



Test Report Serial Number:	45461444 R1.0
Test Report Date:	12 July 2018
Project Number:	1408

## SAR Test Report - New Certification

Applicant:



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

Maximum Reported 1g SAR			W/kg
FCC	Body	0.38	
	Simultaneous	0.38	
ISED	Body	0.45	
	Simultaneous	0.45	
General Pop. Limit:		1.60	

FCC ID:

**IPH-03524**

Product Model Number / HVIN

**A03524**

ISED Registration Number

**1792A-03524**

Product Name / PMN

**A03524**

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**

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 Canada



Test Lab Certificate: 2470.01



IC Registration 3874A-1



FCC Registration: CA3874

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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	25 June 2018
R1.0	Initial Release	Art Voss	12 July 2018
	Revised Section 5.0" Reason for Change" Category Revised Rated Power in Table 7.0 Removed Reference to Integrated Components in Table 9.0 and Appendix C.		

## 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-03524</b>
	<b>IC:</b> <b>1792A-03524</b>
<b>Type of Equipment:</b>	Satellite Transceiver w/ Bluetooth
	Digital Transmission System (DTS) FCC Part 15, RSS 247
<b>Device Model(s) / HVIN:</b>	A03524
<b>Device Marketing Name / PMN:</b>	A03524
<b>Test Sample Serial No.:</b>	T/A Sample - Identical Prototype
<b>Transmit Frequency Range:</b>	Satellite: 1616 - 1626.5 MHz
	BT: 2402-2480 MHz
<b>Number of Channels:</b>	See Section 7.0
<b>Manuf. Max. Rated Output Power:</b>	Satellite: 31.7dBm +/- 0.5dB Peak, 31.0dBm +/- 0.5dB Avg
	BT: 4 dBm
<b>Modulation:</b>	Satellite: CW, DE-QPSK, DE-BPSK
	BT: GFSK, PI/4-DQSK, 8-DPSK
<b>Duty Cycle:</b>	Satellite:9.3%, BT: 46%
<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 SCOPE OF EVALUATION

The A03524, FCC ID: IPH-A03524 ISEDC ID: 1792A-03524 is a hand held transceiver with operation capability in the 2402-2480 MHz frequency band and 1600 MHz communications band. The device is intended for General Population Use. It contains both a Bluetooth Transmitter and Wireless Communication Module A03302, FCC ID: IPH-03302, and is capable of simultaneous transmission between the two transmitter radios. The product operates from an internal proprietary Li-ion rechargeable battery which can be connected to a compliant USB interface port, AC or DC adapter for charging. Test samples provided by the manufacturer were capable of transmitting at select frequencies and modulations preset by the manufacturer. An additional antenna modification was prepared for one sample allowing the ability to connect test equipment for antenna port conducted power analysis. The DUT was evaluated for SAR at the maximum conducted output power level, preset by the manufacturer and in accordance with the procedures described in IEEE 1528, FCC KDB 865646, 447498 and RSS 102.

## 4.0 NORMATIVE REFERENCES



<b>Normative References*</b>	
ANSI / ISO 17025:2017	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.	

**5.0 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> A03524	
<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 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 checked="" type="checkbox"/> 1.6W/kg - 1g Volume <input type="checkbox"/> 8.0W/kg - 1g Volume <input type="checkbox"/> 4.0W/kg - 10g Volume
<b>Reason for Change:</b> Original Filing	<b>Date(s) Evaluated:</b> June 19th-June 21st, 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.

<p>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.</p>		
	<p>Art Voss, P.Eng. Technical Manager Celltech Labs Inc. 25 June 2018 Date</p>	



## 6.0 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**

**7.0 RF CONDUCTED POWER MEASUREMENT**

Table 7.0 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	1616.02	30.89	31.5	1.40	-0.61	Y	Satellite	CW
2	1621.02	30.82	31.5	1.40	-0.68	Y		CW
3	1625.98	30.77	31.5	1.40	-0.73	Y		CW

2402	3.40	4.00	0.003	-0.60		BT	CW
	3.21	4.00	0.003	-0.79			GFSK
	3.40	4.00	0.003	-0.60			2-EDR
	3.44	4.00	0.003	-0.56	Y		3-EDR
	3.14	4.00	0.003	-0.86			HOP
2441	3.34	4.00	0.003	-0.66		BT	CW
	3.17	4.00	0.003	-0.83			GFSK
	3.31	4.00	0.003	-0.69			2-EDR
	3.37	4.00	0.003	-0.63			3-EDR
	3.11	4.00	0.003	-0.89			HOP
2480	3.24	4.00	0.003	-0.76		BT	CW
	3.21	4.00	0.003	-0.79			GFSK
	3.25	4.00	0.003	-0.75			2-EDR
	3.29	4.00	0.003	-0.71			3-EDR
	3.09	4.00	0.003	-0.91			HOP

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. Continuous Wave (CW) mode is a test mode not typical with normal transmission modes and may produce higher 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 Power plus Tolerance. SAR was evaluated using the power level setting specified by the manufacture to be the max output power and produce the most conservative SAR. SAR was evaluated at the *maximum average* tune up tolerance. See section 2.0 Client and Device Information for details. The *reported* SAR was not scaled down.

## 8.0 NUMBER OF TEST CHANNELS ( $N_C$ ) AND CONFIGURATIONS

Table 8.0

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	1626.5	1621	2	3	10.0	5.0
<p><b>KDB 447498: <math>N_C = \text{RoundUp} \{ [ 100 ( F_{HIGH} - F_{LOW} ) / F_C ]^{0.5} \times ( F_C / 100 )^{0.2} \}</math></b></p> <p><b>IEC 62209-1: <math>N_C = 2 \times \{ \text{RoundUp} [ 10 ( F_{HIGH} - F_{LOW} ) / F_C ] \} + 1</math></b></p>						
Notes:						
The number of channels was the maximum from above (3). The channels tested were the low, mid and high channels.						

As per FCC KDB 447498D01, testing of other required channels within the operating mode of a frequency band is not required when the reported 1-g or 10-g SAR for the mid-band or highest output power channel is:

- a)  $\leq 0.8$  W/kg or 2.0 W/kg, for 1-g or 10-g respectively, when the transmission band is  $\leq 100$  MHz
- b)  $\leq 0.6$  W/kg or 1.5 W/kg, for 1-g or 10-g respectively, when the transmission band is between 100 MHz and 200 MHz
- c)  $\leq 0.4$  W/kg or 1.0 W/kg, for 1-g or 10-g respectively, when the transmission band is  $\geq 200$  MHz

## 9.0 ACCESSORIES EVALUATED

**Table 9.0 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
B1*	011-01750-20	Carabiner Clip (BLK/SLV)	n/a	n/a	Y	Y
B2*	010-11022-10	Belt-Clip, Swivel (BLK/BLK)	n/a	n/a	Y	Y
B3*	010-11734-20	Belt Clip, Spine Mount (BLK, BLK)	n/a	n/a	Y	Y
B4**	010-11022-10	Carabiner Clip (BLK/SLV)	n/a	n/a	Y	N
B5	010-12525-02	Powered Mount with RAM Suction Cup	n/a	n/a	Y	N
B6	010-12525-02	Floatation Lanyard	n/a	n/a	Y	N
B7	010-11733-00	Quick Release Lanyard	n/a	n/a	Y	N
B8	010-11023-00	Bike Mount	n/a	n/a	Y	N
B9	010-11602-00	Friction Mount	n/a	n/a	Y	N
B10	010-11855-00	Backpack Tether	n/a	n/a	Y	N
B11	010-10888-00	Retractable Tether	n/a	n/a	Y	N
B12	011-11031-00	Marine Mount	n/a	n/a	Y	N
B13	320-00559-01	Ca Assy, Micro B-A Style USB, 1m	n/a	n/a	N	N
B14	011-11031-00	AC Adapter, 5.0V, 2.0A, USB-A-RECEPT	n/a	n/a	N	N

\*All relevant accessories were evaluated for SAR; however, only a select few were chosen for SAR testing.

