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FCC and IC SAR EVALUATION REPORT FOR CERTIFICATION

Applicant :

Samsung Electronics Co., Ltd.
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Suwon-si, Gyeonggi-do, Korea.
(Post code : 16677)
Attn. : Minhyung Cho

Dates of Issue : May 13, 2016
Test Report No. : NK-16-R-054
Test Site : Nemko Korea Co., Ltd.

FCC
IC

A3LRMCFTJ1AP1
649E-RMCFTJ1AP1

Brand Name

SAMSUNG

Contact Person

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Applied Standard: FCC 47 CFR Part 2(2.1093) and IC RSS-102 Issue 5
Classification: FCC Part 15 Spread Spectrum Transmitter (DSS)
EUT Type: Smart Control

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 May 13. 2016

Tested By : Wonjae Song
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 May 13. 2016

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1. SCOPE

Measurement and determination of electromagnetic field intended to be used at a position near the human body with radio frequency device at distance up to and including 200mm from a human body for compliance with the technical rules and regulations of the Federal Communications Commission under FCC part 2 and IC RSS-102 Issue5.

Responsible Party :	Samsung Electronics Co., Ltd.
Contact Person :	Minhyung Cho
Manufacturer :	Samsung Electronics Co., Ltd. 129, Samsung-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, Korea 16677

- FCC ID A3LRMCFTJ1AP1
- IC : 649E-RMCFTJ1AP1
- Model: RMCFTJ1AP1
- Brand Name: SAMSUNG
- EUT Type: Smart Control
- Classification: Part 15 Spread Spectrum Transmitter
- Applied Standard: FCC 47 CFR Part 2(2.1093) and IC RSS-102 Issue 5
- Test Procedure(s): IEEE 1528-2013, FCC guidance of 447498 D01 General RF exposure Guidance v06, FCC guidance of 865664 D02 RF exposure Reporting v01r02, IEC 62209:2010
- Dates of Test: May 03, 2016 ~ May 11, 2016
- Place of Tests: Nemko Korea Co., Ltd.

2. INTRODUCTION

2.1 Test facility

The measurement procedure described in American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz (ANSI C63.4-2014), the American National Standard for Testing Unlicensed Wireless Devices (ANSI C63.10-2013) was used in determining radiated and conducted emissions emanating from **Samsung Electronics Co., Ltd. FCC ID : A3LRMCFTJ1AP1** and **IC : 649E-RMCFTJ1AP1**

These measurement tests were conducted at **Nemko Korea Co., Ltd. EMC Laboratory**.

The site address 155 & 159, Osan-Ro, Mohyeon-Myeon, Cheoin-Gu, Yongin-Si, Gyeonggi-Do 16885 KOREA, REPUBLIC OF.

The area of Nemko Korea Corporation Ltd. EMC Test Site is located in a mountain area at 80 km (48 miles) southeast and Incheon International Airport (Incheon Airport), 30 km (18miles) south-southeast from central Seoul.

It is located in the valley surrounded by mountains in all directions where ambient radio signal conditions are quiet and a favorable area to measure the radio frequency interference on open field test site for the computing and ISM devices manufactures.

The detailed description of the measurement facility was found to be in compliance with the requirements of ANSI C63.4-2014 according to §2.948.



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Fig. 1. The map above shows the Seoul in Korea vicinity area.
The map also shows Nemko Korea Corporation Ltd. EMC Lab. and Incheon Airport.

2.2 Accreditation and listing

Accreditation type		Accreditation number
	CAB Accreditation for DOC	Designation No. KR0026
	KOLAS Accredited Lab. (Korea Laboratory Accreditation Scheme)	Registration No. 155
	Canada IC Registered site	Site No. 2040E
	VCCI registration site(RE/CE/Telecom CE)	Member No. 2118
	EMC CBTL	-
	KCC(RRL)Designated Lab.	Registration No. KR0026

3. TEST CONDITIONS & EUT INFORMATION

3.1 Operation During Test

The EUT is the transceiver which is the Bluetooth 3.0 module supporting BDR/EDR mode. The Laptop was used to control the EUT to transmit the wanted TX channel by the testing program (Bluetool) which manufacturer supported. The Laptop was removed after controlling the EUT to transmit the wanted signal. The EUT was tested at the lowest channel, middle channel and the highest channel with the maximum output power in accordance with the manufacturer's specifications. The worst data were recorded in the report.

3.1.1 Operating Environment

Parameters	Recording during test	Accepted deviation
Ambient temperature	22.1 °C	(20 ~ 26) °C
Relative Humidity	51 %	(30 ~ 70) %

3.1.2 Table of test power setting

Frequency	Mode	Power setting Level
2402 MHz ~ 2480 MHz	GFSK	Default
	$\pi/4$ DQPSK	
	8DPSK	

3.1.3 Table of test channels

Frequency band	Mode	Test Channel (CH)	Frequency (MHz)
2.4 GHz	GFSK, $\pi/4$ DQPSK, 8DPSK	0	2402
		39	2441
		78	2480

3.1.4 Antenna TX mode information

Frequency band	Mode	Antenna TX mode	Support MIMO
2.4 GHz	GFSK, $\pi/4$ DQPSK, 8DPSK	☒ 1TX, ☐ 2TX	☐ Yes, ☒ No

3.1.5. Additional Information Related to Testing

- SAR testing was performed all EUT orientations with a device-to-phantom separation distance of 0 mm, according to KDB 447498 requirements.
- The EUT is classified Extremity exposure conditions, but the device can be operated in close proximity to the user's body. Therefore, SAR compliance for the body is applied to determine SAR test requirements, according to KDB 447498 4.2.3.

3.2 Support Equipment

EUT	Samsung Electronics Co., Ltd. Model: RMCFTJ1AP1	S/N: N/A
Laptop Computer	Samsung Electronics Co., Ltd. Model : NT-R580 0.3 m unshielded pin connector cable	FCC DOC S/N : ZNU793BZ200566M
Laptop Computer	Hewlett-Packard Co., Ltd. Model : Pavilion dv6	S/N : N/A

3.3. Maximum Target power among production units

- Tune up tolerance is ± 3 dBm, it is specified in operation description page 6.

Mode	Minimum power (dBm)	Maximum power(dBm)
GFSK	9	15
$\pi/4$ DQPSK	6	12
8DPSK	6	12

3.4 EUT Information

The EUT is the **Samsung Smart Control FCC ID: A3LRMCFTJ1AP1, IC: 649E-RMCFTJ1AP1**.
This unit supports full qualified Bluetooth 3.0 with EDR standard system.

Specifications:

EUT Type	Smart Control
Model Name	RMCFTJ1AP1
Brand Name	SAMSUNG
Frequency of Operation	2402 MHz ~ 2480 MHz
Average Output Power (Conducted)	GFSK : 12.10 dBm $\pi/4$ DQPSK : 8.64 dBm 8DPSK : 8.79 dBm
FCC Classification	FCC Part 15 Spread Spectrum Transmitter (DSS)
Method/System	Frequency Hopping Spread Spectrum (FHSS)
Channel Number	79
Modulation	GFSK, $\pi/4$ DQPSK, 8DPSK
Antenna Gain	1.99 dBi (peak)
Power	3 Vdc
Dimensions (L x W x H)	About 17.5 cm x 4.3 cm X 1.8 cm
Weight	About 75 g
H/W Status	
S/W Status	
Remarks	-

3.5. Description of change

- No Comment

3.6. Modifications

- No Comment

4. GUIDANCE APPLIED

The Specific Absorption Rate(SAR)testing specification, method, and procedure for this device is in Accordance with the following standards:

- FCC 47 CFR Part 2(2.1093)
- RSS-102 Issue 5
- IEEE 1528-2013
- IEC 62209:2010
- FCC KDB Publication 447498 D01 v06
- FCC KDB Publication 865664 D01 v01r04
- FCC KDB Publication 865664 D02 v01r01

5. DESCRIPTION OF TEST EQUIPMENT

5.1 SAR Measurement Setup

Robotic System

Measurements are performed using the DASY4 automated dosimetric assessment system. Which is made by Schmid & Partner Engineering AG (SPEAG) in Zurich, Switzerland and consists of high precision robotics system (Stäubli), robot controller, measurement server, H/P computer, nearfield probe, probe alignment sensor, and the SAM 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. 5.1).

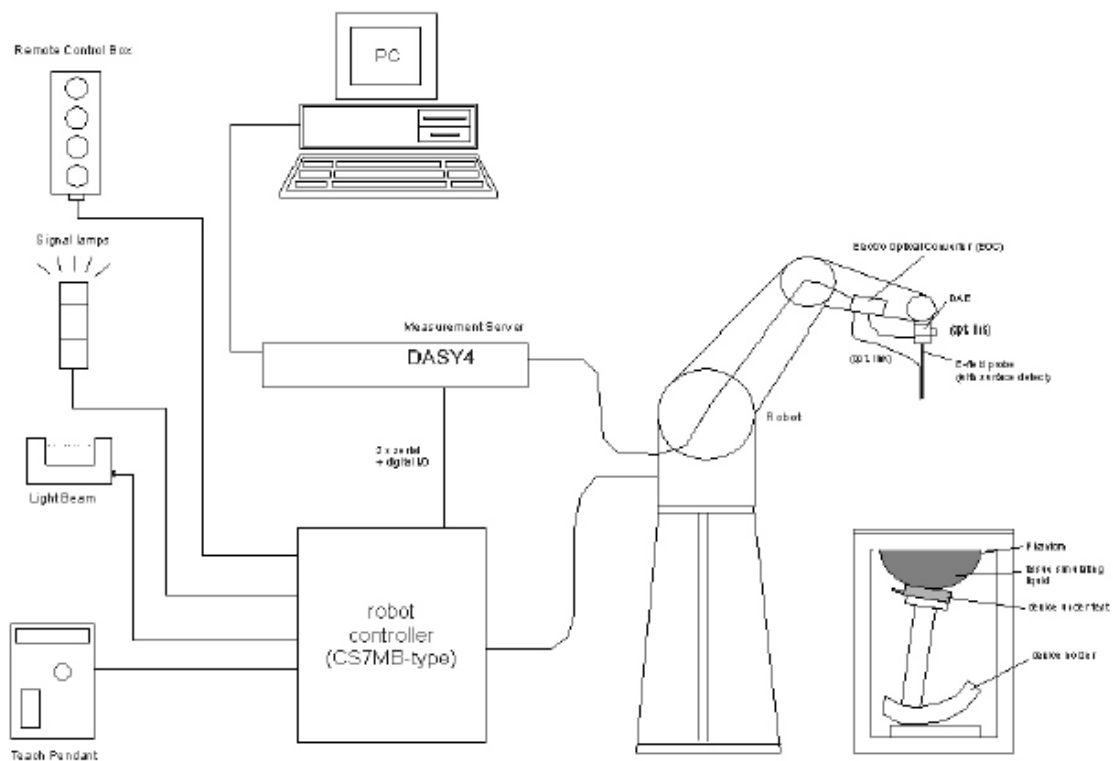


Figure 5.1 SAR Measurement System Setup

System Hardware

A cell controller system contains the power supply, robot controller, teach pendant (Joystick), and a remote control is used to drive the robot motors. The PC consists of the H/P computer with Windows XP system and SAR Measurement Software DASY4, LCD monitor, mouse and keyboard. The Stäubli Robot is connected to the cell controller to allow software manipulation of the robot. A Data Acquisition Electronic (DAE) circuit that performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. Is connected to the Electro-Optical Coupler (EOC). The EOC performs the conversion from the optical into digital electric signal of the DAE and transfers data to the measurement server.

System Electronics

The DAE4 consists of a highly sensitive electrometer-grade preamplifier with autozeroing, a channel and gain-switching multiplexer, a fast 16-bit AD-converter and a command decoder and control logic unit. Transmission to the measurement server is accomplished through an optical downlink for data and status information 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.

5.2 E-field Probe

The SAR measurement were conducted with the dosimetric probe designed in the classical triangular configuration (see Fig.5.3) and optimized for dosimetric evaluation. The probe is constructed using the thick film technique; with printed resistive lines on ceramic substrates.

The probe is equipped with an optical multi-fiber line ending at the front of the probe tip (see Fig.5.4). 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 a System 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 DASY4 software reads the reflection during a software approach and looks for the maximum using a 2nd order fitting (see Fig.5.2). The approach is stopped at reaching the maximum.



