



**SGS-CSTC Standards Technical Services Co., Ltd.
Shenzhen Branch**

No. 1 Workshop, M-10, Middle section, Science & Technology Park,
Shenzhen, Guangdong, China 518057

Telephone: +86 (0) 755 2601 2053
Fax: +86 (0) 755 2671 0594
Email: ee.shenzhen@sgs.com

Report No.: SZEM180200119001
Page: 1 of 66

SAR TEST REPORT

Application No.: SZEM1802001190CR
Applicant: Qualcomm Atheros, Inc.
Address of Applicant: 1700 Technology Drive, San Jose, CA 95110
Manufacturer: Qualcomm Atheros, Inc.
Address of Manufacturer: 1700 Technology Drive, San Jose, CA 95110
Equipment Under Test (EUT):
EUT Name: Single Stream 802.11a/b/g/n/ac + BT 4.1 M.2 Type Card
Brand name: Qualcomm Atheros
Model No.: QCNFA435
FCC ID: PPD-QCNFA435
IC: 4104A-QCNFA435
Standard(s) : FCC 47 CFR Part 2 (2.1093)
IEEE 1528-2013
KDB 248227
KDB 865664
KDB 447498
KDB 616217
RSS102 issue 5
Date of Receipt: January 11, 2018
Date of Test: February 2, 2018 & February 4, 2018
Date of Issue: February 5, 2018

Test Result:	Pass*
---------------------	--------------

* In the configuration tested, the EUT complied with the standards specified above.



Keny Xu
EMC Laboratory Manager

The manufacturer should ensure that all products in series production are in conformity with the product sample detailed in this report. If the product in this report is used in any configuration other than that detailed in the report, the manufacturer must ensure the new system complies with all relevant standards. Any mention of SGS International Electrical Approvals or testing done by SGS International Electrical Approvals in connection with, distribution or use of the product described in this report must be approved by SGS International Electrical Approvals in writing.

This document is issued by the Company subject to its General Conditions of Service printed overleaf, available on request or accessible at <http://www.sgs.com/en/Terms-and-Conditions.aspx> and, for electronic format documents, subject to Terms and Conditions for Electronic Documents at <http://www.sgs.com/en/Terms-and-Conditions/Terms-e-Documents.aspx>. Attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein. Any holder of this document is advised that information contained hereon reflects the Company's findings at the time of its intervention only and within the limits of Client's instructions, if any. The Company's sole responsibility is to its Client and this document does not exonerate parties to a transaction from exercising all their rights and obligations under the transaction documents. This document cannot be reproduced except in full, without prior written approval of the Company. Any unauthorized alteration, forgery or falsification of the content or appearance of this document is unlawful and offenders may be prosecuted to the fullest extent of the law. Unless otherwise stated the results shown in this test report refer only to the sample(s) tested and such sample(s) are retained for 30 days only.

<i>Revision Record</i>				
<i>Version</i>	<i>Chapter</i>	<i>Date</i>	<i>Modifier</i>	<i>Remark</i>
01		2018-02-05		Original

Authorized for issue by:			
			
		Bill Chen /Project Engineer	
			
		Eric Fu /Reviewer	

TABLE OF CONTENTS

	Page
1. EUT DESCRIPTION	4
1.1 MAXIMUM RF OUTPUT POWER WITH TEST CHANNEL	6
1.2 STATEMENT OF COMPLIANCE	7
2. REQUIREMENTS FOR COMPLIANCE TESTING DEFINED BY THE FCC OR ISED	8
3. TEST METHODOLOGY	8
4. TEST CONFIGURATION	9
5. DOSIMETRIC ASSESSMENT SETUP	10
5.1 MEASUREMENT SYSTEM DIAGRAM	11
5.2 SYSTEM COMPONENTS	12
6. EVALUATION PROCEDURES	16
7. MEASUREMENT UNCERTAINTY	21
8. EXPOSURE LIMIT	23
9. MEASUREMENT RESULTS	24
9.1 TEST LIQUIDS CONFIRMATION	24
9.2 LIQUID MEASUREMENT RESULTS	25
9.3 SYSTEM PERFORMANCE CHECK	26
9.4 EUT TUNE-UP PROCEDURES AND TEST MODE	28
9.5 STANDALONE SAR TEST EXCLUSION	36
9.6 SAR TEST CONFIGURATIONS	38
9.7 ANTENNA LOCATION	39
9.8 SAR MEASUREMENT RESULTS	41
9.9 REPEATED SAR MEASUREMENT	46
9.10 SAR TABLET/CONVERTIBLE COMPUTER MULTI XMITER ASSESSMENT	47
10. EQUIPMENT LIST & CALIBRATION STATUS	50
11. TEST LOCATION	51
12. FACILITIES	52
13. REFERENCES	52
14. LABORATORY ACCREDITATIONS AND LISTING	53-66

1. EUT DESCRIPTION

Product Name:	Single Stream 802.11a/b/g/n/ac + BT 4.1 M.2 Type Card				
Brand name:	Qualcomm Atheros				
Model Name.:	QCNFA435				
Series Model:	N/A				
FCC ID:	PPD-QCNFA435				
IC:	4104A-QCNFA435				
Power reduction:	Yes				
DTM Description:	N/A				
Device Category:	Production unit				
Exposure Category:	GENERAL POPULATION/UNCONTROLLED EXPOSURE				
Frequency Range:	WLAN 2.4GHz Band: 2412 MHz ~ 2462 MHz WLAN 5.2GHz Band: 5180 MHz ~ 5240 MHz WLAN 5.3GHz Band: 5260 MHz ~ 5320 MHz WLAN 5.5GHz Band: 5500 MHz ~ 5720 MHz WLAN 5.8GHz Band: 5745 MHz ~ 5825 MHz Bluetooth: 2402 MHz ~ 2480 MHz				
Modulation Technique:	802.11a/b/g/n HT20/HT40/VHT20/VHT40/VHT80 Bluetooth:2.1 + EDR, 8-DPSK Bluetooth:4.1				
Operating Mode:	Maximum continuous output				
Antenna Specification:	Brand	Gain(dBi)			
		2.4GHz	5GHz	2.4GHz	5GHz
		ANT1	ANT1	ANT2	ANT2
	South Star	1.35	1.78	1.64	1.67
	Part No.	64451204800040		64451204800020	
	Luxshare	-0.9	-1.3	-2.6	0.1
	Part No.	L01RF118-NB-H		L01RF117-NB-H	
	Note: ANT1 is Main Antenna; ANT2 is Aux Antenna.				



SGS-CSTC Standards Technical Services Co., Ltd. Shenzhen Branch

Report No.: SZEM180200119001

Page: 5 of 66

Tested System Details

Product	Manufacturer	Model No.
Notebook Computer	Lenovo	Model Name.: Lenovo V530s-14IKB;81EX

Note:

Model discrepancy only for market segment

1.1 MAXIMUM RF OUTPUT POWER WITH TEST CHANNEL

Band / Mode	Target Power(dBm)		
	V2.1 + EDR, GFSK	V2.1+ EDR, $\pi/4$ -DQPSK	V2.1 + EDR, 8-DPSK
Bluetooth	6	6	6

Band / Mode	Target Power(dBm)
	BLE4.1, GFSK
Bluetooth	6

Band / Mode	Channel	SISO Tune up Target Power (dBm)
802.11b	1-11	16
802.11g	1	16
	6	16
	11	13
802.11n 20MHz	1	16
	6	16
	11	12
802.11n 40MHz	3	15.5
	6	16
	9	11.5
802.11 a U-NII-1	36-48	12.5
802.11 a U-NII-2A	52-64	12.5
802.11 a U-NII-2C	100-144	12.5
802.11 a U-NII-3	149-165	13
802.11 n-HT20/ac-VHT20 U-NII-1	36-48	12
802.11 n-HT20/ac-VHT20 U-NII-2A	52-64	12
802.11 n-HT20/ac-VHT20 U-NII-2C	100-144	12
802.11 n-HT20/ac-VHT20 U-NII-3	149-165	12.5
802.11 n-HT40/ac-VHT40 U-NII-1	38	11.5
	46	12
802.11 n-HT40/ac-VHT40 U-NII-2A	54-62	12
802.11 n-HT40/ac-VHT40 U-NII-2C	102-142	12
802.11 n-HT40/ac-VHT40 U-NII-3	151-159	12.5
802.11 ac80 U-NII-1	42	12
802.11 ac80 U-NII-2A	58	11.5
802.11 ac80 U-NII-2C	106	11.5
802.11 ac80 U-NII-2C	122-138	12
802.11 ac80 U-NII-3	155	12.5

1.2 STATEMENT OF COMPLIANCE

The maximum results of Specific Absorption Rate (SAR) found during testing for **Qualcomm Atheros, Single Stream 802.11a/b/g/n/ac + BT 4.1 M.2 Type Card, QCNFA435**, are as follows.

Equipment Class	Frequency Band	Highest SAR Summary
		Body 1g SAR (W/kg)
DTS	2.4GHz WLAN	1.070
NII	5.2GHz WLAN	--
	5.3GHz WLAN	0.781
	5.5GHz WLAN	1.147
	5.8GHz WLAN	0.968
DSSS(BT)	2.4GHz	0.141
Highest Simultaneous Transmission SAR		Body 1g SAR (W/kg)
DTS+DSSS		1.035
NII+DSSS		1.072

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 C95.1-1992, and had been tested in accordance with the measurement methods and procedures specified in IEEE 1528-2013.

2. REQUIREMENTS FOR COMPLIANCE TESTING DEFINED BY THE FCC OR ISED

The US Federal Communications Commission has released the report and order "Guidelines for Evaluating the Environmental Effects of RF Radiation", ET Docket No. 93-62 in August 1996. The order requires routine SAR evaluation prior to equipment authorization of portable transmitter devices, including portable telephones.

RSS-102 issue 5: 2015: Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands).

For consumer products, the applicable limit is 1.6 W/Kg for an uncontrolled environment and 8.0 W/Kg for an occupational/controlled environment as recommended by the ANSI/IEEE standard C95.1-1992; ; RSS-102 issue 5: 2015.

3. TEST METHODOLOGY

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

- ☒ FCC 47 CFR Part 2 (2.1093)
- ☒ ANSI/IEEE C95.1-1992
- ☒ IEEE 1528-2013
- ☒ RSS-102 issue 5: 2015
- ☒ KDB 447498 D01v06 General RF Exposure Guidance
- ☒ KDB 865664 D01v01r04 Measurement 100 MHz to 6 GHz
- ☒ KDB 865664 D02 v01r02 RF Exposure Reporting
- ☒ KDB 248227 D01v02r02 802 11 Wi-Fi SAR
- ☒ KDB 616217 D04v01r02 SAR for laptop and tablets

4. TEST CONFIGURATION

During WLAN SAR testing EUT is configured with the WLAN continuous TX tool, and the transmission duty factor was monitored on the spectrum analyzer with zero-span setting

For WLAN SAR testing, WLAN engineering test software installed on the EUT can provide continuous transmitting RF signal. Duty cycle Form:

Band	Mode	Duty cycle(100%)
2.4GHz	Bluetooth	77
	802.11b	99
	802.11g	95
	802.11n 20MHz	94
	802.11n 40MHz	89
5GHz	802.11a	95
	802.11 20MHz	95
	802.11 40MHz	90
	802.11 ac80	82

5. DOSIMETRIC ASSESSMENT SETUP

These measurements were performed with the automated near-field scanning system DASY 5 from SPEAG. The system is based on a high precision robot (working range greater than 0.9 m), which positions the probes with a positional repeatability of better than ± 0.02 mm. Special E- and H-field probes have been developed for measurements close to material discontinuity, the sensors of which are directly loaded with a Schottky diode and connected via highly resistive lines to the data acquisition unit. The SAR measurements were conducted with the E-field PROBE EX3DV4 (manufactured by SPEAG), designed in the classical triangular configuration and optimized for dosimetric evaluation. The probe has been calibrated according to the procedure described in [7] with accuracy of better than $\pm 10\%$. The spherical isotropy was evaluated with the procedure described in [8] and found to be better than ± 0.25 dB. The phantom used was the SAM Twin Phantom as described in FCC supplement C, IEEE P1528 and CENELEC EN 62209.

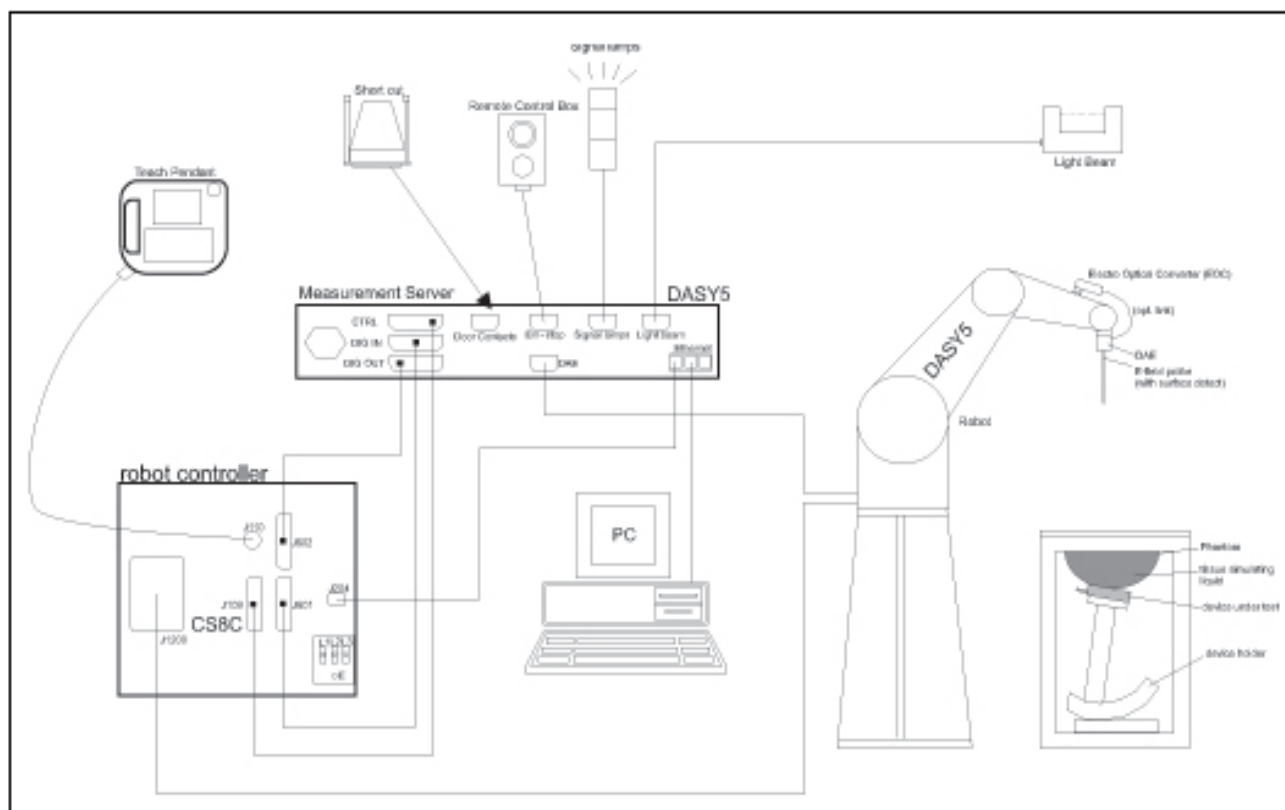
The following table gives the recipes for tissue simulating liquids.

