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CERTIFICATE OF COMPLIANCE
SAR EVALUATION

Intel Mobile Communication	Dates of Test: December 6-10, 2018
100 Center Point Circle, Suite 200	Test Report Number: SAR.20181204
Columbia, SC 29210	Revision B

FCC ID:	PD99560NG (Contains Model 9560NGW & 9560NGW R)
IC Certificate:	1000M-9560NG (Contains Model 9560NGW & 9560NGW R)
Model(s):	TPN-W144
Test Sample:	Engineering Unit Same as Production
Serial Number:	Eng 1
Equipment Type:	Wireless Module Installed in Notebook
Classification:	Portable Transmitter Next to Body
TX Frequency Range:	2412 – 2462 MHz; 5180 – 5320 MHz; 5500 – 5700 MHz; 5745 – 5825 MHz
Frequency Tolerance:	± 2.5 ppm
Maximum RF Output:	2450 MHz (b) – 20.50 dB, 2450 MHz (g) – 20.50 dB, 2450 MHz (n20) – 20.50 dB, 2450 MHz (n40) – 16.00 dB, 5250 MHz (a) – 20.50 dB, 5250 MHz (n20) – 20.50 dB, 5250 MHz (n40) – 19.50 dB, 5250 MHz (ac80) – 18.00 dB, 5250 MHz (ac160) – 13.50 dB, 5600 MHz (a) – 19.00 dB, 5600 MHz (n20) – 19.00 dB, 5600 MHz (n40) – 19.00 dB, 5600 MHz (ac80) – 19.00 dB, 5600 MHz (ac160) – 15.00 dB, 5800 MHz (a) – 18.50 dB, 5800 MHz (n20) – 18.50 dB, 5800 MHz (n40) – 18.50 dB, 5800 MHz (ac80) – 18.50 dB Conducted
Signal Modulation:	DSSS, OFDM
Antenna Type:	WNC, P/N 81EAA415.GHE (Tx1 & Tx2); PIFA Antenna
Application Type:	Certification
FCC Rule Parts:	Part 2, 15C, 15E
KDB Test Methodology:	KDB 447498 D01 v06, KDB 248227 v02r02, KDB 616217 D04 v01r02
Industry Canada:	RSS-102 Issue 5, Safety Code 6
Maximum SAR Value:	1.20 W/kg Reported
Maximum Simultaneous SAR:	1.27 W/kg Reported
Separation Distance:	3.9 mm

This wireless mobile and/or portable device has been shown to be compliant for localized specific absorption rate (SAR) for uncontrolled environment/general exposure limits specified in ANSI/IEEE Std. C95.1-1992 and had been tested in accordance with the measurement procedures specified in IEEE 1528-2013 and IEC 62209-2:2010 (See test report).

I attest to the accuracy of the data. All measurements were performed by myself or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

RF Exposure Lab, LLC certifies that no party to this application is subject to a denial of Federal benefits that includes FCC benefits pursuant to Section 5301 of the Anti-Drug Abuse Act of 1988, 21 U.S.C. 853(a).

Jay M. Moulton
Vice President

ACCREDITED
Testing Cert. # 2387.01

Table of Contents

1. Introduction

This measurement report shows compliance of the Intel Mobile Communications Model 9560NGW & 9560NGW R installed in HP Model TPN-W144 FCC ID: PD99560NG with FCC Part 2, 1093, ET Docket 93-62 Rules for mobile and portable devices and IC Certificate: 1000M-9560NG with RSS102 Issue 5 & Safety Code 6. The FCC have adopted the guidelines for evaluating the environmental effects of radio frequency radiation in ET Docket 93-62 on August 6, 1996 to protect the public and workers from the potential hazards of RF emissions due to FCC regulated portable devices. [1], [6]

The test results recorded herein are based on a single type test of Intel Mobile Communications Model 9560NGW & 9560NGW R installed in HP Model TPN-W144 and therefore apply only to the tested sample.

The test procedures, as described in ANSI C95.1 – 1999 Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz [2], ANSI C95.3 – 2002 Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields [3], IEEE Std.1528 – 2013 Recommended Practice [4], and Industry Canada Safety Code 6 Limits of Human Exposure to Radiofrequency Electromagnetic Fields in the Frequency Range from 3kHz to 300 GHz were employed.

The following table indicates all the wireless technologies operating in the 9560NGW & 9560NGW R installed in HP Model TPN-W144 Wireless Modem. The table also shows the tolerance for the power level for each mode.

Band	Technology	3GPP Nominal Power dBm	Setpoint Nominal Power dBm	Tolerance dBm	Lower Tolerance dBm	Upper Tolerance dBm
WLAN – 2.4 GHz	802.11bgn20	N/A	19.0	±1.5	17.5	20.5
WLAN – 2.4 GHz	802.11n40	N/A	14.5	±1.5	13.0	16.0
WLAN – 5 GHz Band I	802.11an20	N/A	19.0	±1.5	17.5	20.5
WLAN – 5 GHz Band I	802.11n40	N/A	18.0	±1.5	16.5	19.5
WLAN – 5 GHz Band I	802.11ac80	N/A	16.5	±1.5	15.0	18.0
WLAN – 5 GHz Band I	802.11ac160	N/A	12.0	±1.5	10.5	13.5
WLAN – 5 GHz Band IIA	802.11an20	N/A	18.5	±1.5	17.0	20.0
WLAN – 5 GHz Band IIA	802.11n40	N/A	17.0	±1.5	15.5	18.5
WLAN – 5 GHz Band IIA	802.11ac80	N/A	14.0	±1.5	12.5	15.5
WLAN – 5 GHz Band IIC	802.11an20n40	N/A	17.5	±1.5	16.0	19.0
WLAN – 5 GHz Band IIC	802.11ac80	N/A	17.5	±1.5	16.0	19.0
WLAN – 5 GHz Band IIC	802.11ac160	N/A	13.5	±1.5	12.0	15.0
WLAN – 5 GHz Band III	802.11an20n40	N/A	17.0	±1.5	15.5	18.5
WLAN – 5 GHz Band III	802.11ac80	N/A	17.0	±1.5	15.5	18.5
BT – BDR	Bluetooth	N/A	10.5	±1.5	9.0	12.0
BT – EDR2 & EDR3	Bluetooth	N/A	6.5	±1.5	5.0	8.0
BT – BLE	Bluetooth	N/A	10.5	±1.5	9.0	12.0

SAR Definition [5]

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

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

where:

σ = conductivity of the tissue (S/m)

ρ = mass density of the tissue (kg/m^3)

E = rms electric field strength (V/m)

2. SAR Measurement Setup

Robotic System

These measurements are performed using the DASY52 automated dosimetric assessment system. The DASY52 is made by Schmid & Partner Engineering AG (SPEAG) in Zurich, Switzerland and consists of high precision robotics system (Staubli), robot controller, Intel Core2 computer, near-field probe, probe alignment sensor, and the generic twin phantom containing the brain equivalent material. The robot is a six-axis industrial robot performing precise movements to position the probe to the location (points) of maximum electromagnetic field (EMF) (see Fig. 2.1).

System Hardware

A cell controller system contains the power supply, robot controller teach pendant (Joystick), and a remote control used to drive the robot motors. The PC consists of the HP Intel Core2 computer with Windows XP system and SAR Measurement Software DASY52, A/D interface card, monitor, mouse, and keyboard. The Staubli Robot is connected to the cell controller to allow software manipulation of the robot. A data acquisition electronic (DAE) circuit that performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. is connected to the Electro-optical coupler (EOC). The EOC performs the conversion from the optical into digital electric signal of the DAE and transfers data to the PC plug-in card.

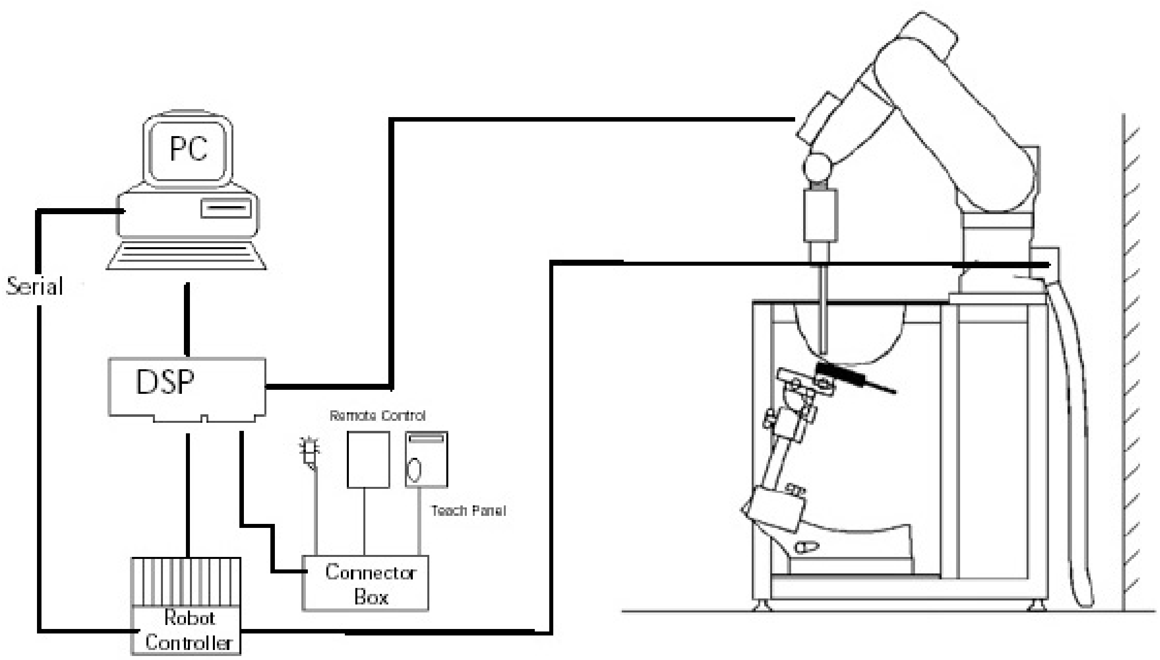


Figure 2.1 SAR Measurement System Setup

System Electronics

The DAE4 consists of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD-converter and a command decoder and control logic unit. Transmission to the PC-card is accomplished through an optical downlink for data and status information and an optical uplink for commands and clock lines. The mechanical probe mounting device includes two different sensor systems for frontal and sidewise probe contacts. They are also used for mechanical surface detection and probe collision detection. The robot uses its own controller with a built in VME-bus computer. The system is described in detail in.

Probe Measurement System

The SAR measurements were conducted with the dosimetric probe EX3DV4, designed in the classical triangular configuration (see Fig. 2.2) and optimized for dosimetric evaluation. The probe is constructed using the thick film technique; with printed resistive lines on ceramic substrates. The probe is equipped with an optical multi fiber line ending at the front of the probe tip. (see Fig. 2.3) It is connected to the EOC box on the robot arm and provides an automatic detection of the phantom surface. Half of the fibers are connected to a pulsed infrared transmitter, the other half to a synchronized receiver. As the probe approaches the surface, the reflection from the surface produces a coupling from the transmitting to the receiving fibers. This reflection increases first during the approach, reaches maximum and then decreases. If the probe is flatly touching the surface, the coupling is zero. The distance of the coupling maximum to the surface is independent of the surface reflectivity and largely independent of the surface to probe angle. The DASY52 software reads the reflection during a software approach and looks for the maximum using a 2nd order fitting. The approach is stopped at reaching the maximum.

DAE System

Probe Specifications

Calibration: In air from 10 MHz to 6.0 GHz
In brain and muscle simulating tissue at Frequencies of 450 MHz, 835 MHz, 1750 MHz, 1900 MHz, 2450 MHz, 2600 MHz, 3500 MHz, 5200 MHz, 5300 MHz, 5600 MHz, 5800 MHz

Frequency: 10 MHz to 6 GHz

Linearity: ±0.2dB (30 MHz to 6 GHz)

Dynamic: 10 mW/kg to 100 W/kg

Range: Linearity: ±0.2dB

Dimensions: Overall length: 330 mm

Tip length: 20 mm

Body diameter: 12 mm

Tip diameter: 2.5 mm

Distance from probe tip to sensor center: 1 mm

Application: SAR Dosimetry Testing
Compliance tests of wireless device

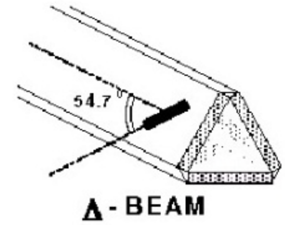


Figure 2.2 Triangular Probe Configurations

Figure 2.3 Probe Thick-Film Technique

Probe Calibration Process

Dosimetric Assessment Procedure

Each probe is calibrated according to a dosimetric assessment procedure described in with accuracy better than +/- 10%. The spherical isotropy was evaluated with the procedure described in and found to be better than +/-0.25dB. The sensitivity parameters (Norm X, Norm Y, Norm Z), the diode compression parameter (DCP) and the conversion factor (Conv F) of the probe is tested.

Free Space Assessment

The free space E-field from amplified probe outputs is determined in a test chamber. This is performed in a TEM cell for frequencies below 1 GHz, and in a waveguide above 1GHz for free space. For the free space calibration, the probe is placed in the volumetric center of the cavity at the proper orientation with the field. The probe is then rotated 360 degrees until the three channels show the maximum reading. The power density readings equates to 1 mW/cm^2.

Temperature Assessment *

E-field temperature correlation calibration is performed in a flat phantom filled with the appropriate simulated brain tissue. The measured free space E-field in the medium, correlates to temperature rise in a dielectric medium. For temperature correlation calibration a RF transparent thermistor based temperature probe is used in conjunction with the E-field probe

$$\text{SAR} = C\frac{\Delta T}{\Delta t}$$

where:

Δt = exposure time (30 seconds),

C = heat capacity of tissue (brain or muscle),

ΔT = temperature increase due to RF exposure.

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

where:

σ = simulated tissue conductivity,

ρ = Tissue density (1.25 g/cm^3 for brain tissue)

SAR is proportional to $\Delta T / \Delta t$, the initial rate of tissue heating, before thermal diffusion takes place.
Now it’s possible to quantify the electric field in the simulated tissue by equating the thermally derived SAR to the E- field;

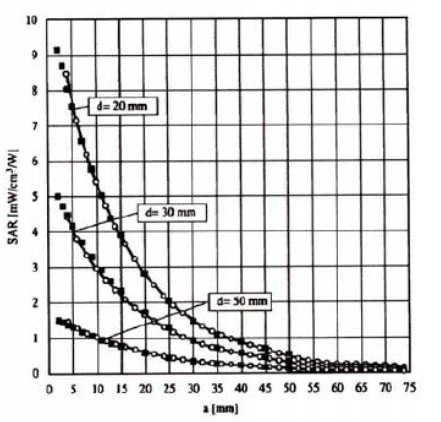


Figure 2.4 E-Field and Temperature Measurements at 900MHz

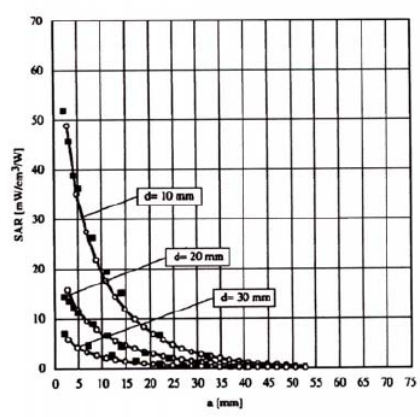


Figure 2.5 E-Field and Temperature Measurements at 1800MHz

Data Extrapolation

The DASY52 software automatically executes the following procedures to calculate the field units from the microvolt readings at the probe connector. 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 like below;

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

with V_i = compensated signal of channel i (i=x,y,z)
U_i = input signal of channel i (i=x,y,z)
cf = crest factor of exciting field (DASY 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:

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

with V_i = compensated signal of channel i (i = x,y,z)
$Norm_i$ = sensor sensitivity of channel i (i = x,y,z) $\mu V/(V/m)^2$ for E-field probes
ConvF = sensitivity of enhancement in solution
E_i = electric field strength of channel i in V/m

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

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

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

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

with SAR = local specific absorption rate in W/g
E_{tot} = total field strength in V/m
σ = conductivity in [mho/m] or [Siemens/m]
ρ = equivalent tissue density in g/cm^3

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

$$P_{pwe} = \frac{E_{tot}^2}{3770}$$

with P_{pwe} = equivalent power density of a plane wave in W/cm^2
E_{tot} = total electric field strength in V/m

Scanning procedure

- The DASY installation includes predefined files with recommended procedures for measurements and system check. They are read-only document files and destined as fully defined but unmeasured masks. All test positions (head or body-worn) are tested with the same configuration of test steps differing only in the grid definition for the different test positions.

