



Test Report Serial Number:	45461427 R3.0
Test Report Date:	11 April 2018
Project Number:	1399

## SAR Test Report - New Certification

Applicant:



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

Maximum Reported 10g SAR			W/kg
FCC	Extremity	0.44	
ISED	Extremity	0.52	
General Pop. Limit:		4.00	

FCC ID:

**IPH-03438**

Product Model Number / HVIN

**A03438**

ISED Registration Number

**1792A-03438**

Product Name / PMN

**A03438**

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

<b>Samples Tested By:</b>	Trevor Whillock		
<b>Report Prepared By:</b>	Art Voss		
<b>Report Reviewed By:</b>	Ben Hewson		
<b>Report Issue Number</b>	<b>Description</b>	<b>By</b>	<b>Report Issue Date</b>
R0.0	Draft	Art Voss	05 March 2018
R1.0	Initial Release	Art Voss	06 March 2018
R 2.0	Removed Referece to Unlicensed National Information Infrastructure (NII) FCC Part 15 Added NFC Frequency Range to Section 2.0	Art Voss	29 March 2018
R 3.0	Removed Description References to DUT and Accessories in Section 8.0 and Appendix B	Art Voss	11 April 2018

## 2.0 CLIENT AND DEVICE INFORMATION

Client Information	
<b>Applicant Name</b>	<b>Garmin International Inc.</b>
<b>Applicant Address</b>	1200 East 151 St.
	Olathe, KS,66062
	USA
DUT Information	
<b>Device Identifier(s):</b>	<b>FCC ID:</b> <b>IPH-03438</b>
	<b>IC:</b> <b>1792A-03438</b>
<b>Type of Equipment:</b>	Digital Transmission System (DTS) FCC Part 15, RSS 247
	Spread Spectrum Transmitter (DSS) FCC Part 15
<b>Device Model(s) / HVIN:</b>	A03438
<b>Device Marketing Name / PMN:</b>	A03438
<b>Test Sample Serial No.:</b>	T/A Sample - Identical Prototype
<b>Transmit Frequency Range:</b>	WiFi: 2412 - 2462 MHz
	BT: 2402 - 2480 MHz
	RFID Low Power NFC: 13.56 MHz
<b>Number of Channels:</b>	See Section 7.0
<b>Manuf. Max. Rated Output Power:</b>	WiFi: CW/22.02 dBm, 802.11b/18.28 dBm,802.11g/16.24 dBm, 802.11n/16.04 dBm
	BT:9.18dBm, ANT:7.33 dBm, BLE:7.37dBm
<b>Modulation:</b>	WiFi: DSSS, OFDM, MCS0-7,CW
	BT: GFSK, PI/4-DQSPK, GMSK
<b>Duty Cycle:</b>	100.0%
<b>DUT Power Source:</b>	5V USB, Internal Li-ion battery
<b>Deviation(s) from standard/procedure:</b>	None
<b>Modification of DUT:</b>	None

### 3.0 NORMATIVE REFERENCES

<b>Normative References*</b>	
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
FCC KDB KDB 248227 D01v02r02	SAR Test Guidance for IEEE 802.11 (WiFi) Transmitters
* When the issue number or issue date is omitted, the latest version is assumed.	

## 4.0 STATEMENT OF COMPLIANCE

This measurement report demonstrates that samples of the product model(s) were evaluated for Specific Absorption Rate (SAR) on the date(s) shown, in accordance with the Measurement Procedures cited and were found to comply with the Standard(s) Applied based on the Exposure Limits of the Use Group indicated for which the product is intended to be used.

<b>Applicant:</b> Garmin International Inc.	<b>Model / HVIN:</b> A03438	
<b>Standard(s) Applied:</b> FCC 47 CFR §2.1093 Health Canada's Safety Code 6	<b>Measurement Procedure(s):</b> FCC KDB 865664, FCC KDB 447498, FCC KDB 248227 Industry Canada RSS-102 Issue 5 IEEE Standard 1528-2013, IEC 62209-2	
<b>Reason For Issue:</b> <input checked="" type="checkbox"/> New Certification <input type="checkbox"/> Class I Permissive Change <input type="checkbox"/> Class II Permissive Change	<b>Use Group:</b> <input checked="" type="checkbox"/> General Population / Uncontrolled <input type="checkbox"/> Occupational / Controlled	<b>Limits Applied:</b> <input type="checkbox"/> 1.6W/kg - 1g Volume <input type="checkbox"/> 8.0W/kg - 1g Volume <input checked="" type="checkbox"/> 4.0W/kg - 10g Volume
<b>Reason for Change:</b> Original Filing		<b>Date(s) Evaluated:</b> February 14 -16th & 23, 2018

The results of this investigation are based solely on the test sample(s) provided by the applicant which was not adjusted, modified or altered in any manner whatsoever except as required to carry out specific tests or measurements. A description of the device, operating configuration, detailed summary of the test results, methodologies and procedures used during this evaluation, the equipment used and the various provisions of the rules are included in this test 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; 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. This test report has been completed in accordance with ISO/IEC 17025.



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

05 March 2018

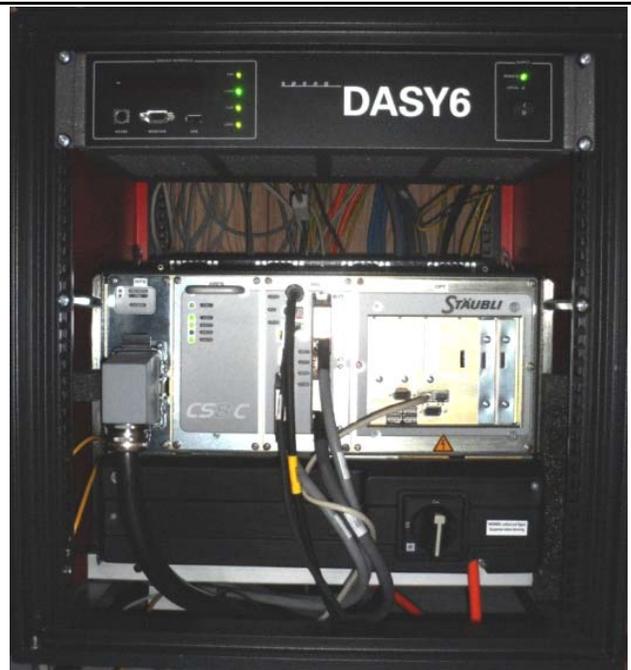
Date



**5.0 SAR MEASUREMENT SYSTEM**

**SAR Measurement System**

Celltech Labs Inc. SAR measurement facility employs a Dosimetric Assessment System (DASY™) manufactured by Schmid & Partner Engineering AG (SPEAG™) of Zurich, Switzerland. The DASY6 measurement system is comprised of the measurement server, a robot controller, a computer, a near-field probe, a probe alignment sensor, an Elliptical Planar Phantom (ELI) phantom and a specific anthropomorphic mannequin (SAM) phantom for Head and/or Body SAR evaluations. The robot is a six-axis industrial robot performing precise movements to position the probe to the location (points) of maximum electromagnetic field (EMF). A cell controller system contains the power supply, robot controller and a teach pendant (Joystick) to control the robot’s servo motors. The Staubli robot is connected to the cell controller to allow software manipulation of the robot. A data acquisition electronic (DAE) circuit 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 form the DAE to digital electronic signal and transfers data to the DASY6 measurement server. The DAE4 utilizes a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16-bit AD-converter, a command decoder and a control logic unit. Transmission to the DASY6 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. The sensor systems are also used for mechanical surface detection and probe collision detection. The robot utilizes a controller with built in VME-bus computer.



**DASY 6 SAR System with SAM Phantom**

**DASY 6 Measurement Controller**

**6.0 RF CONDUCTED POWER MEASUREMENT**

**Table 6.0 Conducted Power Measurements**

Conducted Power Measurements										
Channel	Frequency (MHz)	Measured Power (dBm)	Rated Power (dBm)	Rated Power (W)	Delta (dB)	SAR Test Channel (Y/N)	Mode	Modulation		
1	2412.00	17.65	18.28	0.067	-0.63		WIFI-802.11b	DSS-1Mbps		
		17.59	18.28	0.067	-0.69	-		DSS-2Mbps		
		18.04	18.28	0.067	-0.24	Y		DSS-5.5Mbps*		
		17.87	18.28	0.067	-0.41	-		DSS-11Mbps		
2	2417.00	17.90	18.28	0.067	-0.38	-		WIFI-802.11g	OFDM-6 Mbps	
3	2422.00	17.59	18.28	0.067	-0.69	-				OFDM-9 Mbps
4	2427.00	17.32	18.28	0.067	-0.96	-				OFDM-12 Mbps
5	2432.00	17.47	18.28	0.067	-0.81	-				OFDM-18 Mbps
6	2437.00	17.78	18.28	0.067	-0.5	-				OFDM-24 Mbps
7	2442.00	18.19	18.28	0.067	-0.09	-				OFDM-36 Mbps
8	2447.00	18.28	18.28	0.067	0.00	Y				OFDM-48 Mbps
9	2452.00	18.10	18.28	0.067	-0.18	-	OFDM-54 Mbps			
10	2457.00	17.69	18.28	0.067	-0.59	Y	OFDM-6Mbps			
11	2462.00	17.11	18.28	0.067	-1.17	-				
1	2412.00	16.00	16.24	0.042	-0.24	-				WIFI-802.11g
		16.00	16.24	0.042	-0.24	-				
		15.96	16.24	0.042	-0.28	-				
		15.98	16.24	0.042	-0.26	-				
		16.14	16.24	0.042	-0.10	-				
		16.12	16.24	0.042	-0.12	-				
		16.07	16.24	0.042	-0.17	-				
		16.11	16.24	0.042	-0.13	-				
2	2417.00	15.94	16.24	0.042	-0.30	-	WIFI-802.11g	OFDM-6Mbps		
3	2422.00	15.67	16.24	0.042	-0.57	-				
4	2427.00	15.54	16.24	0.042	-0.70	-				
5	2432.00	15.63	16.24	0.042	-0.61	-				
6	2437.00	15.82	16.24	0.042	-0.42	-				
7	2442.00	16.11	16.24	0.042	-0.13	-				
8	2447.00	16.24	16.24	0.042	0.00	-				
9	2452.00	16.13	16.24	0.042	-0.11	-				
10	2457.00	15.69	16.24	0.042	-0.55	-				
11	2462.00	15.19	16.24	0.042	-1.05	-				

