RF TEST REPORT

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Report No.: FCC_SAR_SL14091201-ZBR-031 Rev1.0
Supersede Report No.: FCC_SAR_SL14091201-ZBR-031

Applicant	Zebra Technologies Corporation
Product Name	N Radio module with 802.11a/b/g/n and BT
Model No.	WYSBMVGXB
Test Standard	47CFR 2.1093, IEEE C95.1-1999 OET 65 C (Ed 01-01), RSS 102 Issue 4.0, IEEE 1528: 2013, IEC 62209-2: 2010
Test Method	IEEE 1528: 2013, IEC 62209-2: 2010 KDB 447498 D01 General RF Exposure Guidance v05r02 KDB 248227 D01 SAR measurement procedures for 802.11 a/b/g v01r02 KDB 865664 D01 SAR Measurement Requirements for 3 to 6 GHz v01r03
FCC ID	I28MD-EXLAN11N
IC ID	3798B-EXLAN11N
Date of test	12/08/2014 – 12/19/2014
Issue Date	01/16/2015
Test Result	Pass Fail
Equipment complied with the specification	[x]
Equipment did not comply with the specification	[ ]

Ricky	David Zhang
Ricky Wang	David Zhang
Test Engineer	**Engineer Reviewer**

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Test result presented in this test report is applicable to the tested sample only

Issued By:
SIEMIC Laboratories
775 Montague Expressway, Milpitas, 95035 CA

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A2LA ACCREDITED
TESTING CERT # 2742-01

Laboratory Introduction

SIEMIC, headquartered in the heart of Silicon Valley, with superior facilities in US and Asia, is one of the leading independent testing and certification facilities providing customers with one-stop shop services for Compliance Testing and Global Certifications.

In addition to testing and certification, SIEMIC provides initial design reviews and compliance management throughout a project. Our extensive experience with China, Asia Pacific, North America, European, and International compliance requirements, assures the fastest, most cost effective way to attain regulatory compliance for the global markets.

Accreditations for Conformity Assessment

Country/Region	Accreditation Body	Scope
USA	FCC, A2LA	EMC , RF/Wireless , Telecom
Canada	IC, A2LA, NIST	EMC, RF/Wireless , Telecom
Taiwan	BSMI , NCC , NIST	EMC, RF, Telecom , Safety
Hong Kong	OFTA , NIST	RF/Wireless ,Telecom
Australia	NATA, NIST	EMC, RF, Telecom , Safety
Korea	KCC/RRA, NIST	EMI, EMS, RF , Telecom, Safety
Japan	VCCI, JATE, TELEC, RFT	EMI, RF/Wireless, Telecom
Mexico	NOM, COFETEL, Caniety	Safety, EMC , RF/Wireless, Telecom
Europe	A2LA, NIST	EMC, RF, Telecom , Safety
Israel	MOC, NIST	EMC, RF, Telecom, Safety

Accreditations for Product Certifications

Country	Accreditation Body	Scope
USA	FCC TCB, NIST	EMC , RF , Telecom
Canada	IC FCB , NIST	EMC , RF , Telecom
Singapore	iDA, NIST	EMC , RF , Telecom
EU	NB	EMC & R&TTE Directive
Japan	MIC (RCB 208)	RF , Telecom
HongKong	OFTA (US002)	RF , Telecom

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1 Report Revision History

Report No.	Report Version	Description	Issue Date
FCC_SAR_SL14091201-ZBR-031	Original	Original	01/05/2015
FCC_SAR_SL14091201-ZBR-031 Rev1.0	Rev1.0	Correct EUT info	01/16/2015

2 Executive Summary

The purpose of this test program was to demonstrate compliance of following product

Company: Zebra Technologies Corporation
Product: N Radio module with 802.11a/b/g/n and BT
Model: WYSBMVGXB

, which is FCC certified radio module (FCC ID: 128MD-EXLAN11N, IC ID: 3798B-EXLAN11N), to be installed into a printer host (Printer Model: ZQ510, ZQ520) and simultaneously transmission with FCC certified NFC Radio Module (FCC ID: 128MD-1356NFC, IC ID: 3798B-1356NFC), against the current Stipulated Standards. The specified model product stated above has demonstrated compliance with the Stipulated Standard listed on 1st page.

Highest Measured SAR	Mode	Highest 1g SAR
	DTS band (2.4GHz, 5.8GHz)	0.999 w/kg(body)
	UNII band (5.3GHz, 5.6GHz)	1.151 w/kg(body)

3 Customer information

Applicant Name	Zebra Technologies Corp.
Applicant Address	333 Corporate Woods Pkwy. Vernon Hills,IL 60061, USA
Manufacturer Name	Zebra Technologies Corp.
Manufacturer Address	333 Corporate Woods Pkwy. Vernon Hills,IL 60061, USA

4 Test site information

Lab performing tests	SIEMIC Laboratories
Lab Address	775 Montague Expressway, Milpitas, CA 95035
FCC Test Site No.	881796
IC Test Site No.	4842D-2
VCCI Test Site No.	A0133

5 Modification

Index	Item	Description	Note
-	-	-	-

6 EUT Information

6.1 EUT Description

Product Name	N Radio module with 802.11a/b/g/n and BT
Model No.	WYSBMVGXB
Trade Name	Zebra
Serial No.	JUC232145
Host Printer Serial No.	ZQ510:XXRAJ144300271/ZQ520:XXRBJ143300204
Input Power	3.3VDC
Power Adapter Manu/Model	N/A
Power Adapter SN	N/A
Hardware version	N/A
Software version	N/A
Date of EUT received	12/01/2014
Equipment Class/ Category	DTS, UNII, DSS
Port/Connectors	USB
Remark	The host printer models ZQ510 and ZQ520 are identical to each other except the following characteristics: - ZQ510 has 3" (72mm) wide thermal printhead, 20mm DC step motor, and maximum paper roll width of 3". - ZQ520 has 4" (104mm) wide thermal printhead, 25mm DC step motor, and maximum paper roll width of 4"

Additional EUT Information
Any variants of the primary device? ☒Yes ☐No If yes, please list the different models & differences: The models ZQ510 and ZQ520 are identical to each other except the following characteristics: - ZQ510 has a 3" (72mm) wide thermal print head, and maximum paper roll width of 3". - ZQ520 has a 4" (104mm) wide thermal print head, and maximum paper roll width of 4".
Accessories (Sold with device): Regular battery, Extended battery
The device uses configuration: ☒Handheld Device ☒Body worn Device ☐Held to ear ☐Data Grip
Is the device being sold with multiple antenna options? ☐Yes ☒No
Power Adaptor: ☐With DC Adaptor ☒With AC Adaptor
Battery Configuration: ☐Fixed Battery ☒Removable/Swappable

6.2 Host Printer Radio Description

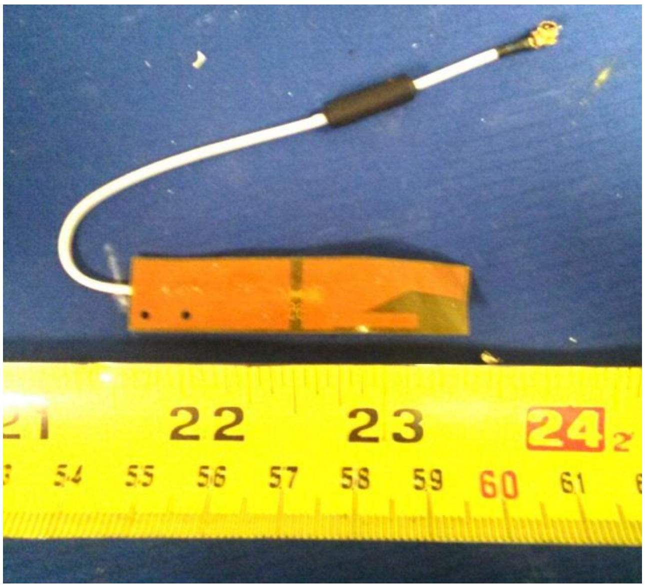
WLAN 2.4GHz	802.11b/g/n-HT20: 2412-2462MHz 802.11n-HT40: 2422-2452MHz
WLAN 5GHz	802.11a/n-HT20: 5180-5320MHz, 5500-5700MHz, 5745-5825MHz 802.11n-HT40: 5190-5310MHz, 5510-5670MHz, 5755-5795MHz
Bluetooth 2.4GHz	BDR/EDR: 2402-2480MHz
NFC	13.56MHz
Antenna Type	Patch Antenna
Antenna Gain	WLAN (2.4GHz)/Bluetooth: 3.81dBi; WLAN (5GHz): 3.19 dBi.
Antenna Connector Type	U. FL connector

6.3 EUT Photos

EUT - Top

EUT – Bottom

Antenna Top View



Antenna Bottom View

6.4 Host Printer Photos

Host Printer – Front View (ZQ510)

Host Printer – Rear View (ZQ510)

Host Printer – Left View (ZQ510)

Host Printer – Right View (ZQ510)

Host Printer – Top View (ZQ510)

Host Printer – Bottom View (ZQ510)

Host Printer – Front View (ZQ520)

Host Printer – Rear View (ZQ520)

Host Printer – Left View (ZQ520)

Host Printer – Right View (ZQ520)

Host Printer – Top View (ZQ520)

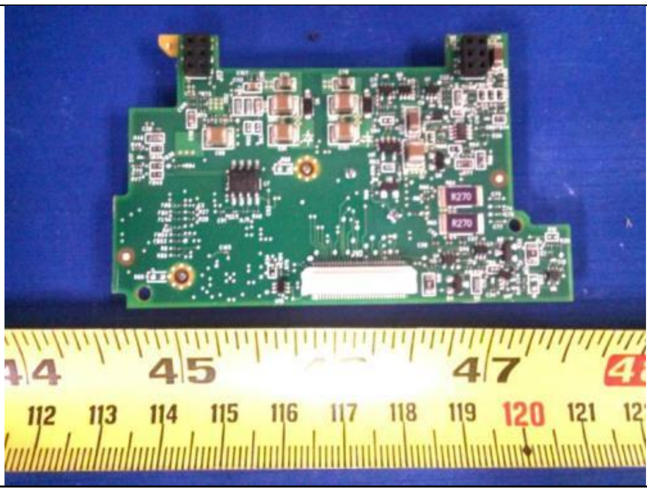
Host Printer – Bottom View (ZQ520)