Ingredients (% by weight)	Frequency (MHz)									
	450		835		915		1900		2450	
Tissue Type	Head	Body	Head	Body	Head	Body	Head	Body	Head	Body
Water	38.56	51.16	41.45	52.4	41.05	56.0	54.9	40.4	62.7	73.2
Salt (NaCl)	3.95	1.49	1.45	1.4	1.35	0.76	0.18	0.5	0.5	0.04
Sugar	56.32	46.78	56.0	45.0	56.5	41.76	0.0	58.0	0.0	0.0
HEC	0.98	0.52	1.0	1.0	1.0	1.21	0.0	1.0	0.0	0.0
Bactericide	0.19	0.05	0.1	0.1	0.1	0.27	0.0	0.1	0.0	0.0
Triton X-100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	36.8	0.0
DGBE	0.0	0.0	0.0	0.0	0.0	0.0	44.92	0.0	0.0	26.7
Dielectric Constant	43.42	58.0	42.54	56.1	42.0	56.8	39.9	54.0	39.8	52.5
Conductivity (S/m)	0.85	0.83	0.91	0.95	1.0	1.07	1.42	1.45	1.88	1.78

Simulating Liquids for 5 GHz, Manufactured by SPEAG

Ingredients	(% by weight)
Water	78
Mineral oil	11
Emulsifiers	9
Additives and Salt	2

5.1 MEASUREMENT SYSTEM DIAGRAM



The DASYS5 system for performing compliance tests consists of the following items:

- A standard high precision 6-axis robot (Stäubli RX family) with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- A dosimetric probe, i.e., an isotropic E-field probe optimized and calibrated for usage in tissue simulating liquid. The probe is equipped with an optical surface detector system.
- A data acquisition electronics (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
- The Electro-optical converter (EOC) performs the conversion between optical and electrical of the signals for the digital communication to the DAE and for the analog signal from the optical surface detection. The EOC is connected to the measurement server.
- The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- A probe alignment unit which improves the (absolute) accuracy of the probe positioning.
- A computer operating Windows 7.
- DASYS5 software.
- Remote control with teach pendant and additional circuitry for robot safety such as warning lamps, etc.
- The SAM twin phantom enabling testing left-hand and right-hand usage.
- The device holder for handheld mobile phones.

- Tissue simulating liquid mixed according to the given recipes.
- Validation dipole kits allowing validating the proper functioning of the system.

5.2 SYSTEM COMPONENTS

	The DASY5 measurement server is based on a PC/104 CPU board with a 400MHz intel ULV celeron, 128MB chip-disk and 128 MB RAM. The necessary circuits for communication with either the DAE4(or DAE3) electronic box as well as the 16-bit AD-converter system for optical detection and digital I/O interface are contained on the DASY5 I/O-board, which is directly connected to the PC/104 bus of the CPU board. The measurement server performs all real-time data evaluation for field measurements and surface detection, controls robot movements and handles safety operation.
	The PC-operating system cannot interfere with these time critical processes. All connections are supervised by a watchdog, and disconnection of any of the cables to the measurement server will automatically disarm the robot and disable all program-controlled robot movements. Furthermore, the measurement server is equipped with two expansion slots which are reserved for future applications. Please note that the expansion slots do not have a standardized pinout and therefore only the expansion cards provided by SPEAG can be inserted. Expansion cards from any other supplier could seriously damage the measurement server. Calibration: No calibration required.
Data Acquisition Electronics (DAE)	
	The data acquisition electronics (DAE4) consists of a highly sensitive electrometer grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD converter and a command decoder and control logic unit. Transmission to the measurement server is accomplished through an optical downlink for data and status information as well as an optical uplink for commands and the clock. The mechanical probe mounting device includes two different sensor systems for frontal and sideways probe contacts. They are used for mechanical surface detection and probe collision detection. The input impedance of the DAE4 box is 200MOhm; the inputs are symmetrical and floating. Common mode rejection is above 80 dB.

EX3DV4 Isotropic E-Field Probe for Dosimetric Measurements



Construction: Symmetrical design with triangular core
Built-in shielding against static charges
PEEK enclosure material (resistant to organic solvents, e.g., DGBE)

Calibration: Basic Broad Band Calibration in air: 10-3000 MHz.
Conversion Factors (CF) for HSL 900 and HSL 1800 CF-
Calibration for other liquids and frequencies upon request.

Frequency: 10 MHz to > 6 GHz; Linearity: ± 0.2 dB (30 MHz to 3 GHz)

Directivity: ± 0.3 dB in HSL (rotation around probe axis)
 ± 0.5 dB in HSL (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: 9 mm)
Tip diameter: 2.5 mm (Body: 10 mm)
Distance from probe tip to dipole centers: 1 mm

Application: High precision dosimetric measurements in any exposure scenario (e.g., very strong gradient fields). Only probe which enables compliance testing for frequencies up to 6 GHz with precision of better 30%.



Interior of probe

SAM Twin Phantom

Construction:

The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (SAM) phantom defined in IEEE 1528-200X, CENELEC 50360 and IEC 62209. 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 manually teaching three points with the robot.

Shell Thickness: 2 $\pm$ 0.2 mm

Filling Volume: Approx. 25 liters

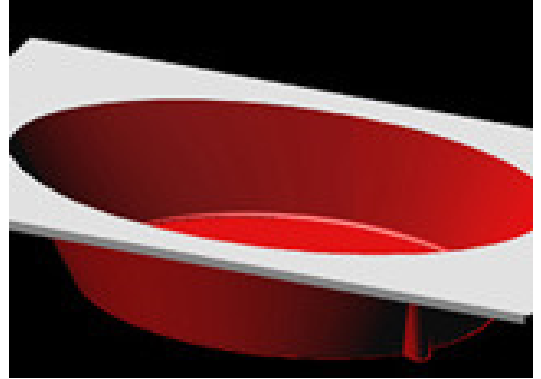
Dimensions: Height: 850mm; Length: 1000mm; Width: 750mm



SAM Phantom (ELI4 v4.0)

Description Construction:

Phantom for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30 MHz to 6 GHz. ELI4 is fully compatible with the latest draft of the standard IEC 62209 Part II and all known tissue simulating liquids. ELI4 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 supported by software version DASY4/DASY5.5 and higher and is compatible with all SPEAG dosimetric probes and dipoles



Shell Thickness: 2.0 ± 0.2 mm (sagging: <1%)

Filling Volume: Approx. 25 liters

Dimensions: Major ellipse axis: 600 mm

Minor axis: 400 mm 500mm

Device Holder for SAM Twin Phantom

Construction: In combination with the Twin SAM Phantom, the Mounting Device (made from POM) enables the rotation of the mounted transmitter in spherical coordinates, whereby the rotation point is the ear opening. The devices can be easily and accurately positioned according to IEC, IEEE, CENELEC, FCC or other specifications. The device holder can be locked at different phantom locations (left head, right head, and flat phantom).



System Validation Kits for SAM Twin Phantom

Construction: Symmetrical dipole with 1/4 balun Enables measurement of feedpoint impedance with NWA Matched for use near flat phantoms filled with brain simulating solutions Includes distance holder and tripod adaptor.

Frequency: 900,1800,2450,5800 MHz

ReTune loss: > 20 dB at specified validation position

Power capability: > 100 W (f < 1GHz); > 40 W (f > 1GHz)

Dimensions:

D835V2: dipole length: 161 mm; overall height: 340 mm

D1800V2: dipole length: 72.5 mm; overall height: 300 mm

D1900V2: dipole length: 67.7 mm; overall height: 300 mm

D2450V2: dipole length: 51.5 mm; overall height: 290 mm



D5GHzV2: dipole length: 20.6 mm; overall height: 300mm	
System Validation Kits for ELI4 phantom	
Construction: Symmetrical dipole with 1/4 balun Enables measurement of feedpoint impedance with NWA Matched for use near flat phantoms filled with brain simulating solutions Includes distance holder and tripod adaptor. Frequency: 900, 1800, 2450, 5800 MHz ReTune loss: > 20 dB at specified validation position Power capability: > 100 W (f < 1GHz); > 40 W (f > 1GHz)	
Dimensions: D835V2: dipole length: 161 mm; overall height: 340 mm D1800V2: dipole length: 72.5 mm; overall height: 300 mm D1900V2: dipole length: 67.7 mm; overall height: 300 mm D2450V2: dipole length: 51.5 mm; overall height: 290 mm D5GHzV2: dipole length: 20.6 mm; overall height: 300 mm	

6. EVALUATION PROCEDURES

DATA EVALUATION

The DASY 5 post processing 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	$Norm_i, a_{i0}, a_{i1}, a_{i2}$
	- Conversion factor	$ConvF_i$
	- Diode compression point	dcp_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 be imported into the software from the configuration files issued for the DASY 5 components. In the direct measuring mode of the multi-meter 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:

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

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 (DASY 5 parameter)
	dcp_i	= Diode compression point (DASY 5 parameter)

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

E-field probes:

$$E_i = \sqrt{\frac{V_i}{Norm_i \cdot ConvF}}$$

H-field probes:

$$H_i = \sqrt{V_i} \cdot \frac{a_{i0} + a_{i1}f + a_{i2}f^2}{f}$$

with V_i = Compensated signal of channel i (i = x, y, z)
 $Norm_i$ = Sensor sensitivity of channel i (i = x, y, z)
 $\mu V/(V/m)^2$ for E0field 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.

$$SAR = E_{tot}^2 \cdot \frac{\sigma}{\rho \cdot 1000}$$

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.

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

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

with 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

SAR EVALUATION PROCEDURES

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 doing a finer measurement around the hot spot. The sophisticated interpolation routines implemented in DASY 5 software can find the maximum locations even in relatively coarse grids. The scan area is defined by an editable grid. This grid is anchored at the grid reference point of the selected section in the phantom. When the area scan's property sheet is brought-up, grid was at to 15 mm by 15 mm and can be edited by a user.

- **Zoom Scan**

Zoom scans are used to assess the peak spatial SAR values within a cubic averaging volume containing 1 g and 10 g of simulated tissue. The default zoom scan measures 5 x 5 x 7 points within a cube whose base faces are centered around the maximum found in a preceding area scan job within the same procedure. If the preceding Area Scan job indicates more than one maximum, the number of Zoom Scans has to be enlarged accordingly (The default number inserted is 1).

- **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 DASY 5 software stop the measurements if this limit is exceeded.

- **Z-Scan**

The Z Scan job measures points along a vertical straight line. The line runs along the Z-axis of a one-dimensional grid. A user can anchor the grid to the current probe location. As with any other grids, the local Z-axis of the anchor location establishes the Z-axis of the grid.

SPATIAL PEAK SAR EVALUATION

The procedure for spatial peak SAR evaluation has been implemented according to the IEEE1529 standard. It can be conducted for 1 g and 10 g.

The DASY 5 system allows evaluations that combine measured data and robot positions, such as:

- maximum search
- extrapolation
- boundary correction
- peak search for averaged SAR

During a maximum search, global and local maximum searches are automatically performed in 2-D after each Area Scan measurement with at least 6 measurement points. It is based on the evaluation of the local SAR gradient calculated by the Quadratic Shepard's method. The algorithm will find the global maximum and all local maxima within -2 dB of the global maxima for all SAR distributions.

Extrapolation

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. Several measurements at different distances are necessary for the extrapolation.

Extrapolation routines require at least 10 measurement points in 3-D space. They are used in the Cube Scan to obtain SAR values between the lowest measurement points and the inner phantom surface. The routine uses the modified Quadratic Shepard's method for extrapolation. For a grid using 5x5x7 measurement points with 5mm resolution amounting to 343 measurement points, the uncertainty of the extrapolation routines is less than 1% for 1 g and 10 g cubes.

Boundary effect

For measurements in the immediate vicinity of a phantom surface, the field coupling effects between the probe and the boundary influence the probe characteristics. Boundary effect errors of different dosimetric probe types have been analyzed by measurements and using a numerical probe model. As expected, both methods showed an enhanced sensitivity in the immediate vicinity of the boundary. The effect strongly depends on the probe dimensions and disappears with increasing distance from the boundary. The sensitivity can be approximately given as:

$$S \approx S_o + S_b \exp\left(-\frac{z}{a}\right) \cos\left(\pi \frac{z}{\lambda}\right)$$

Since the decay of the boundary effect dominates for small probes ($a \ll \lambda$), the cos-term can be omitted. Factors S_b (parameter Alpha in the DASY 5 software) and a (parameter Delta in the DASY 5 software) are assessed during probe calibration and used for numerical compensation of the

boundary effect. Several simulations and measurements have confirmed that the compensation is valid for different field and boundary configurations.

This simple compensation procedure can largely reduce the probe uncertainty near boundaries. It works well as long as:

- the boundary curvature is small
- the probe axis is angled less than 30° to the boundary normal
- the distance between probe and boundary is larger than 25% of the probe diameter
- the probe is symmetric (all sensors have the same offset from the probe tip)

Since all of these requirements are fulfilled in a DASY 5 system, the correction of the probe boundary effect in the vicinity of the phantom surface is performed in a fully automated manner via the measurement data extraction during post processing.

