TEST REPORT

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1. Report No : DRRFCC1705-0052

2. Customer

   • Name : DRTECH Corporation

   • Address : Suite No.2, 3 Floor, 29, Dunchon-daero 541beon-gil Seongnam-si, Gyeonggi-do, Republic of Korea

3. Use of Report : FCC Original Grant

4. Product Name / Model Name : Flat Panel Digital X-ray Detector / EVS 2430Wi

   FCC ID : RNH-EVS2430WI

5. Test Method Used : RF exposure KDB procedures

   Test Specification : CFR §2.1093

6. Date of Test : 2017-01-25 ~ 2017-02-03

7. Testing Environment : See appended test report

8. Test Result : Refer to the attached Test Result

Affirmation	Tested by Name : ChangWon Lee (Signature)	Technical Manager Name : WonJung Lee (Signature)

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2017 .05 .11 .

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If this test report is required to confirmation of authenticity, please contact toreport@dtnc.net

Test Report Version

Test Report No.	Date	Description
DRRFCC1705-0052	May. 11, 2017	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

Product	Flat Panel Digital X-ray Detector
Model Name	EVS 2430Wi
FCC ID	RNH-EVS2430WI
Host product	Flat Panel Digital X-ray Detector
Host Marketing Name	EVS 2430Wi
add model name	EVS 2430GWi
Equipment add model name	N/A
Equipment serial no.	Identical prototype
Mode(s) of Operation	2.4 GHz W-LAN(802.11b/g/n HT20/n HT40),5 GHz W-LAN (802.11a/n HT20/n HT40)

	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
	U-NII-3	802.11a/n	HT20	5745 ~ 5825 MHz
		802.11n	HT40	5755 ~ 5795 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
	U-NII-3	802.11a/n	HT20	5745 ~ 5825 MHz
		802.11n	HT40	5755 ~ 5795 MHz

Band	Mode	Reported SAR 1g SAR (W/kg) Head		Reported SAR 1g SAR (W/kg) Body	
		SISO	MIMO	SISO	MIMO
DTS	2.4 GHz W-LAN	0.115	0.028	0.105	0.025
U-NII-1	5.2 GHz W-LAN	0.780	0.475	0.252	0.163
U-NII-3	5.8 GHz W-LAN	**0.968**	0.403	0.395	0.209

FCC Equipment Class	Digital Transmission System(DTS) Unlicensed National Information Infrastructure (UNII)
Date(s) of Tests	2017-01-25 ~ 2017-02-03
Antenna Type	Internal Type Antenna
Functions	• W-LAN(2.4GHz 802.11b/g/n(HT20, HT40)), W-LAN(5GHz 802.11a/n(HT20)/ n(HT40) supported.

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 648474 D04 Handset SAR v01r03
- 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

1.2Device Overview

Band	Mode	Operating Modes	Tx Frequency
DTS	2.4 GHz W-LAN	Data	2412 ~ 2462 MHz
U-NII-1	5.2 GHz W-LAN	Data	5180 ~ 5240 MHz
U-NII-3	5.8 GHz W-LAN	Data	5745 ~ 5825 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			ModulatedAverage[dBm]								
			Ant.1			Ant.2			MIMO		
			Ch Low	Ch Mid	Ch High	Ch Low	Ch Mid	Ch High	Ch Low	Ch Mid	Ch High
DTS	IEEE802.11b (2.4GHz)	Maximum	18.5	18.0	18.5	18.0	17.5	18.0	-	-	-
		Nominal	17.5	17.0	17.5	17.0	16.5	17.0			
		Minimum	16.5	16.0	16.5	16.0	15.5	16.0			
	IEEE802.11g (2.4GHz)	Maximum	16.0	15.5	15.0	15.5	15.5	14.5	-	-	-
		Nominal	15.0	14.5	14.0	14.5	14.5	13.5			
		Minimum	14.0	13.5	13.0	13.5	13.5	12.5			
	IEEE802.11n HT20 (2.4GHz)	Maximum	13.5	13.0	12.5	14.0	14.0	14.5	17.0	16.5	16.5
		Nominal	12.5	12.0	11.5	13.0	13.0	13.5	16.0	15.5	15.5
		Minimum	11.5	11.0	10.5	12.0	12.0	12.5	15.0	14.5	14.5
	IEEE802.11n HT40 (2.4GHz)	Maximum	11.5	11.0	11.0	13.0	10.5	10.5	15.5	14.0	14.0
		Nominal	10.5	10.0	10.0	12.0	9.5	9.5	14.5	13.0	13.0
		Minimum	9.5	9.0	9.0	11.0	8.5	8.5	13.5	12.0	12.0

Band& Mode			ModulatedAverage[dBm]								
			Ant.1			Ant.2			MIMO		
			Ch Low	Ch Mid	Ch High	Ch Low	Ch Mid	Ch High	Ch Low	Ch Mid	Ch High
U-NII-1	IEEE 802.11a (5.2 GHz)	Maximum	14.0	13.5	13.0	13.5	13.5	13.0	-	-	-
		Nominal	13.0	12.5	12.0	12.5	12.5	12.0			
		Minimum	12.0	11.5	11.0	11.5	11.5	11.0			
U-NII-3	IEEE 802.11a (5.8 GHz)	Maximum	10.5	10.5	9.0	10.5	10.0	8.5	-	-	-
		Nominal	9.5	9.5	8.0	9.5	9.0	7.5			
		Minimum	8.5	8.5	7.0	8.5	8.0	6.5			
U-NII-1	IEEE 802.11n HT20 (5.2 GHz)	Maximum	10.5	10.5	10.5	9.0	10.0	9.0	12.5	13.0	13.0
		Nominal	9.5	9.5	9.5	8.0	9.0	8.0	11.5	12.0	12.0
		Minimum	8.5	8.5	8.5	7.0	8.0	7.0	10.5	11.0	11.0
U-NII-3	IEEE 802.11n HT20 (5.8 GHz)	Maximum	13.0	9.0	9.5	13.0	10.5	9.0	16.0	12.5	12.5
		Nominal	12.0	8.0	8.5	12.0	9.5	8.0	15.0	11.5	11.5
		Minimum	11.0	7.0	7.5	11.0	8.5	7.0	14.0	10.5	10.5
U-NII-1	IEEE 802.11n HT40 (5.2 GHz)	Maximum	13.0	-	12.5	13.0	-	12.5	16.5	-	15.5
		Nominal	12.0		11.5	12.5		11.5	15.5		14.5
		Minimum	11.0		10.5	11.5		10.5	14.5		13.5
U-NII-3	IEEE 802.11n HT40 (5.8 GHz)	Maximum	10.5	-	10.5	11.0	-	10.0	13.5	-	13.0
		Nominal	9.5		9.5	10.0		9.0	12.5		12.0
		Minimum	8.5		8.5	9.0		8.0	11.5		11.0

1.4 Antenna Location

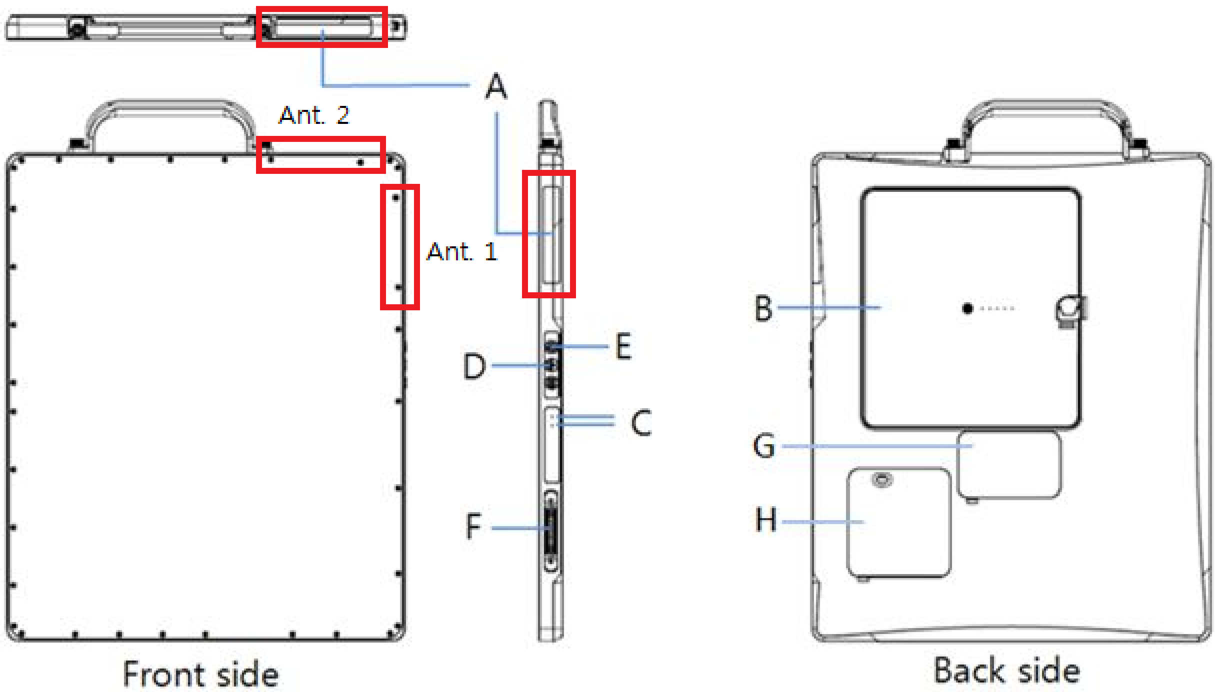

Figure 4.1. Detector Components

A. Wireless antena : Transmits image data with wireless comunication (IEEE802.11n).

Note: Exact antenna dimensions and separation distances are shown in the "Antenna Location_RNH-EVS2430Wi.pdf" in the FCC Filing.

1.5SAR Test Configurations and Exclusions

(A) WIFI

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 1.1SAR exclusion threshold for distances < 50 mm

Band	Mode	Equation	Result	SAR exclusion threshold	Required SAR
DTS	2.4 GHz W-LAN - Ant.1	[(71/5)* √2.462]	22.2	3.0	O
	2.4 GHz W-LAN - Ant.2	[(63/5)* √2.462]	19.8	3.0	O
	2.4 GHz W-LAN - MIMO	[(50/5)* √2.412]	15.6	3.0	O
U-NII-1	5.2 GHz W-LAN- Ant.1	[(25/5)* √5.180]	11.4	3.0	O
	5.2 GHz W-LAN- Ant.2	[(20/5)* √5.190]	9.1	3.0	O
	5.2 GHz W-LAN-MIMO	[(45/5)* √5.190]	20.4	3.0	O
U-NII-3	5.8 GHz W-LAN - Ant.1	[(18/5)* √5.745]	9.6	3.0	O
	5.8 GHz W-LAN - Ant.2	[(18/5)* √5.745]	9.6	3.0	O
	5.8 GHz W-LAN - MIMO	[(40/5)* √5.745]	19.1	3.0	O

Per KDB Publication 447498 D01v06, 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	Serial Number
2.4 GHz W-LAN	FCC #1
5 GHz W-LAN	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 theincident field in relations to the dimensions and geometry of the irradiated organism, the orientation of theorganism 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 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 Robotis 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 per forms the conversion from the optical in to digital electric signal of the DAE and transfers data to the PC plug-in card.

