SAR TEST REPORT

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1. Customer
   - Name : LG Electronics USA, Inc.
   - Address : 1000 Sylvan Avenue, Englewood Cliffs, New Jersey 07632
2. Use of Report : FCC Original Grant
3. Product Name (FCC ID): Mobile Computer (BEJNT-LG15Z96)
4. Date of Test :2015-12-16 ~ 2015-12-18
5. Test Method Used: CFR §2.1093
6. Testing Environment :See appended test report
7. Test Result : ☒ Pass☐ Fail

The results shown in this test report refer only to the sample(s) tested unless otherwise stated. This Test Report cannot be reproduced, except in full.

Affirmation	Tested by Name : ChangWon, Lee (Signature)	Technical Manager Name : Harvey Sung (Signature)

2016. 01. 15.

DT&C Co., Ltd.

Test Report Version

Test Report No.	Date	Description
DRRFCC1601-0005	Jan. 15, 2016	Initial issue

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1. DESCRIPTION OF DEVICE

Environmental evaluation measurements of specific absorption rate (SAR) distributions in emulated human head and body tissues exposed to radio frequency (RF) radiation from wireless portable devices for compliance with the rules and regulations of the U.S. Federal Communications Commission (FCC).

General Information

EUT type	Notebook Computer
FCC ID	BEJNT-LG15Z96
Equipment model name	LG15Z96
Equipment add model name	15Z960, 15ZD960 3 models are same mechanical, electrical and functional. The only difference is the model name, which are changed for marketing purpose.
Equipment serial no.	Identical prototype
Mode(s) of Operation	2.4 GHz W-LAN(802.11b/g/n HT20/n HT40), 5 G W-LAN (802.11a/n HT20/n HT40/ac VHT20/ac VHT40/ac VHT80)

	Band	Mode	Bandwidth	Frequency
TX Frequency Range	DTS	802.11b/g/n	HT20	2412 ~ 2462 MHz
		802.11n	HT40	2422 ~ 2452 MHz
	U-NII-1	802.11a/n	HT20	5180 ~ 5240 MHz
		802.11n	HT40	5190 ~ 5230 MHz
		802.11ac	VHT 80	5210 MHz
	U-NII-2A	802.11a/n	HT20	5260 ~ 5320 MHz
		802.11n	HT40	5270 ~ 5310 MHz
		802.11ac	VHT 80	5290 MHz
	U-NII-2C	802.11a/n	HT20	5500 ~ 5700 MHz
		802.11n	HT40	5510 ~ 5670 MHz
		802.11ac	VHT 20	5720 MHz
		802.11ac	VHT 40	5710 MHz
		802.11ac	VHT 80	5530, 5690 MHz
	U-NII-3	802.11a/n	HT20	5745 ~ 5825 MHz
		802.11n	HT40	5755 ~ 5795 MHz
		802.11ac	VHT 80	5775 MHz
RX Frequency Range	DTS	802.11b/g/n	HT20	2412 ~ 2462 MHz
		802.11n	HT40	2422 ~ 2452 MHz
	U-NII-1	802.11a/n	HT20	5180 ~ 5240 MHz
		802.11n	HT40	5190 ~ 5230 MHz
		802.11ac	VHT 80	5210 MHz
	U-NII-2A	802.11a/n	HT20	5260 ~ 5320 MHz
		802.11n	HT40	5270 ~ 5310 MHz
		802.11ac	VHT 80	5290 MHz
	U-NII-2C	802.11a/n	HT20	5500 ~ 5700 MHz
		802.11n	HT40	5510 ~ 5670 MHz
		802.11ac	VHT 20	5720 MHz
		802.11ac	VHT 40	5710 MHz
		802.11ac	VHT 80	5530, 5690 MHz
	U-NII-3	802.11a/n	HT20	5745 ~ 5825 MHz
		802.11n	HT40	5755 ~ 5795 MHz
		802.11ac	VHT 80	5775 MHz

Band	Mode	Ch	Reported SAR 1g SAR (W/kg) SISO Body	Ch	Reported SAR 1g SAR (W/kg) MIMO Body
DTS	2.4 GHz W-LAN	6	0.43	6	0.43
U-NII-1	5.2 GHz W-LAN	46	0.22	N/A	N/A
U-NII-2A	5.3 GHz W-LAN	58	0.38	60	0.41
U-NII-2C	5.6 GHz W-LAN	142	0.25	138	0.38
U-NII-3	5.8 GHz W-LAN	159	0.37	157	0.37
DSS/DTS	Bluetooth	N/A	0.13[Note]	N/A	N/A
Simultaneous SAR per KDB 690783 D01v01r03			0.56	N/A	N/A

FCC Equipment Class	Part 15 Spread Spectrum Transmitter(DSS) Digital Transmission System(DTS) Unlicensed National Information Infrastructure (UNII)
Date(s) of Tests	2015-12-16 ~ 2015-12-18
Antenna Type	Internal Type Antenna
Note	Bluetooth SAR was estimated.
Functions	● BT(2.4GHz) / W-LAN(2.4GHz 802.11b/g/n(HT20)/n(HT40)), W-LAN(5GHz 802.11a/n(HT20)/n(HT40)/ac(VHT20)/ac(VHT40)/ac(VHT80)) supported ● No simultaneous transmission between W-LAN(2.4GHz) & W-LAN(5GHz). ● Simultaneous transmission between BT Ant.1 & W-LAN Ant.2.

1.1 Guidance Applied

- IEEE 1528-2013
- FCC KDB Publication 248227 D01v02r02 (802.11 Wi-Fi SAR)
- FCC KDB Publication 447498 D01v06 (General RF Exposure Guidance)
- FCC KDB Publication 616217 D04 SAR for laptop and tablets v01r02
- FCC KDB Publication 690783 D01 SAR Listings on Grants v01r03
- FCC KDB Publication 865664 D01 SAR Measurement 100 MHz to 6 GHz v01r04
- FCC KDB Publication 865664 D02 RF Exposure Reporting v01r02

1.2 Device Overview

Band	Mode	Operating Modes	Tx Frequency
DTS	2.4 GHz WLAN	Data	2412 ~ 2462 MHz
U-NII-1	5.2 GHz WLAN	Data	5180 ~ 5240 MHz
U-NII-2A	5.3 GHz WLAN	Data	5260 ~ 5320 MHz
U-NII-2C	5.6 GHz WLAN	Data	5500 ~ 5700 MHz
U-NII-3	5.8 GHz WLAN	Data	5745 ~ 5825 MHz
DSS	Bluetooth	Data	2402 ~ 2480 MHz

1.3 Nominal and Maximum Output Power Specifications

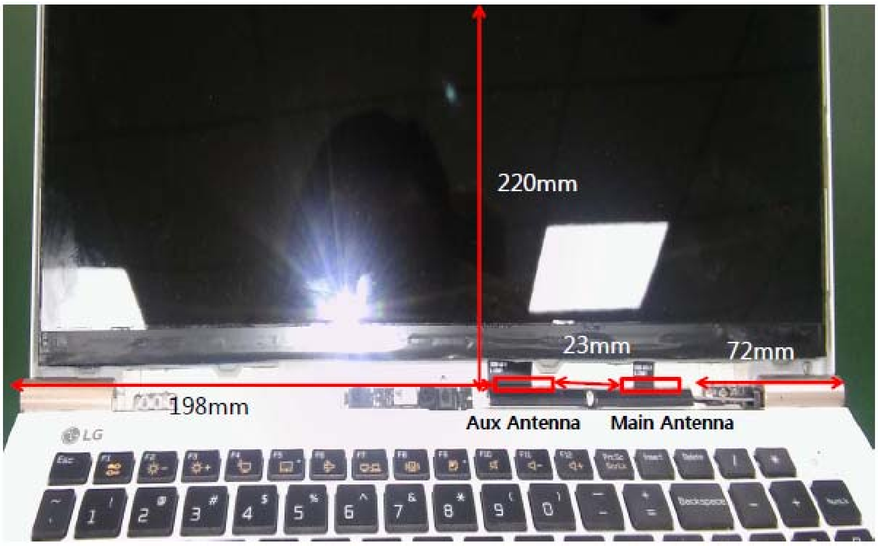
This device operates using the following maximum and nominal output power specifications. SAR values were scaled to the maximum allowed power to determine compliance per KDB Publication 447498 D01v06.

Band & Mode			Modulated Average[dBm]								
			Ant. 1			Ant. 2			MIMO		
			Ch Low	Ch Mid	Ch High	Ch Lo	Ch Mid	Ch High	Ch Low	Ch Mid	Ch High
DTS	IEEE 802.11b (2.4 GHz)	Maximum	14.0	18.0	13.0	16.5	17.0	16.5	-	-	-
		Nominal	13.0	17.0	12.0	15.5	16.0	15.5	-	-	-
	IEEE 802.11g (2.4 GHz)	Maximum	11.0	17.5	11.0	12.5	17.5	12.0	-	-	-
		Nominal	10.0	16.5	10.0	11.5	16.5	11.0	-	-	-
	IEEE 802.11n HT20 (2.4 GHz)	Maximum	10.0	18.0	10.0	12.5	17.5	12.0	12.5	20.5	10.5
		Nominal	9.0	17.0	9.0	11.5	16.5	11.0	11.5	19.5	9.5
	IEEE 802.11n HT40 (2.4 GHz)	Maximum	7.0	17.5	8.0	9.5	17.5	11.0	9.0	20.5	8.5
		Nominal	6.0	16.5	7.0	8.5	16.5	10.0	8.0	19.5	7.5

Band & Mode			Modulated Average[dBm]											
			Ant. 1				Ant. 2				MIMO			
			Ch Low	Ch Mid-1 (Ch Mid)	Ch Mid-2 (Ch Mid)	Ch High	Ch Low	Ch Mid-1 (Ch Mid)	Ch Mid-2 (Ch Mid)	Ch High	Ch Low	Ch Mid-1 (Ch Mid)	Ch Mid-2 (Ch Mid)	Ch High
U-NII-1	IEEE 802.11a (5.2 GHz)	Maximum	10.0	10.0	9.5	10.0	14.0	16.5	16.5	15.5	-	-	-	-
		Nominal	9.0	9.0	8.5	9.0	13.0	15.5	15.5	14.5	-	-	-	-
U-NII-2A	IEEE 802.11a (5.3 GHz)	Maximum	10.5	12.5	11.0	12.0	15.0	16.0	14.5	13.5	-	-	-	-
		Nominal	9.5	11.5	10.0	11.0	14.0	15.0	13.5	12.5	-	-	-	-
U-NII-2C	IEEE 802.11a (5.6 GHz)	Maximum	14.0	15.5	15.5	13.5	14.5	16.5	16.5	14.0	-	-	-	-
		Nominal	13.0	14.5	14.5	12.5	13.5	15.5	15.5	13.0	-	-	-	-
U-NII-3	IEEE 802.11a (5.8 GHz)	Maximum	15.5	15.5		16.5	15.5	15.5		15.5	-	-	-	-
		Nominal	14.5	14.5		15.5	14.5	14.5		14.5	-	-	-	-
U-NII-1	IEEE 802.11n HT20 (5.2 GHz)	Maximum	9.5	10.5	11.0	11.5	14.0	16.5	16.5	15.0	12.5	13.5	14.0	14.5
		Nominal	8.5	9.5	10.0	10.5	13.0	15.5	15.5	14.0	11.5	12.5	13.0	13.5
U-NII-2A	IEEE 802.11n HT20 (5.3 GHz)	Maximum	11.0	13.0	12.0	12.5	15.0	16.0	14.5	13.5	14.5	15.0	17.5	15.5
		Nominal	10.0	12.0	11.0	11.5	14.0	15.0	13.5	12.5	13.5	14.0	16.5	14.5
U-NII-2C	IEEE 802.11n HT20 (5.6 GHz)	Maximum	14.0	15.5	15.5	13.5	14.0	16.5	16.0	13.0	20.0	20.0	18.5	18.5
		Nominal	13.0	14.5	14.5	12.5	13.0	15.5	15.0	12.0	19.0	19.0	17.5	17.5
U-NII-3	IEEE 802.11n HT20 (5.8 GHz)	Maximum	16.5	16.0		16.0	15.5	15.5		15.0	18.5	18.5		18.0
		Nominal	15.5	15.0		15.0	14.5	14.5		14.0	17.5	17.5		17.0
U-NII-1	IEEE 802.11n HT40 (5.2 GHz)	Maximum	12.0	-	-	11.0	11.0	-	-	16.5	13.5	-	-	13.5
		Nominal	11.0	-	-	10.0	10.0	-	-	15.5	12.5	-	-	12.5
U-NII-2A	IEEE 802.11n HT40 (5.3 GHz)	Maximum	13.0	-	-	13.0	11.5	-	-	13.5	13.5	-	-	14.5
		Nominal	12.0	-	-	12.0	10.5	-	-	12.5	12.5	-	-	13.5
U-NII-2C	IEEE 802.11n HT40 (5.6 GHz)	Maximum	12.5	16.5	16.5	18.0	14.0	18.0	16.0	15.0	17.0	19.5	20.0	19.5
		Nominal	11.5	15.5	15.5	17.0	13.0	17.0	15.0	14.0	16.0	18.5	19.0	18.5
U-NII-3	IEEE 802.11n HT40 (5.8 GHz)	Maximum	14.5	-	-	15.5	14.0	-	-	15.5	16.5	-	-	18.0
		Nominal	13.5	-	-	14.5	13.0	-	-	14.5	15.5	-	-	17.0
U-NII-2C	IEEE 802.11ac VHT20 (5.6 GHz)	Maximum	-	13.5		-	-	13.0		-	-	16.5		-
		Nominal	-	12.5		-	-	12.0		-	-	15.5		-
U-NII-2C	IEEE 802.11ac VHT40 (5.6 GHz)	Maximum	-	17.5		-	-	16.0		-	-	18.5		-
		Nominal	-	16.5		-	-	15.0		-	-	17.5		-
U-NII-1	IEEE 802.11ac VHT80 (5.2 GHz)	Maximum	-	12.0		-	-	13.0		-	-	13.5		-
		Nominal	-	11.0		-	-	12.0		-	-	12.5		-
U-NII-2A	IEEE 802.11ac VHT80 (5.3 GHz)	Maximum	-	14.0		-	-	9.0		-	-	12.0		-
		Nominal	-	13.0		-	-	8.0		-	-	11.0		-
U-NII-2C	IEEE 802.11ac VHT80 (5.6 GHz)	Maximum	14.5	-	-	16.5	12.5	-	-	14.5	14.0	-	-	20.0
		Nominal	13.5	-	-	15.5	11.5	-	-	13.5	13.0	-	-	19.0
U-NII-3	IEEE 802.11ac VHT80 (5.8 GHz)	Maximum	-	13.5		-	-	9.5		-	-	11.0		-
		Nominal	-	12.5		-	-	8.5		-	-	10.0		-

Band & Mode			Modulated Average [dBm]
DSS/DTS	Bluetooth 1 Mbps	Maximum	5.0
		Nominal	4.0
	Bluetooth 2 Mbps	Maximum	1.5
		Nominal	0.5
	Bluetooth 3 Mbps	Maximum	0.5
		Nominal	-0.5
	Bluetooth LE	Maximum	2.0
		Nominal	1.0

1.4 DUT Antenna Locations



Note: Exact antenna dimensions and separation distances are shown in the "Antenna Location_ BEJNT-LG15Z96" in the FCC Filing.

Mode	Body Sides for SAR Testing					
	Top	Bottom	Front	Rear	Right	Left
2.4G W-LAN_Ant.1	X	X	X	O	X	X
2.4G W-LAN_Ant.2	X	X	X	O	X	X
2.4G W-LAN_MIMO	X	X	X	O	X	X
5G W-LAN_Ant.1	X	X	X	O	X	X
5G W-LAN_Ant.2	X	X	X	O	X	X
5G W-LAN_MIMO	X	X	X	O	X	X

Note: The rear with touch configuration was only tested since only the rear is touched to human body in normal operation condition of this device.

1.5 SAR Test Exclusions Applied

(A) WIFI & BT

Per FCC KDB 447498 D01v06, **the 1g SAR exclusion threshold for distances < 50 mm** is defined by the following equation:

$$\frac{Max\ Power\ of\ Channel\ (mW)}{Test\ Separation\ Dist\ (mm)} * \sqrt{Frequency(GHz)} \leq 3.0$$

Table 1. SAR exclusion threshold for distances < 50 mm

Band	Mode	Equation	Result	SAR exclusion threshold	Required SAR
DSS	Bluetooth	[(3/5)* √2.480]	1.0	3.0	X
DTS	Bluetooth LE	[(2/5)* √2.480]	0.5	3.0	X
DTS	2.4 GHz W-LAN	[(112/5)* √2.437]	35.0	3.0	O
U-NII-1	5.2 GHz W-LAN	[(45/5)* √5.230]	20.4	3.0	O
U-NII-2A	5.3 GHz W-LAN	[(56/5)* √5.300]	25.9	3.0	O
U-NII-2C	5.6 GHz W-LAN	[100/5)* √5.690]	47.7	3.0	O
U-NII-3	5.8 GHz W-LAN	[(71/5)* √5.785]	34.1	3.0	O

Per KDB Publication 447498 D01v05r02, the maximum power of the channel was rounded to the nearest mW before calculation.

1.6 Power Reduction for SAR

There is no power reduction used for any band/mode implemented in this device for SAR purposes.

1.7 Device Serial Numbers

Band & Mode	Body Serial Number
2.4 GHz WLAN	FCC #1
5 GHz WLAN	FCC #1

2. INTROCUCTION

The FCC and Industry Canada have adopted the guidelines for evaluating the environmental effects of radio frequency (RF) radiation in ET Docket 93-62 on Aug. 6, 1996 and Health Canada Safety Code 6 to protect the public and workers from the potential hazards of RF emissions due to FCC-regulated portable devices.

