SAR EVALUATION REPORT

FCC 47 CFR § 2.1093
IEEE Std 1528-2013

For
WIRELESS HEADSET

FCC ID: BCG-A1722
Model Name: A1722

Report Number: 16U23784-S1V1
Issue Date: 8/30/2016

Prepared for
APPLE INC.
1 INFINITE LOOP, MS 26A
CUPERTINO, CA 95014-2084

Prepared by
Prepared by
UL VERIFICATION SERVICES INC.
47173 BENICIA STREET
FREMONT, CA 94538, U.S.A.
TEL: (510) 771-1000
FAX: (510) 661-0888

NVLAP LAB CODE 200065-0

Revision History

Rev.	Date	Revisions	Revised By
V1	8/30/2016	Initial Issue	--

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1. Attestation of Test Results

Applicant Name	APPLE INC			
FCC ID	BCG-A1722			
Model Name	A1722			
Exposure Category	General Population/Uncontrolled Exposure			
Applicable Standards	FCC 47 CFR § 2.1093 Published RF exposure KDB procedures IEEE Std 1528-2013			
Exposure Category	SAR Limits (W/Kg)			
	Peak spatial-average(1g of tissue)		Extremities (hands, wrists, ankles, etc.) (10g of tissue)	
General population/Uncontrolled exposure	1.6		4	
RF Exposure Conditions	Equipment Class - Highest Reported SAR (W/kg)			
	PCE	DTS	NII	DSS
Head	N/A	0.510	N/A	0.510
Date Tested	8/8/2016 to 8/9/2016, 8/23/2016			
Test Results	Pass			

UL Verification Services Inc. tested the above equipment in accordance with the requirements set forth in the above standards. All indications of Pass/Fail in this report are opinions expressed by UL Verification Services Inc. based on interpretations and/or observations of test results. Measurement Uncertainties were not taken into account and are published for informational purposes only. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

Note: The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. This document may not be altered or revised in any way unless done so by UL Verification Services Inc. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL Verification Services Inc. will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, any agency of the Federal Government, or any agency of any government (NIST Handbook 150, Annex A). This report is written to support regulatory compliance of the applicable standards stated above.

Approved & Released By:	Prepared By:
	
Bobby Bayani Senior Engineer UL Verification Services Inc.	Jose Abadilla Laboratory Technician UL Verification Services Inc.

2. Test Specification, Methods and Procedures

The tests documented in this report were performed in accordance with IC RSS-102 Issue 5, IEEE STD 1528:2013, the following Specific FCC Published RF exposure KDB procedures:

- KDB 865664 D01 (Section 3.5): SAR Measurement 100 MHz to 6 GHz v01r04
- KDB 447498 D01: General RF exposure Guidance v06 (see Notice 2012-DRS1203 for exceptions)

3. Facilities and Accreditation

The test sites and measurement facilities used to collect data are located at

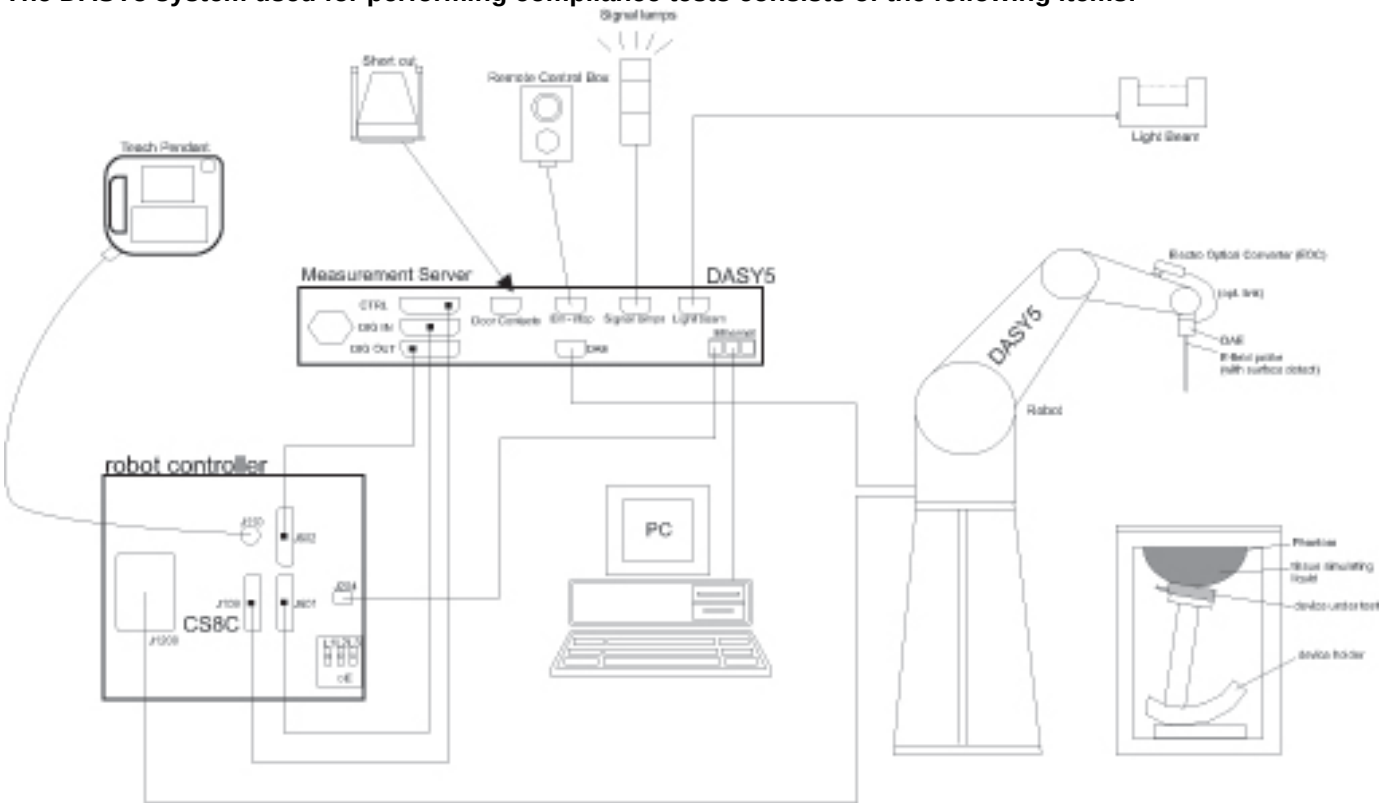
47173 Benicia Street	47266 Benicia Street
SAR Lab A	SAR Lab 1
SAR Lab B	SAR Lab 2
SAR Lab C	SAR Lab 3
SAR Lab D	SAR Lab 4
SAR Lab E	SAR Lab 5
SAR Lab F	
SAR Lab G	
SAR Lab H	

UL Verification Services Inc. is accredited by NVLAP, Laboratory Code 200065-0.

4. SAR Measurement System & Test Equipment

4.1. SAR Measurement System

The DASY5 system used for performing compliance tests consists of the following items:



- A standard high precision 6-axis robot 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 or Win7 and the DASY5 software.
- Remote control and teach pendant as well as additional circuitry for robot safety such as warning lamps, etc.
- The phantom, the device holder and other accessories according to the targeted measurement.

4.2. SAR Scan Procedures

Step 1: Power Reference Measurement

The Power Reference Measurement and Power Drift Measurements are for monitoring the power drift of the device under test in the batch process. The minimum distance of probe sensors to surface determines the closest measurement point to phantom surface. The minimum distance of probe sensors to surface is 2.1 mm. This distance cannot be smaller than the distance of sensor calibration points to probe tip as defined in the probe properties.

Step 2: Area Scan

The Area Scan is used as a fast scan in two dimensions to find the area of high field values, before doing a fine measurement around the hot spot. The sophisticated interpolation routines implemented in DASY software can find the maximum locations even in relatively coarse grids. When an Area Scan has measured all reachable points, it computes the field maximal found in the scanned area, within a range of the global maximum. The range (in dB) is specified in the standards for compliance testing. For example, a 2 dB range is required in IEEE Standard 1528 and IEC 62209 standards, whereby 3 dB is a requirement when compliance is assessed in accordance with the ARIB standard (Japan). If only one Zoom Scan follows the Area Scan, then only the absolute maximum will be taken as reference. For cases where multiple maximums are detected, the number of Zoom Scans has to be increased accordingly.

Area Scan Parameters extracted from KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz

	≤ 3 GHz	> 3 GHz
Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface	5 ± 1 mm	½·δ·ln(2) ± 0.5 mm
Maximum probe angle from probe axis to phantom surface normal at the measurement location	30° ± 1°	20° ± 1°
Maximum area scan spatial resolution: Δx_{Area}, Δy_{Area}	≤ 2 GHz: ≤ 15 mm 2 – 3 GHz: ≤ 12 mm	3 – 4 GHz: ≤ 12 mm 4 – 6 GHz: ≤ 10 mm
	When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be ≤ the corresponding x or y dimension of the test device with at least one measurement point on the test device.	

Step 3: Zoom Scan

Zoom Scans are used to assess the peak spatial SAR values within a cubic averaging volume containing 1 g and 10 g of simulated tissue. The Zoom Scan measures points (refer to table below) within a cube whose base faces are centered on the maxima found in a preceding area scan job within the same procedure. When the measurement is done, the Zoom Scan evaluates the averaged SAR for 1 g and 10 g and displays these values next to the job's label.

Zoom Scan Parameters extracted from KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz

			≤ 3 GHz	> 3 GHz
Maximum zoom scan spatial resolution: Δx_{Zoom}, Δy_{Zoom}			≤ 2 GHz: ≤ 8 mm 2 – 3 GHz: ≤ 5 mm*	3 – 4 GHz: ≤ 5 mm* 4 – 6 GHz: ≤ 4 mm*
Maximum zoom scan spatial resolution, normal to phantom surface	uniform grid: $\Delta z_{Zoom}(n)$		≤ 5 mm	3 – 4 GHz: ≤ 4 mm 4 – 5 GHz: ≤ 3 mm 5 – 6 GHz: ≤ 2 mm
	graded grid	$\Delta z_{Zoom}(1)$: between 1st two points closest to phantom surface	≤ 4 mm	3 – 4 GHz: ≤ 3 mm 4 – 5 GHz: ≤ 2.5 mm 5 – 6 GHz: ≤ 2 mm
		$\Delta z_{Zoom}(n>1)$: between subsequent points	≤ 1.5·$\Delta z_{Zoom}(n-1)$	
Minimum zoom scan volume	x, y, z		≥ 30 mm	3 – 4 GHz: ≥ 28 mm 4 – 5 GHz: ≥ 25 mm 5 – 6 GHz: ≥ 22 mm

Note: δ is the penetration depth of a plane-wave at normal incidence to the tissue medium; see draft standard IEEE P1528-2011 for details.