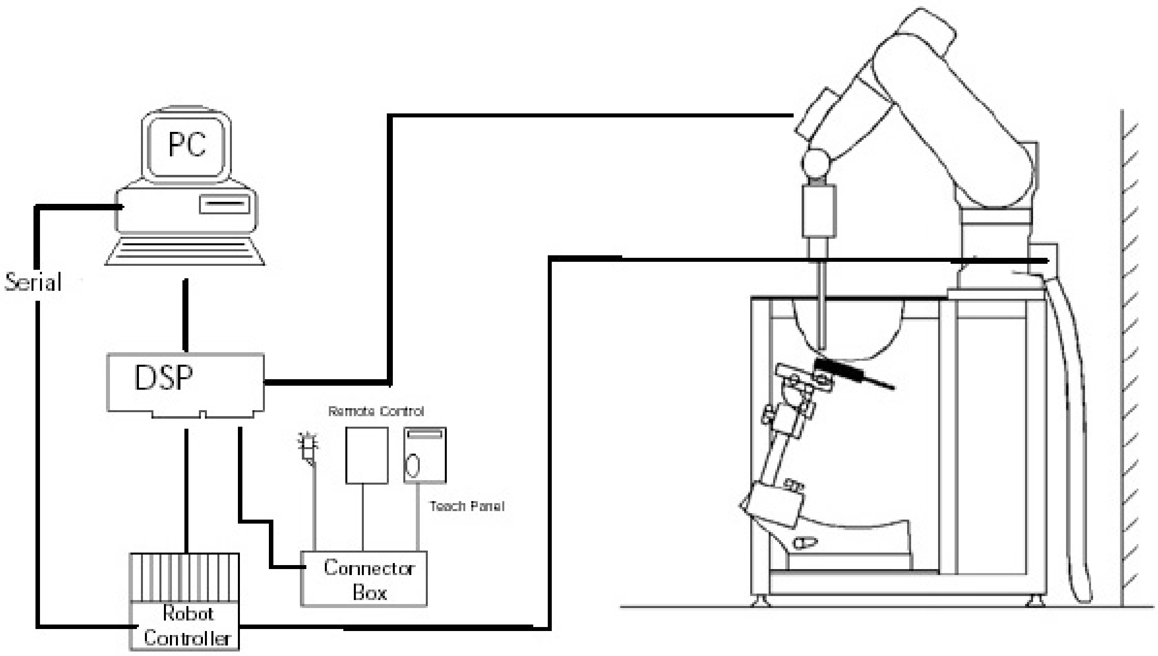

Figure 3.1 SAR Measurement System Setup

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
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 : ±0.2dB

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

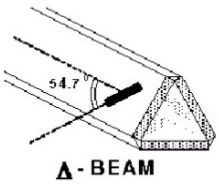

Figure 3.2 Triangular Probe Configurations

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 anopticalmultitier 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 (NormX, NormY, NormZ), the diode compression parameter (DCP) and the conversion factor (ConvF) 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.

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

where:

Δt = exposure time (30 seconds),

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

ΔT = temperature increase due to RF exposure.

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

where:

σ = simulated tissue conductivity,

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

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

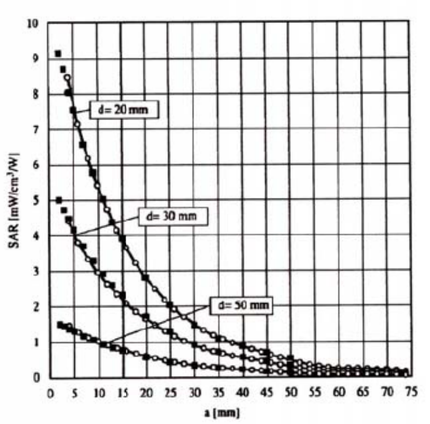

Figure 3.4E-Field and Temperature Measurements at 900MHz

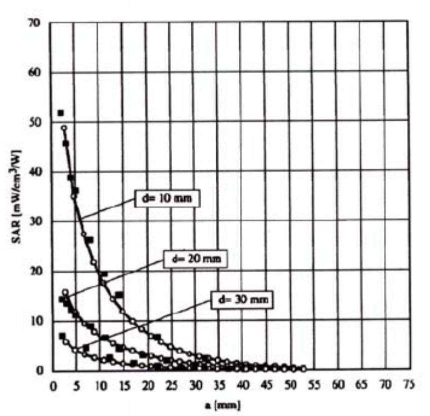

Figure 3.5 E-Field and Temperature Measurements at 1800MHz

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/cm^3

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

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

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

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 dep this 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

3.6Device 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

3.7Brain & 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. Harts grove.

Figure 3.8 SimulatedTissues

Table3.1 Composition of the Tissue Equivalent Matter

Ingredients (% by weight)	Frequency (MHz)			
	2450		5200 ~ 5800	
Tissue Type	**Head**	**Body**	**Head**	**Body**
Water	71.88	73.40	65.52	80.00
Salt (NaCl)	0.160	0.060	-	-
Sugar	-	-	-	-
HEC	-	-	-	-
Bactericide	-	-	-	-
Triton X-100	19.97	-	17.24	-
DGBE	7.990	26.54	-	-
Diethylene glycol hexyl ether	-	-	17.24	-
Polysorbate (Tween) 80	-	-		20.00
Target for Dielectric Constant	39.2	52.7	-	-
Target for Conductivity (S/m)	1.80	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	TX60L	N/A	N/A	F14/5VR2A1/A/01
☒	Robot Controller	SCHMID	C58C	N/A	N/A	F14/5VR2A1/C/01
☒	Joystick	SCHMID	N/A	N/A	N/A	D21142605A
☒	IntelCorei7-37703.40GHz 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 ELI5	SCHMID	QDOVA003AA	N/A	N/A	2008
☒	DataAcquisition Electronics	SCHMID	DAE4V1	2016-05-26	2017-05-26	1392
☒	Dosimetric E-Field Probe	SCHMID	EX3DV4	2016-06-29	2017-06-29	3866
☒	2450 MHz SAR Dipole	SCHMID	D2450V2	2016-09-23	2018-09-23	920
☒	5 GHz SAR Dipole	SCHMID	D5GHzV2	2016-03-15	2018-03-15	1212
☒	Network Analyzer	Agilent	E5071C	2016-12-02	2017-12-02	MY46111534
☒	Signal Generator	Agilent	E4438C	2016-09-09	2017-09-09	US41461520
☒	Amplifier	EMPOWER	BBS3Q7ELU	2016-09-08	2017-09-08	1020
☒	Amplifier	EMPOWER	BBS3Q8CCJ	2016-10-18	2017-10-18	1005
☒	Power Meter	HP	EPM-442A	2017-01-04	2018-01-04	GB37170267
☒	Power Meter	HP	EPM-442A	2016-06-23	2017-06-23	GB37170413
☒	Power Sensor	HP	8481A	2016-06-23	2017-06-23	3318A96332
☒	Power Sensor	HP	8481A	2017-01-04	2018-01-04	3318A96566
☒	Power Sensor	HP	8481A	2017-01-04	2018-01-04	2702A65976
☒	Directional Coupler	HP	772D	2016-07-26	2017-07-26	2889A01064
☒	Low Pass Filter 3.0GHz	Micro LAB	LA-30N	2016-09-08	2017-09-08	N/A
☒	Low Pass Filter 6.0 GHz	Micro LAB	LA-60N	2017-01-04	2018-01-04	N/A
☒	Attenuators(3 dB)	Agilent	8491B	2016-06-22	2017-06-22	MY39260700
☒	Attenuators(10 dB)	WEINSCHEL	23-10-34	2017-01-04	2018-01-04	BP4387
☒	Dielectric Probe kit	SCHMID	DAK-3.5	2016-07-26	2017-07-26	1046
		SCHMID	DAKS_VNA R140	2016-07-26	2017-07-26	101213

NOTE: The E-field probe was calibrated by SPEAG, by temperature measurement procedure. Dipole Verification measurement is performed by DT&Cbefore 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	StäubliUnimation Corp. Robot Model: TX90XL
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: 3866
Construction	Triangular core fiber optic detection system
Frequency	10 MHz to 6 GHz
Linearity	± 0.2 dB (30 MHz to 6 GHz)

Phantom

Phantom	2mm Oval Phantom ELI6
Shell Material	Composite
Thickness	2.0 ± 0.2 mm

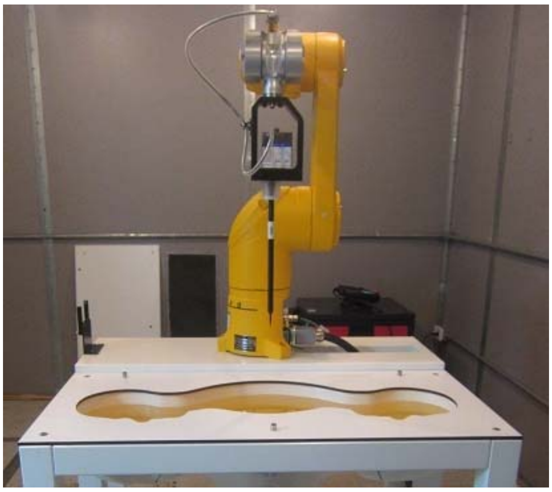

Figure 4.1 DASY5 Test System

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:

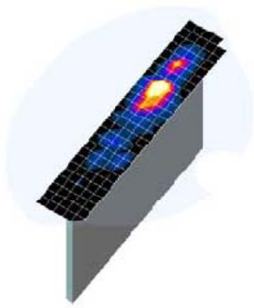

Figure 5.1
Sample SAR Area Scan

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-headand 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.

3. Based on the area scan data, the peak of the region with maximum SAR was determined by sp line interpolation. Around this point, a volume was assessed according to the measurement resolution and volume size requirements of FCC KDB Publication 865664 D01v01r04 (SeeTable5-1) 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 sp lines 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

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. 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 248227D01v02r02 for more details.

7.2.1General 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.

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-1 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, 802.11n and 802.11ac 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 and 802.11ac 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.

When the reported SAR ≤ 0.8 W/kg, no additional measurements on other test channels are required.
Otherwise, SAR is evaluated using the subsequent highest average RF output channel until the reported SAR result is ≤ 1.2 W/kg or all channels are measured.

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 MIMO SAR considerations

Per KDB Publication 248227 D01v02r02, the simultaneous SAR provision in KDB Publication 447498 D01v06 should be applied to determine simultaneous transmission SAR test exclusion for WIFI MIMO. If the sum of 1g single transmission chain SAR measurements is < 1.6 W/kg, no additional SAR measurements for MIMO are required. Alternatively, SAR for MIMO can be measured with all antennas transmitting simultaneously at the specified maximum output power of MIMO operation.

