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SAR Report

EUT Name: Knocki
EUT Model: KNC1
FCC ID: 2AME7KS7SNFN4M
IC ID: 22824-ICABADQQ

Prepared for:

Swan Solutions, Inc.
8300 Bissonnet Street Suite 245
Houston TX 77074
USA

Prepared by:

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Report/Issue Date: February 1, 2018
Report Number: 31752392.001

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Statement of Compliance

Manufacturer:	Swan Solutions, Inc. 8300 Bissonnet Street Suite 245 Houston TX 77074 USA
Name of Equipment:	Knocki
Model Number:	KNC1
FCC ID:	2AME7KS7SNFN4M
IC ID:	22824-ICABADQQ
Type of Equipment:	Intentional Radiator
Test Dates:	July 6, 2017, August 1, 2017

Guidance Documents:

FCC Code of Federal Regulations Title 47, Various FCC KDBs

RSS-102, Safety Code 6, Various FCC KDBs

Test Methods:

IEEE 1528-2013, Various FCC KDBs

IEEE 1528-2013, IEC 62209-1:2005, IEC 62209-2:2010, Various FCC KDBs

The RF exposure test and documented data described in this report has been performed and recorded by TUV Rheinland, in accordance with the standards and procedures listed herein. As the responsible authorized agent of the EMC laboratory, I hereby declare that the equipment described above has been shown to be compliant with the RF exposure requirements of the stated regulations and standards based on these results. If any special accessories and/or modifications were required for compliance, they are listed in this report.

This report must not be used to claim product endorsement by A2LA or any agency of the U.S. Government. This report shall not be reproduced except in full, without the written authorization of TUV Rheinland of North America.

Josie Sabado	February 1, 2018	Arndt Stoecker	February 1, 2018
Test Engineer	Date	Laboratory Signatory	Date

Test Cert. # 31331.02

1 Executive Summary

1.1 Scope

This report is intended to document the status of conformance with the applicable RF exposure requirements based on the results of testing performed on July 6, 2017 through August 1, 2017 on the Knocki Model KNC1 manufactured by Swan Solutions, Inc. This report only applies to the specific samples tested under the stated test conditions. It is the responsibility of the manufacturer to assure that production units of this model are manufactured with identical or equivalent electrical and mechanical components. This report is further intended to document changes and modifications to the EUT throughout its life cycle. All documentation will be included as a supplement.

1.2 Purpose

Testing was performed to evaluate the SAR levels of the EUT in accordance with the applicable requirements, procedures, and criteria defined in the application of regulations and application of standards listed in this report.

1.3 Summary of Test Results

Equipment Class	Exposure Condition	Maximum Reported 1g SAR (W/kg)	Result
DTS	Body	0.585	Complies

1.4 Equipment Modifications

A communication cable was permanently attached on the PCB to enable connection to a test laptop. The laptop is used to send commands to start transmission. The laptop is disconnected during SAR measurements. The communication cable is fixed to the unit away from the antenna. See antenna locations photo for cable placement. The communication cable is used for test purposes only and will not be present in final production.

1.5 Deviations from the Specifications

None

1.6 Revision History

The latest revision replaces all previous versions

Revision No.	Date (MM/DD/YYYY)	Reason for change	Author
0	08/01/2017	Original	JS
1	08/31/2017	Updated client address	JS
2	02/01/2018	Added additional result plots	JS

2 Laboratory Information

2.1 Accreditations & Endorsements

2.1.1 US Federal Communications Commission

TUV Rheinland of North America at 5015 Brandin Court, Fremont, CA 94538, is accredited by the commission for performing testing services for the general public on a fee basis. These laboratory test facilities have been fully described in reports submitted to and accepted by the FCC. The laboratory scope of accreditation includes: Title 47 CFR Parts 15, 18, and 90. The accreditation is updated every 3 years.

2.1.2 NIST / A2LA

TUV Rheinland of North America is accredited by the National Voluntary Laboratory Accreditation Program, which is administered under the auspices of the National Institute of Standards and Technology. The laboratory has been assessed and accredited in accordance with ISO Guide 17025:1999 and ISO 9002 (Lab Code US5254). The scope of laboratory accreditation includes emission and immunity testing. The accreditation is updated annually.

2.1.3 Canada – Industry Canada

TUV Rheinland of North America at the 5015 Brandin Court, Fremont, CA 94538 address is accredited by Industry Canada for performing testing services for the general public on a fee basis. This laboratory test facilities have been fully described in reports submitted to and accepted by Industry Canada (File Number 2932M). The accreditation is updated every 3 years.

2.1.4 Acceptance by Mutual Recognition Arrangement

The United States has an established agreement with specific countries under the Asia Pacific Laboratory Accreditation Corporation (APLAC) Mutual Recognition Arrangement. Under this agreement, all TUV Rheinland at 5015 Brandin Court, Fremont, CA 94538 test results and test reports within the scope of the laboratory NIST / A2LA accreditation will be accepted by each member country.

2.2 Test Facilities

All of the test facilities are located at 1279 Quarry Lane, Ste. A, Pleasanton, California 94566, USA. The 5015 Brandin Court, Fremont, CA 94538, USA location is considered a Pleasanton annex.

3 Product Information

3.1 Product Description

The EUT is an IoT smart home sensor containing a 2.4 GHz 802.11 b/g/n radio. The EUT can be placed on or below a desk within 20 cm of a person.

3.2 Equipment Under Test (EUT)

EUT Specification	
EUT Dimensions	88 mm diameter 22 mm height
Power Input	3.3 VDC
Exposure Type	☒ General Population / Uncontrolled ☐ Occupational / Controlled
Exposure Condition	☐ Next to the Ear ☐ Body Worn ☒ Next to the Body ☐ Limb ☐ Personal Wireless Router (Hotspot)
Hardware Version	REV0B
RF Software Version	v0.5.1-rc1
Power Reduction Modes	None

3.3 Air Interfaces

Air Interface	Supported Capabilities	Modulation	Maximum Duty Cycle	Band	Frequency Range (MHz)	Maximum Output Power Including Tolerance (dBm)
WLAN: 802.11 b/g/n	• n mode, HT20	• BPSK • QPSK • 16QAM • 64QAM	100%	N/A	2400 – 2483.5	19.5

3.4 Antenna Information

Antenna	Internal / External	Antenna Type	Frequency Range (MHz)	Antenna Gain (dBi)
2.4 GHz WLAN	Internal	Chip	2400-2483.5	1.9

3.5 Equipment Configuration

Test software was used to set the channel, duty cycle, power, and modulation.

3.6 Description of Sample used for Testing

Device	Serial Number	Used For
KNC1	KNC-A1W-00000032	SAR Testing

4 SAR Measurement Information

4.1 Test Specifications

The following specifications were used during the course of testing and are referenced in this test report.