6.5 Host Printer Accessories

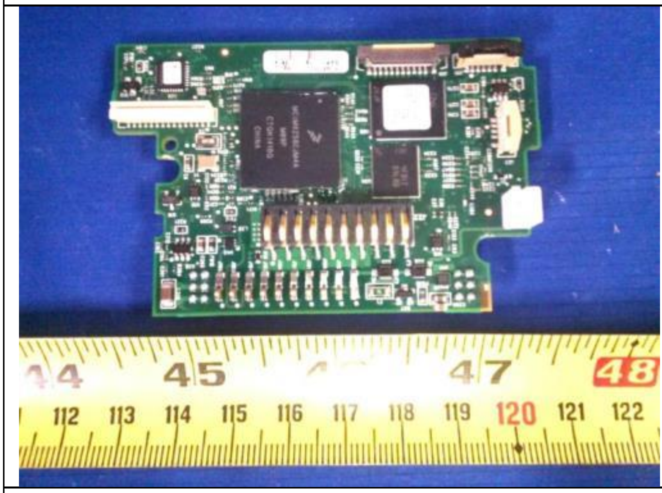
	
Battery View 1	**Battery View 2**
	
Extended Battery View 1	**Extended Battery View 2**
	
Exoskeleton for ZQ520	**Exoskeleton for ZQ510**

6.6 Host Printer Photos - Internal

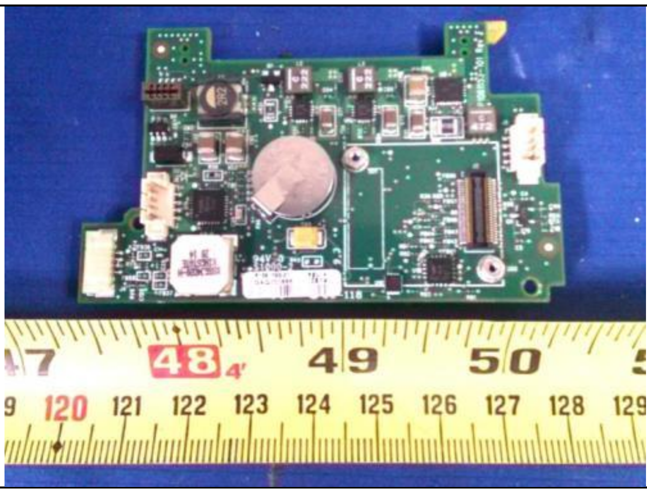
Host Printer Cover Off View



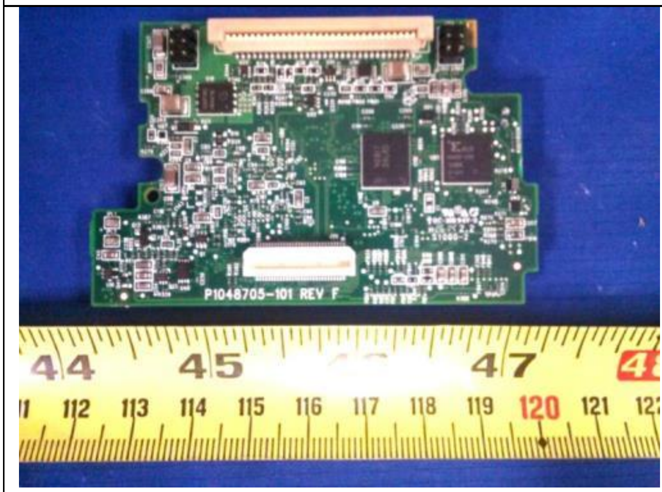
PCB1 Top View



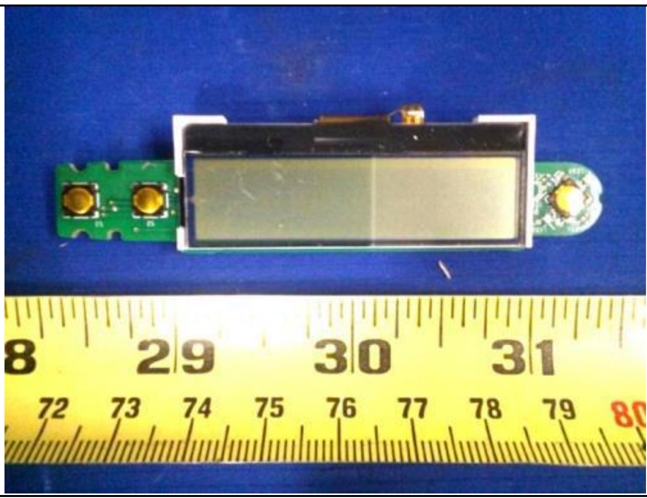
PCB1 Bottom View



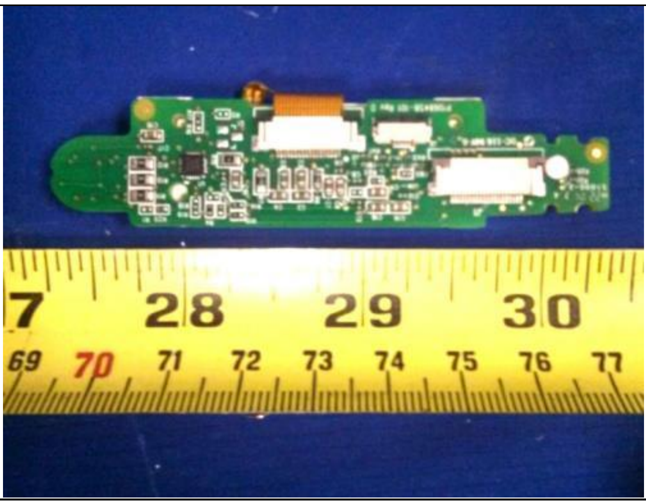
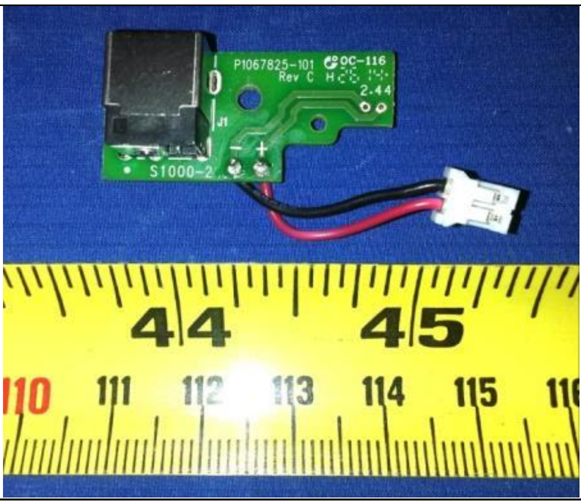
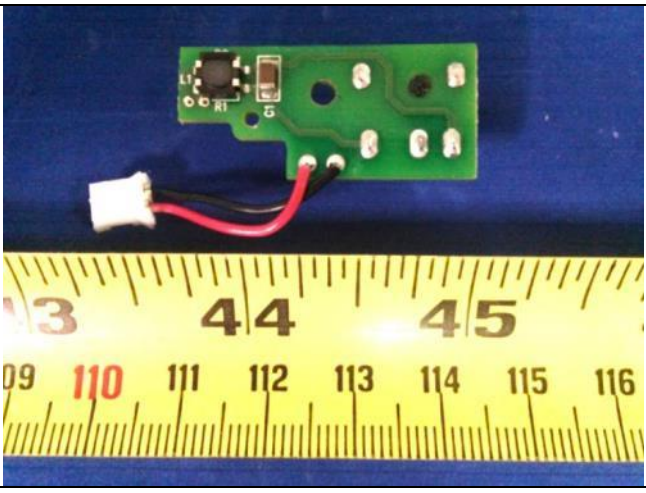
PCB2 Top View

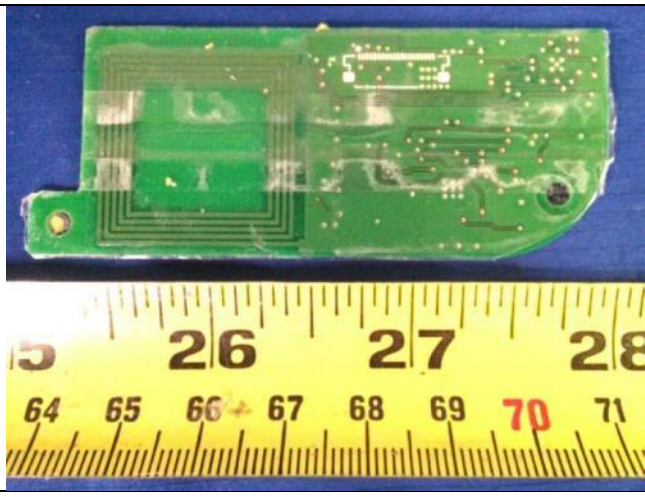


PCB2 Bottom View



LCD Board Top View

	
LCD Board Bottom View	**Power Board Top View**
	
Power Board Bottom View	**PCB3 Top View**
	
PCB3 Bottom View	**N Radio Module Top View**

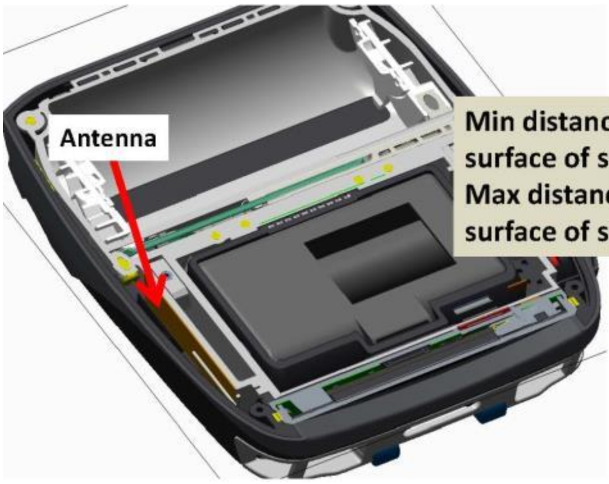
	
N Radio Module Bottom View	**NFC Board Location View**
	
NFC Board Top View	**NFC Board Bottom View**
	
WLAN/BT Antenna Top View	**WLAN/BT Antenna Bottom View**

6.7 Host Printer Test Setup Photos

	
ZQ520 Test Setup	**ZQ510 Test Setup**

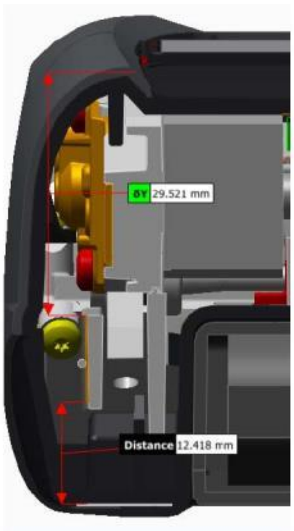
6.8 Antenna Location

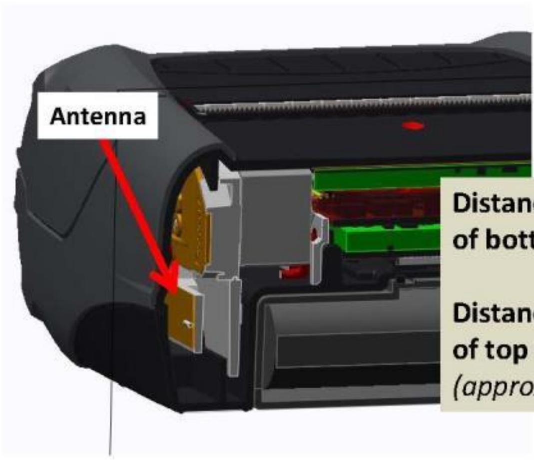
ZQ510 Wifi Antenna Location



Min distance from antenna surface to outside surface of side wall = 6.8mm
Max distance from antenna surface to outside surface of side wall = 10mm

ZQ510 Wifi Antenna Location

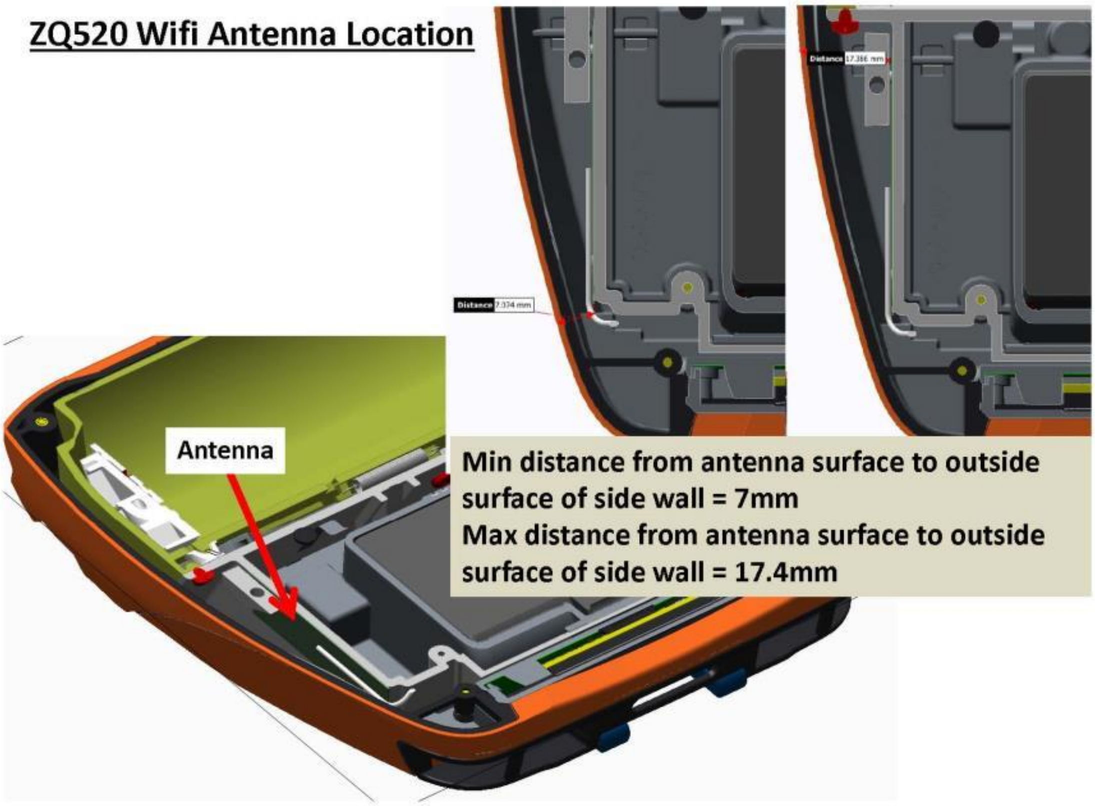




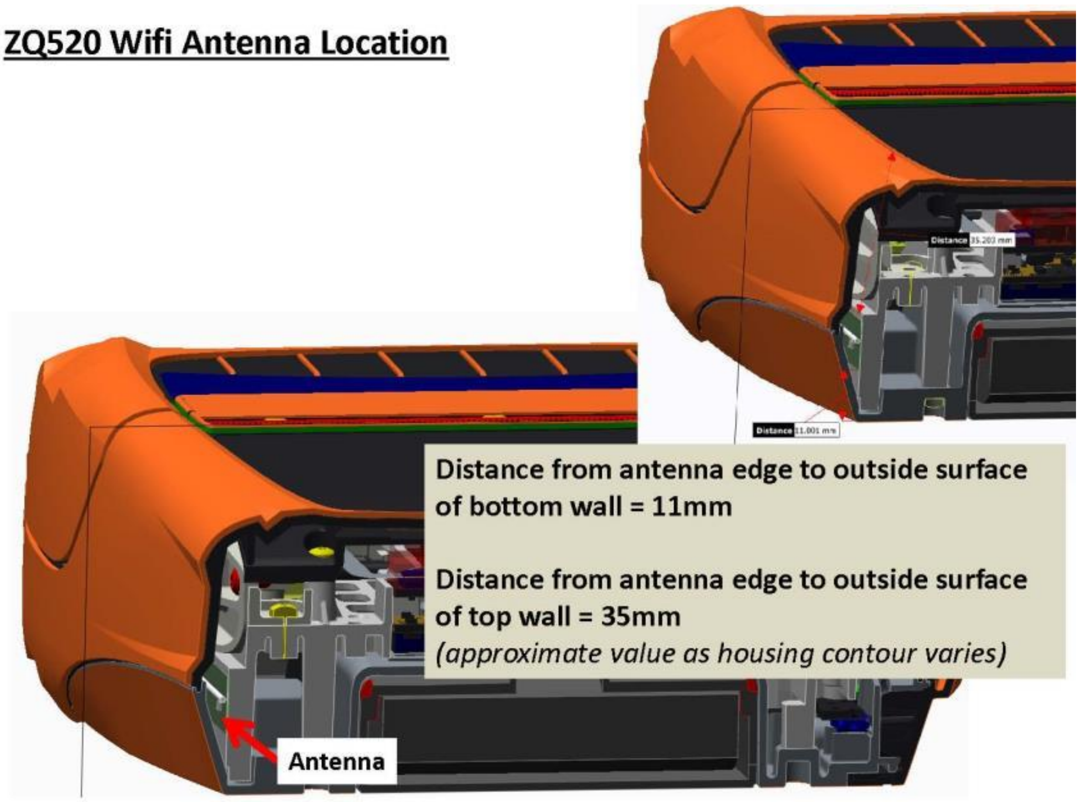
Distance from antenna edge to outside surface of bottom wall = 12.4mm

Distance from antenna edge to outside surface of top wall = 30mm
(approximate value as housing contour varies)

ZQ520 Wifi Antenna Location



ZQ520 Wifi Antenna Location



6.9 Host Printer Accessories analysis

ZQ510 with regular battery installed

ZQ510 with extended battery installed

The extended battery has larger capacity. The printer is to be used with the bottom side against human body, the use of extended battery will increase the separation of printer bottom side to human body, thus decreasing the SAR value. The SAR testing in current report was performed with regular battery to represent the worst case.

Exoskeleton for ZQ520 open view

Exoskeleton for ZQ520 open view

The Exoskeleton is a plastic enclosure to provide the extra protection to the printer, which will also provide additional separation from the printer to human body. So the SAR value with the Exoskeleton will be much less than the value without Exoskeleton. The SAR testing in current report was performed without Exoskeleton to represent the worst case.