* When zoom scan is required and the *reported* SAR from the *area scan based 1-g SAR estimation* procedures of KDB 447498 is ≤ 1.4 W/kg, ≤ 8 mm, ≤ 7 mm and ≤ 5 mm zoom scan resolution may be applied, respectively, for 2 GHz to 3 GHz, 3 GHz to 4 GHz and 4 GHz to 6 GHz.

Step 4: Power drift measurement

The Power Drift Measurement measures the field at the same location as the most recent power reference measurement within the same procedure, and with the same settings. The Power Drift Measurement gives the field difference in dB from the reading conducted within the last Power Reference Measurement. This allows a user to monitor the power drift of the device under test within a batch process. The measurement procedure is the same as Step 1.

Step 5: Z-Scan (FCC only)

The Z Scan measures points along a vertical straight line. The line runs along the Z-axis of a one-dimensional grid. In order to get a reasonable extrapolation the extrapolated distance should not be larger than the step size in Z-direction.

4.3. Test Equipment

The measuring equipment used to perform the tests documented in this report has been calibrated in accordance with the manufacturers' recommendations, and is traceable to recognized national standards.

Dielectric Property Measurements

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
Network Analyzer	Agilent	8753ES	MY40000980	4/27/2017
Dielectric Probe kit	SPEAG	DAK-3.5	1082	9/15/2016
Shorting block	SPEAG	DAK-3.5 Short	SM DAK 200 BA	N/A
Thermometer	Traceable Calibration Control Co.	4242	140562250	8/24/2016

System Check

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
Synthesized Signal Generator	Agilent	N5181A	MY50140610	5/9/2017
Power Meter	Agilent	N1912A	MY55196008	5/3/2017
Power Sensor	Agilent	N1921A	MY52270022	12/17/2016
Power Sensor	Agilent	N1921A	MY52200012	10/10/2016
Amplifier	MITEQ	AMF-4D-00400600-50-30P	1795093	N/A
Directional coupler	Werlatone	C8060-102	2149	N/A
DC Power Supply	BK PRECISION	1611	215-02292	N/A
Synthesized Signal Generator	Angilent	N5181A	MY50140630	5/9/2017
Power Meter	HP	437B	3125U09248	9/3/2016
Power Sensor	HP	8481A	3318A92374	9/16/2016
Amplifier	MITEQ	AMF-4D-00400600-50-30P	1795092	N/A
Bi-directional coupler	Werlatone, Inc.	C8060-102	2141	N/A
DC Power Supply	HP	6296A	2841A-05955	N/A
E-Field Probe (SAR Lab H)	SPEAG	EX3DV4	3989	2/23/2017
Data Acquisition Electronics (SAR Lab H)	SPEAG	DAE4	1357	2/19/2017
System Validation Dipole	SPEAG	D2450V2	748	2/22/2017

Other

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
Power Meter	Agilent	N1912A	MY50001018	10/19/2017

5. Measurement Uncertainty

Per KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz, when the highest measured 1-g SAR within a frequency band is < 1.5 W/kg and the measured 10-g SAR within a frequency band is < 3.75 W/kg, the extensive SAR measurement uncertainty analysis described in IEEE Std 1528-2013 is not required in SAR reports submitted for equipment approval.

6. Device Under Test (DUT) Information

6.1. DUT Description

A1722 is a Bluetooth earbud for the left ear. It has an integral battery, microphone and antenna. It can charge via bottom contacts to A1602 charge case. It is designed to work in conjunction with right earbud, A1523.	
Device Dimension	Overall (Length x Width x Height): 42 mm x 17 mm x 16 mm

6.2. Wireless Technologies

Wireless technologies	Frequency bands	Operating mode	Duty Cycle used for SAR testing
Bluetooth	2.4 GHz	Version 2.1 + EDR, Version 4.0 LE	77.5% (DH5)

6.3. Maximum Output Power from Tune-up Procedure

KDB 447498 sec.4.1.(3) at the maximum rated output power and within the tune-up tolerance range specified for the product, but not more than 2 dB lower than the maximum tune-up tolerance limit

RF Air interface	Max. RF Output Power (dBm)
Bluetooth	**12.5**
Bluetooth EDR	**10.0**
Bluetooth LE	**10.0**

7. RF Exposure Conditions (Test Configurations)

Wireless technologies	RF Exposure Conditions	DUT-to-User Separation	Test Position	Antenna-to-edge/surface	SAR Required	Note
Bluetooth	Head	0 mm	Left Touch	< 25mm	Yes	
			Rear Touch	< 25mm	Yes	

8. Dielectric Property Measurements & System Check

8.1. Dielectric Property Measurements

The temperature of the tissue-equivalent medium used during measurement must also be within 18°C to 25°C and within ± 2°C of the temperature when the tissue parameters are characterized.
The dielectric parameters must be measured before the tissue-equivalent medium is used in a series of SAR measurements. The parameters should be re-measured after each 3 – 4 days of use; or earlier if the dielectric parameters can become out of tolerance; for example, when the parameters are marginal at the beginning of the measurement series.
Tissue dielectric parameters were measured at the low, middle and high frequency of each operating frequency range of the test device.
For SAR measurement systems that have implemented the SAR error compensation algorithms documented in IEEE Std 1528-2013, to automatically compensate the measured SAR results for deviations between the measured and required tissue dielectric parameters, the tolerance for εr and σ may be relaxed to ± 10%. This is limited to frequencies ≤ 3 GHz.

Tissue Dielectric Parameters

FCC KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz

Target Frequency (MHz)	Head		Body	
	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
5000	36.2	4.45	49.3	5.07
5100	36.1	4.55	49.1	5.18
5200	36.0	4.66	49.0	5.30
5300	35.9	4.76	48.9	5.42
5400	35.8	4.86	48.7	5.53
5500	35.6	4.96	48.6	5.65
5600	35.5	5.07	48.5	5.77
5700	35.4	5.17	48.3	5.88
5800	35.3	5.27	48.2	6.00

IEEE Std 1528-2013

Refer to Table 3 within the IEEE Std 1528-2013

IC RSS-102 Issue 5

Refer to Annex D - Body Tissue Equivalent Liquid

Dielectric Property Measurements Results:

SAR Room	Date	Tissue Type	Band (MHz)	Frequency (MHz)	Relative Permittivity (εr)			Conductivity (σ)		
					Measured	Target	Delta ±5 %	Measured	Target	Delta ±5 %
H	8/8/2016	2450	Head	2450	38.05	39.20	-2.93	1.88	1.80	4.22
				2400	38.19	39.30	-2.82	1.81	1.75	3.33
				2480	37.93	39.16	-3.15	1.90	1.83	3.74
H	8/23/2016	2450	Head	2450	39.03	39.20	-0.43	1.85	1.80	2.78
				2400	39.19	39.30	-0.27	1.80	1.75	2.76
				2480	38.94	39.16	-0.57	1.88	1.83	2.60

8.2. System Check

SAR system verification is required to confirm measurement accuracy, according to the tissue dielectric media, probe calibration points and other system operating parameters required for measuring the SAR of a test device. The system verification must be performed for each frequency band and within the valid range of each probe calibration point required for testing the device. The same SAR probe(s) and tissue-equivalent media combinations used with each specific SAR system for system verification must be used for device testing. When multiple probe calibration points are required to cover substantially large transmission bands, independent system verifications are required for each probe calibration point. A system verification must be performed before each series of SAR measurements using the same probe calibration point and tissue-equivalent medium. Additional system verification should be considered according to the conditions of the tissue-equivalent medium and measured tissue dielectric parameters, typically every three to four days when the liquid parameters are re-measured or sooner when marginal liquid parameters are used at the beginning of a series of measurements.

System Performance Check Measurement Conditions:

- The measurements were performed in the flat section of the TWIN SAM or ELI phantom, shell thickness: 2.0 ±0.2 mm (bottom plate) filled with Body or Head simulating liquid of the following parameters.
- The depth of tissue-equivalent liquid in a phantom must be ≥ 15.0 cm for SAR measurements ≤ 3 GHz and ≥ 10.0 cm for measurements > 3 GHz.
- The DASY system with an E-Field Probe was used for the measurements.
- The dipole was mounted on the small tripod so that the dipole feed point was positioned below the center marking of the flat phantom section and the dipole was oriented parallel to the body axis (the long side of the phantom). The standard measuring distance was 10 mm (above 1 GHz) and 15 mm (below 1 GHz) from dipole center to the simulating liquid surface.
- The coarse grid with a grid spacing of 15 mm was aligned with the dipole.
  For 5 GHz band - The coarse grid with a grid spacing of 10 mm was aligned with the dipole.
- Special 7x7x7 (below 3 GHz) and/or 8x8x7 (above 3 GHz) fine cube was chosen for the cube.
- Distance between probe sensors and phantom surface was set to 3 mm.
  For 5 GHz band - Distance between probe sensors and phantom surface was set to 2.5 mm
- The dipole input power (forward power) was 100 mW.
- The results are normalized to 1 W input power.

System Check Results

The 1-g and 10-g SAR measured with a reference dipole, using the required tissue-equivalent medium at the test frequency, must be within 10% of the manufacturer calibrated dipole SAR target.

SAR Room	Date	Tissue Type	Dipole Type Serial #	Dipole Cal. Due Data	Measured Results for 1g SAR				Measured Results for 10g SAR				Plot No.
					Zoom Scan to 100 mW	Normalize to 1 W	Target (Ref. Value)	Delta ±10 %	Zoom Scan to 100 mW	Normalize to 1 W	Target (Ref. Value)	Delta ±10 %	
H	8/8/2016	Head	D2450V2 SN:748	2/22/2017	5.410	54.10	50.90	6.29	2.440	24.40	23.70	2.95	1,2
H	8/23/2016	Head	D2450V2 SN:748	2/22/2017	5.050	50.50	50.90	-0.79	2.290	22.90	23.70	-3.38	3,4

9. Conducted Output Power Measurements

9.1. Bluetooth

Band (GHz)	Mode	Ch #	Freq. (MHz)	Avg Pwr (dBm)
2.4	Basic GFSK	0	2402	12.47
		39	2441	12.45
		78	2480	12.50
	V2.1 + EDR, π/4 DQPSK	0	2402	10.0
		39	2441	10.0
		78	2480	9.9
	V4.0 LE, GFSK	0	2402	10.0
		19	2440	10.0
		39	2480	10.0

Notes:

1. SAR for BLE mode is represented by GFSK test results.

10. Measured and Reported (Scaled) SAR Results

SAR Test Reduction criteria are as follows:

KDB 447498 D01 General RF Exposure Guidance:

Testing of other required channels within the operating mode of a frequency band is not required when the reported 1-g or 10-g SAR for the mid-band or highest output power channel is:

- ≤ 0.8 W/kg or 2.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≤ 100 MHz
- ≤ 0.6 W/kg or 1.5 W/kg, for 1-g or 10-g respectively, when the transmission band is between 100 MHz and 200 MHz
- ≤ 0.4 W/kg or 1.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≥ 200 MHz

10.1. Bluetooth

Frequency Band	RF Exposure Conditions	Mode	Dist. (mm)	Test Position	Ch #.	Freq. (MHz)	Power (dBm)		1-g SAR (W/kg)		10-g SAR (W/kg)		Plot No.
							Tune-up limit	Meas.	Meas.	Scaled	Meas.	Scaled	
2.4 GHz	Head	GFSK	0	Left Touch	39	2441.0	12.50	12.45	0.024	0.024	0.010	0.010	
				Rear Touch	39	2441.0	12.50	12.45	0.504	0.510	0.132	0.133	1

Notes:

1. SAR Testing was performed on the Flat Phantom for normal use for Head. Additional SAR Testing was performed on the location closest to the Antenna (Rear of the Device) of similar configuration to demonstrate compliance. This was reported as the highest SAR.
2. SAR for BLE mode is represented by GFSK test results.