- The „reference“ and „drift“ measurements are located at the beginning and end of the batch process. They measure the field drift at one single point in the liquid over the complete procedure. The indicated drift is mainly the variation of the DUT’s output power and should vary max. +/- 5 %.

- The highest integrated SAR value is the main concern in compliance test applications. These values can mostly be found at the inner surface of the phantom and cannot be measured directly due to the sensor offset in the probe. To extrapolate the surface values, the measurement distances to the surface must be known accurately. A distance error of 0.5mm could produce SAR errors of 6% at 1800 MHz. Using predefined locations for measurements is not accurate enough. Any shift of the phantom (e.g., slight deformations after filling it with liquid) would produce high uncertainties. For an automatic and accurate detection of the phantom surface, the DASY5 system uses the mechanical surface detection. The detection is always at touch, but the probe will move backward from the surface the indicated distance before starting the measurement.

- The „area scan“ measures the SAR above the DUT or verification dipole on a parallel plane to the surface. It is used to locate the approximate location of the peak SAR with 2D spline interpolation. The robot performs a stepped movement along one grid axis while the local electrical field strength is measured by the probe. The probe is touching the surface of the SAM during acquisition of measurement values. The scan uses different grid spacings for different frequency measurements. Standard grid spacing for head measurements in frequency ranges ≤ 2GHz is 15 mm in x - and y- dimension. For higher frequencies a finer resolution is needed, thus for the grid spacing is reduced according the following table:

Area scan grid spacing for different frequency ranges	
Frequency range	Grid spacing
≤ 2 GHz	≤ 15 mm
2 – 4 GHz	≤ 12 mm
4 – 6 GHz	≤ 10 mm

Grid spacing and orientation have no influence on the SAR result. For special applications where the standard scan method does not find the peak SAR within the grid, e.g. mobile phones with flip cover, the grid can be adapted in orientation. Results of this coarse scan are shown in annex B.

- A „zoom scan" measures the field in a volume around the 2D peak SAR value acquired in the previous „coarse" scan. It uses a fine meshed grid where the robot moves the probe in steps along all the 3 axis (x,y and z-axis) starting at the bottom of the Phantom. The grid spacing for the cube measurement is varied according to the measured frequency range, the dimensions are given in the following table:

Zoom scan grid spacing and volume for different frequency ranges			
Frequency range	Grid spacing for x, y axis	Grid spacing for z axis	Minimum zoom scan volume
≤ 2 GHz	≤ 8 mm	≤ 5 mm	≥ 30 mm
2 – 3 GHz	≤ 5 mm	≤ 5 mm	≥ 28 mm
3 – 4 GHz	≤ 5 mm	≤ 4 mm	≥ 28 mm
4 – 5 GHz	≤ 4 mm	≤ 3 mm	≥ 25 mm
5 – 6 GHz	≤ 4 mm	≤ 2 mm	≥ 22 mm

DASY is also able to perform repeated zoom scans if more than 1 peak is found during area scan. In this document, the evaluated peak 1g and 10g averaged SAR values are shown in the 2D-graphics in annex B. Test results relevant for the specified standard (see section 3) are shown in table form in section 7.

Spatial Peak SAR Evaluation

The spatial peak SAR - value for 1 and 10 g is evaluated after the Cube measurements have been done. The basis of the evaluation are the SAR values measured at the points of the fine cube grid consisting of all points in the three directions x, y and z. The algorithm that finds the maximal averaged volume is separated into three different stages.

- The data between the dipole center of the probe and the surface of the phantom are extrapolated. This data cannot be measured since the center of the dipole is 1 to 2.7 mm away from the tip of the probe and the distance between the surface and the lowest measuring point is about 1 mm (see probe calibration sheet). The extrapolated data from a cube measurement can be visualized by selecting 'Graph Evaluated'.

- The maximum interpolated value is searched with a straight-forward algorithm. Around this maximum the SAR - values averaged over the spatial volumes (1g or 10 g) are computed using the 3d-spline interpolation algorithm. If the volume cannot be evaluated (i.e., if a part of the grid was cut off by the boundary of the measurement area) the evaluation will be started on the corners of the bottom plane of the cube.

- All neighboring volumes are evaluated until no neighboring volume with a higher average value is found.

Extrapolation

The extrapolation is based on a least square algorithm [W. Gander, Computermathematik, p.168-180]. Through the points in the first 3 cm along the z-axis, polynomials of order four are calculated. These polynomials are then used to evaluate the points between the surface and the probe tip. The points, calculated from the surface, have a distance of 1 mm from each other.

Interpolation

The interpolation of the points is done with a 3d-Spline. The 3d-Spline is composed of three one-dimensional splines with the "Not a knot"-condition [W. Gander, Computermathematik, p.141-150] (x, y and z -direction) [Numerical Recipes in C, Second Edition, p.123ff].

Volume Averaging

At First the size of the cube is calculated. Then the volume is integrated with the trapezoidal algorithm. 8000 points (20x20x20) are interpolated to calculate the average.

Advanced Extrapolation

DASY uses the advanced extrapolation option which is able to compensate boundary effects on E-field probes.

SAM PHANTOM

The SAM Twin Phantom V4.0 is constructed of a fiberglass shell integrated in a wooden table. The shape of the shell is based on data from an anatomical study designed to determine the maximum exposure in at least 90% of all users. It enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region. A cover prevents 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. (see Fig. 2.6)

Phantom Specification

Phantom: SAM Twin Phantom (V4.0)
Shell Material: Vivac Composite
Thickness: 2.0 ± 0.2 mm

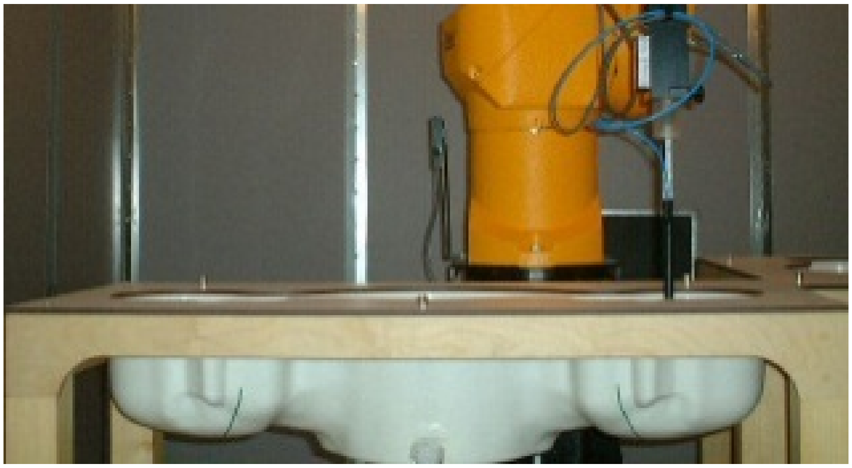


Figure 2.6 SAM Twin Phantom

Device Holder for Transmitters

In combination with the SAM Twin Phantom V4.0 the Mounting Device (see Fig. 2.7), enables the rotation of the mounted transmitter in spherical coordinates whereby the rotation point is the ear opening. The devices can be easily, accurately, and repeat ably be positioned according to the FCC, CENELEC, IEC and IEEE specifications. The device holder can be locked at different phantom locations (left head, right head, flat phantom).

Figure 2.7 Mounting Device

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. To produce the worst-case condition (the hand absorbs antenna output power), the hand is omitted during the tests.

3. Probe and Dipole Calibration

See Appendix D and E.

4. Phantom & Simulating Tissue Specifications

Head & Body Simulating Mixture Characterization

The head and body mixtures consist of the material based on the table listed below. The mixture is calibrated to obtain proper dielectric constant (permittivity) and conductivity of the desired tissue. Body tissue parameters that have not been specified in IEEE1528-2013 are derived from the issue dielectric parameters computed from the 4-Cole-Cole equations.

Table 4.1 Typical Composition of Ingredients for Tissue

Ingredients		Simulating Tissue			
		2450 MHz Body	5250 MHz Body	5600 MHz Body	5785 MHz Body
Mixing Percentage					
Water		73.20	Proprietary Mixture Procured from Speag		
Sugar		0.00			
Salt		0.04			
HEC		0.00			
Bactericide		0.00			
DGBE		26.70			
Dielectric Constant	Target	52.70	48.96	48.47	48.25
Conductivity (S/m)	Target	1.95	5.35	5.77	5.96

5. ANSI/IEEE C95.1 – 1992 RF Exposure Limits [2]

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.

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. This 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.

Table 5.1 Human Exposure Limits

	UNCONTROLLED ENVIRONMENT General Population (W/kg) or (mW/g)	CONTROLLED ENVIROMENT Professional Population (W/kg) or (mW/g)
SPATIAL PEAK SAR[1] Head	1.60	8.00
SPATIAL AVERAGE SAR[2] Whole Body	0.08	0.40
SPATIAL PEAK SAR[3] Hands, Feet, Ankles, Wrists	4.00	20.00

[1] The Spatial Peak value of the SAR averaged over any 1 gram of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.
[2] The Spatial Average value of the SAR averaged over the whole body.
[3] The Spatial Peak value of the SAR averaged over any 10 grams of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.

6. Measurement Uncertainty

Measurement uncertainty table is not required per KDB 865664 D01 v01r04 section 2.8.2 page 12. SAR measurement uncertainty analysis is required in the SAR report only when the highest measured SAR in a frequency band is ≥ 1.5 W/kg for 1-g SAR. The equivalent ratio (1.5/1.6) should be applied to extremity and occupational exposure conditions. The highest reported value is less than 1.5 W/kg. Therefore, the measurement uncertainty table is not required.

7. System Validation

Tissue Verification

Table 7.1 Measured Tissue Parameters

		2450 MHz Body		5250 MHz Body	
Date(s)		Dec. 10, 2018		Dec. 6, 2018	
Liquid Temperature (˚C)	20.0	Target	Measured	Target	Measured
Dielectric Constant: ε		52.70	52.64	48.95	48.96
Conductivity: σ		1.95	1.96	5.36	5.35
		5600 MHz Body		5750 MHz Body	
Date(s)		Dec. 6, 2018		Dec. 6, 2018	
Liquid Temperature (˚C)	20.0	Target	Measured	Target	Measured
Dielectric Constant: ε		48.47	48.43	48.27	48.21
Conductivity: σ		5.77	5.74	5.94	5.91

See Appendix A for data printout.

Test System Verification

Prior to assessment, the system is verified to the ±10% of the specifications at the test frequency by using the system kit. Power is normalized to 1 watt. (Graphic Plots Attached)

Table 7.2 System Dipole Validation Target & Measured

	Test Frequency	Targeted SAR_{1g} (W/kg)	Measure SAR_{1g} (W/kg)	Tissue Used for Verification	Deviation Target and Fast SAR to SAR (%)	Plot Number
10-Dec-2018	2450 MHz	51.00	52.00	Body	+ 1.96	1
06-Dec-2018	5250 MHz	76.80	77.60	Body	+ 1.04	2
06-Dec-2018	5600 MHz	79.50	79.10	Body	- 0.50	3
06-Dec-2018	5750 MHz	76.20	76.60	Body	+ 0.52	4

See Appendix A for data plots.

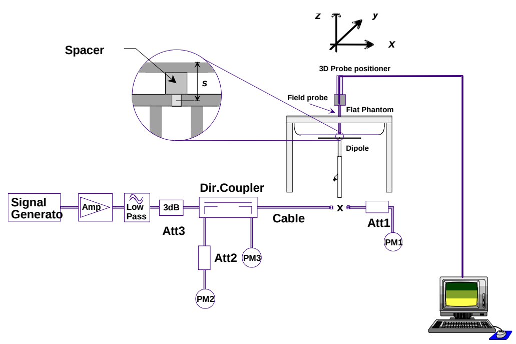


Figure 7.1 Dipole Validation Test Setup

8. SAR Test Data Summary

See Measurement Result Data Pages

See Appendix B for SAR Test Data Plots.
See Appendix C for SAR Test Setup Photos.

Procedures Used To Establish Test Signal

The device was either placed into simulated transmit mode using the manufacturer's test codes or the actual transmission is activated through a base station simulator or similar equipment. See data pages for actual procedure used in measurement.

Device Test Condition

In order to verify that the device was tested at full power, conducted output power measurements were performed before and after each SAR measurement to confirm the output power unless otherwise noted. If a conducted power deviation of more than 5% occurred, the test was repeated. The power drift of each test is measured at the start of the test and again at the end of the test. The drift percentage is calculated by the formula ((end/start)-1)*100 and rounded to three decimal places. The drift percentage is calculated into the resultant SAR value on the data sheet for each test.

The EUT was tested on the bottom of the laptop with the LCD screen at a 90° angle from the phantom. All measurements were conducted with the side of the device in direct contact with the phantom. For sides of the antenna which were not measured in this report, the SAR was conduct on the module in the modular approval with the maximum distance of 8 mm on all six sides of the antenna. Therefore, the requirements mentioned in RSS-102 Supplementary Procedures (SPR)-001 – SAR Testing Requirements with Regards to Bystanders for Laptop Type Computers with Antennas Built-In on Display Screen (Laptop Mode) are covered.

The Bluetooth transmitter does simultaneously transmit with the WiFi transmitter. When the BT is turned on, it transmits on Aux and the WiFi transmits on Main. Simultaneous transmission is evaluated on page 35.