7 Supporting Equipment/Software and cabling Description

7.1 Supporting Equipment

Item	Supporting Equipment Description	Model	Serial Number	Manufacturer	Note
1	Laptop	HSTNN-072	5CD2132LM5	HP	-

7.2 Test Software Description

Test Item	Software	Description
RF Testing	Toolbox 1.71	Set the EUT to different modulation and channel

8 Test Summary

Test Item	Test standard		Test Method/Procedure		Pass / Fail	
SAR	FCC	OET Bulletin 65 Supplement C	IEEE	Std 1528-2013, FCC KDBs	☒ Pass	☐ N/A

9 SAR Introduction

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.

SAR Definition

Specific Absorption Rate is defined as 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).

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

SAR is expressed in units of watts per kilogram (W/kg). SAR can be related to the electric field at a point by

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

Where:

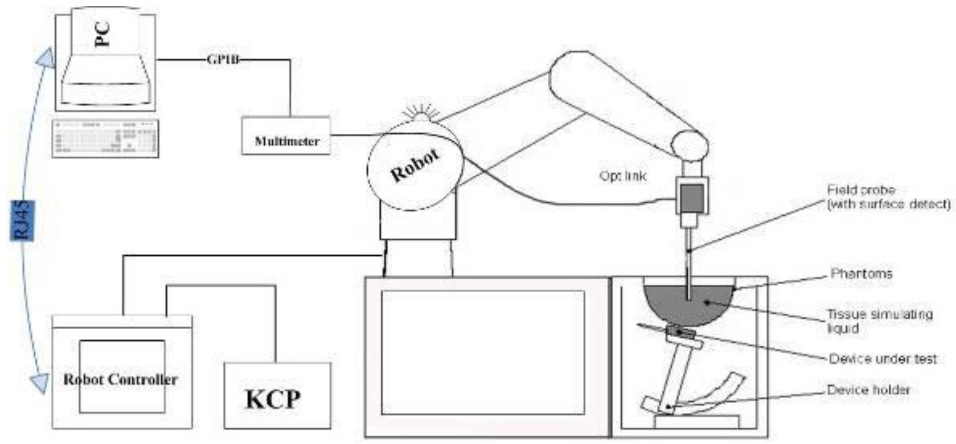
σ = conductivity of the tissue (S/m)
ρ = mass density of the tissue (kg/m3)
E = RMS electric field strength (V/m)

10 SAR Measurement Setup

Dosimetric Assessment System

These measurements were performed with the automated near-field scanning system OPENSAR from SATIMO. The system is based on a high precision robot (working range: 850 mm), which positions the probes with a positional repeatability of better than ± 0.02 mm. Special E- and H-field probes have been developed for measurements close to material discontinuity, the sensors of which are directly loaded with a Schottky diode and connected via highly resistive lines to the data acquisition unit.

Measurement System Diagram



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

- A standard high precision 6-axis robot (KUKA) with controller and software.
- KUKA Control Panel (KCP).
- A dosimetric probe, i.e., an isotropic E-field probe optimized and calibrated for usage in tissue simulating liquid. The probe is equipped with an optical surface detector system.
- A computer operating Windows XP.
- OPENSAR software.
- Remote control with teaches pendant and additional circuitry for robot safety such as warning lamps, etc.
- The SAM phantom enabling testing left-hand right-hand and body usage.
- The Position device for handheld EUT.
- Tissue simulating liquid mixed according to the given recipes.
- System validation dipoles to validate the proper functioning of the system.

EP100 Probe

The SAR measurements were conducted with dosimetric probe (manufactured by SATIMO), designed in the classical triangular configuration and optimized for dosimetric evaluation. The probe has been calibrated according to the procedure described in SAR standard with accuracy of better than ±10%.

It is connected to the KRC box on the robot arm and provides an automatic detection of the phantom surface. The 3D file of the phantom is include in OpenSAR software. The Video Positioning System allow the system to take the automatic reference and to move the probe safely and accurately on the phantom.

Parameter	Description
Frequency Range	100 MHz to 6 GHz
Linearity	0.25 dB (100 MHz to 6 GHz)
Directivity	0.25 dB in brain tissue (rotation around probe axis) 0.5 dB in brain tissue (rotation normal probe axis)
Dynamic	0.001W/kg to > 100W/kg
Range Linearity	0.25 dB
Surface	0.2 mm repeatability in air and liquids
Dimensions Overall length	330 mm
Tip length	16 mm
Body diameter	8 mm
Tip diameter	2.6 mm
Distance from probe tip to dipole centers	<1.5 mm

E-Field Probe Calibration

Each probe is calibrated according to a dosimetric assessment procedure described in SAR standard with accuracy better than +/-10%. The spherical isotropy was evaluated with the procedure described in SAR standard and found to be better than +/-0.25dB. The sensitivity parameters (NormX, NormY, NormZ), the diode compression parameter (DCP) and the conversion factor (ConvF) of the probe are tested.

The free space E-field from probe outputs is determined in a test chamber. This is performed in a TEM cell for frequencies bellow 0.8 GHz, and in a waveguide above 0.8 GHz for free space. For the free space calibration, the probe is placed in the volumetric center of the cavity and at the proper orientation with the field. E-field correlation calibration is performed in a flat phantom filled with the appropriate simulated brain tissue.

SAM Phantom

The SAM Phantom SAM29 is constructed of a fiberglass shell Integrated in a wooden table. The shape of the shell is in compliance with the specification set in IEEE P1528 and CENELEC EN62209-1.
The phantom enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region.
A cover prevents the evaporation of the liquid.
Reference markings on the Phantom allow the complete setup of all predefined phantom positions and measurement grids by manually teaching three points in the robot.

Shell Thickness: 0.2 mm
Filling Volume: Approx. 25 liters
Dimensions (H x L x W): 810 x 1000 x 500 mm

Liquid is filled to at least 15mm from the bottom of Phantom.

Device Holder

In combination with the Generic Twin Phantom V3.0, the Mounting Device enables the rotation of the mounted transmitter in spherical coordinates whereby the rotation points is the ear opening. The devices can be easily, accurately, and repeatedly positioned according to the FCC and CENELEC specifications. The device holder can be locked at different phantom locations (left head, right head, flat phantom).

Note: A simulating human hand is not used due to the complex anatomical and geometrical structure of the hand that may produce infinite number of configurations [10]. To produce the worst-case condition. (the hand absorbs antenna output power), the hand is omitted during the tests.

Data Evaluation

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

Probe Parameters	- Sensitivity	$Norm_i$
	- Conversion factor	ConvFi
	- Diode compression point	Dcpi
Device Parameter	- Frequency	f
	- Crest factor	cf
Media Parameters	- Conductivity	σ
	- Density	ρ

These parameters must be set correctly in the software. They can either be found in the component documents or are imported into the software from the configuration files issued for the OPENSAR components.

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

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

Where V_i = Compensated signal of channel i (i = x, y, z)
U_i = Input signal of channel i (i = x, y, z)
cf = Crest factor of exciting field (DASY parameter)
dcp_i = Diode compression point (DASY parameter)

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

E-field probes: $$E_i = \sqrt{\frac{V_i}{Norm_i \cdot ConvF}}$$

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

Where V_i = Compensated signal of channel i (i = x, y, z)
$Norm_i$ = Sensor sensitivity of channel i (i = x, y, z)
μV/(V/m)2 for E0field Probes
ConvF = Sensitivity enhancement in solution
a_{ij} = Sensor sensitivity factors for H-field probes
f = Carrier frequency (GHz)
E_i = Electric field strength of channel i in V/m
H_i = Magnetic field strength of channel i in A/m

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

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

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

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

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

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

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

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

where P_{pwe} = Equivalent power density of a plane wave in mW/cm2
E_{tot} = total electric field strength in V/m
H_{tot} = total magnetic field strength in A/m

SAR Evaluation – Peak Spatial - Average

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

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

- **Area Scan**
  The area scan is used as a fast scan in two dimensions to find the area of high field values, before doing a finer measurement around the hot spot. The sophisticated interpolation routines implemented in OPENSAR software can find the maximum locations even in relatively coarse grids. The scan area is defined by an editable grid. This grid is anchored at the grid reference point of the selected section in the phantom. When the area scan's property sheet is brought-up, grid was at to 15 mm by 15 mm and can be edited by a user.

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

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

SAR Evaluation – Peak SAR

The procedure for spatial peak SAR evaluation has been implemented according to the IEEE1529 standard. It can be conducted for 1 g and 10 g. The OPENSAR system allows evaluations that combine measured data and robot positions, such as:

- Maximum search
- Extrapolation
- Boundary correction
- Peak search for averaged SAR

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

Extrapolation

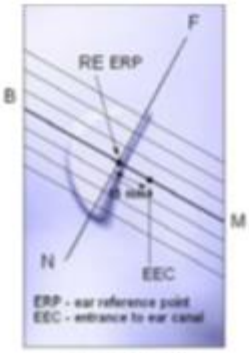
Extrapolation routines are used to obtain SAR values between the lowest measurement points and the inner phantom surface. The extrapolation distance is determined by the surface detection distance and the probe sensor offset. Several measurements at different distances are necessary for the extrapolation.
They are used in the Cube Scan to obtain SAR values between the lowest measurement points and the inner phantom surface. The routine uses the fourth order least square polynomial method for extrapolation. For a grid using 5x5x7 measurement points with 5mm resolution amounting to 343 measurement points, the uncertainty of the extrapolation routines is less than 1% for 1 g and 10 g cubes.

Device Reference Points

Definition of Reference Points

Ear Reference Point

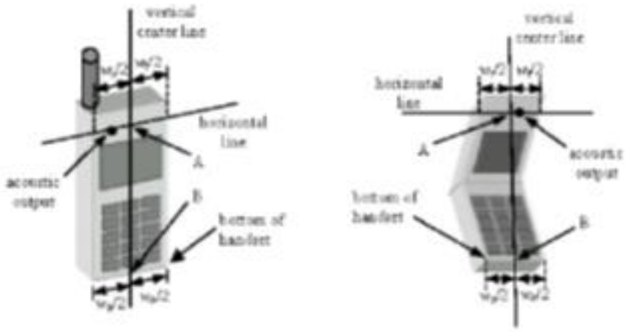
Figure 6.2 shows the front, back and side views of the SAM Phantom. The point "M" is the reference point for the center of the mouth, "LE" is the left ear reference point (ERP), and "RE" is the right ERP. The ERPs are 15mm posterior to the entrance to the ear canal (EEC) along the B-M line (Back-Mouth), as shown in Figure 6.1. The plane passing through the two ear canals and M is defined as the Reference Plane. The line N-F (Neck-Front) is perpendicular to the reference plane and passing through the RE (or LE) is called the Reference Pivoting Line (see Figure 6.1). Line B-M is perpendicular to the N-F line. Both N-F and B-M lines are marked on the external phantom shell to facilitate handset positioning [5].



Close-up
side view of ERP's

Front, back and side view of SAM

Two imaginary lines on the device need to be established: the vertical centerline and the horizontal line. The test device is placed in a normal operating position with the "test device reference point" located along the "vertical centerline" on the front of the device aligned to the "ear reference point" (See Fig. 6.3). The "test device reference point" is than located at the same level as the center of the ear reference point. The test device is positioned so that the "vertical centerline" is bisecting the front surface of the device at it's top and bottom edges, positioning the "ear reference point" on the outer surface of both the left and right head phantoms on the ear reference point.



Handset Vertical Center & Horizontal Line Reference Points

Test Configuration – Positioning for Cheek / Touch

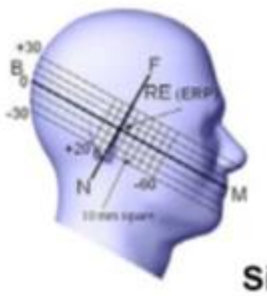
1. Position the device close to the surface of the phantom such that point A is on the (virtual) extension of the line passing through points RE and LE on the phantom (see Figure below), such that the plane defined by the vertical center line and the horizontal line of the device is approximately parallel to the sagittal plane of the phantom

Front, Side and Top View of Cheek/Touch Position

2. Translate the device towards the phantom along the line passing through RE and LE until the device touches the ear.

3. While maintaining the device in this plane, rotate it around the LE-RE line until the vertical centerline is in the plane normal to MB-NF including the line MB (called the reference plane).
4. Rotate the device around the vertical centerline until the device (horizontal line) is symmetrical with respect to the line NF.

5. While maintaining the vertical centerline in the reference plane, keeping point A on the line passing through RE and LE and maintaining the device contact with the ear, rotate the device about the line NF until any point on the device is in contact with a phantom point below the ear (cheek). See Figure below.



Side view w/ relevant markings

Test Configuration – Positioning for Ear / 15° Tilt

With the test device aligned in the Cheek/Touch Position":

1. While maintaining the orientation of the device, retracted the device parallel to the reference plane far enough to enable a rotation of the device by 15 degrees.
2. Rotate the device around the horizontal line by 15 degrees.
3. While maintaining the orientation of the device, move the device parallel to the reference plane until any part of the device touches the head. (In this position, point A is located on the line RE-LE). The tilted position is obtained when the contact is on the pinna. If the contact is at any location other than the pinna, the angle of the device shall be reduced. The tilted position is obtained when any part of the device is in contact with the ear as well as a second part of the device is in contact with the head (see Figure below).

Front, Side and Top View of Ear/15° Tilt Position

Test Position – Body Worn Configurations

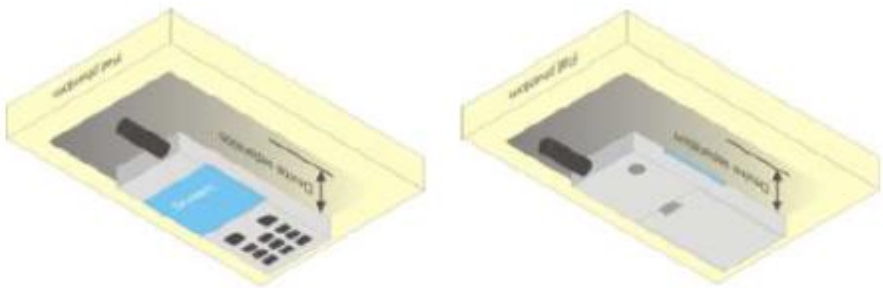
Body-worn operating configurations are tested with the accessories attached to the device and positioned against a flat phantom in a normal use configuration. A device with a headset output is tested with a headset connected to the device. Body dielectric parameters are used.

