

SAR Test Report - New Filing

Applicant:



Garmin International Inc.
1200 East 151 St.
Olathe, KS, 66062
USA

FCC ID:

IPH9603N

Product Model Number / HVIN

9603N

Maximum Reported 1g SAR

FCC	BODY:	0.63	W/kg
ISED	BODY:	0.66	
General Pop. Limit:		1.60	

IC Registration Number

1792A-9603N

Product Name / PMN

9603N

In Accordance With:

FCC 47 CFR §2.1093

Radiofrequency Radiation Exposure Evaluation: Portable Devices

IC RSS-102 Issue 5

Radio Frequency Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)

Approved By:



Ben Hewson, President

Celltech Labs Inc.

21-364 Lougheed Rd.

Kelowna, BC, V1X 7R8

Canada



Test Lab Certificate: 2470.01



**Industry
Canada**

IC Registration 3874A-1



FCC Registration: 714830

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1.0 DOCUMENT CONTROL

Prepared By:	Art Voss		
Reviewed By:	Ben Hewson		
Issue Number	Description	By	Issue Date
1.0	Initial Release	Art Voss	8 November 2016
2.0	Corrections per TCB	Art Voss	3 January 2017
2.1	Added Details of Operation	Art Voss	5 January 2017
2.2	Corrected Identification of Equipment	Jasmeet Gill	11 January 2017

2.0 NORMATIVE REFERENCES

Normative References*	
ANSI / ISO 17025:2005	General Requirements for competence of testing and calibration laboratories
FCC CFR Title 47 Part 2 Title 47: Part 2.1093:	Code of Federal Regulations Telecommunication Radiofrequency Radiation Exposure Evaluation: Portable Devices
Health Canada Safety Code 6 (2015)	Limits of Human Exposure to Radiofrequency Electromagnetic Energy in the Frequency Range from 3kHz to 300GHz
Industry Canada Spectrum Management & Telecommunications Policy RSS-102 Issue 5:	Radio Frequency Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)
IEEE International Committee on Electromagnetic Safety IEEE 1528-2013:	IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques
IEC International Standard IEC 62209-2 2010	Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices - Part 2
FCC KDB KDB 865664 D01v01r04	SAR Measurement Requirements for 100MHz to 6GHz
FCC KDB KDB 447498 D01v06	Mobile and Portable Devices RF Exposure Procedures and Equipment Authorization Policies
* When the issue number or issue date is omitted, the latest version is assumed.	

3.0 CLIENT AND DEVICE INFORMATION

Client Information					
Applicant Name	Garmin International Inc.				
Applicant Address	1200 East 151 St.				
	Olathe, KS, 66062				
	USA				
DUT Information					
Device Identifier(s):	<table border="1"> <tr> <td>FCC ID:</td> <td>IPH9603N</td> </tr> <tr> <td>IC:</td> <td>1792A-9603N</td> </tr> </table>	FCC ID:	IPH9603N	IC:	1792A-9603N
FCC ID:	IPH9603N				
IC:	1792A-9603N				
Type of Equipment:	Iridium Satalite Transceiver w/ BlueTooth				
Device Model(s) / HVIN:	9603N				
Device Marketing Name / PMN:	9603N				
Test Sample Serial No.:	T/A Sample - Identical Prototype				
Transmit Frequency Range:	Iridium: 1616-1626MHz, BlueTooth: 2400-2483.5 MHz				
Number of Channels:	n/a				
Manuf. Max. Rated Output Power:	Iridium: 1.28W (31dBm), BlueTooth: 2.5mW (4dBm)				
Modulation:	Iridium: QPSK/BPSK, BlueTooth: GFSK/DQSK/DPSK				
Duty Cycle:	Iridium: 9.2%, BT: 46%				
DUT Power Source:	Li-Poly, 3100mAh				
Deviation(s) from standard/procedure:	None				
Modification of DUT:	None				

4.0 STATEMENT OF COMPLIANCE

This measurement report demonstrates that the:

Applicant: Garmin International Inc.	Model / HVIN: 9603N
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complies with the SAR (Specific Absorption Rate) RF exposure requirements and limits specified in the following:

Standard(s): FCC 47 CFR §2.1093 Health Canada's Safety Code 6	Measurement Procedure(s): FCC KDB 865664, FCC KDB 447498 Industry Canada RSS-102 Issue 5 IEEE Standard 1528-2013, IEC 62209-2
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Use Group: ☐ Occupational / Controlled	☒ General Population / Uncontrolled
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Reason for Issue: New Certification

A description of the device, operating configuration, detailed summary of the test results, methodology and procedures used during this evaluation, equipment used and the various provisions of the rules are included within this test report.

5.0 RF CONDUCTED POWER MEASUREMENT

Table 5.0

Conducted Power Measurements						
Channel	Frequency (MHz)	Measured Power (dBm)	Rated Power (dBm)	Rated Power (W)	Delta (dBm)	SAR Test Channel (Y/N)
Iridium Channels (As reported by Verkota OY)						
1*	1616.0000	30.30	31.07	1.28	-0.77	Y
120*	1621.0000	30.20	31.07	1.28	-0.87	Y
240*	1626.0000	30.10	31.07	1.28	-0.97	Y
BlueTooth Channels						
37**	2402.0000	2.59	4.00	0.0025	-1.41	N
17**	2441.0000	2.36	4.00	0.0025	-1.64	N
39**	2480.0000	1.97	4.00	0.0025	-2.03	N
Notes:						
*The Conducted Power of the DUT was measured at the antenna port, with a fully charged battery and transmitting at 9.2% duty cycle. **The Conducted Power of the DUT was measured at the antenna port, with a fully charged battery and transmitting at 100% duty cycle, CW Mode.						

