SAR Test Report

Report No.	:	**SF191114C17A**
Applicant	:	**Lenovo (Shanghai) Electronics Technology Co., Ltd.**
Address	:	**Section 304-305, Building No. 4, #222, Meiyue Road, China (Shanghai) Pilot Free Trade Zone**
Product	:	**Notebook Computer**
FCC ID	:	**O57AX200NGW**
Brand	:	**Lenovo**
Model No.	:	**IdeaPad Slim 7 14ARE05**
Standards	:	**FCC 47 CFR Part 2 (2.1093), IEEE C95.1:1992, IEEE Std 1528:2013 KDB 865664 D01 v01r04, KDB 865664 D02 v01r02 KDB 248227 D01 v02r02 , KDB 447498 D01 v06, KDB 616217 D04 v01r02**
Sample Received Date	:	**Dec. 13, 2019**
Date of Testing	:	**Dec. 27, 2019 ~ Jan. 05, 2020**
Lab Address	:	**No. 47-2, 14th Ling, Chia Pau Vil., Lin Kou Dist., New Taipei City, Taiwan**
Test Location	:	**No. 19, Hwa Ya 2nd Rd., Wen Hwa Vil., Kwei Shan Dist., Taoyuan City, Taiwan**

CERTIFICATION: The above equipment have been tested by **Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch–Lin Kou Laboratories**, 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 : Lena Wang

Lena Wang / Specialist

Approved By : Gordon Lin

Gordon Lin / Manager

FCC Accredited No.: TW0003

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 DASY6 System 6
3.2.1 Robot 7
3.2.2 Probes 8
3.2.3 Data Acquisition Electronics (DAE) 8
3.2.4 Phantoms 8
3.2.5 Device Holder 9
3.2.6 System Validation Dipoles 10
3.2.7 Power Source 10
3.2.8 Tissue Simulating Liquids 11
3.3 SAR System Verification 13
3.4 SAR Measurement Procedure 14
3.4.1 Area Scan and Zoom Scan Procedure 14
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 20
4.2.1 Body Exposure Conditions 20
4.3 Tissue Verification 20
4.4 System Validation 21
4.5 System Verification 21
4.6 Maximum Output Power 22
4.6.1 Maximum Target Conducted Power 22
4.6.2 Measured Conducted Power Result 27
4.7 SAR Testing Results 28
4.7.1 SAR Test Reduction Considerations 28
4.7.2 SAR Results for Body Exposure Condition (Test Separation Distance is 0 mm) 29
4.7.3 SAR Measurement Variability 31
4.7.4 Simultaneous Multi-band Transmission Evaluation 32
5. Calibration of Test Equipment **35**
6. Measurement Uncertainty **36**
7. Information of the Testing Laboratories **37**

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

Report No.	Reason for Change	Date Issued
SF191114C17A	Initial release	Jan. 14, 2020

1. Summary of Maximum SAR Value

Equipment Class	Mode	Highest SAR-1g Body Tested at 0 mm (W/kg)	
		WNC	HTK
DTS	2.4G WLAN	0.24	0.45
NII	5.3G WLAN	0.42	0.76
	5.6G WLAN	0.55	1.00
	5.8G WLAN	0.44	0.95
DSS	Bluetooth	0.01	0.06

Highest Simultaneous Transmission SAR	Highest SAR-1g Body Tested at 0 mm (W/kg)	
	WNC	HTK
	0.97	1.59

Note:

1. The SAR criteria **(Head & Body: SAR-1g1.6 W/kg, and Extremity: SAR-10g 4.0 W/kg)**for general population/uncontrolled exposure is specified in FCC 47 CFR part 2 (2.1093) and ANSI/IEEE C95.1-1992.
2. All of the WLAN MIMO max tune up power are less than the WLAN SISO max tune up power, so there are no need to add MIMO mode testing.

2. Description of Equipment Under Test

EUT Type	Notebook Computer
FCC ID	O57AX200NGW
Brand Name	Lenovo
Model Name	IdeaPad Slim 7 14ARE05
EUT Configuration	Sample 1: EUT with WNC Antenna (No. 1) Sample 2: EUT with WNC Antenna (No. 2) Sample 3: EUT with High-Tek Antenna (No. 3) Sample 4: EUT with High-Tek Antenna (No. 4)
Tx Frequency Bands (Unit: MHz)	WLAN : 2412 ~ 2472, 5180 ~ 5240, 5260 ~ 5320, 5500 ~ 5700,5745 ~ 5825 Bluetooth : 2402 ~ 2480
Uplink Modulations	802.11b : DSSS 802.11a/g/n/ac/ax : OFDM, OFDMA Bluetooth : GFSK, π/4-DQPSK, 8-DPSK
Maximum Tune-up Conducted Power (Unit: dBm)	Please refer to section 4.6.1 of this report
Antenna Type	Refer to note as below
EUT Stage	Production Unit

Note:

1. The WLAN/BT module (Brand: Intel, Model: AX200NGW) was installed in the EUT.
2. The antenna information is listed as below.

No.	Antenna Type	Manufacturer	Parts Number	Antenna Gain (dBi)				
				BT	WLAN 2.4GHz	WLAN 5.15~5.35 GHz	WLAN 5.47~5.725 GHz	WLAN 5.725~5.85 GHz
1	PIFA	Wistron Neweb Corporation	Main / Tx1 Antenna: DQ6615G8600 (81EAA615.G86) Aux / Tx2. Antenna: DQ6615G8600 (81EAA615.G86)	Aux.: -1.18	Main: -1.80 Aux.: -1.18	Main: -0.26 Aux.: -0.15	Main: -1.13 Aux.: -2.01	Main: -0.80 Aux.: -2.01
2		Wistron Neweb Corporation	Main / Tx1 Antenna: DQ6615G9300 (81EAA615.G93) Aux / Tx2. Antenna: DQ6615G9300 (81EAA615.G93)	Aux.: -0.53	Main: -2.27 Aux.: -0.53	Main: -0.53 Aux.: -0.29	Main: -1.55 Aux.: -0.82	Main: -1.19 Aux.: -0.99
3		HTK	Main / Tx1 Antenna: DQ60ACQD063 (0ACQD019089N) Aux / Tx2. Antenna: DQ60ACQD063 (0ACQD019089N)	Aux.: 0.75	Main: -1.71 Aux.: 0.75	Main: -0.03 Aux.: -0.50	Main: 1.88 Aux.: 0.27	Main: 2.80 Aux.: 0.27
4		HTK	Main / Tx1 Antenna: DQ60ACQD064(0ACQD019069N) Aux / Tx2. Antenna: DQ60ACQD064(0ACQD019069N)	Aux.: -0.86	Main: 0.05 Aux.: -0.86	Main: 1.74 Aux.: -0.71	Main: 2.27 Aux.: 0.92	Main: 2.87 Aux.: 0.13
* Only the antenna which has the maximum gain was chosen as a representative for the final test.								

3. 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.

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:

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

SAR is expressed in units of Watts per kilogram (W/kg)
SAR measurement can be related to the electrical field in the tissue by

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

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 DASY6 System

DASY6 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 DASY6 software defined. The DASY6 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 form the optical into digital electric signal of the DAE and transfers data to the PC.

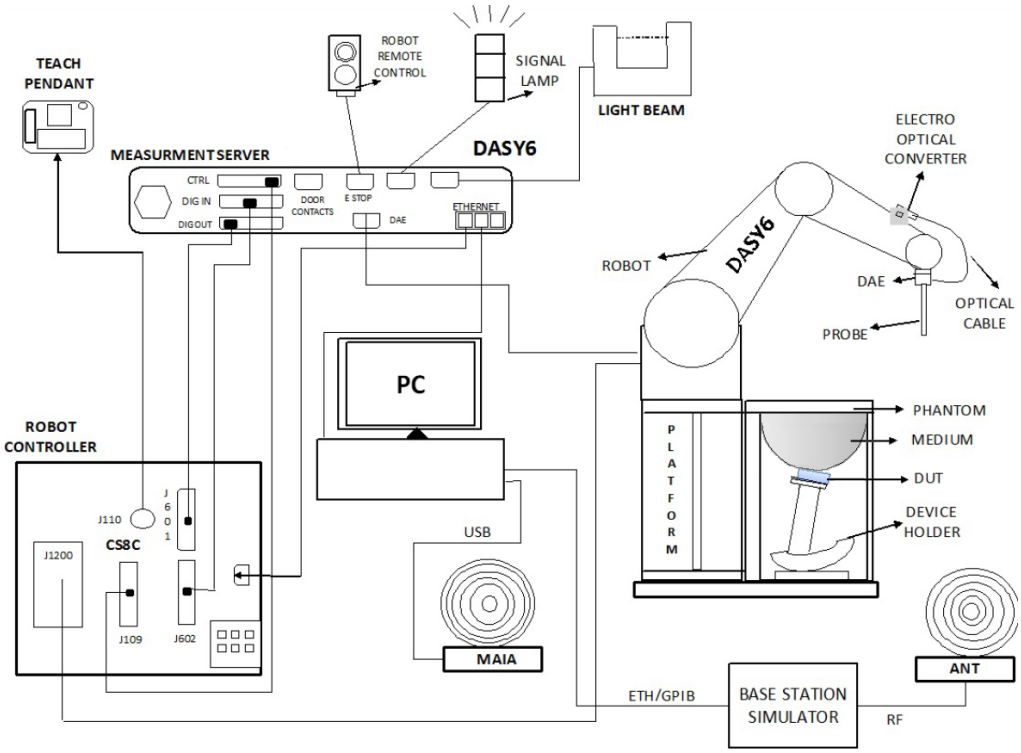


Fig-3.1 SPEAG DASY6 System Setup

3.2.1 Robot

The DASY6 systems use the high precision robots from Stäubli SA (France). For the 6-axis controller system, the robot controller version of CS8c from Stäubli is used. The Stäubli robot series have many features that are important for our application:

- High precision (repeatability ±0.035 mm)
- High reliability (industrial design)
- Jerk-free straight movements
- Low ELF interference (the closed metallic construction shields against motor control fields)

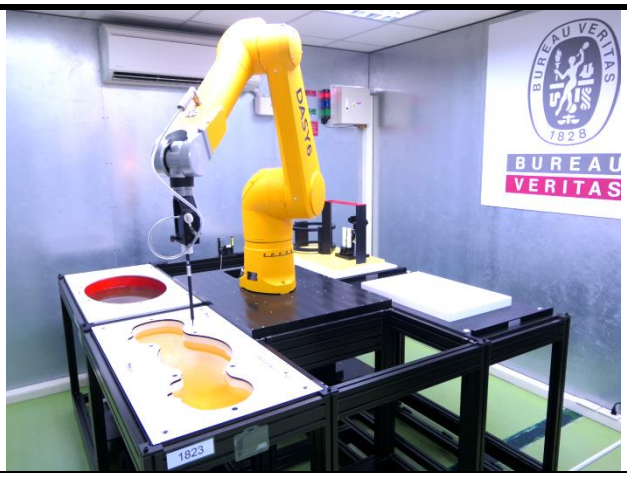


Fig-3.2 SPEAG DASY6 System

3.2.2 Probes

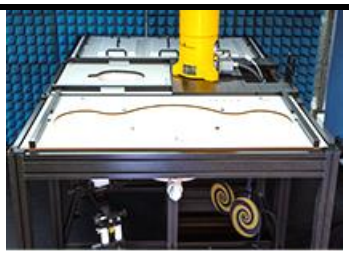
The SAR measurement is conducted with the dosimetric probe. The probe is specially designed and calibrated for use in liquid with high permittivity. The dosimetric probe has special calibration in liquid at different frequency.

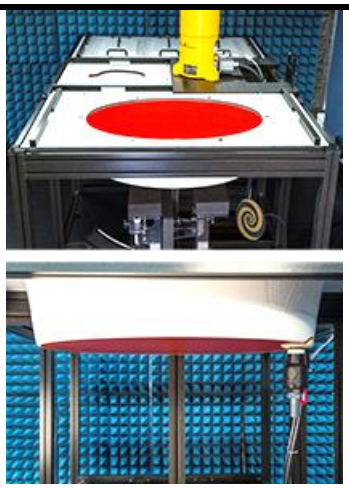
Model	EX3DV4	
Construction	Symmetrical design with triangular core. Built-in shielding against static charges. PEEK enclosure material (resistant to organic solvents, e.g., DGBE).	
Frequency	4 MHz to 10 GHz Linearity: ± 0.2 dB	
Directivity	± 0.1 dB in TSL (rotation around probe axis) ± 0.3 dB in TSL (rotation normal to probe axis)	
Dynamic Range	10 µW/g to 100 mW/g Linearity: ± 0.2 dB (noise: typically < 1 µW/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	

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 DASY 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	< 5µV (with auto zero)	
Input Bias Current	< 50 fA	
Dimensions	60 x 60 x 68 mm	

3.2.4 Phantoms

Model	SAM-Twin Phantom	
Construction	The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (SAM) phantom defined in IEEE Std 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, fiberglass 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	The ELI phantom is used for compliance testing of handheld and body-mounted wireless devices. 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, fiberglass 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	MD4HHTV5 - Mounting Device for Hand-Held Transmitters	
Construction	In combination with the Twin SAM or ELI phantoms, the Mounting Device for Hand-Held Transmitters enables rotation of the mounted transmitter device to specified spherical coordinates. At the heads, the rotation axis is at the ear opening. Transmitter devices can be easily and accurately positioned according to IEC 62209-1, IEEE 1528, FCC, or other specifications. The device holder can be locked for positioning at different phantom sections (left head, right head, flat).	
Material	Polyoxymethylene (POM)	

Model	MDA4WTV5 - Mounting Device Adaptor for Ultra Wide Transmitters	
Construction	An upgrade kit to Mounting Device to enable easy mounting of wider devices like big smart-phones, e-books, small tablets, etc. It holds devices with width up to 140 mm.	
Material	Polyoxymethylene (POM)	

Model	MDA4SPV6 - Mounting Device Adaptor for Smart Phones	
Construction	The solid low-density MDA4SPV6 adaptor assuring no impact on the DUT radiation performance and is conform with any DUT design and shape.	
Material	ROHACELL	

Model	MD4LAPV5 - Mounting Device for Laptops and other Body-Worn Transmitters	
Construction	In combination with the Twin SAM or ELI phantoms, the Mounting Device (Body-Worn) enables testing of transmitter devices according to IEC 62209-2 specifications. The device holder can be locked for positioning at a flat phantom section.	
Material	Polyoxymethylene (POM), PET-G, Foam	

3.2.6 System Validation Dipoles

Model	D-Serial	
Construction	Symmetrical dipole with l/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 Power Source

Model	Powersource1	
Signal Type	Continuous Wave	
Operating Frequencies	600 MHz to 5850 MHz	
Output Power	-5.0 dBm to +17.0 dBm	
Power Supply	5V DC, via USB jack	
Power Consumption	<3 W	
Applications	System performance check and validation with a CW signal.	

3.2.8 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 10 % are listed in Table-3.1.