11. SAR Measurement Variability

In accordance with published RF Exposure KDB 865664 D01 SAR measurement 100 MHz to 6 GHz. These additional measurements are repeated after the completion of all measurements requiring the same head or body tissue-equivalent medium in a frequency band. The test device should be returned to ambient conditions (normal room temperature) with the battery fully charged before it is re-mounted on the device holder for the repeated measurement(s) to minimize any unexpected variations in the repeated results.

1) Repeated measurement is not required when the original highest measured SAR is <0.8 or 2 W/kg (1-g or 10-g respectively); steps 2) through 4) do not apply.
2) When the original highest measured SAR is ≥ 0.8 or 2 W/kg (1-g or 10-g respectively), repeat that measurement once.
3) Perform a second repeated measurement only if the ratio of largest to smallest SAR for the original and first repeated measurements is > 1.20 or 3 (1-g or 10-g respectively) or when the original or repeated measurement is ≥ 1.45 or 3.6 W/kg (~ 10% from the 1-g or 10-g respective SAR limit).
4) Perform a third repeated measurement only if the original, first, or second repeated measurement is ≥ 1.5 or 3.75 W/kg (1-g or 10-g respectively) and the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 1.20 or 3 (1-g or 10-g respectively).

Frequency Band (MHz)	Air Interface	RF Exposure Conditions	Test Position	Repeated SAR (Yes/No)	Highest Measured SAR (W/kg)	First Repeated		Second Repeated		Third Repeated
						Measured SAR (W/kg)	Largest to Smallest SAR Ratio	Measured SAR (W/kg)	Largest to Smallest SAR Ratio	Measured SAR (W/kg)
2400	BT	Head	Rear Touch	No	0.504	N/A	N/A	N/A	N/A	N/A

Note(s):

Second Repeated Measurement is not required since the ratio of the largest to smallest SAR for the original and first repeated measurement is not > 1.20 or 3 (1-g or 10-g respectively).

12. Simultaneous Transmission SAR Analysis

N/A

Appendixes

Refer to separated files for the following appendixes.

16U23784-S1V1 SAR_App A Setup Photos

16U23784-S1V1 SAR_App B System Check Plots

16U23784-S1V1 SAR_App C Highest Test Plots

16U23784-S1V1 SAR_App D Tissue Ingredients

16U23784-S1V1 SAR_App E Probe Cal. Certificates

16U23784-S1V1 SAR_App F Dipole Cal. Certificates

END OF REPORT

20160808_SystemPerformanceCheck-D2450V2 SN 748

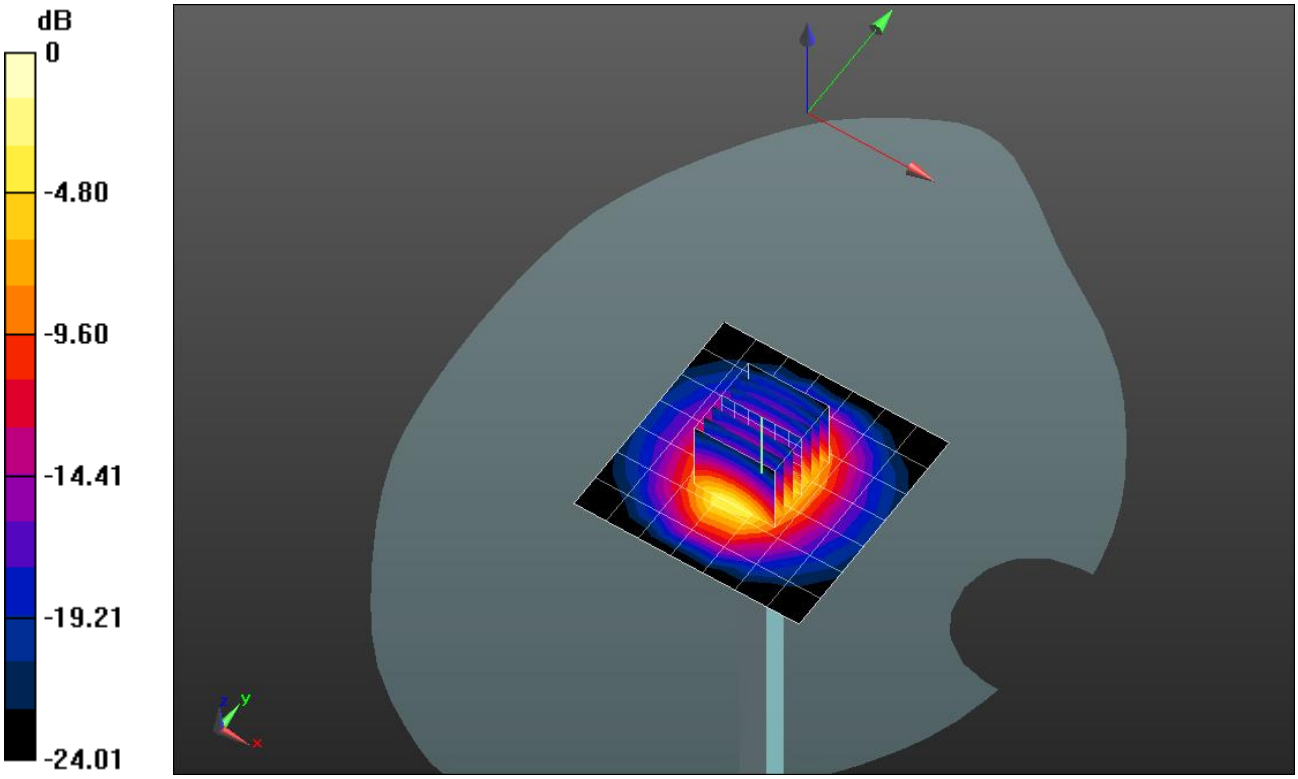
Frequency: 2450 MHz; Duty Cycle: 1:1; Room Ambient Temperature: 24.0°C; Liquid Temperature: 23.0°C
Medium parameters used: f = 2450 MHz; σ = 1.876 S/m; ε_r = 38.05; ρ = 1000 kg/m^3
DASY5 Configuration:
- Area Scan Setting: Find Secondary Maximum Within: 2.0 dB and with a peak SAR value greater than 0.0012W/kg
- Electronics: DAE4 Sn1357; Calibrated: 2/19/2016
- Probe: EX3DV4 - SN3989; ConvF(7.66, 7.66, 7.66); Calibrated: 2/23/2016;
- Sensor-Surface: 2.5mm (Mechanical Surface Detection)
- Phantom: SAM with CRP v5.0; Type: QD000P40CD; Serial: TP:xxxx

Head/Pin=100 mW/Area Scan (8x8x1): Measurement grid: dx=12mm, dy=12mm

Maximum value of SAR (measured) = 5.91 W/kg

Head/Pin=100 mW/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 65.315 V/m; Power Drift = 0.03 dB
Peak SAR (extrapolated) = 11.9 W/kg
SAR(1 g) = 5.41 W/kg; SAR(10 g) = 2.44 W/kg
Maximum value of SAR (measured) = 7.83 W/kg



