart phone with a display diagonal dimension $> 15.0 \text{ cm}$ or an overall diagonal dimension $> 16.0 \text{ cm}$, When hotspot mode applies, 10-g extremity SAR is required only for the surfaces and edges with hotspot mode 1-g reported SAR $> 1.2 \text{ W/kg}$.
18. 10-g extremity SAR is required only for the surfaces and edges with hotspot mode 1-g SAR $> 1.2 \text{ W/kg}$.

4.7. Measurement Uncertainty (300MHz-3GHz)

Not required as SAR measurement uncertainty analysis is required in SAR reports only when the highest measured SAR in a frequency band is $\geq 1.5 \text{ W/kg}$ for 1-g SAR accordidng to KDB865664D01.

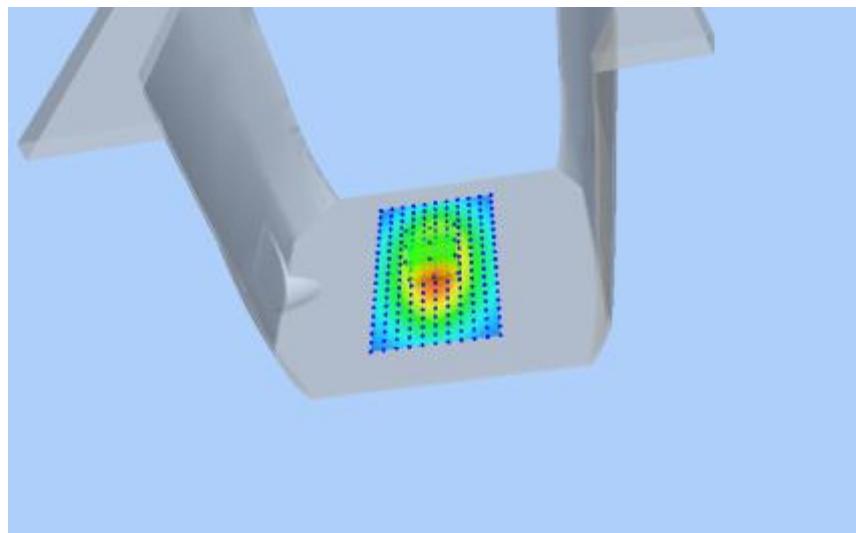
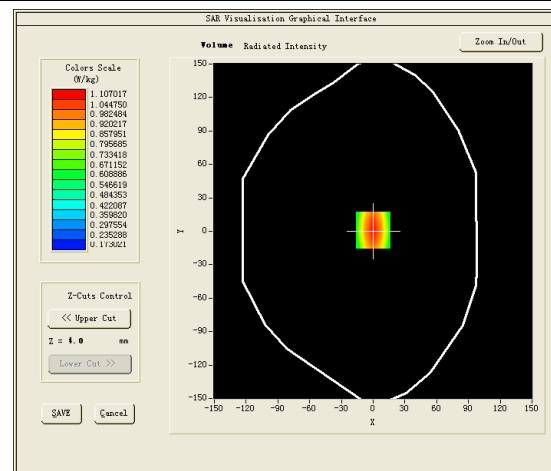
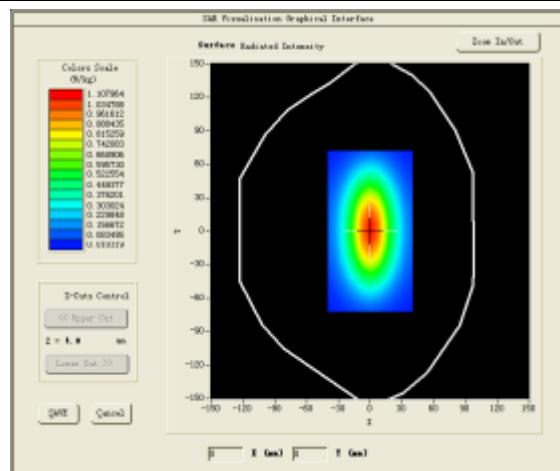
4.8. System Check Results

Test mode:835MHz(Head)
 Product Description:Validation
 Model:Dipole SID835
 E-Field Probe:SSE5(SN17/14 EP220)
 Test Date: May 24, 2016

Medium(liquid type)	HSL_900
Frequency (MHz)	835.000000
Relative permittivity (real part)	42.63
Conductivity (S/m)	0.91
Input power	100mW
Crest Factor	1.0
Conversion Factor	4.86
Variation (%)	-1.5700000
SAR 10g (W/Kg)	0.6047063
SAR 1g (W/Kg)	0.9471289

SURFACE SAR

VOLUME SAR



Test mode:835MHz(Body)

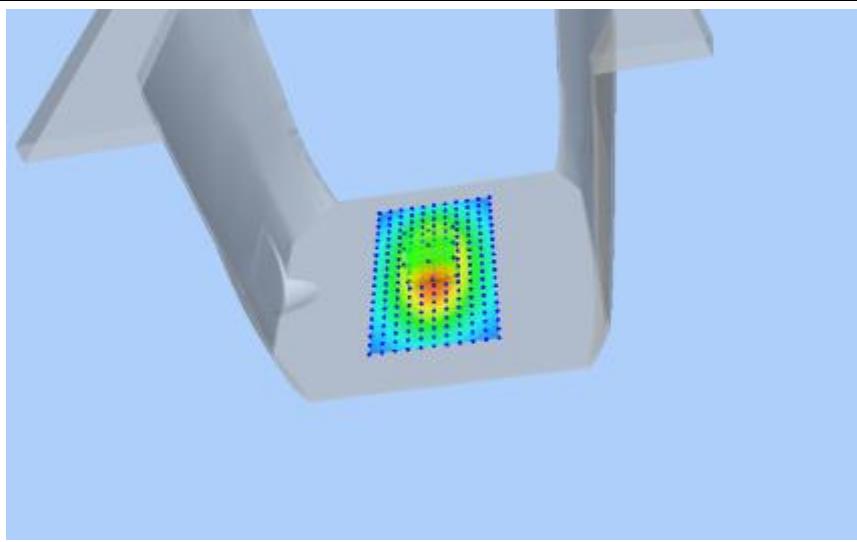
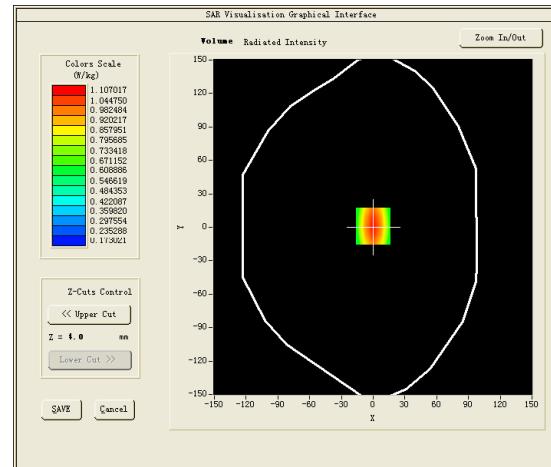
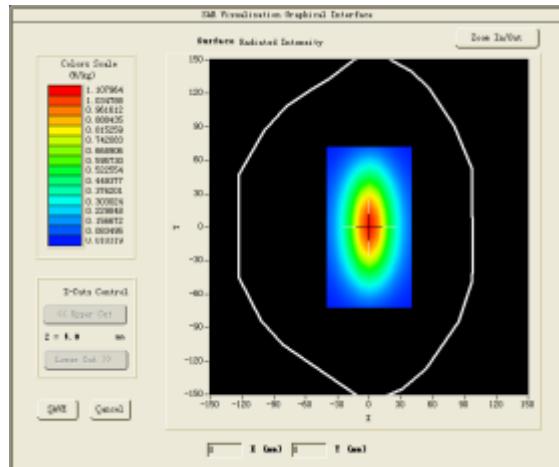
Product Description:Validation

Model:Dipole SID835

E-Field Probe:SSE5(SN17/14 EP220)

Test Date: May 24, 2016

Medium(liquid type)	MSL_900
Frequency (MHz)	835.0000
Relative permittivity (real part)	53.20
Conductivity (S/m)	0.99
Input power	100mW
Crest Factor	1.0
Conversion Factor	5.04
Variation (%)	0.9100000
SAR 10g (W/Kg)	0.6130225
SAR 1g (W/Kg)	0.9800314

SURFACE SAR**VOLUME SAR**

Test mode:1900MHz(Head)

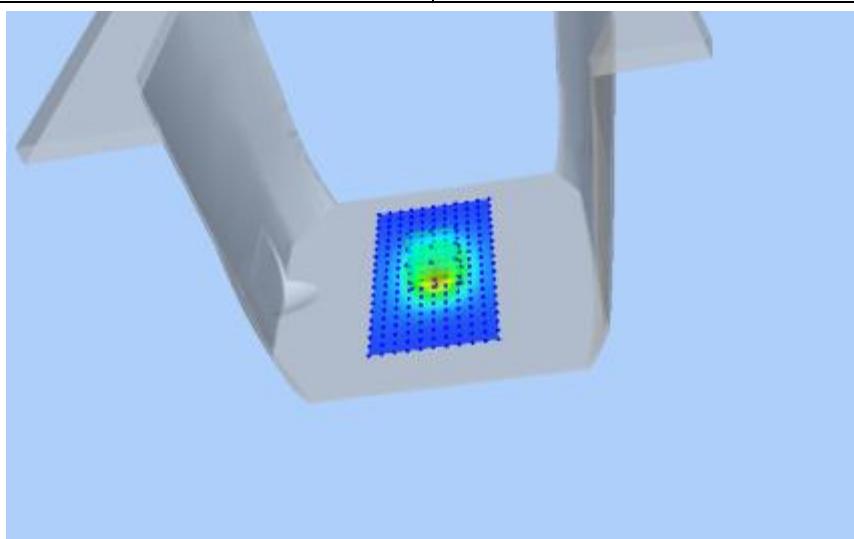
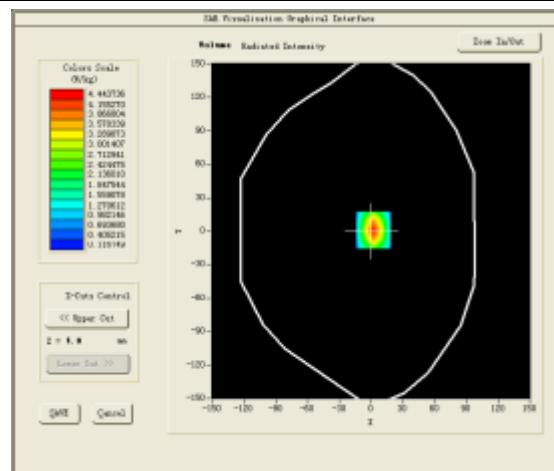
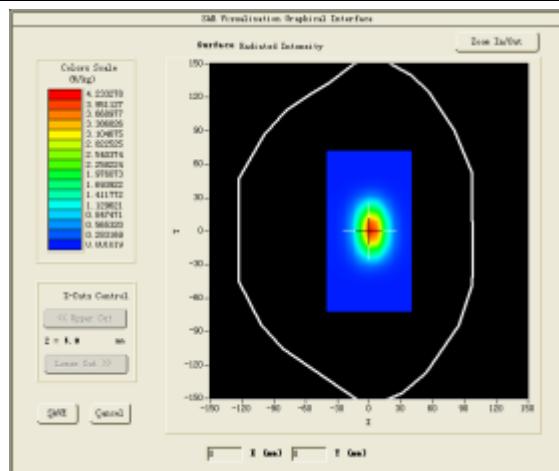
Product Description:Validation

