

FCC SAR Test Report

Report No. : SA130610E03
Applicant : Qualcomm Atheros, Inc.
Address : 1700 Technology Drive, San Jose, CA 95110
Product : PCIE 802.11a/b/g/n 2.4GHz/5GHz + USB BT 4.0 card
FCC ID : PPD-QCNFA222
Brand : Qualcomm Atheros
Model No. : QCNFA222
Standards : FCC 47 CFR Part 2 (2.1093) / IEEE C95.1:1992 / IEEE 1528:2003
FCC OET Bulletin 65 Supplement C (Edition 01-01)
KDB 248227 D01 v01r02 / KDB 447498 D01 v05r01
Date of Testing : Jul. 09, 2013 ~ Aug. 02, 2013

CERTIFICATION: The above equipment have been tested by **Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch - Taiwan HwaYa Lab**, and found compliance with the requirement of the above standards. The test record, data evaluation & Equipment Under Test (EUT) configurations represented herein are true and accurate accounts of the measurements of the sample's SAR characteristics under the conditions specified in this report. It should not be reproduced except in full, without the written approval of our laboratory. The client should not use it to claim product certification, approval, or endorsement by TAF or any government agencies.

Prepared By :

Vera Huang

Vera Huang / Specialist

Approved By :

Roy Wu

Roy Wu / Manager



This report is for your exclusive use. Any copying or replication of this report to or for any other person or entity, or use of our name or trademark, is permitted only with our prior written permission. This report sets forth our findings solely with respect to the test samples identified herein. The results set forth in this report are not indicative or representative of the quality or characteristics of the lot from which a test sample was taken or any similar or identical product unless specifically and expressly noted. Our report includes all of the tests requested by you and the results thereof based upon the information that you provided to us. You have 60 days from date of issuance of this report to notify us of any material error or omission caused by our negligence, provided, however, that such notice shall be in writing and shall specifically address the issue you wish to raise. A failure to raise such issue within the prescribed time shall constitute your unqualified acceptance of the completeness of this report, the tests conducted and the correctness of the report contents. Unless specific mention, the uncertainty of measurement has been explicitly taken into account to declare the compliance or non-compliance to the specification.

Table of Contents

Release Control Record	3
1. Summary of Maximum SAR Value	4
2. Description of Equipment Under Test	5
3. SAR Measurement System	6
3.1 Definition of Specific Absorption Rate (SAR)	6
3.2 SPEAG DASY System	6
3.2.1 Robot	7
3.2.2 Probes	8
3.2.3 Data Acquisition Electronics (DAE)	8
3.2.4 Phantoms	9
3.2.5 Device Holder	10
3.2.6 System Validation Dipoles	10
3.2.7 Tissue Simulating Liquids	11
3.3 SAR System Verification	14
3.4 SAR Measurement Procedure	15
3.4.1 Area & Zoom Scan Procedure	15
3.4.2 Volume Scan Procedure	15
3.4.3 Power Drift Monitoring	16
3.4.4 Spatial Peak SAR Evaluation	16
3.4.5 SAR Averaged Methods	16
4. SAR Measurement Evaluation	17
4.1 EUT Configuration and Setting	17
4.2 EUT Testing Position	17
4.3 Tissue Verification	18
4.4 System Validation	18
4.5 System Verification	18
4.6 Maximum Output Power	19
4.6.1 Maximum Conducted Power	19
4.6.2 Measured Conducted Power Result	19
4.7 SAR Testing Results	21
4.7.1 SAR Results for Body (Separation Distance is 8 mm Gap)	21
4.7.2 SAR Measurement Variability	22
4.7.3 Simultaneous Multi-band Transmission Evaluation	22
5. Calibration of Test Equipment	24
6. Measurement Uncertainty	25
7. Information on the Testing Laboratories	27
Appendix A. SAR Plots of System Verification	
Appendix B. SAR Plots of SAR Measurement	
Appendix C. Calibration Certificate for Probe and Dipole	
Appendix D. Photographs of EUT and Setup	



Release Control Record

Issue No.	Reason for Change	Date Issued
R01	Initial release	Aug. 06, 2013

1. Summary of Maximum SAR Value

Equipment Class	Mode	Highest Reported Body SAR _{1g} (8 mm Gap) (W/kg)
DTS	2.4G WLAN	0.66
	5.8G WLAN	0.34
NII	5.2G WLAN	0.28
	5.3G WLAN	0.40
	5.6G WLAN	0.33
DSS	Bluetooth	N/A
Highest Simultaneous Transmission SAR		Body (W/kg)
DTS+DSS		0.76
NII+DSS		0.50

Note:

- The SAR limit (**SAR_{1g} 1.6 W/kg**) for general population / uncontrolled exposure is specified in FCC 47 CFR part 2 (2.1093) and ANSI/IEEE C95.1-1992.

2. Description of Equipment Under Test

EUT Type	PCIE 802.11a/b/g/n 2.4GHz/5GHz + USB BT 4.0 card
FCC ID	PPD-QCNFA222
Brand Name	Qualcomm Atheros
Model Name	QCNFA222
Tx Frequency Bands (Unit: MHz)	WLAN : 2412 ~ 2462, 5180 ~ 5240, 5260 ~ 5320, 5500 ~ 5700, 5745 ~ 5825 Bluetooth : 2402 ~ 2480
Uplink Modulations	802.11b : DSSS 802.11a/g/n : OFDM Bluetooth : GFSK
Maximum Tune-up Conducted Power (Unit: dBm)	WLAN 2.4G : 20.0 WLAN 5.2G : 16.5 WLAN 5.3G : 18.0 WLAN 5.6G : 17.5 WLAN 5.8G : 18.0 Bluetooth : 5.7
Antenna Type	PIFA Antenna
EUT Stage	Identical Prototype

Note:

1. The above EUT information is declared by manufacturer and for more detailed features description please refers to the manufacturer's specifications or User's Manual.
2. The simultaneous transmission configuration is as below.

Configuration	Chain 0	Chain 1
WLAN 2x2 + BT	11a/b/g/n + BT	11a/b/g/n

3. WLAN 2.4G and WLAN 5G cannot transmit simultaneously.

3. SAR Measurement System

3.1 Definition of Specific Absorption Rate (SAR)

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

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

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

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

SAR measurement can be related to the electrical field in the tissue by

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

Where: σ is the conductivity of the tissue, ρ is the mass density of the tissue and E is the RMS electrical field strength.

3.2 SPEAG DASY System

DASY system consists of high precision robot, probe alignment sensor, phantom, robot controller, controlled measurement server and near-field probe. The robot includes six axes that can move to the precision position of the DASY4/5 software defined. The DASY software can define the area that is detected by the probe. The robot is connected to controlled box. Controlled measurement server is connected to the controlled robot box. The DAE includes amplifier, signal multiplexing, AD converter, offset measurement and surface detection. It is connected to the Electro-optical coupler (ECO). The ECO performs the conversion from the optical into digital electric signal of the DAE and transfers data to the PC.



The DASY system uses the high precision robots from Stäubli SA (France). For the 6-axis controller system, the robot controller version (DASY4: CS7MB; DASY5: CS8c) from Stäubli is used. The Stäubli robot series have many features that are important for our application:

-
- Fig-3.2 DASY4**
- Fig-3.3 DASY5**


Fig-3.2 DASY4


Fig-3.3 DASY5

FCC SAR Test Report


3.2.2 Probes

The SAR measurement is conducted with the dosimetric probe. The probe is specially designed and calibrated for use in liquid with high permittivity. The dosimetric probe has special calibration in liquid at different frequency.


Model	EX3DV4	
Construction	Symmetrical design with triangular core. Built-in shielding against static charges. PEEK enclosure material (resistant to organic solvents, e.g., DGBE).	
Frequency	10 MHz to 6 GHz Linearity: ± 0.2 dB	
Directivity	± 0.3 dB in HSL (rotation around probe axis) ± 0.5 dB in tissue material (rotation normal to probe axis)	
Dynamic Range	10 μ W/g to 100 mW/g Linearity: ± 0.2 dB (noise: typically < 1 μ W/g)	
Dimensions	Overall length: 337 mm (Tip: 20 mm) Tip diameter: 2.5 mm (Body: 12 mm) Typical distance from probe tip to dipole centers: 1 mm	

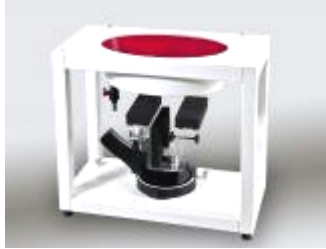
Model	ES3DV3	
Construction	Symmetrical design with triangular core. Interleaved sensors. Built-in shielding against static charges. PEEK enclosure material (resistant to organic solvents, e.g., DGBE).	
Frequency	10 MHz to 4 GHz Linearity: ± 0.2 dB	
Directivity	± 0.2 dB in HSL (rotation around probe axis) ± 0.3 dB in tissue material (rotation normal to probe axis)	
Dynamic Range	5 μ W/g to 100 mW/g Linearity: ± 0.2 dB	
Dimensions	Overall length: 337 mm (Tip: 20 mm) Tip diameter: 3.9 mm (Body: 12 mm) Distance from probe tip to dipole centers: 2.0 mm	

3.2.3 Data Acquisition Electronics (DAE)


Model	DAE3, DAE4	
Construction	Signal amplifier, multiplexer, A/D converter and control logic. Serial optical link for communication with DASY4/5 embedded system (fully remote controlled). Two step probe touch detector for mechanical surface detection and emergency robot stop.	
Measurement Range	-100 to +300 mV (16 bit resolution and two range settings: 4mV, 400mV)	
Input Offset Voltage	< 5 μ V (with auto zero)	
Input Bias Current	< 50 fA	
Dimensions	60 x 60 x 68 mm	

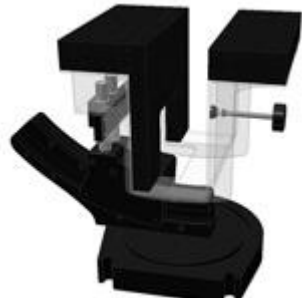
3.2.4 Phantoms

Model	Twin SAM	
Construction	The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (SAM) phantom defined in IEEE 1528 and IEC 62209-1. It 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 evaporation of the liquid. Reference markings on the phantom allow the complete setup of all predefined phantom positions and measurement grids by teaching three points with the robot.	
Material	Vinylester, glass fiber reinforced (VE-GF)	
Shell Thickness	2 ± 0.2 mm (6 ± 0.2 mm at ear point)	
Dimensions	Length: 1000 mm Width: 500 mm Height: adjustable feet	
Filling Volume	approx. 25 liters	


Model	ELI	
Construction	Phantom for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30 MHz to 6 GHz. ELI is fully compatible with the IEC 62209-2 standard and all known tissue simulating liquids. ELI has been optimized regarding its performance and can be integrated into our standard phantom tables. A cover prevents evaporation of the liquid. Reference markings on the phantom allow installation of the complete setup, including all predefined phantom positions and measurement grids, by teaching three points. The phantom is compatible with all SPEAG dosimetric probes and dipoles.	
Material	Vinylester, glass fiber reinforced (VE-GF)	
Shell Thickness	2.0 ± 0.2 mm (bottom plate)	
Dimensions	Major axis: 600 mm Minor axis: 400 mm	
Filling Volume	approx. 30 liters	

3.2.5 Device Holder

Model	Mounting Device	
Construction	In combination with the Twin SAM Phantom or ELI4, the Mounting Device enables the rotation of the mounted transmitter device in spherical coordinates. Rotation point is the ear opening point. Transmitter devices can be easily and accurately positioned according to IEC, IEEE, FCC or other specifications. The device holder can be locked for positioning at different phantom sections (left head, right head, flat).	
Material	POM	