\*\*Identical in design to accessory B1

## 10.0 SAR MEASUREMENT SUMMARY

Table 10.0: Measured Results

Measured SAR Results (1g) - 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)		1g	10g			
				(MHz)							(dBm)	(W/kg)	(W/kg)	(dB)			
<b>Satellite Band</b>																	
19 Jun 2018	B1	A03524	Body- Backside	1616.02	CW-CF10.8	n.a	n/a	n/a	n/a	0	0	30.89	0.327	0.189	-0.740		
20 Jun 2018	B2	A03524	Body- Backside	1621.02	CW-CF10.8	n.a	n/a	n/a	n/a	0	0	30.82	0.304	0.179	-0.130		
20 Jun 2018	B3	A03524	Body- Backside	1625.98	CW-CF10.8	n.a	n/a	n/a	n/a	0	0	30.77	0.291	0.182	0.060		
19 Jun 2018	B4	A03524	Body-Backside	1616.02	CW-CF10.8	n.a	n/a	B1	n/a	0	30	30.89	0.317	0.158	-0.020		
19 Jun 2018	B5	A03524	Body-Backside	1616.02	CW-CF10.8	n.a	n/a	B2	n/a	0	50	30.89	0.038	0.025	1.020		
20 Jun 2018	B6	A03524	Body-Backside	1616.02	CW-CF10.8	n.a	n/a	B3	n/a	0	41	30.89	0.076	0.050	-0.050		
<b>Simultaneous Transmit Satellite and Bluetooth</b>																	
20 Jun 2018	B7	A03524	Body-Backside	1616.02/2402	CW-CF10.8	n.a	n.a	n/a	n/a	0	0	30.89	0.291	0.182	0.630		
21 Jun 2018	B8	A03524	Body-Backside	2441	BT-3-EDR	n.a	n.a	n/a	n/a	0	0	3.44	0.004	0.001	10.000		
<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>Body</b>		<b>1g Average</b>		<b>1.6 W/kg</b>		<b>General Population</b>	

See Section 8.0 for details

This device transmits only textual data in the Satellite bands and has a transmit duty cycle of 9.3% as indicated Section 13.2. This duty cycle cannot be altered by the user. A measurement Crest Factor of 10.8 was used by the SAR measurement server. The measured SAR in the above table is the post-processed SAR adjusted by the Crest Factor.

This device is not intended to be used or transmit while placed in the user's pocket or within the user's apparel.

## 11.0 SCALING OF MAXIMUM MEASURE SAR

**Table 11.0 SAR Scaling**

Scaling of Maximum Measured SAR <sup>(1)</sup>									
Plot ID	Configuration	Freq	Measured Fluid Deviation		Measured Conducted Power	Measured Drift	Measured SAR (1g)		
		(MHz)	Permittivity	Conductivity	(dBm)	(dB)	(W/kg)		
B1	Body-Backside	1616.02	-4.15%	-4.11%	30.9	-0.740	0.327		
Step 1									
Fluid Sensitivity Adjustment									
Plot ID	Scale Factor (%)		X		Measured SAR (W/kg)	=	Step 1 Adjusted SAR (W/kg)		
B1	0.98		X		0.327	=	0.327		
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 (W/kg)
B1	30.9		31.5	0.6	+		0.327	=	0.375
Step 3 (ISED)									
Drift Adjustment									
Plot ID	Measured Drift (dB)		+		Step 2 Adjusted SAR (W/kg)	=	Step 3 Adjusted SAR (W/kg)		
B1	-0.740		+		0.375	=	0.445		
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 (W/kg)
B8*	2.5	2402	0	0.004	+		0.375	=	0.379
Step 5 (ISED)									
Simultaneous Transmission - Bluetooth and/or WiFi									
Plot ID	Rated Output Power (Pmax) (mW)	Freq (MHz)	Separation Distance (mm)	Measured SAR (W/kg)	+		Step 3 Adjusted SAR (W/kg)	=	Step 4 Adjusted SAR (W/kg)
B8*	2.5	2402	0	0.004	+		0.445	=	0.449
Step 6									
Reported SAR									
Plot ID	FCC				ISED				
	From Steps 1, 2 and 4				From Steps 1,2,3 and 5				
	1g SAR (W/kg)				1g SAR (W/kg)				
B1	<b>0.375</b>				<b>0.445</b>				
Simultaneous	<b>0.379</b>				<b>0.449</b>				

The device is capable of simultaneous transmission between the Bluetooth transmitter and the Satellite transmitter, Test exclusion of the Bluetooth transmitter is evaluated using Max Power = 4dBm (2.52mW), Separation Distance = 5mm, Transmit Frequency = 2.402GHz.

Per KDB 447498 D01v06 [4.3.1(a)], SAR Test Exclusion is given by:


$$[(\text{Max Power, mW}) / (\text{Separation Distance, mm})] * [\sqrt{f, \text{GHz}}] \leq 3.0 \text{ for 1g SAR}$$

$$[(2.52)/(5)] * [(\sqrt{2.402})] = 0.774 \leq 3.0$$

Therefore the Bluetooth transmitter meets the SAR Test Exclusion criteria.

\*The BT Transmitter meets Simultaneous Transmission Test Exclusion. The measure SAR was 0.004W/kg

NOTES to Table 11.0	
<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 5. 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 5 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 11.1 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>	Per RSS-102. The SAR, either measured or calculated, of ANY and ALL simultaneous transmitters must be added together and includes all contributors.
<b>Step 6</b>	The Reported SAR is the Maximum Final Adjusted Cumulative SAR from the applicable Steps 1 through 5 are reported on Page 1 of this report.

<p>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.</p>	 <hr/> <b>Trevor Whillock</b> Test Lab Engineer Celltech Labs Inc. <hr/> <b>25 June 2018</b> Date
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## 12.0 SAR EXPOSURE LIMITS

Table 12.0 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)		<b>1.6 W/kg</b>	8.0 W/kg
Spatial Peak <sup>(3)</sup> (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.			