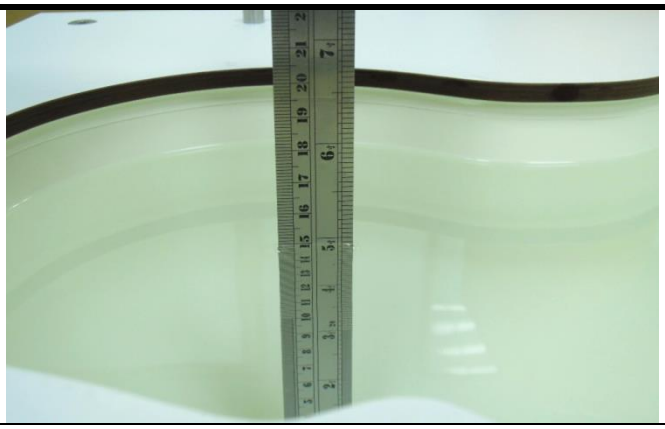


Photo of Liquid Height for Head Position

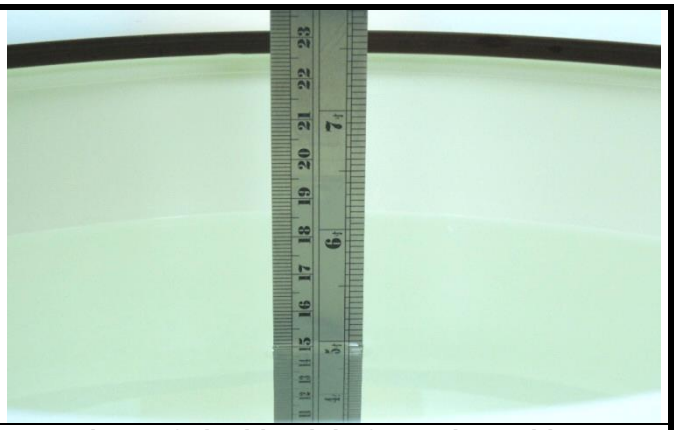


Photo of Liquid Height for Body Position

Table-3.1 Targets of Tissue Simulating Liquid

Frequency (MHz)	Target Permittivity	Range of ±10 %	Target Conductivity	Range of ±10 %
450	43.5	39.2 ~ 47.9	0.87	0.78 ~ 0.96
750	41.9	37.7 ~ 46.1	0.89	0.80 ~ 0.98
835	41.5	37.4 ~ 45.7	0.90	0.81 ~ 0.99
900	41.5	37.4 ~ 45.7	0.97	0.87 ~ 1.07
1450	40.5	36.5 ~ 44.6	1.20	1.08 ~ 1.32
1500	40.4	36.4 ~ 44.4	1.23	1.11 ~ 1.35
1640	40.2	36.2 ~ 44.2	1.31	1.18 ~ 1.44
1750	40.1	36.1 ~ 44.1	1.37	1.23 ~ 1.51
1800	40.0	36.0 ~ 44.0	1.40	1.26 ~ 1.54
1900	40.0	36.0 ~ 44.0	1.40	1.26 ~ 1.54
2000	40.0	36.0 ~ 44.0	1.40	1.26 ~ 1.54
2100	39.8	35.8 ~ 43.8	1.49	1.34 ~ 1.64
2300	39.5	35.6 ~ 43.5	1.67	1.50 ~ 1.84
2450	39.2	35.3 ~ 43.1	1.80	1.62 ~ 1.98
2600	39.0	35.1 ~ 42.9	1.96	1.76 ~ 2.16
3000	38.5	34.7 ~ 42.4	2.40	2.16 ~ 2.64
3500	37.9	34.1 ~ 41.7	2.91	2.62 ~ 3.20
4000	37.4	33.7 ~ 41.1	3.43	3.09 ~ 3.77
4500	36.8	33.1 ~ 40.5	3.94	3.55 ~ 4.33
5000	36.2	32.6 ~ 39.8	4.45	4.01 ~ 4.90
5200	36.0	32.4 ~ 39.6	4.66	4.19 ~ 5.13
5400	35.8	32.2 ~ 39.4	4.86	4.37 ~ 5.35
5600	35.5	32.0 ~ 39.1	5.07	4.56 ~ 5.58
5800	35.3	31.8 ~ 38.8	5.27	4.74 ~ 5.80
6000	35.1	31.6 ~ 38.6	5.48	4.93 ~ 6.03

The dielectric properties of the tissue simulating liquids are defined in IEC 62209-1 and IEC 62209-2. The dielectric properties of the tissue simulating liquids were verified prior to the SAR evaluation using a dielectric assessment kit and a network analyzer.

Since the range of ±10 % of the required target values is used to measure relative permittivity and conductivity, the SAR correction procedure is applied to correct measured SAR for the deviations in permittivity and conductivity. Only positive correction has been used to scale up the measured SAR, and SAR result would not be corrected if the correction △SAR has a negative sign.

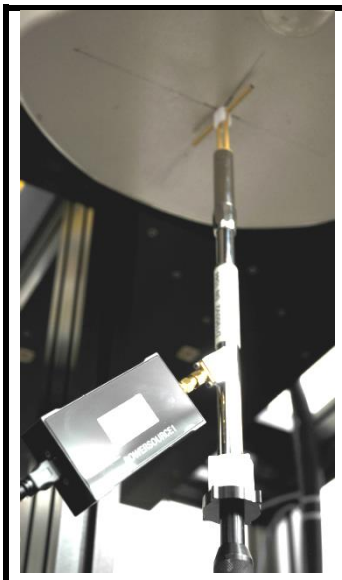
The following table gives the recipes for tissue simulating liquids.

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

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.



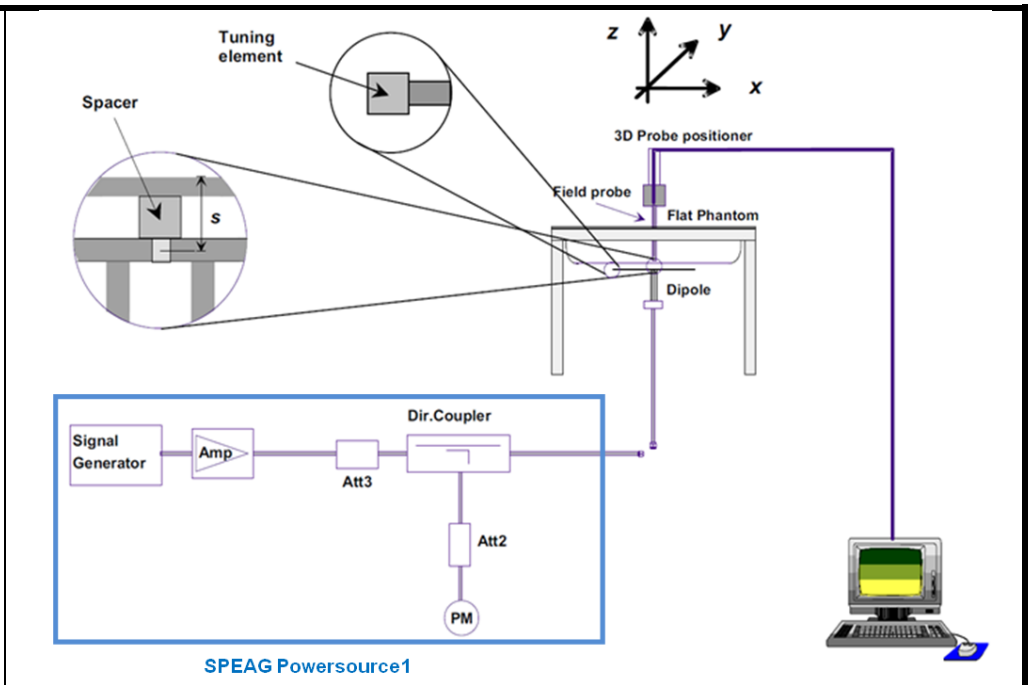


Fig-3.3 System Verification Setup

The SPEAG Powersource1 is a portable and very stable RF source providing a continuous wave (CW) signal. It is designed for conducting SAR system checks and SAR system validation of DASY and is compatible with IEC 62209-1, IEC 62209-2 and IEEE Std 1528 standards. The Powersource1 has been calibrated by SPEAG's ISO/IEC 17025-accredited calibration center. When using Powersource1, the setup can be simplified, as shown in Fig-3.3. The signal purity is warranted by design. Since the Powersource1 is calibrated, no additional equipment is needed and the Powersource1 can directly be connected to the SMA connector of the dipole without a cable as all separate components (signal generator, amplifier, coupler and power meter) are built into the unit.

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 Powersource1 is adjusted for the desired forward power of 17 dBm at the dipole connector and the RF output power would be turned on. 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:

(a) Power reference measurement
(b) Area scan
(c) Zoom scan
(d) Power drift measurement

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

(a) Make EUT to transmit maximum output power
(b) Measure conducted output power through RF cable
(c) Place the EUT in the specific position of phantom
(d) Perform SAR testing steps on the DASY system
(e) Record the SAR value

3.4.1 Area Scan and 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.

Measure the local SAR at a test point at 1.4 mm of the inner surface of the phantom recommended by SEPAG. The area scan (two-dimensional SAR distribution) is performed cover at least an area larger than the projection of the EUT or antenna. The measurement resolution and spatial resolution for interpolation shall be chosen to allow identification of the local peak locations to within one-half of the linear dimension of the corresponding side of the zoom scan volume. Following table provides the measurement parameters required for the area scan.

Parameter	$f \leqq$ 3 GHz	3 GHz < $f \leqq$ 6 GHz
Maximum distance from closest measurement point to phantom surface	5 ± 1	δ ln(2)/2 ±0.5
Maximum probe angle from probe axis to phantom surface normal at the measurement location	30° ±1°	20° ±1°
Maximum area scan spatial resolution: Δx_{Area}, Δy_{Area}	≦2 GHz: ≦15 mm 2 – 3 GHz: ≦12 mm	3 – 4 GHz: ≦12 mm 4 – 6 GHz: ≦10 mm

From the scanned SAR distribution, identify the position of the maximum SAR value, in addition identify the positions of any local maxima with SAR values within 2 dB of the maximum value that will not be within the zoom scan of other peaks. Additional peaks shall be measured only when the primary peak is within 2 dB of the SAR compliance limit (e.g. 1 W/kg for 1.6 W/kg, 1 g limit; or 1.26 W/kg for 2 W/kg, 10 g limit).

The zoom scan (three-dimensional SAR distribution) is performed at the local maxima locations identified in previous area scan procedure. The zoom scan volume must be larger than the required minimum dimensions. When graded grids are used, which only applies in the direction normal to the phantom surface, the initial grid separation closest to the phantom surface and subsequent graded grid increment ratios must satisfy the required protocols. The 1-g SAR averaging volume must be fully contained within the zoom scan measurement volume boundaries; otherwise, the measurement must be repeated by shifting or expanding the zoom scan volume. The similar requirements also apply to 10-g SAR measurements. Following table provides the measurement parameters required for the zoom scan.

Parameter		$f \leqq 3$ GHz	3 GHz < $f \leqq$ 6 GHz
Maximum zoom scan spatial resolution: Δx_{Zoom}, Δy_{Zoom}		≦2 GHz: ≦8 mm 2 – 3 GHz: ≦5 mm	3 – 4 GHz: ≦5 mm 4 – 6 GHz: ≦4 mm
Maximum zoom scan spatial resolution, normal to phantom surface	*uniform grid:* $\Delta z_{Zoom}(n)$	≦5 mm	3 – 4 GHz: ≦4 mm 4 – 5 GHz: ≦3 mm 5 – 6 GHz: ≦2 mm
	graded grids: $\Delta z_{Zoom}(1)$	≦4 mm	3 – 4 GHz: ≦3.0 mm 4 – 5 GHz: ≦2.5 mm 5 – 6 GHz: ≦2.0 mm
	$\Delta z_{Zoom}(n>1)$	≦1.5·$\Delta z_{Zoom}(n-1)$ mm	
Minimum zoom scan volume (x, y, z)		≥30 mm	3 – 4 GHz: ≥28 mm 4 – 5 GHz: ≥25 mm 5 – 6 GHz: ≥22 mm

Per IEC 62209-2 AMD1, the successively higher resolution zoom scan is required if the zoom scan measured as defined above complies with both of the following criteria, or if the peak spatial-average SAR is below 0.1 W/kg, no additional measurements are needed:

(1) The smallest horizontal distance from the local SAR peaks to all points 3 dB below the SAR peak shall be larger than the horizontal grid steps in both x and y directions (Δx, Δy). This shall be checked for the measured zoom scan plane conformal to the phantom at the distance zM1.

(2) The ratio of the SAR at the second measured point (M2) to the SAR at the closest measured point (M1) at the x-y location of the measured maximum SAR value shall be at least 30 %.

If one or both of the above criteria are not met, the zoom scan measurement shall be repeated using a finer resolution. New horizontal and vertical grid steps shall be determined from the measured SAR distribution so that the above criteria are met. Compliance with the above two criteria shall be demonstrated for the new measured zoom scan.

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.

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 form 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

<Considerations Related to WLAN for Setup and Testing>

In general, various vendor specific external test software and chipset based internal test modes are typically used for SAR measurement. These chipset based test mode utilities are generally hardware and manufacturer dependent, and often include substantial flexibility to reconfigure or reprogram a device. A Wi-Fi device must be configured to transmit continuously at the required data rate, channel bandwidth and signal modulation, using the highest transmission duty factor supported by the test mode tools for SAR measurement. The test frequencies established using test mode must correspond to the actual channel frequencies. When 802.11 frame gaps are accounted for in the transmission, a maximum transmission duty factor of 92 - 96% is typically achievable in most test mode configurations. A minimum transmission duty factor of 85% is required to avoid certain hardware and device implementation issues related to wide range SAR scaling. In addition, a periodic transmission duty factor is required for current generation SAR systems to measure SAR correctly. The reported SAR must be scaled to 100% transmission duty factor to determine compliance at the maximum tune-up tolerance limit.

According to KDB 248227 D01,this device has installed WLAN engineering testing software which can provide continuous transmitting RF signal. During WLAN SAR testing, this device was operated to transmit continuously at the maximum transmission duty with specified transmission mode, operating frequency, lowest data rate, and maximum output power.

Initial Test Configuration

An initial test configuration is determined for OFDM transmission modes in 2.4 GHz and 5 GHz bands according to the channel bandwidth, modulation and data rate combination(s) with the highest maximum output power specified for production units in each standalone and aggregated frequency band. When the same maximum power is specified for multiple transmission modes in a frequency band, the largest channel bandwidth, lowest order modulation, lowest data rate and lowest order 802.11a/g/n/ac mode is used for SAR measurement, on the highest measured output power channel in the initial test configuration, for each frequency band.

Subsequent Test Configuration

SAR measurement requirements for the remaining 802.11 transmission mode configurations that have not been tested in the initial test configuration are determined separately for each standalone and aggregated frequency band, in each exposure condition, according to the maximum output power specified for production units. Additional power measurements may be required to determine if SAR measurements are required for subsequent highest output power channels in a subsequent test configuration. When the highest reported SAR for the initial test configuration according to the initial test position or fixed exposure position requirements, is adjusted by the ratio of the subsequent test configuration to initial test configuration specified maximum output power and the adjusted SAR is ≤ 1.2 W/kg, SAR is not required for that subsequent test configuration.

SAR Test Configuration and Channel Selection

When multiple channel bandwidth configurations in a frequency band have the same specified maximum output power, the initial test configuration is using largest channel bandwidth, lowest order modulation, lowest data rate, and lowest order 802.11 mode (i.e., 802.11a is chosen over 802.11n then 802.11ac or 802.11g is chosen over 802.11n).After an initial test configuration is determined, if multiple test channels have the same measured maximum output power, the channel chosen for SAR measurement is determined according to the following.

1) The channel closest to mid-band frequency is selected for SAR measurement.

2) For channels with equal separation from mid-band frequency; for example, high and low channels or two mid-band channels, the higher frequency (number) channel is selected for SAR measurement.

Test Reduction for U-NII-1 (5.2 GHz) and U-NII-2A (5.3 GHz) Bands

For devices that operate in both U-NII 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).

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.

<Considerations Related to Bluetooth for Setup and Testing>

The Bluetooth call box has been used during SAR measurement and the EUT was set to DH5 mode at the maximum output power. Its duty factor was calculated as below and the measured SAR for Bluetooth would be scaled to the 100% transmission duty factor to determine compliance.

Time-domain plot for Bluetooth transmission signal

The duty factor of Bluetooth signal has been calculated as following.

Duty Factor = Pulse Width / Total Period = (2.640-2.250) / (2.875-2.250) = 62.4 %

4.2 EUT Testing Position

4.2.1 Body Exposure Conditions

For laptop PC, according to KDB 616217 D04, SAR evaluation is required for the bottom surface of the keyboard. This EUT was tested in the base of EUT directly against the flat phantom. The required minimum test separation distance for incorporating transmitters and antennas into laptop computer display is determined with the display screen opened at an angle of 90° to the keyboard compartment.