8. RF CONDUCTED POWERS

8.1 W-LAN 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	17.86	17.85	17.83	17.73
	2437	6	17.32	17.24	17.08	16.95
	2462	11	<u>17.89</u>	17.85	17.77	17.66

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	17.43	17.42	17.38	17.30
	2437	6	16.96	16.88	16.85	16.84
	2462	11	<u>17.43</u>	17.36	17.26	17.22

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	15.06	15.05	14.92	14.85	14.82	14.79	14.54	14.51
	2437	6	14.78	14.69	14.68	14.55	14.53	14.50	14.30	14.28
	2462	11	14.03	13.98	13.87	13.83	13.80	13.79	13.49	13.40

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	14.68	14.62	14.42	14.39	14.34	14.24	13.99	13.97
	2437	6	14.55	14.47	14.33	14.25	14.22	14.15	13.77	13.68
	2462	11	13.94	13.92	13.88	13.88	13.83	13.82	13.66	13.59

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	12.81	12.65	12.58	12.53	12.50	12.33	12.27	12.17
	2437	6	11.89	11.76	11.72	11.71	11.61	11.17	11.14	11.11
	2462	11	11.57	11.51	11.45	11.43	11.41	11.14	11.10	11.02

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	13.30	13.22	13.12	13.09	13.02	12.54	12.44	12.39
	2437	6	13.10	13.03	12.90	12.86	12.79	12.55	12.54	12.49
	2462	11	13.71	13.65	13.61	13.59	13.55	13.05	13.04	12.97

Table 8.6 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	**16.13**	15.88	15.97	15.98	16.08	15.94	16.04	15.97
	2437	6	15.63	15.38	15.62	15.43	15.43	15.62	15.38	15.40
	2462	11	15.84	15.83	15.66	15.63	15.75	15.83	15.72	15.64

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	10.87	10.83	10.82	10.79	10.79	10.72	10.66	10.65
	2437	6	10.41	10.38	10.36	10.29	10.24	10.17	10.10	10.08
	2452	9	10.38	10.32	10.27	10.20	10.13	10.10	10.09	10.03

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	11.96	11.94	11.94	11.91	11.84	11.82	11.78	11.72
	2437	6	9.72	9.70	9.68	9.62	9.55	9.53	9.45	9.37
	2452	9	9.92	9.88	9.82	9.79	9.77	9.70	9.63	9.56

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	14.51	14.45	14.28	14.43	14.32	14.37	14.42	14.43
	2437	6	13.12	13.06	12.93	12.99	13.08	12.96	12.88	13.06
	2452	9	13.21	13.05	13.15	13.14	13.16	13.01	13.19	13.00

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	13.04	13.00	12.80	12.84	12.83	12.93	12.83	12.96
	5200	40	12.71	12.62	12.62	12.46	12.47	12.54	12.66	12.54
	5240	48	12.47	12.25	12.28	12.25	12.27	12.38	12.44	12.38
	5745	149	9.87	9.61	9.73	9.68	9.63	9.70	9.74	9.85
	5785	157	9.61	9.37	9.60	9.52	9.43	9.58	9.53	9.56
	5825	165	8.37	8.24	8.19	8.27	8.23	8.35	8.22	8.25

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	12.69	12.56	12.62	12.68	12.46	12.56	12.57	12.47
	5200	40	12.52	12.50	12.41	12.44	12.36	12.44	12.27	12.40
	5240	48	12.39	12.37	12.27	12.29	12.19	12.39	12.37	12.36
	5745	149	9.67	9.62	9.42	9.50	9.57	9.56	9.52	9.52
	5785	157	9.26	9.04	9.13	9.15	9.21	9.14	9.20	9.10
	5825	165	7.98	7.96	7.76	7.89	7.93	7.83	7.91	7.96

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	9.61	9.44	9.50	9.39	9.57	9.40	9.42	9.50
	5200	40	9.87	9.75	9.79	9.77	9.70	9.73	9.75	9.75
	5240	48	9.71	9.59	9.59	9.69	9.66	9.56	9.70	9.52
	5745	149	12.47	12.38	12.39	12.35	12.42	12.39	12.27	12.32
	5785	157	8.22	7.97	8.06	8.19	8.17	8.08	8.10	7.99
	5825	165	8.76	8.63	8.54	8.59	8.56	8.53	8.70	8.58

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	8.41	8.24	8.34	8.27	8.38	8.28	8.38	8.33
	5200	40	9.04	9.02	8.93	8.89	8.94	8.90	8.85	8.89
	5240	48	8.37	8.24	8.26	8.14	8.15	8.24	8.19	8.35
	5745	149	**12.46**	12.42	12.44	12.39	12.27	12.38	12.36	12.31
	5785	157	9.64	9.45	9.44	9.58	9.49	9.44	9.60	9.53
	5825	165	8.47	8.23	8.28	8.30	8.30	8.28	8.36	8.28

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
802.11n (HT-20)	5180	36	12.06	11.53	11.59	11.71	11.61	11.71	11.74	11.60
	5200	40	12.49	12.42	12.41	12.29	12.36	12.26	12.34	12.39
	5240	48	12.10	12.08	12.01	12.01	11.91	11.88	11.89	12.07
	5745	149	**15.48**	15.33	15.27	15.27	15.32	15.36	15.47	15.39
	5785	157	12.00	11.82	11.99	11.93	11.85	11.88	11.88	11.80
	5825	165	11.63	11.59	11.41	11.58	11.40	11.51	11.52	11.40

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	12.13	11.90	11.93	11.90	11.88	11.92	12.09	11.96
	5230	46	11.53	11.42	11.32	11.31	11.36	11.33	11.44	11.43
	5755	151	9.94	9.69	9.74	9.69	9.70	9.79	9.78	9.81
	5795	159	9.51	9.26	9.42	9.48	9.29	9.46	9.42	9.50

Table 8.16 IEEE 802.11n HT40 Average RF Power Ant.1

Mode	Freq.	Channel	802.11n HT40 (5 GHz) Conducted Power (dBm) Ant.2							
			Data Rate (Mbps)							
	(MHz)		MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
802.11n (HT-40)	5190	38	**12.87**	12.63	12.81	12.86	12.70	12.67	12.84	12.86
	5230	46	11.57	11.54	11.50	11.45	11.34	11.37	11.51	11.40
	5755	151	10.03	9.94	9.92	9.97	10.00	9.89	9.79	9.84
	5795	159	9.14	8.89	8.97	9.05	8.90	9.06	9.11	8.99

Table 8.17 IEEE 802.11n HT40 Average RF Power Ant.2

Mode	Freq.	Channel	802.11n HT40 (5 GHz) Conducted Power (dBm) MIMO							
			Data Rate (Mbps)							
	(MHz)		MCS8	MCS9	MCS10	MCS11	MCS12	MCS13	MCS14	MCS15
802.11n (HT-40)	5190	38	**15.53**	15.32	15.40	15.28	15.51	15.38	15.49	15.29
	5230	46	14.56	14.36	14.48	14.51	14.54	14.53	14.38	14.31
	5755	151	13.00	12.90	12.81	12.76	12.86	12.74	12.97	12.80
	5795	159	12.34	12.25	12.16	12.10	12.15	12.19	12.17	12.15

Table 8.18 IEEE 802.11n HT40 Average RF Power MIMO

Justification for reduced test configurations for WIFI channels per KDB Publication 248227 D01v02r02:

- 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.

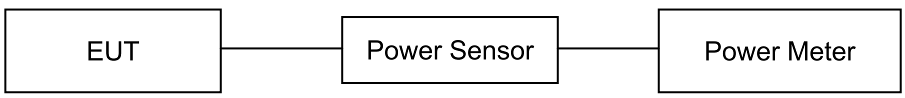

Figure 8.1 Power Measurement Setup

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 [%]
Jan. 25. 2017	2450 Head	20.8	21.2	2412	39.27	1.766	40.628	1.722	3.47	-2.51
				2437	39.22	1.788	40.598	1.744	3.51	-2.49
				2450	39.20	1.800	40.560	1.753	3.47	-2.61
				2462	39.18	1.813	40.519	1.761	3.41	-2.86
Jan. 25. 2017	2450 Body	20.8	21.4	2412	52.75	1.914	52.447	1.857	-0.58	-2.96
				2437	52.72	1.938	52.361	1.889	-0.68	-2.51
				2450	52.70	1.950	52.573	1.913	-0.24	-1.90
				2462	52.68	1.967	52.522	1.922	-0.31	-2.29
Jan. 31. 2017	5180~ 5240 Head	20.7	21.0	5180	36.02	4.639	36.280	4.790	0.72	3.26
				5190	36.01	4.650	36.314	4.795	0.84	3.13
				5200	36.00	4.660	36.318	4.796	0.88	2.92
				5230	35.97	4.690	36.205	4.801	0.65	2.37
				5240	35.96	4.700	36.137	4.811	0.49	2.36
Jan. 31. 2017	5180~ 5240 Body	20.7	20.9	5180	49.04	5.276	47.469	5.348	-3.21	1.37
				5190	49.03	5.288	47.452	5.360	-3.21	1.37
				5200	49.01	5.299	47.433	5.375	-3.23	1.43
				5230	48.97	5.334	47.409	5.411	-3.19	1.44
				5240	48.96	5.346	47.392	5.419	-3.20	1.37
Feb. 03. 2017	5745~ 5825 Head	21.3	21.7	5745	35.36	5.215	34.930	5.152	-1.20	-1.21
				5785	35.32	5.255	34.853	5.193	-1.31	-1.18
				5800	35.30	5.270	34.835	5.214	-1.32	-1.06
				5825	35.28	5.296	34.828	5.253	-1.27	-0.82
Feb. 03. 2017	5745~ 5825 Body	21.3	21.0	5745	48.27	5.936	46.441	6.058	-3.80	2.06
				5785	48.22	5.982	46.350	6.116	-3.88	2.23
				5800	48.20	6.000	46.324	6.144	-3.89	2.40
				5825	48.17	6.029	46.302	6.192	-3.87	2.70

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 GHzby 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: 920	Jan. 25. 2017	Head	20.8	21.2	3866	250	52.5	13.50	54.00	2.86
D	2450	D2450V2, SN: 920	Jan. 25. 2017	Body	20.8	21.4	3866	250	51.0	12.90	51.60	1.18
D	5200	D5GHzV2, SN: 1212	Jan. 31. 2017	Head	20.7	21.0	3866	100	75.4	7.70	77.00	2.12
D	5200	D5GHzV2, SN: 1212	Jan. 31. 2017	Body	20.7	20.9	3866	100	73.2	7.48	74.80	2.19
D	5800	D5GHzV2, SN: 1212	Feb. 03. 2017	Head	21.3	21.7	3866	100	75.9	7.75	77.50	2.11
D	5800	D5GHzV2, SN: 1212	Feb. 03. 2017	Body	21.3	21.0	3866	100	75.5	7.23	72.30	-4.24

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 9.1 Dipole Verification Test Setup Diagram & Photo

10. SAR TEST RESULTS

10.1 Head SAR Results

Table 10.1 DTS Head SAR

MEASUREMENT RESULTS														
FREQUENCY		Mode	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	Scaling Factor (Duty Cycle)	SAR (W/kg)	Plots #
MHz	Ch													
2462	11	802.11b Ant.1	18.50	17.89	0.060	0 mm [Front]	FCC #1	1	97.8	0.098	1.151	1.023	**0.115**	A1
2462	11	802.11b Ant.2	18.00	17.43	0.170	0 mm [Front]	FCC #1	1	97.8	0.053	1.140	1.023	0.062	
2412	1	802.11n HT20 MIMO	17.00	16.13	0.150	0 mm [Front]	FCC #1	MCS8	77.4	0.018	1.222	1.293	0.028	
ANSI / IEEE C95.1-2005– SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population Exposure								**Head 1.6 W/kg (mW/g)** averaged over 1 gram						

Note(s):
1. Highest reported SAR is ≤ 0.4 W/kg. Therefore, further SAR measurements within this exposure condition are not required.
2. The front with touch configuration was only tested since only the front is touched to human head and 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											
2462	11	802.11b Ant.1	DSSS	18.50	0.115	2412	802.11g	OFDM	16.00	0.562	**0.065**	X
2462	11	802.11b Ant.1	DSSS	18.50	0.115	2412	802.11n HT20	OFDM	13.50	0.316	**0.036**	X
2462	11	802.11b Ant.1	DSSS	18.50	0.115	2422	802.11n HT40	OFDM	11.50	0.200	**0.023**	X
2462	11	802.11b Ant.2	DSSS	18.00	0.062	2437	802.11g	OFDM	15.50	0.562	**0.035**	X
2462	11	802.11b Ant.2	DSSS	18.00	0.062	2437	802.11n HT20	OFDM	14.00	0.398	**0.025**	X
2462	11	802.11b Ant.2	DSSS	18.00	0.062	2422	802.11n HT40	OFDM	13.00	0.316	**0.020**	X
ANSI / IEEE C95.1-2005– SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population Exposure						**Head 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 Head SAR