1	2412.00	15.82	16.04	0.040	-0.22	-	WIFI- 802.11n	MCS-0 Mbps
		15.87	16.04	0.040	-0.17	-		MCS-1 Mbps
		15.67	16.04	0.040	-0.37	-		MCS-2 Mbps
		15.79	16.04	0.040	-0.25	-		MCS-3 Mbps
		15.62	16.04	0.040	-0.42	-		MCS-4 Mbps
		15.84	16.04	0.040	-0.20	-		MCS-5 Mbps
		15.68	16.04	0.040	-0.36	-		MCS-6 Mbps
		15.80	16.04	0.040	-0.24	-		MCS-7 Mbps
2	2417.00	15.77	16.04	0.040	-0.27	-	MCS-1 Mbps	
3	2422.00	15.61	16.04	0.040	-0.43	-		
4	2427.00	15.41	16.04	0.040	-0.63	-		
5	2432.00	15.48	16.04	0.040	-0.56	-		
6	2437.00	15.77	16.04	0.040	-0.27	-		
7	2442.00	16.04	16.04	0.040	0.00	-		
8	2447.00	15.63	16.04	0.040	-0.41	-		
9	2452.00	15.98	16.04	0.040	-0.06	-		
10	2457.00	15.64	16.04	0.040	-0.40	-		
11	2462.00	15.14	16.04	0.040	-0.90	-		

2402	7.33	7.33	0.005	0.00	-	ANT	CARRIER
	7.33	7.33	0.005	0.00	Y		BEACON
	7.38	9.18	0.008	-2.50	-	BT	CW
	7.41	9.18	0.008	-2.47	-		GFSK
	3.48	9.18	0.008	-6.40	-		QPSK
	7.44	9.18	0.008	-2.44	-		GMSK
	7.44	9.18	0.008	-2.44	-		ANT
2419	9.09	9.18	0.008	-0.79	-	BT	CW
	9.15	9.18	0.008	-0.73	-		GFSK
	5.16	9.18	0.008	-4.72	-		QPSK
	9.17	9.18	0.008	-0.71	-		GMSK
	9.18	9.18	0.008	-0.70	Y		ANT
2439	6.22	9.18	0.008	-3.66	-	BT	CW
	6.29	9.18	0.008	-3.59	-		GFSK
	2.89	9.18	0.008	-6.99	-		QPSK
	6.25	9.18	0.008	-3.63	-		GMSK
	6.26	9.18	0.008	-3.62	-		ANT
2441	6.18	7.33	0.005	-3.70	-	ANT	CARRIER
	6.18	7.33	0.005	-3.70	-		BEACON
2480	5.58	7.33	0.005	-4.30	-	ANT	CARRIER
	5.57	7.33	0.005	-4.31	-		BEACON
	5.55	9.18	0.008	-4.33	-	BT	CW
	5.67	9.18	0.008	-4.21	-		GFSK
	1.98	9.18	0.008	-7.90	-		QPSK
	5.68	9.18	0.008	-4.20	-		GMSK
	5.70	9.18	0.008	-4.18	-		ANT

2402	7.37	7.37	0.005	0.00	-	BLE	CW
	5.93	7.37	0.005	-1.44	-		PRB29
	5.92	7.37	0.005	-1.45	-		0x0F
	5.98	7.37	0.005	-1.39	-		0x55
2440	6.23	7.37	0.005	-1.14	-		CW
	4.93	7.37	0.005	-2.44	-		PRB29
	5.07	7.37	0.005	-2.30	-		0x0F
	4.90	7.37	0.005	-2.47	-		0x55
2480	5.58	7.37	0.005	-1.79	-		CW
	3.92	7.37	0.005	-3.45	-		PRB29
	3.89	7.37	0.005	-3.48	-		0x0F
	3.91	7.37	0.005	-3.46	-		0x55

The rated power and tolerance are stated for typical transmission modes and data rates. Some modes and data rates may produce lower than rated conducted power levels. Power measurements taken across the various channels, modes and data rates did not produce levels in excess of the Rated Average Power plus Tolerance. \*SAR was evaluated using WIFI DSS mode at 5.5 Mbps data rate. BT and ANT modes were evaluate at the level specified by the manufacture to be the max output power and produce the most conservative SAR. The reported SAR was not scaled down.

## 7.0 NUMBER OF TEST CHANNELS ( $N_c$ ) AND CONFIGURATIONS

As per FCC KDB 248277, the required 802.11 test channels are Ch1, Ch6 and Ch 11. In this case Low, Mid and High test channels were selected based on the highest conducted output power. BT and ANT channels were also evaluated. NOTE: These transmitters are not capable of simultaneous transmission. This device is a wrist-worn device and was evaluated for extremity SAR. Although the intended use is to be wrist-worn with the back side of the device in contact with the human skin, the device was evaluated on ALL surfaces using Head Tissue fluid. The worst case test position was then re-evaluated using Body Tissue Fluid to provide a SAR level for a non-intended scenario.

## 8.0 ACCESSORIES EVALUATED

**Table 8.0 Accessories Evaluated**

Manufacturer's Accessory List						
Test Report ID Number	Manufacturer's Part Number	Description	UDC Group <sup>(1)</sup>	Type II Group <sup>(2)</sup>	SAR <sup>(3)</sup> Evaluated	SAR <sup>(4)</sup> Tested
<b>B1</b>	010-12517-00	Black Silicone Wrist Band	n/a	n/a	Y	Y
<b>B2</b>	010-12741-01	Carbon Grey Titanium Wrist Band	n/a	n/a	Y	Y
<b>P1</b>	362-00087-00	AC Adapter	n/a	n/a	n/a	n/a
<b>P2</b>	010-12491-01	Charging Cable	n/a	n/a	n/a	n/a

## 9.0 SAR MEASUREMENT SUMMARY

Table 9.0: Measured Results

Measured SAR Results (10g) - BODY(FCC/ISED)															
Date	Plot ID #	DUT Model	Test Type	Test Freq.	Modulation	Accessories				DUT Spacing		Meas. Cond. Power	Measured SAR	SAR Drift	
						Antenna ID	Battery ID	Body ID	Audio ID	DUT (mm)	Antenna (mm)				
				(MHz)		(dBm)	(W/kg)	(dB)							
<b>Extremity SAR</b>															
Feb 14 2018	B1	A03438	Body/Touch - Back	2412	DSS-5.5Mbps	n/a	n/a	B1	n/a	0	0	18.04	0.287	-0.600	
Feb 15 2018	B2	A03438	Body/Touch - Back	2412	DSS-5.5Mbps	n/a	n/a	B2	n/a	0	0	18.04	0.241	-0.530	
Feb 16 2018	B3-2	A03438	Body/Touch - Back	2447	DSS-5.5Mbps	n/a	n/a	B1	n/a	0	0	18.28	0.337	-0.340	
Feb 16 2018	B4	A03438	Body/Touch - Back	2457	DSS-5.5Mbps	n/a	n/a	B1	n/a	0	0	17.69	<b>0.380</b>	-0.780	
Feb 16 2018	B5	A03438	Body/Touch - Back	2419	BT ANT-GFSK	n/a	n/a	B1	n/a	0	0	9.15	0.046	0.210	
Feb 16 2018	B6	A03438	Body/Touch - Back	2402	ANT-Beacon	n/a	n/a	B1	n/a	0	0	7.33	0.028	-0.100	
Feb 23 2018	B7	A03438	Body - Front	2457	DSS-5.5Mbps	n/a	n/a	B1	n/a	5	5	17.69	0.310	-0.550	
<b>SAR Limit</b>						<b>Spatial Peak</b>				<b>RF Exposure Category</b>					
<b>FCC 47 CFR 2.1093</b>						<b>Health Canada Safety Code 6</b>		<b>Extremity</b>	<b>10g Average</b>		<b>4.0 W/kg</b>		<b>General Population</b>		

Reference Section 7.0 for details

## 10.0 SCALING OF MAXIMUM MEASURE SAR

**Table 10.0 SAR Scaling**

Scaling of Maximum Measured SAR <sup>(1)</sup>								
Plot ID	Configuration	Freq (MHz)	Measured Fluid Deviation		Measured Conducted Power (dBm)	Measured Drift (dB)	Measured SAR (10g) (W/kg)	
			Permittivity	Conductivity				
B4	Body	2457	1.37%	3.73%	17.7	0.780	0.380	
Step 1								
Fluid Sensitivity Adjustment								
Plot ID	Scale Factor		X	Measured SAR		=	Step 1 Adjusted SAR (10g) (W/kg)	
	%			(W/kg)				
B4	N/A		X	0.380		=	0.380	
Step 2								
Manufacturer's Tune-Up Tolerance								
Plot ID	Measured Conducted Power (dBm)	Rated Power (dBm)		Delta (dB)	+	Step 1 Adjusted SAR (W/kg)	=	Step 2 Adjusted SAR (10g) (W/kg)
	B4	17.7	18.3					
Step 3 (ISED)								
Drift Adjustment								
Plot ID	Measured Drift (dB)		+	Step 2 Adjusted SAR		=	Step 3 Adjusted SAR (10g) (W/kg)	
	(dB)			(W/kg)				
B4	-0.780		+	0.435		=	0.521	
Step 4 (FCC)								
Simultaneous Transmission - Bluetooth and/or WiFi								
Plot ID	Rated Output Power (Pmax) (mW)	Freq (MHz)	Separation Distance (mm)	Measured SAR (W/kg)	+	Step 2 Adjusted SAR (W/kg)	=	Step 4 Adjusted SAR (10g) (W/kg)
	B4*		8.28	2419				
Step 5								
Reported SAR								
Plot ID	FCC From Steps 1, 2 and 4 10g SAR (W/kg)			ISED From Steps 1 through 3 10g SAR (W/kg)				
	B4	0.435			0.521			

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

$$[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \times [\sqrt{f(\text{GHz})}] \leq 7.5 \text{ for 10-g SAR}$$

$$[(8.28)/(5)] \times [\sqrt{2.419}] = 2.58 \leq 7.5$$

Where:

max. power of channel, including tune-up tolerance, mW = 8.28mW

min. test separation distance, mm = 5mm

f(GHz) = 2.419GHz

\*The WiFi, BlueTooth (BLE) and ANT transmitters share the same antenna and cannot simultaneously transmit.