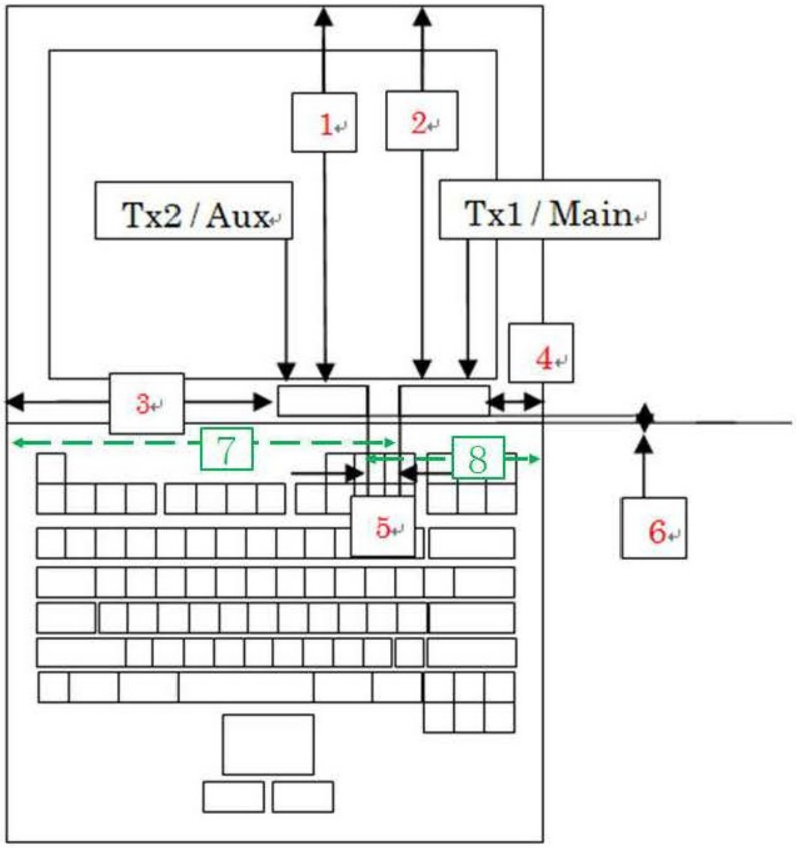
The main antenna was evaluated for stand-alone SAR per RSS-102 Issue 5 for BT. Please see data sheet summary on page 31.

The data rates used when evaluating the WiFi transmitter were the lowest data rates for each mode. The device was operating at its maximum output power at the lowest data rate for all measurements.

The Laptop was using the Intel test utility DRTU Version 11.1832.0-08048 and the device driver was version 20.90.0.7.

The antenna was on a minimum of 10 cm of Styrofoam during each test. The following is a pictorial drawing of the locations and separation distances.

Location and Separation Distances Diagrams



Dimension:	1	2	3	4	5	6	7	8
mm	198.35	197.65	145.32	59.82	6.5	3.9	199.82	113.32

Main to Left side: (3)+Aux width+(5) = (7)=199.82 mm
Aux to Right side : (5)+ Main width+(4)=(8)=113.32 mm

Band	Mode	Bandwidth (MHz)	Channel	Frequency (MHz)	Data Rate	Antenna	Avg Power (dBm)	Tune-up Pwr (dBm)
2450 MHz	802.11b	20	2	2417	1 Mbps	Chain A	20.45	20.50
			6	2437			20.50	20.50
			10	2457			20.50	20.50
			2	2417		Chain B	20.44	20.50
			6	2437			20.50	20.50
			10	2457			20.50	20.50
	802.11g	20	3	2422	6 Mbps	Chain A	20.47	20.50
			6	2437			20.44	20.50
			9	2452			20.44	20.50
			3	2422		Chain B	20.39	20.50
			6	2437			20.36	20.50
			9	2452			20.42	20.50
	802.11n	20	3	2422	HT0	Chain A	20.45	20.50
			6	2437			20.37	20.50
			9	2452			20.40	20.50
			3	2422		Chain B	20.41	20.50
			6	2437			20.38	20.50
			9	2452			20.39	20.50
	802.11n	40	4	2427	HT0	Chain A	15.95	16.00
			6	2437			15.87	16.00
			8	2447			15.90	16.00
			4	2427		Chain B	15.91	16.00
			6	2437			15.88	16.00
			8	2447			15.89	16.00
5.15-5.25 GHz	802.11a	20	36	5180	6 Mbps	Chain A	18.42	18.50
			40	5200			20.00	20.00
			44	5220			20.00	20.50
			48	5240			20.47	20.50
			36	5180		Chain B	18.98	19.00
			40	5200			20.50	20.50
			44	5220			20.50	20.50
			48	5240			20.44	20.50
	802.11n	20	36	5180	HT0	Chain A	18.41	18.50
			40	5200			19.88	20.00
			44	5220			20.39	20.50
			46	5230			20.35	20.50
			36	5180		Chain B	18.84	19.00
			40	5200			20.38	20.50
			44	5220			20.39	20.50
			46	5230			20.33	20.50
	802.11n	40	38	5190	HT0	Chain A	17.92	18.00
			46	5230			19.44	19.50
			38	5190	HT0	Chain B	17.98	18.00
			46	5230			18.95	19.00
	802.11ac	80	42	5210	VHT0	Chain A	17.92	18.00
						Chain B	17.44	17.50
		160	50	5250		Chain A	13.36	13.50
			50	5250		Chain B	13.39	13.50
5.25-5.35 GHz	802.11a	20	52	5260	6 Mbps	Chain A	19.95	20.00
			56	5280			20.00	20.00
			60	5300			20.00	20.00
			64	5320			15.97	16.00
			52	5260		Chain B	19.94	20.00
			56	5280			20.00	20.00
			60	5300			20.00	20.00
			64	5320			16.48	16.50
	802.11n	20	52	5260	HT0	Chain A	19.92	20.00
			56	5280			19.89	20.00
			60	5300			19.88	20.00
			64	5320			15.90	16.00
			52	5260		Chain B	19.91	20.00
			56	5280			19.83	20.00
			60	5300			19.86	20.00
			64	5320			16.39	16.50
	802.11n	40	54	5270	HT0	Chain A	18.32	18.50
			62	5310			14.34	14.50
			54	5270	HT0	Chain B	18.39	18.50
			60	5300			14.40	14.50
	802.11ac	80	58	5290	VHT0	Chain A	15.35	15.50
						Chain B	15.41	15.50

Band	Mode	Bandwidth (MHz)	Channel	Frequency (MHz)	Data Rate	Antenna	Avg Power (dBm)	Tune-up Pwr (dBm)
5600 MHz	802.11a	20	100	5500	6 Mbps	Chain A	18.92	19.00
			104	5520			19.00	19.00
			108	5540			18.95	19.00
			112	5560			18.97	19.00
			116	5580			19.00	19.00
			120	5600			18.91	19.00
			124	5620			19.00	19.00
			128	5640			18.98	19.00
			132	5660			18.94	19.00
			136	5680			19.00	19.00
			140	5700			18.40	18.50
			100	5500		Chain B	18.89	19.00
			104	5520			19.00	19.00
			108	5540			18.92	19.00
			112	5560			18.97	19.00
			116	5580			19.00	19.00
			120	5600			18.93	19.00
			124	5620			19.00	19.00
			128	5640			18.91	19.00
			132	5660			18.88	19.00
			136	5680			19.00	19.00
			138	5690			18.44	18.50
	802.11n	20	102	5510	HT0	Chain A	18.88	19.00
			104	5520			18.83	19.00
			108	5540			18.85	19.00
			112	5560			18.86	19.00
			116	5580			18.84	19.00
			120	5600			18.90	19.00
			124	5620			18.91	19.00
			128	5640			18.84	19.00
			132	5660			18.81	19.00
			136	5680			18.89	19.00
			138	5690			18.38	18.50
			100	5500		Chain B	18.92	19.00
			104	5520			18.90	19.00
			108	5540			18.87	19.00
			112	5560			18.89	19.00
			116	5580			18.83	19.00
			120	5600			18.86	19.00
			124	5620			18.90	19.00
			128	5640			18.94	19.00
			132	5660			18.91	19.00
			136	5680			18.86	19.00
			138	5690			18.39	18.50
	802.11n	40	102	5510	HT0	Chain A	16.95	17.00
			110	5550			18.90	19.00
			118	5580			18.92	19.00
			126	5610			18.87	19.00
			134	5670			18.38	18.50
			102	5510		Chain B	19.34	16.50
			110	5550			18.90	19.00
			118	5580			18.83	19.00
			126	5610			18.88	19.00
			134	5670			18.85	19.00
	802.11ac	80	106	5530	VHT0	Chain A	17.38	17.50
			122	5610			18.92	19.00
			138	5690			18.86	19.00
			106	5530		Chain B	16.88	17.00
			122	5610			18.91	19.00
			138	5690			18.88	19.00
		160	114	5570		Chain A	14.89	15.00
			114	5570		Chain B	14.91	15.00

Band	Mode	Bandwidth (MHz)	Channel	Frequency (MHz)	Data Rate	Antenna	Avg Power (dBm)	Tune-up Pwr (dBm)
5800 MHz	802.11a	20	149	5745	6 Mbps	Chain A	18.50	18.50
			153	5765			18.42	18.50
			157	5785			18.50	18.50
			161	5805			18.44	18.50
			165	5825			18.50	18.50
			150	5750		Chain B	18.50	18.50
			153	5765			18.43	18.50
			157	5785			18.50	18.50
			161	5805			18.44	18.50
			165	5825			18.50	18.50
	802.11n	20	150	5750	HT0	Chain A	18.38	18.50
			153	5765			18.37	18.50
			157	5785			18.40	18.50
			161	5805			18.42	18.50
			164	5820			18.44	18.50
			150	5750		Chain B	18.45	18.50
			153	5765			18.40	18.50
			157	5785			18.39	18.50
			161	5805			18.35	18.50
			164	5820			18.37	18.50
	802.11n	40	152	5760	HT0	Chain A	18.42	18.50
			159	5795			18.45	18.50
			152	5760		Chain B	18.43	18.50
			159	5795			18.40	18.50
	802.11ac	80	155	5775	VHT0	Chain A	18.42	18.50
						Chain B	18.44	18.50

Band	Mode	Channel	Frequency (MHz)	Data Rate	Antenna	Avg Power (dBm)	Tune-up Pwr (dBm)
2450 MHz	Bluetooth v4.0	0	2402	Basic Rate GFSK	Chain B	11.40	12.00
		39	2441			11.47	12.00
		78	2480			11.42	12.00
		0	2402	EDR π/4 DQPSK		11.42	8.00
		39	2441			11.43	8.00
		78	2480			11.38	8.00
		0	2402	EDR 8-DPSK		11.44	8.00
		39	2441			11.41	8.00
		78	2480			11.43	8.00
		0	2402	Low Energy GFSK		8.99	12.00
		39	2441			8.88	12.00
		78	2480			8.93	12.00

Figure 8.1 Test Reduction Table – 2.4 GHz Main WNC

Mode	Side	Required Channel	Tested/Reduced
802.11b	Laptop Mode	1 – 2412 MHz	Reduced[1]
		6 – 2437 MHz	Tested
		11 – 2462 MHz	Reduced[1]
802.11g	Laptop Mode	1 – 2412 MHz	Reduced[3]
		6 – 2437 MHz	Reduced[3]
		11 – 2462 MHz	Reduced[3]
802.11n	Laptop Mode	1 – 2412 MHz	Reduced[3]
		6 – 2437 MHz	Reduced[3]
		11 – 2462 MHz	Reduced[3]

Reduced[1] – When the reported SAR is ≤ 0.4 W/kg, SAR is not required for the remaining test configuration per KDB 248227 D01 v02r02 section 5.1.1 1) page 9.

Reduced[2] – When the reported SAR is >0.8 W/kg, test the next highest configuration until the SAR value is ≤ 1.2 W/kg per KDB 248227 D01 v02r02 section 5.1.1 3) page 9.

Reduced[3] – 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, SAR is not required per KDB 248227 D01 v02r02 section 5.2.2 2) page 10.

Figure 8.2 Test Reduction Table – 2.4 GHz Aux WNC

Mode	Side	Required Channel	Tested/Reduced
802.11b	Laptop Mode	1 – 2412 MHz	Reduced[2]
		6 – 2437 MHz	Tested
		11 – 2462 MHz	Tested
802.11g	Laptop Mode	1 – 2412 MHz	Reduced[3]
		6 – 2437 MHz	Reduced[3]
		11 – 2462 MHz	Reduced[3]
802.11n	Laptop Mode	1 – 2412 MHz	Reduced[3]
		6 – 2437 MHz	Reduced[3]
		11 – 2462 MHz	Reduced[3]

Reduced[1] – When the reported SAR is ≤ 0.4 W/kg, SAR is not required for the remaining test configuration per KDB 248227 D01 v02r02 section 5.1.1 1) page 9.

Reduced[2] – When the reported SAR is >0.4 W/kg, test the next highest configuration until the SAR value is ≤ 0.8 W/kg per KDB 248227 D01 v02r02 section 5.1.1 2) page 9.

Reduced[3] – 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, SAR is not required per KDB 248227 D01 v02r02 section 5.2.2 2) page 10.

Figure 8.3 Test Reduction Table – 5.1 GHz Main WNC

Mode	Side	Required Channel	Tested/Reduced
802.11a 5150 MHz	Laptop Mode	36 – 5180 MHz	Reduced[1]
		40 – 5200 MHz	Reduced[1]
		44 – 5220 MHz	Reduced[1]
		48 – 5240 MHz	Reduced[1]
802.11n 5150 MHz	Laptop Mode	36 – 5180 MHz	Reduced[1]
		40 – 5200 MHz	Reduced[1]
		44 – 5220 MHz	Reduced[1]
		48 – 5240 MHz	Reduced[1]
802.11ac 5210 MHz	Laptop Mode	42 – 5210 MHz	Reduced[1]

Reduced[1] – When the adjusted SAR is ≤ 1.2 W/kg for UNII-2A, SAR is not required for the UNII-1 band with lower or equal maximum output power in that test configuration per KDB 248227 D01 v02 section 5.3.1 2) page 11.

Figure 8.4 Test Reduction Table – 5.1 GHz Aux WNC

Mode	Side	Required Channel	Tested/Reduced
802.11a 5150 MHz	Laptop Mode	36 – 5180 MHz	Reduced[1]
		40 – 5200 MHz	Reduced[1]
		44 – 5220 MHz	Reduced[1]
		48 – 5240 MHz	Reduced[1]
802.11n 5150 MHz	Laptop Mode	36 – 5180 MHz	Reduced[1]
		40 – 5200 MHz	Reduced[1]
		44 – 5220 MHz	Reduced[1]
		48 – 5240 MHz	Reduced[1]
802.11ac 5210 MHz	Laptop Mode	42 – 5210 MHz	Reduced[1]

Reduced[1] – When the adjusted SAR is ≤ 1.2 W/kg for UNII-2A, SAR is not required for the UNII-1 band with lower or equal maximum output power in that test configuration per KDB 248227 D01 v02 section 5.3.1 2) page 11.

Figure 8.5 Test Reduction Table – 5.2 GHz Main WNC

Mode	Side	Required Channel	Tested/Reduced
802.11a 5250 MHz	Laptop Mode	52 – 5260 MHz	Reduced[2]
		56 – 5280 MHz	Tested
		60 – 5300 MHz	Tested
		64 – 5320 MHz	Reduced[2]
802.11n 5250 MHz	Laptop Mode	52 – 5260 MHz	Reduced[2]
		56 – 5280 MHz	Reduced[2]
		60 – 5300 MHz	Reduced[2]
		64 – 5320 MHz	Reduced[2]
802.11ac 5210 MHz	Laptop Mode	58 – 5290 MHz	Reduced[2]

Reduced[1] – When the reported SAR is ≤ 0.4 W/kg, SAR is not required for the remaining test configuration per KDB 248227 D01 v02r02 section 5.1.1 1) page 9.
Reduced[2] – When the reported SAR is >0.8 W/kg, test the next highest configuration until the SAR value is ≤ 1.2 W/kg per KDB 248227 D01 v02r02 section 5.1.1 3) page 9.