The FCC has adopted the guidelines for evaluating the environmental effects of radio frequency radiation in ET Docket 93-62 on Aug. 6, 1996 to protect the public and workers from the potential hazards of RF emissions due to FCC-regulated portable devices. The safety limits used for the environmental evaluation measurements are based on the criteria published by the American National Standards Institute (ANSI) for localized specific absorption rate (SAR) in IEEE/ANSI C95*.1-2005 Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz. 1992 by the Institute of Electrical and Electronics Engineers, Inc., New York, New York 10017. The measurement procedure described in IEEE/ANSI C95.3-1992 Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields - RF and Microwave is used for guidance in measuring SAR due to the RF radiation exposure from the Equipment Under Test (EUT). These criteria for SAR evaluation are similar to those recommended by the National Council on Radiation Protection and Measurements (NCRP) in Biological Effects and Exposure Criteria for Radio frequency Electromagnetic Fields," NCRP Report No. 86 NCRP, 1986, Bethesda, MD 20814. SAR is a measure of the rate of energy absorption due to exposure to an RF transmitting source. SAR values have been related to threshold levels for potential biological hazards.

SAR Definition

Specific Absorption Rate (SAR) is defined as the time derivative (rate) of the incremental energy (dU) absorbed by (dissipated in) an incremental mass (dm) contained in a volume element (dV) of a given density (ρ) It is also defined as the rate of RF energy absorption per unit mass at a point in an absorbing body (see Fig. 2.1)

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

Fig. 2.1 SAR Mathematical Equation

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

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

where:
σ = conductivity of the tissue-simulating material (S/m)
ρ = mass density of the tissue-simulating material (kg/m^3)
E = Total RMS electric field strength (V/m)

NOTE: The primary factors that control rate of energy absorption were found to be the wavelength of the incident field in relations to the dimensions and geometry of the irradiated organism, the orientation of the organism in relation to the polarity of field vectors, the presence of reflecting surfaces, and whether conductive contact is made by the organism with a ground plane.

3. DESCRIPTION OF TEST EQUIPMENT

3.1 SAR MEASUREMENT SETUP

Measurements are performed using the DASY5 automated dosimetric assessment system. The DASY5 is made by Schmid & Partner Engineering AG (SPEAG) in Zurich, Switzerland and consists of high precision robotics system (Staubli), robot controller, desktop 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. 3.1).

A cell controller system contains the power supply, robot controller each pendant (Joystick), and a remote control used to drive the robot motors. The PC consists of the Intel Core i7-3770 3.40 GHz desktop computer with Windows 7 system and SAR Measurement Software DASY5, 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.

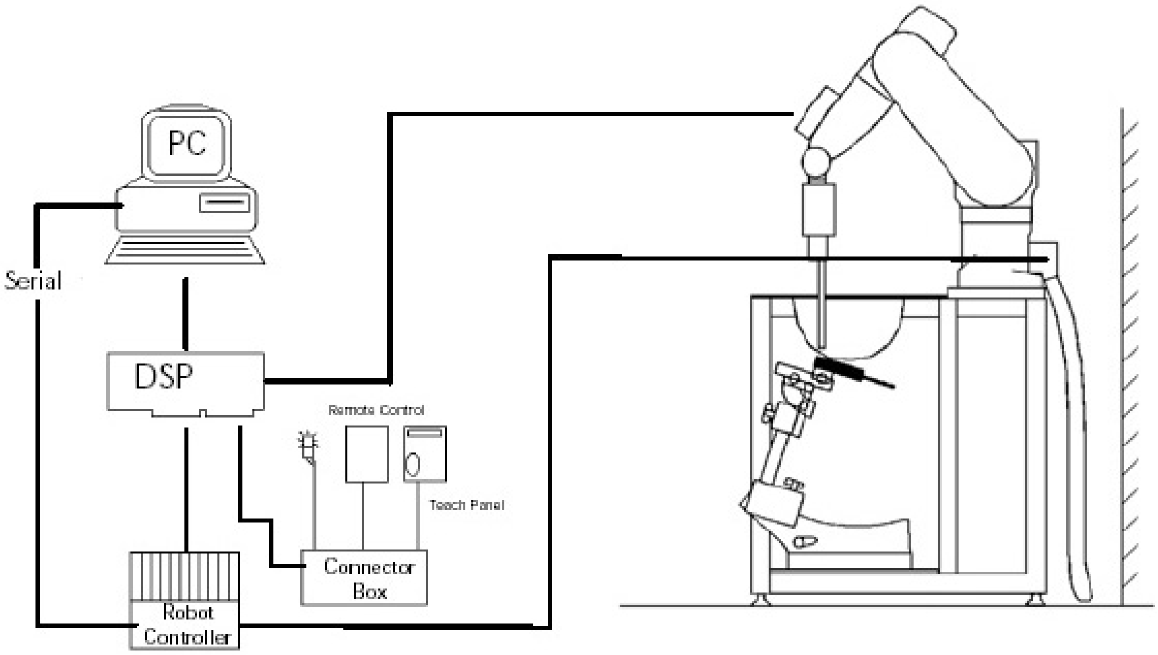


Figure 3.1 SAR Measurement System Setup

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.

3.2 EX3DV4Probe Specification

Calibration In air from 10 MHz to 6 GHz
In brain and muscle simulating tissue at Frequencies of
300 MHz, 450 MHz, 600 MHz, 750 MHz, 835 MHz, 900 MHz, 1750 MHz, 1900 MHz, 2300 MHz
2450 MHz, 2600 MHz, 3500 MHz, 5200 MHz, 5300 MHz, 5500 MHz, 5600 MHz, 5800 MHz

Frequency 10 MHz to 6 GHz

Linearity ± 0.2 dB(30 MHz to 6 GHz)

Dynamic 10 μW/g to > 100 mW/g

Range Linearity : ± 0.2 dB

Dimensions Overall length : 337 mm

Tip length 20 mm

Body diameter 12 mm

Tip diameter 2.5 mm

Distance from probe tip to sensor center 1.0 mm

Application SAR Dosimetry Testing
Compliance tests of mobile phones

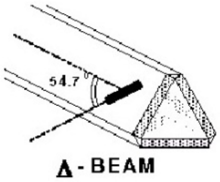


Figure 3.2 Triangular Probe Configurations

Figure 3.3 Probe Thick-Film Technique

DAE System

The SAR measurements were conducted with the dosimetric probe EX3DV4, designed in the classical triangular configuration(see Fig. 3.2) 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 multitier line ending at the front of the probe tip. 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 DASY5 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.

3.3 Probe Calibration Process

3.3.1 E-Probe Calibration

Dosimetric Assessment Procedure

Each probe is calibrated according to a dosimetric assessment procedure with accuracy better than +/- 10%. The spherical isotropy was evaluated with the procedure 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.

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 the remits or based temperature probe is used in conjunction with the E-field probe.

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

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

where:

Δt = exposure time (30 seconds),

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

ΔT = temperature increase due to RF exposure.

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;

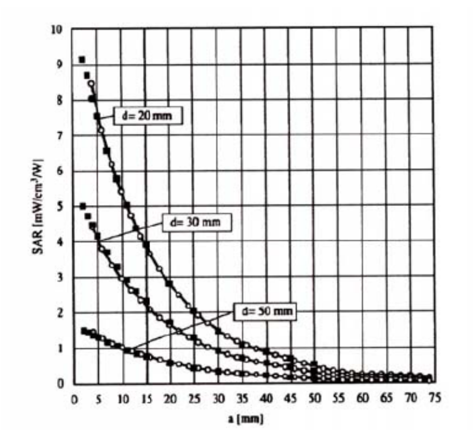


Figure 3.4E-Field and Temperature Measurements at 900MHz

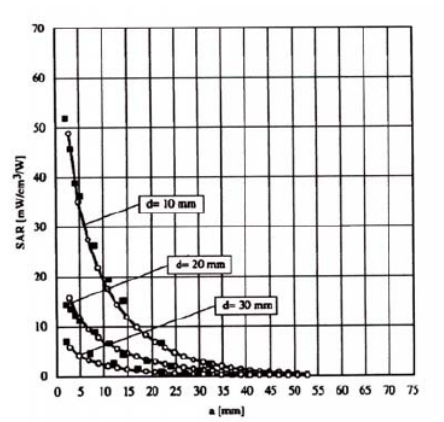


Figure 3.5 E-Field and Temperature Measurements at 1800MHz

3.4 Data Extrapolation

The DASY5 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/cm³

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/cm²
E_{tot} = total electric field strength in V/m

3.5 ELI PHANTOM

Phantom for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30 MHz to 6 GHz. ELI is fully compatible with the IEC 62209-2 standard and all known tissue simulating liquids. ELI has been optimized regarding its performance and can be integrated into our standard phantom tables. A cover prevents evaporation of the liquid. Reference markings on the phantom allow installation of the complete setup, including all predefined phantom positions and measurement grids, by teaching three points. The phantom is compatible with all SPEAG dosimetric probes and dipoles.

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. 3.6)

Figure 3.6 ELI Phantom

ELI Phantom Specification:

Construction	ELI V5.0 has the same shell geometry and is manufactured from the same material as ELI4, but has reinforced top structure. ELI V6.0, released in August 2014, has the same shell geometry as ELI4 but offers increased long term stability. A cover prevents evaporation of the liquid. Reference markings on the phantom allow the complete setup of all predefined phantom positions and measurement grids by teaching three points with the robot. The liquid depth is maintained at a minimum depth of 15cm to minimize reflections from the upper surface.
Shell Thickness	2.0 ± 0.2 mm
Filling Volume	Approx. 30 liters
Dimensions	Major axis: 600 mm Minor axis: 400 mm

3.6 Device Holder for Transmitters

In combination with the Twin SAM V5.0/V5.0c or ELI Phantoms, the Mounting Device (Body-Worn) enables testing of tansmitter devices according to IEC 62209-2 specifications. The device holder can be locked for positioning at flat phantom section.
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.

Figure 3.7 Mounting Device

3.7 Muscle Simulation Mixture Characterization

The muscle mixtures consist of a viscous gel using hydrox-ethylcellulose (HEC) gelling agent and saline solution (see Table 3.1). Preservation with a bactericide is added and visual inspection is made to make sure air bubbles are not trapped during the mixing process. The mixture is calibrated to obtain proper dielectric constant (permittivity) and conductivity of the desired tissue. The mixture characterizations used for the muscle tissue simulating liquids are according to the data by C. Gabriel and G. Hartsgrove.


Figure 3.8 Simulated Tissues

Table3.1 Composition of the Tissue Equivalent Matter

Ingredients (% by weight)	Frequency (MHz)			
	835	1900	2450	5200 ~ 5800
Tissue Type	**Body**	**Body**	**Body**	**Body**
Water	50.75	70.23	73.40	80.00
Salt (NaCl)	0.940	0.290	0.060	-
Sugar	48.21	-	-	-
HEC	-	-	-	-
Bactericide	0.100	-	-	-
Triton X-100	-	-	-	-
DGBE	-	29.48	26.54	-
Diethylene glycol hexyl ether	-	-	-	-
Polysorbate (Tween) 80	-	-	-	20.00
Target for Dielectric Constant	55.2	53.3	52.7	-
Target for Conductivity (S/m)	0.97	1.52	1.95	-

Salt:	99 % Pure Sodium Chloride	Sugar:	98 % Pure Sucrose
Water:	De-ionized, 16M resistivity	HEC:	Hydroxyethyl Cellulose
DGBE:	99 % Di(ethylene glycol) butyl ether,[2-(2-butoxyethoxy) ethanol]		
Triton X-100(ultra pure):	Polyethylene glycol mono[4-(1,1,3,3-tetramethylbutyl)phenyl] ether		

3.8 SAR TEST EQUIPMENT

Table 3.2 Test Equipment Calibration

	Type	Manufacturer	Model	Cal.Date	Next.Cal.Date	S/N
☒	SEMITEC Engineering	SEMITEC	N/A	N/A	N/A	Shield Room
☒	Robot	SCHMID	TX90XL	N/A	N/A	F13/5RR2A1/A/01
☒	Robot Controller	SCHMID	CS8C	N/A	N/A	F13/5RR2A1/C/01
☒	Joystick	SCHMID	N/A	N/A	N/A	S-13200990
☒	IntelCorei7-3770 3.40 GHz Windows 7 Professional	N/A	N/A	N/A	N/A	N/A
☒	Probe Alignment Unit LB	N/A	N/A	N/A	N/A	SE UKS 030 AA
☒	Laptop Holder	SCHMID	SMLH1001CD	N/A	N/A	N/A
☒	2mm Oval Phantom	SCHMID	QDIVA001BB	N/A	N/A	1223
☒	Data Acquisition Electronics	SCHMID	DAE4V1	2015-08-27	2016-08-27	1396
☒	Dosimetric E-Field Probe	SCHMID	EX3DV4	2015-09-29	2017-09-29	3933
☐	Dummy Probe	N/A	N/A	N/A	N/A	N/A
☒	2450 MHz SAR Dipole	SCHMID	D2450V2	2015-09-28	2017-09-28	726
☒	5 GHz SAR Dipole	SCHMID	D5GHzV2	2015-03-23	2017-03-23	1103
☒	Network Analyzer	Agilent	E5071C	2014-12-19 2015-12-14	2015-12-19 2016-12-14	MY46111534
☒	Signal Generator	Agilent	E4438C	2015-09-09	2016-09-09	US41461520
☒	Amplifier	EMPOWER	BBS3Q7ELU	2015-09-09	2016-09-09	1020
☒	Amplifier	EMPOWER	BBS3Q8CCJ	2015-10-20	2016-10-20	1005
☒	Power Meter	HP	EPM-442A	2015-02-26	2016-02-26	GB37170267
☒	Power Meter	Anritsu	ML2495A	2015-09-23	2016-09-23	1435003
☒	Wide Bandwidth Power Sensor	Anritsu	MA2490A	2015-09-23	2016-09-23	1409034
☒	Power Sensor	HP	8481A	2015-02-26	2016-02-26	3318A96566
☒	Power Sensor	HP	8481A	2015-02-06	2016-02-06	2702A65976
☒	Dual Directional Coupler	Agilent	778D-012	2015-01-06	2016-01-06	50228
☒	Directional Coupler	HP	772D	2015-07-27	2016-07-27	2889A01064
☒	Low Pass Filter 3.0 GHz	Micro LAB	LA-30N	2015-09-09	2016-09-09	N/A
☒	Low Pass Filter 6.0 GHz	Micro LAB	LA-60N	2015-02-25	2016-02-25	N/A
☒	Attenuators (3 dB)	Agilent	8491B	2015-06-26	2016-06-26	MY39260700
☒	Attenuators (10 dB)	WEINSCHEL	23-10-34	2015-01-06	2016-01-06	BP4387
☐	Step Attenuator	HP	8494A	2015-09-10	2016-09-10	3308A33341
☒	Dielectric Probe kit	SCHMID	DAK-3.5	2014-12-09 2015-11-19	2015-12-09 2016-11-19	1092
☒	Power Splitter	Anritsu	K241B	2015-02-25	2016-02-25	1301184
☒	Bluetooth Tester	TESCOM	TC-3000B	2015-01-06	2016-01-06	3000B770243

NOTE: The E-field probe was calibrated by SPEAG, by temperature measurement procedure. Dipole Verification measurement is performed by DT&C before each test. The brain and muscle simulating material are calibrated by DT&C using the dielectric probe system and network analyzer to determine the conductivity and permittivity (dielectric constant) of the brain-equivalent material. Each equipment item was used solely within its respective calibration period.

4. TEST SYSTEM SPECIFICATIONS

Automated TEST SYSTEM SPECIFICATIONS:

Positioner

Robot	Stäubli Unimation Corp. Robot Model: TX60L
Repeatability	0.02 mm
No. of axis	6

Data Acquisition Electronic (DAE) System

Cell Controller

Processor	Intel Core i7-3770
Clock Speed	3.40 GHz
Operating System	Windows 7 Professional
Data Card	DASY5 PC-Board

Data Converter

Features	Signal, multiplexer, A/D converter. & control logic
Software	DASY5
Connecting Lines	Optical downlink for data and status info Optical uplink for commands and clock

PC Interface Card

Function	24 bit (64 MHz) DSP for real time processing Link to DAE 4 16 bit A/D converter for surface detection system serial link to robot direct emergency stop output for robot

E-Field Probes

Model	EX3DV4 S/N: 3933
Construction	Triangular core fiber optic detection system
Frequency	10 MHz to 6 GHz
Linearity	± 0.2 dB (30 MHz to 6 GHz)

Phantom

Phantom	SAM Twin Phantom (V5.0)
Shell Material	Composite
Thickness	2.0 ± 0.2 mm

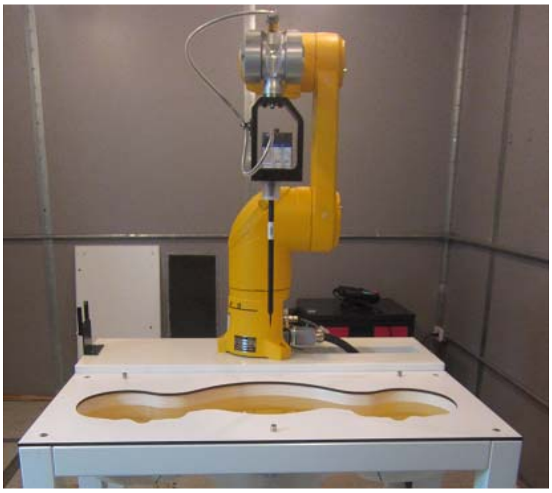


Figure 4.1 DASY5 Test System

5. SAR MEASUREMENT PROCEDURE

5.1 Measurement Procedure

The evaluation was performed using the following procedure compliant to
FCC KDB Publication 865664 D01v01r04 and IEEE 1528-2013:

1. The SAR distribution at the exposed side of the head or body was measured at a distance no greater than 5.0 mm from the inner surface of the shell. The area covered the entire dimension of the device-head and body interface and the horizontal grid resolution was determined per FCC KDB Publication 865664 D01v01r04 (See Table 5-1) and IEEE1528-2013.

2. The point SAR measurement was taken at the maximum SAR region determined from Step 1 to enable the monitoring of SAR fluctuations/drifts during the 1g/10g cube evaluation. SAR at this fixed point was measured and used as a reference value.