The RFID transmitter is a low power communication device transmitter and does not require standalone SAR evaluation.

Simultaneous transmission evaluation with it and the 802.11b/g/n or BT 802.15 is not required

NOTES to Table 10.0	
<p>(1) Scaling of the Maximum Measured SAR is based on the highest, 100% duty cycle, 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 in Annex A of this report.</p> <p>NOTE: Some of the scaling factors in Steps 1 through 4 may not apply and are identified by light gray text.</p>	
<b>Step 1</b>	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 9.1 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 (+).
<b>Step 2</b>	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.
<b>Step 3</b>	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.
<b>Step 4</b>	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.
<b>Step 5</b>	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; 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. This test report has been completed in accordance with ISO/IEC 17025.



Trevor Whillock  
 Test Lab Engineer  
 Celltech Labs Inc.

05 March 2018

Date

## 11.0 SAR EXPOSURE LIMITS

Table 11.0 Exposure Limits

SAR RF EXPOSURE LIMITS			
FCC 47 CFR§2.1093	Health Canada Safety Code 6	General Population / Uncontrolled Exposure <sup>(4)</sup>	Occupational / Controlled Exposure <sup>(5)</sup>
Spatial Average <sup>(1)</sup> (averaged over the whole body)		0.08 W/kg	0.4 W/kg
Spatial Peak <sup>(2)</sup> (Head and Trunk averaged over any 1 g of tissue)		1.6 W/kg	8.0 W/kg
Spatial Peak <sup>(3)</sup> (Hands/Wrists/Feet/Ankles averaged over 10 g)		<b>4.0 W/kg</b>	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.			

## 12.0 DETAILS OF SAR EVALUATION

### 12.0 Day Log

DAY LOG					Fluid Dielectric	SPC	Test
Date	Ambient Temp °C	Fluid Temp °C	Humidity	TSL			
13 Feb 2018	24	22.5	28%	2450B	X	X	
14 Feb 2018	24	21.7	28%	2450B			X
15 Feb 2018	25	21.0	28%	2450B			X
16 Feb 2018	25	22.9	26%	2450B			X
22 Feb 2018	25	23.5	28%	2450B	X		
23 Feb 2018	24	23.3	28%	2450B		X	X

### 12.1 DUT Setup and Configuration

DUT Setup and Configuration	
1	<p>The DUT was evaluated for SAR in accordance with the procedures described in IEEE 1528, FCC KDB 865646, and RSS-102. The device was evaluated at a phantom separation distance of 5mm or less.</p>
2	<p>2.4GHz 802.11g/n OFDM SAR Test Exclusion</p> <p>As Per KDB 248277 D01v02r02 - 5.2.2,            b) When the highest reported SAR for DSSS is adjusted by the ratio of OFDM to DSSS specified maximum output power and the adjusted SAR is <math>\leq 1.2</math> W/kg.</p> <p>Maximum 802.11g/n OFDM specified power(POFDM)= 16.24dBm            Maximum 802.11b DSSS specified power (PDSSS)= 18.28dBm            Ratio OFDM/DSSS power = -2.04dBm(63%)            Highest reported* SAR (SARMAX)= 0.380 W/kg</p> <p>POFDM/PDSSS X SARMAX = 0.239W/kg</p> <p>Since the ratio of the ODFM/DSSS specified power is less than one (0dB), the reported SAR would not exceed 1.2W/kg</p> <p>*The reported SAR in this case is the measured SAR adjusted for fluid sensitivity.</p>
3	<p>The Device was capable of transmitting at various modulations and data rates. The Conducted Power was higher when measured in DSS Mode-5.5Mbps than any other configuration. The DUT was evaluated for SAR at the maximum conducted output power level, preset by the manufacturer.</p> <p>Each SAR evaluation was performed with a fully charged battery.</p>

### 12.2 DUT Positioning

DUT Positioning	
<b>Positioning</b>	<p>The DUT Positioner was securely fastened to the Phantom Platform. Registration marks were placed on the DUT and the Positioner to ensure consistent positioning of the DUT for each test evaluation.</p>
<b>FACE Configuration</b>	<p>This device is not intended to be held to the face and was not tested in the FACE configuration.</p>
<b>BODY Configuration</b>	<p>The DUT was securely clamped into the device holder with the surface of the DUT normally in contact with the body in direct contact with the bottom of the phantom, or 0mm separation from the DUT's accessory to the phantom.</p>
<b>HEAD Configuration</b>	<p>This device is not intended to be held to the ear and was not tested in the HEAD configuration.</p>

### 12.3 General Procedures and Report

<b>General Procedures and Reporting</b>	
<b>General Procedures</b>	<p>The fluid dielectric parameters of the Active Tissue Simulating Liquid (TSL) were measured as described in this Section, recorded and entered into the DASY Measurement Server. Active meaning the TSL used during the SAR evaluation of the DUT. The temperature of the Active TSL was measured and recorded prior to performing a System Performance Check (SPC). An SPC was performed with the Active TSL prior to the start of the test series. The temperature of the Active TSL was measured throughout the day and the Active TSL temperature was maintained to <math>\pm 0.5^{\circ}\text{C}</math>. The Active TSL temperature was maintained to within <math>\pm 1.0^{\circ}\text{C}</math> throughout the test series. TSL analysis and SPC were repeated when the Active TSL use exceeded 84 hours.</p> <p>An Area Scan exceeding the length and width of the DUT projection was performed and the locations of all maximas within 2dB of the Peak SAR recorded. A Zoom Scan centered over the Peak SAR location(s) was performed and the 1g and 10g SAR values recorded. The resolutions of the Area Scan and Zoom Scan are described in the Scan Resolution table(s) in this Section. A Power Reference Measurement was taken at the phantom reference point immediately prior to the Area Scan. A Power Drift measurement was taken at the phantom reference point immediately following the Zoom Scan to determine the power drift. A Z-Scan from the <u>Maximum Distance to Phantom Surface</u> to the fluid surface was performed following the power drift measurement.</p>
<b>Reporting</b>	<p>The 1g SAR, 10g SAR and power drift measurements are recorded in the SAR Measurement Summary tables in the SAR Measurement Summary Section of this report. The SAR values shown in the 100% DC (Duty Cycle) column are the SAR values reported by the SAR Measurement Server with the DUT operating at 100% transmit duty cycle. These tables also include other information such as transmit channel and frequency, modulation, accessories tested and DUT-phantom separation distance.</p> <p>In the Scaling of Maximum Measured SAR Section of this report, the highest measured SAR in the BODY configuration, within the entire scope of this assessment, are, when applicable, scaled for Fluid Sensitivity, Manufacturer's Tune-Up Tolerance, Simultaneous Transmission and Drift. With the exception of Duty Cycle correction/compensation, SAR values are <u>ONLY</u> scaled up, not down. The final results of this scaling is the <u>reported SAR</u> which appears on the Cover Page of this report.</p>

## 12.4 Fluid Dielectric and Systems Performance Check

<b>Fluid Dielectric and Systems Performance Check</b>	
<b>Fluid Dielectric Measurement Procedure</b>	
<p>The fluid dielectric parameters of the Tissue Simulating Liquid (TSL) are measured using the Open-Ended Coax Method connected to an Agilent 8753ET Network Analyzer connected to a measurement server running April Dielectric Property Measurement System. A frequency range of <math>\pm 100\text{MHz}</math> for frequencies <math>&gt; 300\text{MHz}</math> and <math>\pm 50\text{MHz}</math> for frequencies <math>\leq 300\text{MHz}</math> with frequency step size of <math>10\text{MHz}</math> is used. The center frequency is centered around the SAR measurement probe's calibration point for that TSL frequency range. A calibration of the setup is performed using a short-open-deionized water (at <math>23^\circ\text{C}</math> in a 300ml beaker) method. A sample of the TSL is placed in a 300ml beaker and the open-ended coax is submerged approximately 8mm below the fluid surface in the approximate center of the beaker. A check of the setup is made to ensure no air is trapped under the open-ended coax. The sample of TSL is measured and compared to the FCC OET Bulletin 65 Supplement C targets for HEAD or BODY for the entire fluid measurement range. Fluid adjustment are made if the dielectric parameters are <math>&gt; 5\%</math> in range that the DUT is to be tested. If the adjustments fail to bring the parameters to <math>\leq 5\%</math> but are <math>&lt; 10\%</math>, the SAR Fluid Sensitivity as per IEC 62201-1 and FCC KDB 865664 are applied to the highest measured SAR. A TSL with dielectric parameters <math>&gt; 10\%</math> in the DUT test frequency range are not used.</p>	
<b>Systems Performance Check</b>	
<p>The fluid dielectric parameters of the Active TSL are entered into the DASY Measurement Server at each of the <math>10\text{MHz}</math> step size intervals. Active meaning the TSL used during the SAR evaluation of the DUT. The DASY Measurement System will automatically interpolate the dielectric parameters for DUT test frequencies that fall between the <math>10\text{MHz}</math> step intervals.</p> <p>A Systems Performance Check (SPC) is performed in accordance with IEEE 1528 "System Check" and FCC KDB 865664 "System Verification". A validation source, dipole or Confined Loop Antenna (CLA), is placed under the geometric center of the phantom and separated from the phantom in accordance to the validation source's Calibration Certificate data. A CW signal set to the frequency of the validate source's and SAR measurement probe's calibration frequency with a forward power set to the validation source's Calibration Certificate data power setting is applied to the validation source. An Area Scan is centered over the projection of the validation source's feed point and an Area Scan is taken. A Zoom Scan centered over the Peak SAR measurement of the Area Scan and the 1g and 10g SAR is measured. The measured 1g and 10g SAR is compared to the 1g and 10g SAR measurements from the validation source's Calibration Certificate. When required, the measured SAR is normalized to 1.0W and compared to the normalized SAR indicated on the validation source's Calibration Certificate. The SPC is considered valid when the measured and normalized SAR is <math>\leq 10\%</math> of the measured and normalize SAR of the validation source's Calibration Certificate.</p> <p>The fluid dielectric parameters of the Active TSL and SPC are repeated when the Active TSL has been in use for greater than 84 hours or if the Active TSL temperature has exceed <math>\pm 1^\circ\text{C}</math> of the initial fluid analysis.</p>	