6.0 NUMBER OF TEST CHANNELS (N_C)

Table 6.0

Number of Required Test Channels						
Frequency			Number of Channels		Spacing	
f_{LOW} (MHz)	f_{HIGH} (MHz)	f_C (MHz)	KDB 447498 (N_C)	IEC 62209 (N_C)	KDB 447498 (MHz)	IEC 62209 (MHz)
1616	1626	1621	2	3	10.0	5.0
KDB 447498: $N_C = \text{RoundUp} \{ [100 (F_{HIGH} - F_{LOW}) / F_C]^{0.5} \times (F_C / 100)^{0.2} \}$ IEC 62209-1: $N_C = 2 \times \{ \text{RoundUp} [10 (F_{HIGH} - F_{LOW}) / F_C] \} + 1$						
Notes:						
The number of channels was the maximum from above (3). The channels tested were the low, mid and high channels.						

7.0 ACCESSORIES EVALUATED

Table 7.0

Manufacturer's Accessories Tested			
Test Report ID Number	Manufacturer's Part Number	Description	SAR Evaluated
Battery			
P1	361-00107-00	Li-Ion Polymer	X
Body-Worn Accessory			
B1	n/a	Carabiner Clip	X
B2	010-11734-00	Belt Clip	X
B3	n/a	Swivel Belt Clip	X

8.0 SAR MEASUREMENT SUMMARY

Table 8.0

Measured SAR Results (1g) - FACE Configuration (FCC/ISED)														
Date	Plot ID	DUT		Test Frequency (MHz)	Modulation	Accessories				DUT Spacing		Conducted Power* (dBm)	Measured SAR (1g)* (W/kg)	SAR Drift* (dB)
		M/N	Type			Antenna ID	Battery ID	Body ID	Audio ID	DUT (mm)	Antenna (mm)			
28 Oct 2016	2	9603N	Default	1616	Default	Default	P1	B1	n/a	0	n/a	30.3	0.439	-0.180
28 Oct 2016	n/a			1621				B1				30.2	0.302	-0.190
28 Oct 2016	n/a			1626				B1				30.1	0.141	0.030
28 Oct 2016	n/a			1616				B2				30.3	0.063	-0.180
28 Oct 2016	n/a			1616				B3				30.3	0.042	0.230
SAR Limit								Spatial Peak				Head/Body		RF Exposure Category
FCC 47 CFR 2.1093				Health Canada Safety Code 6			1 Gram Average			1.6W/kg		General Pop./Uncontrolled		

The DUT does not transmit or receive voice signals therefore no Head/Face evaluation is required.
 As reported by Verkotan OY.

9.0 SCALING OF MAXIMUM MEASURE SAR

Table 9.0

Scaling of Maximum Measured SAR ⁽¹⁾							
Plot ID	Configuration	Freq	Measured Fluid Deviation		Measured Conducted Power	Measured Drift	Measured SAR (1g)
		(MHz)	Permittivity	Conductivity	(dBm)	(dB)	(W/kg)
2	Body	1616	-4.10%	-3.00%	30.3	-0.180	0.439
Step 1							
Fluid Sensitivity Adjustment							
Plot ID	Scale Factor		X	Measured SAR		=	Step 1 Adjusted SAR (1g)
	(%)			(W/kg)			(W/kg)
2			X	0.439		=	0.439
Step 2							
Manufacturer's Tune-Up Tolerance							
Plot ID	Measured Conducted Power		Rated Power		Delta	Step 1 Adjusted SAR	Step 2 Adjusted SAR (1g)
	(dBm)		(dBm)		(dB)		
2	30.3		31.07		0.77	+	0.524
Step 3							
Simultaneous Transmission - Bluetooth and/or WiFi							
Plot ID	Rated Output Power (Pmax)	Freq	Separation Distance		Estimated SAR	Step 2 Adjusted SAR	Step 3 Adjusted SAR (1g)
	(mW)	(MHz)	(mm)		(W/kg)		
2	2.5	2480	5		0.105	+	0.629
Step 4							
Drift Adjustment							
Plot ID	Measured Drift		+	Step 3 Adjusted SAR		=	Step 4 Adjusted SAR (1g)
	(dB)			(W/kg)			(W/kg)
2	-0.180		+	0.629		=	0.656
Step 5							
Reported SAR							
Plot ID	FCC				IC		
	From Steps 1 through 3				From Steps 1 through 4		
	1g SAR (W/kg)				1g SAR (W/kg)		
2	0.63				0.66		

The SAR test exclusion threshold for the BlueTooth transmitter as per FCC KDB 447498 4.3.1 is as follows:

$$[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \times [\sqrt{f}(\text{GHz})] \leq 3.0 \text{ for 1-g SAR}$$

$$[(2.5)/(5)] \times [\sqrt{2.48}] = 0.787 \leq 3.0$$

The estimated SAR per FCC KDB 447498 4.3.2 is as follows:

$$[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \cdot [\sqrt{f}(\text{GHz})/x] \text{ W/kg}$$

where $x = 7.5$ for 1-g SAR

$$[(2.5)/(5)] \times [(\sqrt{2.48})/7.5] = 0.105 \text{ W/kg}$$

Where:

max. power of channel, including tune-up tolerance, mW = 2.5mW

min. test separation distance, mm = 5mm

f(GHz) = 2.48GHz

The estimated simultaneous SAR contribution is added to the measured SAR in Step 3 above.

NOTES to Table 10.0

(1) Scaling of the Maximum Measured SAR is based on the highest Face, Body and/or Head SAR measured of ALL test channels, configurations and accessories used during THIS evaluation. The Measured Fluid Deviation parameters apply only to deviation of the tissue equivalent fluids used at the frequencies which produced the highest measured SAR. The Measured Conducted Power applies to the Conducted Power measured at the frequencies producing the highest Face and Body SAR. The Measured Drift is the SAR drift associated with that specific SAR measurement. The Reported SAR is the accumulation of all SAR Adjustments from the applicable Steps 1 through 4. The Plot ID is for identification of the SAR Measurement Plots is later in this report.