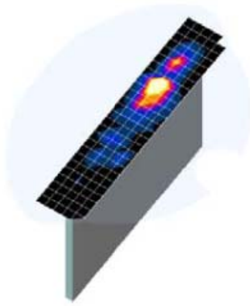


Figure 5.1
Sample SAR Area Scan

3. Based on the area scan data, the peak of the region with maximum SAR was determined by spline interpolation. Around this point, a volume was assessed according to the measurement resolution and volume size requirements of FCC KDB Publication 865664 D01v01r04 (See Table 5-1) and IEEE 1528-2013. On the basis of this data set, the spatial peak SAR value was evaluated with the following procedure (see references or the DASY manual online for more details):

   a. SAR values at the inner surface of the phantom are extrapolated from the measured values along the line away from the surface with spacing no greater than that in Table 3-1. The extrapolation was based on a least-squares algorithm. A polynomial of the fourth order was calculated through the points in the z-axis (normal to the phantom shell).

   b. After the maximum interpolated values were calculated between the points in the cube, the SAR was averaged over the spatial volume (1g or 10g) using a 3D-Spline interpolation algorithm. The 3D-spline is composed of three one-dimensional splines with the “Not a knot” condition (in x, y, and z directions). The volume was then integrated with the trapezoidal algorithm. One thousand points (10 x 10 x 10) were obtained through interpolation, in order to calculate the averaged SAR.

   c. All neighboring volumes were evaluated until no neighboring volume with a higher average value was found.

4. The SAR reference value, at the same location as step 2, was re-measured after the zoom scan was complete to calculate the SAR drift. If the drift deviated by more than 5%, the SAR test and drift measurements were repeated.

Frequency	Maximum Area Scan Resolution (mm) (Δx_{area}, Δy_{area})	Maximum Zoom Scan Resolution (mm) (Δx_{zoom}, Δy_{zoom})	Maximum Zoom Scan Spatial Resolution (mm)			Minimum Zoom Scan Volume (mm) (x,y,z)
			Uniform Grid	Graded Grid		
			$\Delta z_{zoom}(n)$	$\Delta z_{zoom}(1)$*	$\Delta z_{zoom}(n>1)$*	
≤ 2 GHz	≤ 15	≤ 8	≤ 5	≤ 4	≤ 1.5*$\Delta z_{zoom}(n-1)$	≥ 30
2-3 GHz	≤ 12	≤ 5	≤ 5	≤ 4	≤ 1.5*$\Delta z_{zoom}(n-1)$	≥ 30
3-4 GHz	≤ 12	≤ 5	≤ 4	≤ 3	≤ 1.5*$\Delta z_{zoom}(n-1)$	≥ 28
4-5 GHz	≤ 10	≤ 4	≤ 3	≤ 2.5	≤ 1.5*$\Delta z_{zoom}(n-1)$	≥ 25
5-6 GHz	≤ 10	≤ 4	≤ 2	≤ 2	≤ 1.5*$\Delta z_{zoom}(n-1)$	≥ 22

Table 5.1 Area and Zoom Scan Resolutions per FCC KDB Publication 865664 D01v01r04*
*Also compliant to IEEE 1528-2013 Table 6

6. RF EXPOSURE LIMITS

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 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 8.1.SAR Human Exposure Specified in ANSI/IEEE C95.1-2005

	HUMAN EXPOSURE LIMITS	
	General Public Exposure (W/kg) or (mW/g)	Occupational Exposure (W/kg) or (mW/g)
SPATIAL PEAK SAR * (Brain)	1.60	8.00
SPATIAL AVERAGE SAR ** (Whole Body)	0.08	0.40
SPATIAL PEAK SAR *** (Hands / Feet / Ankle / Wrist)	4.00	20.0

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.

Uncontrolled Environments are defined as locations where there is the exposure of individuals who have no knowledge or control of their exposure.

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).

7. FCC MEASUREMENT PROCEDURES

Power measurements were performed using a base station simulator under digital average power.

7.1 Measured and Reported SAR

Per FCC KDB Publication 447498 D01v06, When SAR is not measured at the maximum power level allowed for production units, the results must be scaled to the maximum tune-up tolerance limit according to the power applied to the individual channels tested to determine compliance. For simultaneous transmission, the measured aggregate SAR must be scaled according to the sum of the differences between the maximum tune-up tolerance and actual power used to test each transmitter. When SAR is measured at or scaled to the maximum tune-up tolerance limit, the results are referred to as reported SAR. The highest reported SAR results are identified on the grant of equipment authorization according to procedures in KDB 690783 D01v01r03.

7.2 SAR Testing with 802.11 Transmitters

Normal network operating configurations are not suitable for measuring the SAR of 802.11 b/g/n transmitters. Unpredictable fluctuations in network traffic and antenna diversity conditions can introduce undesirable variations in SAR results. The SAR for these devices should be measured using chipset based test mode software to ensure the results are consistent and reliable. See KDB Publication 248227 D01v02r02 for more details.

7.2.1 General Device Setup

Chipset based test mode software is hardware dependent and generally varies among manufacturers. The device operating parameters established in test mode for SAR measurements must be identical to those programmed in production units, including output power levels, amplifier gain settings and other RF performance tuning parameters. The test frequencies should correspond to actual channel frequencies defined for domestic use. SAR for devices with switched diversity should be measured with only one antenna transmitting at a time during each SAR measurement, according to a fixed modulation and data rate. The same data pattern should be used for all measurements.

A periodic duty factor is required for current generation SAR systems to measure SAR. When 802.11 frame gaps are accounted for in the transmission, a maximum transmission duty factor of 92 - 96 % is typically achievable in most test mode configurations. A minimum transmission duty factor of 85% is required to avoid certain hardware and device implementation issues related to wide range SAR scaling. The reported SAR is scaled to 100% transmission duty factor to determine compliance at the maximum tune-up tolerance limit.

7.2.2 U-NII and U-NII-2A

For devices that operate in only one of the U-NII-1 and U-NII-2A bands, the normally required SAR procedures for OFDM configurations are applied. For devices that operate in both U-NII bands using the same transmitter and antenna(s), SAR test reduction is determined according to the following, with respect to the highest reported SAR and maximum output power specified for production units. The procedures are applied independently to each exposure configuration; for example, head, body, hotspot mode etc.

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

7.2.3 U-NII-2C and U-NII-3

The frequency range covered by U-NII-2C and U-NII-3 is 380 MHz (5.47 – 5.85 GHz), which requires a minimum of at least two SAR probe calibration frequency points to support SAR measurements.
When Terminal Doppler Weather Rader (TDWR) restriction applies, the channels at 5.60 – 5.65 GHz in U-NII-2C band must be disabled with acceptable mechanisms and documented in the equipment certification.
Unless band gap channels are permanently disabled, SAR must be considered for these channels. When band gap channels are disabled, each band is tested independently according to the normally required OFDM SAR measurements and probe calibration frequency points requirements.

7.2.4 Initial Test Position Procedure

For exposure conditions with multiple test positions, such as handset operating next to the ear, devices with hotspot mode or UMPC mini-tablet, procedures for initial test position can be applied. Using the transmission mode determined by the DSSS procedure or initial test configuration, area scans are measured for all position in an exposure condition. The test position with the highest extrapolated (peak) SAR is used as the initial test position. When reported SAR for the initial test position is ≤ 0.4 W/kg, no additional testing for the remaining test positions is required. Otherwise, SAR is evaluated at the subsequent highest peak SAR position until the reported SAR result is ≤ 0.8 W/kg or all test position are measured.

7.2.5 2.4 GHz SAR Test Requirements

SAR is measured for 2.4 GHz 802.11b DSSS using either a fixed test position or, when applicable, the initial test position procedure. SAR test reduction is determined according to the following:

1) When the reported SAR of the highest measured maximum output power channel for the exposure configuration is ≤ 0.8 W/kg, no further SAR testing is required for 802.11b DSSS in that exposure configuration.
2) When the reported SAR is > 0.8 W/kg, SAR is required for that exposure configuration using the next highest measured output power channel. When any reported SAR is > 1.2 W/kg, SAR is required for the third channel; i.e., all channels require testing.

2.4 GHz 802.11 g/n OFDM are additionally evaluated for SAR if the highest reported SAR for 802.11b, adjusted by the ratio of the OFDM to DSSS specified maximum output power is > 1.2 W/kg. When SAR is required for OFDM modes in 2.4 GHz band, the Initial Test Configuration Procedures should be followed.

7.2.6 OFDM Transmission Mode and SAR Test Channel Selection

For the 2.4 GHz and 5 GHz bands, when the same maximum output power was specified for multiple OFDM transmission mode configurations in a frequency band or aggregated band, SAR is measured using the configuration with the largest channel bandwidth, lowest order modulation and lowest data rate. When the maximum output power of a channel is the same for equivalent OFDM configurations; for example, 802.11a and 802.11n or 802.11g and 802.11n with the same channel bandwidth, modulation and data rate etc., the lower order 802.11 mode i.e., 802.11a, then 80211n or 802.11g then 802.11n is used for SAR measurement. When the maximum output power ware the same for multiple test channels, either according to the default or additional power measurement requirements, SAR is measured using the channel closest to the middle of the frequency band or aggregated band. When there are multiple channels with the same maximum output power, SAR is measured using the higher number channel.

7.2.7 Initial Test Configuration Procedure

For OFDM, in both 2.4 and 5 GHz bands, an initial test configuration is determined for each frequency band and aggregated band, according to the transmission mode with the highest maximum output power specified for SAR measurements. When the same maximum output is specified for multiple OFDM transmission mode configurations in a frequency band or aggregated band, SAR is measured using the configuration(s) with the largest channel bandwidth, lowest order modulation, and lowest data rate. The channel of the transmission mode with the highest average RF output conducted power will be the initial test configuration.

7.2.8 Subsequent Test Configuration Procedures

For OFDM configurations, in each frequency band and aggregated band, SAR is evaluated for initial test configuration using the fixed test position or the initial test position procedure, when applicable. When the highest reported SAR for the initial test configuration, adjusted by the ratio of the subsequent test configuration to initial test configuration specified maximum output power is ≤ 1.2 W/kg, no additional SAR testing for the subsequent test configurations is required.

7.2.9 Simultaneous Transmission of MIMO Chains

The simultaneous transmission conditions for MIMO must be considered separately for each standalone and aggregated frequency band according to the 802.11 transmission mode configurations and exposure conditions to determine SAR compliance. The aggregate maximum output power of all simultaneous transmitting antennas in all transmission chains may be used to determine SAR test exclusion for each frequency band and transmission mode configuration. The most conservative SAR test separation distance among the antennas must be used to apply the standalone SAR test exclusion provisions in KDB Publication 447498. When this power-based standalone SAR test exclusion does not apply, the sum of 1-g SAR provision in KDB Publication 447498 should be used to determine simultaneous transmission SAR test exclusion.

8. RF CONDUCTED POWERS

8.1 WLAN Conducted Powers

Mode	Freq. (MHz)	Channel	802.11b (2.4 GHz) Conducted Power (dBm) Ant 1 Data Rate (Mbps)			
			1	2	5.5	11
802.11b	2412	1	13.57	13.52	13.47	13.53
	2437	6	<u>**17.81**</u>	17.72	17.65	17.73
	2462	11	12.88	12.84	12.84	12.63

Table 8.1 IEEE 802.11b Average RF Power Ant 1

Mode	Freq. (MHz)	Channel	802.11b (2.4 GHz) Conducted Power (dBm) Ant 2 Data Rate (Mbps)			
			1	2	5.5	11
802.11b	2412	1	16.10	16.06	16.07	15.90
	2437	6	<u>**16.55**</u>	16.39	16.30	16.33
	2462	11	16.07	15.98	15.98	16.06

Table 8.2 IEEE 802.11b Average RF Power Ant 2

Mode	Freq. (MHz)	Channel	802.11g (2.4 GHz) Conducted Power (dBm) Ant 1 Data Rate (Mbps)							
			6	9	12	18	24	36	48	54
802.11g	2412	1	10.89	10.73	10.81	10.83	10.73	10.87	10.73	10.83
	2437	6	17.50	17.46	17.41	17.38	17.27	17.28	17.47	17.32
	2462	11	10.63	10.59	10.60	10.43	10.48	10.48	10.43	10.53

Table 8.3 IEEE 802.11g Average RF Power Ant 1

Mode	Freq. (MHz)	Channel	802.11g (2.4 GHz) Conducted Power (dBm) Ant 2 Data Rate (Mbps)							
			6	9	12	18	24	36	48	54
802.11g	2412	1	12.44	12.22	12.41	12.25	12.19	12.19	12.33	12.33
	2437	6	17.32	17.14	17.15	17.25	17.10	17.11	17.27	17.25
	2462	11	11.82	11.65	11.72	11.77	11.58	11.77	11.57	11.67

Table 8.4 IEEE 802.11g Average RF Power Ant 2

Mode	Freq. (MHz)	Channel	802.11n HT20 (2.4 GHz) Conducted Power (dBm) Ant 1							
			Data Rate (Mbps)							
			MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
802.11n (HT-20)	2412	1	9.56	9.44	9.40	9.51	9.48	9.36	9.42	9.36
	2437	6	17.88	17.73	17.65	17.77	17.73	17.69	17.70	17.83
	2462	11	9.76	9.54	9.73	9.57	9.51	9.51	9.65	9.65

Table 8.5 IEEE 802.11n HT20 Average RF Power Ant 1

Mode	Freq. (MHz)	Channel	802.11n HT20 (2.4 GHz) Conducted Power (dBm) Ant 2							
			Data Rate (Mbps)							
			MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
802.11n (HT-20)	2412	1	12.50	12.28	12.47	12.31	12.25	12.25	12.39	12.39
	2437	6	17.33	17.15	17.16	17.26	17.11	17.12	17.28	17.26
	2462	11	11.62	11.45	11.52	11.57	11.38	11.57	11.37	11.47

Table8.6 IEEE 802.11n HT20 Average RF Power Ant 2

Mode	Freq. (MHz)	Channel	802.11n HT20 (2.4 GHz) Conducted Power (dBm) MIMO							
			Data Rate (Mbps)							
			MCS8	MCS9	MCS10	MCS11	MCS12	MCS13	MCS14	MCS15
802.11n (HT-20)	2412	1	12.10	11.98	12.06	12.02	12.07	11.96	11.93	11.93
	2437	6	20.14	20.05	19.89	20.01	20.03	20.08	20.13	20.07
	2462	11	10.39	10.32	10.19	10.21	10.32	10.27	10.31	10.29

Table 8.7 IEEE 802.11n HT20 Average RF Power MIMO

Mode	Freq. (MHz)	Channel	802.11n HT40 (2.4 GHz) Conducted Power (dBm) Ant 1							
			Data Rate (Mbps)							
			MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
802.11n (HT-40)	2422	3	6.97	6.85	6.81	6.92	6.89	6.77	6.83	6.77
	2437	6	17.33	17.12	17.10	17.22	17.18	17.14	17.15	17.28
	2452	9	7.80	7.58	7.77	7.61	7.55	7.55	7.69	7.69

Table 8.8 IEEE 802.11n HT40 Average RF Power Ant 1

Mode	Freq. (MHz)	Channel	802.11n HT40 (2.4 GHz) Conducted Power (dBm) Ant 2							
			Data Rate (Mbps)							
			MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
802.11n (HT-40)	2422	3	9.18	9.13	9.06	9.07	9.06	9.03	9.15	8.93
	2437	6	17.21	17.09	17.09	17.08	17.13	17.14	17.10	17.14
	2452	9	10.94	10.86	10.86	10.91	10.89	10.83	10.73	10.82

Table 8.9 IEEE 802.11n HT40 Average RF Power Ant 2

Mode	Freq. (MHz)	Channel	802.11n HT40 (2.4 GHz) Conducted Power (dBm) MIMO							
			Data Rate (Mbps)							
			MCS8	MCS9	MCS10	MCS11	MCS12	MCS13	MCS14	MCS15
802.11n (HT-40)	2422	3	8.76	8.74	8.59	8.66	8.58	8.63	8.67	8.67
	2437	6	**20.05**	19.81	19.94	19.94	19.98	19.88	19.99	20.02
	2452	9	8.01	7.78	8.00	7.87	7.95	7.83	7.85	7.82

Table 8.10 IEEE 802.11n HT40 Average RF Power MIMO

Mode	Freq. (MHz)	Channel	802.11a (5 GHz) Conducted Power (dBm) Ant 1							
			Data Rate (Mbps)							
			6	9	12	18	24	36	48	54
802.11a	5180	36	9.64	9.61	9.43	9.40	9.63	9.51	9.58	9.63
	5200	40	9.92	9.83	9.91	9.78	9.82	9.68	9.70	9.90
	5220	44	9.41	9.34	9.31	9.18	9.32	9.33	9.25	9.34
	5240	48	9.95	9.72	9.93	9.85	9.92	9.74	9.82	9.79
	5260	52	10.42	10.36	10.30	10.35	10.35	10.18	10.21	10.19
	5280	56	12.37	12.19	12.33	12.17	12.19	12.17	12.36	12.14
	5300	60	10.93	10.83	10.87	10.72	10.78	10.76	10.85	10.88
	5320	64	11.52	11.38	11.34	11.46	11.29	11.31	11.38	11.41
	5500	100	13.72	13.60	13.70	13.60	13.63	13.61	13.62	13.55
	5580	116	15.34	15.30	15.18	15.28	15.26	15.27	15.12	15.17
	5660	132	15.48	15.40	15.28	15.33	15.44	15.27	15.44	15.39
	5720	144	13.25	13.15	13.14	13.04	13.17	13.09	13.03	13.15
	5745	149	15.35	15.34	15.22	15.18	15.22	15.27	15.33	15.22
	5785	157	15.05	14.99	15.00	14.83	15.01	14.99	14.93	14.92
	5825	165	**16.35**	16.22	16.28	16.14	16.32	16.34	16.22	16.25