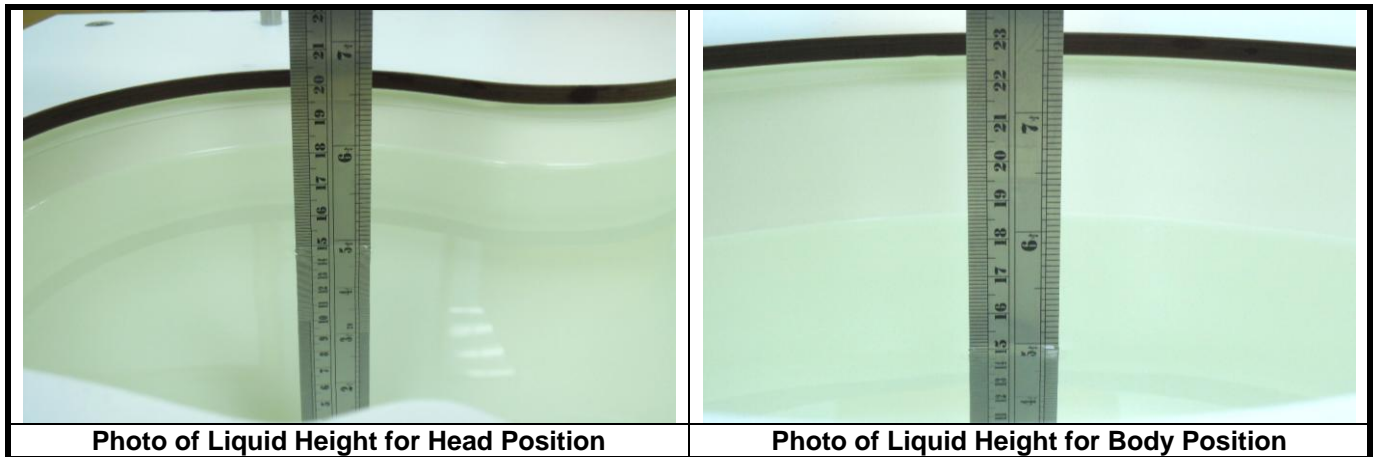
Model	Laptop Extensions Kit	
Construction	Simple but effective and easy-to-use extension for Mounting Device that facilitates the testing of larger devices according to IEC 62209-2 (e.g., laptops, cameras, etc.). It is lightweight and fits easily on the upper part of the Mounting Device in place of the phone positioner.	
Material	POM, Acrylic glass, Foam	

3.2.6 System Validation Dipoles

Model	D-Serial	
Construction	Symmetrical dipole with 1/4 balun. Enables measurement of feed point impedance with NWA. Matched for use near flat phantoms filled with tissue simulating solutions.	
Frequency	750 MHz to 5800 MHz	
Return Loss	> 20 dB	
Power Capability	> 100 W (f < 1GHz), > 40 W (f > 1GHz)	

3.2.7 Tissue Simulating Liquids

For SAR measurement of the field distribution inside the phantom, the phantom must be filled with homogeneous tissue simulating liquid to a depth of at least 15 cm. For head SAR testing, the liquid height from the ear reference point (ERP) of the phantom to the liquid top surface is larger than 15 cm. For body SAR testing, the liquid height from the center of the flat phantom to the liquid top surface is larger than 15 cm. The nominal dielectric values of the tissue simulating liquids in the phantom and the tolerance of 5% are listed in Table-3.1.



The dielectric properties of the head tissue simulating liquids are defined in IEEE 1528 and FCC OET 65 Supplement C Appendix C. For the body tissue simulating liquids, the dielectric properties are defined in FCC OET 65 Supplement C Appendix C. The dielectric properties of the tissue simulating liquids were verified prior to the SAR evaluation using an Agilent 85070D Dielectric Probe Kit and an Agilent Network Analyzer.

Table-3.1 Targets of Tissue Simulating Liquid

Frequency (MHz)	Target Permittivity	Range of $\pm 5\%$	Target Conductivity	Range of $\pm 5\%$
For Head				
750	41.9	39.8 ~ 44.0	0.89	0.85 ~ 0.93
835	41.5	39.4 ~ 43.6	0.90	0.86 ~ 0.95
900	41.5	39.4 ~ 43.6	0.97	0.92 ~ 1.02
1450	40.5	38.5 ~ 42.5	1.20	1.14 ~ 1.26
1640	40.3	38.3 ~ 42.3	1.29	1.23 ~ 1.35
1750	40.1	38.1 ~ 42.1	1.37	1.30 ~ 1.44
1800	40.0	38.0 ~ 42.0	1.40	1.33 ~ 1.47
1900	40.0	38.0 ~ 42.0	1.40	1.33 ~ 1.47
2000	40.0	38.0 ~ 42.0	1.40	1.33 ~ 1.47
2300	39.5	37.5 ~ 41.5	1.67	1.59 ~ 1.75
2450	39.2	37.2 ~ 41.2	1.80	1.71 ~ 1.89
2600	39.0	37.1 ~ 41.0	1.96	1.86 ~ 2.06
3500	37.9	36.0 ~ 39.8	2.91	2.76 ~ 3.06
5200	36.0	34.2 ~ 37.8	4.66	4.43 ~ 4.89
5300	35.9	34.1 ~ 37.7	4.76	4.52 ~ 5.00
5500	35.6	33.8 ~ 37.4	4.96	4.71 ~ 5.21
5600	35.5	33.7 ~ 37.3	5.07	4.82 ~ 5.32
5800	35.3	33.5 ~ 37.1	5.27	5.01 ~ 5.53
For Body				
750	55.5	52.7 ~ 58.3	0.96	0.91 ~ 1.01
835	55.2	52.4 ~ 58.0	0.97	0.92 ~ 1.02
900	55.0	52.3 ~ 57.8	1.05	1.00 ~ 1.10
1450	54.0	51.3 ~ 56.7	1.30	1.24 ~ 1.37
1640	53.8	51.1 ~ 56.5	1.40	1.33 ~ 1.47
1750	53.4	50.7 ~ 56.1	1.49	1.42 ~ 1.56
1800	53.3	50.6 ~ 56.0	1.52	1.44 ~ 1.60
1900	53.3	50.6 ~ 56.0	1.52	1.44 ~ 1.60
2000	53.3	50.6 ~ 56.0	1.52	1.44 ~ 1.60
2300	52.9	50.3 ~ 55.5	1.81	1.72 ~ 1.90
2450	52.7	50.1 ~ 55.3	1.95	1.85 ~ 2.05
2600	52.5	49.9 ~ 55.1	2.16	2.05 ~ 2.27
3500	51.3	48.7 ~ 53.9	3.31	3.14 ~ 3.48
5200	49.0	46.6 ~ 51.5	5.30	5.04 ~ 5.57
5300	48.9	46.5 ~ 51.3	5.42	5.15 ~ 5.69
5500	48.6	46.2 ~ 51.0	5.65	5.37 ~ 5.93
5600	48.5	46.1 ~ 50.9	5.77	5.48 ~ 6.06
5800	48.2	45.8 ~ 50.6	6.00	5.70 ~ 6.30

The following table gives the recipes for tissue simulating liquids.

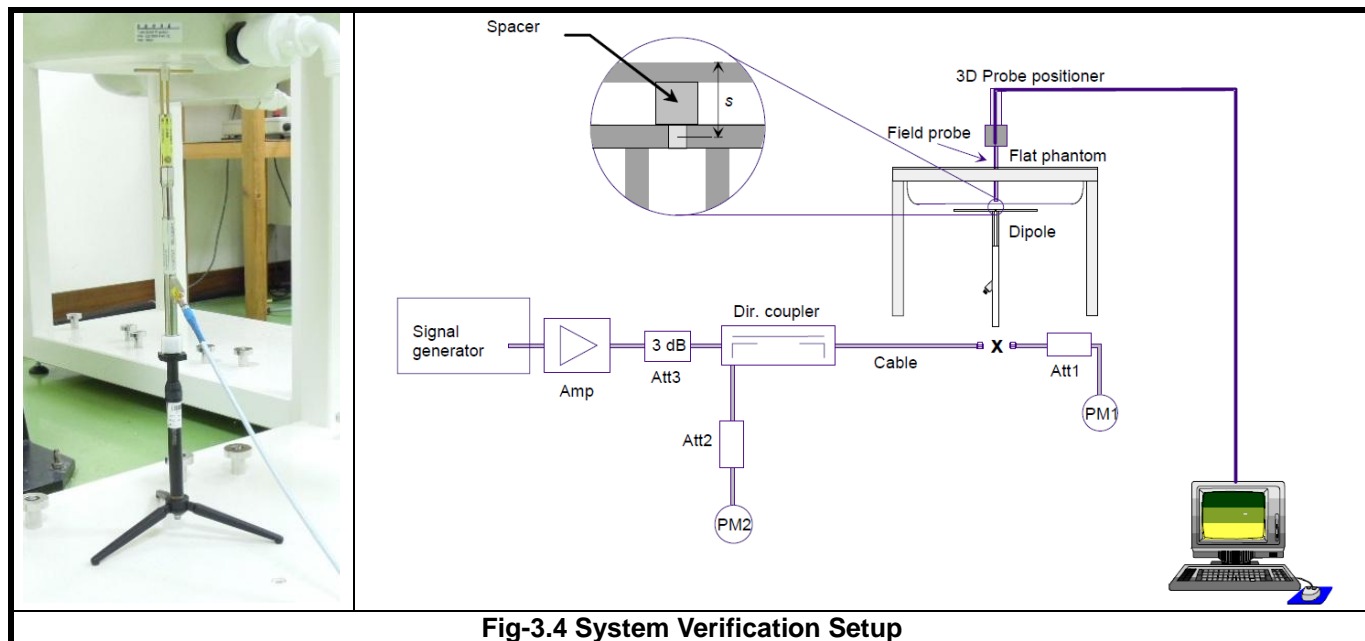
Table-3.2 Recipes of Tissue Simulating Liquid

Tissue Type	Bactericide	DGBE	HEC	NaCl	Sucrose	Triton X-100	Water	Diethylene Glycol Mono-hexylether
H750	0.2	-	0.2	1.5	56.0	-	42.1	-
H835	0.2	-	0.2	1.5	57.0	-	41.1	-
H900	0.2	-	0.2	1.4	58.0	-	40.2	-
H1450	-	43.3	-	0.6	-	-	56.1	-
H1640	-	45.8	-	0.5	-	-	53.7	-
H1750	-	47.0	-	0.4	-	-	52.6	-
H1800	-	44.5	-	0.3	-	-	55.2	-
H1900	-	44.5	-	0.2	-	-	55.3	-
H2000	-	44.5	-	0.1	-	-	55.4	-
H2300	-	44.9	-	0.1	-	-	55.0	-
H2450	-	45.0	-	0.1	-	-	54.9	-
H2600	-	45.1	-	0.1	-	-	54.8	-
H3500	-	8.0	-	0.2	-	20.0	71.8	-
H5G	-	-	-	-	-	17.2	65.5	17.3
B750	0.2	-	0.2	0.8	48.8	-	50.0	-
B835	0.2	-	0.2	0.9	48.5	-	50.2	-
B900	0.2	-	0.2	0.9	48.2	-	50.5	-
B1450	-	34.0	-	0.3	-	-	65.7	-
B1640	-	32.5	-	0.3	-	-	67.2	-
B1750	-	31.0	-	0.2	-	-	68.8	-
B1800	-	29.5	-	0.4	-	-	70.1	-
B1900	-	29.5	-	0.3	-	-	70.2	-
B2000	-	30.0	-	0.2	-	-	69.8	-
B2300	-	31.0	-	0.1	-	-	68.9	-
B2450	-	31.4	-	0.1	-	-	68.5	-
B2600	-	31.8	-	0.1	-	-	68.1	-
B3500	-	28.8	-	0.1	-	-	71.1	-
B5G	-	-	-	-	-	10.7	78.6	10.7

FCC SAR Test Report

3.3 SAR System Verification

The system check verifies that the system operates within its specifications. It is performed daily or before every SAR measurement. The system check uses normal SAR measurements in the flat section of the phantom with a matched dipole at a specified distance. The system verification setup is shown as below.



The validation dipole is placed beneath the flat phantom with the specific spacer in place. The distance spacer is touch the phantom surface with a light pressure at the reference marking and be oriented parallel to the long side of the phantom. The power meter PM1 measures the forward power at the location of the system check dipole connector. The signal generator is adjusted for the desired forward power (250 mW is used for 700 MHz to 3 GHz, 100 mW is used for 3.5 GHz to 6 GHz) at the dipole connector and the power meter PM2 is read at that level. After connecting the cable to the dipole, the signal generator is readjusted for the same reading at power meter PM2.

After system check testing, the SAR result will be normalized to 1W forward input power and compared with the reference SAR value derived from validation dipole certificate report. The deviation of system check should be within 10 %.

3.4 SAR Measurement Procedure

According to the SAR test standard, the recommended procedure for assessing the peak spatial-average SAR value consists of the following steps:

- Power reference measurement
- Area scan
- Zoom scan
- Power drift measurement

The SAR measurement procedures for each of test conditions are as follows:

- Make EUT to transmit maximum output power
- Measure conducted output power through RF cable
- Place the EUT in the specific position of phantom
- Perform SAR testing steps on the DASY system
- Record the SAR value

3.4.1 Area & Zoom Scan Procedure

First Area Scan is used to locate the approximate location(s) of the local peak SAR value(s). The measurement grid within an Area Scan is defined by the grid extent, grid step size and grid offset. Next, in order to determine the EM field distribution in a three-dimensional spatial extension, Zoom Scan is required. The Zoom Scan is performed around the highest E-field value to determine the averaged SAR-distribution over 10 g. According to KDB 865664 D01 v01r01, the resolution for Area and Zoom scan is specified in the table below.