Specification Number	Title	Version
IEEE 1528	IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques	2013
FCC KDB 447498, D01	RF Exposure Procedures and Equipment Authorization Policies for Mobile and Portable Devices	v06
FCC KDB 865664, D01	SAR Measurement Requirements for 100 MHz to 6 GHz	v01r04
FCC KDB 248227, D01	SAR Guidance for IEEE 802.11 (Wi-Fi) Transmitters	v02r02
RSS-102	Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)	Issue 5 March 2015
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)	Ed. 1.0 2010

4.2 SAR Limit

The following SAR limits have been applied in this test report to evaluate the compliance of the EUT against regulatory requirements.

Reference	Exposure Condition	Limit (W/kg)	Average Mass (g)
FCC §1.1310 & §2.1093	Head and Trunk	1.6	1
RSS-102 Safety Code 6	Head, Neck, and Trunk	1.6	1

4.3 Environmental Conditions

The ambient and liquid temperature is measured throughout the course of SAR measurements and is maintained between 18 °C to 25 °C. The temperature drift of the liquid is ≤ 2 °C

4.4 Device Test Positions

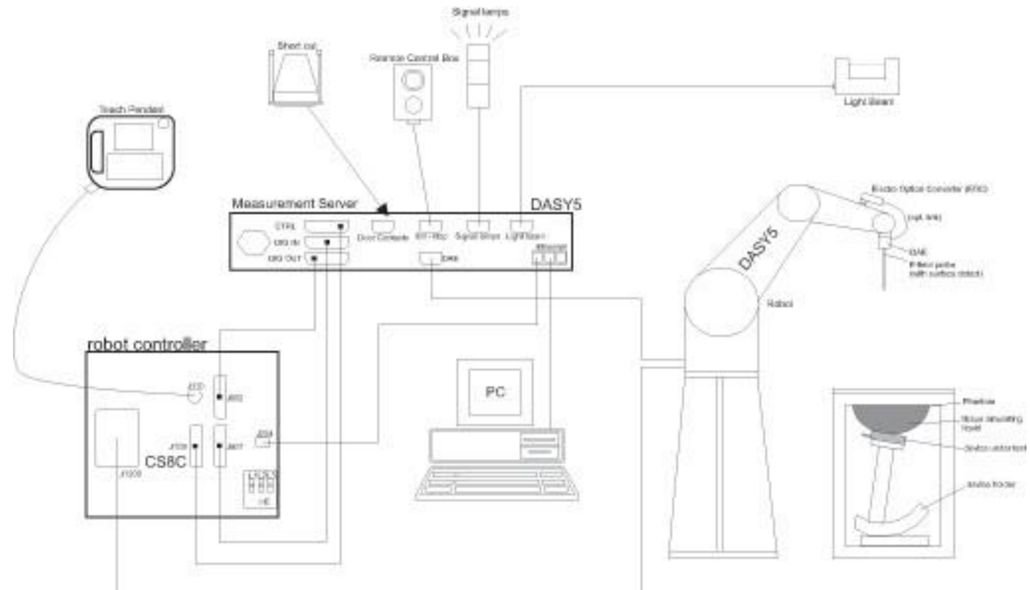
Body Positions

Body SAR measurements are done for the surfaces of the EUT that would face the user during normal operation. The center of the EUT surface is centered on the surface of the flat phantom. If applicable, a separation distance specified by the manufacturer is used between the EUT and the phantom.

For EUTs that do not fit completely within the measurement area of the phantom, pretest measurements are done to find the hot spot. Once the hot spot is found, the EUT is placed so that the hot spot is at the center of the flat phantom.

4.5 SPEAG DASY5 Measurement System

4.5.1 System Overview



The SPEAG DASY5 measurement system consists of the following items:

- A standard high precision 6-axis robot (Stäubli TX/RX family) with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- An isotropic field probe optimized and calibrated for the targeted measurement.
- A data acquisition electronics (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
- The Electro-optical converter (EOC) performs the conversion from optical to electrical signals for the digital communication to the DAE. To use optical surface detection, a special version of the EOC is required. The EOC signal is transmitted to the measurement server.
- The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- The Light Beam used is for probe alignment. This improves the (absolute) accuracy of the probe positioning.
- A computer running Win7 professional operating system and the DASY5 software.
- Remote control and teach pendant as well as additional circuitry for robot safety such as warning lamps, etc.
- The phantom, the device holder and other accessories according to the targeted measurement.

4.5.2 Robot

The Stäubli TX60L robot is a high precision, high reliability industrial robot. The placement precision repeatability is within ±0.02 mm. It uses a brushless synchronous motor with low ELF interference. The robot is controlled by the Stäubli CS8c robot controller.

4.5.3 Data Acquisition Electronics

The data acquisition electronics consist 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 with a control logic unit. Transmission to the measurement server is accomplished through an optical downlink for data and status information, as well as an optical uplink for commands and the clock.

The mechanical probe mounting device includes two different sensor systems for frontal and sideways probe contacts. They are used for mechanical surface detection and probe collision detection.

The input impedance of both the DAE4 as well as of the DAE3 box is 200MOhm; the inputs are symmetrical and floating. Common mode rejection is above 80 dB.

4.5.4 Probe

The ES3DV3 and EX3DV4 dosimetric SAR probe are specially designed and calibrated for use in liquids with high permittivities. The enclosure of the probe is made of PEEK material. The probe is calibrated by SPEAG according to ISO/IEC 17025. See the appendix for the probe calibration report including specifications of probe parameters.

4.5.5 Phantoms

The SAM twin phantom is a fiberglass shell phantom with 2 mm ± 0.2 mm shell thickness (except the ear region, where shell thickness increases to 6 mm ± 0.2 mm). The phantom has three measurement areas:

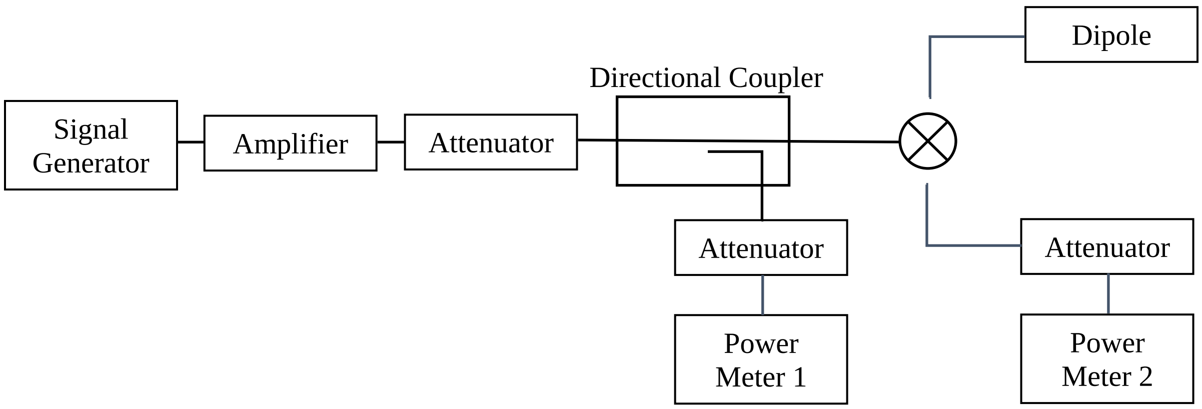
- Left hand
- Right hand
- Flat phantom

The shape of the left hand and right hand phantoms are according to IEEE 1528 and IEC 62209-1. The relative permittivity of the shell is 3.5 ± 0.5. The loss tangent is ≤ 0.05.

