

FCC SAR TEST REPORT

APPLICANT : Lenovo (Shanghai) Electronics
Technology Co., Ltd.

EQUIPMENT : Portable Tablet Computer

BRAND NAME : Lenovo

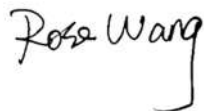
Model Name : A101LV

FCC ID : O57TAB A101LV

STANDARD : FCC 47 CFR Part 2 (2.1093)

The product was received on Mar. 18, 2021 and testing was started from Mar. 22, 2021 and completed on Mar. 27, 2021. We, Sporton International (Kunshan) Inc., would like to declare that the tested sample has been evaluated in accordance with the test procedures and has been in compliance with the applicable technical standards.

The test results in this report apply exclusively to the tested model / sample. Without written approval of Sporton International (Kunshan) Inc., the test report shall not be reproduced except in full.



Reviewed by: Rose Wang / Supervisor



Approved by: Kat Yin / Manager



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History of this test report

Report No.	Version	Description	Issued Date
FA120303	Rev. 01	Initial issue of report	May 11, 2021

1. Statement of Compliance

The maximum results of Specific Absorption Rate (SAR) found during testing for **Lenovo (Shanghai) Electronics Technology Co., Ltd., Portable Tablet Computer, A101LV**, are as follows.

Highest Standalone 1g SAR Summary				
Equipment Class	Frequency Band		Body	Highest Simultaneous Transmission 1g SAR (W/kg)
			1g SAR (W/kg)	
Licensed	LTE	Band 41	1.17	1.19
DTS	WLAN	2.4GHz WLAN	1.19	1.19
NII		5GHz WLAN	1.19	1.19
DSS	Bluetooth	Bluetooth	0.53	1.19
Date of Testing:		2021/3/22 ~ 2021/3/27		

Declaration of Conformity:
The test results with all measurement uncertainty excluded are presented in accordance with the regulation limits or requirements declared by manufacturers.
Comments and Explanations:
The declared of product specification for EUT presented in the report are provided by the manufacturer, and the manufacturer takes all the responsibilities for the accuracy of product specification.

This device is in compliance with Specific Absorption Rate (SAR) for general population/uncontrolled exposure limits (1.6 W/kg for Partial-Body 1g SAR) 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 and FCC KDB publications

2. Administration Data

Sporton International (Kunshan) Inc. is accredited to ISO/IEC 17025:2017 by American Association for Laboratory Accreditation with Certificate Number 5145.02.

Testing Laboratory		
Test Firm	Sporton International (Kunshan) Inc.	
Test Site Location	No. 1098, Pengxi North Road, Kunshan Economic Development Zone Jiangsu Province 215300 People's Republic of China TEL : +86-512-57900158 FAX : +86-512-57900958	
Test Site No.	FCC Designation No.	FCC Test Firm Registration No.
	CN1257	314309

Applicant	
Company Name	Lenovo (Shanghai) Electronics Technology Co., Ltd.
Address	Section 304-305, Building No. 4, # 222, Meiyue Road, China (Shanghai) Pilot Free Trade Zone

Manufacturer	
Company Name	Lenovo PC HK Limited
Address	23/F, Lincoln House, Taikoo Place 979 King's Road, Quarry Bay, Hong Kong, P.R.China

3. Guidance Applied

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
- FCC KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz v01r04
- FCC KDB 865664 D02 SAR Reporting v01r02
- FCC KDB 447498 D01 General RF Exposure Guidance v06
- FCC KDB 248227 D01 802.11 Wi-Fi SAR v02r02
- FCC KDB 616217 D04 SAR for laptop and tablets v01r02
- FCC KDB 941225 D05 SAR for LTE Devices v02r05
- FCC KDB 941225 D05A Rel.10 LTE SAR Test Guidance v01r02

4. Equipment Under Test (EUT) Information

4.1 General Information

Product Feature & Specification	
Equipment Name	Portable Tablet Computer
Brand Name	Lenovo
Model Name	A101LV
FCC ID	O57TABA101LV
IMEI Code	863921050014748
Wireless Technology and Frequency Range	LTE Band 41: 2496 MHz ~ 2690 MHz WLAN 2.4GHz Band: 2400 MHz ~ 2483.5 MHz WLAN 5.2GHz Band: 5150 MHz ~ 5250 MHz WLAN 5.3GHz Band: 5250 MHz ~ 5350 MHz WLAN 5.5GHz Band: 5470 MHz ~ 5730 MHz WLAN 5.8GHz Band: 5725 MHz ~ 5850 MHz Bluetooth: 2400 MHz ~ 2483.5 MHz
Mode	LTE: QPSK, 16QAM, 64QAM WLAN 2.4GHz 802.11b/g/n HT20/HT40 WLAN 5GHz 802.11a/n/ac HT20/HT40/VHT20/VHT40/VHT80 Bluetooth BR/EDR/LE
HW Version	Lenovo Tablet A101LV
SW Version	A101LV_S000016_210305_Q6350-userdebug_jp
EUT Stage	Identical Prototype
Remark: 1. This device has no voice function. 2. The device employs proximity sensors that detect the presence of the user's body also a finger or hand near the bottom face, edge 1 or edge 4 of the device, reduced power will be active for all WWAN bands. (P-sensor can't work at detecting presence of the user's body at other edges of the device.) 3. The device employs proximity sensors that detect the presence of the user's body also a finger or hand near the bottom face, edge 1, edge 2 of the device, reduced power will be active for all WLAN bands. (P-sensor can't work at detecting presence of the user's body at other edges of the device.) 4. LTE band 41 supports HPUE, we chose power class 3 full SAR testing and power class 2 verify the worst case of power class 3 SAR. 5. There are two different types of EUT. For model change note, please refer the product equality declaration exhibit submitted. According to the difference, we choose the sample 1 to full test and the sample 2 to verify.	

4.2 General LTE SAR Test and Reporting Considerations

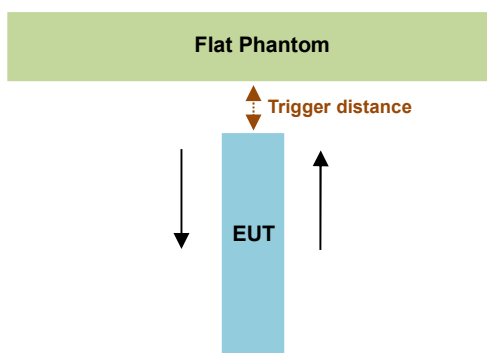
Summarized necessary items addressed in KDB 941225 D05 v02r05									
FCC ID		O57TABA101LV							
Equipment Name		Portable Tablet Computer							
Operating Frequency Range of each LTE transmission band		LTE Band 41: 2496 MHz ~ 2690 MHz							
Channel Bandwidth		LTE Band 41: 5MHz, 10MHz, 15MHz, 20MHz							
uplink modulations used		QPSK / 16QAM / 64QAM							
LTE release		R15, Cat 11							
CA support		Supported, Downlink only							
LTE Voice / Data requirements		Data only							
LTE MPR permanently built-in by design		Table 6.2.3-1: Maximum Power Reduction (MPR) for Power Class 1, 2 and 3							
		Modulation	Channel bandwidth / Transmission bandwidth (N _{RB})					MPR (dB)	
			1.4 MHz	3.0 MHz	5 MHz	10 MHz	15 MHz		20 MHz
		QPSK	> 5	> 4	> 8	> 12	> 16	> 18	≤ 1
		16 QAM	≤ 5	≤ 4	≤ 8	≤ 12	≤ 16	≤ 18	≤ 1
		16 QAM	> 5	> 4	> 8	> 12	> 16	> 18	≤ 2
		64 QAM	≤ 5	≤ 4	≤ 8	≤ 12	≤ 16	≤ 18	≤ 2
		64 QAM	> 5	> 4	> 8	> 12	> 16	> 18	≤ 3
		256 QAM	≥ 1					≤ 5	
LTE A-MPR		In the base station simulator configuration, Network Setting value is set to NS_01 to disable A-MPR during SAR testing and the LTE SAR tests was transmitting on all TTI frames (Maximum TTI)							
Spectrum plots for RB configuration		A properly configured base station simulator was used for the SAR and power measurement; therefore, spectrum plots for each RB allocation and offset configuration are not included in the SAR report.							
Power reduction applied to satisfy SAR compliance		Yes, Proximity Sensor. Power reduction will be active at bottom face, edge 1 or edge 4 for all WWAN bands.							
LTE Carrier Information	Aggregation	Additional	This device supports maximum of 2 carriers in the downlink. Additional following LTE Release features are not supported: Relay, HetNet, Enhanced MIMO, eICI, WiFi Offloading, MDH, eMBMA, Cross-Carrier Scheduling, Enhanced SC-FDMA.						

Transmission (H, M, L) channel numbers and frequencies in each LTE band								
LTE Band 41								
	Bandwidth 5 MHz		Bandwidth 10 MHz		Bandwidth 15 MHz		Bandwidth 20 MHz	
	Ch. #	Freq. (MHz)	Ch. #	Freq. (MHz)	Ch. #	Freq. (MHz)	Ch. #	Freq. (MHz)
L	39675	2498.5	39700	2501	39725	2503.5	39750	2506
LM	40148	2545.8	40160	2547	40173	2548.3	40185	2549.5
M	40620	2593	40620	2593	40620	2593	40620	2593
HM	41093	2640.3	41080	2639	41068	2637.8	41055	2636.5
H	41565	2687.5	41540	2685	41515	2682.5	41490	2680

5. Proximity Sensor Triggering Test

<Proximity Sensor Triggering Distance (KDB 616217 D04 section 6.2)>:

1. Proximity sensor triggering distance testing was performed according to the procedures outlined in KDB 616217 D04 section 6.2, and EUT moving further away from the flat phantom and EUT moving toward the flat phantom were both assessed and the tissue-equivalent medium for highest frequency 5850MHz and lowest 2400MHz frequency was used for proximity sensor triggering testing.
2. Capacitive proximity sensor placed coincident with antenna elements at the Bottom Face and Edge 1 and Edge 2 and Edge 4 of the device are utilized to determine when the device comes in proximity of the user's body at the Bottom Face or Edge 1 or Edge 2 or Edge 4 side of the device. There is no need to do sensor coverage testing for the proximity sensor is designed to support sufficient detection range and sensitivity to cover regions of the sensors in all applicable directions since the proximity sensor entirely covers the antenna.
3. When the sensor is active, all WWAN/WLAN bands reduced power will be active.
4. The sensors used to detect the proximity of the user's body at the Bottom Face or Edge 1 or Edge 4 side for WWAN, Bottom Face or Edge 1 or Edge 2 side for WLAN of the device use a detection threshold distance. The data shown in the sections below shows the distance(s).



<WWAN Frequency Bands>

Proximity Sensor Triggering Distance (mm)						
Position	Bottom Face		Edge 1		Edge 4	
	Moving away	Moving towards	Moving away	Moving towards	Moving away	Moving towards
Minimum	16	16	15	15	23	23

<WLAN Frequency Bands>

Proximity Sensor Triggering Distance (mm)						
Position	Bottom Face		Edge 1		Edge 2	
	Moving away	Moving towards	Moving away	Moving towards	Moving away	Moving towards
Minimum	16	16	14	14	17	17

<Proximity Sensor Triggering Coverage (KDB 616217 D04 section 6.3)>:

If a sensor is spatially offset from the antenna(s), it is necessary to verify sensor triggering for conditions where the antenna is next to the user but the sensor is laterally further away to ensure sensor coverage is sufficient for reducing the power to maintain compliance. For p-sensor coverage testing, the device is moved and "along the direction of maximum antenna and sensor offset".

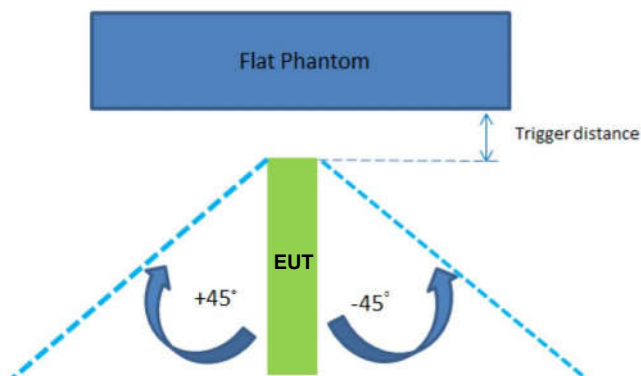
Illustrated in the internal photo exhibit, although the sensor is spatially offset, there is no trigger condition where the antenna is next to the user but the sensor is laterally further away, therefore proximity sensor coverage testing is not required.

This procedure is not required because antenna and sensor are collocated and the peak SAR location is overlapping with the sensor.

<Tablet Tilt angle influences to proximity sensor triggering (KDB 616217 D04 section 6.4)>:

The influence of table tilt angles to proximity sensor triggering was determined by positioning each tablet edge that contains a transmitting antenna, perpendicular to the flat phantom, at 15 mm at Edge 1, 23 mm at Edge 4 separation for WWAN bands and 14mm at Edge 1, 17mm at Edge 2 for WLAN.

Rotating the tablet around the edge next to the phantom in $\leq 10^\circ$ increments until the tablet is $\pm 45^\circ$ from the vertical position at 0° , and the maximum output power remains in the reduced mode.


<WWAN Frequency Bands>

The Sensor Trigger Distance (mm)		
Position	Edge 1	Edge 4
Minimum	15	23

<WLAN Frequency Bands>

The Sensor Trigger Distance (mm)		
Position	Edge 1	Edge 2
Minimum	14	17

Proximity sensor power reduction

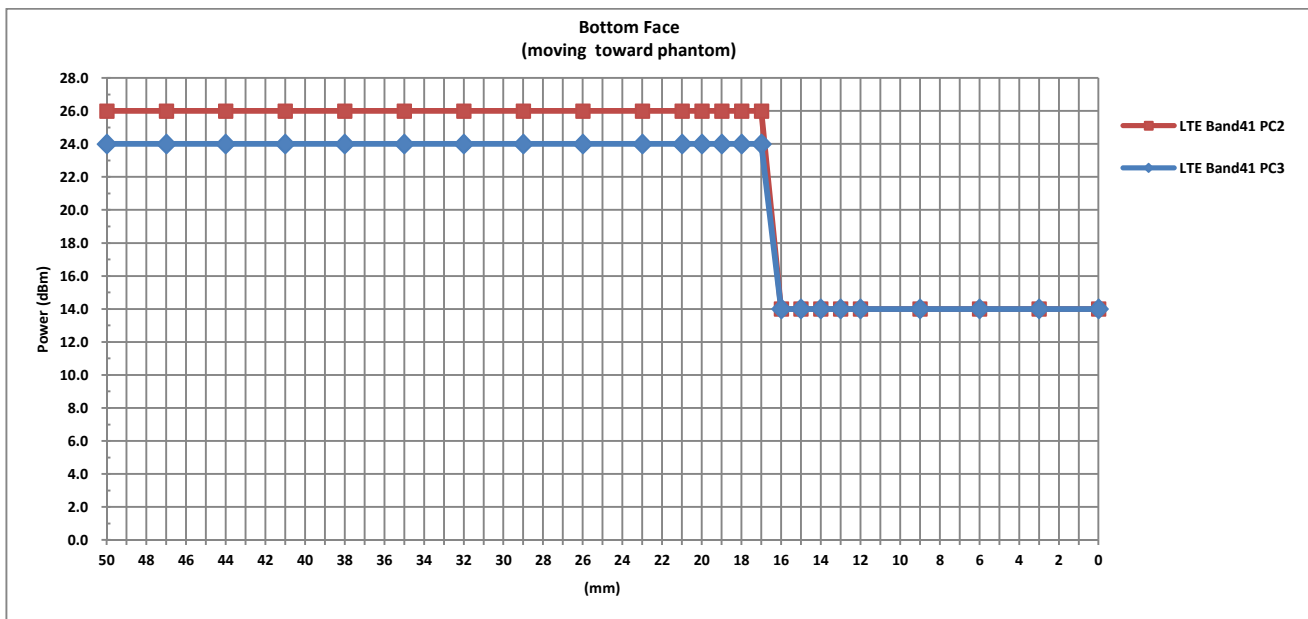
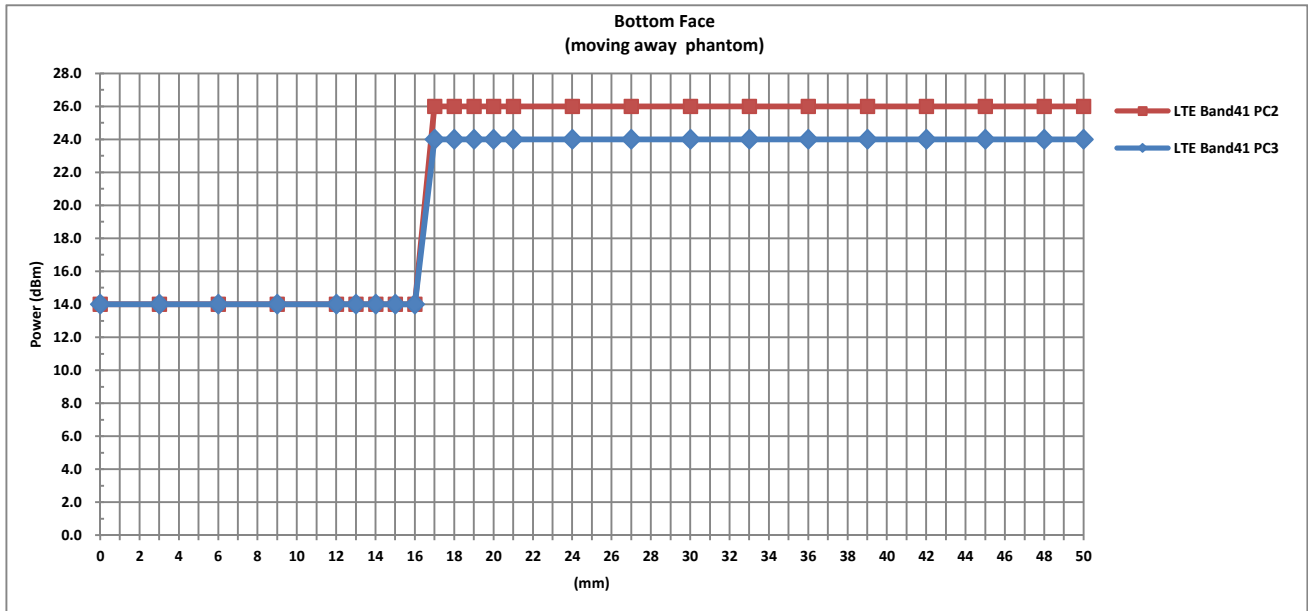
Exposure Position / wireless mode	Bottom Face ⁽¹⁾	Edge 1 ⁽¹⁾	Edge 2 ⁽¹⁾	Edge 3	Edge 4 ⁽¹⁾
LTE Band 41 class 3	10.0 dB	10.0 dB	0 dB	0 dB	10.0 dB
LTE Band 41 class 2	12.0 dB	12.0 dB	0 dB	0 dB	12.0 dB
WLAN 2.4GHz	7.0 dB	7.0 dB	7.0 dB	0 dB	0 dB
WLAN 5.2GHz	2.0 dB	2.0 dB	2.0 dB	0 dB	0 dB
WLAN 5.3GHz	2.0 dB	2.0 dB	2.0 dB	0 dB	0 dB
WLAN 5.5GHz	2.0 dB	2.0 dB	2.0 dB	0 dB	0 dB
WLAN 5.8GHz	3.0 dB	3.0 dB	3.0 dB	0 dB	0 dB