NOTE: Some of the scaling factors in Steps 1 through 4 may not apply and are identified by light gray text.

Step 1

Per IEC-62209-1 and FCC KDB 865664. Scaling required only when Measured Fluid Deviation is greater than 5%. If the Measured Fluid Deviation is greater than 5%, Table 10.1 will be shown and will indicate the SAR scaling factor in percent (%). SAR is MULTIPLIED by this scaling factor only when the scaling factor is positive (+).

Step 2

Per KDB 447498. Scaling required only when the difference (Delta) between the Measured Conducted Power and the Manufacturer's Rated Conducted Power is (-) Negative. The absolute value of Delta is ADDED to the SAR.

Step 3

Per KDB 447498 4.3.2. The SAR, either measured or calculated, of ANY and ALL simultaneous transmitters must be added together and includes all contributors.

Step 4

Per IEC 62209-1. Scaling required only when Measured Drift is (-) Negative. The absolute value of Measured Drift is added to Reported or Simultaneous Reported SAR.

Step 5

The Reported SAR is the Maximum Final Adjusted Cumulative SAR from the applicable Steps 1 through 4 and are reported on Page 1 of this report.

I attest that the data reported herein is true and accurate within the tolerance of the Measurement Instrument Uncertainty; that all tests and measurements were performed in accordance with accepted practices or procedures. The results of this investigation are based solely on the test sample(s) provided by the client which were not adjusted, modified or altered in any manner whatsoever, except as required to carry out specific tests or measurements. This test report has been completed in accordance with ISO/IEC 17025.



Art Voss, P.Eng.
Technical Manager
Celltech Labs Inc.

8 November 2016

Date



10.0 SAR EXPOSURE LIMITS

Table 10.0

SAR RF EXPOSURE LIMITS			
FCC 47 CFR§2.1093	Health Canada Safety Code 6	General Population / Uncontrolled Exposure ⁽⁴⁾	Occupational / Controlled Exposure ⁽⁵⁾
Spatial Average⁽¹⁾ (averaged over the whole body)		0.08 W/kg	0.4 W/kg
Spatial Peak⁽²⁾ (Head and Trunk averaged over any 1 g of tissue)		1.6 W/kg	8.0 W/kg
Spatial Peak⁽³⁾ (Hands/Wrists/Feet/Ankles averaged over 10 g)		4.0 W/kg	20.0 W/kg
(1) The Spatial Average value of the SAR averaged over the whole body.			
(2) The Spatial Peak value of the SAR averaged over any 1 gram of tissue, defined as a tissue volume in the shape of a cube and over the appropriate averaging time.			
(3) The Spatial Peak value of the SAR averaged over any 10 grams of tissue, defined as a tissue volume in the shape of a cube and over the appropriate averaging time.			
(4) Uncontrolled environments are defined as locations where there is potential exposure to individuals who have no knowledge or control of their potential exposure.			
(5) Controlled environments are defined as locations where there is potential exposure to individuals who have knowledge of their potential exposure and can exercise control over their exposure.			

11.0 DETAILS OF SAR EVALUATION

SAR testing for the Iridium band for the DUT was undertaken by a Subcontractor, Verkotan Oy, an ISO 17025 accredited testing facility accredited by FINAS (cert.#T287) under extension ILAC-MRA. The SAR evaluation is of the module to be installed and its use in a portable host configuration. The SAR report follows in the next 20 pages, with DUT and test set-up photos (2 pages) in a separate file to facilitate regulatory upload requirements.

Details of Operation: This device requires a clear, unobstructed view of the sky (satellite network). Best results are obtained when the device is attached to a backpack or upper body using one of the three body-worn accessories available. The device will also work while handheld. This device is capable of sending and receiving text messages and SOS Emergency messages via the Iridium satellite network. This device is also capable of connecting (pairing) to another BlueTooth device. Text messages can be Preset, selected from a list of Quick Text messages or a brief manually entered text. The user must select which text to send then select Send Message. The text messages are sent immediately once the Send Message is selected. To send an SOS message to the GEOS International Emergency Rescue Coordination Center, the user must lift a protective cover then press and hold the SOS button and wait for the device to count-down, approximately 10 seconds. After which the GPS location of the user is then sent to the emergency response service. The user must send a reply message to a confirmation message sent from the emergency response service.

12.0 EQUIPMENT CALIBRATION

Table 12.0

Test Equipment List				
DESCRIPTION	ASSET NO.	SERIAL NO.	DATE CALIBRATED	CALIBRATION DUE
Gigatronics 8652A Power Meter	110	1835801	29-Feb-16	29-Feb-19
Gigatronics 80701A Power Sensor	248	1833687	29-Feb-16	29-Feb-19
HP 8753ET Network Analyzer	134	US39170292	22-Oct-14	22-Oct-17
Generator	6	100104	8-May-14	8-May-17
Amplifier	106	26235	CNR	CNR

CNR = Calibration Not Required



SAR Compliance Test Report

Date of Report	11/01/2017	Client's Contact person:	Ben Hewson
Number of pages:	20	Responsible Test engineer:	Ilpo Joensuu
Testing laboratory:	Verkotan Oy Elektroniikkatie 17 90590 Oulu Finland	Client:	Celltech 21-364 Lougheed road Kelowna BC V1X 7R8 Canada
Tested device	9603N		
Related reports:	-		
Testing has been carried out in accordance with:	47CFR §2.1093 Radiofrequency Radiation Exposure Evaluation: Portable Devices FCC published RF exposure KDB procedures RSS-102, Issue 5 Evaluation Procedure for Mobile and Portable Radio Transmitters with Respect to Health Canada's Safety Code 6 for Exposure of Humans to Radio Frequency Fields IEEE 1528 - 2013 IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Technique		
Documentation:	The test report must always be reproduced in full; reproduction of an excerpt only is subject to written approval of the testing laboratory		
Test Results:	The EUT complies with the requirements in respect of all parameters subject to the test. The test results relate only to devices specified in this document		