## 13.0 DETAILS OF SAR EVALUATION

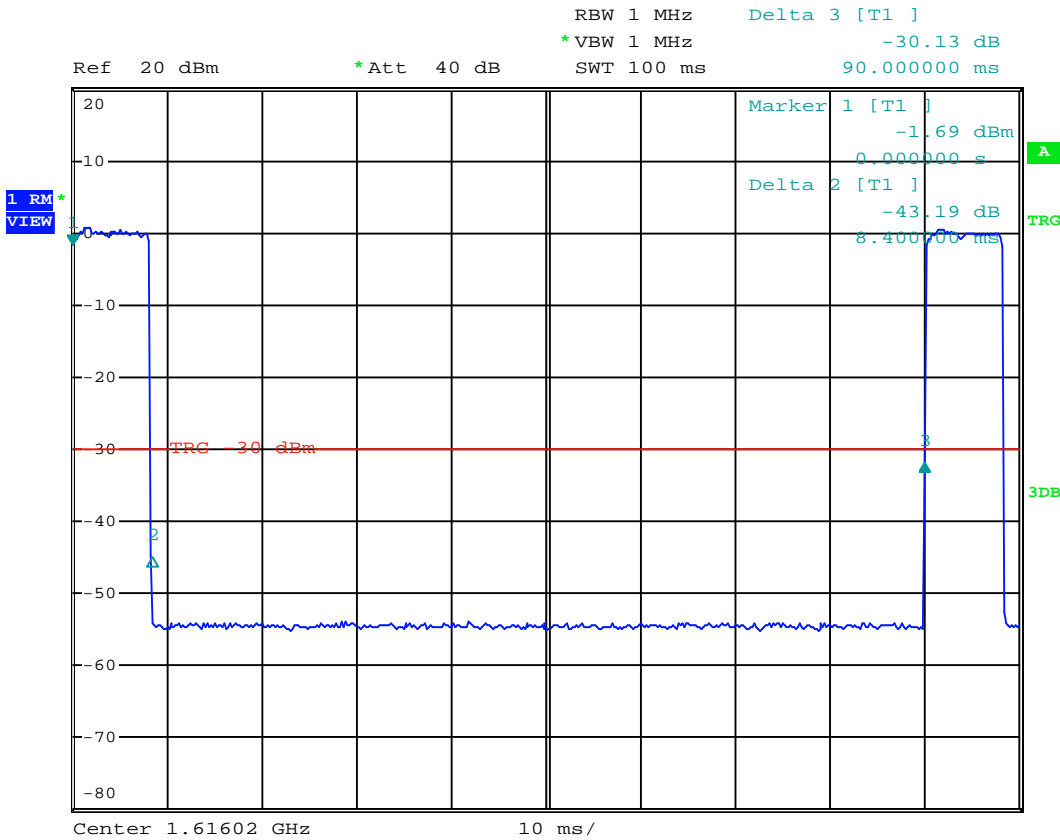
### 13.0 Day Log

DAY LOG					Fluid Dielectric	SPC	Test
Date	Ambient Temp °C	Fluid Temp °C	Humidity	TSL			
19 Jun 2018	25	22.2	27%	1640B	X	X	X
20 Jun 2018	25	23.1	26%	1640B			X
20 Jun 2018	24	24.3	26%	1640B	X		
21 June 2018	24	24.2	31%	2450B		X	X

### 13.1 DUT Setup and Configuration

DUT Setup and Configuration	
<b>Overview</b>	<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 less than 5mm.</p> <p>The Device was capable of transmitting at various modulations and data rates. The Conducted Power was higher when measured in CW 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>

### 13.2 Duty Cycle Evaluation



Date: 14.JUN.2018 14:05:38

This device transmits only textual data in the Satellite band and has a transmit duty cycle of 9.3% as indicated in the above plot. This duty cycle cannot be altered by the user. A measurement Crest Factor of 10.8 was used by the SAR measurement server. The measured SAR in Table 10.0 is the post-processed SAR adjusted by the Crest Factor.

### 13.3 DUT Positioning

DUT Positioning	
<b>Positioning</b>	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.
<b>FACE Configuration</b>	This device is not intended to be held to the face and was not tested in the FACE configuration.
<b>BODY Configuration</b>	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.
<b>HEAD Configuration</b>	This device is not intended to be held to the ear and was not tested in the HEAD configuration.

### 13.4 General Procedures and Report

General Procedures and Reporting	
<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>

### 13.5 Fluid Dielectric and Systems Performance Check

Fluid Dielectric and Systems Performance Check	
<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>

### 13.6 Scan Resolution 100MHz to 2GHz

Scan Resolution 100MHz to 2GHz	
<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	

### 13.7 Scan Resolution 2GHz to 3GHz

Scan Resolution 2GHz to 3GHz	
Maximum distance from the closest measurement point to phantom surface: (Geometric Center of Probe Center)	4 ± 1 mm
Maximum probe angle normal to phantom surface. (Flat Section ELI Phantom)	5° ± 1°
Area Scan Spatial Resolution $\Delta X, \Delta Y$	12 mm
Zoom Scan Spatial Resolution $\Delta X, \Delta Y$	5 mm
Zoom Scan Spatial Resolution $\Delta Z$ (Uniform Grid)	5 mm
Zoom Scan Volume X, Y, Z	30 mm
Phantom	ELI
Fluid Depth	150 ± 5 mm
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	

### 13.8 Scan Resolution 5GHz to 6GHz

Scan Resolution 5GHz to 6GHz	
Maximum distance from the closest measurement point to phantom surface: (Geometric Center of Probe Center)	4 ± 1 mm
Maximum probe angle normal to phantom surface. (Flat Section ELI Phantom)	5° ± 1°
Area Scan Spatial Resolution $\Delta X, \Delta Y$	10 mm
Zoom Scan Spatial Resolution $\Delta X, \Delta Y$	4 mm
Zoom Scan Spatial Resolution $\Delta Z$ (Uniform Grid)	2 mm
Zoom Scan Volume X, Y, Z	22 mm
Phantom	ELI
Fluid Depth	100 ± 5 mm
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	

## 14.0 MEASUREMENT UNCERTAINTIES

Table 14.0 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 14.1 Calculation of Degrees of Freedom**

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

## 15.0 FLUID DIELECTRIC PARAMETERS

**Table 15.0 Fluid Dielectric Parameters 1640MHz BODY TSL**

\*\*\*\*\*  
 Aprel Laboratory  
 Test Result for UIM Dielectric Parameter  
 Tue 19/Jun/2018 12:49:04  
 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
1.5400	53.89	1.36	52.08	1.26
1.5500	53.88	1.36	51.81	1.27
1.5600	53.86	1.37	51.99	1.26
1.5700	53.85	1.38	51.74	1.29
1.5800	53.84	1.38	51.72	1.29
1.5900	53.83	1.39	51.83	1.32
1.6000	53.81	1.39	51.75	1.31
1.6100	53.80	1.40	51.52	1.33
1.6200	53.77	1.41	51.57	1.35
1.6300	53.75	1.41	51.67	1.37
1.6400	53.72	1.42	51.54	1.34
1.6500	53.69	1.43	51.49	1.35
1.6600	53.67	1.43	51.35	1.38
1.6700	53.64	1.44	51.26	1.38
1.6800	53.62	1.44	51.27	1.39
1.6900	53.59	1.45	51.18	1.39
1.7000	53.56	1.46	51.09	1.44
1.7100	53.54	1.46	51.16	1.42