Accessories for Body-worn operation configurations are divided into two categories: those that do not contain metallic components and those that do contain metallic components. When multiple accessories that do not contain metallic components are supplied with the device, the device is tested with only the accessory that dictates the closest spacing to the body. Then, when multiple accessories that contain metallic components are supplied with the device, the device is tested with each accessory that contains a unique metallic component. If multiple accessories share an identical metallic component (i.e. the same metallic belt-clip used with different holsters with no other metallic components) only the accessory that dictates the closest spacing to the body is tested.

Body-worn accessories may not always be supplied or available as options for some devices intended to be authorized for body-worn use. In this case, a test configuration where a separation distance between the back of the device and the flat phantom is used. All test position spacing are documented.

Transmitters that are designed to operate in front of a person's face, as in push-to-talk configurations, are tested for SAR compliance with the front of the device positioned to face the flat phantom. For devices that are carried next to the body such as a shoulder, waist or chest-worn transmitters, SAR compliance is tested with the accessory(ies), including headsets and microphones, attached to the device and positioned against a flat phantom in a normal use configuration.

In all cases SAR measurements are performed to investigate the worst-case positioning. Worst-case positioning is then documented and used to perform Body SAR testing.



11 Measurement Uncertainty

The component of uncertainly may generally be categorized according to the methods used to evaluate them. The evaluation of uncertainly by the statistical analysis of a series of observations is termed a Type An evaluation of uncertainty. The evaluation of uncertainty by means other than the statistical analysis of a series of observation is termed a Type B evaluation of uncertainty. Each component of uncertainty, however evaluated, is represented by an estimated standard deviation, termed standard uncertainty, which is determined by the positive square root of the estimated variance

A Type A evaluation of standard uncertainty may be based on any valid statistical method for treating data. This includes calculating the standard deviation of the mean of a series of independent observations; using the method of least squares to fit a curve to the data in order to estimate the parameter of the curve and their standard deviations; or carrying out an analysis of variance in order to identify and quantify random effects in certain kinds of measurement.

A type B evaluation of standard uncertainty is typically based on scientific judgment using all of the relevant information available. These may include previous measurement data, experience and specification, data provided in calibration reports and uncertainties assigned to reference data taken from handbooks. Broadly speaking, the uncertainty is either obtained from an outdoor source or obtained from an assumed distribution, such as the normal distribution, rectangular or triangular distributions indicated in Table below :

Uncertainty Distribution	Normal	Rectangle	Triangular	U Shape
Multi-plying Factor[(a)]	1/k[(b)]	1 / √3	1 / √6	1 / √2

(a) Standard uncertainty is determined as the product of the multiplying factor and the estimated range of variations in the measured quantity
(b) K is the coverage factor

Standard Uncertainty for Assumed Distribution

The combined standard uncertainty of the measurement result represents the estimated standard deviation of the result. It is obtained by combining the individual standard uncertainties of both Type A and Type -sum-by taking the positive square root of the estimated variances.

Expanded uncertainty is a measure of uncertainty that defines an interval about the measurement result within which the measured value is confidently believed to lie. It is obtained by multiplying the combined standard uncertainty by a coverage factor. Typically, the coverage factor ranges from 2 to 3. Using a coverage factor allows the true value of a measured quantity to be specified with a defined probability within the specified uncertainty range. For purpose of this document, a coverage factor two is used, which corresponds to confidence interval of about 95 %.

The COMOSAR Uncertainty Budget is show in below table:

Uncertainty Budget of COMOSAR for frequency range 300 MHz to 6 GHz

Uncertainty Component	Tolerances %	Probability Distribution	Divisor	Ci (1g)	Ci (10g)	Uncertainty 1g(%)	Uncertainty 10g(%)
Measurement System Related							
Probe Calibration	6	N	1	1	1	6	6
Axial Isotropy	3	R	√3	√ (1-Cp)	√ (1-Cp)	1.22474	1.22474
Hemispherical Isotropy	4	R	√3	√ Cp	√ Cp	1.63299	1.63299
Boundary Effect	1	R	√3	1	1	0.57735	0.57735
Linearity	5	R	√3	1	1	2.88675	2.88675
System Detection Limits	1	R	√3	1	1	0.57735	0.57735
Readout Electronics	0.5	N	1	1	1	0.5	0.5
Response Time	0.2	R	√3	1	1	0.11547	0.11547
Integration Time	2	R	√3	1	1	1.1547	1.1547
RF Ambient Conditions	3	R	√3	1	1	1.73205	1.73205
Probe Positioner Mechanical Tolerances	2	R	√3	1	1	1.1547	1.1547
Probe Positioning with respect to Phantom Shell	1	R	√3	1	1	0.57735	0.57735
Extrapolation, Interpolation and integration Algorithms for Max. SAR Evaluation.	1.5	R	√3	1	1	0.86603	0.86603
Test Sample Related							
Test Sample Positioning	1.5	N	1	1	1	1.5	1.5
Device Holder Uncertainty	5	N	1	1	1	5	5
Output Power Variation – SAR Drift measurement	3	R	√3	1	1	1.73205	1.73205
Phantom and Tissue Parameters Related							
Phantom Uncertainty (Shape and thickness Tolerances)	4	R	√3	1	1	2.3094	2.394
Liquid Conductivity – deviation from target value	5	R	√3	0.64	0.43	1.84752	1.2413
Liquid Conductivity – Measurement Uncertainty	2.5	N	1	0.64	0.43	1.6	1.075
Liquid Permittivity – deviation from target value	3	R	√3	0.6	0.49	1.03923	0.8487
Liquid Permittivity – Measurement Uncertainty	2.5	N	1	0.6	0.49	1.5	1.225
Combined Standard Uncertainty						9.66051 %	9.52428 %
Expanded Standard Uncertainty (K=2 , confidence 95%)						18.9346 %	18.6676 %

12 Liquid Validation

Liquid Validation

The dielectric parameters were checked prior to assessment using the HP85070C dielectric probe kit. The dielectric parameters measured are reported in each correspondent section.

Liquid depth ≥ 15cm

IEEE SCC-34/SC-2 P1528 recommended Tissue Dielectric Parameters

The head tissue dielectric parameters recommended by the IEEE SCC-34/SC-2 in P1528 have been incorporated in the following table. These head parameters are derived from planar layer models simulating the highest expected SAR for the dielectric properties and tissue thickness variations in a human head. Other head and body tissue parameters that have not been specified in P1528 are derived from the tissue dielectric parameters computed from the 4-Cole-Cole equations and extrapolated according to the head parameters specified in P1528

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

Note: *ε_r = relative permittivity, σ = conductivity and ρ = 1000 kg/m^3*

Liquid Validation Result:

Liquid type/ Band(MHz)	Measured Date	Parameters	Measured	Target	Deviation (%)	Limit (%)
2412 Body	12/08/2014	Permittivity	51.49	52.75	-2.39	±5.00
		Conductivity	1.91	1.91	-0.13	±5.00
2437 Body	12/08/2014	Permittivity	51.48	52.72	-2.34	±5.00
		Conductivity	1.94	1.94	0.28	±5.00
2450 Body	12/08/2014	Permittivity	51.48	52.70	-2.31	±5.00
		Conductivity	1.94	1.95	-0.71	±5.00
2462 Body	12/08/2014	Permittivity	51.48	52.68	-2.29	±5.00
		Conductivity	1.98	1.97	0.77	±5.00
5180 Body	12/10/2014	Permittivity	50.07	49.04	2.10	±5.00
		Conductivity	5.46	5.28	3.45	±5.00
5190 Body	12/10/2014	Permittivity	50.07	49.04	2.10	±5.00
		Conductivity	5.46	5.28	3.45	±5.00
5200 Body	12/10/2014	Permittivity	50.07	49.01	2.15	±5.00
		Conductivity	5.47	5.30	3.20	±5.00
5230 Body	12/10/2014	Permittivity	50.02	48.96	2.17	±5.00
		Conductivity	5.54	5.35	3.63	±5.00
5240 Body	12/10/2014	Permittivity	50.02	48.96	2.17	±5.00
		Conductivity	5.54	5.35	3.63	±5.00
5260 Body	12/10/2014	Permittivity	50.00	48.93	2.18	±5.00
		Conductivity	5.58	5.37	3.84	±5.00
5270 Body	12/10/2014	Permittivity	50.00	48.93	2.18	±5.00
		Conductivity	5.58	5.37	3.84	±5.00
5310 Body	12/10/2014	Permittivity	49.94	48.85	2.23	±5.00
		Conductivity	5.67	5.44	4.20	±5.00
5320 Body	12/10/2014	Permittivity	49.94	48.85	2.23	±5.00
		Conductivity	5.67	5.44	4.20	±5.00
5500 Body	12/10/2014	Permittivity	48.99	48.61	0.79	±5.00
		Conductivity	5.87	5.65	3.84	±5.00
5510 Body	12/10/2014	Permittivity	48.99	48.61	0.79	±5.00
		Conductivity	5.87	5.65	3.84	±5.00
5520 Body	12/10/2014	Permittivity	48.91	48.58	0.68	±5.00
		Conductivity	5.89	5.67	3.90	±5.00
5550 Body	12/10/2014	Permittivity	48.67	48.50	0.35	±5.00
		Conductivity	5.98	5.74	4.10	±5.00
5580 Body	12/10/2014	Permittivity	48.67	48.50	0.35	±5.00
		Conductivity	5.98	5.74	4.10	±5.00
5600 Body	12/10/2014	Permittivity	48.59	48.47	0.24	±5.00
		Conductivity	6.01	5.77	4.17	±5.00
5670 Body	12/10/2014	Permittivity	47.51	48.36	-1.76	±5.00
		Conductivity	6.08	5.86	3.69	±5.00
5680 Body	12/10/2014	Permittivity	47.51	48.36	-1.76	±5.00
		Conductivity	6.08	5.86	3.69	±5.00
5745 Body	12/10/2014	Permittivity	47.13	48.27	-2.37	±5.00
		Conductivity	6.16	5.94	3.75	±5.00
5755 Body	12/10/2014	Permittivity	47.13	48.27	-2.37	±5.00
		Conductivity	6.16	5.94	3.75	±5.00
5785 Body	12/10/2014	Permittivity	47.04	48.22	-2.46	±5.00
		Conductivity	6.22	5.98	3.90	±5.00
5795 Body	12/10/2014	Permittivity	47.04	48.22	-2.46	±5.00
		Conductivity	6.22	5.98	3.90	±5.00
5800 Body	12/10/2014	Permittivity	48.00	48.20	-0.41	±5.00
		Conductivity	6.24	6.00	3.96	±5.00
5825 Body	12/10/2014	Permittivity	48.00	48.20	-0.41	±5.00
		Conductivity	6.24	6.00	3.96	±5.00

13 System Validation and System Verification

13.1 System Validation

The system validation procedure evaluates the system against reference SAR values and the performance of the probe, readout electronics, and software. The test setup utilizes a flat phantom and a reference dipole.

Thus, the system validation process does not include data scatter due to the use of anthropomorphic phantoms or uncertainty due to handset positioning variability. System validation should be performed annually, or when a new system is put into operation, or whenever modifications have been made to the system, such as a new software release, different readout electronics or different types of probes. The probe used in the test system to be validated should be properly calibrated.

System validation provides a means of system-level validation. The test system utilizes a flat phantom and a reference dipole. Thus, system validation verifies the system accuracy against its specifications but does not include the uncertainty due to the use of anthropomorphic phantoms, nor does it include the uncertainty due to handset positioning variability. This test is performed annually (e.g., after probe calibration), before measurements related to inter laboratory comparison and every time modifications have been made to the system, such as a new software release, different readout electronics, and for different types of probes.

System Validation procedure is at below,

a) **SAR evaluation**: A complete 1 g or 10 g averaged SAR measurement is performed. The reference dipole input power is adjusted to produce a 1 g averaged SAR value falling in the range of 0.4–10 W/kg. The 1 g or 10 g averaged SAR is measured at frequencies in reference table within the range to be used in compliance tests. The results are normalized to 1 W forward input power and compared with the reference SAR values shown in reference value. The differences from the reference values should be less than the tolerance specified for the SAR measurement system by the manufacturer or designer, i.e., within the expanded uncertainty for the system validation.
b) **Extrapolation routine**: Local SAR values are measured along a vertical axis directly above the reference dipole feed-point using the same test grid-point spacing as used for handset SAR evaluations. This measurement is repeated along another vertical axis with a 2 cm transverse offset from the reference dipole feed-point. SAR values at the phantom surface are extrapolated and compared with the numerical values given in reference table. The difference from the reference values should be less than the tolerance specified for the SAR measurement system by the manufacturer or designer, i.e., within the expanded uncertainty for system validation.
c) **Probe linearity**: The measurement in step a) is repeated using different reference dipole input power levels. The power levels are selected for each frequency to produce 1 g averaged SAR values of approximately 10 W/kg, 2 W/kg, and 0.4 W/kg. The measured SAR values are normalized to 1 W forward input power and compared with the 1 W normalized value from step a). The difference between these values should be less than the tolerance specified for the SAR measurement system by the manufacturer or designer, i.e., within the expanded uncertainty for the linearity component.
d) **Modulation response**: The measurements in step a) are repeated with pulse-modulated signals having a duty factor of 0.1 and pulse repetition rate of 10 Hz. The power is adjusted to produce a 1 g-averaged SAR of approximately 8 W/kg with the pulse modulated signal (corresponding to a peak spatial-average SAR of approximately 80 W/kg). The measured SAR values are normalized to 1 W forward input power and duty factor of 1, and compared with the 1 W normalized values from step a). The difference between these values should be less than the tolerance specified for the SAR measurement system by the manufacturer or designer, i.e., within the expanded uncertainty for system validation.
e) **System offset**: The measurements in step a) are repeated with a reference dipole input forwardpower that produces a 1 g or 10 g averaged SAR of approximately 0.05 W/kg. The measured SAR values are normalized to 1 W forward input power and compared with the 1 W normalized values from step a). The difference between these values should be less than the tolerance specified for the SAR measurement system by the manufacturer or designer, i.e., within the expanded uncertainty for system validation.
f) **Probe axial isotropy**: The center point of the probe's sensors is placed directly above the reference dipole center at a measurement distance of approximately 5–10 mm from the phantom inner surface. The probe (or reference dipole, if precise rotations are supported by the dipole fixture) is rotated around its axis ± 180° in steps no larger than 15°. The maximum and minimum SAR readings are recorded. The difference between these values should be less than the tolerance specified for the SAR measurement system by the manufacturer or designer, i.e., within the expanded uncertainty for the axial isotropy component.