Table 8.11 IEEE 802.11a Average RF Power Ant 1

Mode	Freq. (MHz)	Channel	802.11a (5 GHz) Conducted Power (dBm) Ant 2							
			Data Rate (Mbps)							
			6	9	12	18	24	36	48	54
802.11a	5180	36	13.92	13.84	13.85	13.70	13.75	13.91	13.75	13.70
	5200	40	16.37	16.23	16.32	16.26	16.34	16.31	16.23	16.27
	5220	44	16.21	16.13	16.05	15.99	16.11	16.17	16.08	16.17
	5240	48	15.02	14.89	14.94	15.00	14.89	14.86	14.79	14.81
	5260	52	14.93	14.90	14.70	14.83	14.87	14.88	14.76	14.69
	5280	56	15.92	15.72	15.72	15.89	15.91	15.72	15.83	15.89
	5300	60	14.22	14.09	14.00	14.19	14.13	14.11	14.00	14.02
	5320	64	13.13	13.06	12.96	13.06	13.12	13.03	12.99	12.96
	5500	100	14.05	13.88	13.93	13.93	13.82	14.03	13.83	13.92
	5580	116	16.28	16.06	16.19	16.24	16.19	16.19	16.15	16.21
	5660	132	16.07	15.90	15.99	15.84	15.97	15.85	16.06	15.95
	5720	144	13.99	13.91	13.84	13.86	13.82	13.97	13.81	13.97
	5745	149	15.25	15.15	15.09	15.22	15.11	15.16	15.07	15.14
	5785	157	15.24	15.16	15.14	15.08	15.21	15.11	15.14	15.06
	5825	165	15.03	14.96	14.85	14.79	14.98	14.95	14.87	14.91

Table 8.12 IEEE 802.11a Average RF Power Ant 2

Mode	Freq. (MHz)	Channel	802.11n HT20 (5 GHz) Conducted Power (dBm) Ant 1							
			Data Rate (Mbps)							
			MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
802.11n (HT-20)	5180	36	9.11	8.93	8.98	9.08	8.88	9.01	9.05	9.06
	5200	40	10.21	10.19	10.02	10.05	10.19	10.01	10.09	10.05
	5220	44	10.92	10.74	10.83	10.78	10.73	10.81	10.73	10.70
	5240	48	11.14	10.97	11.00	11.07	11.13	11.03	10.92	11.12
	5260	52	10.80	10.78	10.72	10.71	10.69	10.76	10.58	10.63
	5280	56	12.93	12.83	12.85	12.82	12.78	12.84	12.89	12.74
	5300	60	11.76	11.72	11.71	11.67	11.75	11.59	11.63	11.62
	5320	64	12.22	12.17	12.01	12.14	11.99	12.10	12.16	12.05
	5500	100	13.62	13.42	13.60	13.41	13.54	13.38	13.43	13.40
	5580	116	15.16	15.11	14.93	14.95	15.00	15.14	14.94	15.04
	5660	132	15.31	15.27	15.30	15.20	15.11	15.28	15.21	15.20
	5720	144	13.11	12.98	13.05	13.04	12.96	12.98	13.04	13.03
	5745	149	16.41	16.39	16.22	16.25	16.39	16.21	16.29	16.25
	5785	157	15.94	15.70	15.88	15.88	15.73	15.90	15.78	15.90
	5825	165	15.82	15.64	15.69	15.79	15.59	15.72	15.76	15.77

Table 8.13 IEEE 802.11n HT20 Average RF Power Ant 1

Mode	Freq. (MHz)	Channel	802.11n HT20 (5 GHz) Conducted Power (dBm) Ant 2							
			Data Rate (Mbps)							
			MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
802.11n (HT-20)	5180	36	13.88	13.80	13.64	13.69	13.66	13.77	13.85	13.68
	5200	40	16.38	16.19	16.28	16.16	16.16	16.35	16.14	16.24
	5220	44	16.15	15.95	16.12	16.05	16.04	15.97	16.05	16.02
	5240	48	14.94	14.79	14.81	14.87	14.86	14.76	14.92	14.90
	5260	52	14.71	14.62	14.60	14.67	14.49	14.54	14.53	14.48
	5280	56	15.84	15.63	15.80	15.68	15.80	15.73	15.71	15.67
	5300	60	14.05	14.01	13.97	13.84	13.87	13.87	14.01	13.88
	5320	64	13.07	12.89	12.85	12.87	12.92	13.06	12.98	12.91
	5500	100	13.55	13.44	13.40	13.37	13.40	13.45	13.52	13.33
	5580	116	16.12	15.96	16.11	15.89	15.98	16.02	16.09	15.90
	5660	132	15.95	15.91	15.77	15.78	15.94	15.78	15.90	15.71
	5720	144	12.88	12.76	12.78	12.78	12.85	12.78	12.65	12.82
	5745	149	15.07	14.99	14.84	14.95	15.01	14.90	15.05	14.93
	5785	157	15.15	14.98	14.94	14.98	14.93	15.07	15.04	15.08
	5825	165	14.94	14.72	14.90	14.86	14.86	14.90	14.86	14.77

Table 8.14 IEEE 802.11n HT20 Average RF Power Ant 2

Mode	Freq. (MHz)	Channel	802.11n HT20 (5 GHz) Conducted Power (dBm) MIMO								
			Data Rate (Mbps)								
			MCS8	MCS9	MCS10	MCS11	MCS12	MCS13	MCS14	MCS15	MCS16
802.11n (HT-20)	5180	36	12.29	12.14	12.15	12.17	12.24	12.14	12.16	12.20	12.29
	5200	40	13.14	13.06	13.00	13.07	12.99	13.01	13.01	12.97	13.14
	5220	44	13.74	13.65	13.70	13.61	13.52	13.60	13.51	13.67	13.74
	5240	48	14.41	14.31	14.27	14.30	14.27	14.27	14.30	14.22	14.41
	5260	52	14.38	14.25	14.20	14.30	14.34	14.27	14.35	14.16	14.38
	5280	56	14.51	14.32	14.40	14.46	14.40	14.39	14.30	14.38	14.51
	5300	60	**17.48**	17.26	17.34	17.40	17.37	17.34	17.40	17.26	17.48
	5320	64	15.29	15.24	15.19	15.15	15.13	15.16	15.19	15.14	15.29
	5500	100	19.60	19.50	19.44	19.49	19.47	19.45	19.56	19.45	19.60
	5580	116	19.77	19.63	19.64	19.73	19.59	19.64	19.65	19.69	19.77
	5660	132	18.29	18.18	18.14	18.15	18.21	18.22	18.17	18.17	18.29
	5720	144	18.45	18.30	18.37	18.44	18.31	18.34	18.24	18.34	18.45
	5745	149	18.25	18.05	18.13	18.16	18.09	18.11	18.15	18.05	18.25
	5785	157	**18.45**	18.33	18.34	18.29	18.38	18.33	18.35	18.32	18.45
	5825	165	17.57	17.44	17.51	17.41	17.48	17.39	17.46	17.45	17.57

Table 8.15 IEEE 802.11n HT20 Average RF Power MIMO

Mode	Freq. (MHz)	Channel	802.11n HT40 (5 GHz) Conducted Power (dBm) Ant 1							
			Data Rate (Mbps)							
			MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
802.11n (HT-40)	5190	38	11.51	11.40	11.29	11.49	11.34	11.43	11.28	11.41
	5230	46	10.77	10.56	10.54	10.58	10.67	10.55	10.55	10.74
	5270	54	12.90	12.78	12.78	12.66	12.78	12.70	12.87	12.77
	5310	62	12.53	12.52	12.34	12.51	12.45	12.43	12.37	12.50
	5510	102	12.37	12.23	12.33	12.31	12.30	12.19	12.13	12.32
	5550	110	16.11	15.97	16.07	16.07	16.04	16.05	15.99	16.07
	5670	134	16.25	16.13	16.14	16.06	16.08	16.08	16.16	16.14
	5710	142	**17.68**	17.64	17.55	17.56	17.65	17.47	17.50	17.67
	5755	151	14.04	13.98	13.80	13.85	13.91	13.92	14.03	13.98
	5795	159	15.15	14.95	15.13	14.94	15.07	14.91	14.96	14.93

Table 8.16 IEEE 802.11n HT20 Average RF Power Ant 1

Mode	Freq. (MHz)	Channel	802.11n HT40 (5 GHz) Conducted Power (dBm) Ant 2							
			Data Rate (Mbps)							
			MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
802.11n (HT-40)	5190	38	10.57	10.41	10.35	10.55	10.40	10.48	10.55	10.37
	5230	46	**16.38**	16.17	16.34	16.22	16.34	16.27	16.25	16.21
	5270	54	11.39	11.35	11.31	11.18	11.21	11.21	11.35	11.22
	5310	62	13.50	13.32	13.28	13.30	13.35	13.49	13.41	13.34
	5510	102	13.75	13.64	13.60	13.57	13.60	13.65	13.72	13.53
	5550	110	**17.51**	17.35	17.50	17.28	17.37	17.41	17.48	17.29
	5670	134	15.90	15.86	15.72	15.73	15.89	15.73	15.85	15.66
	5710	142	14.87	14.75	14.77	14.77	14.84	14.77	14.64	14.81
	5755	151	13.77	13.71	13.75	13.66	13.72	13.53	13.56	13.54
	5795	159	**15.01**	14.84	14.80	14.84	14.79	14.93	14.90	14.94

Table 8.17 IEEE 802.11n HT20 Average RF Power Ant 2

Mode	Freq. (MHz)	Channel	802.11n HT40 (5 GHz) Conducted Power (dBm) MIMO								
			Data Rate (Mbps)								
			MCS8	MCS9	MCS10	MCS11	MCS12	MCS13	MCS14	MCS15	MCS16
802.11n (HT-40)	5190	38	13.31	13.12	13.21	13.18	13.17	13.17	13.09	13.22	13.31
	5230	46	13.38	13.31	13.24	13.27	13.18	13.26	13.29	13.20	13.38
	5270	54	13.29	13.10	13.21	13.14	13.17	13.17	13.07	13.23	13.29
	5310	62	14.06	13.95	13.88	13.95	13.86	13.95	13.97	13.88	14.06
	5510	102	16.99	16.89	16.86	16.91	16.86	16.86	16.85	16.86	16.99
	5550	110	19.34	19.13	19.20	19.23	19.15	19.15	19.17	19.22	19.34
	5670	134	19.83	19.71	19.66	19.72	19.74	19.69	19.74	19.61	19.83
	5710	142	19.10	18.93	18.91	18.96	19.04	18.93	19.01	18.95	19.10
	5755	151	16.41	16.31	16.36	16.30	16.19	16.30	16.32	16.26	16.41
	5795	159	17.98	17.85	17.76	17.92	17.84	17.88	17.90	17.87	17.98

Table 8.18 IEEE 802.11n HT20 Average RF Power MIMO

Mode	Freq. (MHz)	Channel	802.11ac VHT20 (5 GHz) Conducted Power (dBm) Ant 1								
			Data Rate (Mbps)								
			MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7	MCS8
802.11ac (VHT-20)	5720	144	13.05	13.03	13.04	12.85	13.00	12.90	12.97	12.99	12.94

Table 8.19 IEEE 802.11ac VHT20 Average RF Power Ant 1

Mode	Freq. (MHz)	Channel	802.11ac VHT20 (5 GHz) Conducted Power (dBm) Ant 2								
			Data Rate (Mbps)								
			MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7	MCS8
802.11ac (VHT-20)	5720	144	12.75	12.56	12.52	12.66	12.57	12.66	12.68	12.57	12.69

Table 8.20 IEEE 802.11ac VHT20 Average RF Power Ant 2

Mode	Freq. (MHz)	Channel	802.11ac VHT20 (5 GHz) Conducted Power (dBm) MIMO								
			Data Rate (Mbps)								
			MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7	MCS8
802.11ac (VHT-20)	5720	144	16.35	16.18	16.30	16.30	16.12	16.21	16.28	16.31	16.22

Table 8.21 IEEE 802.11ac VHT20 Average RF Power MIMO

Mode	Freq. (MHz)	Channel	802.11ac VHT40 (5 GHz) Conducted Power (dBm) Ant 1									
			Data Rate (Mbps)									
			MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7	MCS8	MCS9
802.11ac (VHT-40)	5710	142	17.27	17.06	17.17	17.23	17.14	17.19	17.10	17.09	17.12	17.22

Table 8.22 IEEE 802.11ac VHT40 Average RF Power Ant 1

Mode	Freq. (MHz)	Channel	802.11ac VHT40 (5 GHz) Conducted Power (dBm) Ant 2									
			Data Rate (Mbps)									
			MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7	MCS8	MCS9
802.11ac (VHT-40)	5710	142	15.91	15.73	15.77	15.69	15.78	15.78	15.88	15.90	15.68	15.74

Table 8.23 IEEE 802.11ac VHT40 Average RF Power Ant 2

Mode	Freq. (MHz)	Channel	802.11ac VHT40 (5 GHz) Conducted Power (dBm) MIMO									
			Data Rate (Mbps)									
			MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7	MCS8	MCS9
802.11ac (VHT-40)	5710	142	18.13	18.08	17.95	18.01	18.05	18.02	18.04	18.01	18.05	17.99

Table 8.24 IEEE 802.11ac VHT40 Average RF Power MIMO

Mode	Freq. (MHz)	Channel	802.11ac VHT80 (5 GHz) Conducted Power (dBm) Ant 1 Data Rate (Mbps)									
			MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7	MCS8	MCS9
802.11ac (VHT-80)	5210	42	11.52	11.34	11.41	11.31	11.41	11.37	11.34	11.37	11.42	11.49
	5290	58	13.69	13.50	13.67	13.46	13.53	13.68	13.46	13.55	13.59	13.66
	5530	106	14.24	14.20	14.12	14.19	14.20	14.06	14.07	14.23	14.07	14.19
	5690	138	16.15	16.04	16.01	15.98	16.03	16.05	16.05	16.12	16.05	15.92
	5775	155	13.08	13.06	13.00	12.99	12.97	13.04	12.86	12.91	12.90	12.85

Table 8.25 IEEE 802.11ac VHT80 Average RF Power Ant 1

Mode	Freq. (MHz)	Channel	802.11ac VHT80 (5 GHz) Conducted Power (dBm) Ant 2 Data Rate (Mbps)									
			MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7	MCS8	MCS9
802.11ac (VHT-80)	5210	42	12.61	12.44	12.40	12.44	12.39	12.53	12.50	12.54	12.51	12.52
	5290	58	8.93	8.71	8.89	8.85	8.85	8.89	8.85	8.76	8.81	8.71
	5530	106	12.29	12.21	12.26	12.20	12.07	12.05	12.05	12.15	12.08	12.11
	5690	138	14.01	13.96	13.79	13.87	13.84	13.78	13.86	13.86	13.97	13.82
	5775	155	9.32	9.26	9.17	9.22	9.30	9.17	9.16	9.27	9.28	9.32

Table 8.26 IEEE 802.11ac VHT80 Average RF Power Ant 2

Mode	Freq. (MHz)	Channel	802.11ac VHT80 (5 GHz) Conducted Power (dBm) MIMO Data Rate (Mbps)									
			MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7	MCS8	MCS9
802.11ac (VHT-80)	5210	42	13.24	13.06	13.12	13.17	13.01	13.08	13.07	13.13	13.18	13.17
	5290	58	11.62	11.48	11.39	11.56	11.47	11.51	11.54	11.50	11.50	11.47
	5530	106	13.85	13.70	13.77	13.71	13.68	13.65	13.83	13.71	13.66	13.73
	5690	138	19.55	19.44	19.41	19.47	19.38	19.35	19.38	19.49	19.48	19.47
	5775	155	10.91	10.83	10.81	10.74	10.70	10.81	10.81	10.74	10.80	10.80

Table 8.27 IEEE 802.11ac VHT80 Average RF Power MIMO

Justification for reduced test configurations for WIFI channels per KDB Publication 248227 D01v02r01 and October 2012 / April 2013 FCC/TCB Meeting Notes:

- Power measurements were performed for the transmission mode configuration with the highest maximum output power specified for production units.
- For transmission modes with the same maximum output power specification, powers were measured for the largest channel bandwidth, lowest order modulation and lowest data rate.
- For transmission modes with identical maximum specified output power, channel bandwidth, modulation and data rates, power measurements were required for all identical configurations.
- For each transmission mode configuration, powers were measured for the highest and lowest channels; and at the mid-band channel(s) when there were at least 3 channels supported. For configurations with multiple mid-band channels, duo to an even number of channels, both channels were measured.
- Output Power and SAR is not required for 802.11 g/n HT20 channels when the highest reported SAR for DSSS is adjusted by the ratio of OFDM to DSSS specified maximum output power and the adjust SAR is ≤ 1.2 W/kg.
- The underlined data rate and channel above were tested for SAR.

The average output powers of this device were tested by below configuration.

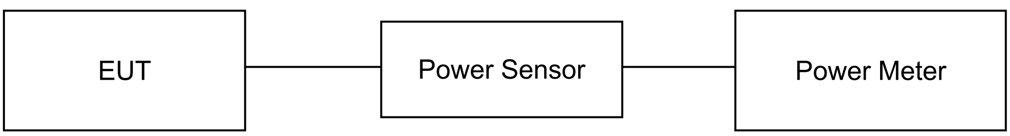


Figure 8.1 Power Measurement Setup

8.2 Bluetooth Conducted Powers

Channel	Frequency	Frame AVG Output Power (1Mbps)		Frame AVG Output Power (2Mbps)		Frame AVG Output Power (3Mbps)	
	(MHz)	(dBm)	(mW)	(dBm)	(mW)	(dBm)	(mW)
Low	2402	4.51	2.83	1.06	1.28	-0.05	0.99
Mid	2441	4.38	2.74	0.90	1.23	-0.02	1.00
High	2480	**4.60**	2.88	1.11	1.29	0.18	1.04

Table 8.28 Bluetooth Frame Average RF Power

Channel	Frequency	Frame AVG Output Power (LE)	
	(MHz)	(dBm)	(mW)
Low	2402	1.35	1.37
Mid	2440	1.72	1.49
High	2480	1.87	1.54

Table 8.29 Bluetooth LE Frame Average RF Power

- **Bluetooth Conducted Powers procedures**

1. Bluetooth (BDR, EDR)
 1) Enter DUT mode in EUT and operate it.
 When it operating, The EUT is transmitting at maximum power level and duty cycle fixed.
 2) Instruments and EUT were connected like Figure 10.4(A).
 3) The maximum output powers of BDR(1 Mbps), EDR(2, 3 Mbps) and each frequency were set by a Bluetooth Tester.
 4) Power levels were measured by a Power Meter.