Figure 8.6 Test Reduction Table – 5.2 GHz Aux WNC

Mode	Side	Required Channel	Tested/Reduced
802.11a 5250 MHz	Laptop Mode	52 – 5260 MHz	Reduced[2]
		56 – 5280 MHz	Tested
		60 – 5300 MHz	Tested
		64 – 5320 MHz	Reduced[2]
802.11n 5250 MHz	Laptop Mode	52 – 5260 MHz	Reduced[2]
		56 – 5280 MHz	Reduced[2]
		60 – 5300 MHz	Reduced[2]
		64 – 5320 MHz	Reduced[2]
802.11ac 5210 MHz	Laptop Mode	58 – 5290 MHz	Reduced[2]

Reduced[1] – When the reported SAR is ≤ 0.4 W/kg, SAR is not required for the remaining test configuration per KDB 248227 D01 v02r02 section 5.1.1 1) page 9.
Reduced[2] – When the reported SAR is >0.8 W/kg, test the next highest configuration until the SAR value is ≤ 1.2 W/kg per KDB 248227 D01 v02r02 section 5.1.1 3) page 9.

Figure 8.7 Test Reduction Table – 5.6 GHz Main WNC

Mode	Side	Required Channel	Tested/Reduced
802.11a 5600 MHz	Laptop Back	100 – 5500 MHz	Reduced[2]
		104 – 5520 MHz	Reduced[2]
		108 – 5540 MHz	Reduced[2]
		112 – 5560 MHz	Reduced[2]
		116 – 5580 MHz	Tested
		120 – 5600 MHz	Reduced[2]
		124 – 5620 MHz	Tested
		128 – 5640 MHz	Reduced[2]
		132 – 5660 MHz	Reduced[2]
		136 – 5680 MHz	Reduced[2]
		140 – 5700 MHz	Reduced[2]

Reduced[1] – When the reported SAR is ≤ 0.4 W/kg, SAR is not required for the remaining test configuration per KDB 248227 D01 v02r02 section 5.1.1 1) page 9.
Reduced[2] – When the reported SAR is >0.8 W/kg, test the next highest configuration until the SAR value is ≤ 1.2 W/kg per KDB 248227 D01 v02r02 section 5.1.1 3) page 9.

Figure 8.8 Test Reduction Table – 5.6 GHz Aux WNC

Mode	Side	Required Channel	Tested/Reduced
802.11a 5600 MHz	Laptop Back	100 – 5500 MHz	Reduced[2]
		104 – 5520 MHz	Reduced[2]
		108 – 5540 MHz	Reduced[2]
		112 – 5560 MHz	Reduced[2]
		116 – 5580 MHz	Tested
		120 – 5600 MHz	Reduced[2]
		124 – 5620 MHz	Tested
		128 – 5640 MHz	Reduced[2]
		132 – 5660 MHz	Reduced[2]
		136 – 5680 MHz	Reduced[2]
		140 – 5700 MHz	Reduced[2]

Reduced[1] – When the reported SAR is ≤ 0.4 W/kg, SAR is not required for the remaining test configuration per KDB 248227 D01 v02r02 section 5.1.1 1) page 9.
Reduced[2] – When the reported SAR is >0.8 W/kg, test the next highest configuration until the SAR value is ≤ 1.2 W/kg per KDB 248227 D01 v02r02 section 5.1.1 3) page 9.

Figure 8.9 Test Reduction Table – 5.6 GHz Main WNC

Mode	Side	Required Channel	Tested/Reduced
802.11n 5600 MHz	Laptop Mode	100 – 5500 MHz	Reduced[2]
		104 – 5520 MHz	Reduced[2]
		108 – 5540 MHz	Reduced[2]
		112 – 5560 MHz	Reduced[2]
		116 – 5580 MHz	Reduced[2]
		120 – 5600 MHz	Reduced[2]
		124 – 5620 MHz	Reduced[2]
		128 – 5640 MHz	Reduced[2]
		132 – 5660 MHz	Reduced[2]
		136 – 5680 MHz	Reduced[2]
		140 – 5700 MHz	Reduced[2]

Reduced[1] – When the reported SAR is ≤ 0.4 W/kg, SAR is not required for the remaining test configuration per KDB 248227 D01 v02r02 section 5.1.1 1) page 9.
Reduced[2] – When the reported SAR is >0.8 W/kg, test the next highest configuration until the SAR value is ≤ 1.2 W/kg per KDB 248227 D01 v02r02 section 5.1.1 3) page 9.

Figure 8.10 Test Reduction Table – 5.6 GHz Aux WNC

Mode	Side	Required Channel	Tested/Reduced
802.11n 5600 MHz	Laptop Mode	100 – 5500 MHz	Reduced[2]
		104 – 5520 MHz	Reduced[2]
		108 – 5540 MHz	Reduced[2]
		112 – 5560 MHz	Reduced[2]
		116 – 5580 MHz	Reduced[2]
		120 – 5600 MHz	Reduced[2]
		124 – 5620 MHz	Reduced[2]
		128 – 5640 MHz	Reduced[2]
		132 – 5660 MHz	Reduced[2]
		136 – 5680 MHz	Reduced[2]
		140 – 5700 MHz	Reduced[2]

Reduced[1] – When the reported SAR is ≤ 0.4 W/kg, SAR is not required for the remaining test configuration per KDB 248227 D01 v02r02 section 5.1.1 1) page 9.
Reduced[2] – When the reported SAR is >0.8 W/kg, test the next highest configuration until the SAR value is ≤ 1.2 W/kg per KDB 248227 D01 v02r02 section 5.1.1 3) page 9.

Figure 8.11 Test Reduction Table – 5.6 GHz Main WNC

Mode	Side	Required Channel	Tested/Reduced
802.11ac 5600 MHz	Laptop Mode	106 – 5530 MHz	Reduced[2]
		122 – 5610 MHz	Reduced[2]
		138 – 5690 MHz	Reduced[2]

Reduced[1] – When the reported SAR is ≤ 0.4 W/kg, SAR is not required for the remaining test configuration per KDB 248227 D01 v02r02 section 5.1.1 1) page 9.
Reduced[2] – When the reported SAR is >0.8 W/kg, test the next highest configuration until the SAR value is ≤ 1.2 W/kg per KDB 248227 D01 v02r02 section 5.1.1 3) page 9.

Figure 8.12 Test Reduction Table – 5.6 GHz Aux WNC

Mode	Side	Required Channel	Tested/Reduced
802.11ac 5600 MHz	Laptop Mode	106 – 5530 MHz	Reduced[2]
		122 – 5610 MHz	Reduced[2]
		138 – 5690 MHz	Reduced[2]

Reduced[1] – When the reported SAR is ≤ 0.4 W/kg, SAR is not required for the remaining test configuration per KDB 248227 D01 v02r02 section 5.1.1 1) page 9.
Reduced[2] – When the reported SAR is >0.8 W/kg, test the next highest configuration until the SAR value is ≤ 1.2 W/kg per KDB 248227 D01 v02r02 section 5.1.1 3) page 9.

Figure 8.13 Test Reduction Table – 5.8 GHz Main WNC

Mode	Side	Required Channel	Tested/Reduced
802.11a 5800 MHz	Laptop Mode	149 – 5745 MHz	Reduced[2]
		153 – 5765 MHz	Reduced[2]
		157 – 5785 MHz	Tested
		161 – 5805 MHz	Reduced[2]
		165 – 5825 MHz	Tested
802.11n 5800 MHz	Laptop Mode	149 – 5745 MHz	Reduced[2]
		153 – 5765 MHz	Reduced[2]
		157 – 5785 MHz	Reduced[2]
		161 – 5805 MHz	Reduced[2]
		165 – 5825 MHz	Reduced[2]
802.11ac 5775 MHz	Laptop Mode	155 – 5775 MHz	Reduced[2]

Reduced[1] – When the reported SAR is ≤ 0.4 W/kg, SAR is not required for the remaining test configuration per KDB 248227 D01 v02r02 section 5.1.1 1) page 9.
Reduced[2] – When the reported SAR is >0.4 W/kg, test the next highest configuration until the SAR value is ≤ 0.8 W/kg per KDB 248227 D01 v02r02 section 5.1.1 2) page 9.

Figure 8.14 Test Reduction Table – 5.8 GHz Aux WNC

Mode	Side	Required Channel	Tested/Reduced
802.11a 5800 MHz	Laptop Mode	149 – 5745 MHz	Reduced[2]
		153 – 5765 MHz	Reduced[2]
		157 – 5785 MHz	Tested
		161 – 5805 MHz	Reduced[2]
		165 – 5825 MHz	Tested
802.11n 5800 MHz	Laptop Mode	149 – 5745 MHz	Reduced[2]
		153 – 5765 MHz	Reduced[2]
		157 – 5785 MHz	Reduced[2]
		161 – 5805 MHz	Reduced[2]
		165 – 5825 MHz	Reduced[2]
802.11ac 5775 MHz	Laptop Mode	155 – 5775 MHz	Reduced[2]

Reduced[1] – When the reported SAR is ≤ 0.4 W/kg, SAR is not required for the remaining test configuration per KDB 248227 D01 v02r02 section 5.1.1 1) page 9.
Reduced[2] – When the reported SAR is >0.8 W/kg, test the next highest configuration until the SAR value is ≤ 1.2 W/kg per KDB 248227 D01 v02r02 section 5.1.1 3) page 9.

SAR Data Summary – 2450 MHz Body 802.11b & BT

MEASUREMENT RESULTS

Plot	Gap	Antenna	Position	Frequency		Modulation	Antenna	End Power	Measured SAR (W/kg)	Reported SAR (W/kg)
				MHz	Ch.			(dBm)		
-----	0 mm	WNC	Laptop	2437	6	DSSS	Main	20.50	0.141	0.14
-----				2437	6	DSSS	Aux	20.50	0.550	0.55
1				2457	10	DSSS		20.50	0.565	0.57
-----				2440	39	GFSK	Aux	11.47	0.0706	0.07

Body
1.6 W/kg (mW/g)
averaged over 1 gram

1. Battery is fully charged for all tests.
   Power Measured ☒Conducted ☐ERP ☐EIRP
2. SAR Measurement
   Phantom Configuration ☐Left Head ☒Eli4 ☐Right Head
   SAR Configuration ☐Head ☒Body
3. Test Signal Call Mode ☒Test Code ☐Base Station Simulator
4. Test Configuration ☐With Belt Clip ☐Without Belt Clip ☒N/A
5. Tissue Depth is at least 15.0 cm

Jay M. Moulton
Vice President

SAR Data Summary – 5250 MHz Body 802.11a

MEASUREMENT RESULTS										
Plot	**Gap**	**Antenna**	**Position**	**Frequency**		**Modulation**	**Antenna**	**End Power**	**Measured SAR (W/kg)**	**Reported SAR (W/kg)**
				MHz	**Ch.**			**(dBm)**		
-----	0 mm	WNC	Laptop	5280	56	OFDM	Main	20.00	1.18	1.18
2				5300	60	OFDM		20.00	1.20	1.20
-----				5280	56	OFDM	Aux	20.00	0.910	0.91
-----				5300	60	OFDM		20.00	0.961	0.96
-----			Repeated	5300	60	OFDM	Main	20.00	1.18	1.18

Body
1.6 W/kg (mW/g)
averaged over 1 gram

1. Battery is fully charged for all tests.
   Power Measured ☒Conducted ☐ERP ☐EIRP
2. SAR Measurement
   Phantom Configuration ☐Left Head ☒Eli4 ☐Right Head
   SAR Configuration ☐Head ☒Body
3. Test Signal Call Mode ☒Test Code ☐Base Station Simulator
4. Test Configuration ☐With Belt Clip ☐Without Belt Clip ☒N/A
5. Tissue Depth is at least 15.0 cm

Jay M. Moulton
Vice President

SAR Data Summary – 5600 MHz Body 802.11a

MEASUREMENT RESULTS										
Plot	Gap	Antenna	Position	Frequency		Modulation	Antenna	End Power	Measured SAR	Reported SAR
				MHz	Ch.			(dBm)	(W/kg)	(W/kg)
-----	0 mm	WNC	Laptop	5580	116	OFDM	Main	19.00	0.999	1.00
-----				5620	124	OFDM		19.00	0.632	0.63
-----				5580	116	OFDM	Aux	19.00	1.12	1.12
3				5620	124	OFDM		19.00	1.18	1.18
-----			Repeated	5620	124	OFDM	Aux	19.00	1.17	1.17

Body
1.6 W/kg (mW/g)
averaged over 1 gram

1. Battery is fully charged for all tests.
   Power Measured ☒Conducted ☐ERP ☐EIRP
2. SAR Measurement
   Phantom Configuration ☐Left Head ☒Eli4 ☐Right Head
   SAR Configuration ☐Head ☒Body
3. Test Signal Call Mode ☒Test Code ☐Base Station Simulator
4. Test Configuration ☐With Belt Clip ☐Without Belt Clip ☒N/A
5. Tissue Depth is at least 15.0 cm

Jay M. Moulton
Vice President

SAR Data Summary – 5800 MHz Body 802.11a

MEASUREMENT RESULTS										
Plot	**Gap**	**Antenna**	**Position**	**Frequency**		**Modulation**	**Antenna**	**End Power**	**Measured SAR (W/kg)**	**Reported SAR (W/kg)**
				MHz	**Ch.**			**(dBm)**		
-----	0 mm	WNC	Laptop	5785	157	OFDM	Main	18.50	0.736	0.74
-----				5825	165	OFDM		18.50	0.654	0.65
-----				5785	157	OFDM	Aux	18.50	0.835	0.84
4				5825	165	OFDM		18.50	0.889	0.89
-----			Repeated	5825	165	OFDM	Aux	18.50	0.864	0.86

Body
1.6 W/kg (mW/g)
averaged over 1 gram

1. Battery is fully charged for all tests.
   Power Measured ☒Conducted ☐ERP ☐EIRP
2. SAR Measurement
   Phantom Configuration ☐Left Head ☒Eli4 ☐Right Head
   SAR Configuration ☐Head ☒Body
3. Test Signal Call Mode ☒Test Code ☐Base Station Simulator
4. Test Configuration ☐With Belt Clip ☐Without Belt Clip ☒N/A
5. Tissue Depth is at least 15.0 cm

Jay M. Moulton
Vice President

SAR Data Summary – Simultaneous Evaluation

MEASUREMENT RESULTS – BT

Frequency		Modulation	Frequency		Modulation	SAR_1	SAR_2	SAR Total
MHz	Ch.		MHz	Ch.				
2437	6	DSSS	2440	39	GFSK	0.14	0.07	0.21
5300	60	OFDM	2440	39	GFSK	1.20	0.07	1.27
5580	116	OFDM	2440	39	GFSK	1.00	0.07	1.07
5785	157	OFDM	2440	39	GFSK	0.74	0.07	0.81

Body
1.6 W/kg (mW/g)
averaged over 1 gram

The sum of the two transmitters is less than the limit; therefore, the simultaneous transmission meets the requirements of KDB447498 D01 v06 section 4.3.2 page 11.