Numerical reference SAR values (W/kg) for reference dipole and flat phantom

Frequency (MHz)	1 g SAR	10 g SAR	Local SAR at surface (above feed-point)	Local SAR at surface (y = 2 cm offset from feed-point)[a]
300	3.0	2.0	4.4	2.1
450	4.9	3.3	7.2	3.2
835	9.5	6.2	4.1	4.9
900	10.8	6.9	16.4	5.4
1450	29.0	16.0	50.2	6.5
1800	38.1	19.8	69.5	6.8
1900	39.7	20.5	72.1	6.6
2000	41.1	21.1	74.6	6.5
2450	52.4	24.0	104.2	7.7
3000	63.8	25.7	140.2	9.5

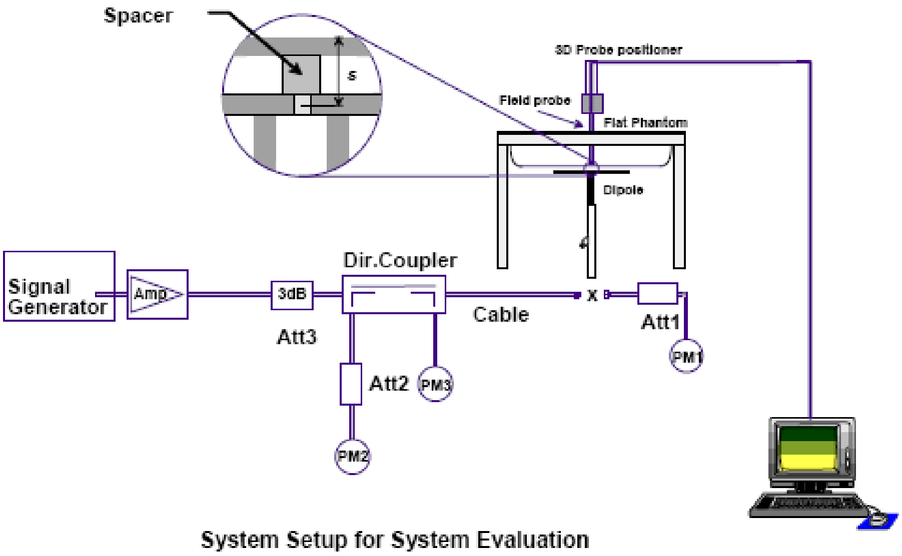
System Validation Status

Frequency (MHz)	Temp (°C)	Humidity (%)	Validation Date	Probe SN	Validation Cycle	Validation Due
835	22	58	Oct 23rd, 2014	17/14 EPG213	1 year	Oct 23rd, 2015
900	22	58	Oct 23rd, 2014	17/14 EPG213	1 year	Oct 23rd, 2015
1800	22	58	Oct 23rd, 2014	17/14 EPG213	1 year	Oct 23rd, 2015
1900	22	58	Oct 23rd, 2014	17/14 EPG213	1 year	Oct 23rd, 2015
2000	22	58	Oct 23rd, 2014	17/14 EPG213	1 year	Oct 23rd, 2015
2450	22	58	Oct 23rd, 2014	17/14 EPG213	1 year	Oct 23rd, 2015
5200	22	58	Oct 23rd, 2014	17/14 EPG213	1 year	Oct 23rd, 2015
5400	22	58	Oct 23rd, 2014	17/14 EPG213	1 year	Oct 23rd, 2015
5600	22	58	Oct 23rd, 2014	17/14 EPG213	1 year	Oct 23rd, 2015
5800	22	58	Oct 23rd, 2014	17/14 EPG213	1 year	Oct 23rd, 2015

13.2 System Verification

The system performance check verifies that the system operates within its specifications. System and operator errors can be detected and corrected. It is recommended that the system performance check be performed prior to any usage of the system in order to guarantee reproducible results. The system performance check uses normal SAR measurements in a simplified setup with a well characterized source. This setup was selected to give a high sensitivity to all parameters that might fail or vary over time. The system check does not intend to replace the calibration of the components, but indicates situations where the system uncertainty is exceeded due to drift or failure.

In the simplified setup for system evaluation, the DUT is replaced by a calibrated dipole and the power source is replaced by a continuous wave that comes from a signal generator. The calibrated dipole must be placed beneath the flat phantom section of the SAM twin phantom with the correct distance holder. The distance holder should touch the phantom surface with a light pressure at the reference marking and be oriented parallel to the long side of the phantom. The equipment setup is shown below:



System Setup for System Evaluation

Note: Equipment description

1. Signal Generator
2. Amplifier
3. Directional Coupler
4. Power Meter
5. Calibrated Dipole

System Verification Results

Test Date	Test Condition		Freq. (MHz)	Target (W/kg)	Input Power (dBm)	Measured (W/kg)	1W Normalized SAR10g (W/kg)	Delta(%)	Limit (%)
12/08/2014	Temp (°C)	22	2450	54.49	15	1.83	57.87	6.20	±10.00
	Humidity (%)	48							
	ATM (mbar)	1019							
12/10/2014	Temp (°C)	22	5200	161.23	15	4.99	157.80	-2.13	±10.00
	Humidity (%)	51							
	ATM (mbar)	1003							
12/10/2014	Temp (°C)	22	5600	177.31	15	5.61	177.40	0.05	±10.00
	Humidity (%)	51							
	ATM (mbar)	1003							
12/10/2014	Temp (°C)	22	5800	183.88	15	5.89	186.26	1.29	±10.00
	Humidity (%)	51							
	ATM (mbar)	1003							

14 Output Power Measurement Results

Requirement(s):

<table>
<tr><td>Spec</td><td>Item</td><td colspan="3">Requirement</td><td>Applicable</td></tr>
<tr><td>-</td><td>-</td><td colspan="3">Time averaged conducted output power to be measured</td><td>☒</td></tr>
<tr><td>Test Setup</td><td colspan="5">
</td></tr>
<tr><td>Test Procedure</td><td colspan="5"><u>Measurement using an Average Power Meter (PM)</u>

Measurements may be performed using a wideband gated RF power meter provided that the gate parameters are adjusted such that the power is measured only when the EUT is transmitting at its maximum power control level. Since the measurement is made only during the ON time of the transmitter, no duty cycle correction factor is required.
- Connect EUT's RF output power to power meter
- Set EUT to be continuous transmission mode
- Measurement the average output power using power meter and record the result
Repeat above steps for different test channel and other modulation type.</td></tr>
<tr><td>Test Date</td><td colspan="2">12/08/2014</td><td>Environmental condition</td><td colspan="2">Temperature 23°C
Relative Humidity 58%
Atmospheric Pressure 1019mbar</td></tr>
<tr><td>Remark</td><td colspan="5">-</td></tr>
<tr><td>Result</td><td colspan="5">☒ Pass ☐ Fail</td></tr>
</table>

Test Data ☒ Yes ☐ N/A

Output Power measurement result

WLAN 2.4GHz

Band(GHz)	Mode	Channel Number	Frequency (MHz)	ZQ510 Conducted Average Output Power (dBm)	ZQ520 Conducted Average Output Power (dBm)	Average tune up power range (dBm)
2.4	802.11b	1	2412	12.79	13.13	13±1
		7	2442	12.38	12.76	13±1
		13	2472	13.35	13.72	13±1
	802.11g	1	2412	7.29	7.77	8±1.5
		7	2442	7.89	8.06	8±1.5
		13	2472	9.50	9.15	8±1.5
	802.11n-HT20	1	2412	6.23	6.35	6±1
		7	2442	5.98	6.02	6±1
		13	2472	6.13	6.36	6±1
	802.11n-HT40	3	2422	5.19	5.77	6±1
		7	2442	6.23	6.38	6±1
		11	2462	6.75	6.77	6±1

Note: Per KDB 248227 D01, SAR is not required for 802.11g/HT20 channels when the maximum average output power is less than 1/4 dB higher than that measured on the corresponding 802.11b channels.

WLAN 5GHz

Mode	Band(GHz)	Channel No.	Frequency (MHz)	ZQ510 Conducted Average Output Power (dBm)	ZQ520 Conducted Average Output Power (dBm)	Average tune up power range (dBm)
802.11a	5.2	36	5180	13.17	13.34	13±1
		40	5200	13.12	13.10	13±1
		48	5240	12.96	12.94	13±1
	5.3	52	5260	12.20	12.13	13±1
		56	5280	13.22	13.45	13±1
		64	5320	12.80	12.98	13±1
	5.5	100	5500	11.54	12.00	12±1
		116	5580	11.47	12.05	12±1
		140	5700	11.39	11.83	12±1
	5.8	149	5745	12.53	12.33	13±1
		157	5785	13.20	13.21	13±1
		165	5825	13.25	13.28	13±1
802.11n-HT20	5.2	36	5180	13.16	13.30	13±1
		40	5200	13.02	13.45	13±1
		48	5240	13.28	13.62	13±1
	5.3	52	5260	13.15	13.31	13±1
		56	5280	13.25	13.38	13±1
		64	5320	12.67	13.14	13±1
	5.5	100	5500	11.21	12.05	12±1
		116	5580	11.58	12.12	12±1
		140	5700	11.50	12.00	12±1
	5.8	149	5745	12.06	11.55	12.5±1
		157	5785	11.76	11.79	12.5±1
		165	5825	13.25	13.19	12.5±1
802.11n-HT40	5.2	36	5190	12.71	12.88	13±1
		48	5230	12.40	12.75	13±1
	5.3	52	5270	12.98	12.99	13±1
		56	5310	13.21	13.42	13±1
	5.5	102	5510	10.85	11.79	11±1
		110	5550	11.65	12.13	11±1
		134	5670	11.82	12.06	12±1
	5.8	151	5755	12.59	11.91	12±1
		159	5795	12.60	13.12	12±1

Note: Per KDB 248227, SAR is not required for 802.11n HT20/HT40 channels when the maximum average output power is less than 1/4 dB higher than that measured on the corresponding 802.11a channels.

Bluetooth

Mode	Channel No.	Frequency (MHz)	Conducted Average Output Power (dBm)	Average tune up power range (dBm)
BDR	1	2402	5.2	6±1
	40	2441	6.5	6±1
	79	2480	6.3	6±1
EDR	1	2402	2.3	3±1
	40	2441	4.0	3±1
	79	2480	3.7	3±1
LE 4.0	1	2402	5.1	6±1
	13	2426	6.4	6±1
	79	2480	6.2	6±1

Note: Per KDB 447498, Standalone SAR is not required for BT.

15 SAR Test Results

Requirement(s):

Spec	Item	Requirement	Applicable
IEEE 1528: 2003	1	SAR limit for devices used by the General public (Uncontrolled Environment) in localized Head and Trunk is 1.6 W/kg	☒
	2	SAR limit for Controlled Use Devices (Controlled Environment) in localized Head and Trunk is 8 W/kg	☐
Test Method	IEEE 1528: 2003 IEC 62209-2: 2010 447498 D01 General RF Exposure Guidance v05r01 248227 SAR measurement procedures for 802.11 a/b/g TX KDB 865664 SAR Measurement Requirements for 3 to 6 GHz v05r01		
Test Setup	Refer to Section 6: SAR Measurement Setup		
Test Procedure	**Steps:** 1. Use client test software to set EUT transmit RF power in cont-TX mode in the highest power channel 2. Measure output power through spectrum analyzer 3. Place the DUT in the positions selected 4. Set scan area, grid size and other setting on the SATIMO software 5. Make SAR measurement for the selected highest output power channel at each testing position 6. Find out the position with highest SAR result 7. Measure additional SAR for other modes at the highest SAR position SAR measurement system will proceed the following basic steps: 1. Initial power reference measurement 2. Area Scan 3. Zoom Scan 4. Power drift measurement		
Test Date	12/08/2014-12/19/2014	Environmental condition	Temperature 23oC Relative Humidity 58% Atmospheric Pressure 1008mbar
Remark	The testing in current report is to be performed at 0 cm separation distance.		
Result	☒ Pass ☐ Fail		

Test Data ☒ Yes ☐ N/A

Test Plot ☒ Yes ☐ N/A

ZQ520 Test Results

Freq Band	Freq (MHz)	Position	Rated Max Power (dBm)	Measured Output Power (dBm)	Raw SAR 1g(W/kg)	Power Drift (%)	Scaled SAR (W/kg)	1g SAR Limit (W/kg)
802.11b	2412	Bottom Touch	14	13.13	0.615	-3.01	0.751	1.6
802.11b	2437	Bottom Touch	14	12.76	0.599	-2.55	0.797	1.6
802.11b	2462	Bottom Touch	14	13.72	0.511	2.51	0.545	1.6
802.11a-5.2G	5180	Bottom Touch	14	13.34	0.757	0.36	0.881	1.6
802.11a-5.2G	5240	Bottom Touch	14	12.94	0.784	1.20	1.001	1.6
802.11a--5.3G	5260	Bottom Touch	14	12.13	0.629	-3.41	0.967	1.6
802.11a--5.3G	5320	Bottom Touch	14	12.98	0.751	-1.11	0.950	1.6
802.11a--5.5G	5520	Bottom Touch	14	12.00	0.726	2.05	1.151	1.6
802.11a--5.5G	5580	Bottom Touch	13	12.05	0.748	2.48	0.931	1.6
802.11a-5.5G	5680	Bottom Touch	13	11.83	0.689	-2.73	0.902	1.6
802.11a--5.8G	5745	Bottom Touch	14	12.33	0.680	-0.52	0.999	1.6
802.11a--5.8G	5785	Bottom Touch	14	13.21	0.625	-0.98	0.750	1.6
802.11a--5.8G	5825	Bottom Touch	14	13.28	0.774	2.35	0.914	1.6
802.11n40-5.2G	5190	Bottom Touch	14	12.88	0.695	1.26	0.899	1.6
802.11n40-5.2G	5230	Bottom Touch	14	12.75	0.696	0.65	0.928	1.6
802.11n40-5.3G	5270	Bottom Touch	14	12.99	0.414	3.94	0.522	1.6
802.11n40-5.3G	5310	Bottom Touch	14	13.42	0.435	2.10	0.497	1.6
802.11n40-5.5G	5510	Bottom Touch	12	11.79	0.473	2.51	0.496	1.6
802.11n40-5.5G	5550	Bottom Touch	12	12.13	0.427	1.44	0.414	1.6
802.11n40-5.5G	5670	Bottom Touch	13	12.06	0.522	2.23	0.648	1.6
802.11n40-5.8G	5755	Bottom Touch	13	11.91	0.660	1.95	0.848	1.6
802.11n40-5.8G	5795	Bottom Touch	13	13.12	0.716	2.13	0.696	1.6

ZQ510 Test Results

Freq Band	Freq (MHz)	Position	Rated Max Power (dBm)	Measured Output Power (dBm)	Raw SAR 1g(W/kg)	Power Drift (%)	Scaled SAR (W/kg)	1g SAR Limit (W/kg)
802.11b	2437	Bottom Touch	14	12.38	0.250	-0.38	0.363	1.6
802.11a--5.3G	5320	Bottom Touch	14	12.80	0.286	3.57	0.377	1.6
802.11n40--5.2G	5230	Bottom Touch	14	12.40	0.239	1.77	0.345	1.6

16 Simultaneous SAR Evaluation

16.1 SAR Estimation

Per KDB 447498, when the standalone SAR test exclusion is applied to an antenna that transmits simultaneously with other antennas, the standalone SAR must be estimated according to the following to determine simultaneous transmission SAR test exclusion.