Model :Dipole SID1900

E-Field Probe:SSE5(SN17/14 EP221)

Test Date: May 25, 2016

Medium(liquid type)	HSL_1900
Frequency (MHz)	1900.0000
Relative permittivity (real part)	41.25
Conductivity (S/m)	1.44
Input power	100mW
Crest Factor	1.0
Conversion Factor	4.71
Variation (%)	-0.4300000
SAR 10g (W/Kg)	2.1742638
SAR 1g (W/Kg)	3.7003144

SURFACE SAR**VOLUME SAR**

Test mode:1900MHz(Body)

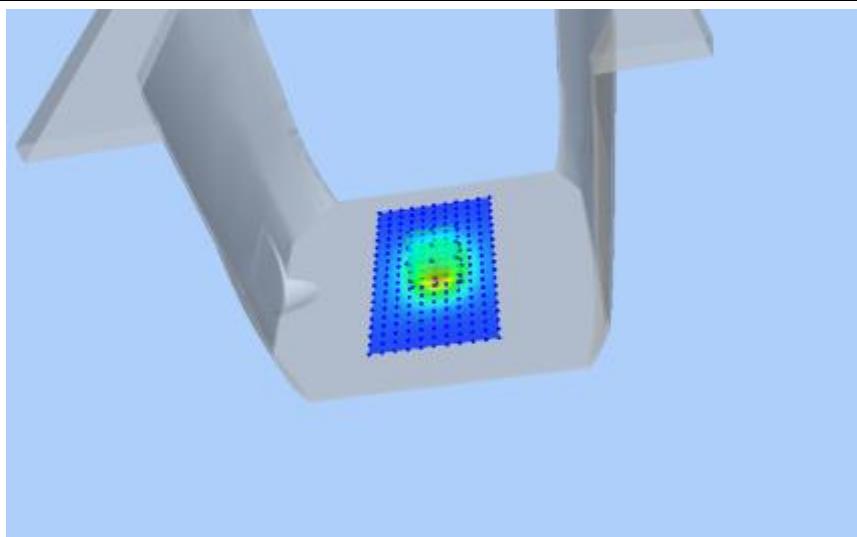
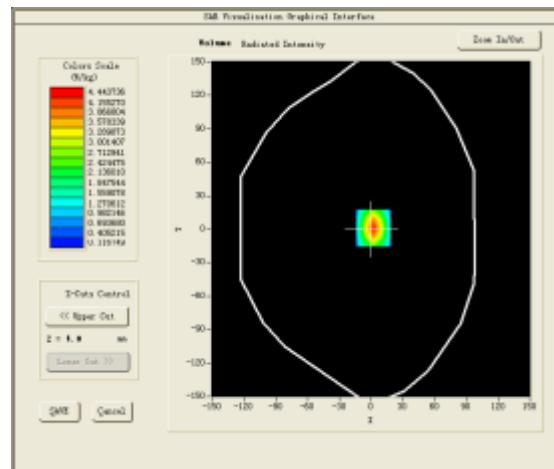
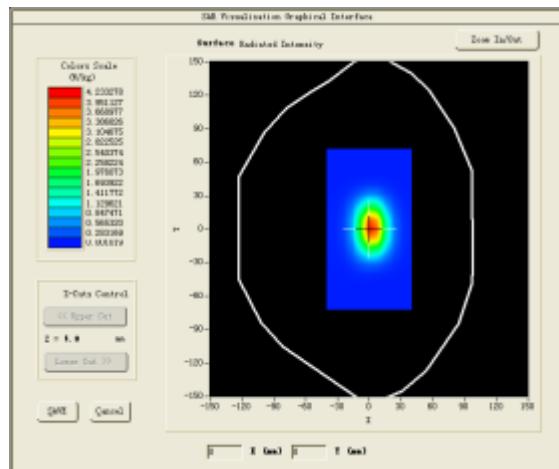
Product Description:Validation

Model :Dipole SID1900

E-Field Probe:SSE5(SN17/14 EP221)

Test Date: May 25, 2016

Medium(liquid type)	MSL_1900
Frequency (MHz)	1900.0000
Relative permittivity (real part)	54.41
Conductivity (S/m)	1.53
Input power	100mW
Crest Factor	1.0
Conversion Factor	4.85
Variation (%)	1.5300000
SAR 10g (W/Kg)	1.9452841
SAR 1g (W/Kg)	3.9754816

SURFACE SAR**VOLUME SAR**

4.9. SAR Test Graph Results

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

#1

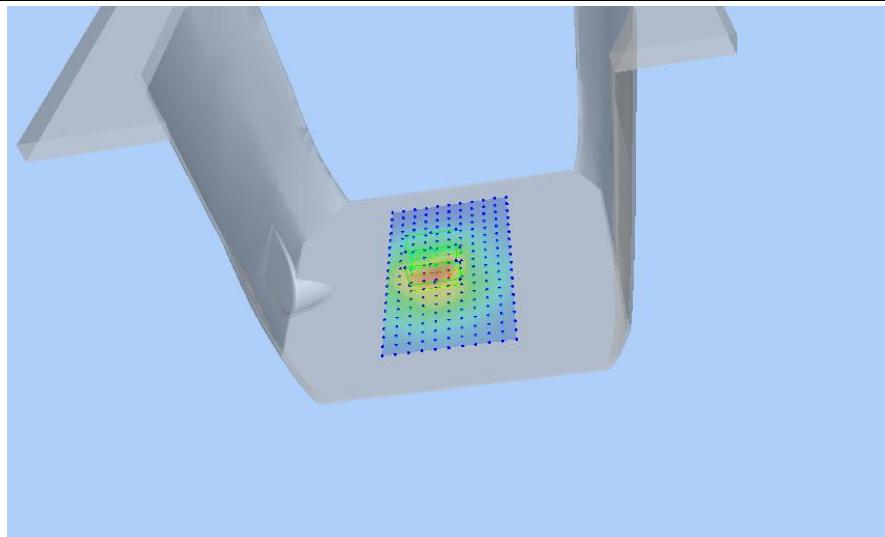
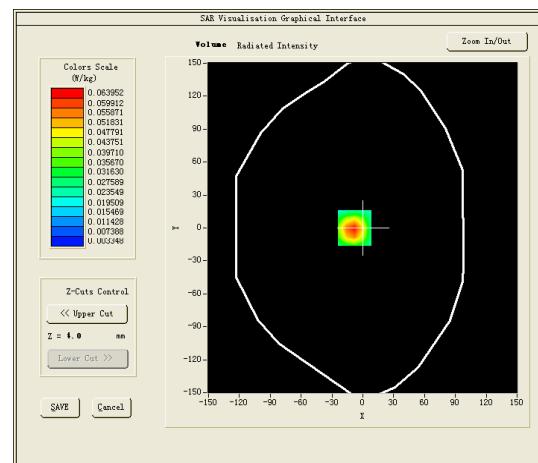
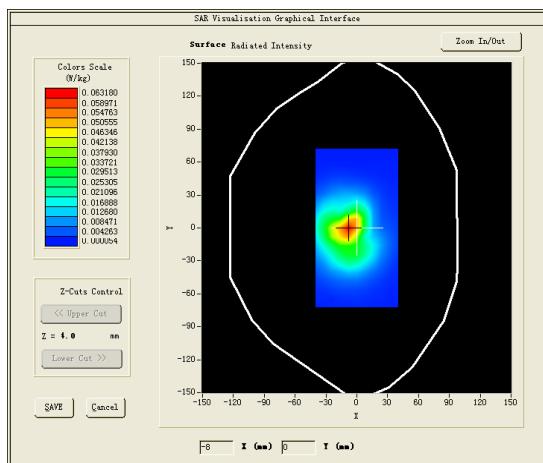
Test Mode: GSM 850MHz, Mid channel(Front Next to Mouth)

Product Description: Smart Watch

Model: G3

Test Date: May 24, 2016

Medium(liquid type)	MSL_900
Frequency (MHz)	836.600000
Relative permittivity (real part)	42.81
Conductivity (S/m)	0.89
E-Field Probe	SN 17/14 EP220
Crest Factor	8.0
Conversion Factor	4.83
Sensor	4mm
Area Scan	dx=8mm dy=8mm
Zoom Scan	5x5x7, dx=8mm dy=8mm dz=5mm
Variation (%)	4.190000
SAR 10g (W/Kg)	0.031511
SAR 1g (W/Kg)	0.060880
SURFACE SAR	VOLUME SAR



#2

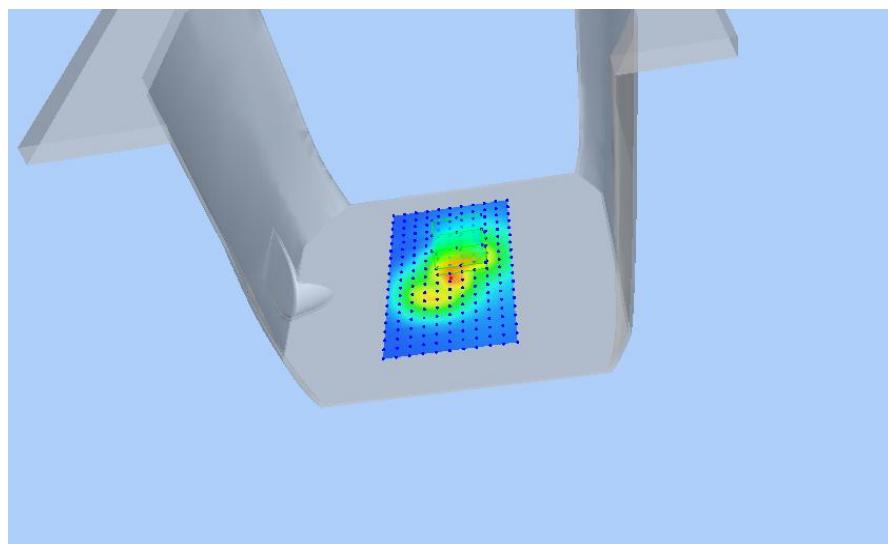
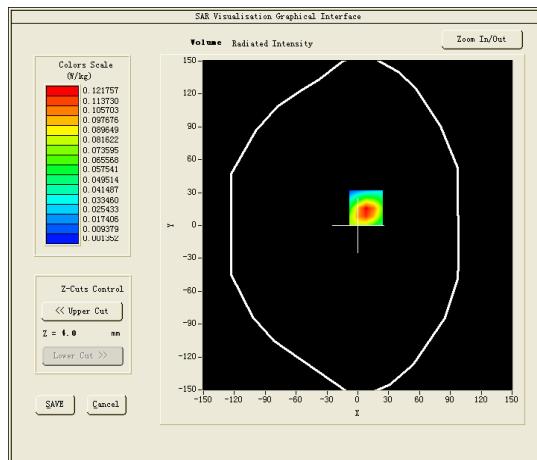
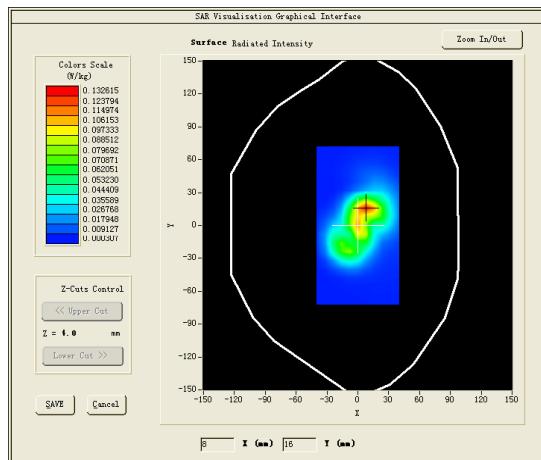
Test Mode: GSM 1900MHz, Mid channel(Front Next to Mouth)