The ELI phantom is intended for compliance testing of handheld and body-mounted wireless devices. It is fully compatible with IEC 62209-2. The flat bottom surface is an elliptical shape measuring 600 mm in length and 400 mm in width. The shell thickness is 2 mm ± 0.2 mm. The relative permittivity is 4 ± 1 and the loss tangent is ≤ 0.05.

4.5.6 System Check Procedure

The purpose of the system check is to verify that a specific SAR measurement system operates within its specifications at the device test frequencies. It is done within 24 hours before SAR measurements. The setup for system check is as follows



1. An unmodulated continuous wave signal is generated at the frequency to be tested.
2. The power at the input to the dipole is measured using power meter 2 while the forward power at the directional coupler is measured using power meter 1. The output power of the signal generator is varied until 20 dBm is measured at power meter 2.
3. Power meter 2 is disconnected and the dipole is connected. The output power of the signal generator is varied until power meter 1 measures the same forward power as when 20 dBm was measured with power meter 2.
4. A SAR measurement is performed using the dipole with the same area scan and zoom scan parameters required for a SAR measurement on the EUT.
5. The 1g and 10g SAR result is compared to the 1g and 10g SAR value in the dipole's calibration certificate.

4.5.7 SAR Measurement Procedure

Power Reference Measurement

A single point SAR measurement is measured above the center of the radiating structure. This power reference measurement is compared to the power drift measurement after the zoom scan to ensure the output power of the EUT does not drift during the SAR measurement.

Area Scan

The area scan is done in the x-y plane. The measurement grid is larger than the area of the EUT surface under test with the following characteristics:

	≤ 3 GHz	> 3 GHz
Maximum distance from the closest measurement point (geometric center of probe sensors) to phantom surface	5 mm ± 1 mm	$\delta \cdot \ln(2)/2$ mm ± 0.5 mm
Maximum probe angle from probe axis to phantom surface normal at the measurement location	30° ± 1°	20° ± 1°
Maximum area scan spatial resolution: Δx_{Area}, Δy_{Area}	≤ 2 GHz: ≤ 15mm 2 – 3 GHz: ≤ 12 mm	3 – 4 GHz: ≤ 12 mm 4 – 6 GHz: ≤ 10 mm
	When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be ≤ the corresponding x or y dimension of the test device with at least one measurement point on the test device.	
Note: δ is the penetration depth of a plane-wave at normal incidence to the tissue medium.		

Zoom Scan

Once the hot spot is found in the area scan, a zoom scan measurement is done above the hot spot. A uniform measurement grid is done in the x, y, and z direction in the form of a cube. The following characteristics are used:

	≤ 3 GHz	> 3 GHz
Maximum zoom scan spatial resolution: Δx_{zoom}, Δy_{zoom}	≤ 2 GHz: ≤ 8 mm 2 – 3 GHz: ≤ 5 mm	3 – 4 GHz: ≤ 5 mm 4 – 6 GHz: ≤ 4 mm
Maximum zoom scan spatial resolution, normal to phantom surface: Δz_{zoom}	≤ 5 mm	3 – 4 GHz: ≤ 4 mm 4 – 5 GHz: ≤ 3 mm 5 – 6 GHz: ≤ 2 mm
Minimum zoom scan volume: x, y, z	≥ 30 mm	3 – 4 GHz: ≥ 28 mm 4 – 5 GHz: ≥ 25 mm 5 – 6 GHz: ≥ 22 mm

Power Drift Measurement

A second single point SAR measurement is done at the same location as the power reference measurement. The delta between the power reference measurement and the power drift measurement shall not be more than ± 5%

4.5.8 Measurement Uncertainty

The uncertainty budge is included for ISED. See the measurement variability section for FCC.

4.5.8.1 IEEE 1528-2013, 300 MHz - 3 GHz

Error Description	Uncertainty Value	Probability Distribution	Divisor	(c_i) 1g	(c_i) 10g	Std. Unc. (1g)	Std. Unc. (10g)	(v_i) v_{eff}
Measurement System								
Probe Calibration	± 6.0%	N	1	1	1	± 6.0%	± 6.0%	∞
Axial Isotropy	± 4.7%	R	√3	0.7	0.7	± 1.9%	± 1.9%	∞
Hemispherical Isotropy	± 9.6%	R	√3	0.7	0.7	± 3.9%	± 3.9%	∞
Boundary Effects	± 1.0%	R	√3	1	1	± 0.6%	± 0.6%	∞
Linearity	± 4.7%	R	√3	1	1	± 2.7%	± 2.7%	∞
System Detection Limits	± 1.0%	R	√3	1	1	± 0.6%	± 0.6%	∞
Modulation Response	± 2.4%	R	√3	1	1	± 1.4%	± 1.4%	∞
Readout Electronics	± 0.3%	N	1	1	1	± 0.3%	± 0.3%	∞
Response Time	± 0.8%	R	√3	1	1	± 0.5%	± 0.5%	∞
Integration Time	± 2.6%	R	√3	1	1	± 1.5%	± 1.5%	∞
RF Ambient Noise	± 3.0%	R	√3	1	1	± 1.7%	± 1.7%	∞
RF Ambient Reflections	± 3.0%	R	√3	1	1	± 1.7%	± 1.7%	∞
Probe Positioner	± 0.4%	R	√3	1	1	± 0.2%	± 0.2%	∞
Probe Positioning	± 2.9%	R	√3	1	1	± 1.7%	± 1.7%	∞
Max. SAR Evaluation	± 2.0%	R	√3	1	1	± 1.2%	± 1.2%	∞
Test Sample Related								
Device Positioning	± 2.9%	N	1	1	1	± 2.9%	± 2.9%	145
Device Holder	± 3.6%	N	1	1	1	± 3.6%	± 3.6%	5
Power Drift	± 5.0%	R	√3	1	1	± 2.9%	± 2.9%	∞
Power Scaling	± 0%	R	√3	1	1	± 0.0%	± 0.0%	∞
Phantom and Setup								
Phantom Uncertainty	± 6.1%	R	√3	1	1	± 3.5%	± 3.5%	∞
SAR correction	± 1.9%	R	√3	1	0.84	± 1.1%	± 0.9%	∞
Liquid Conductivity (mea.)[DAK]	± 2.5%	R	√3	0.78	0.71	± 1.1%	± 1.0%	∞
Liquid Permittivity (mea.)[DAK]	± 2.5%	R	√3	0.26	0.26	± 0.3%	± 0.4%	∞
Temp. unc. - Conductivity	± 3.4%	R	√3	0.78	0.71	± 1.5%	± 1.4%	∞
Temp. unc. - Permittivity	± 0.4%	R	√3	0.23	0.26	± 0.1%	± 0.1%	∞
Combined Std. Uncertainty						± 11.2%	± 11.1%	361
Expanded STD Uncertainty						**± 22.3%**	**± 22.2%**	