Date and signatures:

11.01.2017

For the contents:



Laboratory Manager

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1. SUMMARY OF SAR TEST REPORT

1.1 Test Details

Equipment under Test (EUT):

Product:	9603N
Manufacturer:	Garmin
Type:	Satellite communication hand held device
Serial Number:	M124RE, M11Y37
FCC ID Number:	IPH9603N
IC ID Number:	1792A9603N
Hardware Version:	9603N
DUT Number:	23131,23135
Battery Type used in testing:	3100mAh Li-poly
Portable/ Mobile device	Portable
State of the Sample	Prototype

Testing information:

Testing performed:	28.10.2016
Notes:	-
Document name:	-
Temperature °C	22±2 / Controlled
Humidity RH%	40±20 / Controlled
Measurement performed by:	Ilpo Joensuu

1.2 Maximum Results

The maximum reported* SAR values for Body-worn configurations is shown in a table below. The device conforms to the requirements of the standards when the maximum reported SAR value is less than or equal to the limit. The SAR limit specified in FCC 47 CFR part 2 (2.1093) for Body is SAR_{1g} 1.6 W/kg,

System	Highest Reported* SAR _{1g} (W/kg) in Body-Worn Condition	Result
Iridium 9603N	0.52	PASS

* Reported SAR Values are scaled to, or measured at, upper limit of power tuning tolerance.

1.2.1 Maximum Drift

Maximum Drift During Measurements	0.23 dB *
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*drifts > 0.2 dB are compensated in the scaling factors.

1.2.2 Measurement Uncertainty

Expanded Uncertainty (k=2) 95 %	±24.5 %
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2. DESCRIPTION OF THE DEVICE UNDER TEST (DUT)

The tested device is a hand held Iridium Transceiver. The product can also be used in a bodyworn configuration i.e. belt clip.

Device Category	Portable
Exposure Environment	Uncontrolled

2.1 Supported Frequency Bands and Operational Modes

TX Frequency bands	Modes of Operation	Modulation Mode	Transmitter Frequency Range (MHz)
	Bluetooth	GFSK, PI/4-DQSK, 8-DPSK	2400 - 2483.5
	Iridium 9603N	DE-QPSK/DE-BPSK	1616 - 1626

Common features	
Output Power and Batteries	Non –removable

3. OUTPUT POWER

3.1 Maximum specified conducted output power

From a Customer;

		Upper Limit (dBm)		
Standard	Modulation	CH 1 1616 MHz	CH 120 1621 MHz	CH 240 1626 MHz
Iridium	DE-QPSK / DE-BPSK	31.07	31.07	31.07

3.2 Tested conducted power

		Measured Power (dBm)		
Standard	Modulation	CH 1 1616 MHz	CH 120 1621 MHz	CH 240 1626 MHz
Iridium	DE-QPSK / DE-BPSK	30.3	30.2	30.1

4. TEST EQUIPMENT

Dasy4 near field scanning system, manufactured by SPEAG was used for SAR testing. The test system consists of high precision robotics system (Staubli), robot controller, computer, near-field probe, probe alignment sensor, and a phantom containing the tissue equivalent material. The robot is a six-axis industrial robot performing precise movements to position the probe to the location of maximum electromagnetic field.

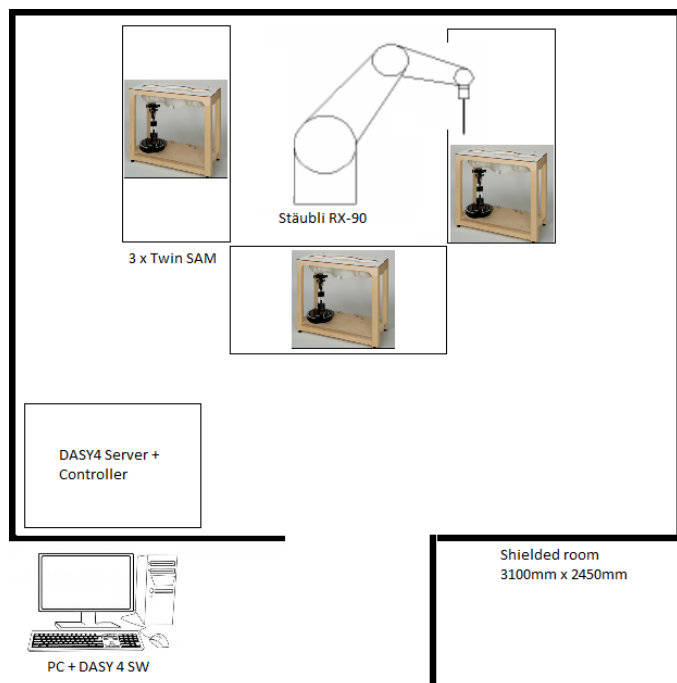


Figure 1 Schematic Laboratory Picture

4.1 Test Equipment List

Main used test system components are listed below. For full equipment list and calibration intervals, please contact the testing laboratory.