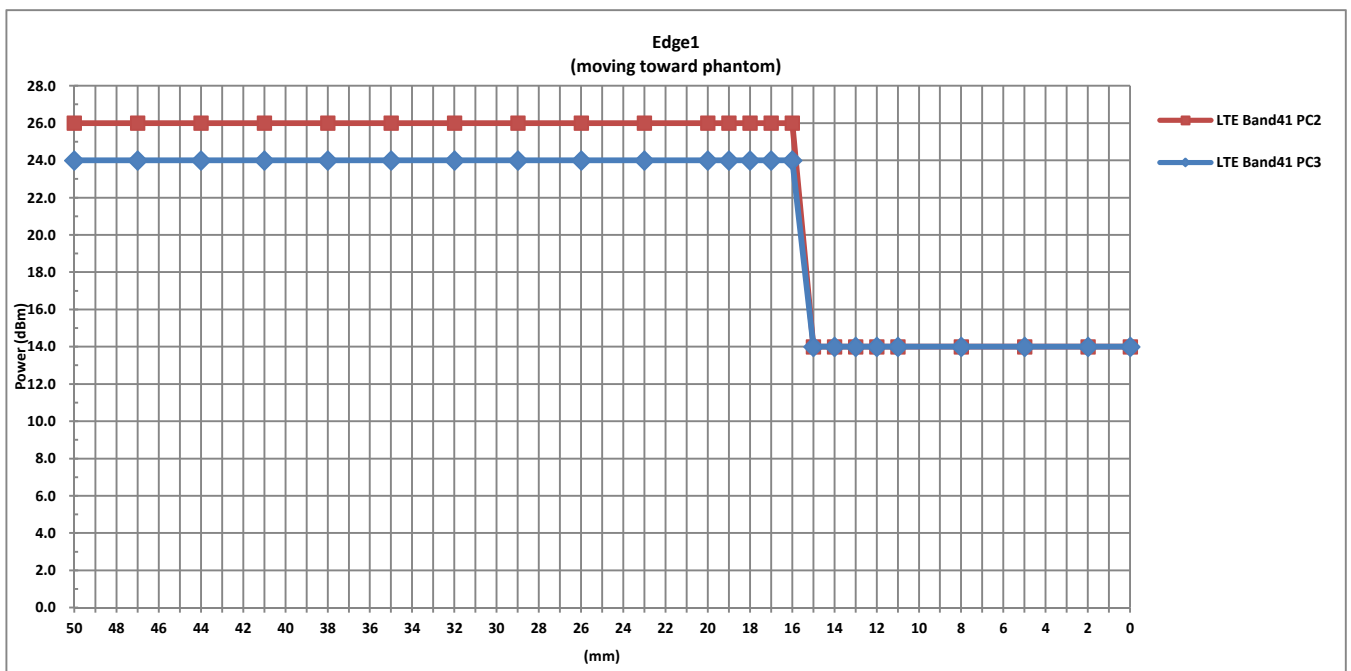
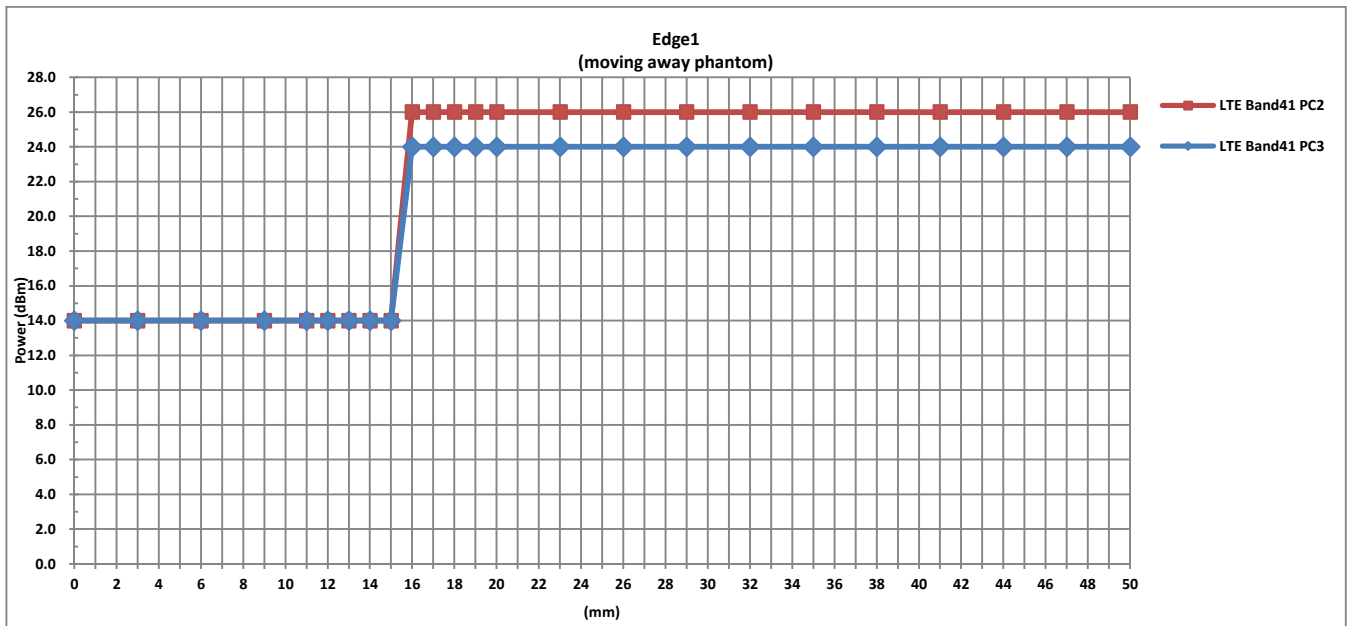
Remark:

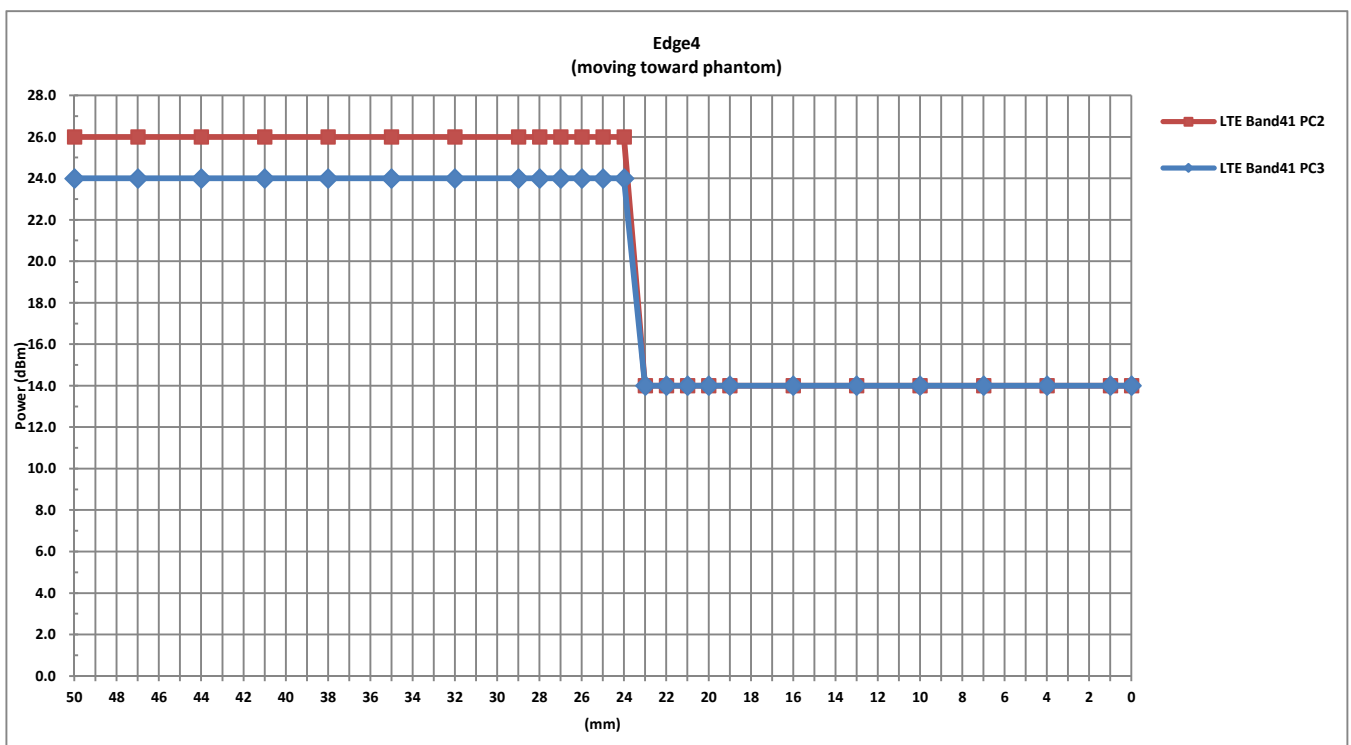
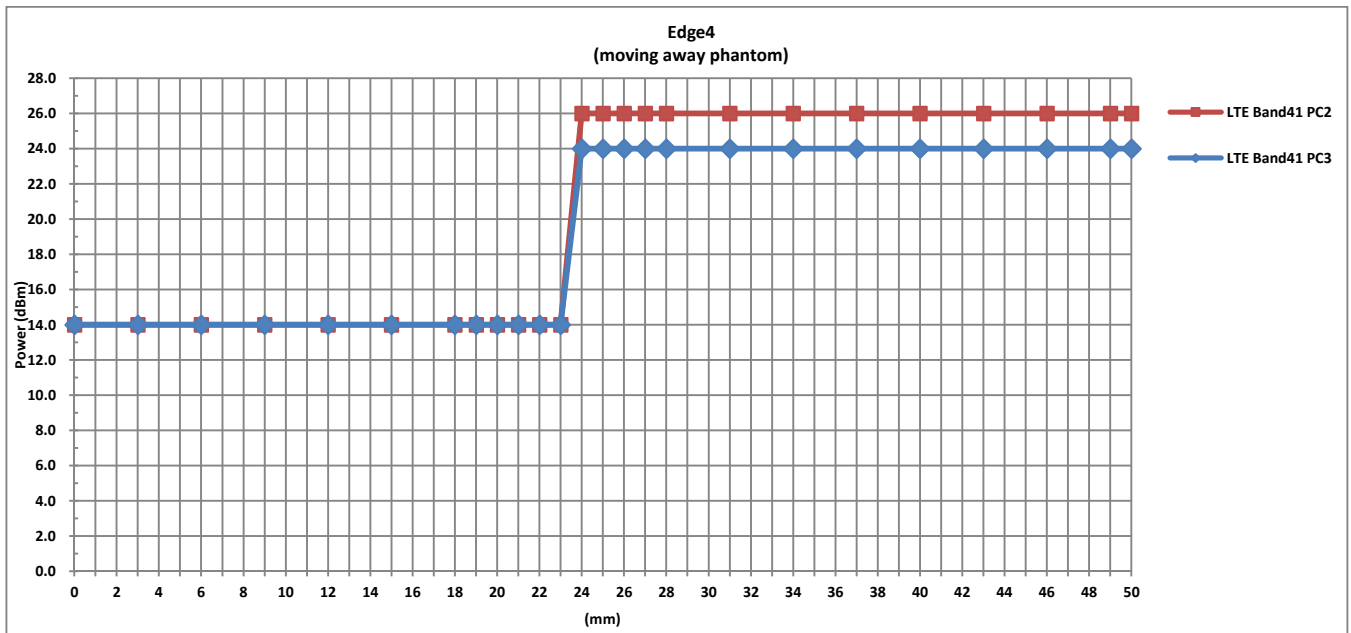
- ⁽¹⁾: Reduced maximum limit applied by activation of proximity sensor.
- Power reduction is not applicable for Bluetooth.
- Tests were performed in accordance with KDB 616217 D04 section 6.1, 6.2, 6.3, 6.4 and 6.5 and compliant results are shown and described in exhibit "P-Sensor operational description"
- For verification of compliance of power reduction scheme, additional SAR testing with EUT transmitting at full RF power at a conservative trigger distance was performed:
 - Bottom Face: 15 mm
 - Edge 2: 16 mm
 - Edge 4: 22 mm
 For WLAN:
 - Edge 1: 13 mm
 For WWAN:
 - Edge 1: 13 mm (Declared by Manufacturer)

Power Measurement during Sensor Trigger distance testing

Band/Mode	Measured power reduction (dBm)		Reduction Levels
	w/o power back-off	w/ power back-off	(dB)
LTE Band 41 class 3	24.00	14.00	10.0
LTE Band 41 class 2	26.00	14.00	12.0

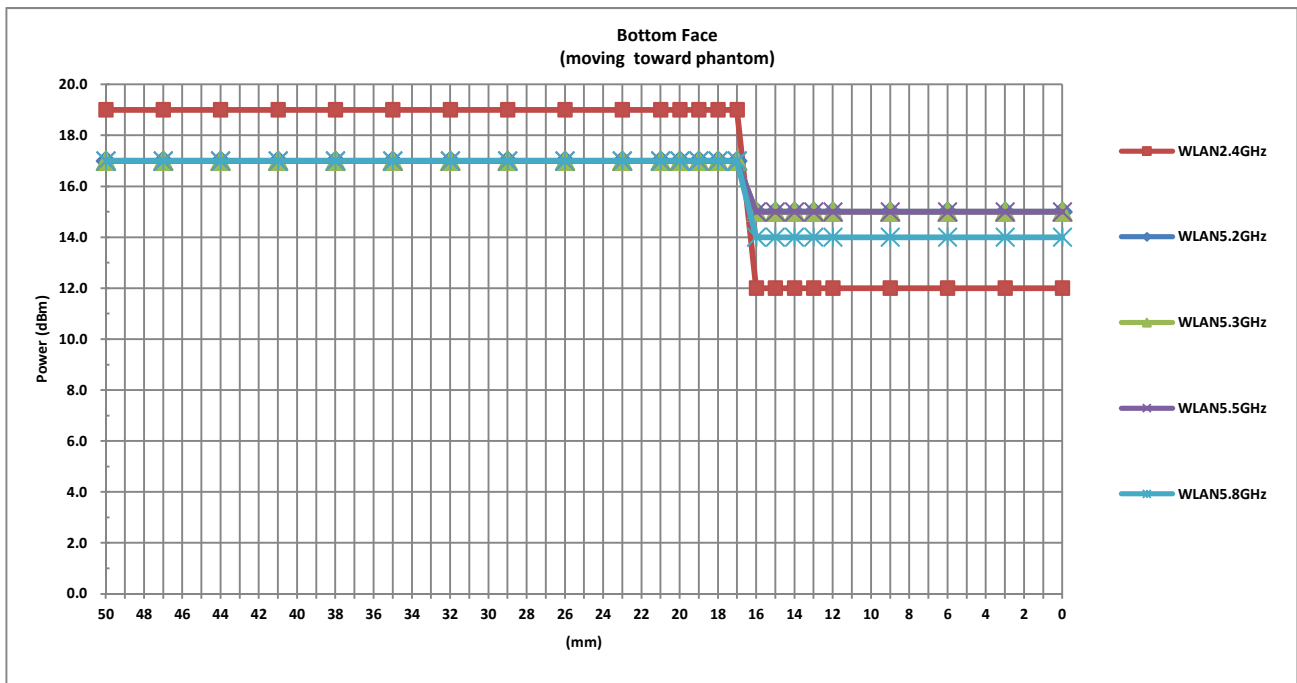
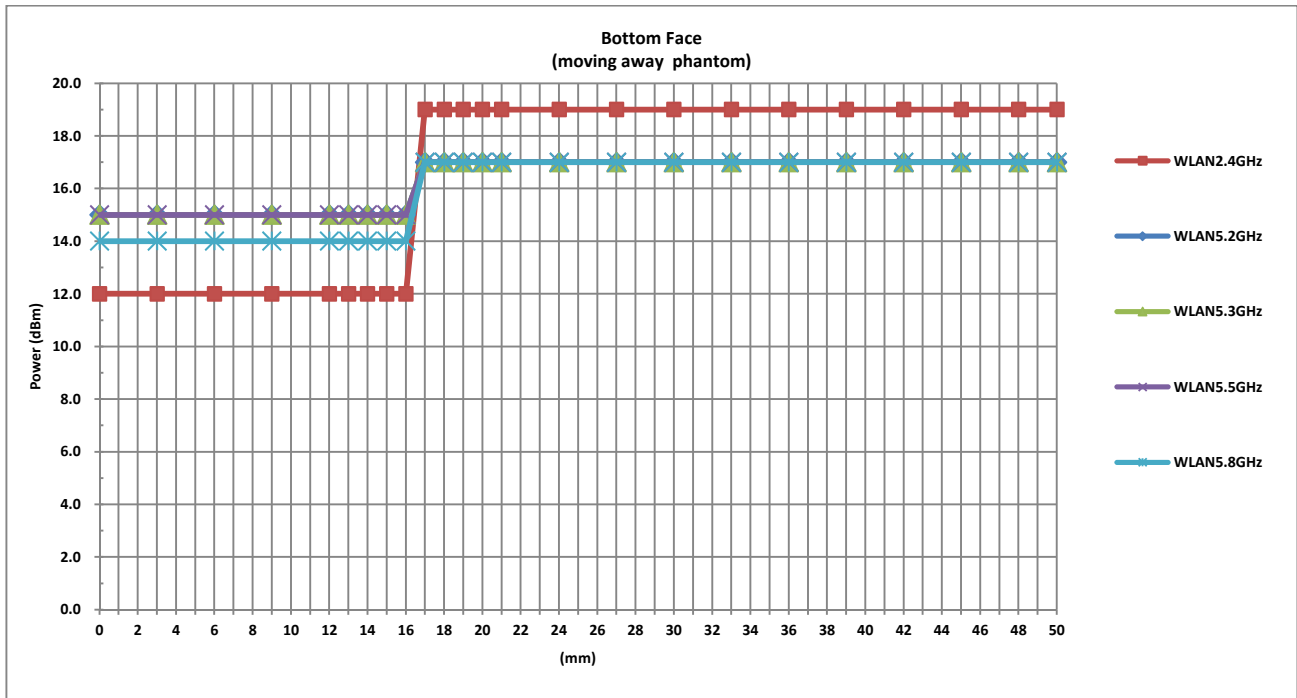