16.2 Sum of SAR

ZQ520

Band	Mode	Channel Frequency (MHz)	SAR 1g (W/kg)	BT Estimation SAR 1g (W/kg)	Sum	Limit (W/kg)
2.4GHz	802.11b	2412	0.751	0	0.751	1.6
	802.11b	2437	0.797	0	0.797	1.6
	802.11b	2462	0.545	0	0.545	1.6
5.2GHz	802.11a	5180	0.881	0	0.881	1.6
	802.11a	5240	1.001	0	1.001	1.6
5.3GHz	802.11a	5260	0.967	0	0.967	1.6
	802.11a	5320	0.950	0	0.950	1.6
5.5GHz	802.11a	5520	1.151	0	1.151	1.6
	802.11a	5580	0.931	0	0.931	1.6
	802.11a	5680	0.902	0	0.902	1.6
5.8GHz	802.11a	5745	0.999	0	0.999	1.6
	802.11a	5785	0.750	0	0.750	1.6
	802.11a	5825	0.914	0	0.914	1.6
5.2GHz	802.11n40	5190	0.899	0	0.899	1.6
	802.11n40	5230	0.928	0	0.928	1.6
5.3GHz	802.11n40	5270	0.522	0	0.522	1.6
	802.11n40	5310	0.497	0	0.497	1.6
5.5GHz	802.11n40	5510	0.496	0	0.496	1.6
	802.11n40	5550	0.414	0	0.414	1.6
	802.11n40	5670	0.648	0	0.648	1.6
5.8GHz	802.11n40	5755	0.848	0	0.848	1.6
	802.11n40	5795	0.696	0	0.696	1.6

ZQ510

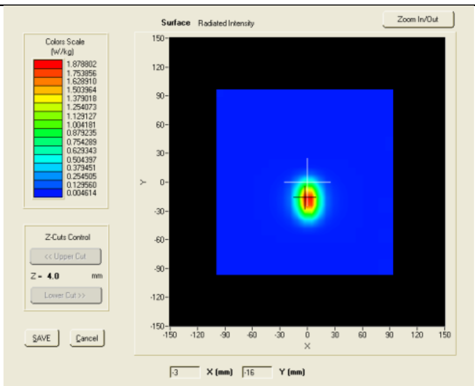
Band	Mode	Channel Frequency (MHz)	SAR 1g (W/kg)	BT Estimation SAR 1g (W/kg)	Sum	Limit (W/kg)
2.4GHz	802.11b	2437	0.363	0	0.363	1.6
5.3GHz	802.11a	5320	0.377	0	0.377	1.6
5.2GHz	802.11n40	5230	0.345	0	0.345	1.6

Note: Per KDB 447498, when the sum of SAR is not larger than the limit, Simultaneous SAR test is not required

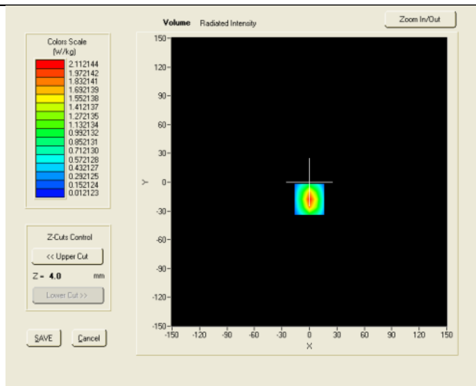
17 System Performance Plots

Test specification:	System Verification			
Environ Conditions:	Temp(oC):	23	Result:	Pass
	Humidity(%):	58		
	Atmospheric(mPa):	1009		
Mains Power:	N/A			
Test Date:	1208/2014			
Tested by:	Ricky Wang			
Remarks:	System Validation, dipole, CW signal, duty cycle =1			

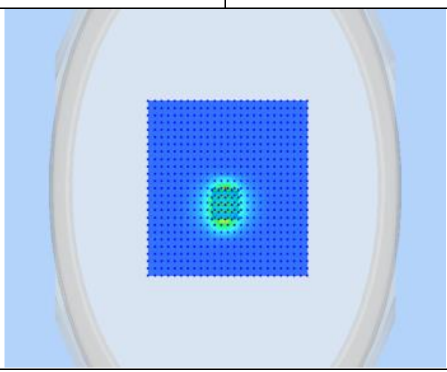
Frequency (MHz)	2450.000000
Relative permittivity (real part)	51.48
Conductivity (S/m)	1.94
Transmission Duty Factor	1.00
Probe SN	1714_EPG213
Conversion Factor (dB)	7.89
Area Scan Resolution	8 mm
Zoom Scan Resolution	dx=4mm, dy=4mm, dz=2mm
Zoom Scan Size	24x24x24 mm
Measurement Drifts (%)	2.84
Highest Extrapolated SAR (W/Kg)	3.242
SAR 1g (W/Kg)	1.81
Peak SAR Location	0mm(x),-18mm(y),4mm(z)



SURFACE SAR

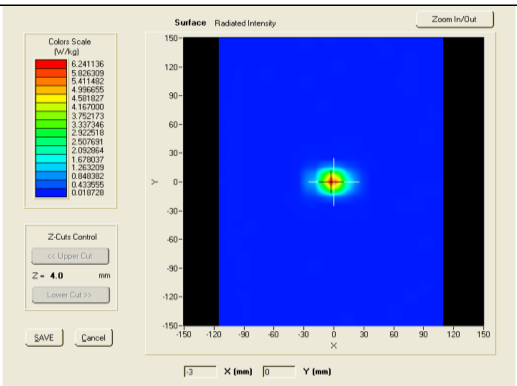
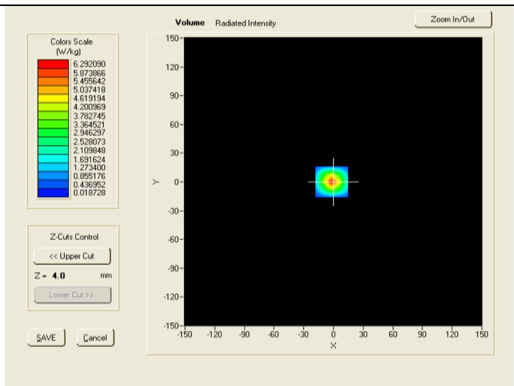
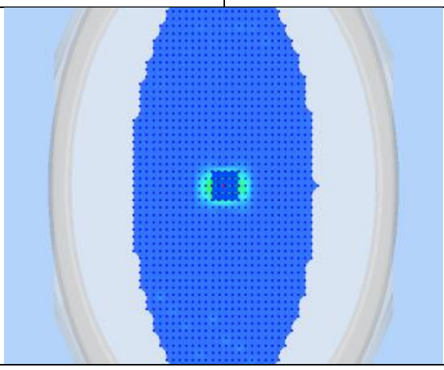


VOLUME SAR



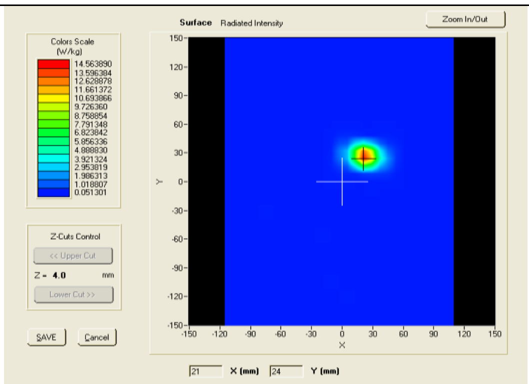
3D View

Test specification:	System Validation			
Environ Conditions:	Temp(oC):	23	Result:	Pass
	Humidity(%):	58		
	Atmospheric(mPa):	1009		
Mains Power:	N/A			
Test Date:	1210/2014			
Tested by:	Ricky Wang			
Remarks:	System Validation, dipole, CW signal, duty cycle =1			

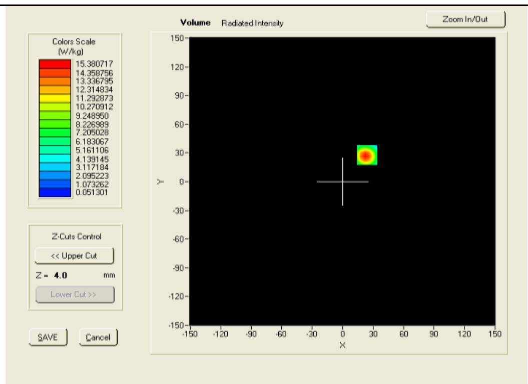
Frequency (MHz)	5200.000000
Relative permittivity (real part)	50.07
Conductivity (S/m)	5.47
Transmission Duty Factor	1.00
Probe SN	1714_EPG213
Conversion Factor (dB)	5.69
Area Scan Resolution	4 mm
Zoom Scan Resolution	dx=4mm, dy=4mm, dz=2mm
Zoom Scan Size	24x24x24 mm
Measurement Drifts (%)	3.74
Highest Extrapolated SAR (W/Kg)	9.41
SAR 1g (W/Kg)	4.99
Peak SAR Location	-2mm(x),0mm(y),4mm(z)
	
SURFACE SAR	VOLUME SAR
	
3D View	

Test specification:	System Validation			
Environ Conditions:	Temp(oC):	23	Result:	Pass
	Humidity(%):	58		
	Atmospheric(mPa):	1009		
Mains Power:	N/A			
Test Date:	1210/2014			
Tested by:	Ricky Wang			
Remarks:	System Validation, dipole, CW signal, duty cycle =1			

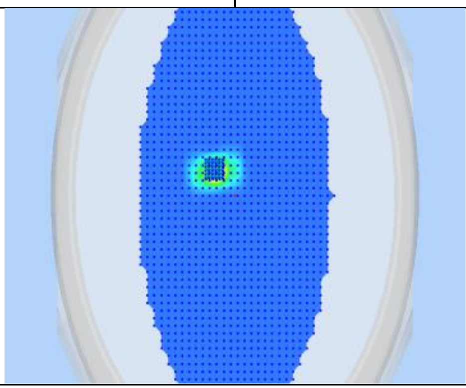
Frequency (MHz)	5500.000000
Relative permittivity (real part)	48.99
Conductivity (S/m)	5.87
Transmission Duty Factor	1.00
Probe SN	1714_EPG213
Conversion Factor (dB)	5.69
Area Scan Resolution	4 mm
Zoom Scan Resolution	dx=4mm, dy=4mm, dz=2mm
Zoom Scan Size	24x24x24 mm
Measurement Drifts (%)	-4.09
Highest Extrapolated SAR (W/Kg)	28.621
SAR 1g (W/Kg)	16.91
Peak SAR Location	21mm(x),22mm(y),4mm(z)



SURFACE SAR



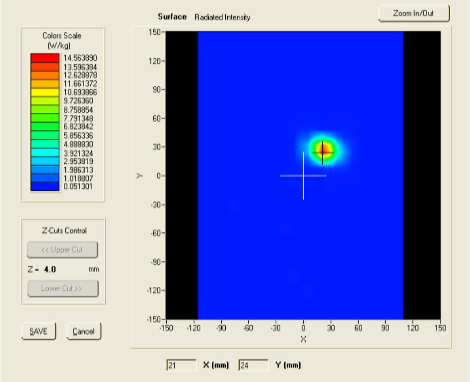
VOLUME SAR



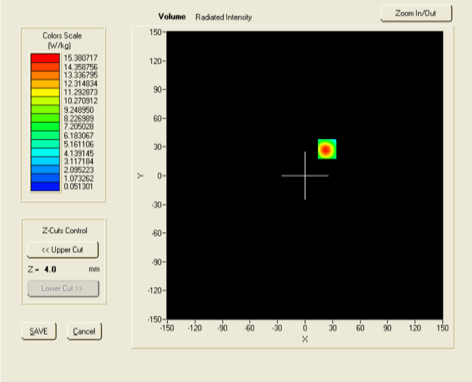
3D View

Test specification:	System Validation			
Environ Conditions:	Temp(oC):	23	Result:	Pass
	Humidity(%):	58		
	Atmospheric(mPa):	1009		
Mains Power:	N/A			
Test Date:	1210/2014			
Tested by:	Ricky Wang			
Remarks:	System Validation, dipole, CW signal, duty cycle =1			

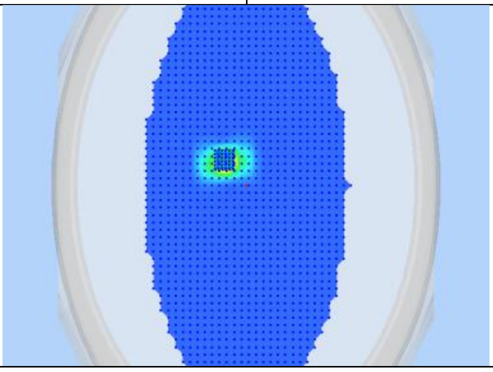
Frequency (MHz)	5800.000000
Relative permittivity (real part)	48.00
Conductivity (S/m)	6.24
Transmission Duty Factor	1.00
Probe SN	1714_EPG213
Conversion Factor (dB)	5.69
Area Scan Resolution	4 mm
Zoom Scan Resolution	dx=4mm, dy=4mm, dz=2mm
Zoom Scan Size	24x24x24 mm
Measurement Drifts (%)	2.93
Highest Extrapolated SAR (W/Kg)	33.182
SAR 1g (W/Kg)	17.89
Peak SAR Location	21mm(x),22mm(y),4mm(z)