Test Equipment	Model	Serial Number	Calibration Date	Calibration Expiry
DAE	DAE3	371	01/2016	01/2017
Probe	Probe	ET3DV6	1381	09/2017
Dipole	Dipole	DIP1G640-433	37/16 DIP 1G640-433	09/2019
DASY Software	v4.7	na	na	na
Signal Generator	SMIQ06B	834968/023	na	na
Amplifier	AR 5S1G4	27573	na	na
Power Reflection Meter	R&S NRT	835065/049	12/2015	12/2016
Power Sensor	NRT Z-44	835374/021	01/2016	01/2017

4.1.1 Isotropic E-field Probe Type ET3DV6

Construction	Symmetric design with triangular core Built-in optical fiber for surface detection system (ET3DV6 only) Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)
Frequency	10 MHz – 2.3 GHz
Directivity	±0.2 dB in TSL (rotation around probe axis) ±0.4 dB in TSL (rotation normal to probe axis)
Dynamic Range	5 µW/g – >100 mW/g; Linearity: ±0.2 dB
Dimensions	Overall length: 337 mm (tip: 16 mm) Tip diameter: 6.8 mm (body: 12 mm) Distance from probe tip to dipole centers: 2.7 mm
Application	General dosimetric measurements up to 2.3 GHz Compliance tests of mobile phones Fast automatic scanning in arbitrary phantoms

4.2 Phantoms

The phantom used in SAR tests was the flat phantom section of the twin-headed "SAM Phantom", manufactured by SPEAG. The phantom conforms to the requirements of IEEE 1528 and FCC published RF Exposure KDB Procedures.

4.3 Tissue Simulants

Recommended values for the dielectric parameters of the tissue simulants are given in IEEE 1528 and FCC published RF Exposure KDB Procedures. The dielectric parameters of the used tissue simulants were within ±5% of the recommended values in all frequencies used. SAR testing was carried out within 24 hours of measuring the dielectric parameters. Depth of the tissue simulant was at least 15.0 cm from the inner surface of the flat phantom.

4.3.1 Recipes

Ingredient	% by weight
	Body1900 MHz
Deionised Water	70.25
Tween 20	29.41
Salt	0.34

4.4 System Validation Status

Frequency [MHz]	Dipole Type / SN	Probe Type / SN	Calibrated Signal Type	DAE Unit / SN	Validation Done	
					Head tissue simulant	Body tissue simulant
1640	37/16DIP1G640-433	ET3DV6	CW	DAE3 / 371	10/2016	10/2016

4.5 System Check

Date	Tissue Type	Tissue Temp. [°C]	Frequency [MHz]	Input Power	Measured SAR _{1g} [W/kg]	1 W Target SAR _{1g} [W/kg]	1 W Normalized SAR _{1g} [W/kg]	Deviation _{1g} (%)	Plot #
28.10.2016	B1900	22	1640	250mW	8.15	35.66	32.6	-8.6	1

4.5.1 Tissue Simulant Verification

				Target		Measured			
Date	Tissue Type	Tissue Temp. [°C]	Frequency [MHz]	Conductivity, σ [S/m]	Dielectric Constant [ϵ]	Conductivity σ [S/m]	Dielectric Constant [ϵ]	Deviation σ (%)	Deviation ϵ (%)
28.10.2016	B1900	22	1640	1.42	53.7	1.37	52.0	-3.1	-3.6
28.10.2016	B1900	22	1616	1.40	53.7	1.35	52.1	-3.0	-4.1
28.10.2016	B1900	22	1621	1.41	53.7	1.35	52.1	-3.0	-4.0
28.10.2016	B1900	22	1626	1.41	53.7	1.36	52.1	-3.1	-3.8

5. TEST PROCEDURE

The DUT was set to transmit at a maximum power level using a manufacturer specified test software. It was tested in a body-worn configuration using 3 belt clips with a fully charged battery. Low, mid and high channels were tested using belt clip providing the closest separation distance to the user. Other 2 belt clips were tested with the channel causing the highest SAR.

5.1 Test Positions

5.1.1 Body-worn Configuration, 0 mm separation distance

The DUT was placed below the flat phantom using a SPEAG device holder. The DUT was lifted towards the phantom until it was in touch with the phantom. Pictures of the test positions are in appendix A.



5.2 Scan Procedures

First, area scans were used for determination of the field distribution. Next, a zoom scan, a minimum of 5x5x7 points below 2GHz, 7x7x7 points between 2 and 3 GHz and 8x8x7 points above 5GHz covering a volume of at least 30x30x30mm at frequencies below 3GHz and 22x22x22mm at frequencies above 5GHz, was performed around the highest E-field value to determine the averaged SAR value. Power drift was determined by measuring the same point at the start of the area scan and again at the end of the zoom scan.

5.3 SAR Averaging Methods

The maximum SAR value is averaged over a cube of tissue using interpolation and extrapolation.

Extrapolation routines are used to obtain SAR values between the lowest measurement points and the inner phantom surface. The extrapolation distance is determined by the surface detection distance and the probe sensor o_set. Several measurements at different distances are necessary for the extrapolation.

The interpolation, extrapolation and maximum search routines within Dasy47 are all based on the modified Quadratic Shepard's method (Robert J. Renka, "Multivariate Interpolation of Large Sets of Scattered Data", University of North Texas ACM Transactions on Mathematical Software, vol. 14, no. 2, June 1988, pp. 139-148).