Figure 5.2 DAE System

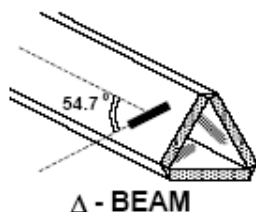


Figure 5.3 Triangular Probe Configuration



Figure 5.4 Probe Thick-Film Technique

Probe Specifications

Manufacturer : SPEAG
model name: EX3DV4
Serial number : 3947
Probe spec : refer to the Appendix C
Probe calibration : September 01, 2015

5.3 SAM Phantom

The SAM Twin Phantom V4.0C is constructed of a fiberglass shell Integrated in a wooden table. The shape of the shell is based on data from an anatomical study designed to determine the maximum exposure in at least 90% of all users.

It enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region.

A cover prevents the evaporation of the liquid. Reference markings on the phantom allow the complete setup of all predefined phantom positions and measurement grids by manually teaching three points in the robot.

(See Figure 5.5)



Figure 5.5 SAM Twin Phantom

Phantom Specification

Construction : The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (SAM) phantom defined in IEEE 1528-2013.

It enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region.

A cover prevents 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.

Shell Thickness : 2 ± 0.2 mm

Filling Volume : Approx. 25 liters

Dimensions : Height; 830 mm; Length: 1000 mm; Width: 500 mm

5.4 Simulating Mixture Characterization

The dielectric properties of the liquid material used in the phantom shall be those listed in Table 5.1. The mixture is calibrated to obtain proper dielectric constant (permittivity) and conductivity of the desired tissue. The tissue dielectric parameters recommended by the IEEE SCC-34/SC-2 have been incorporated in the following table.

Table 5.1 Composition of the Body Tissue Equivalent Matter

INGREDIENTS	SIMULATING TISSUE
	2450 MHz Body
De-ionised water	56 %
DGBE	44 %
Salt	0.0 %
Sum	100 %



2 GHz (Body) Tissue Simulating Liquid, Depth: 150 mm

5.5 Device Holder for Transmitters

In combination with the SAM Twin Phantom V4.0, the Mounting Device (see Fig. 5.6) enables the rotation of the mounted transmitter in spherical coordinates whereby the rotation point is the ear opening.

The device holder can be locked at different phantom locations (left head, right head, flat phantom).

* Note: A simulating human hand is not used due to the Complex anatomical and geometrical structure of the hand that may produce infinite number of configurations .

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



Figure 5.6 Device Holder

6. SAR MEASUREMENT PROCEDURE

EUT at the maximum power level is placed by a non metallic device holder in the above described positions at a shell phantom of a human being.

The distribution of the electric field strength E is measured in the tissue simulating liquid within the shell phantom.

For this miniaturized field probes with high sensitivity and low field disturbance are used.

Afterwards the corresponding SAR values are calculated with the known electrical conductivity σ and the mass density ρ of the tissue in the SEMCAD software.

The software is able to determine the averaged SAR values (averaging region 1g or 10g) for compliance testing.

The measurements are done by two scans: first a coarse scan determines the region of the maximum SAR, afterwards the averaged SAR is measured in a second scan within the sharp of a cube.

The measurement times takes about 20 minutes.

The following steps are used for each test position:

STEP 1

Establish a call with the maximum output power with a base station simulator.

The connection between the mobile phone and the base station simulator is established via air interface.

STEP 2

Measurement of the local E-Field value at a fixed location (P1).

This value serves as a reference value for calculating a possible power drift.

STEP 3

Measurement of the SAR distribution with a grid spacing of 15mm × 15mm and a constant distance to the inner surface of the phantom.

Since the sensors cannot directly measure at the inner surface of the phantom.

Since the sensors can not directly measure at the inner phantom surface, the values between the sensors and the inner phantom surface are extrapolated. With this values the area of the maximum SAR is calculated by a interpolation scheme (combination of a least-square fitted function and a weighted average method). Additional peaks within 3dB of the maximum SAR are searched.

STEP 4

Around this points, a cube of 30mm×30mm×30mm is assessed by measuring 5×5×5 points.

With these data, the peak spatial-average SAR value can be calculated with the SEMCAD software.

STEP 5

The used extrapolation and interpolation routines are all based on the modified Quadratic Shepard's method [DASY4].

STEP 6

Repetition of the E-Field measurement at the fixed location(P1) and repetition of the whole procedure if the two results differ by more than $\pm 0.223\text{dB}$.

7. DEFINITION OF REFERENCE POINTS

7.1 EAR Reference Point

Figure 7.1 shows the front, back and side views of SAM. The point "M" is the reference point for the center of mouth, "LE" is the left ear reference point (ERP), and "RE" is the right ERP. The ERPs are 15 mm posterior to the entrance to ear canal (EEC) along the B-M line (Back-Mouth), as shown in Figure 7.2.



Figure 7.1 Front, back and side view of SAM

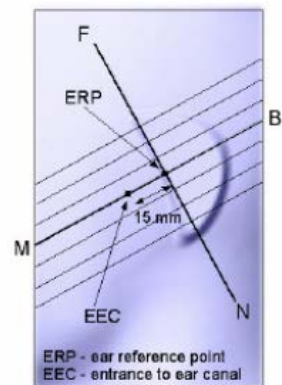


Figure 7.2 Close up side view

The plane passing through the two ear canals and M is defined as the Reference Plane. The line N-F (Neck-Front) perpendicular to the reference plane and passing through the RE (or LE) is called the Reference Pivoting Line (see Figure 7.3). Line B-M is perpendicular to the N-F line. Both N-F and B-M Lines should be marked on the external phantom shell to facilitate handset positioning. Posterior to the N-F line, the thickness of the phantom shell with the shape of an ear is a flat surface 6 mm thick at the ERPs.

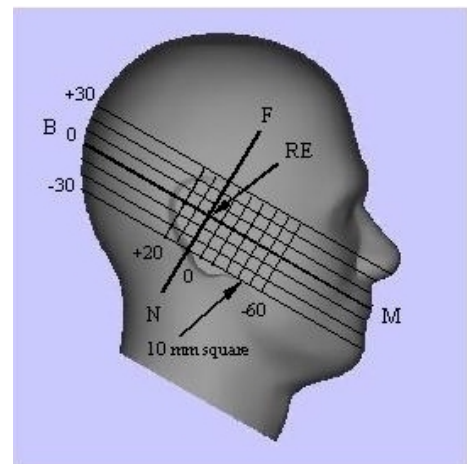


Figure 7.3 Side view of the

phantom showing relevant markings

7.2 Handset Reference Points

Two imaginary lines on the handset were established: the vertical centerline and the horizontal line. The test device was placed in a normal operating position with the “test device reference point” located along the “vertical centerline” on the front of the device aligned to the “ear reference point” (see Fig. 7.4).

The “test device reference point” was then located at the same level as the center of the ear reference point. The test device was positioned so that the “vertical centerline” was bisecting the front surface of the handset at its tip and bottom edges, positioning the “ear reference point” on the outer surface of the both the left and right head phantoms on the ear reference point.

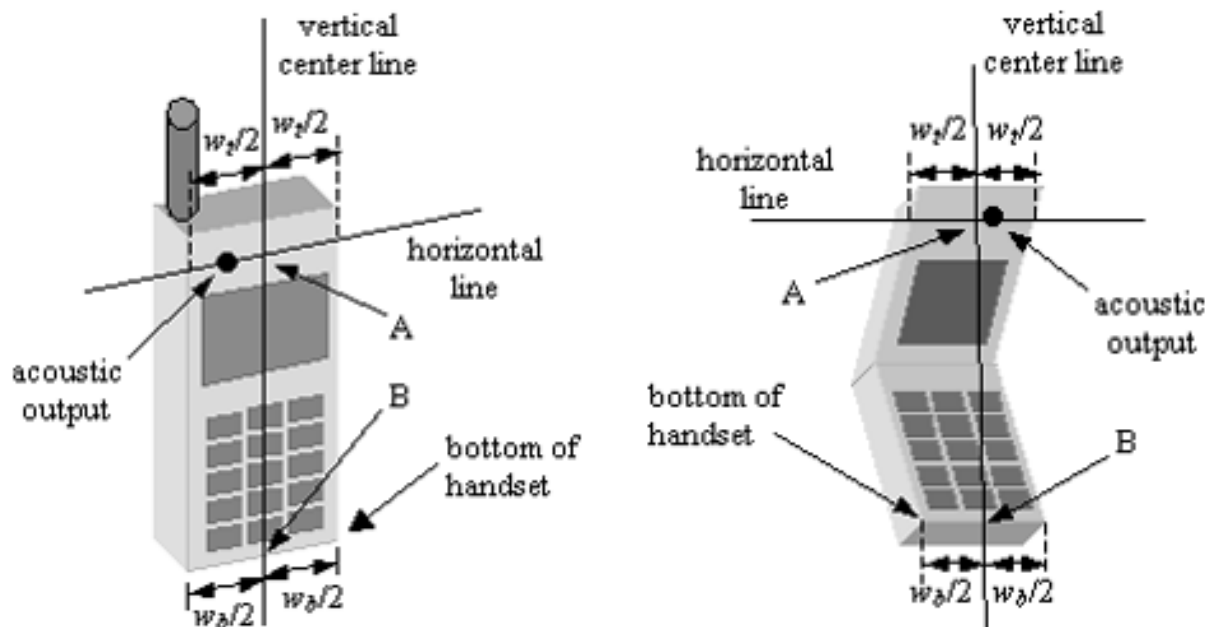


Figure 7.4 Handset vertical and horizontal reference lines

8. TEST CONFIGURATION POSITIONS

8.1 Cheek/Touch Position

Step 1

The test device was positioned with the handset close to the surface of the phantom such that point A is on the (virtual) extension of the line passing through points RE and LE on the phantom (see Figure 8.1), such that the plane defined by the vertical center line and the horizontal line of the phone is approximately parallel to the sagittal plane of the phantom.

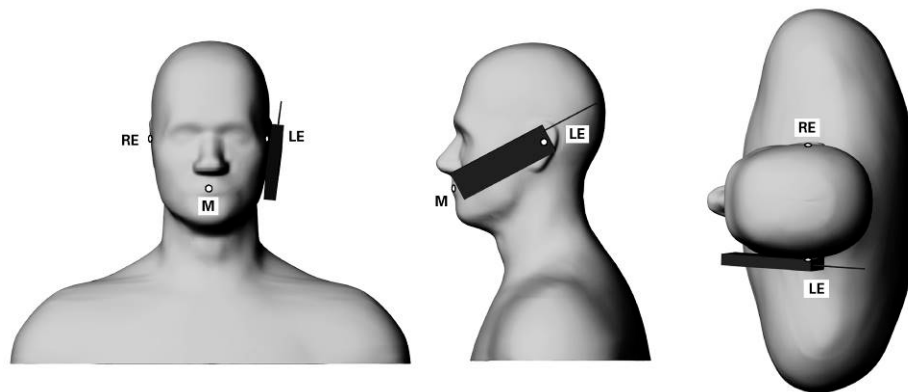


Figure 8.1 Front Side and Top View of Cheek/Touch Position

Step 2

The handset was translated towards the phantom along the line passing through RE & LE until the handset touches the ear.

Step 3

While maintaining the handset in this plane, the handset was rotated around the LE-RE line until the vertical centerline was in the plane normal to MB-NF including the line MB (reference plane).

Step 4

Rotate the handset around the vertical centerline until the phone (horizontal line) was symmetrical with respect to the line NF.

Step 5

While maintaining the vertical centerline in the reference plane, keeping point A on the line passing through RE and LE, and maintaining the phone contact with the ear, the handset was rotated about the line NF until any point on the handset made contact with a phantom point below the ear cheek. (See Figure 7.2)

8.2 EAR/Tilt 15° Position

With the test device aligned in the “Cheek/Touch Position”:

Step 1

Repeat steps 1 to 5 of 6.2 to place the device in the “Cheek/Touch Position”

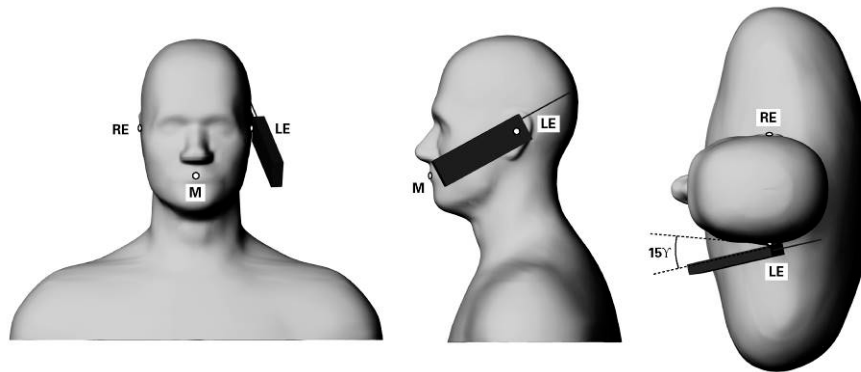


Figure 8.2 Front, side and Top View of Ear/Tilt 15° Position

Step 2

While maintaining the orientation of the phone, the phone was retracted parallel to the reference plane far enough to enable a rotation of the phone by 15 degree.