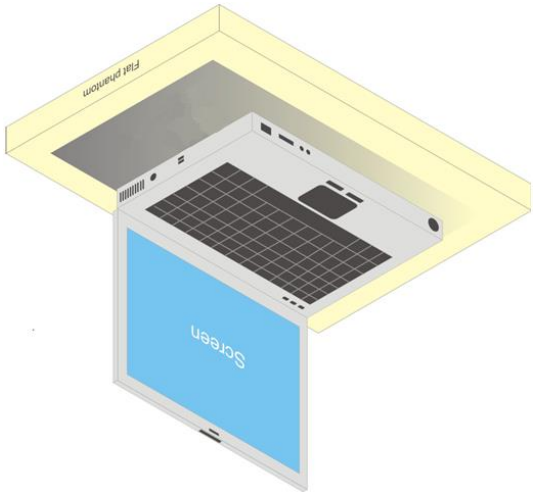


Fig-4.1 Illustration for Laptop Setup

4.3 Tissue Verification

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

Frequency (MHz)	Liquid Temp. (℃)	Measured Conductivity (σ)	Measured Permittivity (ε_r)	Target Conductivity (σ)	Target Permittivity (ε_r)	Conductivity Deviation (%)	Permittivity Deviation (%)	Test Date
2450	23.1	1.866	38.343	1.8	39.2	3.67	-2.19	Dec. 29, 2019
2450	23.4	1.854	38.402	1.8	39.2	3.00	-2.04	Jan. 03, 2020
2450	23.4	1.885	37.962	1.8	39.2	4.72	-3.16	Jan. 05, 2020
5250	23.2	4.597	36.617	4.71	35.9	-2.40	2.00	Dec. 27, 2019
5250	23.5	4.913	36.014	4.71	35.9	4.31	0.32	Dec. 28, 2019
5250	23.2	4.714	36.412	4.71	35.9	0.08	1.43	Dec. 30, 2019
5250	23.4	4.901	36.752	4.71	35.9	4.06	2.37	Jan. 03, 2020
5600	23.2	5.006	36.08	5.07	35.5	-1.26	1.63	Dec. 27, 2019
5600	23.5	5.302	35.397	5.07	35.5	4.58	-0.29	Dec. 28, 2019
5600	23.1	5.141	35.813	5.07	35.5	1.40	0.88	Dec. 30, 2019
5600	23.4	5.234	36.177	5.07	35.5	3.23	1.91	Jan. 03, 2020
5750	23.2	5.175	35.814	5.22	35.4	-0.86	1.17	Dec. 27, 2019
5750	23.4	5.476	35.157	5.22	35.4	4.90	-0.69	Dec. 28, 2019
5750	23.2	5.315	35.552	5.22	35.4	1.82	0.43	Dec. 30, 2019
5750	23.4	5.366	35.661	5.22	35.4	2.80	0.74	Jan. 03, 2020

Note:

The dielectric properties of the tissue simulating liquid have been measured within 24 hours before the SAR testing and within ±10 % of the target values. Liquid temperature during the SAR testing has kept within ±2 ℃.

4.4 System Validation

The SAR measurement system was validated according to procedures in KDB 865664 D01. 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
Dec. 29, 2019	7472	2450	1.866	38.343	Pass	Pass	Pass	OFDM	N/A	Pass
Jan. 03, 2020	3898	2450	1.854	38.402	Pass	Pass	Pass	OFDM	N/A	Pass
Jan. 05, 2020	3898	2450	1.885	37.962	Pass	Pass	Pass	OFDM	N/A	Pass
Dec. 27, 2019	7537	5250	4.597	36.617	Pass	Pass	Pass	OFDM	N/A	Pass
Dec. 28, 2019	7537	5250	4.913	36.014	Pass	Pass	Pass	OFDM	N/A	Pass
Dec. 30, 2019	7472	5250	4.714	36.412	Pass	Pass	Pass	OFDM	N/A	Pass
Jan. 03, 2020	3898	5250	4.901	36.752	Pass	Pass	Pass	OFDM	N/A	Pass
Dec. 27, 2019	7537	5600	5.006	36.08	Pass	Pass	Pass	OFDM	N/A	Pass
Dec. 28, 2019	7537	5600	5.302	35.397	Pass	Pass	Pass	OFDM	N/A	Pass
Dec. 30, 2019	7472	5600	5.141	35.813	Pass	Pass	Pass	OFDM	N/A	Pass
Jan. 03, 2020	3898	5600	5.234	36.177	Pass	Pass	Pass	OFDM	N/A	Pass
Dec. 27, 2019	7537	5750	5.175	35.814	Pass	Pass	Pass	OFDM	N/A	Pass
Dec. 28, 2019	7537	5750	5.476	35.157	Pass	Pass	Pass	OFDM	N/A	Pass
Dec. 30, 2019	7472	5750	5.315	35.552	Pass	Pass	Pass	OFDM	N/A	Pass
Jan. 03, 2020	3898	5750	5.366	35.661	Pass	Pass	Pass	OFDM	N/A	Pass

4.5 System Verification

The measuring result for system verification is tabulated as below.

Test Date	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
Dec. 29, 2019	2450	52.70	2.51	50.20	-4.74	737	7472	579
Jan. 03, 2020	2450	52.70	2.53	50.60	-3.98	737	3898	914
Jan. 05, 2020	2450	52.70	2.57	51.40	-2.47	737	3898	914
Dec. 27, 2019	5250	80.70	3.66	73.20	-9.29	1019	7537	1585
Dec. 28, 2019	5250	80.70	3.91	78.20	-3.10	1019	7537	1585
Dec. 30, 2019	5250	80.70	3.84	76.80	-4.83	1019	7472	579
Jan. 03, 2020	5250	80.70	4.4	88.00	9.05	1019	3898	914
Dec. 27, 2019	5600	85.80	4.01	80.20	-6.53	1019	7537	1585
Dec. 28, 2019	5600	85.80	4.04	80.80	-5.83	1019	7537	1585
Dec. 30, 2019	5600	85.80	4.08	81.60	-4.90	1019	7472	579
Jan. 03, 2020	5600	85.80	4.03	80.60	-6.06	1019	3898	914
Dec. 27, 2019	5750	81.50	3.7	74.00	-9.20	1019	7537	1585
Dec. 28, 2019	5750	81.50	3.85	77.00	-5.52	1019	7537	1585
Dec. 30, 2019	5750	81.50	3.77	75.40	-7.48	1019	7472	579
Jan. 03, 2020	5750	81.50	4.26	85.20	4.54	1019	3898	914

Note:

Comparing to the reference SAR value provided by SPEAG in dipole calibration certificate, the deviation of system check results is within its specification of 10 %. The result indicates the system check can meet the variation criterion and the plots please refer to Appendix A of this report.

4.6 Maximum Output Power

4.6.1 Maximum Target Conducted Power

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

<WLAN 2.4G>

Mode	Channel	Frequency (MHz)	Tune up Power (Ant-0)	Tune up Power (Ant-1)	Tune up Power (Ant-0 + Ant-1)
802.11b	1	2412	17.0	17.0	-
	6	2437	17.0	17.0	-
	11	2462	17.0	17.0	-
	12	2467	17.0	17.0	-
	13	2472	17.0	17.0	-
802.11g	1	2412	17.0	17.0	17.0
	6	2437	17.0	17.0	17.0
	11	2462	17.0	17.0	17.0
	12	2467	17.0	17.0	17.0
	13	2472	17.0	17.0	17.0
802.11n (HT20)	1	2412	17.0	17.0	17.0
	6	2437	17.0	17.0	17.0
	11	2462	17.0	17.0	17.0
	12	2467	17.0	17.0	17.0
	13	2472	17.0	17.0	17.0
802.11n (HT40)	3	2422	17.0	17.0	17.0
	6	2437	17.0	17.0	17.0
	9	2452	17.0	17.0	17.0
	10	2457	17.0	17.0	17.0
	11	2462	17.0	17.0	0.0
802.11ac (VHT20)	1	2412	17.0	17.0	17.0
	6	2437	17.0	17.0	17.0
	11	2462	17.0	17.0	17.0
	12	2467	17.0	17.0	17.0
	13	2472	17.0	17.0	17.0
802.11ac (VHT40)	3	2422	17.0	17.0	17.0
	6	2437	17.0	17.0	17.0
	9	2452	17.0	17.0	17.0
	10	2457	17.0	17.0	17.0
	11	2462	17.0	17.0	17.0
802.11ax (HE20)	1	2412	17.0	17.0	17.0
	6	2437	17.0	17.0	17.0
	11	2462	17.0	17.0	17.0
	12	2467	17.0	17.0	17.0
	13	2472	17.0	17.0	17.0
802.11ax (HE40)	3	2422	17.0	17.0	17.0
	6	2437	17.0	17.0	17.0
	9	2452	17.0	17.0	17.0
	10	2457	17.0	17.0	17.0
	11	2462	17.0	17.0	17.0

<WLAN 5.2G>

Mode	Channel	Frequency (MHz)	Tune up Power (Ant-0)	Tune up Power (Ant-1)	Tune up Power (Ant-0 + Ant-1)
802.11a	36	5180	17.0	17.0	17.0
	40	5200	17.0	17.0	17.0
	44	5220	17.0	17.0	17.0
	48	5240	17.0	17.0	17.0
802.11n (HT20)	36	5180	17.0	17.0	17.0
	40	5200	17.0	17.0	17.0
	44	5220	17.0	17.0	17.0
	48	5240	17.0	17.0	17.0
802.11n (HT40)	38	5190	17.0	17.0	17.0
	46	5230	17.0	17.0	17.0
802.11ac (VHT20)	36	5180	17.0	17.0	17.0
	40	5200	17.0	17.0	17.0
	44	5220	17.0	17.0	17.0
	48	5240	17.0	17.0	17.0
802.11ac (VHT40)	38	5190	17.0	17.0	17.0
	46	5230	17.0	17.0	17.0
802.11ac (VHT80)	42	5210	17.0	17.0	17.0
802.11ax (HE20)	36	5180	17.0	17.0	17.0
	40	5200	17.0	17.0	17.0
	44	5220	17.0	17.0	17.0
	48	5240	17.0	17.0	17.0
802.11ax (HE40)	38	5190	17.0	17.0	17.0
	46	5230	17.0	17.0	17.0
802.11ax (HE80)	42	5210	17.0	17.0	17.0

<WLAN 5.3G>

Mode	Channel	Frequency (MHz)	Tune up Power (Ant-0)	Tune up Power (Ant-1)	Tune up Power (Ant-0 + Ant-1)
802.11a	52	5260	17.0	17.0	17.0
	56	5280	17.0	17.0	17.0
	60	5300	17.0	17.0	17.0
	64	5320	17.0	17.0	17.0
802.11n (HT20)	52	5260	17.0	17.0	17.0
	56	5280	17.0	17.0	17.0
	60	5300	17.0	17.0	17.0
	64	5320	17.0	17.0	17.0
802.11n (HT40)	54	5270	17.0	17.0	17.0
	62	5310	17.0	17.0	17.0
802.11ac (VHT20)	52	5260	17.0	17.0	17.0
	56	5280	17.0	17.0	17.0
	60	5300	17.0	17.0	17.0
	64	5320	17.0	17.0	17.0
802.11ac (VHT40)	54	5270	17.0	17.0	17.0
	62	5310	17.0	17.0	17.0
802.11ac (VHT80)	58	5290	17.0	17.0	17.0
802.11ac (VHT160)	50	5250	17.0	17.0	17.0
802.11ax (HE20)	52	5260	17.0	17.0	17.0
	56	5280	17.0	17.0	17.0
	60	5300	17.0	17.0	17.0
	64	5320	17.0	17.0	17.0
802.11ax (HE40)	54	5270	17.0	17.0	17.0
	62	5310	17.0	17.0	17.0
802.11ax (HE80)	58	5290	17.0	17.0	17.0
802.11ax (HE160)	50	5250	17.0	17.0	17.0

<WLAN 5.6G>

Mode	Channel	Frequency (MHz)	Tune up Power (Ant-0)	Tune up Power (Ant-1)	Tune up Power (Ant-0 + Ant-1)
802.11a	100	5500	17.0	17.0	17.0
	116	5580	17.0	17.0	17.0
	120	5600	17.0	17.0	17.0
	124	5620	17.0	17.0	17.0
	132	5660	17.0	17.0	17.0
	140	5700	17.0	17.0	17.0
	144	5720	17.0	17.0	17.0
802.11n (HT20)	100	5500	17.0	17.0	17.0
	116	5580	17.0	17.0	17.0
	120	5600	17.0	17.0	17.0
	124	5620	17.0	17.0	17.0
	132	5660	17.0	17.0	17.0
	140	5700	17.0	17.0	17.0
	144	5720	17.0	17.0	17.0
802.11n (HT40)	102	5510	17.0	17.0	17.0
	110	5550	17.0	17.0	17.0
	118	5590	17.0	17.0	17.0
	126	5630	17.0	17.0	17.0
	134	5670	17.0	17.0	17.0
	142	5710	17.0	17.0	17.0
802.1ac (VHT20)	100	5500	17.0	17.0	17.0
	116	5580	17.0	17.0	17.0
	120	5600	17.0	17.0	17.0
	124	5620	17.0	17.0	17.0
	132	5660	17.0	17.0	17.0
	140	5700	17.0	17.0	17.0
	144	5720	17.0	17.0	17.0
802.11ac (VHT40)	102	5510	17.0	17.0	17.0
	110	5550	17.0	17.0	17.0
	118	5590	17.0	17.0	17.0
	126	5630	17.0	17.0	17.0
	134	5670	17.0	17.0	17.0
	142	5710	17.0	17.0	17.0
802.11ac (VHT80)	106	5530	17.0	17.0	17.0
	122	5610	17.0	17.0	17.0
	138	5690	17.0	17.0	17.0
802.11ac (VHT160)	114	5570	17.0	17.0	17.0
802.11ax (HE20)	100	5500	17.0	17.0	17.0
	116	5580	17.0	17.0	17.0
	120	5600	17.0	17.0	17.0
	124	5620	17.0	17.0	17.0
	132	5660	17.0	17.0	17.0
	140	5700	17.0	17.0	17.0
	144	5720	17.0	17.0	17.0
802.11ax (HE40)	102	5510	17.0	17.0	17.0
	110	5550	17.0	17.0	17.0
	118	5590	17.0	17.0	17.0
	126	5630	17.0	17.0	17.0
	134	5670	17.0	17.0	17.0
	142	5710	17.0	17.0	17.0
802.11ax (HE80)	106	5530	17.0	17.0	17.0
	122	5610	17.0	17.0	17.0
	138	5690	17.0	17.0	17.0
802.11ax (HE160)	114	5570	17.0	17.0	17.0

<WLAN 5.8G>

Mode	Channel	Frequency (MHz)	Tune up Power (Ant-0)	Tune up Power (Ant-1)	Tune up Power (Ant-0 + Ant-1)
802.11a	149	5745	17.0	17.0	17.0
	153	5765	17.0	17.0	17.0
	157	5785	17.0	17.0	17.0
	161	5805	17.0	17.0	17.0
	165	5825	17.0	17.0	17.0
802.11n (HT20)	149	5745	17.0	17.0	17.0
	153	5765	17.0	17.0	17.0
	157	5785	17.0	17.0	17.0
	161	5805	17.0	17.0	17.0
	165	5825	17.0	17.0	17.0
802.11n (HT40)	151	5755	17.0	17.0	17.0
	159	5795	17.0	17.0	17.0
802.11ac (VHT20)	149	5745	17.0	17.0	17.0
	153	5765	17.0	17.0	17.0
	157	5785	17.0	17.0	17.0
	161	5805	17.0	17.0	17.0
	165	5825	17.0	17.0	17.0
802.11ac (VHT40)	151	5755	17.0	17.0	17.0
	159	5795	17.0	17.0	17.0
802.11ac (VHT80)	155	5775	17.0	17.0	17.0
802.11ax (HE20)	149	5745	17.0	17.0	17.0
	153	5765	17.0	17.0	17.0
	157	5785	17.0	17.0	17.0
	161	5805	17.0	17.0	17.0
	165	5825	17.0	17.0	17.0
802.11ax (HE40)	151	5755	17.0	17.0	17.0
	159	5795	17.0	17.0	17.0
802.11ax (HE80)	155	5775	17.0	17.0	17.0

<Bluetooth>

Mode	Channel	Frequency (MHz)	Tune up Power
Bluetooth EDR	0	2402	9.0
	39	2441	9.0
	78	2480	9.0
Bluetooth LE	0	2402	7.0
	19	2440	7.0
	39	2480	7.0

4.6.2 Measured Conducted Power Result

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

<WLAN 2.4G>

Mode	Channel	Frequency (MHz)	Average Power (Ant-0)	Average Power (Ant-1)	Average Power (Ant-0 + Ant-1)
'802.11b	1	2412	16.97	16.97	-
	6	2437	16.98	16.93	-
	11	2462	16.99	16.99	-
	12	2467	16.93	16.98	-
	13	2472	16.91	16.91	-
802.11n (HT40)	3	2422	-	-	16.99
	6	2437	-	-	16.97
	9	2452	-	-	16.93
	10	2457	-	-	15.63
	11	2462	-	-	15.72

<WLAN 5.2G>

Mode	Channel	Frequency (MHz)	Average Power (Ant-0)	Average Power (Ant-1)	Average Power (Ant-0 + Ant-1)
802.11ac (VHT80)	42	5210	16.98	16.98	16.99

<WLAN 5.3G>

Mode	Channel	Frequency (MHz)	Average Power (Ant-0)	Average Power (Ant-1)	Average Power (Ant-0 + Ant-1)
802.11ac (VHT80)	58	5290	16.99	16.99	16.99
802.11ac (VHT160)	50	5250	16.98	16.97	16.98

<WLAN 5.6G>

Mode	Channel	Frequency (MHz)	Average Power (Ant-0)	Average Power (Ant-1)	Average Power (Ant-0 + Ant-1)
802.11ac (VHT160)	114	5570	16.98	16.99	16.96

<WLAN 5.8G>

Mode	Channel	Frequency (MHz)	Average Power (Ant-0)	Average Power (Ant-1)	Average Power (Ant-0 + Ant-1)
802.11ac (VHT80)	155	5775	16.99	16.99	16.98

<Bluetooth>

Mode	Channel	Frequency (MHz)	Average Power
Bluetooth EDR	0	2402	8.97
	39	2441	8.55
	78	2480	8.99
Bluetooth LE	0	2402	6.80
	19	2440	6.91
	39	2480	6.93

4.7 SAR Testing Results

4.7.1 SAR Test Reduction Considerations

<KDB 447498 D01, General RF Exposure Guidance>

Testing of other required channels within the operating mode of a frequency band is not required when the reported SAR for the mid-band or highest output power channel is:

(1) ≤ 0.8 W/kg or 2.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≤ 100 MHz

(2) ≤ 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

(3) ≤ 0.4 W/kg or 1.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≥ 200 MHz

When SAR is not measured at the maximum power level allowed for production units, the measured SAR will be scaled to the maximum tune-up tolerance limit to determine compliance. The scaling factor for the tune-up power is defined as maximum tune-up limit (mW) / measured conducted power (mW). The reported SAR would be calculated by measured SAR x tune-up power scaling factor.