2. Bluetooth (LE)
 1) Enter LE mode in EUT and operate it.
 When it operating, The EUT is transmitting at maximum power level and duty cycle fixed.
 2) Instruments and EUT were connected like Figure 10.4(B).
 3) The average conducted output powers of LE and each frequency can measurement according to setting program in EUT.
 4) Power levels were measured by a Power Meter.

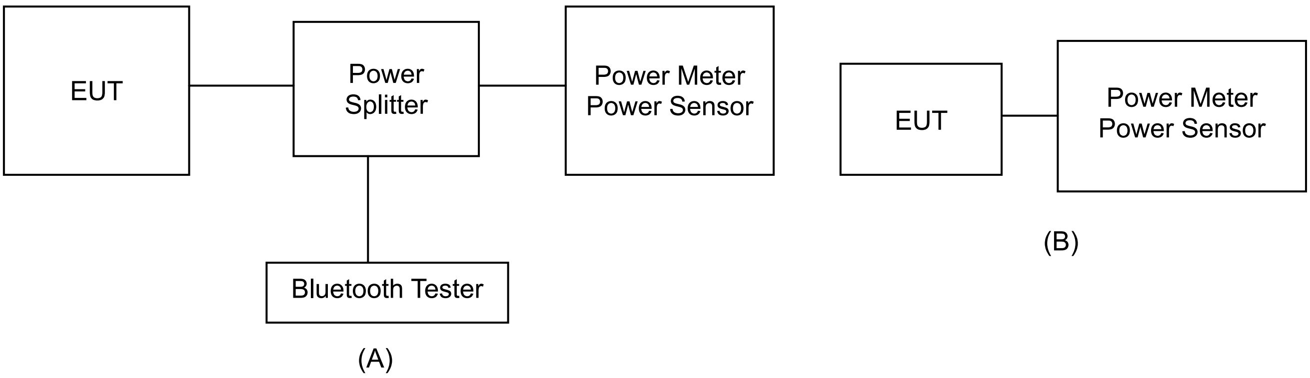


Figure 8.2 Average Power Measurement Setup

The average conducted output powers of Bluetooth were measured using above test setup and a wideband gated RF power meter when the EUT is transmitting at its maximum power level.

9. SYSTEM VERIFICATION

9.1 Tissue Verification

MEASURED TISSUE PARAMETERS										
Date(s)	**Tissue Type**	**Ambient Temp.[°C]**	**Liquid Temp.[°C]**	**Measured Frequency [MHz]**	**Target Dielectric Constant, εr**	**Target Conductivity, σ (S/m)**	**Measured Dielectric Constant, εr**	**Measured Conductivity, σ (S/m)**	**ErDeviation [%]**	**σ Deviation [%]**
Dec. 16. 2015	2450 Body	20.9	21.3	2402	52.760	1.904	51.256	1.917	-2.85	0.68
				2412	52.750	1.914	51.234	1.929	-2.87	0.78
				2422	52.740	1.923	51.210	1.941	-2.90	0.94
				2437	52.720	1.938	51.176	1.959	-2.93	1.08
				2441	52.710	1.941	51.165	1.963	-2.93	1.13
				2450	52.700	1.950	51.139	1.974	-2.96	1.23
				2452	52.700	1.953	51.135	1.977	-2.97	1.23
				2462	52.680	1.967	51.112	1.988	-2.98	1.07
				2480	52.660	1.993	51.060	2.009	-3.04	0.80
Dec. 17. 2015	5180~ 5320 Body	20.5	21.0	5180	49.040	5.276	49.536	5.217	1.01	-1.12
				5190	49.030	5.288	49.512	5.229	0.98	-1.12
				5200	49.010	5.299	49.485	5.244	0.97	-1.04
				5210	49.000	5.311	49.467	5.260	0.95	-0.96
				5220	48.990	5.323	49.459	5.275	0.96	-0.90
				5230	48.970	5.334	49.447	5.288	0.97	-0.86
				5240	48.960	5.346	49.431	5.300	0.96	-0.86
				5260	48.930	5.369	49.389	5.326	0.94	-0.80
				5270	48.920	5.381	49.365	5.341	0.91	-0.74
				5280	48.910	5.393	49.348	5.355	0.90	-0.70
				5290	48.890	5.404	49.333	5.366	0.91	-0.70
				5300	48.880	5.416	49.307	5.378	0.87	-0.70
				5310	48.860	5.428	49.278	5.393	0.86	-0.64
				5320	48.850	5.439	49.263	5.409	0.85	-0.55
Dec. 18. 2015	5500~ 5825 Body	20.7	20.9	5500	48.610	5.650	48.319	5.594	-0.60	-0.99
				5510	48.590	5.661	48.310	5.605	-0.58	-0.99
				5530	48.570	5.685	48.261	5.632	-0.64	-0.93
				5550	48.540	5.708	48.235	5.662	-0.63	-0.81
				5580	48.500	5.743	48.180	5.702	-0.66	-0.71
				5590	48.480.	5.755	48.162	5.717	-0.66	-0.66
				5600	48.470	5.766	48.145	5.733	-0.67	-0.57
				5660	48.390	5.836	48.050	5.815	-0.70	-0.36
				5670	48.380	5.848	48.035	5.828	-0.71	-0.34
				5690	48.350	5.872	47.996	5.856	-0.73	-0.27
				5700	48.340	5.883	47.975	5.872	-0.76	-0.19
				5710	48.320	5.895	47.961	5.889	-0.74	-0.10
				5720	48.310	5.907	47.955	5.902	-0.73	-0.08
				5745	48.270	5.936	47.902	5.932	-0.76	-0.07
				5755	48.260	5.947	47.886	5.949	-0.77	0.03
				5775	48.230	5.971	47.859	5.977	-0.77	0.10
				5785	48.220	5.982	47.839	5.990	-0.79	0.13
				5795	48.210	5.994	47.819	6.006	-0.81	0.20
				5800	48.200	6.000	47.810	6.013	-0.81	0.22
				5825	48.170	6.029	47.777	6.052	-0.82	0.38

The above measured tissue parameters were used in the DASY software. The DASY software was used to perform interpolation to determine the dielectric parameters at the SAR test device frequencies (per KDB 865664 and IEEE 1528-2013 6.6.1.2). The tissue parameters listed in the SAR test plots may slightly differ from the table above due to significant digit rounding in the software.

Measurement Procedure for Tissue verification:

1) The network analyzer and probe system was configured and calibrated.
2) The probe was immersed in the sample which was placed in a nonmetallic container. Trapped air bubbles beneath the flange were minimized by placing the probe at a slight angle.
3) The complex admittance with respect to the probe aperture was measured
4) The complex relative permittivity , for example from the below equation (Pournaropoulos and Misra):

$$Y = \frac{j2\omega\varepsilon_r\varepsilon_0}{[\ln(b/a)]^2}\int_a^b\int_a^b\int_0^\pi \cos\phi' \frac{\exp\left[-j\omega r(\mu_0\varepsilon_r'\varepsilon_0)^{1/2}\right]}{r} d\phi' d\rho' d\rho$$

where Y is the admittance of the probe in contact with the sample, the primed and unprimed coordinates refer to source and observation points, respectively, $r^2 = \rho^2 + \rho'^2 - 2\rho\rho'\cos\phi'$, ω is the angular frequency, and $j = \sqrt{-1}$.

9.2 Test System Verification

Prior to assessment, the system is verified to the ± 10 % of the specifications at 2450 MHz and 5 GHz by using the SAR Dipole kit(s). (Graphic Plots Attached)

SYSTEM DIPOLE VERIFICATION TARGET & MEASURED												
SAR System #	Freq. [MHz]	SAR Dipole kits	Date(s)	Tissue Type	Ambient Temp.[°C]	Liquid Temp.[°C]	Probe S/N	Input Power (mW)	1 W Target SAR_{1g} (W/kg)	Measured SAR_{1g} (W/kg)	1 W Normalized SAR_{1g} (W/kg)	Deviation [%]
D	2450	D2450V2, SN: 726	Dec. 16. 2015	Body	20.9	21.3	3933	250	49.5	12.9	51.6	4.24
D	5200	D5GV2, SN: 1103	Dec. 17. 2015	Body	20.5	21.0	3933	100	74.6	7.79	77.9	4.42
D	5300	D5GV2, SN: 1103	Dec. 17. 2015	Body	20.5	21.0	3933	100	75.0	7.22	72.2	-3.73
D	5500	D5GV2, SN: 1103	Dec. 18. 2015	Body	20.7	20.9	3933	100	80.2	7.61	76.1	-5.11
D	5600	D5GV2, SN: 1103	Dec. 18. 2015	Body	20.7	20.9	3933	100	78.7	8.06	80.6	2.41
D	5800	D5GV2, SN: 1103	Dec. 18. 2015	Body	20.7	20.9	3933	100	76.8	7.80	78.0	1.56

Note1 : System Verification was measured with input 250 mW , 100 mW(5200-5800 MHz) and normalized to 1W.
Note2 : To confirm the proper SAR liquid depth, the z-axis plots from the system verifications were included since the system verifications were performed using the same liquid, probe and DAE as the SAR tests in the same time period.
Note3: Full system validation status and results can be found in Attachment 3.

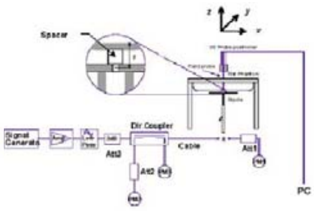


Figure 11.1 Dipole Verification Test Setup Diagram & Photo

10. SAR TEST RESULTS

10.1 Body SAR Results

Table 10.1 DTS Body SAR

MEASUREMENT RESULTS															
FREQUENCY		Mode/ Antenna	Service	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Drift Power [dB]	Phantom Position	Device Serial Number	Data Rate [Mbps]	Duty Cycle	1g SAR (W/kg)	Scaling Factor (Power)	Scaling Factor (Duty Cycle)	1g Scaled SAR (W/kg)	Plots #
MHz	Ch														
2437	6	802.11b Ant.1	DSSS	18.00	17.81	-0.080	0 mm [Rear]	FCC #1	1	98.8	0.165	1.045	1.012	**0.174**	A1
2437	6	802.11b Ant.2	DSSS	17.00	16.55	-0.010	0 mm [Rear]	FCC #1	1	98.8	0.381	1.069	1.012	**0.428**	A2
2437	6	802.11n HT40 MIMO	OFDM	20.50	20.05	-0.180	0 mm [Rear]	FCC #1	MCS8	94.7	0.365	1.109	1.056	**0.427**	A3
ANSI / IEEE C95.1-2005– SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population Exposure									**Body 1.6 W/kg (mW/g)** averaged over 1 gram						

Note: The rear with touch configuration was only tested since only the rear is touched to human body in normal operation condition of this device.

Adjusted SAR results for OFDM SAR												
FREQUENCY		Mode/ Antenna	Service	Maximum Allowed Power [dBm]	1g Scaled SAR (W/kg)	FREQUENCY [MHz]	Mode	Service	Maximum Allowed Power [dBm	Ratio of OFDM to DSSS	1g Adjusted SAR (W/kg)	Determine OFDM SAR
MHz	Ch											
2437	6	802.11b Ant.1	DSSS	18.00	0.174	2437	802.11g	OFDM	17.50	0.891	**0.155**	X
2437	6	802.11b Ant.1	DSSS	18.00	0.174	2437	802.11n HT20	OFDM	18.00	1.000	**0.174**	X
2437	6	802.11b Ant.1	DSSS	18.00	0.174	2437	802.11n HT40	OFDM	17.50	0.891	**0.155**	X
2437	6	802.11b Ant.2	DSSS	17.00	0.434	2437	802.11g	OFDM	17.50	1.122	**0.480**	X
2437	6	802.11b Ant.2	DSSS	17.00	0.434	2437	802.11n HT20	OFDM	17.50	1.122	**0.480**	X
2437	6	802.11b Ant.2	DSSS	17.00	0.434	2437	802.11n HT40	OFDM	17.50	1.122	**0.480**	X
2437	6	802.11n HT40 MIMO	OFDM	20.50	0.427	2437	802.11n HT20 MIMO	OFDM	20.50	1.000	**0.427**	X
ANSI / IEEE C95.1-2005– SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population Exposure							**Body 1.6 W/kg (mW/g)** averaged over 1 gram					

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

Table 10.2 UNII Body SAR

MEASUREMENT RESULTS															
FREQUENCY		Mode/ Antenna	Service	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Drift Power [dB]	Phantom Position	Device Serial Number	Data Rate [Mbps]	Duty Cycle	1g SAR (W/kg)	Scaling Factor (Power)	Scaling Factor (Duty Cycle)	1g Scaled SAR (W/kg)	Plots #
MHz	Ch														
5290	58	802.11ac VHT80 Ant.1	OFDM	14.00	13.69	-0.000	0 mm [Rear]	FCC #1	MCS0	93.7	0.331	1.074	1.067	**0.379**	A4
5710	142	802.11n HT40 Ant.1	OFDM	18.00	17.68	0.060	0 mm [Rear]	FCC #1	MCS0	97.0	0.227	1.076	1.031	**0.252**	A5
5825	165	802.11a Ant.1	OFDM	16.50	16.35	-0.040	0 mm [Rear]	FCC #1	6	98.6	0.278	1.035	1.014	**0.292**	A6
5230	46	802.11n HT40 Ant.2	OFDM	16.50	16.38	0.100	0 mm [Rear]	FCC #1	MCS0	97.0	0.206	1.028	1.031	**0.218**	A7
5550	110	802.11n HT40 Ant.2	OFDM	18.00	17.51	0.020	0 mm [Rear]	FCC #1	MCS0	97.0	0.190	1.119	1.031	**0.219**	A8
5795	159	802.11n HT40 Ant.2	OFDM	15.50	15.01	-0.180	0 mm [Rear]	FCC #1	MCS0	97.0	0.321	1.119	1.031	**0.370**	A9
5300	60	802.11n HT20 MIMO	OFDM	17.50	17.48	0.040	0 mm [Rear]	FCC #1	MCS8	97.1	0.394	1.005	1.030	**0.408**	A10
5690	138	802.11ac VHT80 MIMO	OFDM	20.00	19.55	-0.070	0 mm [Rear]	FCC #1	MCS0	89.7	0.305	1.109	1.115	**0.377**	A11
5785	157	802.11n HT20 MIMO	OFDM	18.50	18.45	-0.160	0 mm [Rear]	FCC #1	MCS8	97.1	0.357	1.012	1.030	**0.372**	A12
ANSI / IEEE C95.1-2005– SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population Exposure									**Body 1.6 W/kg (mW/g)** averaged over 1 gram						

Note: The rear with touch configuration was only tested since only the rear is touched to human body in normal operation condition of this device.

Adjusted SAR results for UNII-1 and UNII-2A SAR												
FREQUENCY		Mode/ Antenna	Service	Maximum Allowed Power [dBm]	1g Scaled SAR (W/kg)	FREQUENCY [MHz]	Mode	Service	Maximum Allowed Power [dBm	Adjusted Factor	1g Adjusted SAR (W/kg)	SAR for the band with lower maximum output power
MHz	Ch											
5290	58	802.11ac VHT80 Ant.1	OFDM	14.00	0.379	5210	802.11ac VHT80 Ant.1	OFDM	12.00	0.631	**0.239**	X
5230	46	802.11n HT40 Ant.2	OFDM	16.50	0.218	5280	802.11a Ant.2	OFDM	16.00	0.891	**0.194**	X
5300	60	802.11n HT20 MIMO	OFDM	17.50	0.408	5240	802.11n HT20 MIMO	OFDM	14.50	0.501	**0.204**	X
ANSI / IEEE C95.1-2005– SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population Exposure							**Body 1.6 W/kg (mW/g)** averaged over 1 gram					

Note(s):

1. U-NII-1 and U-NII-2A Bands: When different maximum output power is specified for the bands, begin SAR measurement in the band with higher specified maximum output power. The highest reported SAR for the tested configuration is adjusted by the ratio of lower to higher specified maximum output power for the two bands. When the adjusted SAR is ≤ 1.2 W/kg, SAR is not required for the band with lower maximum output power in that test configuration.

10.2 SAR Test Notes

General Notes:

1. The test data reported are the worst-case SAR values according to test procedures specified in IEEE 1528-2013, and FCC KDB Publication447498 D01v06.
2. Batteries are fully charged at the beginning of the SAR measurements. A standard battery was used for all SAR measurements.
3. Liquid tissue depth was at least 15.0 cm for all frequencies.
4. The manufacturer has confirmed that the device(s) tested have the same physical, mechanical and thermal characteristics and are within operational tolerances expected for production units
5. SAR results were scaled to the maximum allowed power to demonstrate compliance per FCCKDB Publication 447498 D01v06.
6. The rear with touch configuration was only tested since the rear is touched to human body in normal operation condition of this device.
7. Per FCC KDB 865664 D01v01r04, variability SAR tests were performed when the measured SAR results for a frequency band were greater than 0.8 W/kg. Repeated SAR measurements are highlighted in the tables above for clarity. Please see Section 14 for variability analysis.

WLAN Notes:

1. The initial test position procedures were applied. The test position with the highest extrapolated peak SAR will be used as the initial test position. When reported SAR for the initial test position is ≤ 0.4 W/kg, no additional testing for the remaining test positions was required. Otherwise, SAR is evaluated at the subsequent highest peak SAR positions until the reported SAR result is ≤ 0.8 W/kg or all test positions are measured.
2. Justification for test configurations for WLAN per KDB Publication 248227 D01v02r02 for 2.4 GHz WIFI single transmission chain operations, the highest measured maximum output power channel for DSSS was selected for SAR measurement. SAR for OFDM modes (2.4 GHz 802.11g/n) was not required duo to the maximum allowed powers and the highest reported DSSS SAR when the highest reported SAR for DSSS is adjusted by the ratio of OFDM to DSSS specified maximum output and the adjust SAR is ≤ 1.2 W/kg.
3. Justification for test configurations for WLAN per KDB Publication 248227 D01v02r02 for 5 GHz WIFI single transmission chain operations, the initial test configuration was selected according to the transmission mode with the highest maximum allowed powers. Other transmission modes were not investigated since the highest reported SAR for initial test configuration adjusted by the ratio of maximum output powers is less than 1.2 W/kg.
4. When the maximum reported 1g averaged SAR ≤ 0.8 W/kg, SAR testing on additional channels was not required. Otherwise, SAR for the next highest output power channel was required until the reported SAR result was ≤ 1.20 W/kg or all test channels were measured**.**
5. The device was configured to transmit continuously at the required data rate, channel bandwidth and signal modulation, using the highest transmission duty factor to determine compliance.