Step 3

The phone was then rotated around the horizontal line by 15 degree.

Step 4

While maintaining the orientation of the phone, the phone was moved parallel to the reference plane until any part of the phone touches the head.

(In this position, point A was located on the line RE-LE). The tilted position is obtained when the contact is on the pinna. If the contact was at any location other than the pinna, the angle of the phone would then be reduced.

The tilted position was obtained when any part of the phone was in contact of the ear as well as a second part of the phone was in contact with the head. (See Figure 8.2)

8.3 Body-worn and Other Configurations

8.3.1 Phantom Requirement

For body-worn and other configurations a flat phantom shall be used which is comprised of material with electrical properties similar to the corresponding tissues.

8.3.2 Test Position

The body-worn configurations shall be tested with the supplied accessories (belt-clips, holsters, etc.) attached to the device in normal use configuration. Devices with a headset output shall be tested with a connected headset. Since the IEC 62209-2 was mainly issued for mobile phones it is only a guideline and therefore some requirements are not usable or practical for devices other than mobile phones.

8.3.3 Test to be Performed

For purpose of determining test requirements, accessories may be divided into two categories: those that do not contain metallic components and those that do. For multiple accessories that do not contain metallic components, the device may be tested only with that accessory which provides the closest spacing to the body.

For multiple accessories that contain metallic components, the device must be tested with each accessory that contains a unique metallic component. If multiple accessories share an identical metallic component, only the accessory that provides the closest spacing to the body must be tested. If the manufacturer provides none body accessories, a separation distance of 0 cm between the back of the device and the flat phantom is recommended to cover the worst-case usage scenarios. Other separation distances may be used, but they shall not exceed 2.5cm. In these cases, the device may use body-worn accessories that provide a separation distance greater than that tested for the device provided however that the accessory contains no metallic components.

For devices with retractable antenna, the SAR test shall be performed with the antenna fully extended and fully retracted. Other factors that may affect the exposure shall also be tested. For example, optional antennas or optional battery packs which may significantly change the volume, lengths, flip open/closed, etc. of the device or any other accessories which might have the potential to considerably increase the peak spatial-average SAR value.

The SAR test shall be performed at the high, middle and low frequency channels of each operating mode. If the SAR measured at the middle channel for each test configuration is at least 3.0dB lower than the SAR limit, testing at the high and low channel is optional.

9. LIMITS FOR SPECIFIC ABSORPTION RATE (SAR)

HUMAN EXPOSURE	SAR (W/kg)	
	General Population / Uncontrolled Exposure Environment	Occupational / Controlled Exposure Environment
Spatial Peak SAR (Brain)	1.6	8.0
Spatial Average SAR (Whole Body)	0.08	0.4
Spatial Peak SAR (Hands, Wrists, Feet and Ankles)	4.0	20.0

1. This limits accord to SAR Human Exposure Specified in ANSI/IEEE C95.1-1992 and Health Canada Safety Code 6
2. The Spatial Peak value of the SAR averaged over any 1g of tissue and over the appropriate averaging time.
3. The Spatial average value of the SAR averaged over the whole body.
4. The Spatial Peak value of the SAR averaged over any 10g of tissue and over the appropriate averaging time.

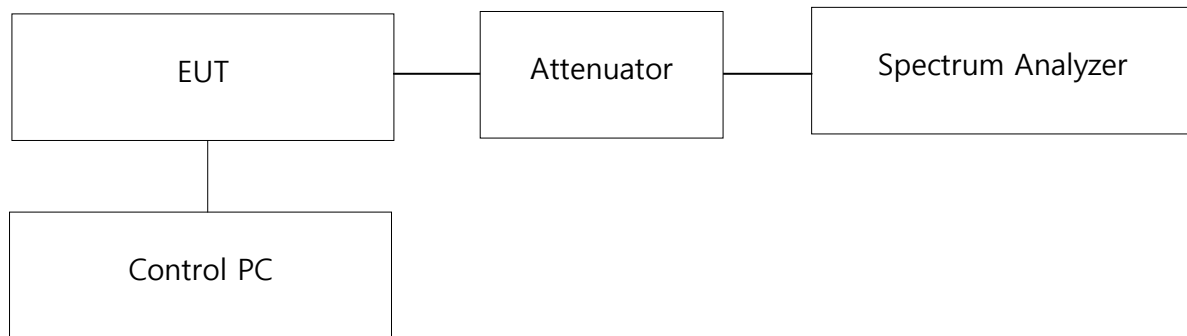
10. MEASUREMENT UNCERTAINTY

Uncertainty Component	Tolerance (±%)	Prob. Dist.	Divisor	(Ci)	Standard Uncertainty (±%)	(Vi)
				(1 g)	(1 g)	
Measurement System						
Probe Calibration	6.00	Normal	1	1.00	6.00	∞
Axial Isotropy	4.70	Rectangular	√3	0.70	1.90	∞
Hemispherical Isotropy	9.60	Rectangular	√3	0.70	3.90	∞
boundary Effects	1.00	Rectangular	√3	1.00	0.60	∞
Linearity	4.70	Rectangular	√3	1.00	2.70	∞
System Detection Limits	1.00	Rectangular	√3	1.00	0.60	∞
Modulation response	4.00	Rectangular	√3	1.00	2.31	∞
Readout Electronics	1.00	Normal	1	1.00	1.00	∞
Response Time	0.80	Rectangular	√3	1.00	0.50	∞
Integration Time	2.60	Rectangular	√3	1.00	1.50	∞
RF Ambient Conditions	3.00	Rectangular	√3	1.00	1.70	∞
Probe Positioner	0.40	Rectangular	√3	1.00	0.20	∞
Probe Positioning	2.90	Rectangular	√3	1.00	1.70	∞
Max. SAR Eval.	1.00	Rectangular	√3	1.00	0.60	∞
Test Sample Related						
Device Positioning	0.86	Normal	1	1.00	0.86	11
Device Holder	2.80	Normal	1	1.00	2.80	5
Power Drift	5.00	Rectangular	√3	1.00	2.90	∞
Phantom and Setup						
Phantom Uncertainty	4.00	Rectangular	√3	1.00	2.30	∞
Liquid Conductivity(Meas.)	0.28	Normal	1	0.64	0.18	5
Liquid Permittivity(meas.)	3.84	Normal	1	0.60	2.30	5
Liquid Conductivity temperature uncertainty –	1.70	Rectangular	√3	0.78	0.77	∞
Liquid Permittivity temperature uncertainty –	2.70	Rectangular	√3	0.23	0.36	∞
Combined Std. Uncertainty		RSS			11.04	790
Expanded STD Uncertainty		k=2			22.07	

11. OUTPUT POWER MEASUREMENT

11.1 Measurement procedure for Output Power

EUTs average output power was measured at low, middle, high channels with a Spectrum Analyzer connected to the antenna terminal while the EUTs operating at its maximum power control level.



Power measurement Test Setup

11.2 Conducted RF Output Power (Unit: dBm)

Mode	Measured Frequency (MHz)	Measured Output Power (dBm)
GFSK	2402	11.83
	2441	12.10
	2480	11.48
4QDPSK	2402	8.34
	2441	8.64
	2480	7.84
8DPSK	2402	8.46
	2441	8.79
	2480	7.86

12. SYSTEM VERIFICATION

12.1 Tissue Verification

For the measurement of the following parameters the DAK-3.5 was used, representing the open-ended slim form probe measurement procedure. The measured values should be within $\pm 5\%$ of the recommended values given by IEEE 1528-2013.

Table 12.1 Measured Tissue Parameters

Date	Liquid Type	Liquid Temp. (°C)	Frequency (MHz)	Measured relative Permittivity (ϵ)	Measured Conductivity (S/m)	Target relative Permittivity (ϵ)	Target Conductivity (S/m)	Permittivity tolerance (%)	Conductivity tolerance (%)
May 11.2016	2G /Body	22.4	2402	54.22	1.943	52.76 *)	1.904 *)	2.77	2.05
May 11.2016	2G /Body	22.4	2450	53.98	2.01	52.70	1.950	2.43	3.23
May 11.2016	2G /Body	22.4	2480	53.92	2.06	52.66 *)	1.993 *)	2.39	3.26

*) This value is linearly interpolated.

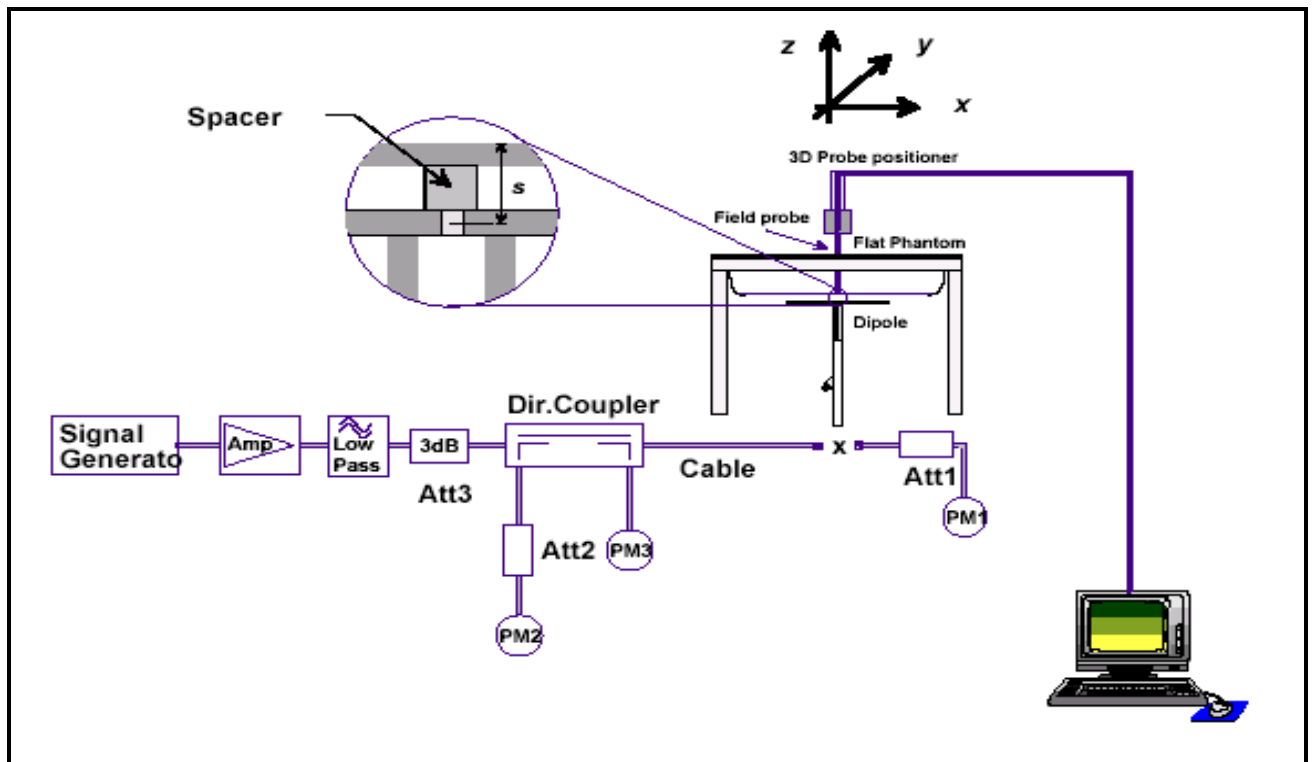
12.2 Test System Validation

A complete 1 g and/or 10 g averaged SAR measurement is performed using a standard source. The input power of the standard source is adjusted to produce a 1 g and/or 10 g averaged SAR value falling in the range of 0,4 W/kg to 10 W/kg. The 1 g and/or 10 g averaged SAR is measured at frequencies in Table 12.2 within the range to be used in compliance tests. The results are normalized to 1 W forward input power and compared with the reference SAR value.

Table 12.2 System Validation Results

Date	Liquid Temperature (°C)	Measured Frequency (MHz)	Targeted 1 g SAR (W/kg)	Measured 1 g SAR (W/kg)	Normalized 1 g SAR (W/kg)	Deviation (%)	Plot No.
May 11.2016	22.4	2450	49.2	12.8	51.2	4.07	#V01

12.3 System Validation Test Setup



13. SAR MEASUREMENT RESULTS

1. Per KDB 447498 D01v06, the reported SAR is the measured SAR value adjusted for maximum tune-up tolerance.

Scaling Factor = Tune-up limit power (mW) / EUT RF Power (mW), Where tune-up limit is the maximum rated power among all production units.