4.5.8.2 IEC 62209-1/2, 30 MHz – 6 GHz

Error Description	Uncertainty Value	Probability Distribution	Divisor	(c_i) 1g	(c_i) 10g	Std. Unc. (1g)	Std. Unc. (10g)	(v_i) v_{eff}
Measurement System								
Probe Calibration	± 6.55%	N	1	1	1	± 6.55%	± 6.55%	∞
Axial Isotropy	± 4.70%	R	√3	0.7	0.7	± 1.9%	± 1.9%	∞
Hemispherical Isotropy	± 9.60%	R	√3	0.7	0.7	± 3.9%	± 3.9%	∞
Boundary Effects	± 2.00%	R	√3	1	1	± 1.2%	± 1.2%	∞
Linearity	± 4.70%	R	√3	1	1	± 2.7%	± 2.7%	∞
System Detection Limits	± 1.00%	R	√3	1	1	± 0.6%	± 0.6%	∞
Modulation Response	± 2.40%	R	√3	1	1	± 1.4%	± 1.4%	∞
Readout Electronics	± 0.30%	N	1	1	1	± 0.3%	± 0.3%	∞
Response Time	± 0.80%	R	√3	1	1	± 0.5%	± 0.5%	∞
Integration Time	± 2.60%	R	√3	1	1	± 1.5%	± 1.5%	∞
RF Ambient Noise	± 3.00%	R	√3	1	1	± 1.7%	± 1.7%	∞
RF Ambient Reflections	± 3.00%	R	√3	1	1	± 1.7%	± 1.7%	∞
Probe Positioner	± 0.80%	R	√3	1	1	± 0.5%	± 0.5%	∞
Probe Positioning	± 6.70%	R	√3	1	1	± 3.9%	± 3.9%	∞
Post-processing	± 4.00%	R	√3	1	1	± 2.3%	± 2.3%	∞
Test Sample Related								
Device Positioning	± 2.90%	N	1	1	1	± 2.9%	± 2.9%	145
Device Holder	± 3.60%	N	1	1	1	± 3.6%	± 3.6%	5
Power Drift	± 5.00%	R	√3	1	1	± 2.9%	± 2.9%	∞
Power Scaling	± 0%	R	√3	1	1	± 0.0%	± 0.0%	∞
Phantom and Setup								
Phantom Uncertainty	± 7.90%	R	√3	1	1	± 4.6%	± 4.6%	∞
SAR correction	± 1.90%	R	√3	1	0.84	± 1.1%	± 0.9%	∞
Liquid Conductivity (mea.)^{DAK}	± 2.50%	R	√3	0.78	0.71	± 1.1%	± 1.0%	∞
Liquid Permittivity (mea.)^{DAK}	± 2.50%	R	√3	0.26	0.26	± 0.4%	± 0.4%	∞
Temp. unc. - Conductivity	± 3.40%	R	√3	0.78	0.71	± 1.5%	± 1.4%	∞
Temp. unc. - Permittivity	± 0.40%	R	√3	0.23	0.26	± 0.1%	± 0.1%	∞
Combined Std. Uncertainty						± 12.5%	± 12.5%	748
Expanded STD Uncertainty						± **25.1%**	± **25.0%**	

4.6 SAR Scaling (Reported SAR)

Measured 1g and 10g SAR values are scaled up to the maximum output power including tolerance of the EUT as declared by the manufacturer. Conducted output power measurements are performed to ensure the output power of the EUT is close to the maximum power. After SAR measurements are performed, the measured SAR is scaled up by the delta between the measured output power and the manufacturer's declared maximum output power including tolerance.

The SAR scaling factor is calculated as

$$SAR\ Scaling\ Factor = \frac{Maximum\ Output\ Power\ Including\ Tolerance,\ mW}{Measured\ Output\ Power,\ mW}$$

The reported SAR is

$$Reported\ SAR = Measured\ SAR\ \times SAR\ Scaling\ Factor$$

For Example:

Measured SAR: 1.0 W/kg

Measured output power: 250 mW

Maximum output power including tolerance: 300 mW

SAR scaling factor = 1.2

Reported SAR = 1.2 W/kg

5 Conducted Output Power Measurements

5.1 WLAN

Conducted output power measurements are not possible on the EUT used for SAR testing. Output power values are taken from the FCC 15.247 test report for this EUT.

2.4 GHz WLAN – 802.11 b/g/n

		802.11b	802.11g	802.11n, HT20
Ch. 1 / 2412 MHz	Measured Burst Avg. Power (dBm)	17.1	17.1	17
	Max Output Power Including Tolerance (dBm)	19.5	19.5	19.5
Ch. 6 / 2437 MHz	Measured Burst Avg. Power (dBm)	17.2	17.2	17.1
	Max Output Power Including Tolerance (dBm)	19.5	19.5	19.5
Ch. 11 / 2462 MHz	Measured Burst Avg. Power (dBm)	17.2	17.2	17
	Max Output Power Including Tolerance (dBm)	19.5	19.5	19.5

6 SAR Measurement Results

6.1 System Check

System check is performed within 24 hours before the SAR measurement on the EUT. A SAR measurement is done with a calibrated reference dipole. The measured SAR is normalized to 1 W and compared to the 1 W reference SAR value provided in the calibration report for the dipole. The system check is verified to be within ±10% of the reference SAR value.

Frequency (MHz)	Liquid Type	Date	1 W Normalized 1g SAR (W/kg)	1 W Reference 1g SAR (W/kg)	Difference
2450	Body	July 6, 2017	51.97	56.00	-7%
2450	Body	August 1, 2017	53.60	56.00	-4%

6.2 Test Configurations

The following configurations were tested for SAR.

Configuration #	Exposure Condition	Position	Distance
B1	Body	Top	0 mm
B2		Bottom	0 mm

6.3 Body SAR Results

Under FCC, low and high channels are required when the reported SAR is greater than 0.8 W/kg. Under ISED, low and high channels are required regardless of the reported SAR at mid channel.

2.4 GHz WLAN

Channel	Frequency (MHz)	Config. #	Power Drift (dB)	Measured 10g SAR (W/kg)	SAR Scaling Factor	Reported 10g SAR (W/kg)	Plot #
6	2437	B1	-0.05	0.303	1.7	0.515	1
		B2	0.17	0.066	1.7	0.112	2
1	2412	B1	0.02	0.187	1.7	0.318	3
11	2462	B1	0.05	0.344	1.7	0.585	4

6.4 Measurement Variability

According to FCC KDB 865664, When the highest measured 1-g SAR within a frequency band is < 1.5 W/kg, the extensive SAR measurement uncertainty analysis described in IEEE Std 1528-2013 is not required in SAR reports submitted for equipment approval. SAR measurement variability is assessed for each frequency band for the tissue simulating liquid with the highest measured SAR and using the highest measured SAR configuration. The following procedure is used to assess measurement variability:

1. Repeated measurement is not required when the original highest measured SAR is < 0.80 W/kg; steps 2) through 4) do not apply.
2. When the original highest measured SAR is ≥ 0.80 W/kg, repeat that measurement once.
3. Perform a second repeated measurement only if the ratio of largest to smallest SAR for the original and first repeated measurements is > 1.20 or when the original or repeated measurement is ≥ 1.45 W/kg (~ 10% from the 1-g SAR limit).
4. Perform a third repeated measurement only if the original, first or second repeated measurement is ≥ 1.5 W/kg and the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 1.20.