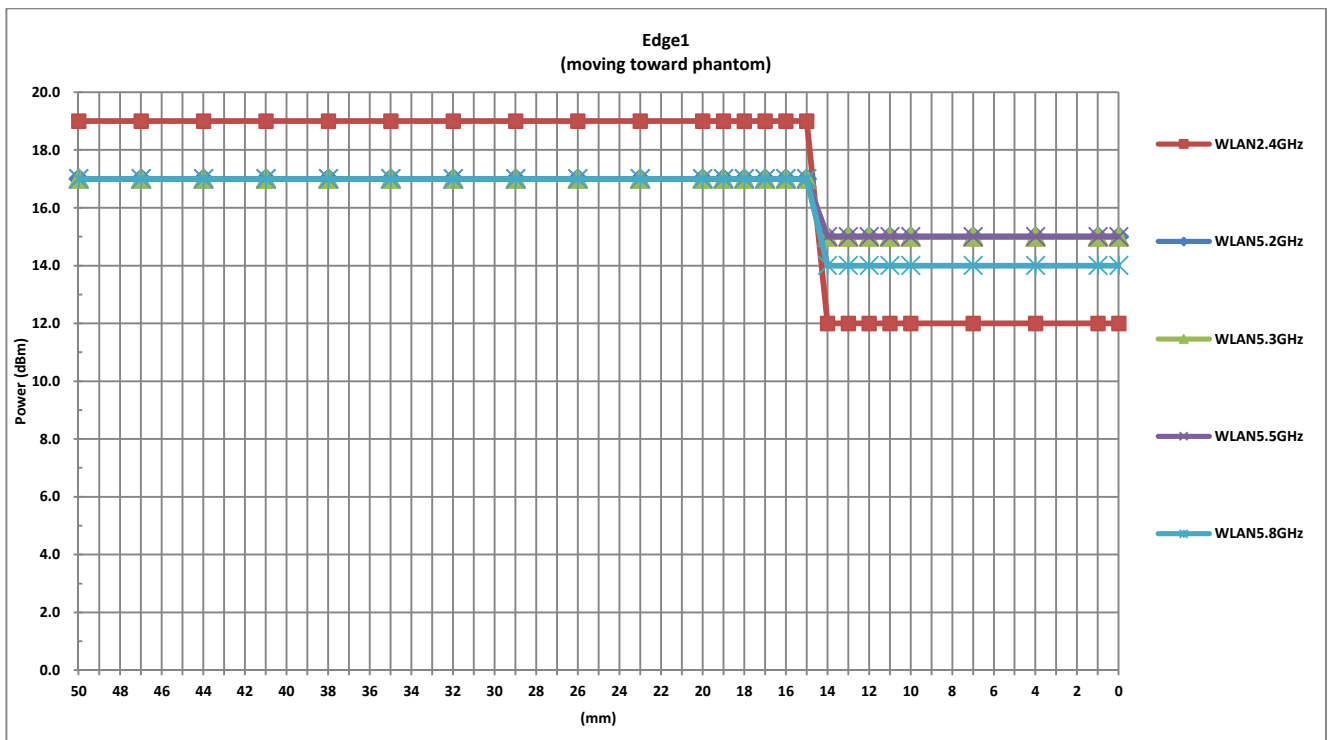
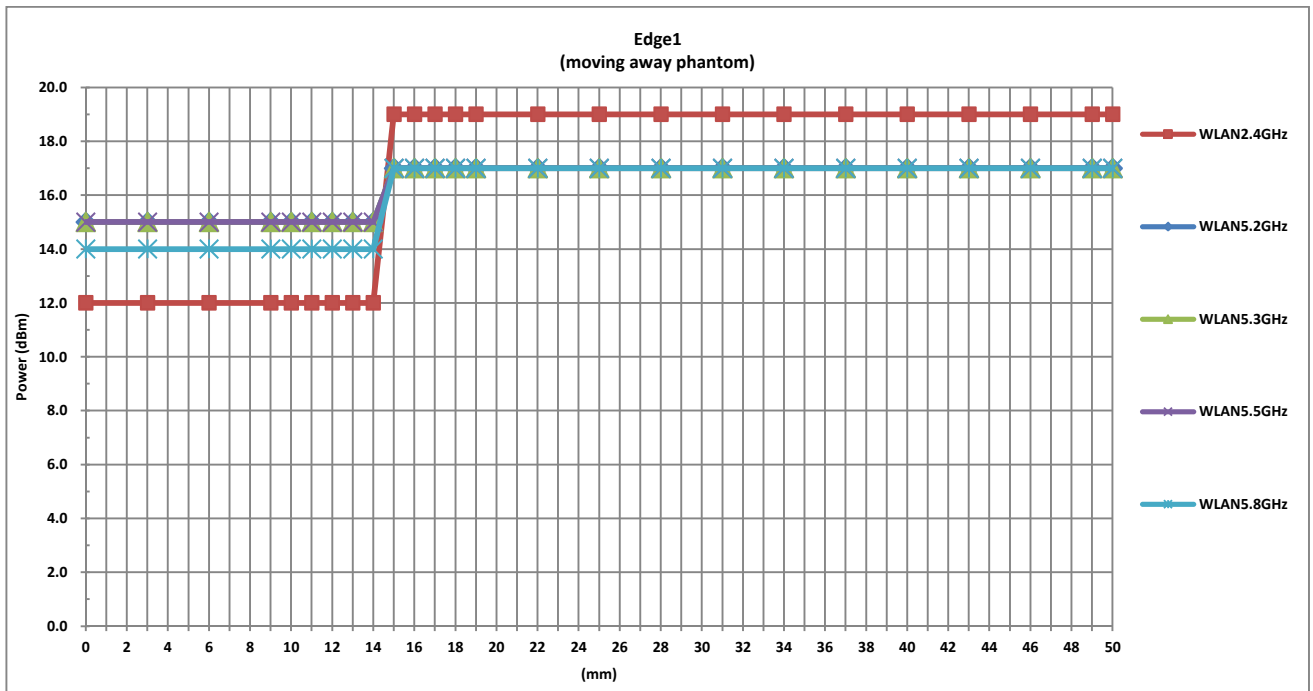


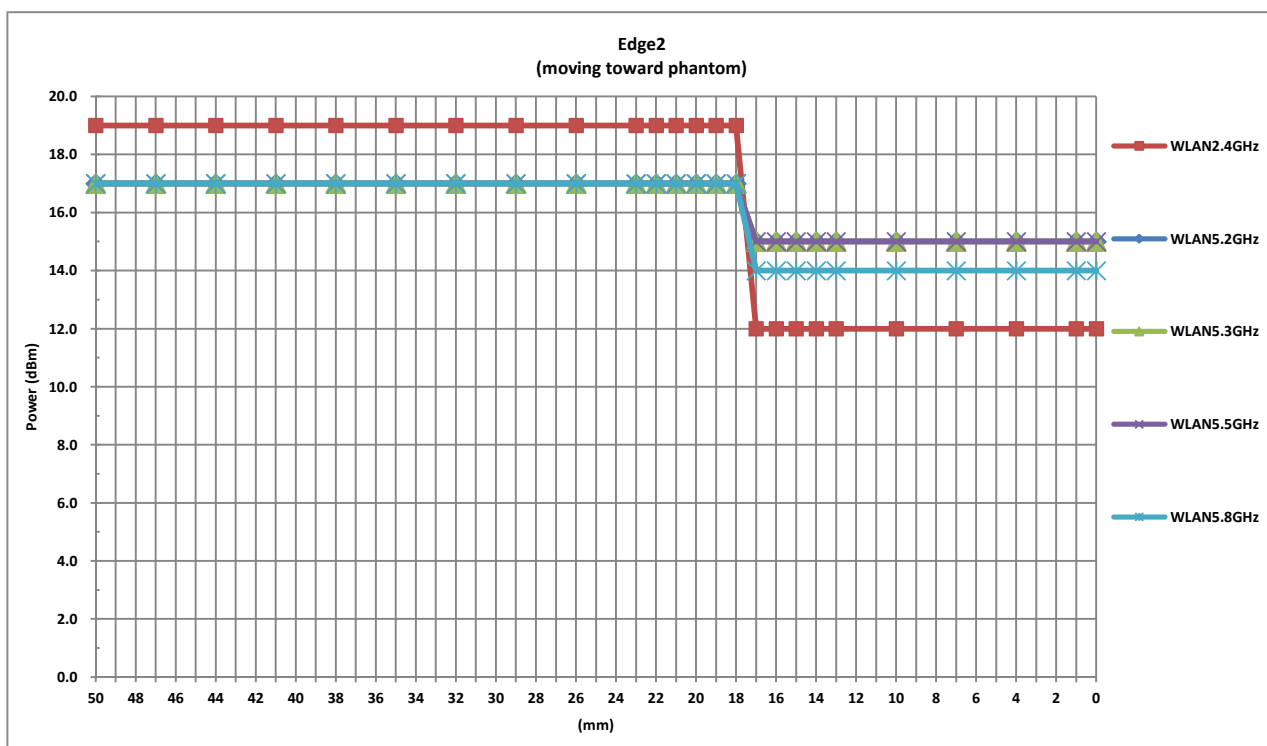
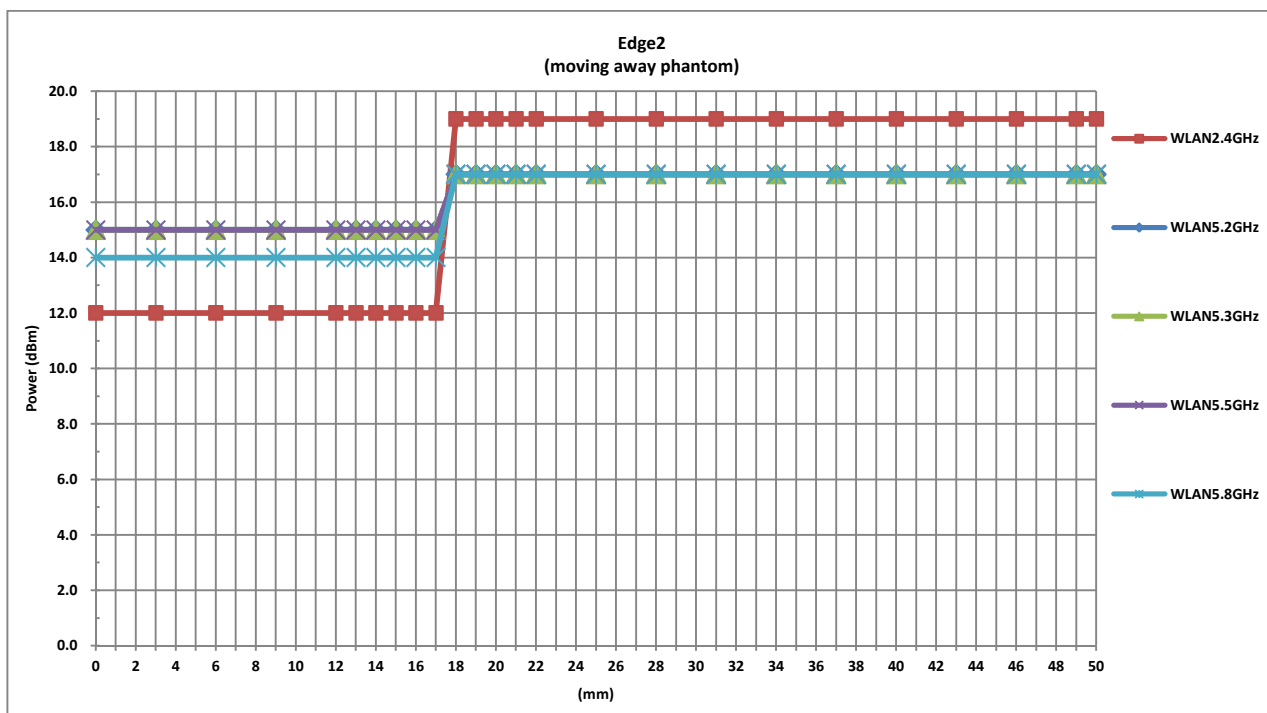


Power Measurement during Sensor Trigger distance testing

Band/Mode	Measured power reduction (dBm)		Reduction Levels (dB)
	w/o power back-off	w/ power back-off	
WLAN 2.4GHz	19.00	12.00	7.0
WLAN 5.2GHz	17.00	15.00	2.0
WLAN 5.3GHz	17.00	15.00	2.0
WLAN 5.5GHz	17.00	15.00	2.0
WLAN 5.8GHz	17.00	14.00	3.0







6. RF Exposure Limits

6.1 Uncontrolled Environment

Uncontrolled Environments are defined as locations where there is the exposure of individuals who have no knowledge or control of their exposure. The general population/uncontrolled exposure limits are applicable to situations in which the general public may be exposed or in which persons who are exposed as a consequence of their employment may not be made fully aware of the potential for exposure or cannot exercise control over their exposure. Members of the general public would come under this category when exposure is not employment-related; for example, in the case of a wireless transmitter that exposes persons in its vicinity.

6.2 Controlled Environment

Controlled Environments are defined as locations where there is exposure that may be incurred by persons who are aware of the potential for exposure, (i.e. as a result of employment or occupation). In general, occupational/controlled exposure limits are applicable to situations in which persons are exposed as a consequence of their employment, who have been made fully aware of the potential for exposure and can exercise control over their exposure. The exposure category is also applicable when the exposure is of a transient nature due to incidental passage through a location where the exposure levels may be higher than the general population/uncontrolled limits, but the exposed person is fully aware of the potential for exposure and can exercise control over his or her exposure by leaving the area or by some other appropriate means.

Limits for Occupational/Controlled Exposure (W/kg)

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

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

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

Whole-Body SAR is averaged over the entire body, partial-body SAR is averaged over any 1gram 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.

7. Specific Absorption Rate (SAR)

7.1 Introduction

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

7.2 SAR Definition

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

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

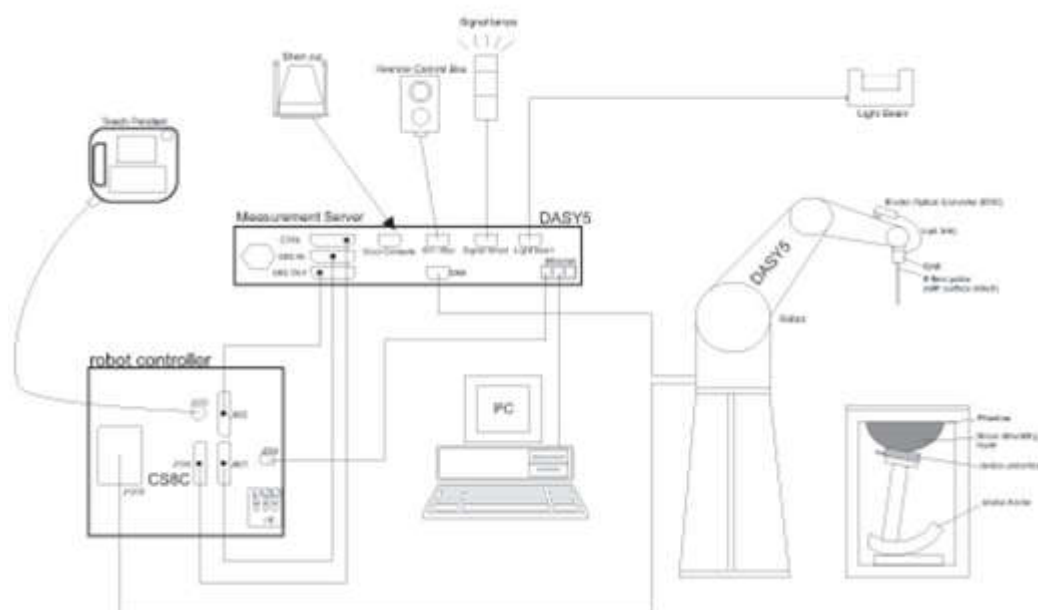
SAR is expressed in units of Watts per kilogram (W/kg)

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

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

8. System Description and Setup

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



- A standard high precision 6-axis robot with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- An isotropic Field probe optimized and calibrated for the targeted measurement.
- 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 from optical to electrical signals for the digital communication to the DAE. To use optical surface detection, a special version of the EOC is required. The EOC signal is transmitted 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.
- The Light Beam used is for probe alignment. This improves the (absolute) accuracy of the probe positioning.
- A computer running WinXP or Win7 and the DASY5 software.
- Remote control and teach pendant as well as additional circuitry for robot safety such as warning lamps, etc.
- The phantom, the device holder and other accessories according to the targeted measurement.

8.1 E-Field Probe

The SAR measurement is conducted with the dosimetric probe (manufactured by SPEAG). 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. This probe has a built in optical surface detection system to prevent from collision with phantom.

<EX3DV4 Probe>

Construction	Symmetric design with triangular core Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)	
Frequency	10 MHz – >6 GHz Linearity: ± 0.2 dB (30 MHz – 6 GHz)	
Directivity	± 0.3 dB in TSL (rotation around probe axis) ± 0.5 dB in TSL (rotation normal to probe axis)	
Dynamic Range	10 μ W/g – >100 mW/g Linearity: ± 0.2 dB (noise: typically <1 μ W/g)	
Dimensions	Overall length: 337 mm (tip: 20 mm) Tip diameter: 2.5 mm (body: 12 mm) Typical distance from probe tip to dipole centers: 1 mm	

8.2 Data Acquisition Electronics (DAE)

The data acquisition electronics (DAE) 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 input impedance of the DAE is 200 MOhm; the inputs are symmetrical and floating. Common mode rejection is above 80 dB.



Fig 5.1 Photo of DAE

8.3 Phantom

<SAM Twin Phantom>

Shell Thickness	2 ± 0.2 mm; Center ear point: 6 ± 0.2 mm	
Filling Volume	Approx. 25 liters	
Dimensions	Length: 1000 mm; Width: 500 mm; Height: adjustable feet	
Measurement Areas	Left Hand, Right Hand, Flat Phantom	

The bottom plate contains three pair of bolts for locking the device holder. The device holder positions are adjusted to the standard measurement positions in the three sections. A white cover is provided to tap the phantom during off-periods to prevent water evaporation and changes in the liquid parameters. On the phantom top, three reference markers are provided to identify the phantom position with respect to the robot.

<ELI Phantom>

Shell Thickness	2 ± 0.2 mm (sagging: <1%)	
Filling Volume	Approx. 30 liters	
Dimensions	Major ellipse axis: 600 mm Minor axis: 400 mm	

The ELI phantom is intended 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 standard and all known tissue simulating liquids.

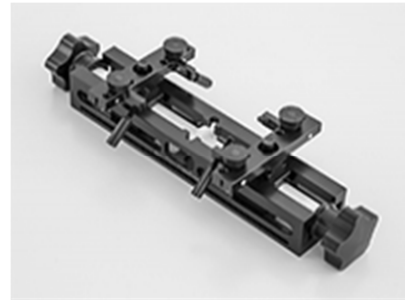
8.4 Device Holder

<Mounting Device for Hand-Held Transmitter>

In combination with the Twin SAM V5.0/V5.0c 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). And 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.



Mounting Device for Hand-Held Transmitters



Mounting Device Adaptor for Wide-Phones

<Mounting Device for Laptops and other Body-Worn Transmitters>

The extension is lightweight and made of POM, acrylic glass and foam. It fits easily on the upper part of the mounting device in place of the phone positioned. The extension is fully compatible with the SAM Twin and ELI phantoms.