MEASUREMENT RESULTS – MIMO (No BT)

Frequency		Modulation	Frequency		Modulation	SAR_1	SAR_2	SAR Total
MHz	Ch.		MHz	Ch.				
2437	6	DSSS	2457	10	DSSS	0.14	0.57	0.71
5300	60	OFDM	5300	60	OFDM	1.20	0.96	2.16
5580	116	OFDM	5620	124	OFDM	1.00	1.18	2.18
5785	157	OFDM	5825	165	OFDM	0.74	0.89	1.63

Body
1.6 W/kg (mW/g)
averaged over 1 gram

MEASUREMENT RESULTS – MIMO (With BT)

Frequency		Modulation	Frequency		Modulation	SAR_1	SAR_2 + BT	SAR Total
MHz	Ch.		MHz	Ch.				
5300	60	OFDM	5300	60	OFDM	1.20	1.03	2.23
5580	116	OFDM	5620	124	OFDM	1.00	1.25	2.25
5785	157	OFDM	5825	165	OFDM	0.74	0.96	1.70

Body
1.6 W/kg (mW/g)
averaged over 1 gram

In MIMO mode, the worst case condition is in the 5.6 GHz band. The main and aux antennas are a minimum of 5 mm apart. Using the highest reported SAR to calculate the simultaneous Tx using peak separation ratio, the highest ratio would be 0.68 which does not meet meets the requirements of KDB 447498 section 4.3.2 3) on page 13. The calculation is shown below.

Simultaneous Separation Ratio Calculation

$(SAR_1 + SAR_2)^{1.5}/R_i \leq 0.04$ rounded to two digits

$(1.00 + 1.25)^{1.5}/5 = 0.68$

A volume scan was conducted for the two highest configurations. The volume scan SAR value is 1.19 W/kg which meets the limit of 1.6 W/kg. The plot is shown in appendix B as plot 5.

9. Test Equipment List

Table 9.1 Equipment Specifications

Type	Calibration Due Date	Calibration Done Date	Serial Number
Staubli Robot TX60L	N/A	N/A	F07/55M6A1/A/01
Measurement Controller CS8c	N/A	N/A	1012
ELI5 Flat Phantom	N/A	N/A	2037
Device Holder	N/A	N/A	N/A
Data Acquisition Electronics 4	01/10/2019	01/10/2018	1321
SPEAG E-Field Probe EX3DV4	01/16/2019	01/16/2018	3833
Speag Validation Dipole D2450V2	07/12/2019	07/12/2018	829
Speag Validation Dipole D5GHzV2	07/19/2019	07/19/2018	1085
Agilent N1911A Power Meter	05/20/2019	03/20/2017	GB45100254
Agilent N1922A Power Sensor	06/21/2019	06/21/2017	MY45240464
Advantest R3261A Spectrum Analyzer	03/26/2019	03/20/2017	31720068
Agilent (HP) 8350B Signal Generator	03/26/2019	03/20/2017	2749A10226
Agilent (HP) 83525A RF Plug-In	03/26/2019	03/20/2017	2647A01172
Agilent (HP) 8753C Vector Network Analyzer	03/26/2019	03/20/2017	3135A01724
Agilent (HP) 85047A S-Parameter Test Set	03/26/2019	03/20/2017	2904A00595
Agilent (HP) 8960 Base Station Sim.	03/30/2019	03/30/2017	MY48360364
Anritsu MT8820C	07/27/2019	07/27/2017	6201176199
Agilent 778D Dual Directional Coupler	N/A	N/A	MY48220184
MiniCircuits BW-N20W5+ Fixed 20 dB Attenuator	N/A	N/A	N/A
MiniCircuits SPL-10.7+ Low Pass Filter	N/A	N/A	R8979513746
Aprel Dielectric Probe Assembly	N/A	N/A	0011
Body Equivalent Matter (2450 MHz)	N/A	N/A	N/A
Body Equivalent Matter (5 GHz)	N/A	N/A	N/A

10. Conclusion

The SAR measurement indicates that the EUT complies with the RF radiation exposure limits of the FCC/IC. These measurements are taken to simulate the RF effects exposure under worst-case conditions. Precise laboratory measures were taken to assure repeatability of the tests. The tested device complies with the requirements in respect to all parameters subject to the test. The test results and statements relate only to the item(s) tested.

Please note that the absorption and distribution of electromagnetic energy in the body is a very complex phenomena that depends on the mass, shape, and size of the body; the orientation of the body with respect to the field vectors; and, the electrical properties of both the body and the environment. Other variables that may play a substantial role in possible biological effects are those that characterize the environment (e.g. ambient temperature, air velocity, relative humidity, and body insulation) and those that characterize the individual (e.g. age, gender, activity level, debilitation, or disease). Because innumerable factors may interact to determine the specific biological outcome of an exposure to electromagnetic fields, any protection guide shall consider maximal amplification of biological effects as a result of field-body interactions, environmental conditions, and physiological variables.

11. References

[1] Federal Communications Commission, ET Docket 93-62, Guidelines for Evaluating the Environmental Effects of Radio Frequency Radiation, August 1996

[2] ANSI/IEEE C95.1 – 1992, American National Standard Safety Levels with respect to Human Exposure to Radio Frequency Electromagnetic Fields, 300kHz to 100GHz, New York: IEEE, 1992.

[3] ANSI/IEEE C95.3 – 2002, IEEE Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields – RF and Microwave, New York: IEEE, 2002.

[4] International Electrotechnical Commission, IEC 62209-2 (Edition 1.0), Human Exposure to radio frequency fields from hand-held and body mounted wireless communication devices – Human models, instrumentation, and procedures – Part 2: Procedure to determine the specific absorption rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz), March 2010.

[5] IEEE Standard 1528 – 2013, IEEE Recommended Practice for Determining the Peak-Spatial Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communication Devices: Measurement Techniques, June 2013.

[6] Industry Canada, RSS – 102 Issue 5, Radio Frequency Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands), March 2015.

[7] Health Canada, Safety Code 6, Limits of Human Exposure to Radiofrequency Electromagnetic Fields in the Frequency Range from 3kHz to 300 GHz, 2009.

Appendix A – System Validation Plots and Data

```
***********************************************************
Test Result for UIM Dielectric Parameter
Mon 10/Dec/2018
Freq   Frequency(GHz)
FCC_eH Limits for Head Epsilon
FCC_sH Limits for Head Sigma
FCC_eB Limits for Body Epsilon
FCC_sB Limits for Body Sigma
Test_e Epsilon  of  UIM
Test_s Sigma of UIM
***********************************************************
```

Freq	FCC_eB	FCC_sB	Test_e	Test_s
2.4100	52.75	1.91	52.71	1.92
2.4170	52.743	1.917	52.696	1.927*
2.4200	52.74	1.92	52.69	1.93
2.4300	52.73	1.93	52.68	1.94
2.4370	52.716	1.937	52.666	1.947*
2.4400	52.71	1.94	52.66	1.95
2.4500	52.70	1.95	52.64	1.96
2.4570	52.693	1.957	52.633	1.974*
2.4600	52.69	1.96	52.63	1.98
2.4700	52.67	1.98	52.61	1.99
2.4800	52.66	1.99	52.60	2.00

* value interpolated

```
************************************************************
Test Result for UIM Dielectric Parameter
Thu 07/Dec/2018
Freq   Frequency(GHz)
FCC_eH Limits for Head Epsilon
FCC_sH Limits for Head Sigma
FCC_eB Limits for Body Epsilon
FCC_sB Limits for Body Sigma
Test_e Epsilon  of  UIM
Test_s Sigma of UIM
************************************************************
```

Freq	FCC_eB	FCC_sB	Test_e	Test_s
5.1000	49.15	5.18	49.08	5.20
5.1200	49.12	5.21	49.05	5.22
5.1400	49.10	5.23	49.02	5.24
5.1600	49.07	5.25	48.99	5.26
5.1800	49.04	5.28	48.96	5.28
5.2000	49.01	5.30	48.93	5.30
5.2100	49.00	5.31	48.915	5.31*
5.2200	48.99	5.32	48.90	5.32
5.2400	48.96	5.35	48.97	5.34
5.2500	48.945	5.36	48.955	5.35*
5.2600	48.93	5.37	48.94	5.36
5.2800	48.91	5.39	48.91	5.38
5.2900	48.895	5.405	48.895	5.395*
5.3000	48.88	5.42	48.88	5.41
5.3200	48.85	5.44	48.85	5.43
5.3400	48.82	5.46	48.82	5.45
5.3600	48.80	5.49	48.79	5.47
5.3800	48.77	5.51	48.76	5.49
5.4000	48.74	5.53	48.73	5.51
5.4200	48.72	5.56	48.70	5.53
5.4400	48.69	5.58	48.67	5.56
5.4600	48.66	5.60	48.64	5.58
5.4800	48.63	5.63	48.61	5.60
5.5000	48.61	5.65	48.58	5.62
5.5200	48.58	5.67	48.55	5.65
5.5400	48.55	5.70	48.52	5.67
5.5600	48.53	5.72	48.49	5.69
5.5800	48.50	5.74	48.46	5.71
5.6000	48.47	5.77	48.43	5.74
5.6100	48.455	5.78	48.415	5.75*
5.6200	48.44	5.79	48.40	5.76
5.6400	48.42	5.81	48.37	5.78
5.6600	48.39	5.84	48.34	5.81
5.6800	48.36	5.86	48.31	5.83
5.7000	48.34	5.88	48.28	5.85
5.7200	48.31	5.91	48.25	5.88
5.7400	48.28	5.93	48.22	5.90
5.7450	48.273	5.935	48.213	5.905*
5.7500	48.265	5.94	48.205	5.91*
5.7600	48.25	5.95	48.19	5.92
5.7750	48.235	5.973	48.168	5.943*
5.7800	48.23	5.98	48.16	5.95
5.7850	48.223	5.985	48.153	5.955*
5.8000	48.20	6.00	48.13	5.97
5.8200	48.17	6.02	48.10	5.99
5.8250	48.165	6.028	48.093	5.998*
5.8400	48.15	6.05	48.07	6.02

* value interpolated

RF Exposure Lab

Plot 1

DUT: Dipole 2450 MHz D2450V2; Type: D2450V2; Serial: D2450V2 - SN:829

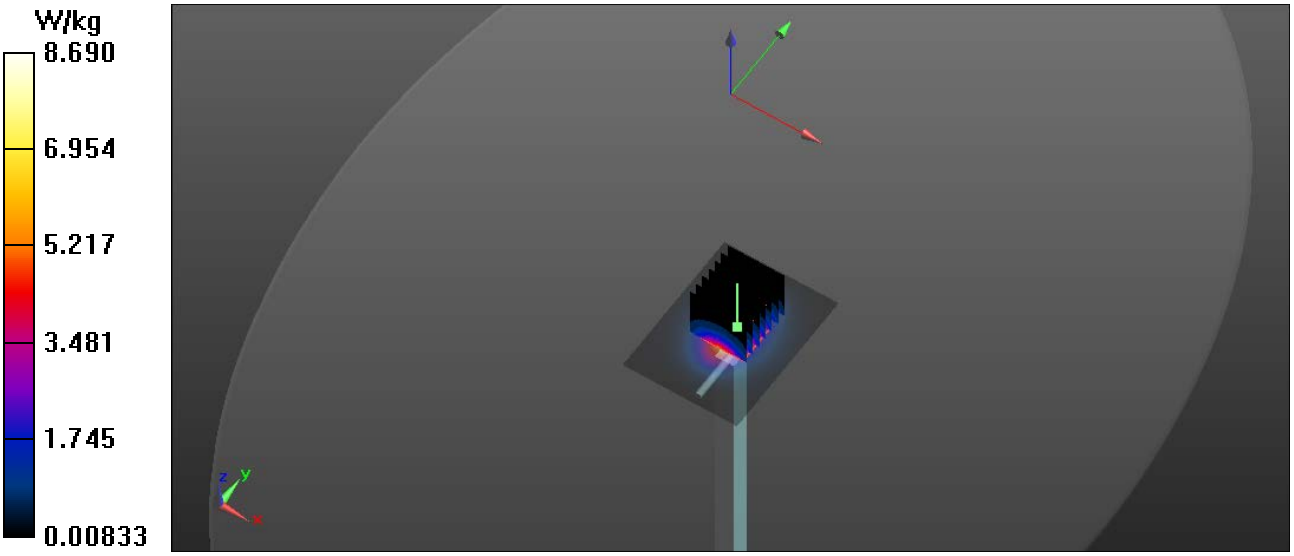
Communication System: CW; Frequency: 2450 MHz; Duty Cycle: 1:1
Medium: MSL2450; Medium parameters used: f = 2450 MHz; σ = 1.96 S/m; ε_r = 52.64; ρ = 1000 kg/m^3
Phantom section: Flat Section

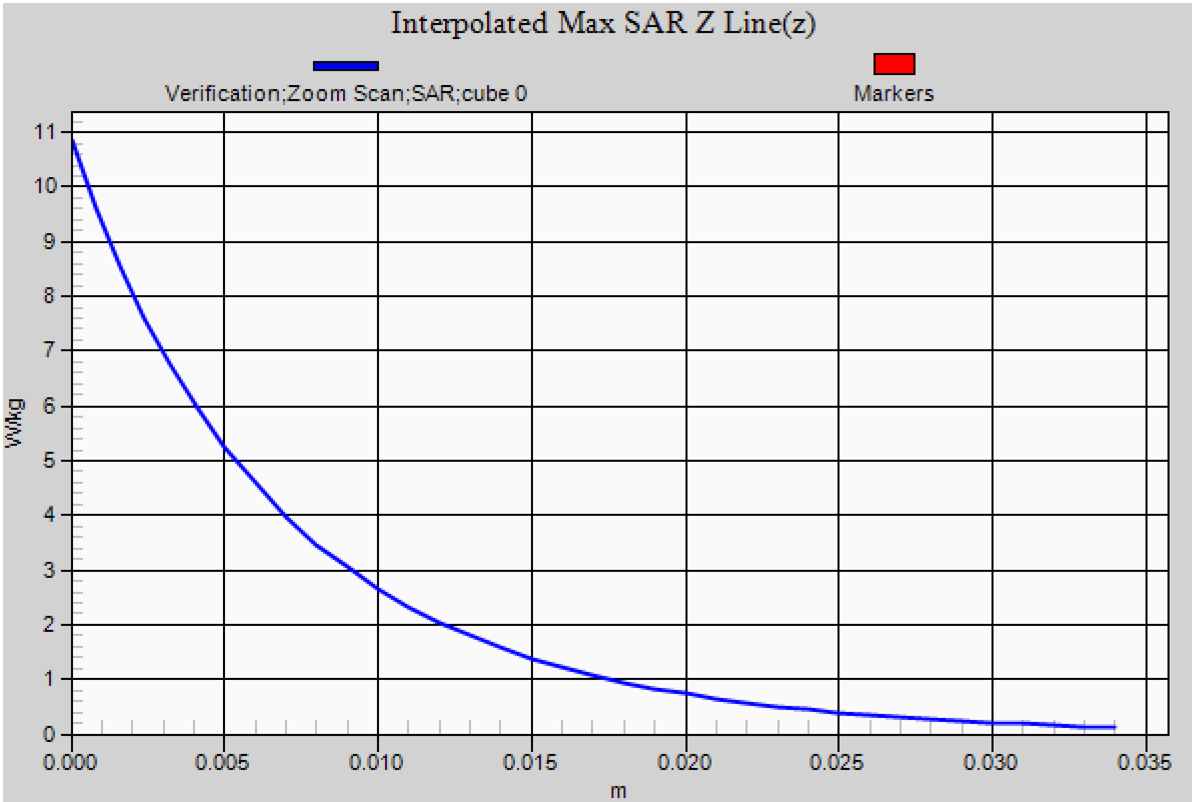
Test Date: Date: 12/10/2018; Ambient Temp: 23 °C; Tissue Temp: 21 °C
Probe: EX3DV4 - SN3833; ConvF(6.84, 6.84, 6.84); Calibrated: 1/16/2018;
Sensor-Surface: 2mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1321; Calibrated: 1/10/2018
Phantom: ELI v5.0; Type: QDOVA002AA; Serial: 2037
Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417)