Items	<= 2 GHz	2-3 GHz	3-4 GHz	4-5 GHz	5-6 GHz
Area Scan ($\Delta x, \Delta y$)	<= 15 mm	<= 12 mm	<= 12 mm	<= 10 mm	<= 10 mm
Zoom Scan ($\Delta x, \Delta y$)	<= 8 mm	<= 5 mm	<= 5 mm	<= 4 mm	<= 4 mm
Zoom Scan (Δz)	<= 5 mm	<= 5 mm	<= 4 mm	<= 3 mm	<= 2 mm
Zoom Scan Volume	>= 30 mm	>= 30 mm	>= 28 mm	>= 25 mm	>= 22 mm

Note:

When zoom scan is required and report SAR is <= 1.4 W/kg, the zoom scan resolution of $\Delta x / \Delta y$ (2-3GHz: <= 8 mm, 3-4GHz: <= 7 mm, 4-6GHz: <= 5 mm) may be applied.

3.4.2 Volume Scan Procedure

The volume scan is used for assess overlapping SAR distributions for antennas transmitting in different frequency bands. It is equivalent to an oversized zoom scan used in standalone measurements. The measurement volume will be used to enclose all the simultaneous transmitting antennas. For antennas transmitting simultaneously in different frequency bands, the volume scan is measured separately in each frequency band. In order to sum correctly to compute the 1g aggregate SAR, the EUT remain in the same test position for all measurements and all volume scan use the same spatial resolution and grid spacing. When all volume scan were completed, the software, SEMCAD postprocessor can combine and subsequently superpose these measurement data to calculating the multiband SAR.

FCC SAR Test Report

3.4.3 Power Drift Monitoring

All SAR testing is under the EUT install full charged battery and transmit maximum output power. In DASY measurement software, the power reference measurement and power drift measurement procedures are used for monitoring the power drift of EUT during SAR test. Both these procedures measure the field at a specified reference position before and after the SAR testing. The software will calculate the field difference in dB. If the power drift more than 5%, the SAR will be retested.

3.4.4 Spatial Peak SAR Evaluation

The procedure for spatial peak SAR evaluation has been implemented according to the test standard. It can be conducted for 1g and 10g, as well as for user-specific masses. The DASY software includes all numerical procedures necessary to evaluate the spatial peak SAR value.

The base for the evaluation is a "cube" measurement. The measured volume must include the 1g and 10g cubes with the highest averaged SAR values. For that purpose, the center of the measured volume is aligned to the interpolated peak SAR value of a previously performed area scan.

The entire evaluation of the spatial peak values is performed within the post-processing engine (SEMCAD). The system always gives the maximum values for the 1g and 10g cubes. The algorithm to find the cube with highest averaged SAR is divided into the following stages:

- (a) Extraction of the measured data (grid and values) from the Zoom Scan
- (b) Calculation of the SAR value at every measurement point based on all stored data (A/D values and measurement parameters)
- (c) Generation of a high-resolution mesh within the measured volume
- (d) Interpolation of all measured values from the measurement grid to the high-resolution grid
- (e) Extrapolation of the entire 3-D field distribution to the phantom surface over the distance from sensor to surface
- (f) Calculation of the averaged SAR within masses of 1g and 10g

3.4.5 SAR Averaged Methods

In DASY, the interpolation and extrapolation are both based on the modified Quadratic Shepard's method. The interpolation scheme combines a least-square fitted function method and a weighted average method which are the two basic types of computational interpolation and approximation.

Extrapolation routines are used to obtain SAR values between the lowest measurement points and the inner phantom surface. The extrapolation distance is determined by the surface detection distance and the probe sensor offset. The uncertainty increases with the extrapolation distance. To keep the uncertainty within 1% for the 1 g and 10 g cubes, the extrapolation distance should not be larger than 5 mm.

4. SAR Measurement Evaluation

4.1 EUT Configuration and Setting

For WLAN SAR testing, the setup laptop PC has installed WLAN engineering testing software which can provide continuous transmitting RF signal. According to KDB 248227 D01, WLAN SAR should tested at the lowest data rate, and testing at higher data rate is not required when the maximum average output power is less than 1/4 dB higher than those measured at the lowest data rate. Since the WLAN power at lowest data rate has highest output power, WLAN SAR for this device was performed at the lowest data rate as set in 1 Mbps for 802.11b, and 6 Mbps for 802.11a. This RF signal utilized in SAR measurement has almost 100% duty cycle and the duty factor is 1 during WLAN SAR testing.

4.2 EUT Testing Position

This EUT were tested in six positions. They are Front Face, Rear Face, Left Side, Right Side, Top Side, and Bottom Side. In these positions, the air gap between the EUT and the phantom is 8 mm.

According to KDB 447498 D01, the SAR test exclusion condition is based on source-based time-averaged maximum conducted output power, adjusted for tune-up tolerance, and the minimum test separation distance required for the exposure conditions. The SAR exclusion threshold is determined by the following formula.

- For the test separation distance ≤ 50 mm

$$\frac{\text{Max. Tune up Power}_{(\text{mW})}}{\text{Min. Test Separation Distance}_{(\text{mm})}} \times \sqrt{f_{(\text{GHz})}} \leq 3.0$$

When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion.

- For the test separation distance > 50 mm, and the frequency at 100 MHz to 1500 MHz

$$\left[(\text{Threshold at 50 mm in Step 1}) + (\text{Test Separation Distance} - 50 \text{ mm}) \times \left(\frac{f_{(\text{MHz})}}{150} \right) \right]_{(\text{mW})}$$

- For the test separation distance > 50 mm, and the frequency at > 1500 MHz to 6 GHz

$$[(\text{Threshold at 50 mm in Step 1}) + (\text{Test Separation Distance} - 50 \text{ mm}) \times 10]_{(\text{mW})}$$

Mode	Max. Tune-up Power (dBm)	Max. Tune-up Power (mW)	Ant. to Surface (mm)	Calculated Result	Require SAR Testing?
BT (2.48GHz)	5.7	4	8	0.8	No

4.3 Tissue Verification

The measuring results for tissue simulating liquid are shown as below.

Test Date	Tissue Type	Frequency (MHz)	Liquid Temp. (°C)	Measured Conductivity (σ)	Measured Permittivity (ϵ_r)	Target Conductivity (σ)	Target Permittivity (ϵ_r)	Conductivity Deviation (%)	Permittivity Deviation (%)
Jul. 09, 2013	Body	2450	20.5	1.979	51.322	1.95	52.7	1.49	-2.61
Aug. 02, 2013	Body	5200	20.5	5.354	47.668	5.30	49.0	1.02	-2.72
Aug. 02, 2013	Body	5300	20.5	5.495	47.444	5.42	48.9	1.38	-2.98
Aug. 02, 2013	Body	5600	20.5	5.90	46.819	5.77	48.5	2.25	-3.47
Aug. 02, 2013	Body	5800	20.5	6.178	46.487	6.00	48.2	2.97	-3.55

Note:

The dielectric properties of the tissue simulating liquid must be measured within 24 hours before the SAR testing and within $\pm 5\%$ of the target values. Liquid temperature during the SAR testing must be within $\pm 2^\circ\text{C}$.

4.4 System Validation

The SAR measurement system was validated according to procedures in KDB 865664 D01 v01r01. The validation status in tabulated summary is as below.

Test Date	Probe S/N	Calibration Point		Measured Conductivity (σ)	Measured Permittivity (ϵ_r)	Validation for CW			Validation for Modulation		
						Sensitivity Range	Probe Linearity	Probe Isotropy	Modulation Type	Duty Factor	PAR
Jul. 09, 2013	3801	Body	2450	1.979	51.322	Pass	Pass	Pass	OFDM	N/A	Pass
Aug. 02, 2013	3650	Body	5200	5.354	47.668	Pass	Pass	Pass	OFDM	N/A	Pass
Aug. 02, 2013	3650	Body	5300	5.495	47.444	Pass	Pass	Pass	OFDM	N/A	Pass
Aug. 02, 2013	3650	Body	5600	5.90	46.819	Pass	Pass	Pass	OFDM	N/A	Pass
Aug. 02, 2013	3650	Body	5800	6.178	46.487	Pass	Pass	Pass	OFDM	N/A	Pass

4.5 System Verification

The measuring result for system verification is tabulated as below.

Test Date	Mode	Frequency (MHz)	1W Target SAR-1g (W/kg)	Measured SAR-1g (W/kg)	Normalized to 1W SAR-1g (W/kg)	Deviation (%)	Dipole S/N	Probe S/N	DAE S/N
Jul. 09, 2013	Body	2450	49.60	12.3	49.20	-0.81	737	3801	579
Aug. 02, 2013	Body	5200	73.00	7.32	73.20	0.27	1019	3650	914
Aug. 02, 2013	Body	5300	74.60	7.20	72.00	-3.49	1019	3650	914
Aug. 02, 2013	Body	5600	79.90	8.33	83.30	4.26	1019	3650	914
Aug. 02, 2013	Body	5800	73.40	7.04	70.40	-4.09	1019	3650	914

Note:

Comparing to the reference SAR value provided by SPEAG, the validation data should be within its specification of 10 %. The result indicates the system check can meet the variation criterion and the plots can be referred to Appendix A of this report.

4.6 Maximum Output Power

4.6.1 Maximum Conducted Power

The maximum conducted power (Unit: dBm) including tune-up tolerance is shown as below.

Mode	2.4G WLAN	5.2G WLAN	5.3G WLAN	5.6G WLAN	5.8G WLAN
802.11b	20.0	N/A	N/A	N/A	N/A
802.11g	19.5	N/A	N/A	N/A	N/A
802.11a	N/A	16.5	18.0	17.5	18.0
802.11n HT20	18.5	16.0	16.0	15.5	15.5
802.11n HT40	17.5	15.5	16.0	16.0	15.5

Note: The above tune-up target values are dual chain combined powers.

Mode	Bluetooth
All	5.7

4.6.2 Measured Conducted Power Result

The measuring conducted power (Unit: dBm) is shown as below.

<WLAN 2.4G>

Mode	802.11b		
Channel / Frequency (MHz)	1 (2412)	6 (2437)	11 (2462)
Average Power (Ant-0 + Ant-1)	19.56	19.28	19.64
Mode	802.11g		
Channel / Frequency (MHz)	1 (2412)	6 (2437)	11 (2462)
Average Power (Ant-0 + Ant-1)	15.56	19.38	14.64
Mode	802.11n (HT20)		
Channel / Frequency (MHz)	1 (2412)	6 (2437)	11 (2462)
Average Power (Ant-0 + Ant-1)	14.53	18.32	13.44
Mode	802.11n (HT40)		
Channel / Frequency (MHz)	3 (2422)	6 (2437)	9 (2452)
Average Power (Ant-0 + Ant-1)	14.03	17.18	13.51

<WLAN 5.2G>

Mode	802.11a			
Channel / Frequency (MHz)	36 (5180)	40 (5200)	44 (5220)	48 (5240)
Average Power (Ant-0 + Ant-1)	16.19	16.19	15.86	15.90
Mode	802.11n (HT20)			
Channel / Frequency (MHz)	36 (5180)	40 (5200)	44 (5220)	48 (5240)
Average Power (Ant-0 + Ant-1)	15.36	15.26	14.97	15.51
Mode	802.11n (HT40)			
Channel / Frequency (MHz)	38 (5190)		46 (5230)	
Average Power (Ant-0 + Ant-1)	13.55		15.33	

FCC SAR Test Report

A D T

<WLAN 5.3G>

Mode	802.11a			
Channel / Frequency (MHz)	52 (5260)	56 (5280)	60 (5300)	64 (5320)
Average Power (Ant-0 + Ant-1)	17.58	16.97	17.50	17.18
Mode	802.11n (HT20)			
Channel / Frequency (MHz)	52 (5260)	56 (5280)	60 (5300)	64 (5320)
Average Power (Ant-0 + Ant-1)	15.60	15.16	15.15	15.25
Mode	802.11n (HT40)			
Channel / Frequency (MHz)	54 (5270)	62 (5310)		
Average Power (Ant-0 + Ant-1)	15.65	13.30		