SURFACE SAR



VOLUME SAR

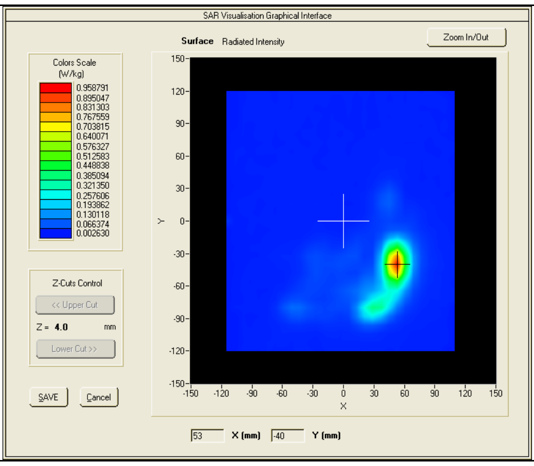


3D View

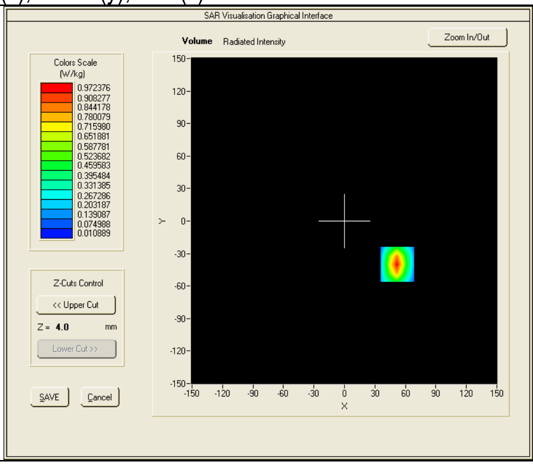
18 SAR Test Plots

Test specification:	Q520_Bottom Touch_2412_B mode			
Environ Conditions:	Temp(oC):	21	Result:	Pass
	Humidity(%):	46		
	Atmospheric(mPa):	1005		
Mains Power:	7.2VDC Battery			
Test Date:	12/08/2014			
Tested by:	Ricky Wang			
Remarks:	N/A			

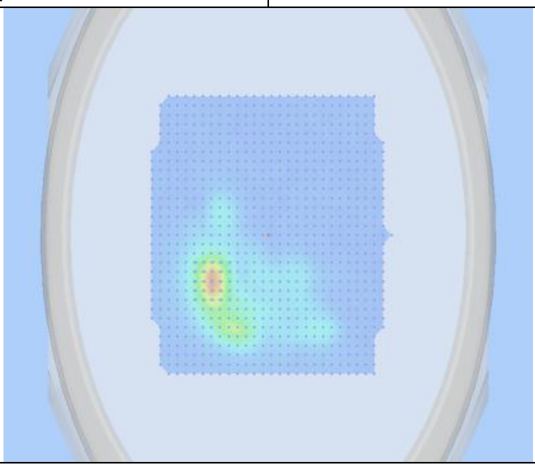
Frequency (MHz)	2412.000000
Relative permittivity (real part)	51.49
Conductivity (S/m)	1.91
Transmission Duty Factor	1.0
Probe SN	1714_EPG213
Conversion Factor (dB)	21.96
Area Scan Resolution	8 mm
Zoom Scan Resolution	dx=8mm, dy=8mm, dz=5mm
Zoom Scan Size	32x32x34 mm
Measurement Drifts (%)	-3.01
Highest Extrapolated SAR (W/Kg)	1.3463
SAR 1g (W/Kg)	0.6149
Peak SAR Location	52mm(x),-40mm(y),4mm(z)



SURFACE SAR



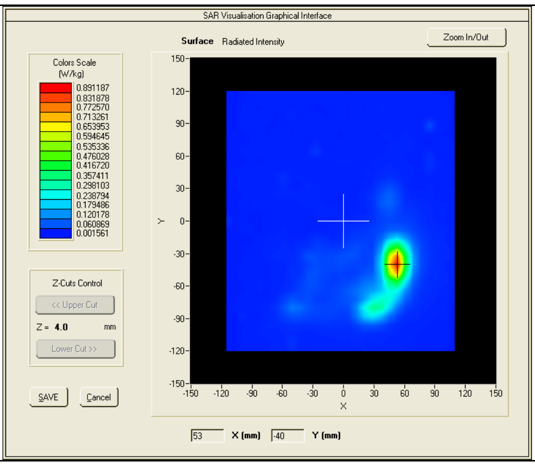
VOLUME SAR



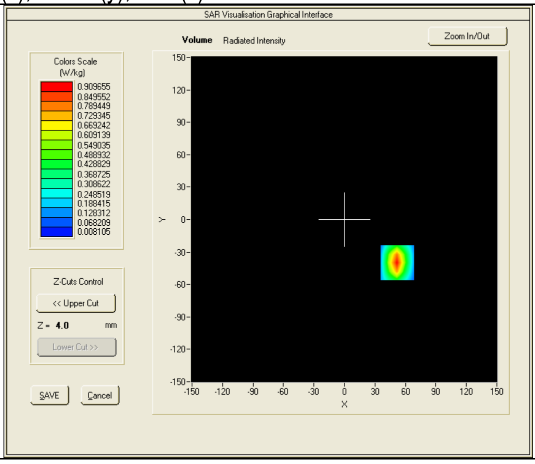
3D View Plot

Test specification:	Q520_Bottom Touch_2437_B mode			
Environ Conditions:	Temp(oC):	21	Result:	Pass
	Humidity(%):	46		
	Atmospheric(mPa):	1005		
Mains Power:	7.2VDC Battery			
Test Date:	12/08/2014			
Tested by:	Ricky Wang			
Remarks:	N/A			

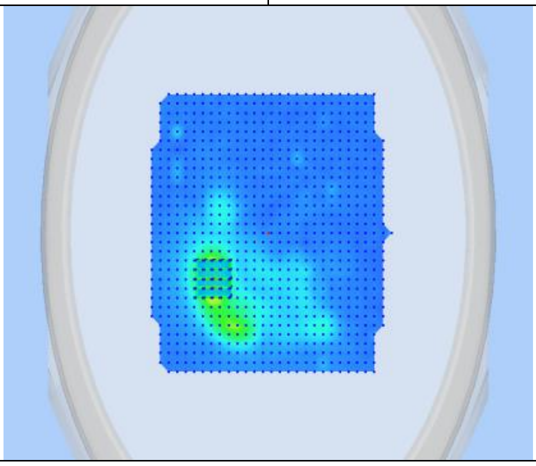
Frequency (MHz)	2437.000000
Relative permittivity (real part)	51.48
Conductivity (S/m)	1.94
Transmission Duty Factor	1.0
Probe SN	1714_EPG213
Conversion Factor (dB)	21.96
Area Scan Resolution	8 mm
Zoom Scan Resolution	dx=8mm, dy=8mm, dz=5mm
Zoom Scan Size	32x32x34 mm
Measurement Drifts (%)	-2.55
Highest Extrapolated SAR (W/Kg)	1.3179
SAR 1g (W/Kg)	0.5994
Peak SAR Location	52mm(x),-40mm(y),4mm(z)



SURFACE SAR



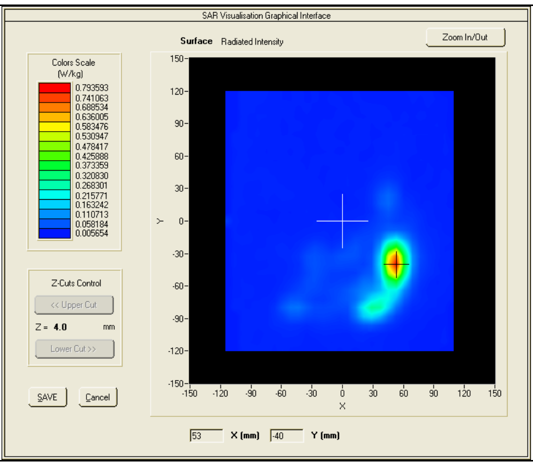
VOLUME SAR



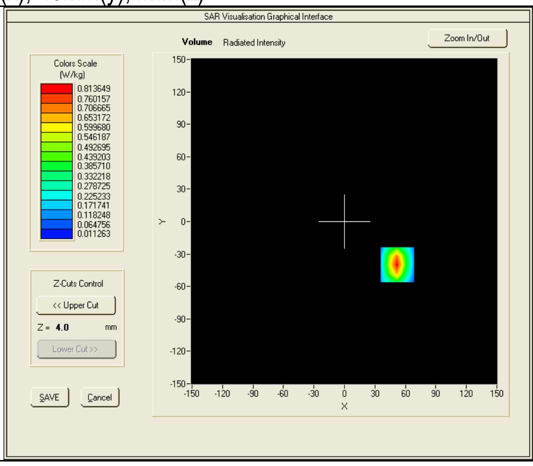
3D View Plot

Test specification:	Q520_Bottom Touch_2462_B mode			
Environ Conditions:	Temp(oC):	21	Result:	Pass
	Humidity(%):	46		
	Atmospheric(mPa):	1005		
Mains Power:	7.2VDC Battery			
Test Date:	12/08/2014			
Tested by:	Ricky Wang			
Remarks:	N/A			

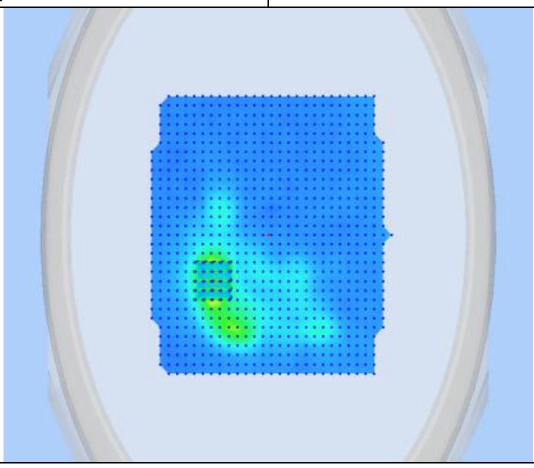
Frequency (MHz)	2462.000000
Relative permittivity (real part)	51.48
Conductivity (S/m)	1.98
Transmission Duty Factor	1.0
Probe SN	1714_EPG213
Conversion Factor (dB)	21.96
Area Scan Resolution	8 mm
Zoom Scan Resolution	dx=8mm, dy=8mm, dz=5mm
Zoom Scan Size	32x32x34 mm
Measurement Drifts (%)	2.51
Highest Extrapolated SAR (W/Kg)	1.1494
SAR 1g (W/Kg)	0.5105
Peak SAR Location	52mm(x),-40mm(y),4mm(z)



SURFACE SAR



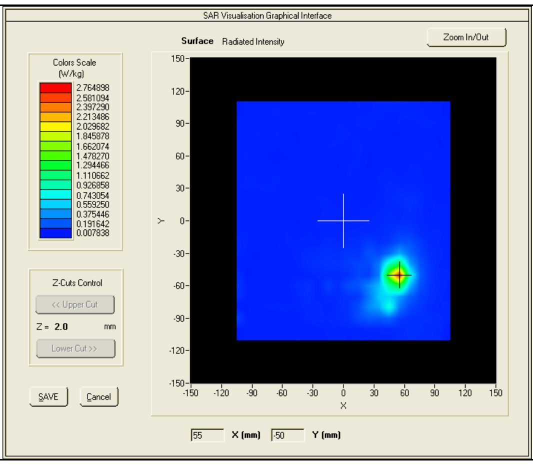
VOLUME SAR



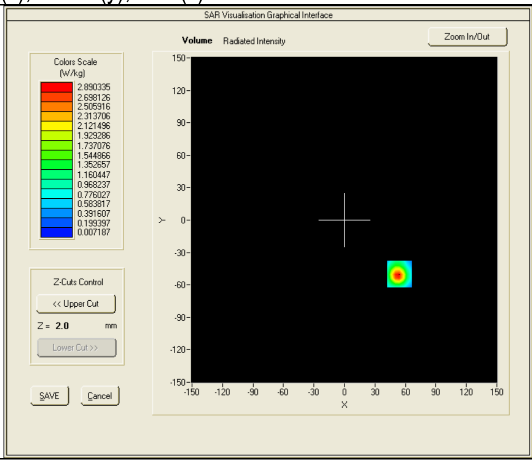
3D View Plot

Test specification:	Q520_Bottom Touch_5180_n-A mode			
Environ Conditions:	Temp(oC):	21	Result:	Pass
	Humidity(%):	46		
	Atmospheric(mPa):	1005		
Mains Power:	7.2VDC Battery			
Test Date:	12/08/2014			
Tested by:	Ricky Wang			
Remarks:	N/A			

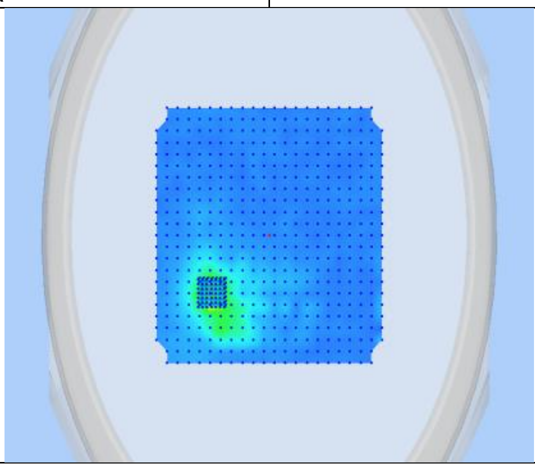
Frequency (MHz)	5180.000000
Relative permittivity (real part)	50.07
Conductivity (S/m)	5.46
Transmission Duty Factor	1.0
Probe SN	1714_EPG213
Conversion Factor (dB)	16.15
Area Scan Resolution	4 mm
Zoom Scan Resolution	dx=4mm, dy=4mm, dz=2mm
Zoom Scan Size	24x24x24 mm
Measurement Drifts (%)	0.36
Highest Extrapolated SAR (W/Kg)	2.5652
SAR 1g (W/Kg)	0.7567
Peak SAR Location	54mm(x),-50mm(y),4mm(z)



