

	Date(s) of Evaluation Jun. 20, 2013	Test Report Serial No. 061213IPH-1239S	Test Report Revision No. Rev. 1.1 (2nd Release)	
	Test Report Issue Date Jul. 3, 2013	Description of Test(s) Specific Absorption Rate	RF Exposure Category Gen. Pop. / Uncontrolled	

Test Lab Certificate No. 2470.01

DECLARATION OF COMPLIANCE		SAR RF EXPOSURE EVALUATION			FCC & IC		
Test Lab Information	CELLTECH LABS INC. 21-364 Lougheed Road, Kelowna, BC. V1X 7R8 Canada						
Test Lab Accreditation	A2LA - ISO/IEC 17025:2005 (A2LA TEST LAB CERTIFICATE NO. 2470.01)						
Applicant Information	GARMIN INTERNATIONAL INC. 1200, East 151 st Street, Olathe, KS, 66062 USA						
Application Type(s)	FCC	TCB Certification	IC	CB Certification			
Standard(s) Applied	FCC	47 CFR §2.1093	IC	Health Canada Safety Code 6			
Procedure(s) Applied	FCC	OET Bulletin 65, Supplement C (01-01)					
		KDB 447498 D01v05 - General RF Exposure Procedures					
	IC	KDB 248227 D01v01r02 - SAR Measurement Procedures for 802.11a/b/g Transmitters					
		RSS-102 Issue 4					
Device RF Exposure Category	IEEE	1528-2003	IEC	62209-2:2010			
	FCC/IC	General Population / Uncontrolled Environment					
Device Classification(s)	FCC	DTS - Digital Transmission System (Part 15 Subpart C)					
	IC	Low Power License-Exempt Radio-communication Device (RSS-210)					
Device Identifier(s)	FCC ID:	IPH-F3ARGD00	IC:	1792A-F3ARGD00			
Device Model No.	F3ARGD00						
Test Sample Serial No.	n/a (Identical Prototype)						
Test Sample Hardware Rev. No.	v5		Test Sample Firmware Rev. No.		V0.20		
Measurement Date(s)	Jun. 20, 2013		Date of Sample Receipt		Jun. 12, 2013		
Device Description	Wrist-worn GPS Device						
Internal Transmitter(s) Type	802.11b/g		802.15				
Transmitter Type Tested	802.11b/g						
Transmitter Specifications	Frequency Range - 2412 - 2462 MHz						
	802.11b - Modulations [DSSS, CCK] - Data Rates [1, 2, 5.5, 11]						
	802.11g - Modulations [OFDM] - Data Rates [6, 9, 12, 24, 36, 48, 54]						
	Maximum Rated Conducted Output Power = 10 mW						
Co-located Transmitter(s)	Duty Cycle = 44%						
	802.15	2402 - 2480 MHZ	2 mW	No simultaneous tx			
Antenna Type(s) Tested	Internal (2.4 GHz)						
Battery Type(s) Tested	Internal Lithium-ion (150 mAh)			P/N: 361-00072-00			
Max. SAR Level(s) Evaluated	Extremity	802.11b	0.021 W/kg	10g average	FCC/IC SAR Limit	4.0 W/kg	10g average
Celltech Labs Inc. declares under its sole responsibility that this wireless portable device was compliant with the Specific Absorption Rate (SAR) RF exposure requirements specified in FCC 47 CFR §2.1093 and Health Canada's Safety Code 6 for the General Population / Uncontrolled Exposure environment. The device was tested in accordance with the measurement procedures specified in FCC OET Bulletin 65, Supplement C (Edition 01-01), Industry Canada RSS-102 Issue 4, IEEE Standard 1528-2003 and IEC International Standard 62209-2:2010. All measurements were performed in accordance with the SAR system manufacturer recommendations.							
I attest to the accuracy of data. All measurements were performed by me or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.							
The results and statements contained in this report pertain only to the device evaluated.							
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Test Report Approved By			Mike Meaker	Engineering Technologist		Celltech Labs Inc.	

Applicant:	Garmin International Inc.	FCC ID:	IPH-F3ARGD00	IC:	1792A-F3ARGD00	
Model:	F3ARGD00	DUT Type:	Wrist-worn GPS Device			
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Model:	F3ARGD00	DUT Type:	Wrist-worn GPS Device			
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REVISION HISTORY			
REVISION NO.	DESCRIPTION	IMPLEMENTED BY	RELEASE DATE
1.0	1st Release	Mike Meaker	Jul. 3, 2013
1.1	Minor fixes - model name and mode	Mike Meaker	Jul. 8, 2013

TEST REPORT SIGN-OFF			
DEVICE TESTED BY	REPORT PREPARED BY	QA REVIEW BY	REPORT APPROVED BY
Mike Meaker	Mike Meaker	Glen Westwell	Mike Meaker

Applicant:	Garmin International Inc.	FCC ID:	IPH-F3ARGD00	IC:	1792A-F3ARGD00	
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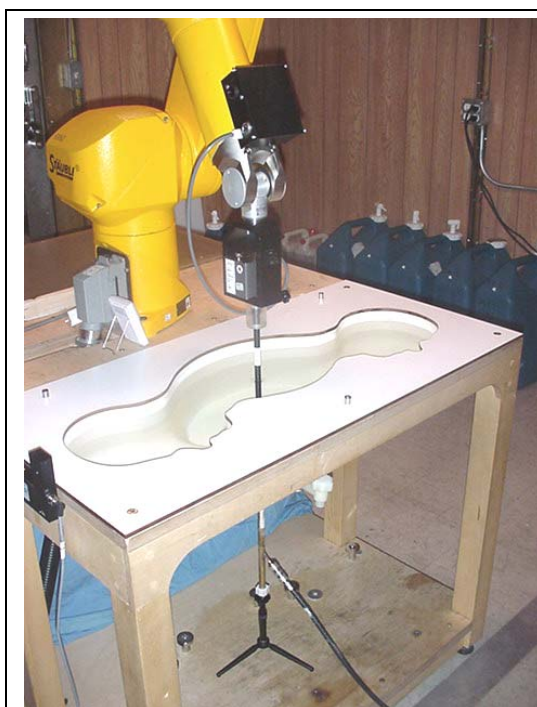
Test Lab Certificate No. 2470.01

1.0 INTRODUCTION

This measurement report demonstrates that the Garmin International Inc. Model: F3ARGD00 Wrist-worn GPS Device complies with the SAR (Specific Absorption Rate) RF exposure requirements specified in FCC 47 CFR §2.1093 (see reference [1]) and Health Canada's Safety Code 6 (see reference [2]) for the General Population / Uncontrolled Exposure environment. The test procedures described in FCC OET Bulletin 65, Supplement C, Edition 01-01 (see reference [3]), IC RSS-102 Issue 4 (see reference [4]), IEEE Standard 1528-2003 (see reference [5]) and IEC International Standard 62209-2:2010 (see reference [7]) were employed. A description of the product, operating configuration, detailed summary of the test results, methodology and procedures used in the evaluation, equipment used, and the various provisions of the rules are included within this test report.

2.0 SAR MEASUREMENT SYSTEM


Celltech Labs Inc. SAR measurement facility utilizes the Dosimetric Assessment System (DASY™) manufactured by Schmid & Partner Engineering AG (SPEAG™) of Zurich, Switzerland. The DASY4 measurement system is comprised of the measurement server, robot controller, computer, near-field probe, probe alignment sensor, specific anthropomorphic mannequin (SAM) phantom, and various planar phantoms 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, teach pendant (Joystick), and remote control, is used to drive the robot 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 into digital electric signal of the DAE and transfers data to the DASY4 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 and a command decoder and control logic unit. Transmission to the DASY4 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.



DASY4 System with SAM Twin Phantom V4.0C



DASY4 Measurement Server

Applicant:	Garmin International Inc.	FCC ID:	IPH-F3ARGD00	IC:	1792A-F3ARGD00	
Model:	F3ARGD00	DUT Type:	Wrist-worn GPS Device			
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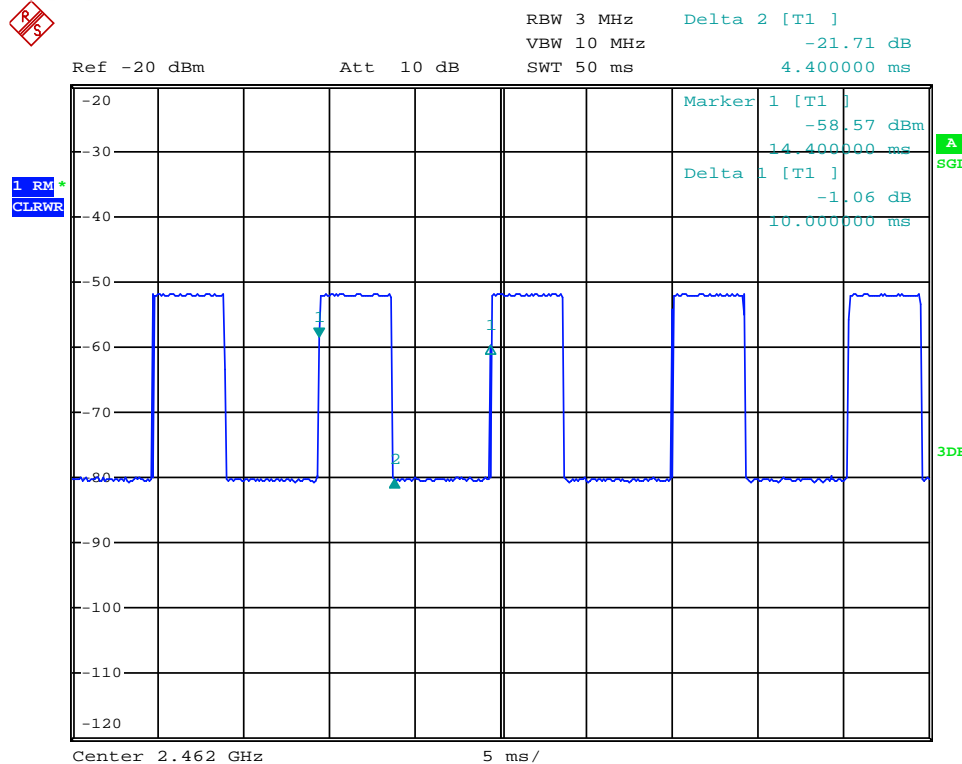
3.0 CONDUCTED OUTPUT POWER MEASUREMENTS

Freq. (MHz)	Channel	Peak Conducted Output Power (Watts)
802.11b Mode		1 Mbps
2412	1	0.008
2437	6	0.009
2462	11	0.009
802.11g Mode		6 Mbps
2412	1	0.006
2437	6	0.007
2462	11	0.007



Notes

1. According to the manufacturer the conducted power levels of all higher data rates are <1/4 dB higher than the lowest data rates.
2. The peak conducted power levels were provided by the EMC lab.
3. The manufacturer confirmed that the SAR test sample met the output power specifications.

Duty Cycle Measurement



The maximum transmit duty cycle was measured to be 44%.