MEASUREMENT RESULTS														
FREQUENCY		Mode	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	Scaling Factor (Duty Cycle)	1g Scaled SAR (W/kg)	Plots #
MHz	Ch													
5180	36	802.11a Ant.1	14.00	13.04	0.010	0 mm [Front]	FCC #1	6	87.6	0.237	1.247	1.141	0.337	
5190	38	802.11n HT40 Ant.2	13.00	12.87	0.020	0 mm [Front]	FCC #1	6	63.7	0.482	1.030	1.571	**0.780**	A2
5190	38	802.11n HT40 MIMO	16.50	15.53	0.040	0 mm [Front]	FCC #1	MCS8	63.7	0.242	1.250	1.571	0.475	
5745	149	802.11n HT20 Ant.1	13.00	12.47	0.000	0 mm [Front]	FCC #1	MCS0	77.3	0.427	1.130	1.294	0.624	
5745	149	802.11n HT20 Ant.2	13.00	12.46	-0.100	0 mm [Front]	FCC #1	MCS0	77.3	0.661	1.132	1.294	**0.968**	A3
5785	157	802.11n HT20 Ant.2	10.50	9.64	-0.030	0 mm [Front]	FCC #1	MCS0	77.3	0.383	1.219	1.294	0.604	
5745	149	802.11n HT20 MIMO	16.00	15.48	-0.140	0 mm [Front]	FCC #1	MCS8	77.3	0.276	1.127	1.294	0.403	
ANSI / IEEE C95.1-2005– SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population Exposure								**Head 1.6 W/kg (mW/g)** averaged over 1 gram						

Note(s):
1. Highest reported SAR is ≤ 0.4 W/kg. Therefore, further SAR measurements within this exposure condition are not required.
2. Highest reported SAR is > 0.4 W/kg. Due to the highest reported SAR for this test position, other test position is Head exposure condition were evaluated until a SAR ≤ 0.8 W/kg was reported.
3. The front with touch configuration was only tested since only the front is touched to human head and body in normal operation condition of this device.

10.2 Body SAR Results

Table 10.3 DTS Body SAR

MEASUREMENT RESULTS														
FREQUENCY		Mode	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	Scaling Factor (Duty Cycle)	SAR (W/kg)	Plots #
MHz	Ch													
2462	11	802.11b Ant.1	18.50	17.89	0.040	0 mm [Front]	FCC #1	1	97.8	0.089	1.151	1.023	**0.105**	A4
2462	11	802.11b Ant.2	18.00	17.43	-0.130	0 mm [Front]	FCC #1	1	97.8	0.047	1.140	1.023	0.055	
2412	1	802.11n HT20 MIMO	17.00	16.13	0.170	0 mm [Front]	FCC #1	MCS8	77.4	0.016	1.222	1.293	0.025	
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. Highest reported SAR is ≤ 0.4 W/kg. Therefore, further SAR measurements within this exposure condition are not required.
2. The front with touch configuration was only tested since only the front is touched to human head and 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											
2462	11	802.11b Ant.1	DSSS	18.50	0.105	2412	802.11g	OFDM	16.00	0.562	**0.059**	X
2462	11	802.11b Ant.1	DSSS	18.50	0.105	2412	802.11n HT20	OFDM	13.50	0.316	**0.033**	X
2462	11	802.11b Ant.1	DSSS	18.50	0.105	2422	802.11n HT40	OFDM	11.50	0.200	**0.021**	X
2462	11	802.11b Ant.2	DSSS	18.00	0.055	2437	802.11g	OFDM	15.50	0.562	**0.031**	X
2462	11	802.11b Ant.2	DSSS	18.00	0.055	2437	802.11n HT20	OFDM	14.00	0.398	**0.022**	X
2462	11	802.11b Ant.2	DSSS	18.00	0.055	2422	802.11n HT40	OFDM	13.00	0.316	**0.017**	X
ANSI / IEEE C95.1-2005– SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population Exposure							**Head 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 10.4 UNII Body SAR

MEASUREMENT RESULTS														
FREQUENCY		Mode	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	Scaling Factor (Duty Cycle)	1g Scaled SAR (W/kg)	Plots #
MHz	Ch													
5180	36	802.11a Ant.1	14.00	13.04	0.000	0 mm [Front]	FCC #1	6	87.6	0.094	1.247	1.141	0.134	
5190	38	802.11n HT40 Ant.2	13.00	12.87	-0.050	0 mm [Front]	FCC #1	6	63.7	0.156	1.030	1.571	**0.252**	A5
5190	38	802.11n HT40 MIMO	16.50	15.53	0.060	0 mm [Front]	FCC #1	MCS8	63.7	0.083	1.250	1.571	0.163	
5745	149	802.11n HT20 Ant.1	13.00	12.47	-0.130	0 mm [Front]	FCC #1	MCS0	77.3	0.243	1.130	1.294	0.355	
5745	149	802.11n HT20 Ant.2	13.00	12.46	-0.070	0 mm [Front]	FCC #1	MCS0	77.3	0.270	1.132	1.294	**0.395**	A6
5745	149	802.11n HT20 Ant.2	13.50	12.46	-0.010	0 mm [Front]	FCC #1	MCS0	77.3	0.127	1.271	1.294	0.209	
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. Highest reported SAR is ≤ 0.4 W/kg. Therefore, further SAR measurements within this exposure condition are not required.
2. Highest reported SAR is > 0.4 W/kg. Due to the highest reported SAR for this test position, other test position is Body exposure condition were evaluated until a SAR ≤ 0.8 W/kg was reported.
3. The front with touch configuration was only tested since only the front is touched to human head and body in normal operation condition of this device.

10.3SAR 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 front with touch configuration was only tested since the front is touched to human body in normal operation condition of this device.

W-LAN 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 W-LAN 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 W-LAN 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. IEEE P1528 –MEASUREMENT UNCERTAINTIES

2450 MHz Head

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.)	± 4.3	Normal	1	0.64	± 4.3 %	∞
Liquid permittivity (Target)	± 5.0	Rectangular	√3	0.6	± 2.887 %	∞
Liquid permittivity (Meas.)	± 3.7	Normal	1	0.6	± 3.7 %	∞
Temp. unc. - Conductivity	± 2.0	Rectangular	√3	0.78	± 1.155 %	∞
Temp. unc. - Permittivity	± 1.7	Rectangular	√3	0.23	± 0.981 %	∞
Combined Standard Uncertainty					**± 12.1 %**	330
Expanded Uncertainty (k=2)					**± 24.2 %**	

The above measurement uncertainties are according to IEEE P1528 (2013)

5200 MHz Head

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.)	± 4.4	Normal	1	0.6	± 4.4 %	∞
Temp. unc. - Conductivity	± 1.8	Rectangular	√3	0.78	± 1.039 %	∞
Temp. unc. - Permittivity	± 1.6	Rectangular	√3	0.23	± 0.924 %	∞
Combined Standard Uncertainty					**± 12.4 %**	330
Expanded Uncertainty (k=2)					**± 24.8%**	

The above measurement uncertainties are according to IEEE P1528 (2013)

5800 MHz Head

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.)	± 4.1	Normal	1	0.64	± 4.1 %	∞
Liquid permittivity (Target)	± 5.0	Rectangular	√3	0.6	± 2.887 %	∞
Liquid permittivity (Meas.)	± 3.8	Normal	1	0.6	± 3.8 %	∞
Temp. unc. - Conductivity	± 2.2	Rectangular	√3	0.78	± 1.270 %	∞
Temp. unc. - Permittivity	± 1.8	Rectangular	√3	0.23	± 1.039 %	∞
Combined Standard Uncertainty					**± 12.3 %**	330
Expanded Uncertainty (k=2)					**± 24.6%**	

The above measurement uncertainties are according to IEEE P1528 (2013)

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.)	± 4.7	Normal	1	0.64	± 4.7 %	∞
Liquid permittivity (Target)	± 5.0	Rectangular	√3	0.6	± 2.887 %	∞
Liquid permittivity (Meas.)	±4.4	Normal	1	0.6	± 4.4 %	∞
Temp. unc. - Conductivity	± 1.9	Rectangular	√3	0.78	± 1.097 %	∞
Temp. unc. - Permittivity	± 1.7	Rectangular	√3	0.23	± 0.981 %	∞
Combined Standard Uncertainty					**± 12.2 %**	330
Expanded Uncertainty (k=2)					**± 24.4 %**	

The above measurement uncertainties are according to IEEE P1528 (2013)

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.)	± 4.1	Normal	1	0.64	± 4.1 %	∞
Liquid permittivity (Target)	± 5.0	Rectangular	√3	0.6	± 2.887 %	∞
Liquid permittivity (Meas.)	± 4.2	Normal	1	0.6	± 4.2 %	∞
Temp. unc. - Conductivity	± 2.1	Rectangular	√3	0.78	± 1.212 %	∞
Temp. unc. - Permittivity	± 1.8	Rectangular	√3	0.23	± 1.039 %	∞
Combined Standard Uncertainty					**± 12.4 %**	330
Expanded Uncertainty (k=2)					**± 24.8%**	

The above measurement uncertainties are according to IEEE P1528 (2013)

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.)	± 4.1	Normal	1	0.64	± 4.1 %	∞
Liquid permittivity (Target)	± 5.0	Rectangular	√3	0.6	± 2.887 %	∞
Liquid permittivity (Meas.)	± 4.5	Normal	1	0.6	± 4.5 %	∞
Temp. unc. - Conductivity	± 2.0	Rectangular	√3	0.78	± 1.155 %	∞
Temp. unc. - Permittivity	± 1.7	Rectangular	√3	0.23	± 0.981 %	∞
Combined Standard Uncertainty					**± 12.5 %**	330
Expanded Uncertainty (k=2)					**± 25.0 %**	

The above measurement uncertainties are according to IEEE P1528 (2013)

12.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.

13. REFERENCES

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

[2] ANSI/IEEE C95.1-2005, American National Standard safety levels with respect to human exposure to radiofrequency electromagnetic fields, 3kHz to 300GHz, New York: IEEE, 2006.

[3] ANSI/IEEE C95.1-1992, American National Standard safety levels with respect to human exposure to radiofrequency electromagnetic fields, 3kHz to 300GHz, New York: IEEE, Sept. 1992.

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

[5] IEEE Standards Coordinating Committee 39 – IEEE Std. 1528-2013,Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices.

[6] NCRP, National Council on Radiation Protection and Measurements, Biological Effects and Exposure Criteria for Radio Frequency Electromagnetic Fields, NCRP Report No. 86, 1986. Reprinted Feb. 1995.

[7] T. Schmid, O. Egger, N. Kuster, Automated E-field scanning system for dosimetric assessments, IEEE Transaction on Microwave Theory and Techniques, vol. 44, Jan. 1996, pp. 105-113.

[8] K. Pokovic, T. Schmid, N. Kuster, Robust setup for precise calibration of E-field probes in tissue simulating liquids at mobile communications frequencies, ICECOM97, Oct. 1997, pp. -124.