Product Description: Smart Watch

Model: G3

Test Date: May 25, 2016

Medium(liquid type)	MSL_1900
Frequency (MHz)	1880.000000
Relative permittivity (real part)	41.09
Conductivity (S/m)	1.42
E-Field Probe	SN17/14 EP221
Crest Factor	8.0
Conversion Factor	4.71
Sensor	4mm
Area Scan	dx=8mm dy=8mm
Zoom Scan	5x5x7, dx=8mm dy=8mm dz=5mm
Variation (%)	-1.230000
SAR 10g (W/Kg)	0.062250
SAR 1g (W/Kg)	0.116225

SURFACE SAR**VOLUME SAR**

#3

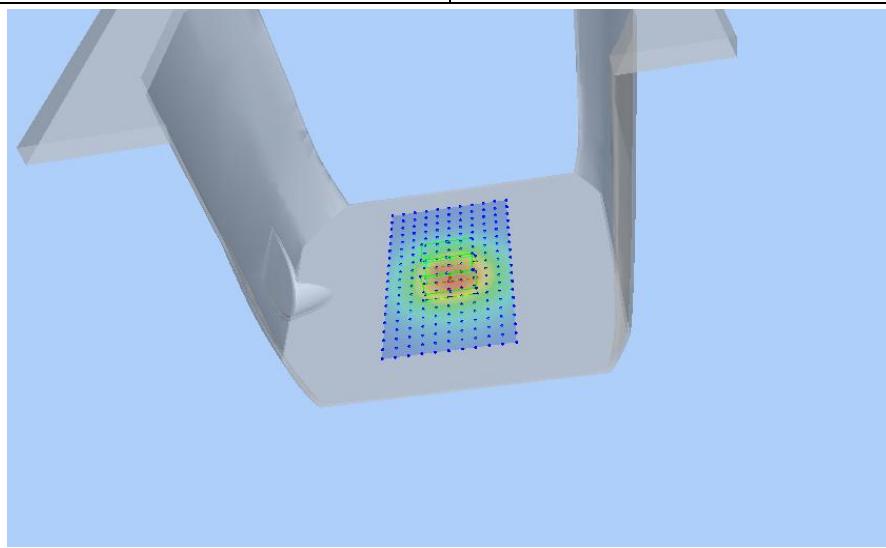
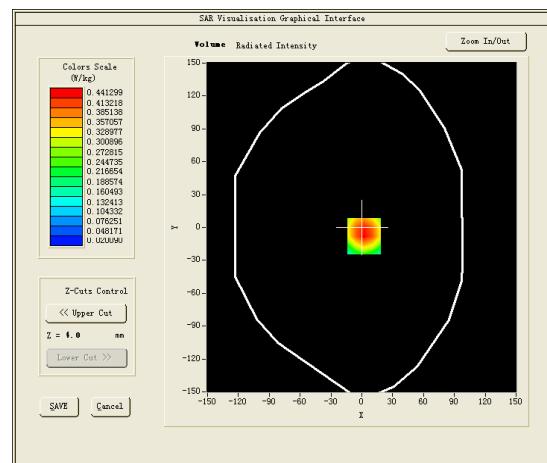
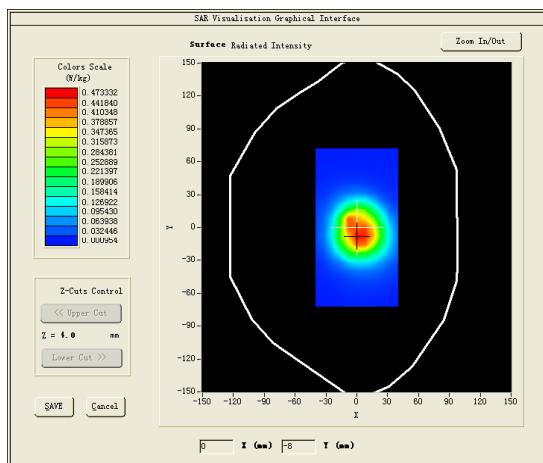
Test Mode: GSM 850MHz, Mid channel((Back Wrist-Wron))

Product Description: Smart Watch

Model: G3

Test Date: May 24, 2016

Medium(liquid type)	MSL_900
Frequency (MHz)	836.600000
Relative permittivity (real part)	42.81
Conductivity (S/m)	0.89
E-Field Probe	SN 17/14 EP220
Crest Factor	8.0
Conversion Factor	4.83
Sensor	4mm
Area Scan	dx=8mm dy=8mm
Zoom Scan	5x5x7, dx=8mm dy=8mm dz=5mm
Variation (%)	2.270000
SAR 10g (W/Kg)	0.263377
SAR 1g (W/Kg)	0.430975

SURFACE SAR**VOLUME SAR**

#4

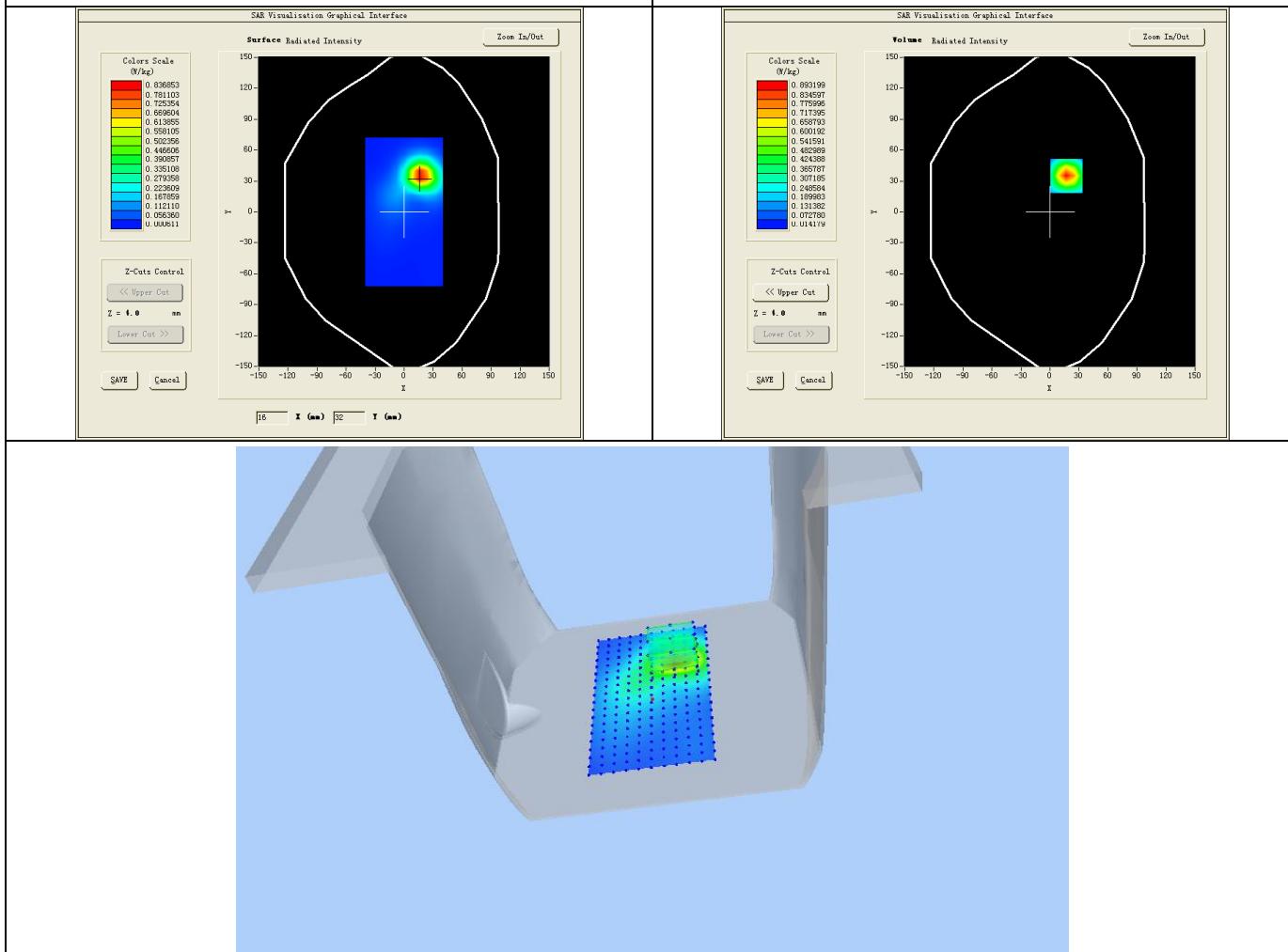
Test Mode: GPRS 850 MHz, Mid channel(Back Wrist-Wron)

Product Description: Smart Watch

Model: G3

Test Date: May 24, 2016

Medium(liquid type)	MSL_900
Frequency (MHz)	836.600000
Relative permittivity (real part)	53.46
Conductivity (S/m)	0.96
E-Field Probe	SN 17/14 EP220
Crest Factor	6.02
Conversion Factor	5.02
Sensor	4mm
Area Scan	dx=8mm dy=8mm
Zoom Scan	5x5x7, dx=8mm dy=8mm dz=5mm
Variation (%)	3.340000
SAR 10g (W/Kg)	0.382054
SAR 1g (W/Kg)	0.811910
SURFACE SAR	VOLUME SAR