6. MEASUREMENT UNCERTAINTY

Uncertainty Budget								
Error Description	Uncert. value	Prob. Dist.	Div.	(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	±4.7 %	R	√ ₂	0.7	0.7	±1.9 %	±1.9 %	∞
Hemispherical Isotropy	±9.6 %	R	√ ₂	0.7	0.7	±3.9 %	±3.9 %	∞
Boundary Effects	±2.0 %	R	√ ₂	1	1	±1.2 %	±1.2 %	∞
Linearity	±4.7 %	R	√ ₂	1	1	±2.7 %	±2.7 %	∞
System Detection Limits	±1.0 %	R	√ ₂	1	1	±0.6 %	±0.6 %	∞
Modulation Response ^m	±2.4 %	R	√ ₂	1	1	±1.4 %	±1.4 %	∞
Readout Electronics	±0.3 %	N	1	1	1	±0.3 %	±0.3 %	∞
Response Time	±0.8 %	R	√ ₂	1	1	±0.5 %	±0.5 %	∞
Integration Time	±2.6 %	R	√ ₂	1	1	±1.5 %	±1.5 %	∞
RF Ambient Noise	±3.0 %	R	√ ₂	1	1	±1.7 %	±1.7 %	∞
RF Ambient Reflections	±3.0 %	R	√ ₂	1	1	±1.7 %	±1.7 %	∞
Probe Positioner	±0.8 %	R	√ ₂	1	1	±0.5 %	±0.5 %	∞
Probe Positioning	±6.7 %	R	√ ₂	1	1	±3.9 %	±3.9 %	∞
Max. SAR Eval.	±4.0 %	R	√ ₂	1	1	±2.3 %	±2.3 %	∞
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	√ ₂	1	1	±2.9 %	±2.9 %	∞
Power Scaling ^p	±0 %	R	√ ₂	1	1	±0.0 %	±0.0 %	∞
Phantom and Setup								
Phantom Uncertainty	±6.6 %	R	√ ₂	1	1	±3.8 %	±3.8 %	∞
SAR correction	±1.9 %	R	√ ₂	1	0.84	±1.1 %	±0.9 %	∞
Liquid Conductivity (mea.) ^{DAK}	±2.5 %	R	√ ₂	0.78	0.71	±1.1 %	±1.0 %	∞
Liquid Permittivity (mea.) ^{DAK}	±2.5 %	R	√ ₂	0.26	0.26	±0.3 %	±0.4 %	∞
Temp. unc. - Conductivity ^{BB}	±3.4 %	R	√ ₂	0.78	0.71	±1.5 %	±1.4 %	∞
Temp. unc. - Permittivity ^{BB}	±0.4 %	R	√ ₂	0.23	0.26	±0.1 %	±0.1 %	∞
Combined Std. Uncertainty						±12.3 %	±12.2 %	748
Expanded STD Uncertainty						±24.6 %	±24.5 %	

7. TEST RESULTS

Body-worn configuration, Belt Clip 1

Iridium freq [MHz]	Test Position	Maximum Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Duty Cycle	Measured SAR _{10g} [mW/g]	Scaling Factor	Reported SAR _{10g} [mW/g]	Plot #
1616	0 mm	31.07	30.3	-0.18	1:10	0.439	1.19	0.522	2
1621	0 mm	31.07	30.2	-0.19	1:10	0.302	1.22	0.368	
1626	0 mm	31.07	30.1	0.03	1:10	0.141	1.25	0.176	

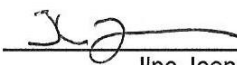
Body-worn configuration, Belt Clip 2

Iridium freq [MHz]	Test Position	Maximum Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Duty Cycle	Measured SAR _{10g} [mW/g]	Scaling Factor	Reported SAR _{10g} [mW/g]	Plot #
1616	0 mm	31.07	30.3	-0.18	1:10	0.063	1.19	0.075	

Body-worn configuration, Belt Clip 3

Iridium freq [MHz]	Test Position	Maximum Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Duty Cycle	Measured SAR _{10g} [mW/g]	Scaling Factor	Reported SAR _{10g} [mW/g]	Plot #
1616	0 mm	31.07	30.3	0.23	1:10	0.0422	1.46	0.06	

I attest that the data reported herein is true and accurate within the tolerance of the Measurement Instrument Uncertainty; that all tests and measurements were performed in accordance with accepted practices or procedures; and that all tests and measurements were performed by me or by trained personnel under my direct supervision. The results of this investigation are based solely on the test sample(s) provided by the client which were not adjusted, modified or altered in any manner whatsoever, except as required to carry out specific tests or measurements.


Ilpo Joensuu
Responsible Test Engineer
Verkotan Oy
3.11.2016
Date

APPENDIX A: PHOTOS OF THE DUT

Belt Clips



DUT test position with clip 1.



DUT test position with clip 2.



Dut test position with clip 3.



APPENDIX B: SYSTEM CHECK SCAN

Plot 1

Date/Time: 28.10.2016 18:28:47

Test Laboratory: Verkotan Oy

DUT: Dipole 1640 MHz; Type: DIP1G640-433; Serial: SN 37/16 DIP 1G640-433

Program Name: System Performance Check at 1640 MHz

Communication System: CW; Frequency: 1640 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 1640 \text{ MHz}$; $\sigma = 1.37 \text{ mho/m}$; $\epsilon_r = 52$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

DASY4 Configuration:

- Probe: ET3DV6 - SN1381; ConvF(5.19, 5.19, 5.19); Calibrated: 15.09.2016
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn371; Calibrated: 22.04.2016
- Phantom: SAM_3; Type: SAM Twin; Serial: TP-1289
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