Reported SAR (W/kg) = Scaling Factor * Measured SAR (W/kg)

2. Tune-up limit power is refer to page 8.

Measured Frequency		Mode	Test distance	Average Power (mW)	Tune-Up Limit pwr (mW) *)	Scaling Factor	EUT Configuration	Measured SAR 1g (W/kg)	Reported SAR 1g (W/kg)	Plot No.
MHz	CH									
2441	39	GFSK	0 mm	16.22	31.62	1.95	Front	0.234	0.456	#S01
				16.22	31.62	1.95	Right	0.071	0.138	#S02
				16.22	31.62	1.95	Left	0.001	0.002	#S03
				16.22	31.62	1.95	Top	0.156	0.304	#S04
				16.22	31.62	1.95	Bottom	0.004	0.008	#S05
				16.22	31.62	1.95	Back	0.166	0.324	#S06
2402	0			15.24	31.62	2.07	Front	0.110	0.228	#S07
2480	78			14.06	31.62	2.25	Front	0.124	0.279	#S08

*) 2 GHz GFSK Mode Tune-up Limit : 12 dBm ± 3 dB = Max. target pwr

14. TEST EQUIPMENTS

Description	Model	Serial No.	Data of next Calibration	Used Equipment
Staubli Robot Unit	RX60L	F05/51E1A1/A/01	N/A	√
Electro-Optical Converter	EOC3	398	N/A	√
SAM Twin Phantom V4.0C	TP-1358	SM 000 T02 DA	N/A	√
Device Holder	DH2005	SD HAC H01CA	N/A	√
Dielectric Probe Kit	85070E	MY44300121	N/A	√
Data Acquisition Electronics	DAE4	672	2017.02.19	√
E-Field Probe	EX3DV4	3947	2016.09.01	√
Validation Dipole Antenna	D450V2	1022	2017.01.23	
Validation Dipole Antenna	D835V2	4d017	2018.01.27	
Validation Dipole Antenna	D900V2	1d016	2017.01.22	
Validation Dipole Antenna	D1800V2	2d111	2017.01.25	
Validation Dipole Antenna	D1900V2	5d059	2016.08.26	
Validation Dipole Antenna	D2450V2	774	2018.04.19	√
Validation Dipole Antenna	D5GHzV2	1146	2017.01.21	
Power Amplifier	5800842	-	2017.01.08	√
Power Amplifier	RWHPA	-	2017.01.08	
Network Analyzer	8753E	JP38161044	2016.10.07	√
Radio Communication Analyzer	MT8820C	6200985423	2017.04.04	
Dual Directional Coupler	778D	15550	2017.01.08	
Dual Directional Coupler	11692D	1212A02175	2016.07.16	√
VSA Series Transmitter Tester	E4406A	US39480757	2016.07.17	
PSA Series Spectrum Analyzer	E4440A	MY44022567	2016.10.15	
Power Meter	NRVS	835360/002	2017.01.08	√
Power Sensor	NRV-Z5	833722/006	2017.01.08	√
Power Meter	437B	2912U01687	2016.10.06	√
Power Sensor	8481A	3318A83210	2016.07.17	√
Power Meter	ML2437A	97310060	2016.10.15	√
Power Sensor	MA2474A	181289	2016.10.15	√
Wideband Power Sensor	NRP-Z81	100634	2016.07.17	
Vector Signal Generator	SMBV100A	257152	2016.10.06	√
Vector Signal Generator	N5182A	MY5014918	2016.07.16	√
Dielectric Field probe	DAK 3.5	1128	2016.08.25	√
Vector Signal Analyzer	N9020A	MY51110087	2016.10.15	√

15. CONCLUSION

The SAR evaluation indicates that the EUT complies with the RF radiation exposure limits of the FCC and Industry Canada,, with respect to all parameters subject to this test. These measurements were taken to simulate the RF effects of RF exposure under worst-case conditions. The results and statements relate only to the item(s) tested.

APPENDIX A. PLOTS OF SAR RESULTS

#S01

Test Laboratory: Nemko Korea File Name: [Front side 2441 gap 0mm position GFSK.da4](#)

DUT: RMCFTJ1AP1 Type: Smart control Serial: N/A Applicant: SAMSUNG

Communication System: Bluetooth Frequency: 2441 MHz

Duty Cycle: 1:1 Phantom section: Flat Section

Medium parameters used: $f = 2441 \text{ MHz}$; $\sigma = 2 \text{ mho/m}$; $\epsilon_r = 54$; $\rho = 1000 \text{ kg/m}^3$

DASY4 Configuration:

Probe: EX3DV4 - SN3947; ConvF(7.39, 7.39, 7.39); Calibrated: 2015-09-01

Sensor-Surface: 2mm (Mechanical Surface Detection)

Electronics: DAE4 Sn672; Calibrated: 2016-02-19

Phantom: SAM with Flat_20131029; Type: SAM; Serial: SM 000 T02 DA

Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

RMCFTJ1AP1 Front Gap 0mm Position/Area Scan (9x17x1): Measurement grid:

$dx=12\text{mm}$, $dy=12\text{mm}$

Maximum value of SAR (measured) = 0.326 mW/g

RMCFTJ1AP1 Front Gap 0mm Position/Zoom Scan (7x7x7)/Cube 0: Measurement

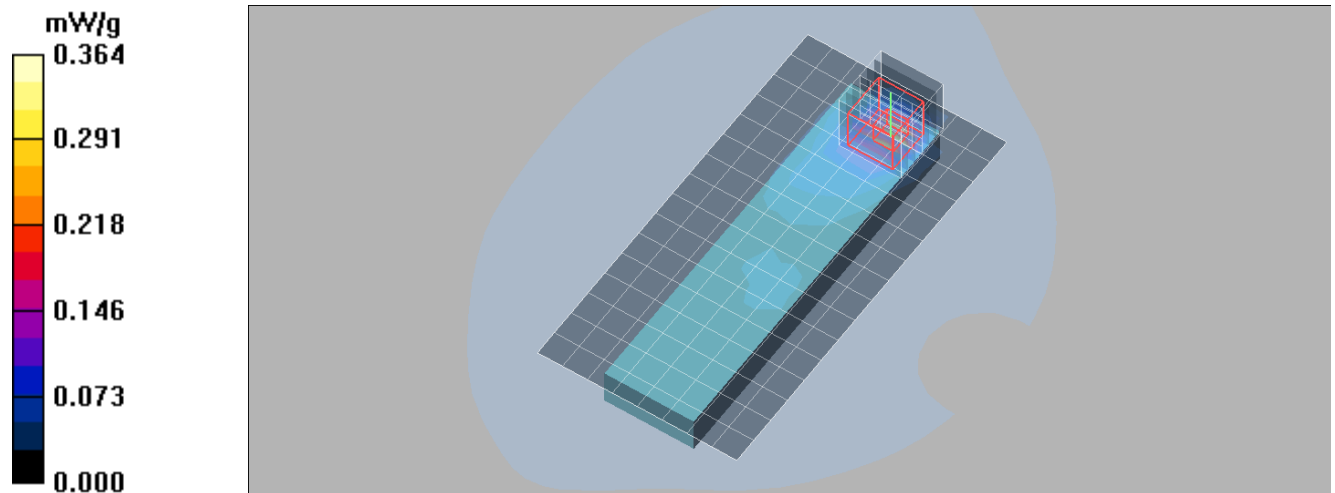
grid: $dx=5\text{mm}$, $dy=5\text{mm}$, $dz=5\text{mm}$

Reference Value = 3.57 V/m; Power Drift = -0.164 dB

Peak SAR (extrapolated) = 0.530 W/kg

SAR(1 g) = 0.234 mW/g; SAR(10 g) = 0.104 mW/g

Maximum value of SAR (measured) = 0.364 mW/g



#S02

Date/Time: 2016-05-11 AM 11:27:06

Test Laboratory: Nemko Korea File Name: [Right side 2441 gap 0mm position_GFSK.da4](#)

DUT: RMCFTJ1AP1 Type: Smart control Serial: N/A Applicant: SAMSUNG

Communication System: Bluetooth Frequency: 2441 MHz

Duty Cycle: 1:1 Phantom section: Flat Section

Medium parameters used: $f = 2441 \text{ MHz}$; $\sigma = 2 \text{ mho/m}$; $\epsilon_r = 54$; $\rho = 1000 \text{ kg/m}^3$

DASY4 Configuration:

Probe: EX3DV4 - SN3947; ConvF(7.39, 7.39, 7.39); Calibrated: 2015-09-01

Sensor-Surface: 2mm (Mechanical Surface Detection)

Electronics: DAE4 Sn672; Calibrated: 2016-02-19

Phantom: SAM with Flat_20131029; Type: SAM; Serial: SM 000 T02 DA

Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

RMCFTJ1AP1 Right Gap 0mm Position/Area Scan (7x17x1): Measurement grid:

$dx=12\text{mm}$, $dy=12\text{mm}$

Maximum value of SAR (measured) = 0.082 mW/g

RMCFTJ1AP1 Right Gap 0mm Position/Zoom Scan (7x7x7)/Cube 0: Measurement

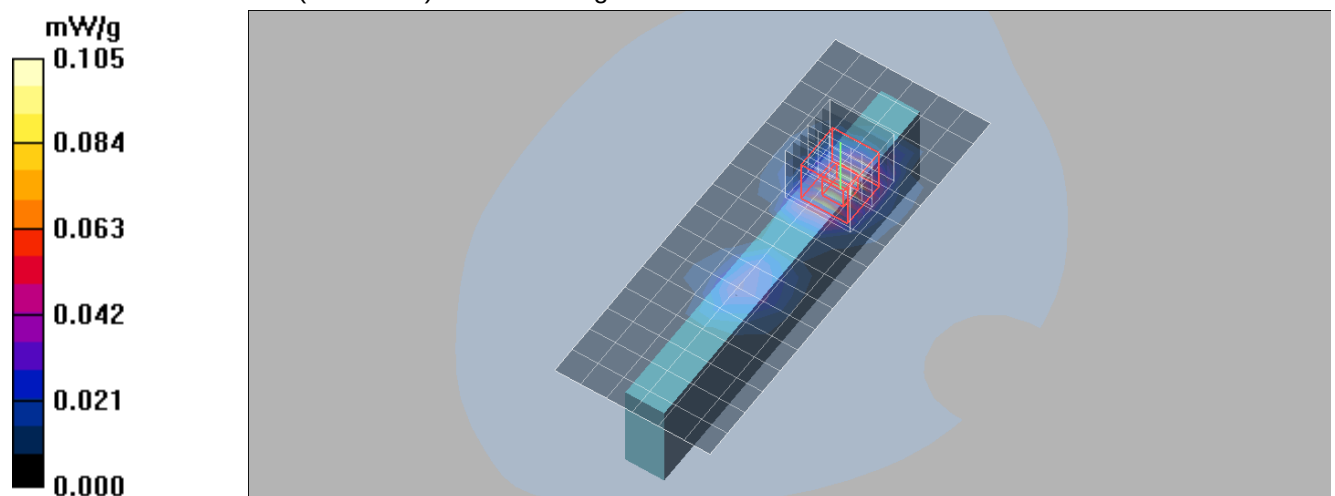
grid: $dx=5\text{mm}$, $dy=5\text{mm}$, $dz=5\text{mm}$

Reference Value = 2.53 V/m; Power Drift = 0.000 dB

Peak SAR (extrapolated) = 0.138 W/kg

SAR(1 g) = 0.071 mW/g; SAR(10 g) = 0.035 mW/g

Maximum value of SAR (measured) = 0.105 mW/g



#S03

Date/Time: 2016-05-11 PM 1:56:01

Test Laboratory: Nemko Korea File Name: [Left side 2441 gap 0mm position_GFSK.da4](#)

DUT: RMCFTJ1AP1 Type: Smart control Serial: N/A Applicant: SAMSUNG

Communication System: Bluetooth Frequency: 2441 MHz

Duty Cycle: 1:1 Phantom section: Flat Section

Medium parameters used: $f = 2441 \text{ MHz}$; $\sigma = 2 \text{ mho/m}$; $\epsilon_r = 54$; $\rho = 1000 \text{ kg/m}^3$

DASY4 Configuration:

Probe: EX3DV4 - SN3947; ConvF(7.39, 7.39, 7.39); Calibrated: 2015-09-01

Sensor-Surface: 2mm (Mechanical Surface Detection)