#5

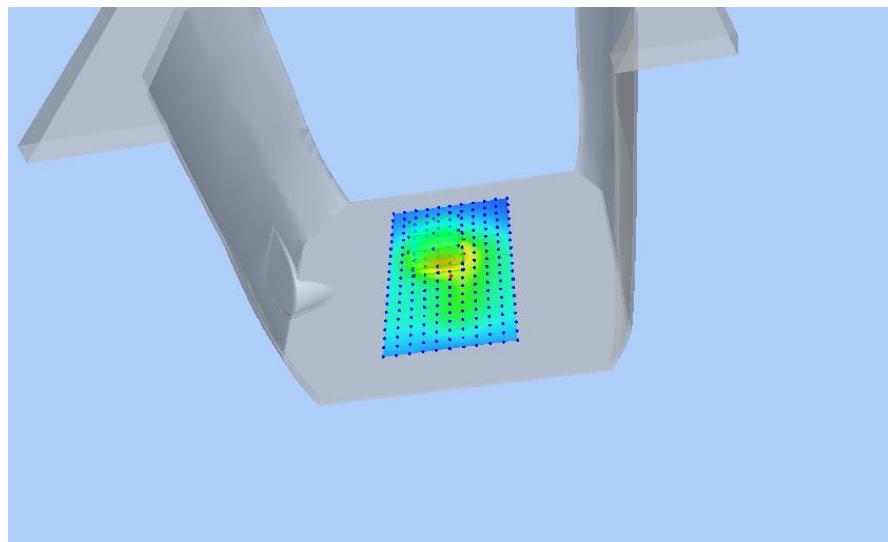
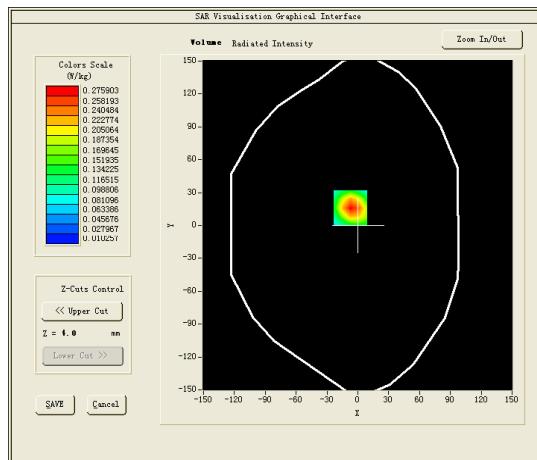
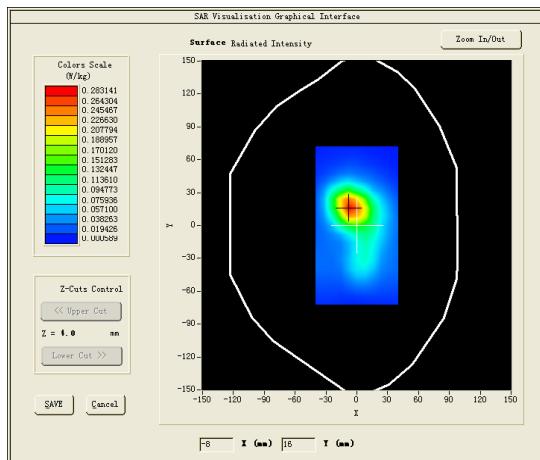
Test Mode: GSM 1900MHz, Mid channel(Back Wrist-Wron)

Product Description: Smart Watch

Model: G3

Test Date: May 25, 2016

Medium(liquid type)	MSL_1900
Frequency (MHz)	1880.000000
Relative permittivity (real part)	41.09
Conductivity (S/m)	1.42
E-Field Probe	SN17/14 EP221
Crest Factor	8.0
Conversion Factor	4.71
Sensor	4mm
Area Scan	dx=8mm dy=8mm
Zoom Scan	5x5x7, dx=8mm dy=8mm dz=5mm
Variation (%)	0.510000
SAR 10g (W/Kg)	0.143379
SAR 1g (W/Kg)	0.256756

SURFACE SAR**VOLUME SAR**

#6

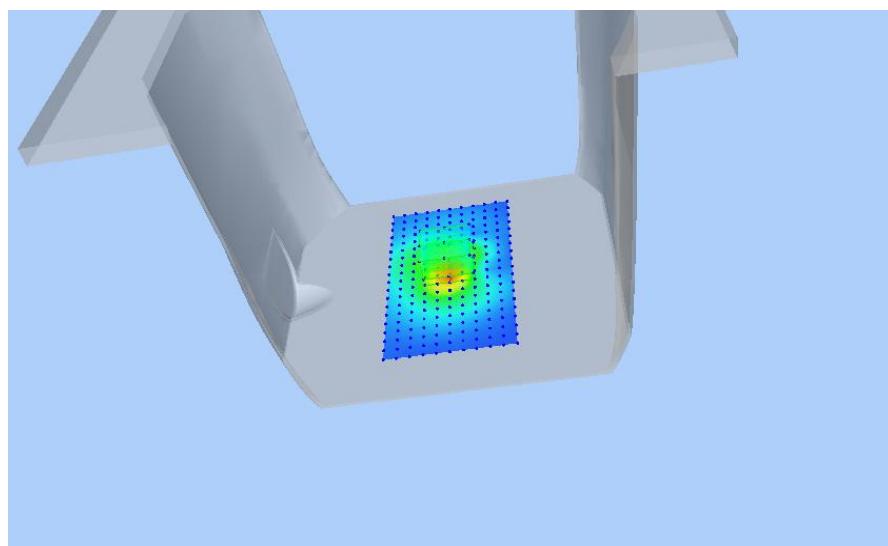
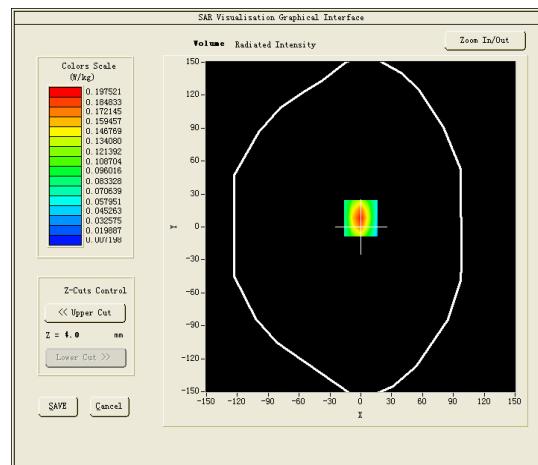
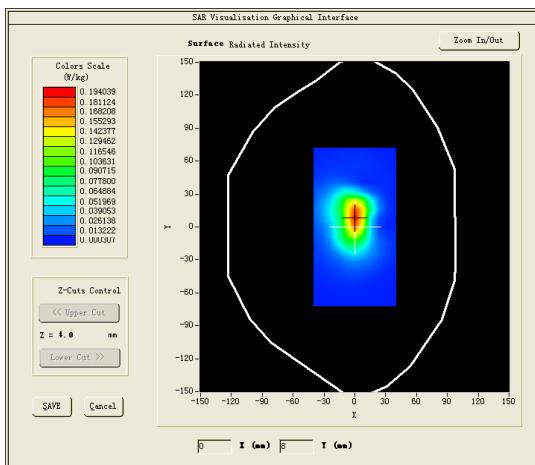
Test Mode: GPRS1900MHz, Mid channel(Back Wrist-Wron)

Product Description: Smart Watch

Model: G3

Test Date: May 25, 2016

Medium(liquid type)	MSL_1900
Frequency (MHz)	1880.000000
Relative permittivity (real part)	54.20
Conductivity (S/m)	1.54
E-Field Probe	SN17/14 EP221
Crest Factor	4.06
Conversion Factor	4.85
Sensor	4mm
Area Scan	dx=8mm dy=8mm
Zoom Scan	5x5x7, dx=8mm dy=8mm dz=5mm
Variation (%)	-0.450000
SAR 10g (W/Kg)	0.096038
SAR 1g (W/Kg)	0.182319
SURFACE SAR	VOLUME SAR



5.CALIBRATION CERTIFICATES

5.1 Probe-EP220 Calibration Certificate



COMOSAR E-Field Probe Calibration Report

Ref: ACR.287.1.14.SATU.A

**SHENZHEN LCS COMPLIANCE TESTING
LABORATORY LTD.**
**1F., XINGYUAN INDUSTRIAL PARK, TONGDA ROAD,
BAO'AN BLVD**
BAO'AN DISTRICT, SHENZHEN, GUANGDONG, CHINA
SATIMO COMOSAR DOSIMETRIC E-FIELD PROBE
SERIAL NO.: SN 17/14 EP220

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



10/01/2015

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.



COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.287.1.14.SATU.A

	Name	Function	Date	Signature
Prepared by :	Jérôme LUC	Product Manager	10/14/2015	
Checked by :	Jérôme LUC	Product Manager	10/14/2015	
Approved by :	Kim RUTKOWSKI	Quality Manager	10/14/2015	Kim RUTKOWSKI

	Customer Name
Distribution :	Shenzhen LCS Compliance Testing Laboratory Ltd.

Issue	Date	Modifications
A	10/14/2015	Initial release

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COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.287.1.14.SAT.U.A

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COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.287.1.14.SATU.A

1 DEVICE UNDER TEST

Device Under Test	
Device Type	COMOSAR DOSIMETRIC E FIELD PROBE
Manufacturer	Satimo
Model	SSE5
Serial Number	SN 17/14 EP220
Product Condition (new / used)	New
Frequency Range of Probe	0.7 GHz-3GHz
Resistance of Three Dipoles at Connector	Dipole 1: R1=0.179 MΩ Dipole 2: R2=0.175 MΩ Dipole 3: R3=0.180 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.



COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.287.1.14.SATU.A

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%

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COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.287.1.14.SATU.A

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

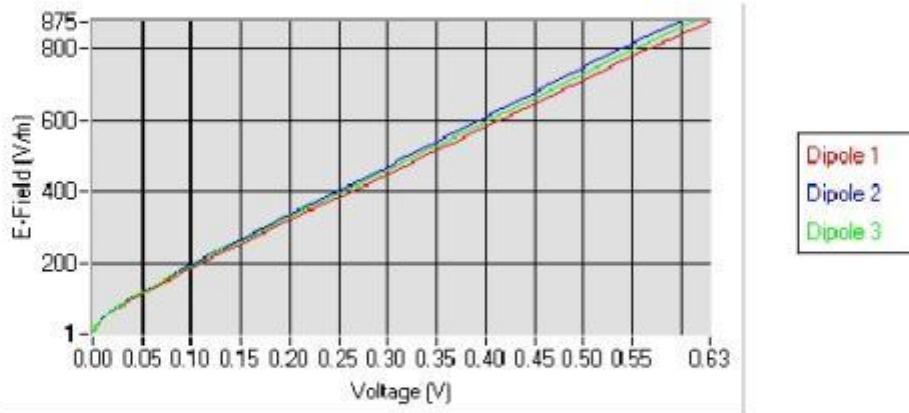
Normx dipole 1 ($\mu\text{V}/(\text{V}/\text{m})^2$)	Normy dipole 2 ($\mu\text{V}/(\text{V}/\text{m})^2$)	Normz dipole 3 ($\mu\text{V}/(\text{V}/\text{m})^2$)
6.02	5.52	5.72

DCP dipole 1 (mV)	DCP dipole 2 (mV)	DCP dipole 3 (mV)
99	98	99

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

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

Calibration curves



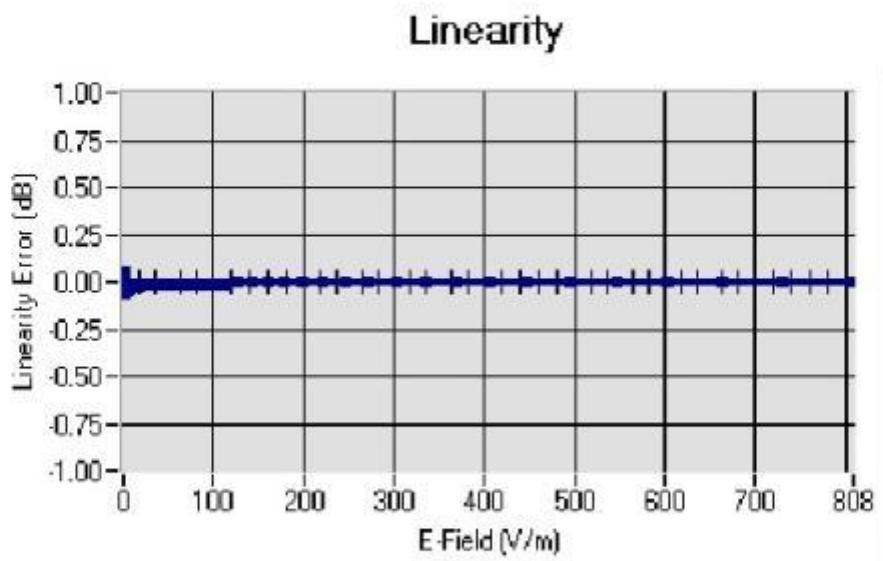
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COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.287.1.14.SATU.A

5.2 LINEARITYLinearity: +/-1.47% (+/-0.06dB)5.3 SENSITIVITY IN LIQUID

Liquid	Frequency (MHz +/- 100MHz)	Permittivity	Epsilon (S/m)	ConvF
HL750	750	42.06	0.89	4.58
BL750	750	56.57	0.99	4.71
HL850	835	42.81	0.89	4.86
BL850	835	53.46	0.96	5.04
HL900	900	42.47	0.96	4.74
BL900	900	56.69	1.08	4.92
HL1800	1800	41.31	1.38	4.16
BL1800	1800	53.27	1.51	4.29
HL2000	2000	39.72	1.43	4.19
BL2000	2000	53.91	1.53	4.28
HL2450	2450	39.05	1.77	3.94
BL2450	2450	52.97	1.93	4.05

LOWER DETECTION LIMIT: 7mW/kg



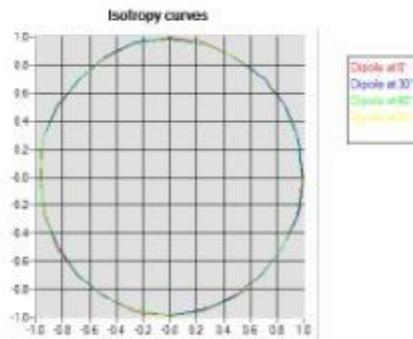
COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.287.1.14.SATU.A

5.4 ISOTROPY

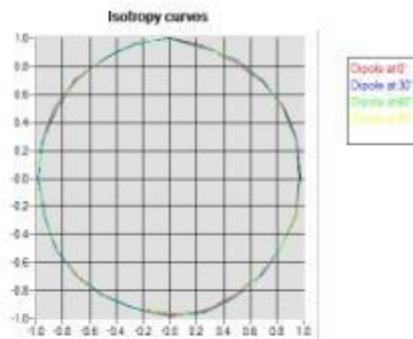
HL900 MHz

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



HL1800 MHz

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





COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.287.1.14.SAT.U.A

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	02/2014	02/2017
Reference Probe	Satimo	EP 94 SN 37/08	10/2015	10/2016
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

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5.2 Probe-EP221 Calibration Certificate



COMOSAR E-Field Probe Calibration Report

Ref : ACR.262.1.14.SATU.A

**SHENZHEN LCS COMPLIANCE TESTING
LABORATORY LTD.**
**1/F, KINGYUAN INDUSTRIAL PARK, TONGDA ROAD,
BAOAN BLVD**
BAO'AN DISTRICT, SHENZHEN, GUANGDONG, CHINA
SATIMO COMOSAR DOSIMETRIC E-FIELD PROBE
SERIAL NO.: SN 17/14 EP221

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



09/01/2015

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.



COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.262.1.14.SATU.A

	Name	Function	Date	Signature
Prepared by :	Jérôme LUC	Product Manager	9/19/2015	
Checked by :	Jérôme LUC	Product Manager	9/19/2015	
Approved by :	Kim RUTKOWSKI	Quality Manager	9/19/2015	Kim RUTKOWSKI

	Customer Name
Distribution :	Shenzhen LCS Compliance Testing Laboratory Ltd.

Issue	Date	Modifications
A	9/19/2015	Initial release

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COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.262.1.14.SATU.A

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COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.262.1.14.SATU.A

1 DEVICE UNDER TEST

Device Under Test	
Device Type	COMOSAR DOSIMETRIC E FIELD PROBE
Manufacturer	Satimo
Model	SSE5
Serial Number	SN 17/14 EP221
Product Condition (new / used)	New
Frequency Range of Probe	0.4 GHz- 6 GHz
Resistance of Three Dipoles at Connector	Dipole 1: $R1=0.179\text{ M}\Omega$ Dipole 2: $R2=0.167\text{ M}\Omega$ Dipole 3: $R3=0.178\text{ M}\Omega$

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.



COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.262.1.14.SATU.A

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%

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COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.262.1.14.SATU.A

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

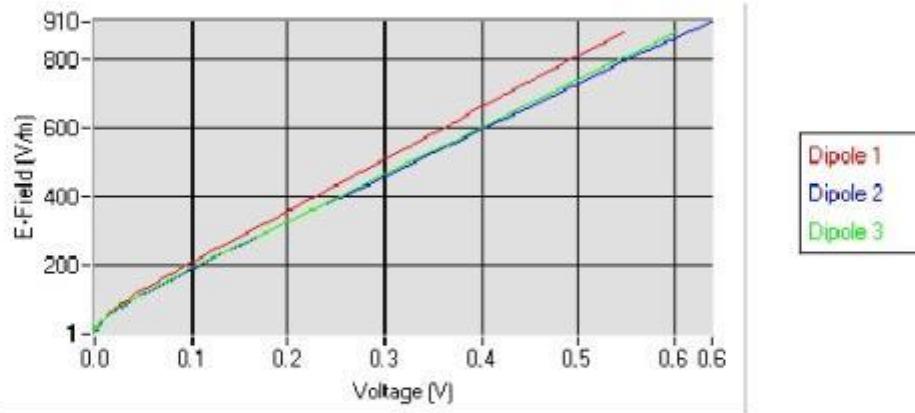
Normx dipole 1 ($\mu\text{V}/(\text{V}/\text{m})^2$)	Normy dipole 2 ($\mu\text{V}/(\text{V}/\text{m})^2$)	Normz dipole 3 ($\mu\text{V}/(\text{V}/\text{m})^2$)
4.81	6.15	6.02

DCP dipole 1 (mV)	DCP dipole 2 (mV)	DCP dipole 3 (mV)
95	100	90

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

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

Calibration curves



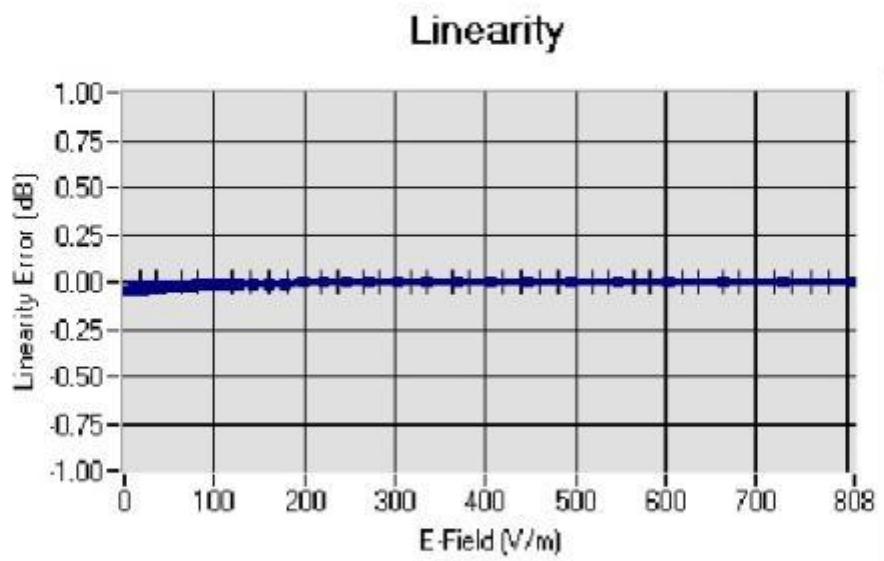
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COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.262.1.14.SATU.A

5.2 LINEARITYLinearity: +/-1.16% (+/-0.05dB)5.3 SENSITIVITY IN LIQUID

Liquid	Frequency (MHz +/- 100MHz)	Permittivity	Epsilon (S/m)	ConvF
HL450	450	43.90	0.87	4.84
BL450	450	58.63	0.98	4.98
HL750	750	42.06	0.89	4.53
BL750	750	56.57	0.99	4.70
HL850	835	42.81	0.89	4.83
BL850	835	53.46	0.96	5.02
HL900	900	42.47	0.96	4.74
BL900	900	56.69	1.08	4.89
HL1800	1800	41.31	1.38	4.25
BL1800	1800	53.27	1.51	4.34
HL1900	1900	41.09	1.42	4.71
BL1900	1900	54.20	1.54	4.85
HL2000	2000	39.72	1.43	4.27
BL2000	2000	53.91	1.53	4.44
HL2450	2450	39.05	1.77	4.11
BL2450	2450	52.97	1.93	4.25
HL2600	2600	38.35	1.92	4.20
BL2600	2600	51.81	2.19	4.32

LOWER DETECTION LIMIT: 7mW/kg

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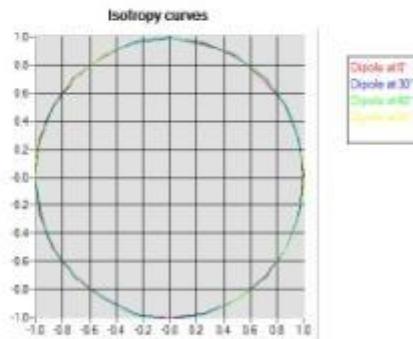
COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.262.1.14.SATU.A