Mounting Device for Laptops

9. Measurement Procedures

The measurement procedures are as follows:

<Conducted power measurement>

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

<SAR measurement>

- (a) Use base station simulator to configure EUT WWAN transmission in radiated connection, and engineering software to configure EUT WLAN/BT continuously transmission, at maximum RF power, in the highest power channel.
- (b) Place the EUT in the positions as Appendix D demonstrates.
- (c) Set scan area, grid size and other setting on the DASY software.
- (d) Measure SAR results for the highest power channel on each testing position.
- (e) Find out the largest SAR result on these testing positions of each band
- (f) Measure SAR results for other channels in worst SAR testing position if the reported SAR of highest power channel is larger than 0.8 W/kg

According to the 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

9.1 Spatial Peak SAR Evaluation

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

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

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

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

9.2 Power Reference Measurement

The Power Reference Measurement and Power Drift Measurements are for monitoring the power drift of the device under test in the batch process. The minimum distance of probe sensors to surface determines the closest measurement point to phantom surface. This distance cannot be smaller than the distance of sensor calibration points to probe tip as defined in the probe properties.

9.3 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 fine measurement around the hot spot. The sophisticated interpolation routines implemented in DASY software can find the maximum found in the scanned area, within a range of the global maximum. The range (in dB0) is specified in the standards for compliance testing. For example, a 2 dB range is required in IEEE standard 1528 and IEC 62209 standards, whereby 3 dB is a requirement when compliance is assessed in accordance with the ARIB standard (Japan), if only one zoom scan follows the area scan, then only the absolute maximum will be taken as reference. For cases where multiple maximums are detected, the number of zoom scans has to be increased accordingly.

Area scan parameters extracted from FCC KDB 865664 D01v01r04 SAR measurement 100 MHz to 6 GHz.

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

9.4 Zoom Scan

Zoom scans are used to assess the peak spatial SAR values within a cubic averaging volume containing 1 gram and 10 gram of simulated tissue. The zoom scan measures points (refer to table below) within a cube whose base faces are centered on the maxima found in a preceding area scan job within the same procedure. When the measurement is done, the zoom scan evaluates the averaged SAR for 1 gram and 10 gram and displays these values next to the job's label.

Zoom scan parameters extracted from FCC KDB 865664 D01v01r04 SAR measurement 100 MHz to 6 GHz.

			≤ 3 GHz	> 3 GHz
Maximum zoom scan spatial resolution: $\Delta x_{\text{Zoom}}, \Delta y_{\text{Zoom}}$			≤ 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: $\Delta z_{\text{Zoom}}(n)$		≤ 5 mm	3 – 4 GHz: ≤ 4 mm 4 – 5 GHz: ≤ 3 mm 5 – 6 GHz: ≤ 2 mm
	graded grid	$\Delta z_{\text{Zoom}}(1)$: between 1 st two points closest to phantom surface	≤ 4 mm	3 – 4 GHz: ≤ 3 mm 4 – 5 GHz: ≤ 2.5 mm 5 – 6 GHz: ≤ 2 mm
		$\Delta z_{\text{Zoom}}(n>1)$: between subsequent points	$\leq 1.5 \cdot \Delta z_{\text{Zoom}}(n-1)$	
Minimum zoom scan volume	x, y, z		≥ 30 mm	3 – 4 GHz: ≥ 28 mm 4 – 5 GHz: ≥ 25 mm 5 – 6 GHz: ≥ 22 mm
Note: δ is the penetration depth of a plane-wave at normal incidence to the tissue medium; see draft standard IEEE P1528-2011 for details.				
* When zoom scan is required and the <i>reported</i> SAR from the <i>area scan based 1-g SAR estimation</i> procedures of KDB 447498 is ≤ 1.4 W/kg, ≤ 8 mm, ≤ 7 mm and ≤ 5 mm zoom scan resolution may be applied, respectively, for 2 GHz to 3 GHz, 3 GHz to 4 GHz and 4 GHz to 6 GHz.				

9.5 Volume Scan Procedures

The volume scan is used to 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.

9.6 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 drifts more than 5%, the SAR will be retested.

10. Test Equipment List

Manufacturer	Name of Equipment	Type/Model	Serial Number	Calibration	
				Last Cal.	Due Date
SPEAG	2450MHz System Validation Kit	D2450V2	908	2019/3/25	2022/3/23
SPEAG	2600MHz System Validation Kit	D2600V2	1061	2020/11/26	2021/11/25
SPEAG	5000MHz System Validation Kit	D5GHzV2	1113	2019/9/24	2022/9/23
SPEAG	Data Acquisition Electronics	DAE4	1358	2020/4/28	2021/4/27
SPEAG	Dosimetric E-Field Probe	EX3DV4	3857	2020/9/25	2021/9/24
SPEAG	ELI4 Phantom	QD 0VA 001 BB	TP-1201	NCR	NCR
SPEAG	Phone Positioner	N/A	N/A	NCR	NCR
Anritsu	Radio Communication Analyzer	MT8821C	6201432831	2020/4/14	2021/4/13
Agilent	Wireless Communication Test Set	E5515C	MY52102706	2020/10/17	2021/10/16
Agilent	ENA Series Network Analyzer	E5071C	MY46106933	2020/8/1	2021/7/31
SPEAG	Dielectric Probe Kit	DAK-3.5	1138	2020/5/19	2021/5/18
Anritsu	Vector Signal Generator	MG3710A	6201682672	2021/1/7	2022/1/6
Rohde & Schwarz	Power Meter	NRVD	102081	2020/8/13	2021/8/12
Rohde & Schwarz	Power Sensor	NRV-Z5	100538	2020/8/13	2021/8/12
Rohde & Schwarz	Power Sensor	NRV-Z5	100539	2020/8/13	2021/8/12
R&S	CBT BLUETOOTH TESTER	CBT	101246	2020/4/14	2021/4/13
EXA	Spectrum Analyzer	FSV7	101632	2021/1/7	2022/1/6
Testo	Hygrometer	608-H1	1241332088	2021/1/7	2022/1/6
FLUKE	DIGITAC THERMOMETER	51II	97240029	2020/8/14	2021/8/13
BONN	POWER AMPLIFIER	BLMA 0830-3	087193A	Note 1	
BONN	POWER AMPLIFIER	BLMA 2060-2	087193B	Note 1	
ARRA	Power Divider	A3200-2	N/A	Note 1	
MCL	Attenuation1	BW-S10W5+	N/A	Note 1	
MCL	Attenuation2	BW-S10W5+	N/A	Note 1	
MCL	Attenuation3	BW-S10W5+	N/A	Note 1	
Agilent	Dual Directional Coupler	778D	20500	Note 1	
Agilent	Dual Directional Coupler	11691D	MY48151020	Note 1	

Note:

1. Prior to system verification and validation, the path loss from the signal generator to the system check source and the power meter, which includes the amplifier, cable, attenuator and directional coupler, was measured by the network analyzer. The reading of the power meter was offset by the path loss difference between the path to the power meter and the path to the system check source to monitor the actual power level fed to the system check source.
2. Referring to KDB 865664 D01v01r04, the dipole calibration interval can be extended to 3 years with justification. The dipoles are also not physically damaged, or repaired during the interval.
3. The justification data of dipole can be found in appendix C. The return loss is < -20dB, within 20% of prior calibration, the impedance is within 5 ohm of prior calibration.

11. System Verification

11.1 Tissue Simulating Liquids

For the measurement of the field distribution inside the SAM phantom with DASY, the phantom must be filled with around 25 liters of homogeneous body tissue simulating liquid. For body SAR testing, the liquid height from the center of the flat phantom to the liquid top surface is larger than 15 cm, which is shown in Fig. 11.1.

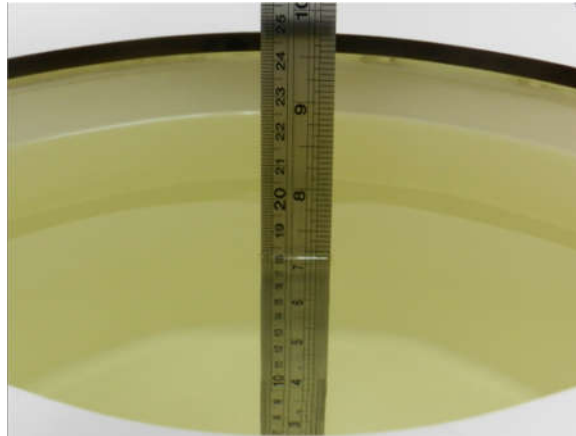


Fig 11.1 Photo of Liquid Height for Body SAR

11.2 Tissue Verification

The following tissue formulations are provided for reference only as some of the parameters have not been thoroughly verified. The composition of ingredients may be modified accordingly to achieve the desired target tissue parameters required for routine SAR evaluation.

Frequency (MHz)	Water (%)	Sugar (%)	Cellulose (%)	Salt (%)	Preventol (%)	DGBE (%)	Conductivity (σ)	Permittivity (ϵ_r)
For Head								
2450	55.0	0	0	0	0	45.0	1.80	39.2
2600	54.8	0	0	0.1	0	45.1	1.96	39.0

Simulating Liquid for 5GHz, Manufactured by SPEAG

Ingredients	(% by weight)
Water	64~78%
Mineral oil	11~18%
Emulsifiers	9~15%
Additives and Salt	2~3%

<Tissue Dielectric Parameter Check Results>

Frequency (MHz)	Tissue Type	Liquid Temp. (°C)	Conductivity (σ)	Permittivity (ϵ_r)	Conductivity Target (σ)	Permittivity Target (ϵ_r)	Delta (σ) (%)	Delta (ϵ_r) (%)	Limit (%)	Date
2450	Head	22.6	1.765	39.364	1.80	39.20	-1.94	0.42	±5	2021/3/22
2600	Head	22.7	1.879	39.158	1.96	39.00	-4.13	0.41	±5	2021/3/23
5250	Head	22.6	4.635	36.427	4.71	35.95	-1.59	1.33	±5	2021/3/25
5600	Head	22.7	4.981	35.791	5.07	35.50	-1.76	0.82	±5	2021/3/26
5750	Head	22.9	5.210	35.492	5.22	35.35	-0.19	0.40	±5	2021/3/27

11.3 System Performance Check Results

Comparing to the original SAR value provided by SPEAG, the verification data should be within its specification of 10 %. Below table shows the target SAR and measured SAR after normalized to 1W input power. The table below indicates the system performance check can meet the variation criterion and the plots can be referred to Appendix A of this report.

Date	Frequency (MHz)	Tissue Type	Input Power (mW)	Dipole S/N	Probe S/N	DAE S/N	Measured 1g SAR (W/kg)	Targeted 1g SAR (W/kg)	Normalized 1g SAR (W/kg)	Deviation (%)
2021/3/22	2450	Head	250	908	3857	1358	12.90	52.80	51.6	-2.27
2021/3/23	2600	Head	250	1061	3857	1358	13.60	56.60	54.4	-3.89
2021/3/25	5250	Head	100	1113	3857	1358	7.85	80.50	78.5	-2.48
2021/3/26	5600	Head	100	1113	3857	1358	8.38	83.40	83.8	0.48
2021/3/27	5750	Head	100	1113	3857	1358	7.56	80.00	75.6	-5.50

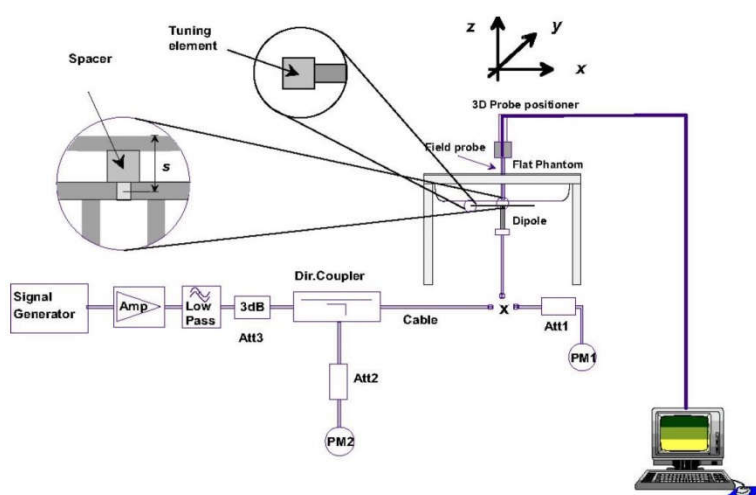


Fig 8.3.1 System Performance Check Setup



Fig 8.3.2 Setup Photo



12. RF Exposure Positions

12.1 SAR Testing for Tablet

This device can be used also in full sized tablet exposure conditions, due to its size. Per FCC KDB 616217, the back surface and edges of the tablet should be tested for SAR compliance with the tablet touching the phantom. The SAR exclusion threshold in KDB 447498 D01v06 can be applied to determine SAR test exclusion for adjacent edge configurations. The closest distance from the antenna to an adjacent tablet edge is used to determine if SAR testing is required for the adjacent edges, with the adjacent edge positioned against the phantom and the edge containing the antenna positioned perpendicular to the phantom.

<EUT Setup Photos>

Please refer to Appendix D for the test setup photos.

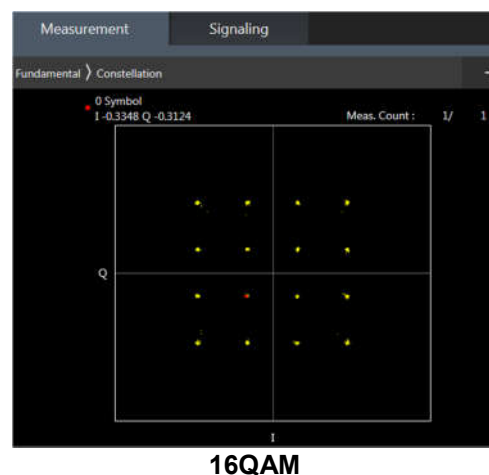
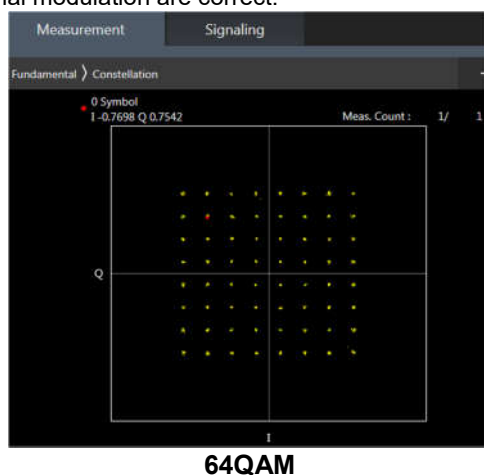
13. LTE Output Power (Unit: dBm)

The detailed conducted power table can refer to Appendix E.

<LTE Conducted Power>

General Note:

1. Anritsu MT8820C base station simulator was used to setup the connection with EUT; the frequency band, channel bandwidth, RB allocation configuration, modulation type are set in the base station simulator to configure EUT transmitting at maximum power and at different configurations which are requested to be reported to FCC, for conducted power measurement and SAR testing.
2. Per KDB 941225 D05v02r05, when a properly configured base station simulator is used for the SAR and power measurements, spectrum plots for each RB allocation and offset configuration is not required.
3. Per KDB 941225 D05v02r05, start with the largest channel bandwidth and measure SAR for QPSK with 1 RB allocation, using the RB offset and required test channel combination with the highest maximum output power for RB offsets at the upper edge, middle and lower edge of each required test channel.
4. Per KDB 941225 D05v02r05, 50% RB allocation for QPSK SAR testing follows 1RB QPSK allocation procedure.
5. Per KDB 941225 D05v02r05, For QPSK with 100% RB allocation, SAR is not required when the highest maximum output power for 100 % RB allocation is less than the highest maximum output power in 50% and 1 RB allocations and the highest reported SAR for 1 RB and 50% RB allocation are ≤ 0.8 W/kg. Otherwise, SAR is measured for the highest output power channel; and if the reported SAR is > 1.45 W/kg, the remaining required test channels must also be tested.
6. Per KDB 941225 D05v02r05, 16QAM output power for each RB allocation configuration is $>$ not $\frac{1}{2}$ dB higher than the same configuration in QPSK and the reported SAR for the QPSK configuration is ≤ 1.45 W/kg; Per KDB 941225 D05v02r05, 16QAM SAR testing is not required.
7. Per KDB 941225 D05v02r05, Smaller bandwidth output power for each RB allocation configuration is $>$ not $\frac{1}{2}$ dB higher than the same configuration in the largest supported bandwidth, and the reported SAR for the largest supported bandwidth is ≤ 1.45 W/kg; Per KDB 941225 D05v02r05, smaller bandwidth SAR testing is not required.
8. According to 2017 TCB workshop, for 64 QAM and 16 QAM should be verified by checking the signal constellation with a call box to avoid incorrect maximum power levels due to MPR and other requirements associated with signal modulation, and the following figure is taken from the "Fundamental Measurement >> Modulation Analysis >> constellation" mode of the device connect to the MT8821C base station, therefore, the device 64QAM and 16QAM signal modulation are correct.



<TDD LTE SAR Measurement>

TDD LTE configuration setup for SAR measurement

SAR was tested with a fixed periodic duty factor according to the highest transmission duty factor implemented for the device and supported by 3GPP.

- 3GPP TS 36.211 section 4.2 for Type 2 Frame Structure and Table 4.2-2 for uplink-downlink configurations
- "special subframe S" contains both uplink and downlink transmissions, it has been taken into consideration to determine the transmission duty factor according to the worst case uplink and downlink cyclic prefix requirements for UpPTS
- Establishing connections with base station simulators ensure a consistent means for testing SAR and recommended for evaluating SAR. The Anritsu MT8820C (firmware: #22.52#004) was used for LTE output power measurements and SAR testing.

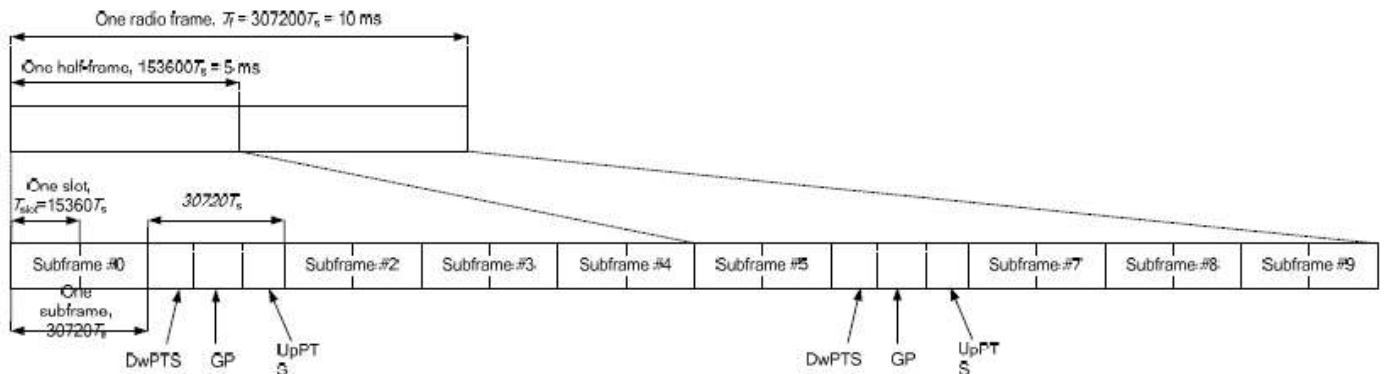


Figure 4.2-1: Frame structure type 2 (for 5 ms switch-point periodicity).