[9] K. Pokovic, T. Schmid, and N. Kuster, E-field Probe with improved isotropy in brain simulating liquids, Proceedings of the ELMAR, Zadar, Croatia, June 23-25, 1996, pp. 172-175.

[10] Schmid& Partner Engineering AG, Application Note: Data Storage and Evaluation, June 1998, p2.

[11] V. Hombach, K. Meier, M. Burkhardt, E. Kuhn, N. Kuster, The Dependence of EM Energy Absorption upon Human Modeling at 900 MHz, IEEE Transaction on Microwave Theory and Techniques, vol. 44 no. 10, Oct.1996, pp. 1865-1873.

[12] N. Kuster and Q. Balzano, Energy absorption mechanism by biological bodies in the near field of dipole antennas above 300MHz, IEEE Transaction on Vehicular Technology, vol. 41, no. 1, Feb. 1992, pp. 17-23.

[13] G. Hartsgrove, A. Kraszewski, A. Surowiec, Simulated Biological Materials for Electromagnetic Radiation Absorption Studies, University of Ottawa, Bioelectromagnetics, Canada: 1987, pp. 29-36.

[14] Q. Balzano, O. Garay, T. Manning Jr., Electromagnetic Energy Exposure of Simulated Users of Portable Cellular Telephones, IEEE Transactions on Vehicular Technology, vol. 44, no.3, Aug. 1995.

[15] W. Gander, Computer mathematick, Birkhaeuser, Basel, 1992.

[16] W.H. Press, S.A. Teukolsky, W.T. Vetter ling, and B.P. Flannery, Numerical Recipes in C, The Art of Scientific Computing, Second edition, Cambridge University Press, 1992.

[17] N. Kuster, R. Kastle, T. Schmid, Dosimetric evaluation of mobile communications equipment with known precision, IEEE Transaction on Communications, vol. E80-B, no. 5, May 1997, pp. 645-652.

[18] CENELEC CLC/SC111B, European Pre standard (prENV 50166-2), Human Exposure to Electromagnetic Fields High-frequency: 10kHz-300GHz, Jan. 1995.

[19] Prof. Dr. Niels Kuster, ETH, Eidgenössische Technisc he Hoschschule Zürich, Dosimetric Evaluation of the Cellular Phone.

[20] IEC 62209-1, Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices - Human models, instrumentation, and procedures - Part 1: Procedure to determine the specific absorption rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300MHz to 3 GHz), Feb. 2005.

[21] Industry Canada RSS-102 Radio Frequency Exposure Compliance of Radio communication Apparatus (All Frequency Bands) Issue 5, March 2015.

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

[23] FCC SAR Test Procedures for 2G-3G Devices, Mobile Hotspot and UMPC Devices KDB Publications 941225,D01-D07

[24] SAR Measurement procedures for IEEE 802.11a/b/g KDB Publication 248227 D01v02r02

[25] FCC SAR Considerations for Handsets with Multiple Transmitters and Antennas, KDB Publications 648474D03-D04

[26] FCC SAR Evaluation Considerations for Laptop, Notebook, Net book and Tablet Computers, FCC KDB Publication 616217 D04

[27] FCC SAR Measurement and Reporting Requirements for 100MHz – 6 GHz, KDB Publications 865664 D01-D02

[28] FCC General RF Exposure Guidance and SAR Procedures for Dongles, KDB Publication 447498, D01-D02

[29] 615223 D01 802 16e WI-Max SAR Guidance v01, Nov. 13, 2009

[30] Anexo à Resolução No. 533, de 10 de September de 2009.

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

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
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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: **EX3-3866_Jun16**

CALIBRATION CERTIFICATE

Object	EX3DV4 - SN:3866
Calibration procedure(s)	QA CAL-01.v9, QA CAL-14.v4, QA CAL-23.v5, QA CAL-25.v6 Calibration procedure for dosimetric E-field probes
Calibration date:	June 29, 2016

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 NRP	SN: 104778	06-Apr-16 (No. 217-02288/02289)	Apr-17
Power sensor NRP-Z91	SN: 103244	06-Apr-16 (No. 217-02288)	Apr-17
Power sensor NRP-Z91	SN: 103245	06-Apr-16 (No. 217-02289)	Apr-17
Reference 20 dB Attenuator	SN: S5277 (20x)	05-Apr-16 (No. 217-02293)	Apr-17
Reference Probe ES3DV2	SN: 3013	31-Dec-15 (No. ES3-3013_Dec15)	Dec-16
DAE4	SN: 660	23-Dec-15 (No. DAE4-660_Dec15)	Dec-16
Secondary Standards	ID	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB41293874	06-Apr-16 (in house check Jun-16)	In house check: Jun-18
Power sensor E4412A	SN: MY41498087	06-Apr-16 (in house check Jun-16)	In house check: Jun-18
Power sensor E4412A	SN: 000110210	06-Apr-16 (in house check Jun-16)	In house check: Jun-18
RF generator HP 8648C	SN: US3642U01700	04-Aug-99 (in house check Jun-16)	In house check: Jun-18
Network Analyzer HP 8753E	SN: US37390585	18-Oct-01 (in house check Oct-15)	In house check: Oct-16

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

Issued: June 29, 2016

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
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).

Probe EX3DV4

SN:3866

Manufactured: February 2, 2012
Repaired: June 23, 2016
Calibrated: June 29, 2016

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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3866

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu V/(V/m)^2$)[A]	0.42	0.34	0.37	± 10.1 %
DCP (mV)[B]	99.1	104.1	102.0	

Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB√μV	C	D dB	VR mV	Unc[E] (k=2)
0	CW	X	0.0	0.0	1.0	0.00	148.2	±3.5 %
		Y	0.0	0.0	1.0		153.4	
		Z	0.0	0.0	1.0		158.3	

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:3866

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)
750	41.9	0.89	9.73	9.73	9.73	0.37	0.98	± 12.0 %
835	41.5	0.90	9.36	9.36	9.36	0.37	0.88	± 12.0 %
900	41.5	0.97	9.19	9.19	9.19	0.45	0.87	± 12.0 %
1750	40.1	1.37	7.96	7.96	7.96	0.35	0.80	± 12.0 %
1900	40.0	1.40	7.56	7.56	7.56	0.33	0.88	± 12.0 %
2300	39.5	1.67	7.38	7.38	7.38	0.32	0.92	± 12.0 %
2450	39.2	1.80	7.17	7.17	7.17	0.35	0.83	± 12.0 %
2600	39.0	1.96	6.88	6.88	6.88	0.38	0.87	± 12.0 %
3500	37.9	2.91	6.66	6.66	6.66	0.45	0.95	± 13.1 %
5200	36.0	4.66	5.34	5.34	5.34	0.30	1.80	± 13.1 %
5300	35.9	4.76	5.00	5.00	5.00	0.35	1.80	± 13.1 %
5500	35.6	4.96	4.69	4.69	4.69	0.40	1.80	± 13.1 %
5600	35.5	5.07	4.46	4.46	4.46	0.45	1.80	± 13.1 %
5800	35.3	5.27	4.58	4.58	4.58	0.45	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.

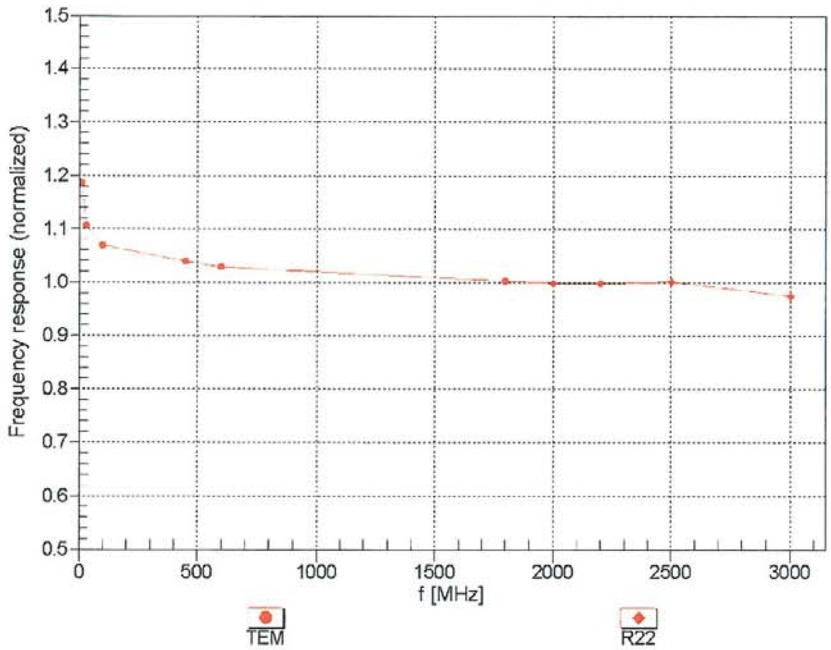
DASY/EASY - Parameters of Probe: EX3DV4 - SN:3866

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)
750	55.5	0.96	9.31	9.31	9.31	0.44	0.87	± 12.0 %
835	55.2	0.97	9.21	9.21	9.21	0.41	0.90	± 12.0 %
900	55.0	1.05	9.28	9.28	9.28	0.46	0.80	± 12.0 %
1750	53.4	1.49	7.73	7.73	7.73	0.41	0.80	± 12.0 %
1900	53.3	1.52	7.45	7.45	7.45	0.35	0.80	± 12.0 %
2300	52.9	1.81	7.27	7.27	7.27	0.44	0.80	± 12.0 %
2450	52.7	1.95	7.20	7.20	7.20	0.34	0.80	± 12.0 %
2600	52.5	2.16	6.82	6.82	6.82	0.39	0.80	± 12.0 %
3500	51.3	3.31	6.31	6.31	6.31	0.45	0.95	± 13.1 %
5200	49.0	5.30	4.65	4.65	4.65	0.45	1.90	± 13.1 %
5300	48.9	5.42	4.47	4.47	4.47	0.45	1.90	± 13.1 %
5500	48.6	5.65	3.97	3.97	3.97	0.50	1.90	± 13.1 %
5600	48.5	5.77	3.82	3.82	3.82	0.50	1.90	± 13.1 %
5800	48.2	6.00	4.05	4.05	4.05	0.55	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)