### FLUID DIELECTRIC PARAMETERS

Date:	19 Jun 2018	Fluid Temp:	22.2	Frequency:	1640MHz	Tissue:	Body
Freq (MHz)	Test_e	Test_s	Target_e	Target_s	Deviation Permittivity	Deviation Conductivity	
1540.0000		52.0800	1.2600	53.8900	1.36	-3.36%	-7.35%
1550.0000		51.8100	1.2700	53.8800	1.36	-3.84%	-6.62%
1560.0000		51.9900	1.2600	53.8600	1.37	-3.47%	-8.03%
1570.0000		51.7400	1.2900	53.8500	1.38	-3.92%	-6.52%
1580.0000		51.7200	1.2900	53.8400	1.38	-3.94%	-6.52%
1590.0000		51.8300	1.3200	53.8300	1.39	-3.72%	-5.04%
1600.0000		51.7500	1.3100	53.8100	1.39	-3.83%	-5.76%
1610.0000		51.5200	1.3300	53.8000	1.40	-4.24%	-5.00%
1616.0200	*	51.5501	1.3420	53.7819	1.41	-4.15%	-4.55%
1620.0000		51.5700	1.3500	53.7700	1.41	-4.09%	-4.26%
1621.0200	*	51.5802	1.3520	53.7680	1.41	-4.07%	-4.11%
1625.9800	*	51.6298	1.3620	53.7580	1.41	-3.96%	-3.41%
1630.0000		51.6700	1.3700	53.7500	1.41	-3.87%	-2.84%
1640.0000		51.5400	1.3400	53.7200	1.42	-4.06%	-5.63%
1650.0000		51.4900	1.3500	53.6900	1.43	-4.10%	-5.59%
1660.0000		51.3500	1.3800	53.6700	1.43	-4.32%	-3.50%
1670.0000		51.2600	1.3800	53.6400	1.44	-4.44%	-4.17%
1680.0000		51.2700	1.3900	53.6200	1.44	-4.38%	-3.47%
1690.0000		51.1800	1.3900	53.5900	1.45	-4.50%	-4.14%
1700.0000		51.0900	1.4400	53.5600	1.46	-4.61%	-1.37%
1710.0000		51.1600	1.4200	53.5400	1.46	-4.45%	-2.74%