SURFACE SAR



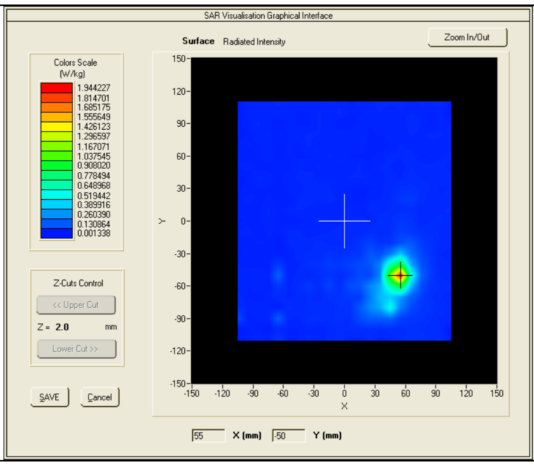
VOLUME SAR



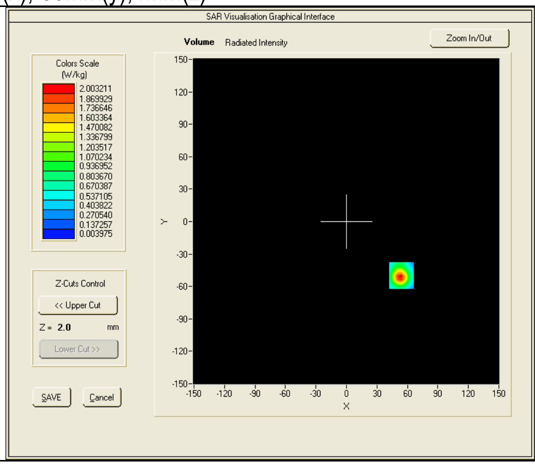
3D View Plot

Test specification:	Q520_Bottom Touch_5240_A mode			
Environ Conditions:	Temp(oC):	21	Result:	Pass
	Humidity(%):	46		
	Atmospheric(mPa):	1005		
Mains Power:	7.2VDC Battery			
Test Date:	12/10/2014			
Tested by:	Ricky Wang			
Remarks:	N/A			

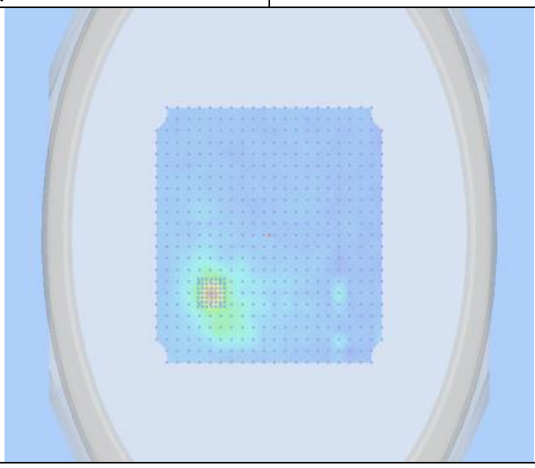
Frequency (MHz)	5240.000000
Relative permittivity (real part)	50.02
Conductivity (S/m)	5.54
Transmission Duty Factor	1.0
Probe SN	1714_EPG213
Conversion Factor (dB)	16.15
Area Scan Resolution	4 mm
Zoom Scan Resolution	dx=4mm, dy=4mm, dz=2mm
Zoom Scan Size	24x24x24 mm
Measurement Drifts (%)	1.20
Highest Extrapolated SAR (W/Kg)	2.3783
SAR 1g (W/Kg)	0.7837
Peak SAR Location	54mm(x),-50mm(y),4mm(z)



SURFACE SAR



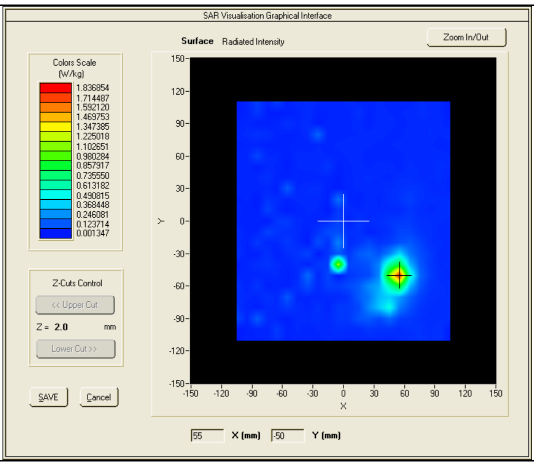
VOLUME SAR



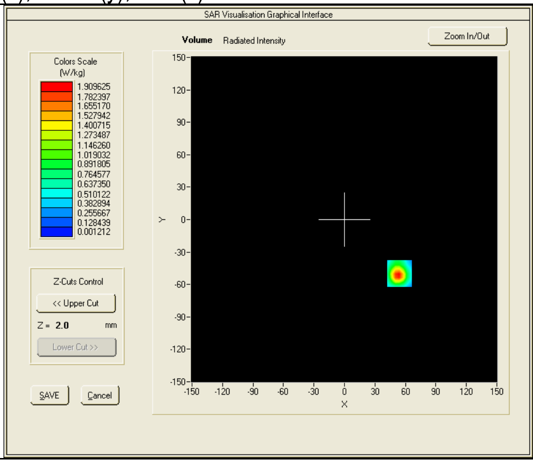
3D View Plot

Test specification:	Q520_Bottom Touch_5260_A mode			
Environ Conditions:	Temp(oC):	21	Result:	Pass
	Humidity(%):	46		
	Atmospheric(mPa):	1005		
Mains Power:	7.2VDC Battery			
Test Date:	12/10/2014			
Tested by:	Ricky Wang			
Remarks:	N/A			

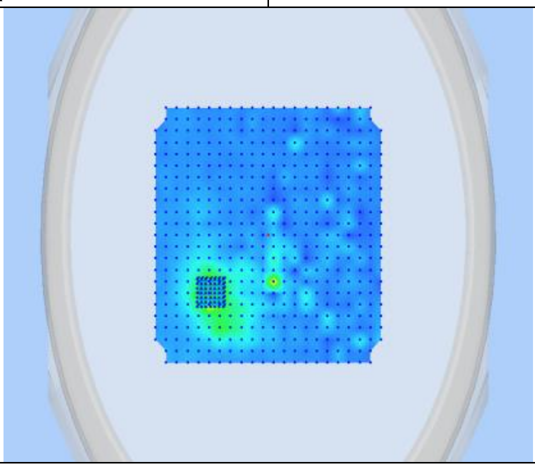
Frequency (MHz)	5260.000000
Relative permittivity (real part)	50.00
Conductivity (S/m)	5.58
Transmission Duty Factor	1.0
Probe SN	1714_EPG213
Conversion Factor (dB)	16.15
Area Scan Resolution	4 mm
Zoom Scan Resolution	dx=4mm, dy=4mm, dz=2mm
Zoom Scan Size	24x24x24 mm
Measurement Drifts (%)	-3.41
Highest Extrapolated SAR (W/Kg)	2.1883
SAR 1g (W/Kg)	0.6288
Peak SAR Location	54mm(x),-50mm(y),4mm(z)



SURFACE SAR

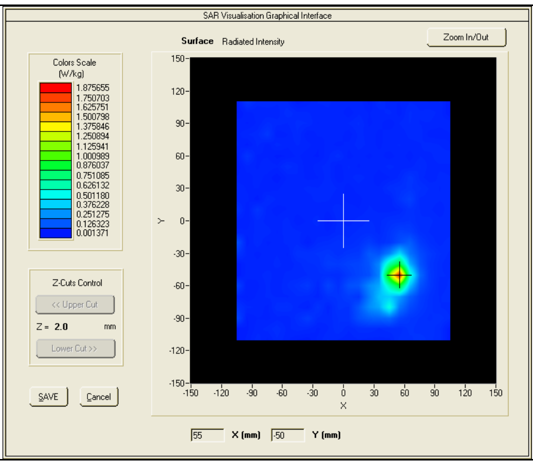


VOLUME SAR

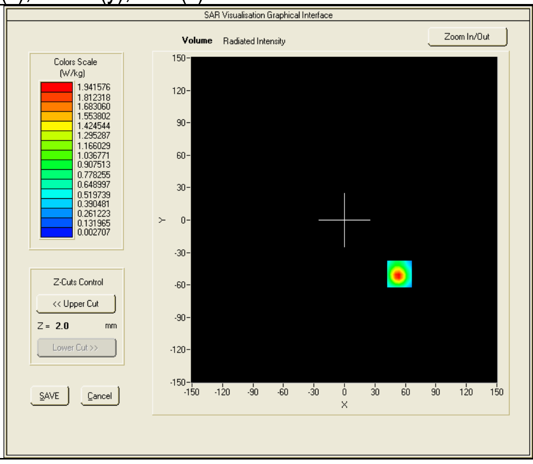


Test specification:	Q520_Bottom Touch_5320_A mode			
Environ Conditions:	Temp(oC):	21	Result:	Pass
	Humidity(%):	46		
	Atmospheric(mPa):	1005		
Mains Power:	7.2VDC Battery			
Test Date:	12/10/2014			
Tested by:	Ricky Wang			
Remarks:	N/A			

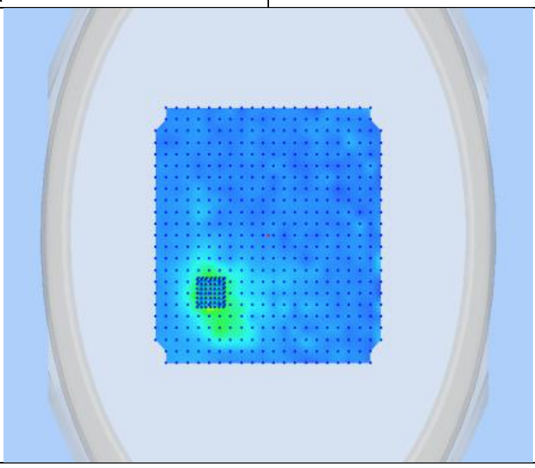
Frequency (MHz)	5320.000000
Relative permittivity (real part)	49.94
Conductivity (S/m)	5.67
Transmission Duty Factor	1.0
Probe SN	1714_EPG213
Conversion Factor (dB)	16.15
Area Scan Resolution	4 mm
Zoom Scan Resolution	dx=4mm, dy=4mm, dz=2mm
Zoom Scan Size	24x24x24 mm
Measurement Drifts (%)	-1.11
Highest Extrapolated SAR (W/Kg)	2.2668
SAR 1g (W/Kg)	0.7263
Peak SAR Location	54mm(x),-50mm(y),4mm(z)



SURFACE SAR



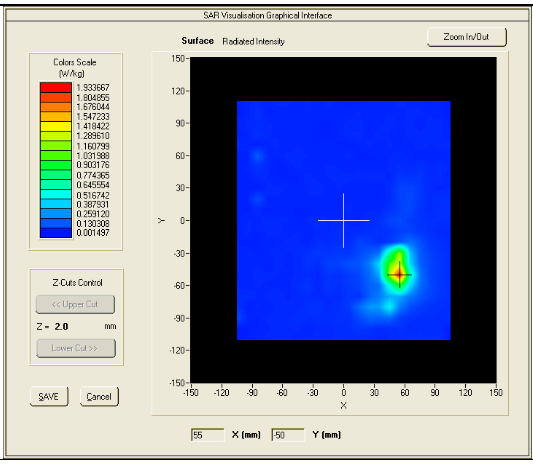
VOLUME SAR



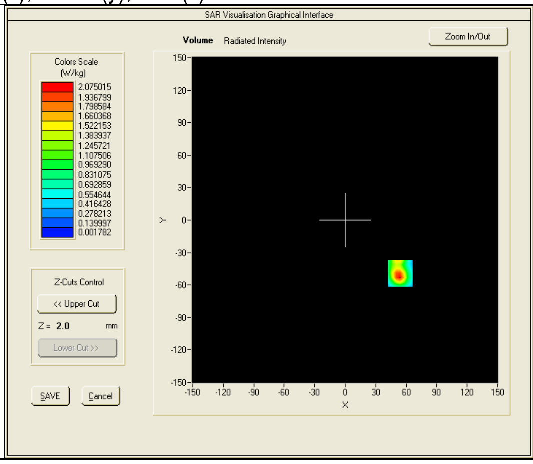
3D View Plot

Test specification:	Q520_Bottom Touch_5520_A mode			
Environ Conditions:	Temp(oC):	21	Result:	Pass
	Humidity(%):	46		
	Atmospheric(mPa):	1005		
Mains Power:	7.2VDC Battery			
Test Date:	12/10/2014			
Tested by:	Ricky Wang			
Remarks:	N/A			

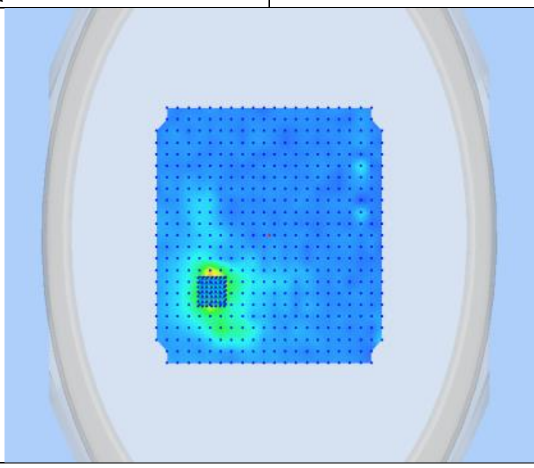
Frequency (MHz)	5520.000000
Relative permittivity (real part)	48.91
Conductivity (S/m)	5.89
Transmission Duty Factor	1.0
Probe SN	1714_EPG213
Conversion Factor (dB)	16.15
Area Scan Resolution	4 mm
Zoom Scan Resolution	dx=4mm, dy=4mm, dz=2mm
Zoom Scan Size	24x24x24 mm
Measurement Drifts (%)	2.05
Highest Extrapolated SAR (W/Kg)	2.4862
SAR 1g (W/Kg)	0.7961
Peak SAR Location	54mm(x),-49mm(y),4mm(z)



SURFACE SAR



VOLUME SAR



3D View Plot