Table 4.2-2: Uplink-downlink configurations.

Uplink-downlink configuration	Downlink-to-Uplink Switch-point periodicity	Subframe number									
		0	1	2	3	4	5	6	7	8	9
0	5 ms	D	S	U	U	U	D	S	U	U	U
1	5 ms	D	S	U	U	D	D	S	U	U	D
2	5 ms	D	S	U	D	D	D	S	U	D	D
3	10 ms	D	S	U	U	U	D	D	D	D	D
4	10 ms	D	S	U	U	D	D	D	D	D	D
5	10 ms	D	S	U	D	D	D	D	D	D	D
6	5 ms	D	S	U	U	U	D	S	U	U	D

Table 4.2-1: Configuration of special subframe (lengths of DwPTS/GP/UpPTS).

Special subframe configuration	Normal cyclic prefix in downlink			Extended cyclic prefix in downlink		
	DwPTS	UpPTS		DwPTS	UpPTS	
		Normal cyclic prefix in uplink	Extended cyclic prefix in uplink		Normal cyclic prefix in uplink	Extended cyclic prefix in uplink
0	$6592 \cdot T_s$	$2192 \cdot T_s$	$2560 \cdot T_s$	$7680 \cdot T_s$	$2192 \cdot T_s$	$2560 \cdot T_s$
1	$19760 \cdot T_s$			$20480 \cdot T_s$		
2	$21952 \cdot T_s$			$23040 \cdot T_s$		
3	$24144 \cdot T_s$			$25600 \cdot T_s$		
4	$26336 \cdot T_s$	$4384 \cdot T_s$	$5120 \cdot T_s$	$7680 \cdot T_s$	$4384 \cdot T_s$	$5120 \cdot T_s$
5	$6592 \cdot T_s$			$20480 \cdot T_s$		
6	$19760 \cdot T_s$			$23040 \cdot T_s$		
7	$21952 \cdot T_s$			$12800 \cdot T_s$	-	-
8	$24144 \cdot T_s$			-		
9	$13168 \cdot T_s$			-	-	-

Special subframe (30720·T _s): Normal cyclic prefix in downlink (UpPTS)			
	Special subframe configuration	Normal cyclic prefix in uplink	Extended cyclic prefix in uplink
Uplink duty factor in one special subframe	0~4	7.13%	8.33%
	5~9	14.3%	16.7%

Special subframe(30720·T _s): Extended cyclic prefix in downlink (UpPTS)			
	Special subframe configuration	Normal cyclic prefix in uplink	Extended cyclic prefix in uplink
Uplink duty factor in one special subframe	0~3	7.13%	8.33%
	4~7	14.3%	16.7%

The highest duty factor is resulted from:

For LTE Band 41 Power class 2

- Uplink-downlink configuration: 1. In a half-frame consisted of 5 subframes, uplink operation is in 2 uplink subframes and 1 special subframe.
- special subframe configuration: 5-9 for normal cyclic prefix in downlink, 4-7 for extended cyclic prefix in downlink
- for special subframe with extended cyclic prefix in uplink, the total uplink duty factor in one half-frame is:
 $(2+0.167)/5 = 43.3\%$
- for special subframe with normal cyclic prefix in uplink, the total uplink duty factor in one half-frame is:
 $(2+0.143)/5 = 42.9\%$
- For TDD LTE SAR measurement, the duty cycle 1:2.33 (42.9 %) was used perform testing and considering the theoretical duty cycle of 43.3% for extended cyclic prefix in the uplink, and the theoretical duty cycle of 42.9% for normal cyclic prefix in uplink, a scaling factor of extended cyclic prefix $43.3\%/42.9\% = 1.009$ is applied to scale-up the measured SAR result. The scaled TDD LTE SAR = measured SAR (W/kg)* Tune-up Scaling Factor* scaling factor for extended cyclic prefix.

For LTE Band 41 Power class 3

- Uplink-downlink configuration: 0. In a half-frame consisted of 5 subframes, uplink operation is in 3 uplink subframes and 1 special subframe.
- special subframe configuration: 5-9 for normal cyclic prefix in downlink, 4-7 for extended cyclic prefix in downlink
- for special subframe with extended cyclic prefix in uplink, the total uplink duty factor in one half-frame is:
 $(3+0.167)/5 = 63.3\%$
- for special subframe with normal cyclic prefix in uplink, the total uplink duty factor in one half-frame is:
 $(3+0.143)/5 = 62.9\%$
- For TDD LTE SAR measurement, the duty cycle 1:1.59 (62.9 %) was used perform testing and considering the theoretical duty cycle of 63.3% for extended cyclic prefix in the uplink, and the theoretical duty cycle of 62.9% for normal cyclic prefix in uplink, a scaling factor of extended cyclic prefix $63.3\%/62.9\% = 1.006$ is applied to scale-up the measured SAR result. The scaled TDD LTE SAR = measured SAR (W/kg)* Tune-up Scaling Factor* scaling factor for extended cyclic prefix.

<LTE Carrier Aggregation>

General Note:

1. This device supports Carrier Aggregation on downlink for intra band. For the device supports bands and bandwidths and configurations are provided as follow table was according to 3GPP.
2. In applying the existing power measurement procedures of KDB 941225 D05A for DL CA SAR test exclusion, only the subset with the largest number of combinations of frequency bands and CCs in each row need combination, and for this device that all the configurations were choose to power measurement.

2CC Downlink Carrier Aggregation		
Number	Combination	Restriction
1	CA_41C	-

LTE 2x2 MIMO or 4x4 MIMO (Downlink)

This device supports downlink 2x2 MIMO or 4x4 MIMO operations for LTE Band 41 only. Uplink transmission is limited to a single output stream. Power measurements were performed with downlink 4x4 MIMO active for the configuration with highest measured maximum conducted power with 4x4 downlink MIMO inactive measured among the channel bandwidth, modulation, and RB combinations in each frequency band.

Per FCC Guidance, SAR for downlink 2x2 MIMO or 4x4 MIMO was not needed since the maximum average output power in 2x2 MIMO or 4x4 MIMO mode was not > 0.25 dB higher than the maximum output power with downlink 2x2 MIMO or 4x4 MIMO inactive. When carrier aggregation is applicable, power measurements were performed with the downlink carrier aggregation and 4x4 DL MIMO active for the configuration with highest measured maximum conducted power with downlink carrier aggregation inactive measured among the channel bandwidth, modulation, and RB combinations in each frequency band.

LTE Band 41	MIMO Downlink only	
	2x2	
	4x4	

LTE Carrier Aggregation Conducted Power (Downlink)

- i. According to KDB941225 D05A v01r02, Uplink maximum output power measurement with downlink carrier aggregation active should be measured, using the highest output channel measured without downlink carrier aggregation, to confirm that uplink maximum output power with downlink carrier aggregation active remains within the specified tune-up tolerance limits and not more than ¼ dB higher than the maximum output measured without downlink carrier aggregation active.
- ii. Uplink maximum output power with downlink carrier aggregation active does not show more than ¼ dB higher than the maximum output power without downlink carrier aggregation active, therefore SAR evaluation with downlink carrier aggregation active can be excluded.
- iii. The device supports downlink two carrier aggregation. For power measurement were control and acknowledge data is sent on uplink channels that operate identical to specifications when downlink carrier aggregation is inactive.
- iv. Selected highest measured power when downlink carrier aggregation is inactive for conducted power comparison with downlink carrier aggregation is active, to confirm that when downlink carrier aggregation is active uplink maximum output power remains within the specified tune-up tolerance limits and not more than ¼ dB higher than the maximum output power measured when downlink carrier aggregation inactive.
- v. For non-contiguous intra-band CA, the SCC selected to provide maximum separation from the PCC and must remain fully within the downlink transmission band.
- vi. For Intra-band, contiguous CA, the downlink channels selected to perform the uplink power measurement must satisfy 3GPP channel spacing (5.4.1A of 3GPP TS 36.521 or equivalent) and channel bandwidth (5.4.2A) requirements.

$$\text{Nominal channel spacing} = \left\lceil \frac{BW_{\text{Channel}(1)} + BW_{\text{Channel}(2)} - 0.1 |BW_{\text{Channel}(1)} - BW_{\text{Channel}(2)}|}{0.6} \right\rceil 0.3 \text{ [MHz]}$$

14. WiFi/Bluetooth Output Power (Unit: dBm)

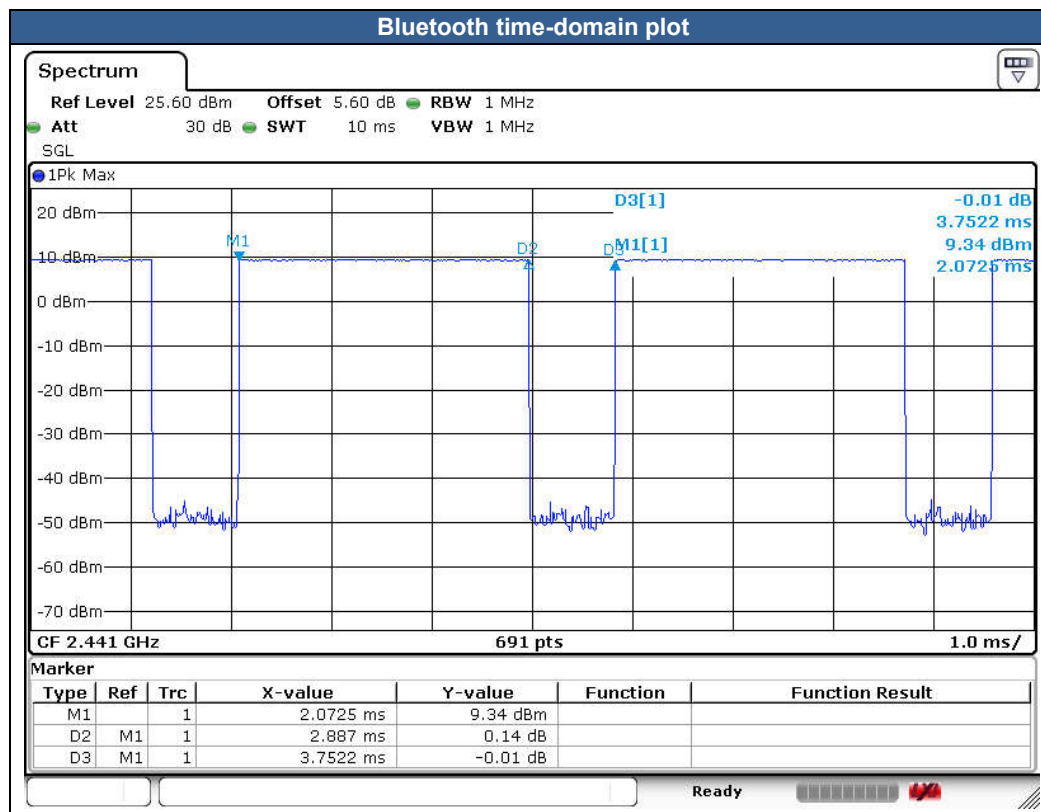
General Note:

1. Per KDB 248227 D01v02r02, SAR test reduction is determined according to 802.11 transmission mode configurations and certain exposure conditions with multiple test positions. In the 2.4 GHz band, separate SAR procedures are applied to DSSS and OFDM configurations to simplify DSSS test requirements. For OFDM, in both 2.4 and 5 GHz bands, an initial test configuration must be determined for each standalone and aggregated frequency band, according to the transmission mode configuration with the highest maximum output power specified for production units to perform SAR measurements. If the same highest maximum output power applies to different combinations of channel bandwidths, modulations and data rates, additional procedures are applied to determine which test configurations require SAR measurement. When applicable, an initial test position may be applied to reduce the number of SAR measurements required for next to the ear, UMPC mini-tablet or hotspot mode configurations with multiple test positions.
2. For 2.4 GHz 802.11b DSSS, either the initial test position procedure for multiple exposure test positions or the DSSS procedure for fixed exposure position is applied; these are mutually exclusive. For 2.4 GHz and 5 GHz OFDM configurations, the initial test configuration is applied to measure SAR using either the initial test position procedure for multiple exposure test position configurations or the initial test configuration procedures for fixed exposure test conditions. Based on the reported SAR of the measured configurations and maximum output power of the transmission mode configurations that are not included in the initial test configuration, the subsequent test configuration and initial test position procedures are applied to determine if SAR measurements are required for the remaining OFDM transmission configurations. In general, the number of test channels that require SAR measurement is minimized based on maximum output power measured for the test sample(s).
3. For OFDM transmission configurations in the 2.4 GHz and 5 GHz bands, 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 for each frequency band.
4. DSSS and OFDM configurations are considered separately according to the required SAR procedures. SAR is measured in the initial test position using the 802.11 transmission mode configuration required by the DSSS procedure or initial test configuration and subsequent test configuration(s) according to the OFDM procedures.18 The initial test position procedure is described in the following:
 - a. When the reported SAR of the initial test position is ≤ 0.4 W/kg, further SAR measurement is not required for the other test positions in that exposure configuration and 802.11 transmission mode combinations within the frequency band or aggregated band.
 - b. When the reported SAR of the test position is > 0.4 W/kg, SAR is repeated for the 802.11 transmission mode configuration tested in the initial test position to measure the subsequent next closet/smallest test separation distance and maximum coupling test position on the highest maximum output power channel, until the report SAR is ≤ 0.8 W/kg or all required test position are tested.
 - c. For all positions/configurations, when the reported SAR is > 0.8 W/kg, SAR is measured for these test positions/configurations on the subsequent next highest measured output power channel(s) until the reported SAR is ≤ 1.2 W/kg or all required channels are tested.

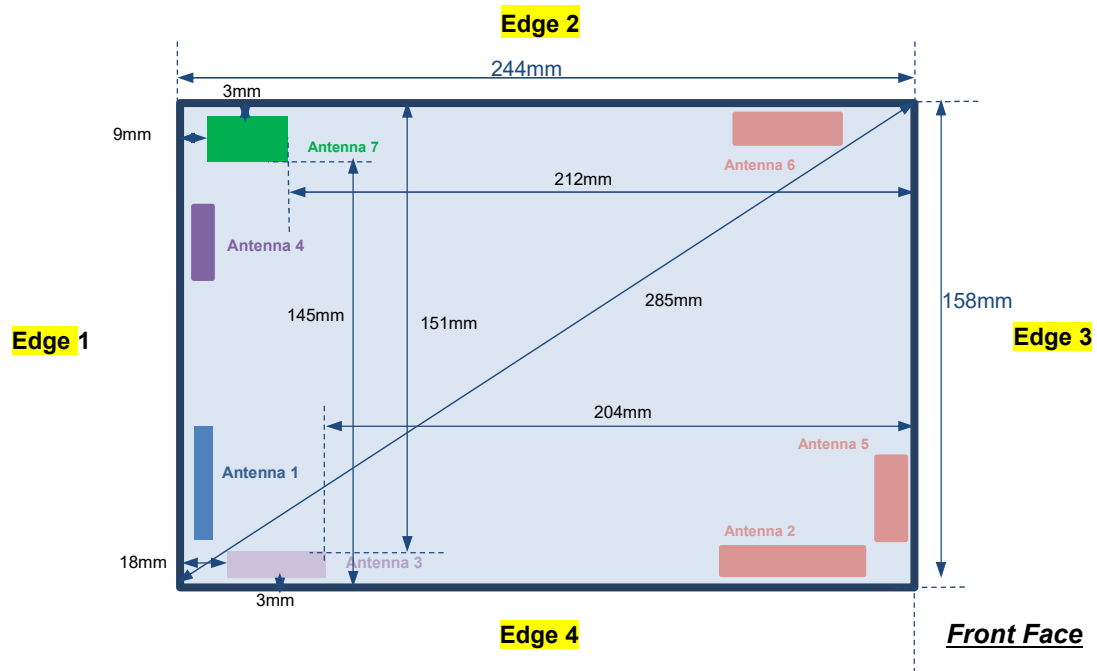
<2.4GHz Bluetooth>

General Note:

1. For 2.4GHz Bluetooth SAR testing was selected 1Mbps, due to its highest average power.
2. The Bluetooth duty cycle is 76.94 % as following figure, according to 2016 Oct. TCB workshop for Bluetooth SAR scaling need further consideration and the maximum duty cycle is 100%, therefore the actual duty cycle will be scaled up to 100% for Bluetooth reported SAR calculation



15. Antenna Location



Antenna	Support Band
Antenna 3	LTE: B41
Antenna 7	WLAN2.4G&5G Bluetooth

Note: Other antenna supports non-US band, no need to consider SAR testing.

<SAR test exclusion table>
General Note:

1. The below table, when the distance is < 50 mm exclusion threshold is "Ratio", when the distance is > 50 mm exclusion threshold is "mW"
2. Maximum power is the source-based time-average power and represents the maximum RF output power among production units
3. Per KDB 447498 D01v06, for larger devices, the test separation distance of adjacent edge configuration is determined by the closest separation between the antenna and the user.
4. Per KDB 447498 D01v06, standalone SAR test exclusion threshold is applied; If the test separation distance is < 5mm, 5mm is used to determine SAR exclusion threshold.
5. Per KDB 447498 D01v06, 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:

$$[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}] \leq 3.0 \text{ for 1-g SAR and } \leq 7.5 \text{ for 10-g extremity SAR}$$
 - f(GHz) is the RF channel transmit frequency in GHz
 - Power and distance are rounded to the nearest mW and mm before calculation
 - The result is rounded to one decimal place for comparison
6. Per KDB 447498 D01v06, at 100 MHz to 6 GHz and for *test separation distances* > 50 mm, the SAR test exclusion threshold is determined according to the following
 - a) [Threshold at 50 mm in step 1) + (test separation distance - 50 mm) · (f(MHz)/150)] mW, at 100 MHz to 1500 MHz
 - b) [Threshold at 50 mm in step 1) + (test separation distance - 50 mm) · 10] mW at > 1500 MHz and ≤ 6 GHz

Exposure Position	Wireless Interface	LTE Band 41	BT	2.4GHz WLAN	5GHz WLAN
	Calculated Frequency	2687MHz	2480MHz	2462MHz	5825MHz
	Maximum power (dBm)	26	10	19	17
	Maximum rated power(mW)	398.0	10.0	79.0	50.0
Bottom Face	Separation distance(mm)	5.0	5.0	5.0	5.0
	exclusion threshold	130.5	3.2	24.8	24.1
	Testing required?	Yes	Yes	Yes	Yes
Edge 1	Separation distance(mm)	18.0	9.0	9.0	9.0
	exclusion threshold	36.2	1.8	13.8	13.4
	Testing required?	Yes	No	Yes	Yes
Edge 2	Separation distance(mm)	151.0	3.0	3.0	3.0
	exclusion threshold	1102.0	3.2	24.8	24.1
	Testing required?	No	Yes	Yes	Yes
Edge 3	Separation distance(mm)	204.0	212.0	212.0	212.0
	exclusion threshold	1632.0	1715.0	1716.0	1682.0
	Testing required?	No	No	No	No
Edge 4	Separation distance(mm)	3.0	145.0	145.0	145.0
	exclusion threshold	130.5	1045.0	1046.0	1012.0
	Testing required?	Yes	No	No	No

16. SAR Test Results

General Note:

1. Per KDB 447498 D01v06, 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 SAR testing of WLAN/Bluetooth signal with non-100% duty cycle, the measured SAR is scaled-up by the duty cycle scaling factor which is equal to "1/(duty cycle)"
 - c. For WWAN: Reported SAR(W/kg)= Measured SAR(W/kg)*Tune-up Scaling Factor
 - d. For WLAN/Bluetooth: Reported SAR(W/kg)= Measured SAR(W/kg)* Duty Cycle scaling factor * Tune-up scaling factor
 - e. For TDD LTE SAR measurement, the duty cycle 1:1.59 (62.9 %) was used perform testing and considering the theoretical duty cycle of 63.3% for extended cyclic prefix in the uplink, and the theoretical duty cycle of 62.9% for normal cyclic prefix in uplink, a scaling factor of extended cyclic prefix 63.3%/62.9% = 1.006 is applied to scale-up the measured SAR result.
The Reported TDD LTE SAR = measured SAR (W/kg)* Tune-up Scaling Factor* scaling factor for extended cyclic prefix.
2. Per KDB 447498 D01v06, 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
3. Per KDB 865664 D01v01r04, for each frequency band, repeated SAR measurement is required only when the measured SAR is ≥ 0.8 W/kg.
4. The device employs proximity sensors that detect the presence of the user's body also a finger or hand near the bottom face, edge 1 or edge 4 of the device, reduced power will be active for all WWAN bands. (P-sensor can't work at detecting presence of the user's body at other edges of the device.)
5. For WLAN, the device employs proximity sensors that detect the presence of the user's body also a finger or hand near the bottom face, edge 1 or edge 2 of the device, reduced power will be active for all WLAN bands. (P-sensor can't work at detecting presence of the user's body at other edges of the device.)
6. There are two different types of EUT. For model change note, please refer the product equality declaration exhibit submitted. According to the difference, we choose the sample 1 to full test and the sample 2 is verified.