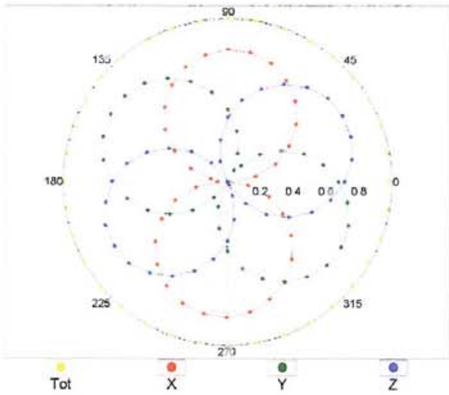


Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

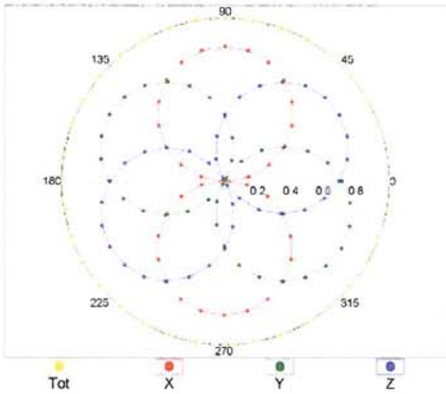
EX3DV4– SN:3866 June 29, 2016

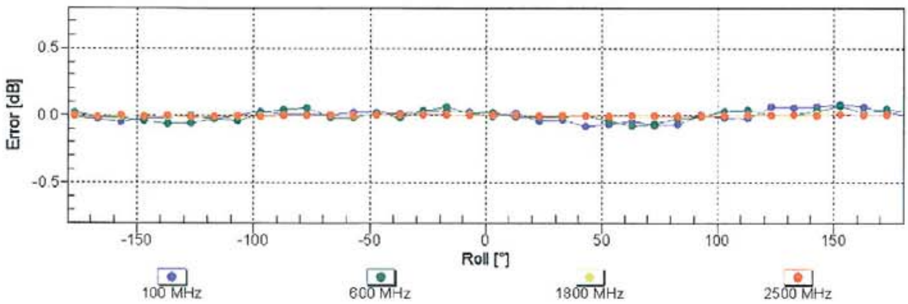
Receiving Pattern (ϕ), $\vartheta = 0°$

f=600 MHz,TEM



f=1800 MHz,R22

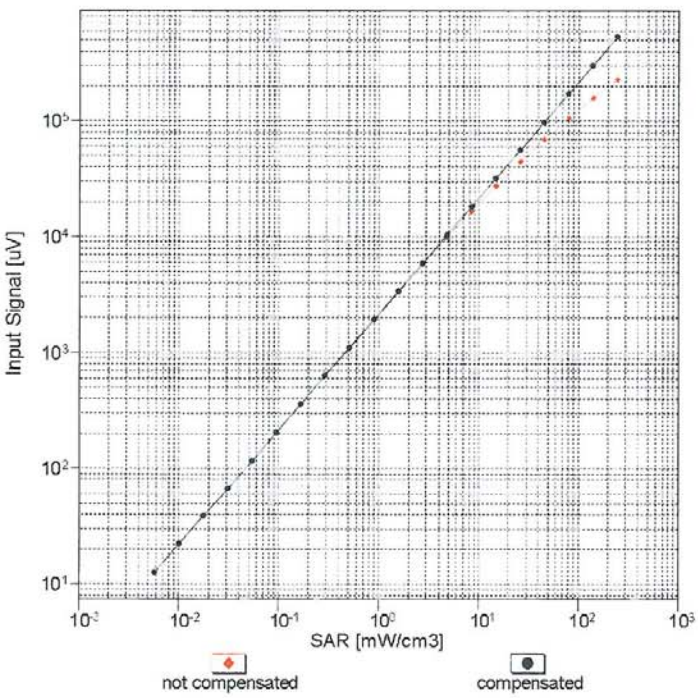


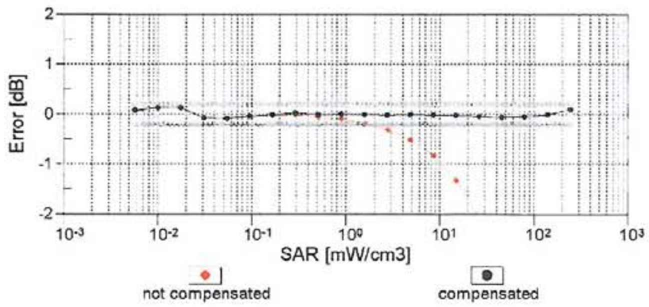


Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

EX3DV4– SN:3866 June 29, 2016

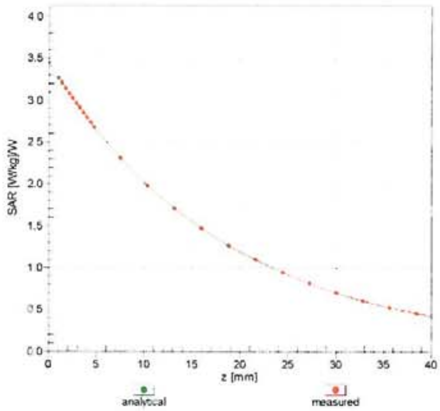
Dynamic Range f(SAR_{head})
(TEM cell , f_{eval}= 1900 MHz)

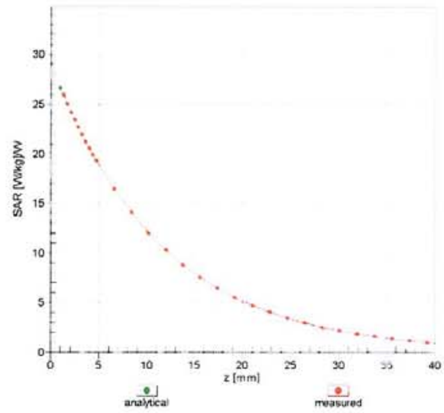




Uncertainty of Linearity Assessment: ± 0.6% (k=2)

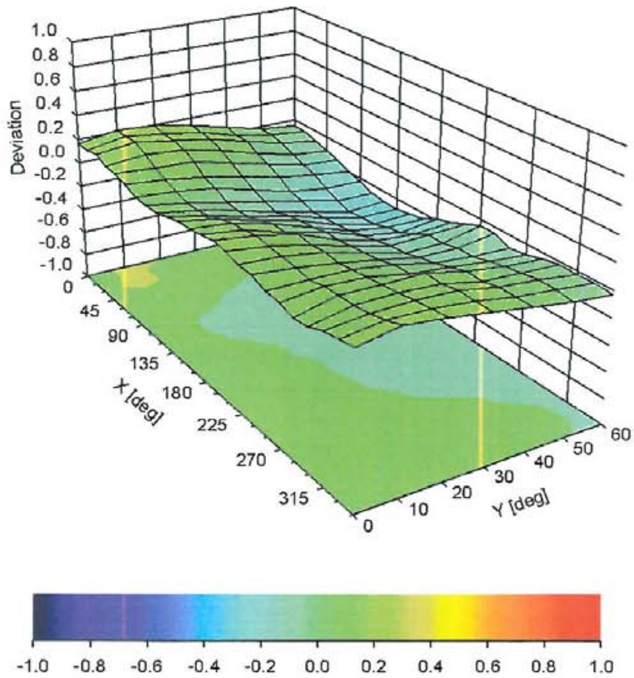
Conversion Factor Assessment





Deviation from Isotropy in Liquid

Error (ϕ, ϑ), f = 900 MHz



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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3866

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	63
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: **D2450V2-920_Sep16**

CALIBRATION CERTIFICATE

Object	D2450V2 - SN:920
Calibration procedure(s)	QA CAL-05.v9 Calibration procedure for dipole validation kits above 700 MHz
Calibration date:	September 23, 2016

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 NRP	SN: 104778	06-Apr-16 (No. 217-02288/02289)	Apr-17
Power sensor NRP-Z91	SN: 103244	06-Apr-16 (No. 217-02288)	Apr-17
Power sensor NRP-Z91	SN: 103245	06-Apr-16 (No. 217-02289)	Apr-17
Reference 20 dB Attenuator	SN: 5058 (20k)	05-Apr-16 (No. 217-02292)	Apr-17
Type-N mismatch combination	SN: 5047.2 / 06327	05-Apr-16 (No. 217-02295)	Apr-17
Reference Probe EX3DV4	SN: 7349	15-Jun-16 (No. EX3-7349_Jun16)	Jun-17
DAE4	SN: 601	30-Dec-15 (No. DAE4-601_Dec15)	Dec-16

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter EPM-442A	SN: GB37480704	07-Oct-15 (No. 217-02222)	In house check: Oct-16
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (No. 217-02222)	In house check: Oct-16
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (No. 217-02223)	In house check: Oct-16
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Jun-15)	In house check: Oct-16
Network Analyzer HP 8753E	SN: US37390585	18-Oct-01 (in house check Oct-15)	In house check: Oct-16

	Name	Function	Signature
Calibrated by:	Leif Klysner	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: September 26, 2016

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	37.9 ± 6 %	1.88 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	13.5 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**52.5 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.28 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**24.7 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	51.6 ± 6 %	2.04 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	13.1 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**51.0 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	250 mW input power	6.12 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**24.1 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	55.9 Ω + 2.3 jΩ
Return Loss	- 24.5 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	52.3 Ω + 5.0 jΩ
Return Loss	- 25.5 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.154 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	December 19, 2012

DASY5 Validation Report for Head TSL

Date: 23.09.2016

Test Laboratory: SPEAG, Zurich, Switzerland

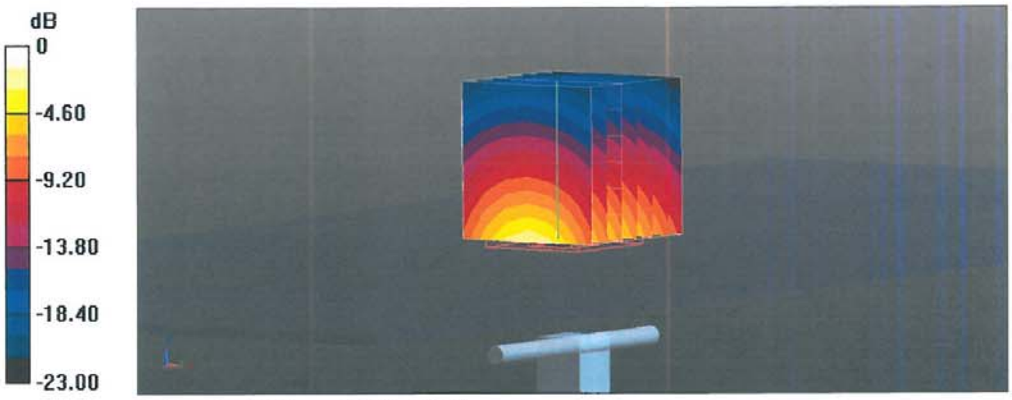
DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:920

Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; σ = 1.88 S/m; ε_r = 37.9; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

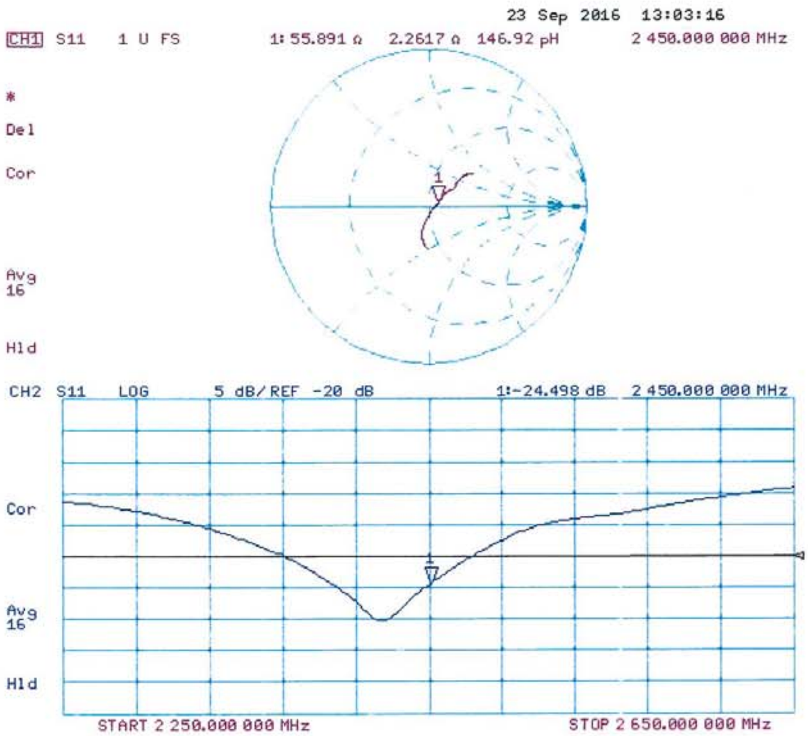
- Probe: EX3DV4 - SN7349; ConvF(7.72, 7.72, 7.72); Calibrated: 15.06.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