<WLAN 5.6G>

Mode	802.11a							
Channel / Frequency (MHz)	100 (5500)	104 (5520)	108 (5540)	112 (5560)	116 (5580)	132 (5660)	136 (5680)	140 (5700)
Average Power (Ant-0 + Ant-1)	17.44	17.26	17.06	17.01	17.27	17.48	17.14	15.99
Mode	802.11n (HT20)							
Channel / Frequency (MHz)	100 (5500)	104 (5520)	108 (5540)	112 (5560)	116 (5580)	132 (5660)	136 (5680)	140 (5700)
Average Power (Ant-0 + Ant-1)	15.26	14.96	14.97	15.11	15.23	15.22	14.91	14.38
Mode	802.11n (HT40)							
Channel / Frequency (MHz)	102 (5510)				134 (5670)			
Average Power (Ant-0 + Ant-1)	12.89				15.56			

<WLAN 5.8G>

Mode	802.11a				
Channel / Frequency (MHz)	149 (5745)	153 (5765)	157 (5785)	161 (5805)	165 (5825)
Average Power (Ant-0 + Ant-1)	17.37	17.21	17.58	17.26	17.36
Mode	802.11n (HT20)				
Channel / Frequency (MHz)	149 (5745)	153 (5765)	157 (5785)	161 (5805)	165 (5825)
Average Power (Ant-0 + Ant-1)	15.44	15.19	15.26	15.16	15.25
Mode	802.11n (HT40)				
Channel / Frequency (MHz)	151 (5755)		159 (5795)		
Average Power (Ant-0 + Ant-1)	15.24		15.16		

4.7 SAR Testing Results

4.7.1 SAR Results for Body (Separation Distance is 8 mm Gap)

Plot No.	Band	Test Position	Ch.	Ant Status	Max. Tune-up Power (dBm)	Measured Conducted Power (dBm)	Scaling Factor	Power Drift (dB)	Measured SAR-1g (W/kg)	Scaled SAR-1g (W/kg)
	802.11b	Front Face	11	0+1	20.0	19.64	1.09	0.04	0.57	0.62
	802.11b	Rear Face	11	0+1	20.0	19.64	1.09	0.19	0.207	0.22
	802.11b	Left Side	11	0+1	20.0	19.64	1.09	0.17	0.125	0.14
	802.11b	Right Side	11	0+1	20.0	19.64	1.09	0.13	0.086	0.09
01	802.11b	Top Side	11	0+1	20.0	19.64	1.09	0.08	0.605	0.66
	802.11b	Bottom Side	11	0+1	20.0	19.64	1.09	0.07	0.225	0.24
02	802.11a	Front Face	36	0+1	16.5	16.19	1.07	0.09	0.259	0.28
	802.11a	Rear Face	36	0+1	16.5	16.19	1.07	0.09	0.043	0.05
	802.11a	Left Side	36	0+1	16.5	16.19	1.07	0.04	0.083	0.09
	802.11a	Right Side	36	0+1	16.5	16.19	1.07	-0.07	0.018	0.02
	802.11a	Top Side	36	0+1	16.5	16.19	1.07	-0.03	0.185	0.20
	802.11a	Bottom Side	36	0+1	16.5	16.19	1.07	0.04	0.05	0.05
03	802.11a	Front Face	52	0+1	18.0	17.58	1.10	0.13	0.36	0.40
	802.11a	Rear Face	52	0+1	18.0	17.58	1.10	0.04	0.063	0.07
	802.11a	Left Side	52	0+1	18.0	17.58	1.10	0.08	0.109	0.12
	802.11a	Right Side	52	0+1	18.0	17.58	1.10	0.15	0.029	0.03
	802.11a	Top Side	52	0+1	18.0	17.58	1.10	-0.07	0.221	0.24
	802.11a	Bottom Side	52	0+1	18.0	17.58	1.10	-0.03	0.08	0.09
04	802.11a	Front Face	132	0+1	17.5	17.48	1.00	0.17	0.332	0.33
	802.11a	Rear Face	132	0+1	17.5	17.48	1.00	-0.06	0.085	0.09
	802.11a	Left Side	132	0+1	17.5	17.48	1.00	0.10	0.134	0.13
	802.11a	Right Side	132	0+1	17.5	17.48	1.00	-0.03	0.045	0.05
	802.11a	Top Side	132	0+1	17.5	17.48	1.00	0.04	0.225	0.23
	802.11a	Bottom Side	132	0+1	17.5	17.48	1.00	-0.01	0.106	0.11
05	802.11a	Front Face	157	0+1	18.0	17.58	1.10	-0.15	0.309	0.34
	802.11a	Rear Face	157	0+1	18.0	17.58	1.10	0.07	0.12	0.13
	802.11a	Left Side	157	0+1	18.0	17.58	1.10	0.04	0.159	0.18
	802.11a	Right Side	157	0+1	18.0	17.58	1.10	0.01	0.035	0.04
	802.11a	Top Side	157	0+1	18.0	17.58	1.10	-0.02	0.247	0.27
	802.11a	Bottom Side	157	0+1	18.0	17.58	1.10	-0.02	0.144	0.16

Note:

1. According to KDB 248227, when the extrapolated maximum peak SAR for the maximum output power channel is ≤ 1.6 W/kg and the 1g averaged SAR is ≤ 0.8 W/kg, WLAN SAR testing for other channels is not required.
2. SAR testing for 802.11g/n is not required when its maximum power is less than 1/4 dB higher than 802.11b.
3. SAR testing for 802.11n is not required when its maximum power is less than 1/4 dB higher than 802.11a.

4.7.2 SAR Measurement Variability

According to KDB 865664 D01 v01r01, SAR measurement variability was assessed for each frequency band, which is determined by the SAR probe calibration point and tissue-equivalent medium used for the device measurements. When both head and body tissue-equivalent media are required for SAR measurements in a frequency band, the variability measurement procedures should be applied to the tissue medium with the highest measured SAR, using the highest measured SAR configuration for that tissue-equivalent medium. Alternatively, if the highest measured SAR for both head and body tissue-equivalent media are ≤ 1.45 W/kg and the ratio of these highest SAR values, i.e., largest divided by smallest value, is ≤ 1.10 , the highest SAR configuration for either head or body tissue-equivalent medium may be used to perform the repeated measurement. These additional measurements are repeated after the completion of all measurements requiring the same head or body tissue-equivalent medium in a frequency band. The test device should be returned to ambient conditions (normal room temperature) with the battery fully charged before it is re-mounted on the device holder for the repeated measurement(s) to minimize any unexpected variations in the repeated results.

Since all the measured SAR are less than 0.8 W/kg, the repeated measurement is not required.

4.7.3 Simultaneous Multi-band Transmission Evaluation

<Estimated SAR Calculation>

According to KDB 447498 D01, when standalone SAR test exclusion applies to an antenna that transmits simultaneously with other antennas, the standalone SAR was estimated according to following formula to result in substantially conservative SAR values of ≤ 0.4 W/kg to determine simultaneous transmission SAR test exclusion.

$$\text{Estimated SAR} = \frac{\text{Max. Tune up Power}_{(\text{mW})}}{\text{Min. Test Separation Distance}_{(\text{mm})}} \times \frac{\sqrt{f_{(\text{GHz})}}}{7.5}$$

If the minimum test separation distance is < 5 mm, a distance of 5 mm is used for estimated SAR calculation. When the test separation distance is > 50 mm, the 0.4 W/kg is used for SAR-1g.

Mode / Band	Frequency (GHz)	Max. Tune-up Power (dBm)	Test Position	Separation Distance (mm)	Estimated SAR (W/kg)
BT (DSS)	2.48	5.7	Body	8	0.10

Note:

1. The separation distance is determined from the outer housing of the EUT to the user.
2. When standalone SAR testing is not required, an estimated SAR can be applied to determine simultaneous transmission SAR test exclusion.

FCC SAR Test Report

A D T

<SAR Summation Analysis>

Simultaneous transmission SAR test exclusion is determined for each operating configuration and exposure condition according to the reported standalone SAR of each applicable simultaneous transmitting antenna. When the sum of SAR_{1g} of all simultaneously transmitting antennas in an operating mode and exposure condition combination is within the SAR limit (SAR_{1g} 1.6 W/kg), the simultaneous transmission SAR is not required. When the sum of SAR_{1g} is greater than the SAR limit (SAR_{1g} 1.6 W/kg), SAR test exclusion is determined by the SPLSR.

No.	Conditions (SAR1 + SAR2)	Exposure Condition	Test Position	Max. SAR1	Max. SAR2	SAR Summation	SPLSR Analysis
1	WLAN (DTS) + BT (DSS)	Body	Front Face	0.62	0.10	0.72	Σ SAR < 1.6, Not required
			Rear Face	0.22	0.10	0.32	Σ SAR < 1.6, Not required
			Left Side	0.18	0.10	0.28	Σ SAR < 1.6, Not required
			Right Side	0.09	0.10	0.19	Σ SAR < 1.6, Not required
			Top Side	0.66	0.10	0.76	Σ SAR < 1.6, Not required
			Bottom Side	0.24	0.10	0.34	Σ SAR < 1.6, Not required
2	WLAN (NII) + BT (DSS)	Body	Front Face	0.40	0.10	0.50	Σ SAR < 1.6, Not required
			Rear Face	0.09	0.10	0.19	Σ SAR < 1.6, Not required
			Left Side	0.13	0.10	0.23	Σ SAR < 1.6, Not required
			Right Side	0.05	0.10	0.15	Σ SAR < 1.6, Not required
			Top Side	0.24	0.10	0.34	Σ SAR < 1.6, Not required
			Bottom Side	0.11	0.10	0.21	Σ SAR < 1.6, Not required

Test Engineer : Mars Chang, and Allen Chen

5. Calibration of Test Equipment

Equipment	Manufacturer	Model	SN	Cal. Date	Cal. Interval
System Validation Kit	SPEAG	D2450V2	737	Jan. 21, 2013	Annual
System Validation Kit	SPEAG	D5GHzV2	1019	Nov. 16, 2012	Annual
Dosimetric E-Field Probe	SPEAG	EX3DV4	3650	Apr. 30, 2013	Annual
Dosimetric E-Field Probe	SPEAG	EX3DV4	3801	Jun. 20, 2013	Annual
Data Acquisition Electronics	SPEAG	DAE3	579	Apr. 24, 2013	Annual
Data Acquisition Electronics	SPEAG	DAE4	914	Jan. 16, 2013	Annual
SAM Phantom	SPEAG	QD000P40CD	TP-1653	N/A	N/A
ELI Phantom	SPEAG	QDOVA001B	TP-1039	N/A	N/A
ENA Series Network Analyzer	Agilent	E5071C	MY46107999	Mar. 25, 2013	Annual
MXG Analog Signal Generator	Agilent	N5181A	MY50143868	Jun. 06, 2013	Annual
Power Meter	Anritsu	ML2495A	1218009	Jun. 11, 2013	Annual
Power Sensor	Anritsu	MA2411B	1207252	Jun. 11, 2013	Annual
EXA Spectrum Analyzer	Agilent	N9010A	MY52100136	Jun. 26, 2013	Annual
Dielectric Probe Kit	Agilent	85070D	E2-020018	May 13, 2013	Annual
Thermometer	YFE	YF-160A	110600361	Feb. 20, 2013	Annual
Directional Coupler	Woken	0110A05602O-10	11122702	Apr. 18, 2013	Annual
Power Amplifier	AR	5S1G4	0339656	Apr. 18, 2013	Annual
Power Amplifier	Mini-Circuit	ZVE-8G	001000422	Apr. 18, 2013	Annual
Attenuator	Woken	00800A1G01L-03	N/A	Apr. 18, 2013	Annual