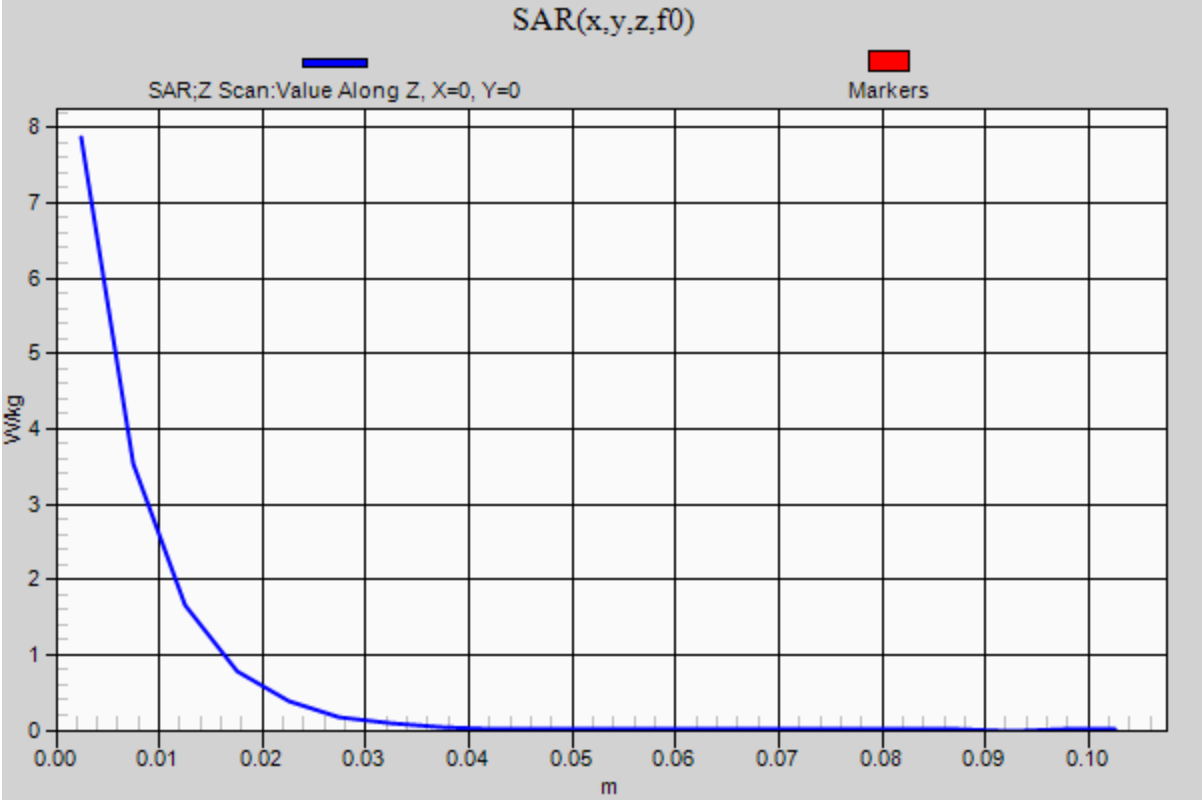
0 dB = 7.83 W/kg = 8.94 dBW/kg

20160808_SystemPerformanceCheck-D2450V2 SN 748

Frequency: 2450 MHz; Duty Cycle: 1:1

Head/Pin=100 mW/Z Scan (1x1x21): Measurement grid: dx=20mm, dy=20mm, dz=5mm

Maximum value of SAR (measured) = 7.86 W/kg



20160823_SystemPerformanceCheck-D2450V2 SN 748

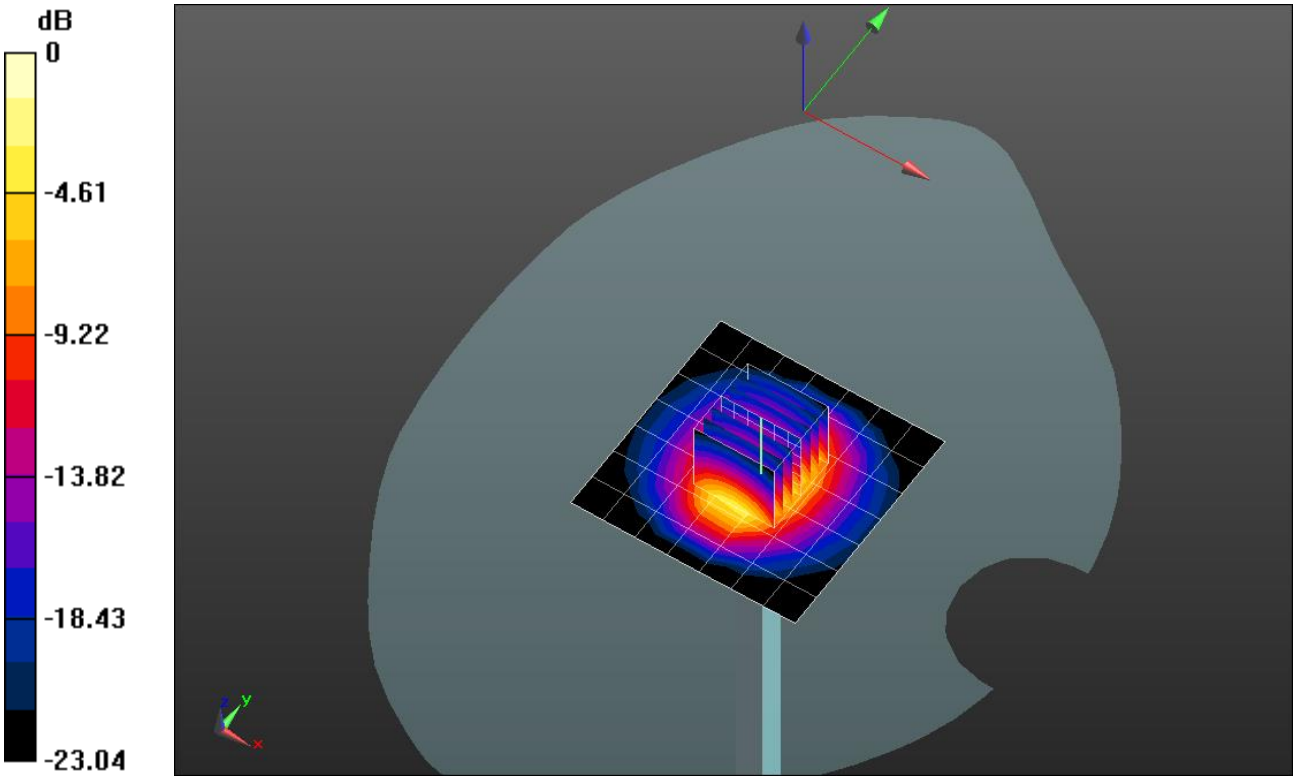
Frequency: 2450 MHz; Duty Cycle: 1:1; Room Ambient Temperature: 24.0°C; Liquid Temperature: 23.0°C
Medium parameters used: f = 2450 MHz; σ = 1.85 S/m; ε_r = 39.035; ρ = 1000 kg/m^3
DASY5 Configuration:
- Area Scan Setting: Find Secondary Maximum Within: 2.0 dB and with a peak SAR value greater than 0.0012W/kg
- Electronics: DAE4 Sn1357; Calibrated: 2/19/2016
- Probe: EX3DV4 - SN3989; ConvF(7.66, 7.66, 7.66); Calibrated: 2/23/2016;
- Sensor-Surface: 2.5mm (Mechanical Surface Detection)
- Phantom: SAM with CRP v5.0; Type: QD000P40CD; Serial: TP:xxxx

Head/Pin=100 mW/Area Scan (8x8x1): Measurement grid: dx=12mm, dy=12mm

Maximum value of SAR (measured) = 5.58 W/kg

Head/Pin=100 mW/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 63.251 V/m; Power Drift = -0.02 dB
Peak SAR (extrapolated) = 10.8 W/kg
SAR(1 g) = 5.05 W/kg; SAR(10 g) = 2.29 W/kg
Maximum value of SAR (measured) = 7.27 W/kg



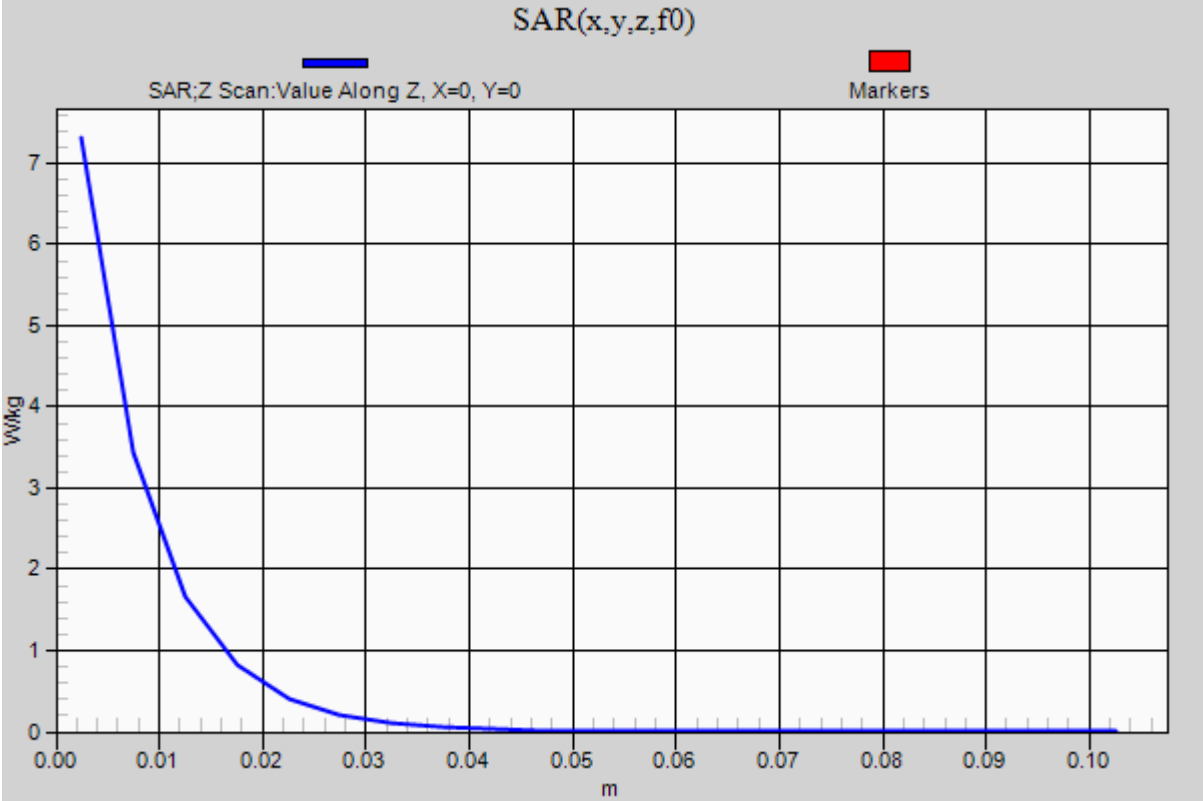
0 dB = 7.27 W/kg = 8.62 dBW/kg

20160823_SystemPerformanceCheck-D2450V2 SN 748

Frequency: 2450 MHz; Duty Cycle: 1:1

Head/Pin=100 mW/Z Scan (1x1x21): Measurement grid: dx=20mm, dy=20mm, dz=5mm

Maximum value of SAR (measured) = 7.31 W/kg



Bluetooth

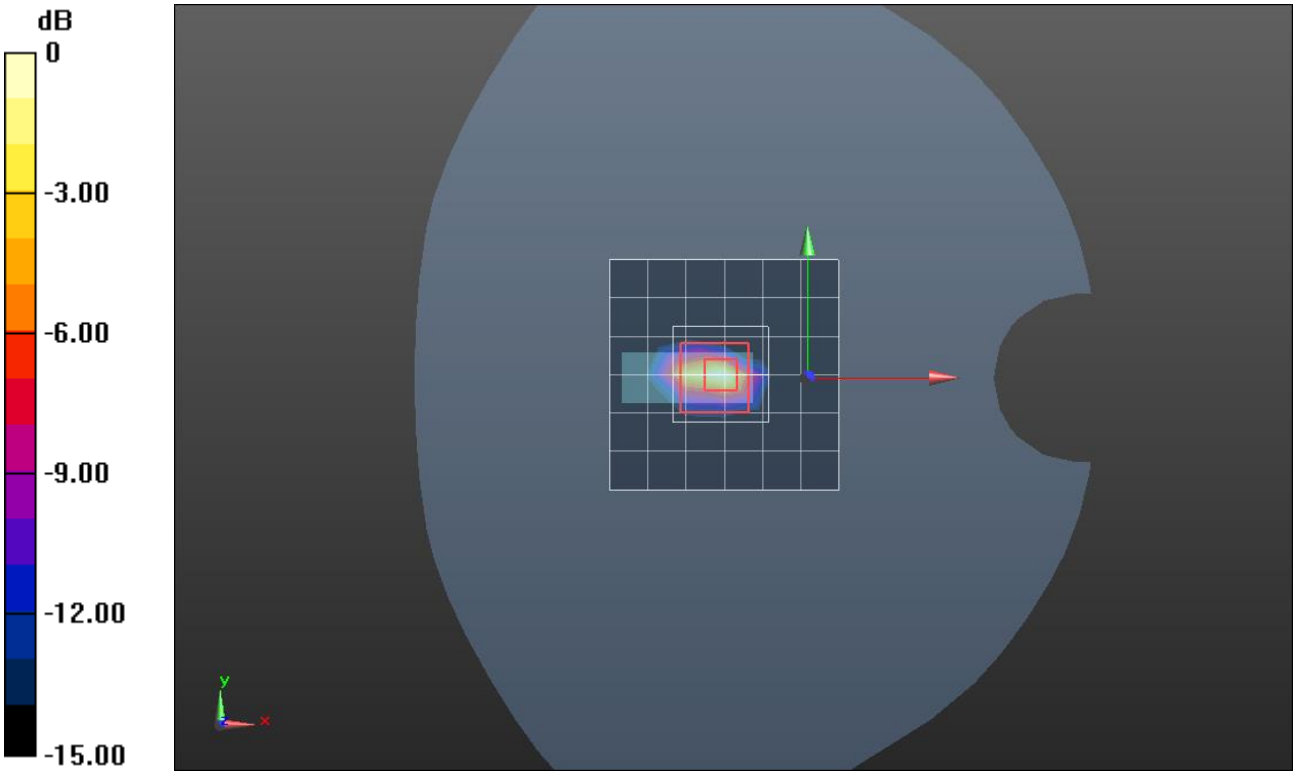
Frequency: 2441 MHz; Duty Cycle: 1:1.29033; Room Ambient Temperature: 24.0°C; Liquid Temperature: 23.0°C
Medium parameters used (interpolated): f = 2441 MHz; σ = 1.866 S/m; ε_r = 38.059; ρ = 1000 kg/m^3
DASY5 Configuration:
- Area Scan Setting: Find Secondary Maximum Within: 2.0 dB and with a peak SAR value greater than 0.0012W/kg
- Electronics: DAE4 Sn1357; Calibrated: 2/19/2016
- Probe: EX3DV4 - SN3989; ConvF(7.66, 7.66, 7.66); Calibrated: 2/23/2016;
- Sensor-Surface: 2.5mm (Mechanical Surface Detection (Locations From Previous Scan Used)), Sensor-Surface: 2.5mm (Mechanical Surface Detection)
- Phantom: SAM with CRP v5.0; Type: QD000P40CD; Serial: TP:xxxx