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 = 114.0 V/m; Power Drift = -0.02 dB
Peak SAR (extrapolated) = 27.5 W/kg
SAR(1 g) = 13.5 W/kg; SAR(10 g) = 6.28 W/kg
Maximum value of SAR (measured) = 22.4 W/kg



0 dB = 22.4 W/kg = 13.50 dBW/kg

Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 23.09.2016

Test Laboratory: SPEAG, Zurich, Switzerland

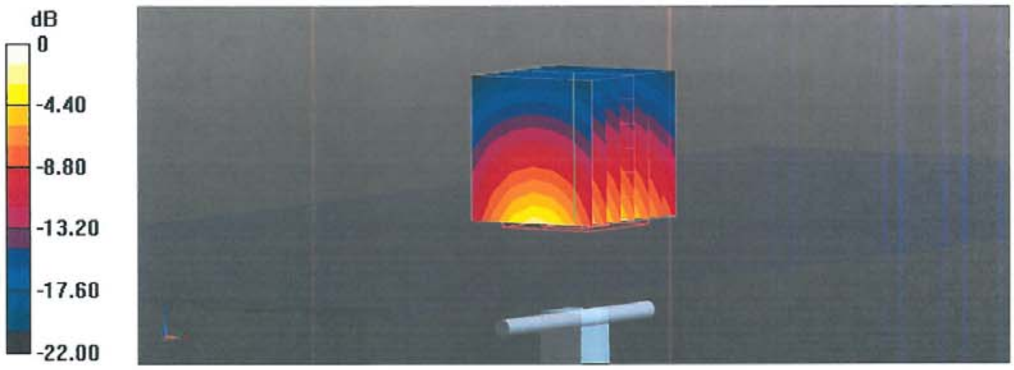
DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:920

Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; σ = 2.04 S/m; ε_r = 51.6; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.79, 7.79, 7.79); Calibrated: 15.06.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

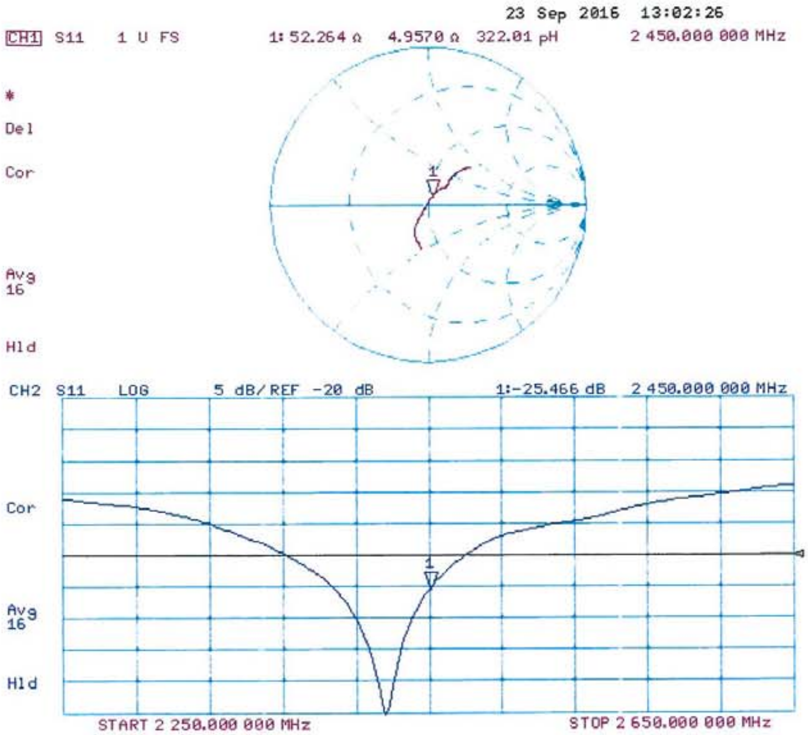
Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 106.3 V/m; Power Drift = -0.03 dB
Peak SAR (extrapolated) = 26.0 W/kg
SAR(1 g) = 13.1 W/kg; SAR(10 g) = 6.12 W/kg
Maximum value of SAR (measured) = 21.2 W/kg



0 dB = 21.2 W/kg = 13.26 dBW/kg

Certificate No: D2450V2-920_Sep16 Page 7 of 8

Impedance Measurement Plot for Body TSL



Certificate No: D2450V2-920_Sep16 Page 8 of 8

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Accreditation No.: **SCS 0108**

Client **DT&C (Dymstec)**

Certificate No: **D5GHzV2-1212_Mar16**

CALIBRATION CERTIFICATE

Object: D5GHzV2 - SN:1212

Calibration procedure(s): QA CAL-22.v2
Calibration procedure for dipole validation kits between 3-6 GHz

Calibration date: March 15, 2016

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-15 (No. 217-02222)	Oct-16
Power sensor HP 8481A	US37292783	07-Oct-15 (No. 217-02222)	Oct-16
Power sensor HP 8481A	MY41092317	07-Oct-15 (No. 217-02223)	Oct-16
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: 3503	31-Dec-15 (No. EX3-3503_Dec15)	Dec-16
DAE4	SN: 601	30-Dec-15 (No. DAE4-601_Dec15)	Dec-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-15)	In house check: Oct-16

	Name	Function	Signature
Calibrated by:	Claudio Leubler	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: March 15, 2016

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

Certificate No: D5GHzV2-1212_Mar16 Page 1 of 16

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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 62209-2, "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
c) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

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 5300 MHz ± 1 MHz 5500 MHz ± 1 MHz 5600 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	34.8 ± 6 %	4.49 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	7.60 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**75.4 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.18 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**21.6 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 %	4.58 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	8.19 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**81.2 W / kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.36 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**23.3 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	34.4 ± 6 %	4.77 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	8.08 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**80.1 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.31 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**22.8 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	34.2 ± 6 %	4.87 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	7.99 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**79.1 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	34.0 ± 6 %	5.08 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	7.66 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**75.9 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.18 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**21.6 W/kg ± 19.5 % (k=2)**

Body TSL parameters at 5200 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	49.0	5.30 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	47.4 ± 6 %	5.37 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5200 MHz

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.37 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**73.2 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.08 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**20.6 W/kg ± 19.5 % (k=2)**

Body TSL parameters at 5300 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.9	5.42 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	47.2 ± 6 %	5.50 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5300 MHz

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.67 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**76.2 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.15 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**21.3 W/kg ± 19.5 % (k=2)**

Body TSL parameters at 5500 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.6	5.65 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	46.8 ± 6 %	5.76 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5500 MHz

SAR averaged over 1 cm³ (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.95 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**79.0 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm³ (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.22 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**22.0 W/kg ± 19.5 % (k=2)**

Body TSL parameters at 5600 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.5	5.77 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	46.7 ± 6 %	5.90 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5600 MHz

SAR averaged over 1 cm³ (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.89 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**78.4 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm³ (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.22 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**22.0 W/kg ± 19.5 % (k=2)**

Body TSL parameters at 5800 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.2	6.00 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	46.3 ± 6 %	6.19 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5800 MHz

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.60 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**75.5 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.12 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**21.0 W/kg ± 19.5 % (k=2)**

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL at 5200 MHz

Impedance, transformed to feed point	49.2 Ω - 4.6 jΩ
Return Loss	- 26.5 dB

Antenna Parameters with Head TSL at 5300 MHz

Impedance, transformed to feed point	48.0 Ω - 0.4 jΩ
Return Loss	- 33.7 dB

Antenna Parameters with Head TSL at 5500 MHz

Impedance, transformed to feed point	47.2 Ω + 2.6 jΩ
Return Loss	- 28.2 dB

Antenna Parameters with Head TSL at 5600 MHz

Impedance, transformed to feed point	50.5 Ω + 2.1 jΩ
Return Loss	- 33.3 dB

Antenna Parameters with Head TSL at 5800 MHz

Impedance, transformed to feed point	52.1 Ω + 2.8 jΩ
Return Loss	- 29.3 dB

Antenna Parameters with Body TSL at 5200 MHz

Impedance, transformed to feed point	49.0 Ω - 3.3 jΩ
Return Loss	- 29.1 dB

Antenna Parameters with Body TSL at 5300 MHz

Impedance, transformed to feed point	47.4 Ω + 0.2 jΩ
Return Loss	- 31.5 dB

Antenna Parameters with Body TSL at 5500 MHz

Impedance, transformed to feed point	46.8 Ω + 3.6 jΩ
Return Loss	- 26.1 dB

Antenna Parameters with Body TSL at 5600 MHz

Impedance, transformed to feed point	49.9 Ω + 4.0 jΩ
Return Loss	- 27.9 dB

Antenna Parameters with Body TSL at 5800 MHz

Impedance, transformed to feed point	52.5 Ω + 4.9 jΩ
Return Loss	- 25.3 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.192 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	November 14, 2014

DASY5 Validation Report for Head TSL

Date: 14.03.2016

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1212

Communication System: UID 0 - CW; Frequency: 5200 MHz, Frequency: 5300 MHz, Frequency: 5500 MHz, Frequency: 5600 MHz, Frequency: 5800 MHz
Medium parameters used: f = 5200 MHz; σ = 4.49 S/m; ε_r = 34.8; ρ = 1000 kg/m^3 , Medium parameters used: f = 5300 MHz; σ = 4.58 S/m; ε_r = 34.6; ρ = 1000 kg/m^3 , Medium parameters used: f = 5500 MHz; σ = 4.77 S/m; ε_r = 34.4; ρ = 1000 kg/m^3 , Medium parameters used: f = 5600 MHz; σ = 4.87 S/m; ε_r = 34.2; ρ = 1000 kg/m^3 , Medium parameters used: f = 5800 MHz; σ = 5.08 S/m; ε_r = 34; ρ = 1000 kg/m^3
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(5.59, 5.59, 5.59); Calibrated: 31.12.2015, ConvF(5.25, 5.25, 5.25); Calibrated: 31.12.2015, ConvF(5.18, 5.18, 5.18); Calibrated: 31.12.2015, ConvF(4.99, 4.99, 4.99); Calibrated: 31.12.2015, ConvF(4.95, 4.95, 4.95); Calibrated: 31.12.2015;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom Type: QD000P50AA
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

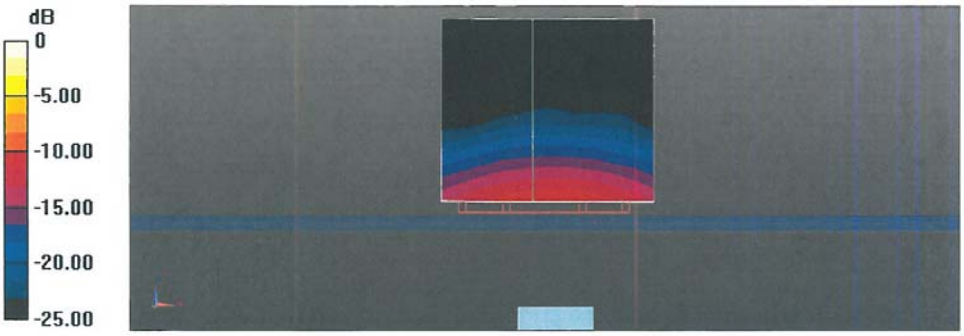
Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5200 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 72.04 V/m; Power Drift = -0.04 dB
Peak SAR (extrapolated) = 27.4 W/kg
SAR(1 g) = 7.6 W/kg; SAR(10 g) = 2.18 W/kg
Maximum value of SAR (measured) = 17.5 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5300 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 73.31 V/m; Power Drift = 0.03 dB
Peak SAR (extrapolated) = 30.5 W/kg
SAR(1 g) = 8.19 W/kg; SAR(10 g) = 2.36 W/kg
Maximum value of SAR (measured) = 19.1 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5500 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 72.28 V/m; Power Drift = 0.06 dB
Peak SAR (extrapolated) = 31.8 W/kg
SAR(1 g) = 8.08 W/kg; SAR(10 g) = 2.31 W/kg
Maximum value of SAR (measured) = 19.2 W/kg