d=10mm, Pin=250mW/Area Scan (81x81x1): Measurement grid: dx=15mm, dy=15mm

Maximum value of SAR (interpolated) = 9.27 mW/g

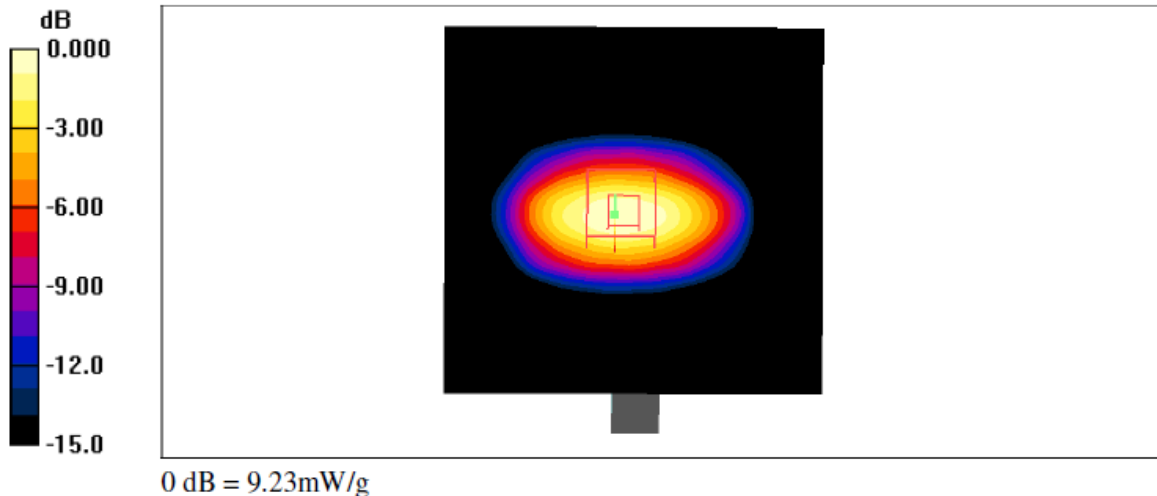
d=10mm, Pin=250mW/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 86.9 V/m; Power Drift = 0.066 dB

Peak SAR (extrapolated) = 12.3 W/kg

SAR(1 g) = 8.15 mW/g; SAR(10 g) = 4.6 mW/g

Maximum value of SAR (measured) = 9.23 mW/g



APPENDIX C: MEASUREMENT SCAN

Plot 2 Date/Time: 28.10.2016 19:04:09

Test Laboratory: Verkotan Oy

DUT: Garmin; Type: Satellite Phone; Serial: M11Y37
Program Name: Body-worn Configuration

Communication System: Iridium; Frequency: 1616 MHz; Duty Cycle: 1:10.9

Medium parameters used: $f = 1616 \text{ MHz}$; $\sigma = 1.35 \text{ mho/m}$; $\epsilon_r = 52.1$; $\rho = 1000 \text{ kg/m}^3$

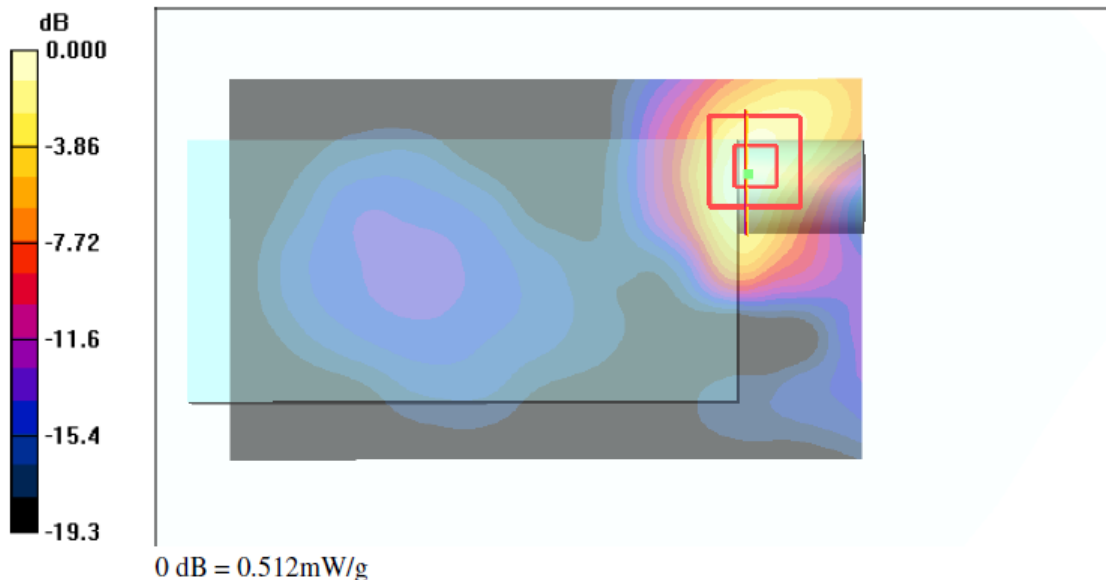
Phantom section: Flat Section

DASY4 Configuration:

- Probe: ET3DV6 - SN1381; ConvF(5.19, 5.19, 5.19); Calibrated: 15.09.2016
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn371; Calibrated: 22.04.2016
- Phantom: SAM_3; Type: SAM Twin; Serial: TP-1289
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Iridium/Area Scan (61x101x1): Measurement grid: $dx=15\text{mm}$, $dy=15\text{mm}$
Maximum value of SAR (interpolated) = 0.496 mW/g

Iridium/Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=7.5\text{mm}$, $dy=7.5\text{mm}$, $dz=5\text{mm}$
Reference Value = 3.10 V/m ; Power Drift = 0.177 dB
Peak SAR (extrapolated) = 0.804 W/kg
SAR(1 g) = 0.439 mW/g ; SAR(10 g) = 0.223 mW/g
Maximum value of SAR (measured) = 0.512 mW/g



APPENDIX D: RELEVANT PAGES FROM PROBE CALIBRATION REPORTS

**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 **Verkotan**

Certificate No: **ET3-1381_Sep16**

CALIBRATION CERTIFICATE

Object **ET3DV6 - SN:1381**

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

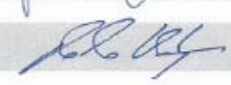
Calibration date: **September 15, 2016**

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

All calibrations have been conducted in the closed laboratory facility: environment temperature $(22 \pm 3)^\circ\text{C}$ and humidity $< 70\%$.