7. MEASUREMENT UNCERTAINTY

Measurement uncertainty for 30 MHz to 3 GHz averaged over 1 gram						
Uncertainty Component	Uncertainty	Prob.	Div.	$C_i(1g)$	Std. Unc. (1-g)	V_i or V_{eff}
Measurement System						
Probe Calibration ($k=1$)	5.50	Normal	1	1	5.50	∞
Probe Isotropy	4.70	Rectangular	$\sqrt{3}$	0.7	1.90	∞
Modulation Response	2.40	Rectangular	$\sqrt{3}$	1	1.39	∞
Hemispherical Isotropy	9.60	Rectangular	$\sqrt{3}$	0.7	3.88	∞
Boundary Effect	1.00	Rectangular	$\sqrt{3}$	1	0.58	∞
Linearity	4.70	Rectangular	$\sqrt{3}$	1	2.71	∞
System Detection Limit	1.00	Rectangular	$\sqrt{3}$	1	0.58	∞
Readout Electronics	0.30	Normal	1	1	0.30	∞
Response Time	0.80	Rectangular	$\sqrt{3}$	1	0.46	∞
Integration Time	2.60	Rectangular	$\sqrt{3}$	1	1.50	∞
RF Ambient Noise	3.00	Rectangular	$\sqrt{3}$	1	1.73	∞
RF Ambient Reflections	3.00	Rectangular	$\sqrt{3}$	1	1.73	∞
Probe Positioner	0.40	Rectangular	$\sqrt{3}$	1	0.23	∞
Probe Positioning	2.90	Rectangular	$\sqrt{3}$	1	1.67	∞
Max. SAR Evaluation	2.00	Rectangular	$\sqrt{3}$	1	1.15	∞
Test sample Related						
Test sample Positioning	2.9	Normal	1	1	2.9	145
Device Holder Uncertainty	3.6	Normal	1	1	3.6	5
Power drift	5	Rectangular	$\sqrt{3}$	1	2.89	∞
Power Scaling	0	Rectangular	$\sqrt{3}$	1	0.00	∞
Phantom and Tissue Parameters						
Phantom Uncertainty	6.1	Rectangular	$\sqrt{3}$	1	3.52	∞
SAR correction	1.9	Rectangular	$\sqrt{3}$	1	1.10	∞
Liquid Conductivity (target)	5	Rectangular	$\sqrt{3}$	0.64	1.85	∞
Liquid Conductivity (meas)	-2.92	Rectangular	$\sqrt{3}$	0.78	-1.31	∞
Liquid Permittivity (target)	5	Rectangular	$\sqrt{3}$	0.6	1.73	∞
Liquid Permittivity (meas)	-0.61	Rectangular	$\sqrt{3}$	0.26	-0.09	∞
Temp. unc. - Conductivity	3.4	Rectangular	$\sqrt{3}$	0.78	1.53	∞
Temp. unc. - Permittivity	0.4	Rectangular	$\sqrt{3}$	0.23	0.05	∞
Combined Std. Uncertainty		RSS			11.20	361
Expanded STD Uncertainty		$k=2$			22. 40%	

Measurement uncertainty for 3 GHz to 6 GHz averaged over 1 gram						
Uncertainty Component	Uncertainty	Prob.	Div.	$C_i(1g)$	Std. Unc. (1-g)	V_i or V_{eff}
Measurement System						
Probe Calibration ($k=1$)	6.55	Normal	1	1	6.55	∞
Probe Isotropy	4.70	Rectangular	$\sqrt{3}$	0.7	1.90	∞
Modulation Response	2.40	Rectangular	$\sqrt{3}$	1	1.39	∞
Hemispherical Isotropy	9.60	Rectangular	$\sqrt{3}$	0.7	3.88	∞
Boundary Effect	2.00	Rectangular	$\sqrt{3}$	1	1.15	∞
Linearity	4.70	Rectangular	$\sqrt{3}$	1	2.71	∞
System Detection Limit	1.00	Rectangular	$\sqrt{3}$	1	0.58	∞
Readout Electronics	0.30	Normal	1	1	0.30	∞
Response Time	0.80	Rectangular	$\sqrt{3}$	1	0.46	∞
Integration Time	2.60	Rectangular	$\sqrt{3}$	1	1.50	∞
RF Ambient Noise	3.00	Rectangular	$\sqrt{3}$	1	1.73	∞
RF Ambient Reflections	3.00	Rectangular	$\sqrt{3}$	1	1.73	∞
Probe Positioner	0.80	Rectangular	$\sqrt{3}$	1	0.46	∞
Probe Positioning	6.70	Rectangular	$\sqrt{3}$	1	3.87	∞
Max. SAR Evaluation	4.00	Rectangular	$\sqrt{3}$	1	2.31	∞
Test sample Related						
Test sample Positioning	2.9	Normal	1	1	2.9	145
Device Holder Uncertainty	3.6	Normal	1	1	3.6	5
Power drift	5	Rectangular	$\sqrt{3}$	1	2.89	∞
Power Scaling	0	Rectangular	$\sqrt{3}$	1	0.00	∞
Phantom and Tissue Parameters						
Phantom Uncertainty	4	Rectangular	$\sqrt{3}$	1	2.31	∞
SAR correction	1.9	Rectangular	$\sqrt{3}$	1	1.10	∞
Liquid Conductivity (target)	5	Rectangular	$\sqrt{3}$	0.64	1.85	∞
Liquid Conductivity (meas)	-3.19	Rectangular	$\sqrt{3}$	0.78	-1.44	∞
Liquid Permittivity (target)	5	Rectangular	$\sqrt{3}$	0.6	1.73	∞
Liquid Permittivity (meas)	-1.68	Rectangular	$\sqrt{3}$	0.26	-0.25	∞
Temp. unc. - Conductivity	3.4	Rectangular	$\sqrt{3}$	0.78	1.53	∞
Temp. unc. - Permittivity	0.4	Rectangular	$\sqrt{3}$	0.23	0.05	∞
Combined Std. Uncertainty		RSS			12.19	748
Expanded STD Uncertainty		$k=2$			24. 39%	
Expanded STD Uncertainty		$k=2$			1. 90dB	

8. EXPOSURE LIMIT

(A). Limits for Occupational/Controlled Exposure (W/kg)

Whole-Body	Partial-Body	Hands, Wrists, Feet and Ankles
0.4	8.0	20.0

(B). Limits for General Population/Uncontrolled Exposure (W/kg)

Whole-Body	Partial-Body	Hands, Wrists, Feet and Ankles
0.08	1.6	4.0

Note: Whole-Body SAR is averaged over the entire body, **partial-body SAR** is averaged over any 1 gram of tissue defined as a tissue volume in the shape of a cube. **SAR for hands, wrists, feet and ankles** is averaged over any 10 grams of tissue defined as a tissue volume in the shape of a cube.

Population/Uncontrolled Environments are defined as locations where there is the exposure of individuals 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).

NOTE GENERAL POPULATION/UNCONTROLLED EXPOSURE PARTIAL BODY LIMIT 1.6 W/kg

9. MEASUREMENT RESULTS

9.1 TEST LIQUIDS CONFIRMATION

SIMULATED TISSUE LIQUID PARAMETER CONFIRMATION

The dielectric parameters were checked prior to assessment using the SPEAG DAK3.5 dielectric probe kit. The dielectric parameters measured are reported in each correspondent section.

IEEE SCC-34/SC-2 P1528 RECOMMENDED TISSUE DIELECTRIC PARAMETERS

The head tissue dielectric parameters recommended by the IEEE SCC-34/SC-2 in 1528 have been incorporated in the following table. These head parameters are derived from planar layer models simulating the highest expected SAR for the dielectric properties and tissue thickness variations in a human head. Other head and body tissue parameters that have not been specified in 1528 are derived from the tissue dielectric parameters computed from the 4-Cole-Cole equations and extrapolated according to the head parameters specified in 1528

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

(ϵ_r = relative permittivity, σ = conductivity and $\rho = 1000 \text{ kg/m}^3$)

9.2 LIQUID MEASUREMENT RESULTS

The following table show the measuring results for simulating liquid:

Liquid Type	Liquid Temp. (°C)	Parameters	Target	Measured	Deviation (%)	Limited (%)	Measured Date
Body2402	21.5	Permittivity(ϵ)	52.76	52.76	0.00	± 5	2018-2-2
		Conductivity(σ)	1.89	1.88	-0.43	± 5	
Body2412	21.5	Permittivity(ϵ)	52.75	52.70	-0.09	± 5	2018-2-2
		Conductivity(σ)	1.90	1.89	-0.83	± 5	
Body2437	21.5	Permittivity(ϵ)	52.72	52.56	-0.29	± 5	2018-2-2
		Conductivity(σ)	1.93	1.91	-1.44	± 5	
Body2441	21.5	Permittivity(ϵ)	52.71	52.55	-0.30	± 5	2018-2-2
		Conductivity(σ)	1.94	1.90	-1.82	± 5	
Body2462	21.5	Permittivity(ϵ)	52.68	52.41	-0.53	± 5	2018-2-2
		Conductivity(σ)	1.97	1.91	-2.80	± 5	
Body2480	21.5	Permittivity(ϵ)	52.66	52.34	-0.61	± 5	2018-2-2
		Conductivity(σ)	1.99	1.93	-2.92	± 5	
Body5260	21.5	Permittivity(ϵ)	48.95	48.26	-1.41	± 5	2018-2-4
		Conductivity(σ)	5.42	5.27	-2.87	± 5	
Body5280	21.5	Permittivity(ϵ)	48.92	48.39	-1.09	± 5	2018-2-4
		Conductivity(σ)	5.44	5.34	-1.85	± 5	
Body5300	21.5	Permittivity(ϵ)	48.90	48.49	-0.84	± 5	2018-2-4
		Conductivity(σ)	5.46	5.39	-1.42	± 5	
Body5320	21.5	Permittivity(ϵ)	48.87	48.42	-0.92	± 5	2018-2-4
		Conductivity(σ)	5.49	5.40	-1.56	± 5	
Body5500	21.5	Permittivity(ϵ)	48.62	48.29	-0.67	± 5	2018-2-4
		Conductivity(σ)	5.68	5.50	-3.19	± 5	
Body5560	21.5	Permittivity(ϵ)	48.54	47.77	-1.58	± 5	2018-2-4
		Conductivity(σ)	5.75	5.78	0.50	± 5	
Body5640	21.5	Permittivity(ϵ)	48.42	47.72	-1.44	± 5	2018-2-4
		Conductivity(σ)	5.83	5.66	-2.98	± 5	
Body5720	21.5	Permittivity(ϵ)	48.31	47.81	-1.04	± 5	2018-2-4
		Conductivity(σ)	5.92	5.86	-0.98	± 5	
Body5745	21.5	Permittivity(ϵ)	48.28	47.46	-1.68	± 5	2018-2-4
		Conductivity(σ)	5.94	5.76	-3.14	± 5	
Body5785	21.5	Permittivity(ϵ)	48.22	47.55	-1.39	± 5	2018-2-4
		Conductivity(σ)	5.98	6.06	1.26	± 5	
Body5825	21.5	Permittivity(ϵ)	47.99	48.05	0.14	± 5	2018-2-4
		Conductivity(σ)	6.03	6.01	-0.35	± 5	

Note: 1. Since the maximum deviation of dielectric properties of the tissue simulating liquid is within 5%, SAR correction is evaluated in the measurement uncertainty shown on section 8 of this report.

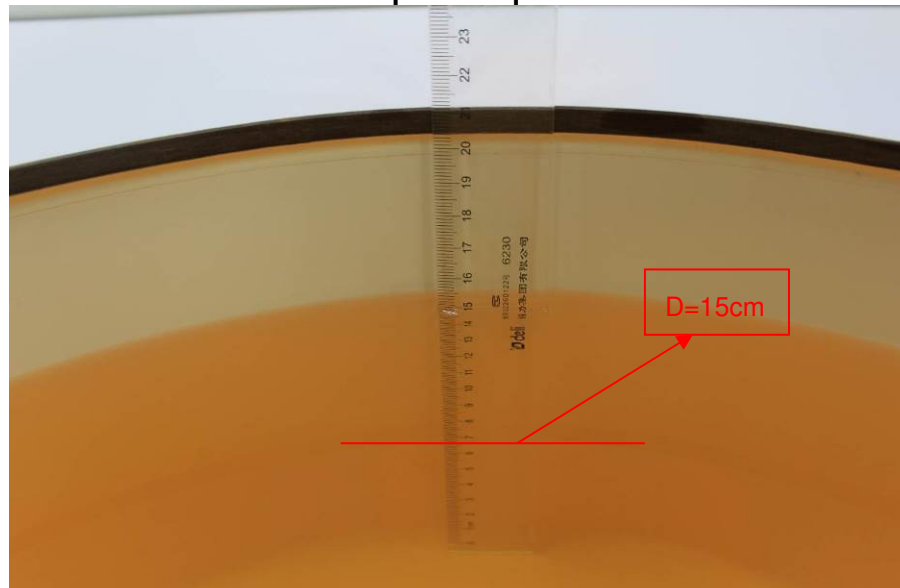
9.3 SYSTEM PERFORMANCE CHECK

The system performance check is performed prior to any usage of the system in order to guarantee reproducible results. The system performance check verifies that the system operates within its specifications of $\pm 10\%$. The system performance check results are tabulated below. And also the corresponding SAR plot is attached as well in the SAR plots files.

SYSTEM PERFORMANCE CHECK MEASUREMENT CONDITIONS

- The measurements were performed in the flat section of the SAM twin phantom filled with head and body simulating liquid of the following parameters.
- The DASY5 system with an E-field probe EX3DV4 SN: 3798 was used for the measurements.
- The dipole was mounted on the small tripod so that the dipole feed point was positioned below the center marking of the flat phantom section and the dipole was oriented parallel to the body axis (the long side of the phantom). The standard measuring distance was 15 mm from dipole center to the simulating liquid surface.
- The coarse grid with a grid spacing of 10mm was aligned with the dipole.
- Special 7x7x7 fine cube was chosen for cube integration ($dx = 5\text{ mm}$, $dy = 5\text{ mm}$, $dz = 5\text{ mm}$).
- Distance between probe sensors and phantom surface was set to 2 mm.
- The dipole less than 3G input power was $250\text{ mW} \pm 3\%$.
- The dipole above than 3G input power was $100\text{ mW} \pm 3\%$.
- The results are normalized to 1 W input power.