Rear Touch/Bluetooth_ch 39/Area Scan (7x7x1): Measurement grid: dx=12mm, dy=12mm

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 1.35 W/kg

Rear Touch/Bluetooth_ch 39/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 4.811 V/m; Power Drift = 0.10 dB
Peak SAR (extrapolated) = 2.59 W/kg
SAR(1 g) = 0.504 W/kg; SAR(10 g) = 0.130 W/kg
Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 1.20 W/kg



0 dB = 1.20 W/kg = 0.79 dBW/kg

Head Tissue Simulating Liquids

Head Tissue	Parameters according to IEEE Std 1528-2013 / IEC 62209 / FCC KDB 865664 D01		
Narrow-Band Solutions (±5% tolerance)	**Product**	**Test Frequency (MHz)**	**Main Ingredients**
	HSL300V2	300	Water, Sugar
	HSL450V2	450	Water, Sugar
	HSL750V2	750	Water, Sugar
	HSL900V2	835, 900	Water, Sugar
	HSL1450V2	1450, 1500, 1640	Water, DGBE
	HSL1750V2	1750	Water, DGBE
	HSL1800V2	1800, 1900	Water, DGBE
	HSL1900V2	1900	Water, DGBE
	HSL1950V2	1950, 2000	Water, DGBE
	HSL2450V2	2450, 2600	Water, DGBE
Broad-Band Solutions (±5% tolerance)	**Product**	**Test Frequency (MHz)**	**Main Ingredients**
	HBBL30-250V3	30-250	Water, Tween
	HBBL1350-1850V3	1400-1800	Water, Tween
	HBBL1550-1950V3	1750-1900	Water, Tween
	HBBL1900-3800V3	1950-3000	Water, Tween
	HBBL3500-5800V5	3500-5800	Water, Oil

Body Tissue Simulating Liquids

Body Tissue (Muscle)	Parameters according to FCC KDB 865664 D01		
Narrow-Band Solutions (±5% tolerance)	**Product**	**Test Frequency (MHz)**	**Main Ingredients**
	MSL300V2	300	Water, Sugar
	MSL450V2	400, 450	Water, Sugar
	MSL750V2	750	Water, Sugar
	MSL900V2	835, 900	Water, Sugar
	MSL1450V2	1450, 1500, 1640	Water, DGBE
	MSL1750V2	1750	Water, DGBE
	MSL1800V2	1800, 1900	Water, DGBE
	MSL1900V2	1900	Water, DGBE
	MSL1950V2	1950, 2100	Water, DGBE
	MSL2450V2	2450, 2600	Water, DGBE
Broad-Band Solutions (±5% tolerance)	**Product**	**Test Frequency (MHz)**	**Main Ingredients**
	MBBL130-250V3	130-250	Water, Tween
	MBBL1350-1850V3	1350-1800	Water, Tween
	MBBL1550-1950V3	1550-1850	Water, Tween
	MBBL1900-3800V3	1950-3800	Water, Tween
	MBBL3500-5800V5	3500-5800	Water, Oil

Schmid & Partner Engineering AG

Zeughausstrasse 43, 8004 Zurich, Switzerland
Phone +41 44 245 9700, Fax +41 44 245 9779
info@speag.com, http://www.speag.com

Measurement Certificate / Material Test

Item Name	**Head Tissue Simulating Liquid (HSL750V2)**
Product No.	SL AAH 075 AA (Charge: 140210-5)
Manufacturer	SPEAG

Measurement Method

TSL dielectric parameters measured using calibrated OCP probe.

Setup Validation

Validation results were within ± 2.5% towards the target values of Methanol.

Target Parameters

Target parameters as defined in the IEEE 1528 and IEC 62209 compliance standards.

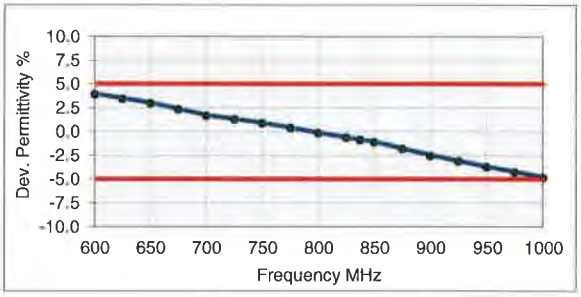
Test Condition

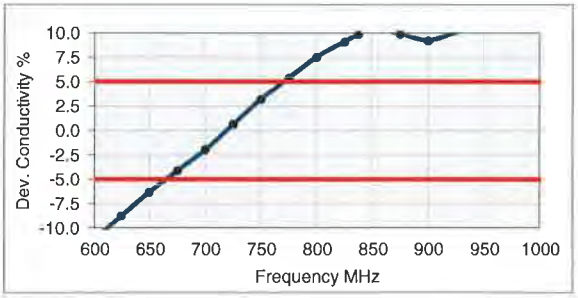
Ambient	Environment temperatur (22 ± 3)°C and humidity < 70%.
TSL Temperature	22°C
Test Date	12-Feb-14
Operator	IEN

Additional Information

TSL Density	1.284 g/cm^3
TSL Heat-capacity	2.701 kJ/(kg*K)

	Measured			Target		Diff.to Target [%]	
f [MHz]	HP-e'	HP-e''	sigma	eps	sigma	Δ-eps	Δ-sigma
600	44.4	23.49	0.78	42.7	0.88	3.9	-11.1
625	44.1	23.23	0.81	42.6	0.88	3.5	-8.6
650	43.7	22.96	0.83	42.5	0.89	3.0	-6.2
675	43.3	22.68	0.85	42.3	0.89	2.4	-4.1
700	42.9	22.40	0.87	42.2	0.89	1.7	-1.9
725	42.6	22.25	0.90	42.1	0.89	1.3	0.7
750	**42.3**	**22.10**	**0.92**	**41.9**	**0.89**	**0.9**	**3.2**
775	42.0	21.89	0.94	41.8	0.90	0.4	5.4
800	41.6	21.67	0.96	41.7	0.90	-0.1	7.5
825	41.3	21.55	0.99	41.6	0.91	-0.6	9.0
838	41.2	21.49	1.00	41.5	0.91	-0.8	9.8
850	41.1	21.42	1.01	41.5	0.92	-1.1	10.6
875	40.8	21.29	1.04	41.5	0.94	-1.8	9.9
900	40.5	21.15	1.06	41.5	0.97	-2.5	9.2
925	40.2	21.01	1.08	41.5	0.98	-3.1	10.0
950	39.9	20.87	1.10	41.4	0.99	-3.7	10.9
975	39.6	20.79	1.13	41.4	1.00	-4.3	12.2
1000	39.4	20.71	1.15	41.3	1.01	-4.8	13.5





Schmid & Partner Engineering AG

Zeughausstrasse 43, 8004 Zurich, Switzerland
Phone +41 44 245 9700, Fax +41 44 245 9779
info@speag.com, http://www.speag.com

Measurement Certificate / Material Test

Item Name	**Head Tissue Simulating Liquid (HSL900V2)**
Product No.	SL AAH 090 BB (Charge: 140205-4)
Manufacturer	SPEAG

Measurement Method

TSL dielectric parameters measured using calibrated OCP probe.

Setup Validation

Validation results were within ± 2.5% towards the target values of Methanol.

Target Parameters

Target parameters as defined in the IEEE 1528 and IEC 62209 compliance standards.

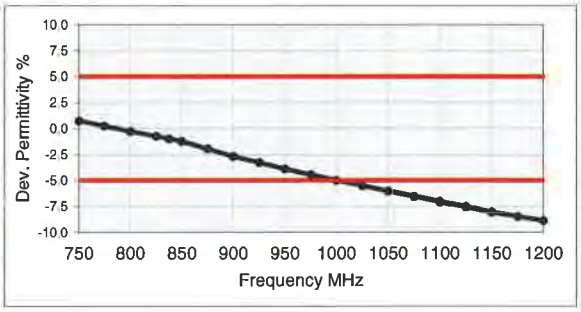
Test Condition

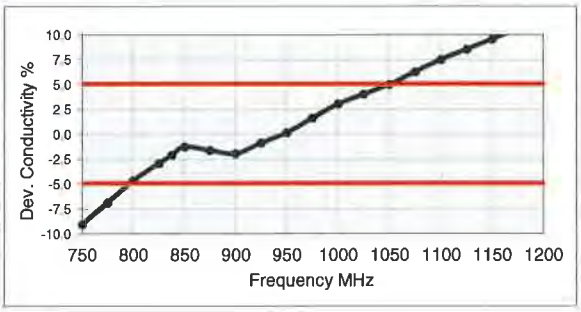
Ambient	Environment temperatur (22 ± 3)°C and humidity < 70%.
TSL Temperature	22°C
Test Date	12-Feb-14
Operator	IEN

Additional Information

TSL Density	1.280 g/cm^3
TSL Heat-capacity	2.942 kJ/(kg*K)