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4.0 FLUID DIELECTRIC PARAMETERS

FLUID DIELECTRIC PARAMETERS						
Date: 06/20/2013		Frequency: 2450 MHz			Tissue: Body	
Freq	Test_e	Test_s	Target_e	Target_s	Deviation Permittivity	Deviation Conductivity
2.350	53.04	1.8	52.7	1.95	0.65%	-7.69%
2.360	53.07	1.81	52.7	1.95	0.70%	-7.18%
2.370	52.99	1.81	52.7	1.95	0.55%	-7.18%
2.380	52.75	1.82	52.7	1.95	0.09%	-6.67%
2.390	52.83	1.86	52.7	1.95	0.25%	-4.62%
2.400	52.97	1.88	52.7	1.95	0.51%	-3.59%
2.410	52.84	1.89	52.7	1.95	0.27%	-3.08%
2.412*	52.8	1.89	52.7	1.95	0.19%	-3.08%
2.420	52.68	1.89	52.7	1.95	-0.04%	-3.08%
2.430	52.81	1.92	52.7	1.95	0.21%	-1.54%
2.440	52.87	1.95	52.7	1.95	0.32%	0.00%
2.442*	52.9	1.95	52.7	1.95	0.38%	0.00%
2.450	52.83	1.94	52.7	1.95	0.25%	-0.51%
2.460	52.84	1.95	52.7	1.95	0.27%	0.00%
2.462*	52.8	1.95	52.7	1.95	0.19%	0.00%
2.470	52.64	1.96	52.7	1.95	-0.11%	0.51%
2.480	52.69	1.98	52.7	1.95	-0.02%	1.54%
2.490	52.58	1.99	52.7	1.95	-0.23%	2.05%
2.500	52.52	2.01	52.7	1.95	-0.34%	3.08%
2.510	52.36	2.02	52.7	1.95	-0.65%	3.59%
2.520	52.41	2.06	52.7	1.95	-0.55%	5.64%
2.530	52.54	2.05	52.7	1.95	-0.30%	5.13%
2.540	52.4	2.08	52.7	1.95	-0.57%	6.67%
2.550	52.62	2.07	52.7	1.95	-0.15%	6.15%

*interpolated using DASY4 software


Test Date	Fluid Type	Ambient Temperature	Fluid Temperature	Fluid Depth	Atmospheric Pressure	Relative Humidity	ρ (Kg/m ³)
Jun 20	2450 Body	24°C	23.8 °C	≥ 15 cm	100.6 kPa	43%	1000



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5.0 SAR MEASUREMENT SUMMARY

WRIST-WORN SAR EVALUATION RESULTS										
WLAN Mode	Test Mode	Test Freq.	Test Chan.	Data Rate	Battery	DUT Position (Side facing phantom)	DUT Distance to Phantom	Conducted Power Before Test	SAR Drift During Test	Measured SAR (10g)
		MHz		Mbps				W	dB	W/kg
802.11b	DSSS	2412	1	1	Li-ion	Back Touch	0mm	0.008	-0.788	0.017
802.11b	DSSS	2442	6	1	Li-ion	Back Touch	0mm	0.009	-0.338	0.019
802.11b	DSSS	2462	11	1	Li-ion	Back Touch	0mm	0.009	-0.353	0.018
SAR SAFETY LIMIT(S)					BODY		SPATIAL PEAK	RF EXPOSURE CATEGORY		
FCC 47 CFR 2.1093		Health Canada Safety Code 6			4.0 W/kg		10g average	General Population / Uncontrolled		
Test Date(s):		Jun. 20, 2013								
Notes										
1.	Detailed measurement data and plots showing the maximum SAR location of the DUT are reported in Appendix A.									
2.	The DUT was not required to be evaluated in 802.11g mode or higher data rates because the highest output power channel was < ¼ dB higher than the corresponding 802.11b channel on the lowest data rate, in accordance with the procedures of FCC KDB 248227 (see reference [9]).									
3.	The SAR drift of the DUT was measured by the DASY4 system for the duration of the SAR evaluation.									
4.	The DUT battery was fully charged prior to each SAR evaluation.									
5.	The fluid temperature remained within +/-2°C from the dielectric parameter measurement to the completion of the SAR test.									
6.	The dielectric parameters of the simulated tissue mixture were measured prior to the SAR evaluations using a Dielectric Probe Kit and a Network Analyzer.									

Applicant:	Garmin International Inc.	FCC ID:	IPH-F3ARGD00	IC:	1792A-F3ARGD00	
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6.0 SAR SCALING FOR TUNE-UP TOLERANCE



SCALED SAR							
Test Config.	Freq. (MHz)	Test Ch.	Data Rate	Measured Conducted Power (W)	Maximum Rated Conducted Power (W)	Measured SAR Level 10g (W/kg)	Scaled SAR 10g (W/kg)
WRIST	2442	6	1 Mbps	0.009	0.010	0.019	0.021

7.0 SIMULTANEOUS TRANSMISSION ASSESSMENT

802.11b/g + 802.15

These transmitters are not capable of simultaneous transmission. The 802.15 is rated at 2 mW and is below the threshold for standalone SAR evaluation.

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8.0 DETAILS OF SAR EVALUATION

1. The DUT was evaluated for Wrist-worn extremity SAR in accordance with the test positions required by FCC KDB 447498 D01v05 (see reference [8]). Based on this the back side of the device at a distance of 0mm to the phantom surface was tested.
2. The DUT was supplied with test mode software that was able to transmit at any selected channel / data-rate required for SAR testing.
3. The DUT was tested with a modulated DSSS signal in 802.11b mode.
4. The battery was fully charged before each SAR evaluation.

9.0 SAR EVALUATION PROCEDURES

- (i) The evaluation was performed in the applicable area of the phantom depending on the type of device being tested. For devices held to the ear during normal operation, both the left and right ear positions were evaluated using the SAM phantom.
- (ii) For body-worn and face-held devices a planar phantom was used.
- The SAR was determined by a pre-defined procedure within the DASY4 software. Upon completion of a reference and optical surface check, the exposed region of the phantom was scanned near the inner surface with a grid spacing of 10mm x 10mm.
An area scan was determined as follows:
- Based on the defined area scan grid, a more detailed grid is created to increase the points by a factor of 10. The interpolation function then evaluates all field values between corresponding measurement points.
- A linear search is applied to find all the candidate maxima. Subsequently, all maxima are removed that are >2 dB from the global maximum. The remaining maxima are then used to position the cube scans.
A 1g and 10g spatial peak SAR was determined as follows:
- Extrapolation is used to determine the values between the dipole center of the probe and the surface of the phantom. This data cannot be measured because the center of the dipole sensors is 1.0 mm away from the probe tip and the distance between the probe and the boundary must be larger than 25% of the probe diameter. The probe diameter is 2.4 mm. In the DASY4 software, the distance between the sensor center and phantom surface is set to 2.0 mm. This provides a distance of 1.0 mm between the probe tip and the surface. The extrapolation of the values between the dipole center and the surface of the phantom was based on trivariate quadratics computed from the previously calculated 3D interpolated points nearest the phantom surface.
- Interpolated data is used to calculate the average SAR over 1g and 10g cubes by spatially discretizing the entire measured cube. The volume used to determine the averaged SAR is a 1mm grid (42875 interpolated points).
- A zoom scan volume of 30 mm x 30 mm x 30 mm (5x5x7 points) centered at the peak SAR location determined from the area scan is used for all zoom scans for devices with a transmit frequency < 800 MHz. Zoom scans for frequencies ≥ 800 MHz are determined with a scan volume of 30 mm x 30 mm x 30 mm (7x7x7 points) to ensure complete capture of the peak spatial-average SAR. When the area scan estimated SAR is < 1.4W/kg, less points can be used for higher frequency zoom scans.

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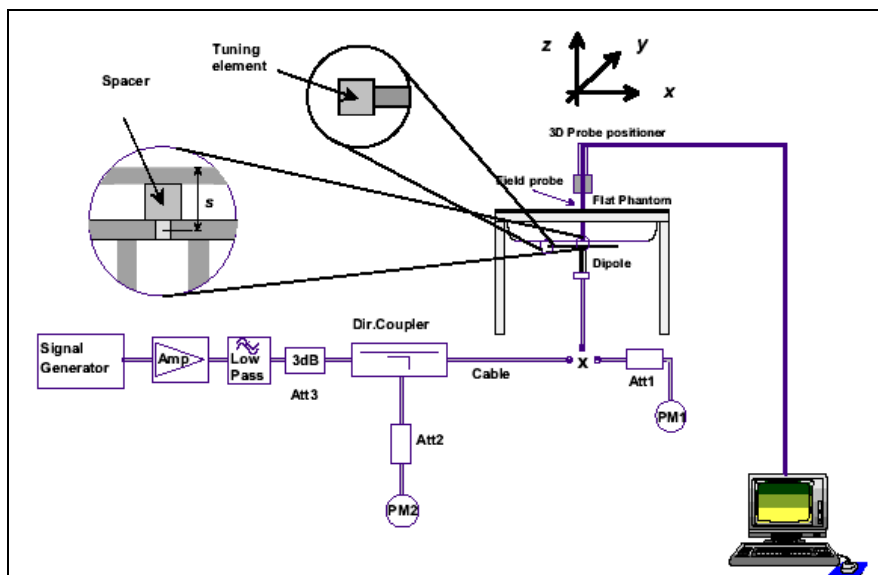
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10.0 SYSTEM VERIFICATION

Prior to the SAR evaluations, a system check was performed at the planar section of the SAM phantom with a 2450MHz SPEAG validation dipole (see Appendix B) in accordance with the procedures described in IEEE Standard 1528-2003 (see reference [5]) and IEC 62209-2:2010 (see reference [7]). A forward power of 250 mW was applied to the dipole and the system was verified to a tolerance of $\pm 10\%$ from the system manufacturer's dipole calibration target SAR value (see Appendix E).

SYSTEM PERFORMANCE CHECK EVALUATION


Test Date	Equiv. Tissue	SAR 10g (W/kg)			Dielectric Constant ϵ_r			Conductivity σ (mho/m)			ρ (Kg/m ³)	Amb. Temp. (°C)	Fluid Temp. (°C)	Fluid Depth (cm)	Humid. (%)	Barom. Press. (kPa)
	Freq. (MHz)	Target	Meas.	Dev.	Target	Meas.	Dev.	Target	Meas.	Dev.						
Jun 20	BODY 2450	5.91 $\pm 10\%$	6.49	+9.8%	52.7 $\pm 5\%$	52.8	+0.2%	1.95 $\pm 5\%$	1.94	-0.5%	1000	24.0	23.8	≥ 15	43	100.6
Notes	1. The target SAR value is the measured value from the dipole calibration performed by the system manufacturer (see Appendix E).															
	2. The target dielectric parameters are the nominal values from the dipole calibration performed by SPEAG (see Appendix E) and specified in IC RSS-102 Issue 4 (see reference [4]).															
	3. The fluid temperature remained within $\pm 2^\circ\text{C}$ from the dielectric parameter measurement to the completion of the system performance check evaluation.															
	4. 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 (see Appendix C).															





System Performance Check Measurement Setup Diagram



2450 MHz Validation Dipole Setup

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11.0 SIMULATED EQUIVALENT TISSUES



The simulated equivalent tissue recipe listed in the table below is derived from the SAR system manufacturer's suggested recipe in the DASY4 manual (see reference [11]). The ingredient percentage may have been adjusted minimally in order to achieve the appropriate target dielectric parameters within the specified tolerance.

2450 MHz SIMULATED TISSUE MIXTURES	
INGREDIENT	2450 MHz Body
Water	69%
Glycol Monobutyl	31%

12.0 SAR LIMITS


SAR RF EXPOSURE LIMITS			
FCC 47 CFR 2.1093	Health Canada Safety Code 6	(General Population / Uncontrolled Exposure)	(Occupational / Controlled Exposure)
Spatial Average (averaged over the whole body)		0.08 W/kg	0.4 W/kg
Spatial Peak (averaged over any 1 g of tissue)		1.6 W/kg	8.0 W/kg
Spatial Peak (hands/wrists/feet/ankles averaged over 10 g)		4.0 W/kg	20.0 W/kg
The Spatial Average value of the SAR averaged over the whole body.			
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.			
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.			
Uncontrolled environments are defined as locations where there is potential exposure of individuals who have no knowledge or control of their potential exposure.			
Controlled environments are defined as locations where there is potential exposure of individuals who have knowledge of their potential exposure and can exercise control over their exposure.			



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	Test Report Issue Date Jul. 3, 2013	Description of Test(s) Specific Absorption Rate	RF Exposure Category Gen. Pop. / Uncontrolled	

13.0 ROBOT SYSTEM SPECIFICATIONS

<u>Specifications</u>	
Positioner	Stäubli Unimation Corp. Robot Model: RX60L
Repeatability	0.02 mm
No. of axis	6
<u>Data Acquisition Electronic (DAE) System</u>	
<u>Cell Controller</u>	
Processor	AMD Athlon XP 2400+
Clock Speed	2.0 GHz
Operating System	Windows XP Professional
<u>Data Converter</u>	
Features	Signal Amplifier, multiplexer, A/D converter, and control logic
Software	Measurement Software: DASY4, V4.7 Build 80
	Postprocessing Software: SEMCAD, V1.8 Build 186
Connecting Lines	Optical downlink for data and status info.; Optical uplink for commands and clock
<u>DASY4 Measurement Server</u>	
Function	Real-time data evaluation for field measurements and surface detection
Hardware	PC/104 166MHz Pentium CPU; 32 MB chipdisk; 64 MB RAM
Connections	COM1, COM2, DAE, Robot, Ethernet, Service Interface
<u>E-Field Probe</u>	
Model	EX3DV4
Serial No.	3600
Construction	Symmetrical design with triangular core
Frequency	10 MHz to 6 GHz
Linearity	±0.2 dB (30 MHz to 3 GHz)
<u>Phantom(s)</u>	
Type	SAM V4.0C
Shell Material	Fiberglass
Thickness	2.0 ±0.1 mm
Volume	Approx. 25 liters

Applicant:	Garmin International Inc.	FCC ID:	IPH-F3ARGD00	IC:	1792A-F3ARGD00	
Model:	F3ARGD00	DUT Type:	Wrist-worn GPS Device			
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14.0 PROBE SPECIFICATION (EX3DV4)

Construction: Symmetrical design with triangular core
Built-in shielding against static charges
PEEK enclosure material (resistant to organic solvents, e.g. DGBE)

Calibration: Basic Broadband Calibration in air: 10-3000 MHz
Conversion Factors (CF) for HSL 900 and HSL 1750

Frequency: 10 MHz to >6 GHz; Linearity: ± 0.2 dB (30 MHz to 3 GHz)

Directivity: ± 0.3 dB in HSL (rotation around probe axis)
 ± 0.5 dB in tissue material (rotation normal to probe axis)

Dynamic Range: 10 μ W/g to >100 mW/g; Linearity: ± 0.2 dB
(noise: typically < 1 μ W/g)

Dimensions: Overall length: 330 mm (Tip: 20 mm)
Tip diameter: 2.5 mm (Body: 12 mm)
Typical distance from probe tip to dipole centers: 1.0 mm

Application: High precision dosimetric measurements in any exposure scenario (e.g., very strong gradient fields). Only probe which enables compliance testing for frequencies up to 6 GHz with precision of better than 30%.



