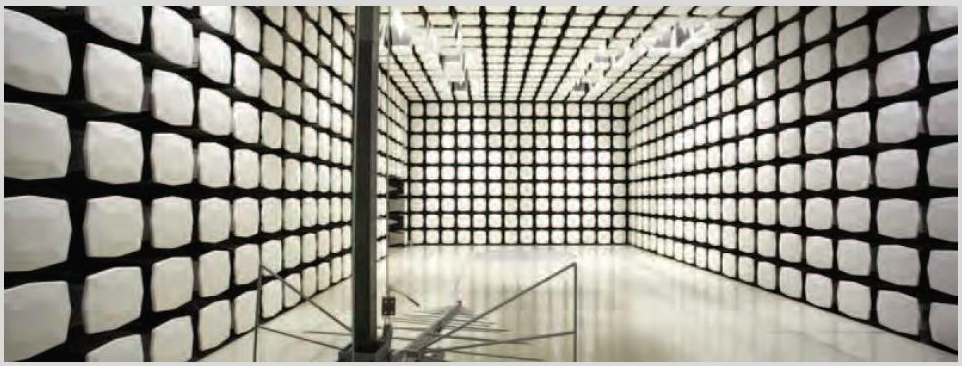
Sonetics Corporation

Connect

SAR Evaluation Report: FIRC0038.3, Issue Date: June 8, 2020

Evaluated to the following SAR specification:

FCC 2.1093:2020



NVLAP LAB CODE: 200881-0

CERTIFICATE OF TEST

Last Date of Test: May 27, 2020
Sonetics Corporation
EUT: Connect

Applicable Standard

Test Description	Specification	Test Method	Pass/Fail
SAR Evaluation	FCC 2.1093:2020	FCC KDB 865664 D01 v01r04 FCC KDB 865664 D02 v01r02 FCC KDB 447498 D01 v06 IEEE Std 1528:2013	Pass

Highest SAR Values:

Frequency Bands (GHz)	Body (W/kg) 1g	Limit (W/kg) 1g	Exposure Environment
1.92-1.93	0.074	1.6	General Population
2.402-2.48	0.010	1.6	

Highest Simultaneous SAR Values:

Frequency Bands (GHz)	Body (W/kg) 1g	Limit (W/kg) 1g	Exposure Environment
1.92-1.93	0.084	1.6	General Population
2.402-2.48			

Deviations From Test Standards

None

Approved By:

Don Facteau, Systems Architect

REVISION HISTORY

Revision Number	Description	Date (yyyy-mm-dd)	Page Number
00	None		

ACCREDITATIONS AND AUTHORIZATIONS

United States

FCC - Designated by the FCC as a Telecommunications Certification Body (TCB). Certification chambers, Open Area Test Sites, and conducted measurement facilities are listed with the FCC.

A2LA - Accredited by A2LA to ISO / IEC 17065 as a product certifier. This allows Element to certify transmitters to FCC and IC specifications.

NVLAP - Each laboratory is accredited by NVLAP to ISO 17025

Canada

ISED - Recognized by Innovation, Science and Economic Development Canada as a Certification Body (CB) and as a CAB for the acceptance of test data.

European Union

European Commission – Within Element, we have a EU Notified Body validated for the EMCD and RED Directives.

Australia/New Zealand

ACMA - Recognized by ACMA as a CAB for the acceptance of test data.

Korea

MSIT / RRA - Recognized by KCC's RRA as a CAB for the acceptance of test data.

Japan

VCCI - Associate Member of the VCCI. Conducted and radiated measurement facilities are registered.

Taiwan

BSMI – Recognized by BSMI as a CAB for the acceptance of test data.

NCC - Recognized by NCC as a CAB for the acceptance of test data.

Singapore

IDA – Recognized by IDA as a CAB for the acceptance of test data.

Israel

MOC – Recognized by MOC as a CAB for the acceptance of test data.

Hong Kong

OFCA – Recognized by OFCA as a CAB for the acceptance of test data.

Vietnam

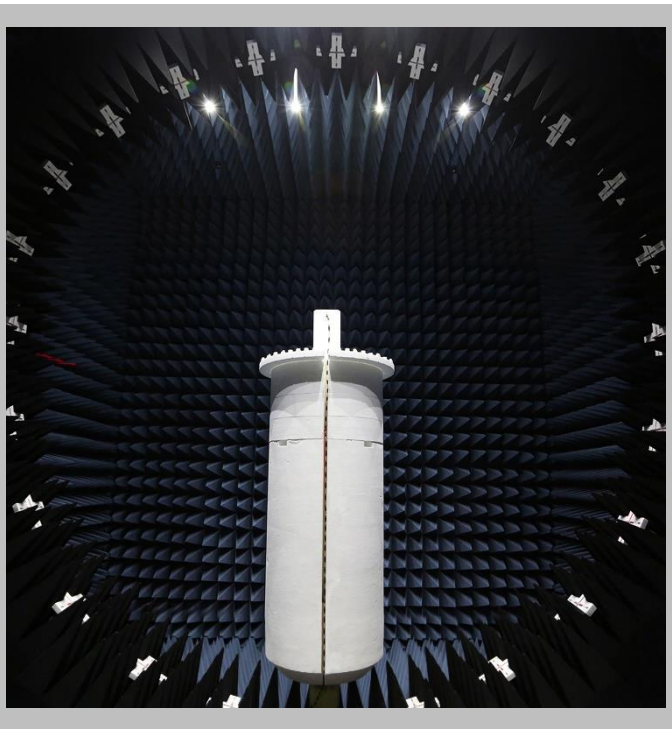
MIC – Recognized by MIC as a CAB for the acceptance of test data.

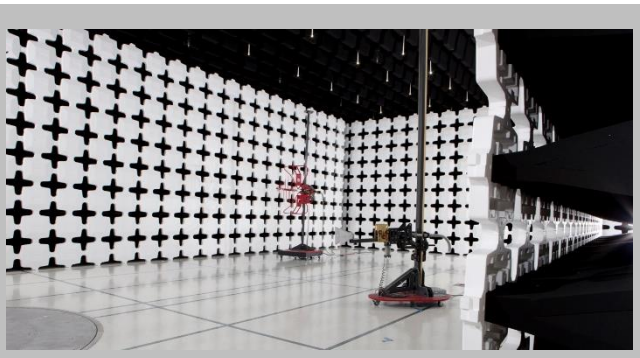
SCOPE

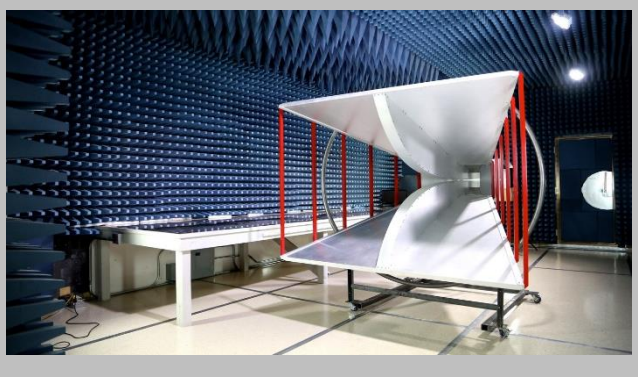
For details on the Scopes of our Accreditations, please visit:
https://www.nwemc.com/emc-testing-accreditations

FACILITIES

California	Minnesota	Oregon	Texas	Washington
Labs OC01-17 41 Tesla Irvine, CA 92618 (949) 861-8918	Labs MN01-10 9349 W Broadway Ave. Brooklyn Park, MN 55445 (612)-638-5136	Labs EV01-12 6775 NE Evergreen Pkwy #400 Hillsboro, OR 97124 (503) 844-4066	Labs TX01-09 3801 E Plano Pkwy Plano, TX 75074 (469) 304-5255	Labs NC01-05 19201 120th Ave NE Bothell, WA 98011 (425)984-6600
NVLAP				
NVLAP Lab Code: 200676-0	NVLAP Lab Code: 200881-0	NVLAP Lab Code: 200630-0	NVLAP Lab Code:201049-0	NVLAP Lab Code: 200629-0
Innovation, Science and Economic Development Canada				
2834B-1, 2834B-3	2834E-1, 2834E-3	2834D-1	2834G-1	2834F-1
BSMI				
SL2-IN-E-1154R	SL2-IN-E-1152R	SL2-IN-E-1017	SL2-IN-E-1158R	SL2-IN-E-1153R
VCCI				
A-0029	A-0109	A-0108	A-0201	A-0110
Recognized Phase I CAB for ISED, ACMA, BSMI, IDA, KCC/RRA, MIC, MOC, NCC, OFCA				
US0158	US0175	US0017	US0191	US0157







PRODUCT DESCRIPTION

2014-12-10

Client and Equipment Under Test (EUT) Information

Company Name:	Sonetics Corporation
Address:	17600 SW 65th Ave
City, State, Zip:	Lake Oswego, OR 97035 USA
Test Requested By:	Marcie Dobyns
Model:	Connect
First Date of Test:	April 29, 2020
Last Date of Test:	May 26, 2020
Receipt Date of Samples:	April 8, 2020
Equipment Design Stage:	Production
Equipment Condition:	No Damage
Purchase Authorization:	Verified

Information Provided by the Party Requesting the Test

Functional Description of the EUT:

The Connect Device is a team communication product. It uses up to 2 radios to allow team Communication with other members on a secure DECT connection.

FCC IDs: WAP3026, V9N950140600V1

The device contains the following radios:
Bluetooth BR/EDR: 2402 – 2480 MHz
Bluetooth LE: 2402 – 2480 MHz
DECT 1919.808 – 1928.448 MHz

Location of transmit antenna(s):

Bluetooth Antenna

PRODUCT DESCRIPTION

2014-12-10

Testing Locations:

For clarity, the sides of the EUT are referred to as front side, back side, volume buttons side, no button side, power button side, and charger side.

When no accessory is used, the EUT can have any orientation exposed to the human body. For the DECT radio, the 3 sides that place the antenna in closest proximity to the human body are the front side, back side, and no buttons side. These are the orientations tested. For the Bluetooth combination radio, the 3 sides that place the antenna in closest proximity to the human body are the front side, back side, and volume buttons side. These are the orientations tested.

When the metallic belt clip accessory is used, only the back of the EUT will be in proximity to the human body. This orientation was the only orientation tested for both the DECT and Bluetooth combination radio.

Testing Objective:

To demonstrate compliance of the Bluetooth, Bluetooth Low energy, and the DECT radio with the SAR requirements of FCC 2.1093:2020.

Scaling:

Max power

Per FCC KDB 447498, the measured SAR values were scaled to the maximum tune-up tolerance limit. The results are referred to as the "Reported SAR" values. The following formula was used to calculate the linear SAR scaling factor:

SAR scaling factor = 10^((Tune-up Tolerance Power (dBm) - Measured Power (dBm)) / 10)

A summary of scaling factors is as follows:

Tune-Up Tolerance and Scaling

Radio	Max Measured OP (dBm)	Declared Tune-Up OP (dBm)	Scaling Factor
Bluetooth BDR/EDR and LE	2.15	3	1.22
DECT	18.9	20.5	1.45

Duty Cycle

The Bluetooth radio was operating at 100% duty cycle. No duty cycle scaling was applied for this radio.

The DECT radio was operating at 8% duty cycle. The EUT in the field is firmware limited to a maximum operating duty cycle of 8%. No duty cycle scaling was applied for this radio. Extra care was taken during the measurements to ensure that the signal was properly captured.