The SAR has been measured with highest transmission duty factor supported by the test mode tools for WLAN and/or Bluetooth. When the transmission duty factor could not achieve 100%, the reported SAR will be scaled to 100% transmission duty factor to determine compliance at the maximum tune-up power. The scaling factor for the duty factor is defined as 100% / transmission duty cycle (%). The reported SAR would be calculated by measured SAR x tune-up power scaling factor x duty cycle scaling factor.

<KDB 248227 D01, SAR Guidance for Wi-Fi Transmitters>

(1) For handsets operating next to ear, hotspot mode or mini-tablet configurations, the initial test position procedures were applied. The test position with the highest extrapolated peak SAR will be used as the initial test position. When the reported SAR of initial test position is <= 0.4 W/kg, SAR testing for remaining test positions is not required. Otherwise, SAR is evaluated at the subsequent highest peak SAR positions until the reported SAR result is <= 0.8 W/kg or all test positions are measured.

(2) For WLAN 2.4 GHz, the highest measured maximum output power channel for DSSS was selected for SAR measurement. When the reported SAR is <= 0.8 W/kg, no further SAR testing is required. Otherwise, SAR is evaluated at the next highest measured output power channel. When any reported SAR is >1.2 W/kg, SAR is required for the third channel. For OFDM modes (802.11g/n),SAR is not required when the highest reported SAR for DSSS is adjusted by the ratio of OFDM to DSSS specified maximum output power and it is <= 1.2 W/kg.

(3) For WLAN 5GHz, the initial test configuration was selected according to the transmission mode with the highest maximum output power. When the reported SAR of initial test configuration is > 0.8 W/kg, SAR is required for the subsequent highest measured output power channel until the reported SAR result is <=1.2 W/kg or all required channels are measured. For other transmission modes, SAR is not required when the highest reported SAR for initial test configuration is adjusted by the ratio of subsequent test configuration to initial test configuration specified maximum output power and it is <= 1.2 W/kg.

(4) For WLAN MIMO mode, the power-based standalone SAR test exclusion or the sum of SAR provision in KDB 447498to determine simultaneous transmission SAR test exclusion should be applied. Otherwise, SAR for MIMO mode will be measured with all applicable antennas transmitting simultaneously at the specified maximum output power of MIMO operation.

4.7.2 SAR Results for Body Exposure Condition (Test Separation Distance is 0 mm)

<WNC>

Plot No.	Band	Mode	Test Position	Ch.	Sample	Tx Antenna	Duty Cycle	Crest Factor	Max. Tune-up Power (dBm)	Measured Conducted Power (dBm)	Scaling Factor	Power Drift (dB)	Measured SAR-1g (W/kg)	Scaled SAR-1g (W/kg)
	WLAN2.4G	802.11b	Bottom	11	1	Ant 0	99.50	1.01	17.0	16.99	1.00	-0.03	0.231	0.23
	WLAN2.4G	802.11b	Bottom	11	1	Ant 1	99.50	1.01	17.0	16.99	1.00	0.00	0.138	0.14
01	WLAN2.4G	802.11b	Bottom	1	1	Ant 0	99.50	1.01	17.0	16.97	1.01	-0.07	0.231	**0.24**
	WLAN2.4G	802.11b	Bottom	6	1	Ant 0	99.50	1.01	17.0	16.98	1.00	-0.03	0.229	0.23
	WLAN2.4G	802.11b	Bottom	12	1	Ant 0	99.50	1.01	17.0	16.93	1.02	0.02	0.220	0.23
	WLAN2.4G	802.11b	Bottom	13	1	Ant 0	99.50	1.01	17.0	16.91	1.02	0.05	0.225	0.23
	WLAN2.4G	802.11b	Bottom	1	2	Ant 0	99.50	1.01	17.0	16.97	1.01	-0.02	0.215	0.22
	WLAN5.3G	802.11ac VHT160	Bottom	50	1	Ant 0	99.50	1.01	17.0	16.98	1.00	0.02	0.232	0.23
02	WLAN5.3G	802.11ac VHT160	Bottom	50	1	Ant 1	99.30	1.01	17.0	16.97	1.01	-0.12	0.413	**0.42**
	WLAN5.3G	802.11ac VHT160	Bottom	50	2	Ant 1	99.30	1.01	17.0	16.97	1.01	0.01	0.116	0.12
	WLAN5.6G	802.11ac VHT160	Bottom	114	1	Ant 0	99.50	1.01	17.0	16.98	1.00	0.08	0.418	0.42
03	WLAN5.6G	802.11ac VHT160	Bottom	114	1	Ant 1	99.30	1.01	17.0	16.99	1.00	-0.17	0.541	**0.55**
	WLAN5.6G	802.11ac VHT160	Bottom	114	2	Ant 1	99.30	1.01	17.0	16.99	1.00	-0.04	0.352	0.36
	WLAN5.8G	802.11ac VHT80	Bottom	155	1	Ant 0	98.00	1.02	17.0	16.99	1.00	-0.12	0.420	0.43
04	WLAN5.8G	802.11ac VHT80	Bottom	155	1	Ant 1	98.30	1.02	17.0	16.99	1.00	-0.08	0.429	**0.44**
	WLAN5.8G	802.11ac VHT80	Bottom	155	2	Ant 1	98.30	1.02	17.0	16.99	1.00	0.01	0.254	0.26
	BT	BDR	Bottom	0	1	Ant 1	76.80	1.30	9.0	8.97	1.01	-0.06	< 0.001	0.00
	BT	BDR	Bottom	39	1	Ant 1	76.80	1.30	9.0	8.55	1.11	0.15	< 0.001	0.00
05	BT	BDR	Bottom	78	1	Ant 1	76.80	1.30	9.0	8.99	1.00	-0.10	0.00568	**0.01**
	BT	BDR	Bottom	78	2	Ant 1	76.80	1.30	9.0	8.99	1.00	0.15	0.00322	0.01

Note :

1. The "< 0.001" means there is no SAR value or the SAR is too low to be measured.
2. All of the WLAN MIMO max tune up power are less than the WLAN SISO max tune up power, so there are no need to add MIMO mode testing.

<HTK>

Plot No.	Band	Mode	Test Position	Ch.	Sample	Tx Antenna	Duty Cycle	Crest Factor	Max. Tune-up Power (dBm)	Measured Conducted Power (dBm)	Scaling Factor	Power Drift (dB)	Measured SAR-1g (W/kg)	Scaled SAR-1g (W/kg)
	WLAN2.4G	802.11b	Bottom	11	3	Ant 0	99.50	1.01	17.0	16.99	1.00	-0.14	0.327	0.33
	WLAN2.4G	802.11b	Bottom	11	3	Ant 1	99.50	1.01	17.0	16.99	1.00	-0.05	0.305	0.31
06	WLAN2.4G	802.11b	Bottom	1	3	Ant 1	99.50	1.01	17.0	16.97	1.01	-0.03	0.438	**0.45**
	WLAN2.4G	802.11b	Bottom	6	3	Ant 1	99.50	1.01	17.0	16.93	1.02	-0.01	0.293	0.30
	WLAN2.4G	802.11b	Bottom	12	3	Ant 1	99.50	1.01	17.0	16.98	1.00	-0.05	0.29	0.29
	WLAN2.4G	802.11b	Bottom	13	3	Ant 1	99.50	1.01	17.0	16.91	1.02	0.03	0.278	0.29
	WLAN2.4G	802.11b	Bottom	1	4	Ant 1	99.50	1.01	17.0	16.97	1.01	-0.03	0.315	0.32
	WLAN5.3G	802.11ac VHT160	Bottom	50	3	Ant 0	99.50	1.01	17.0	16.98	1.00	-0.03	0.485	0.49
	WLAN5.3G	802.11ac VHT160	Bottom	50	3	Ant 1	99.30	1.01	17.0	16.97	1.01	0.14	0.593	0.60
07	WLAN5.3G	802.11ac VHT160	Bottom	50	4	Ant 0	99.50	1.01	17.0	16.98	1.00	-0.08	0.752	**0.76**
	WLAN5.6G	802.11ac VHT160	Bottom	114	3	Ant 0	99.50	1.01	17.0	16.98	1.00	0.18	0.832	0.84
	WLAN5.6G	802.11ac VHT160	Bottom	114	3	Ant 1	99.30	1.01	17.0	16.99	1.00	0.07	0.788	0.80
08	WLAN5.6G	802.11ac VHT160	Bottom	114	4	Ant 0	99.50	1.01	17.0	16.98	1.00	-0.11	0.994	**1.00**
	WLAN5.6G	802.11ac VHT160	Bottom	114	4	Ant 0	99.50	1.01	17.0	16.98	1.00	-0.07	0.977	0.99
	WLAN5.8G	802.11ac VHT80	Bottom	155	3	Ant 0	98.00	1.02	17.0	16.99	1.00	-0.14	0.742	0.76
	WLAN5.8G	802.11ac VHT80	Bottom	155	3	Ant 1	98.30	1.02	17.0	16.99	1.00	-0.07	0.632	0.64
09	WLAN5.8G	802.11ac VHT80	Bottom	155	4	Ant 0	98.00	1.02	17.0	16.99	1.00	-0.08	0.927	**0.95**
	WLAN5.8G	802.11ac VHT80	Bottom	155	4	Ant 0	98.00	1.02	17.0	16.99	1.00	0.03	0.895	0.91
	BT	BDR	Bottom	0	3	Ant 1	76.80	1.30	9.0	8.97	1.01	0.02	0.018	0.02
	BT	BDR	Bottom	39	3	Ant 1	76.80	1.30	9.0	8.55	1.11	0.14	0.018	0.03
10	BT	BDR	Bottom	78	3	Ant 1	76.80	1.30	9.0	8.99	1.00	-0.02	0.043	**0.06**
	BT	BDR	Bottom	78	4	Ant 1	76.80	1.30	9.0	8.99	1.00	0.01	0.026	0.03

Note :

1. The “< 0.001” means there is no SAR value or the SAR is too low to be measured.
2. All of the WLAN MIMO max tune up power are less than the WLAN SISO max tune up power, so there are no need to add MIMO mode testing.

4.7.3 SAR Measurement Variability

According to KDB 865664 D01, 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 maybe 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.

SAR repeated measurement procedure:

1. When the highest measured SAR is < 0.80 W/kg, repeated measurement is not required.
2. When the highest measured SAR is >= 0.80 W/kg, repeat that measurement once.
3. If the ratio of largest to smallest SAR for the original and first repeated measurements is > 1.20, or when the original or repeated measurement is >= 1.45 W/kg, perform a second repeated measurement.
4. If the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 1.20, and the original, first or second repeated measurement is >= 1.5 W/kg, perform a third repeated measurement.

Band	Mode	Test Position	Ch.	Original Measured SAR-1g (W/kg)	1st Repeated SAR-1g (W/kg)	L/S Ratio	2nd Repeated SAR-1g (W/kg)	L/S Ratio	3rd Repeated SAR-1g (W/kg)	L/S Ratio
WLAN5.6G	802.11ac VHT160	Bottom	114	0.994	0.977	1.02	N/A	N/A	N/A	N/A
WLAN5.8G	802.11ac VHT80	Bottom	155	0.927	0.895	1.04	N/A	N/A	N/A	N/A

4.7.4 Simultaneous Multi-band Transmission Evaluation

<Possibilities of Simultaneous Transmission>

The simultaneous transmission possibilities for this device are listed as below.

Simultaneous TX Combination	Capable Transmit Configurations	Body Exposure Condition
1	WLAN2.4G_Ant0+BT_Ant1	Yes
2	WLAN5G_Ant0+BT_Ant1	Yes
3	WLAN2.4G_Ant0+WLAN2.4G_Ant1	Yes
4	WLAN5G_Ant0+WLAN5G_Ant1	Yes

Note :

1. The WLAN 2.4G and WLAN 5G cannot transmit simultaneously.

<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.

<WNC>

Position	WWAN Gap (mm)	1g SAR W/kg										Summing result 1g SAR W/kg					
		1	2	3	4	5	6	7	8	9	10	1+10	6+10	1+2	3+7	4+8	5+9
		WLAN 2.4GHz Ant 0	WLAN 2.4GHz Ant 1	WLAN 5.3GHz Ant 0	WLAN 5.6GHz Ant 0	WLAN 5.8GHz Ant 0	Max WLAN 5GHz Ant 0	WLAN 5.3GHz Ant 1	WLAN 5.6GHz Ant 1	WLAN 5.8GHz Ant 1	BT Ant 1						
Bottom	0	0.24	0.14	0.23	0.42	0.43	0.43	0.42	0.55	0.44	0.01	0.25	0.44	0.38	0.65	0.97	0.87

<HTK>

Position	WWAN Gap (mm)	1g SAR W/kg										Summing result 1g SAR W/kg					
		1	2	3	4	5	6	7	8	9	10	1+10	6+10	1+2	3+7	4+8	5+9
		WLAN 2.4GHz Ant 0	WLAN 2.4GHz Ant 1	WLAN 5.3GHz Ant 0	WLAN 5.6GHz Ant 0	WLAN 5.8GHz Ant 0	Max WLAN 5GHz Ant 0	WLAN 5.3GHz Ant 1	WLAN 5.6GHz Ant 1	WLAN 5.8GHz Ant 1	BT Ant 1						
Bottom	0	0.33	0.45	0.76	1.00	0.95	1.00	0.60	0.80	0.64	0.06	0.39	1.06	0.78	1.36	1.80	1.59

<SAR to Peak Location Separation Ratio Analysis>

The simultaneous transmitting antennas in each operating mode and exposure condition combination are considered one pair at a time to determine the SPLSR. When SAR is measured for both antennas in the pair, the peak location separation distance is computed by the following formula.

$$\text{Peak Location Separation Distance} = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2 + (z_1 - z_2)^2}$$

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 area or zoom scans.

When standalone test exclusion applies, SAR is estimated; the peak location is assumed to be at the feed-point or geometric center of the antenna. Due to curvatures on the SAM phantom, when SAR is estimated for one of the antennas in an antenna pair, the measured peak SAR location will be translated onto the test device to determine the peak location separation for the antenna pair.