EX3DV4 E-Field Probe

15.0 SAM TWIN PHANTOM V4.0C

The SAM Twin Phantom V4.0C is a fiberglass shell phantom with a 2.0 mm (+/-0.2 mm) shell thickness for left and right head and flat planar area integrated in a wooden table. The shape of the fiberglass shell corresponds to the phantom defined by SCC34-SC2. The device holder positions are adjusted to the standard measurement positions in the three sections (see Appendix G for specifications of the SAM Twin Phantom V4.0C).




SAM Twin Phantom V4.0C



16.0 DEVICE HOLDER

The DASY4 device holder 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. For evaluations of larger devices a Plexiglas platform is attached to the device holder.




Device Holder



Applicant:	Garmin International Inc.	FCC ID:	IPH-F3ARGD00	IC:	1792A-F3ARGD00	
Model:	F3ARGD00	DUT Type:	Wrist-worn GPS Device			
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17.0 TEST EQUIPMENT LIST

TEST EQUIPMENT DESCRIPTION	ASSET NO.	SERIAL NO.	DATE CALIBRATED	CALIBRATION INTERVAL
Schmid & Partner DASY4 System	-	-	-	-
-DASY4 Measurement Server	00158	1078	CNR	CNR
-Robot	00046	599396-01	CNR	CNR
-DAE4	00019	353	19-Apr-12	Biennial
-EX3DV4 E-Field Probe	00213	3600	27-Apr-13	Annual
-D2450V2 Validation Dipole	00219	825	25-Apr-12	Triennial
-SAM Twin Phantom V4.0C	00154	1033	CNR	CNR
HP 85070C Dielectric Probe Kit	00033	None	CNR	CNR
Gigatronics 8652A Power Meter	00007	1835272	03-May-12	Biennial
Gigatronics 80701A Power Sensor	00014	1833542	03-May-12	Biennial
Gigatronics 80334A Power Sensor	-	1837001	03-May-12	Biennial
HP 8753ET Network Analyzer	00134	US39170292	26-Apr-12	Biennial
Rohde & Schwarz SMR20 Signal Generator	00006	100104	02-May-12	Biennial
Amplifier Research 5S1G4 Power Amplifier	00106	26235	CNR	CNR
CNR = Calibration Not Required				

Applicant:	Garmin International Inc.	FCC ID:	IPH-F3ARGD00	IC:	1792A-F3ARGD00	
Model:	F3ARGD00	DUT Type:	Wrist-worn GPS Device			
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Test Lab Certificate No. 2470.01


18.0 MEASUREMENT UNCERTAINTY (IEC 62209-2)



UNCERTAINTY BUDGET FOR DEVICE EVALUATION (IEC 62209-2:2010)

Source of Uncertainty	IEC 62209-2 Section	Tolerance / Uncertainty $\pm\%$	Probability Distribution	Divisor	ci 1g	ci 10g	Standard Uncertainty $\pm\%$ (1g)	Standard Uncertainty $\pm\%$ (10g)	V_i or V_{eff}
Measurement System									
Probe Calibration (2450 MHz)	7.2.2.1	6.0	Normal	1	1	1	6.0	6.0	∞
Isotropy	7.2.2.2	4.7	Rectangular	1.732050808	1	1	2.7	2.7	∞
Boundary Effect	7.2.2.6	1	Rectangular	1.732050808	1	1	0.6	0.6	∞
Linearity	7.2.2.3	4.7	Rectangular	1.732050808	1	1	2.7	2.7	∞
Detection Limits	7.2.2.5	1	Rectangular	1.732050808	1	1	0.6	0.6	∞
Readout Electronics	7.2.2.7	0.3	Normal	1	1	1	0.3	0.3	∞
Response Time	7.2.2.8	0.8	Rectangular	1.732050808	1	1	0.5	0.5	∞
Integration Time	7.2.2.9	2.6	Rectangular	1.732050808	1	1	1.5	1.5	∞
RF Ambient Conditions	7.2.4.5	3	Rectangular	1.732050808	1	1	1.7	1.7	∞
Probe Positioner Mechanical Restrictions	7.2.3.1	0.4	Rectangular	1.732050808	1	1	0.2	0.2	∞
Probe Positioning wrt Phantom Shell	7.2.3.3	2.9	Rectangular	1.732050808	1	1	1.7	1.7	∞
Post-processing	7.2.5	1	Rectangular	1.732050808	1	1	0.6	0.6	∞
Test Sample Related									
Test Sample Positioning	7.2.3.4.3	2.9	Normal	1	1	1	2.9	2.9	12
Device Holder Uncertainty	7.2.3.4.2	3.6	Normal	1	1	1	3.6	3.6	8
Drift of Output Power (meas. SAR drift)	7.2.2.10	5	Rectangular	1.732050808	1	1	2.9	2.9	∞
Phantom and Tissue Parameters									
Phantom Uncertainty	7.2.3.2	4	Rectangular	1.732050808	1	1	2.3	2.3	∞
SAR Correction Algorithm for deviations in permittivity and conductivity	7.2.4.3	0.97	Normal	1	1	0.81	1.0	0.79	∞
Liquid Conductivity (measured)	7.2.4.3	3.08	Normal	1	0.78	0.71	2.4	2.2	∞
Liquid Permittivity (measured)	7.2.4.3	0.38	Normal	1	0.23	0.26	0.1	0.1	∞
Liquid Permittivity - temp. uncertainty	7.2.4.4	1.23	Rectangular	1.732050808	0.78	0.71	0.6	0.5	∞
Liquid Conductivity - temp. uncertainty	7.2.4.4	0.93	Rectangular	1.732050808	0.23	0.26	0.1	0.1	∞
Combined Standard Uncertainty	7.3.1		RSS				10.11	10.04	
Expanded Uncertainty (95% Confidence Interval)	7.3.2		k=2				20.22	20.09	

Measurement Uncertainty Table in accordance with International Standard IEC 62209-2:2010


This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2



Applicant:	Garmin International Inc.	FCC ID:	IPH-F3ARGD00	IC:	1792A-F3ARGD00	
Model:	F3ARGD00	DUT Type:	Wrist-worn GPS Device			
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19.0 REFERENCES



- [1] Federal Communications Commission - "Radiofrequency radiation exposure evaluation: portable devices", Rule Part 47 CFR §2.1093.
- [2] Health Canada - "Limits of Human Exposure to Radiofrequency Electromagnetic Fields in the Frequency Range from 3 kHz to 300 GHz", Safety Code 6: 1999.
- [3] Federal Communications Commission - "Evaluating Compliance with FCC Guidelines for Human Exposure to Radio frequency Electromagnetic Fields", OET Bulletin 65, Supplement C (Edition 01-01), FCC, Washington, D.C.: June 2001.
- [4] Industry Canada - "Radio Frequency Exposure Compliance of Radio Communication Apparatus (All Frequency Bands)", Radio Standards Specification RSS-102 Issue 4: March 2010.
- [5] IEEE Standard 1528-2003 - "Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques": December 2003.
- [6] International Standard IEC 62209-1:2005 - "Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices - Human models, instrumentation, and procedures."
- [7] International Standard IEC 62209-2 Edition 1.0 2010-03 - "Human exposure to radio frequency fields from hand-held & body-mounted wireless communication devices - Part 2: Procedure to determine the specific absorption rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)".
- [8] Federal Communications Commission, Office of Engineering and Technology - "Mobile and Portable Devices RF Exposure Procedures and Equipment Authorization Policies"; KDB 447498 D01v05r01: May 2013.
- [9] Federal Communications Commission, Office of Engineering and Technology - "SAR Measurement Procedures for 802.11a/b/g Transmitters"; KDB 248227 D01 v01r02: May 2007.
- [10] Federal Communications Commission, Office of Engineering and Technology - "SAR Measurement Requirements for 100MHz to 6GHz"; KDB 865664 D01v01r01: May 2013.
- [11] Schmid & Partner Engineering AG - DASY4 Manual V4.6, Chapter 17 Application Note, Body Tissue Recipe: Sept. 2005.
- [12] International Standard ISO/IEC 17025:2005 - "General requirements for the competence of testing and calibration laboratories".
- [13] Federal Communications Commission - "Measurements Required: RF Power Output"; Rule Part 47 CFR §2.1046.
- [14] Industry Canada - "General Requirements and Information for the Certification of Radiocommunication Equipment", Radio Standards Specification RSS-Gen Issue 2: June 2007.

Applicant:	Garmin International Inc.	FCC ID:	IPH-F3ARGD00	IC:	1792A-F3ARGD00	
Model:	F3ARGD00	DUT Type:	Wrist-worn GPS Device			
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APPENDIX A - SAR MEASUREMENT PLOTS

Applicant:	Garmin International Inc.	FCC ID:	IPH-F3ARGD00	IC:	1792A-F3ARGD00	
Model:	F3ARGD00	DUT Type:	Wrist-worn GPS Device			
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Test Date: 06/20/2013

Extremity - 802.11b - Ch. 1 - 2412 MHz - 1Mbps

DUT: F3ARGD00; Type: Wrist-worn GPS; Serial: Not Specified

Program Notes: Ambient Temp: 24C; Fluid Temp: 23.8C; Barometric Pressure: 100.6 kPa; Humidity: 43%

Procedure Notes:

Communication System: WLAN

Frequency: 2412 MHz; Duty Cycle: 1:2.3

Medium: M2450 Medium parameters used (interpolated): $f = 2412 \text{ MHz}$; $\sigma = 1.89 \text{ mho/m}$; $\epsilon_r = 52.8$; $\rho = 1000 \text{ kg/m}^3$

- Probe: EX3DV4 - SN3600; ConvF(6.61, 6.61, 6.61); Calibrated: 26/04/2013
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn353; Calibrated: 19/04/2012
- Phantom: SAM 4.0; Type: Fiberglass; Serial: 1033
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

802.11b - 2412 - 1Mbps/Area Scan (7x7x1): Measurement grid: $dx=10\text{mm}$, $dy=10\text{mm}$

Info: Interpolated medium parameters used for SAR evaluation.

Maximum value of SAR (measured) = 0.042 mW/g

802.11b - 2412 - 1Mbps/Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=7.5\text{mm}$, $dy=7.5\text{mm}$, $dz=5\text{mm}$

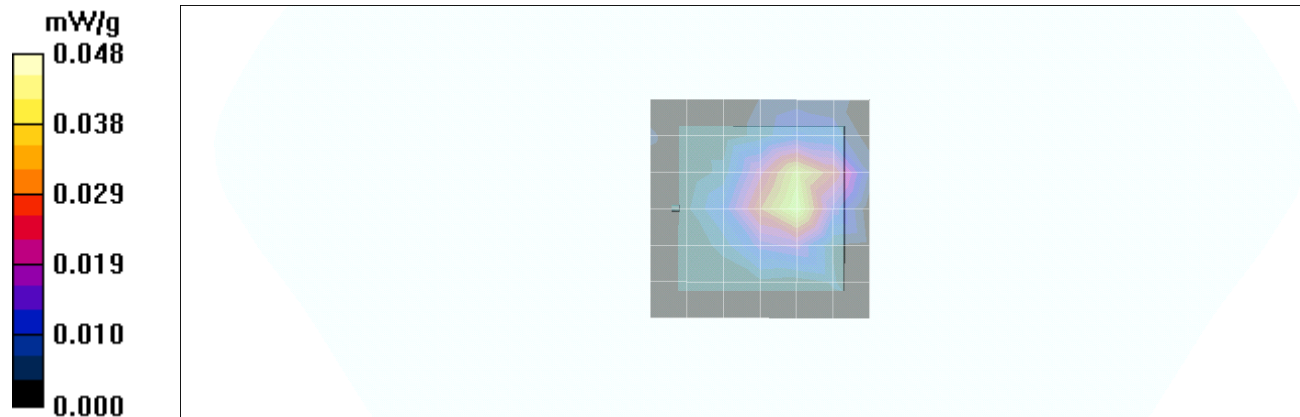
Reference Value = 3.76 V/m; Power Drift = -0.788 dB

Peak SAR (extrapolated) = 0.066 W/kg


SAR(1 g) = 0.036 mW/g; SAR(10 g) = 0.017 mW/g



Info: Interpolated medium parameters used for SAR evaluation.