Simultaneous Transmissions:

The EUT is capable of simultaneous transmissions. The DECT radio can be on at the same as either the Bluetooth or the Bluetooth Low Energy radio. The Bluetooth radio has a strictly higher output power than the Bluetooth Low Energy radio. Therefore, the worst case transmission occurs when Bluetooth is transmitting at the same time as the DECT radio.

The highest individual values from the Bluetooth and DECT radios are added together and compared against the limit to determine simultaneous transmission compliance.

DECT Radio 1g SAR + Bluetooth Radio 1g SAR ≤ 1.6 W/kg over 1g
0.074 W/kg over 1g + 0.010 W/kg over 1g ≤ 1.6 W/kg over 1g
0.084 W/kg over 1g ≤ 1.6 W/kg over 1g

The EUT passes the simultaneous transmission requirement.

CONFIGURATIONS

Configuration FIRC0038- 2

EUT			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Connect	Sonetics Corporation	Connect	R14-10

Peripherals in test setup boundary			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Laptop	Dell	Latitude 7490	6XW78Y2

Cables					
Cable Type	**Shield**	**Length (m)**	**Ferrite**	**Connection 1**	**Connection 2**
USB Cable	Yes	0.5m	No	Connect	Unterminated

Configuration FIRC0038- 3

EUT			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Connect	Sonetics Corporation	Connect	R14-15

Peripherals in test setup boundary			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Laptop	Dell	Latitude 7490	6XW78Y2

Cables					
Cable Type	**Shield**	**Length (m)**	**Ferrite**	**Connection 1**	**Connection 2**
USB Cable	Yes	0.5m	No	Connect	Unterminated

Configuration FIRC0038- 4

EUT			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Connect	Sonetics Corporation	Connect	R12-J

Peripherals in test setup boundary			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Laptop	Dell	Latitude 7490	6XW78Y2

Cables					
Cable Type	**Shield**	**Length (m)**	**Ferrite**	**Connection 1**	**Connection 2**
USB Cable	Yes	0.5m	No	Connect	Unterminated

MODIFICATIONS

Equipment Modifications

Item	Date	Test	Modification	Note	Disposition of EUT
1	2020-04-29	Output Power	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	EUT remained at Element following the test.
2	2020-04-30	SAR Evaluation	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	EUT remained at Element following the test.
3	2020-05-26	SAR Evaluation	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	Scheduled testing was completed.

TISSUE – EQUIVALENT LIQUID DESCRIPTION

Characterization of tissue-equivalent liquid dielectric properties

The measured values must be within ±10% of the target values provided SAR error compensation algorithms documented in IEEE Std 1528-2013 section E.3.2.2 are implemented for upward correction purposes only. The temperature variation in the liquid during SAR measurements must be within ± 2 °C of that recorded when the dielectric properties were measured.

The dielectric parameters of the tissue-equivalent liquids were measured using the SPEAG DAKS:200 dielectric assessment kit. The dielectric measurements were made across the frequency range of the liquid. The attached data sheets show that the dielectric parameters of the liquid were within the required tolerances.

Target values of dielectric parameters

Per KDB 865664 D01 v01r04, Appendix A:

The head tissue dielectric parameters recommended by IEEE Std 1528-2013 have been incorporated in the following table. These head parameters are derived from planar layer models simulating the highest expected SAR for the dielectric properties and tissue thickness variations in a human head. Other head and body tissue parameters that have not been specified in IEEE Std 1528 are derived from tissue dielectric parameters computed from the 4-Cole-Cole equations described above and extrapolated according to the head parameters specified in IEEE Std 1528."

Linear interpolation is used for determining target dielectric parameters for values between those listed.

Target Frequency	Head		Body	
(MHz)	ε_r	σ (S/m)	ε_r	σ (S/m)
150	52.3	0.76	61.9	0.80
300	45.3	0.87	58.2	0.92
450	43.5	0.87	56.7	0.94
835	41.5	0.90	55.2	0.97
900	41.5	0.97	55.0	1.05
915	41.5	0.98	55.0	1.06
1450	40.5	1.20	54.0	1.30
1610	40.3	1.29	53.8	1.40
1800 – 2000	40.0	1.40	53.3	1.52
2450	39.2	1.80	52.7	1.95
3000	38.5	2.40	52.0	2.73
5800	35.3	5.27	48.2	6.00

(ε_r = relative permittivity, σ = conductivity and ρ = 1000 kg/m^3)

TISSUE – EQUIVALENT LIQUID DESCRIPTION

Composition of Ingredients for Liquid Tissue Phantoms

Element uses broadband tissue equivalent liquids prepared by SPEAG and confirmed by Element to be within +/- 10% of target values. SAR error compensation algorithms documented in IEEE Std 1528-2013 are implemented for upward correction purposes only.

By percent weight, the approximate compositions of the broadband tissue are listed below. The composition of ingredients may be modified accordingly to achieve the desired target tissue parameters required for routine SAR evaluation:

Material	Percent Weight
Ethanediol	1.0 - 4.9%
Sodium Petroleum Sulfonate	<2.9%
Hexylene Glycol	<2.9%
Alkoxylated Alcohol	<2.0%
Mineral Oils	<20%
Deionized Water	Fill to volume

The exact liquid recipes are proprietary to the tissue equivalent liquid manufacturer.

SAR Correction Formula for Deviation from Target Dielectric Values

A correction formula is automatically applied by the measurement software to SAR data to account for the deviation from the target dielectric values. The correction formula only scales measured values upward. The SAR system manufacturer has been contacted and has verified Element's implementation and understanding of the SAR correction formula. The correction is calculated following IEEE Std 1528-2013 Annex E.3. Where SAR correction is considered, there will be a note stating "SAR corrected for target medium." The equation is as follows:

$$\Delta SAR = c_\varepsilon \Delta\varepsilon_r + c_\sigma \Delta\sigma$$

Where the values for, $\Delta\varepsilon_r$ and $\Delta\sigma$ and are the percent the permittivity and conductivity respectively are away from ideal values and where ΔSAR is the percent the measured SAR value is corrected.

When 1 g peak spatial-average SAR measurements are taken:

$$c_\varepsilon = -7.854 \times 10^{-4} f^3 + 9.402 \times 10^{-3} f^2 - 2.742 \times 10^{-2} f - 0.2026$$
$$c_\sigma = 9.804 \times 10^{-3} f^3 - 8.661 \times 10^{-2} f^2 + 2.981 \times 10^{-2} f + 0.7829$$

Where *f* is the frequency in GHz.

When 10 g peak spatial-average SAR measurements are taken:

$$c_\varepsilon = 3.456 \times 10^{-3} f^3 - 3.531 \times 10^{-2} f^2 + 7.675 \times 10^{-2} f - 0.1860$$
$$c_\sigma = 4.479 \times 10^{-3} f^3 - 1.586 \times 10^{-2} f^2 - 0.1972 f + 0.7717$$

Where *f* is the frequency in GHz.

TISSUE – EQUIVALENT LIQUID

element
WSTE.2020.04.03.0

Date:	04/29/2020	Temperature:	21.8°C
Tissue:	MBBL600-6000V6	Liquid Temperature:	20°C
Tested By:	Marcelo Aguayo, Kyle McMullan	Relative Humidity:	36.2%
Job Site:	MN11	Bar. Pressure:	1014 mb

TEST SPECIFICATIONS

Specification:	Method:
FCC 2.1093:2020	FCC KDB 865664 D01 v01r04 FCC KDB 865664 D02 v01r02 FCC KDB 447498 D01 v06 IEEE Std 1528:2013

RESULTS

	Actual Values		Target Values		Deviation (%)	
Frequency(MHz)	Relative Perm.	Conductivity	Relative Perm.	Frequency(MHz)	Relative Perm.	Conductivity
2450	52.48	2.08	52.7	1.95	-0.42	6.67

Freq (MHz)	Relative Perm.	Cond. (S/m)
400	56.53	0.84
450	56.32	0.85
500	56.12	0.87
550	55.92	0.88
600	55.73	0.90
650	55.55	0.92
700	55.39	0.93
750	55.23	0.95
800	55.09	0.97
850	54.97	0.99
900	54.87	1.01
950	54.77	1.03
1000	54.69	1.06
1050	54.61	1.08
1100	54.52	1.10
1150	54.43	1.13
1200	54.35	1.16
1250	54.26	1.18
1300	54.18	1.21
1350	54.11	1.24
1400	54.04	1.27
1450	53.97	1.30
1500	53.89	1.33
1550	53.81	1.36
1600	53.73	1.40
1650	53.65	1.43
1700	53.58	1.46
1750	53.50	1.50
1800	53.42	1.53
1850	53.35	1.57
1900	53.27	1.61
1950	53.20	1.64
2000	53.13	1.68
2050	53.06	1.72
2100	53.00	1.76
2150	52.93	1.80
2200	52.86	1.85
2250	52.79	1.89
2300	52.71	1.93
2350	52.64	1.98
2400	52.56	2.03
2450	52.48	2.08
2500	52.40	2.13
2550	52.32	2.18
2600	52.22	2.23
2650	52.13	2.28
2700	52.03	2.33
2750	51.93	2.39
2800	51.83	2.44
2850	51.73	2.49
2900	51.62	2.55
2950	51.52	2.60
3000	51.42	2.65
3050	51.32	2.71
3100	51.21	2.76
3150	51.11	2.82
3200	51.01	2.87
3250	50.90	2.93
3300	50.80	2.98
3350	50.71	3.04
3400	50.61	3.10
3450	50.51	3.15
3500	50.42	3.21
3550	50.33	3.27
3600	50.25	3.33
3650	50.16	3.39
3700	50.08	3.45
3750	49.99	3.51
3800	49.91	3.57
3850	49.82	3.63
3900	49.73	3.70
3950	49.65	3.76
4000	49.56	3.83
4050	49.47	3.90
4100	49.39	3.96
4150	49.29	4.03
4200	49.20	4.10
4250	49.11	4.17
4300	49.02	4.24
4350	48.92	4.31
4400	48.82	4.38
4450	48.71	4.45
4500	48.59	4.52
4550	48.51	4.59
4600	48.40	4.65
4650	48.28	4.73
4700	48.14	4.80
4750	48.03	4.86
4800	47.92	4.94
4850	47.81	5.01
4900	47.72	5.10
4950	47.63	5.18
5000	47.57	5.26
5050	47.51	5.34
5100	47.43	5.42
5150	47.34	5.49
5200	47.25	5.58
5250	47.15	5.67
5300	47.05	5.75
5350	46.96	5.83
5400	46.89	5.90
5450	46.82	5.96
5500	46.75	6.02
5550	46.69	6.08
5600	46.59	6.14
5650	46.44	6.21
5700	46.28	6.28
5750	46.09	6.36
5800	45.92	6.42
5850	45.70	6.49
5900	45.49	6.57
5950	45.27	6.65
6000	45.10	6.73

TISSUE – EQUIVALENT LIQUID

element
WSTE.2020.04.03.0

Date:	04/30/2020	Temperature:	21.2°C
Tissue:	MBBL600-6000V6	Liquid Temperature:	21.1°C
Tested By:	Marcelo Aguayo, Kyle McMullan	Relative Humidity:	34.1%
Job Site:	MN11	Bar. Pressure:	1016 mb

TEST SPECIFICATIONS

Specification:	Method:
FCC 2.1093:2020	FCC KDB 865664 D01 v01r04 FCC KDB 865664 D02 v01r02 FCC KDB 447498 D01 v06 IEEE Std 1528:2013