Electronics: DAE4 Sn672; Calibrated: 2016-02-19

Phantom: SAM with Flat_20131029; Type: SAM; Serial: SM 000 T02 DA

Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

RMCFTJ1AP1 Left Gap 0mm Position/Area Scan (7x17x1): Measurement grid:

$dx=12\text{mm}$, $dy=12\text{mm}$

Maximum value of SAR (measured) = 0.002 mW/g

RMCFTJ1AP1 Left Gap 0mm Position/Zoom Scan (7x7x7)/Cube 0: Measurement

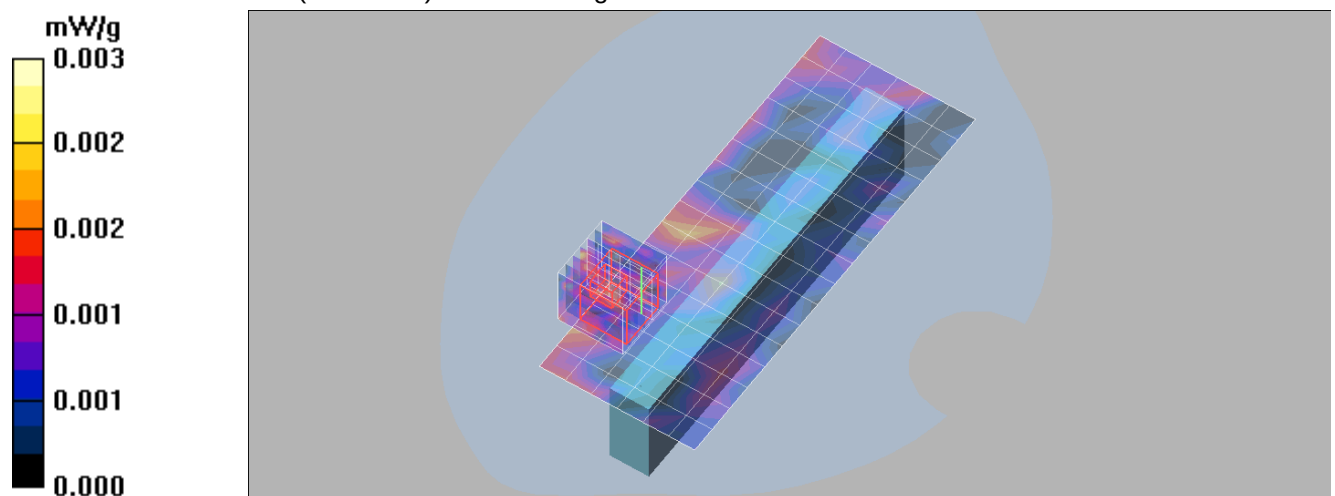
grid: $dx=5\text{mm}$, $dy=5\text{mm}$, $dz=5\text{mm}$

Reference Value = 0.000 V/m; Power Drift = 0.000 dB

Peak SAR (extrapolated) = 0.004 W/kg

SAR(1 g) = 0.00122 mW/g; SAR(10 g) = 0.000524 mW/g

Maximum value of SAR (measured) = 0.003 mW/g



#S04

Date/Time: 2016-05-11 PM 12:46:29

Test Laboratory: Nemko Korea File Name: [Top side 2441 gap 0mm position_GFSK.da4](#)

DUT: RMCFTJ1AP1 Type: Smart control Serial: N/A Applicant: SAMSUNG

Communication System: Bluetooth Frequency: 2441 MHz

Duty Cycle: 1:1 Phantom section: Flat Section

Medium parameters used: $f = 2441 \text{ MHz}$; $\sigma = 2 \text{ mho/m}$; $\epsilon_r = 54$; $\rho = 1000 \text{ kg/m}^3$

DASY4 Configuration:

Probe: EX3DV4 - SN3947; ConvF(7.39, 7.39, 7.39); Calibrated: 2015-09-01

Sensor-Surface: 2mm (Mechanical Surface Detection)

Electronics: DAE4 Sn672; Calibrated: 2016-02-19

Phantom: SAM with Flat_20131029; Type: SAM; Serial: SM 000 T02 DA

Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

RMCFTJ1AP1 Top Gap 0mm Position/Area Scan (7x9x1): Measurement grid:

$dx=12\text{mm}$, $dy=12\text{mm}$

Maximum value of SAR (measured) = 0.228 mW/g

RMCFTJ1AP1 Top Gap 0mm Position/Zoom Scan (7x7x7)/Cube 0: Measurement

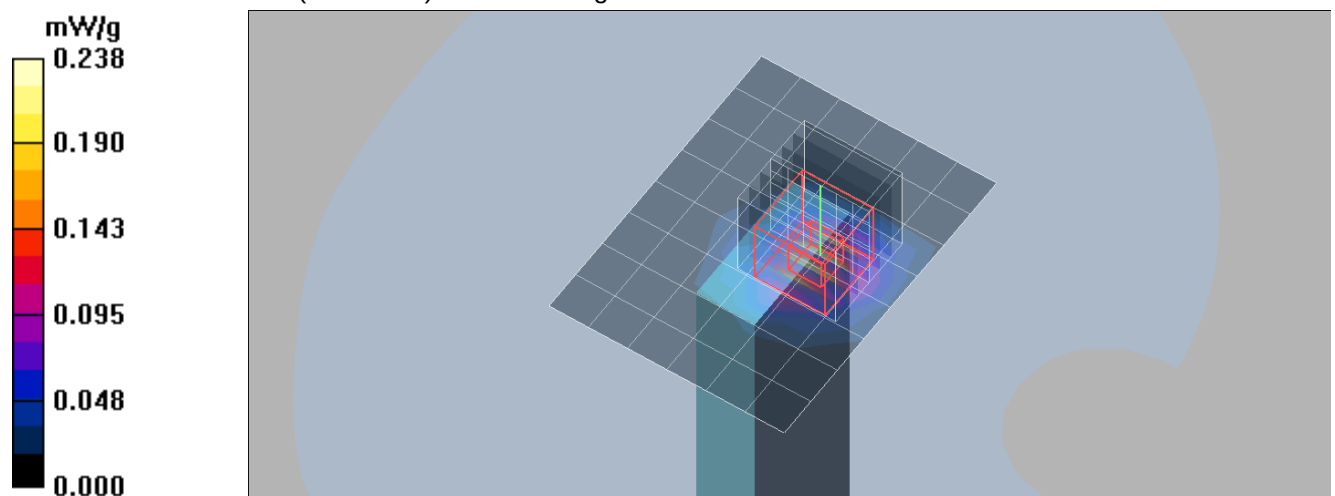
grid: $dx=5\text{mm}$, $dy=5\text{mm}$, $dz=5\text{mm}$

Reference Value = 6.72 V/m; Power Drift = 0.003 dB

Peak SAR (extrapolated) = 0.322 W/kg

SAR(1 g) = 0.156 mW/g; SAR(10 g) = 0.071 mW/g

Maximum value of SAR (measured) = 0.238 mW/g



#S05

Date/Time: 2016-05-11 PM 1:08:54

Test Laboratory: Nemko Korea File Name: [Bottom side 2441 gap 0mm position_GFSK.da4](#)

DUT: RMCFTJ1AP1 Type: Smart control Serial: N/A Applicant: SAMSUNG

Communication System: Bluetooth Frequency: 2441 MHz

Duty Cycle: 1:1 Phantom section: Flat Section

Medium parameters used: $f = 2441 \text{ MHz}$; $\sigma = 2 \text{ mho/m}$; $\epsilon_r = 54$; $\rho = 1000 \text{ kg/m}^3$

DASY4 Configuration:

Probe: EX3DV4 - SN3947; ConvF(7.39, 7.39, 7.39); Calibrated: 2015-09-01

Sensor-Surface: 2mm (Mechanical Surface Detection)

Electronics: DAE4 Sn672; Calibrated: 2016-02-19

Phantom: SAM with Flat_20131029; Type: SAM; Serial: SM 000 T02 DA

Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

RMCFTJ1AP1 Bottom Gap 0mm Position/Area Scan (7x9x1): Measurement grid:

$dx=12\text{mm}$, $dy=12\text{mm}$

Maximum value of SAR (measured) = 0.005 mW/g

RMCFTJ1AP1 Bottom Gap 0mm Position/Zoom Scan (7x7x7)/Cube 0:

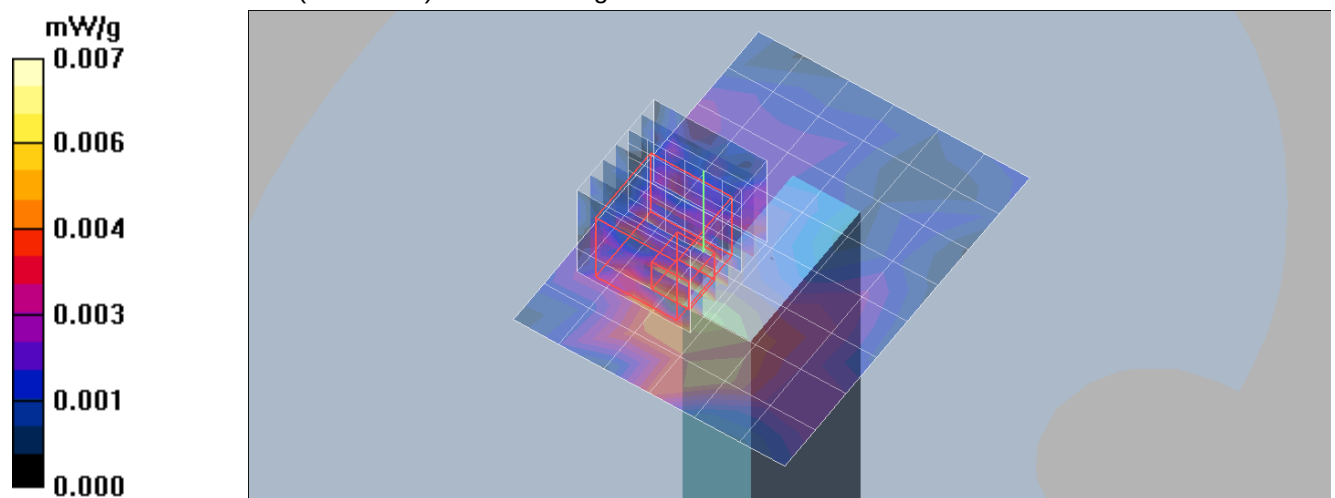
Measurement grid: $dx=5\text{mm}$, $dy=5\text{mm}$, $dz=5\text{mm}$

Reference Value = 1.00 V/m; Power Drift = 0.169 dB

Peak SAR (extrapolated) = 0.010 W/kg

SAR(1 g) = 0.00405 mW/g; SAR(10 g) = 0.00161 mW/g

Maximum value of SAR (measured) = 0.007 mW/g



#S06

Date/Time: 2016-05-11 AM 10:55:24

Test Laboratory: Nemko Korea File Name: [Back side 2441 gap 0mm position_GFSK.da4](#)

DUT: RMCFTJ1AP1 Type: Smart control Serial: N/A Applicant: SAMSUNG

Communication System: Bluetooth Frequency: 2441 MHz

Duty Cycle: 1:1 Phantom section: Flat Section

Medium parameters used: $f = 2441 \text{ MHz}$; $\sigma = 2 \text{ mho/m}$; $\epsilon_r = 54$; $\rho = 1000 \text{ kg/m}^3$

DASY4 Configuration:

Probe: EX3DV4 - SN3947; ConvF(7.39, 7.39, 7.39); Calibrated: 2015-09-01

Sensor-Surface: 2mm (Mechanical Surface Detection)

Electronics: DAE4 Sn672; Calibrated: 2016-02-19

Phantom: SAM with Flat_20131029; Type: SAM; Serial: SM 000 T02 DA

Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

RMCFTJ1AP1 Back Gap 0mm Position/Area Scan (9x17x1): Measurement grid:

$dx=12\text{mm}$, $dy=12\text{mm}$

Maximum value of SAR (measured) = 0.251 mW/g

RMCFTJ1AP1 Back Gap 0mm Position/Zoom Scan (7x7x7)/Cube 0: Measurement

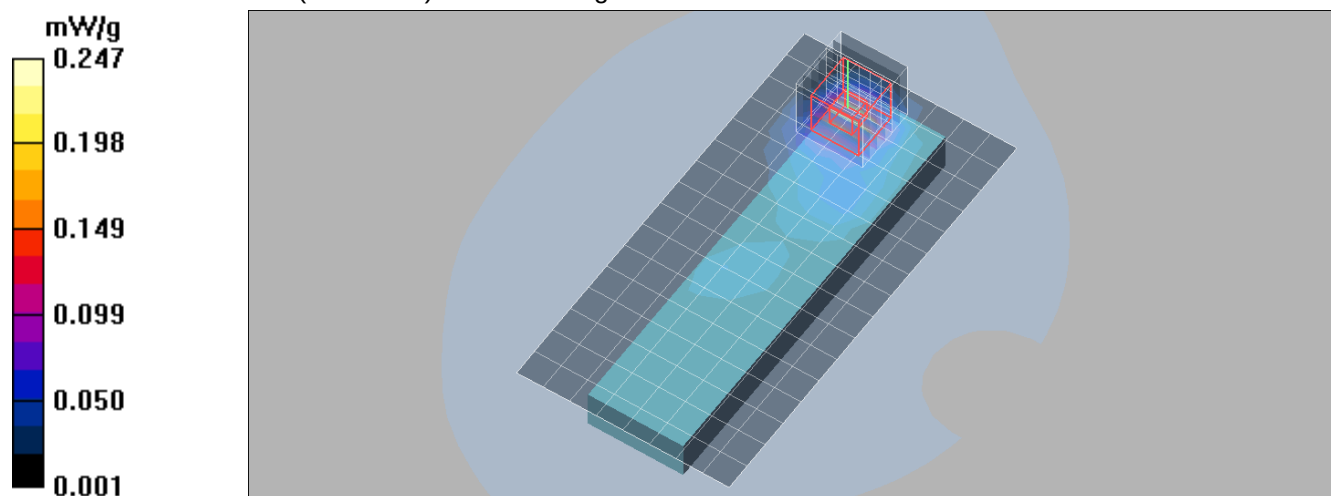
grid: $dx=5\text{mm}$, $dy=5\text{mm}$, $dz=5\text{mm}$

Reference Value = 3.79 V/m; Power Drift = -0.011 dB

Peak SAR (extrapolated) = 0.362 W/kg

SAR(1 g) = 0.166 mW/g; SAR(10 g) = 0.076 mW/g

Maximum value of SAR (measured) = 0.247 mW/g



#S07

Date/Time: 2016-05-11 PM 4:20:44

Test Laboratory: Nemko Korea File Name: [Front side 2402 gap 0mm position_GFSK.da4](#)

DUT: RMCFTJ1AP1 Type: Smart control Serial: N/A Applicant: SAMSUNG

Communication System: Bluetooth Frequency: 2402 MHz

Duty Cycle: 1:1 Phantom section: Flat Section

Medium parameters used: $f = 2402 \text{ MHz}$; $\sigma = 1.95 \text{ mho/m}$; $\epsilon_r = 54.2$; $\rho = 1000 \text{ kg/m}^3$

DASY4 Configuration:

Probe: EX3DV4 - SN3947; ConvF(7.39, 7.39, 7.39); Calibrated: 2015-09-01

Sensor-Surface: 2mm (Mechanical Surface Detection)

Electronics: DAE4 Sn672; Calibrated: 2016-02-19

Phantom: SAM with Flat_20131029; Type: SAM; Serial: SM 000 T02 DA

Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

RMCFTJ1AP1 Front Gap 0mm Position/Area Scan (9x17x1): Measurement grid:

$dx=12\text{mm}$, $dy=12\text{mm}$

Maximum value of SAR (measured) = 0.162 mW/g

RMCFTJ1AP1 Front Gap 0mm Position/Zoom Scan (7x7x7)/Cube 0: Measurement

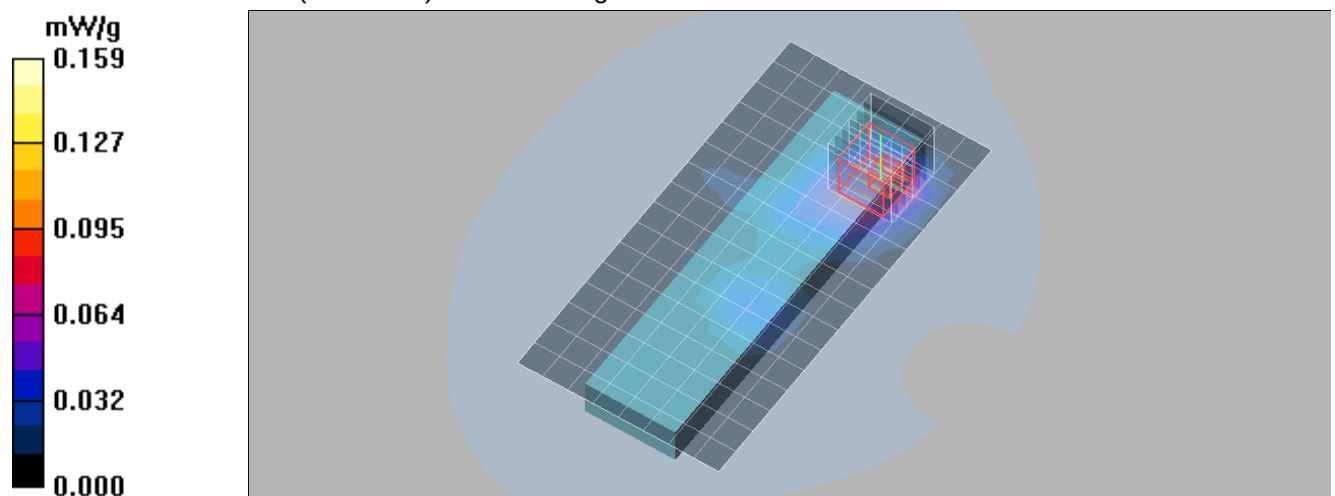
grid: $dx=5\text{mm}$, $dy=5\text{mm}$, $dz=5\text{mm}$

Reference Value = 2.49 V/m; Power Drift = -0.190 dB

Peak SAR (extrapolated) = 0.227 W/kg

SAR(1 g) = 0.110 mW/g; SAR(10 g) = 0.055 mW/g

Maximum value of SAR (measured) = 0.159 mW/g



#S08

Date/Time: 2016-05-11 PM 3:50:42

Test Laboratory: Nemko Korea File Name: [Front side 2480 gap 0mm position_GFSK.da4](#)

DUT: RMCFTJ1AP1 Type: Smart control Serial: N/A Applicant: SAMSUNG

Communication System: Bluetooth Frequency: 2480 MHz

Duty Cycle: 1:1 Phantom section: Flat Section

Medium parameters used: $f = 2480 \text{ MHz}$; $\sigma = 2.06 \text{ mho/m}$; $\epsilon_r = 53.9$; $\rho = 1000 \text{ kg/m}^3$

DASY4 Configuration:

Probe: EX3DV4 - SN3947; ConvF(7.39, 7.39, 7.39); Calibrated: 2015-09-01

Sensor-Surface: 2mm (Mechanical Surface Detection)

Electronics: DAE4 Sn672; Calibrated: 2016-02-19

Phantom: SAM with Flat_20131029; Type: SAM; Serial: SM 000 T02 DA

Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

RMCFTJ1AP1 Front Gap 0mm Position/Area Scan (9x17x1): Measurement grid:

$dx=12\text{mm}$, $dy=12\text{mm}$

Maximum value of SAR (measured) = 0.161 mW/g

RMCFTJ1AP1 Front Gap 0mm Position/Zoom Scan (7x7x7)/Cube 0: Measurement

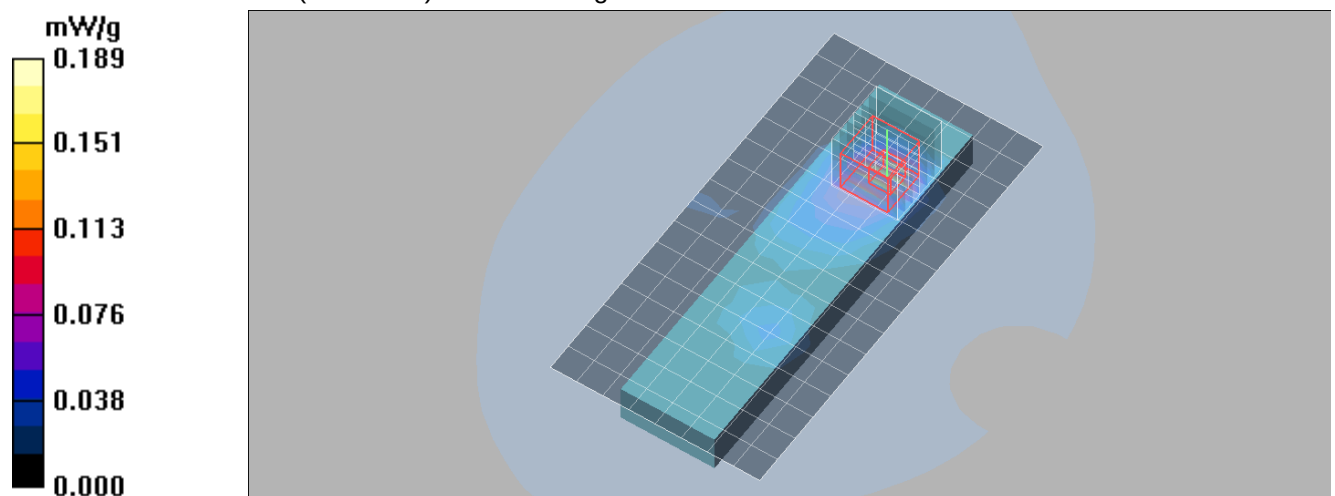
grid: $dx=5\text{mm}$, $dy=5\text{mm}$, $dz=5\text{mm}$

Reference Value = 3.10 V/m; Power Drift = 0.033 dB

Peak SAR (extrapolated) = 0.261 W/kg

SAR(1 g) = 0.124 mW/g; SAR(10 g) = 0.058 mW/g

Maximum value of SAR (measured) = 0.189 mW/g



APPENDIX B. PLOTS OF SYSTEM VALIDATION

#V01

Test Laboratory: Nemko Korea File Name: [System Validation for 2.45GHz_2016-05-11FCC.da4](#)

DUT: Dipole 2450 MHz Type: D2450V2 Serial: D2450V2 - SN:774

Communication System: CW Frequency: 2450 MHz

Duty Cycle: 1:1 Phantom section: Flat Section

Medium parameters used: $f = 2450 \text{ MHz}$; $\sigma = 2.01 \text{ mho/m}$; $\epsilon_r = 54$; $\rho = 1000 \text{ kg/m}^3$

DASY4 Configuration:

Probe: EX3DV4 - SN3947; ConvF(7.39, 7.39, 7.39); Calibrated: 2015-09-01

Sensor-Surface: 2mm (Mechanical Surface Detection)

Electronics: DAE4 Sn672; Calibrated: 2016-02-19

Phantom: SAM with Flat_20131029; Type: SAM; Serial: SM 000 T02 DA

Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

2.45GHz Dipole Validation/Area Scan (7x7x1): Measurement grid: $dx=15\text{mm}$, $dy=15\text{mm}$

Maximum value of SAR (measured) = 19.0 mW/g

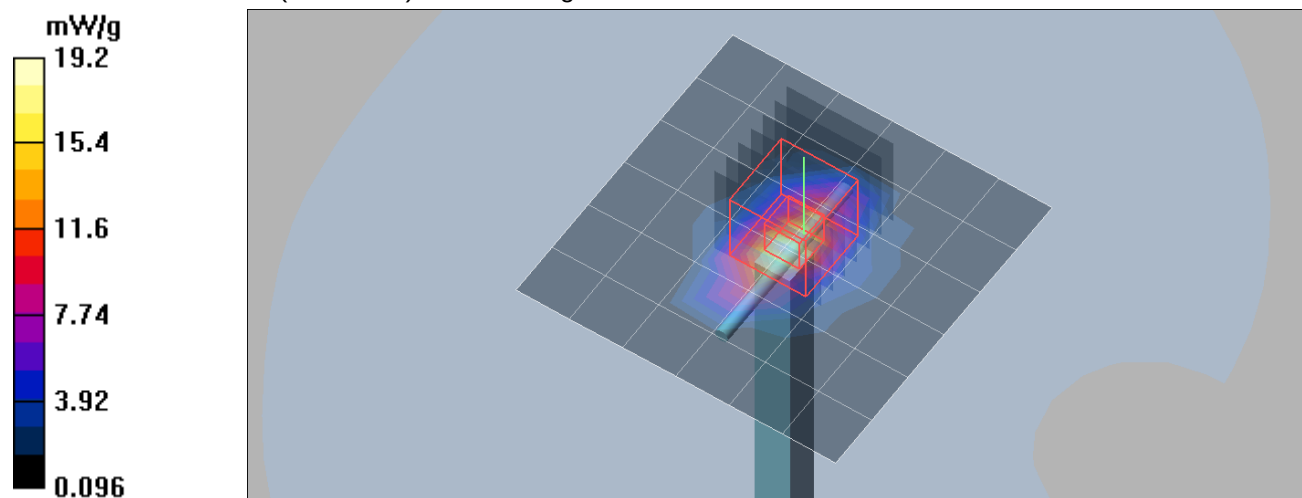
2.45GHz Dipole Validation/Zoom Scan (7x7x7)/Cube 0: Measurement grid: $dx=5\text{mm}$, $dy=5\text{mm}$, $dz=5\text{mm}$