Maximum value of SAR (measured) = 0.048 mW/g



DUT orientation: Top edge to the left.

Applicant:	Garmin International Inc.	FCC ID:	IPH-F3ARGD00	IC:	1792A-F3ARGD00	
Model:	F3ARGD00	DUT Type:	Wrist-worn GPS Device			
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Test Date: 06/20/2013

Extremity - 802.11b - Ch. 6 - 2442 MHz - 1Mbps

DUT: F3ARGD00; Type: Wrist-worn GPS; Serial: Not Specified

Program Notes: Ambient Temp: 24C; Fluid Temp: 23.8C; Barometric Pressure: 100.6 kPa; Humidity: 43%

Procedure Notes:

Communication System: WLAN

Frequency: 2442 MHz; Duty Cycle: 1:2.3

Medium: M2450 Medium parameters used (interpolated): $f = 2442 \text{ MHz}$; $\sigma = 1.95 \text{ mho/m}$; $\epsilon_r = 52.9$; $\rho = 1000 \text{ kg/m}^3$

- Probe: EX3DV4 - SN3600; ConvF(6.61, 6.61, 6.61); Calibrated: 26/04/2013
- Sensor-Surface: 3mm (Mechanical Surface Detection (Locations From Previous Scan Used)) Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn353; Calibrated: 19/04/2012
- Phantom: SAM 4.0; Type: Fiberglass; Serial: 1033
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

802.11b - 2442 - 1Mbps/Area Scan (7x7x1): Measurement grid: $dx=10\text{mm}$, $dy=10\text{mm}$

Info: Interpolated medium parameters used for SAR evaluation.

Maximum value of SAR (measured) = 0.052 mW/g

802.11b - 2442 - 1Mbps/Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=7.5\text{mm}$, $dy=7.5\text{mm}$, $dz=5\text{mm}$

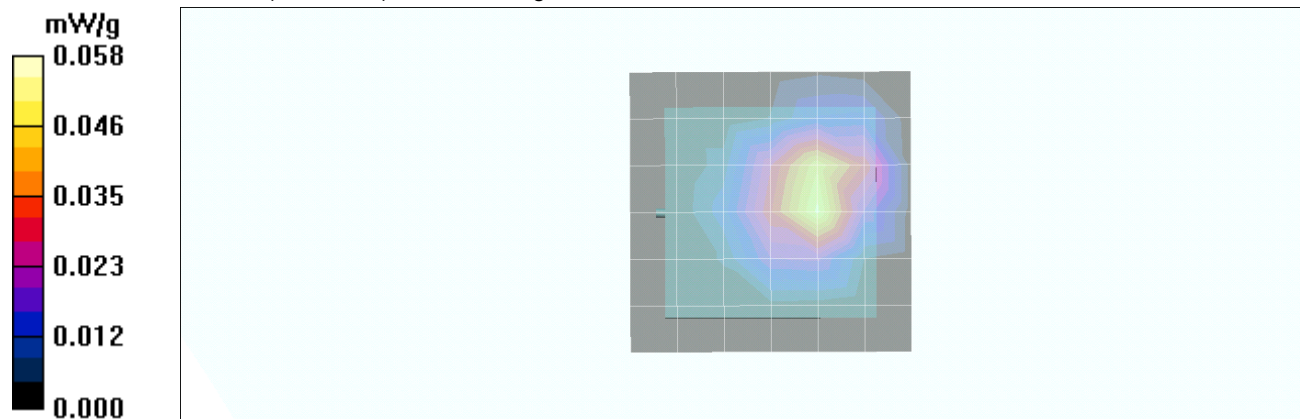
Reference Value = 4.24 V/m; Power Drift = -0.338 dB

Peak SAR (extrapolated) = 0.078 W/kg


SAR(1 g) = 0.042 mW/g; SAR(10 g) = 0.019 mW/g



Info: Interpolated medium parameters used for SAR evaluation.

Maximum value of SAR (measured) = 0.058 mW/g

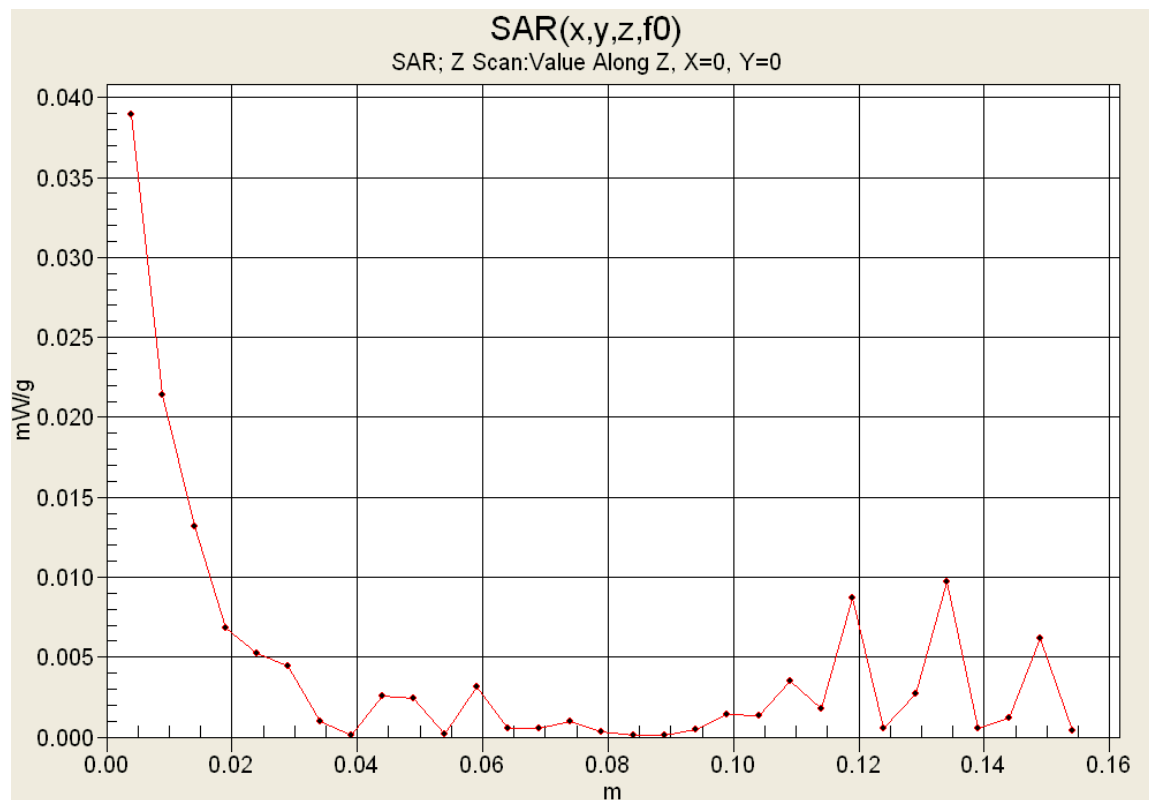



DUT orientation: Top edge to the left.



Applicant:	Garmin International Inc.	FCC ID:	IPH-F3ARGD00	IC:	1792A-F3ARGD00	
Model:	F3ARGD00	DUT Type:	Wrist-worn GPS Device			
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Z-axis Scan



Applicant:	Garmin International Inc.	FCC ID:	IPH-F3ARGD00	IC:	1792A-F3ARGD00	
Model:	F3ARGD00	DUT Type:	Wrist-worn GPS Device			
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Test Date: 06/20/2013

Extremity - 802.11b - Ch. 11 - 2462 MHz - 1Mbps

DUT: F3ARGD00; Type: Wrist-worn GPS; Serial: Not Specified

Program Notes: Ambient Temp: 24C; Fluid Temp: 23.8C; Barometric Pressure: 100.6 kPa; Humidity: 43%

Procedure Notes:

Communication System: WLAN

Frequency: 2462 MHz; Duty Cycle: 1:2.3

Medium: M2450 Medium parameters used (interpolated): $f = 2462$ MHz; $\sigma = 1.95$ mho/m; $\epsilon_r = 52.8$; $\rho = 1000$ kg/m³

- Probe: EX3DV4 - SN3600; ConvF(6.61, 6.61, 6.61); Calibrated: 26/04/2013
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn353; Calibrated: 19/04/2012
- Phantom: SAM 4.0; Type: Fiberglass; Serial: 1033
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

802.11b - 2462 - 1Mbps/Area Scan (7x7x1): Measurement grid: dx=10mm, dy=10mm

Info: Interpolated medium parameters used for SAR evaluation.

Maximum value of SAR (measured) = 0.059 mW/g

802.11b - 2462 - 1Mbps/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=7.5mm, dy=7.5mm, dz=5mm

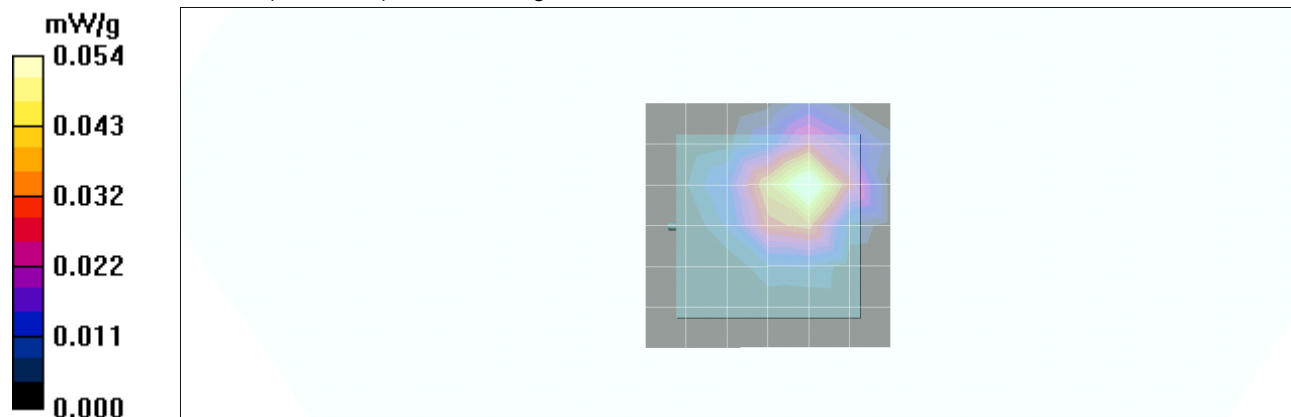
Reference Value = 4.50 V/m; Power Drift = -0.353 dB

Peak SAR (extrapolated) = 0.079 W/kg


SAR(1 g) = 0.041 mW/g; SAR(10 g) = 0.018 mW/g



Info: Interpolated medium parameters used for SAR evaluation.

Maximum value of SAR (measured) = 0.054 mW/g






DUT orientation: Top edge to the left.