Depth of Liquid



- Note: For SAR testing, the liquid depth is 15cm shown above

SYSTEM PERFORMANCE CHECK RESULTS

SGS-CSTC Standards Technical Services Co., Ltd. Shenzhen Branch

Report No.: SZEM180200119001

Page: 27 of 66

Liquid Type	Ambient Temp. (°C)	Liquid Temp. (°C)	Input Power (W)	Measured SAR _{1g} (W/Kg)	1W Target SAR _{1g} (W/Kg)	1W Normalized SAR _{1g} (W/Kg)	Deviation (%)	Limited (%)	Date
Body2450	22	21.5	0.25	12.90	51.50	51.60	0.19	± 10	2018/2/2
Body5200	22	21.5	0.1	7.60	74.50	76	2.01	± 10	2018/2/4
Body5300	22	21.5	0.1	7.64	77.20	76.4	-1.04	± 10	2018/2/4
Body5500	22	21.5	0.1	7.94	81.10	79.4	-2.10	± 10	2018/2/4
Body5600	22	21.5	0.1	7.77	79.80	77.7	-2.63	± 10	2018/2/4
Body5800	22	21.5	0.1	7.71	77.20	77.1	-0.13	± 10	2018/2/4

9.4 EUT TUNE-UP PROCEDURES AND TEST MODE

Conducted output power(dBm):

General Note:

- 1 Power must be measured at each transmit antenna port according to the DSSS and OFDM transmission configurations in each standalone and aggregated frequency band.
- 2 Power measurement is required for the transmission mode configuration with the highest maximum output power specified for production units.
 - 1) When the same highest maximum output power specification applies to multiple transmission modes, the largest channel bandwidth configuration with the lowest order modulation and lowest data rate is measured.
 - 2) When the same highest maximum output power is specified for multiple largest channel bandwidth configurations with the same lowest order modulation or lowest order modulation and lowest data rate, power measurement is required for all equivalent 802.11 configurations with the same maximum output power.
- 3 For each transmission mode configuration, power must be measured for the highest and lowest channels; and at the mid-band channel(s) when there are at least 3 channels. For configurations with multiple mid-band channels, due to an even number of channels, both channels should be measured.
- 4 Apply the default power measurement procedures to measure maximum output power for each standalone and aggregated frequency band.
 - a) When band gap channels between U-NII-2C band and U-NII-3 band or §15.247 5.8 GHz band are supported and the bands are aggregated for SAR testing according to KDB 248227D01 sections 2.3 and 3.3, apply the following to determine high, middle and low channels for power measurement and SAR test reduction.
 - i) channels in U-NII-2C band below 5.65 GHz are considered as one band
 - ii) channels above 5.65 GHz, together with channels in 5.8 GHz U-NII-3 or §15.247 band, are considered as a separate band
 - b) The maximum output power of band gap channels is limited to the lowest maximum output power certified for the adjacent bands regardless of whether band aggregation is applied for SAR testing.
 - c) The measured maximum output power results are used to reduce the number of channels that need testing.

WLAN 2.4G Chain0

Mode	Channel	Frequency (MHZ)	Chain0 Target power(dBm)	Tune up tolerance (dBm)	Maximum Tune up power (dBm)	Average power (dBm)
802.11 b	1	2412	14.5	±1.5	16	16.00
	6	2437	14.5	±1.5	16	15.96
	11	2462	14.5	±1.5	16	15.62
802.11 g	1	2412	14.5	±1.5	16	Not required
	6	2437	14.5	±1.5	16	
	11	2462	11.5	±1.5	13	
802.11 n HT20	1	2412	14.5	±1.5	16	
	6	2437	14.5	±1.5	16	
	11	2462	10.5	±1.5	12	
802.11 n HT40	3	2422	14	±1.5	15.5	
	6	2437	14.5	±1.5	16	
	9	2452	10	±1.5	11.5	

WLAN 2.4G Chain1

Mode	Channel	Frequency (MHZ)	Chain1 Target power(dBm)	Tune up tolerance (dBm)	Maximum Tune up power (dBm)	Average power (dBm)
802.11 b	1	2412	14.5	±1.5	16	16.00
	6	2437	14.5	±1.5	16	15.89
	11	2462	14.5	±1.5	16	15.59
802.11 g	1	2412	14.5	±1.5	16	Not required
	6	2437	14.5	±1.5	16	
	11	2462	11.5	±1.5	13	
802.11 n HT20	1	2412	14.5	±1.5	16	
	6	2437	14.5	±1.5	16	
	11	2462	10.5	±1.5	12	
802.11 n HT40	3	2422	14	±1.5	15.5	
	6	2437	14.5	±1.5	16	
	9	2452	10	±1.5	11.5	

WLAN Conducted output power(dBm):

U-NII-1 Chain0

Mode	Channel	Frequency (MHZ)	Chain0 Target power(dBm)	Tune up tolerance (dBm)	Maximum Tune up power (dBm)	Average Power (dBm)
802.11 a	36	5180	10.5	±2	12.5	12.50
	40	5200	10.5	±2	12.5	12.40
	44	5220	10.5	±2	12.5	12.26
	48	5240	10.5	±2	12.5	12.48
802.11 n HT20	36	5180	10	±2	12	Not required
	40	5200	10	±2	12	
	44	5220	10	±2	12	
	48	5240	10	±2	12	
802.11 n HT40	38	5190	9.5	±2	11.5	
	46	5230	10	±2	12	
802.11 ac80	42	5210	10	±2	12	

U-NII-1 Chain1

Mode	Channel	Frequency (MHZ)	Chain1 Target power(dBm)	Tune up tolerance (dBm)	Maximum Tune up power (dBm)	Average Power (dBm)
802.11 a	36	5180	10.5	±2	12.5	12.47
	40	5200	10.5	±2	12.5	12.18
	44	5220	10.5	±2	12.5	12.46
	48	5240	10.5	±2	12.5	12.36
802.11 n HT20	36	5180	10	±2	12	Not required
	40	5200	10	±2	12	
	44	5220	10	±2	12	
	48	5240	10	±2	12	
802.11 n HT40	38	5190	9.5	±2	11.5	
	46	5230	10	±2	12	
802.11 ac80	42	5210	10	±2	12	

U-NII-2A Chain0

Mode	Channel	Frequency (MHZ)	Chain0 Target power(dBm)	Tune up tolerance (dBm)	Maximum Tune up power (dBm)	Average Power (dBm)
802.11 a	52	5260	10.5	±2	12.5	12.26
	56	5280	10.5	±2	12.5	12.31
	60	5300	10.5	±2	12.5	12.23
	64	5320	10.5	±2	12.5	12.47
802.11 n HT20	52	5260	10	±2	12	Not required
	56	5280	10	±2	12	
	60	5300	10	±2	12	
	64	5320	10	±2	12	
802.11 n HT40	54	5270	10	±2	12	
	62	5310	10	±2	12	
802.11 ac80	58	5290	9.5	±2	11.5	

U-NII-2A Chain1

Mode	Channel	Frequency (MHZ)	Chain1 Target power(dBm)	Tune up tolerance (dBm)	Maximum Tune up power (dBm)	Average Power (dBm)
802.11 a	52	5260	10.5	±2	12.5	12.19
	56	5280	10.5	±2	12.5	12.37
	60	5300	10.5	±2	12.5	12.50
	64	5320	10.5	±2	12.5	12.38
802.11 n HT20	52	5260	10	±2	12	Not required
	56	5280	10	±2	12	
	60	5300	10	±2	12	
	64	5320	10	±2	12	
802.11 n HT40	54	5270	10	±2	12	
	62	5310	10	±2	12	
802.11 ac80	58	5290	9.5	±2	11.5	

U-NII-2C Chain0

Mode	Channel	Frequency (MHZ)	Chain0 Target power(dBm)	Tune up tolerance (dBm)	Maximum Tune up power (dBm)	Average Power (dBm)
802.11 a	100	5500	10.5	±2	12.5	12.11
	112	5560	10.5	±2	12.5	12.50
	116	5580	10.5	±2	12.5	12.48
	128	5640	10.5	±2	12.5	12.45
	132	5660	10.5	±2	12.5	12.46
	136	5680	10.5	±2	12.5	12.44
	140	5700	10.5	±2	12.5	12.40
	144	5720	10.5	±2	12.5	12.48
802.11 n HT20	100	5500	10	±2	12	Not required
	112	5560	10	±2	12	
	116	5580	10	±2	12	
	128	5640	10	±2	12	
	132	5660	10	±2	12	
	136	5680	10	±2	12	
	140	5700	10	±2	12	
	144	5720	10	±2	12	
802.11 n HT40	102	5510	10	±2	12	
	110	5550	10	±2	12	
	118	5590	10	±2	12	
	126	5630	10	±2	12	
	134	5670	10	±2	12	
	142	5710	10	±2	12	
802.11 ac80	106	5530	9.5	±2	11.5	
	122	5610	10	±2	12	
	138	5690	10	±2	12	

U-NII-2C Chain1

Mode	Channel	Frequency (MHZ)	Chain1 Target power(dBm)	Tune up tolerance (dBm)	Maximum Tune up power (dBm)	Average Power (dBm)
802.11 a	100	5500	10.5	±2	12.5	12.35
	112	5560	10.5	±2	12.5	12.11
	116	5580	10.5	±2	12.5	12.14
	128	5640	10.5	±2	12.5	12.49
	132	5660	10.5	±2	12.5	12.25
	136	5680	10.5	±2	12.5	12.37
	140	5700	10.5	±2	12.5	12.48
	144	5720	10.5	±2	12.5	12.43
802.11 n HT20	100	5500	10	±2	12	Not required
	112	5560	10	±2	12	
	116	5580	10	±2	12	
	128	5640	10	±2	12	
	132	5660	10	±2	12	
	136	5680	10	±2	12	
	140	5700	10	±2	12	
	144	5720	10	±2	12	
802.11 n HT40	102	5510	10	±2	12	
	110	5550	10	±2	12	
	118	5590	10	±2	12	
	126	5630	10	±2	12	
	134	5670	10	±2	12	
	142	5710	10	±2	12	
802.11 ac80	106	5530	9.5	±2	11.5	
	122	5610	10	±2	12	
	138	5690	10	±2	12	

U-NII-3 Chain0

Mode	Channel	Frequency	Chain0 Target power(dBm)	Tune up tolerance (dBm)	Maximum Tune up power (dBm)	Average power (dBm)
802.11 a	149	5745	11	±2	13	12.97
	157	5785	11	±2	13	12.85
	165	5825	11	±2	13	12.87
802.11 n HT20	149	5745	10.5	±2	12.5	Not required
	157	5785	10.5	±2	12.5	
	165	5825	10.5	±2	12.5	
802.11 n HT40	151	5755	10.5	±2	12.5	
	159	5795	10.5	±2	12.5	
802.11 ac80	155	5775	10.5	±2	12.5	

U-NII-3 Chain1

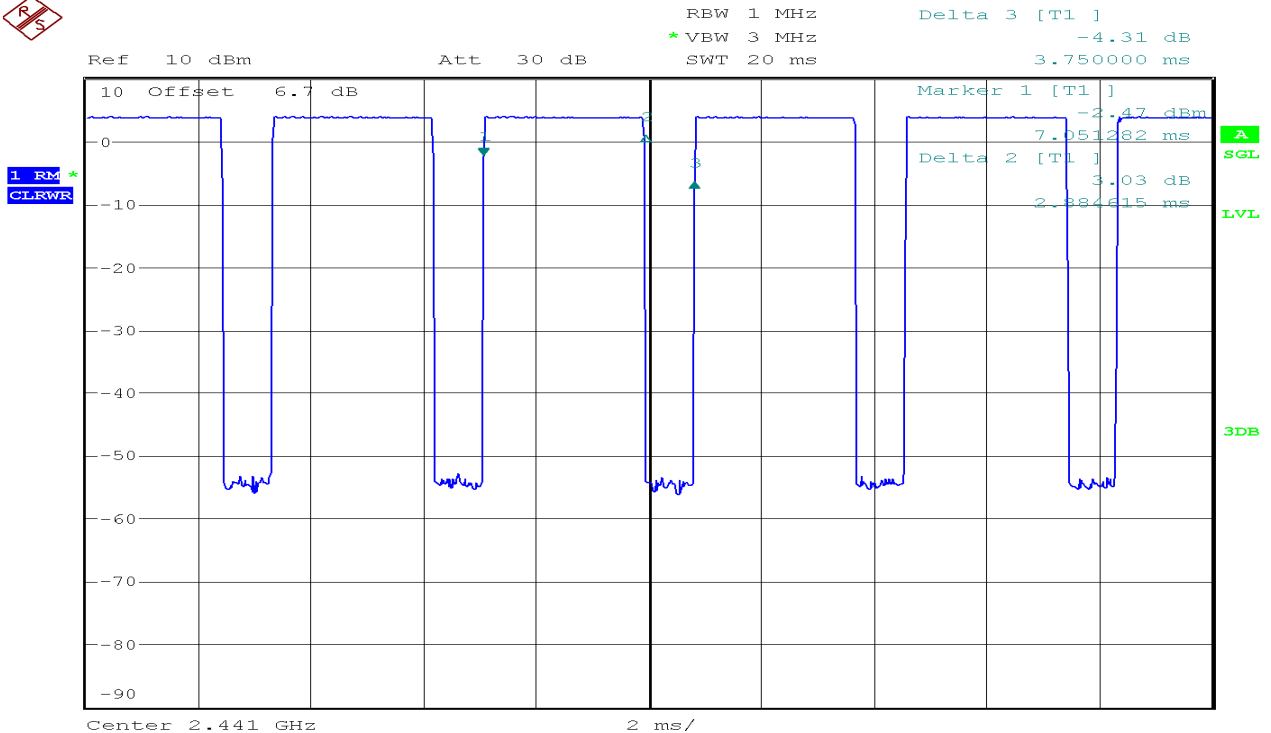
Mode	Channel	Frequency	Chain1 Target power(dBm)	Tune up tolerance (dBm)	Maximum Tune up power (dBm)	Average power (dBm)
802.11 a	149	5745	11	±2	13	12.75
	157	5785	11	±2	13	12.96
	165	5825	11	±2	13	12.85
802.11 n HT20	149	5745	10.5	±2	12.5	Not required
	157	5785	10.5	±2	12.5	
	165	5825	10.5	±2	12.5	
802.11 n HT40	151	5755	10.5	±2	12.5	
	159	5795	10.5	±2	12.5	
802.11 ac80	155	5775	10.5	±2	12.5	

Bluetooth

Band	Mode	Channel	Frequency	Averaged Power (dBm)
2.4 GHz	Bluetooth BR (GFSK)	0	2402	3.78
		39	2441	4.16
		78	2480	4.51
	Bluetooth EDR2 ($\pi/4$ -DQPSK)	0	2402	0.34
		39	2441	0.68
		78	2480	1.03
	Bluetooth EDR3 (8-DPSK)	0	2402	0.21
		39	2441	0.72
		78	2480	0.99
	Bluetooth LE	0	2402	-0.51
		19	2440	-0.26
		39	2480	-0.16

Bluetooth Duty cycle

Duty Cycle			
Configuration	TX ON (ms)	TX ALL (ms)	Duty Cycle (%)
BR-1Mbps	2.885	3.75	77%



9.5 STANDALONE SAR TEST EXCLUSION

According to KDB447498 D01: The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at *test separation distances* ≤ 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,²⁴ where

- $f_{\text{(GHz)}}$ is the RF channel transmit frequency in GHz
- Power and distance are rounded to the nearest mW and mm before calculation²⁵
- The result is rounded to one decimal place for comparison
- 3.0 and 7.5 are referred to as the numeric thresholds in the step 2 below

If the test separation distance (antenna-user) is < 5 mm, 5 mm is used for excluded SAR calculation

	Wireless Interface	Bluetooth
	Tune-up Maximum power (dBm)	6
	Tune-up Maximum rated power (mW)	3.981
Body	Antenna to user (mm)	5
	Frequency (GHz)	2480
	SAR exclusion threshold	1.254

Per KDB 447498 D01 exclusion thresholds is $1.254 < 3$, Bluetooth RF exposure evaluation is not required.