5.4 ISOTROPY

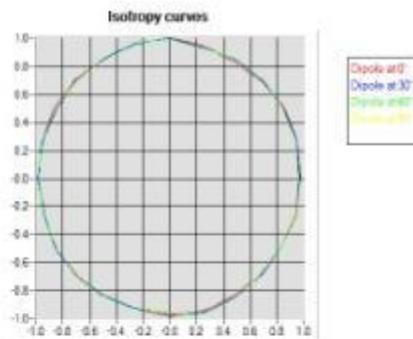
HL900 MHz

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



HL1800 MHz

- Axial isotropy: 0.05 dB
- Hemispherical isotropy: 0.08 dB





COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.262.1.14.SATU.A

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	02/2014	02/2017
Reference Probe	Satimo	EP 94 SN 37/08	10/2015	10/2016
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

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5.3 SID835Dipole Calibration Ceriticate



SAR Reference Dipole Calibration Report

Ref: ACR.287.4.14.SATU.A

**SHENZHEN LCS COMPLIANCE TESTING
LABORATORY LTD.**
**1F., XINGYUAN INDUSTRIAL PARK, TONGDA ROAD,
BAO'AN BLVD**
BAO'AN DISTRICT, SHENZHEN, GUANGDONG, CHINA
SATIMO COMOSAR REFERENCE DIPOLE
FREQUENCY: 835 MHZ
SERIAL NO.: SN 07/14 DIP 0G835-303

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



10/01/2015

Summary:

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



SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.287.4.14.SATU.A

	Name	Function	Date	Signature
Prepared by :	Jérôme LUC	Product Manager	10/14/2015	
Checked by :	Jérôme LUC	Product Manager	10/14/2015	
Approved by :	Kim RUTKOWSKI	Quality Manager	10/14/2015	

	Customer Name
Distribution :	Shenzhen LCS Compliance Testing Laboratory Ltd.

Issue	Date	Modifications
A	10/14/2015	Initial release

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SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.287.4.14.SATU.A

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SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.287.4.14.SATU.A

1 INTRODUCTION

This document contains a summary of the requirements set forth by the IEEE 1528, OET 65 Bulletin C 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 835 MHz REFERENCE DIPOLE
Manufacturer	Satimo
Model	SID835
Serial Number	SN 07/14 DIP 0G835-303
Product Condition (new / used)	New

A yearly calibration interval is recommended.

3 PRODUCT DESCRIPTION

3.1 GENERAL INFORMATION

Satimo's COMOSAR Validation Dipoles are built in accordance to the IEEE 1528, OET 65 Bulletin C and CEI/IEC 62209 standards. The product is designed for use with the COMOSAR test bench only.



Figure 1 – Satimo COMOSAR Validation Dipole



SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.287.4.14.SATU.A

4 MEASUREMENT METHOD

The IEEE 1528, OET 65 Bulletin C 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 constructed 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, OET 65 Bulletin C, 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 %

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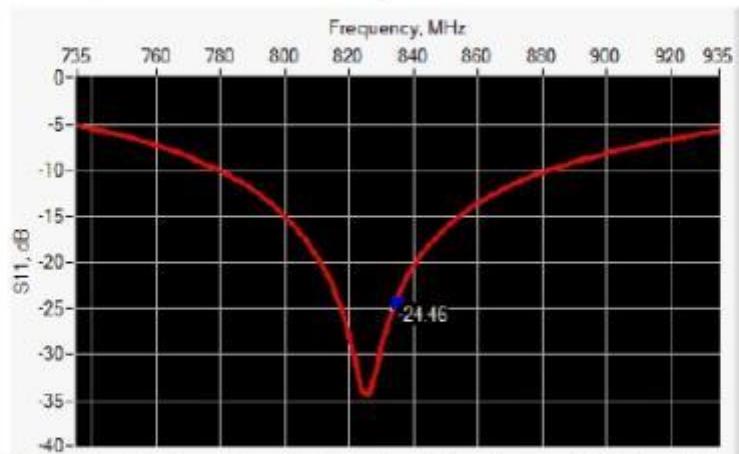
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SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.287.4.14.SATU.A

6 CALIBRATION MEASUREMENT RESULTS

6.1 RETURN LOSS AND IMPEDANCE

Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
835	-24.46	-20	$55.4 \Omega + 2.4 j\Omega$

6.2 MECHANICAL DIMENSIONS

Frequency MHz	L mm		h mm		d mm	
	required	measured	required	measured	required	measured
300	420.0 \pm 1 %.		250.0 \pm 1 %.		6.35 \pm 1 %.	
450	290.0 \pm 1 %.		166.7 \pm 1 %.		6.35 \pm 1 %.	
750	176.0 \pm 1 %.		100.0 \pm 1 %.		6.35 \pm 1 %.	
835	161.0 \pm 1 %.	PASS	89.8 \pm 1 %.	PASS	3.6 \pm 1 %.	PASS
900	149.0 \pm 1 %.		83.3 \pm 1 %.		3.6 \pm 1 %.	
1450	89.1 \pm 1 %.		51.7 \pm 1 %.		3.6 \pm 1 %.	
1500	80.5 \pm 1 %.		50.0 \pm 1 %.		3.6 \pm 1 %.	
1640	79.0 \pm 1 %.		45.7 \pm 1 %.		3.6 \pm 1 %.	
1750	75.2 \pm 1 %.		42.9 \pm 1 %.		3.6 \pm 1 %.	
1800	72.0 \pm 1 %.		41.7 \pm 1 %.		3.6 \pm 1 %.	
1900	68.0 \pm 1 %.		39.5 \pm 1 %.		3.6 \pm 1 %.	
1950	66.3 \pm 1 %.		38.5 \pm 1 %.		3.6 \pm 1 %.	
2000	64.5 \pm 1 %.		37.5 \pm 1 %.		3.6 \pm 1 %.	
2100	61.0 \pm 1 %.		35.7 \pm 1 %.		3.6 \pm 1 %.	
2300	55.5 \pm 1 %.		32.6 \pm 1 %.		3.6 \pm 1 %.	
2450	51.5 \pm 1 %.		30.4 \pm 1 %.		3.6 \pm 1 %.	
2600	48.5 \pm 1 %.		28.8 \pm 1 %.		3.6 \pm 1 %.	
3000	41.5 \pm 1 %.		25.0 \pm 1 %.		3.6 \pm 1 %.	
3500	37.0 \pm 1 %.		26.4 \pm 1 %.		3.6 \pm 1 %.	
3700	34.7 \pm 1 %.		26.4 \pm 1 %.		3.6 \pm 1 %.	

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SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.287.4.14.SATU.A

7 VALIDATION MEASUREMENT

The IEEE Std. 1528, OET 65 Bulletin C 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 \pm 5 %		0.87 \pm 5 %	
450	43.5 \pm 5 %		0.87 \pm 5 %	
750	41.9 \pm 5 %		0.89 \pm 5 %	
835	41.5 \pm 5 %	PASS	0.90 \pm 5 %	PASS
900	41.5 \pm 5 %		0.97 \pm 5 %	
1450	40.5 \pm 5 %		1.20 \pm 5 %	
1500	40.4 \pm 5 %		1.23 \pm 5 %	
1640	40.2 \pm 5 %		1.31 \pm 5 %	
1750	40.1 \pm 5 %		1.37 \pm 5 %	
1800	40.0 \pm 5 %		1.40 \pm 5 %	
1900	40.0 \pm 5 %		1.40 \pm 5 %	
1950	40.0 \pm 5 %		1.40 \pm 5 %	
2000	40.0 \pm 5 %		1.40 \pm 5 %	
2100	39.8 \pm 5 %		1.49 \pm 5 %	
2300	39.5 \pm 5 %		1.67 \pm 5 %	
2450	39.2 \pm 5 %		1.80 \pm 5 %	
2600	39.0 \pm 5 %		1.96 \pm 5 %	
3000	38.5 \pm 5 %		2.40 \pm 5 %	
3500	37.9 \pm 5 %		2.91 \pm 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: ϵ_r' : 42.3 sigma : 0.92
Distance between dipole center and liquid	15.0 mm
Area scan resolution	dx=8mm/dy=8mm

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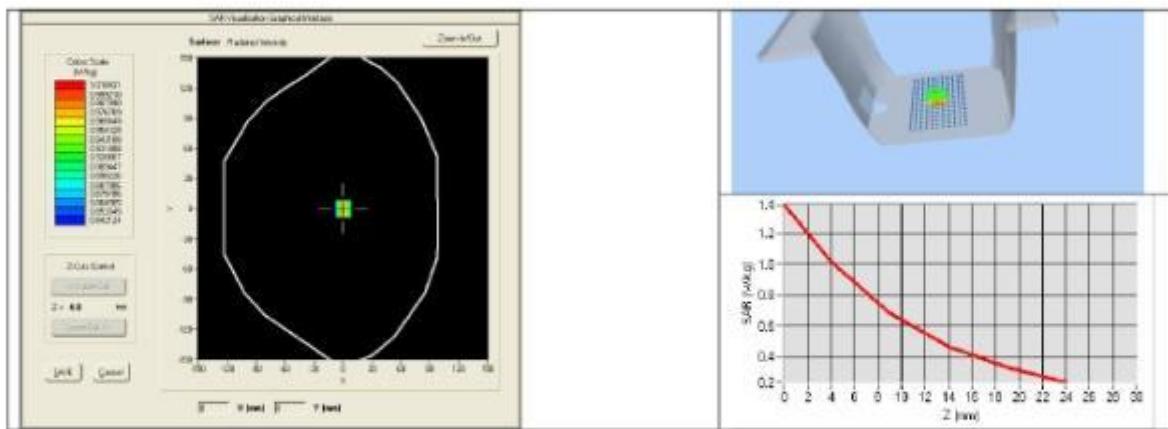


SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.287.4.14.SATU.A

Zoon Scan Resolution	dx=8mm/dy=8m/dz=5mm
Frequency	835 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		5.55	
835	9.56	9.60 (0.96)	6.22	6.20 (0.62)
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	



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SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.287.4.14.SATU.A

7.3 BODY LIQUID MEASUREMENT

Frequency MHz	Relative permittivity (ϵ_r')		Conductivity (σ) S/m	
	required	measured	required	measured
150	61.9 \pm 5 %		0.80 \pm 5 %	
300	58.2 \pm 5 %		0.92 \pm 5 %	
450	56.7 \pm 5 %		0.94 \pm 5 %	
750	55.5 \pm 5 %		0.96 \pm 5 %	
835	55.2 \pm 5 %	PASS	0.97 \pm 5 %	PASS
900	55.0 \pm 5 %		1.05 \pm 5 %	
915	55.0 \pm 5 %		1.06 \pm 5 %	
1450	54.0 \pm 5 %		1.30 \pm 5 %	
1610	53.8 \pm 5 %		1.40 \pm 5 %	
1800	53.3 \pm 5 %		1.52 \pm 5 %	
1900	53.3 \pm 5 %		1.52 \pm 5 %	
2000	53.3 \pm 5 %		1.52 \pm 5 %	
2100	53.2 \pm 5 %		1.62 \pm 5 %	
2450	52.7 \pm 5 %		1.95 \pm 5 %	
2600	52.5 \pm 5 %		2.16 \pm 5 %	
3000	52.0 \pm 5 %		2.73 \pm 5 %	
3500	51.3 \pm 5 %		3.31 \pm 5 %	
5200	49.0 \pm 10 %		5.30 \pm 10 %	
5300	48.9 \pm 10 %		5.42 \pm 10 %	
5400	48.7 \pm 10 %		5.53 \pm 10 %	
5500	48.6 \pm 10 %		5.65 \pm 10 %	
5600	48.5 \pm 10 %		5.77 \pm 10 %	
5800	48.2 \pm 10 %		6.00 \pm 10 %	