6. Measurement Uncertainty

Error Description	Uncertainty Value (±%)	Probability Distribution	Divisor	Ci (1g)	Standard Uncertainty (1g)	Vi
Measurement System						
Probe Calibration	6.0	Normal	1	1	± 6.0 %	∞
Axial Isotropy	4.7	Rectangular	√3	0.7	± 1.9 %	∞
Hemispherical Isotropy	9.6	Rectangular	√3	0.7	± 3.9 %	∞
Boundary Effects	1.0	Rectangular	√3	1	± 0.6 %	∞
Linearity	4.7	Rectangular	√3	1	± 2.7 %	∞
System Detection Limits	1.0	Rectangular	√3	1	± 0.6 %	∞
Readout Electronics	0.6	Normal	1	1	± 0.6 %	∞
Response Time	0.0	Rectangular	√3	1	± 0.0 %	∞
Integration Time	1.7	Rectangular	√3	1	± 1.0 %	∞
RF Ambient Noise	3.0	Rectangular	√3	1	± 1.7 %	∞
RF Ambient Reflections	3.0	Rectangular	√3	1	± 1.7 %	∞
Probe Positioner	0.5	Rectangular	√3	1	± 0.3 %	∞
Probe Positioning	2.9	Rectangular	√3	1	± 1.7 %	∞
Max. SAR Eval.	2.3	Rectangular	√3	1	± 1.3 %	∞
Test Sample Related						
Device Positioning	3.9	Normal	1	1	± 3.9 %	31
Device Holder	2.7	Normal	1	1	± 2.7 %	19
Power Drift	5.0	Rectangular	√3	1	± 2.9 %	∞
Phantom and Setup						
Phantom Uncertainty	4.0	Rectangular	√3	1	± 2.3 %	∞
Liquid Conductivity (Target)	5.0	Rectangular	√3	0.64	± 1.8 %	∞
Liquid Conductivity (Meas.)	5.0	Normal	1	0.64	± 3.2 %	29
Liquid Permittivity (Target)	5.0	Rectangular	√3	0.6	± 1.7 %	∞
Liquid Permittivity (Meas.)	5.0	Normal	1	0.6	± 3.0 %	29
Combined Standard Uncertainty					± 11.7 %	
Expanded Uncertainty (K=2)					± 23.4 %	

Uncertainty budget for frequency range 300 MHz to 3 GHz

FCC SAR Test Report

A D T

Error Description	Uncertainty Value (±%)	Probability Distribution	Divisor	Ci (1g)	Standard Uncertainty (1g)	Vi
Measurement System						
Probe Calibration	6.55	Normal	1	1	± 6.55 %	∞
Axial Isotropy	4.7	Rectangular	√3	0.7	± 1.9 %	∞
Hemispherical Isotropy	9.6	Rectangular	√3	0.7	± 3.9 %	∞
Boundary Effects	2.0	Rectangular	√3	1	± 1.2 %	∞
Linearity	4.7	Rectangular	√3	1	± 2.7 %	∞
System Detection Limits	1.0	Rectangular	√3	1	± 0.6 %	∞
Readout Electronics	0.3	Normal	1	1	± 0.3 %	∞
Response Time	0.8	Rectangular	√3	1	± 0.5 %	∞
Integration Time	2.6	Rectangular	√3	1	± 1.5 %	∞
RF Ambient Noise	3.0	Rectangular	√3	1	± 1.7 %	∞
RF Ambient Reflections	3.0	Rectangular	√3	1	± 1.7 %	∞
Probe Positioner	0.8	Rectangular	√3	1	± 0.5 %	∞
Probe Positioning	9.9	Rectangular	√3	1	± 5.7 %	∞
Max. SAR Eval.	4.0	Rectangular	√3	1	± 2.3 %	∞
Test Sample Related						
Device Positioning	3.9	Normal	1	1	± 3.9 %	31
Device Holder	2.7	Normal	1	1	± 2.7 %	19
Power Drift	5.0	Rectangular	√3	1	± 2.9 %	∞
Phantom and Setup						
Phantom Uncertainty	4.0	Rectangular	√3	1	± 2.3 %	∞
Liquid Conductivity (Target)	5.0	Rectangular	√3	0.64	± 1.8 %	∞
Liquid Conductivity (Meas.)	5.0	Normal	1	0.64	± 3.2 %	30
Liquid Permittivity (Target)	5.0	Rectangular	√3	0.6	± 1.7 %	∞
Liquid Permittivity (Meas.)	5.0	Normal	1	0.6	± 3.0 %	30
Combined Standard Uncertainty					± 13.4 %	
Expanded Uncertainty (K=2)					± 26.8 %	

Uncertainty budget for frequency range 3 GHz to 6 GHz

7. Information on the Testing Laboratories

We, Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch, were founded in 1988 to provide our best service in EMC, Radio, Telecom and Safety consultation. Our laboratories are accredited and approved according to ISO/IEC 17025.

If you have any comments, please feel free to contact us at the following:

Taiwan HwaYa EMC/RF/Safety/Telecom Lab:

Add: No. 19, Hwa Ya 2nd Rd, Wen Hwa Vil., Kwei Shan Hsiang, Taoyuan Hsien 333, Taiwan, R.O.C.

Tel: 886-3-318-3232

Fax: 886-3-327-0892

Taiwan LinKo EMC/RF Lab:

Add: No. 47, 14th Ling, Chia Pau Vil., Linkou Dist., New Taipei City 244, Taiwan, R.O.C.

Tel: 886-2-2605-2180

Fax: 886-2-2605-1924

Taiwan HsinChu EMC/RF Lab:

Add: No. 81-1, Lu Liao Keng, 9th Ling, Wu Lung Vil., Chiung Lin Township, Hsinchu County 307, Taiwan, R.O.C.

Tel: 886-3-593-5343

Fax: 886-3-593-5342

Email: service.adt@tw.bureauveritas.com

Web Site: www.adt.com.tw

The road map of all our labs can be found in our web site also.

---END---

Appendix A. SAR Plots of System Verification

The plots for system verification with largest deviation for each SAR system combination are shown as follows.

System Check_B2450_130709**DUT: Dipole 2450 MHz; Type: D2450V2; SN: 737**

Communication System: CW; Frequency: 2450 MHz; Duty Cycle: 1:1

Medium: B2450_0709 Medium parameters used: $f = 2450$ MHz; $\sigma = 1.979$ S/m; $\epsilon_r = 51.322$; $\rho = 1000$ kg/m³

Ambient Temperature : 21.8 °C; Liquid Temperature : 20.5 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN3801; ConvF(6.69, 6.69, 6.69); Calibrated: 2013/06/20;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn579; Calibrated: 2013/04/24
- Phantom: SAM Phantom_Front; Type: SAM V4.0; Serial: TP 1653
- Measurement SW: DASY52, Version 52.8 (4); SEMCAD X Version 14.6.8 (7028)

Pin=250mW/Area Scan (81x81x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm

Maximum value of SAR (interpolated) = 19.3 W/kg

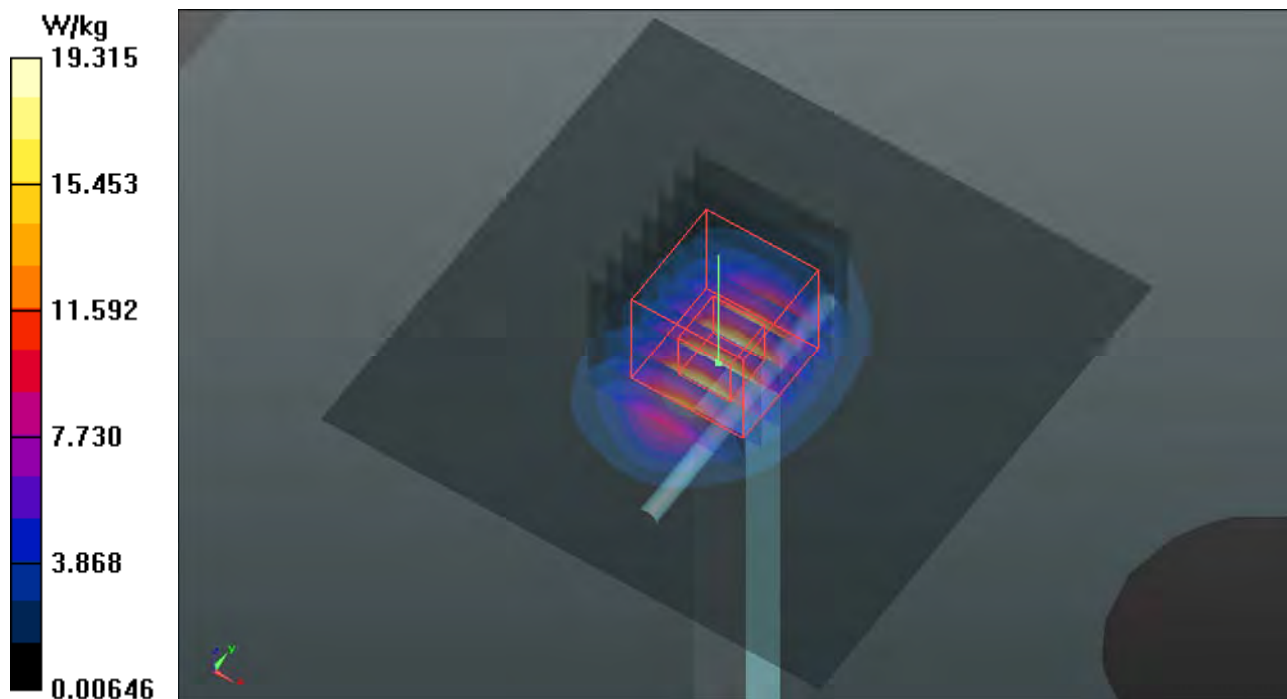
Pin=250mW/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 98.180 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 26.0 W/kg

SAR(1 g) = 12.3 W/kg; SAR(10 g) = 5.65 W/kg

Maximum value of SAR (measured) = 19.0 W/kg



System Check_B5200_130802**DUT: Dipole 5 GHz; Type: D5GHzV2; SN: 1019**

Communication System: CW; Frequency: 5200 MHz; Duty Cycle: 1:1

Medium: B5G_0802 Medium parameters used: $f = 5200$ MHz; $\sigma = 5.354$ S/m; $\epsilon_r = 47.668$; $\rho = 1000$ kg/m³

Ambient Temperature : 21.5 °C; Liquid Temperature : 20.5 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN3650; ConvF(4.51, 4.51, 4.51); Calibrated: 2013/04/30;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn914; Calibrated: 2013/01/16
- Phantom: ELI v4.0_Left; Type: QDOVA001BB; Serial: TP:1039
- Measurement SW: DASY52, Version 52.8 (7); SEMCAD X Version 14.6.10 (7164)

Pin=100mW/Area Scan (91x91x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 15.0 W/kg

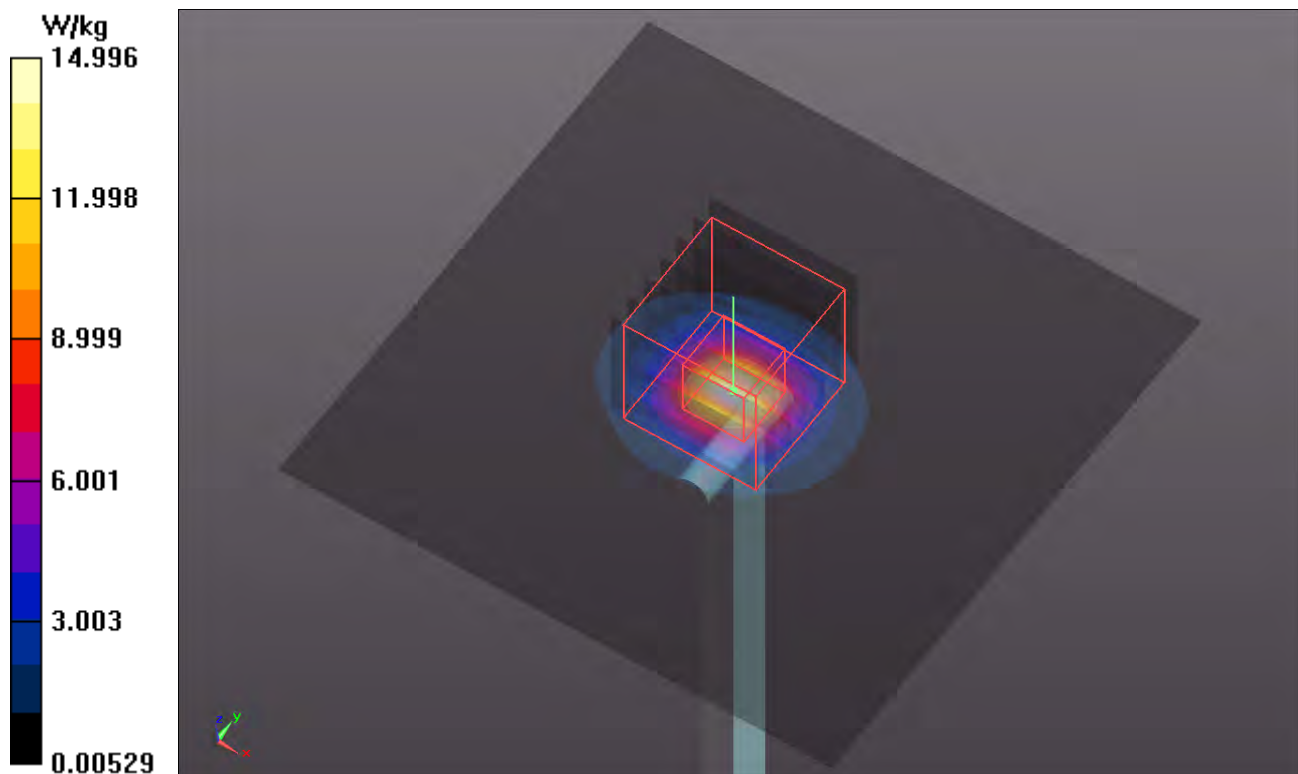
Pin=100mW/Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm

Reference Value = 57.907 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 29.5 W/kg

SAR(1 g) = 7.32 W/kg; SAR(10 g) = 2.09 W/kg

Maximum value of SAR (measured) = 15.4 W/kg



System Check_B5300_130802**DUT: Dipole 5 GHz; Type: D5GHzV2; SN: 1019**

Communication System: CW; Frequency: 5300 MHz; Duty Cycle: 1:1

Medium: B5G_0802 Medium parameters used: $f = 5300$ MHz; $\sigma = 5.495$ S/m; $\epsilon_r = 47.444$; $\rho = 1000$ kg/m³

Ambient Temperature : 21.5 °C; Liquid Temperature : 20.5 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN3650; ConvF(4.31, 4.31, 4.31); Calibrated: 2013/04/30;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn914; Calibrated: 2013/01/16
- Phantom: ELI v4.0_Left; Type: QDOVA001BB; Serial: TP:1039
- Measurement SW: DASY52, Version 52.8 (7); SEMCAD X Version 14.6.10 (7164)

Pin=100mW/Area Scan (91x91x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 15.2 W/kg

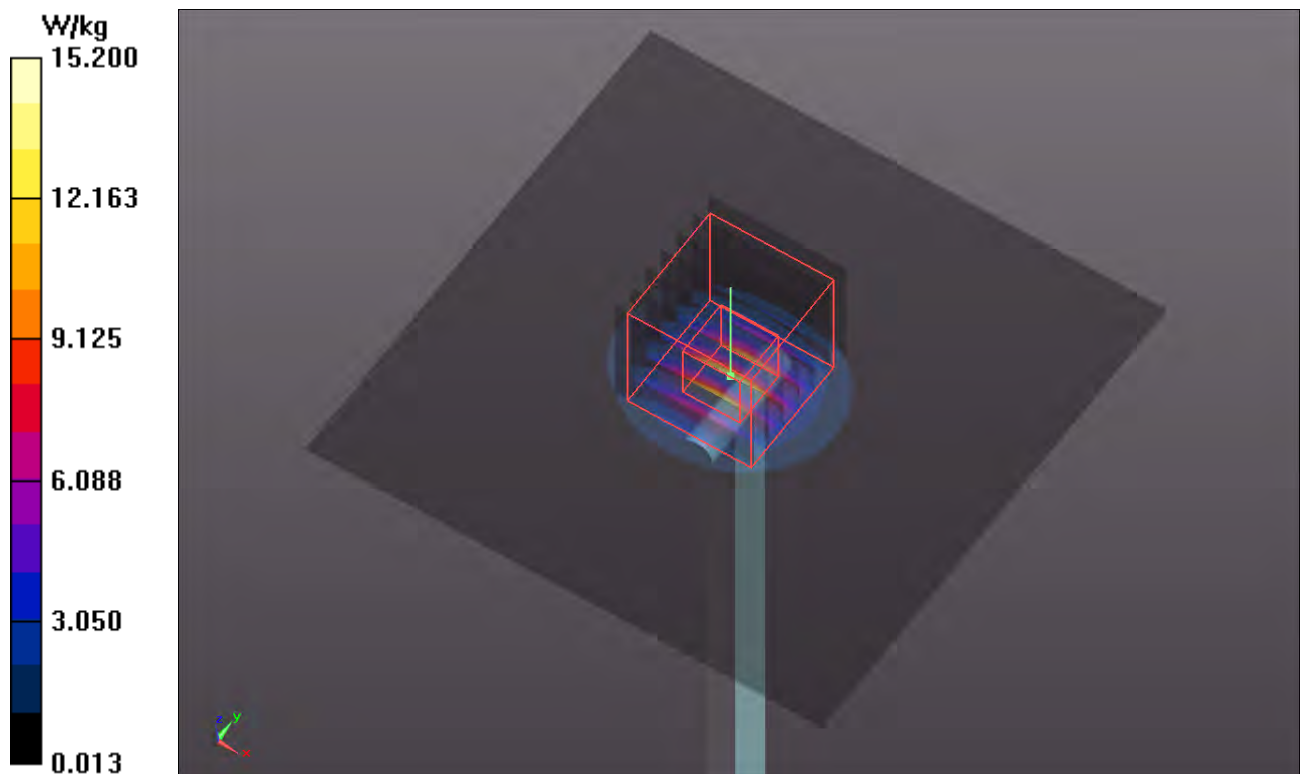
Pin=100mW/Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm

Reference Value = 56.738 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 29.4 W/kg

SAR(1 g) = 7.2 W/kg; SAR(10 g) = 2.04 W/kg

Maximum value of SAR (measured) = 15.0 W/kg



System Check_B5600_130802**DUT: Dipole 5 GHz; Type: D5GHzV2; SN: 1019**

Communication System: CW; Frequency: 5600 MHz; Duty Cycle: 1:1

Medium: B5G_0802 Medium parameters used: $f = 5600$ MHz; $\sigma = 5.9$ S/m; $\epsilon_r = 46.819$; $\rho = 1000$ kg/m³

Ambient Temperature : 21.5 °C; Liquid Temperature : 20.5 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN3650; ConvF(4, 4, 4); Calibrated: 2013/04/30;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn914; Calibrated: 2013/01/16
- Phantom: ELI v4.0_Left; Type: QDOVA001BB; Serial: TP:1039
- Measurement SW: DASY52, Version 52.8 (7); SEMCAD X Version 14.6.10 (7164)

Pin=100mW/Area Scan (91x91x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 17.6 W/kg

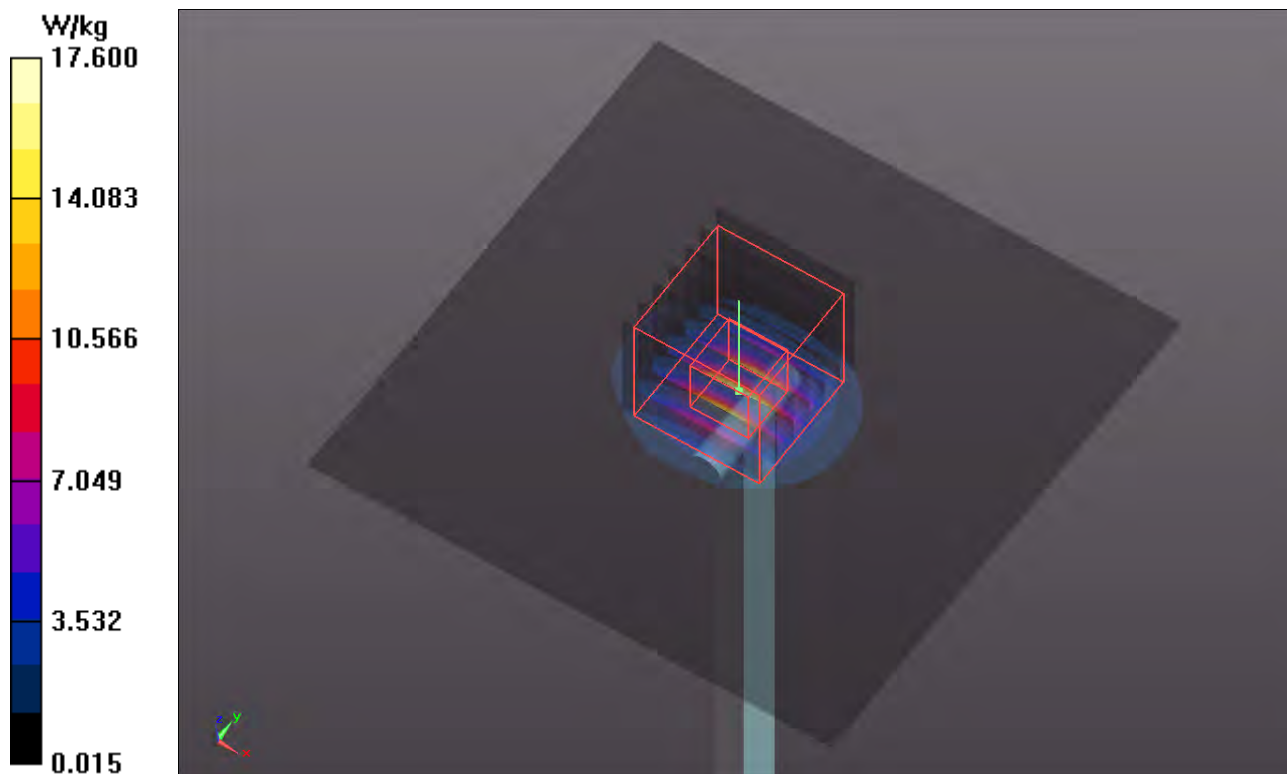
Pin=100mW/Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm

Reference Value = 58.895 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 34.1 W/kg

SAR(1 g) = 8.33 W/kg; SAR(10 g) = 2.36 W/kg

Maximum value of SAR (measured) = 17.4 W/kg



System Check_B5800_130802**DUT: Dipole 5 GHz; Type: D5GHzV2; SN: 1019**

Communication System: CW; Frequency: 5800 MHz; Duty Cycle: 1:1

Medium: B5G_0802 Medium parameters used: $f = 5800$ MHz; $\sigma = 6.178$ S/m; $\epsilon_r = 46.487$; $\rho = 1000$ kg/m³

Ambient Temperature : 21.5 °C; Liquid Temperature : 20.5 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN3650; ConvF(4.21, 4.21, 4.21); Calibrated: 2013/04/30;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn914; Calibrated: 2013/01/16
- Phantom: ELI v4.0_Left; Type: QDOVA001BB; Serial: TP:1039
- Measurement SW: DASY52, Version 52.8 (7); SEMCAD X Version 14.6.10 (7164)

Pin=100mW/Area Scan (91x91x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 15.0 W/kg

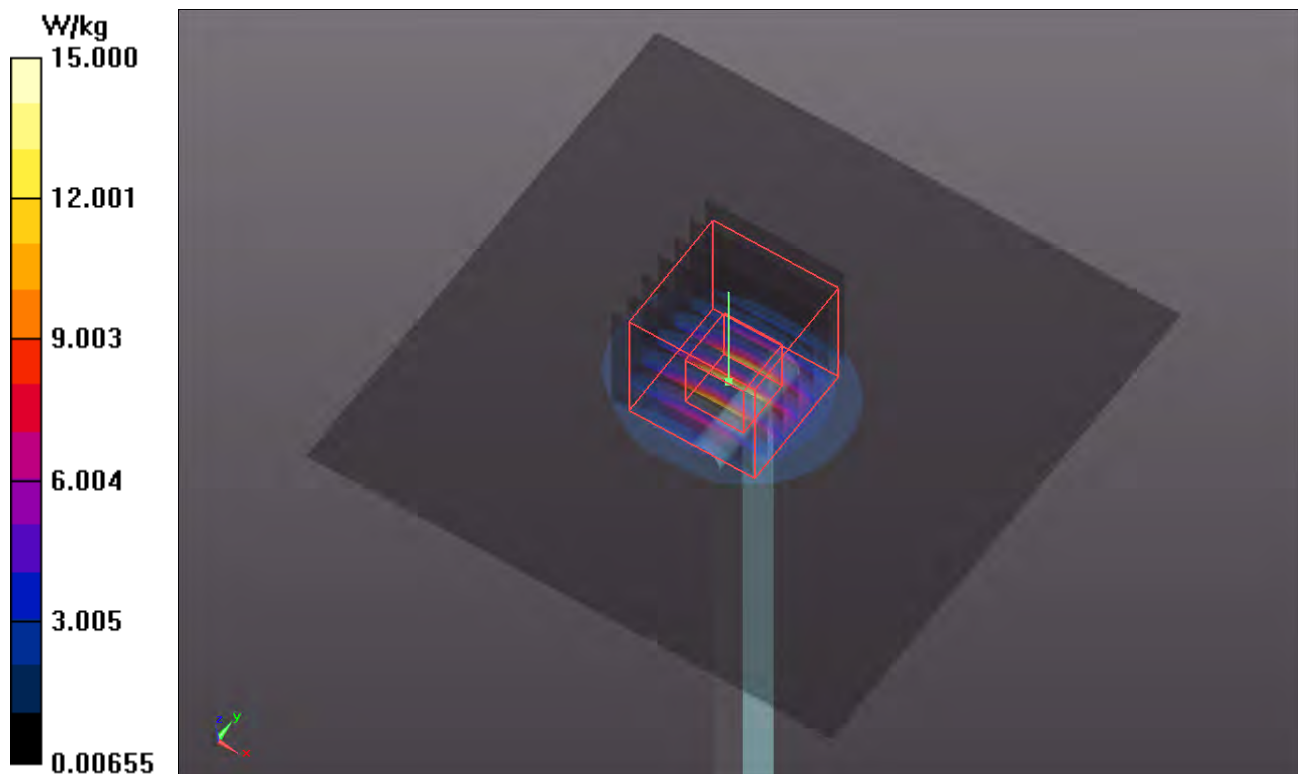
Pin=100mW/Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm

Reference Value = 54.062 V/m; Power Drift = 0.06 dB

Peak SAR (extrapolated) = 29.5 W/kg

SAR(1 g) = 7.04 W/kg; SAR(10 g) = 2 W/kg

Maximum value of SAR (measured) = 14.8 W/kg





Appendix B. SAR Plots of SAR Measurement

The SAR plots for highest measured SAR in each exposure configuration, wireless mode and frequency band combination, and measured SAR > 1.5 W/kg are shown as follows.