11. FCC MULTI-TX AND ANTENNA SAR CONSIDERATIONS

11.1 Introduction

The following procedures adopted from FCC KDB Publication 447498 D01v06 are applicable to handsets with built-in unlicensed transmitters such as 802.11b/g/n and Bluetooth devices which may simultaneously transmit with the licensed transmitter.

11.2 Simultaneous Transmission Procedures

This device contains transmitters that may operate simultaneously. Therefore simultaneous transmission analysis is required. Per FCC KDB 447498 D01v06 4.3.2 and IEEE 1528-2013 Section 6.3.4.1.2, simultaneous transmission SAR test exclusion may be applied when the sum of the 1-g SAR for all the simultaneous transmitting antennas in a specific a physical test configuration is $\leq$ 1.6 W/kg. When standalone SAR is not required to be measured, per FCC KDB 447498 D01v06 4.3.2 b), the following equation must be used to estimate the standalone 1g SAR for simultaneous transmission assessment involving that transmitter.

$$\text{Estimated SAR} = \frac{\sqrt{f(GHz)}}{7.5} * \frac{(\text{Max Power of channel, mW})}{\text{Min. Separation Distance, mm}}$$

Table 11.1 Estimated 1g SAR

Mode	Frequency	Maximum Allowed Power		Separation Distance (Body)	Estimated SAR (Body)
	[MHz]	[dBm]	[mW]	[mm]	[W/kg]
Bluetooth	2480	5	3	5	0.133

11.3 Simultaneous Transmission Capabilities

According to FCC KDB Publication 447498 D01v06, transmitters are considered to be transmitting simultaneously when there is overlapping transmission, with the exception of transmissions during network hand-offs with maximum hand-off duration less than 30 seconds. Possible transmission paths for the DUT are shown in Figure 13.1 and are color-coded to indicate communication modes which share the same path. Modes which share the same transmission path cannot transmit simultaneously with one another.

Path 1	**Path 2**
Bluetooth	WLAN

Figure 11.1 Simultaneous Transmission Paths

This device contains multiple transmitters that may operate simultaneously, and therefore requires a simultaneous transmission analysis according to FCC KDB Publication 447498 D01v06.

Table 11.2 Simultaneous Transmission Scenarios

No	Capable TX configuration	W-LAN 2.4GHz 802.11b/g/n	W-LAN 5GHz 802.11a/n/ac	Bluetooth 2.4GHz
1	W-LAN 2.4GHz 802.11b/g/n		No	Yes
2	W-LAN 5GHz 802.11a/n/ac	No		Yes
3	Bluetooth 2.4GHz	Yes	Yes	

Table 11.3 Simultaneous SAR Cases

No.	Capable Transmit Configuration	Body	Note
1	W-LAN 2.4 GHz Ant.2 + Bluetooth Ant.1	Yes	Bluetooth transmitter does simultaneous transmit with the W-LAN transmitter. When the BT is turn on, it transmits on Ant.1 and the W-LAN transmits on Ant.2.
2	W-LAN 5 GHz Ant.2 + Bluetooth Ant.1	Yes	

Notes:
1. This device supports only simultaneous transmission between BT Ant.1 & W-LAN Ant.2.
2. This device supports 2x2 MIMO Tx for W-LAN 802.11n/ac. Each W-LAN antenna can transmit independently or together when operating with MIMO.

11.4 Body Simultaneous Transmission Analysis

Table 11.4 Simultaneous Transmission Scenario with Bluetooth

Configuration	Mode	W-LAN Ant.2 SAR (W/kg)	Bluetooth Ant.1 SAR (W/kg)	ΣSAR (W/kg)
Rear Side	W-LAN 2.4 GHz	0.428	0.133	**0.561**
Rear Side	W-LAN 5.2 GHz	0.218	0.133	0.351
Rear Side	W-LAN 5.6 GHz	0.219	0.133	0.352
Rear Side	W-LAN 5.8 GHz	0.370	0.133	0.503

Note: Bluetooth SAR was not required to be measured per FCC KDB 447498 D01v06. Estimated SAR results were used in the above table to determine simultaneous transmission SAR test exclusion.

11.5 Simultaneous Transmission Conclusion

The above numerical summed SAR results for all the worst-case simultaneous transmission conditions were below the SAR limit. Therefore, the above analysis is sufficient to determine that simultaneous transmission cases will not exceed the SAR limit and therefore no measured volumetric simultaneous SAR summation is required per FCC KDB Publication 447498 D01v06 and IEEE 1528-2013 Section 6.3.4.1.2.

12. SAR MEASUREMENT VARIABILITY

12.1 Measurement Variability

Per FCC KDB Publication 865664 D01v01r04, SAR measurement variability was assessed for each frequency band, which was determined by the SAR probe calibration point and tissue-equivalent medium used for the device measurements. When both head and body tissue-equivalent media were required for SAR measurements in a frequency band, the variability measurement procedures were applied to the tissue medium with the highest measured SAR, using the highest measured SAR configuration for that tissue-equivalent medium. These additional measurements were repeated after the completion of all measurements requiring the same head or body tissue-equivalent medium in a frequency band. The test device was returned to ambient conditions (normal room temperature) with the battery fully charged before it was re-mounted on the device holder for the repeated measurement(s) to minimize any unexpected variations in the repeated results.

SAR Measurement Variability was assessed using the following procedures for each frequency band:

1. When the original highest measured SAR is ≥ 0.80 W/kg, the measurement was repeated once.
2. A second repeated measurement was preformed only if the ratio of largest to smallest SAR for the original and first repeated measurements was > 1.20 or when the original or repeated measurement was ≥ 1.45 W/kg (~ 10% from the 1-g SAR limit).
3. A third repeated measurement was performed only if the original, first or second repeated measurement was ≥ 1.5 W/kg and the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 1.20.
4. Repeated measurements are not required when the original highest measured SAR is < 0.80 W/kg

12.2 Measurement Uncertainty

The measured SAR was <1.5 W/kg for all frequency bands. Therefore, per KDB Publication 865664D01v01r04, the standard measurement uncertainty analysis per IEEE 1528-2013 was not required.

13. IEEE P1528 –MEASUREMENT UNCERTAINTIES

2450 MHz Body

Error Description	Uncertainty value ±%	Probability Distribution	Divisor	(Ci) 1g	Standard (1g)	vi 2 or Veff
Measurement System						
Probe calibration	± 6.0	Normal	1	1	± 6.0 %	∞
Axial isotropy	± 4.7	Rectangular	√3	1	± 2.714 %	∞
Hemispherical isotropy	± 9.6	Rectangular	√3	1	± 5.543 %	∞
Boundary Effects	± 0.8	Rectangular	√3	1	± 0.462 %	∞
Probe Linearity	± 4.7	Rectangular	√3	1	± 2.714 %	∞
Detection limits	± 0.25	Rectangular	√3	1	± 0.145 %	∞
Readout Electronics	± 1.0	Normal	1	1	± 1.0 %	∞
Response time	± 0.8	Rectangular	√3	1	± 0.462 %	∞
Integration time	± 2.6	Rectangular	√3	1	± 1.501 %	∞
RF Ambient Conditions	± 3.0	Rectangular	√3	1	± 1.732 %	∞
Probe Positioner	± 0.4	Rectangular	√3	1	± 0.231 %	∞
Probe Positioning	± 2.9	Rectangular	√3	1	± 1.674 %	∞
Algorithms for Max. SAR Eval.	± 1.0	Rectangular	√3	1	± 0.577 %	∞
Test Sample Related						
Device Positioning	± 2.9	Normal	1	1	± 2.9 %	145
Device Holder	± 3.6	Normal	1	1	± 3.6 %	5
Power Drift	± 5.0	Rectangular	√3	1	± 2.887 %	∞
Physical Parameters						
Phantom Shell	± 4.0	Rectangular	√3	1	± 2.31 %	∞
Liquid conductivity (Target)	± 5.0	Rectangular	√3	0.64	± 2.887 %	∞
Liquid conductivity (Meas.)	± 4.4	Normal	1	0.64	± 4.4 %	∞
Liquid permittivity (Target)	± 5.0	Rectangular	√3	0.6	± 2.887 %	∞
Liquid permittivity (Meas.)	± 3.8	Normal	1	0.6	± 3.8 %	∞
Combined Standard Uncertainty					**± 12.1 %**	330
Expanded Uncertainty (k=2)					**± 24.2 %**	

The above measurement uncertainties are according to IEEE P1528 (2003)

5200 MHz Body

Error Description	Uncertainty value ±%	Probability Distribution	Divisor	(Ci) 1g	Standard (1g)	vi 2 or Veff
Measurement System						
Probe calibration	± 6.55	Normal	1	1	± 6.55 %	∞
Axial isotropy	± 4.7	Rectangular	√3	1	± 2.714 %	∞
Hemispherical isotropy	± 9.6	Rectangular	√3	1	± 5.543 %	∞
Boundary Effects	± 0.8	Rectangular	√3	1	± 0.462 %	∞
Probe Linearity	± 4.7	Rectangular	√3	1	± 2.714 %	∞
Detection limits	± 0.25	Rectangular	√3	1	± 0.145 %	∞
Readout Electronics	± 1.0	Normal	1	1	± 1.0 %	∞
Response time	± 0.8	Rectangular	√3	1	± 0.462 %	∞
Integration time	± 2.6	Rectangular	√3	1	± 1.501 %	∞
RF Ambient Conditions	± 3.0	Rectangular	√3	1	± 1.732 %	∞
Probe Positioner	± 0.4	Rectangular	√3	1	± 0.231 %	∞
Probe Positioning	± 2.9	Rectangular	√3	1	± 1.674 %	∞
Algorithms for Max. SAR Eval.	± 1.0	Rectangular	√3	1	± 0.577 %	∞
Test Sample Related						
Device Positioning	± 2.9	Normal	1	1	± 2.9 %	145
Device Holder	± 3.6	Normal	1	1	± 3.6 %	5
Power Drift	± 5.0	Rectangular	√3	1	± 2.887 %	∞
Physical Parameters						
Phantom Shell	± 4.0	Rectangular	√3	1	± 2.31 %	∞
Liquid conductivity (Target)	± 5.0	Rectangular	√3	0.64	± 2.887 %	∞
Liquid conductivity (Meas.)	± 3.9	Normal	1	0.64	± 3.9 %	∞
Liquid permittivity (Target)	± 5.0	Rectangular	√3	0.6	± 2.887 %	∞
Liquid permittivity (Meas.)	± 4.2	Normal	1	0.6	± 4.2 %	∞
Combined Standard Uncertainty					**± 12.3 %**	330
Expanded Uncertainty (k=2)					**± 24.6 %**	

The above measurement uncertainties are according to IEEE P1528 (2003)

5300 MHz Body

Error Description	Uncertainty value ±%	Probability Distribution	Divisor	(Ci) 1g	Standard (1g)	vi 2 or Veff
Measurement System						
Probe calibration	± 6.55	Normal	1	1	± 6.55 %	∞
Axial isotropy	± 4.7	Rectangular	√3	1	± 2.714 %	∞
Hemispherical isotropy	± 9.6	Rectangular	√3	1	± 5.543 %	∞
Boundary Effects	± 0.8	Rectangular	√3	1	± 0.462 %	∞
Probe Linearity	± 4.7	Rectangular	√3	1	± 2.714 %	∞
Detection limits	± 0.25	Rectangular	√3	1	± 0.145 %	∞
Readout Electronics	± 1.0	Normal	1	1	± 1.0 %	∞
Response time	± 0.8	Rectangular	√3	1	± 0.462 %	∞
Integration time	± 2.6	Rectangular	√3	1	± 1.501 %	∞
RF Ambient Conditions	± 3.0	Rectangular	√3	1	± 1.732 %	∞
Probe Positioner	± 0.4	Rectangular	√3	1	± 0.231 %	∞
Probe Positioning	± 2.9	Rectangular	√3	1	± 1.674 %	∞
Algorithms for Max. SAR Eval.	± 1.0	Rectangular	√3	1	± 0.577 %	∞
Test Sample Related						
Device Positioning	± 2.9	Normal	1	1	± 2.9 %	145
Device Holder	± 3.6	Normal	1	1	± 3.6 %	5
Power Drift	± 5.0	Rectangular	√3	1	± 2.887 %	∞
Physical Parameters						
Phantom Shell	± 4.0	Rectangular	√3	1	± 2.31 %	∞
Liquid conductivity (Target)	± 5.0	Rectangular	√3	0.64	± 2.887 %	∞
Liquid conductivity (Meas.)	± 4.4	Normal	1	0.64	± 4.4 %	∞
Liquid permittivity (Target)	± 5.0	Rectangular	√3	0.6	± 2.887 %	∞
Liquid permittivity (Meas.)	± 4.0	Normal	1	0.6	± 4.0 %	∞
Combined Standard Uncertainty					**± 12.4 %**	330
Expanded Uncertainty (k=2)					**± 24.8 %**	

The above measurement uncertainties are according to IEEE P1528 (2003)

5500 MHz Body

Error Description	Uncertainty value ±%	Probability Distribution	Divisor	(Ci) 1g	Standard (1g)	vi 2 or Veff
Measurement System						
Probe calibration	± 6.55	Normal	1	1	± 6.55 %	∞
Axial isotropy	± 4.7	Rectangular	√3	1	± 2.714 %	∞
Hemispherical isotropy	± 9.6	Rectangular	√3	1	± 5.543 %	∞
Boundary Effects	± 0.8	Rectangular	√3	1	± 0.462 %	∞
Probe Linearity	± 4.7	Rectangular	√3	1	± 2.714 %	∞
Detection limits	± 0.25	Rectangular	√3	1	± 0.145 %	∞
Readout Electronics	± 1.0	Normal	1	1	± 1.0 %	∞
Response time	± 0.8	Rectangular	√3	1	± 0.462 %	∞
Integration time	± 2.6	Rectangular	√3	1	± 1.501 %	∞
RF Ambient Conditions	± 3.0	Rectangular	√3	1	± 1.732 %	∞
Probe Positioner	± 0.4	Rectangular	√3	1	± 0.231 %	∞
Probe Positioning	± 2.9	Rectangular	√3	1	± 1.674 %	∞
Algorithms for Max. SAR Eval.	± 1.0	Rectangular	√3	1	± 0.577 %	∞
Test Sample Related						
Device Positioning	± 2.9	Normal	1	1	± 2.9 %	145
Device Holder	± 3.6	Normal	1	1	± 3.6 %	5
Power Drift	± 5.0	Rectangular	√3	1	± 2.887 %	∞
Physical Parameters						
Phantom Shell	± 4.0	Rectangular	√3	1	± 2.31 %	∞
Liquid conductivity (Target)	± 5.0	Rectangular	√3	0.64	± 2.887 %	∞
Liquid conductivity (Meas.)	± 4.2	Normal	1	0.64	± 4.2 %	∞
Liquid permittivity (Target)	± 5.0	Rectangular	√3	0.6	± 2.887 %	∞
Liquid permittivity (Meas.)	± 4.5	Normal	1	0.6	± 4.5 %	∞
Combined Standard Uncertainty					**± 12.4 %**	330
Expanded Uncertainty (k=2)					**± 24.8 %**	

The above measurement uncertainties are according to IEEE P1528 (2003)

5600 MHz Body

Error Description	Uncertainty value ±%	Probability Distribution	Divisor	(Ci) 1g	Standard (1g)	vi 2 or Veff
Measurement System						
Probe calibration	± 6.55	Normal	1	1	± 6.55 %	∞
Axial isotropy	± 4.7	Rectangular	√3	1	± 2.714 %	∞
Hemispherical isotropy	± 9.6	Rectangular	√3	1	± 5.543 %	∞
Boundary Effects	± 0.8	Rectangular	√3	1	± 0.462 %	∞
Probe Linearity	± 4.7	Rectangular	√3	1	± 2.714 %	∞
Detection limits	± 0.25	Rectangular	√3	1	± 0.145 %	∞
Readout Electronics	± 1.0	Normal	1	1	± 1.0 %	∞
Response time	± 0.8	Rectangular	√3	1	± 0.462 %	∞
Integration time	± 2.6	Rectangular	√3	1	± 1.501 %	∞
RF Ambient Conditions	± 3.0	Rectangular	√3	1	± 1.732 %	∞
Probe Positioner	± 0.4	Rectangular	√3	1	± 0.231 %	∞
Probe Positioning	± 2.9	Rectangular	√3	1	± 1.674 %	∞
Algorithms for Max. SAR Eval.	± 1.0	Rectangular	√3	1	± 0.577 %	∞
Test Sample Related						
Device Positioning	± 2.9	Normal	1	1	± 2.9 %	145
Device Holder	± 3.6	Normal	1	1	± 3.6 %	5
Power Drift	± 5.0	Rectangular	√3	1	± 2.887 %	∞
Physical Parameters						
Phantom Shell	± 4.0	Rectangular	√3	1	± 2.31 %	∞
Liquid conductivity (Target)	± 5.0	Rectangular	√3	0.64	± 2.887 %	∞
Liquid conductivity (Meas.)	± 4.7	Normal	1	0.64	± 4.7 %	∞
Liquid permittivity (Target)	± 5.0	Rectangular	√3	0.6	± 2.887 %	∞
Liquid permittivity (Meas.)	± 4.3	Normal	1	0.6	± 4.3 %	∞
Combined Standard Uncertainty					**± 12.5 %**	330
Expanded Uncertainty (k=2)					**± 25.0 %**	

The above measurement uncertainties are according to IEEE P1528 (2003)

5800 MHz body

Error Description	Uncertainty value ±%	Probability Distribution	Divisor	(Ci) 1g	Standard (1g)	vi 2 or Veff
Measurement System						
Probe calibration	± 6.55	Normal	1	1	± 6.55 %	∞
Axial isotropy	± 4.7	Rectangular	√3	1	± 2.714 %	∞
Hemispherical isotropy	± 9.6	Rectangular	√3	1	± 5.543 %	∞
Boundary Effects	± 0.8	Rectangular	√3	1	± 0.462 %	∞
Probe Linearity	± 4.7	Rectangular	√3	1	± 2.714 %	∞
Detection limits	± 0.25	Rectangular	√3	1	± 0.145 %	∞
Readout Electronics	± 1.0	Normal	1	1	± 1.0 %	∞
Response time	± 0.8	Rectangular	√3	1	± 0.462 %	∞
Integration time	± 2.6	Rectangular	√3	1	± 1.501 %	∞
RF Ambient Conditions	± 3.0	Rectangular	√3	1	± 1.732 %	∞
Probe Positioner	± 0.4	Rectangular	√3	1	± 0.231 %	∞
Probe Positioning	± 2.9	Rectangular	√3	1	± 1.674 %	∞
Algorithms for Max. SAR Eval.	± 1.0	Rectangular	√3	1	± 0.577 %	∞
Test Sample Related						
Device Positioning	± 2.9	Normal	1	1	± 2.9 %	145
Device Holder	± 3.6	Normal	1	1	± 3.6 %	5
Power Drift	± 5.0	Rectangular	√3	1	± 2.887 %	∞
Physical Parameters						
Phantom Shell	± 4.0	Rectangular	√3	1	± 2.31 %	∞
Liquid conductivity (Target)	± 5.0	Rectangular	√3	0.64	± 2.887 %	∞
Liquid conductivity (Meas.)	± 4.2	Normal	1	0.64	± 4.2 %	∞
Liquid permittivity (Target)	± 5.0	Rectangular	√3	0.6	± 2.887 %	∞
Liquid permittivity (Meas.)	± 3.8	Normal	1	0.6	± 3.8 %	∞
Combined Standard Uncertainty					**± 12.3 %**	330
Expanded Uncertainty (k=2)					**± 24.6 %**	

The above measurement uncertainties are according to IEEE P1528 (2003)

14. CONCLUSION

Measurement Conclusion

The SAR measurement indicates that the EUT complies with the RF radiation exposure limits of the FCC. These measurements are taken to simulate the RF effects exposure under the 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 are every complex phenomena that depend 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 impossible biological effect 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.