## 12.5 Scan Resolution 100MHz to 2GHz

<b>Scan Resolution 100MHz to 2GHz</b>	
<b>Maximum distance from the closest measurement point to phantom surface: (Geometric Center of Probe Center)</b>	<b><math>4 \pm 1 \text{ mm}</math></b>
<b>Maximum probe angle normal to phantom surface. (Flat Section ELI Phantom)</b>	<b><math>5^\circ \pm 1^\circ</math></b>
<b>Area Scan Spatial Resolution <math>\Delta X, \Delta Y</math></b>	<b>15 mm</b>
<b>Zoom Scan Spatial Resolution <math>\Delta X, \Delta Y</math></b>	<b>7.5 mm</b>
<b>Zoom Scan Spatial Resolution <math>\Delta Z</math> (Uniform Grid)</b>	<b>5 mm</b>
<b>Zoom Scan Volume X, Y, Z</b>	<b>30 mm</b>
<b>Phantom</b>	<b>ELI</b>
<b>Fluid Depth</b>	<b><math>150 \pm 5 \text{ mm}</math></b>
An Area Scan with an area extending beyond the device was used to locate the candidate maximas within 2dB of the global maxima.	
A Zoom Scan centered over the peak SAR location(s) determined by the Area Scan was used to determine the 1-gram and 10-gram peak spatial-average SAR	

## 12.6 Scan Resolution 2GHz to 3GHz

<b>Scan Resolution 2GHz to 3GHz</b>	
Maximum distance from the closest measurement point to phantom surface: (Geometric Center of Probe Center)	<b>4 ± 1 mm</b>
Maximum probe angle normal to phantom surface. (Flat Section ELI Phantom)	<b>5° ± 1°</b>
Area Scan Spatial Resolution $\Delta X, \Delta Y$	<b>12 mm</b>
Zoom Scan Spatial Resolution $\Delta X, \Delta Y$	<b>5 mm</b>
Zoom Scan Spatial Resolution $\Delta Z$ (Uniform Grid)	<b>5 mm</b>
Zoom Scan Volume X, Y, Z	<b>30 mm</b>
Phantom	<b>ELI</b>
Fluid Depth	<b>150 ± 5 mm</b>
An Area Scan with an area extending beyond the device was used to locate the candidate maximas within 2dB of the global maxima.	
A Zoom Scan centered over the peak SAR location(s) determined by the Area Scan was used to determine the 1-gram and 10-gram peak spatial-average SAR	

## 12.7 Scan Resolution 5GHz to 6GHz

<b>Scan Resolution 5GHz to 6GHz</b>	
Maximum distance from the closest measurement point to phantom surface: (Geometric Center of Probe Center)	<b>4 ± 1 mm</b>
Maximum probe angle normal to phantom surface. (Flat Section ELI Phantom)	<b>5° ± 1°</b>
Area Scan Spatial Resolution $\Delta X, \Delta Y$	<b>10 mm</b>
Zoom Scan Spatial Resolution $\Delta X, \Delta Y$	<b>4 mm</b>
Zoom Scan Spatial Resolution $\Delta Z$ (Uniform Grid)	<b>2 mm</b>
Zoom Scan Volume X, Y, Z	<b>22 mm</b>
Phantom	<b>ELI</b>
Fluid Depth	<b>100 ± 5 mm</b>
An Area Scan with an area extending beyond the device was used to locate the candidate maximas within 2dB of the global maxima.	
A Zoom Scan centered over the peak SAR location(s) determined by the Area Scan was used to determine the 1-gram and 10-gram peak spatial-average SAR	

### 13.0 MEASUREMENT UNCERTAINTIES

Table 13.0 Measurement Uncertainty

UNCERTAINTY BUDGET FOR DEVICE EVALUATION (IEEE 1528-2013 Table 9)									
Uncertainty Component	IEEE 1528 Section	Uncertainty Value ±%	Probability Distribution	Divisor	ci 1g	ci 10g	Uncertainty Value ±% (1g)	Uncertainty Value ±% (10g)	V <sub>i</sub> or V <sub>eff</sub>
<b>Measurement System</b>									
Probe Calibration*	E.2.1	6.6	Normal	1	1	1	6.60	6.60	∞
Axial Isotropy*	E.2.2	4.7	Rectangular	1.732050808	0.7	0.7	1.9	1.9	∞
Hemispherical Isotropy*	E.2.2	9.6	Rectangular	1.732050808	0.7	0.7	3.9	3.9	∞
Boundary Effect*	E.2.3	8.3	Rectangular	1.732050808	1	1	4.8	4.8	∞
Linearity*	E.2.4	4.7	Rectangular	1.732050808	1	1	2.7	2.7	∞
System Detection Limits*	E.2.4	1.0	Rectangular	1.732050808	1	1	0.6	0.6	∞
Modulation Response	E.2.5	4.0	Rectangular	1.732050808	1	1	2.3	2.3	∞
Readout Electronics*	E.2.6	1.0	Normal	1	1	1	1.0	1.0	∞
Response Time*	E.2.7	0.8	Rectangular	1.732050808	1	1	0.5	0.5	∞
Integration Time*	E.2.8	1.4	Rectangular	1.732050808	1	1	0.8	0.8	∞
RF Ambient Conditions - Noise	E.6.1	0.0	Rectangular	1.732050808	1	1	0.0	0.0	∞
RF Ambient Conditions - Reflection	E.6.1	0.0	Rectangular	1.732050808	1	1	0.0	0.0	∞
Probe Positioner Mechanical Tolerance*	E.6.2	0.4	Rectangular	1.732050808	1	1	0.2	0.2	∞
Probe Positioning wrt Phantom Shell*	E.6.3	2.9	Rectangular	1.732050808	1	1	1.7	1.7	∞
Extrapolation, interpolation & integration algorithms for max. SAR evaluation*	E.5	3.9	Rectangular	1.732050808	1	1	2.3	2.3	∞
<b>Test Sample Related</b>									
Test Sample Positioning	E.4.2	0.3	Normal	1	1	1	0.3	0.3	5
Device Holder Uncertainty*	E.4.1	3.6	Normal	1	1	1	3.6	3.6	∞
SAR Drift Measurement**	E.2.9	0.0	Rectangular	1.732050808	1	1	0.0	0.0	∞
SAR Scaling***	E.6.5	2.0	Rectangular	1.732050808	1	1	1.2	1.2	∞
<b>Phantom and Tissue Parameters</b>									
Phantom Uncertainty*	E.3.1	4.0	Rectangular	1.732050808	1	1	2.3	2.3	∞
SAR Correction Uncertainty	E.3.2	1.2	Normal	1	1	0.84	1.2	1.0	∞
Liquid Conductivity (measurement)	E.3.3	6.8	Normal	1	0.78	0.71	5.3	4.8	10
Liquid Permittivity (measurement)	E.3.3	5.3	Normal	1	0.23	0.26	1.2	1.4	10
Liquid Conductivity (Temperature)	E.3.2	0.1	Rectangular	1.732050808	0.78	0.71	0.1	0.0	∞
Liquid Permittivity Temperature)	E.3.2	0.0	Rectangular	1.732050808	0.23	0.26	0.0	0.0	∞
<b>Effective Degrees of Freedom<sup>(1)</sup></b>								<b>V<sub>eff</sub> =</b>	<b>873.2</b>
<b>Combined Standard Uncertainty</b>			<b>RSS</b>				<b>12.59</b>	<b>12.40</b>	
<b>Expanded Uncertainty (95% Confidence Interval)</b>			<b>k=2</b>				<b>25.18</b>	<b>24.80</b>	

Measurement Uncertainty Table in accordance with IEEE Standard 1528-2003

(1) The Effective Degrees of Freedom is > 30 therefore a coverage factor of k=2 represents an approximate confidence level of 95%.

\* Provided by SPEAG

**Table 13.1 Calculation of Degrees of Freedom**

Calculation of the Degrees and Effective Degrees of Freedom	
$v_i = n - 1$	$v_{\text{eff}} = \frac{u_c^4}{m \sum_{i=1}^m \frac{c_i^4 u_i^4}{v_i}}$

## 14.0 FLUID DIELECTRIC PARAMETERS

Table 14.0 Fluid Dielectric Parameters 2450MHz BODY TSL

```

*****
Aprel Laboratory
Test Result for UIM Dielectric Parameter
Tue 13/Feb/2018 11:55:57
Freq Frequency(GHz)
FCC_eHFCC Bulletin 65 Supplement C ( June 2001) Limits for Head Epsilon
FCC_sHFCC Bulletin 65 Supplement C (June 2001) Limits for Head Sigma
FCC_eB FCC Limits for Body Epsilon
FCC_sB FCC Limits for Body Sigma
Test_e Epsilon of UIM
Test_s Sigma of UIM
*****

```

Freq	FCC_eB	FCC_sB	Test_e	Test_s
2.3500	52.83	1.85	52.23	1.86
2.3600	52.82	1.86	52.17	1.87
2.3700	52.81	1.87	52.16	1.89
2.3800	52.79	1.88	52.03	1.90
2.3900	52.78	1.89	51.89	1.91
2.4000	52.77	1.90	52.03	1.92
2.4100	52.75	1.91	51.96	1.95
2.4200	52.74	1.92	51.79	1.97
2.4300	52.73	1.93	51.93	1.97
2.4400	52.71	1.94	51.77	1.98
2.4500	52.70	1.95	51.47	2.03
2.4600	52.69	1.96	51.81	2.03
2.4700	52.67	1.98	51.78	2.05
2.4800	52.66	1.99	51.64	2.06
2.4900	52.65	2.01	51.51	2.04
2.5000	52.64	2.02	51.33	2.08
2.5100	52.62	2.04	51.50	2.08
2.5200	52.61	2.05	51.49	2.08
2.5300	52.60	2.06	51.41	2.09
2.5400	52.59	2.08	51.41	2.16
2.5500	52.57	2.09	51.41	2.14