The maximum measured 1g SAR is 0.344. Measurement variability is not required.

7 Test Equipment List

Equipment	Manufacturer	Model #	Serial/Inst #	Last Cal mm/dd/yyyy	Next Cal mm/dd/yyyy
System check – power monitoring kit	Art-Fi	PMK	002	02/06/2017	02/06/2018
2450 MHz Dipole	IMST	diSARA2450	304324-2402103	03/13/2017	03/13/2018
DASY5 Robot	Staubli	TX60L	F13/5R4XC1/A/01	N/A	N/A
DASY5 Robot Controller	Staubli	CS8Cspeag-TX60	F13/5R4XC1/C/01	N/A	N/A
DASY5 Measurement Server	SPEAG	SE UMS 011 DA	1398	N/A	N/A
Data Acquisition Electronics	SPEAG	DAE4	1419	03/09/2017	03/09/2018
SAR Probe	SPEAG	EX3DV4	3957	03/23/2017	03/23/2018
SAM Phantom	SPEAG	QD 000P40 CD	1806	N/A	N/A
ELI Phantom	SPEAG	QD OVA 002 AA	2154	N/A	N/A
Body Liquid 600 MHz – 6 GHz	SPEAG	MBBL	161115-1	N/A	N/A
Dielectric Assessment Kit	SPEAG	DAKS-3.5	1079	12/11/2016	12/11/2017
Submersible Digital Thermometer	LKM Electronic	DTM 3000	3641	01/30/2017	01/30/2018
Temperature Sensor	Control Company	4184	170255262	03/16/2017	03/16/2019

8 Result Plots

Plot 1: WLAN 2437 MHz, Top Side

Date/Time: 7/6/2017 1:16:35 PM

Test Laboratory: TUV Rheinland of North America
DUT: Swan Solutions - Knocki; Serial: KNC-A1W-00000032

Communication System: UID 0, WiFi - 100% Duty Cycle (0); Frequency: 2437 MHz;Duty Cycle: 1:1
Medium parameters used (interpolated): f = 2437 MHz; σ = 2.027 S/m; ε_r = 51.597; ρ = 1000 kg/m^3
Phantom section: Flat Section

Procedure Notes: Operator: Josie; Ambient Temp: 24°C; Liquid Temp: 24°C; Comments: ;

DASY5 Configuration:

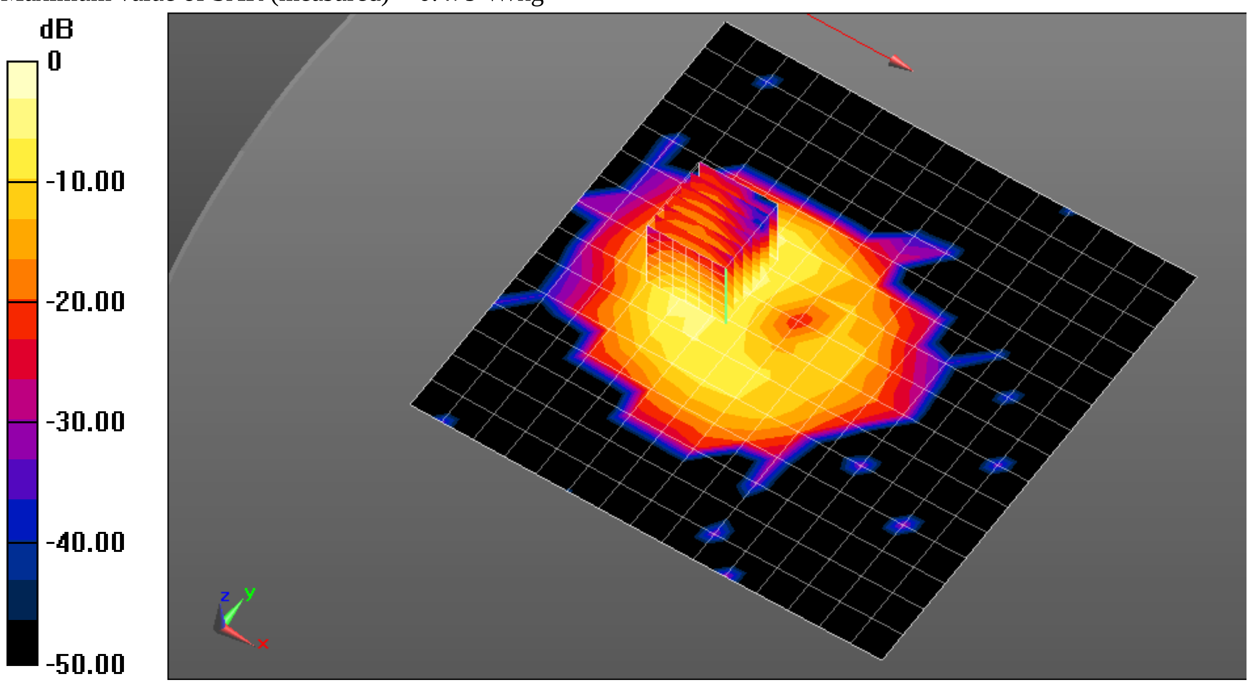
- Probe: EX3DV4 - SN3957; ConvF(7.98, 7.98, 7.98); Calibrated: 3/23/2017;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1419; Calibrated: 3/9/2017
- Phantom: ELI v5.0; Type: QDOVA002AA; Serial: TP: 1254
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Body/Top_0 mm_Mid Ch/Area Scan (16x16x1): Measurement grid: dx=12mm, dy=12mm

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 0.458 W/kg

Body/Top_0 mm_Mid Ch/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 9.003 V/m; Power Drift = -0.05 dB
Peak SAR (extrapolated) = 0.726 W/kg
SAR(1 g) = 0.303 W/kg; SAR(10 g) = 0.119 W/kg (SAR corrected for target medium)

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 0.479 W/kg



0 dB = 0.458 W/kg = -3.39 dBW/kg

Plot 2: WLAN 2437 MHz, Bottom Side

Date/Time: 7/6/2017 2:02:24 PM

Test Laboratory: TUV Rheinland of North America
DUT: Swan Solutions - Knocki; Serial: KNC-A1W-00000032