Applicant:	Garmin International Inc.	FCC ID:	IPH-F3ARGD00	IC:	1792A-F3ARGD00	
Model:	F3ARGD00	DUT Type:	Wrist-worn GPS Device			
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APPENDIX B - SYSTEM PERFORMANCE CHECK PLOTS

Applicant:	Garmin International Inc.	FCC ID:	IPH-F3ARGD00	IC:	1792A-F3ARGD00	
Model:	F3ARGD00	DUT Type:	Wrist-worn GPS Device			
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Test Date: 06/20/2013

System Performance Check - 2450 MHz Dipole - Body

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: 825; Calibrated: 25/04/2012

Program Notes: Ambient Temp: 24C; Fluid Temp: 23.8C; Barometric Pressure: 100.6 kPa; Humidity: 43%

Procedure Notes:

Communication System: CW

Frequency: 2450 MHz; Duty Cycle: 1:1

Medium: M2450 Medium parameters used: $f = 2450 \text{ MHz}$; $\sigma = 1.94 \text{ mho/m}$; $\epsilon_r = 52.8$; $\rho = 1000 \text{ kg/m}^3$

- Probe: EX3DV4 - SN3600; ConvF(6.61, 6.61, 6.61); Calibrated: 26/04/2013
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn353; Calibrated: 19/04/2012
- Phantom: SAM 4.0; Type: Fiberglass; Serial: 1033
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

2450 MHz Dipole d=10mm P=250mW/Area Scan (6x10x1): Measurement grid: dx=10mm, dy=10mm

Maximum value of SAR (measured) = 15.5 mW/g

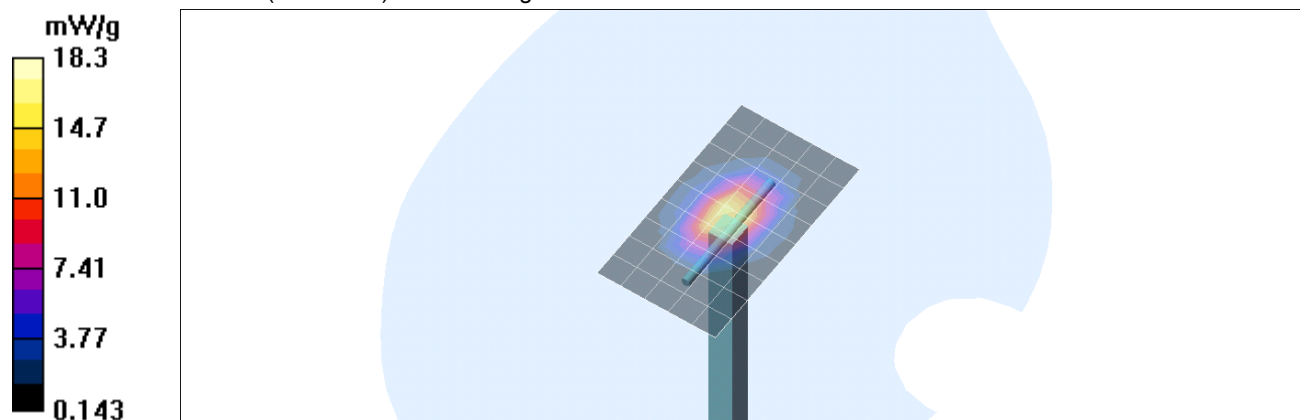
2450 MHz Dipole d=10mm P=250mW/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm


Reference Value = 96.1 V/m; Power Drift = -0.027 dB



Peak SAR (extrapolated) = 27.9 W/kg

SAR(1 g) = 13.9 mW/g; SAR(10 g) = 6.49 mW/g

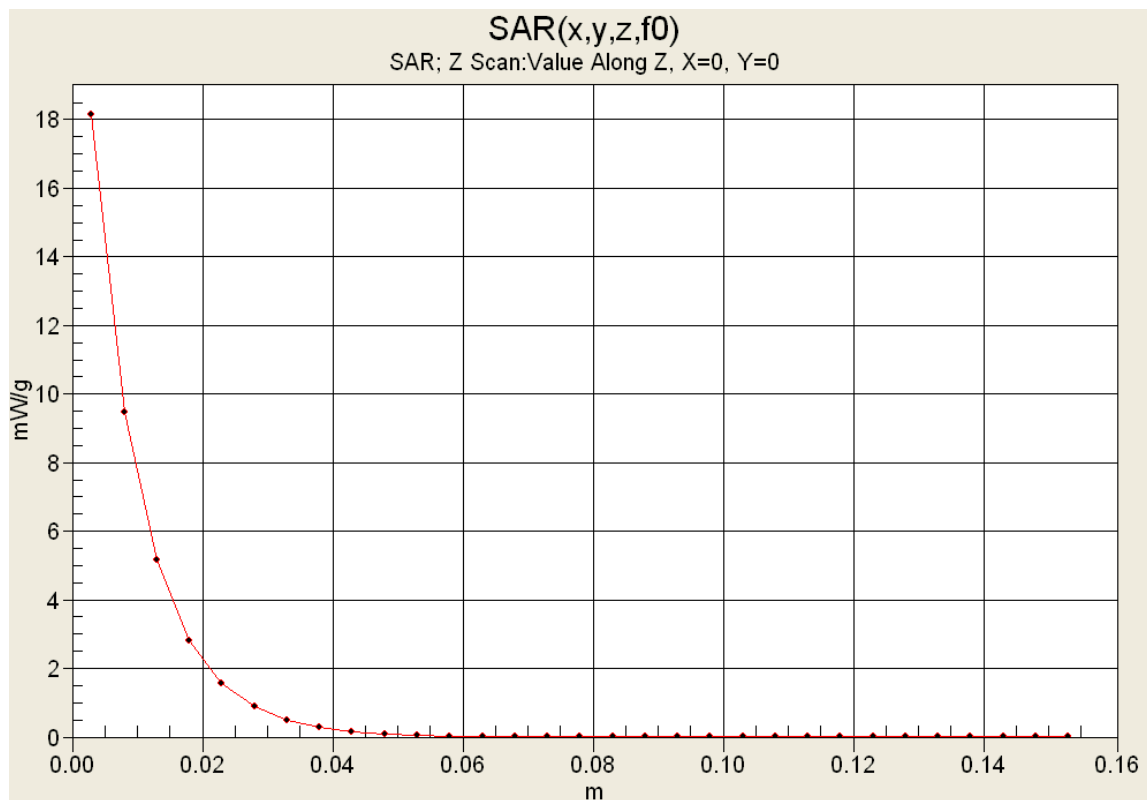
Maximum value of SAR (measured) = 18.3 mW/g






Applicant:	Garmin International Inc.	FCC ID:	IPH-F3ARGD00	IC:	1792A-F3ARGD00	
Model:	F3ARGD00	DUT Type:	Wrist-worn GPS Device			
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	<u>Date(s) of Evaluation</u> Jun. 20, 2013	<u>Test Report Serial No.</u> 061213IPH-1239S	<u>Test Report Revision No.</u> Rev. 1.1 (2nd Release)	 Test Lab Certificate No. 2470.01
	<u>Test Report Issue Date</u> Jul. 3, 2013	<u>Description of Test(s)</u> Specific Absorption Rate	<u>RF Exposure Category</u> Gen. Pop. / Uncontrolled	


Z-axis Scan





Applicant:	Garmin International Inc.	FCC ID:	IPH-F3ARGD00	IC:	1792A-F3ARGD00	
Model:	F3ARGD00	DUT Type:	Wrist-worn GPS Device			
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	<u>Date(s) of Evaluation</u> Jun. 20, 2013	<u>Test Report Serial No.</u> 061213IPH-1239S	<u>Test Report Revision No.</u> Rev. 1.1 (2nd Release)	 Test Lab Certificate No. 2470.01
	<u>Test Report Issue Date</u> Jul. 3, 2013	<u>Description of Test(s)</u> Specific Absorption Rate	<u>RF Exposure Category</u> Gen. Pop. / Uncontrolled	

APPENDIX C - MEASURED FLUID DIELECTRIC PARAMETERS

Applicant:	Garmin International Inc.	FCC ID:	IPH-F3ARGD00	IC:	1792A-F3ARGD00	
Model:	F3ARGD00	DUT Type:	Wrist-worn GPS Device			
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	<u>Date(s) of Evaluation</u> Jun. 20, 2013	<u>Test Report Serial No.</u> 061213IPH-1239S	<u>Test Report Revision No.</u> Rev. 1.1 (2nd Release)	 Test Lab Certificate No. 2470.01
	<u>Test Report Issue Date</u> Jul. 3, 2013	<u>Description of Test(s)</u> Specific Absorption Rate	<u>RF Exposure Category</u> Gen. Pop. / Uncontrolled	



2450 MHz Body

Celltech Labs Inc.
Test Result for UIM Dielectric Parameter
20/Jun/2013


Freq Frequency(GHz)
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	53.04	1.80
2.3600	52.82	1.86	53.07	1.81
2.3700	52.81	1.87	52.99	1.81
2.3800	52.79	1.88	52.75	1.82
2.3900	52.78	1.89	52.83	1.86
2.4000	52.77	1.90	52.97	1.88
2.4100	52.75	1.91	52.84	1.89
2.4200	52.74	1.92	52.68	1.89
2.4300	52.73	1.93	52.81	1.92
2.4400	52.71	1.94	52.87	1.95
2.4500	52.70	1.95	52.83	1.94
2.4600	52.69	1.96	52.84	1.95
2.4700	52.67	1.98	52.64	1.96
2.4800	52.66	1.99	52.69	1.98
2.4900	52.65	2.01	52.58	1.99
2.5000	52.64	2.02	52.52	2.01
2.5100	52.62	2.04	52.36	2.02
2.5200	52.61	2.05	52.41	2.06
2.5300	52.60	2.06	52.54	2.05
2.5400	52.59	2.08	52.40	2.08
2.5500	52.57	2.09	52.62	2.07

Applicant:	Garmin International Inc.	FCC ID:	IPH-F3ARGD00	IC:	1792A-F3ARGD00	
Model:	F3ARGD00	DUT Type:	Wrist-worn GPS Device			
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	<u>Date(s) of Evaluation</u> Jun. 20, 2013	<u>Test Report Serial No.</u> 061213IPH-1239S	<u>Test Report Revision No.</u> Rev. 1.1 (2nd Release)	 Test Lab Certificate No. 2470.01
	<u>Test Report Issue Date</u> Jul. 3, 2013	<u>Description of Test(s)</u> Specific Absorption Rate	<u>RF Exposure Category</u> Gen. Pop. / Uncontrolled	

APPENDIX E - DIPOLE CALIBRATION

Applicant:	Garmin International Inc.	FCC ID:	IPH-F3ARGD00	IC:	1792A-F3ARGD00	
Model:	F3ARGD00	DUT Type:	Wrist-worn GPS Device			
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Accreditation No.: **SCS 108**

Client **Celltech**

Certificate No: **D2450V2-825_Apr12**

CALIBRATION CERTIFICATE

Object **D2450V2 - SN: 825**

Calibration procedure(s) **QA CAL-05.v8**
Calibration procedure for dipole validation kits above 700 MHz

Calibration date: **April 25, 2012**

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	05-Oct-11 (No. 217-01451)	Oct-12
Power sensor HP 8481A	US37292783	05-Oct-11 (No. 217-01451)	Oct-12
Reference 20 dB Attenuator	SN: 5058 (20k)	27-Mar-12 (No. 217-01530)	Apr-13
Type-N mismatch combination	SN: 5047.2 / 06327	27-Mar-12 (No. 217-01533)	Apr-13
Reference Probe ES3DV3	SN: 3205	30-Dec-11 (No. ES3-3205_Dec11)	Dec-12
DAE4	SN: 601	04-Jul-11 (No. DAE4-601_Jul11)	Jul-12
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power sensor HP 8481A	MY41092317	18-Oct-02 (in house check Oct-11)	In house check: Oct-13
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-11)	In house check: Oct-13
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-11)	In house check: Oct-12

	Name	Function	Signature
Calibrated by:	Jeton Kastrati	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: April 25, 2012

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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Glossary:

TSL	tissue simulating liquid
ConvF	sensitivity in TSL / NORM x,y,z
N/A	not applicable or not measured

Calibration is Performed According to the Following Standards:

- IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
- IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- Federal Communications Commission Office of Engineering & Technology (FCC OET), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields; Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Supplement C (Edition 01-01) to Bulletin 65

Additional Documentation:

- DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

- Measurement Conditions:** Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- Antenna Parameters with TSL:** The dipole is mounted with the spacer to position its feed point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis.
- Feed Point Impedance and Return Loss:** These parameters are measured with the dipole positioned under the liquid filled phantom. The impedance stated is transformed from the measurement at the SMA connector to the feed point. The Return Loss ensures low reflected power. No uncertainty required.
- Electrical Delay:** One-way delay between the SMA connector and the antenna feed point. No uncertainty required.
- SAR measured:** SAR measured at the stated antenna input power.
- SAR normalized:** SAR as measured, normalized to an input power of 1 W at the antenna connector.
- SAR for nominal TSL parameters:** The measured TSL parameters are used to calculate the nominal SAR result.

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor $k=2$, which for a normal distribution corresponds to a coverage probability of approximately 95%.

Measurement Conditions

DASY system configuration, as far as not given on page 1.