### FLUID DIELECTRIC PARAMETERS

Date:	13 Feb 2018	Fluid Temp:	22.5	Frequency:	2450MHz	Tissue:	Body
Freq (MHz)	Test_e	Test_s	Target_e	Target_s	Deviation Permittivity	Deviation Conductivity	
2350.0000		52.2300	1.8600	52.8300	1.85	-1.14%	0.54%
2360.0000		52.1700	1.8700	52.8200	1.86	-1.23%	0.54%
2370.0000		52.1600	1.8900	52.8100	1.87	-1.23%	1.07%
2380.0000		52.0300	1.9000	52.7900	1.88	-1.44%	1.06%
2390.0000		51.8900	1.9100	52.7800	1.89	-1.69%	1.06%
2400.0000		52.0300	1.9200	52.7700	1.90	-1.40%	1.05%
2402.0000	*	52.0160	1.9260	52.7660	1.90	-1.42%	1.26%
2410.0000		51.9600	1.9500	52.7500	1.91	-1.50%	2.09%
2412.0000	*	51.9260	1.9540	52.7480	1.91	-1.56%	2.20%
2419.0000	*	51.8070	1.9680	52.7410	1.92	-1.77%	2.55%
2420.0000		51.7900	1.9700	52.7400	1.92	-1.80%	2.60%
2430.0000		51.9300	1.9700	52.7300	1.93	-1.52%	2.07%
2440.0000		51.7700	1.9800	52.7100	1.94	-1.78%	2.06%
2447.0000	*	51.5600	2.0150	52.7030	1.95	-2.17%	3.49%
2450.0000		51.4700	2.0300	52.7000	1.95	-2.33%	4.10%
2457.0000	*	51.7080	2.0300	52.6930	1.96	-1.87%	3.73%
2460.0000		51.8100	2.0300	52.6900	1.96	-1.67%	3.57%
2467.0000	*	51.7890	2.0440	52.6760	1.97	-1.68%	3.55%
2470.0000		51.7800	2.0500	52.6700	1.98	-1.69%	3.54%
2480.0000		51.6400	2.0600	52.6600	1.99	-1.94%	3.52%
2490.0000		51.5100	2.0400	52.6500	2.01	-2.17%	1.49%
2500.0000		51.3300	2.0800	52.6400	2.02	-2.49%	2.97%
2510.0000		51.5000	2.0800	52.6200	2.04	-2.13%	1.96%
2520.0000		51.4900	2.0800	52.6100	2.05	-2.13%	1.46%
2530.0000		51.4100	2.0900	52.6000	2.06	-2.26%	1.46%
2540.0000		51.4100	2.1600	52.5900	2.08	-2.24%	3.85%
2550.0000		51.4100	2.1400	52.5700	2.09	-2.21%	2.39%

\*Channel Frequency Tested

**Table 14.1 Fluid Dielectric Parameters 2450MHz BODY TSL**

```

*****
                Aprel Laboratory
                Test Result for UIM Dielectric Parameter
                Thu 22/Feb/2018 14:00:04
                Freq    Frequency(GHz)
                FCC_eH FCC Bulletin 65 Supplement C ( June 2001) Limits for Head Epsilon
                FCC_sH FCC Bulletin 65 Supplement C (June 2001) Limits for Head Sigma
                FCC_eB FCC Limits for Body Epsilon
                FCC_sB FCC Limits for Body Sigma
                Test_e  Epsilon of UIM
                Test_s  Sigma of UIM
*****

```

Freq	FCC_eB	FCC_sB	Test_e	Test_s
2.3500	52.83	1.85	54.32	1.86
2.3600	52.82	1.86	54.45	1.88
2.3700	52.81	1.87	54.36	1.89
2.3800	52.79	1.88	54.38	1.92
2.3900	52.78	1.89	54.16	1.92
2.4000	52.77	1.90	54.20	1.94
2.4100	52.75	1.91	54.15	1.95
2.4200	52.74	1.92	54.20	1.98
2.4300	52.73	1.93	54.13	1.99
2.4400	52.71	1.94	54.09	1.99
2.4500	52.70	1.95	54.20	2.03
2.4600	52.69	1.96	54.04	2.02
2.4700	52.67	1.98	53.99	2.04
2.4800	52.66	1.99	53.99	2.07
2.4900	52.65	2.01	54.02	2.04
2.5000	52.64	2.02	53.89	2.08
2.5100	52.62	2.04	53.76	2.11
2.5200	52.61	2.05	53.90	2.10
2.5300	52.60	2.06	53.89	2.12
2.5400	52.59	2.08	53.69	2.16
2.5500	52.57	2.09	53.80	2.17

### FLUID DIELECTRIC PARAMETERS

Date:	22 Feb 2018	Fluid Temp:	23.5	Frequency:	2450MHz	Tissue:	Body
Freq (MHz)	Test_e	Test_s	Target_e	Target_s	Deviation Permittivity	Deviation Conductivity	
2350.0000		54.3200	1.8600	52.8300	1.85	2.82%	0.54%
2360.0000		54.4500	1.8800	52.8200	1.86	3.09%	1.08%
2370.0000		54.3600	1.8900	52.8100	1.87	2.94%	1.07%
2380.0000		54.3800	1.9200	52.7900	1.88	3.01%	2.13%
2390.0000		54.1600	1.9200	52.7800	1.89	2.61%	1.59%
2400.0000		54.2000	1.9400	52.7700	1.90	2.71%	2.11%
2410.0000		54.1500	1.9500	52.7500	1.91	2.65%	2.09%
2412.0000	*	54.1600	1.9560	52.7480	1.91	2.68%	2.30%
2420.0000		54.2000	1.9800	52.7400	1.92	2.77%	3.13%
2430.0000		54.1300	1.9900	52.7300	1.93	2.66%	3.11%
2440.0000		54.0900	1.9900	52.7100	1.94	2.62%	2.58%
2442.0000	*	54.1120	1.9980	52.7080	1.94	2.66%	2.88%
2450.0000		54.2000	2.0300	52.7000	1.95	2.85%	4.10%
2457.0000	*	54.0880	2.0230	52.6930	1.96	2.65%	3.37%
2460.0000		54.0400	2.0200	52.6900	1.96	2.56%	3.06%
2470.0000		53.9900	2.0400	52.6700	1.98	2.51%	3.03%
2480.0000		53.9900	2.0700	52.6600	1.99	2.53%	4.02%
2490.0000		54.0200	2.0400	52.6500	2.01	2.60%	1.49%
2500.0000		53.8900	2.0800	52.6400	2.02	2.37%	2.97%
2510.0000		53.7600	2.1100	52.6200	2.04	2.17%	3.43%
2520.0000		53.9000	2.1000	52.6100	2.05	2.45%	2.44%
2530.0000		53.8900	2.1200	52.6000	2.06	2.45%	2.91%
2540.0000		53.6900	2.1600	52.5900	2.08	2.09%	3.85%
2550.0000		53.8000	2.1700	52.5700	2.09	2.34%	3.83%

\*Channel Frequency Tested

## 15.0 SYSTEM VERIFICATION TEST RESULTS

Table 15.0 System Verification Results 2450MHz BODY TSL

System Verification Test Results					
Date		Frequency (MHz)	Validation Source		
			P/N		S/N
13 Feb 2018		2450	D2450V2		825
Fluid Type	Fluid Temp °C	Ambient Temp °C	Ambient Humidity (%)	Forward Power (mW)	Source Spacing (mm)
Body	22.5	24	28%	250	10
Fluid Parameters					
Permittivity			Conductivity		
Measured	Target	Deviation	Measured	Target	Deviation
51.47	52.70	-2.33%	2.03	1.95	4.10%
Measured SAR					
1 gram			10 gram		
Measured	Target	Deviation	Measured	Target	Deviation
13.60	13.00	4.62%	6.26	6.05	3.47%
Measured SAR Normalized to 1.0W					
1 gram			10 gram		
Normalized	Target	Deviation	Normalized	Target	Deviation
54.40	50.70	7.30%	25.04	23.80	5.21%
<p>Prior to the SAR evaluations, system checks were performed on the planar section of the phantom and a SPEAG validation dipole in accordance with the procedures described in IEEE 1528-2013, FCC KDB 846224 and IEC 62209-1.</p> <p>The dielectric parameters of the simulated tissue mixture were measured prior to the system performance check using a Dielectric Probe Kit and a Network Analyzer.</p> <p>The forward power was applied to the dipole and the system was verified to a tolerance of +10% from the system manufacturer's dipole calibration target SAR value.</p> <p>The forward power applied was same forward power applied by the calibration lab during the calibration of this validation source.</p>					

**Table 15.1 System Verification Results 2450MHz BODY TSL**

<b>System Verification Test Results</b>					
Date		Frequency (MHz)	Validation Source		
			P/N		S/N
23 Feb 2018		2450	D2450V2		825
Fluid Type	Fluid Temp °C	Ambient Temp °C	Ambient Humidity (%)	Forward Power (mW)	Source Spacing (mm)
Body	23.3	24	28%	250	10
Fluid Parameters					
Permittivity			Conductivity		
Measured	Target	Deviation	Measured	Target	Deviation
54.20	52.70	2.85%	2.03	1.95	4.10%
Measured SAR					
1 gram			10 gram		
Measured	Target	Deviation	Measured	Target	Deviation
13.10	13.00	0.77%	6.11	6.05	0.99%
Measured SAR Normalized to 1.0W					
1 gram			10 gram		
Normalized	Target	Deviation	Normalized	Target	Deviation
52.40	50.70	3.35%	24.44	23.80	2.69%
<p>Prior to the SAR evaluations, system checks were performed on the planar section of the phantom and a SPEAG validation dipole in accordance with the procedures described in IEEE 1528-2013, FCC KDB 846224 and IEC 62209-1.</p> <p>The dielectric parameters of the simulated tissue mixture were measured prior to the system performance check using a Dielectric Probe Kit and a Network Analyzer.</p> <p>The forward power was applied to the dipole and the system was verified to a tolerance of +10% from the system manufacturer's dipole calibration target SAR value.</p> <p>The forward power applied was same forward power applied by the calibration lab during the calibration of this validation source.</p>					