Communication System: UID 0, WiFi - 100% Duty Cycle (0); Frequency: 2437 MHz;Duty Cycle: 1:1
Medium parameters used (interpolated): f = 2437 MHz; σ = 2.027 S/m; ε_r = 51.597; ρ = 1000 kg/m^3
Phantom section: Flat Section

Procedure Notes: Operator: Josie; Ambient Temp: 24°C; Liquid Temp: 24°C; Comments: ;

DASY5 Configuration:

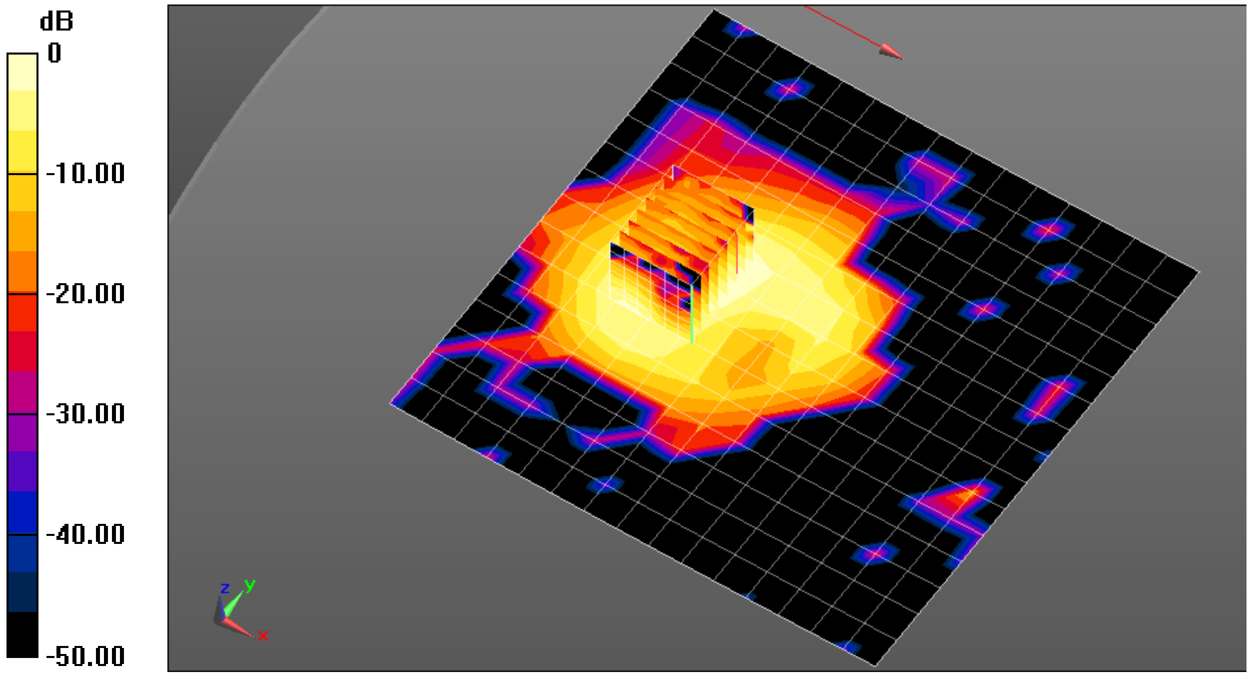
- Probe: EX3DV4 - SN3957; ConvF(7.98, 7.98, 7.98); Calibrated: 3/23/2017;
- Sensor-Surface: 2mm (Mechanical Surface Detection (Locations From Previous Scan Used)), Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1419; Calibrated: 3/9/2017
- Phantom: ELI v5.0; Type: QDOVA002AA; Serial: TP: 1254
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Body/Bottom_0 mm_Mid Ch/Area Scan (16x16x1): Measurement grid: dx=12mm, dy=12mm

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 0.110 W/kg

Body/Bottom_0 mm_Mid Ch/Zoom Scan (7x8x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 5.557 V/m; Power Drift = 0.17 dB
Peak SAR (extrapolated) = 0.118 W/kg
SAR(1 g) = 0.066 W/kg; SAR(10 g) = 0.032 W/kg (SAR corrected for target medium)

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 0.0932 W/kg



0 dB = 0.110 W/kg = -9.59 dBW/kg

Plot 3: WLAN 2412 MHz, Top Side

Date/Time: 8/1/2017 9:23:53 AM

Test Laboratory: TUV Rheinland of North America
DUT: Swan Solutions - Knocki; Serial: KNC-A1W-00000032

Communication System: UID 0, WiFi - 100% Duty Cycle (0); Frequency: 2412 MHz;Duty Cycle: 1:1
Medium parameters used (interpolated): f = 2412 MHz; $\sigma = 1.962$ S/m; $\varepsilon_r = 51.292$; $\rho = 1000$ kg/m^3
Phantom section: Flat Section

Procedure Notes: Operator: Josie; Ambient Temp: 23°C; Liquid Temp: 23°C; Comments: ;

DASY5 Configuration:

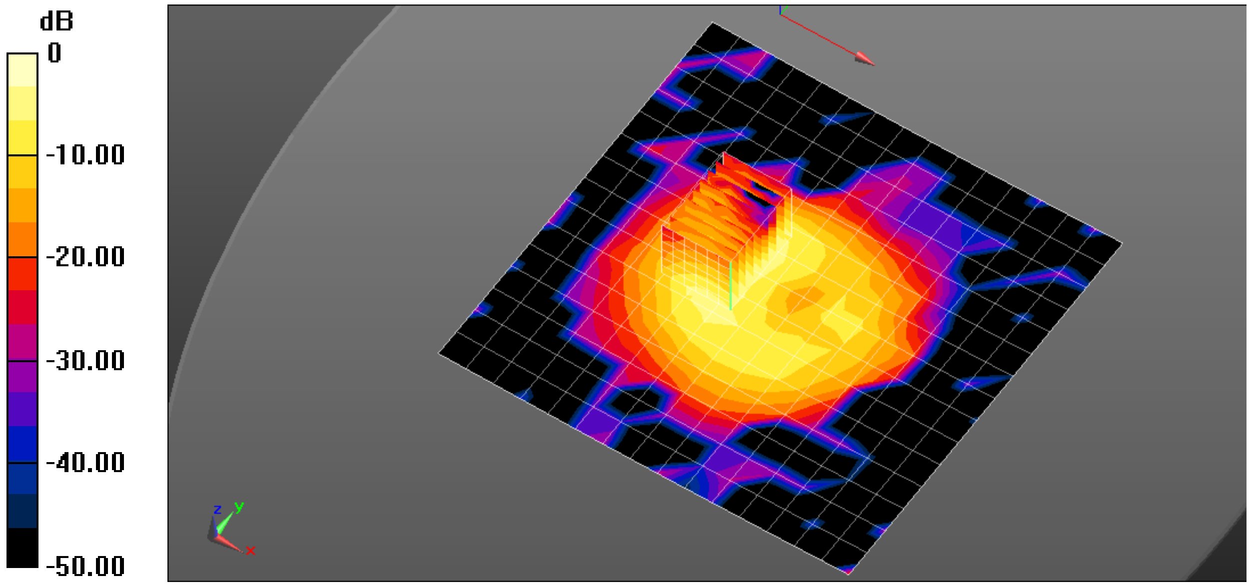
- Probe: EX3DV4 - SN3957; ConvF(7.98, 7.98, 7.98); Calibrated: 3/23/2017;
- Sensor-Surface: 2mm (Mechanical Surface Detection (Locations From Previous Scan Used)), Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1419; Calibrated: 3/9/2017
- Phantom: ELI v5.0; Type: QDOVA002AA; Serial: TP: 1254
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Body 2/Top_0 mm_Low Ch/Area Scan (16x16x1): Measurement grid: dx=12mm, dy=12mm