Procedure Notes:

2450 MHz Body/Verification/Area Scan (61x81x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 8.68 W/kg

2450 MHz Body/Verification/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 55.751 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 10.7 W/kg
P_{IN}=100 mW
SAR(1 g) = 5.2 W/kg; SAR(10 g) = 2.4 W/kg
Maximum value of SAR (measured) = 5.91 W/kg




Interpolated Max SAR Z Line(z)
Verification;Zoom Scan;SAR;cube 0
Markers
W/kg
11
10
9
8
7
6
5
4
3
2
1
0
0.000
0.005
0.010
0.015
0.020
0.025
0.030
0.035
m

RF Exposure Lab

Plot 2

DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1085

Communication System: CW; Frequency: 5250 MHz; Duty Cycle: 1:1
Medium: MSL 3-6 GHz; Medium parameters used (interpolated): f = 5250 MHz; σ = 5.35 S/m; ε_r = 48.955; ρ = 1000 kg/m^3
Phantom section: Flat Section

Test Date: Date: 12/6/2018; Ambient Temp: 23 °C; Tissue Temp: 21 °C
Probe: EX3DV4 - SN3833; ConvF(4.1, 4.1, 4.1); Calibrated: 1/16/2018;
Sensor-Surface: 2mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1321; Calibrated: 1/10/2018
Phantom: ELI v5.0; Type: QDOVA002AA; Serial: 2037
Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417)

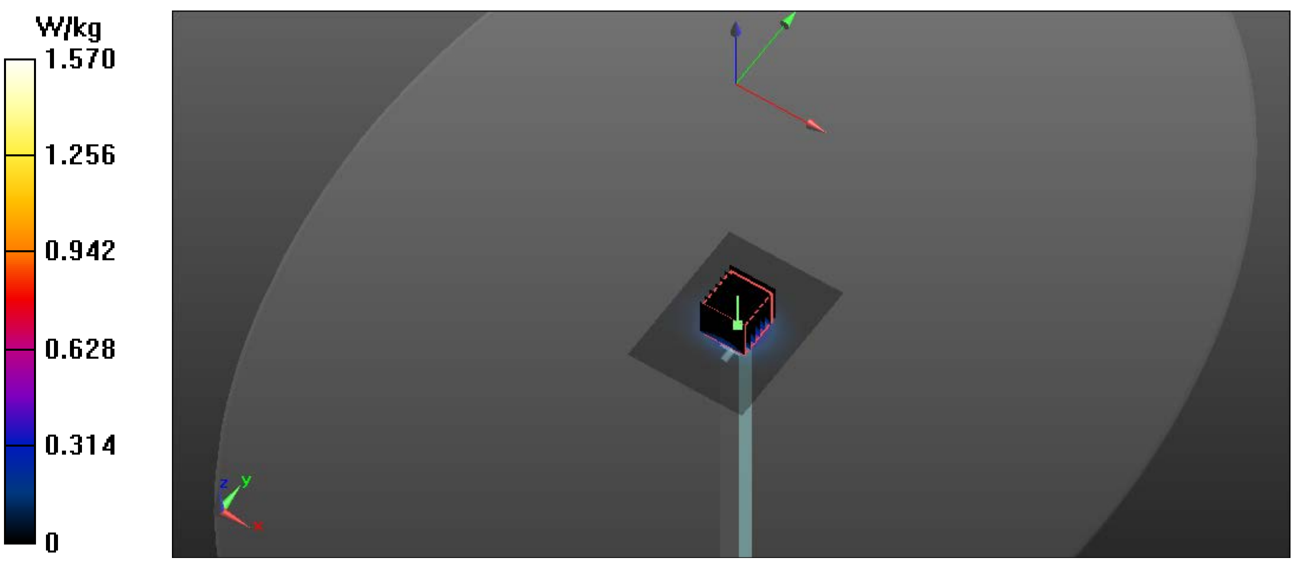
Procedure Notes:

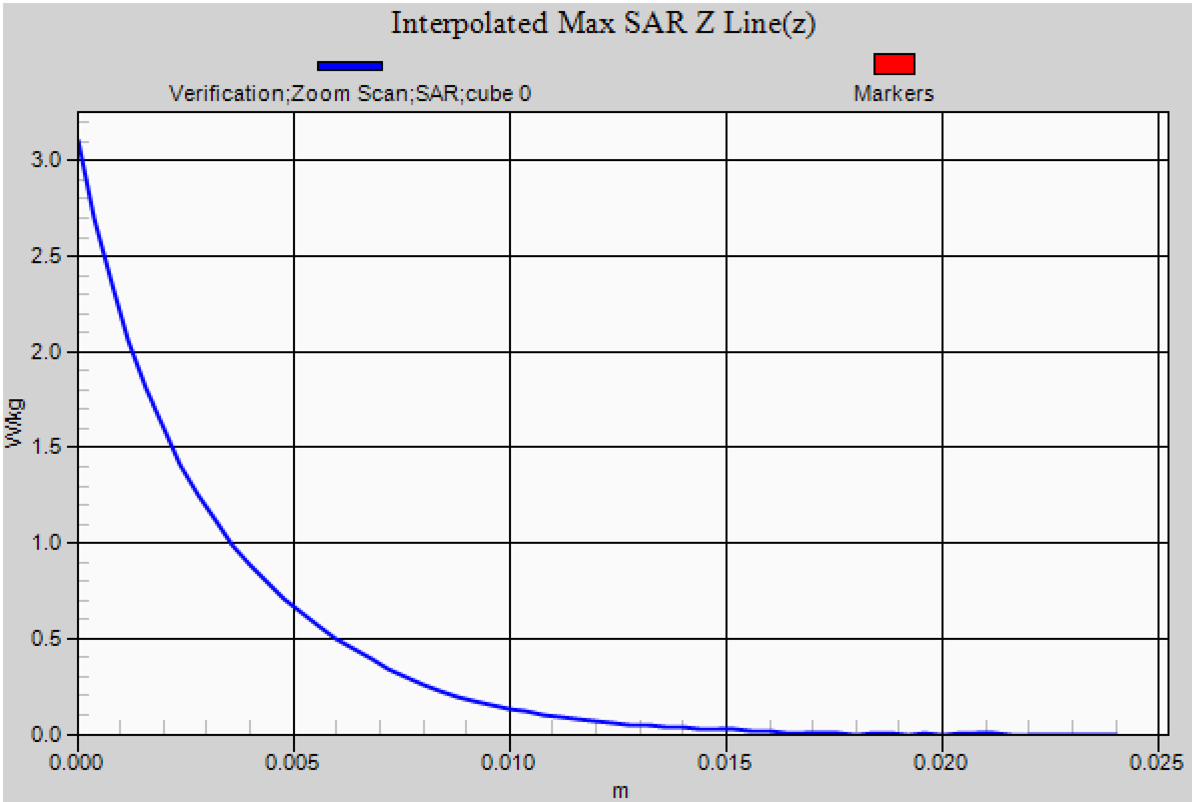
5250 MHz Body/Verification/Area Scan (61x81x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (interpolated) = 1.55 W/kg

5250 MHz Body/Verification/Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 55.759 V/m; Power Drift = -0.04 dB
Peak SAR (extrapolated) = 3.09 W/kg
P_{IN}=10 mW
SAR(1 g) = 0.776 W/kg; SAR(10 g) = 0.225 W/kg

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 1.58 W/kg




Interpolated Max SAR Z Line(z)
Verification;Zoom Scan;SAR;cube 0
Markers
W/kg
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.000
0.005
0.010
0.015
0.020
0.025
m

RF Exposure Lab

Plot 3

DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1085

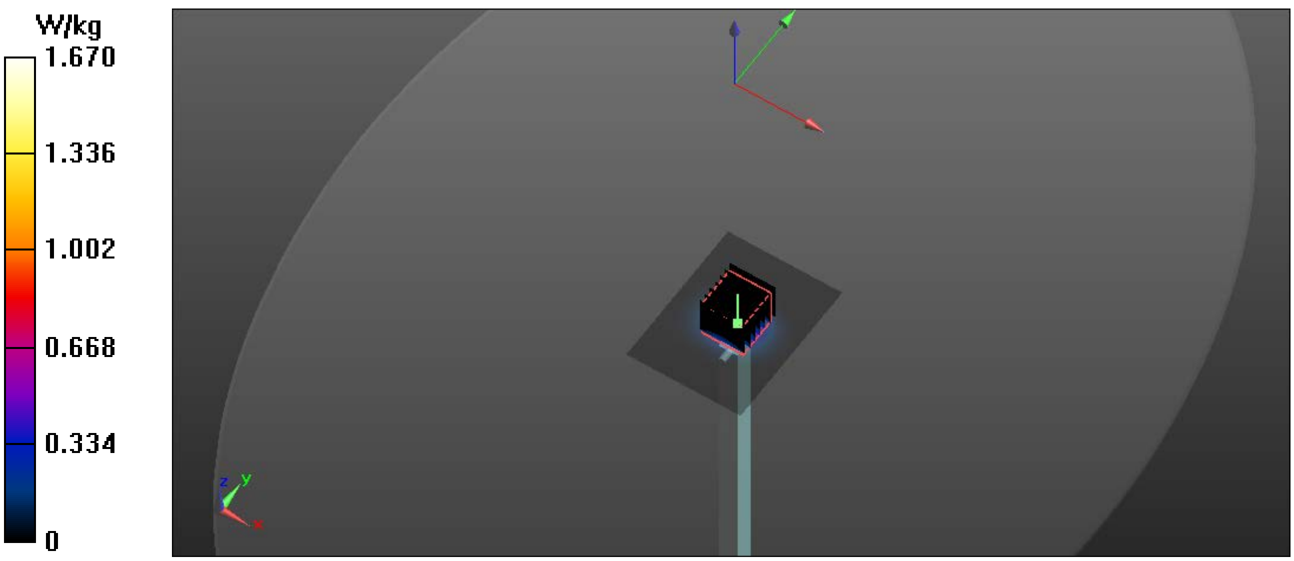
Communication System: CW; Frequency: 5600 MHz; Duty Cycle: 1:1
Medium: MSL 3-6 GHz; Medium parameters used: f = 5600 MHz; σ = 5.74 S/m; ε_r = 48.43; ρ = 1000 kg/m^3
Phantom section: Flat Section

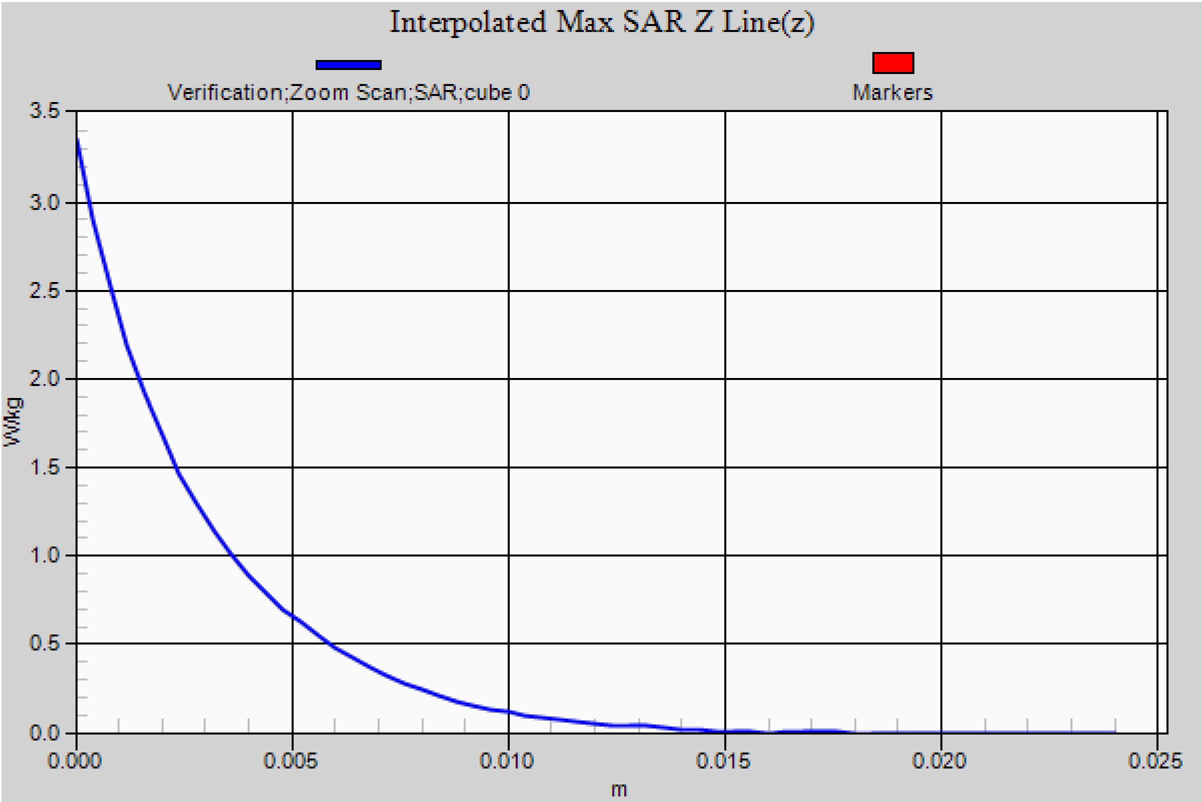
Test Date: Date: 12/6/2018; Ambient Temp: 23 °C; Tissue Temp: 21 °C
Probe: EX3DV4 - SN3833; ConvF(3.69, 3.69, 3.69); Calibrated: 1/16/2018;
Sensor-Surface: 2mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1321; Calibrated: 1/10/2018
Phantom: ELI v5.0; Type: QDOVA002AA; Serial: 2037
Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417)

Procedure Notes:

5600 MHz Body/Verification/Area Scan (61x81x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 1.68 W/kg

5600 MHz Body/Verification/Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 55.852 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 3.37 W/kg
P_{IN}=10 mW
SAR(1 g) = 0.791 W/kg; SAR(10 g) = 0.218 W/kg
Maximum value of SAR (measured) = 1.71 W/kg




Interpolated Max SAR Z Line(z)
Verification;Zoom Scan;SAR;cube 0
Markers
W/kg
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.000
0.005
0.010
0.015
0.020
0.025
m

RF Exposure Lab

Plot 4

DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1085

Communication System: CW; Frequency: 5750 MHz; Duty Cycle: 1:1
Medium: MSL 3-6 GHz; Medium parameters used (interpolated): f = 5750 MHz; σ = 5.91 S/m; ε_r = 48.205; ρ = 1000 kg/m^3
Phantom section: Flat Section