LTE Note:

1. Per KDB 941225 D05v02r05, start with the largest channel bandwidth and measure SAR for QPSK with 1 RB allocation, using the RB offset and required test channel combination with the highest maximum output power for RB offsets at the upper edge, middle and lower edge of each required test channel.
2. Per KDB 941225 D05v02r05, 50% RB allocation for QPSK SAR testing follows 1RB QPSK allocation procedure.
3. Per KDB 941225 D05v02r05, For QPSK with 100% RB allocation, SAR is not required when the highest maximum output power for 100 % RB allocation is less than the highest maximum output power in 50% and 1 RB allocations and the highest reported SAR for 1 RB and 50% RB allocation are ≤ 0.8 W/kg. Otherwise, SAR is measured for the highest output power channel; and if the reported SAR is > 1.45 W/kg, the remaining required test channels must also be tested.
4. Per KDB 941225 D05v02r05, 16QAM output power for each RB allocation configuration is $> \text{not } \frac{1}{2}$ dB higher than the same configuration in QPSK and the reported SAR for the QPSK configuration is ≤ 1.45 W/kg; Per KDB 941225 D05v02r05, 16QAM SAR testing is not required.
5. Per KDB 941225 D05v02r05, Smaller bandwidth output power for each RB allocation configuration is $> \text{not } \frac{1}{2}$ dB higher than the same configuration in the largest supported bandwidth, and the reported SAR for the largest supported bandwidth is ≤ 1.45 W/kg; Per KDB 941225 D05v02r05, smaller bandwidth SAR testing is not required.

WLAN Note:

1. Per KDB 248227 D01v02r02, for 2.4GHz 802.11g/n SAR testing is not required when the highest reported SAR for DSSS is adjusted by the ratio of OFDM to DSSS specified maximum output power and the adjusted SAR is ≤ 1.2 W/kg.
2. Per KDB 248227 D01v02r02, U-NII-1 SAR testing is not required when the U-NII-2A band highest reported SAR for a test configuration is ≤ 1.2 W/kg, SAR is not required for U-NII-1 band.
3. When the reported SAR of the test position is > 0.4 W/kg, SAR is repeated for the 802.11 transmission mode configuration tested in the initial test position to measure the subsequent next closet/smallest test separation distance and maximum coupling test position on the highest maximum output power channel, until the report SAR is ≤ 0.8 W/kg or all required test position are tested.
4. For all positions / configurations, when the reported SAR is > 0.8 W/kg, SAR is measured for these test positions / configurations on the subsequent next highest measured output power channel(s) until the reported SAR is ≤ 1.2 W/kg or all required channels are tested.
5. During SAR testing the WLAN transmission was verified using a spectrum analyzer.

16.1 Body SAR
<LTE TDD SAR>

Plot No.	Band	BW (MHz)	Modulation	RB Size	RB offset	Test Position	Sample	Gap (mm)	Power Reduction	Ch.	Freq. (MHz)	Average Power (dBm)	Tune-Up Limit (dBm)	Tune-up Scaling Factor	Duty Cycle %	Duty Cycle Scaling Factor	Power Drift (dB)	Measured 1g SAR (W/kg)	Reported 1g SAR (W/kg)
	LTE Band 41	20M	QPSK	1	0	Bottom Face	1	0mm	Reduced	40620	2593	13.76	14.00	1.057	62.9	1.006	0.09	0.827	0.879
	LTE Band 41	20M	QPSK	1	0	Bottom Face	1	0mm	Reduced	39750	2506	13.56	14.00	1.107	62.9	1.006	-0.02	0.518	0.577
	LTE Band 41	20M	QPSK	1	0	Bottom Face	1	0mm	Reduced	40185	2549.5	13.70	14.00	1.072	62.9	1.006	0.03	0.643	0.693
	LTE Band 41	20M	QPSK	1	0	Bottom Face	1	0mm	Reduced	41055	2636.5	13.27	14.00	1.183	62.9	1.006	0.04	0.833	0.991
	LTE Band 41	20M	QPSK	1	0	Bottom Face	1	0mm	Reduced	41490	2680	13.41	14.00	1.146	62.9	1.006	0.01	0.990	1.141
	LTE Band 41	20M	QPSK	50	0	Bottom Face	1	0mm	Reduced	40620	2593	13.61	14.00	1.094	62.9	1.006	-0.08	0.768	0.845
	LTE Band 41	20M	QPSK	50	0	Bottom Face	1	0mm	Reduced	39750	2506	13.09	14.00	1.233	62.9	1.006	0.02	0.540	0.670
	LTE Band 41	20M	QPSK	50	0	Bottom Face	1	0mm	Reduced	40185	2549.5	13.26	14.00	1.186	62.9	1.006	-0.01	0.664	0.792
	LTE Band 41	20M	QPSK	50	0	Bottom Face	1	0mm	Reduced	41055	2636.5	13.46	14.00	1.132	62.9	1.006	0.09	0.853	0.972
01	LTE Band 41	20M	QPSK	50	0	Bottom Face	1	0mm	Reduced	41490	2680	13.32	14.00	1.169	62.9	1.006	0.01	0.996	1.172
	LTE Band 41	20M	QPSK	50	0	Bottom Face	2	0mm	Reduced	41490	2680	13.32	14.00	1.169	62.9	1.006	0.09	0.630	0.741
	LTE Band 41-HPUE	20M	QPSK	50	0	Bottom Face	1	0mm	Reduced	41490	2680	13.32	14.00	1.169	42.9	1.009	0.07	0.639	0.754
	LTE Band 41	20M	QPSK	100	0	Bottom Face	1	0mm	Reduced	40620	2593	13.53	14.00	1.114	62.9	1.006	0.05	0.755	0.846
	LTE Band 41	20M	QPSK	1	0	Edge 1	1	0mm	Reduced	40620	2593	13.76	14.00	1.057	62.9	1.006	-0.05	0.050	0.053
	LTE Band 41	20M	QPSK	50	0	Edge 1	1	0mm	Reduced	40620	2593	13.61	14.00	1.094	62.9	1.006	0.12	0.053	0.058
	LTE Band 41	20M	QPSK	1	0	Edge 4	1	0mm	Reduced	40620	2593	13.76	14.00	1.057	62.9	1.006	0.09	0.528	0.561
	LTE Band 41	20M	QPSK	1	0	Edge 4	1	0mm	Reduced	39750	2506	13.56	14.00	1.107	62.9	1.006	-0.01	0.510	0.568
	LTE Band 41	20M	QPSK	1	0	Edge 4	1	0mm	Reduced	40185	2549.5	13.70	14.00	1.072	62.9	1.006	0.01	0.524	0.565
	LTE Band 41	20M	QPSK	1	0	Edge 4	1	0mm	Reduced	41055	2636.5	13.27	14.00	1.183	62.9	1.006	0.16	0.578	0.688
	LTE Band 41	20M	QPSK	1	0	Edge 4	1	0mm	Reduced	41490	2680	13.41	14.00	1.146	62.9	1.006	0.02	0.651	0.750
	LTE Band 41	20M	QPSK	50	0	Edge 4	1	0mm	Reduced	40620	2593	13.61	14.00	1.094	62.9	1.006	0.08	0.540	0.594
	LTE Band 41	20M	QPSK	50	0	Edge 4	1	0mm	Reduced	39750	2506	13.09	14.00	1.233	62.9	1.006	0.01	0.530	0.657
	LTE Band 41	20M	QPSK	50	0	Edge 4	1	0mm	Reduced	40185	2549.5	13.26	14.00	1.186	62.9	1.006	0.09	0.540	0.644
	LTE Band 41	20M	QPSK	50	0	Edge 4	1	0mm	Reduced	41055	2636.5	13.46	14.00	1.132	62.9	1.006	0.04	0.587	0.669
	LTE Band 41	20M	QPSK	50	0	Edge 4	1	0mm	Reduced	41490	2680	13.32	14.00	1.169	62.9	1.006	0.03	0.664	0.781
	LTE Band 41	20M	QPSK	100	0	Edge 4	1	0mm	Reduced	40620	2593	13.53	14.00	1.114	62.9	1.006	-0.06	0.574	0.643
	LTE Band 41	20M	QPSK	1	0	Bottom Face	1	15 mm	Full	40620	2593	23.63	24.00	1.089	62.9	1.006	0.01	0.503	0.551
	LTE Band 41-HPUE	20M	QPSK	1	0	Bottom Face	1	15 mm	Full	40620	2593	25.17	26.00	1.211	42.9	1.009	-0.03	0.483	0.590
	LTE Band 41	20M	QPSK	50	0	Bottom Face	1	15 mm	Full	40620	2593	22.59	23.00	1.099	62.9	1.006	0.09	0.408	0.451
	LTE Band 41	20M	QPSK	1	0	Edge 1	1	13 mm	Full	40620	2593	23.63	24.00	1.089	62.9	1.006	-0.16	0.001	0.001
	LTE Band 41	20M	QPSK	50	0	Edge 1	1	13 mm	Full	40620	2593	22.59	23.00	1.099	62.9	1.006	0.01	0.001	0.001
	LTE Band 41	20M	QPSK	1	0	Edge 4	1	22 mm	Full	40620	2593	23.63	24.00	1.089	62.9	1.006	0.09	0.076	0.083
	LTE Band 41	20M	QPSK	50	0	Edge 4	1	22 mm	Full	40620	2593	22.59	23.00	1.099	62.9	1.006	-0.03	0.078	0.086

<WLAN 2.4GHz SAR>

Plot No.	Band	Mode	Test Position	Sample	Gap (mm)	Power Reduction	Ch.	Freq. (MHz)	Average Power (dBm)	Tune-Up Limit (dBm)	Tune-up Scaling Factor	Duty Cycle %	Duty Cycle Scaling Factor	Power Drift (dB)	Measured 1g SAR (W/kg)	Reported 1g SAR (W/kg)
02	WLAN2.4GHz	802.11b 1Mbps	Bottom Face	1	0mm	Reduced	6	2437	11.28	12.00	1.180	98.93	1.011	-0.06	0.996	1.189
	WLAN2.4GHz	802.11b 1Mbps	Bottom Face	1	0mm	Reduced	1	2412	11.11	12.00	1.227	98.93	1.011	0.01	0.936	1.162
	WLAN2.4GHz	802.11b 1Mbps	Edge 1	1	0mm	Reduced	6	2437	11.28	12.00	1.180	98.93	1.011	-0.03	0.346	0.413
	WLAN2.4GHz	802.11b 1Mbps	Edge 2	1	0mm	Reduced	6	2437	11.28	12.00	1.180	98.93	1.011	0.05	0.564	0.673
	WLAN2.4GHz	802.11b 1Mbps	Bottom Face	1	15 mm	Full	6	2437	17.99	19.00	1.263	98.93	1.011	0.03	0.244	0.312
	WLAN2.4GHz	802.11b 1Mbps	Edge 1	1	13 mm	Full	6	2437	17.99	19.00	1.263	98.93	1.011	-0.02	0.118	0.151
	WLAN2.4GHz	802.11b 1Mbps	Edge 2	1	16 mm	Full	6	2437	17.99	19.00	1.263	98.93	1.011	0.09	0.098	0.125

<Bluetooth SAR>

Plot No.	Band	Mode	Test Position	Sample	Gap (mm)	Power Reduction	Ch.	Freq. (MHz)	Average Power (dBm)	Tune-Up Limit (dBm)	Tune-up Scaling Factor	Duty Cycle %	Duty Cycle Scaling Factor	Power Drift (dB)	Measured 1g SAR (W/kg)	Reported 1g SAR (W/kg)
03	Bluetooth	1Mbps	Bottom Face	1	0mm	Full	0	2402	9.50	10.00	1.122	76.94	1.300	-0.01	0.362	0.528
	Bluetooth	1Mbps	Edge 1	1	0mm	Full	0	2402	9.50	10.00	1.122	76.94	1.300	0.09	0.132	0.193
	Bluetooth	1Mbps	Edge 2	1	0mm	Full	0	2402	9.50	10.00	1.122	76.94	1.300	0.01	0.201	0.293

<WLAN 5GHz SAR>

Plot No.	Band	Mode	Test Position	Sample	Gap (mm)	Power Reduction	Ch.	Freq. (MHz)	Average Power (dBm)	Tune-Up Limit (dBm)	Tune-up Scaling Factor	Duty Cycle %	Duty Cycle Scaling Factor	Power Drift (dB)	Measured 1g SAR (W/kg)	Reported 1g SAR (W/kg)
04	WLAN5.3GHz	802.11ac-VHT80 MCS0	Bottom Face	1	0mm	Reduced	58	5290	14.81	15.00	1.045	89.6	1.116	-0.07	0.946	1.103
	WLAN5.3GHz	802.11ac-VHT80 MCS0	Edge 1	1	0mm	Reduced	58	5290	14.81	15.00	1.045	89.6	1.116	0.09	0.431	0.503
	WLAN5.3GHz	802.11ac-VHT80 MCS0	Edge 2	1	0mm	Reduced	58	5290	14.81	15.00	1.045	89.6	1.116	-0.05	0.814	0.949
	WLAN5.3GHz	802.11n-HT40 MCS0	Bottom Face	1	15 mm	Full	54	5270	16.21	17.00	1.200	94.9	1.054	0.01	0.179	0.226
	WLAN5.3GHz	802.11n-HT40 MCS0	Edge 1	1	13 mm	Full	54	5270	16.21	17.00	1.200	94.9	1.054	0.09	0.051	0.065
	WLAN5.3GHz	802.11n-HT40 MCS0	Edge 2	1	16 mm	Full	54	5270	16.21	17.00	1.200	94.9	1.054	0.04	0.105	0.133
05	WLAN5.5GHz	802.11ac-VHT80 MCS0	Bottom Face	1	0mm	Reduced	106	5530	14.15	15.00	1.216	89.6	1.116	-0.09	0.750	1.018
	WLAN5.5GHz	802.11ac-VHT80 MCS0	Bottom Face	1	0mm	Reduced	138	5690	14.13	15.00	1.222	89.6	1.116	0.01	0.685	0.934
	WLAN5.5GHz	802.11ac-VHT80 MCS0	Edge 1	1	0mm	Reduced	106	5530	14.15	15.00	1.216	89.6	1.116	0.09	0.098	0.133
	WLAN5.5GHz	802.11ac-VHT80 MCS0	Edge 2	1	0mm	Reduced	106	5530	14.15	15.00	1.216	89.6	1.116	0.01	0.254	0.345
	WLAN5.5GHz	802.11n-HT40 MCS0	Bottom Face	1	15 mm	Full	134	5670	16.11	17.00	1.228	94.9	1.054	0.01	0.187	0.242
	WLAN5.5GHz	802.11n-HT40 MCS0	Edge 1	1	13 mm	Full	134	5670	16.11	17.00	1.228	94.9	1.054	0.06	0.079	0.102
	WLAN5.5GHz	802.11n-HT40 MCS0	Edge 2	1	16 mm	Full	134	5670	16.11	17.00	1.228	94.9	1.054	0.07	0.130	0.168
06	WLAN5.8GHz	802.11ac-VHT80 MCS0	Bottom Face	1	0mm	Reduced	155	5775	13.85	14.00	1.035	89.6	1.116	0.07	1.030	1.190
	WLAN5.8GHz	802.11ac-VHT80 MCS0	Bottom Face	2	0mm	Reduced	155	5775	13.85	14.00	1.035	89.6	1.116	0.03	1.020	1.178
	WLAN5.8GHz	802.11ac-VHT80 MCS0	Edge 1	1	0mm	Reduced	155	5775	13.85	14.00	1.035	89.6	1.116	0.09	0.448	0.518
	WLAN5.8GHz	802.11ac-VHT80 MCS0	Edge 2	1	0mm	Reduced	155	5775	13.85	14.00	1.035	89.6	1.116	-0.02	0.980	1.132
	WLAN5.8GHz	802.11n-HT40 MCS0	Bottom Face	1	15 mm	Full	151	5755	16.19	17.00	1.206	94.9	1.054	0.01	0.125	0.159
	WLAN5.8GHz	802.11n-HT40 MCS0	Edge 1	1	13 mm	Full	151	5755	16.19	17.00	1.206	94.9	1.054	0.09	0.001	0.001
	WLAN5.8GHz	802.11n-HT40 MCS0	Edge 2	1	16 mm	Full	151	5755	16.19	17.00	1.206	94.9	1.054	0.05	0.081	0.104

16.2 Repeated SAR Measurement

No.	Band	BW (MHz)	Modulation	RB Size	RB offset	Mode	Test Position	Sample	Gap (mm)	Power Reduction	Ch.	Freq. (MHz)	Average Power (dBm)	Tune-Up Limit (dBm)	Tune-up Scaling Factor	Duty Cycle %	Duty Cycle Scaling Factor	Power Drift (dB)	Measured 1g SAR (W/kg)	Ratio	Reported 1g SAR (W/kg)
1st	LTE Band 41	20M	QPSK	50	0	-	Bottom Face	1	0mm	Reduced	41490	2680	13.32	14.00	1.169	62.9	1.006	0.01	0.996	1	1.172
2nd	LTE Band 41	20M	QPSK	50	0	-	Bottom Face	1	0mm	Reduced	41490	2680	13.32	14.00	1.169	62.9	1.006	0.09	0.986	1.010	1.160
1st	WLAN2.4GHz	-	-	-	-	802.11b 1Mbps	Bottom Face	1	0mm	Reduced	6	2437	11.28	12.00	1.180	98.93	1.011	-0.06	0.996	1	1.189
2nd	WLAN2.4GHz	-	-	-	-	802.11b 1Mbps	Bottom Face	1	0mm	Reduced	6	2437	11.28	12.00	1.180	98.93	1.011	0.02	0.973	1.024	1.161
1st	WLAN5.3GHz	-	-	-	-	802.11ac-VHT80 MCS0	Bottom Face	1	0mm	Reduced	58	5290	14.81	15.00	1.045	89.6	1.116	-0.07	0.946	1	1.103
2nd	WLAN5.3GHz	-	-	-	-	802.11ac-VHT80 MCS0	Bottom Face	1	0mm	Reduced	58	5290	14.81	15.00	1.045	89.6	1.116	0.01	0.928	1.019	1.082
1st	WLAN5.8GHz	-	-	-	-	802.11ac-VHT80 MCS0	Bottom Face	1	0mm	Reduced	155	5775	13.85	14.00	1.035	89.6	1.116	0.07	1.030	1	1.190
2nd	WLAN5.8GHz	-	-	-	-	802.11ac-VHT80 MCS0	Bottom Face	1	0mm	Reduced	155	5775	13.85	14.00	1.035	89.6	1.116	0.01	1.010	1.020	1.167

General Note:

1. Per KDB 865664 D01v01r04, 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 D01v01r04, if the ratio among the 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*.
4. All measurement SAR result is scaled-up to account for tune-up tolerance and is compliant.