7.4 SAR MEASUREMENT RESULT WITH BODY LIQUID

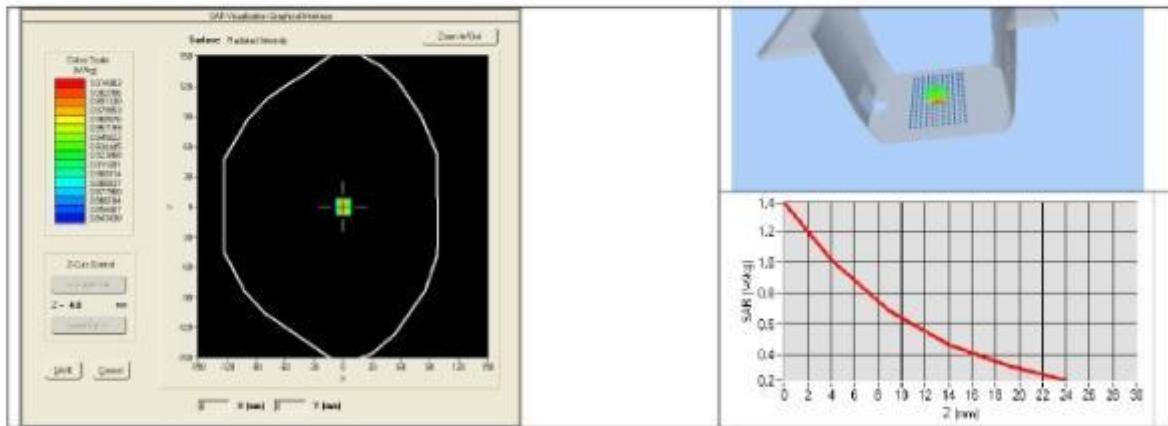
Software	OPENSAR V4
Phantom	SN 20/09 SAM71
Probe	SN 18/11 EPG122
Liquid	Body Liquid Values: ϵ_r' : 54.1 sigma : 0.97
Distance between dipole center and liquid	15.0 mm
Area scan resolution	dx=8mm/dy=8mm
Zoon Scan Resolution	dx=8mm/dy=8m/dz=5mm
Frequency	835 MHz
Input power	20 dBm
Liquid Temperature	21 °C
Lab Temperature	21 °C
Lab Humidity	45 %



SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.287.4.14.SATU.A

Frequency MHz	1 g SAR (W/kg/W)	10 g SAR (W/kg/W)
	measured	measured
835	9.90 (0.99)	6.39 (0.64)



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SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.287.4.14.SATU.A

8 LIST OF EQUIPMENT

Equipment Summary Sheet				
Equipment Description	Manufacturer / Model	Identification No.	Current Calibration Date	Next Calibration Date
SAM 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	02/2014	02/2017
Calipers	Carrera	CALIPER-01	12/2013	12/2016
Reference Probe	Satimo	EPG122 SN 18/11	10/2015	10/2016
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.
Temperature and Humidity Sensor	Control Company	11-661-9	8/2013	8/2016

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5.4 SID1900 Dipole Calibration Certificate



COMOSAR E-Field Probe Calibration Report

Ref : ACR.262.8.14.SATU.A

**SHENZHEN LCS COMPLIANCE TESTING
LABORATORY LTD.**
**1F., XINGYUAN INDUSTRIAL PARK, TONGDA ROAD,
BAO'AN BLVD**
BAO'AN DISTRICT, SHENZHEN, GUANGDONG, CHINA
SATIMO COMOSAR DOSIMETRIC E-FIELD PROBE

FREQUENCY: 1900MHz

SERIAL NO.: SN 30/14 DIP1G900-333

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



10/01/2015

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.



COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.262.8.14.SATU.A

	Name	Function	Date	Signature
Prepared by :	Jérôme LUC	Product Manager	10/14/2015	
Checked by :	Jérôme LUC	Product Manager	10/14/2015	
Approved by :	Kim RUTKOWSKI	Quality Manager	10/14/2015	Kim RUTKOWSKI

	Customer Name
Distribution :	Shenzhen LCS Compliance Testing Laboratory Ltd.

Issue	Date	Modifications
A	10/14/2015	Initial release

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SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.262.8.14.SATU.A

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SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR-262.8.14.SATU.A

1 INTRODUCTION

This document contains a summary of the requirements set forth by the IEEE 1528, OET 65 Bulletin C 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 1900 MHz REFERENCE DIPOLE
Manufacturer	Satimo
Model	SID1900
Serial Number	SN 30/14 DIP1G900-333
Product Condition (new / used)	New

A yearly calibration interval is recommended.

3 PRODUCT DESCRIPTION

3.1 GENERAL INFORMATION

Satimo's COMOSAR Validation Dipoles are built in accordance to the IEEE 1528, OET 65 Bulletin C and CEI/IEC 62209 standards. The product is designed for use with the COMOSAR test bench only.



Figure 1 – Satimo COMOSAR Validation Dipole



SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR-262.8.14.SATU.A

4 MEASUREMENT METHOD

The IEEE 1528, OET 65 Bulletin C 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 constructed 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, OET 65 Bulletin C, 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 %

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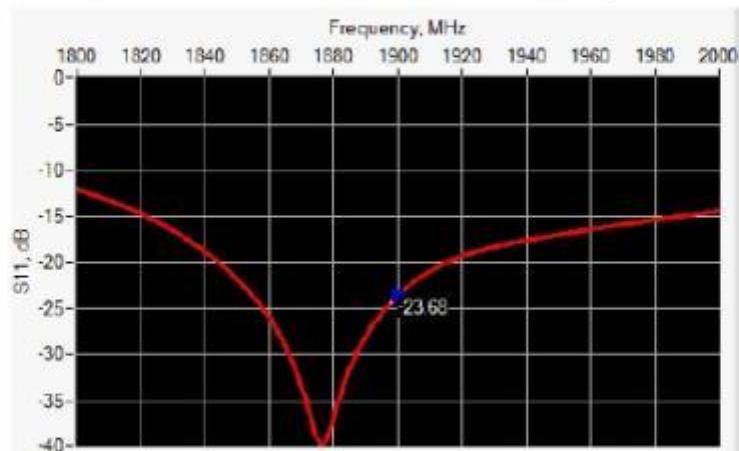


SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.262.8.14.SATU.A

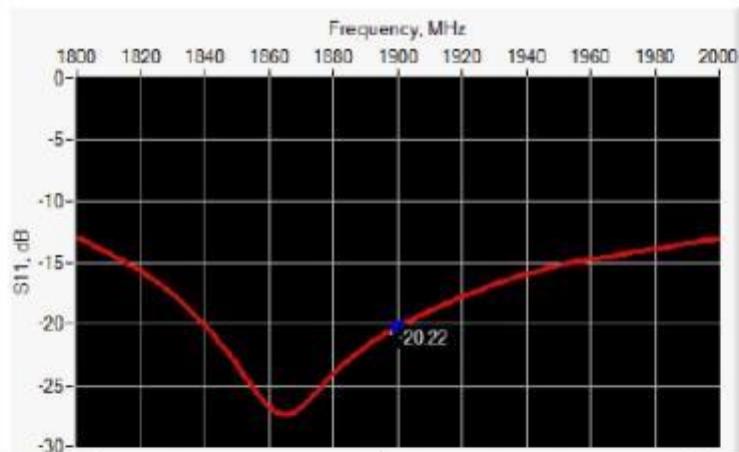
6 CALIBRATION MEASUREMENT RESULTS

6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
1900	-23.68	-20	$51.2 \Omega + 6.4 j\Omega$

6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
1900	-20.22	-20	$48.8 \Omega + 9.6 j\Omega$

6.3 MECHANICAL DIMENSIONS

Frequency MHz	L mm		h mm		d mm	
	required	measured	required	measured	required	measured
300	$420.0 \pm 1\%$		$250.0 \pm 1\%$		$6.35 \pm 1\%$	
450	$290.0 \pm 1\%$		$166.7 \pm 1\%$		$6.35 \pm 1\%$	
750	$176.0 \pm 1\%$		$100.0 \pm 1\%$		$6.35 \pm 1\%$	
835	$161.0 \pm 1\%$		$89.8 \pm 1\%$		$3.6 \pm 1\%$	

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SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR-262.8.14.SATU.A

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

7 VALIDATION MEASUREMENT

The IEEE Std. 1528, OET 65 Bulletin C 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 \pm 5 %		0.87 \pm 5 %	
450	43.5 \pm 5 %		0.87 \pm 5 %	
750	41.9 \pm 5 %		0.89 \pm 5 %	
835	41.5 \pm 5 %		0.90 \pm 5 %	
900	41.5 \pm 5 %		0.97 \pm 5 %	
1450	40.5 \pm 5 %		1.20 \pm 5 %	
1500	40.4 \pm 5 %		1.23 \pm 5 %	
1640	40.2 \pm 5 %		1.31 \pm 5 %	
1750	40.1 \pm 5 %		1.37 \pm 5 %	
1800	40.0 \pm 5 %		1.40 \pm 5 %	
1900	40.0 \pm 5 %	PASS	1.40 \pm 5 %	PASS
1950	40.0 \pm 5 %		1.40 \pm 5 %	
2000	40.0 \pm 5 %		1.40 \pm 5 %	

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Ref: ACR-262.8.14.SATU.A

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: ϵ_r : 41.1 sigma : 1.42
Distance between dipole center and liquid	10.0 mm
Area scan resolution	dx=8mm/dy=8mm
Zoon Scan Resolution	dx=8mm/dy=8m/dz=5mm
Frequency	1900 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		5.55	
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	39.84 (3.98)	20.5	20.20 (2.02)
1950	40.5		20.9	
2000	41.1		21.1	
2100	43.6		21.9	
2300	48.7		23.3	