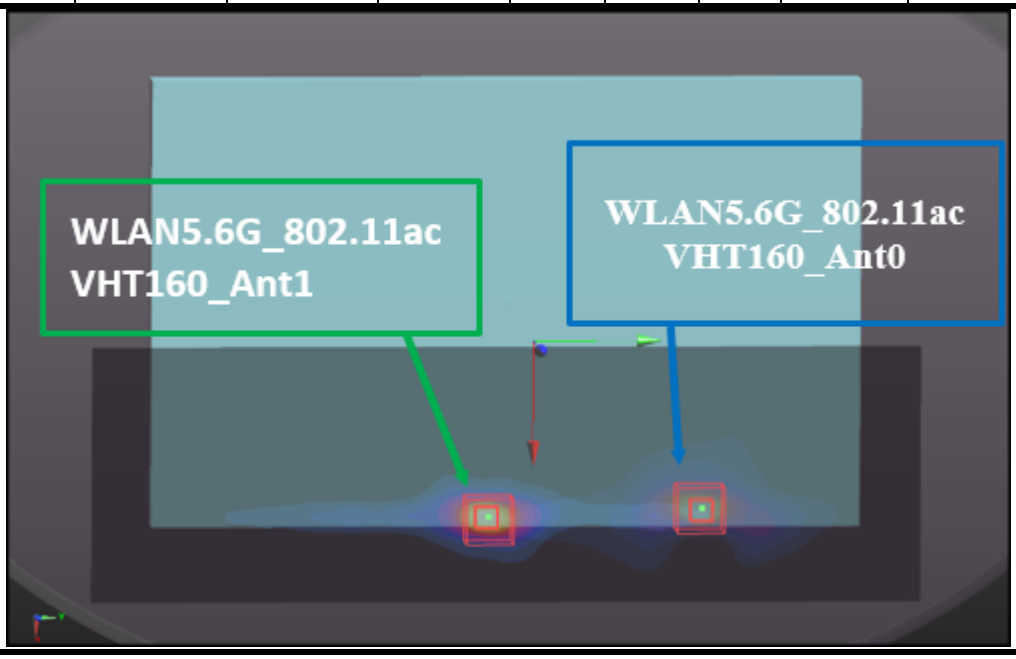
The SPLSR is determined by the following formula.

$$\text{SPLSR} = \frac{(\text{SAR}_1 + \text{SAR}_2)^{1.5}}{R_i}$$

Where SAR_1 and SAR_2 are the highest reported or estimated SAR for each antenna in the pair, and R_i is the separation distance between the peak SAR locations for the antenna pair in mm.

When the SPLSR is <= 0.04, the simultaneous transmission SAR is not required. Otherwise, the enlarged zoom scan and volume scan post-processing procedures will be performed.

Conditions	Exposure Condition	Test Position	SAR Value (W/kg)	Coordinates			Peak Location Separation Distance (R_i, mm)	SPLSR	Simultaneous Transmission SAR Test
				x	y	z			
WLAN5.6G_802.11ac VHT160_Ch114_Ant0	Body	Bottom	1	97.6	82.8	-1.95	91.1	0.03	SPLSR ≤ 0.04, Not required
WLAN5.6G_802.11ac VHT160_Ch114_Ant1			0.80	99.2	-8	5.09			



Test Engineer：Antony Yin, and Mars Chang

5. Calibration of Test Equipment

Equipment	Manufacturer	Model	SN	Cal. Date	Cal. Interval
System Validation Dipole	SPEAG	D2450V2	737	Aug. 26, 2019	1 Year
System Validation Dipole	SPEAG	D5GHzV2	1019	Mar. 21, 2019	1 Year
Dosimetric E-Field Probe	SPEAG	EX3DV4	3898	Jun. 27, 2019	1 Year
Dosimetric E-Field Probe	SPEAG	EX3DV4	7472	Aug. 30, 2019	1 Year
Dosimetric E-Field Probe	SPEAG	EX3DV4	7537	Jun. 18, 2019	1 Year
Data Acquisition Electronics	SPEAG	DAE3	579	Aug. 27, 2019	1 Year
Data Acquisition Electronics	SPEAG	DAE4	861	May. 08, 2019	1 Year
Data Acquisition Electronics	SPEAG	DAE4	1585	Jun. 07, 2019	1 Year
Spectrum Analyzer	R&S	FSL6	102006	Mar. 26, 2019	1 Year
ENA Series Network Analyzer	Agilent	E5071C	MY46214281	Jun. 17, 2019	1 Year
Powersource1	SPEAG	SE_UMS_160 BA	4010	Aug. 21, 2019	1 Year
Thermometer	YFE	YF-160A	130504591	Mar. 22, 2019	1 Year

6. Measurement Uncertainty

According to KDB 865664 D01, SAR measurement uncertainty analysis is required in SAR reports only when the highest measured SAR in a frequency band is ≥ 1.5 W/kg for 1-g SAR, and ≥ 3.75 W/kg for 10-g SAR. The procedures described in IEEE Std 1528-2013should be applied. The expanded SAR measurement uncertainty must be ≤ 30%,for a confidence interval of k = 2. When the highest measured SAR within a frequency band is < 1.5 W/kg for 1-g and < 3.75 W/kg for 10-g, the extensive SAR measurement uncertainty analysis described in IEEE Std 1528-2013 is not required in SAR reports submitted for equipment approval. Hence, the measurement uncertainty analysis is not required in this SAR report because the test result met the condition.

7. Information of 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 Huaya Lab:
Add: No. 19, Huaya 2nd Rd., Guishan Dist., Taoyuan City 333, Taiwan
Tel: +886-(0)3-318-3232
Fax: +886-(0)3-211-5834

Taiwan Linkou Lab:
Add: No. 47-2, Baodoucuokeng, Linkou Dist., New Taipei City 244, Taiwan
Tel: +886-(0)2-2605-2180
Fax: +886-(0)2-2605-2943

Taiwan Hsinchu Lab1:
Add: E-2, No. 1, Lixing 1st Rd., East Dist., Hsinchu City 300, Taiwan
Tel: +886-(0)3-666-8565
Fax: +886-(0)3-666-8323

Taiwan Hsinchu Lab2:
Add: No. 49, Ln. 206, Wende Rd., Qionglin Township, Hsinchu County 307, Taiwan
Tel: +886-(0)3-512-0595
Fax: +886-(0)3-512-0568

Taiwan Xindian Lab:
Add: B2F., No. 215, Sec. 3, Beixin Rd., Xindian Dist., New Taipei City 231, Taiwan
Tel: +886-(0)2-8914-5882
Fax: +886-(0)2-8914-5840

Email: service.adt@tw.bureauveritas.com
Web Site: https://ee.bureauveritas.com.tw/BVInternet/Default

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.

Test Laboratory: Bureau Veritas ADT SAR/HAC Testing Lab Date: 2019/12/29

System Check_H2450_191229

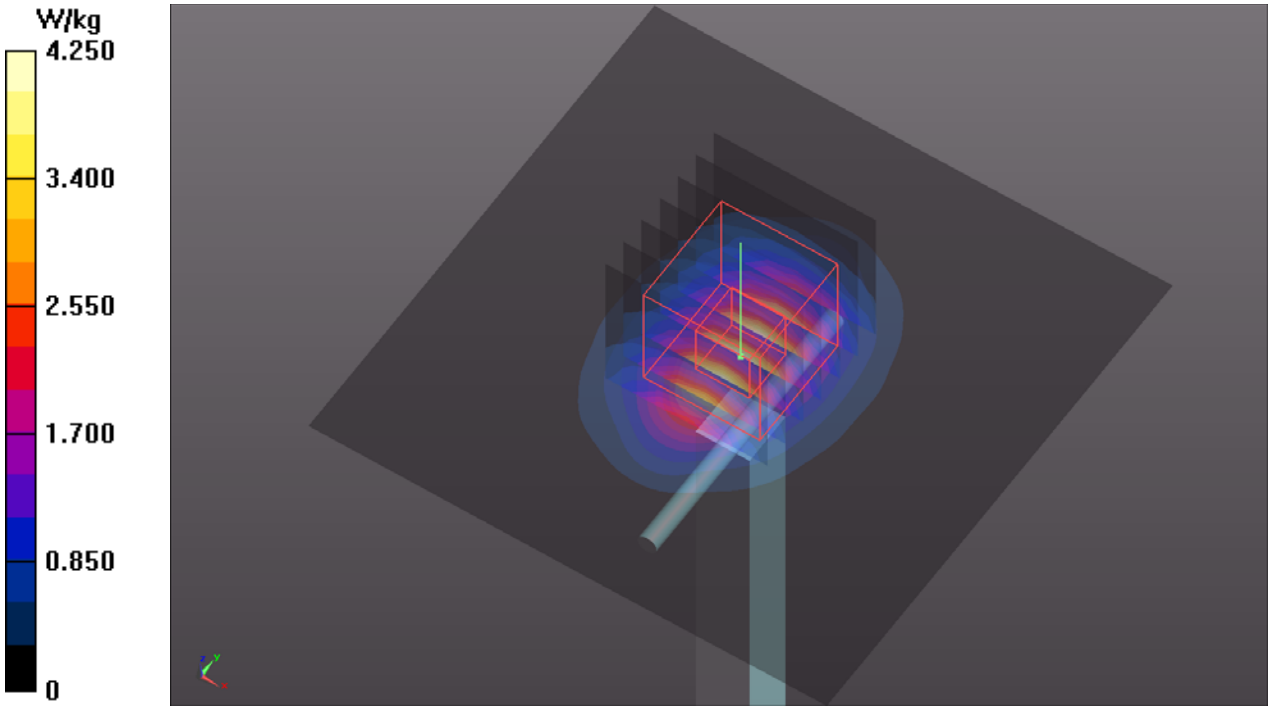
DUT: Dipole 2450 MHz; Type: D2450V2; SN: 737

Communication System: CW; Frequency: 2450 MHz;Duty Cycle: 1:1
Medium: H19T27N1_01229 Medium parameters used: f = 2450 MHz; σ = 1.866 S/m; ε_r = 38.343; ρ = 1000 kg/m^3
Ambient Temperature：23.4 ℃ ； Liquid Temperature：23.1 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN7472; ConvF(7.7, 7.7, 7.7); Calibrated: 2019/08/30
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn579; Calibrated: 2019/08/27
- Phantom: ELI Phantom_1206; Type: QDOVA002AA;
- Measurement SW: DASY52, Version 52.10 (3); SEMCAD X Version 14.6.13 (7474)

Pin=50mW/Area Scan (81x81x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm
Maximum value of SAR (interpolated) = 4.25 W/kg

Pin=50mW/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 49.75 V/m; Power Drift = -0.06 dB
Peak SAR (extrapolated) = 5.22 W/kg
SAR(1 g) = 2.51 W/kg; SAR(10 g) = 1.19 W/kg (SAR corrected for target medium)
Maximum value of SAR (measured) = 4.27 W/kg



System Check_H5250_191227

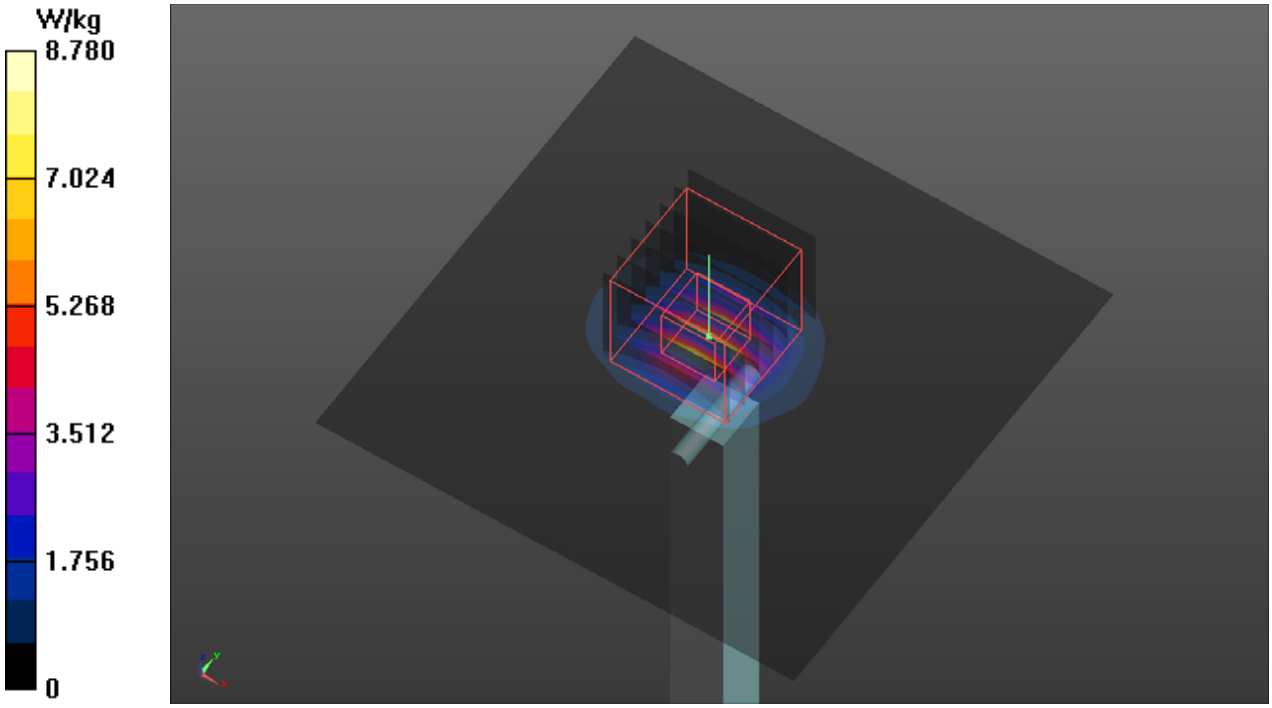
DUT: Dipole D5GHzV2; Type: D5GHzV2; SN: 1019

Communication System: CW; Frequency: 5250 MHz;Duty Cycle: 1:1
Medium: H34T60N4_1227 Medium parameters used: f = 5250 MHz; σ = 4.597 S/m; ε_r = 36.617; ρ = 1000 kg/m^3
Ambient Temperature：23.6 ℃ ； Liquid Temperature：23.2 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN7537; ConvF(5.36, 5.36, 5.36); Calibrated: 2019/06/18
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1585; Calibrated: 2019/06/07
- Phantom: ELI Phantom_1245; Type: QDOVA002AA;
- Measurement SW: DASY52, Version 52.10 (3); SEMCAD X Version 14.6.13 (7474)

Pin=50mW/Area Scan (91x91x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 8.78 W/kg

Pin=50mW/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 45.31 V/m; Power Drift = -0.03 dB
Peak SAR (extrapolated) = 14.9 W/kg
SAR(1 g) = 3.66 W/kg; SAR(10 g) = 1.05 W/kg (SAR corrected for target medium)
Maximum value of SAR (measured) = 9.13 W/kg