According to RSS102-2015 :

SAR evaluation for this device was performed with a separation distance of 5 mm. Observing the SAR evaluation exemption limit table (Table 1, see below) found in § 2.5.1 of RSS102:2015 , it was determined that the SAR exemption limit for this device is 4 mW for 2.4GHz transmission. No Wi-Fi mode qualified for test exemption as all power levels were above the stated thresholds. On the contrary, Bluetooth, with a frequency of 2480 MHz and a maximum output power of 5.43 mW (7.35 dBm, tune-up tolerance accounted for), is Higher than the exemption threshold and therefore exempt from SAR evaluation for either the intended user or bystanders. So Bluetooth RF exposure evaluation is required

**Table 1: SAR evaluation – Exemption limits for routine evaluation based
on frequency and separation distance**

Frequency (MHz)	Exemption Limits (mW)				
	At separation distance of ≤5 mm	At separation distance of 10 mm	At separation distance of 15 mm	At separation distance of 20 mm	At separation distance of 25 mm
≤300	71 mW	101 mW	132 mW	162 mW	193 mW
450	52 mW	70 mW	88 mW	106 mW	123 mW
835	17 mW	30 mW	42 mW	55 mW	67 mW
1900	7 mW	10 mW	18 mW	34 mW	60 mW
2450	4 mW	7 mW	15 mW	30 mW	52 mW
3500	2 mW	6 mW	16 mW	32 mW	55 mW
5800	1 mW	6 mW	15 mW	27 mW	41 mW

Frequency (MHz)	Exemption Limits (mW)				
	At separation distance of 30 mm	At separation distance of 35 mm	At separation distance of 40 mm	At separation distance of 45 mm	At separation distance of ≥50 mm
≤300	223 mW	254 mW	284 mW	315 mW	345 mW
450	141 mW	159 mW	177 mW	195 mW	213 mW
835	80 mW	92 mW	105 mW	117 mW	130 mW
1900	99 mW	153 mW	225 mW	316 mW	431 mW
2450	83 mW	123 mW	173 mW	235 mW	309 mW
3500	86 mW	124 mW	170 mW	225 mW	290 mW
5800	56 mW	71 mW	85 mW	97 mW	106 mW

9.6 SAR TEST CONFIGURATIONS

According to KDB 616217 D04, SAR testing for laptop PC is required for bottom surface. This EUT was tested in the base of EUT directly against the flat phantom.

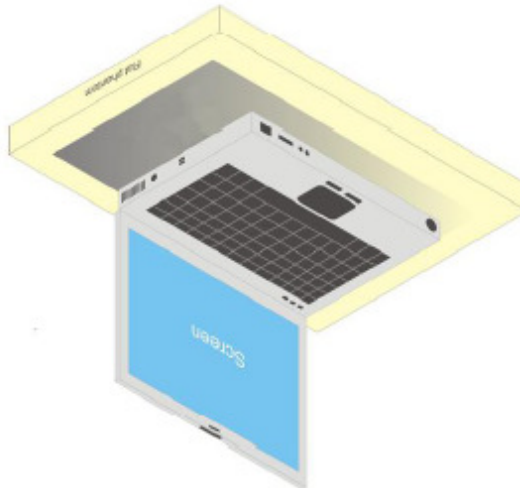
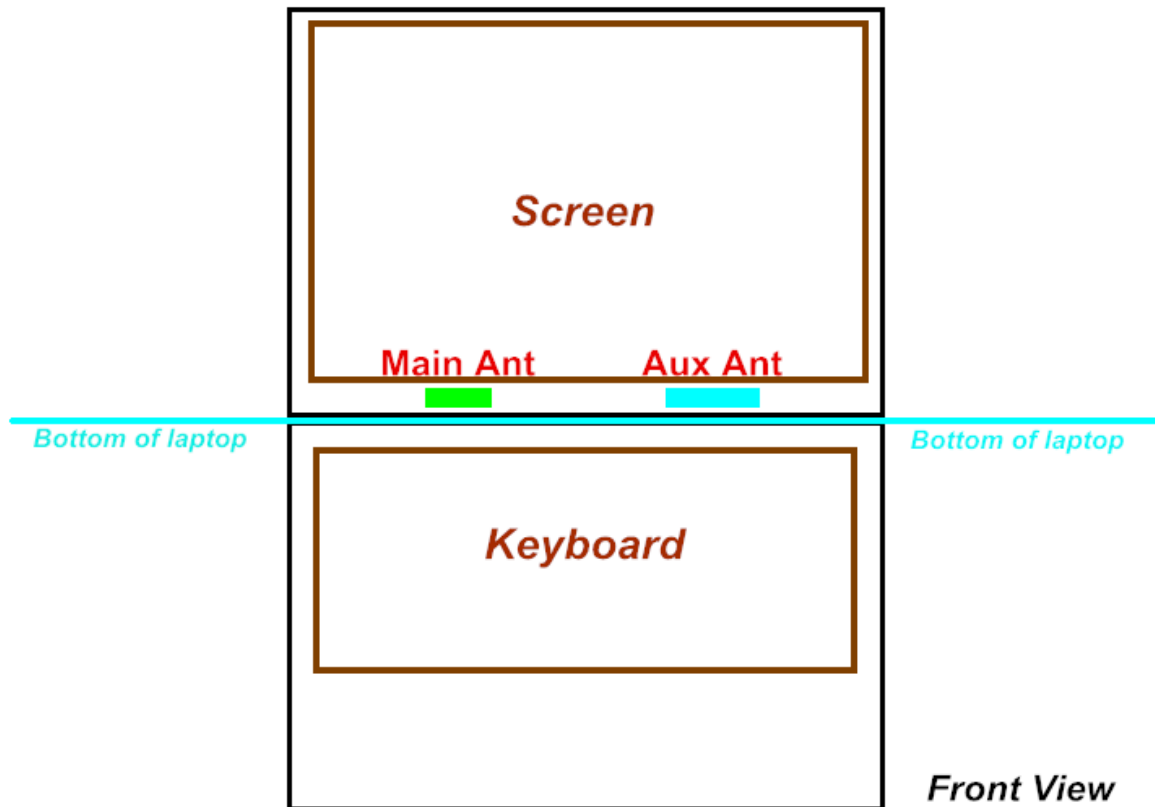


Fig Illustration for Laptop Setup

Note: The distance between EUT bottom surface and Antenna position is 4.00 mm

9.7 ANTENNA LOCATION



Note: The distance between EUT bottom surface and Antenna position is 4.00 mm
Device dimensions for EUT (H x W): 325 x 230 mm



SGS-CSTC Standards Technical Services Co., Ltd.
Shenzhen Branch

Report No.: SZEM180200119001

Page: 40 of 66

Antennas	Wireless Interface
Bluetooth & WLAN Antenna	WLAN 2.4GHz WLAN 5.2GHz WLAN 5.3GHz WLAN 5.5GHz WLAN 5.8GHz Bluetooth
Main Antenna	WLAN TX/RX 2.4GHz/5GHz+ Bluetooth
Aux Antenna	WLAN TX/RX 2.4GHz/5GHz

Test Mode

IEEE 802.11	Data transmission mode(802.11a;802.11b; Bluetooth GFSK)
-------------	---

Note:

Chain0 is Main Antenna

Chain1 is Aux Antenna.

9.8 SAR MEASUREMENT RESULTS

Note:

1. Per KDB 447498 D01, the reported SAR is the measured SAR value adjusted for maximum tune-up tolerance.
 - a. Tune-up scaling Factor = tune-up limit power (mW) / EUT RF power (mW), where tune-up limit is the maximum rated power among all production units.
 - b. For WLAN: Reported SAR(W/kg)= Measured SAR(W/kg)* Duty Cycle scaling factor * Tune-up scaling factor
2. Per KDB 447498 D01, for each exposure position, if the highest output channel reported SAR ≤0.8W/kg, other channels SAR testing is not necessary.
3. Per KDB 447498 D01, for each exposure position, 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

2.4GHz SAR Results for Test Records

South Star Antenna

Band	Mode	Configure	Test Position	Dist. (mm)	Freq. (MHZ)	Ant	max Power (dBm)	Tune-Up Limit (dBm)	Scaling Factor	Power Drift (dB)	Duty Cycle Scaling Factor	SAR1g (mW/g)	Scaled SAR1g (mW/g)	Plot page
WLAN 2.4Ghz	802.11b	NB	Bottom	0	2412	Main	16.00	16.00	1.000	0.02	1.01	1.04	1.051	3
		NB	Bottom	0	2437	Main	15.96	16.00	1.009	0.09	1.01	1.05	1.070	4
		NB	Bottom	0	2462	Main	15.62	16.00	1.091	0.04	1.01	0.924	1.019	5
		NB	Bottom	0	2412	Aux	16.00	16.00	1.000	0.04	1.01	0.860	0.869	6
		NB	Bottom	0	2437	Aux	15.89	16.00	1.026	0.10	1.01	0.863	0.894	7
		NB	Bottom	0	2462	Aux	15.59	16.00	1.099	0.08	1.01	0.775	0.860	8
2.4Ghz	BT GFSK	NB	Bottom	0	2402	Main	3.78	6.00	1.667	0.04	1.30	0.065	0.141	13
		NB	Bottom	0	2441	Main	4.16	6.00	1.528	0.10	1.30	0.064	0.127	14
		NB	Bottom	0	2480	Main	4.51	6.00	1.409	0.05	1.30	0.066	0.121	15

Luxshare Antenna - Worst case

Band	Mode	Configure	Test Position	Dist. (mm)	Freq. (MHZ)	Ant	max Power (dBm)	Tune-Up Limit (dBm)	Scaling Factor	Power Drift (dB)	Duty Cycle Scaling Factor	SAR1g (mW/g)	Scaled SAR1g (mW/g)	Plot page
WLAN 2.4Ghz	802.11b	NB	Bottom	0	2412	Main	16.00	16.00	1.000	0.03	1.01	0.710	0.717	11
WLAN 2.4Ghz	802.11b	NB	Bottom	0	2437	Aux	15.89	16.00	1.026	-0.15	1.01	0.691	0.716	12
2.4Ghz	BT GFSK	NB	Bottom	0	2480	Main	4.51	6.00	1.409	-0.09	1.30	0.055	0.101	16

Remark: SAR is not required for the following 2.4 GHz OFDM conditions.

1) When KDB Publication 447498 SAR test exclusion applies to the OFDM configuration.

2) 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.

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. So 2.4 GHz OFDM mode is not required.

Repeated SAR Test Records for 2.4GHz

Band	Mode	Configure	Test Position	Dist. (mm)	Freq. (MHZ)	Ant	max Power (dBm)	Tune-Up Limit (dBm)	Scaling Factor	Power Drift (dB)	Duty Cycle Scaling Factor	SAR1g (mW/g)	Scaled SAR1g (mW/g)	Plot page
WLAN 2.4Ghz	802.11b	NB	Bottom	0	2437	Main	15.96	16.00	1.009	0.12	1.01	1.00	1.019	9
WLAN 2.4Ghz	802.11b	NB	Bottom	0	2437	Aux	15.89	16.00	1.026	0.14	1.01	0.834	0.864	10

5GHz SAR Results for Test Records

South Star Antenna

Band	Mode	Configure	Test Position	Dist. (mm)	Freq. (MHZ)	Ant	max Power (dBm)	Tune-Up Limit (dBm)	Scaling Factor	Power Drift (dB)	Duty Cycle Scaling Factor	SAR1g (mW/g)	Scaled SAR1g (mW/g)	Plot page
U-NII-2A	802.11a	NB	Bottom	0	5260	Main	12.26	12.50	1.057	-0.10	1.05	0.474	0.527	17
U-NII-2A		NB	Bottom	0	5280	Main	12.31	12.50	1.045	0.03	1.05	0.434	0.477	18
U-NII-2A		NB	Bottom	0	5320	Main	12.47	12.50	1.007	0.13	1.05	0.556	0.589	19
U-NII-2C		NB	Bottom	0	5500	Main	12.11	12.50	1.094	0.19	1.05	0.890	1.025	20
U-NII-2C		NB	Bottom	0	5560	Main	12.50	12.50	1.000	0.09	1.05	1.09	1.147	21
U-NII-2C		NB	Bottom	0	5720	Main	12.48	12.50	1.005	0.12	1.05	0.902	0.954	22
U-NII-3		NB	Bottom	0	5745	Main	12.97	13.00	1.007	0.09	1.05	0.852	0.903	23
U-NII-3		NB	Bottom	0	5785	Main	12.85	13.00	1.035	0.15	1.05	0.793	0.864	24
U-NII-3		NB	Bottom	0	5825	Main	12.87	13.00	1.030	-0.03	1.05	0.665	0.721	25

Luxshare Antenna

Band	Mode	Configure	Test Position	Dist. (mm)	Freq. (MHZ)	Ant	max Power (dBm)	Tune-Up Limit (dBm)	Scaling Factor	Power Drift (dB)	Duty Cycle Scaling Factor	SAR1g (mW/g)	Scaled SAR1g (mW/g)	Plot page
U-NII-2A	802.11a	NB	Bottom	0	5260	Aux	12.19	12.50	1.074	0.19	1.05	0.691	0.781	28
U-NII-2A		NB	Bottom	0	5300	Aux	12.50	12.50	1.000	0.04	1.05	0.710	0.747	29
U-NII-2A		NB	Bottom	0	5320	Aux	12.38	12.50	1.028	0.07	1.05	0.697	0.754	30
U-NII-2C		NB	Bottom	0	5500	Aux	12.35	12.50	1.035	0.02	1.05	0.817	0.890	31
U-NII-2C		NB	Bottom	0	5640	Aux	12.49	12.50	1.002	0.01	1.05	0.881	0.930	32
U-NII-2C		NB	Bottom	0	5720	Aux	12.43	12.50	1.016	0.07	1.05	0.716	0.766	33
U-NII-3		NB	Bottom	0	5745	Aux	12.75	13.00	1.059	-0.10	1.05	0.512	0.571	34
U-NII-3		NB	Bottom	0	5785	Aux	12.96	13.00	1.009	0.07	1.05	0.816	0.867	35
U-NII-3		NB	Bottom	0	5825	Aux	12.85	13.00	1.035	-0.16	1.05	0.683	0.744	36

Luxshare Antenna- Worst case

Band	Mode	Configure	Test Position	Dist. (mm)	Freq. (MHZ)	Ant	max Power (dBm)	Tune-Up Limit (dBm)	Scaling Factor	Power Drift (dB)	Duty Cycle Scaling Factor	SAR1g (mW/g)	Scaled SAR1g (mW/g)	Plot page
U-NII-2C	802.11a	NB	Bottom	0	5560	Main	12.50	12.50	1.000	-0.07	1.05	0.884	0.931	39

South Star Antenna- Worst case

Band	Mode	Configure	Test Position	Dist. (mm)	Freq. (MHZ)	Ant	max Power (dBm)	Tune-Up Limit (dBm)	Scaling Factor	Power Drift (dB)	Duty Cycle Scaling Factor	SAR1g (mW/g)	Scaled SAR1g (mW/g)	Plot page
U-NII-2C	802.11a	NB	Bottom	0	5640	Aux	12.49	12.50	1.002	0.06	1.05	0.764	0.806	40



SGS-CSTC Standards Technical Services Co., Ltd. Shenzhen Branch

Report No.: SZEM180200119001

Page: 44 of 66

Remark: For devices that operate in both U-NII-1 and U-NII-2A bands using the same transmitter and antenna(s), SAR test reduction is determined according to the following

1) When the same maximum output power is specified for both bands, begin SAR measurement in U-NII-2A band by applying the OFDM SAR requirements. If the highest reported SAR for a test configuration is ≤ 1.2 W/kg, SAR is not required for U-NII-1 band for that configuration (802.11 mode and exposure condition); otherwise, each band is tested independently for SAR.