RESULTS

	Actual Values		Target Values		Deviation (%)	
Frequency(MHz)	Relative Perm.	Conductivity	Relative Perm.	Frequency(MHz)	Relative Perm.	Conductivity
1900	52.93	1.60	53.3	1.52	-0.69	5.26
2450	52.16	2.07	52.7	1.95	-1.02	6.15

Freq (MHz)	Relative Perm.	Cond. (S/m)
400	56.33	0.85
450	56.17	0.87
500	56.02	0.89
550	55.87	0.90
600	55.72	0.92
650	55.57	0.94
700	55.42	0.96
750	55.26	0.98
800	55.11	1.00
850	54.96	1.02
900	54.81	1.04
950	54.67	1.06
1000	54.55	1.08
1050	54.43	1.11
1100	54.32	1.13
1150	54.21	1.15
1200	54.11	1.18
1250	54.01	1.20
1300	53.93	1.23
1350	53.85	1.25
1400	53.78	1.28
1450	53.70	1.31
1500	53.63	1.34
1550	53.55	1.37
1600	53.47	1.40
1650	53.38	1.43
1700	53.30	1.46
1750	53.21	1.50
1800	53.12	1.53
1850	53.03	1.57
1900	52.93	1.60
1950	52.85	1.64
2000	52.76	1.67
2050	52.69	1.71
2100	52.62	1.75
2150	52.56	1.79
2200	52.49	1.83
2250	52.43	1.88

Freq (MHz)	Relative Perm.	Cond. (S/m)
2300	52.36	1.92
2350	52.29	1.97
2400	52.23	2.02
2450	52.16	2.07
2500	52.09	2.11
2550	52.02	2.16
2600	51.95	2.21
2650	51.87	2.26
2700	51.78	2.32
2750	51.68	2.37
2800	51.59	2.42
2850	51.49	2.48
2900	51.40	2.53
2950	51.30	2.58
3000	51.20	2.64
3050	51.11	2.69
3100	51.01	2.74
3150	50.91	2.79
3200	50.80	2.85
3250	50.70	2.90
3300	50.60	2.95
3350	50.50	3.01
3400	50.41	3.06
3450	50.31	3.12
3500	50.22	3.17
3550	50.13	3.23
3600	50.05	3.28
3650	49.96	3.34
3700	49.87	3.40
3750	49.79	3.46
3800	49.71	3.52
3850	49.63	3.58
3900	49.54	3.64
3950	49.46	3.71
4000	49.38	3.77
4050	49.29	3.84
4100	49.20	3.91
4150	49.11	3.98

Freq (MHz)	Relative Perm.	Cond. (S/m)
4200	49.02	4.05
4250	48.95	4.11
4300	48.86	4.18
4350	48.77	4.25
4400	48.68	4.32
4450	48.55	4.39
4500	48.45	4.46
4550	48.35	4.54
4600	48.22	4.61
4650	48.11	4.68
4700	47.97	4.75
4750	47.88	4.82
4800	47.76	4.90
4850	47.66	4.97
4900	47.56	5.06
4950	47.48	5.15
5000	47.41	5.23
5050	47.36	5.29
5100	47.29	5.36
5150	47.20	5.44
5200	47.11	5.52
5250	47.03	5.61
5300	46.96	5.69
5350	46.88	5.77
5400	46.80	5.83
5450	46.73	5.89
5500	46.67	5.94
5550	46.60	6.00
5600	46.50	6.07
5650	46.38	6.15
5700	46.24	6.22
5750	46.09	6.29
5800	45.96	6.36
5850	45.80	6.42
5900	45.65	6.49
5950	45.46	6.57
6000	45.33	6.66

TISSUE – EQUIVALENT LIQUID

element
WSTE.2020.04.03.0

Date:	05/26/2020	Temperature:	21.2°C
Tissue:	MBBL600-6000V6	Liquid Temperature:	20°C
Tested By:	Marcelo Aguayo, Kyle McMullan	Relative Humidity:	62%
Job Site:	MN11	Bar. Pressure:	1010 mb

TEST SPECIFICATIONS

Specification:	Method:
FCC 2.1093:2020	FCC KDB 865664 D01 v01r04 FCC KDB 865664 D02 v01r02 FCC KDB 447498 D01 v06 IEEE Std 1528:2013

RESULTS

	Actual Values		Target Values		Deviation (%)	
Frequency(MHz)	Relative Perm.	Conductivity	Relative Perm.	Frequency(MHz)	Relative Perm.	Conductivity
1900	53.51	1.647	53.3	1.52	-0.39	-8.36

Freq (MHz)	Relative Perm.	Cond. (S/m)
400	56.82	0.85
450	56.55	0.86
500	56.28	0.88
550	56.22	0.89
600	56.10	0.91
650	56.00	0.93
700	55.90	0.95
750	55.77	0.97
800	55.58	0.99
850	55.43	1.01
900	55.32	1.03
950	55.23	1.05
1000	55.14	1.08
1050	55.07	1.10
1100	54.98	1.13
1150	54.89	1.15
1200	54.78	1.18
1250	54.64	1.21
1300	54.57	1.24
1350	54.40	1.27
1400	54.33	1.30
1450	54.28	1.33
1500	54.24	1.36
1550	54.18	1.40
1600	54.11	1.43
1650	54.04	1.47
1700	53.88	1.50
1750	53.78	1.54
1800	53.66	1.57
1850	53.54	1.61
1900	53.51	1.65
1950	53.45	1.68
2000	53.39	1.73
2050	53.31	1.77
2100	53.27	1.82
2150	53.18	1.86
2200	53.11	1.91
2250	53.03	1.95

Freq (MHz)	Relative Perm.	Cond. (S/m)
2300	52.97	2.00
2350	52.92	2.05
2400	52.84	2.10
2450	52.76	2.15
2500	52.69	2.20
2550	52.61	2.24
2600	52.48	2.30
2650	52.37	2.36
2700	52.31	2.41
2750	52.19	2.47
2800	52.11	2.53
2850	52.00	2.58
2900	51.92	2.64
2950	51.84	2.69
3000	51.75	2.74
3050	51.59	2.80
3100	51.49	2.86
3150	51.38	2.92
3200	51.25	2.98
3250	51.15	3.03
3300	51.06	3.09
3350	50.93	3.15
3400	50.83	3.22
3450	50.73	3.27
3500	50.61	3.34
3550	50.56	3.40
3600	50.50	3.46
3650	50.38	3.52
3700	50.30	3.58
3750	50.20	3.64
3800	50.13	3.71
3850	50.02	3.78
3900	49.94	3.85
3950	49.82	3.92
4000	49.73	3.98
4050	49.67	4.07
4100	49.61	4.13
4150	49.52	4.20

Freq (MHz)	Relative Perm.	Cond. (S/m)
4200	49.37	4.27
4250	49.27	4.34
4300	49.16	4.42
4350	49.07	4.50
4400	49.01	4.58
4450	48.88	4.65
4500	48.75	4.72
4550	48.63	4.79
4600	48.49	4.87
4650	48.36	4.95
4700	48.23	5.02
4750	48.07	5.10
4800	47.96	5.18
4850	47.58	5.20
4900	47.35	5.22
4950	47.36	5.36
5000	47.36	5.52
5050	47.27	5.61
5100	47.29	5.64
5150	47.13	5.69
5200	46.93	5.79
5250	46.77	5.86
5300	46.47	5.97
5350	46.54	6.10
5400	46.19	6.16
5450	46.37	6.24
5500	46.32	6.30
5550	46.24	6.34
5600	46.03	6.38
5650	45.90	6.46
5700	45.66	6.66
5750	45.59	6.68
5800	45.49	6.71
5850	45.15	6.69
5900	45.14	6.74
5950	44.87	6.96
6000	44.82	7.05

SAR SYSTEM VERIFICATION DESCRIPTION

element
WSSV.2017.1.31

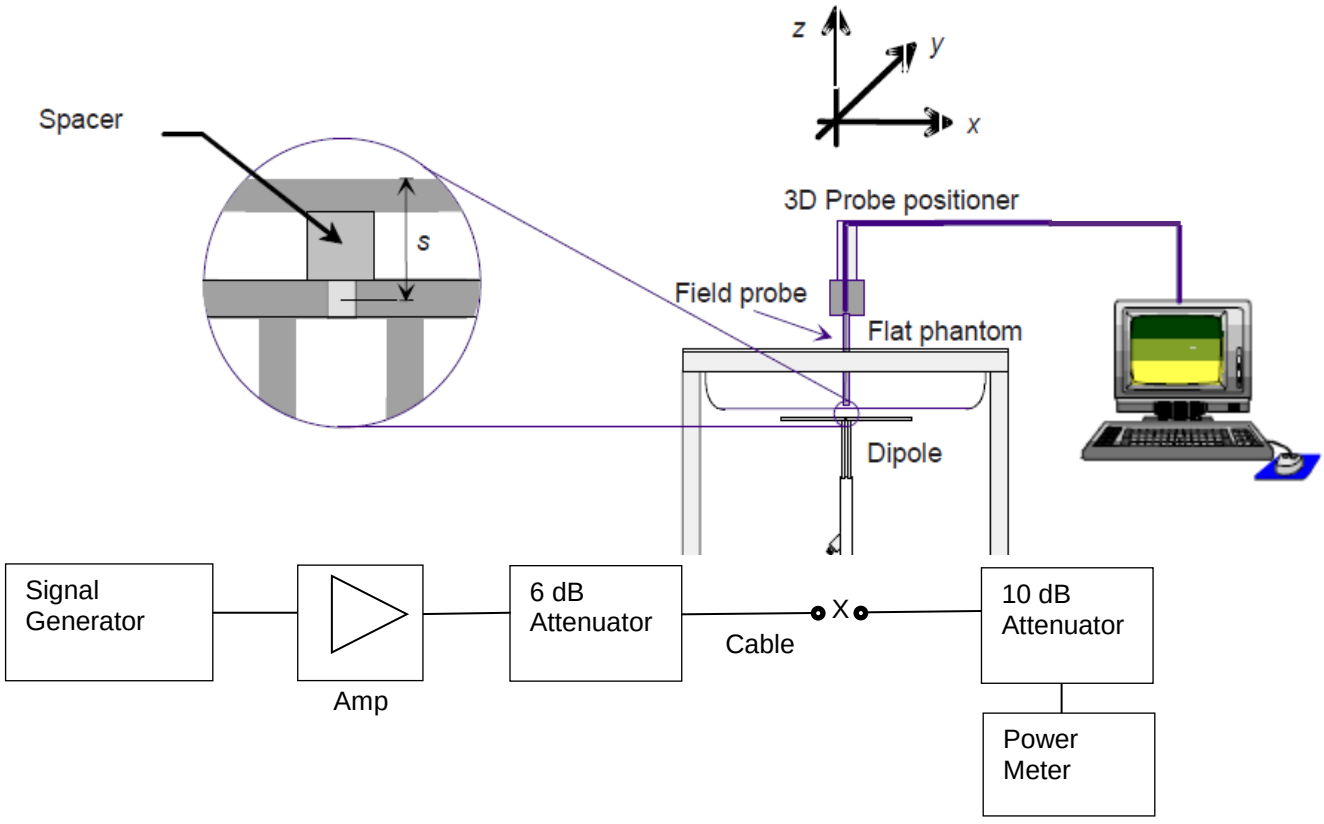
REQUIREMENT
Per IEEE 1528, Section 8.2.1, “System checks are performed prior to compliance tests and the results must always be within ± 10% of the target value corresponding to the test frequency, liquid, and the source used. The target values are 1 g or 10 g averaged SAR values measured on systems having current system validation and calibration status, and using the system check setup as shown in Figure 14. These target values should be determined using a standard source.”