## 16.0 MEASUREMENT SYSTEM SPECIFICATIONS

Table 16.0 Measurement System Specifications

Measurement System Specification	
<b>Specifications</b>	
<b>Positioner</b>	Stäubli Unimation Corp. Robot Model: TX90XL
<b>Repeatability</b>	+/- 0.035 mm
<b>No. of axis</b>	6.0
<b>Data Acquisition Electronic (DAE) System</b>	
<b>Cell Controller</b>	
<b>Processor</b>	Intel(R) Core(TM) i7-7700
<b>Clock Speed</b>	3.60 GHz
<b>Operating System</b>	Windows 10 Professional
<b>Data Converter</b>	
<b>Features</b>	Signal Amplifier, multiplexer, A/D converter, and control logic
<b>Software</b>	Measurement Software: DASY6, V 6.4.0.12171 / DASY52 V52.10.0.1446 Postprocessing Software: SEMCAD X, V14.6.10( Deployment Build )
<b>Connecting Lines</b>	Optical downlink for data and status info., Optical uplink for commands and clock
<b>DASY Measurement Server</b>	
<b>Function</b>	Real-time data evaluation for field measurements and surface detection
<b>Hardware</b>	Intel ULV Celeron CPU 400 MHz; 128 MB chip disk; 128 MB RAM
<b>Connections</b>	COM1, COM2, DAE, Robot, Ethernet, Service Interface
<b>E-Field Probe</b>	
<b>Model</b>	EX3DV4
<b>Serial No.</b>	3600
<b>Construction</b>	Triangular core fiber optic detection system
<b>Frequency</b>	10 MHz to 6 GHz
<b>Linearity</b>	±0.2 dB (30 MHz to 3 GHz)
<b>Phantom</b>	
<b>Type</b>	ELI Elliptical Planar Phantom
<b>Shell Material</b>	Fiberglass
<b>Thickness</b>	2mm +/- .2mm
<b>Volume</b>	> 30 Liter

<b>Measurement System Specification</b>	
<b>Probe Specification</b>	
Construction:	Symmetrical design with triangular core; Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, glycol)
Calibration:	In air from 10 MHz to 2.5 GHz In head simulating tissue at frequencies of 900 MHz and 1.8 GHz (accuracy $\pm 8\%$ )
Frequency:	10 MHz to > 6 GHz; Linearity: $\pm 0.2$ dB (30 MHz to 3 GHz)
Directivity:	$\pm 0.2$ dB in head tissue (rotation around probe axis) $\pm 0.4$ dB in head tissue (rotation normal to probe axis)
Dynamic Range:	5 $\mu$ W/g to > 100 mW/g; Linearity: $\pm 0.2$ dB
Surface Detect:	$\pm 0.2$ mm repeatability in air and clear liquids over diffuse reflecting surfaces
Dimensions:	Overall length: 330 mm; Tip length: 16 mm; Body diameter: 12 mm; Tip diameter: 6.8 mm Distance from probe tip to dipole centers: 2.7 mm
Application:	General dosimetry up to 3 GHz; Compliance tests of mobile phone
	
<b>EX3DV4 E-Field Probe</b>	
<b>Phantom Specification</b>	
The ELI V5.0 phantom is an elliptical planar fiberglass shell phantom with a shell thickness of 2.0mm +/- .2mm at the planar area. This phantom conforms to OET Bulletin 65, Supplement C, IEEE 1528-2013, IEC 62209-1 and IEC 62209-2.	
	
<b>ELI Phantom</b>	
<b>Device Positioner Specification</b>	
The DASY device positioner has two scales for device rotation (with respect to the body axis) and the device inclination (with respect to the line between the ear openings). The plane between the ear openings and the mouth tip has a rotation angle of 65°. The bottom plate contains three pair of bolts for locking the device holder. The device holder positions are adjusted to the standard measurement positions in the three sections.	
	
<b>Device Positioner</b>	

## 17.0 TEST EQUIPMENT LIST

**Table 17.0 Equipment List and Calibration**

Test Equipment List				
DESCRIPTION	ASSET NO.	SERIAL NO.	DATE CALIBRATED	CALIBRATION INTERVAL
Schmid & Partner DASY System	-	-	-	-
-DASY Measurement Server	294	1078	CNR	CNR
-Robot	-	599396-01	CNR	CNR
-DAE4	19	353	24-Apr-17	Annual
-EX3DV4 E-Field Probe	213	3600	27-Apr-17	Annual
-CLA150 Validation Source	251	4007	27-Apr-17	Triennial
-D835V2 Validation Dipole	217	4D075	23-Apr-15	Triennial
-D450V3 Validation Dipole	221	1068	21-Apr-15	Triennial
-D1640V2 Validation Dipole	299	207-00102	07-Nov-17	Triennial
-D2450V2 Validation Dipole	219	825	23-Apr-15	Triennial
-D5GHzV2 Validation Dipole	126	1031	20-Apr-15	Triennial
ELI Phantom	247	-	CNR	CNR
HP 85070C Dielectric Probe Kit	33	none	CNR	CNR
Gigatronics 8652A Power Meter	110	1835801	29-Feb-16	Triennial
Gigatronics 80701A Power Sensor	248	1833687	29-Feb-16	Triennial
HP 8753ET Network Analyzer	134	US39170292	29-Dec-17	Triennial
Rohde & Schwarz SMR20 Signal Generator	6	100104	29-May-17	Triennial
Amplifier Research 5S1G4 Power Amplifier	106	26235	CNR	CNR

## 18.0 FLUID COMPOSITION

Table 18.0 Fluid Composition 2450MHz BODY TSL

Tissue Simulating Liquid (TSL) Composition				
Component by Percent Weight				
Water	Glycol	Salt <sup>(1)</sup>	HEC <sup>(2)</sup>	Bacteriacide <sup>(3)</sup>
69.98	30.0	0.02	0.0	0.0

(1) Non-Iodinized

(2) HydroxyEthyl-Cellulose: Sigma-Aldrich P/N 54290-500g

(3) Dow Chemical Dowicil 75 Antimicrobial Perservative

## APPENDIX A – SYSTEM VERIFICATION PLOTS

Date/Time: 2/13/2018 12:45:15 PM

Test Laboratory: Celltech Labs

**SPC-2450B Feb 13 2018**

**DUT: Dipole 2450 MHz D2450V2; Type: D2450V2; Serial: D2450V2 - SN:825**

Communication System: UID 0, CW (0); Communication System Band: FullSpan (0.0 - 6000.0 MHz); Frequency: 2450 MHz; Communication System PAR: 0 dB; PMF: 1

Medium: TSL\_2450B[13FE18]

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 2.03$  S/m;  $\epsilon_r = 51.47$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY Configuration:

- Probe: EX3DV4 - SN3600; ConvF(6.56, 6.56, 6.56); Calibrated: 4/27/2017;
  - Modulation Compensation:
- Sensor-Surface: 4mm (Mechanical Surface Detection),  $z = -1.5, 31.0, -99.0$
- Electronics: DAE4 Sn353; Calibrated: 4/24/2017
- Phantom: ELI V5.0 (20deg probe tilt); Type: QD OVA 002 Ax;
- DASYS2 52.10.0(1446);

**Frequency: 2450 MHz**

**SPC/SPC 2450B Input=250mw, Target=13.0W/kg/Area Scan (4x9x1):** Measurement grid: dx=12mm, dy=12mm

Maximum value of SAR (measured) = 12.2 W/kg

**SPC/SPC 2450B Input=250mw, Target=13.0W/kg/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 88.49 V/m; Power Drift = -0.04 dB