2) When different maximum output power is specified for the bands, begin SAR measurement in the band with higher specified maximum output power. The highest reported SAR for the tested configuration is adjusted by the ratio of lower to higher specified maximum output power for the two bands. When the adjusted SAR is ≤ 1.2 W/kg, SAR is not required for the band with lower maximum output power in that test configuration; otherwise, each band is tested independently for SAR.

The highest reported SAR for Main Antenna is adjusted by the ratio of U-NII-1 to U-NII-2A specified maximum output power and the adjusted SAR is ≤ 1.2 W/kg. So Main Antenna U-NII-1 mode is not required.



SGS-CSTC Standards Technical Services Co., Ltd. Shenzhen Branch

Report No.: SZEM180200119001

Page: 45 of 66

Repeated SAR Test Records for 5GHz

South Star Antenna

Band	Mode	Configure	Test Position	Dist. (mm)	Freq. (MHZ)	Ant	max Power (dBm)	Tune-Up Limit (dBm)	Scaling Factor	Power Drift (dB)	Duty Cycle Scaling Factor	SAR1g (mW/g)	Scaled SAR1g (mW/g)	Plot page
U-NII-2C	802.11a	NB	Bottom	0	5560	Main	12.50	12.50	1.000	0.01	1.05	1.08	1.137	26
U-NII-3	802.11a	NB	Bottom	0	5745	Main	12.97	13.00	1.007	0.07	1.05	0.913	0.968	27

Luxshare Antenna

Band	Mode	Configure	Test Position	Dist. (mm)	Freq. (MHZ)	Ant	max Power (dBm)	Tune-Up Limit (dBm)	Scaling Factor	Power Drift (dB)	Duty Cycle Scaling Factor	SAR1g (mW/g)	Scaled SAR1g (mW/g)	Plot page
U-NII-2C	802.11a	NB	Bottom	0	5640	Aux	12.49	12.50	1.002	-0.05	1.05	0.882	0.931	37
U-NII-3	802.11a	NB	Bottom	0	5785	Aux	12.96	13.00	1.009	0.02	1.05	0.775	0.823	38

9.9 REPEATED SAR MEASUREMENT

Note:

1. Per KDB 865664 D01v01,for each frequency band, repeated SAR measurement is required only when the measured SAR is $\geq 0.8\text{W/Kg}$
2. Per KDB 865664 D01v01,if the ratio of largest to smallest SAR for the original and first repeated measurement is ≤ 1.2 and the measured SAR $< 1.45\text{W/Kg}$,only one repeated measurement is required.
3. The ratio is the difference in percentage between original and repeated measured SAR.

Band	Mode	Test Position	Ant	Freq (MHZ)	Original Measured SAR1g (mW/g)	1st Repeated SAR1g (mW/g)	Ratio	Original Measured SAR1g (mW/g)	2nd Repeated SAR1g (mW/g)	Ratio
WLAN 2.4Ghz	802.11b	Bottom	Main	2437	1.05	1.00	1.050	--	--	--
WLAN 2.4Ghz	802.11b	Bottom	Aux	2437	0.863	0.834	1.035	--	--	--
U-NII-2C	802.11a	Bottom	Main	5560	1.09	1.08	1.009	--	--	--
U-NII-2C	802.11a	Bottom	Aux	5640	0.881	0.882	1.001	--	--	--
U-NII-3	802.11a	Bottom	Main	5745	0.852	0.913	1.072	--	--	--
U-NII-3	802.11a	Bottom	Aux	5785	0.816	0.775	1.053	--	--	--

9.10 SAR TABLET/CONVERTIBLE COMPUTER MULTI XMITER ASSESSMENT

	Position	Applicable Combination
Simultaneous Transmission	1	WLAN 2.4GHz+BT
	2	WLAN 5GHz+BT

Note:

1. Main Antenna 2.4GHz WLAN and BT share the same antenna, and cannot transmit simultaneously.
2. WLAN 2.4GHz and WLAN 5GHz timely shared antenna and they cannot transmit at the same time.
3. The DUT support chain0 and chain1 WLAN simultaneous transmission
4. The reported SAR summation is calculated based on the same configuration and test position.
5. Per KDB 447498 D01v06, simultaneous transmission SAR is compliant if,
 - 1) Scalar SAR summation < 1.6W/kg.
 - 2) $SPLSR = (SAR_1 + SAR_2)^{1.5} / (\min. \text{ separation distance, mm})$, and the peak separation distance is determined from the square root of $[(x_1-x_2)^2 + (y_1-y_2)^2 + (z_1-z_2)^2]$, where (x_1, y_1, z_1) and (x_2, y_2, z_2) are the coordinates of the extrapolated peak SAR locations in the zoom scan
If $SPLSR \leq 0.04$, simultaneously transmission SAR is compliant
 - 3) Simultaneously transmission SAR measurement, and the reported multi-band SAR < 1.6W/kg

6. According to KDB 447498 D01 simultaneous SAR testing can be excluded under the following conditions:
The sum of the SAR for all simultaneously transmitting antennas is within the SAR limit.

If the sum of the SAR for all simultaneously transmitting antennas exceeds the SAR limit testing can still be excluded if the SAR to Peak Location Ratio (SPLSR) between any pair of simultaneously transmitting antennas is ≤ 0.04

$$SPLSR = (SAR_1 + SAR_2)^{1.5} / Ri$$

Where:

SAR₁ is the highest measured or estimated SAR for the first of a pair of simultaneous transmitting antennas, in a specific test operating mode and exposure condition

SAR₂ is the highest measured or estimated SAR for the second of a pair of simultaneous transmitting antennas, in the same test operating mode and exposure condition as the first

Ri is the separation distance between the pair of simultaneous transmitting antennas. When the SAR is measured, for both antennas in the pair, it is determined by the actual x, y and z coordinates in the 1-g SAR for each SAR peak location, based on the extrapolated and interpolated result in the zoom scan measurement, using the formula of $[(x_1-x_2)^2 + (y_1-y_2)^2 + (z_1-z_2)^2]$

Sum of SAR for worst case standalone measurements (Wi-Fi 2.4 GHz)

SUM Σ SAR1g 2.4G					
Position	Distance [mm]	Stand alone SAR(1g) [W/kg]		SUM SAR(1g)[W/kg]	
		Aux WLAN 2.4G①	Bluetooth ②	①+②	SPLSR (Yes/No)
Bottom	0	0.894	0.141	1.035	No

Conclusion:

When the Σ 1-g SAR is less than 1.6 W/kg simultaneous transmission testing is not required

When the Σ 1-g SAR is greater than 1.6 W/kg SPLSR evaluation is required

Sum of SAR for worst case standalone measurements (Wi-Fi U-NII-2A)

SUM Σ SAR1g 5G					
Position	Distance [mm]	Stand alone SAR(1g) [W/kg]		SUM SAR(1g)[W/kg]	
		Aux U-NII-2A①	Bluetooth ②	①+②	SPLSR (Yes/No)
Bottom	0	0.781	0.141	0.922	No

Conclusion:

When the Σ 1-g SAR is less than 1.6 W/kg simultaneous transmission testing is not required

When the Σ 1-g SAR is greater than 1.6 W/kg SPLSR evaluation is required

Sum of SAR for worst case standalone measurements (Wi-Fi U-NII-2C)

SUM Σ SAR1g 5G					
Position	Distance [mm]	Stand alone SAR(1g) [W/kg]		SUM SAR(1g)[W/kg]	
		Aux U-NII-2C①	Bluetooth ②	①+②	SPLSR (Yes/No)
Bottom	0	0.931	0.141	1.072	No

Conclusion:

When the Σ 1-g SAR is less than 1.6 W/kg simultaneous transmission testing is not required

When the Σ 1-g SAR is greater than 1.6 W/kg SPLSR evaluation is required

Sum of SAR for worst case standalone measurements (Wi-Fi U-NII-3)

SUM Σ SAR1g 5G					
Position	Distance [mm]	Stand alone SAR(1g) [W/kg]		SUM SAR(1g)[W/kg]	
		Aux U-NII-3①	Bluetooth ②	①+②	SPLSR (Yes/No)
Bottom	0	0.867	0.141	1.008	No

Conclusion:

When the Σ 1-g SAR is less than 1.6 W/kg simultaneous transmission testing is not required

When the Σ 1-g SAR is greater than 1.6 W/kg SPLSR evaluation is required

10. EQUIPMENT LIST & CALIBRATION STATUS

Name of Equipment	Manufacturer	Type/Model	Serial Number	Last Calibration	Calibration Due
P C	HP	Core(rm)3.16G	CZCO48171H	N/A	N/A
Signal Generator	Agilent	E8257C	US37101915	02/28/2017	02/27/2018
S-Parameter Network Analyzer	Agilent	E5071B	MY42301382	02/28/2017	02/27/2018
Power meter	Anritsu	ML2495A	1445010	04/26/2017	04/25/2018
Power sensor	Anritsu	MA2411B	1339220	04/26/2017	04/25/2018
E-field PROBE	SPEAG	EX3DV4	3798	07/26/2017	07/25/2018
DAE	SPEAG	DEA4	1245	07/20/2017	07/19/2018
DIPOLE 2450MHZ ANTENNA	SPEAG	D2450V2	817	05/30/2017	05/29/2018
DIPOLE 5GHZ ANTENNA	SPEAG	D5GHzV2	1095	05/23/2017	05/22/2018
DUMMY PROBE	SPEAG	DP_2	SPDP2001AA	N/A	N/A
SAM PHANTOM (ELI4 v4.0)	SPEAG	QDOVA001BB	1102	N/A	N/A
Twin SAM Phantom	SPEAG	QD000P40CD	1609	N/A	N/A
ROBOT	SPEAG	TX60	F10/5E6AA1/A101	N/A	N/A
ROBOT KRC	SPEAG	CS8C	F10/5E6AA1/C101	N/A	N/A
LIQUID CALIBRATION KIT	ANTENNESSA	41/05 OCP9	00425167	N/A	N/A

11. TEST LOCATION

All tests were sub-contracted to:
Compliance Certification Services Inc.
Kun shan Laboratory
No.10 Weiye Rd., Innovation park, Eco&Tec,
Development Zone, Kunshan City, Jiangsu, China
TEL: 86-512-57355888
FAX: 86-512-57370818

12. FACILITIES

All measurement facilities used to collect the measurement data are located at

☒ No.10, Weiye Rd., Innovation Park, Eco & Tec. Development Part, Kunshan City, Jiangsu Province, China.

13. REFERENCES

- [1] Federal Communications Commission, \Report and order: Guidelines for evaluating the environ-mental effects of radiofrequency radiation", Tech. Rep. FCC 96-326, FCC, Washington, D.C. 20554, 1996.
- [2] David L. Means Kwok Chan, Robert F. Cleveland, \Evaluating compliance with FCC guidelines for human exposure to radiofrequency electromagnetic fields", Tech. Rep., Federal Communication Commision, O_cce of Engineering & Technology, Washington, DC, 1997.
- [3] Thomas Schmid, Oliver Egger, and Niels Kuster, \Automated E-_eld scanning system for dosimetric assessments", IEEE Transactions on Microwave Theory and Techniques, vol. 44, pp. 105{113, Jan. 1996.
- [4] Niels Kuster, Ralph K.astle, and Thomas Schmid, \Dosimetric evaluation of mobile communications equipment with known precision", IEICE Transactions on Communications, vol. E80-B, no. 5, pp. 645{652, May 1997.
- [5] CENELEC, \Considerations for evaluating of human exposure to electromagnetic fields (EMFs) from mobile telecommunication equipment (MTE) in the frequency range 30MHz – 6GHz", Tech. Rep., CENELEC, European Committee for Electrotechnical Standardization, Brussels, 1997.
- [6] ANSI, ANSI/IEEE C95.1-1999: IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz, The Institute of Electrical and Electronics Engineers, Inc., New York, NY 10017, 1992.
- [7] Katja Pokovic, Thomas Schmid, and Niels Kuster, \Robust setup for precise calibration of E-_eld probes in tissue simulating liquids at mobile communications frequencies", in ICECOM _97, Dubrovnik, October 15{17, 1997, pp. 120{124.
- [8] Katja Pokovic, Thomas Schmid, and Niels Kuster, \E-_eld probe with improved isotropy in brain simulating liquids", in Proceedings of the ELMAR, Zadar, Croatia, 23{25 June, 1996, pp. 172{175.
- [9] Volker Hombach, Klaus Meier, Michael Burkhardt, Eberhard K. uhn, and Niels Kuster, \The dependence of EM energy absorption upon human head modeling at 900 MHz", IEEE Transactions onMicrowave Theory and Techniques, vol. 44, no. 10, pp. 1865{1873, Oct. 1996.