	Measured			Target		Diff.to Target [%]	
f [MHz]	HP-e'	HP-e''	sigma	eps	sigma	Δ-eps	Δ-sigma
700	42.9	19.58	0.76	42.2	0.89	1.6	-14.3
725	42.6	19.52	0.79	42.1	0.89	1.2	-11.7
750	42.3	19.47	0.81	41.9	0.89	0.8	-9.1
775	41.9	19.35	0.83	41.8	0.90	0.3	-6.8
800	41.6	19.23	0.86	41.7	0.90	-0.3	-4.6
825	41.3	19.18	0.88	41.6	0.91	-0.7	-2.9
838	41.1	19.16	0.89	41.5	0.91	-1.0	-2.1
850	41.0	19.13	0.90	41.5	0.92	-1.2	-1.2
875	40.7	19.07	0.93	41.5	0.94	-1.9	-1.6
900	40.4	19.00	0.95	41.5	0.97	-2.7	-1.9
925	40.1	18.92	0.97	41.5	0.98	-3.3	-0.9
950	39.8	18.85	1.00	41.4	0.99	-3.9	0.2
975	39.6	18.82	1.02	41.4	1.00	-4.4	1.6
1000	39.3	18.80	1.05	41.3	1.01	-5.0	3.0
1025	39.0	18.71	1.07	41.3	1.03	-5.5	4.0
1050	38.8	18.62	1.09	41.2	1.04	-6.0	5.0
1075	38.5	18.59	1.11	41.2	1.05	-6.5	6.3
1100	38.3	18.55	1.14	41.2	1.06	-7.0	7.5
1125	38.0	18.50	1.16	41.1	1.07	-7.5	8.5
1150	37.8	18.44	1.18	41.1	1.08	-8.0	9.6
1175	37.5	18.39	1.20	41.0	1.09	-8.4	10.6
1200	37.3	18.35	1.22	41.0	1.10	-8.9	11.6





Schmid & Partner Engineering AG

Zeughausstrasse 43, 8004 Zurich, Switzerland
Phone +41 44 245 9700, Fax +41 44 245 9779
info@speag.com, http://www.speag.com

Measurement Certificate / Material Test

Item Name	**Head Tissue Simulating Liquid (HSL1750V2)**
Product No.	SL AAH 175 (Charge: 120907-2)
Manufacturer	SPEAG

Measurement Method

TSL dielectric parameters measured using calibrated OCP probe.

Setup Validation

Validation results were within ± 2.5% towards the target values of Methanol.

Target Parameters

Target parameters as defined in the IEEE 1528 and IEC 62209 compliance standards.

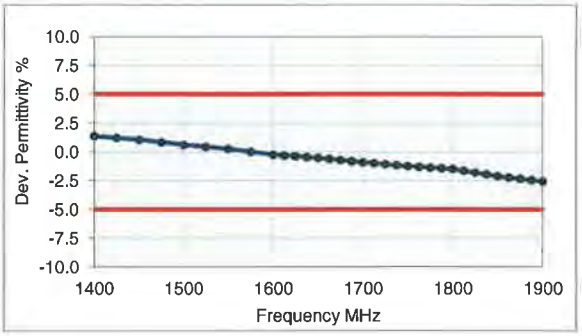
Test Condition

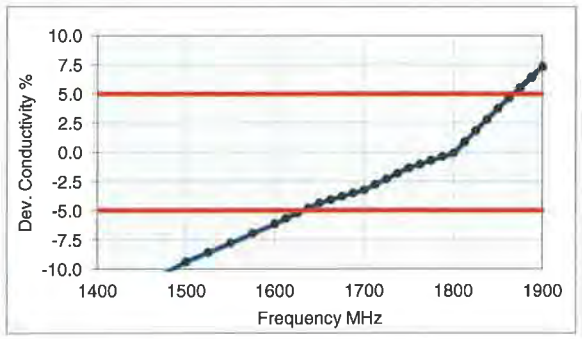
Ambient	Environment temperatur (22 ± 3)°C and humidity < 70%.
TSL Temperature	22°C
Test Date	13-Sep-12
Operator	CL

Additional Information

TSL Density	0.998 g/cm^3
TSL Heat-capacity	3.572 kJ/(kg*K)

	Measured			Target		Diff.to Target [%]	
f [MHz]	HP-e'	HP-e''	sigma	eps	sigma	Δ-eps	Δ-sigma
1400	41.2	13.09	1.02	40.6	1.18	1.4	-13.6
1425	41.0	13.14	1.04	40.5	1.19	1.2	-12.4
1450	40.9	13.19	1.06	40.5	1.20	1.1	-11.3
1475	40.8	13.26	1.09	40.5	1.21	0.8	-10.3
1500	40.7	13.34	1.11	40.4	1.23	0.6	-9.4
1525	40.6	13.39	1.14	40.4	1.24	0.4	-8.6
1550	40.5	13.44	1.16	40.4	1.26	0.3	-7.8
1575	40.3	13.49	1.18	40.3	1.27	0.0	-6.9
1600	40.2	13.55	1.21	40.3	1.28	-0.2	-6.1
1613	40.2	13.58	1.22	40.3	1.29	-0.3	-5.7
1625	40.1	13.62	1.23	40.3	1.30	-0.4	-5.2
1638	40.1	13.65	1.24	40.3	1.31	-0.5	-4.8
1650	40.0	13.68	1.26	40.2	1.31	-0.5	-4.3
1663	40.0	13.70	1.27	40.2	1.32	-0.6	-4.1
1675	39.9	13.71	1.28	40.2	1.33	-0.7	-3.8
1688	39.8	13.72	1.29	40.2	1.33	-0.8	-3.5
1700	39.8	13.73	1.30	40.2	1.34	-0.9	-3.2
1713	39.7	13.77	1.31	40.1	1.35	-1.0	-2.7
1725	39.7	13.81	1.33	40.1	1.36	-1.1	-2.3
1738	39.6	13.85	1.34	40.1	1.36	-1.2	-1.8
1750	39.6	13.89	1.35	40.1	1.37	-1.3	-1.4
1763	39.5	13.91	1.36	40.1	1.38	-1.3	-1.0
1775	39.5	13.93	1.38	40.0	1.39	-1.4	-0.7
1788	39.4	13.95	1.39	40.0	1.39	-1.4	-0.4
1800	39.4	13.97	1.40	40.0	1.40	-1.5	-0.1
1813	39.3	14.01	1.41	40.0	1.40	-1.7	0.9
1825	39.3	14.04	1.43	40.0	1.40	-1.8	1.8
1838	39.2	14.08	1.44	40.0	1.40	-2.0	2.8
1850	39.2	14.11	1.45	40.0	1.40	-2.1	3.8
1863	39.1	14.14	1.47	40.0	1.40	-2.2	4.7
1875	39.1	14.17	1.48	40.0	1.40	-2.3	5.6
1888	39.0	14.19	1.49	40.0	1.40	-2.5	6.5
1900	39.0	14.22	1.50	40.0	1.40	-2.6	7.4





Schmid & Partner Engineering AG

Zeughausstrasse 43, 8004 Zurich, Switzerland
Phone +41 44 245 9700, Fax +41 44 245 9779
info@speag.com, http://www.speag.com

Measurement Certificate / Material Test

Item Name	**Head Tissue Simulating Liquid (HSL 1900)**
Product No.	SL AAH 190 AA (Charge: 120112-1)
Manufacturer	SPEAG

Measurement Method

TSL dielectric parameters measured using calibrated OCP probe (type DAK).

Target Parameters

Target parameters as defined in the IEEE 1528 and IEC 62209 compliance standards.

Test Condition

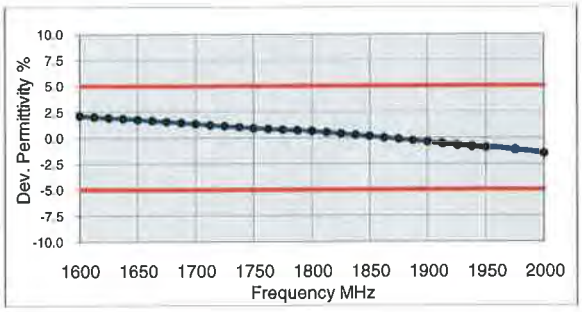
Ambient Condition	22°C ; 30% humidity
TSL Temperature	22°C
Test Date	18-Jan-12

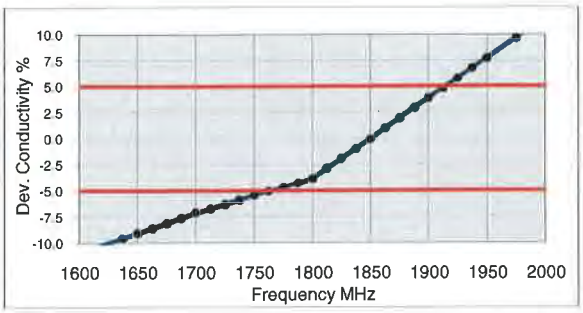
Additional Information

TSL Density	0.985 g/cm^3
TSL Heat-capacity	3.710 kJ/(kg*K)

Results

	Measured			Target		Diff.to Target [%]	
f [MHz]	HP-e'	HP-e"	sigma	eps	sigma	Δ-eps	Δ-sigma
1600	41.2	12.84	1.14	40.3	1.28	2.1	-11.0
1613	41.1	12.88	1.16	40.3	1.29	2.0	-10.5
1625	41.1	12.93	1.17	40.3	1.30	1.9	-10.0
1638	41.0	12.97	1.18	40.3	1.31	1.8	-9.5
1650	40.9	13.01	1.19	40.2	1.31	1.8	-9.1
1663	40.9	13.05	1.21	40.2	1.32	1.7	-8.6
1675	40.8	13.10	1.22	40.2	1.33	1.6	-8.1
1688	40.8	13.14	1.23	40.2	1.33	1.4	-7.6
1700	40.7	13.18	1.25	40.2	1.34	1.3	-7.1
1713	40.6	13.22	1.26	40.1	1.35	1.2	-6.7
1725	40.6	13.25	1.27	40.1	1.36	1.1	-6.3
1738	40.5	13.28	1.28	40.1	1.36	1.0	-5.9
1750	40.5	13.31	1.30	40.1	1.37	0.9	-5.5
1763	40.4	13.35	1.31	40.1	1.38	0.9	-5.1
1775	40.4	13.38	1.32	40.0	1.39	0.8	-4.7
1788	40.3	13.41	1.33	40.0	1.39	0.7	-4.3
1800	40.3	13.44	1.35	40.0	1.40	0.6	-3.9
1813	40.2	13.48	1.36	40.0	1.40	0.5	-2.9
1825	40.2	13.52	1.37	40.0	1.40	0.4	-2.0
1838	40.1	13.55	1.39	40.0	1.40	0.3	-1.0
1850	40.1	13.59	1.40	40.0	1.40	0.1	-0.1
1863	40.0	13.63	1.41	40.0	1.40	0.0	0.9
1875	39.9	13.67	1.43	40.0	1.40	-0.1	1.9
1888	39.9	13.71	1.44	40.0	1.40	-0.3	2.9
1900	39.8	13.75	1.45	40.0	1.40	-0.4	3.8
1913	39.8	13.79	1.47	40.0	1.40	-0.5	4.8
1925	39.7	13.83	1.48	40.0	1.40	-0.7	5.8
1938	39.7	13.86	1.49	40.0	1.40	-0.8	6.7
1950	39.6	13.90	1.51	40.0	1.40	-0.9	7.7
1975	39.5	13.97	1.53	40.0	1.40	-1.2	9.6
2000	39.4	14.04	1.56	40.0	1.40	-1.5	11.6





Schmid & Partner Engineering AG

Zeughausstrasse 43, 8004 Zurich, Switzerland
Phone +41 44 245 9700, Fax +41 44 245 9779
info@speag.com, http://www.speag.com

Measurement Certificate / Material Test

Item Name	**Head Tissue Simulating Liquid (HSL1950V2)**
Product No.	SL AAH 195 CA (Charge: 120717-3)
Manufacturer	SPEAG

Measurement Method

TSL dielectric parameters measured using calibrated OCP probe.