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Attachment 1. – Probe Calibration Data

Calibration Laboratory of
Schmid & Partner
Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland

S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
S Servizio svizzero di taratura
S Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)
The Swiss Accreditation Service is one of the signatories to the EA
Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Client **DT&C (Dymstec)**

Certificate No: **EX3-3933_Sep15**

CALIBRATION CERTIFICATE

Object: EX3DV4 - SN:3933

Calibration procedure(s): QA CAL-01.v9, QA CAL-12.v9, QA CAL-14.v4, QA CAL-23.v5, QA CAL-25.v6
Calibration procedure for dosimetric E-field probes

Calibration date: September 29, 2015

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	01-Apr-15 (No. 217-02128)	Mar-16
Power sensor E4412A	MY41498087	01-Apr-15 (No. 217-02128)	Mar-16
Reference 3 dB Attenuator	SN: S5054 (3c)	01-Apr-15 (No. 217-02129)	Mar-16
Reference 20 dB Attenuator	SN: S5277 (20x)	01-Apr-15 (No. 217-02132)	Mar-16
Reference 30 dB Attenuator	SN: S5129 (30b)	01-Apr-15 (No. 217-02133)	Mar-16
Reference Probe ES3DV2	SN: 3013	30-Dec-14 (No. ES3-3013_Dec14)	Dec-15
DAE4	SN: 660	14-Jan-15 (No. DAE4-660_Jan15)	Jan-16
Secondary Standards	ID	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Apr-13)	In house check: Apr-16
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-14)	In house check: Oct-15

	Name	Function	Signature
Calibrated by:	Israe Elnaouq	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: September 30, 2015

This calibration certificate shall not be reproduced except in full without written approval of the laboratory.

Certificate No: EX3-3933_Sep15 Page 1 of 11

Calibration Laboratory of
Schmid & Partner
Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland

S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
S Servizio svizzero di taratura
Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)
The Swiss Accreditation Service is one of the signatories to the EA
Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Glossary:

TSL	tissue simulating liquid
NORMx,y,z	sensitivity in free space
ConvF	sensitivity in TSL / NORMx,y,z
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C, D	modulation dependent linearization parameters
Polarization φ	φ rotation around probe axis
Polarization ϑ	ϑ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., ϑ = 0 is normal to probe axis
Connector Angle	information used in DASY system to align probe sensor X to the robot coordinate system

Calibration is Performed According to the Following Standards:

a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
c) IEC 62209-2, "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
d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Methods Applied and Interpretation of Parameters:

- *NORMx,y,z*: Assessed for E-field polarization ϑ = 0 (f ≤ 900 MHz in TEM-cell; f > 1800 MHz: R22 waveguide). NORMx,y,z are only intermediate values, i.e., the uncertainties of NORMx,y,z does not affect the E^2-field uncertainty inside TSL (see below *ConvF*).
- *NORM(f)x,y,z = NORMx,y,z * frequency_response* (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of *ConvF*.
- *DCPx,y,z*: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- *PAR*: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- *Ax,y,z; Bx,y,z; Cx,y,z; Dx,y,z; VRx,y,z: A, B, C, D* are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. *VR* is the maximum calibration range expressed in RMS voltage across the diode.
- *ConvF and Boundary Effect Parameters:* Assessed in flat phantom using E-field (or Temperature Transfer Standard for f ≤ 800 MHz) and inside waveguide using analytical field distributions based on power measurements for f > 800 MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to *NORMx,y,z * ConvF* whereby the uncertainty corresponds to that given for *ConvF*. A frequency dependent *ConvF* is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 100 MHz.
- *Spherical isotropy (3D deviation from isotropy)*: in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- *Sensor Offset*: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- *Connector Angle*: The angle is assessed using the information gained by determining the *NORMx* (no uncertainty required).

Certificate No: EX3-3933_Sep15 Page 2 of 11

Probe EX3DV4

SN:3933

Manufactured: July 24, 2013
Calibrated: September 29, 2015

Calibrated for DASY/EASY Systems
(Note: non-compatible with DASY2 system!)

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3933

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu V/(V/m)^2$)[A]	0.51	0.53	0.19	± 10.1 %
DCP (mV)[B]	99.9	100.1	88.1	

Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB$\sqrt{\mu V}$	C	D dB	VR mV	Unc[E] (k=2)
0	CW	X	0.0	0.0	1.0	0.00	186.0	±3.3 %
		Y	0.0	0.0	1.0		194.3	
		Z	0.0	0.0	1.0		178.8	

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.

[A] The uncertainties of Norm X,Y,Z do not affect the E^2-field uncertainty inside TSL (see Pages 5 and 6).
[B] Numerical linearization parameter: uncertainty not required.
[E] Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3933

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unc (k=2)
300	45.3	0.87	12.77	12.77	12.77	0.05	1.20	± 13.3 %
450	43.5	0.87	12.15	12.15	12.15	0.16	1.90	± 13.3 %
600	42.7	0.88	11.12	11.12	11.12	0.05	1.20	± 13.3 %
750	41.9	0.89	10.60	10.60	10.60	0.21	1.35	± 12.0 %
835	41.5	0.90	10.22	10.22	10.22	0.13	1.82	± 12.0 %
900	41.5	0.97	9.94	9.94	9.94	0.16	1.76	± 12.0 %
1750	40.1	1.37	8.62	8.62	8.62	0.22	1.05	± 12.0 %
1900	40.0	1.40	8.32	8.32	8.32	0.38	0.81	± 12.0 %
2300	39.5	1.67	7.94	7.94	7.94	0.29	0.93	± 12.0 %
2450	39.2	1.80	7.51	7.51	7.51	0.26	1.09	± 12.0 %
2600	39.0	1.96	7.65	7.65	7.65	0.27	1.15	± 12.0 %
3500	37.9	2.91	7.36	7.36	7.36	0.16	1.90	± 13.1 %
5200	36.0	4.66	5.25	5.25	5.25	0.35	1.80	± 13.1 %
5300	35.9	4.76	5.03	5.03	5.03	0.35	1.80	± 13.1 %
5500	35.6	4.96	4.78	4.78	4.78	0.40	1.80	± 13.1 %
5600	35.5	5.07	4.70	4.70	4.70	0.40	1.80	± 13.1 %
5800	35.3	5.27	4.61	4.61	4.61	0.40	1.80	± 13.1 %

[C] Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.

[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

[G] Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3933

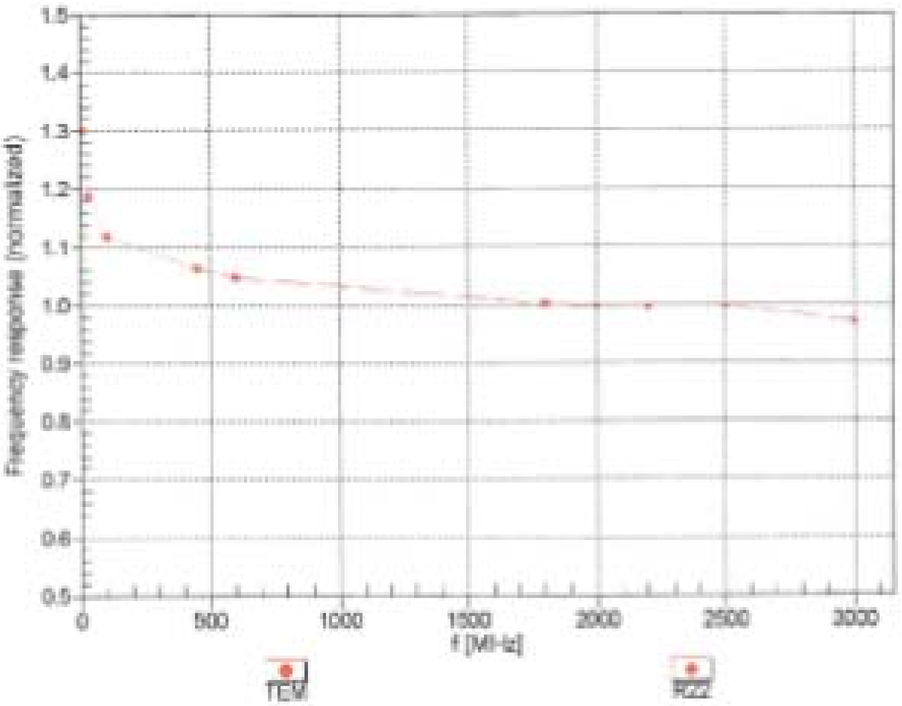
Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unc (k=2)
300	58.2	0.92	12.13	12.13	12.13	0.05	1.10	± 13.3 %
450	56.7	0.94	12.46	12.46	12.46	0.06	1.10	± 13.3 %
600	56.1	0.95	11.11	11.11	11.11	0.06	1.10	± 13.3 %
750	55.5	0.96	10.79	10.79	10.79	0.24	1.18	± 12.0 %
835	55.2	0.97	10.40	10.40	10.40	0.20	1.48	± 12.0 %
900	55.0	1.05	10.29	10.29	10.29	0.23	1.24	± 12.0 %
1750	53.4	1.49	8.49	8.49	8.49	0.37	0.85	± 12.0 %
1900	53.3	1.52	8.03	8.03	8.03	0.33	0.92	± 12.0 %
2300	52.9	1.81	7.81	7.81	7.81	0.30	1.01	± 12.0 %
2450	52.7	1.95	7.63	7.63	7.63	0.39	0.80	± 12.0 %
2600	52.5	2.16	7.25	7.25	7.25	0.37	0.90	± 12.0 %
3500	51.3	3.31	6.85	6.85	6.85	0.20	1.90	± 13.1 %
5200	49.0	5.30	4.75	4.75	4.75	0.40	1.90	± 13.1 %
5300	48.9	5.42	4.65	4.65	4.65	0.35	1.90	± 13.1 %
5500	48.6	5.65	4.26	4.26	4.26	0.40	1.90	± 13.1 %
5600	48.5	5.77	3.98	3.98	3.98	0.45	1.90	± 13.1 %
5800	48.2	6.00	4.07	4.07	4.07	0.50	1.90	± 13.1 %

[C] Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.
[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.
[G] Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

Frequency Response of E-Field

(TEM-Cell:ifi110 EXX, Waveguide: R22)

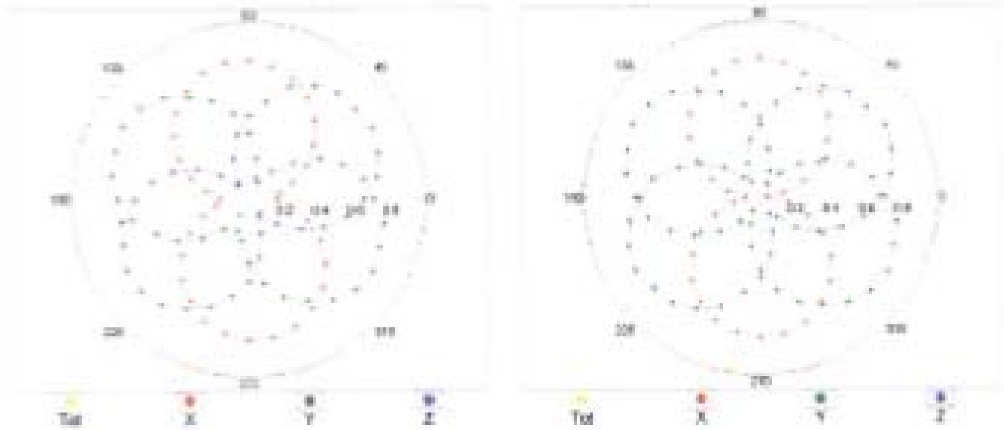


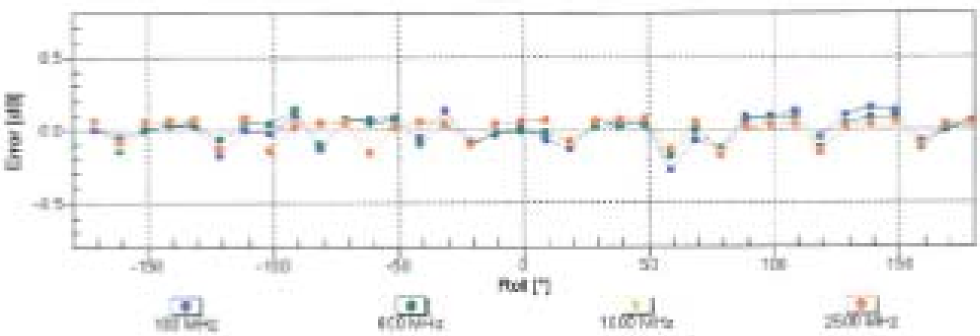
Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

EX3DV4– SN:3933 September 29, 2015

Receiving Pattern (ϕ), ϑ = 0°

f=600 MHz,TEM f=1800 MHz,R22





Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

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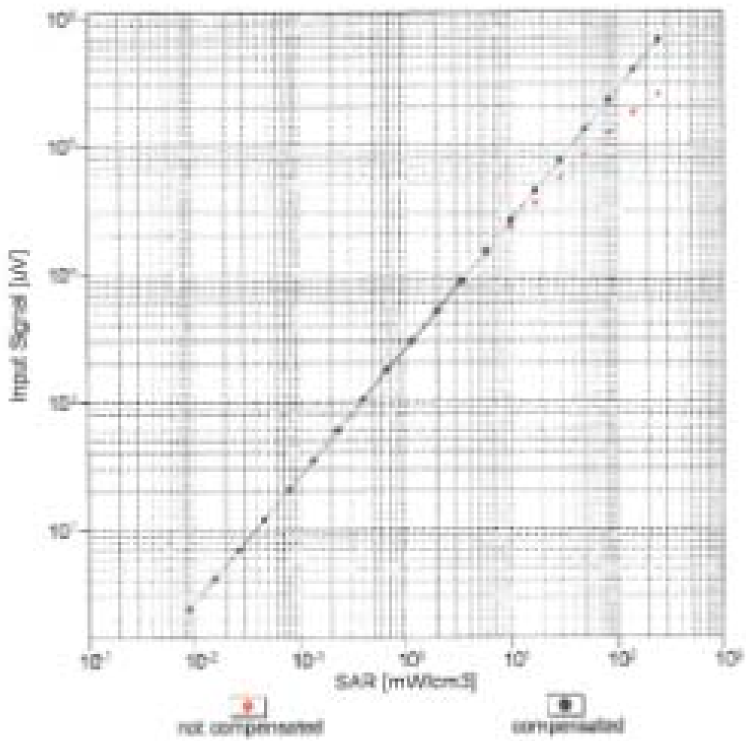
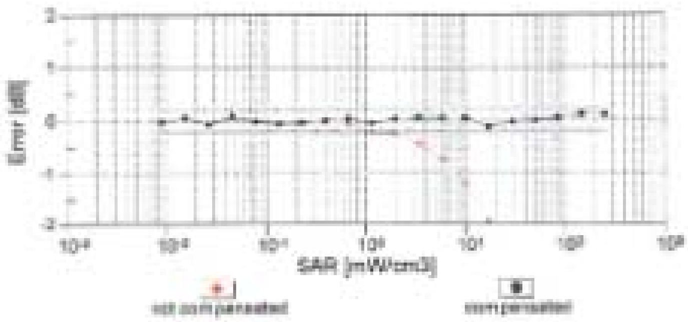
EX3DV4– SN:3933 September 29, 2015

Dynamic Range f(SAR$_{head}$)

(TEM cell , f$_{eval}$= 1900 MHz)





Uncertainty of Linearity Assessment: ± 0.6% (k=2)