P01 802.11b_Top Side_8mm_Ch11_Ant 0+1**DUT: 130610E03**

Communication System: WLAN_2.4G; Frequency: 2462 MHz; Duty Cycle: 1:1

Medium: B2450_0709 Medium parameters used: $f = 2462$ MHz; $\sigma = 1.996$ S/m; $\epsilon_r = 51.281$; $\rho = 1000$ kg/m³

Ambient Temperature : 21.8 °C; Liquid Temperature : 20.5 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN3801; ConvF(6.69, 6.69, 6.69); Calibrated: 2013/06/20;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn579; Calibrated: 2013/04/24
- Phantom: SAM Phantom_Front; Type: SAM V4.0; Serial: TP 1653
- Measurement SW: DASY52, Version 52.8 (4); SEMCAD X Version 14.6.8 (7028)

- Area Scan (41x141x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm

Maximum value of SAR (interpolated) = 0.670 W/kg

- Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 4.881 V/m; Power Drift = 0.08 dB

Peak SAR (extrapolated) = 1.21 W/kg

SAR(1 g) = 0.605 W/kg; SAR(10 g) = 0.290 W/kg

Maximum value of SAR (measured) = 0.898 W/kg

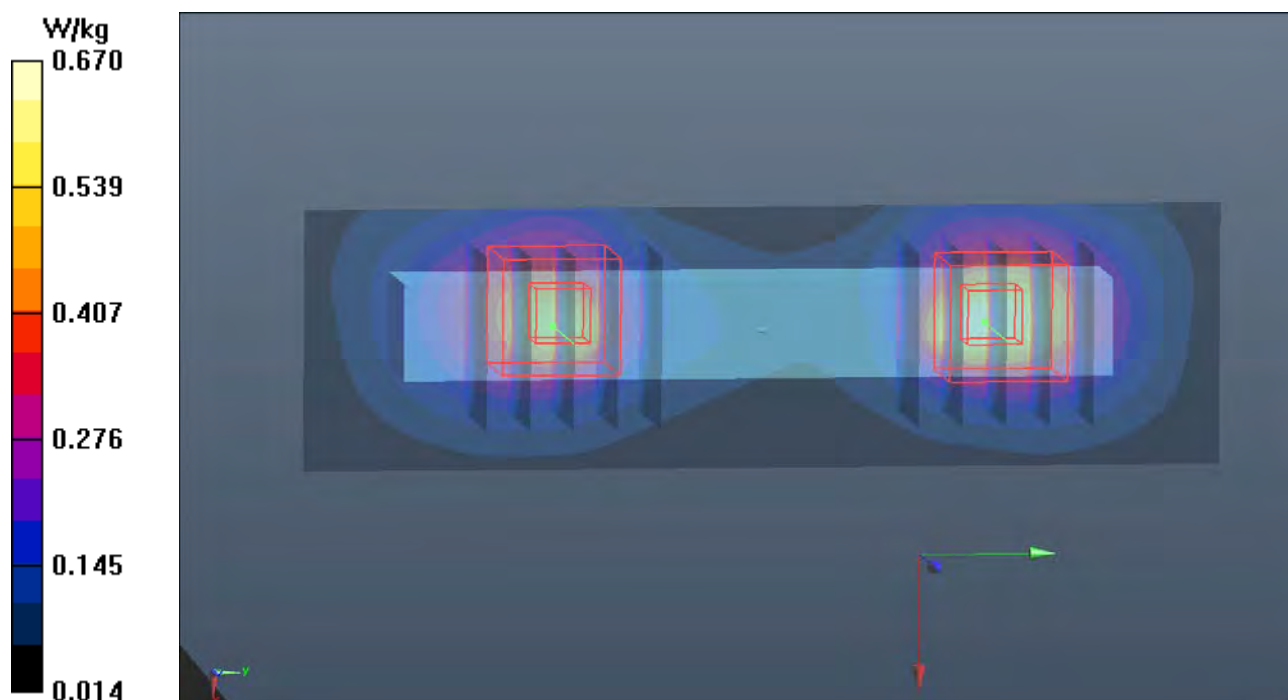
- Zoom Scan (5x5x7)/Cube 1: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 4.881 V/m; Power Drift = 0.08 dB

Peak SAR (extrapolated) = 1.02 W/kg

SAR(1 g) = 0.516 W/kg; SAR(10 g) = 0.250 W/kg

Maximum value of SAR (measured) = 0.721 W/kg



P02 802.11a_Front Face_8mm_Ch36_Ant 0+1**DUT: 130610E03**

Communication System: WLAN_5G; Frequency: 5180 MHz; Duty Cycle: 1:1

Medium: B5G_0802 Medium parameters used: $f = 5180$ MHz; $\sigma = 5.326$ S/m; $\epsilon_r = 47.673$; $\rho = 1000$ kg/m³

Ambient Temperature : 21.5 °C ; Liquid Temperature : 20.5 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN3650; ConvF(4.51, 4.51, 4.51); Calibrated: 2013/04/30;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn914; Calibrated: 2013/01/16
- Phantom: ELI v4.0_Left; Type: QDOVA001BB; Serial: TP:1039
- Measurement SW: DASY52, Version 52.8 (7); SEMCAD X Version 14.6.10 (7164)

- Area Scan (81x161x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 0.483 W/kg

- Zoom Scan (6x6x12)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=2mm

Reference Value = 0.764 V/m; Power Drift = 0.09 dB

Peak SAR (extrapolated) = 0.919 W/kg

SAR(1 g) = 0.259 W/kg; SAR(10 g) = 0.089 W/kg

Maximum value of SAR (measured) = 0.467 W/kg

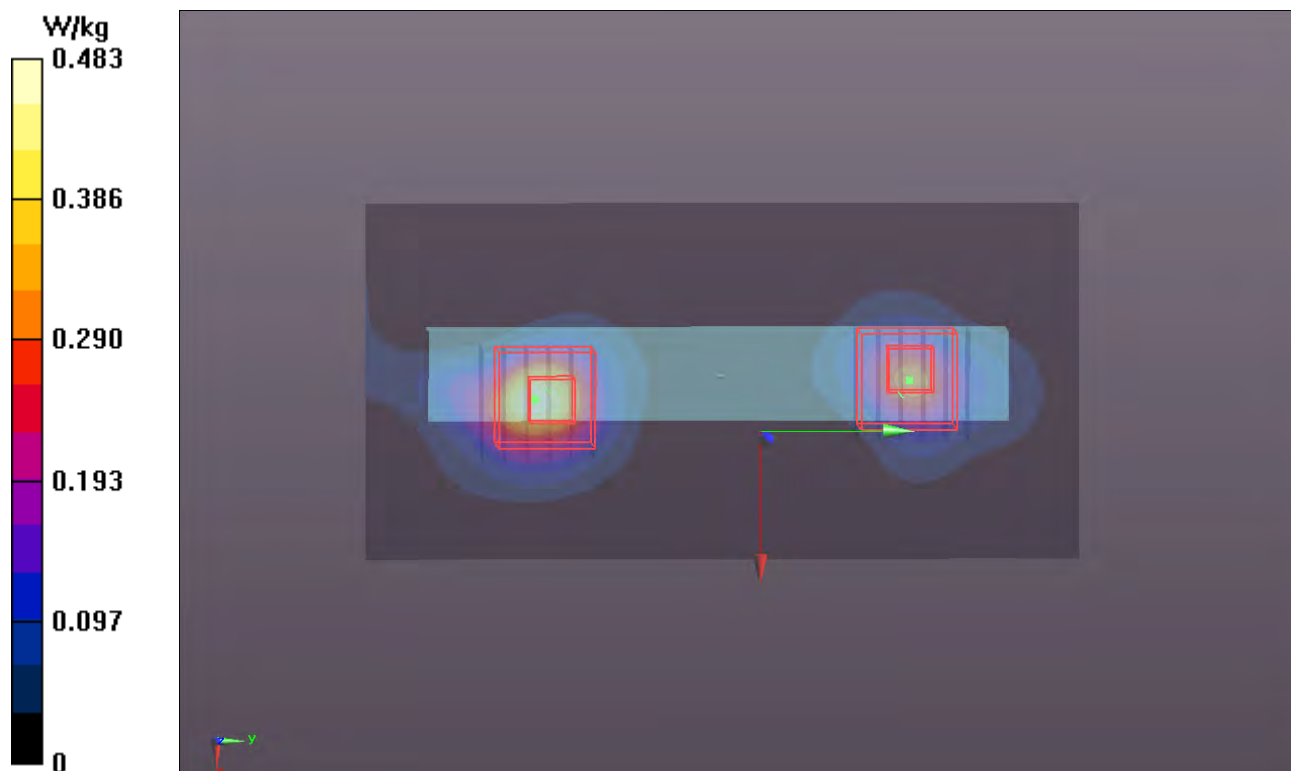
- Zoom Scan (6x6x12)/Cube 1: Measurement grid: dx=5mm, dy=5mm, dz=2mm

Reference Value = 0.764 V/m; Power Drift = 0.09 dB

Peak SAR (extrapolated) = 0.538 W/kg

SAR(1 g) = 0.167 W/kg; SAR(10 g) = 0.060 W/kg

Maximum value of SAR (measured) = 0.293 W/kg



P03 802.11a_Front Face_8mm_Ch52_Ant 0+1**DUT: 130610E03**

Communication System: WLAN_5G; Frequency: 5260 MHz; Duty Cycle: 1:1

Medium: B5G_0802 Medium parameters used: $f = 5260$ MHz; $\sigma = 5.424$ S/m; $\epsilon_r = 47.523$; $\rho = 1000$ kg/m³

Ambient Temperature : 21.5 °C ; Liquid Temperature : 20.5 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN3650; ConvF(4.31, 4.31, 4.31); Calibrated: 2013/04/30;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn914; Calibrated: 2013/01/16
- Phantom: ELI v4.0_Left; Type: QDOVA001BB; Serial: TP:1039
- Measurement SW: DASY52, Version 52.8 (7); SEMCAD X Version 14.6.10 (7164)

- Area Scan (81x161x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 0.689 W/kg