Setup Validation

Validation results were within ± 2.5% towards the target values of Methanol.

Target Parameters

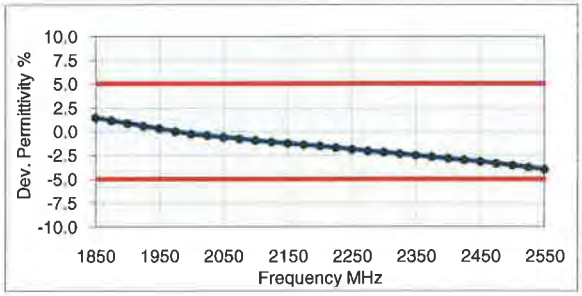
Target parameters as defined in the IEEE 1528 and IEC 62209 compliance standards.

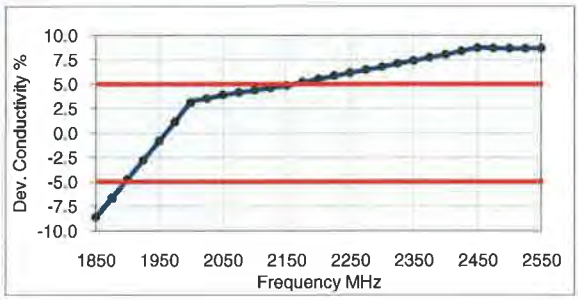
Test Condition

Ambient	Environment temperatur (22 ± 3)°C and humidity < 70%.
TSL Temperature	22°C
Test Date	18-Jul-12
Operator	DI

TSL Density	0.995 g/cm^3
TSL Heat-capacity	3.720 kJ/(kg*K)

	Measured			Target		Diff.to Target [%]	
f [MHz]	HP-e'	HP-e''	sigma	eps	sigma	Δ-eps	Δ-sigma
1850	40.6	12.43	1.28	40.0	1.40	1.5	-8.6
1875	40.5	12.53	1.31	40.0	1.40	1.2	-6.7
1900	40.3	12.62	1.33	40.0	1.40	0.9	-4.7
1925	40.2	12.71	1.36	40.0	1.40	0.6	-2.8
1950	40.1	12.80	1.39	40.0	1.40	0.3	-0.8
1975	40.0	12.89	1.42	40.0	1.40	0.0	1.1
2000	39.9	12.98	1.44	40.0	1.40	-0.3	3.1
2025	39.8	13.07	1.47	40.0	1.42	-0.4	3.5
2050	39.7	13.16	1.50	39.9	1.44	-0.6	3.9
2075	39.6	13.23	1.53	39.9	1.47	-0.8	4.2
2100	39.5	13.30	1.55	39.8	1.49	-0.9	4.4
2125	39.3	13.37	1.58	39.8	1.51	-1.1	4.6
2150	39.2	13.44	1.61	39.7	1.53	-1.2	4.9
2175	39.1	13.52	1.64	39.7	1.56	-1.4	5.2
2200	39.1	13.61	1.67	39.6	1.58	-1.5	5.5
2225	38.9	13.68	1.69	39.6	1.60	-1.7	5.9
2250	38.8	13.76	1.72	39.6	1.62	-1.9	6.2
2275	38.7	13.83	1.75	39.5	1.64	-2.0	6.5
2300	38.6	13.91	1.78	39.5	1.67	-2.2	6.8
2325	38.5	13.98	1.81	39.4	1.69	-2.3	7.1
2350	38.4	14.06	1.84	39.4	1.71	-2.5	7.4
2375	38.3	14.13	1.87	39.3	1.73	-2.7	7.7
2400	38.2	14.21	1.90	39.3	1.76	-2.8	8.0
2425	38.1	14.28	1.93	39.2	1.78	-3.0	8.4
2450	38.0	14.36	1.96	39.2	1.80	-3.1	8.7
2475	37.9	14.42	1.99	39.2	1.83	-3.3	8.7
2500	37.8	14.49	2.02	39.1	1.85	-3.5	8.7
2525	37.6	14.56	2.04	39.1	1.88	-3.7	8.7
2550	37.5	14.62	2.07	39.1	1.91	-3.9	8.7
2575	37.4	14.69	2.10	39.0	1.94	-4.1	8.7
2600	37.3	14.76	2.13	39.0	1.96	-4.3	8.7





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Zeughausstrasse 43, 8004 Zurich, Switzerland
Phone +41 44 245 9700, Fax +41 44 245 9779
info@speag.com, http://www.speag.com

Measurement Certificate / Material Test

Item Name	**Head Tissue Simulating Liquid (HSL2450V2)**
Product No.	SL AAH 245 BA (Charge: 130430-3)
Manufacturer	SPEAG

Measurement Method

TSL dielectric parameters measured using calibrated OCP probe.

Setup Validation

Validation results were within ± 2.5% towards the target values of Methanol.

Target Parameters

Target parameters as defined in the IEEE 1528 and IEC 62209 compliance standards.

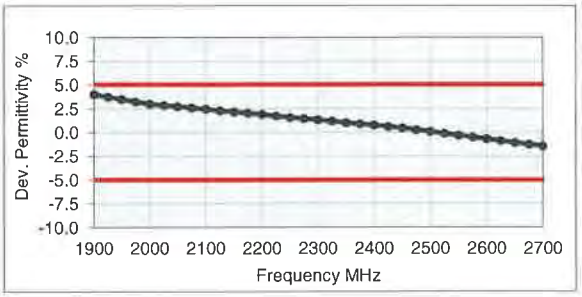
Test Condition

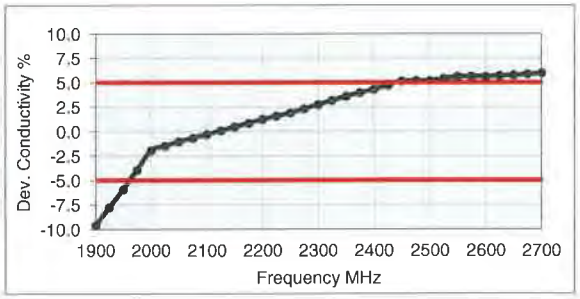
Ambient	Environment temperatur (22 ± 3)°C and humidity < 70%.
TSL Temperature	23°C
Test Date	2-May-13
Operator	CL

Additional Information

TSL Density	0.988 g/cm^3
TSL Heat-capacity	3.680 kJ/(kg*K)

	Measured			Target		Diff.to Target [%]	
f [MHz]	HP-e'	HP-e''	sigma	eps	sigma	Δ-eps	Δ-sigma
1900	41.6	11.98	1.27	40.0	1.40	4.0	-9.6
1925	41.5	12.06	1.29	40.0	1.40	3.8	-7.7
1950	41.4	12.15	1.32	40.0	1.40	3.5	-5.9
1975	41.3	12.24	1.35	40.0	1.40	3.3	-3.9
2000	41.2	12.34	1.37	40.0	1.40	3.0	-1.9
2025	41.1	12.44	1.40	40.0	1.42	2.9	-1.5
2050	41.0	12.54	1.43	39.9	1.44	2.8	-1.0
2075	40.9	12.62	1.46	39.9	1.47	2.6	-0.6
2100	40.8	12.71	1.48	39.8	1.49	2.5	-0.3
2125	40.7	12.80	1.51	39.8	1.51	2.3	0.1
2150	40.6	12.88	1.54	39.7	1.53	2.2	0.5
2175	40.5	12.97	1.57	39.7	1.56	2.0	0.9
2200	40.4	13.05	1.60	39.6	1.58	1.9	1.3
2225	40.3	13.13	1.63	39.6	1.60	1.7	1.6
2250	40.2	13.21	1.65	39.6	1.62	1.6	1.9
2275	40.1	13.30	1.68	39.5	1.64	1.5	2.4
2300	**40.0**	**13.39**	**1.71**	**39.5**	**1.67**	**1.3**	**2.8**
2325	39.9	13.48	1.74	39.4	1.69	1.2	3.2
2350	39.8	13.56	1.77	39.4	1.71	1.0	3.6
2375	39.7	13.64	1.80	39.3	1.73	0.9	4.0
2400	39.6	13.72	1.83	39.3	1.76	0.8	4.3
2425	39.5	13.80	1.86	39.2	1.78	0.6	4.8
2450	**39.4**	**13.89**	**1.89**	**39.2**	**1.80**	**0.5**	**5.2**
2475	39.3	13.96	1.92	39.2	1.83	0.3	5.2
2500	39.2	14.03	1.95	39.1	1.85	0.1	5.2
2525	39.1	14.12	1.98	39.1	1.88	-0.1	5.4
2550	39.0	14.22	2.02	39.1	1.91	-0.3	5.6
2575	38.9	14.28	2.05	39.0	1.94	-0.5	5.6
2600	**38.7**	**14.34**	**2.07**	**39.0**	**1.96**	**-0.7**	**5.6**
2625	38.6	14.41	2.10	39.0	1.99	-0.9	5.7
2650	38.5	14.48	2.13	38.9	2.02	-1.1	5.8
2675	38.4	14.55	2.17	38.9	2.05	-1.3	5.9
2700	38.3	14.62	2.20	38.9	2.07	-1.4	6.0





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Zeughausstrasse 43, 8004 Zurich, Switzerland
Phone +41 44 245 9700, Fax +41 44 245 9779
info@speag.com, http://www.speag.com

Measurement Certificate / Material Test

Item Name	**Head Tissue Simulating Liquid (HBBL1550-1950V3)**
Product No.	SL AAH 181 AA (Charge: 140206-3)
Manufacturer	SPEAG

Measurement Method

TSL dielectric parameters measured using calibrated OCP probe.

Setup Validation

Validation results were within ± 2.5% towards the target values of Methanol.

Target Parameters

Target parameters as defined in the IEEE 1528 and IEC 62209 compliance standards.