- [10] Klaus Meier, Ralf Kastle, Volker Hombach, Roger Tay, and Niels Kuster, "The dependence of EM energy absorption upon human head modeling at 1800 MHz", IEEE Transactions on Microwave Theory and Techniques, Oct. 1997, in press.
- [11] W. Gander, Computermathematik, Birkhaeuser, Basel, 1992.
- [12] W. H. Press, S. A. Teukolsky, W. T. Vetterling, and B. P. Flannery, Numerical Recipes in C, The Art of Scientific Computing, Second Edition, Cambridge University Press, 1992..Dosimetric Evaluation of Sample device, month 1998 9
- [13] NIS81 NAMAS, "The treatment of uncertainty in EMC measurement", Tech. Rep., NAMAS Executive, National Physical Laboratory, Teddington, Middlesex, England, 1994.
- [14] Barry N. Taylor and Christ E. Kuyatt, "Guidelines for evaluating and expressing the uncertainty of NIST measurement results", Tech. Rep., National Institute of Standards and Technology, 1994. Dosimetric Evaluation of Sample device, month 1998 10

14. LABORATORY ACCREDITATIONS AND LISTING

FCC –Designation Number: CN1172.

Compliance Certification Services Inc. Kun shan Laboratory has been registered and fully described in a report filed with the (FCC) Federal Communications Commission. The acceptance letter from the FCC is maintained in our files and the Designation Number: CN1172.

In addition, the test facilities are listed with Industry Canada, Certification and Engineering Bureau, 2324E for SAR chamber.



**SGS-CSTC Standards Technical Services Co., Ltd.
Shenzhen Branch**

Report No.: SZEM180200119001
Page: 54 of 66

Appendix A: DUT AND SAR Setup Photo

Appendix B: Plots of Performance Check

The plots are showing as followings.

Test Laboratory: Compliance Certification Services Inc.

Date: 2/2/2018

SystemPerformanceCheck-Body D2450

DUT: Dipole 2450 MHz D2450V2; Type: D2450V2; Serial: 817

Communication System: UID 0, CW; Communication System Band: D2450 (2450.0 MHz); Frequency: 2450 MHz;Duty Cycle: 1:1

Medium parameters used: $f = 2450$ MHz; $\sigma = 1.9$ S/m; $\epsilon_r = 52.48$; $\rho = 1000$ kg/m³

Room Ambient Temperature: 22°C; Liquid Temperature: 21.5°C

Phantom section: Flat Section

Measurement Standard: DASYS (IEEE/IEC/ANSI C63.19-2007)

DASY Configuration:

- Probe: EX3DV4 - SN3798; ConvF(7.32, 7.32, 7.32); Calibrated: 7/26/2017;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1245; Calibrated: 7/20/2017
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: 1102
- DASYS 52.8.8(1222);
- SEMCAD X Version 14.6.10 (7331)

System Performance Check at Frequencies above 1 GHz/Pin=250 mW, dist=10mm (EX-Probe)/Area Scan (9x10x1): Measurement grid: dx=12mm, dy=12mm

Maximum value of SAR (measured) = 16.3 W/kg

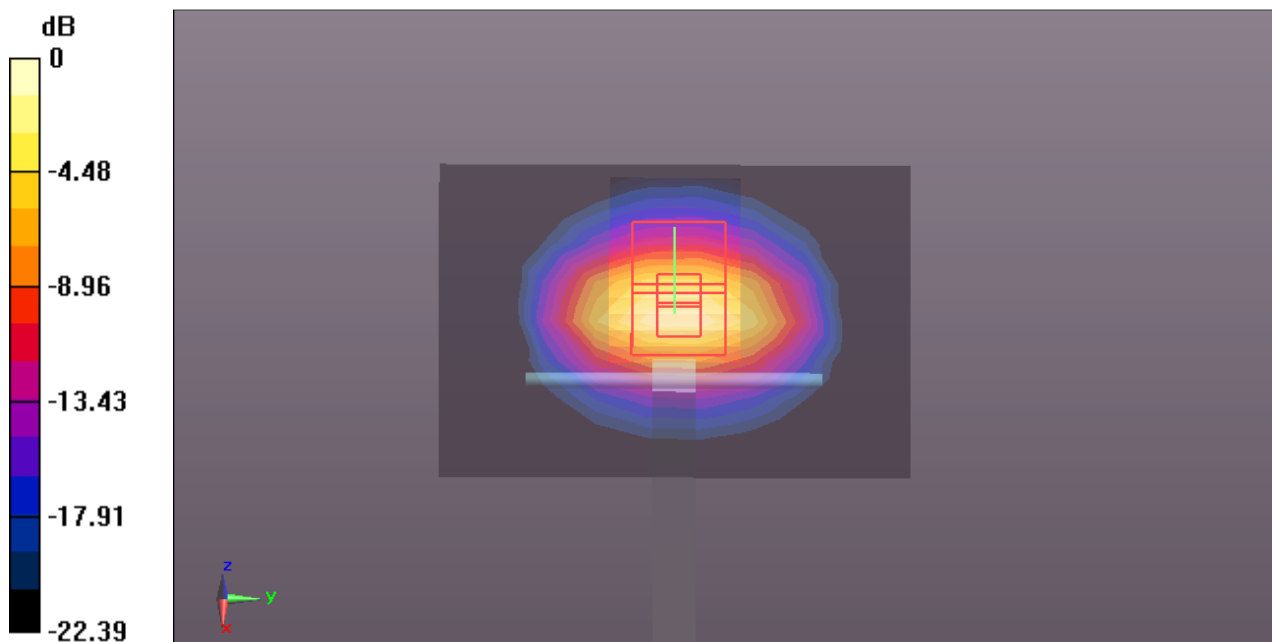
System Performance Check at Frequencies above 1 GHz/Pin=250 mW, dist=10mm (EX-Probe)/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 98.41 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 24.8 W/kg

SAR(1 g) = 12.9 W/kg; SAR(10 g) = 6.09 W/kg

Maximum value of SAR (measured) = 18.6 W/kg





**SGS-CSTC Standards Technical Services Co., Ltd.
Shenzhen Branch**

Report No.: SZEM180200119001

Page: 56 of 66

0 dB = 18.6 W/kg = 12.70 dBW/kg

Test Laboratory: Compliance Certification Services Inc.

Date: 2/4/2018

System Performance Check-Body D5200

DUT: Dipole D5GHzV2; Type: D5GHzV2; SN:1095

Communication System: UID 0, CW; Communication System Band: D5GHz (5000.0 - 6000.0 MHz);

Frequency: 5200 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 5200 \text{ MHz}$; $\sigma = 5.233 \text{ S/m}$; $\epsilon_r = 48.75$; $\rho = 1000 \text{ kg/m}^3$

Room Ambient Temperature: 22°C; Liquid Temperature: 21.5°C

Phantom section: Flat Section

Measurement Standard: DASYS (IEEE/IEC/ANSI C63.19-2007)

DASY Configuration:

- Probe: EX3DV4 - SN3798; ConvF(4.81, 4.81, 4.81); Calibrated: 7/26/2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection), Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1245; Calibrated: 7/20/2017
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: 1102
- DASY52 52.8.8(1222);
- SEMCAD X Version 14.6.10 (7331)

System Performance Check with D5GHzV2 Dipole (graded grid)/d=10mm, Pin=100mW, f=5200 MHz/Area Scan (10x10x1): Measurement grid: dx=10mm, dy=10mm

Maximum value of SAR (measured) = 15.6 W/kg

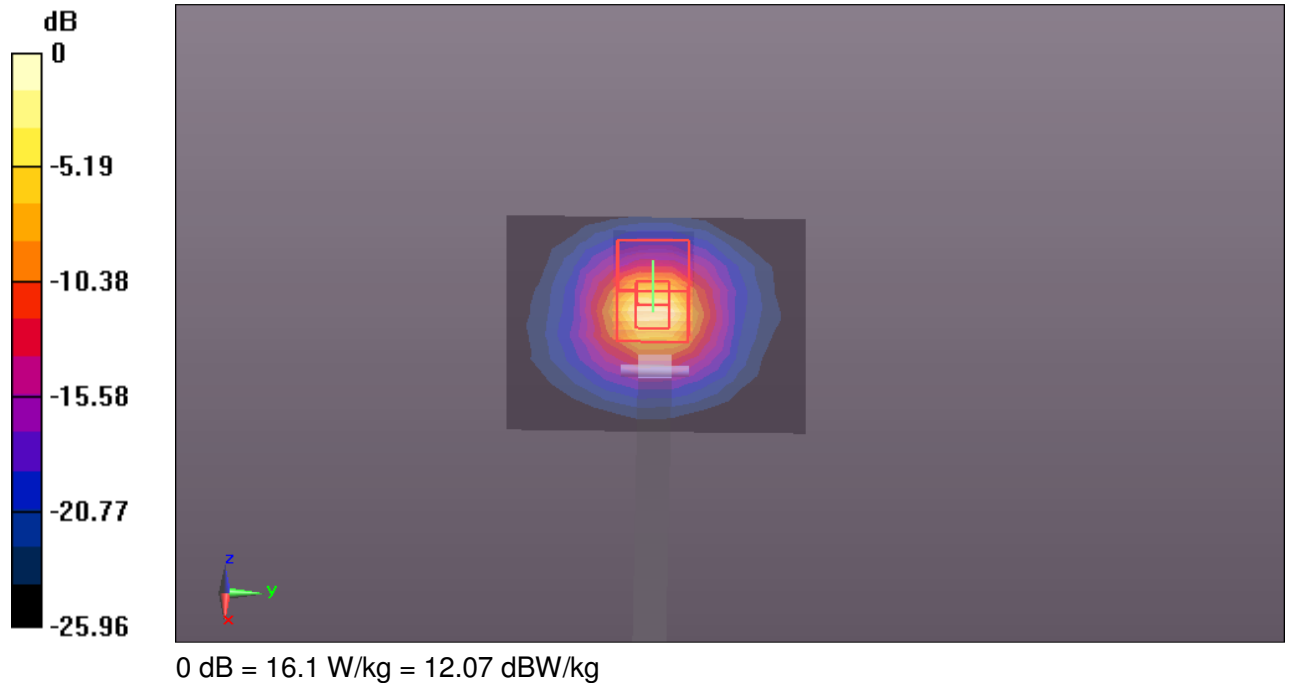
System Performance Check with D5GHzV2 Dipole (graded grid)/d=10mm, Pin=100mW, f=5200 MHz/Zoom Scan (4x4x1.4mm, graded), dist=1.4mm (7x7x6)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm

Reference Value = 57.23 V/m; Power Drift = 0.05 dB

Peak SAR (extrapolated) = 32.4 W/kg

SAR(1 g) = 7.60 W/kg; SAR(10 g) = 2.15 W/kg

Maximum value of SAR (measured) = 16.1 W/kg



Test Laboratory: Compliance Certification Services Inc.

Date: 2/4/2018

SystemPerformanceCheck-Body D5300

DUT: Dipole D5GHzV2; Type: D5GHzV2; SN:1095

Communication System: UID 0, CW; Communication System Band: D5GHz (5000.0 - 6000.0 MHz);

Frequency: 5300 MHz;Duty Cycle: 1:1

Medium parameters used: $f = 5300$ MHz; $\sigma = 5.387$ S/m; $\epsilon_r = 48.486$; $\rho = 1000$ kg/m³

Room Ambient Temperature: 22°C; Liquid Temperature: 21.5°C

Phantom section: Flat Section

Measurement Standard: DASYS (IEEE/IEC/ANSI C63.19-2007)

DASY Configuration:

- Probe: EX3DV4 - SN3798; ConvF(4.67, 4.67, 4.67); Calibrated: 7/26/2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection), Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1245; Calibrated: 7/20/2017
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: 1102
- DASY52 52.8.8(1222);
- SEMCAD X Version 14.6.10 (7331)

System Performance Check with D5GHzV2 Dipole (graded grid)/d=10mm, Pin=100mW, f=5300

MHz 2/Area Scan (10x10x1): Measurement grid: dx=10mm, dy=10mm

Maximum value of SAR (measured) = 16.7 W/kg

System Performance Check with D5GHzV2 Dipole (graded grid)/d=10mm, Pin=100mW, f=5300

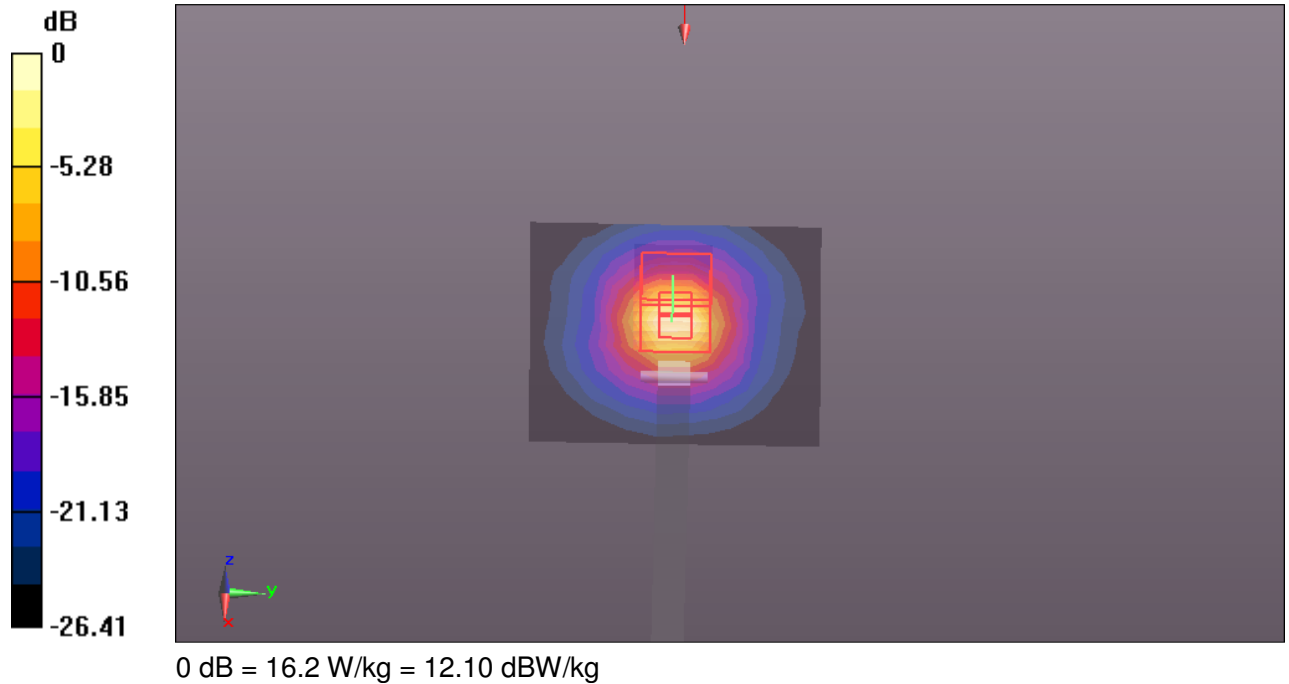
MHz 2/Zoom Scan (4x4x1.4mm, graded), dist=1.4mm (7x7x6)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm

Reference Value = 59.05 V/m; Power Drift = -0.04 dB

Peak SAR (extrapolated) = 33.1 W/kg

SAR(1 g) = 7.64 W/kg; SAR(10 g) = 2.13 W/kg

Maximum value of SAR (measured) = 16.2 W/kg



Test Laboratory: Compliance Certification Services Inc.