16.3 TDD B41 Linearity Data Analysis

General Note:

This device support Power Class 2 and Power Class 3 operations for LTE Band 41. The highest available duty cycle for Power Class 2 operation is 43.3% using UL-DL configuration 1. Per FCC Guidance based on the device behavior, all SAR tests were performed using Power Class 3. Power Class 2 is tested using the highest SAR test configuration in Power Class 3 for each LTE configuration and exposure condition combination, according to the highest time averaged power for all applicable uplink-downlink configurations in Power Class 2. When the reported SAR vs. output power is linearly scaled with < 10% discrepancy between power classes and all reported SAR are < 1.4 W/kg, Separate SAR testing for Power Class 2 is not required

LTE Band 41(HPUE)-Linearity Data for Full Power		
	LTE Band 41 (Power Class 3)	LTE Band 41 (Power Class 2)
Maximum Tune up Power (dBm)	24.00	26.00
Reported 1g SAR (W/kg)	0.551	0.590
Duty Cycle	63.30%	43.30%
Frame Averaged (mW)	159.00	172.38
Linearity SAR (W/kg)	0.597	
% deviation from expected linearity		-1.23%
LTE Band 41(HPUE)-Linearity Data for Sensor On		
	LTE Band 41 (Power Class 3)	LTE Band 41 (Power Class 2)
Maximum Tune up Power (dBm)	14.00	14.00
Reported 1g SAR (W/kg)	1.172	0.754
Duty Cycle	63.30%	43.30%
Frame Averaged (mW)	15.90	10.88
Linearity SAR (W/kg)	0.802	
% deviation from expected linearity		-5.95%

17. Simultaneous Transmission Analysis

No.	Simultaneous Transmission Configurations	Body
1.	WWAN + WLAN2.4GHz	Yes
2.	WWAN + WLAN5GHz	Yes
3.	WWAN + Bluetooth	Yes

General Note:

1. This device has no voice function.
2. EUT will choose either WLAN 2.4GHz or WLAN 5GHz according to the network signal condition; therefore, 2.4GHz WLAN and 5GHz WLAN will not operate simultaneously at any moment though they have independent antenna.
3. WLAN 2.4GHz and Bluetooth share the same antenna so can't transmit simultaneously.
4. According to the EUT character, WLAN 5GHz and Bluetooth cannot transmit simultaneously.
5. The reported SAR summation is calculated based on the same configuration and test position.
6. The worst case 5 GHz WLAN SAR for each configuration was used for SAR summation.
7. Per KDB 447498 D01v06, simultaneous transmission SAR is compliant if,
 - i) Scalar SAR summation $< 1.6\text{W/kg}$.
 - ii) $\text{SPLSR} = (\text{SAR1} + \text{SAR2})^{1.5} / (\text{min. separation distance, mm})$, and the peak separation distance is determined from the square root of $[(x1-x2)^2 + (y1-y2)^2 + (z1-z2)^2]$, where $(x1, y1, z1)$ and $(x2, y2, z2)$ are the coordinates of the extrapolated peak SAR locations in the zoom scan.
 - iii) If $\text{SPLSR} \leq 0.04$ for 1g SAR, simultaneously transmission SAR measurement is not necessary.
 - iv) Simultaneously transmission SAR measurement, and the reported multi-band 1g SAR $< 1.6\text{W/kg}$.
 - v) The SPLSR calculated results please refer to section 17.2.

17.1 Body Exposure Conditions

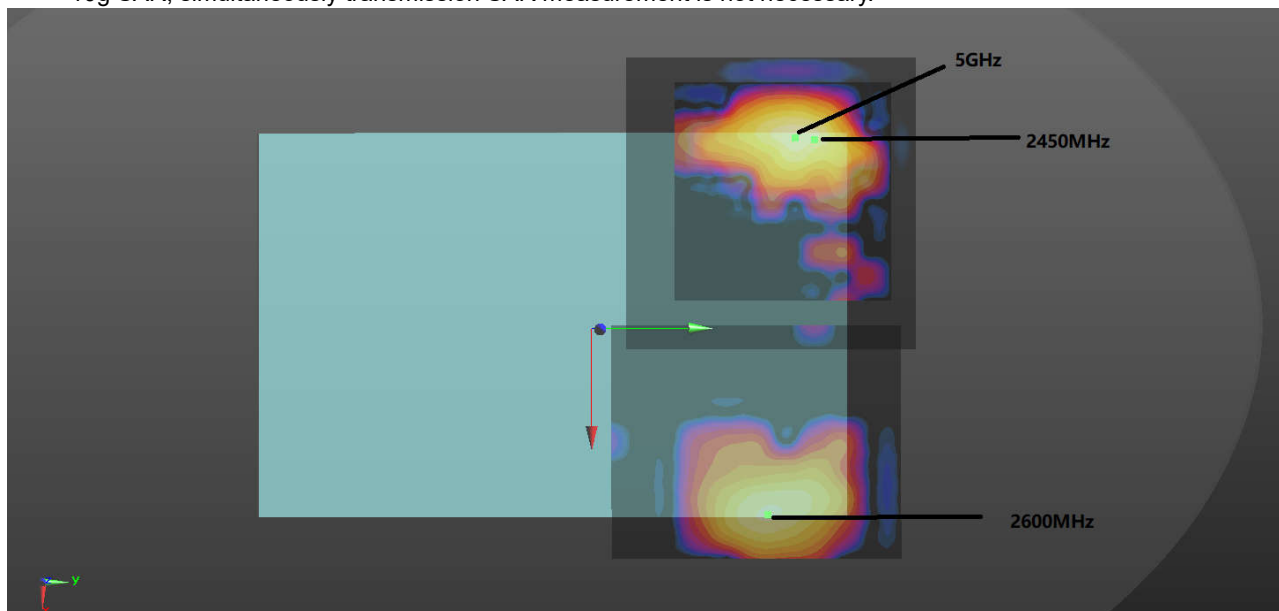
WWAN Band	Exposure Position	1	2	3	4	1+2	Case No	SPLSR	1+3	Case No	SPLSR	1+4	Case No	SPLSR
		WWAN	2.4GHz WLAN	5GHz WLAN	Bluetooth	Summed 1g SAR (W/kg)			Summed 1g SAR (W/kg)			Summed 1g SAR (W/kg)		
		1g SAR (W/kg)	1g SAR (W/kg)	1g SAR (W/kg)	1g SAR (W/kg)									
LTE Band 41	Bottom Face at 0mm	1.172	1.189	1.190	0.528	2.36	#01	0.02	2.36	#02	0.02	1.70	#03	0.01
	Edge 1 at 0mm	0.058	0.413	0.518	0.193	0.47			0.58			0.25		
	Edge 2 at 0mm		0.673	1.132	0.293	0.67			1.13			0.29		
	Edge 4 at 0mm	0.781				0.78			0.78			0.78		
	Bottom Face at 15 mm	0.590	0.312	0.242	0.528	0.90			0.83			1.12		
	Edge 1 at 13 mm	0.001	0.151	0.102	0.193	0.15			0.10			0.19		
	Edge 2 at 16 mm		0.125	0.168	0.293	0.13			0.17			0.29		
	Edge 4 at 22 mm	0.086				0.09			0.09			0.09		

Note: Chose Bluetooth Bottom Face/ Edge 1/ Edge 2 at 0mm as Bottom Face at 15 mm, Edge 1 at 13 mm, and Edge 2 at 16 mm SAR to do co-located with WWAN analysis.

17.2 SPLSR Evaluation and Analysis

General Note:

- When standalone SAR is measured for both antennas in the pair, the peak location separation distance is computed by 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 in the area scans or extrapolated peak SAR locations in the zoom scans, as appropriate.
- $SPLSR = (SAR_1 + SAR_2)1.5 / (\text{min. separation distance, mm})$. If $SPLSR \leq 0.04$ for 1g SAR and $SPLSR \leq 0.10$ for 10g SAR, simultaneously transmission SAR measurement is not necessary.



WWAN+WLAN2.4GHz/ WLAN5GHz/ Bluetooth _0mm

Case 1	Band	Position	SAR (W/kg)	Gap (mm)	SAR peak location (mm)			3D distance (mm)	Summed SAR (W/kg)	SPLSR Results	Simultaneous SAR
					X	Y	Z				
	LTE Band 41	Bottom Face	1.172	0	76	91.8	-3.65	154.0	2.36	0.02	Not required
	WLAN2.4GHz		1.189	0	-77.4	105.2	-3.5				
Case 2	LTE Band 41	Bottom Face	1.172	0	76	91.8	-3.65	152.6	2.36	0.02	Not required
	WLAN5GHz		1.190	0	-76.4	99.8	-2.77				
Case 3	LTE Band 41	Bottom Face	1.172	0	76	91.8	-3.65	150.1	1.70	0.01	Not required
	Bluetooth		0.528	0	-73.5	105	-2.44				

Test Engineer : Nick Hu, Hank Chang, Yuankai Kong



18. Uncertainty Assessment

Per KDB 865664 D01 SAR measurement 100MHz to 6GHz, when the highest measured 1-g SAR within a frequency band is < 1.5 W/kg. The expanded SAR measurement uncertainty must be $\leq 30\%$, for a confidence interval of $k = 2$. If these conditions are met, extensive SAR measurement uncertainty analysis described in IEEE Std 1528-2013 is not required in SAR reports submitted for equipment approval. For this device, the highest measured 1-g SAR is less 1.5W/kg. Therefore, the measurement uncertainty table is not required in this report.

19. References

- [1] FCC 47 CFR Part 2 "Frequency Allocations and Radio Treaty Matters; General Rules and Regulations"
- [2] ANSI/IEEE Std. C95.1-1992, "IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz", September 1992
- [3] IEEE Std. 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", Sep 2013
- [4] SPEAG DASY System Handbook
- [5] FCC KDB 865664 D01 v01r04, "SAR Measurement Requirements for 100 MHz to 6 GHz", Aug 2015.
- [6] FCC KDB 865664 D02 v01r02, "RF Exposure Compliance Reporting and Documentation Considerations" Oct 2015.
- [7] FCC KDB 447498 D01 v06, "Mobile and Portable Device RF Exposure Procedures and Equipment Authorization Policies", Oct 2015
- [8] FCC KDB 248227 D01 v02r02, "SAR Guidance for IEEE 802.11 (WiFi) Transmitters", Oct 2015.
- [9] FCC KDB 616217 D04 v01r02, "SAR Evaluation Considerations for Laptop, Notebook, Netbook and Tablet Computers", Oct 2015
- [10] FCC KDB 941225 D05 v02r05, "SAR Evaluation Considerations for LTE Devices", Dec 2015
- [11] FCC KDB 941225 D05A v01r02, "Rel. 10 LTE SAR Test Guidance and KDB Inquiries", Oct 2015



Appendix A. Plots of System Performance Check

The plots are shown as follows.

System Check_Head_2450MHz**DUT: D2450V2-SN:908**

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

Medium: HSL_2450 Medium parameters used: $f = 2450$ MHz; $\sigma = 1.765$ S/m; $\epsilon_r = 39.364$; $\rho = 1000$ kg/m³

Ambient Temperature : 23.2 °C; Liquid Temperature : 22.6 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN3857; ConvF(7.44, 7.44, 7.44); Calibrated: 2020.9.25
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1358; Calibrated: 2020.4.28
- Phantom: ELI 4; Type: QDOVA002AA; Serial: TP:1201
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

Pin=250mW/Area Scan (71x71x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm

Maximum value of SAR (interpolated) = 19.9 W/kg

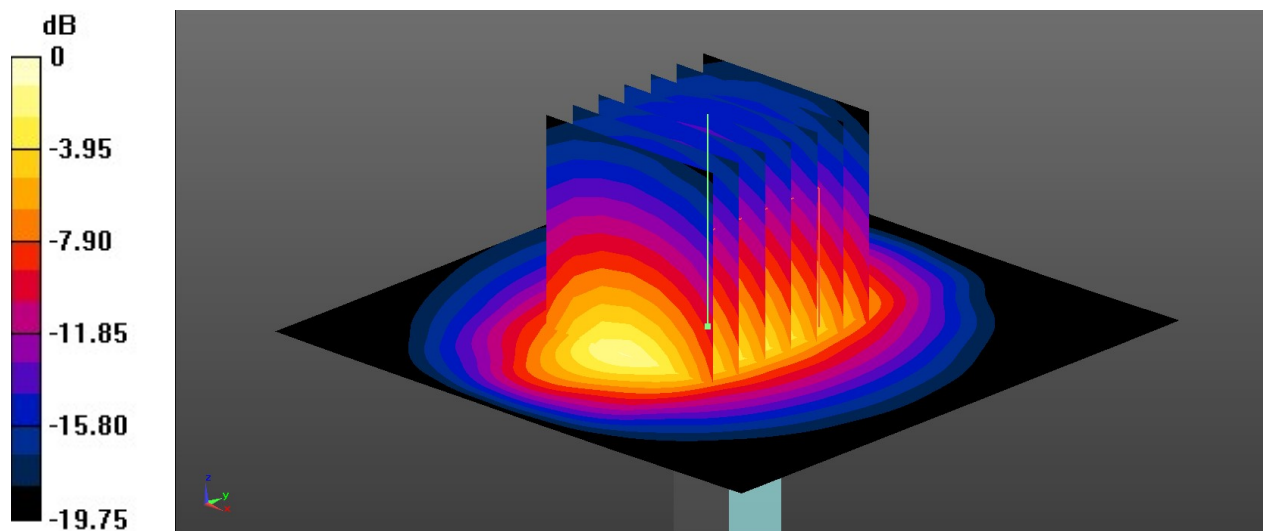
Pin=250mW/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 89.43 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 26.0 W/kg

SAR(1 g) = 12.9 W/kg; SAR(10 g) = 6.06 W/kg

Maximum value of SAR (measured) = 19.6 W/kg



0 dB = 19.6 W/kg = 12.92 dBW/kg

System Check_Head_2600MHz**DUT: D2600V2-SN:1061**

Communication System: UID 0, CW (0); Frequency: 2600 MHz; Duty Cycle: 1:1

Medium: HSL_2600 Medium parameters used: $f = 2600$ MHz; $\sigma = 1.879$ S/m; $\epsilon_r = 39.158$; $\rho = 1000$ kg/m³

Ambient Temperature : 23.2 °C; Liquid Temperature : 22.7 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN3857; ConvF(7.19, 7.19, 7.19); Calibrated: 2020.9.25
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1358; Calibrated: 2020.4.28
- Phantom: ELI 4; Type: QDOVA002AA; Serial: TP:1201
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

Pin=250mW/Area Scan (71x71x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm

Maximum value of SAR (interpolated) = 21.7 W/kg

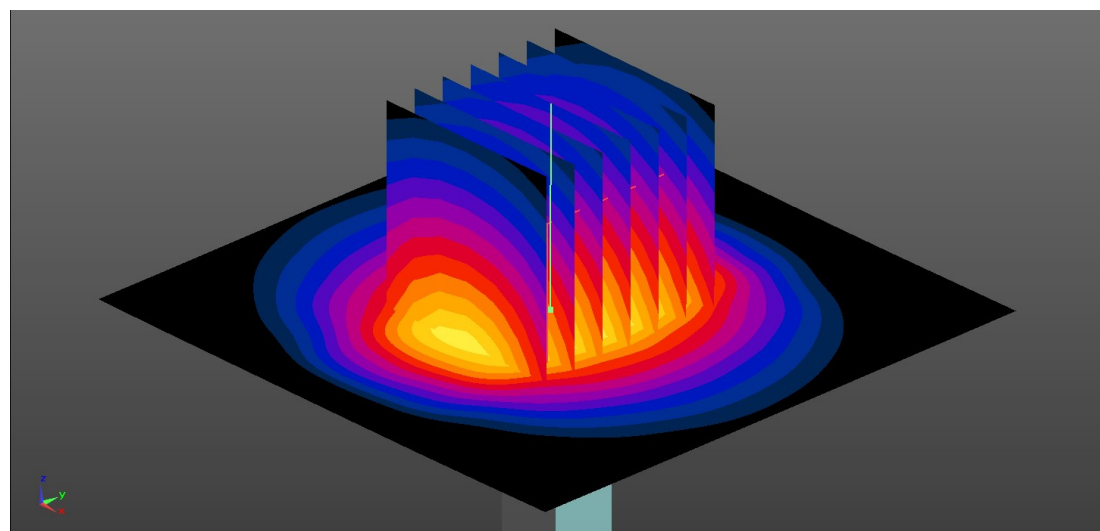
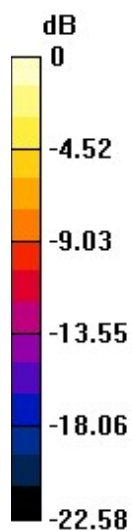
Pin=250mW/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 88.69 V/m; Power Drift = -0.19 dB

Peak SAR (extrapolated) = 28.3 W/kg

SAR(1 g) = 13.6 W/kg; SAR(10 g) = 6.11 W/kg

Maximum value of SAR (measured) = 21.1 W/kg



0 dB = 21.1 W/kg = 13.24 dBW/kg

System Check_Head_5250MHz**DUT: D5GHzV2-SN:1113**

Communication System: UID 0, CW (0); Frequency: 5250 MHz; Duty Cycle: 1:1

Medium: HSL_5000 Medium parameters used: $f = 5250$ MHz; $\sigma = 4.635$ S/m; $\epsilon_r = 36.427$; $\rho = 1000$ kg/m³

Ambient Temperature : 23.3 °C; Liquid Temperature : 22.6 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN3857; ConvF(5.04, 5.04, 5.04); Calibrated: 2020.9.25
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1358; Calibrated: 2020.4.28
- Phantom: ELI 4; Type: QDOVA002AA; Serial: TP:1201
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

Pin=100mW/Area Scan (71x71x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 18.0 W/kg