Peak SAR (extrapolated) = 28.1 W/kg

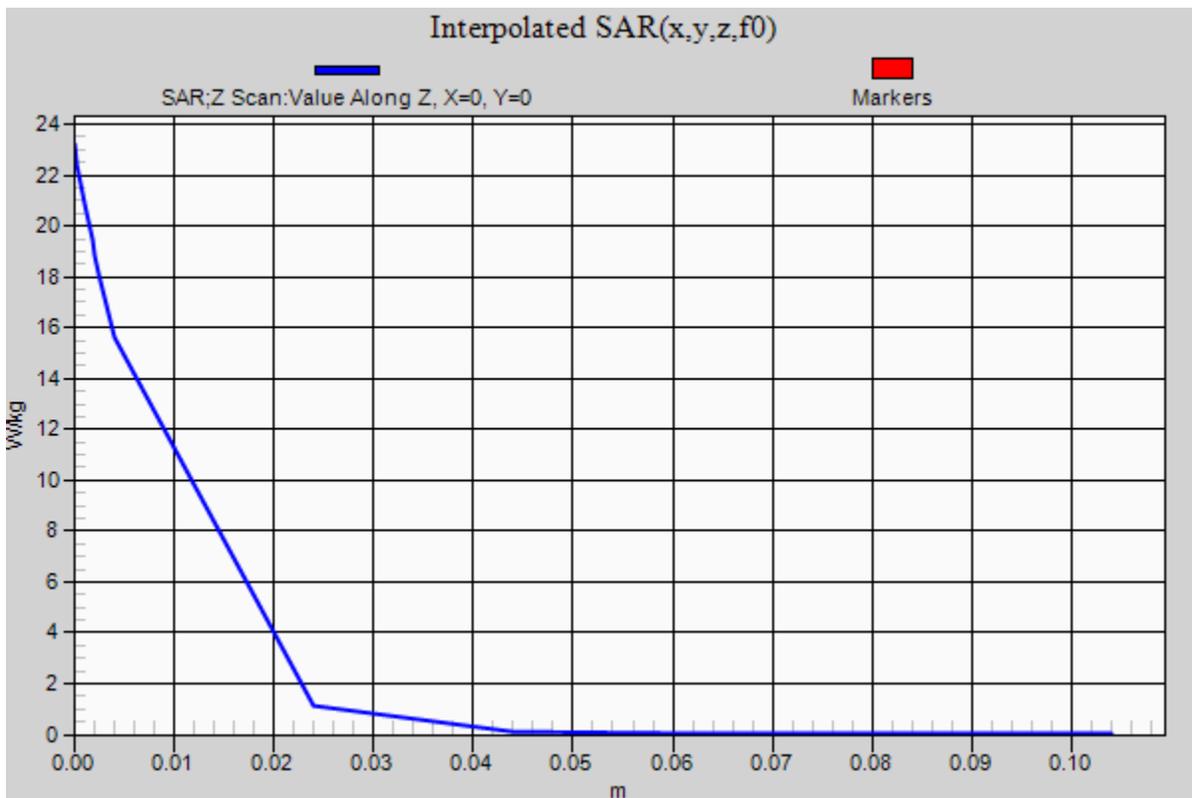
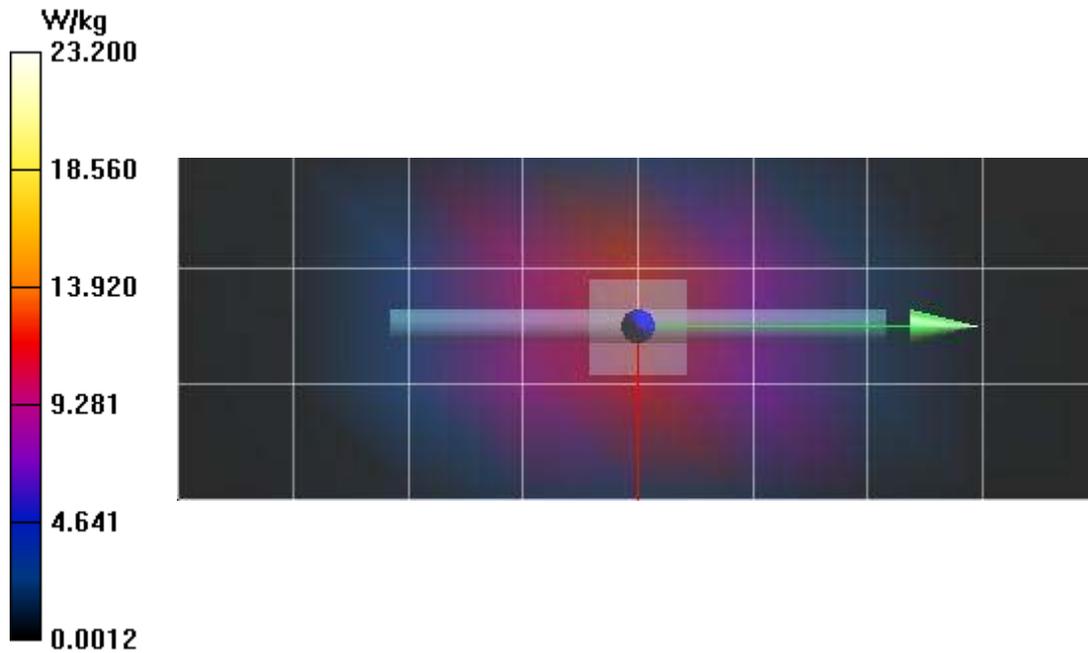
**SAR(1 g) = 13.6 W/kg; SAR(10 g) = 6.26 W/kg**

Maximum value of SAR (measured) = 15.7 W/kg

**SPC/SPC 2450B Input=250mw, Target=13.0W/kg/Z Scan (1x1x17):** Measurement grid: dx=20mm, dy=20mm, dz=20mm

Penetration depth = n/a (n/a, 7.568) [mm]

Maximum value of SAR (interpolated) = 23.2 W/kg



Date/Time: 2/23/2018 9:54:57 AM

Test Laboratory: Celltech Labs

**SPC-2450B Feb 23 2018**

**DUT: Dipole 2450 MHz D2450V2; Type: D2450V2; Serial: D2450V2 - SN:825**

Communication System: UID 0, CW (0); Communication System Band: FullSpan (0.0 - 6000.0 MHz); Frequency: 2450 MHz; Communication System PAR: 0 dB; PMF: 1

Medium: TSL\_2450B[22FE18]

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 2.03$  S/m;  $\epsilon_r = 54.2$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASYS5 (IEEE/IEC/ANSI C63.19-2011)

DASY Configuration:

- Probe: EX3DV4 - SN3600; ConvF(6.56, 6.56, 6.56); Calibrated: 4/27/2017;
  - Modulation Compensation:
- Sensor-Surface: 4mm (Mechanical Surface Detection),  $z = -1.5, 31.0, -99.0$
- Electronics: DAE4 Sn353; Calibrated: 4/24/2017
- Phantom: ELI V5.0 (20deg probe tilt); Type: QD OVA 002 Ax;
- DASYS5 52.10.0(1446);

**Frequency: 2450 MHz**

**SPC/SPC 2450B Input=250mw, Target=13.0W/kg/Area Scan (4x9x1):** Measurement grid: dx=12mm, dy=12mm

Maximum value of SAR (measured) = 13.5 W/kg

**SPC/SPC 2450B Input=250mw, Target=13.0W/kg/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 84.27 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 26.5 W/kg

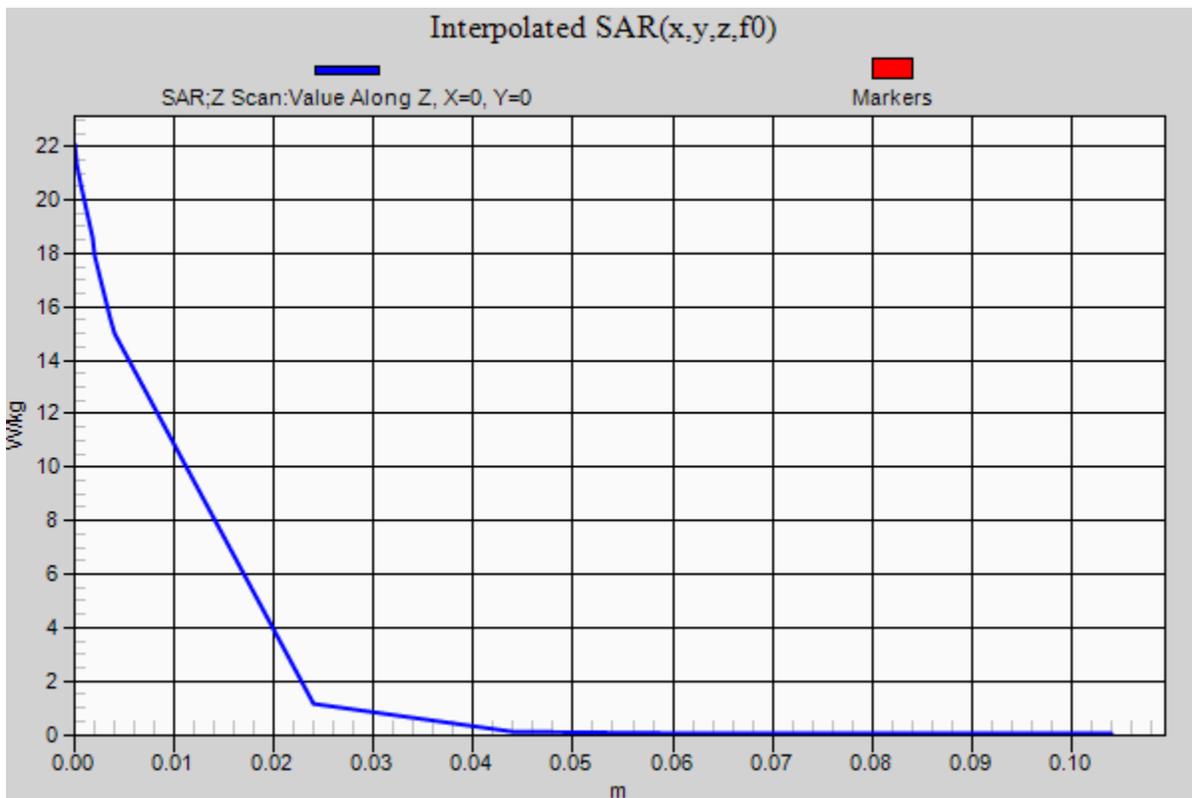
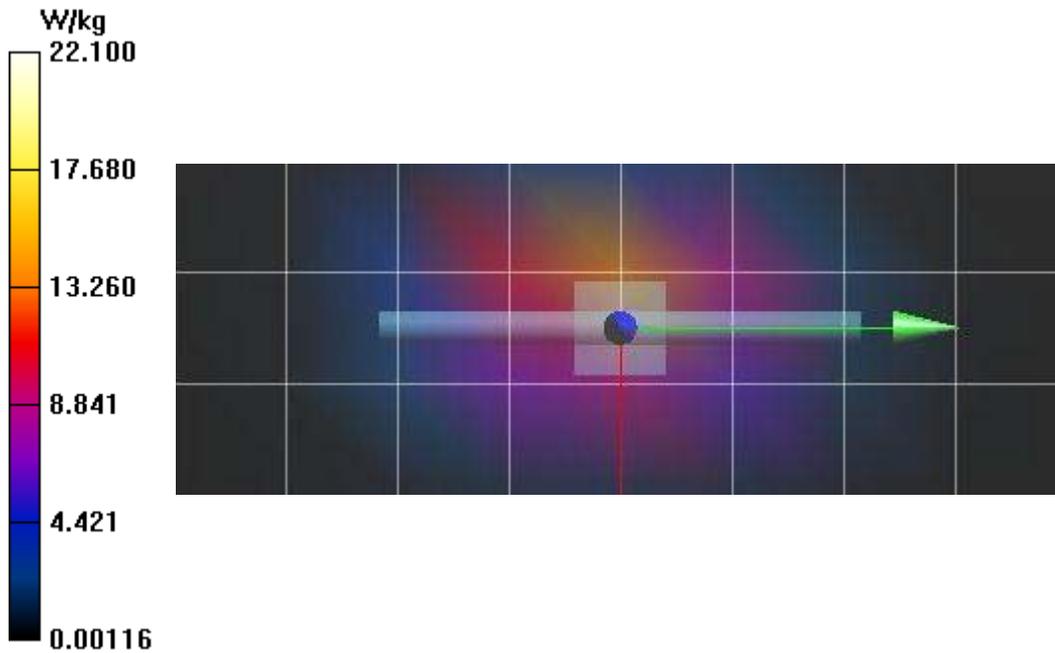
**SAR(1 g) = 13.1 W/kg; SAR(10 g) = 6.11 W/kg**