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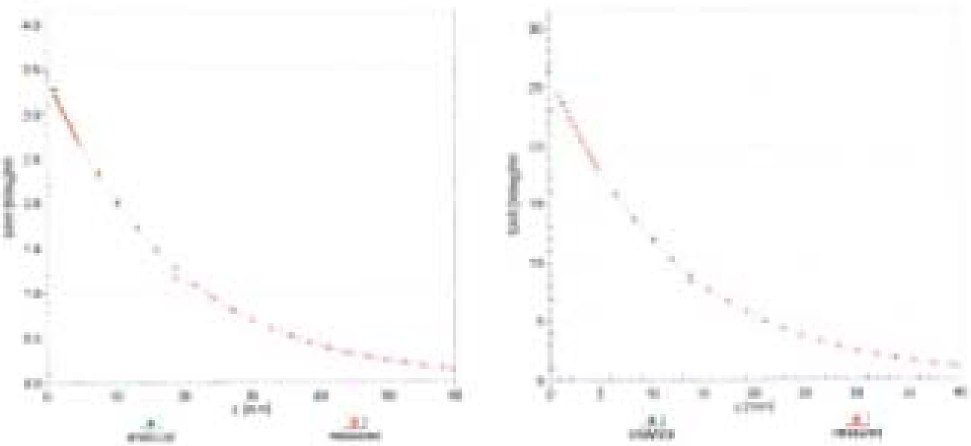
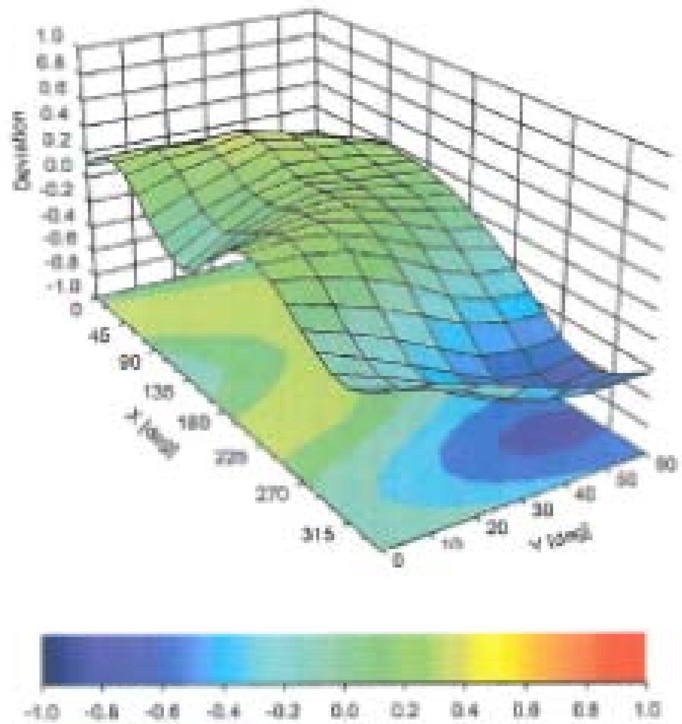
EX3DV4– SN:3933 September 29, 2015

Conversion Factor Assessment



Deviation from Isotropy in Liquid

Error (ϕ, ϑ), f = 900 MHz



Uncertainty of Spherical Isotropy Assessment: ± 2.6% (k=2)

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DASY/EASY - Parameters of Probe: EX3DV4 - SN:3933

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	78.7
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	9 mm
Tip Diameter	2.5 mm
Probe Tip to Sensor X Calibration Point	1 mm
Probe Tip to Sensor Y Calibration Point	1 mm
Probe Tip to Sensor Z Calibration Point	1 mm
Recommended Measurement Distance from Surface	1.4 mm

Attachment 2. – Dipole Calibration Data

Calibration Laboratory of
Schmid & Partner
Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland

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Accreditation No.: **SCS 0108**

Client **DT&C (Dymstec)**

Certificate No: **D2450V2-726_Sep15**

CALIBRATION CERTIFICATE

Object	D2450V2 - SN: 726
Calibration procedure(s)	QA CAL-05.v9 Calibration procedure for dipole validation kits above 700 MHz
Calibration date:	September 28, 2015

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	07-Oct-14 (No. 217-02020)	Oct-15
Power sensor HP 8481A	US37292783	07-Oct-14 (No. 217-02020)	Oct-15
Power sensor HP 8481A	MY41092317	07-Oct-14 (No. 217-02021)	Oct-15
Reference 20 dB Attenuator	SN: 5058 (20k)	01-Apr-15 (No. 217-02131)	Mar-16
Type-N mismatch combination	SN: 5047.2 / 06327	01-Apr-15 (No. 217-02134)	Mar-16
Reference Probe EX3DV4	SN: 7349	30-Dec-14 (No. EX3-7349_Dec14)	Dec-15
DAE4	SN: 601	17-Aug-15 (No. DAE4-601_Aug15)	Aug-16

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator R&S SMT-06	100972	15-Jun-15 (in house check Jun-15)	In house check: Jun-18
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-14)	In house check: Oct-15

	Name	Function	Signature
Calibrated by:	Jeton Kastrati	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: September 28, 2015

This calibration certificate shall not be reproduced except in full without written approval of the laboratory.

Calibration Laboratory of
Schmid & Partner
Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland

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Accreditation No.: **SCS 0108**

Glossary:

TSL	tissue simulating liquid
ConvF	sensitivity in TSL / NORM x,y,z
N/A	not applicable or not measured

Calibration is Performed According to the Following Standards:

a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
c) IEC 62209-2, "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
d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

e) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

- *Measurement Conditions:* Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- *Antenna Parameters with TSL:* The dipole is mounted with the spacer to position its feed point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis.
- *Feed Point Impedance and Return Loss:* These parameters are measured with the dipole positioned under the liquid filled phantom. The impedance stated is transformed from the measurement at the SMA connector to the feed point. The Return Loss ensures low reflected power. No uncertainty required.
- *Electrical Delay:* One-way delay between the SMA connector and the antenna feed point. No uncertainty required.
- *SAR measured:* SAR measured at the stated antenna input power.
- *SAR normalized:* SAR as measured, normalized to an input power of 1 W at the antenna connector.
- *SAR for nominal TSL parameters:* The measured TSL parameters are used to calculate the nominal SAR result.

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.

Measurement Conditions

DASY system configuration, as far as not given on page 1.

DASY Version	DASY5	V52.8.8
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2450 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.2	1.80 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	39.2 ± 6 %	1.86 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.0 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**51.2 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.01 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**23.8 W/kg ± 16.5 % (k=2)**

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	52.7	1.95 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	53.2 ± 6 %	2.00 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	12.5 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**49.5 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.84 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**23.2 W/kg ± 16.5 % (k=2)**

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	53.5 Ω + 5.0 jΩ
Return Loss	- 24.6 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	49.3 Ω + 6.1 jΩ
Return Loss	- 24.2 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.160 ns

After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.
No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	January 09, 2003

DASY5 Validation Report for Head TSL

Date: 28.09.2015

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz ; Type: D2450V2; Serial: D2450V2 - SN: 726

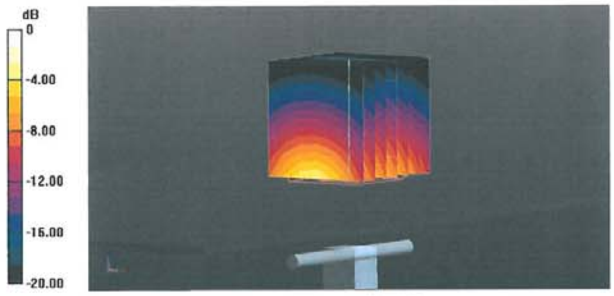
Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; σ = 1.86 S/m; ε_r = 39.2; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.67, 7.67, 7.67); Calibrated: 30.12.2014;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 17.08.2015
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

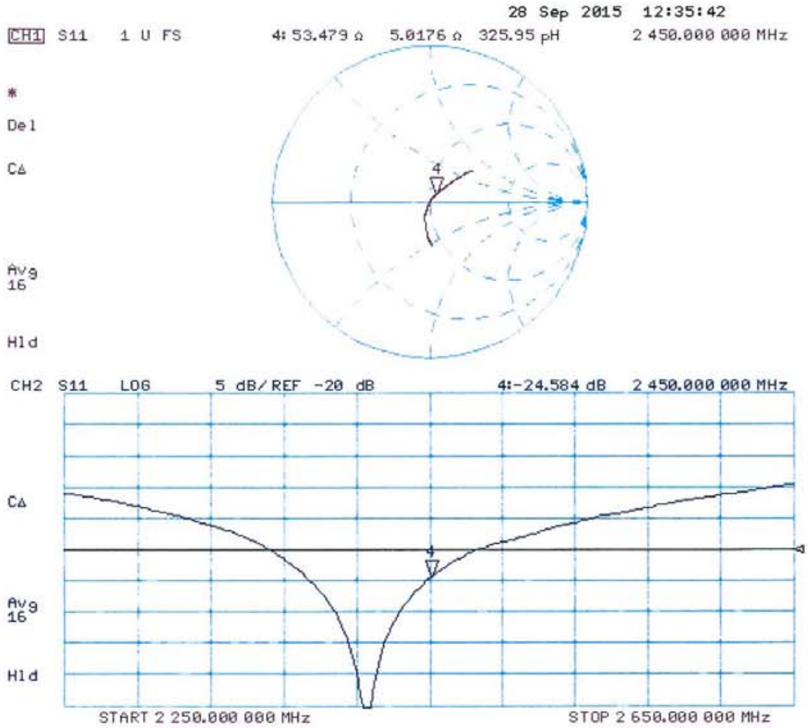
Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 112.1 V/m; Power Drift = 0.02 dB
Peak SAR (extrapolated) = 26.7 W/kg
SAR(1 g) = 13 W/kg; SAR(10 g) = 6.01 W/kg
Maximum value of SAR (measured) = 21.5 W/kg



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

Impedance Measurement Plot for Head TSL



Certificate No: D2450V2-726_Sep15 Page 6 of 8

DASY5 Validation Report for Body TSL

Date: 28.09.2015

Test Laboratory: SPEAG, Zurich, Switzerland

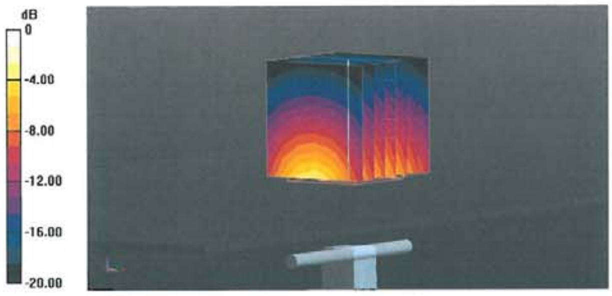
DUT: Dipole 2450 MHz ; Type: D2450V2; Serial: D2450V2 - SN: 726

Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; σ = 2 S/m; ε_r = 53.2; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

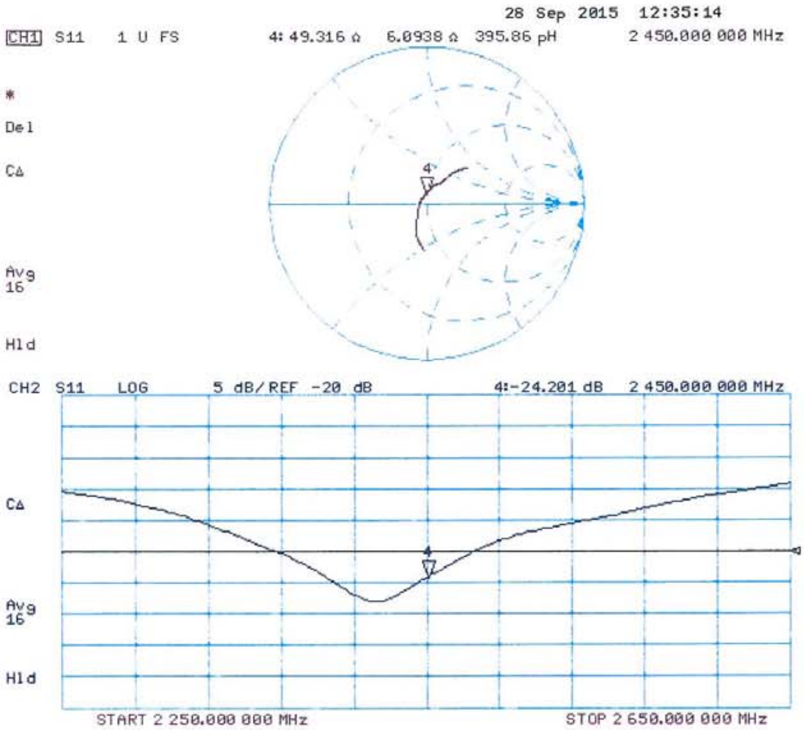
- Probe: EX3DV4 - SN7349; ConvF(7.53, 7.53, 7.53); Calibrated: 30.12.2014;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 17.08.2015
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 105.5 V/m; Power Drift = 0.02 dB
Peak SAR (extrapolated) = 24.7 W/kg
SAR(1 g) = 12.5 W/kg; SAR(10 g) = 5.84 W/kg
Maximum value of SAR (measured) = 20.3 W/kg



0 dB = 20.3 W/kg = 13.07 dBW/kg

Impedance Measurement Plot for Body TSL



Certificate No: D2450V2-726_Sep15 Page 8 of 8

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Accreditation No.: SCS 0108

Client **DT&C (Dymstec)**

Certificate No: D5GHzV2-1103_Mar15

CALIBRATION CERTIFICATE

Object	D5GHzV2 - SN: 1103
Calibration procedure(s)	QA CAL-22.v2 Calibration procedure for dipole validation kits between 3-6 GHz
Calibration date:	March 23, 2015

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	07-Oct-14 (No. 217-02020)	Oct-15
Power sensor HP 8481A	US37292783	07-Oct-14 (No. 217-02020)	Oct-15
Power sensor HP 8481A	MY41092317	07-Oct-14 (No. 217-02021)	Oct-15
Reference 20 dB Attenuator	SN: 5058 (20k)	03-Apr-14 (No. 217-01918)	Apr-15
Type-N mismatch combination	SN: 5047.2 / 06327	03-Apr-14 (No. 217-01921)	Apr-15
Reference Probe EX3DV4	SN: 3503	30-Dec-14 (No. EX3-3503_Dec14)	Dec-15
DAE4	SN: 601	18-Aug-14 (No. DAE4-601_Aug14)	Aug-15

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-13)	In house check: Oct-16
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-14)	In house check: Oct-15

	Name	Function	Signature
Calibrated by:	Michael Weber	Laboratory Technician	M.Weber
Approved by:	Katja Pokovic	Technical Manager	

Issued: March 23, 2015

This calibration certificate shall not be reproduced except in full without written approval of the laboratory.

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S Schweizerischer Kalibrierdienst
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Accredited by the Swiss Accreditation Service (SAS)
The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 0108

Glossary:

TSL	tissue simulating liquid
ConvF	sensitivity in TSL / NORM x,y,z
N/A	not applicable or not measured

Calibration is Performed According to the Following Standards:

a) IEC 62209-2, "Evaluation of Human Exposure to Radio Frequency Fields from Handheld and Body-Mounted Wireless Communication Devices in the Frequency Range of 30 MHz to 6 GHz: Human models, Instrumentation, and Procedures"; Part 2: "Procedure to determine the Specific Absorption Rate (SAR) for including accessories and multiple transmitters", March 2010
b) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"
c) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013

Additional Documentation:

d) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

- *Measurement Conditions:* Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- *Antenna Parameters with TSL:* The dipole is mounted with the spacer to position its feed point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis.
- *Feed Point Impedance and Return Loss:* These parameters are measured with the dipole positioned under the liquid filled phantom. The impedance stated is transformed from the measurement at the SMA connector to the feed point. The Return Loss ensures low reflected power. No uncertainty required.
- *Electrical Delay:* One-way delay between the SMA connector and the antenna feed point. No uncertainty required.
- *SAR measured:* SAR measured at the stated antenna input power.
- *SAR normalized:* SAR as measured, normalized to an input power of 1 W at the antenna connector.
- *SAR for nominal TSL parameters:* The measured TSL parameters are used to calculate the nominal SAR result.

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.

Measurement Conditions

DASY system configuration, as far as not given on page 1.

DASY Version	DASY5	V52.8.8
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom V5.0	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy = 4.0 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	5200 MHz ± 1 MHz 5250 MHz ± 1 MHz 5300 MHz ± 1 MHz 5500 MHz ± 1 MHz 5600 MHz ± 1 MHz 5750 MHz ± 1 MHz 5800 MHz ± 1 MHz	

Head TSL parameters at 5200 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	36.0	4.66 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.7 ± 6 %	4.53 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5200 MHz

SAR averaged over 1 cm³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.94 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**78.7 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.28 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**22.5 W/kg ± 19.5 % (k=2)**

Head TSL parameters at 5250 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.9	4.71 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.6 ± 6 %	4.58 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5250 MHz

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.12 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**80.5 W / kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.34 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**23.1 W/kg ± 19.5 % (k=2)**

Head TSL parameters at 5300 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.9	4.76 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.6 ± 6 %	4.63 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5300 MHz

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.31 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**82.4 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.40 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**23.7 W/kg ± 19.5 % (k=2)**

Head TSL parameters at 5500 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.6	4.96 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.3 ± 6 %	4.82 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5500 MHz

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.37 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**82.9 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.39 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**23.6 W/kg ± 19.5 % (k=2)**

Head TSL parameters at 5600 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.5	5.07 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.1 ± 6 %	4.93 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5600 MHz

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.30 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**82.2 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.37 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**23.4 W/kg ± 19.5 % (k=2)**

Head TSL parameters at 5750 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.4	5.22 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	33.9 ± 6 %	5.08 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5750 MHz

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.00 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**79.2 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.29 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**22.6 W/kg ± 19.5 % (k=2)**

Head TSL parameters at 5800 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.3	5.27 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	33.9 ± 6 %	5.13 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5800 MHz

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.91 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**78.4 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.26 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**22.3 W/kg ± 19.5 % (k=2)**