System Check_H5600_191227

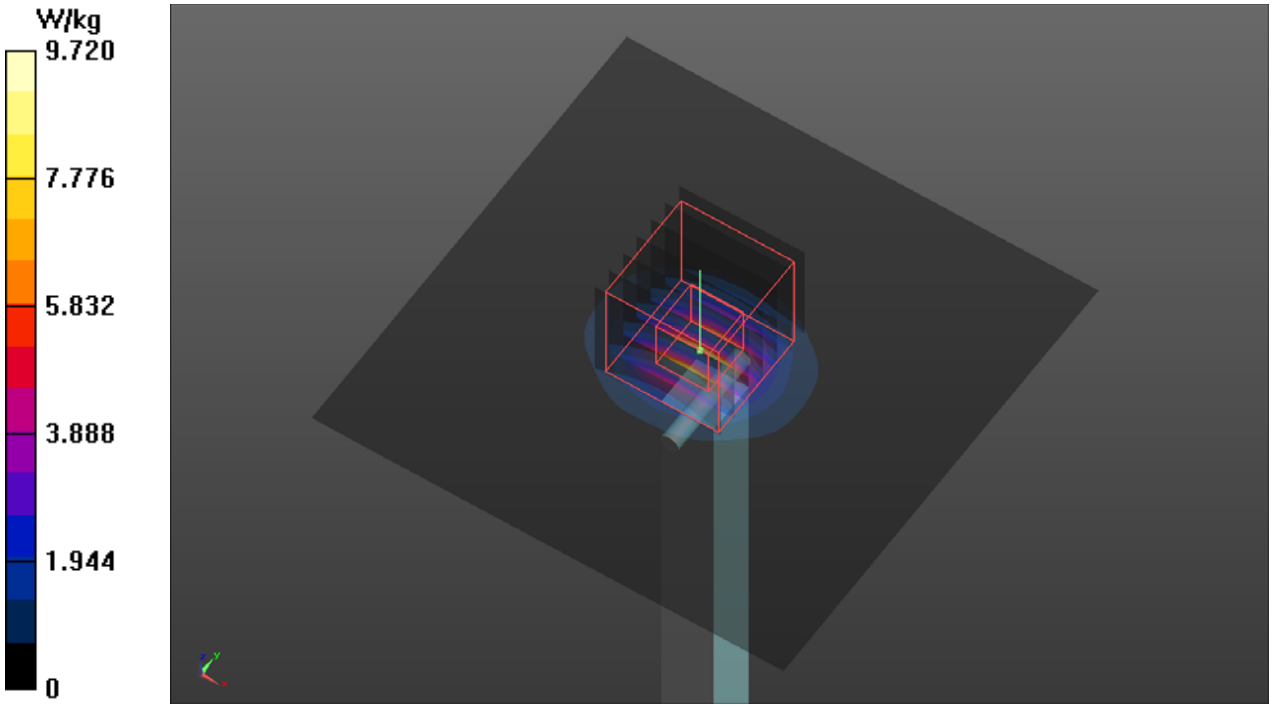
DUT: Dipole 5 GHz; Type: D5GHzV2; SN: 1019

Communication System: CW; Frequency: 5600 MHz;Duty Cycle: 1:1
Medium: H34T60N4_1227 Medium parameters used: f = 5600 MHz; σ = 5.006 S/m; ε_r = 36.08; ρ = 1000 kg/m^3
Ambient Temperature：23.6 ℃ ； Liquid Temperature：23.2 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN7537; ConvF(4.75, 4.75, 4.75); Calibrated: 2019/06/18
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1585; Calibrated: 2019/06/07
- Phantom: ELI Phantom_1245; Type: QDOVA002AA;
- Measurement SW: DASY52, Version 52.10 (3); SEMCAD X Version 14.6.13 (7474)

Pin=50mW/Area Scan (91x91x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 9.72 W/kg

Pin=50mW/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 50.39 V/m; Power Drift = -0.14 dB
Peak SAR (extrapolated) = 18.2 W/kg
SAR(1 g) = 4.01 W/kg; SAR(10 g) = 1.13 W/kg (SAR corrected for target medium)
Maximum value of SAR (measured) = 10.6 W/kg



Test Laboratory: Bureau Veritas ADT SAR/HAC Testing Lab Date: 2019/12/27

System Check_H5750_191227

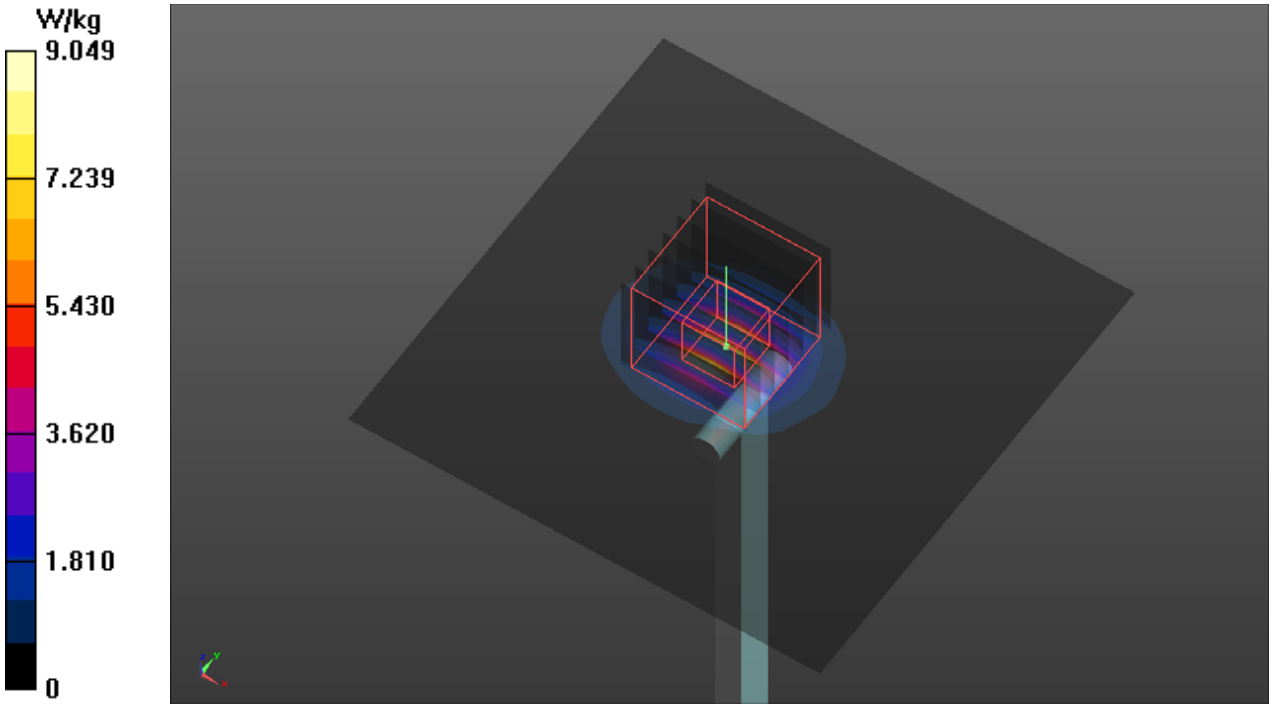
DUT: Dipole 5 GHz; Type: D5GHzV2; SN: 1019

Communication System: CW; Frequency: 5750 MHz;Duty Cycle: 1:1
Medium: H34T60N4_1227 Medium parameters used: f = 5750 MHz; σ = 5.175 S/m; ε_r = 35.814; ρ = 1000 kg/m^3
Ambient Temperature：23.6 ℃ ； Liquid Temperature：23.2 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN7537; ConvF(4.99, 4.99, 4.99); Calibrated: 2019/06/18
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1585; Calibrated: 2019/06/07
- Phantom: ELI Phantom_1245; Type: QDOVA002AA;
- Measurement SW: DASY52, Version 52.10 (3); SEMCAD X Version 14.6.13 (7474)

Pin=50mW/Area Scan (91x91x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 9.05 W/kg

Pin=50mW/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 45.08 V/m; Power Drift = -0.02 dB
Peak SAR (extrapolated) = 17.3 W/kg
SAR(1 g) = 3.70 W/kg; SAR(10 g) = 1.04 W/kg (SAR corrected for target medium)
Maximum value of SAR (measured) = 9.62 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 WLAN2.4G_802.11b_Bottom_0mm_Ch1_Sample1_Ant0

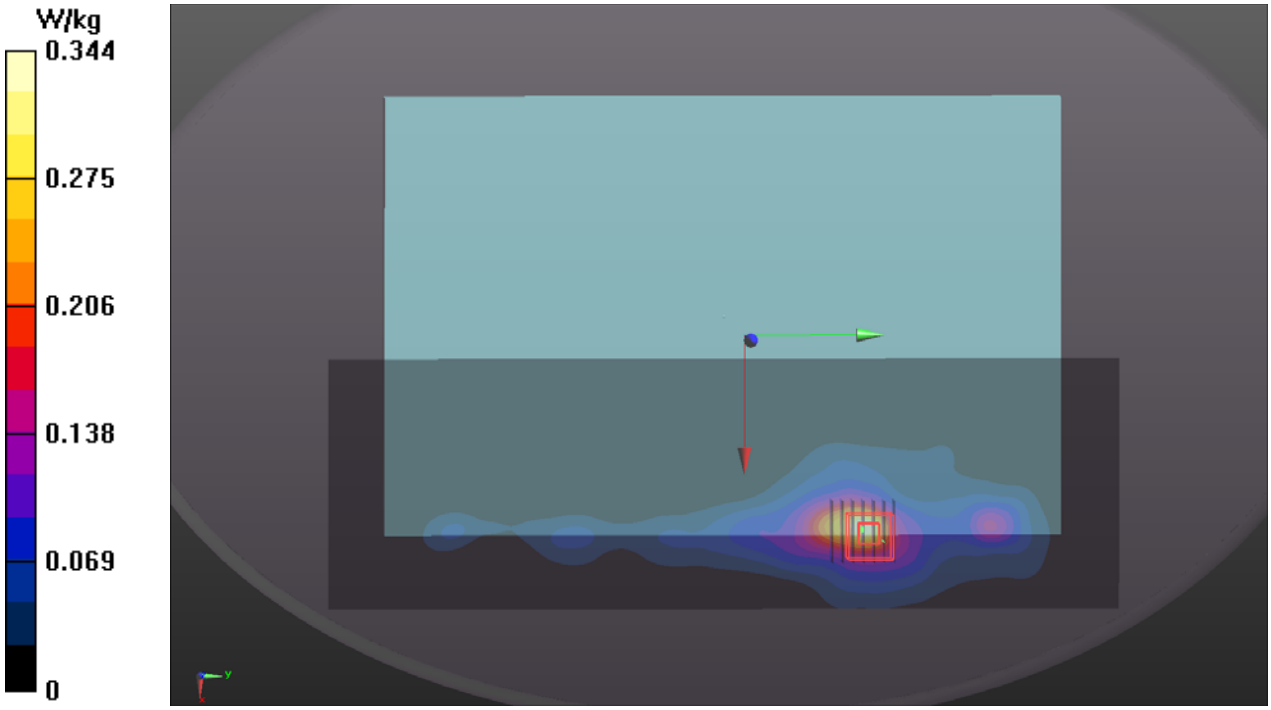
DUT: 191213C02

Communication System: IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps, 99pc duty cycle);
Frequency: 2412 MHz;Duty Cycle: 1:1.01
Medium: H19T27N1_01229 Medium parameters used: f = 2412 MHz; σ = 1.83 S/m; ε_r = 38.504; ρ = 1000 kg/m^3
Ambient Temperature：23.4 ℃； Liquid Temperature：23.1 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN7472; ConvF(7.7, 7.7, 7.7); Calibrated: 2019/08/30
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn579; Calibrated: 2019/08/27
- Phantom: ELI Phantom_1206; Type: QDOVA002AA;
- Measurement SW: DASY52, Version 52.10 (3); SEMCAD X Version 14.6.13 (7474)

- Area Scan (101x321x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm
Maximum value of SAR (interpolated) = 0.344 W/kg

- Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 13.95 V/m; Power Drift = -0.07 dB
Peak SAR (extrapolated) = 0.432 W/kg
SAR(1 g) = 0.231 W/kg; SAR(10 g) = 0.112 W/kg (SAR corrected for target medium)
Smallest distance from peaks to all points 3 dB below = 6.4 mm
Ratio of SAR at M2 to SAR at M1 = 53.3%
Maximum value of SAR (measured) = 0.354 W/kg



P02 WLAN5.3G_802.11ac VHT160_Bottom_0mm_Ch50_Sample1_Ant1

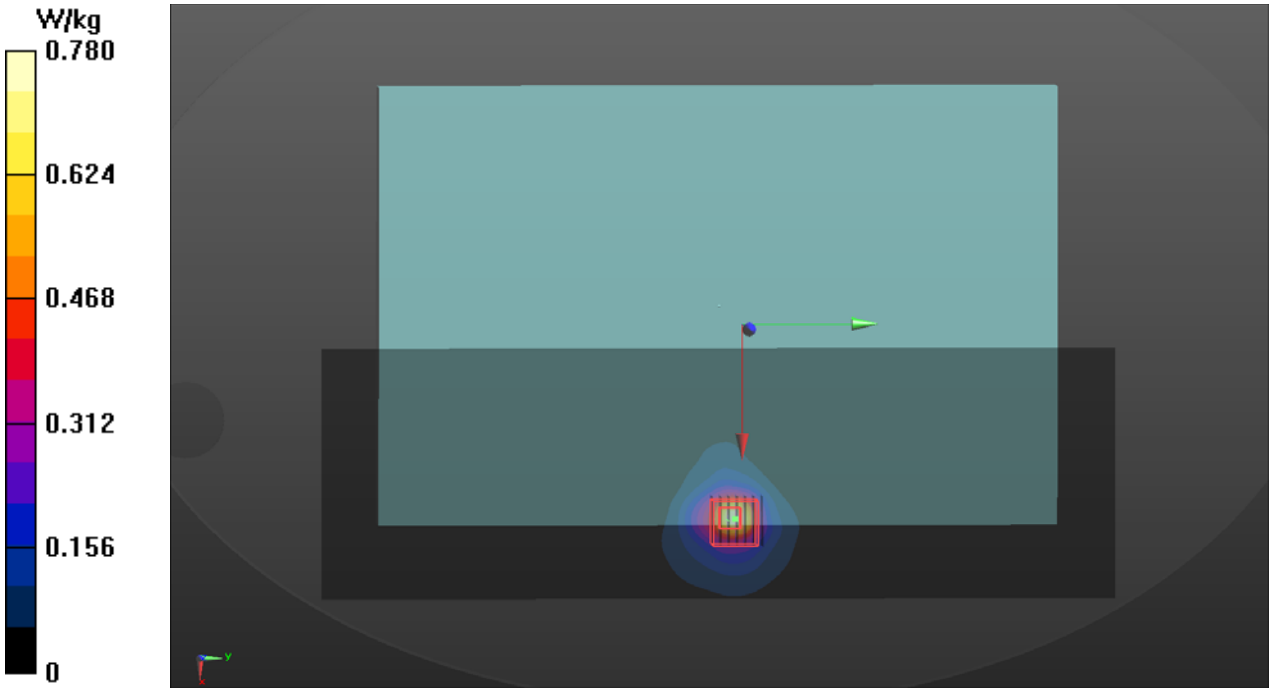
DUT: 191213C02

Communication System: IEEE 802.11ac WiFi (160MHz, MCS0, 99pc duty cycle); Frequency: 5250 MHz;Duty Cycle: 1:1.01
Medium: H34T60N4_1227 Medium parameters used: f = 5250 MHz; σ = 4.597 S/m; ε_r = 36.617; ρ = 1000 kg/m^3
Ambient Temperature：23.6 ℃； Liquid Temperature：23.2 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN7537; ConvF(5.36, 5.36, 5.36); Calibrated: 2019/06/18
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1585; Calibrated: 2019/06/07
- Phantom: ELI Phantom_1245; Type: QDOVA002AA;
- Measurement SW: DASY52, Version 52.10 (3); SEMCAD X Version 14.6.13 (7474)

- Area Scan (121x381x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 0.780 W/kg

- Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 14.13 V/m; Power Drift = -0.12 dB
Peak SAR (extrapolated) = 1.38 W/kg
SAR(1 g) = 0.413 W/kg; SAR(10 g) = 0.146 W/kg (SAR corrected for target medium)
Smallest distance from peaks to all points 3 dB below = 8.2 mm
Ratio of SAR at M2 to SAR at M1 = 68.4%
Maximum value of SAR (measured) = 0.899 W/kg