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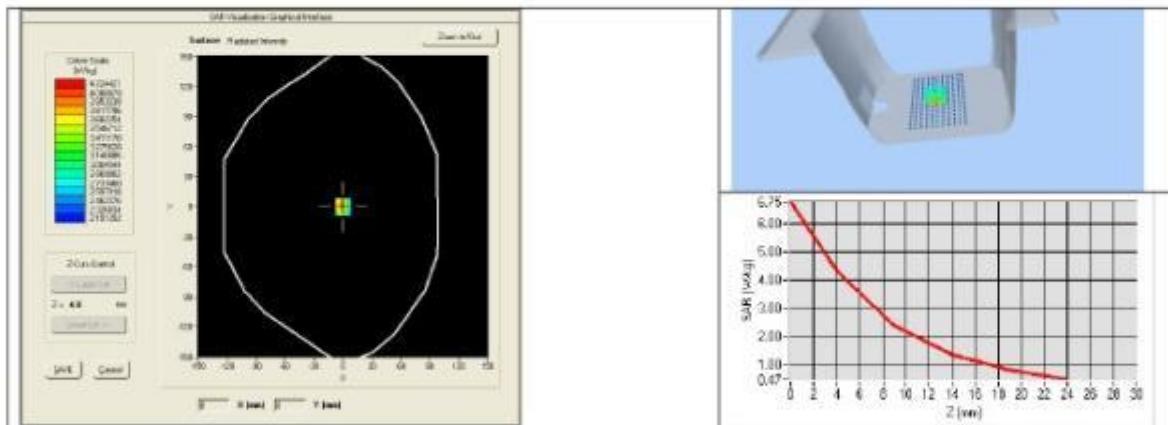
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Ref: ACR.262.8.14.SATU.A

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 \pm 5 %		0.80 \pm 5 %	
300	58.2 \pm 5 %		0.92 \pm 5 %	
450	56.7 \pm 5 %		0.94 \pm 5 %	
750	55.5 \pm 5 %		0.96 \pm 5 %	
835	55.2 \pm 5 %		0.97 \pm 5 %	
900	55.0 \pm 5 %		1.05 \pm 5 %	
915	55.0 \pm 5 %		1.06 \pm 5 %	
1450	54.0 \pm 5 %		1.30 \pm 5 %	
1610	53.8 \pm 5 %		1.40 \pm 5 %	
1800	53.3 \pm 5 %		1.52 \pm 5 %	
1900	53.3 \pm 5 %	PASS	1.52 \pm 5 %	PASS
2000	53.3 \pm 5 %		1.52 \pm 5 %	
2100	53.2 \pm 5 %		1.62 \pm 5 %	
2450	52.7 \pm 5 %		1.95 \pm 5 %	
2600	52.5 \pm 5 %		2.16 \pm 5 %	
3000	52.0 \pm 5 %		2.73 \pm 5 %	
3500	51.3 \pm 5 %		3.31 \pm 5 %	
5200	49.0 \pm 10 %		5.30 \pm 10 %	
5300	48.9 \pm 10 %		5.42 \pm 10 %	
5400	48.7 \pm 10 %		5.53 \pm 10 %	

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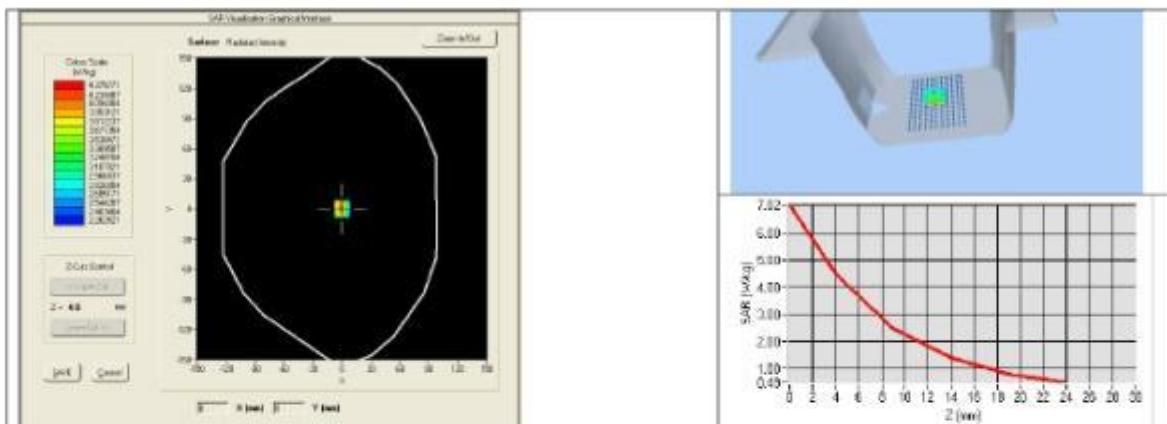
Ref: ACR.262.8.14.SATU.A

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: $\epsilon_r = 54.2$ sigma = 1.54
Distance between dipole center and liquid	10.0 mm
Area scan resolution	$dx=8\text{mm}/dy=8\text{mm}$
Zoon Scan Resolution	$dx=8\text{mm}/dy=8\text{mm}/dz=5\text{mm}$
Frequency	1900 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
1900	43.33 (4.33)	21.59 (2.16)





SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref. ACR.262.8.14.SATU.A

8 LIST OF EQUIPMENT

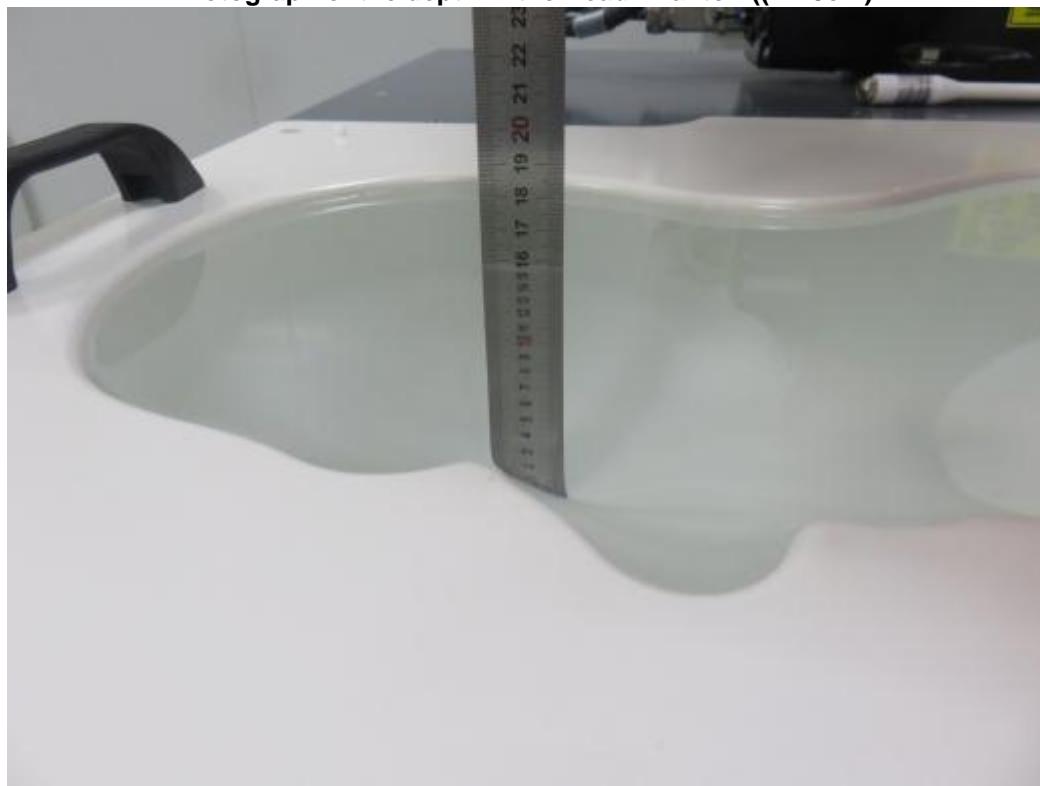
Equipment Summary Sheet				
Equipment Description	Manufacturer / Model	Identification No.	Current Calibration Date	Next Calibration Date
SAM Phantom	Satimo	SN-20/09-SAM71	Validated. No cal required.	Validated. No cal required.
COMOSAR Test Bench	Version 3	NA	Validated. No cal required.	Validated. No cal required.
Network Analyzer	Rhode & Schwarz ZVA	SN100132	02/2014	02/2017
Calipers	Carrera	CALIPER-01	12/2013	12/2016
Reference Probe	Satimo	EPG122 SN 18/11	10/2015	10/2016
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.
Temperature and Humidity Sensor	Control Company	11-661-9	8/2013	8/2016

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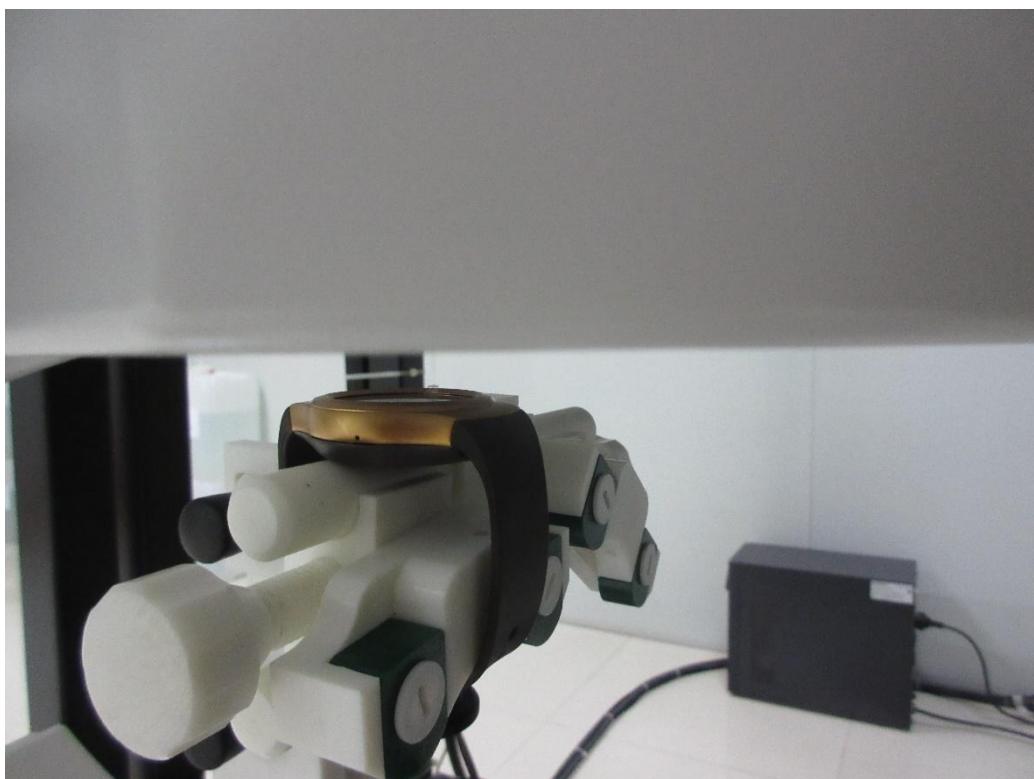
6. EUT TEST PHOTOGRAPHS

Photograph of the depth in the Head Phantom($\geq 15\text{cm}$)



Photograph of the depth in the Body Phantom($\geq 15\text{cm}$)



Body Setup photo(Back 0mm)**Body Setup photo(Front 10mm)**

7. EUT Photographs



.....The End of Test Report.....