\*Channel Frequency Tested

**Table 15.1 Fluid Dielectric Parameters 2450MHz BODY TSL**

```

*****
Aprel Laboratory
Test Result for UIM Dielectric Parameter
Wed 20/Jun/2018 15:25:28
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_eBFCC Limits for Body Epsilon
FCC_sBFCC 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	52.96	1.78
2.3600	52.82	1.86	52.85	1.77
2.3700	52.81	1.87	52.84	1.77
2.3800	52.79	1.88	52.78	1.79
2.3900	52.78	1.89	52.70	1.81
2.4000	52.77	1.90	52.53	1.84
2.4100	52.75	1.91	52.34	1.85
2.4200	52.74	1.92	52.53	1.86
2.4300	52.73	1.93	52.38	1.88
2.4400	52.71	1.94	52.34	1.88
2.4500	52.70	1.95	52.26	1.89
2.4600	52.69	1.96	52.41	1.90
2.4700	52.67	1.98	52.30	1.92
2.4800	52.66	1.99	52.24	1.95

### FLUID DIELECTRIC PARAMETERS

Date:	20 Jun 2018	Fluid Temp:	24.3	Frequency:	2450MHz	Tissue:	Body
Freq (MHz)	Test_e	Test_s	Target_e	Target_s	Deviation Permittivity	Deviation Conductivity	
2350.0000		52.9600	1.7800	52.8300	1.85	0.25%	-3.78%
2360.0000		52.8500	1.7700	52.8200	1.86	0.06%	-4.84%
2370.0000		52.8400	1.7700	52.8100	1.87	0.06%	-5.35%
2380.0000		52.7800	1.7900	52.7900	1.88	-0.02%	-4.79%
2390.0000		52.7000	1.8100	52.7800	1.89	-0.15%	-4.23%
2400.0000		52.5300	1.8400	52.7700	1.90	-0.45%	-3.16%
2402.0000	*	52.4920	1.8420	52.7660	1.90	-0.52%	-3.15%
2410.0000		52.3400	1.8500	52.7500	1.91	-0.78%	-3.14%
2420.0000		52.5300	1.8600	52.7400	1.92	-0.40%	-3.12%
2430.0000		52.3800	1.8800	52.7300	1.93	-0.66%	-2.59%
2440.0000		52.3400	1.8800	52.7100	1.94	-0.70%	-3.09%
2450.0000		52.2600	1.8900	52.7000	1.95	-0.83%	-3.08%
2460.0000		52.4100	1.9000	52.6900	1.96	-0.53%	-3.06%
2470.0000		52.3000	1.9200	52.6700	1.98	-0.70%	-3.03%
2480.0000		52.2400	1.9500	52.6600	1.99	-0.80%	-2.01%
2490.0000		52.4400	1.9400	52.6500	2.01	-0.40%	-3.48%
2500.0000		52.3300	1.9700	52.6400	2.02	-0.59%	-2.48%
2510.0000		52.3600	1.9800	52.6200	2.04	-0.49%	-2.94%
2520.0000		52.2800	1.9900	52.6100	2.05	-0.63%	-2.93%
2530.0000		52.3200	2.0100	52.6000	2.06	-0.53%	-2.43%
2540.0000		52.0700	2.0300	52.5900	2.08	-0.99%	-2.40%
2550.0000		52.0800	2.0400	52.5700	2.09	-0.93%	-2.39%

\*Channel Frequency Tested

## 16.0 SYSTEM VERIFICATION TEST RESULTS

Table 16.0 System Verification Results 1640MHz BODY TSL

System Verification Test Results					
Date		Frequency (MHz)	Validation Source		
			P/N		S/N
19 Jun 2018		1640	ALS-D-1620-S-2		207-00102
Fluid Type	Fluid Temp °C	Ambient Temp °C	Ambient Humidity (%)	Forward Power (mW)	Source Spacing (mm)
Body	22.2	25	27%	1000	10
Fluid Parameters					
Permittivity			Conductivity		
Measured	Target	Deviation	Measured	Target	Deviation
51.54	53.72	-4.06%	1.34	1.42	-5.63%
Measured SAR					
1 gram			10 gram		
Measured	Target	Deviation	Measured	Target	Deviation
31.30	33.29	-5.98%	17.10	18.15	-5.79%
Measured SAR Normalized to 1.0W					
1 gram			10 gram		
Normalized	Target	Deviation	Normalized	Target	Deviation
31.30	33.29	-5.98%	17.10	18.15	-5.79%

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.

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.

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.

The forward power applied was same forward power applied by the calibration lab during the calibration of this validation source.

**Table 16.1 System Verification Results 2450MHz BODY TSL**

<b>System Verification Test Results</b>					
Date		Frequency (MHz)	Validation Source		
			P/N		S/N
21 June 2018		2450	D2450V2		825
Fluid Type	Fluid Temp °C	Ambient Temp °C	Ambient Humidity (%)	Forward Power (mW)	Source Spacing (mm)
Body	24.2	24	31%	250	10
Fluid Parameters					
Permittivity			Conductivity		
Measured	Target	Deviation	Measured	Target	Deviation
52.26	52.70	-0.83%	1.89	1.95	-3.08%
Measured SAR					