Test Date: Date: 12/6/2018; Ambient Temp: 23 °C; Tissue Temp: 21 °C
Probe: EX3DV4 - SN3833; ConvF(3.95, 3.95, 3.95); Calibrated: 1/16/2018;
Sensor-Surface: 2mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1321; Calibrated: 1/10/2018
Phantom: ELI v5.0; Type: QDOVA002AA; Serial: 2037
Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417)

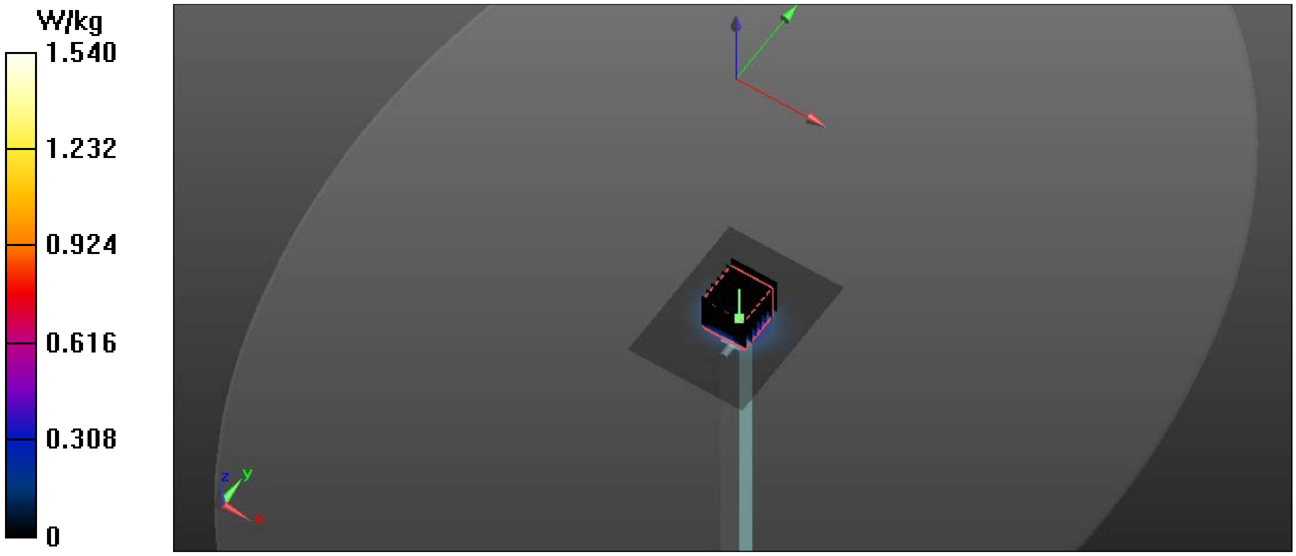
Procedure Notes:

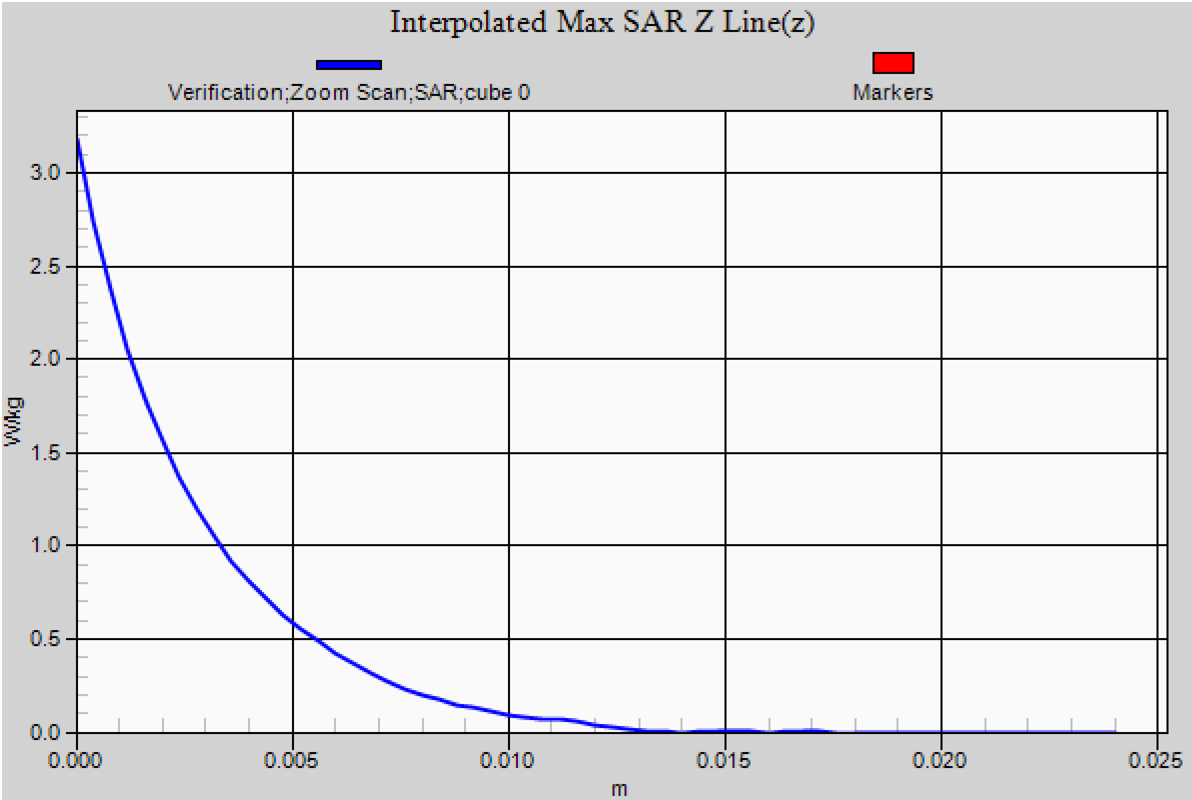
5750 MHz Body/Verification/Area Scan (61x81x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (interpolated) = 1.54 W/kg

5750 MHz Body/Verification/Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 55.812 V/m; Power Drift = -0.03 dB
Peak SAR (extrapolated) = 3.19 W/kg
P_{IN}=10 mW
SAR(1 g) = 0.766 W/kg; SAR(10 g) = 0.219 W/kg

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 1.57 W/kg




Interpolated Max SAR Z Line(z)
Verification;Zoom Scan;SAR;cube 0
Markers
W/kg
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.000
0.005
0.010
0.015
0.020
0.025
m

Appendix B – SAR Test Data Plots

RF Exposure Lab

Plot 1

DUT: TPN-W144; Type: Laptop; Serial: Eng 1

Communication System: WiFi 802.11b (DSSS, 1 Mbps); Frequency: 2457 MHz; Duty Cycle: 1:1
Medium: MSL2450; Medium parameters used (interpolated): f = 2457 MHz; σ = 1.974 S/m; ε_r = 52.633; ρ = 1000 kg/m^3
Phantom section: Flat Section

Test Date: Date: 12/10/2018; Ambient Temp: 23 °C; Tissue Temp: 21 °C

Probe: EX3DV4 - SN3833; ConvF(6.84, 6.84, 6.84); Calibrated: 1/16/2018;
Sensor-Surface: 2mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1321; Calibrated: 1/10/2018
Phantom: ELI v5.0; Type: QDOVA002AA; Serial: 2037
Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417)

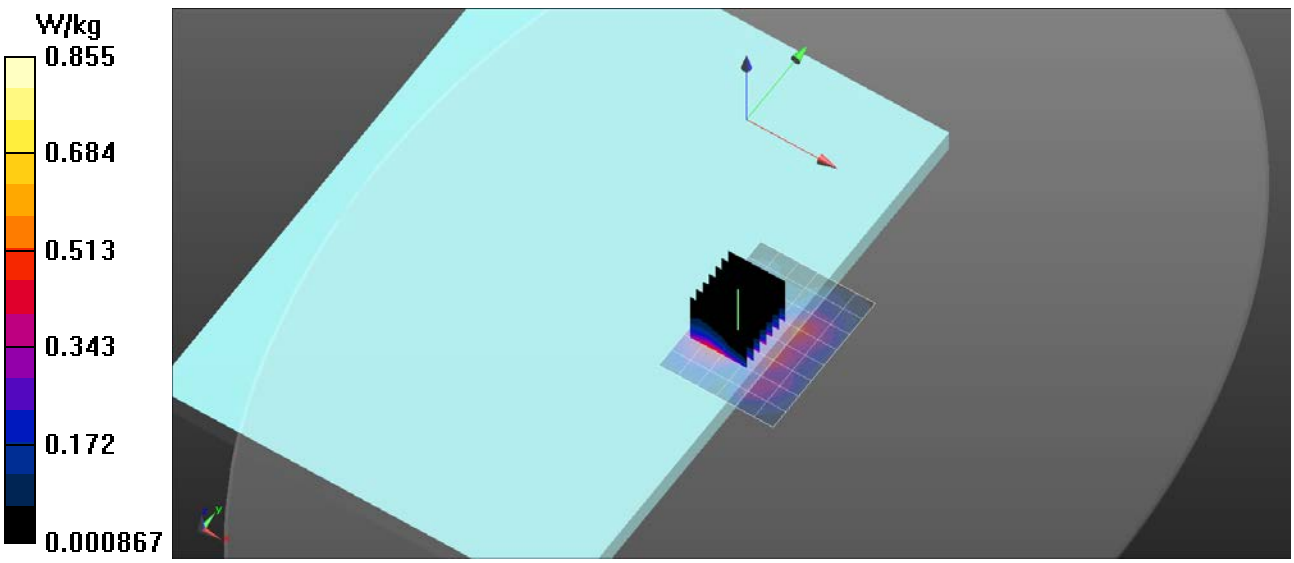
Procedure Notes:

2450 MHz WNC/Laptop Tx2 High/Area Scan (7x9x1): Measurement grid: dx=10mm, dy=10mm

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 0.793 W/kg

2450 MHz WNC/Laptop Tx2 High/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 9.409 V/m; Power Drift = -0.03 dB
Peak SAR (extrapolated) = 1.17 W/kg
SAR(1 g) = 0.565 W/kg

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 0.855 W/kg



RF Exposure Lab

Plot 2

DUT: TPN-W144; Type: Laptop; Serial: Eng 1

Communication System: WiFi 802.11a (OFDM, 6 Mbps); Frequency: 5300 MHz; Duty Cycle: 1:1
Medium: MSL 3-6 GHz; Medium parameters used: f = 5300 MHz; σ = 5.41 S/m; ε_r = 48.88; ρ = 1000 kg/m^3
Phantom section: Flat Section

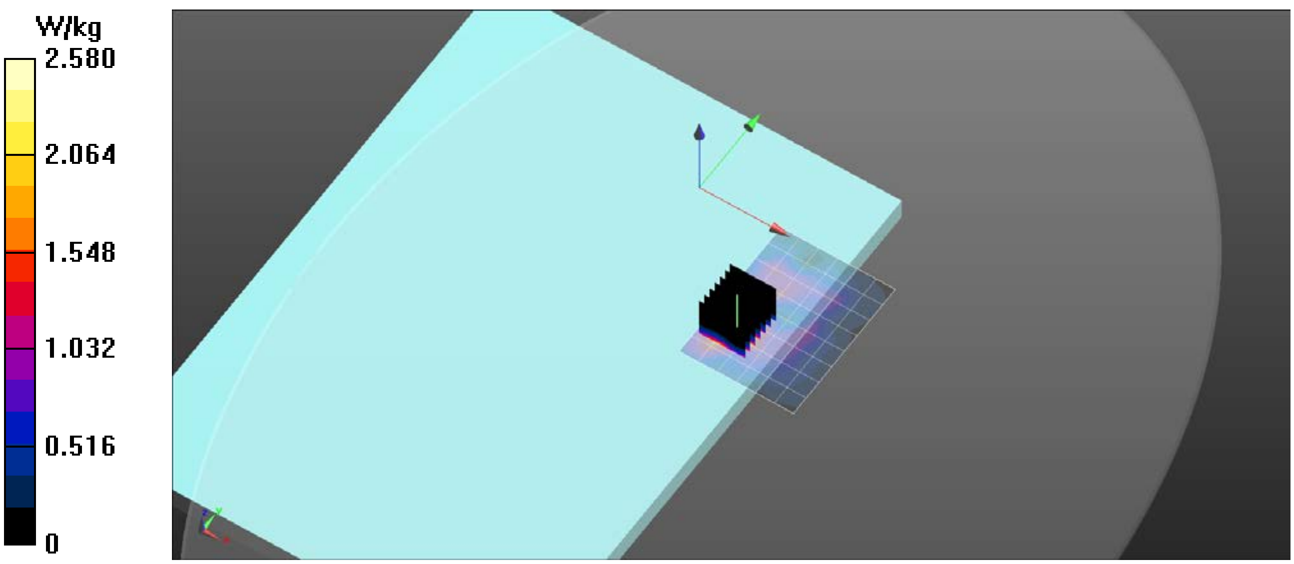
Test Date: Date: 12/6/2018; Ambient Temp: 23 °C; Tissue Temp: 21 °C

Probe: EX3DV4 - SN3833; ConvF(4.1, 4.1, 4.1); Calibrated: 1/16/2018;
Sensor-Surface: 2mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1321; Calibrated: 1/10/2018
Phantom: ELI v5.0; Type: QDOVA002AA; Serial: 2037
Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417)

Procedure Notes:

5200 MHz WNC/Laptop Tx1 60/Area Scan (7x9x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (measured) = 2.09 W/kg

5200 MHz WNC/Laptop Tx1 60/Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 1.198 V/m; Power Drift = 0.02 dB
Peak SAR (extrapolated) = 6.32 W/kg
SAR(1 g) = 1.20 W/kg
Maximum value of SAR (measured) = 2.58 W/kg



RF Exposure Lab

Plot 3

DUT: TPN-W144; Type: Laptop; Serial: Eng 1

Communication System: WiFi 802.11a (OFDM, 6 Mbps); Frequency: 5620 MHz; Duty Cycle: 1:1
Medium: MSL 3-6 GHz; Medium parameters used: f = 5620 MHz; σ = 5.76 S/m; ε_r = 48.4; ρ = 1000 kg/m^3
Phantom section: Flat Section