DASY Version	DASY5	V52.8.1
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2450 MHz \pm 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.2	1.80 mho/m
Measured Head TSL parameters	(22.0 \pm 0.2) °C	39.6 \pm 6 %	1.81 mho/m \pm 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	12.7 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	50.8 mW / g \pm 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	5.90 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	23.6 mW / g \pm 16.5 % (k=2)

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	52.7	1.95 mho/m
Measured Body TSL parameters	(22.0 \pm 0.2) °C	52.4 \pm 6 %	1.98 mho/m \pm 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	12.7 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	50.4 mW / g \pm 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.91 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	23.5 mW / g \pm 16.5 % (k=2)

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	53.0 Ω + 5.5 j Ω
Return Loss	- 24.3 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	50.4 Ω + 6.1 j Ω
Return Loss	- 24.3 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.159 ns
----------------------------------	----------

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

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

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

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	December 11, 2008

DASY5 Validation Report for Head TSL

Date: 25.04.2012

Test Laboratory: SPEAG, Zurich, Switzerland

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

Communication System: CW; Frequency: 2450 MHz

Medium parameters used: $f = 2450$ MHz; $\sigma = 1.81$ mho/m; $\epsilon_r = 39.6$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.45, 4.45, 4.45); Calibrated: 30.12.2011;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.1(838); SEMCAD X 14.6.5(6469)

Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

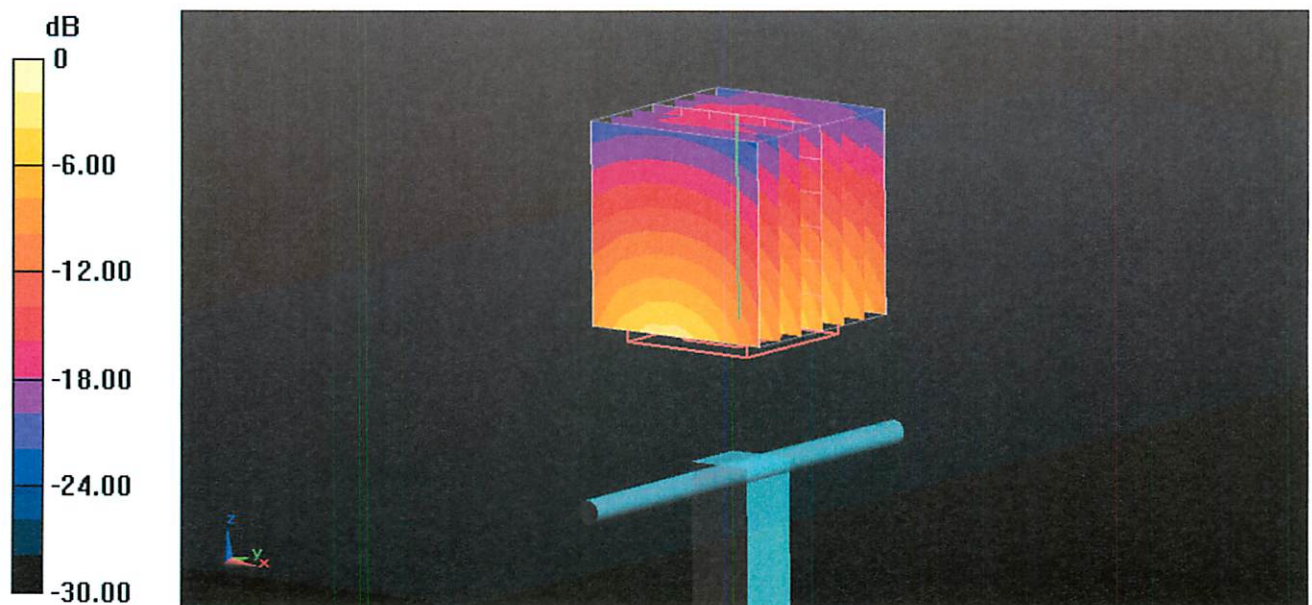
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 99.271 V/m; Power Drift = 0.05 dB

Peak SAR (extrapolated) = 26.216 mW/g

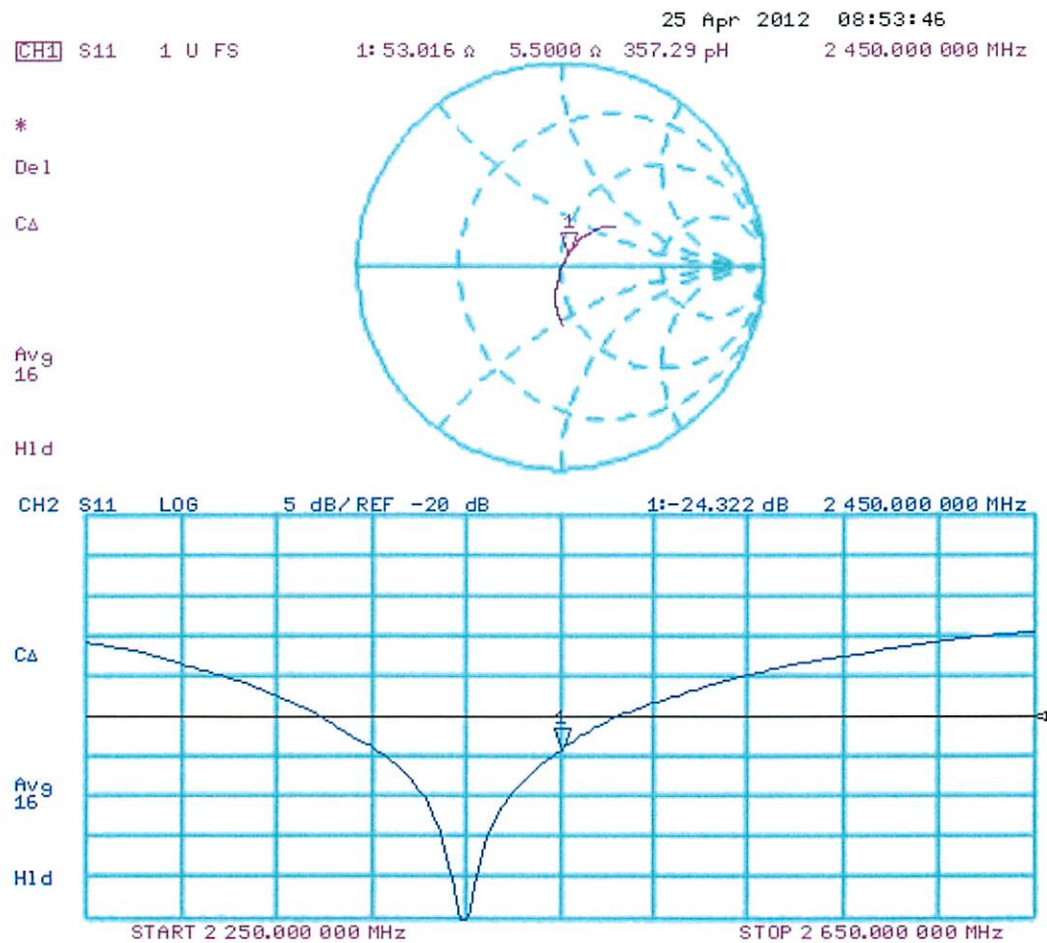
SAR(1 g) = 12.7 mW/g; SAR(10 g) = 5.9 mW/g

Maximum value of SAR (measured) = 16.5 mW/g



0 dB = 16.5 mW/g = 24.35 dB mW/g

Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 25.04.2012

Test Laboratory: SPEAG, Zurich, Switzerland

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

Communication System: CW; Frequency: 2450 MHz

Medium parameters used: $f = 2450$ MHz; $\sigma = 1.98$ mho/m; $\epsilon_r = 52.4$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.26, 4.26, 4.26); Calibrated: 30.12.2011;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.1(838); SEMCAD X 14.6.5(6469)

Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

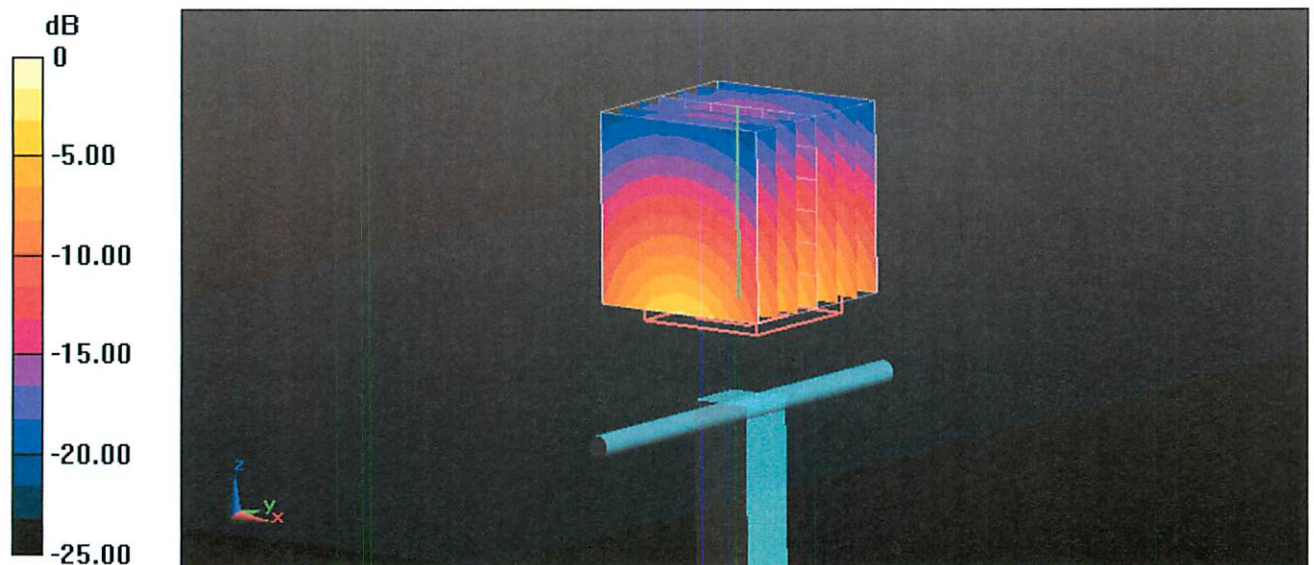
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 95.157 V/m; Power Drift = -0.00 dB

Peak SAR (extrapolated) = 25.807 mW/g

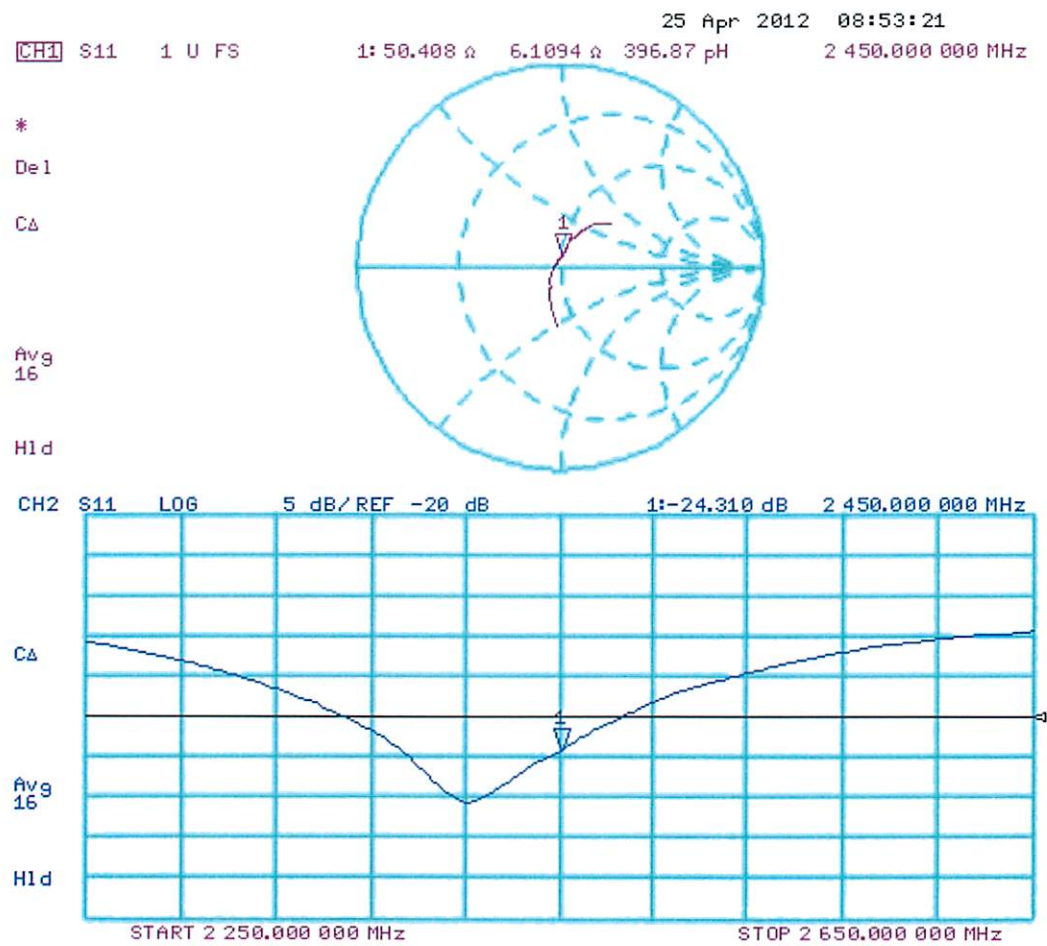
SAR(1 g) = 12.7 mW/g; SAR(10 g) = 5.91 mW/g