1 gram			10 gram		
Measured	Target	Deviation	Measured	Target	Deviation
13.20	13.00	1.54%	6.17	6.05	1.98%
Measured SAR Normalized to 1.0W					
1 gram			10 gram		
Normalized	Target	Deviation	Normalized	Target	Deviation
52.80	50.70	4.14%	24.68	23.80	3.70%
<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>					

## 17.0 SYSTEM VALIDATION SUMMARY


Table 17.0 System Validation Summary

System Validation Summary											
Frequency (MHz)	Validation Date	Probe Model	Probe S/N	Validation Source	Source S/N	Tissue	Tissue Dielectrics		Validation Results		
							Permittivity	Conductivity	Sensitivity	Linearity	Isotropy
30		EX3DV4	3600	CLA-30	1005	Head					
150	03-May-17	EX3DV4	3600	CLA-150	4007	Body	66.48	0.79	Pass	Pass	Pass
150	04-May-17	EX3DV4	3600	CLA-150	4007	Head	51.51	0.81	Pass	Pass	Pass
450	08-May-17	EX3DV4	3600	D450V3	1068	Body	54.65	0.95	Pass	Pass	Pass
450	16-May-17	EX3DV4	3600	D450V3	1068	Head	43.70	0.83	Pass	Pass	Pass
835	03-May-18	EX3DV4	3600	D835V2	4d075	Body	53.31	1.00	Pass	Pass	Pass
835	19-May-17	EX3DV4	3600	D835V2	4d075	Head	42.01	0.89	Pass	Pass	Pass
900	08-May-18	EX3DV4	3600	D900V2	045	Body	54.46	1.10	Pass	Pass	Pass
900	02-Aug-17	EX3DV4	3600	D900V2	045	Head	39.10	0.93	Pass	Pass	Pass
1640	06-May-18	EX3DV4	3600	1620-S-2	207-00102	Body	39.87	1.27	Pass	Pass	Pass
1640	07-May-18	EX3DV4	3600	1620-S-2	207-00102	Head	39.87	1.27	Pass	Pass	Pass
1800	21-Jul-17	EX3DV4	3600	D1800V2	247	Body	54.77	1.53	Pass	Pass	Pass
1800	18-Jul-17	EX3DV4	3600	D1800V2	247	Head	40.70	1.33	Pass	Pass	Pass
2450	23-May-18	EX3DV4	3600	D2450V2	825	Body	49.51	1.92	Pass	Pass	Pass
2450	24-May-18	EX3DV4	3600	D2450V2	825	Head	37.95	1.87	Pass	Pass	Pass
5250	24-Jul-17	EX3DV4	3600	D5GHzV2	1031	Body	46.42	5.69	Pass	Pass	Pass
5250	24-Jul-17	EX3DV4	3600	D5GHzV2	1031	Head	35.96	4.99	Pass	Pass	Pass

## 18.0 MEASUREMENT SYSTEM SPECIFICATIONS

Table 18.0 Measurement System Specifications

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

Measurement System Specification		
Probe Specification		
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	
Phantom Specification		
<p>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.</p>		
		<b>ELI Phantom</b>
Device Positioner Specification		
<p>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 <math>65^{\circ}</math>. 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.</p>		
		<b>Device Positioner</b>



## 19.0 TEST EQUIPMENT LIST

**Table 19.0 Equipment List and Calibration**

Test Equipment List				
DESCRIPTION	ASSET NO.	SERIAL NO.	DATE CALIBRATED	CALIBRATION INTERVAL
Schmid & Partner DASY 6 System	-	-	-	-
-DASY Measurement Server	00158	1078	CNR	CNR
-Robot	00046	599396-01	CNR	CNR
-DAE4	00019	353	20-Apr-18	Annual
-EX3DV4 E-Field Probe	00213	3600	25-Apr-18	Annual
-CLA 30 Validation Dipole	00300	1005	23-Nov-17	Triennial
-CLA150 Validation Dipole	00251	4007	27-Apr-17	Triennial
-D450V3 Validation Dipole	00221	1068	23-Apr-18	Triennial
-D835V2 Validation Dipole	00217	4D075	20-Apr-18	Triennial
-D900V2 Validation Dipole	00020	54	24-Apr-17	Triennial
-D1640/1620-S-2 Validation Dipole	00299	207-00102	07-Nov-17	Triennial
-D2450V2 Validation Dipole	00219	825	24-Apr-18	Triennial
-D5GHzV2 Validation Dipole	00126	1031	26-Apr-18	Triennial
ELI Phantom	00247	-	CNR	CNR
HP 85070C Dielectric Probe Kit	00033	none	CNR	CNR
Gigatronics 8652A Power Meter	00110	1835801	29-Feb-16	Triennial
Gigatronics 80701A Power Sensor	00248	1833687	29-Feb-16	Triennial
HP 8753ET Network Analyzer	00134	US39170292	29-Dec-17	Triennial
Rohde & Schwarz SMR20 Signal Generator	00006	100104	29-May-17	Triennial
Amplifier Research 10W1000C Power Amplifier	00041	27887	CNR	CNR
Amplifier Research 5S1G4 Power Amplifier	00106	26235	CNR	CNR