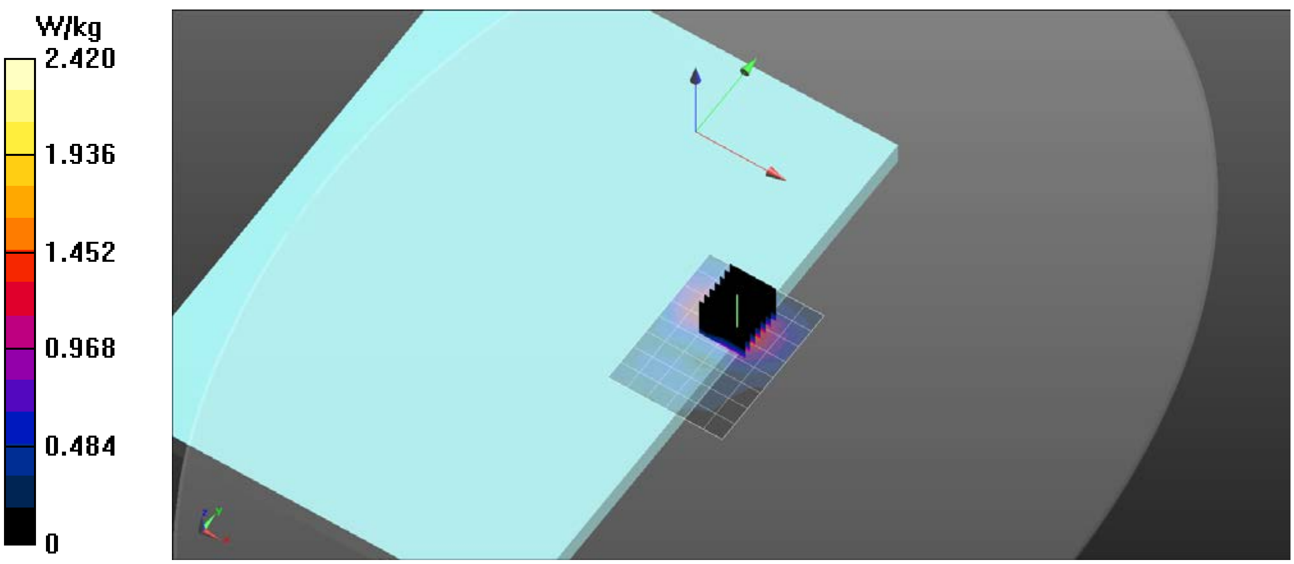
Test Date: Date: 12/6/2018; Ambient Temp: 23 °C; Tissue Temp: 21 °C

Probe: EX3DV4 - SN3833; ConvF(3.69, 3.69, 3.69); Calibrated: 1/16/2018;
Sensor-Surface: 2mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1321; Calibrated: 1/10/2018
Phantom: ELI v5.0; Type: QDOVA002AA; Serial: 2037
Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417)

Procedure Notes:

5600 MHz WNC/Laptop Tx2 124/Area Scan (7x9x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (measured) = 2.13 W/kg

5600 MHz WNC/Laptop Tx2 124/Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 4.900 V/m; Power Drift = 0.02 dB
Peak SAR (extrapolated) = 5.26 W/kg
SAR(1 g) = 1.18 W/kg
Maximum value of SAR (measured) = 2.42 W/kg



RF Exposure Lab

Plot 4

DUT: TPN-W144; Type: Laptop; Serial: Eng 1

Communication System: WiFi 802.11a (OFDM, 6 Mbps); Frequency: 5825 MHz; Duty Cycle: 1:1
Medium: MSL 3-6 GHz; Medium parameters used (interpolated): f = 5825 MHz; σ = 5.998 S/m; ε_r = 48.093; ρ = 1000 kg/m^3
Phantom section: Flat Section

Test Date: Date: 12/6/2018; Ambient Temp: 23 °C; Tissue Temp: 21 °C

Probe: EX3DV4 - SN3833; ConvF(3.95, 3.95, 3.95); Calibrated: 1/16/2018;
Sensor-Surface: 2mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1321; Calibrated: 1/10/2018
Phantom: ELI v5.0; Type: QDOVA002AA; Serial: 2037
Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417)

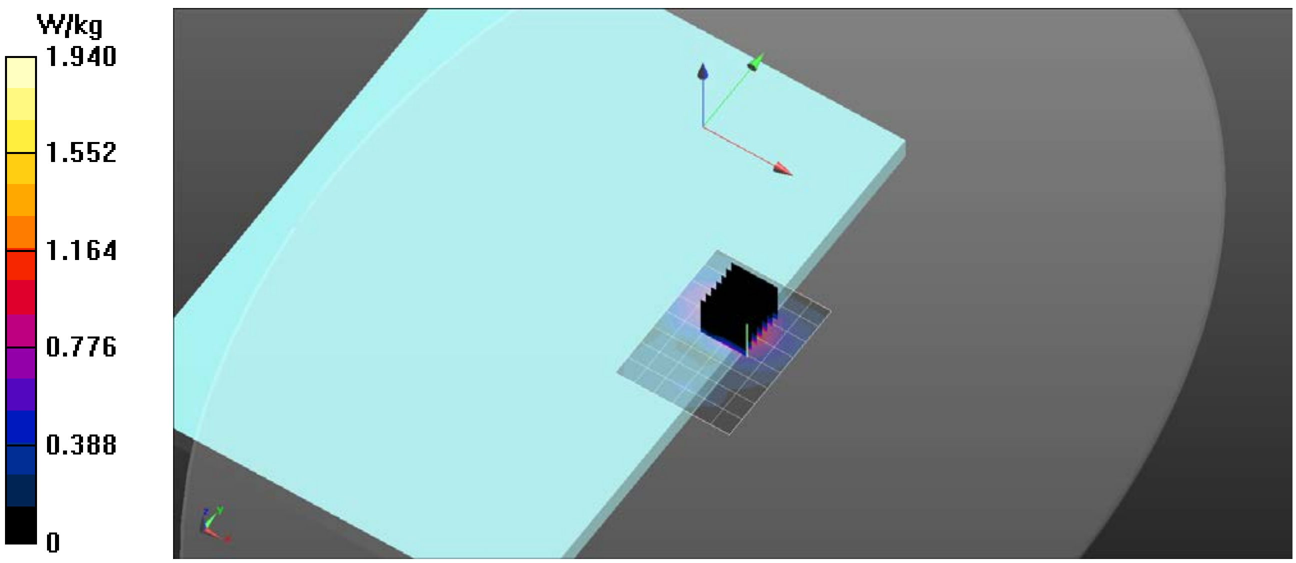
Procedure Notes:

5800 MHz WNC/Laptop Tx2 165/Area Scan (7x9x1): Measurement grid: dx=10mm, dy=10mm

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 1.95 W/kg

5800 MHz WNC/Laptop Tx2 165/Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 2.239 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 4.19 W/kg
SAR(1 g) = 0.889 W/kg

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 1.94 W/kg



RF Exposure Lab

Plot 5

DUT: TPN-W144; Type: Laptop; Serial: Eng 1

Communication System: WiFi 802.11a (OFDM, 6 Mbps); Frequency: 5580 MHz; Duty Cycle: 1:1
Medium: MSL 3-6 GHz; Medium parameters used: f = 5580 MHz; σ = 5.71 S/m; ε_r = 48.46; ρ = 1000 kg/m^3
Phantom section: Flat Section

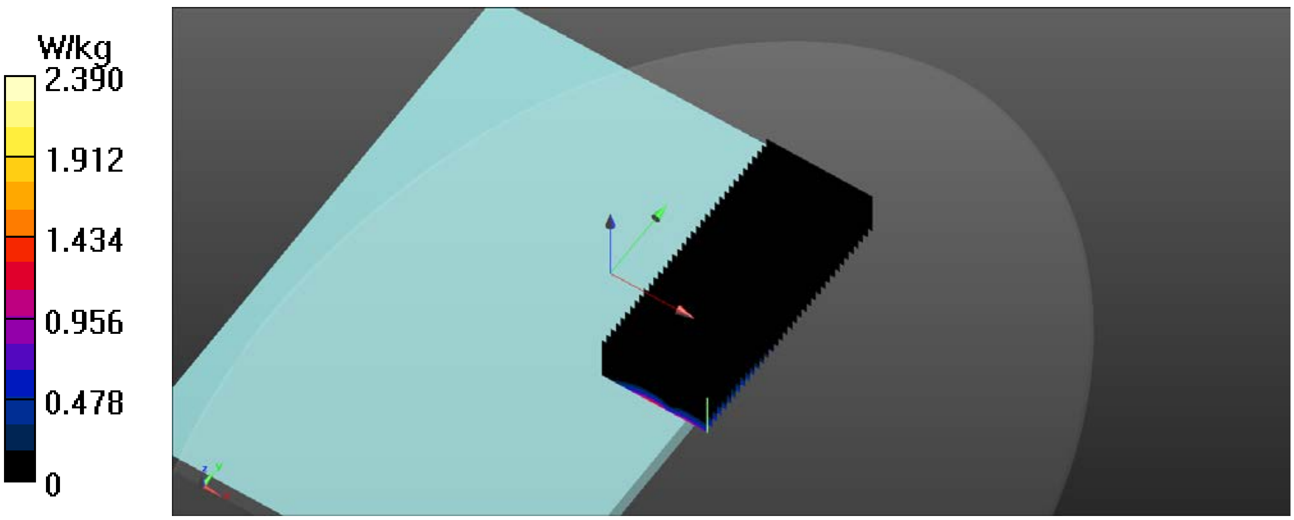
Communication System: WiFi 802.11a (OFDM, 6 Mbps); Frequency: 5620 MHz; Duty Cycle: 1:1
Medium: MSL 3-6 GHz; Medium parameters used: f = 5620 MHz; σ = 5.76 S/m; ε_r = 48.4; ρ = 1000 kg/m^3
Phantom section: Flat Section

Test Date: Date: 12/8/2018; Ambient Temp: 23 °C; Tissue Temp: 21 °C

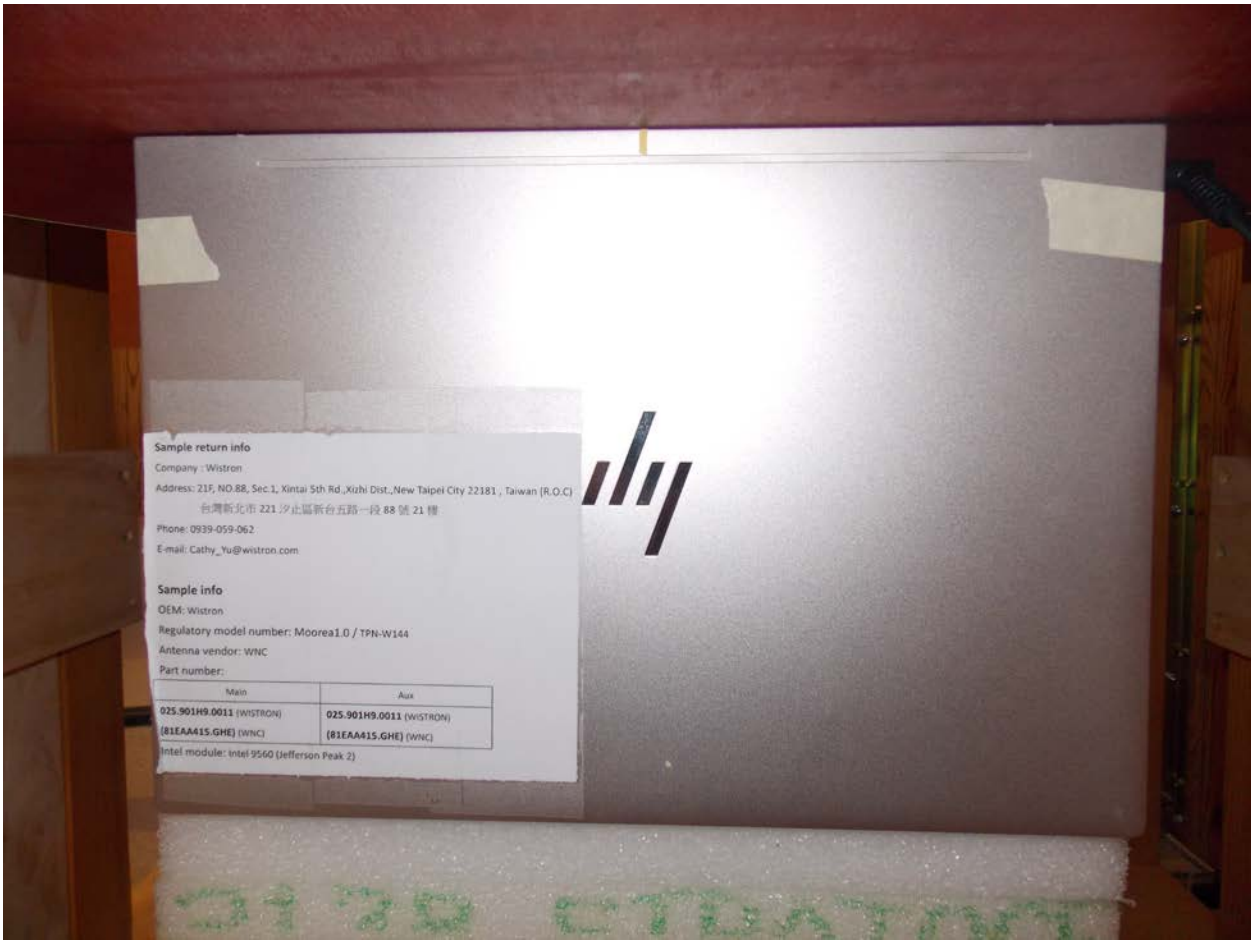
Probe: EX3DV4 - SN3833; ConvF(3.69, 3.69, 3.69); Calibrated: 1/16/2018;
Sensor-Surface: 2mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1321; Calibrated: 1/10/2018
Phantom: ELI v5.0; Type: QDOVA002AA; Serial: 2037
Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417)

Procedure Notes:

Multi Band Result:
SAR(1 g) = 1.19 W/kg
Maximum value of SAR (interpolated) = 2.39 W/kg



Appendix C – SAR Test Setup Photos



Test Position Laptop 0 mm Gap

Front of Device Laptop Mode

Appendix D – Probe Calibration Data Sheets

Appendix E – Dipole Calibration Data Sheets

Appendix F – Phantom Calibration Data Sheets

Appendix G – Validation Summary

Per FCC KDB 865664 D02 v01r02, SAR system validation status should be documented to confirm measurement accuracy. The SAR systems (including SAR probes, system components and software versions) used for this device were validated against its performance specifications prior to the SAR measurements. Reference dipoles were used with the required tissue equivalent media for system validation according to the procedures outlined in FCC KDB 865664 D01 v01r04 and IEEE 1528-2013. Since SAR probe calibrations are frequency dependent, each probe calibration point was validated at a frequency within the valid frequency range of the probe calibration point using the system that normally operates with the probe for routine SAR measurements and according to the required tissue equivalent media.

A tabulated summary of the system validation status including the validation date(s), measurement frequencies, SAR probes and tissue dielectric parameters has been included.

Table G-1
SAR System Validation Summary

SAR System #	Freq. (MHz)	Date	Probe S/N	Probe Type	Probe Cal. Point		Cond. (σ)	Perm. (ε_r)	CW Validation			Modulation Validation		
									Sens-itivity	Probe Linearity	Probe Isotropy	Modulation Type	Duty Factor	PAR
3	2450	1/22/2015	3833	EX3DV4	2450	Body	1.97	52.53	Pass	Pass	Pass	OFDM/TDD	Pass	Pass
3	5200	1/23/2015	3833	EX3DV4	5200	Body	5.32	48.94	Pass	Pass	Pass	OFDM	N/A	Pass
3	5300	1/23/2015	3833	EX3DV4	5300	Body	5.45	48.74	Pass	Pass	Pass	OFDM	N/A	Pass
3	5500	1/24/2015	3833	EX3DV4	5500	Body	5.67	48.50	Pass	Pass	Pass	OFDM	N/A	Pass
3	5600	1/24/2015	3833	EX3DV4	5600	Body	5.79	48.33	Pass	Pass	Pass	OFDM	N/A	Pass
3	5800	1/24/2015	3833	EX3DV4	5800	Body	6.03	48.14	Pass	Pass	Pass	OFDM	N/A	Pass