Maximum value of SAR (measured) = 16.7 mW/g



0 dB = 16.7 mW/g = 24.45 dB mW/g

Impedance Measurement Plot for Body TSL





 Testing and Engineering Services Lab	<u>Date:</u> Jun 17, 2013	<u>Revision No.</u> Rev. 1.0	 Test Lab Certificate No. 2470.01
	2450 MHz Dipole Extended Calibration		


Dipole: D2450V2
Serial Number: 825
Last Calibrated: Apr. 25, 2012

Antenna Parameters with Head TSL						
	Impedance Real (ohms)	Deviation from cal	Impedance Imaginary (ohms)	Deviation from cal	Return Loss (dB)	Deviation from Cal
Last Calibration	53.0	-	+5.5	-	-24.3	-
Extended Cal						

Antenna Parameters with Body TSL						
	Impedance Real (ohms)	Deviation from cal (ohms)	Impedance Imaginary (ohms)	Deviation from cal (ohms)	Return Loss (dB)	Deviation from Cal (%)
Last Calibration	50.4	-	+6.1	-	-24.3	-
Extended Cal Jun 17, 2013	49.0	1.4	+7.9	1.8	-21.3	12.3%

	<u>Date(s) of Evaluation</u> Jun. 20, 2013	<u>Test Report Serial No.</u> 061213IPH-1239S	<u>Test Report Revision No.</u> Rev. 1.1 (2nd Release)	 Test Lab Certificate No. 2470.01
	<u>Test Report Issue Date</u> Jul. 3, 2013	<u>Description of Test(s)</u> Specific Absorption Rate	<u>RF Exposure Category</u> Gen. Pop. / Uncontrolled	

APPENDIX F - PROBE CALIBRATION

Applicant:	Garmin International Inc.	FCC ID:	IPH-F3ARGD00	IC:	1792A-F3ARGD00	
Model:	F3ARGD00	DUT Type:	Wrist-worn GPS Device			
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Accreditation No.: **SCS 108**

Client **Celltech**

Certificate No: **EX3-3600_Apr13**

CALIBRATION CERTIFICATE

Object **EX3DV4 - SN:3600**

Calibration procedure(s) **QA CAL-01.v8, QA CAL-14.v3, QA CAL-23.v4, QA CAL-25.v4**
Calibration procedure for dosimetric E-field probes

Calibration date: **April 26, 2013**

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	04-Apr-13 (No. 217-01733)	Apr-14
Power sensor E4412A	MY41498087	04-Apr-13 (No. 217-01733)	Apr-14
Reference 3 dB Attenuator	SN: S5054 (3c)	04-Apr-13 (No. 217-01737)	Apr-14
Reference 20 dB Attenuator	SN: S5277 (20x)	04-Apr-13 (No. 217-01735)	Apr-14
Reference 30 dB Attenuator	SN: S5129 (30b)	04-Apr-13 (No. 217-01738)	Apr-14
Reference Probe ES3DV2	SN: 3013	28-Dec-12 (No. ES3-3013_Dec12)	Dec-13
DAE4	SN: 660	31-Jan-13 (No. DAE4-660_Jan13)	Jan-14
Secondary Standards	ID	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Apr-13)	In house check: Apr-15
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-12)	In house check: Oct-13

Calibrated by:	Name Claudio Leubler	Function Laboratory Technician	Signature
Approved by:	Katja Pokovic	Technical Manager	
Issued: April 27, 2013			
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Accreditation No.: **SCS 108**

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Glossary:

TSL	tissue simulating liquid
NORM _{x,y,z}	sensitivity in free space
ConvF	sensitivity in TSL / NORM _{x,y,z}
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C, D	modulation dependent linearization parameters
Polarization ϕ	ϕ rotation around probe axis
Polarization ϑ	ϑ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., $\vartheta = 0$ is normal to probe axis

Calibration is Performed According to the Following Standards:

- IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
- IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005

Methods Applied and Interpretation of Parameters:

- NORM_{x,y,z}**: Assessed for E-field polarization $\vartheta = 0$ ($f \leq 900$ MHz in TEM-cell; $f > 1800$ MHz: R22 waveguide). NORM_{x,y,z} are only intermediate values, i.e., the uncertainties of NORM_{x,y,z} does not affect the E^2 -field uncertainty inside TSL (see below ConvF).
- NORM(f)_{x,y,z}** = NORM_{x,y,z} * frequency_response (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of ConvF.
- DCP_{x,y,z}**: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- PAR**: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- A_{x,y,z}; B_{x,y,z}; C_{x,y,z}; D_{x,y,z}; VR_{x,y,z}**: A, B, C, D are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- ConvF and Boundary Effect Parameters**: Assessed in flat phantom using E-field (or Temperature Transfer Standard for $f \leq 800$ MHz) and inside waveguide using analytical field distributions based on power measurements for $f > 800$ MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to NORM_{x,y,z} * ConvF whereby the uncertainty corresponds to that given for ConvF. A frequency dependent ConvF is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 100 MHz.
- Spherical isotropy (3D deviation from isotropy)**: in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- Sensor Offset**: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.

Probe EX3DV4

SN:3600

Manufactured: January 10, 2007
Calibrated: April 26, 2013

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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3600

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A	0.48	0.49	0.40	$\pm 10.1 \%$
DCP (mV) ^B	99.8	97.4	99.2	

Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB $\sqrt{\mu\text{V}}$	C	D dB	VR mV	Unc ^E (k=2)
0	CW	X	0.0	0.0	1.0	0.00	127.7	$\pm 3.5 \%$
		Y	0.0	0.0	1.0		153.3	
		Z	0.0	0.0	1.0		154.7	

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor $k=2$, which for a normal distribution corresponds to a coverage probability of approximately 95%.

^A The uncertainties of NormX,Y,Z do not affect the E^2 -field uncertainty inside TSL (see Pages 5 and 6).

^B Numerical linearization parameter: uncertainty not required.

^E Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3600

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) ^C	Relative Permittivity ^F	Conductivity (S/m) ^F	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
1810	40.0	1.40	6.98	6.98	6.98	0.56	0.72	± 12.0 %
1950	40.0	1.40	6.75	6.75	6.75	0.75	0.63	± 12.0 %
2450	39.2	1.80	6.25	6.25	6.25	0.34	0.89	± 12.0 %

^C Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3600

Calibration Parameter Determined in Body Tissue Simulating Media

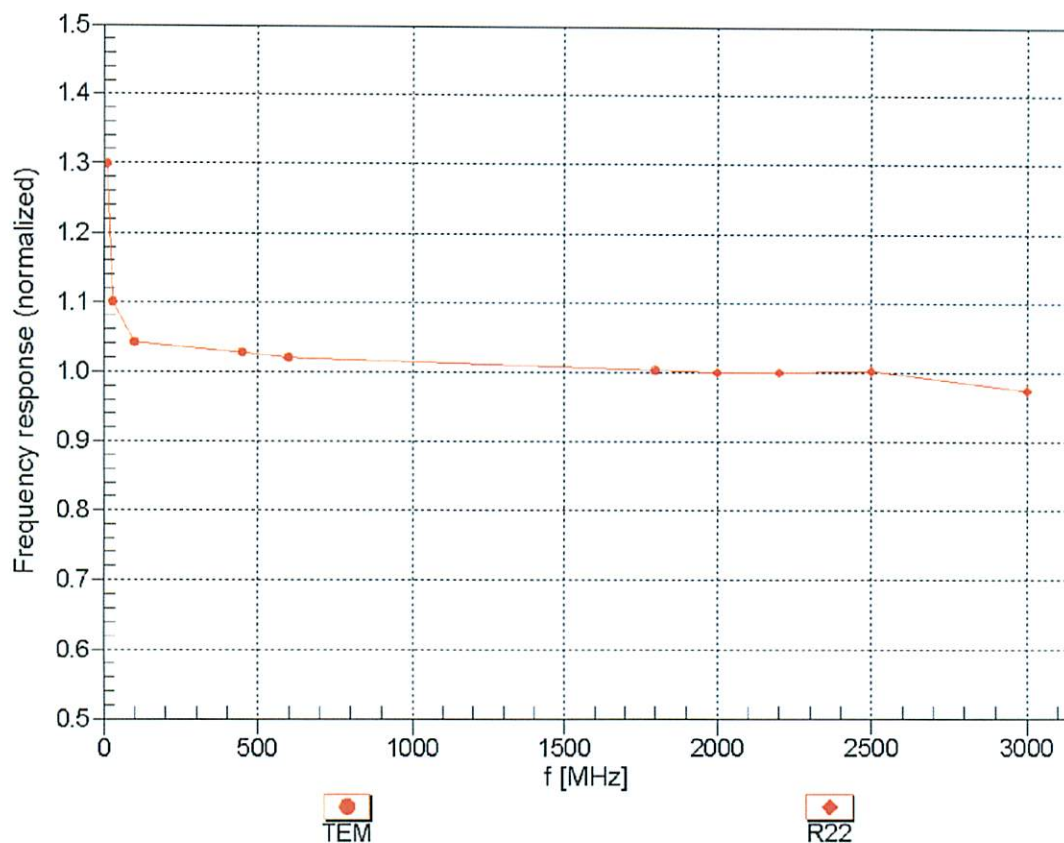
f (MHz) ^C	Relative Permittivity ^F	Conductivity (S/m) ^F	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
1810	53.3	1.52	7.02	7.02	7.02	0.52	0.75	± 12.0 %
1950	53.3	1.52	7.07	7.07	7.07	0.36	0.88	± 12.0 %
2450	52.7	1.95	6.61	6.61	6.61	0.73	0.57	± 12.0 %
5200	49.0	5.30	4.00	4.00	4.00	0.45	1.90	± 13.1 %
5500	48.6	5.65	3.58	3.58	3.58	0.45	1.90	± 13.1 %
5800	48.2	6.00	3.64	3.64	3.64	0.50	1.90	± 13.1 %

^C Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

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

Frequency Response of E-Field

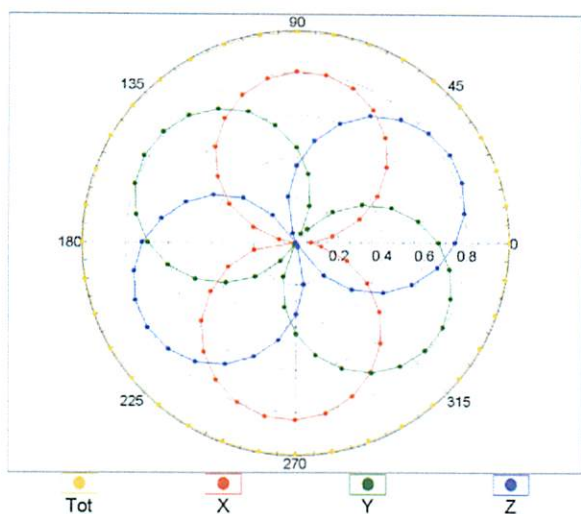
(TEM-Cell:ifi110 EXX, Waveguide: R22)



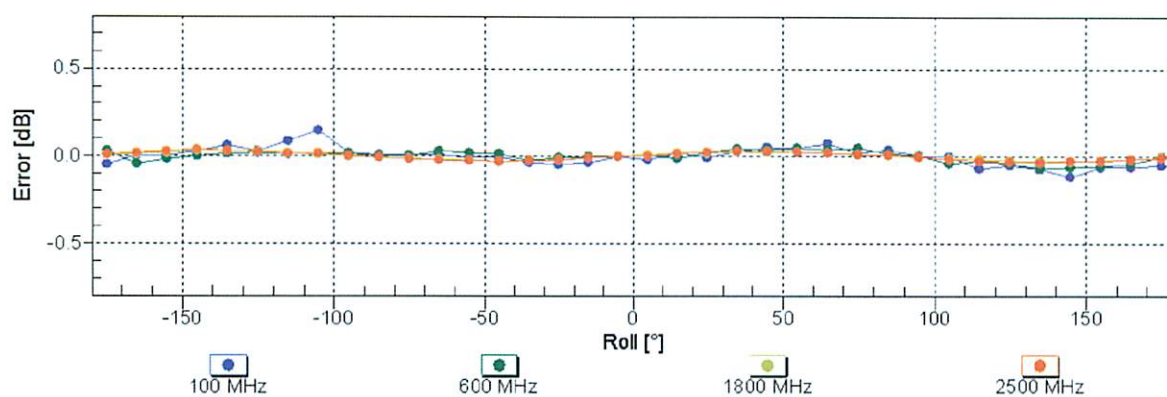
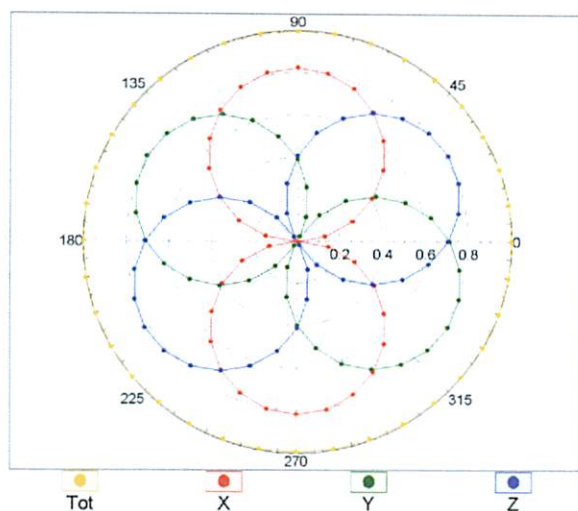
Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ ($k=2$)