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 0.321 W/kg

Body 2/Top_0 mm_Low Ch/Zoom Scan (7x9x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 11.51 V/m; Power Drift = 0.02 dB
Peak SAR (extrapolated) = 0.422 W/kg
SAR(1 g) = 0.187 W/kg; SAR(10 g) = 0.079 W/kg (SAR corrected for target medium)

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 0.285 W/kg



0 dB = 0.321 W/kg = -4.93 dBW/kg

Plot 4: WLAN 2462 MHz, Top Side

Date/Time: 8/1/2017 10:03:22 AM

Test Laboratory: TUV Rheinland of North America
DUT: Swan Solutions - Knocki; Serial: KNC-A1W-00000032

Communication System: UID 0, WiFi - 100% Duty Cycle (0); Frequency: 2462 MHz;Duty Cycle: 1:1
Medium parameters used (interpolated): f = 2462 MHz; σ = 2.005 S/m; ε_r = 51.23; ρ = 1000 kg/m^3
Phantom section: Flat Section

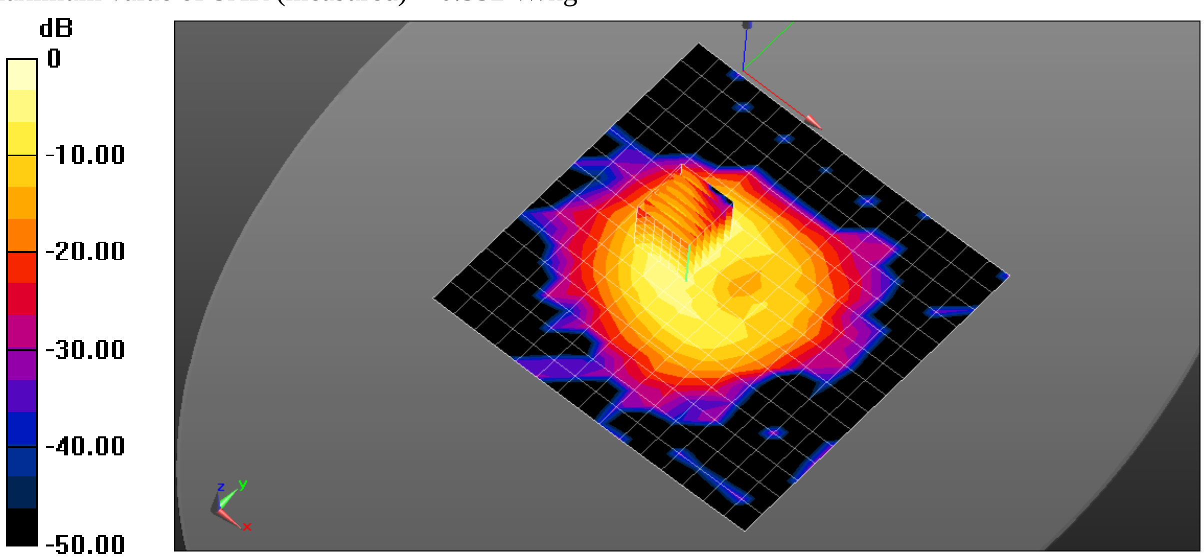
Procedure Notes: Operator: Josie; Ambient Temp: 23°C; Liquid Temp: 23°C; Comments: ;

DASY5 Configuration:

- Probe: EX3DV4 - SN3957; ConvF(7.98, 7.98, 7.98); Calibrated: 3/23/2017;
- Sensor-Surface: 2mm (Mechanical Surface Detection (Locations From Previous Scan Used)), Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1419; Calibrated: 3/9/2017
- Phantom: ELI v5.0; Type: QDOVA002AA; Serial: TP: 1254
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Body 2/Top_0 mm_High Ch/Area Scan (16x16x1): Measurement grid: dx=12mm, dy=12mm
Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 0.603 W/kg

Body 2/Top_0 mm_High Ch/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 12.71 V/m; Power Drift = 0.05 dB
Peak SAR (extrapolated) = 0.766 W/kg
SAR(1 g) = 0.344 W/kg; SAR(10 g) = 0.141 W/kg (SAR corrected for target medium)
Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 0.552 W/kg



0 dB = 0.603 W/kg = -2.20 dBW/kg

9 System Verification Plots

Plot 2: 2450 MHz MBBL System Verification, July 6, 2017

Date/Time: 7/6/2017 9:41:05 AM

Test Laboratory: TUV Rheinland of North America
DUT: Dipole 2450 MHz; Serial: 304324-2402103

Communication System: UID 0, CW (0); Frequency: 2450 MHz;Duty Cycle: 1:1
Medium parameters used: f = 2450 MHz; σ = 2.038 S/m; ε_r = 51.577; ρ = 1000 kg/m^3
Phantom section: Flat Section

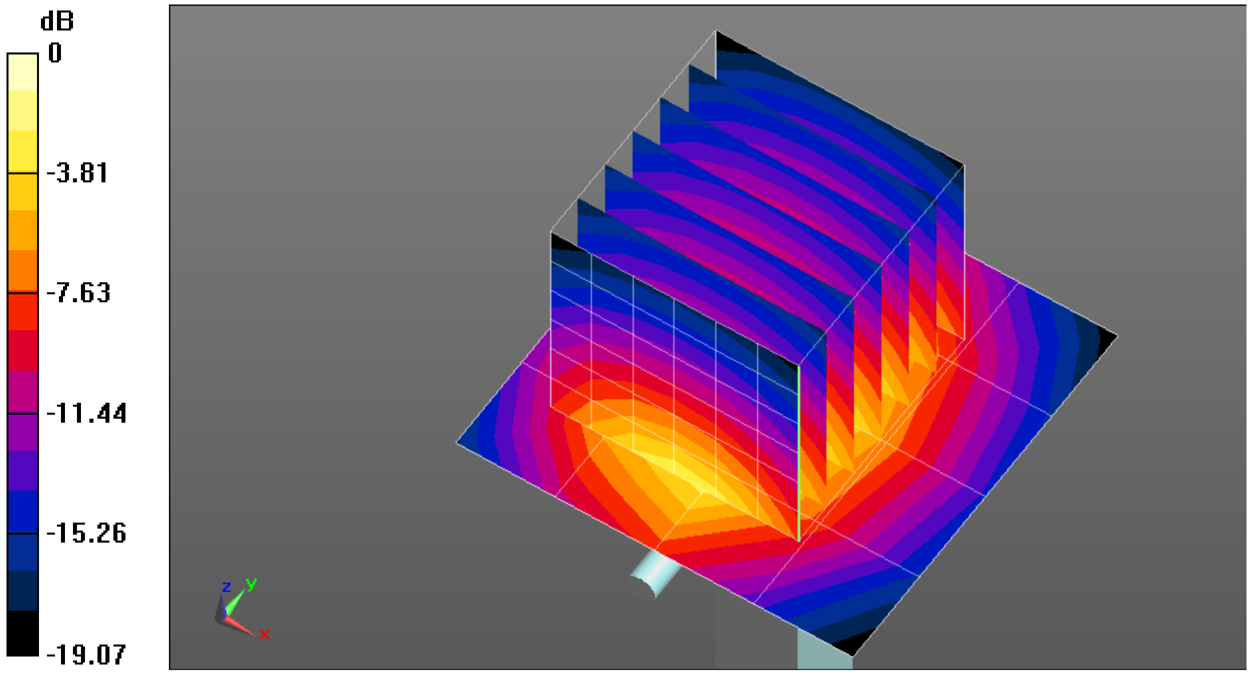
Procedure Notes: Operator: Josie; Ambient Temp: 22°C; Liquid Temp: 22.3°C; Comments: ;