Maximum value of SAR (measured) = 15.1 W/kg

**SPC/SPC 2450B Input=250mw, Target=13.0W/kg/Z Scan (1x1x17):** Measurement grid: dx=20mm, dy=20mm, dz=20mm

Penetration depth = n/a (n/a, 7.864) [mm]

Maximum value of SAR (interpolated) = 22.1 W/kg



## APPENDIX B – MEASUREMENT PLOTS OF MAXIMUM MEASURED SAR

### Plot B4

Date/Time: 2/15/2018 11:59:32 AM

Test Laboratory: Celltech Labs

**Garmin-2450B Feb 16 2018**

**DUT:Type: A03438; Body Worn Transmitter;**

Communication System: UID 10060 - CAB, IEEE 802.11b WiFi 2.4 GHz (DSSS, 5.5 Mbps); Communication System Band: WLAN 2.4GHz (2412.0 - 2484.0 MHz); Frequency: 2457 MHz; Communication System PAR: 2.83 dB; PMF: 1.16547

Medium: TSL\_2450B[13FE18]

Medium parameters used (interpolated):  $f = 2457$  MHz;  $\sigma = 2.03$  S/m;  $\epsilon_r = 51.708$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY Configuration:

- Probe: EX3DV4 - SN3600; ConvF(6.56, 6.56, 6.56); Calibrated: 4/27/2017;
  - Modulation Compensation: PMR for UID 10060 - CAB, Calibrated: 4/27/2017
- Sensor-Surface: 4mm (Mechanical Surface Detection (Locations From Previous Scan Used)), Sensor-Surface: 4mm (Mechanical Surface Detection),  $z = -1.5, 31.0, 101.0$
- Electronics: DAE4 Sn353; Calibrated: 4/24/2017
- Phantom: ELI V5.0 (20deg probe tilt); Type: QD OVA 002 Ax;
- DASYS2 52.10.0(1446);

**Frequency: 2457 MHz**

**2450B/B4-A03438, Body, 2457 MHz, Silicone Band-WIFI/Area Scan (8x7x1):** Measurement grid: dx=12mm, dy=12mm

[Info: Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (measured) = 0.989 W/kg

**2450B/B4-A03438, Body, 2457 MHz, Silicone Band-WIFI/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 30.31 V/m; Power Drift = -0.78 dB

Peak SAR (extrapolated) = 3.32 W/kg

**SAR(1 g) = 1.23 W/kg; SAR(10 g) = 0.380 W/kg**

[Info: Interpolated medium parameters used for SAR evaluation.](#)

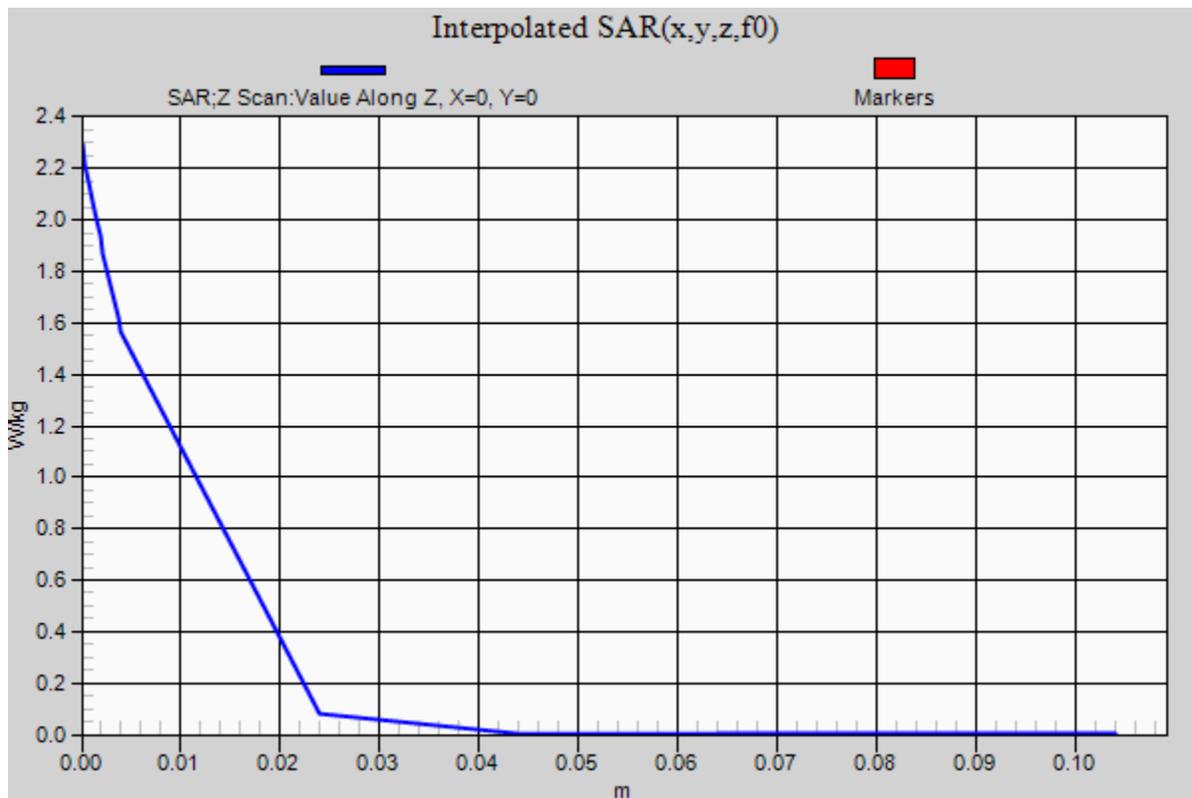
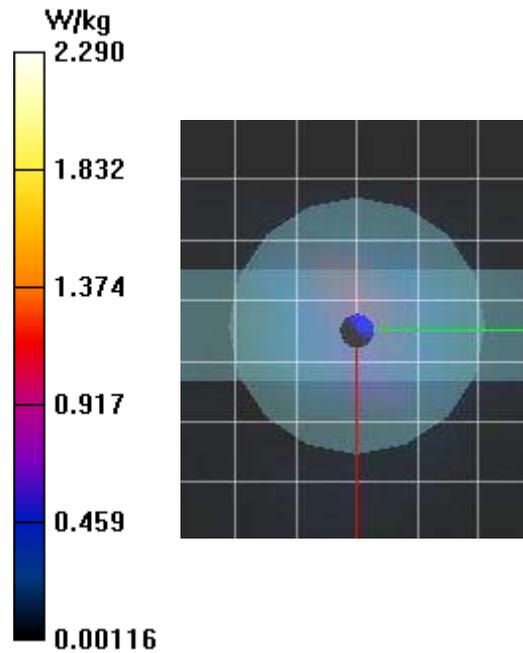
Maximum value of SAR (measured) = 1.63 W/kg

**2450B/B4-A03438, Body, 2457 MHz, Silicone Band-WIFI/Z Scan (1x1x17):** Measurement grid: dx=20mm, dy=20mm, dz=20mm

[Info: Interpolated medium parameters used for SAR evaluation.](#)

Penetration depth = n/a (n/a, 6.671) [mm]

Maximum value of SAR (interpolated) = 2.29 W/kg



**Plot B7**

Date/Time: 2/23/2018 11:11:00 AM

Test Laboratory: Celltech Labs

**Garmin-2450B Feb 23 2018**

**DUT:Type: A03438; Body Worn Transmitter;**

Communication System: UID 10060 - CAB, IEEE 802.11b WiFi 2.4 GHz (DSSS, 5.5 Mbps); Communication System Band: WLAN 2.4GHz (2412.0 - 2484.0 MHz); Frequency: 2457 MHz; Communication System PAR: 2.83 dB; PMF: 1.16547

Medium: TSL\_2450B[22FE18]

Medium parameters used (interpolated):  $f = 2457$  MHz;  $\sigma = 2.023$  S/m;  $\epsilon_r = 54.088$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY Configuration:

- Probe: EX3DV4 - SN3600; ConvF(6.56, 6.56, 6.56); Calibrated: 4/27/2017;
  - Modulation Compensation: PMR for UID 10060 - CAB, Calibrated: 4/27/2017
- Sensor-Surface: 4mm (Mechanical Surface Detection (Locations From Previous Scan Used)), Sensor-Surface: 4mm (Mechanical Surface Detection),  $z = -1.5, 31.0, 101.0$
- Electronics: DAE4 Sn353; Calibrated: 4/24/2017
- Phantom: ELI V5.0 (20deg probe tilt); Type: QD OVA 002 Ax;
- DASY52 52.10.0(1446);

**Frequency: 2457 MHz**

**2450B/B7-A03438, Body/Touch-Front 5mm, 2457MHz, Silicone Band -WIFI/Area Scan (8x7x1):** Measurement grid: dx=12mm, dy=12mm

[Info: Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (measured) = 0.783 W/kg

**2450B/B7-A03438, Body/Touch-Front 5mm, 2457MHz, Silicone Band -WIFI/Zoom Scan (7x8x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 16.61 V/m; Power Drift = -0.55 dB

Peak SAR (extrapolated) = 1.40 W/kg

**SAR(1 g) = 0.704 W/kg; SAR(10 g) = 0.310 W/kg**

[Info: Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (measured) = 0.828 W/kg

**2450B/B7-A03438, Body/Touch-Front 5mm, 2457MHz, Silicone Band -WIFI/Z Scan (1x1x17):** Measurement grid: dx=20mm, dy=20mm, dz=20mm

[Info: Interpolated medium parameters used for SAR evaluation.](#)

Penetration depth = n/a (n/a, 7.612) [mm]

Maximum value of SAR (interpolated) = 1.15 W/kg