Narda Directional Coupler 3020A	00064	-	CNR	CNR
Traceable VWR Thermometer	00291	-	19-Nov-16	Triennial
Traceable VWR Jumbo Humidity/Thermometer	00295	170120555	17-Feb-17	Triennial
DC-18G 10W 30db Attenuator	00102	-	COU	COU
R&S FSP40 Spectrum Analyzer	00241	100500	15-May-18	Triennial
RF Cable-SMA	00311	-	CNR	CNR
HP Calibration Kit	00145	-	10-Feb-17	Triennial

CNR = Calibration Not Required

COU = Calibrate on Use

## 20.0 FLUID COMPOSITION

Table 20.0 Fluid Composition 1640MHz 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>
54.47	45.22	0.33	0.0	0.0

(1) Non-Iodinized

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

(3) Dow Chemical Dowicil 75 Antimicrobial Perservative

Table 20.1 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: 6/19/2018 1:03:42 PM

Test Laboratory: Celltech Labs

**SPC-1640B Jun 19 2018**

**DUT: Dipole 1640 MHz D1640V2; Type: D1640V2; Serial: D1640V2 - SN:207-00102**

Communication System: UID 0, CW (0); Communication System Band: FullSpan (0.0 - 6000.0 MHz); Frequency: 1640 MHz; Communication System PAR: 0 dB; PMF: 1

Medium: TSL\_1640B[19JN18]

Medium parameters used:  $f = 1640$  MHz;  $\sigma = 1.34$  S/m;  $\epsilon_r = 51.54$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY Configuration:

- Probe: EX3DV4 - SN3600; ConvF(7.47, 7.47, 7.47); Calibrated: 4/25/2018, ConvF(7.47, 7.47, 7.47); Calibrated: 4/25/2018, ConvF(7.47, 7.47, 7.47); Calibrated: 4/25/2018;
  - Modulation Compensation:
- Sensor-Surface: 4mm (Mechanical Surface Detection),  $z = 16.0, 31.0, 151.0$
- Electronics: DAE4 Sn353; Calibrated: 4/20/2018
- Phantom: ELI V5.0 (20deg probe tilt); Type: QD OVA 002 Ax;
- DASYS2 52.10.1(1476);

**Frequency: 1640 MHz**

**SPC/SPC 1640B Input=1.0W, Target=33.29W/kg/Area Scan (4x8x1):** Measurement grid: dx=15mm, dy=15mm

Maximum value of SAR (measured) = 32.4 W/kg

**SPC/SPC 1640B Input=1.0W, Target=33.29W/kg/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=7.5mm, dy=7.5mm, dz=5mm

Reference Value = 154.6 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 54.3 W/kg

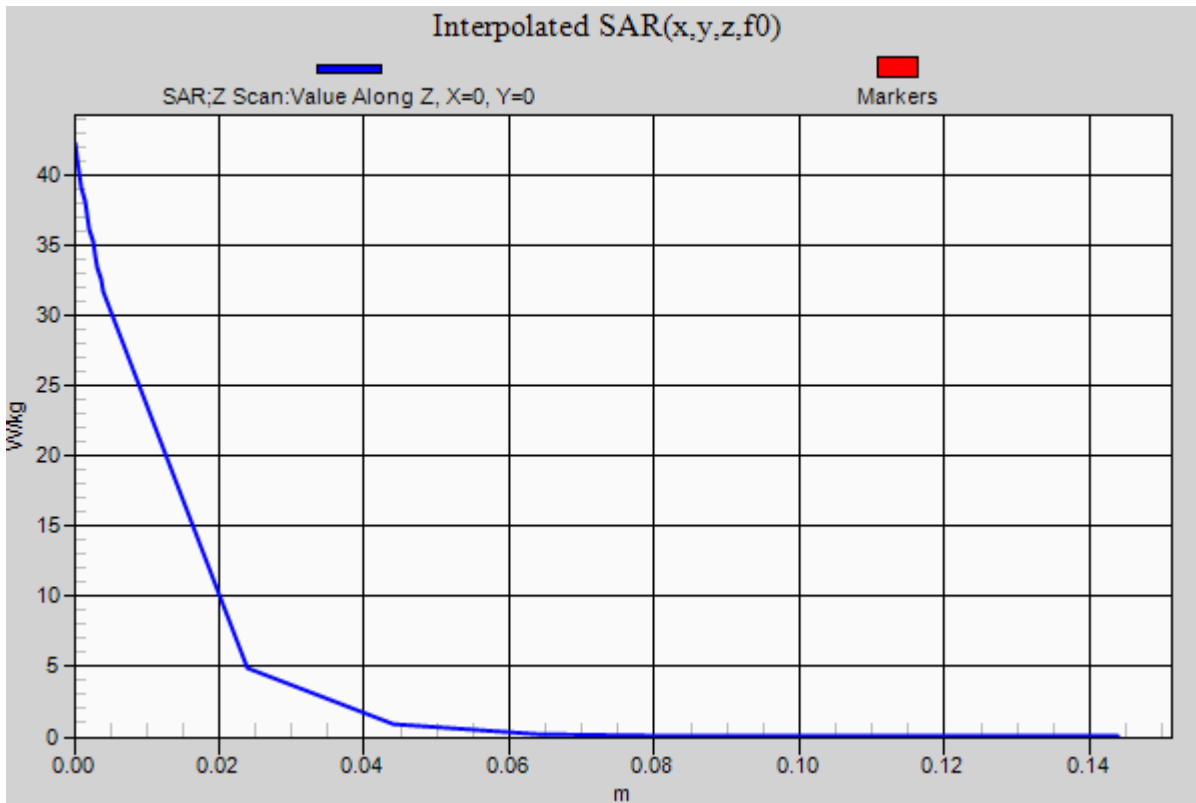
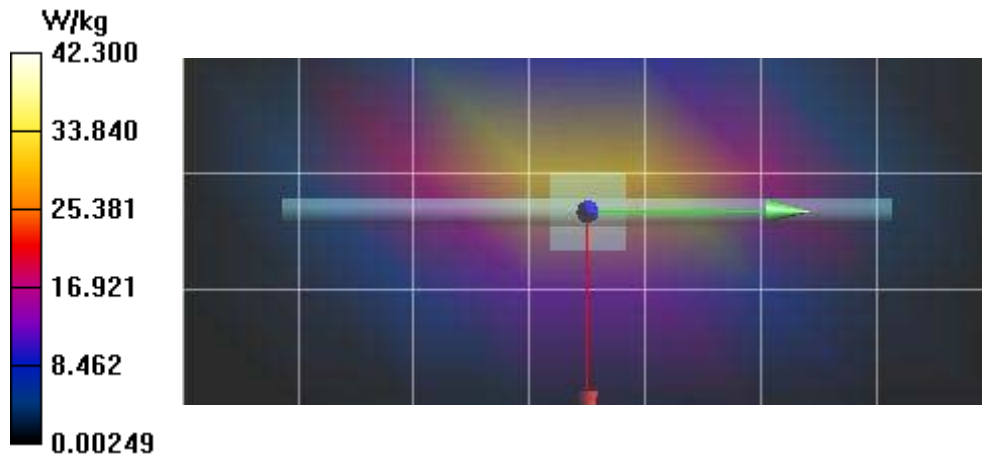
**SAR(1 g) = 31.3 W/kg; SAR(10 g) = 17.1 W/kg**

Maximum value of SAR (measured) = 35.1 W/kg

**SPC/SPC 1640B Input=1.0W, Target=33.29W/kg/Z Scan (1x1x19):** Measurement grid: dx=20mm, dy=20mm, dz=20mm

Penetration depth = n/a (n/a, 10.67) [mm]

Maximum value of SAR (interpolated) = 42.3 W/kg



Date/Time: 6/21/2018 9:27:07 AM

Test Laboratory: Celltech Labs

**SPC-2450B Jun 21 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{20JN18}

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.89$  S/m;  $\epsilon_r = 52.26$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY Configuration:

- Probe: EX3DV4 - SN3600; ConvF(6.54, 6.54, 6.54); Calibrated: 4/25/2018, ConvF(6.54, 6.54, 6.54); Calibrated: 4/25/2018, ConvF(6.54, 6.54, 6.54); Calibrated: 4/25/2018;
  - Modulation Compensation:
- Sensor-Surface: 4mm (Mechanical Surface Detection),  $z = -1.5, 31.0, -99.0$
- Electronics: DAE4 Sn353; Calibrated: 4/20/2018
- Phantom: ELI V5.0 (20deg probe tilt); Type: QD OVA 002 Ax;
- DASYS5 52.10.1(1476);

**Frequency: 2450 MHz**

**SPC/SPC 2450B Input=250mw, Target=12.8W/kg/Area Scan (4x9x1):** Measurement grid: dx=12mm, dy=12mm

Maximum value of SAR (measured) = 13.0 W/kg

**SPC/SPC 2450B Input=250mw, Target=12.8W/kg/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 89.14 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 26.4 W/kg

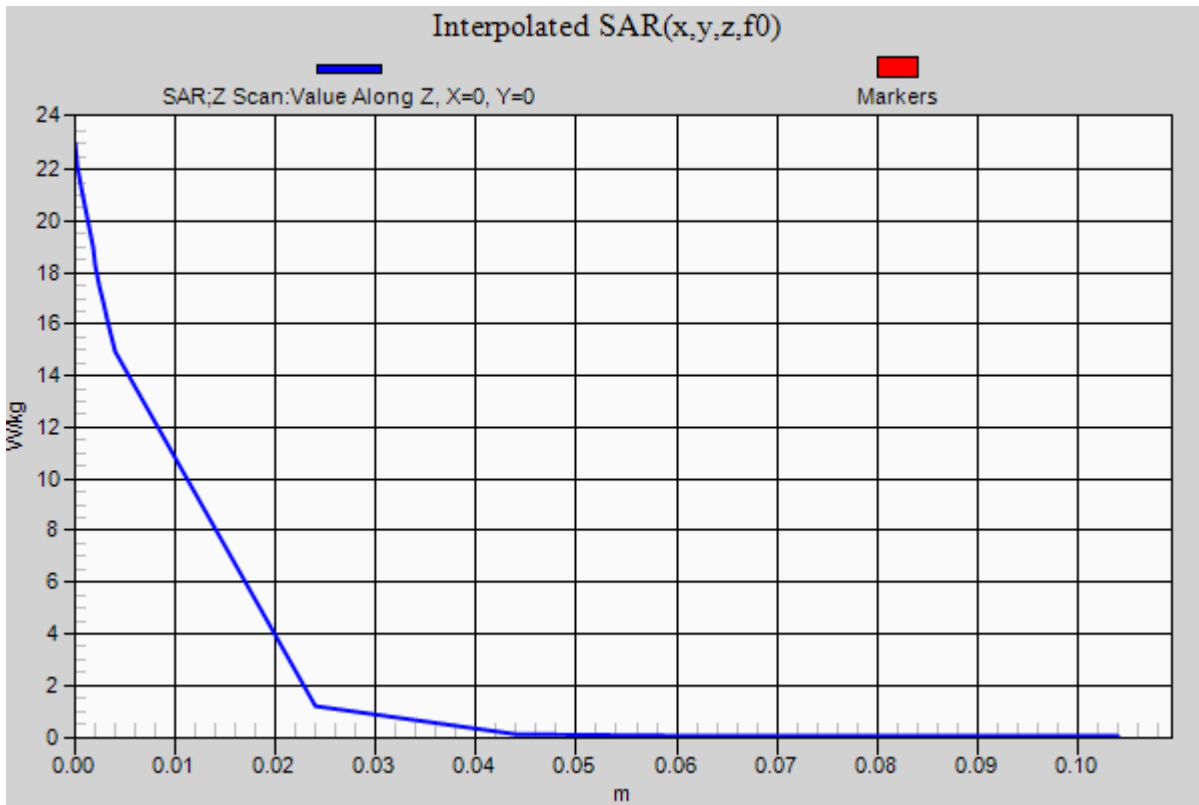
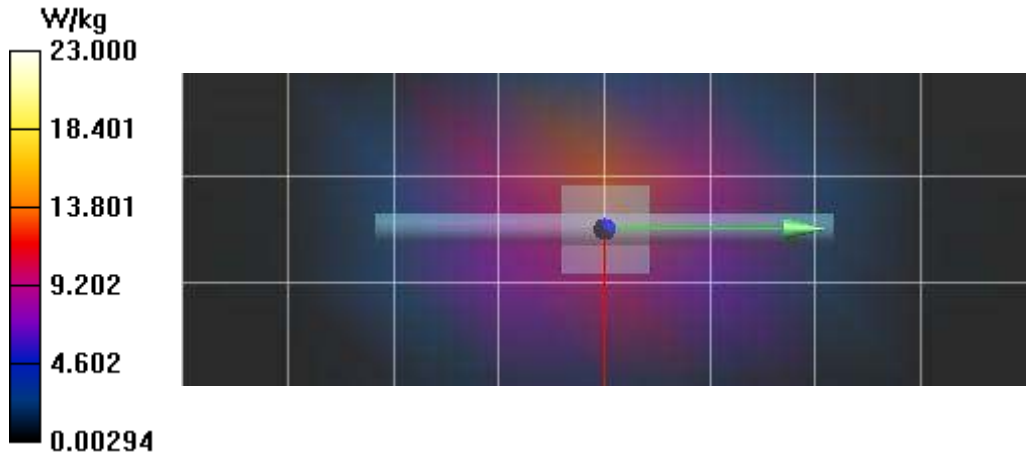