DASY5 Configuration:

- Probe: EX3DV4 - SN3957; ConvF(7.98, 7.98, 7.98); Calibrated: 3/23/2017;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1419; Calibrated: 3/9/2017
- Phantom: ELI v5.0; Type: QDOVA002AA; Serial: TP: 1254
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Body/Sys Verif_2450MHz_MBBL/Area Scan (5x5x1): Measurement grid: dx=12mm, dy=12mm
Maximum value of SAR (measured) = 7.51 W/kg

Body/Sys Verif_2450MHz_MBBL/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 62.88 V/m; Power Drift = -0.04 dB
Peak SAR (extrapolated) = 10.4 W/kg
SAR(1 g) = 5.15 W/kg; SAR(10 g) = 2.39 W/kg (SAR corrected for target medium)
Maximum value of SAR (measured) = 7.78 W/kg



0 dB = 7.51 W/kg = 8.75 dBW/kg

Plot 3: 2450 MHz MBBL System Verification, August 1, 2017

Date/Time: 8/1/2017 8:24:33 AM

Test Laboratory: TUV Rheinland of North America
DUT: Dipole 2450 MHz; Serial: 304324-2402103

Communication System: UID 0, CW (0); Frequency: 2450 MHz;Duty Cycle: 1:1
Medium parameters used: f = 2450 MHz; σ = 1.994 S/m; ε_r = 51.245; ρ = 1000 kg/m^3
Phantom section: Flat Section

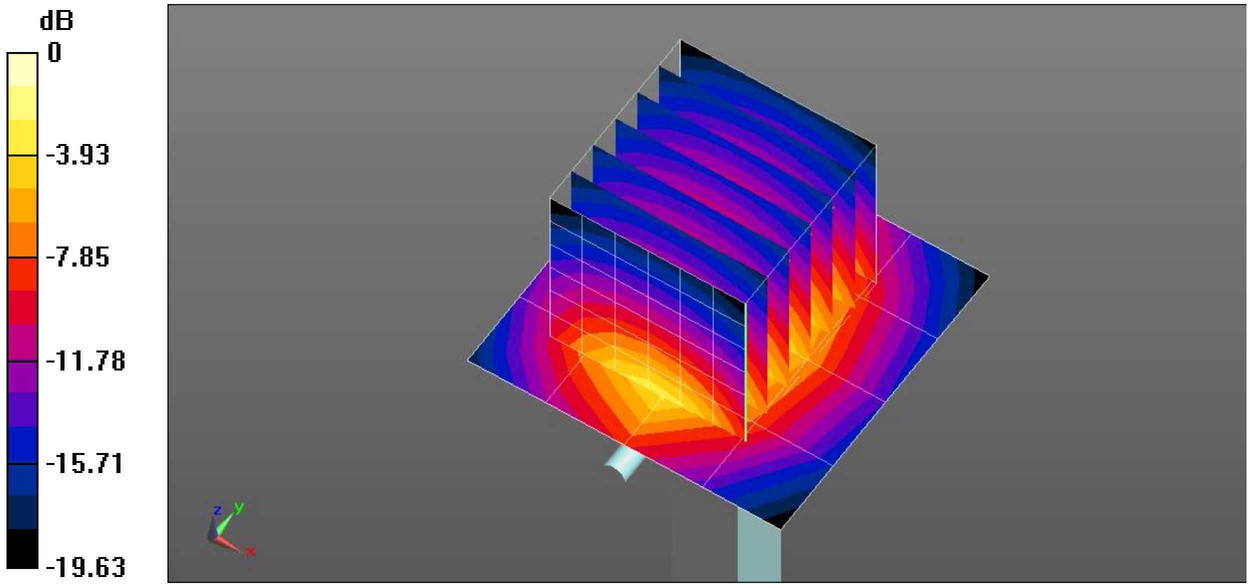
Procedure Notes: Operator: Josie; Ambient Temp: 24°C; Liquid Temp: 23°C; Comments: ;

DASY5 Configuration:

- Probe: EX3DV4 - SN3957; ConvF(7.98, 7.98, 7.98); Calibrated: 3/23/2017;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1419; Calibrated: 3/9/2017
- Phantom: ELI v5.0; Type: QDOVA002AA; Serial: TP: 1254
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Body/Sys Verif_2450MHz_MBBL/Area Scan (5x5x1): Measurement grid: dx=12mm, dy=12mm
Maximum value of SAR (measured) = 7.85 W/kg

Body/Sys Verif_2450MHz_MBBL/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 64.73 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 10.8 W/kg
SAR(1 g) = 5.31 W/kg; SAR(10 g) = 2.44 W/kg (SAR corrected for target medium)
Maximum value of SAR (measured) = 8.13 W/kg



0 dB = 7.85 W/kg = 8.95 dBW/kg

10 Liquid Measurements

Liquid measurements are within +/-10% of the target value. The DASY52 software corrects the measured SAR value to the target conductivity and permittivity only when the SAR value will be higher after correction.

Liquid	Date	Temp (°C)	Frequency	Measured		% Delta	
				Permittivity	Conductivity	Permittivity	Conductivity
MBBL 600-6000V6	July 6, 2017	22.3	2435	51.6005	2.02525	-2.12	4.63
			2440	51.5925	2.02966	-2.13	4.60
			2450	51.5771	2.03848	-2.13	4.54
	August 1, 2017	23	2410	51.2942	1.95983	-2.77	2.51
			2415	51.2882	1.9641	-2.77	2.48
			2450	51.2452	1.99419	-2.76	2.27
			2460	51.2326	2.00283	-2.76	1.97
			2462	51.2263	2.00716	-2.76	1.82