P03 WLAN5.6G_802.11ac VHT160_Bottom_0mm_Ch114_Sample1_Ant1

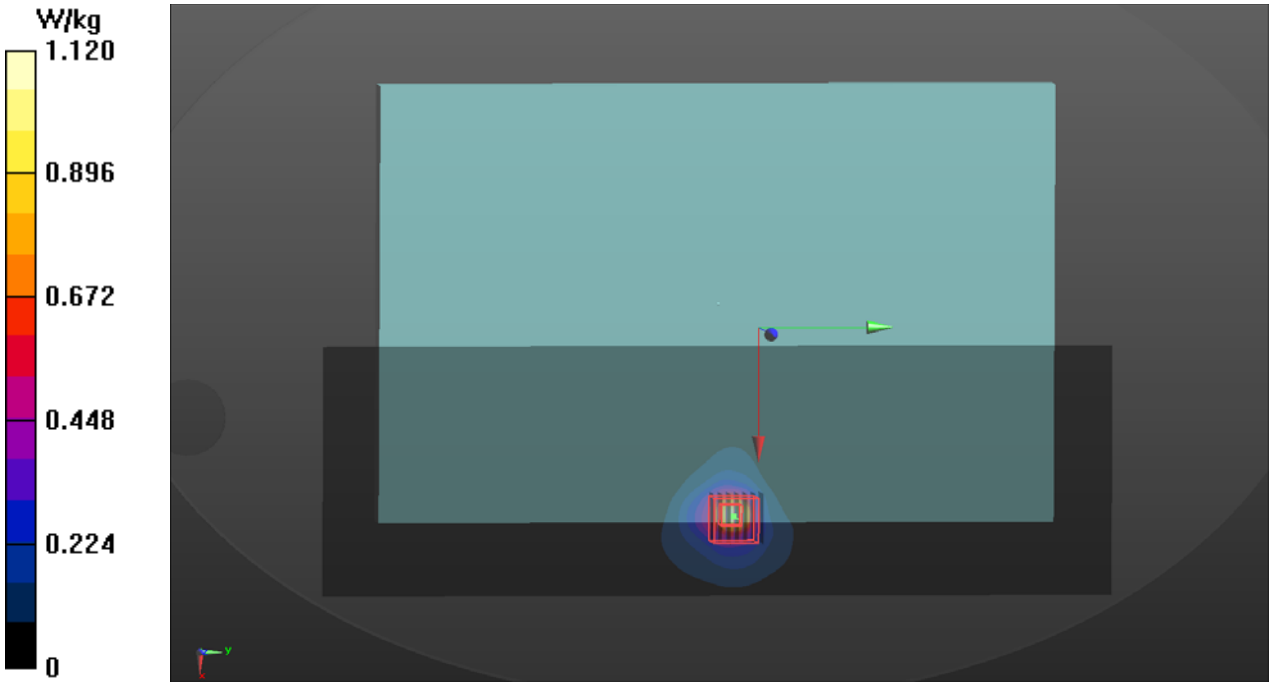
DUT: 191213C02

Communication System: IEEE 802.11ac WiFi (160MHz, MCS0, 99pc duty cycle); Frequency: 5570 MHz;Duty Cycle: 1:1.01
Medium: H34T60N4_1227 Medium parameters used: f = 5570 MHz; σ = 4.966 S/m; ε_r = 36.132; ρ = 1000 kg/m^3
Ambient Temperature：23.6 ℃； Liquid Temperature：23.2 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN7537; ConvF(4.75, 4.75, 4.75); Calibrated: 2019/06/18
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1585; Calibrated: 2019/06/07
- Phantom: ELI Phantom_1245; Type: QDOVA002AA;
- Measurement SW: DASY52, Version 52.10 (3); SEMCAD X Version 14.6.13 (7474)

- Area Scan (121x381x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 1.12 W/kg

- Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 16.31 V/m; Power Drift = -0.17 dB
Peak SAR (extrapolated) = 2.02 W/kg
SAR(1 g) = 0.541 W/kg; SAR(10 g) = 0.185 W/kg (SAR corrected for target medium)
Smallest distance from peaks to all points 3 dB below = 7.9 mm
Ratio of SAR at M2 to SAR at M1 = 64.8%
Maximum value of SAR (measured) = 1.22 W/kg



Test Laboratory: Bureau Veritas ADT SAR/HAC Testing Lab Date: 2019/12/27

P04 WLAN5.8G_802.11ac VHT80_Bottom_0mm_Ch155_Sample1_Ant1

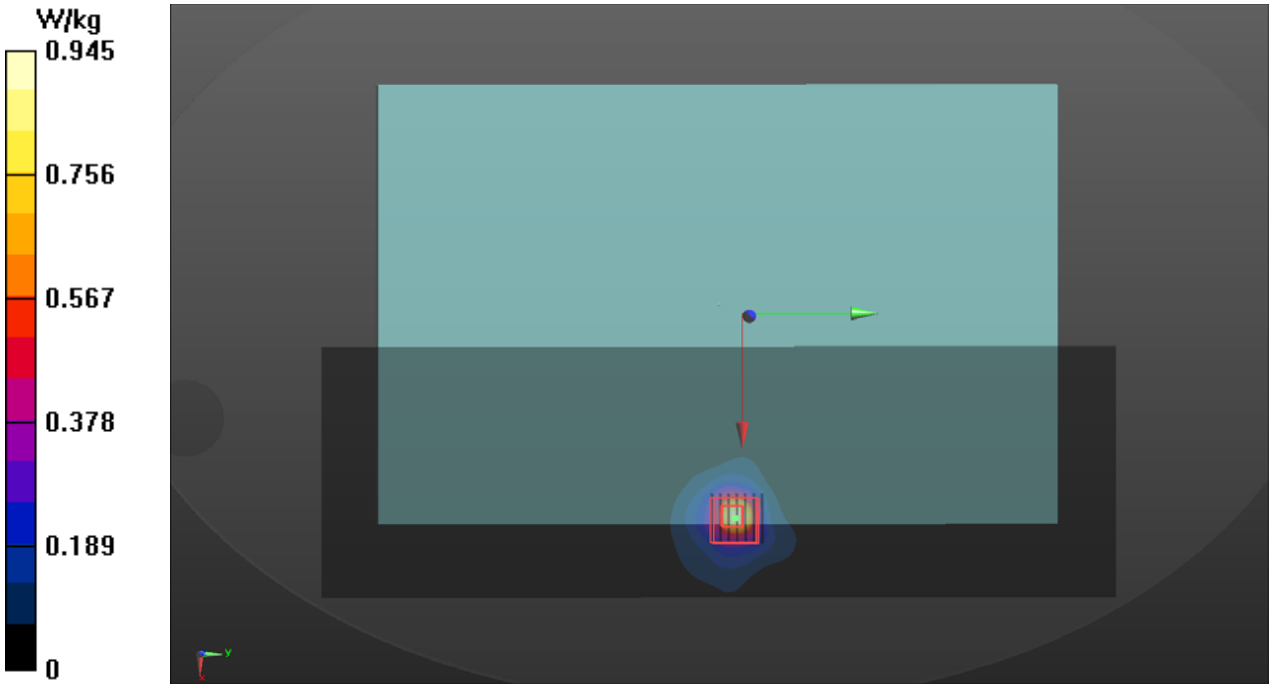
DUT: 191213C02

Communication System: IEEE 802.11ac WiFi (80MHz, MCS0, 99pc duty cycle); Frequency: 5775 MHz;Duty Cycle: 1:1.02
Medium: H34T60N4_1227 Medium parameters used: f = 5775 MHz; σ = 5.203 S/m; ε_r = 35.794; ρ = 1000 kg/m^3
Ambient Temperature：23.6 ℃ ； Liquid Temperature：23.2 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN7537; ConvF(4.99, 4.99, 4.99); Calibrated: 2019/06/18
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1585; Calibrated: 2019/06/07
- Phantom: ELI Phantom_1245; Type: QDOVA002AA;
- Measurement SW: DASY52, Version 52.10 (3); SEMCAD X Version 14.6.13 (7474)

- Area Scan (121x381x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 0.945 W/kg

- Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 14.56 V/m; Power Drift = -0.08 dB
Peak SAR (extrapolated) = 1.70 W/kg
SAR(1 g) = 0.429 W/kg; SAR(10 g) = 0.145 W/kg (SAR corrected for target medium)
Smallest distance from peaks to all points 3 dB below = 7.9 mm
Ratio of SAR at M2 to SAR at M1 = 63.3%
Maximum value of SAR (measured) = 0.995 W/kg



P05 BT_BDR_Bottom_0mm_Ch78_Sample1_Ant1

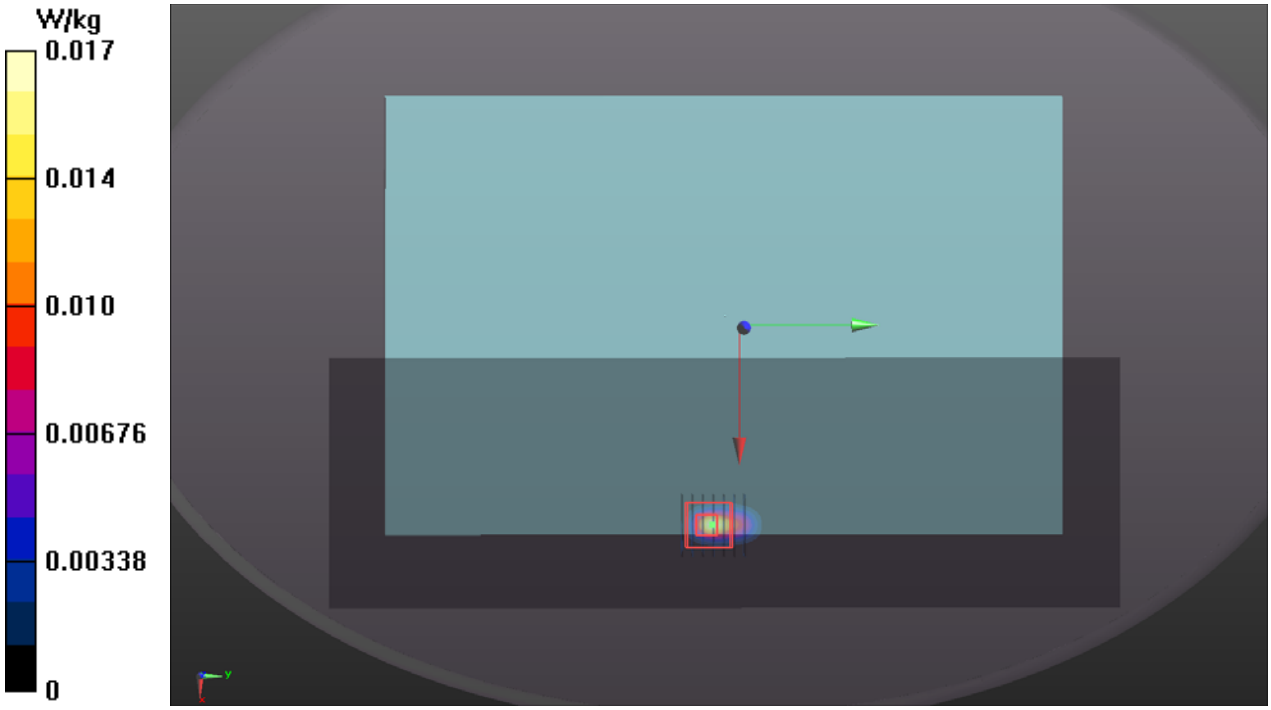
DUT: 191213C02

Communication System: IEEE 802.15.1 Bluetooth (GFSK, DH5); Frequency: 2480 MHz;Duty Cycle: 1:1.3
Medium: H19T27N1_01229 Medium parameters used: f = 2480 MHz; σ = 1.898 S/m; ε_r = 38.232; ρ = 1000 kg/m^3
Ambient Temperature：23.4 ℃ ； Liquid Temperature：23.1 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN7472; ConvF(7.7, 7.7, 7.7); Calibrated: 2019/08/30
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn579; Calibrated: 2019/08/27
- Phantom: ELI Phantom_1206; Type: QDOVA002AA;
- Measurement SW: DASY52, Version 52.10 (3); SEMCAD X Version 14.6.13 (7474)

- Area Scan (101x321x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm
Maximum value of SAR (interpolated) = 0.0169 W/kg

- Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 2.799 V/m; Power Drift = -0.10 dB
Peak SAR (extrapolated) = 0.0200 W/kg
SAR(1 g) = 0.00568 W/kg; SAR(10 g) = 0.00123 W/kg (SAR corrected for target medium)
Ratio of SAR at M2 to SAR at M1 = 35%
Maximum value of SAR (measured) = 0.0146 W/kg



P06 WLAN2.4G_802.11b_Bottom_0mm_Ch1_Sample3_Ant1

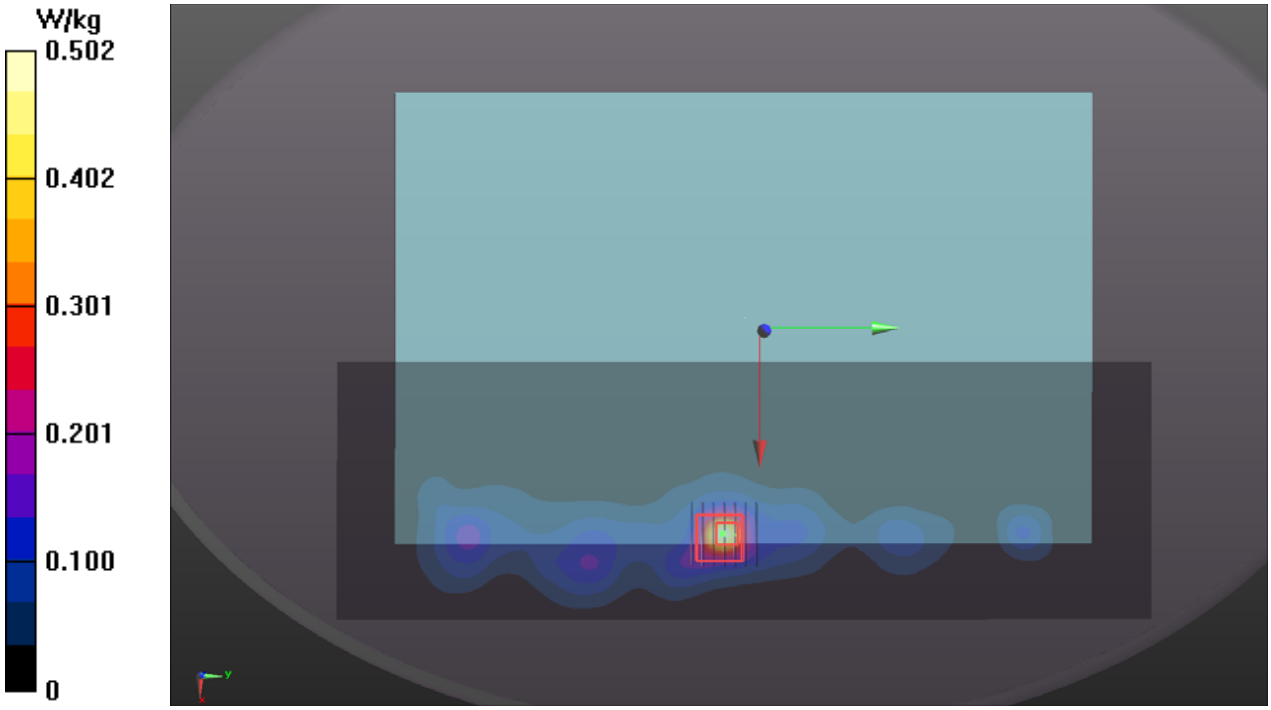
DUT: 191213C02

Communication System: IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps, 99pc duty cycle);
Frequency: 2412 MHz;Duty Cycle: 1:1.01
Medium: H19T27N1_01229 Medium parameters used: f = 2412 MHz; σ = 1.83 S/m; ε_r = 38.504; ρ = 1000 kg/m^3
Ambient Temperature：23.4 ℃； Liquid Temperature：23.1 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN7472; ConvF(7.7, 7.7, 7.7); Calibrated: 2019/08/30
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn579; Calibrated: 2019/08/27
- Phantom: ELI Phantom_1206; Type: QDOVA002AA;
- Measurement SW: DASY52, Version 52.10 (3); SEMCAD X Version 14.6.13 (7474)

- Area Scan (101x321x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm
Maximum value of SAR (interpolated) = 0.502 W/kg

- Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 22.54 V/m; Power Drift = -0.03 dB
Peak SAR (extrapolated) = 0.923 W/kg
SAR(1 g) = 0.438 W/kg; SAR(10 g) = 0.198 W/kg (SAR corrected for target medium)
Smallest distance from peaks to all points 3 dB below = 6.1 mm
Ratio of SAR at M2 to SAR at M1 = 46.4%
Maximum value of SAR (measured) = 0.786 W/kg