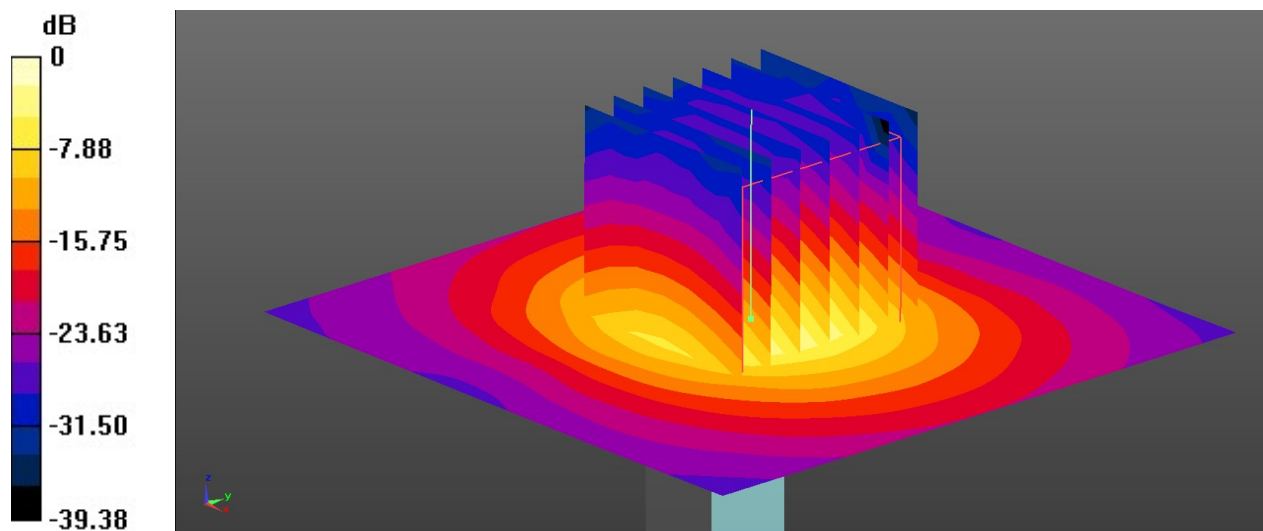
Pin=100mW/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 44.97 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 30.5 W/kg

SAR(1 g) = 7.85 W/kg; SAR(10 g) = 2.27 W/kg

Maximum value of SAR (measured) = 19.5 W/kg



0 dB = 19.5 W/kg = 12.90 dBW/kg

System Check_Head_5600MHz**DUT: D5GHzV2-SN:1113**

Communication System: UID 0, CW (0); Frequency: 5600 MHz; Duty Cycle: 1:1

Medium: HSL_5000 Medium parameters used: $f = 5600$ MHz; $\sigma = 4.981$ S/m; $\epsilon_r = 35.791$; $\rho = 1000$ kg/m³

Ambient Temperature : 23.3 °C; Liquid Temperature : 22.7 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN3857; ConvF(4.67, 4.67, 4.67); Calibrated: 2020.9.25
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1358; Calibrated: 2020.4.28
- Phantom: ELI 4; Type: QDOVA002AA; Serial: TP:1201
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

Pin=100mW/Area Scan (71x71x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 20.2 W/kg

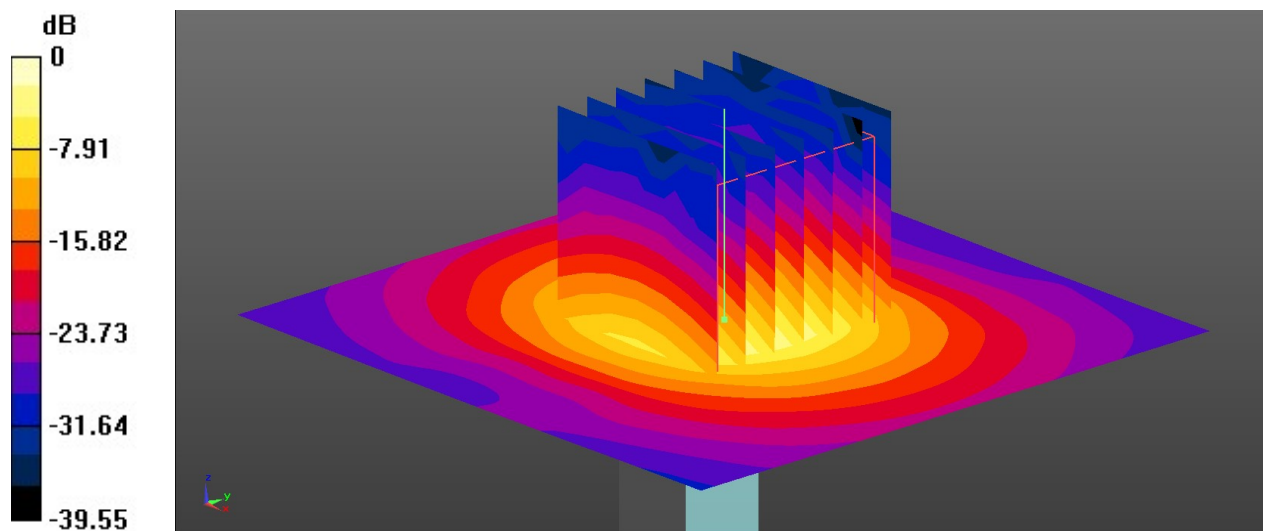
Pin=100mW/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 43.81 V/m; Power Drift = 0.04 dB

Peak SAR (extrapolated) = 35.5 W/kg

SAR(1 g) = 8.38 W/kg; SAR(10 g) = 2.37 W/kg

Maximum value of SAR (measured) = 21.5 W/kg



0 dB = 21.5 W/kg = 13.32 dBW/kg

System Check_Head_5750MHz**DUT: D5GHzV2-SN:1113**

Communication System: UID 0, CW (0); Frequency: 5750 MHz; Duty Cycle: 1:1

Medium: HSL_5000 Medium parameters used: $f = 5750$ MHz; $\sigma = 5.21$ S/m; $\epsilon_r = 35.492$; $\rho = 1000$ kg/m³

Ambient Temperature : 23.3 °C; Liquid Temperature : 22.9 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN3857; ConvF(4.93, 4.93, 4.93); Calibrated: 2020.9.25
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1358; Calibrated: 2020.4.28
- Phantom: ELI 4; Type: QDOVA002AA; Serial: TP:1201
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

Pin=100mW/Area Scan (71x71x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 17.8 W/kg

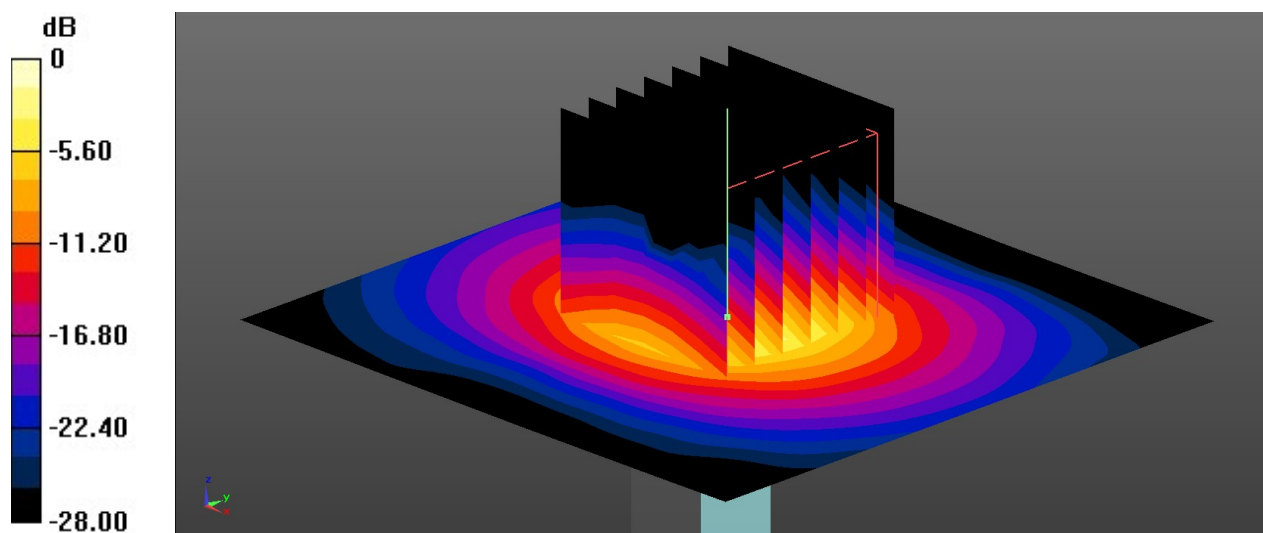
Pin=100mW/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 40.00 V/m; Power Drift = 0.10 dB

Peak SAR (extrapolated) = 33.2 W/kg

SAR(1 g) = 7.56 W/kg; SAR(10 g) = 2.15 W/kg

Maximum value of SAR (measured) = 19.6 W/kg



0 dB = 19.6 W/kg = 12.92 dBW/kg



Appendix B. Plots of SAR Measurement

The plots are shown as follows.

01_LTE Band 41_20M_QPSK_50RB_0Offset_Bottom Face_0mm_Ch41490

Communication System: UID 0, LTE-TDD (0); Frequency: 2680 MHz; Duty Cycle: 1:1.59

Medium: HSL_2600 Medium parameters used: $f = 2680$ MHz; $\sigma = 1.943$ S/m; $\epsilon_r = 39.048$; $\rho = 1000$ kg/m³

Ambient Temperature : 23.2 °C; Liquid Temperature : 22.7 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN3857; ConvF(7.19, 7.19, 7.19); Calibrated: 2020.9.25
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1358; Calibrated: 2020.4.28
- Phantom: ELI v5.0; Type: QDOVA002AA; Serial: TP:1201
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

Area Scan (81x101x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm

Maximum value of SAR (interpolated) = 1.58 W/kg

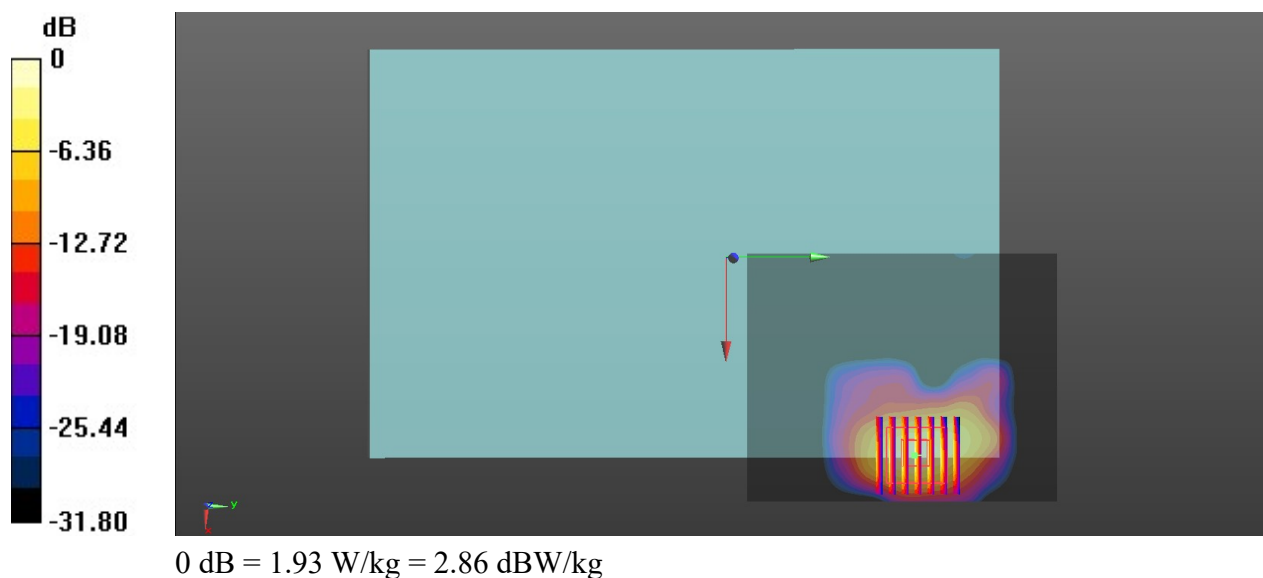
Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 0 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 2.67 W/kg

SAR(1 g) = 0.996 W/kg; SAR(10 g) = 0.370 W/kg

Maximum value of SAR (measured) = 1.93 W/kg



02_WLAN2.4GHz_802.11b 1Mbps_Bottom Face _0mm_Ch6

Communication System: UID 0, 802.11b (0); Frequency: 2437 MHz; Duty Cycle: 1:1.011
Medium: HSL_2450 Medium parameters used: $f = 2437$ MHz; $\sigma = 1.758$ S/m; $\epsilon_r = 39.389$; $\rho = 1000$ kg/m³

Ambient Temperature : 23.2 °C; Liquid Temperature : 22.6 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN3857; ConvF(7.44, 7.44, 7.44); Calibrated: 2020.9.25
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1358; Calibrated: 2020.4.28
- Phantom: ELI 4; Type: QDOVA002AA; Serial: TP:1201
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

Area Scan (101x101x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm

Maximum value of SAR (interpolated) = 1.91 W/kg

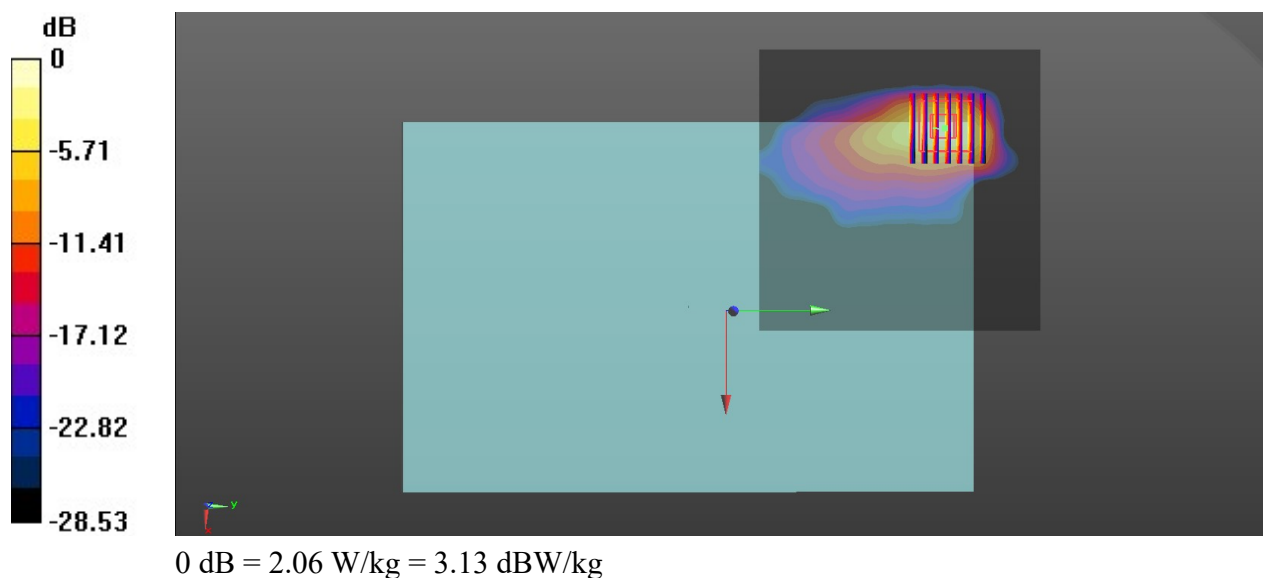
Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 0.6120 V/m; Power Drift = -0.06 dB

Peak SAR (extrapolated) = 2.98 W/kg

SAR(1 g) = 0.996 W/kg; SAR(10 g) = 0.374 W/kg

Maximum value of SAR (measured) = 2.06 W/kg



03_Bluetooth_1Mbps_Bottom Face_0mm_Ch0

Communication System: UID 0, Bluetooth (0); Frequency: 2402 MHz; Duty Cycle: 1:1.3
Medium: HSL_2450 Medium parameters used: $f = 2402$ MHz; $\sigma = 1.723$ S/m; $\epsilon_r = 40.794$; $\rho = 1000$ kg/m³

Ambient Temperature : 23.2 °C; Liquid Temperature : 22.6 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN3857; ConvF(7.44, 7.44, 7.44); Calibrated: 2020.9.25
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1358; Calibrated: 2020.4.28
- Phantom: ELI 4; Type: QDOVA002AA; Serial: TP:1201
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

Area Scan (81x81x1): Interpolated grid: $dx=1.200$ mm, $dy=1.200$ mm

Maximum value of SAR (interpolated) = 0.767 W/kg

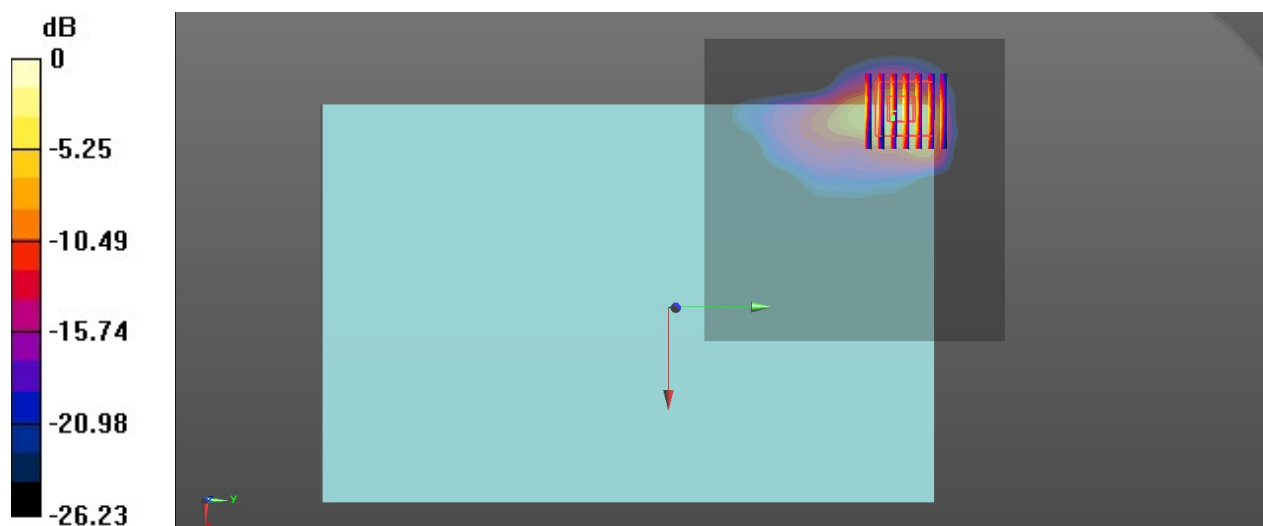
Zoom Scan (7x7x7)/Cube 0: Measurement grid: $dx=5$ mm, $dy=5$ mm, $dz=5$ mm

Reference Value = 0 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 1.03 W/kg

SAR(1 g) = 0.362 W/kg; SAR(10 g) = 0.051 W/kg

Maximum value of SAR (measured) = 0.754 W/kg



0 dB = 0.754 W/kg = -1.23 dBW/kg