TEST DESCRIPTION
Within 24 hours of a measurement, then every 72 hours thereafter, Element used the system validation kit (calibrated reference dipole) to test whether the system was operating within its specifications. The validation was performed in the indicated bands by making SAR measurements of the reference dipole with the phantom filled with the tissue-equivalent liquid. First, a signal generator and power amplifier were used to produce a 100mW level as measured with a power meter at the antenna terminals of the dipole (X). Then, the reference dipole was positioned below the bottom of the phantom and centered with its axis parallel to the longest side of the phantom. A low loss and low relative permittivity spacer was used to establish the correct distance between the center axis of the reference dipole and the liquid.

For the reference dipoles, the spacing distance s is given by:

s = 15mm, +/- 0.2mm for 300MHz ≤ f ≥ 1000 MHz:
s = 10mm, +/- 0.2mm for 1000MHz ≤ f ≥ 6000MHz

The measured 1 g and 10 g spatial average SAR values were normalized to a 1W dipole input power for comparison to the calibration data. The results are summarized in the attached table. The deviation is less than 10% in all cases, indicating that the system performance check was within tolerance.



SAR SYSTEM VERIFICATION

element
WSSV.2016.12.19

TEST SPECIFICATIONS

Specification:	Method:
FCC 2.1093:2020	FCC KDB 865664 D01 v01r04 FCC KDB 865664 D02 v01r02 FCC KDB 447498 D01 v06 IEEE Std 1528:2013

RESULTS

Date	Liquid part number and frequency	Conducted Power into the Dipole (dBm)	Correction Factor	Measured		Normalized to 1W		Target (Normalized to 1W) Get from Dipole Calibration Certificate		% Difference	
				1g	10g	1g	10g	1g	10g	1g	10g
4/30/20	MBBL600-6000V6 (1900 MHz)	20.00	10.00	4.36	2.25	43.60	22.50	40.40	21.20	7.92	6.13
4/29/20	MBBL600-6000V6 (2450 MHz)	20.00	10.00	5.06	2.33	50.60	23.30	50.80	23.80	-0.40	-2.10

SAR SYSTEM VERIFICATION

element
WSSV.2016.12.19

Tested By:	Marcelo Aguayo	Room Temperature (°C):	21.2°C
Date:	4/30/2020	Liquid Temperature (°C):	21.1°C
		Humidity (%RH):	34.1%
		Bar. Pressure (mb):	1016 mb

1900MHz System Check 4-30-20 Rev2
DUT: Dipole 1900 MHz D1900V2; Type: D1900V2; Serial: D1900V2 - SN:xxx
Communication System: UID 0, CW (0); Communication System Band: D1900 (1900.0 MHz); Frequency: 1900 MHz;Communication System PAR: 0 dB; PMF: 1
Medium parameters used: f = 1900 MHz; σ = 1.601 S/m; ε_r = 52.934; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)
DASY Configuration:

- Probe: EX3DV4 - SN3746; ConvF(7.44, 7.44, 7.44) @ 1900 MHz; Calibrated: 11/19/2019
  - Modulation Compensation:
- Sensor-Surface: 1.4mm (Mechanical Surface Detection), Sensor-Surface: 0mm (Fix Surface), z = 31.0, 101.0
- Electronics: DAE4 Sn1237; Calibrated: 2/4/2020
- Phantom: ELI V6.0 (SAC); Type: QD OVA 003 AA; Serial: 2044
- DASY52 52.10.2(1504); SEMCAD X 14.6.12(7470)

System Check/System Check/Zoom Scan (7x7x7) (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 67.03 V/m; Power Drift = -0.28 dB
Peak SAR (extrapolated) = 8.04 W/kg
SAR(1 g) = 4.36 W/kg; SAR(10 g) = 2.25 W/kg (SAR corrected for target medium)
Maximum value of SAR (measured) = 6.80 W/kg

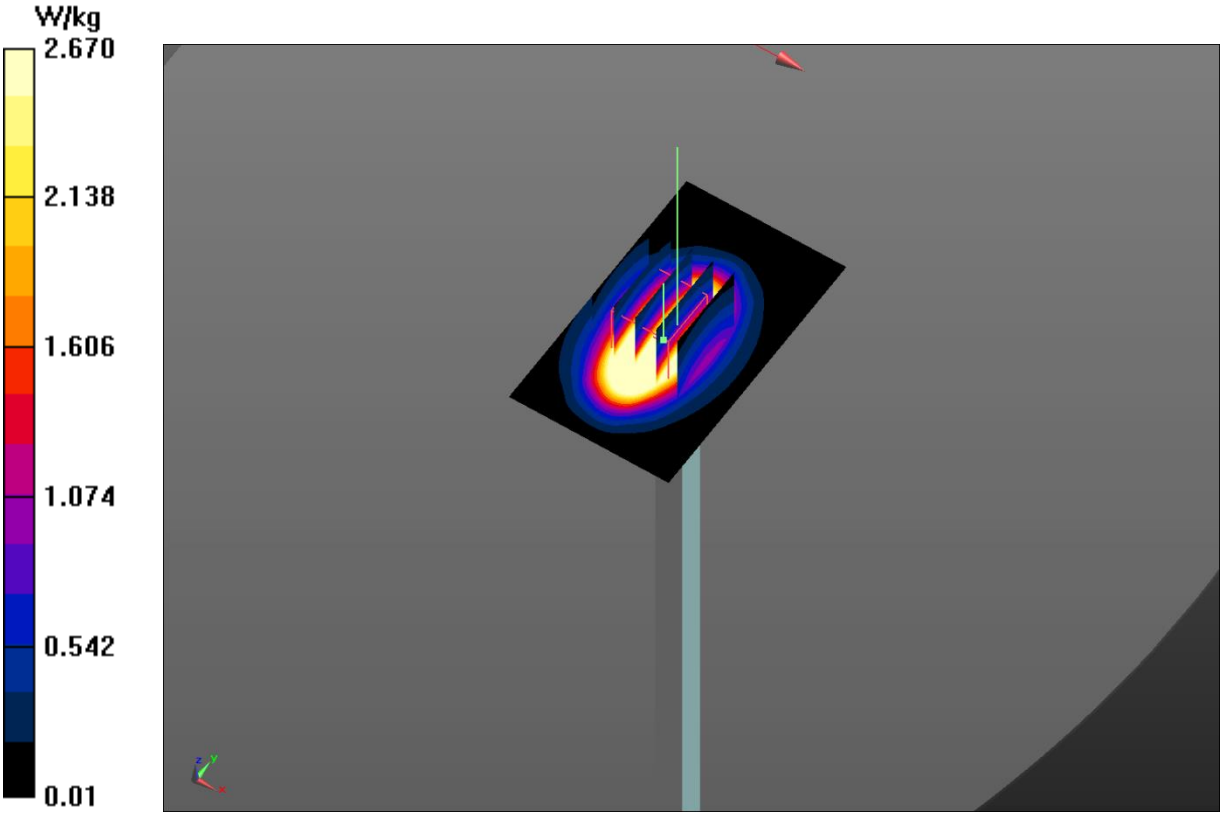
System Check/System Check/Area Scan (61x101x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 6.95 W/kg

System Check/System Check/Z Scan (1x1x21): Measurement grid: dx=20mm, dy=20mm, dz=5mm
Maximum value of Total (measured) = 45.61 V/m

System Check/System Check/Z Scan (1x1x21): Measurement grid: dx=20mm, dy=20mm, dz=5mm
Maximum value of SAR (measured) = 3.33 W/kg

Approved By

1900MHz System Check 4-30-20 Rev2



SAR SYSTEM VERIFICATION

element
WSSV.2016.12.19

Tested By:	Marcelo Aguayo	Room Temperature (°C):	22.3°C
Date:	4/29/2020	Liquid Temperature (°C):	20°C
		Humidity (%RH):	36%
		Bar. Pressure (mb):	1014 mb

2450MHz System Check Rev2 4-29-20
DUT: Dipole 2450 MHz D2450V2; Type: D2450V2; Serial: D2450V2 - SN:xxx
Communication System: UID 0, CW (0); Communication System Band: D2450 (2450.0 MHz); Frequency: 2450 MHz;Communication System PAR: 0 dB; PMF: 1
Medium parameters used: f = 2450 MHz; σ = 2.079 S/m; ε_r = 52.48; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)
DASY Configuration:

- Probe: EX3DV4 - SN3746; ConvF(7.33, 7.33, 7.33) @ 2450 MHz; Calibrated: 11/19/2019
  - Modulation Compensation:
- Sensor-Surface: 1.4mm (Mechanical Surface Detection), Sensor-Surface: 0mm (Fix Surface), z = 31.0, 101.0
- Electronics: DAE4 Sn1237; Calibrated: 2/4/2020
- Phantom: ELI V6.0 (SAC); Type: QD OVA 003 AA; Serial: 2044
- DASY52 52.10.2(1504); SEMCAD X 14.6.12(7470)

System Check/System Check/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 63.08 V/m; Power Drift = 0.14 dB
Peak SAR (extrapolated) = 10.6 W/kg
SAR(1 g) = 5.06 W/kg; SAR(10 g) = 2.33 W/kg (SAR corrected for target medium)
Maximum value of SAR (measured) = 8.51 W/kg

System Check/System Check/Area Scan (61x81x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 8.71 W/kg

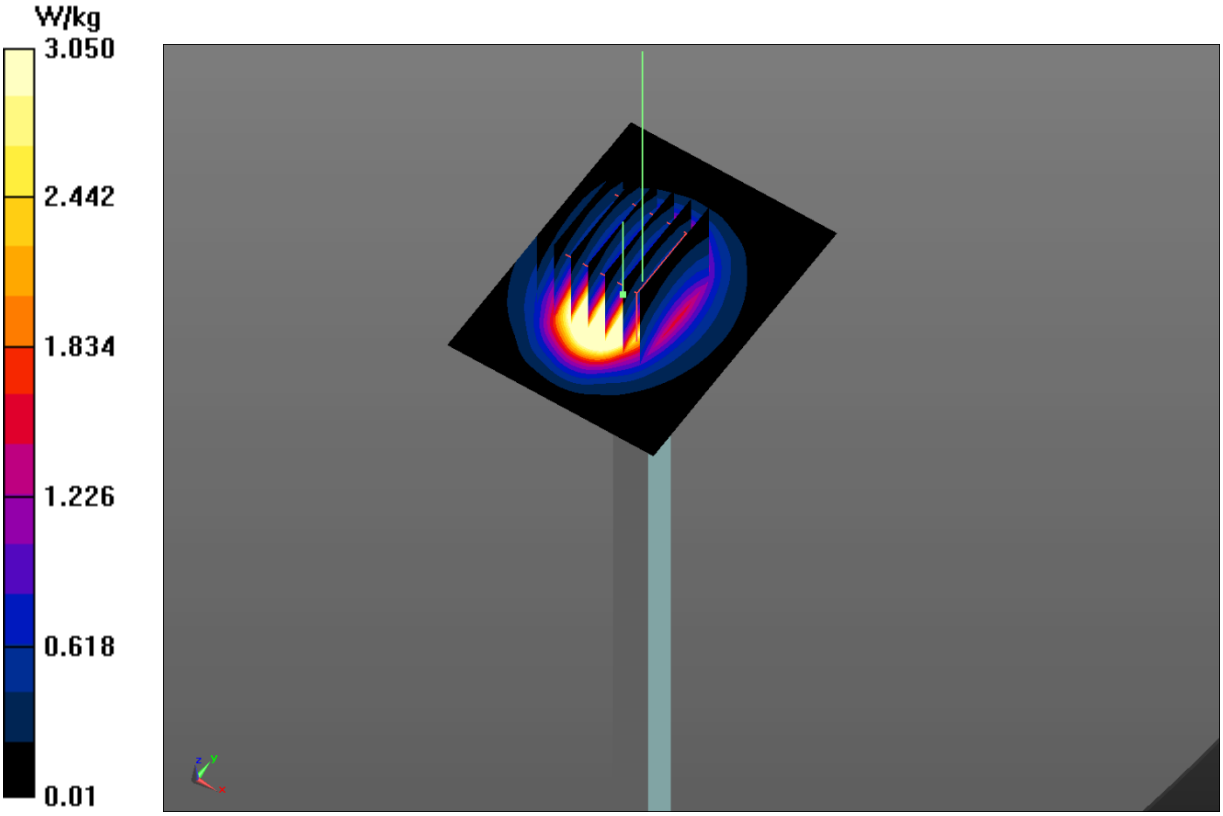
System Check/System Check/Z Scan (1x1x21): Measurement grid: dx=20mm, dy=20mm, dz=5mm
Maximum value of Total (measured) = 42.79 V/m