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

f=600 MHz, TEM

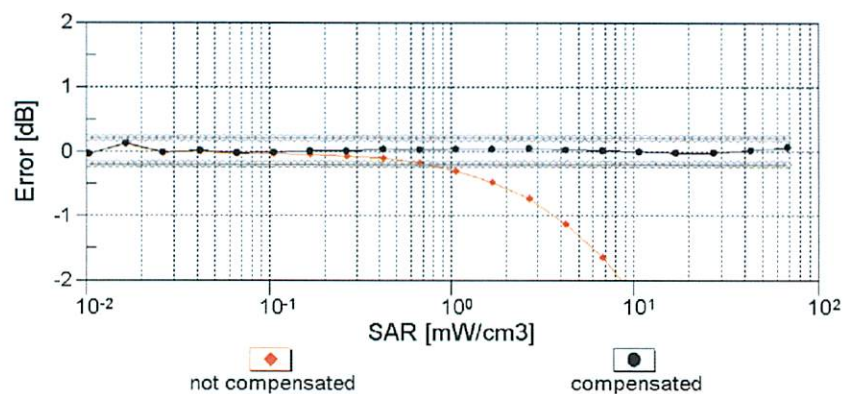
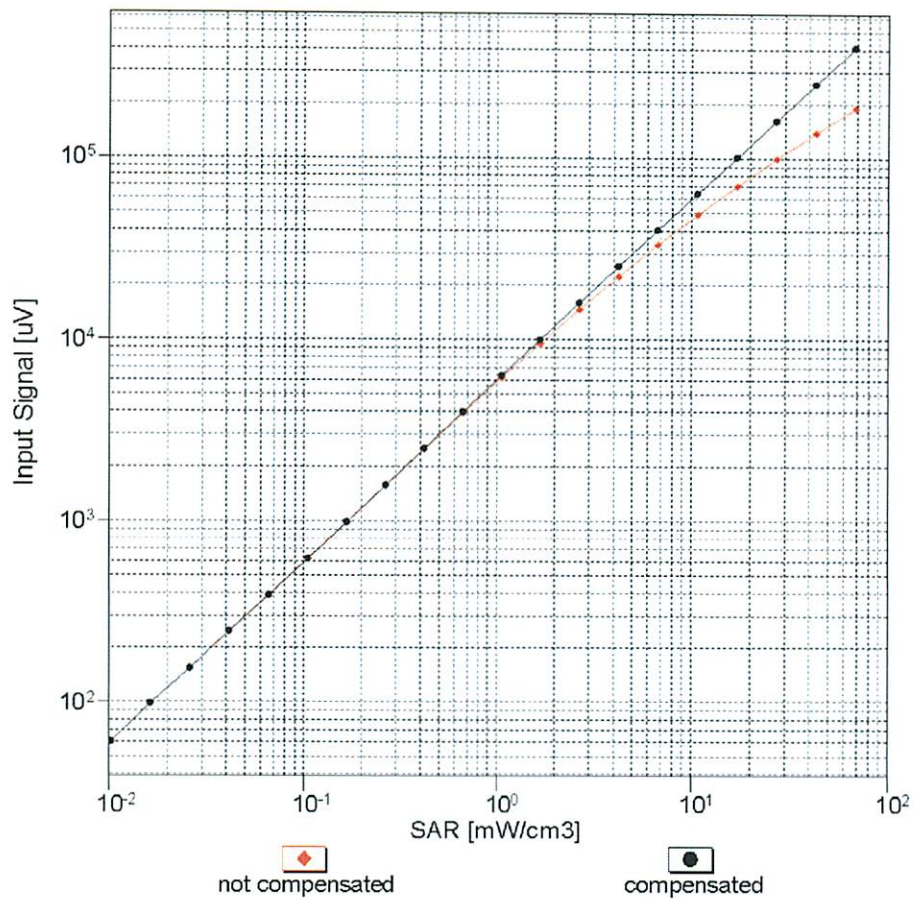


f=1800 MHz, R22



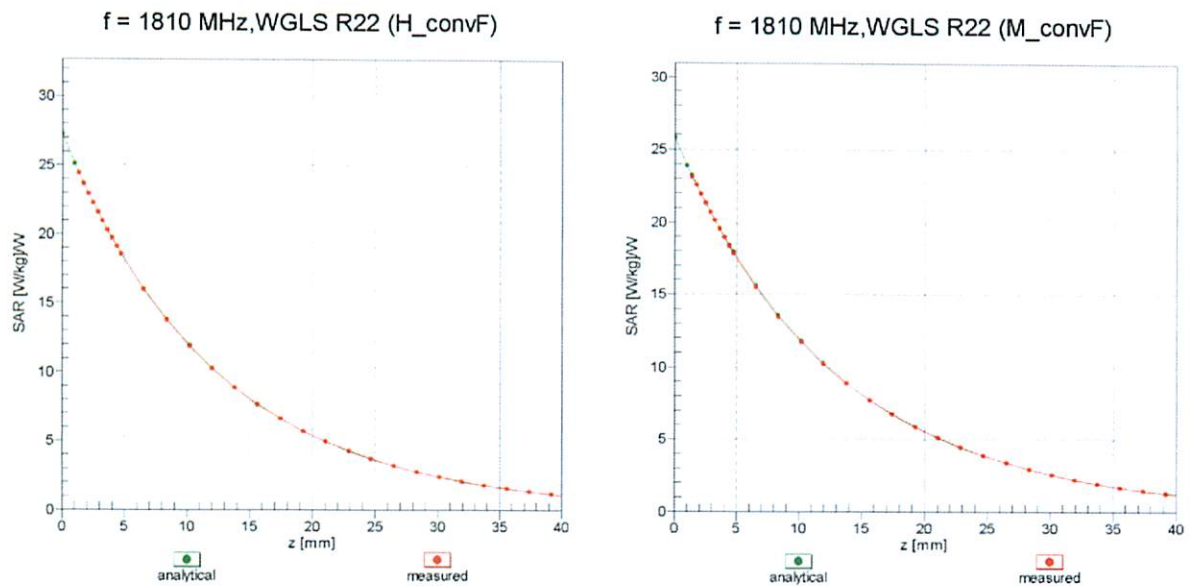
Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ ($k=2$)

Dynamic Range $f(\text{SAR}_{\text{head}})$ (TEM cell , $f = 900 \text{ MHz}$)



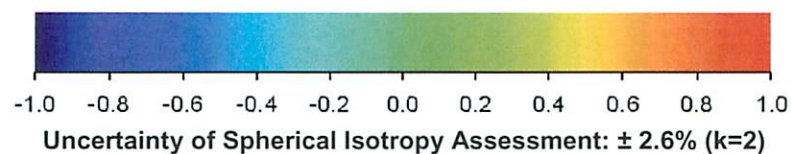
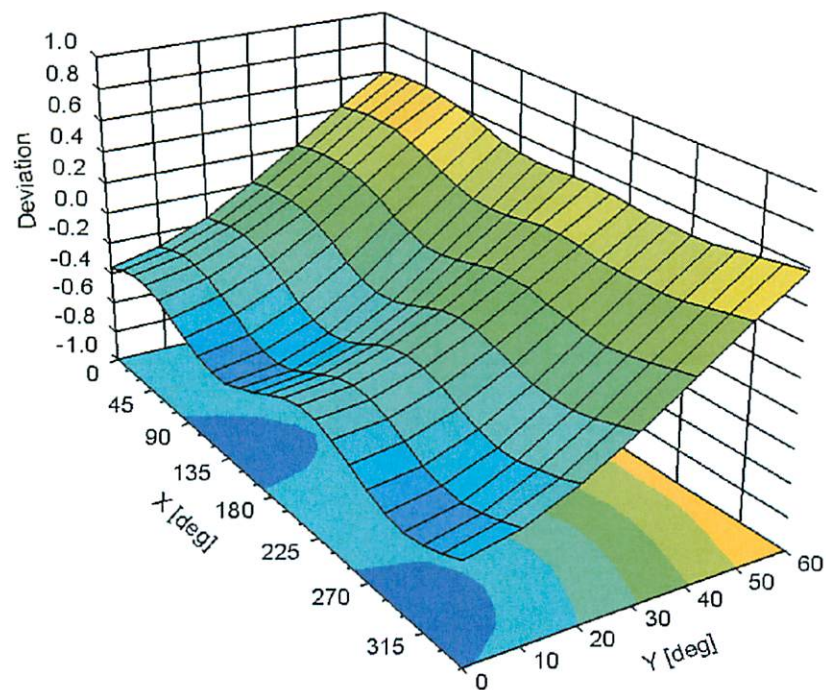
Uncertainty of Linearity Assessment: $\pm 0.6\%$ ($k=2$)

Conversion Factor Assessment



Deviation from Isotropy in Liquid



Error (ϕ , θ), $f = 900 \text{ MHz}$




DASY/EASY - Parameters of Probe: EX3DV4 - SN:3600

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	34.7
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	9 mm
Tip Diameter	2.5 mm
Probe Tip to Sensor X Calibration Point	1 mm
Probe Tip to Sensor Y Calibration Point	1 mm
Probe Tip to Sensor Z Calibration Point	1 mm
Recommended Measurement Distance from Surface	2 mm

	<u>Date(s) of Evaluation</u> Jun. 20, 2013	<u>Test Report Serial No.</u> 061213IPH-1239S	<u>Test Report Revision No.</u> Rev. 1.1 (2nd Release)	 Test Lab Certificate No. 2470.01
	<u>Test Report Issue Date</u> Jul. 3, 2013	<u>Description of Test(s)</u> Specific Absorption Rate	<u>RF Exposure Category</u> Gen. Pop. / Uncontrolled	

APPENDIX G - SAM PHANTOM CERTIFICATE OF CONFORMITY

Applicant:	Garmin International Inc.	FCC ID:	IPH-F3ARGD00	IC:	1792A-F3ARGD00	
Model:	F3ARGD00	DUT Type:	Wrist-worn GPS Device			
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Certificate of conformity / First Article Inspection

Item	SAM Twin Phantom V4.0
Type No	QD 000 P40 BA
Series No	TP-1002 and higher
Manufacturer / Origin	Untersee Composites Hauptstr. 69 CH-8559 Fruthwilen Switzerland

Tests

The series production process used allows the limitation to test of first articles.
Complete tests were made on the pre-series Type No. QD 000 P40 AA, Serial No. TP-1001 and on the series first article Type No. QD 000 P40 BA, Serial No. TP-1006. Certain parameters have been retested using further series units (called samples).

Test	Requirement	Details	Units tested
Shape	Compliance with the geometry according to the CAD model.	IT'IS CAD File (*)	First article, Samples
Material thickness	Compliant with the requirements according to the standards	2mm +/- 0.2mm in specific areas	First article, Samples
Material parameters	Dielectric parameters for required frequencies	200 MHz – 3 GHz Relative permittivity < 5 Loss tangent < 0.05.	Material sample TP 104-5
Material resistivity	The material has been tested to be compatible with the liquids defined in the standards	Liquid type HSL 1800 and others according to the standard.	Pre-series, First article

Standards

- [1] CENELEC EN 50361
- [2] IEEE P1528-200x draft 6.5
- [3] IEC PT 62209 draft 0.9

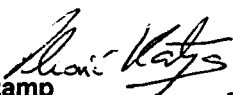
(*) The IT'IS CAD file is derived from [2] and is also within the tolerance requirements of the shapes of [1] and [3].

Conformity

Based on the sample tests above, we certify that this item is in compliance with the uncertainty requirements of SAR measurements specified in standard [1] and draft standards [2] and [3].

Date 18.11.2001

Signature / Stamp



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