**SAR(1 g) = 13.2 W/kg; SAR(10 g) = 6.17 W/kg**

Maximum value of SAR (measured) = 15.2 W/kg

**SPC/SPC 2450B Input=250mw, Target=12.8W/kg/Z Scan (1x1x17):** Measurement grid: dx=20mm, dy=20mm, dz=20mm

Penetration depth = n/a (n/a, 8.020) [mm]

Maximum value of SAR (interpolated) = 23.0 W/kg



## APPENDIX B – MEASUREMENT PLOTS OF MAXIMUM MEASURED SAR

**Garmin-1640B June 19 2018**

**DUT: Garmin A03524; Type: Sample; Serial: IMEI Number**

Communication System: UID 0, CW-CF10.8 (0); Communication System Band: Any; Frequency: 1616.02 MHz; Communication System PAR: 10.334 dB; PMF: 3.28625

Medium: TSL\_1640B[19JN18]

Medium parameters used (interpolated):  $f = 1616.02$  MHz;  $\sigma = 1.342$  S/m;  $\epsilon_r = 51.55$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY Configuration:

- Probe: EX3DV4 - SN3600; ConvF(7.47, 7.47, 7.47); Calibrated: 4/25/2018, ConvF(7.47, 7.47, 7.47); Calibrated: 4/25/2018, ConvF(7.47, 7.47, 7.47); Calibrated: 4/25/2018;
  - Modulation Compensation
- 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: 4/20/2018
- Phantom: ELI V5.0 (20deg probe tilt); Type: QD OVA 002 Ax;
- DASYS2 52.10.1(1476);

**Frequency: 1616.02 MHz**

**1640B/B1-A03524 1616.02MHz Body-Touch Backside, Area Scan (9x15x1):** Measurement grid: dx=15mm, dy=15mm

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

Maximum value of SAR (measured) = 0.365 W/kg

**1640B/B1-A03524 1616.02MHz Body-Touch Backside, Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=7.5mm, dy=7.5mm, dz=5mm

Reference Value = 10.94 V/m; Power Drift = -0.75 dB

Peak SAR (extrapolated) = 0.548 W/kg

**SAR(1 g) = 0.327 W/kg; SAR(10 g) = 0.189 W/kg**

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

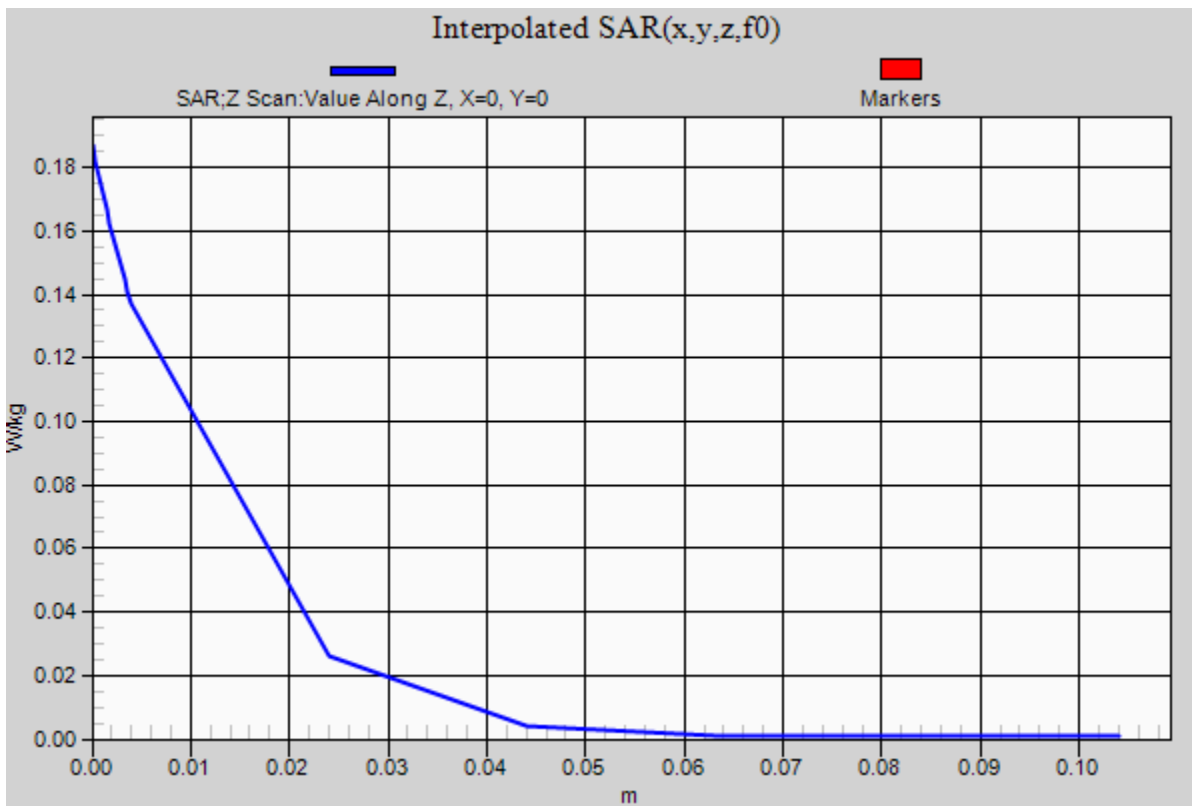
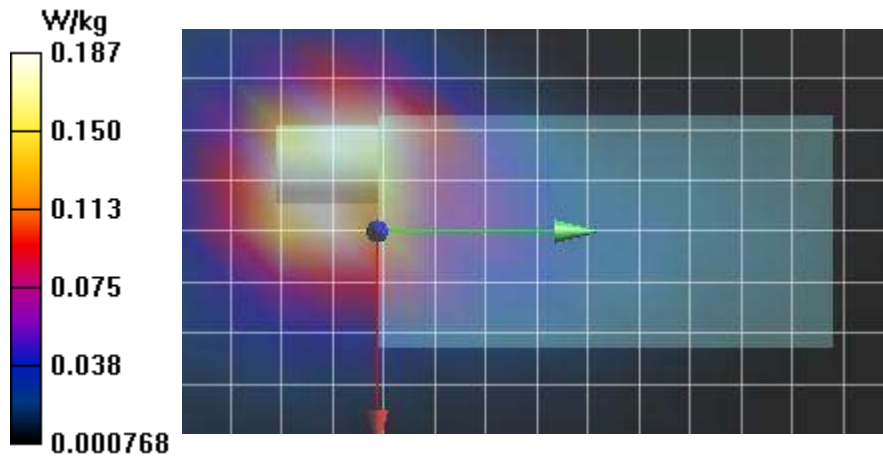
Maximum value of SAR (measured) = 0.359 W/kg

**1640B/B1-A03524 1616.02MHz Body-Touch Backside, 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, 12.12) [mm]

Maximum value of SAR (interpolated) = 0.187 W/kg





**Plot B8**

Date/Time: 6/21/2018 11:12:01 AM

Test Laboratory: Celltech Labs

**Garmin-2450B June 21 2018**

**DUT: Garmin A03524; Type: Sample; Serial: IMEI Number**

Communication System: UID 0, CW(3) (0); Communication System Band: Bluetooth; Frequency: 2402 MHz; Communication System PAR: 0 dB; PMF: 1.12202e-005

Medium: TSL\_2450B[20JN18]

Medium parameters used (interpolated):  $f = 2402$  MHz;  $\sigma = 1.842$  S/m;  $\epsilon_r = 52.492$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY Configuration:

- Probe: EX3DV4 - SN3600; ConvF(6.54, 6.54, 6.54); Calibrated: 4/25/2018, ConvF(6.54, 6.54, 6.54); Calibrated: 4/25/2018, ConvF(6.54, 6.54, 6.54); Calibrated: 4/25/2018;
  - Modulation Compensation:
- 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: 4/20/2018
- Phantom: ELI V5.0 (20deg probe tilt); Type: QD OVA 002 Ax;
- DASYS2 52.10.1(1476);

**Frequency: 2402 MHz**

**2450B/B8-A03524 2402MHz BT-3-EDR, Body-Touch Backside, Area Scan (9x15x1):** Measurement grid: dx=15mm, dy=15mm

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

Maximum value of SAR (measured) = 0.00467 W/kg

**2450B/B8-A03524 2402MHz BT-3-EDR, Body-Touch Backside, Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=7.5mm, dy=7.5mm, dz=5mm

Reference Value = 0.3200 V/m; Power Drift = 10.00 dB

Peak SAR (extrapolated) = 0.0130 W/kg

**SAR(1 g) = 0.0039 W/kg; SAR(10 g) = 0.00146 W/kg**

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

Maximum value of SAR (measured) = 0.00406 W/kg

**2450B/B8-A03524 2402MHz BT-3-EDR, Body-Touch Backside, 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, 8.583) [mm]

Maximum value of SAR (interpolated) = 0.00263 W/kg