System Check/System Check/Z Scan (1x1x21): Measurement grid: dx=20mm, dy=20mm, dz=5mm
Maximum value of SAR (measured) = 3.81 W/kg

Approved By

SAR SYSTEM VERIFICATION

2450MHz System Check Rev2 4-29-20



OUTPUT POWER

element
WTD.2017.11.22.1

EUT:	Connect	Work Order:	FIRC0038
Serial Number:	10, 15	Date:	2020/04/29
Customer:	Sonetics Corporation	Temperature:	22.9 °C
Attendees:	None	Relative Humidity:	29.3% RH
Customer Project:	None	Bar. Pressure:	1018 mbar
Tested By:	Kyle McMullan	Job Site:	MN08
Power:	Battery	Configuration:	FIRC0038-2 FIRC0038-3

TEST SPECIFICATIONS

Specification:	Method:
FCC 2.1093:2020	FCC KDB 447498 D01 V06 FCC KDB 865664 D01 v01r04 FCC KDB 865664 D02 v01r02 IEEE Std 1528:2013

COMMENTS

Configuration FIRC0038-2 with serial number 10 used for Bluetooth output power.
Configuration FIRC0038-3 with serial number 15 used for DECT output power.

DEVIATIONS FROM TEST STANDARD

None

RESULTS

Bluetooth BDR/EDR (Classic)

Frequency	GFSK OP (dBm)	π/4-DQPSK OP (dBm)	8-DPSK OP (dBm)	Software Setting (dBm)
2402	1.46	-2.34	-2.33	3
2441	2.15	-1.83	-1.83	3
2480	1.64	-2.48	-2.48	3

Bluetooth LE

Frequency	OP (dBm)	Software Setting (dBm)
2402	0.92	3
2440	1.18	3
2480	0.52	3

DECT

Channel	Frequency	OP (dBm)
5	1919.808	18.9
4	1921.536	18.8
3	1923.264	18.7
2	1924.992	18.7
1	1926.720	18.6
0	1928.448	18.5

SAR TEST DATA

element
WSTD.2020.04.14.0

EUT:	Connect	Work Order:	FIRC0038
Customer:	Sonetics Corporation	Job Site:	MN11
Attendees:	None	Customer Project:	None

TEST SPECIFICATIONS

Specification:	Method:
FCC 2.1093:2020	FCC KDB 865664 D01 v01r04 FCC KDB 865664 D02 v01r02 FCC KDB 447498 D01 v06 IEEE Std 1528:2013

COMMENTS

Note 1 in measured values indicates that no measurement was found due to the signal being lower than the probe could measure. The SAR probe is capable of measurements down to 0.010 mW/g.
Note 2 in SAR Drift indicates that the measured SAR values were too low to get reliable SAR Drift During Test data.

DEVIATIONS FROM TEST STANDARD

None

RESULTS

Test Config.	Radio Type	Accessory	Transmit Frequency (MHz)	Transmit Channel	EUT Position	SAR Drift During Test (dB)	Measured 1g SAR Level (mW/g)	Measured 10g SAR Level (mW/g)	SAR Scaling Factor	Scaled 1g SAR Level (mW/g)	Scaled 10g SAR Level (mW/g)	Test#
Body	**DECT**	**None**	**1919.8**	**5**	**No buttons Side**	**-0.17**	**0.051**	**0.025**	**1.45**	**0.074**	**0.036**	**1919.8MHz No Buttons Side**
Body	DECT	None	1919.8	5	Back Side	0.12	0.019	0.007	1.45	0.028	0.010	1919.8MHz Back Side
Body	**DECT**	**Clip**	**1919.8**	**5**	**Back Side w/Clip**	**N/A[2]**	**0.001**	**0.001**	**1.45**	**0.001**	**0.001**	**1919.8MHz Back Side with Clip**
Body	**Bluetooth BDR**	**None**	**2441**	**39**	**Volume Side**	**0.18**	**0.008**	**0.002**	**1.22**	**0.010**	**0.002**	**2441MHz Volume Side**
Body	Bluetooth BDR	None	2441	39	No Buttons Side	N/A[1]	N/A[1]	N/A[1]	N/A[1]	N/A[1]	N/A[1]	2441MHz No Buttons Side
Body	Bluetooth BDR	None	2441	39	Back Side	-0.10	0.001	0.001	1.22	0.001	0.001	2441MHz Back Side
Body	Bluetooth BDR	None	2441	39	Front Side	N/A[1]	N/A[1]	N/A[1]	N/A[1]	N/A[1]	N/A[1]	2441MHz Front Side
Body	Bluetooth BDR	Clip	2441	39	Back Side w/Clip	N/A[1]	N/A[1]	N/A[1]	N/A[1]	N/A[1]	N/A[1]	2441MHz Back Side with Clip

SAR TEST DATA

element
WSTD.2020.04.14.0

Tested By:	Marcelo Aguayo, Kyle McMullan	Room Temperature (°C):	21.2°C
Date:	4/30/2020	Liquid Temperature (°C):	21.1°C
Serial Number:	J	Humidity (%RH):	34.1%
Configuration:	FIRC0038-4	Bar. Pressure (mb):	1016 mb
Comments:	None		

2441MHz Volume Side
DUT: Connect; Type: NA; Serial: Unknown
Communication System: UID 0, CW (0); Communication System Band: D2450 (2450.0 MHz); Frequency: 2441 MHz;Communication System PAR: 0 dB; PMF: 1
Medium parameters used (interpolated): f = 2441 MHz; σ = 2.057 S/m; ε_r = 52.172; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)
DASY Configuration:

- Probe: EX3DV4 - SN3746; ConvF(7.33, 7.33, 7.33) @ 2441 MHz; Calibrated: 11/19/2019
  - Modulation Compensation:
- Sensor-Surface: 1.4mm (Mechanical Surface Detection), z = 31.0
- Electronics: DAE4 Sn1237; Calibrated: 2/4/2020
- Phantom: ELI V6.0 (SAC); Type: QD OVA 003 AA; Serial: 2044
- DASY52 52.10.2(1504); SEMCAD X 14.6.12(7470)

Body/Body/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 3.386 V/m; Power Drift = 0.18 dB
Peak SAR (extrapolated) = 0.0380 W/kg
SAR(1 g) = 0.00818 W/kg; SAR(10 g) = 0.00166 W/kg (SAR corrected for target medium)

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 0.0211 W/kg

Body/Body/Reference scan (61x91x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (interpolated) = 0.0201 W/kg

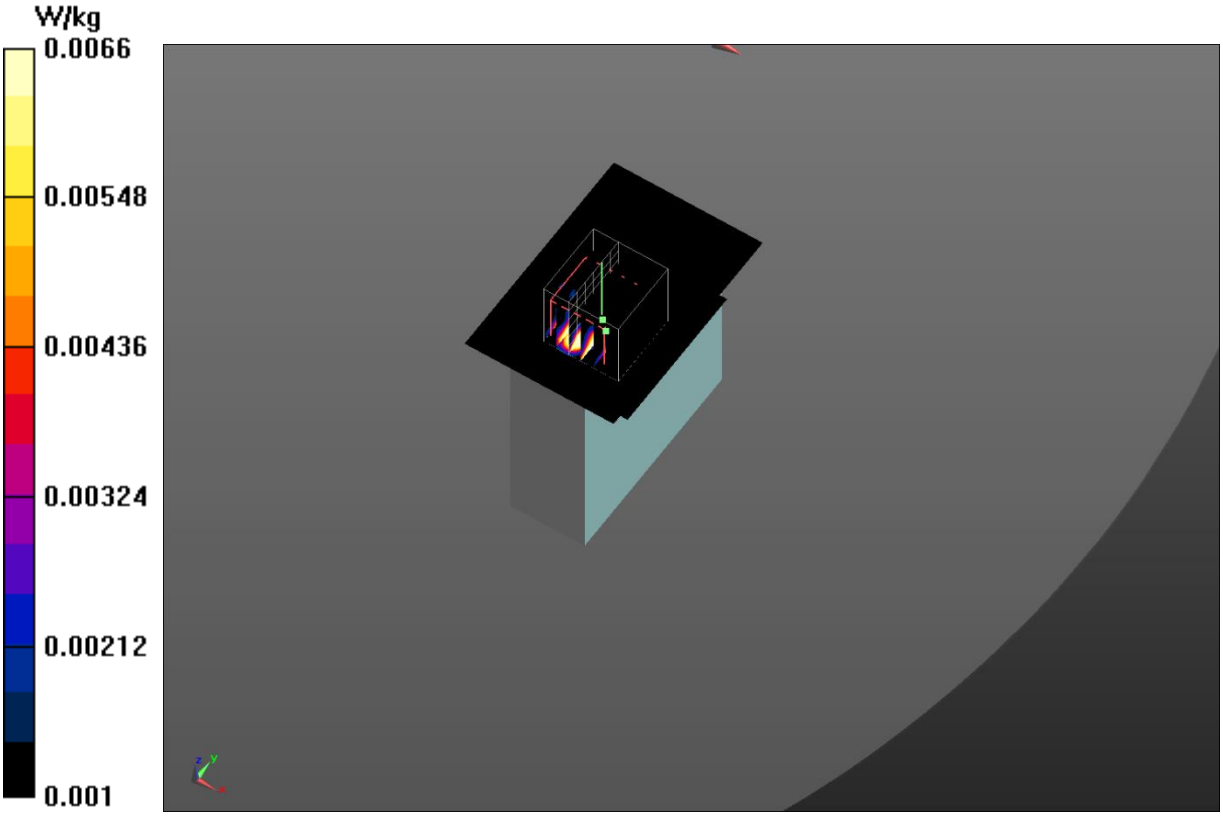
Body/Body/Area scan (51x51x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (interpolated) = 0.0182 W/kg

Approved By

SAR TEST DATA

2441MHz Volume Side



SAR TEST DATA

element
WSTD.2020.04.14.0

Tested By:	Marcelo Aguayo, Kyle McMullan	Room Temperature (°C):	19.6°C
Date:	5/26/2020	Liquid Temperature (°C):	20.0°C
Serial Number:	J	Humidity (%RH):	62.2%
Configuration:	FIRC0038-4	Bar. Pressure (mb):	1008.0 mb
Comments:	None		