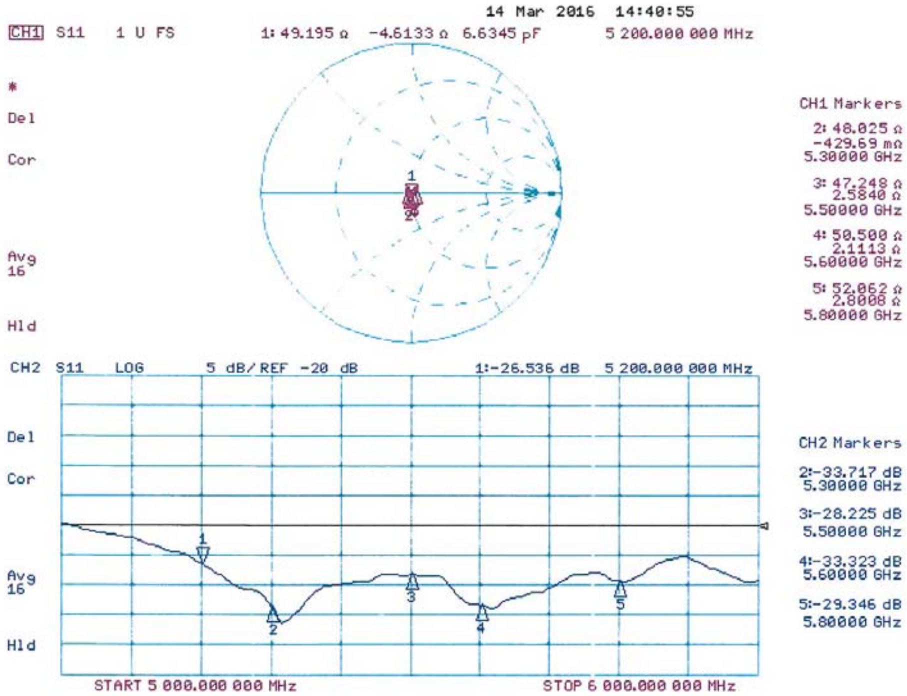
Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 71.82 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 31.4 W/kg
SAR(1 g) = 7.99 W/kg; SAR(10 g) = 2.29 W/kg
Maximum value of SAR (measured) = 18.8 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 69.47 V/m; Power Drift = 0.04 dB
Peak SAR (extrapolated) = 31.6 W/kg
SAR(1 g) = 7.66 W/kg; SAR(10 g) = 2.18 W/kg
Maximum value of SAR (measured) = 18.5 W/kg



0 dB = 18.5 W/kg = 12.67 dBW/kg

Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 15.03.2016

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1212

Communication System: UID 0 - CW; Frequency: 5200 MHz, Frequency: 5300 MHz, Frequency: 5500 MHz, Frequency: 5600 MHz, Frequency: 5800 MHz
Medium parameters used: f = 5200 MHz; σ = 5.37 S/m; ε_r = 47.4; ρ = 1000 kg/m^3 , Medium parameters used: f = 5300 MHz; σ = 5.5 S/m; ε_r = 47.2; ρ = 1000 kg/m^3 , Medium parameters used: f = 5500 MHz; σ = 5.76 S/m; ε_r = 46.8; ρ = 1000 kg/m^3 , Medium parameters used: f = 5600 MHz; σ = 5.9 S/m; ε_r = 46.7; ρ = 1000 kg/m^3 , Medium parameters used: f = 5800 MHz; σ = 6.19 S/m; ε_r = 46.3; ρ = 1000 kg/m^3
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(4.99, 4.99, 4.99); Calibrated: 31.12.2015, ConvF(4.75, 4.75, 4.75); Calibrated: 31.12.2015, ConvF(4.4, 4.4, 4.4); Calibrated: 31.12.2015, ConvF(4.35, 4.35, 4.35); Calibrated: 31.12.2015, ConvF(4.27, 4.27, 4.27); Calibrated: 31.12.2015;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom Type: QD000P50AA
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

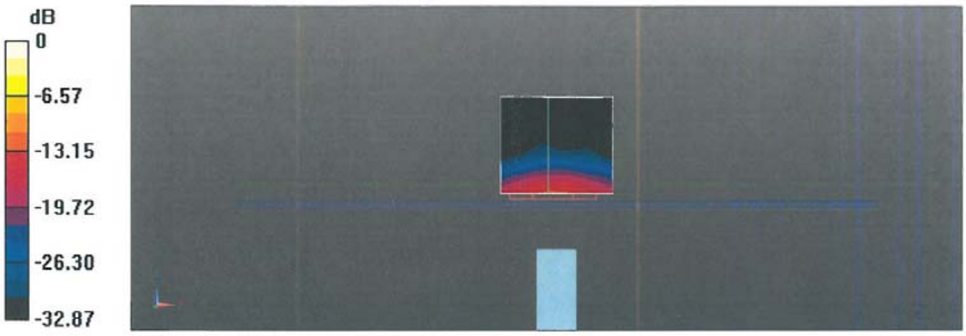
Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5200 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 66.69 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 27.3 W/kg
SAR(1 g) = 7.37 W/kg; SAR(10 g) = 2.08 W/kg
Maximum value of SAR (measured) = 17.3 W/kg

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5300 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 67.48 V/m; Power Drift = -0.00 dB
Peak SAR (extrapolated) = 29.1 W/kg
SAR(1 g) = 7.67 W/kg; SAR(10 g) = 2.15 W/kg
Maximum value of SAR (measured) = 18.2 W/kg

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5500 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 67.62 V/m; Power Drift = -0.00 dB
Peak SAR (extrapolated) = 31.8 W/kg
SAR(1 g) = 7.95 W/kg; SAR(10 g) = 2.22 W/kg
Maximum value of SAR (measured) = 19.2 W/kg

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 67.42 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 32.4 W/kg
SAR(1 g) = 7.89 W/kg; SAR(10 g) = 2.22 W/kg
Maximum value of SAR (measured) = 19.4 W/kg

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 64.97 V/m; Power Drift = 0.00 dB
Peak SAR (extrapolated) = 33.0 W/kg
SAR(1 g) = 7.6 W/kg; SAR(10 g) = 2.12 W/kg
Maximum value of SAR (measured) = 19.0 W/kg



0 dB = 17.3 W/kg = 12.38 dBW/kg

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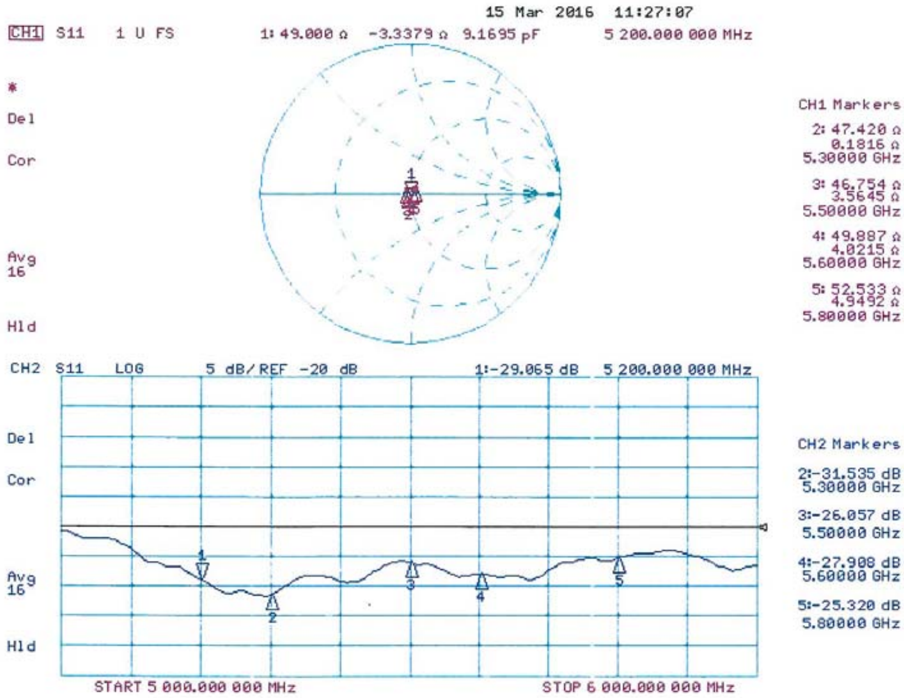
Impedance Measurement Plot for Body TSL



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Attachment 3. – SAR SYSTEM VALIDATION

SAR System Validation

Per FCC KDB 865664 D02v01r02, SAR system validation status should be documented to confirm measurement accuracy. The SAR systems (including SAR probes, system components and software versions) used for this device were validated against its performance specifications prior to the SAR measurements. Reference dipoles were used with the required tissue- equivalent media for system validation, according to the procedures outlined in FCC KDB 865664 D01v01r04 and IEEE 1528-2013.Since SAR probe calibrations are frequency dependent, each probe calibration point was validated at a frequency within the valid frequency range of the probe calibration point, using the system that normally operates with the probe for routine SAR measurements and according to the required tissue-equivalent media.

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

Table Attachment 3.1 SAR System Validation Summary

SAR System	Freq. [MHz]	Date	Probe SN	Probe Type	Probe CAL. Point		PERM.	COND.	CW Validation			MOD. Validation		
							(εr)	(σ)	Sensi-tivity	Probe Linearity	Probe Isortopy	MOD. Type	Duty Factor	PAR
B	2450	2016-07-04	3866	EX3DV4	2450	Head	39.164	1.832	PASS	PASS	PASS	OFDM	N/A	PASS
B	5200	2016-07-05	3866	EX3DV4	5200	Head	35.869	4.641	PASS	PASS	PASS	OFDM	N/A	PASS
B	5800	2016-07-05	3866	EX3DV4	5800	Head	35.471	5.251	PASS	PASS	PASS	OFDM	N/A	PASS
B	2450	2016-07-04	3866	EX3DV4	2450	Body	51.662	1.921	PASS	PASS	PASS	OFDM	N/A	PASS
B	5200	2016-07-05	3866	EX3DV4	5200	Body	49.224	5.217	PASS	PASS	PASS	OFDM	N/A	PASS
B	5800	2016-07-05	3866	EX3DV4	5800	Body	48.312	6.143	PASS	PASS	PASS	OFDM	N/A	PASS

NOTE: While the probes have been calibrated for both a CW and modulated signals, all measurements were performed using communication systems calibrated for CW signals only. Modulations in the table above represent test configurations for which the measurement system has been validated per FCC KDB Publication 865664 D01v01r04 for scenarios when CW probe calibrations are used with other signal types.SAR systems were validated for modulated signals with a periodic duty cycle, such as GMSK, or with a high peak to average ratio (>5 dB), such as OFDM according to KDB 865664.