P07 WLAN5.3G_802.11ac VHT160_Bottom_0mm_Ch50_Sample4_Ant0

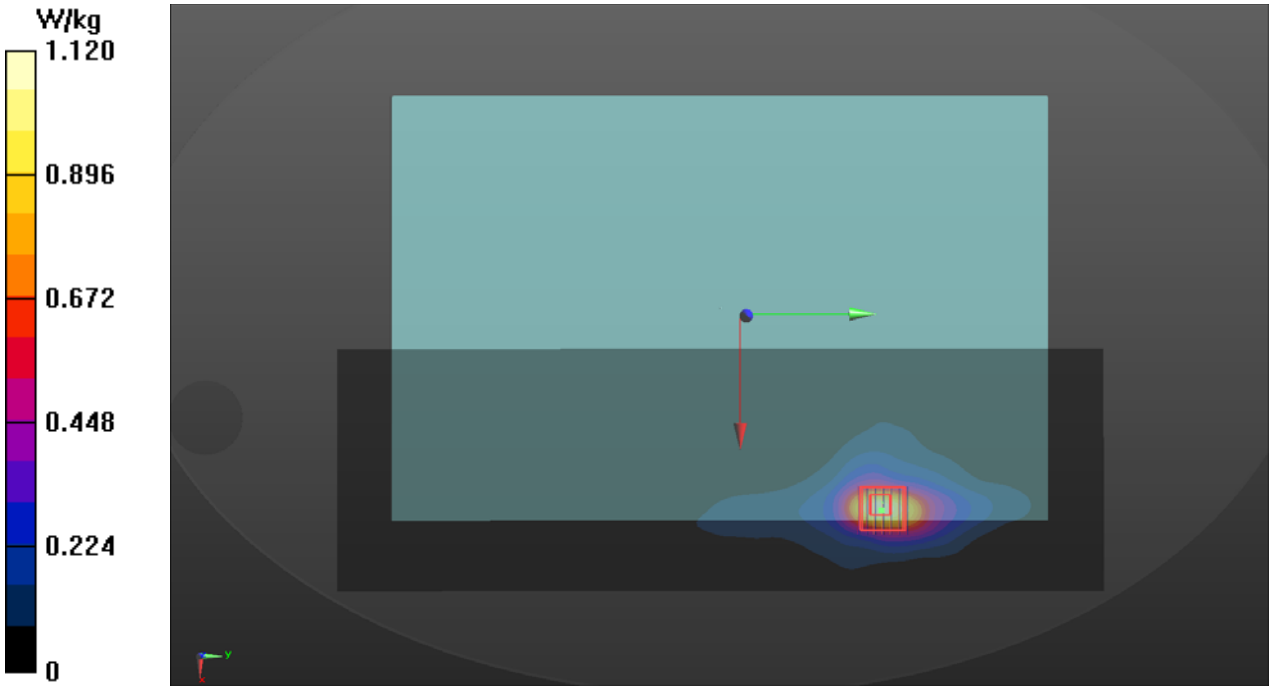
DUT: 191213C02

Communication System: IEEE 802.11ac WiFi (160MHz, MCS0, 99pc duty cycle); Frequency: 5250 MHz;Duty Cycle: 1:1.01
Medium: H34T60N4_1227 Medium parameters used: f = 5250 MHz; σ = 4.597 S/m; ε_r = 36.617; ρ = 1000 kg/m^3
Ambient Temperature：23.6 ℃； Liquid Temperature：23.2 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN7537; ConvF(5.36, 5.36, 5.36); Calibrated: 2019/06/18
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1585; Calibrated: 2019/06/07
- Phantom: ELI Phantom_1245; Type: QDOVA002AA;
- Measurement SW: DASY52, Version 52.10 (3); SEMCAD X Version 14.6.13 (7474)

- Area Scan (121x381x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 1.12 W/kg

- Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 16.18 V/m; Power Drift = -0.08 dB
Peak SAR (extrapolated) = 2.66 W/kg
SAR(1 g) = 0.752 W/kg; SAR(10 g) = 0.260 W/kg (SAR corrected for target medium)
Smallest distance from peaks to all points 3 dB below = 7.9 mm
Ratio of SAR at M2 to SAR at M1 = 66.6%
Maximum value of SAR (measured) = 1.69 W/kg



P08 WLAN5.6G_802.11ac VHT160_Bottom_0mm_Ch114_Sample4_Ant0

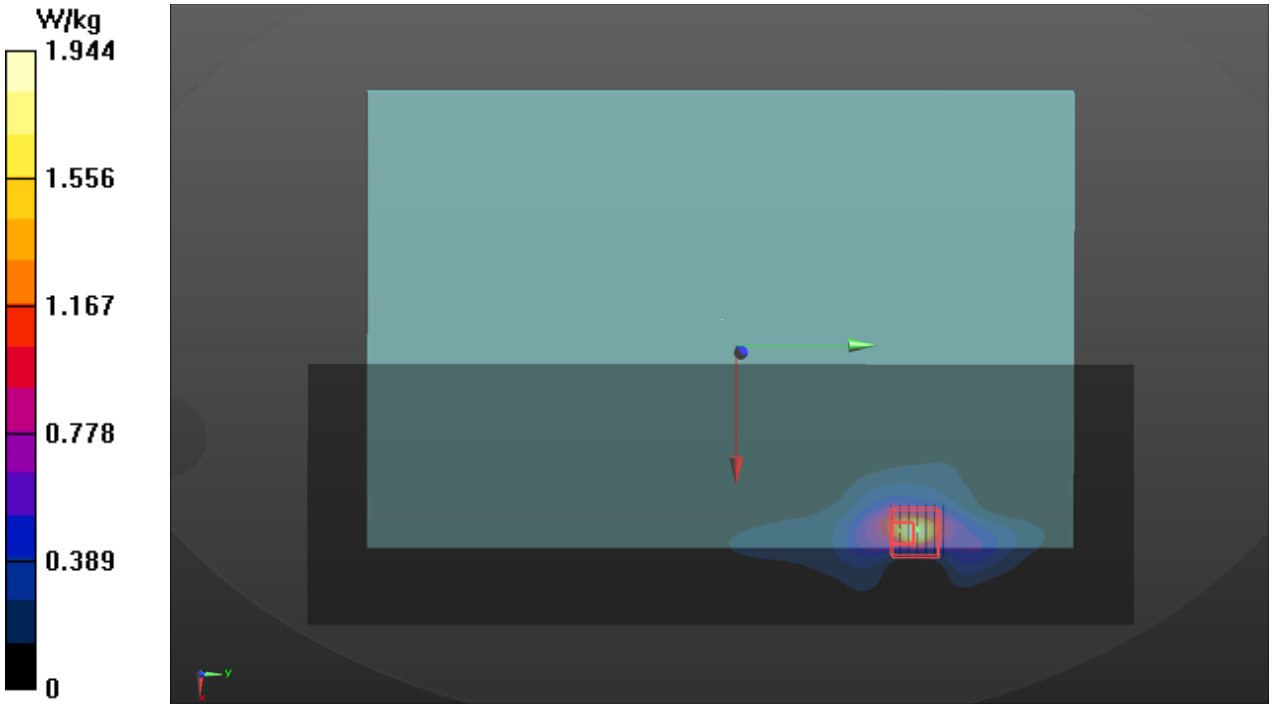
DUT: 191213C02

Communication System: IEEE 802.11ac WiFi (160MHz, MCS0, 99pc duty cycle); Frequency: 5570 MHz;Duty Cycle: 1:1.01
Medium: H34T60N4_1227 Medium parameters used: f = 5570 MHz; σ = 4.966 S/m; ε_r = 36.132; ρ = 1000 kg/m^3
Ambient Temperature：23.6 ℃； Liquid Temperature：23.2 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN7537; ConvF(4.75, 4.75, 4.75); Calibrated: 2019/06/18
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1585; Calibrated: 2019/06/07
- Phantom: ELI Phantom_1245; Type: QDOVA002AA;
- Measurement SW: DASY52, Version 52.10 (3); SEMCAD X Version 14.6.13 (7474)

- Area Scan (121x381x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 1.94 W/kg

- Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 20.43 V/m; Power Drift = -0.11 dB
Peak SAR (extrapolated) = 3.96 W/kg
SAR(1 g) = 0.994 W/kg; SAR(10 g) = 0.300 W/kg (SAR corrected for target medium)
Smallest distance from peaks to all points 3 dB below = 7.9 mm
Ratio of SAR at M2 to SAR at M1 = 63.6%
Maximum value of SAR (measured) = 2.27 W/kg



P09 WLAN5.8G_802.11ac VHT80_Bottom_0mm_Ch155_Sample4_Ant0

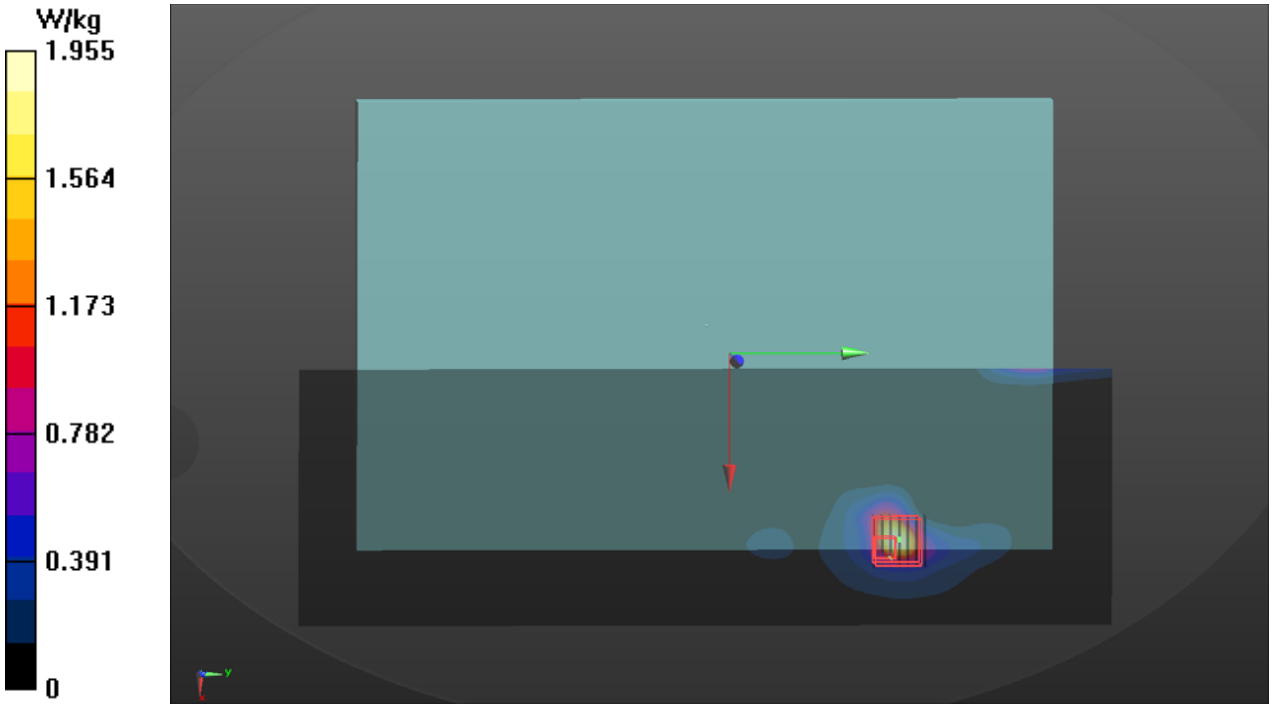
DUT: 191213C02

Communication System: IEEE 802.11ac WiFi (80MHz, MCS0, 99pc duty cycle); Frequency: 5775 MHz;Duty Cycle: 1:1.02
Medium: H34T60N4_1227 Medium parameters used: f = 5775 MHz; σ = 5.203 S/m; ε_r = 35.794; ρ = 1000 kg/m^3
Ambient Temperature：23.6 ℃ ； Liquid Temperature：23.2 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN7537; ConvF(4.99, 4.99, 4.99); Calibrated: 2019/06/18
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1585; Calibrated: 2019/06/07
- Phantom: ELI Phantom_1245; Type: QDOVA002AA;
- Measurement SW: DASY52, Version 52.10 (3); SEMCAD X Version 14.6.13 (7474)

- Area Scan (121x381x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 1.95 W/kg

- Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 21.32 V/m; Power Drift = -0.08 dB
Peak SAR (extrapolated) = 4.66 W/kg
SAR(1 g) = 0.927 W/kg; SAR(10 g) = 0.311 W/kg (SAR corrected for target medium)
Smallest distance from peaks to all points 3 dB below = 4.2 mm
Ratio of SAR at M2 to SAR at M1 = 35.8%
Maximum value of SAR (measured) = 3.59 W/kg

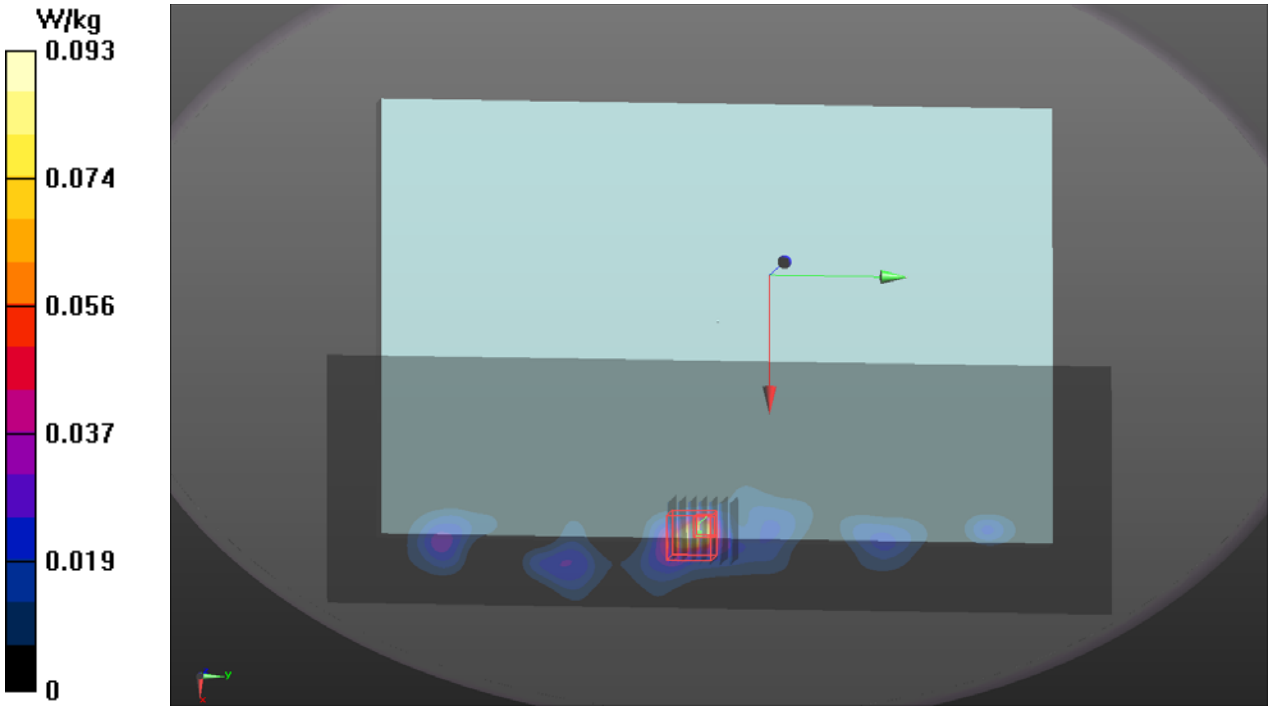


P10 BT_BDR_Bottom_0mm_Ch78_Sample3_Ant1

DUT: 191213C02

Communication System: IEEE 802.15.1 Bluetooth (GFSK, DH5); Frequency: 2480 MHz;Duty Cycle: 1:1.3
Medium: H19T27N1_01229 Medium parameters used: f = 2480 MHz; σ = 1.898 S/m; ε_r = 38.232; ρ = 1000 kg/m^3
Ambient Temperature：23.4 ℃ ； Liquid Temperature：23.1 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN7472; ConvF(7.7, 7.7, 7.7); Calibrated: 2019/08/30
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn579; Calibrated: 2019/08/27
- Phantom: ELI Phantom_1206; Type: QDOVA002AA;
- Measurement SW: DASY52, Version 52.10 (3); SEMCAD X Version 14.6.13 (7474)

- Area Scan (101x321x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm
Maximum value of SAR (interpolated) = 0.0927 W/kg

- Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 6.570 V/m; Power Drift = -0.02 dB
Peak SAR (extrapolated) = 0.101 W/kg
SAR(1 g) = 0.043 W/kg; SAR(10 g) = 0.017 W/kg (SAR corrected for target medium)
Ratio of SAR at M2 to SAR at M1 = 40.1%
Maximum value of SAR (measured) = 0.0757 W/kg