1919.8MHz No Buttons Side
DUT: Connect; Type: NA; Serial: Unknown
Communication System: UID 0, CW (0); Communication System Band: D1950 (1950.0 MHz); Frequency: 1919.81 MHz;Communication System PAR: 0 dB; PMF: 1
Medium parameters used (interpolated): f = 1919.81 MHz; σ = 1.661 S/m; εr = 53.487; ρ = 1000 kg/m3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)
DASY Configuration:

- Probe: EX3DV4 - SN3746; ConvF(7.33, 7.33, 7.33) @ 2441 MHz; Calibrated: 11/19/2019
  - Modulation Compensation:
- Sensor-Surface: 1.4mm (Mechanical Surface Detection), z = 31.0
- Electronics: DAE4 Sn1237; Calibrated: 2/4/2020
- Phantom: ELI V6.0 (SAC); Type: QD OVA 003 AA; Serial: 2044
- DASY52 52.10.2(1504); SEMCAD X 14.6.12(7470)

Body/Body/Reference scan (21x31x1): Interpolated grid: dx=3.000 mm, dy=3.000 mm

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (interpolated) = 0.0613 W/kg

Body/Body/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 6.183 V/m; Power Drift = -0.17 dB
Peak SAR (extrapolated) = 0.101 W/kg
SAR(1 g) = 0.051 W/kg; SAR(10 g) = 0.025 W/kg (SAR corrected for target medium)

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 0.0823 W/kg

Body/Body/Area scan (41x41x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm

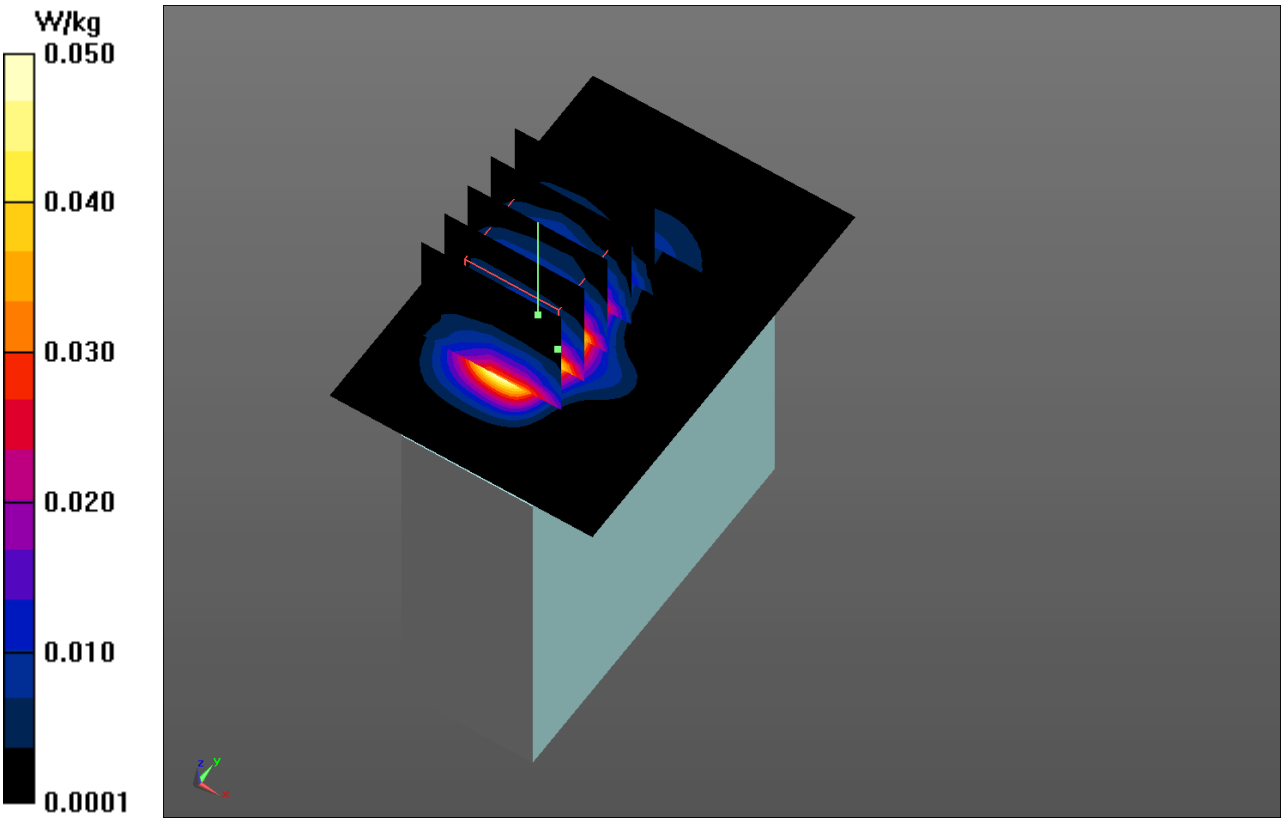
Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (interpolated) = 0.140 W/kg

Approved By

SAR TEST DATA

element
WSTD.2020.04.14.0

1919.8MHz No Buttons Side



SAR TEST DATA

element
WSTD.2020.04.14.0

Tested By:	Marcelo Aguayo, Kyle McMullan	Room Temperature (°C):	19.6°C
Date:	5/26/2020	Liquid Temperature (°C):	20.0°C
Serial Number:	J	Humidity (%RH):	62.2%
Configuration:	FIRC0038-4	Bar. Pressure (mb):	1008.0 mb
Comments:	None		

1919.8MHz Back Side with Clip
DUT: Connect; Type: NA; Serial: Unknown
Communication System: UID 0, CW (0); Communication System Band: D1950 (1950.0 MHz); Frequency: 1919.81 MHz;Communication System PAR: 0 dB; PMF: 1
Medium parameters used (interpolated): f = 1919.81 MHz; σ = 1.661 S/m; εr = 53.487; ρ = 1000 kg/m3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)
DASY Configuration:

- Probe: EX3DV4 - SN3746; ConvF(7.33, 7.33, 7.33) @ 2441 MHz; Calibrated: 11/19/2019
  - Modulation Compensation:
- Sensor-Surface: 1.4mm (Mechanical Surface Detection), z = 31.0
- Electronics: DAE4 Sn1237; Calibrated: 2/4/2020
- Phantom: ELI V6.0 (SAC); Type: QD OVA 003 AA; Serial: 2044
- DASY52 52.10.2(1504); SEMCAD X 14.6.12(7470)

Body/Body/Reference scan (41x41x1): Interpolated grid: dx=3.000 mm, dy=3.000 mm

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (interpolated) = 0.00632 W/kg

Body/Body/Zoom Scan (6x6x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 1.886 V/m; Power Drift = -0.46 dB
Peak SAR (extrapolated) = 0.0130 W/kg
SAR(1 g) = 0.000171 W/kg; SAR(10 g) = 3.45e-005 W/kg (SAR corrected for target medium)

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 0.00587 W/kg

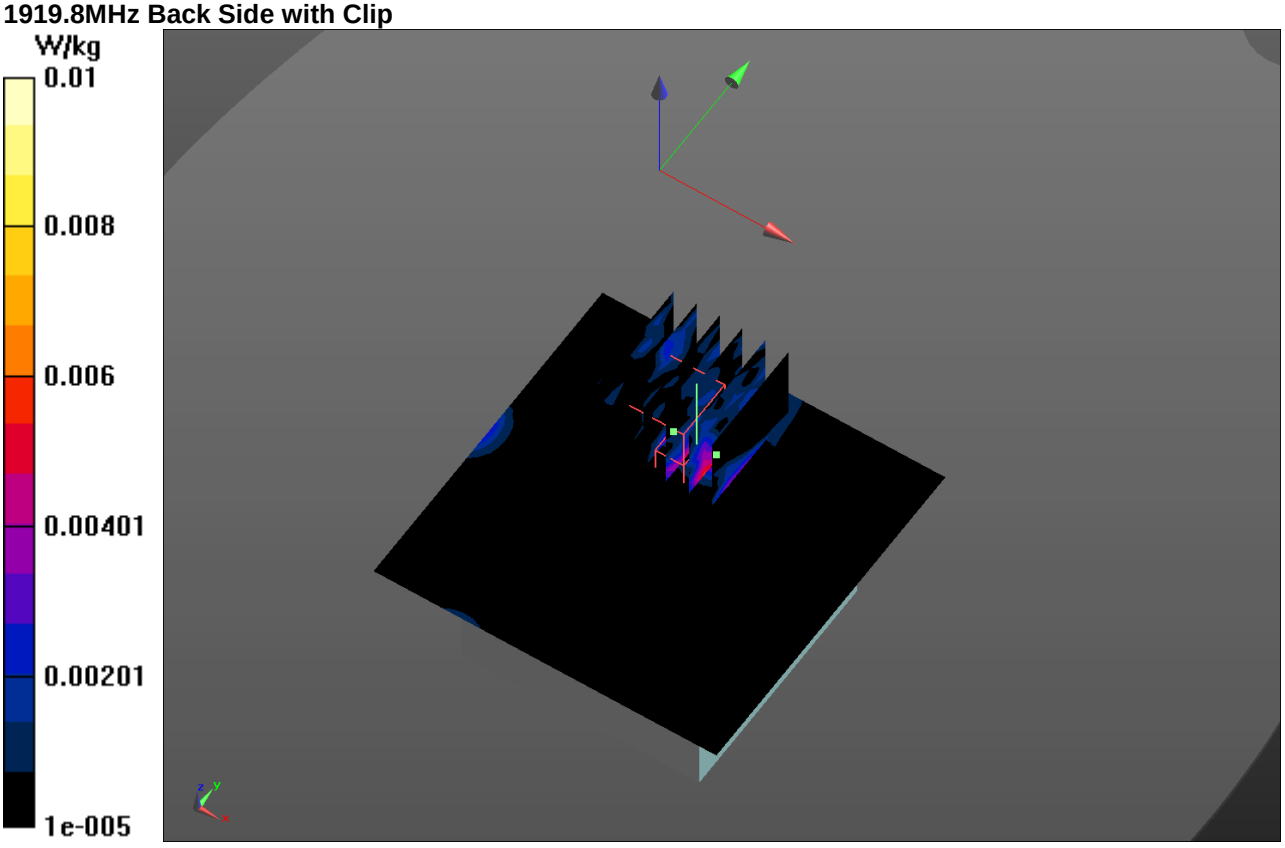
Body/Body/Area scan (41x41x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (interpolated) = 0.00636 W/kg