Calibration Equipment used (M&TE critical for calibration)

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

	Name	Function	Signature
Calibrated by:	Jeton Kastrati	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	
Issued: September 17, 2016			
This calibration certificate shall not be reproduced except in full without written approval of the laboratory.			

Certificate No: ET3-1381_Sep16

Page 1 of 11

ET3DV6- SN:1381

September 15, 2016

DASY/EASY - Parameters of Probe: ET3DV6 - SN:1381

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)
150	52.3	0.76	7.94	7.94	7.94	0.18	2.80	± 13.3 %
450	43.5	0.87	7.29	7.29	7.29	0.29	2.87	± 13.3 %
1640	40.3	1.29	5.56	5.56	5.56	0.75	2.22	± 12.0 %

^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.

ET3DV6- SN:1381

September 15, 2016

DASY/EASY - Parameters of Probe: ET3DV6 - SN:1381

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)
1640	53.8	1.40	5.19	5.19	5.19	0.80	2.45	± 12.0 %

^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.

APPENDIX E: RELEVANT PAGES FROM DIPOLE CALIBRATION REPORTS



SAR Reference Dipole Calibration Report

Ref : ACR.264.2.16.SATU.A

VERKOTAN LTD.
ELEKTRONIIKKATIE 17
90590, OULU, FINLAND
MVG COMOSAR REFERENCE DIPOLE
FREQUENCY: 1640 MHZ
SERIAL NO.: SN 37/16 DIP 1G640-433

Calibrated at MVG US
2105 Barrett Park Dr. - Kennesaw, GA 30144



Calibration Date: 09/16/16

Summary:

This document presents the method and results from an accredited SAR reference dipole calibration performed in MVG USA using the COMOSAR test bench. All calibration results are traceable to national metrology institutions.

3300	37.9 dB	4.91 dB
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7.2 SAR MEASUREMENT RESULT WITH HEAD LIQUID

The IEEE Std. 1528 and CEI/IEC 62209 standards state that the system validation measurements should produce the SAR values shown below (for phantom thickness of 2 mm), within the uncertainty for the system validation. All SAR values are normalized to 1 W forward power. In bracket, the measured SAR is given with the used input power.

Software	OPENSAR V4
Phantom	SN 20/09 SAM71
Probe	SN 18/11 EPG122
Liquid	Head Liquid Values: ϵ_{ps} : 40.1 sigma : 1.32
Distance between dipole center and liquid	10.0 mm
Area scan resolution	dx=8mm/dy=8mm
Zoon Scan Resolution	dx=8mm/dy=8mm/dz=5mm
Frequency	1640 MHz
Input power	20 dBm
Liquid Temperature	21 °C
Lab Temperature	21 °C
Lab Humidity	45 %

Frequency MHz	1 g SAR (W/kg/W)		10 g SAR (W/kg/W)	
	required	measured	required	measured
300	2.85		1.94	
450	4.58		3.06	
750	8.49		5.55	
835	9.56		6.22	
900	10.9		6.99	
1450	29		16	
1500	30.5		16.8	
1640	34.2	35.78 (3.58)	18.4	19.04 (1.90)
1750	36.4		19.3	
1800	38.4		20.1	
1900	39.7		20.5	
1950	40.5		20.9	
2000	41.1		21.1	

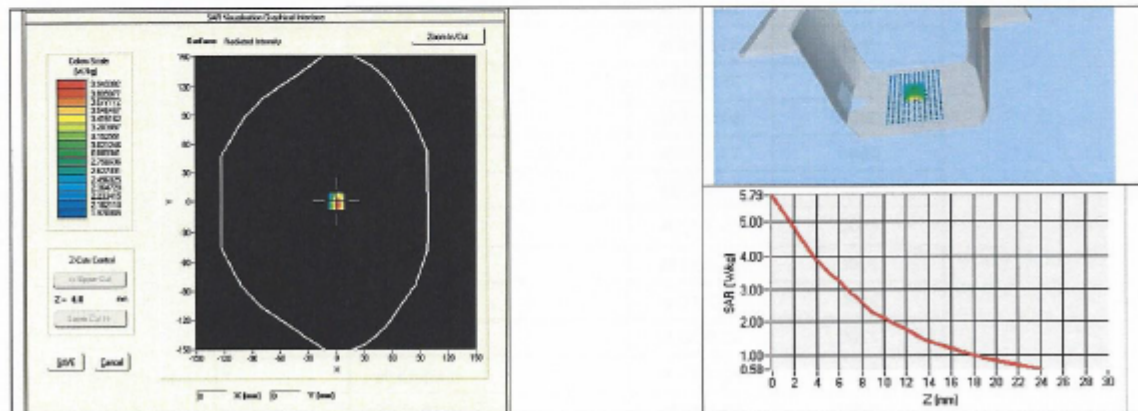
Page: 8/11

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7.4 SAR MEASUREMENT RESULT WITH BODY LIQUID

Software	OPENSAR V4
Phantom	SN 20/09 SAM71
Probe	SN 18/11 EPG122
Liquid	Body Liquid Values: ϵ_{ps} : 54.1 sigma : 1.41
Distance between dipole center and liquid	10.0 mm
Area scan resolution	$dx=8mm/dy=8mm$
Zoon Scan Resolution	$dx=8mm/dy=8mm/dz=5mm$
Frequency	1640 MHz
Input power	20 dBm
Liquid Temperature	21 °C
Lab Temperature	21 °C
Lab Humidity	45 %

Frequency MHz	1 g SAR (W/kg/W)	10 g SAR (W/kg/W)
	measured	measured
1640	35.66 (3.57)	19.13 (1.91)



Page: 10/11

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End of SAR Report