Reference Value = 99.0 V/m; Power Drift = -0.037 dB

Peak SAR (extrapolated) = 26.5 W/kg

SAR(1 g) = 12.8 mW/g; SAR(10 g) = 5.86 mW/g

Maximum value of SAR (measured) = 19.2 mW/g



APPENDIX C. CALIBRATION REPORT OF THE PROBE

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



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

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

Accreditation No.: **SCS 0108**

Client **Nemko Korea (Dymstec)**

Certificate No: **EX3-3947_Sep15**

CALIBRATION CERTIFICATE

Object **EX3DV4 - SN:3947**

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: **September 1, 2015**

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

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

Calibration Equipment used (M&TE critical for calibration)

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

Calibrated by:	Name Claudio Leubler	Function Laboratory Technician	Signature 
Approved by:	Katja Pokovic	Technical Manager	
Issued: September 1, 2015			
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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
NORM _{x,y,z}	sensitivity in free space
ConvF	sensitivity in TSL / NORM _{x,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., $\vartheta = 0$ 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:

- 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
- 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
- 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
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Methods Applied and Interpretation of Parameters:

- NORM_{x,y,z}**: Assessed for E-field polarization $\vartheta = 0$ ($f \leq 900$ MHz in TEM-cell; $f > 1800$ MHz: R22 waveguide). NORM_{x,y,z} are only intermediate values, i.e., the uncertainties of NORM_{x,y,z} does not affect the E^2 -field uncertainty inside TSL (see below ConvF).
- NORM(f)_{x,y,z}** = NORM_{x,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.
- DCP_{x,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
- A_{x,y,z}; B_{x,y,z}; C_{x,y,z}; D_{x,y,z}; VR_{x,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 $f \leq 800$ 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 NORM_{x,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 NORM_x (no uncertainty required).

EX3DV4 – SN:3947

September 1, 2015

Probe EX3DV4

SN:3947

Manufactured:	July 24, 2013
Repaired:	August 25, 2015
Calibrated:	September 1, 2015

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

EX3DV4- SN:3947

September 1, 2015

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3947

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A	0.47	0.34	0.57	± 10.1 %
DCP (mV) ^B	99.6	102.4	99.5	

Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB $\sqrt{\mu\text{V}}$	C	D dB	VR mV	Unc ^E (k=2)
0	CW	X	0.0	0.0	1.0	0.00	134.5	±3.5 %
		Y	0.0	0.0	1.0		130.7	
		Z	0.0	0.0	1.0		148.1	

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 E²-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.

EX3DV4- SN:3947

September 1, 2015

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3947

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)
2450	39.2	1.80	7.24	7.24	7.24	0.29	1.06	± 12.0 %
5200	36.0	4.66	5.39	5.39	5.39	0.35	1.80	± 13.1 %
5300	35.9	4.76	5.10	5.10	5.10	0.35	1.80	± 13.1 %
5500	35.6	4.96	4.73	4.73	4.73	0.40	1.80	± 13.1 %
5600	35.5	5.07	4.62	4.62	4.62	0.40	1.80	± 13.1 %
5800	35.3	5.27	4.60	4.60	4.60	0.40	1.80	± 13.1 %

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

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

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

EX3DV4- SN:3947

September 1, 2015

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3947

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)
2450	52.7	1.95	7.39	7.39	7.39	0.30	0.80	± 12.0 %
5200	49.0	5.30	4.66	4.66	4.66	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	3.99	3.99	3.99	0.50	1.90	± 13.1 %
5600	48.5	5.77	3.75	3.75	3.75	0.55	1.90	± 13.1 %
5800	48.2	6.00	4.15	4.15	4.15	0.50	1.90	± 13.1 %

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

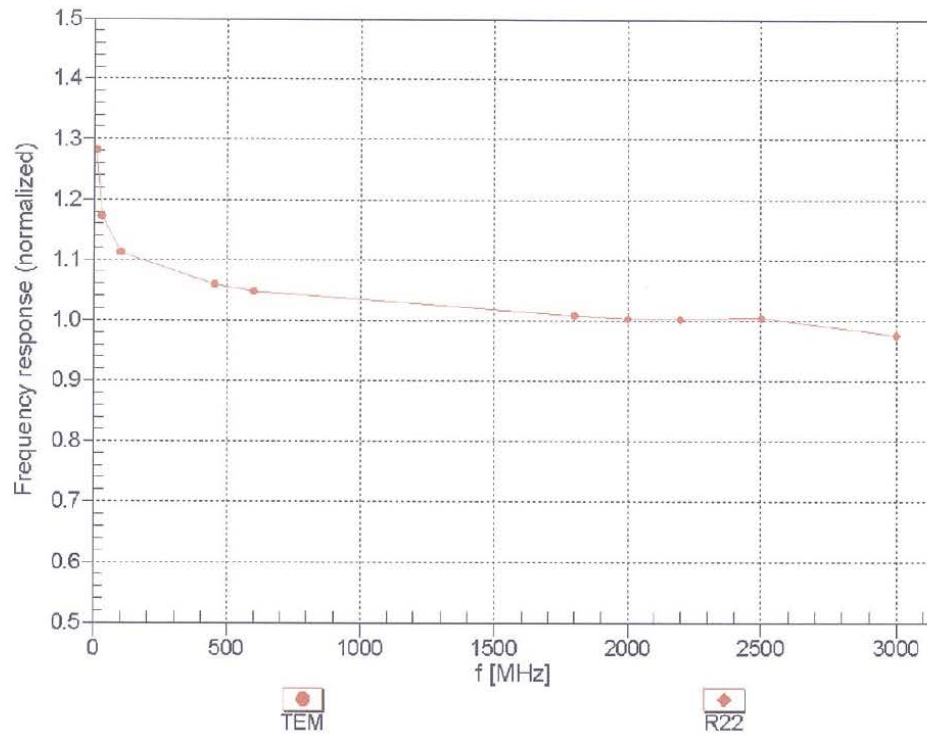
^F At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty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

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

EX3DV4- SN:3947

September 1, 2015

Frequency Response of E-Field (TEM-Cell:ifi110 EXX, Waveguide: R22)

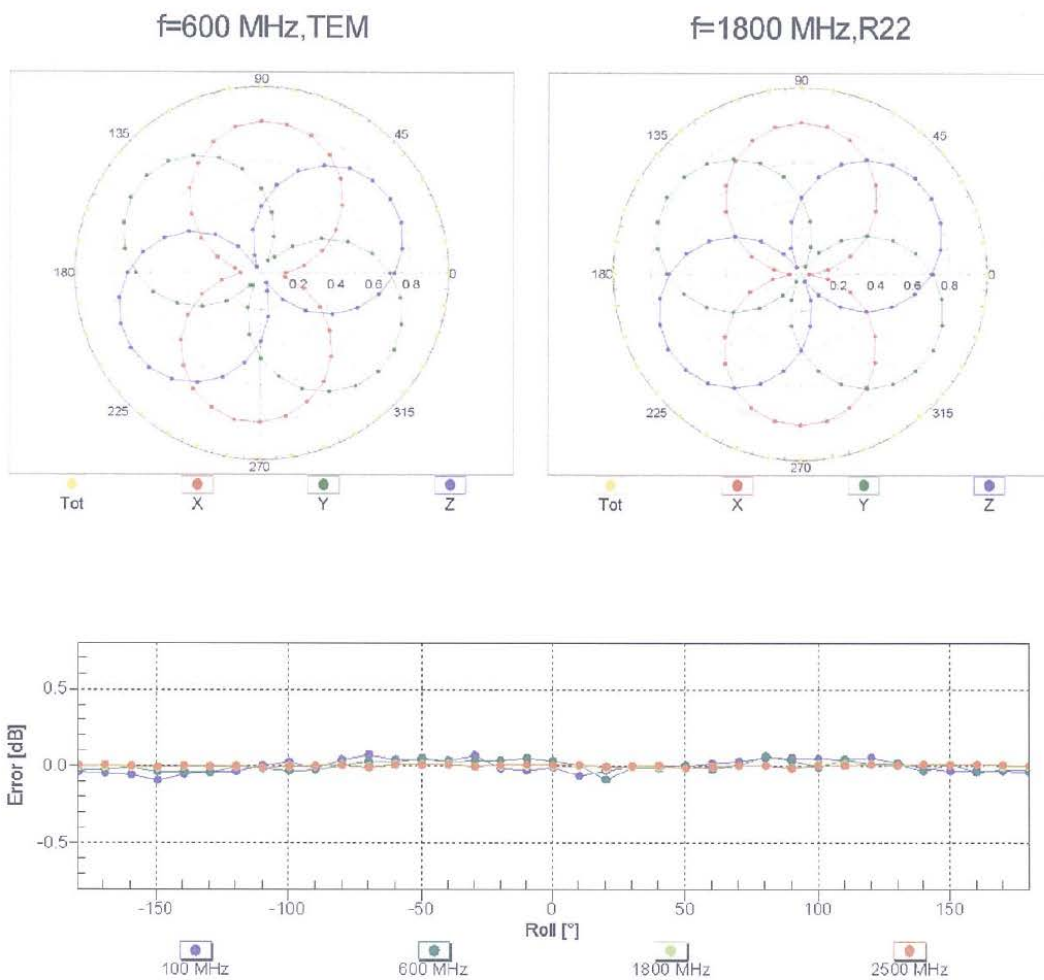


Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ (k=2)

EX3DV4- SN:3947

September 1, 2015

Receiving Pattern (ϕ), $\vartheta = 0^\circ$

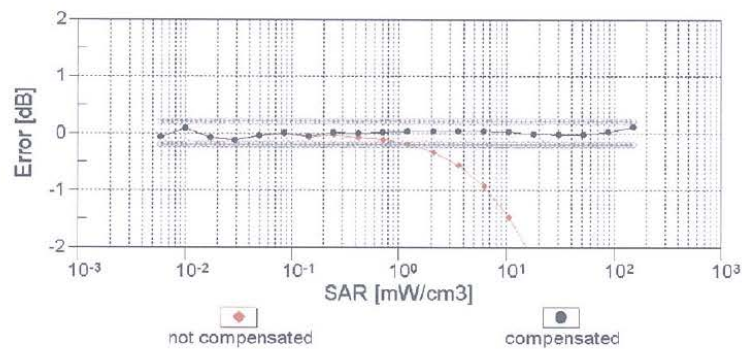
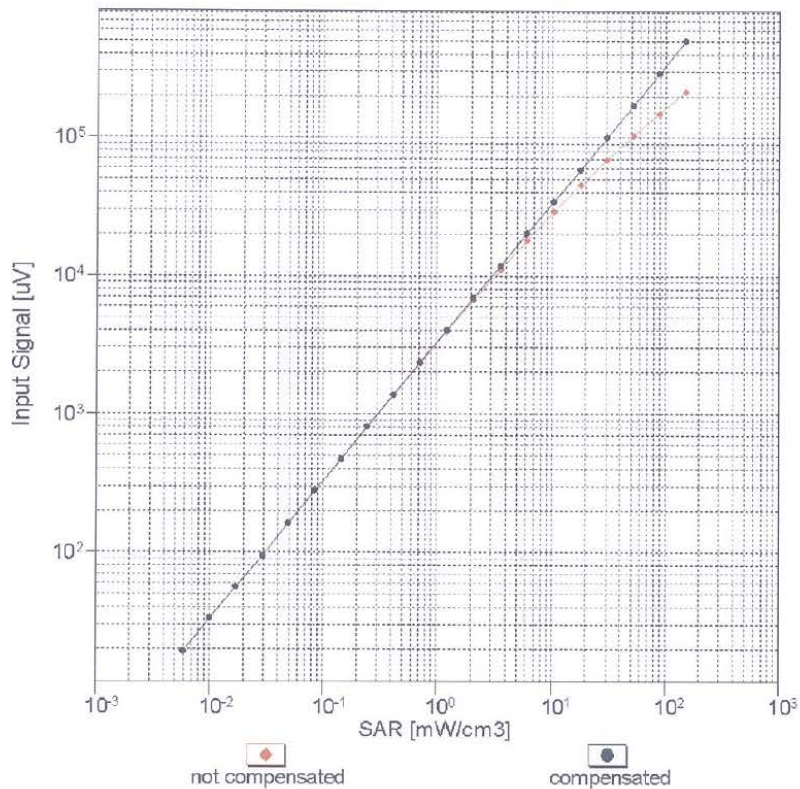


Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ ($k=2$)

EX3DV4- SN:3947

September 1, 2015

Dynamic Range $f(\text{SAR}_{\text{head}})$ (TEM cell , $f_{\text{eval}} = 1900 \text{ MHz}$)

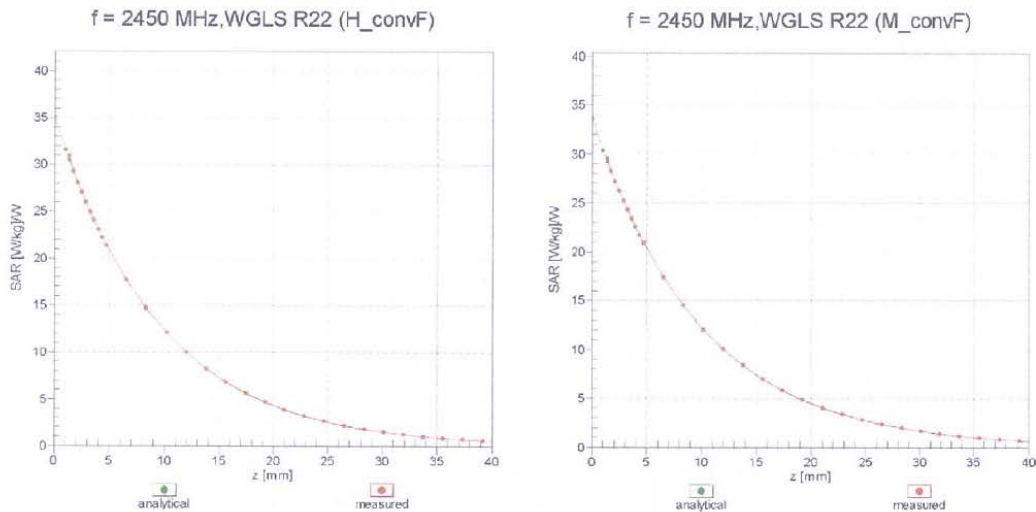


Uncertainty of Linearity Assessment: $\pm 0.6\%$ ($k=2$)

EX3DV4- SN:3947

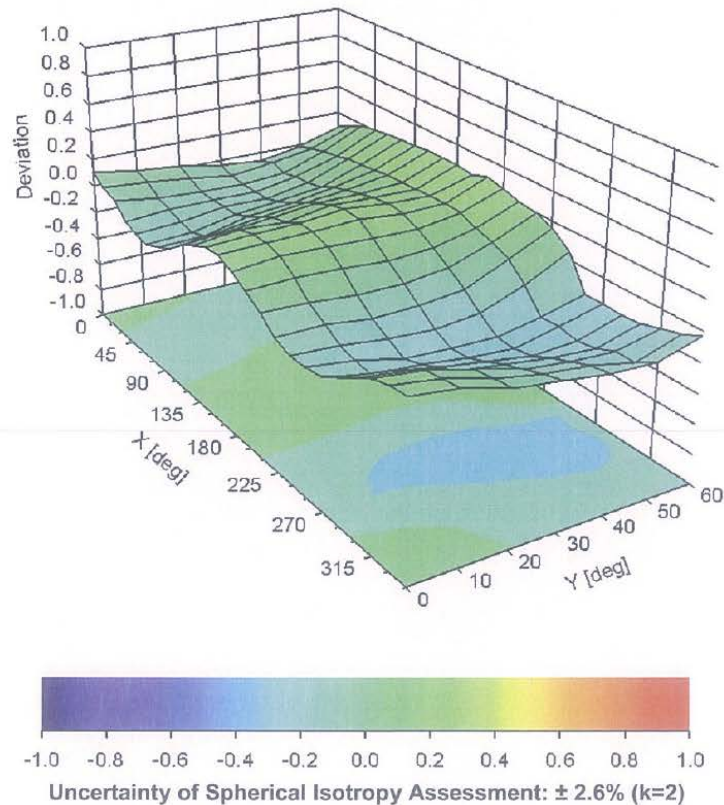
September 1, 2015

Conversion Factor Assessment



Deviation from Isotropy in Liquid

Error (ϕ , θ), f = 900 MHz



EX3DV4- SN:3947

September 1, 2015

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3947

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	-19.7
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	9 mm
Tip Diameter	2.5 mm
Probe Tip to Sensor X Calibration Point	1 mm
Probe Tip to Sensor Y Calibration Point	1 mm
Probe Tip to Sensor Z Calibration Point	1 mm
Recommended Measurement Distance from Surface	1.4 mm



APPENDIX D. CALIBRATION REPORT OF THE DIPOLE ANTENNA

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Accreditation No.: **SCS 0108**

Client **Nemko Korea (Dymstec)**

Certificate No: **D2450V2-774_Apr16**

CALIBRATION CERTIFICATE

Object **D2450V2 - SN: 774**

Calibration procedure(s) **QA CAL-05.v9**
Calibration procedure for dipole validation kits above 700 MHz

Calibration date: **April 19, 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	31-Dec-15 (No. EX3-7349_Dec15)	Dec-16
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

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

Issued: April 20, 2016

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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:

- 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
- 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
- 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
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

- 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 $\pm$ 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 $\pm$ 0.2) °C	40.0 $\pm$ 6 %	1.83 mho/m $\pm$ 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	12.7 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	50.6 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	5.91 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.6 W/kg $\pm$ 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 $\pm$ 0.2) °C	52.7 $\pm$ 6 %	1.98 mho/m $\pm$ 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	12.4 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	49.2 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.80 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	23.1 W/kg $\pm$ 16.5 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	$54.4 \Omega + 3.2 j\Omega$
Return Loss	- 25.6 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	$51.9 \Omega + 6.4 j\Omega$
Return Loss	- 23.7 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.150 ns
----------------------------------	----------

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

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	January 20, 2005

DASY5 Validation Report for Head TSL

Date: 19.04.2016

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 774

Communication System: UID 0 - CW; Frequency: 2450 MHz

Medium parameters used: $f = 2450$ MHz; $\sigma = 1.83$ S/m; $\epsilon_r = 40$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.76, 7.76, 7.76); Calibrated: 31.12.2015;
- 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:

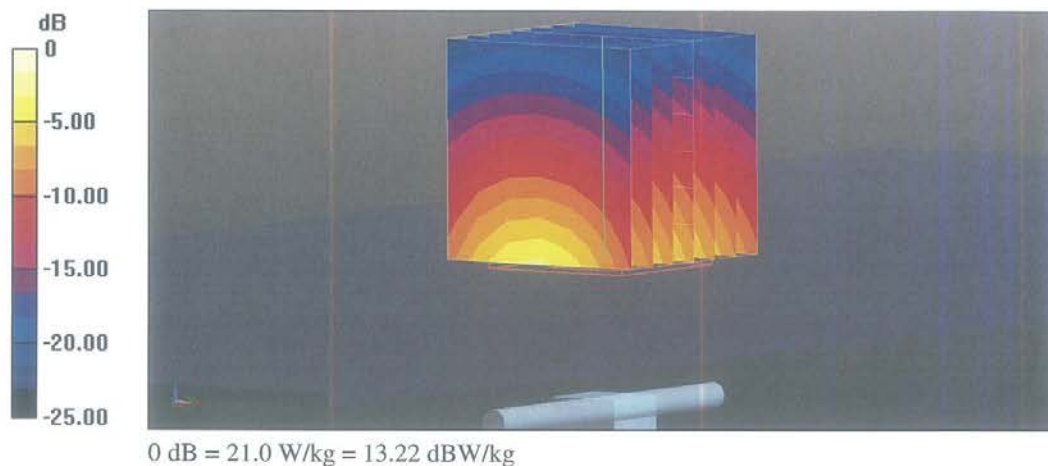
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 113.0 V/m; Power Drift = 0.01 dB

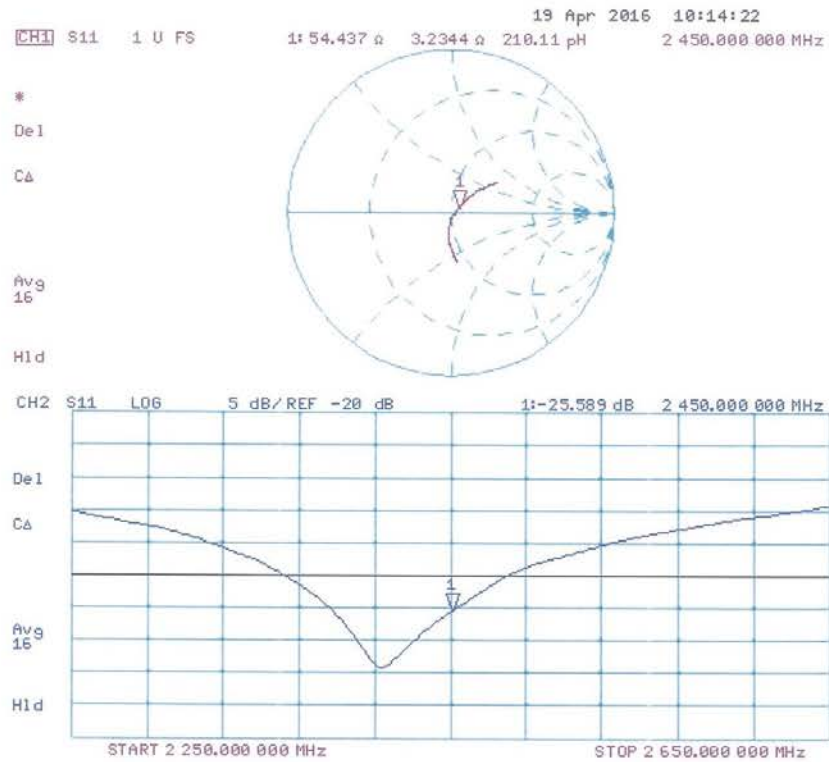
Peak SAR (extrapolated) = 25.7 W/kg

SAR(1 g) = 12.7 W/kg; SAR(10 g) = 5.91 W/kg

Maximum value of SAR (measured) = 21.0 W/kg



Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 19.04.2016

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 774

Communication System: UID 0 - CW; Frequency: 2450 MHz

Medium parameters used: $f = 2450$ MHz; $\sigma = 1.98$ S/m; $\epsilon_r = 52.7$; $\rho = 1000$ kg/m³

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: 31.12.2015;
- 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:

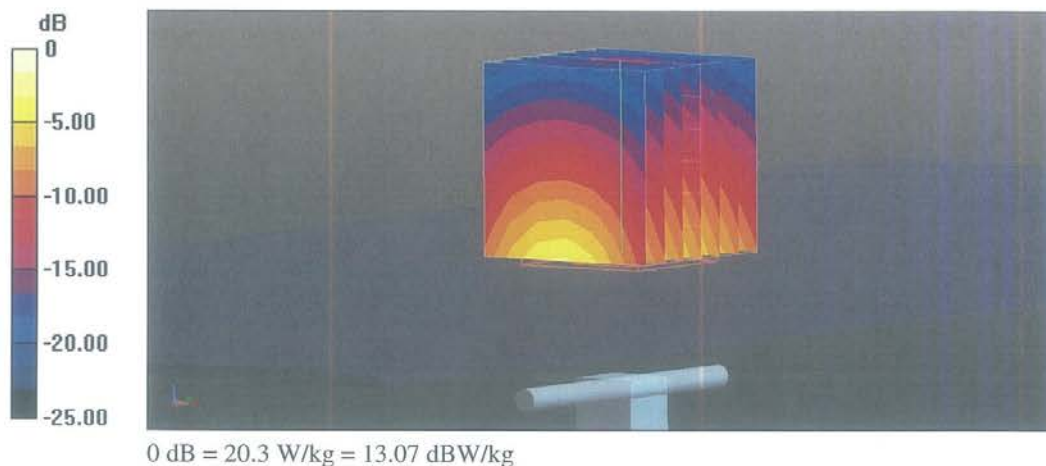
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 105.6 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 24.7 W/kg

SAR(1 g) = 12.4 W/kg; SAR(10 g) = 5.8 W/kg

Maximum value of SAR (measured) = 20.3 W/kg



Impedance Measurement Plot for Body TSL