Approved By

SAR TEST DATA

1919.8MHz Back Side with Clip



SYSTEM AND TEST SITE DESCRIPTION

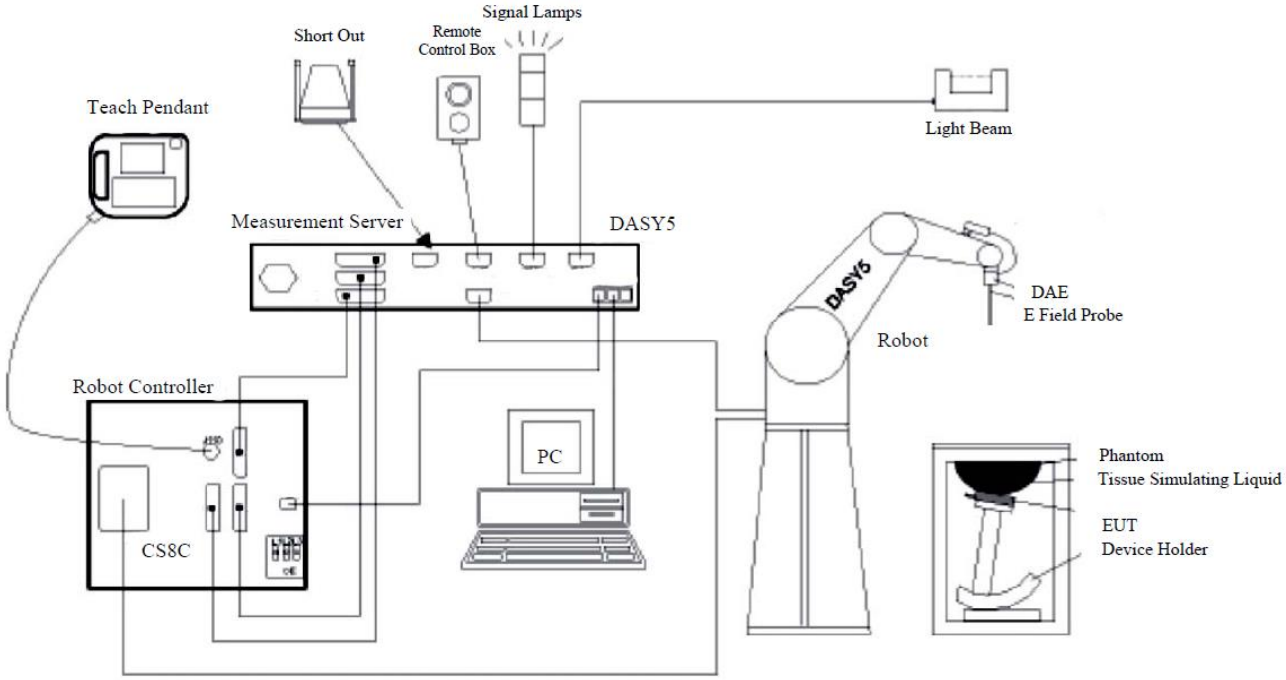
element
WSTD.2017.1.31

SAR MEASUREMENT SYSTEM

Schmid & Partner Engineering AG, DASY52

Element selected the leader in SAR evaluation systems to provide the measurement tools for this evaluation. SPEAG's DASY52 is the fastest and most accurate scanner on the market. It is fully compatible with all world-wide standards for transmitters operating at the ear or within 20cm of the body. It provides full compatibility with IEC 62209-1, IEC 62209-2, IEEE 1528 as well as national adaptations such as FCC OET-65c and Korean Std. MIC #2000-93

The DASY52 system for performing compliance tests consists of the following items:



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

SYSTEM AND TEST SITE DESCRIPTION

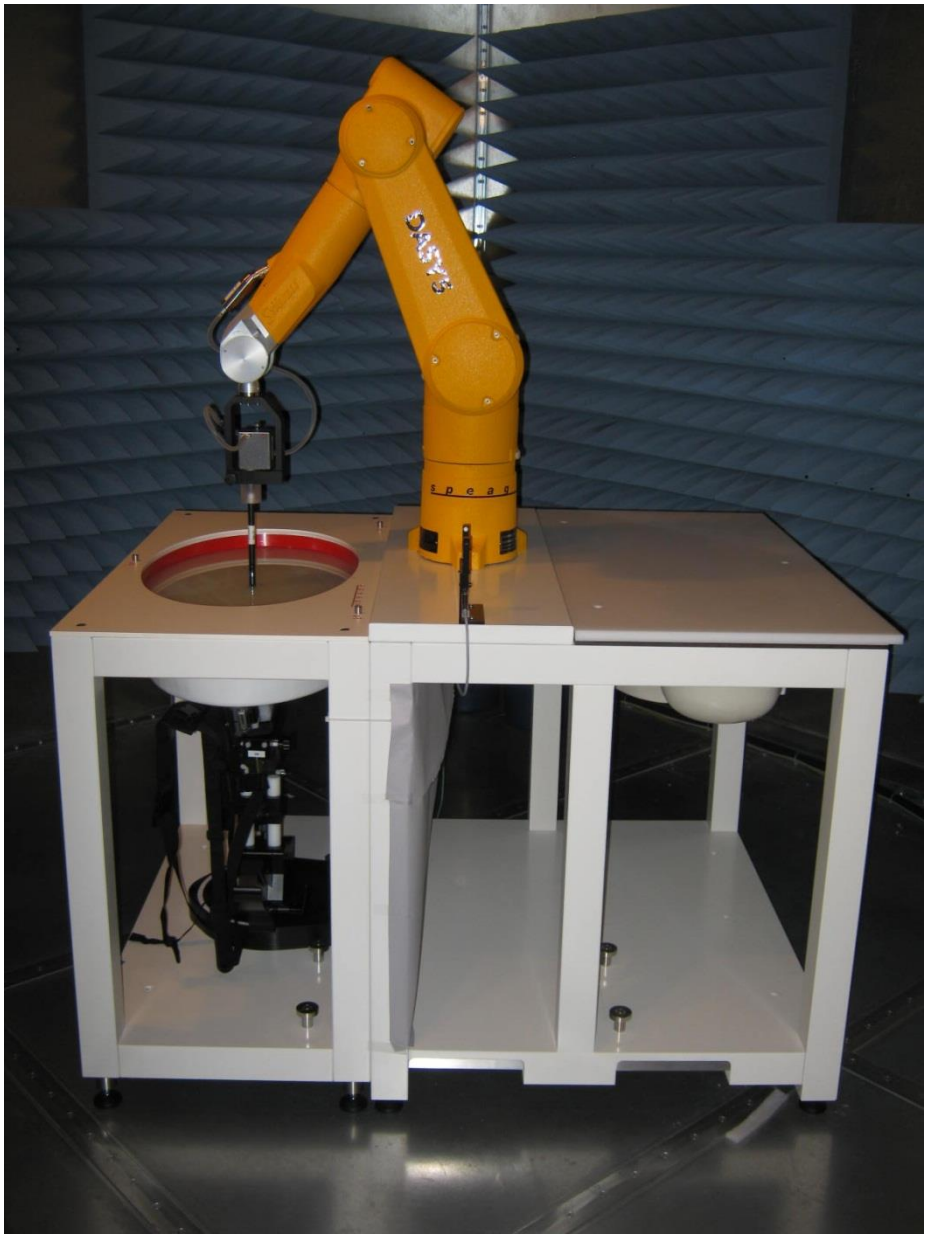
element
WSTD.2017.1.31

TEST SITE

Element

The SAR measurement system is located in a semi-anechoic chamber. This provides an ambient free environment that also eliminates reflections.

The chamber is 12 ft wide by 16 ft long x 8 ft high. A dedicated HVAC unit provides +/- 1 degree C temperature control.



TEST EQUIPMENT

element
WSEQ.2016.12.19

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Interval
Amplifier	Mini Circuits	ZHL-5W-2G-S+	TRZ	NCR [1]	0 mo
Amplifier	Mini Circuits	ZVE-3W-83+	TTA	NCR [1]	0 mo
Antenna - Dipole	SPEAG	D1900V2	ADO	11/13/2019	12 mo
Antenna - Dipole	SPEAG	D2450V2	ADL	11/12/2019	12 mo
Device Holder	SPEAG	N/A	SAW	NCR	0 mo
Dielectric Assessment Kit	SPEAG	DAKS:200	IPR	4/25/2019	36 mo
Generator - Signal	Agilent	V2920A	TIH	NCR	0 mo
Power Sensor	Agilent	N8481A	SQN	7/13/2019	12 mo
Power Meter	Agilent	N1913A	SQL	7/13/2019	12 mo
Probe - Dielectric	SPEAG	DAKS-3.5	IPRA	11/12/2019	36 mo
Probe - SAR	SPEAG	EX3DV4	SAG	11/19/2019	12 mo
SAR - Tissue Test Solution	SPEAG	MBBL600-6000V6	SALM	At start of testing	
SAR Test System	Staeubli	DAYS5	SAK	NCR	0 mo
SAR Test System	SPEAG	QD OVA 001 BB	SAC	NCR	0 mo
Thermometer	Omega Engineering, Inc.	HH311	DUI	2/15/2018	36 mo
DAE	SPEAG	SD 000 D04 EJ	SAH	12/11/2019	12 mo

Note 1: The output of the signal generator / amplifier is verified with the calibrated power meter listed above.

MEASUREMENT UNCERTAINTY

MEASUREMENT UNCERTAINTY BUDGETS PER IEEE 1528:2013

300-3000 MHz Range

Uncertainty Component	Tolerance (+/- %)	Probability Distribution	Divisor	c_i (1g)	c_i (10g)	u_i (1g) (+/-%)	u_i (10g) (+/-%)	v_i
Measurement System								
Probe calibration (k=1)	5.5	normal	1	1	1	5.5	5.5	∞
Axial isotropy	4.7	rectangular	1.732	0.707	0.707	1.9	1.9	∞
Hemispherical isotropy	9.6	rectangular	1.732	0.707	0.707	3.9	3.9	∞
Boundary effect	1.0	rectangular	1.732	1	1	0.6	0.6	∞
Linearity	4.7	rectangular	1.732	1	1	2.7	2.7	∞
System detection limits	1.0	rectangular	1.732	1	1	0.6	0.6	∞
Readout electronics	0.3	normal	1	1	1	0.3	0.3	∞
Response time	0.8	rectangular	1.732	1	1	0.5	0.5	∞
Integration time	2.6	rectangular	1.732	1	1	1.5	1.5	∞
RF ambient conditions - noise	1.7	rectangular	1.732	1	1	1.0	1.0	∞
RF Ambient Reflections	0.0	rectangular	1.732	1	1	0.0	0.0	∞
Probe positioner mechanical tolerance	0.4	rectangular	1.732	1	1	0.2	0.2	∞
Probe positioner with respect to phantom shell	2.9	rectangular	1.732	1	1	1.7	1.7	∞
Extrapolation, interpolation, and integration algorithms for max. SAR evaluation	1.0	rectangular	1.732	1	1	0.6	0.6	∞
Test Sample Related								
Device Positioning	2.9	normal	1	1	1	2.9	2.9	145
Device Holder	3.6	normal	1	1	1	3.6	3.6	5
Power Drift	5.0	rectangular	1.732	1	1	2.9	2.9	∞
Phantom and tissue parameters								
Phantom Uncertainty - shell thickness tolerances	4.0	rectangular	1.732	1	1	2.3	2.3	∞
Liquid conductivity - deviation from target values	5.0	rectangular	1.732	0.64	0.43	1.8	1.2	∞
Liquid conductivity - measurement uncertainty	6.5	normal	1	0.64	0.43	4.2	2.8	∞
Liquid permittivity - deviation from target values	5.0	rectangular	1.732	0.6	0.49	1.7	1.4	∞
Liquid permittivity - measurement uncertainty	3.2	normal	1	0.6	0.49	1.9	1.6	∞
Combined Standard Uncertainty		RSS				11.2	10.6	387
Expanded Measurement Uncertainty (95% Confidence/		normal (k=2)				22.5	21.2	

ADL

Calibration Laboratory of
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Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland

S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
S Servizio svizzero di taratura
S Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)
The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 0108

Client Element

Certificate No: D2450V2-855_Nov19

CALIBRATION CERTIFICATE

Object: D2450V2 - SN:855

Calibration procedure(s): QA CAL-05.v11
Calibration Procedure for SAR Validation Sources between 0.7-3 GHz