- Zoom Scan (6x6x12)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=2mm

Reference Value = 1.174 V/m; Power Drift = 0.13 dB

Peak SAR (extrapolated) = 1.28 W/kg

SAR(1 g) = 0.360 W/kg; SAR(10 g) = 0.130 W/kg

Maximum value of SAR (measured) = 0.637 W/kg

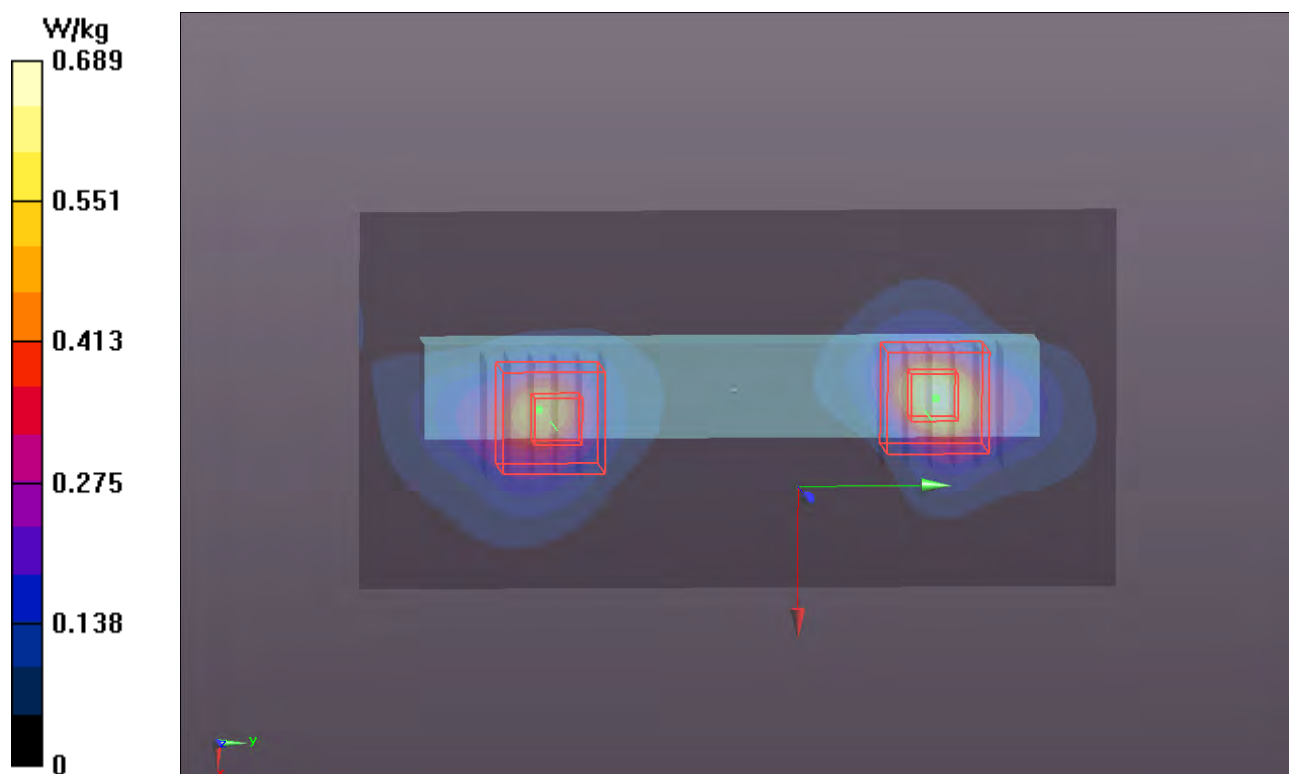
- Zoom Scan (6x6x12)/Cube 1: Measurement grid: dx=5mm, dy=5mm, dz=2mm

Reference Value = 1.174 V/m; Power Drift = 0.13 dB

Peak SAR (extrapolated) = 1.01 W/kg

SAR(1 g) = 0.286 W/kg; SAR(10 g) = 0.102 W/kg

Maximum value of SAR (measured) = 0.527 W/kg



P04 802.11a_Front Face_8mm_Ch132_Ant 0+1**DUT: 130610E03**

Communication System: WLAN_5G; Frequency: 5660 MHz; Duty Cycle: 1:1

Medium: B5G_0802 Medium parameters used: $f = 5660$ MHz; $\sigma = 5.991$ S/m; $\epsilon_r = 46.768$; $\rho = 1000$ kg/m³

Ambient Temperature : 21.5 °C; Liquid Temperature : 20.5 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN3650; ConvF(4, 4, 4); Calibrated: 2013/04/30;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn914; Calibrated: 2013/01/16
- Phantom: ELI v4.0_Left; Type: QDOVA001BB; Serial: TP:1039
- Measurement SW: DASY52, Version 52.8 (7); SEMCAD X Version 14.6.10 (7164)

- Area Scan (81x161x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 0.515 W/kg

- Zoom Scan (6x6x12)/Cube 1: Measurement grid: dx=5mm, dy=5mm, dz=2mm

Reference Value = 1.261 V/m; Power Drift = 0.17 dB

Peak SAR (extrapolated) = 1.30 W/kg

SAR(1 g) = 0.332 W/kg; SAR(10 g) = 0.121 W/kg

Maximum value of SAR (measured) = 0.612 W/kg

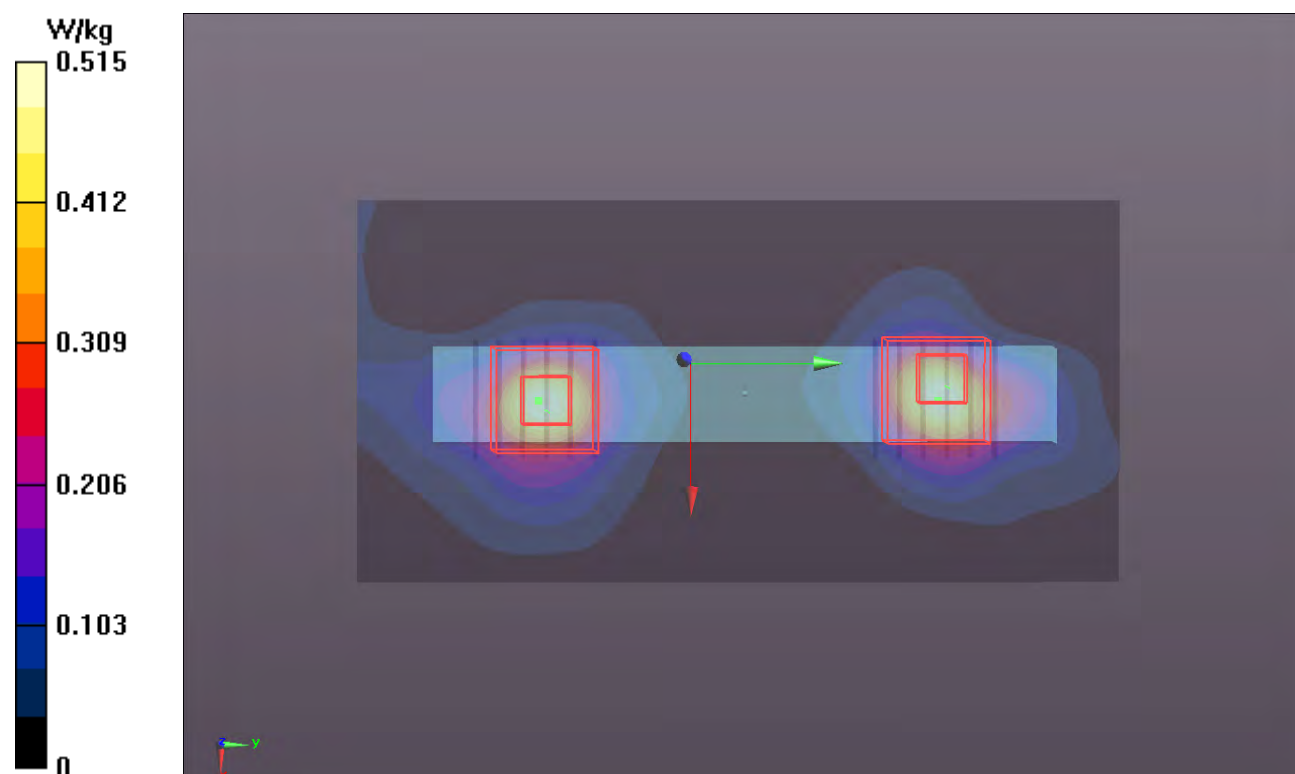
- Zoom Scan (6x6x12)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=2mm

Reference Value = 1.261 V/m; Power Drift = 0.17 dB

Peak SAR (extrapolated) = 1.17 W/kg

SAR(1 g) = 0.305 W/kg; SAR(10 g) = 0.113 W/kg

Maximum value of SAR (measured) = 0.564 W/kg



P05 802.11a_Front Face_8mm_Ch157_Ant 0+1**DUT: 130610E03**

Communication System: WLAN_5G; Frequency: 5785 MHz; Duty Cycle: 1:1

Medium: B5G_0802 Medium parameters used: $f = 5785$ MHz; $\sigma = 6.165$ S/m; $\epsilon_r = 46.544$; $\rho = 1000$ kg/m³

Ambient Temperature : 21.5 °C ; Liquid Temperature : 20.5 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN3650; ConvF(4.21, 4.21, 4.21); Calibrated: 2013/04/30;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn914; Calibrated: 2013/01/16
- Phantom: ELI v4.0_Left; Type: QDOVA001BB; Serial: TP:1039
- Measurement SW: DASY52, Version 52.8 (7); SEMCAD X Version 14.6.10 (7164)

- Area Scan (81x161x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 0.536 W/kg

- Zoom Scan (6x6x12)/Cube 1: Measurement grid: dx=5mm, dy=5mm, dz=2mm

Reference Value = 1.236 V/m; Power Drift = -0.15 dB

Peak SAR (extrapolated) = 1.15 W/kg

SAR(1 g) = 0.309 W/kg; SAR(10 g) = 0.113 W/kg

Maximum value of SAR (measured) = 0.571 W/kg

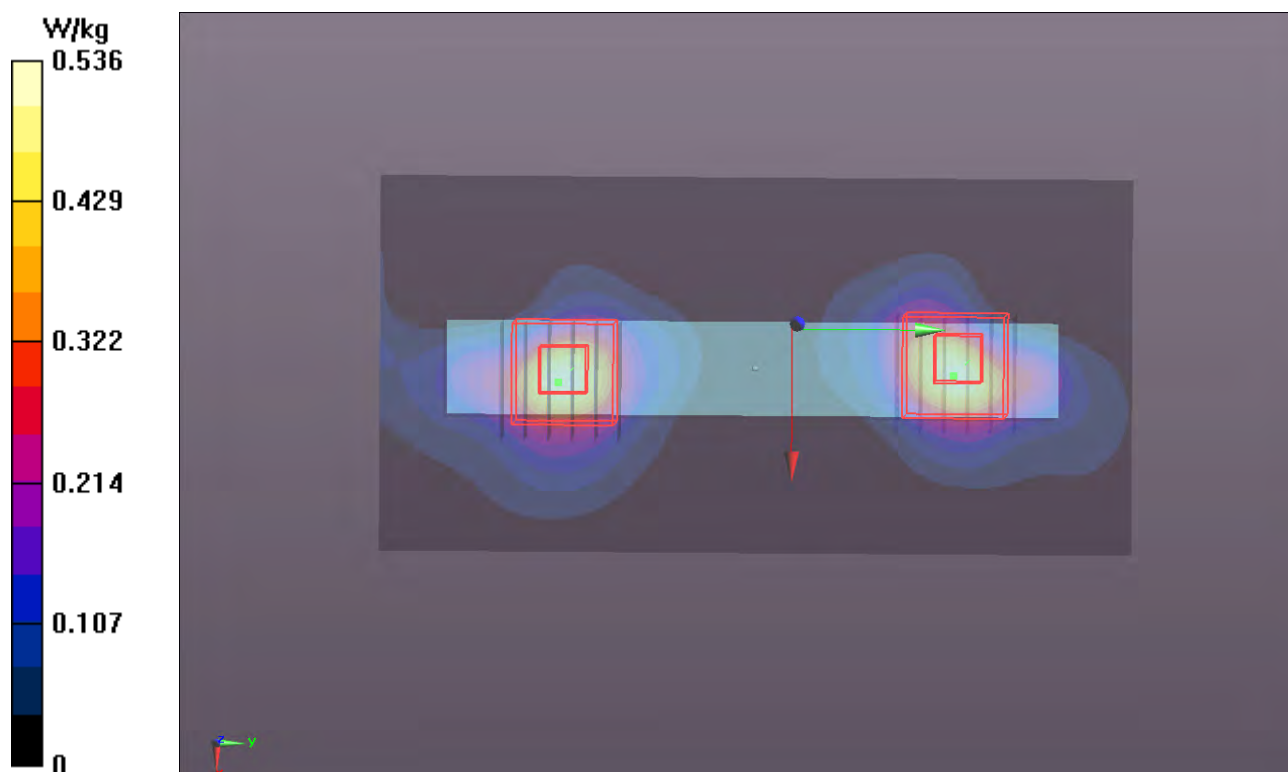
- Zoom Scan (6x6x12)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=2mm

Reference Value = 1.236 V/m; Power Drift = -0.15 dB

Peak SAR (extrapolated) = 1.06 W/kg

SAR(1 g) = 0.284 W/kg; SAR(10 g) = 0.105 W/kg

Maximum value of SAR (measured) = 0.519 W/kg





Appendix C. Calibration Certificate for Probe and Dipole

The SPEAG calibration certificates are shown as follows.



Appendix D. Photographs of EUT and Setup