Date: 2/4/2018

SystemPerformanceCheck-Body D5500

DUT: Dipole D5GHzV2; Type: D5GHzV2; SN:1095

Communication System: UID 0, CW; Communication System Band: D5GHz (5000.0 - 6000.0 MHz);

Frequency: 5500 MHz;Duty Cycle: 1:1

Medium parameters used: $f = 5500$ MHz; $\sigma = 5.501$ S/m; $\epsilon_r = 48.292$; $\rho = 1000$ kg/m³

Room Ambient Temperature: 22°C; Liquid Temperature: 21.5°C

Phantom section: Flat Section

Measurement Standard: DASYS (IEEE/IEC/ANSI C63.19-2007)

DASY Configuration:

- Probe: EX3DV4 - SN3798; ConvF(4.26, 4.26, 4.26); Calibrated: 7/26/2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1245; Calibrated: 7/20/2017
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: 1102
- DASYS 52.8.8(1222);
- SEMCAD X Version 14.6.10 (7331)

System Performance Check with D5GHzV2 Dipole (graded grid)/d=10mm, Pin=100mW, f=5500

MHz 2/Area Scan (10x10x1): Measurement grid: dx=10mm, dy=10mm

Maximum value of SAR (measured) = 17.0 W/kg

System Performance Check with D5GHzV2 Dipole (graded grid)/d=10mm, Pin=100mW, f=5500

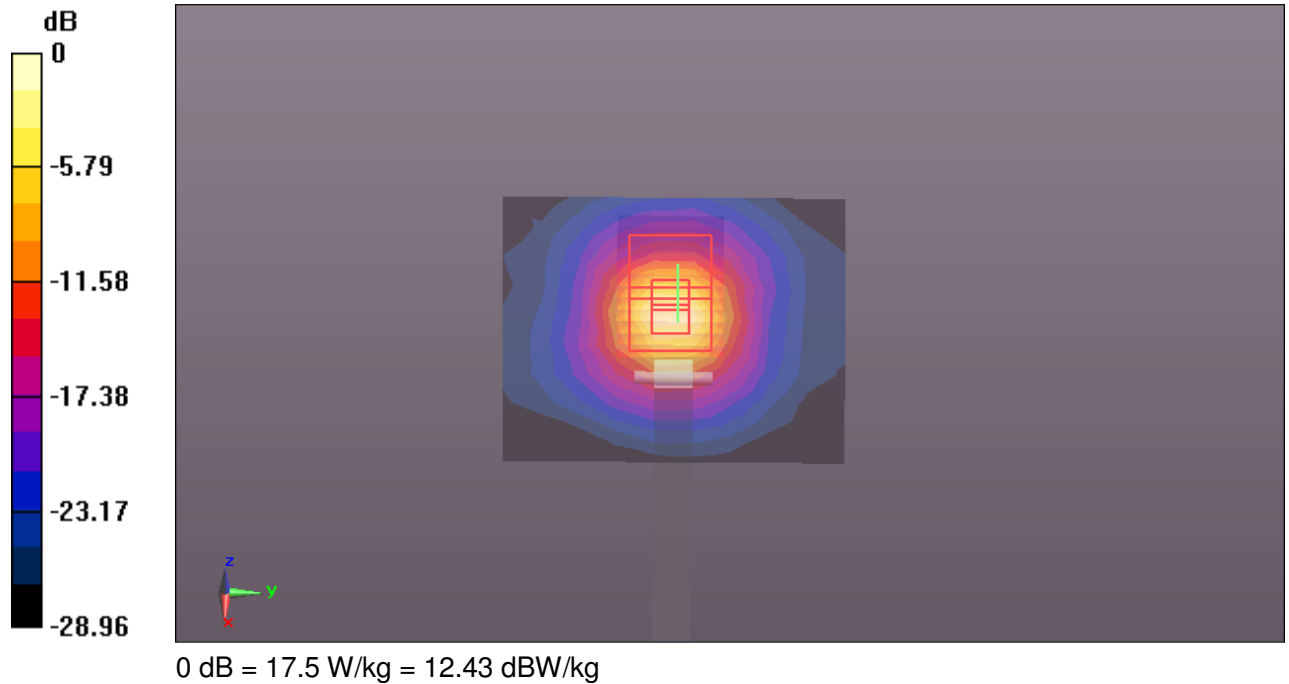
MHz 2/Zoom Scan (4x4x1.4mm, graded), dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 59.93 V/m; Power Drift = -0.06 dB

Peak SAR (extrapolated) = 32.8 W/kg

SAR(1 g) = 7.94 W/kg; SAR(10 g) = 2.29 W/kg

Maximum value of SAR (measured) = 17.5 W/kg



Test Laboratory: Compliance Certification Services Inc.

Date: 2/4/2018

System Performance Check-Body D5600

DUT: Dipole D5GHzV2; Type: D5GHzV2; SN:1095

Communication System: UID 0, CW; Communication System Band: D5GHz (5000.0 - 6000.0 MHz);

Frequency: 5600 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 5600$ MHz; $\sigma = 5.736$ S/m; $\epsilon_r = 48.176$; $\rho = 1000$ kg/m³

Room Ambient Temperature: 22°C; Liquid Temperature: 21.5°C

Phantom section: Flat Section

Measurement Standard: DASYS (IEEE/IEC/ANSI C63.19-2007)

DASY Configuration:

- Probe: EX3DV4 - SN3798; ConvF(4.18, 4.18, 4.18); Calibrated: 7/26/2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1245; Calibrated: 7/20/2017
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: 1102
- DASYS 52.8.8(1222);
- SEMCAD X Version 14.6.10 (7331)

System Performance Check with D5GHzV2 Dipole (graded grid)/d=10mm, Pin=100mW, f=5600

MHz/Area Scan (10x10x1): Measurement grid: dx=10mm, dy=10mm

Maximum value of SAR (measured) = 16.1 W/kg

System Performance Check with D5GHzV2 Dipole (graded grid)/d=10mm, Pin=100mW, f=5600

MHz/Zoom Scan (4x4x1.4mm, graded), dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm,

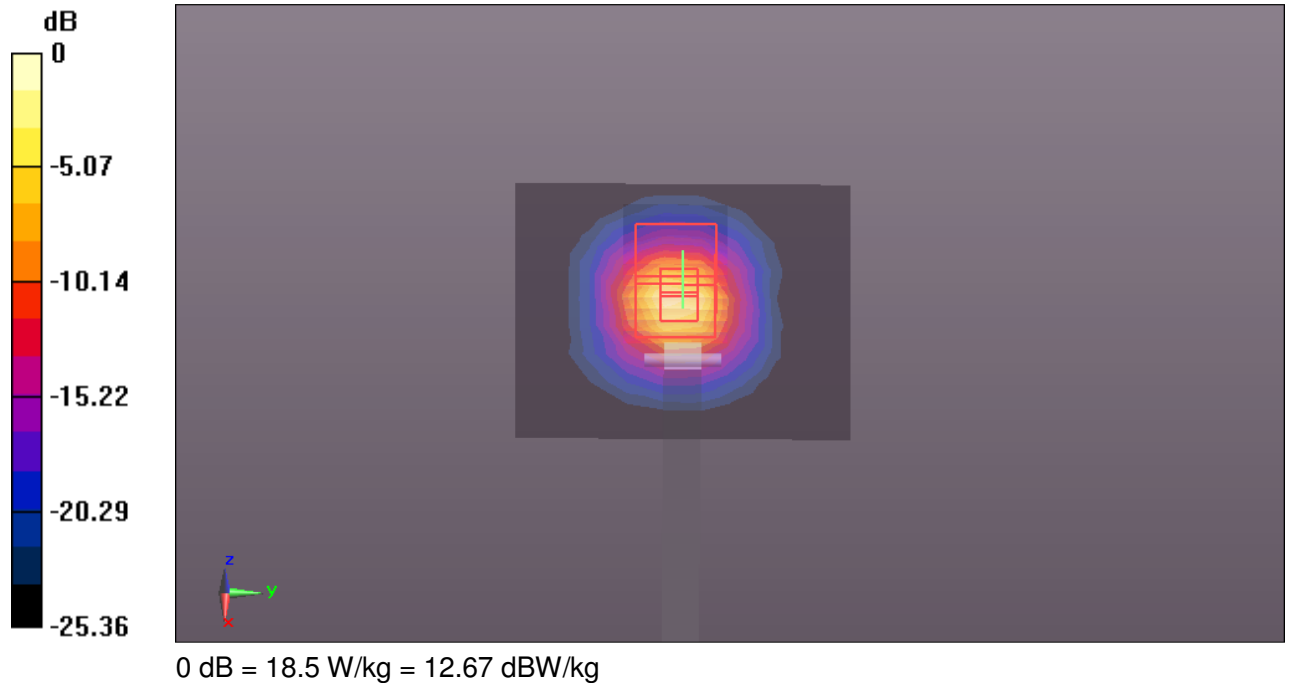
dy=4mm, dz=1.4mm

Reference Value = 60.59 V/m; Power Drift = 0.17 dB

Peak SAR (extrapolated) = 35.7 W/kg

SAR(1 g) = 7.77 W/kg; SAR(10 g) = 2.26 W/kg

Maximum value of SAR (measured) = 18.5 W/kg



Test Laboratory: Compliance Certification Services Inc.

Date: 2/4/2018

SystemPerformanceCheck-Body D5800

DUT: Dipole D5GHzV2; Type: D5GHzV2; SN:1095

Communication System: UID 0, CW; Communication System Band: D5GHz (5000.0 - 6000.0 MHz);

Frequency: 5800 MHz;Duty Cycle: 1:1

Medium parameters used: $f = 5800$ MHz; $\sigma = 6.117$ S/m; $\epsilon_r = 47.901$; $\rho = 1000$ kg/m³

Room Ambient Temperature: 22°C; Liquid Temperature: 21.5°C

Phantom section: Flat Section

Measurement Standard: DASYS (IEEE/IEC/ANSI C63.19-2007)

DASY Configuration:

- Probe: EX3DV4 - SN3798; ConvF(4.45, 4.45, 4.45); Calibrated: 7/26/2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1245; Calibrated: 7/20/2017
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: 1102
- DASYS 52.8.8(1222);
- SEMCAD X Version 14.6.10 (7331)

System Performance Check with D5GHzV2 Dipole (graded grid)/d=10mm, Pin=100mW, f=5800 MHz/Area Scan (10x10x1): Measurement grid: dx=10mm, dy=10mm

Maximum value of SAR (measured) = 13.4 W/kg

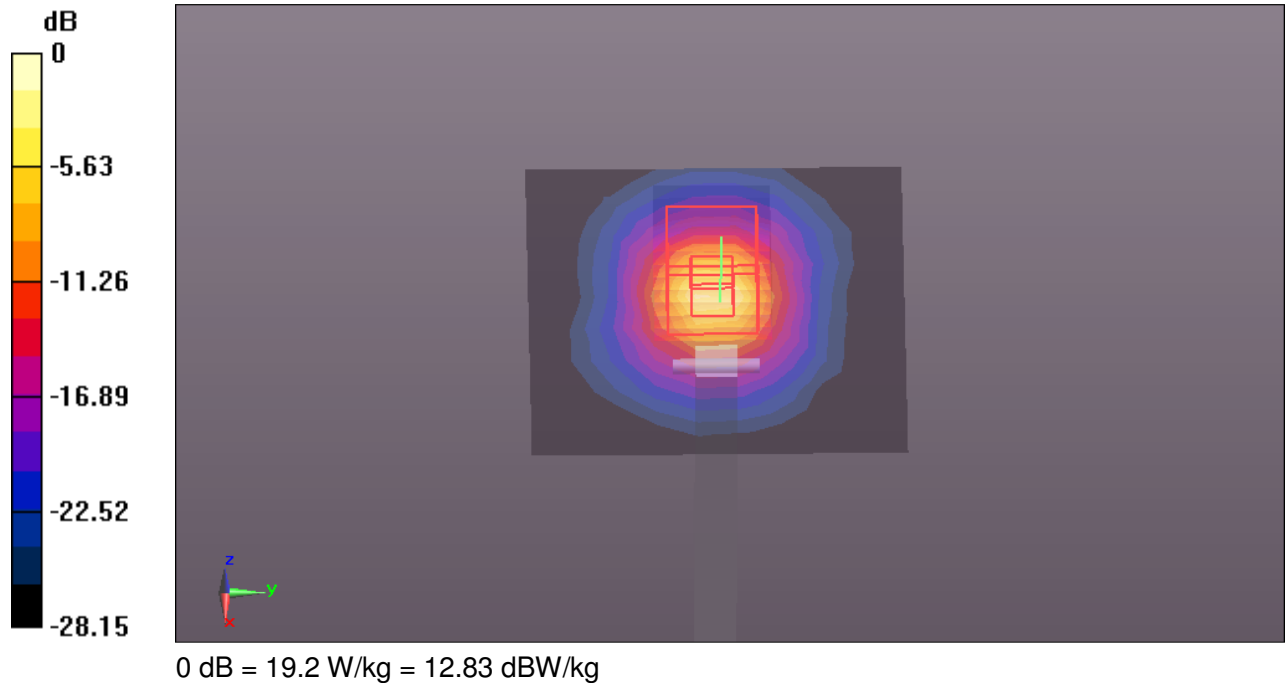
System Performance Check with D5GHzV2 Dipole (graded grid)/d=10mm, Pin=100mW, f=5800 MHz/Zoom Scan (4x4x1.4mm, graded), dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 52.37 V/m; Power Drift = 0.07 dB

Peak SAR (extrapolated) = 38.7 W/kg

SAR(1 g) = 7.71 W/kg; SAR(10 g) = 2.23 W/kg

Maximum value of SAR (measured) = 19.2 W/kg



Appendix C: DASY Calibration Certificate

The DASY Calibration Certificates are showing in the file named Appendix C DASY Calibration Certificate .

Appendix D: Plots of SAR Test Result

The plots are showing in the file named Appendix D Plots of SAR Test Result

- End of the Report -