Calibration date: November 12, 2019

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 NRP	SN: 104778	03-Apr-19 (No. 217-02892/02893)	Apr-20
Power sensor NRP-Z91	SN: 103244	03-Apr-19 (No. 217-02892)	Apr-20
Power sensor NRP-Z91	SN: 103245	03-Apr-19 (No. 217-02893)	Apr-20
Reference 20 dB Attenuator	SN: 5058 (20k)	04-Apr-19 (No. 217-02894)	Apr-20
Type-N mismatch combination	SN: 5047.2 / 06327	04-Apr-19 (No. 217-02895)	Apr-20
Reference Probe EX3DV4	SN: 7349	29-May-19 (No. EX3-7349_May19)	May-20
DAE4	SN: 601	30-Apr-19 (No. DAE4-601_Apr19)	Apr-20

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB39512475	30-Oct-14 (in house check Feb-19)	In house check: Oct-20
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-18)	In house check: Oct-20
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (in house check Oct-18)	In house check: Oct-20
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-18)	In house check: Oct-20
Network Analyzer Agilent E8358A	SN: US41080477	31-Mar-14 (in house check Oct-19)	In house check: Oct-20

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

Issued: November 12, 2019

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Accreditation No.: SCS 0108

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:

a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
b) IEC 62209-1, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
c) IEC 62209-2, "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)", March 2010
d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

e) 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	V52.10.3
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 ± 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 ± 0.2) °C	38.2 ± 6 %	1.84 mho/m ± 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	13.3 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**52.3 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.18 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**24.5 W/kg ± 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 ± 0.2) °C	50.8 ± 6 %	2.01 mho/m ± 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	13.0 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**50.8 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	250 mW input power	6.02 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**23.8 W/kg ± 16.5 % (k=2)**

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	52.2 Ω + 5.6 jΩ
Return Loss	- 24.7 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	49.0 Ω + 6.7 jΩ
Return Loss	- 23.3 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.157 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

DASY5 Validation Report for Head TSL

Date: 12.11.2019

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:855

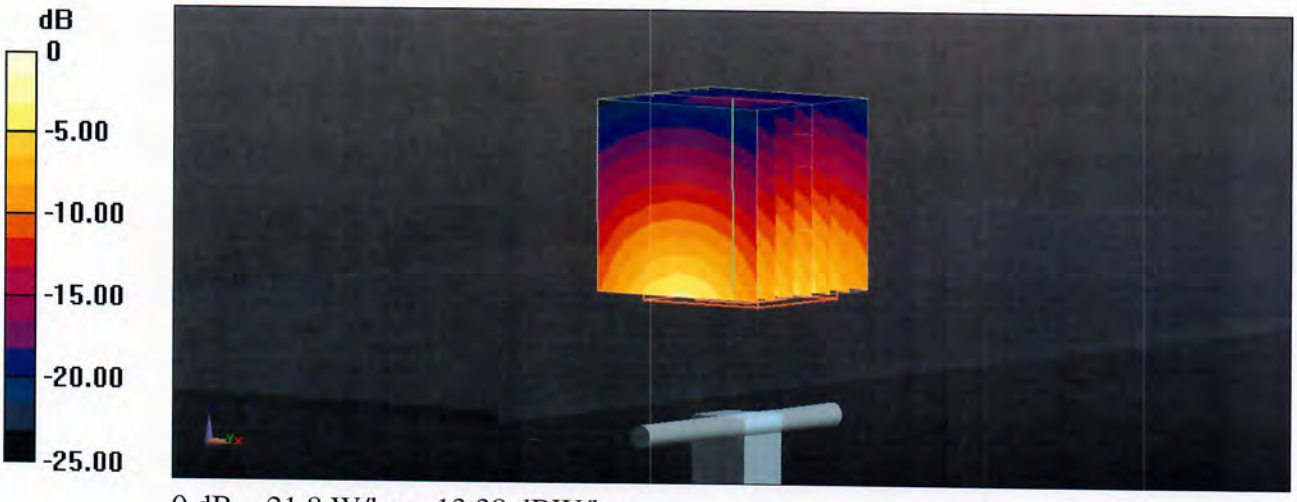
Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; σ = 1.84 S/m; ε_r = 38.2; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.9, 7.9, 7.9) @ 2450 MHz; Calibrated: 29.05.2019
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.04.2019
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.3(1513); SEMCAD X 14.6.13(7474)

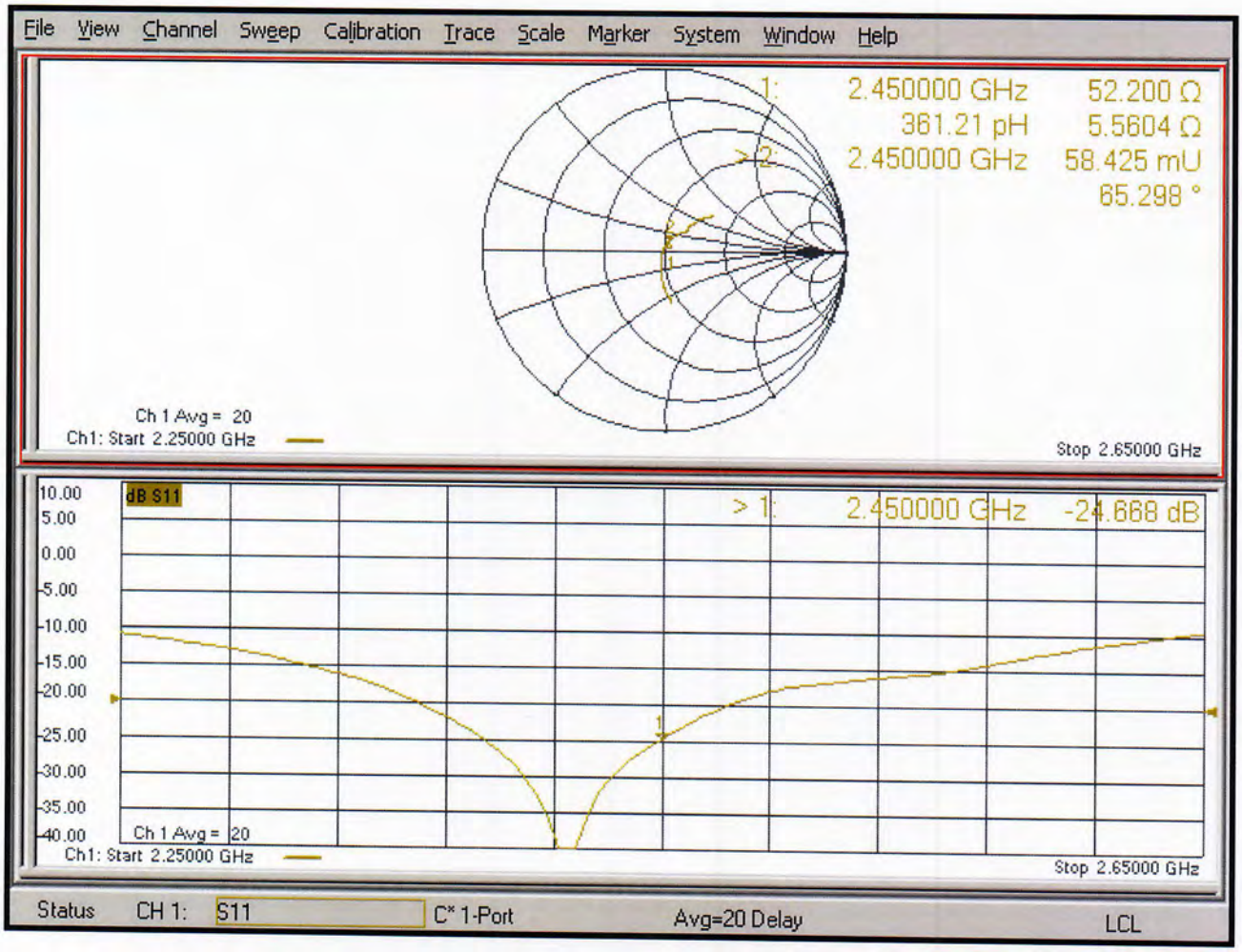
Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 117.0 V/m; Power Drift = -0.05 dB
Peak SAR (extrapolated) = 26.3 W/kg
SAR(1 g) = 13.3 W/kg; SAR(10 g) = 6.18 W/kg
Smallest distance from peaks to all points 3 dB below = 9 mm
Ratio of SAR at M2 to SAR at M1 = 50.6%
Maximum value of SAR (measured) = 21.8 W/kg



0 dB = 21.8 W/kg = 13.38 dBW/kg

Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 12.11.2019

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:855

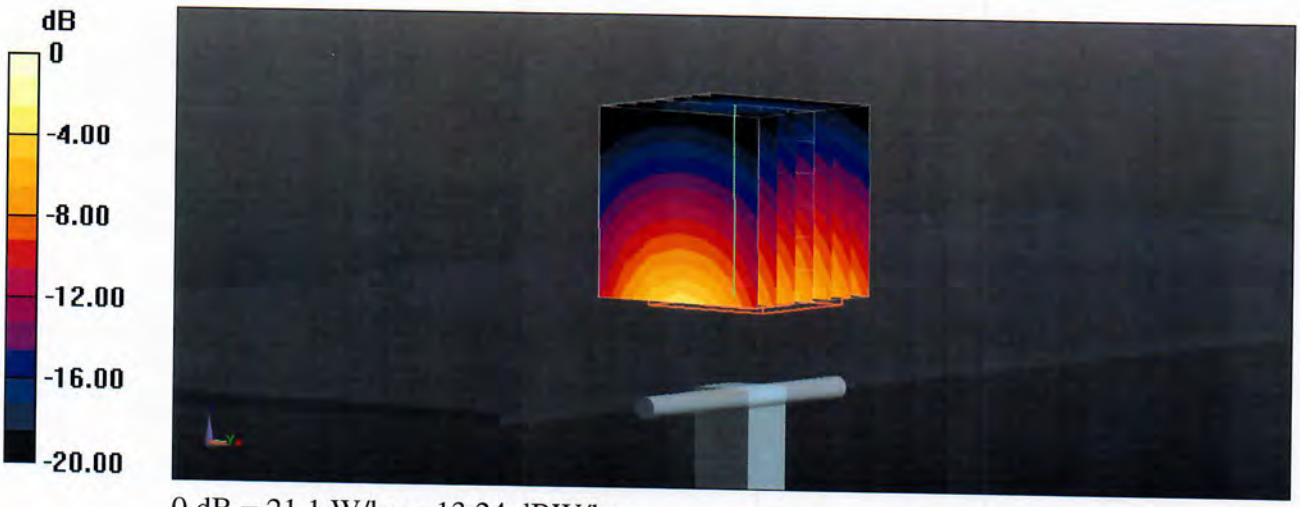
Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; σ = 2.01 S/m; ε_r = 50.8; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.94, 7.94, 7.94) @ 2450 MHz; Calibrated: 29.05.2019
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.04.2019
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.3(1513); SEMCAD X 14.6.13(7474)

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 = 109.3 V/m; Power Drift = -0.05 dB
Peak SAR (extrapolated) = 25.7 W/kg
SAR(1 g) = 13 W/kg; SAR(10 g) = 6.02 W/kg
Smallest distance from peaks to all points 3 dB below = 8.9 mm
Ratio of SAR at M2 to SAR at M1 = 51.1%
Maximum value of SAR (measured) = 21.1 W/kg



0 dB = 21.1 W/kg = 13.24 dBW/kg

Impedance Measurement Plot for Body TSL