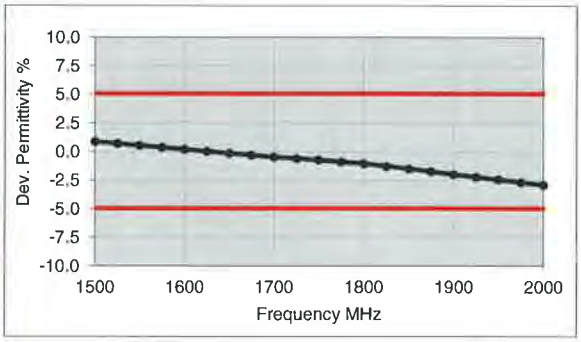
Test Condition

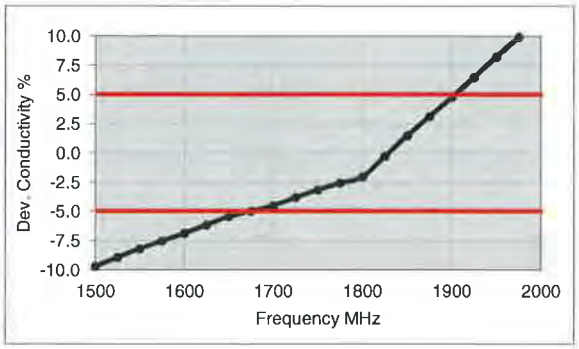
Ambient	Environment temperatur (22 ± 3)°C and humidity < 70%.
TSL Temperature	22°C
Test Date	12-Feb-14
Operator	IEN

Additional Information

TSL Density	1.052 g/cm^3
TSL Heat-capacity	3.322 kJ/(kg*K)

	Measured			Target		Diff.to Target [%]	
f [MHz]	HP-e'	HP-e"	sigma	eps	sigma	Δ-eps	Δ-sigma
1500	40.8	13.29	1.11	40.4	1.23	0.9	-9.7
1525	40.7	13.34	1.13	40.4	1.24	0.7	-8.9
1550	40.6	13.38	1.15	40.4	1.26	0.6	-8.2
1575	40.5	13.41	1.17	40.3	1.27	0.4	-7.5
1600	40.4	13.44	1.20	40.3	1.28	0.2	-6.9
1625	40.3	13.48	1.22	40.3	1.30	0.1	-6.2
1650	40.2	13.53	1.24	40.2	1.31	-0.1	-5.4
1675	40.1	13.54	1.26	40.2	1.33	-0.3	-5.0
1700	40.0	13.55	1.28	40.2	1.34	-0.4	-4.5
1725	39.9	13.60	1.30	40.1	1.36	-0.6	-3.8
1750	39.8	13.64	1.33	40.1	1.37	-0.7	-3.1
1775	39.7	13.67	1.35	40.0	1.39	-0.9	-2.6
1800	39.6	13.70	1.37	40.0	1.40	-1.0	-2.0
1825	39.5	13.75	1.40	40.0	1.40	-1.2	-0.3
1850	39.4	13.81	1.42	40.0	1.40	-1.5	1.5
1875	39.3	13.84	1.44	40.0	1.40	-1.7	3.1
1900	39.2	13.88	1.47	40.0	1.40	-2.0	4.8
1925	39.1	13.92	1.49	40.0	1.40	-2.2	6.5
1950	39.0	13.97	1.52	40.0	1.40	-2.4	8.3
1975	38.9	14.01	1.54	40.0	1.40	-2.6	10.0
2000	38.8	14.05	1.56	40.0	1.40	-2.9	11.6





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Zeughausstrasse 43, 8004 Zurich, Switzerland
Phone +41 44 245 9700, Fax +41 44 245 9779
info@speag.com, http://www.speag.com

Measurement Certificate / Material Test

Item Name	**Head Tissue Simulating Liquid (HBBL1900-3800V3)**
Product No.	SL AAH 196 AB (Charge: 131212-1)
Manufacturer	SPEAG

Measurement Method

TSL dielectric parameters measured using calibrated OCP probe.

Setup Validation

Validation results were within ± 2.5% towards the target values of Methanol.

Target Parameters

Target parameters as defined in the IEEE 1528 and IEC 62209 compliance standards.

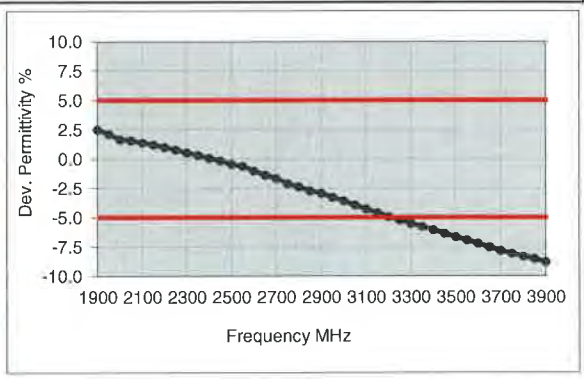
Test Condition

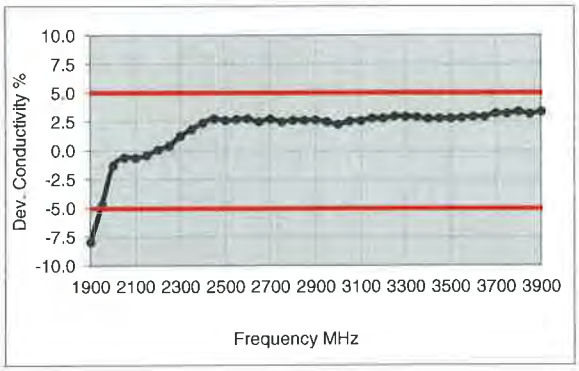
Ambient	Environment temperatur (22 ± 3)°C and humidity < 70%.
TSL Temperature	22°C
Test Date	18-Dec-13
Operator	IEN

Additional Information

TSL Density	1.054 g/cm^3
TSL Heat-capacity	3.389 kJ/(kg*K)

	Measured			Target		Diff.to Target [%]	
f [MHz]	HP-e'	HP-e"	sigma	eps	sigma	Δ-eps	Δ-sigma
1900	41.0	12.2	1.3	40.0	1.4	2.5	-7.9
1950	40.8	12.3	1.3	40.0	1.4	2.1	-4.7
2000	40.7	12.4	1.4	40.0	1.4	1.7	-1.3
2050	40.5	12.6	1.4	39.9	1.4	1.6	-0.6
2100	40.4	12.7	1.5	39.8	1.5	1.4	-0.6
2150	40.2	12.8	1.5	39.7	1.5	1.2	-0.4
2200	40.0	12.9	1.6	39.6	1.6	1.0	0.1
2250	39.9	13.0	1.6	39.6	1.6	0.8	0.4
2300	39.7	13.2	1.7	39.5	1.7	0.5	1.3
2350	39.5	13.3	1.7	39.4	1.7	0.3	1.8
2400	39.3	13.5	1.8	39.3	1.8	0.1	2.4
2450	39.1	13.6	1.9	39.2	1.8	-0.1	2.8
2500	39.0	13.7	1.9	39.1	1.9	-0.4	2.6
2550	38.8	13.8	2.0	39.1	1.9	-0.6	2.7
2600	38.6	14.0	2.0	39.0	2.0	-1.0	2.8
2650	38.4	14.0	2.1	38.9	2.0	-1.4	2.5
2700	38.2	14.2	2.1	38.9	2.1	-1.7	2.7
2750	38.0	14.3	2.2	38.8	2.1	-2.1	2.5
2800	37.8	14.4	2.2	38.8	2.2	-2.4	2.6
2850	37.6	14.5	2.3	38.7	2.2	-2.7	2.6
2900	37.5	14.6	2.4	38.6	2.3	-2.9	2.6
2950	37.3	14.6	2.4	38.6	2.3	-3.3	2.5
3000	37.1	14.7	2.5	38.5	2.4	-3.6	2.3
3050	36.9	14.8	2.5	38.4	2.5	-3.9	2.6
3100	36.7	14.9	2.6	38.4	2.5	-4.3	2.6
3150	36.6	15.0	2.6	38.3	2.6	-4.6	2.8
3200	36.4	15.0	2.7	38.3	2.6	-4.9	2.8
3250	36.2	15.1	2.7	38.2	2.7	-5.2	3.0
3300	36.1	15.2	2.8	38.2	2.7	-5.5	3.0
3350	35.9	15.2	2.8	38.1	2.8	-5.8	2.9
3400	35.7	15.3	2.9	38.0	2.8	-6.0	2.8
3450	35.6	15.3	2.9	38.0	2.9	-6.3	2.8
3500	35.4	15.4	3.0	37.9	2.9	-6.6	2.8
3550	35.3	15.4	3.0	37.9	3.0	-6.9	2.9
3600	35.1	15.5	3.1	37.8	3.0	-7.2	2.9
3650	34.9	15.5	3.2	37.8	3.1	-7.5	2.9
3700	34.7	15.6	3.2	37.7	3.1	-7.8	3.2
3750	34.6	15.7	3.3	37.6	3.2	-8.1	3.2
3800	34.5	15.7	3.3	37.6	3.2	-8.3	3.4
3850	34.3	15.8	3.4	37.5	3.3	-8.5	3.2





Schmid & Partner Engineering AG

Zeughausstrasse 43, 8004 Zurich, Switzerland
Phone +41 44 245 9700, Fax +41 44 245 9779
info@speag.com, http://www.speag.com

Measurement Certificate / Material Test

Item Name	**Head Tissue Simulating Liquid (HBBL3500-5800V5)**
Product No.	SL AAH 502 AB (Charge: 130123-1)
Manufacturer	SPEAG

Measurement Method

TSL dielectric parameters measured using calibrated OCP probe.

Setup Validation

Validation results were within ± 2.5% towards the target values of Methanol.

Target Parameters

Target parameters as defined in the IEEE 1528 and IEC 62209 compliance standards.

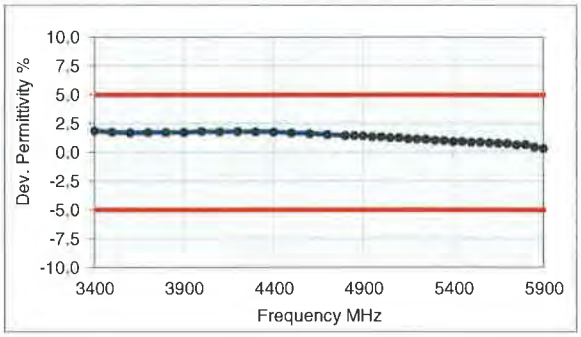
Test Condition

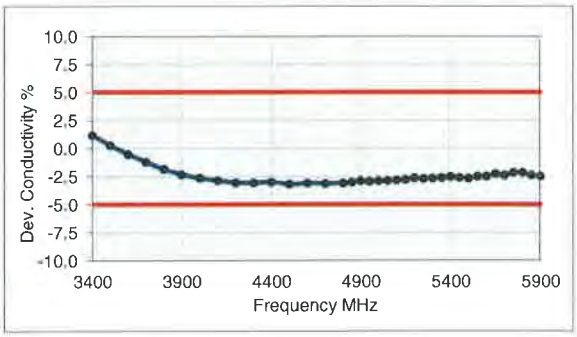
Ambient	Environment temperatur (22 ± 3)°C and humidity < 70%.
TSL Temperature	22°C
Test Date	23-Jan-13
Operator	DI

Additional Information

TSL Density	0.985 g/cm^3
TSL Heat-capacity	3.383 kJ/(kg*K)

	Measured			Target		Diff.to Target [%]	
f [MHz]	HP-e'	HP-e''	sigma	eps	sigma	Δ-eps	Δ-sigma
3400	38.8	15.03	2.84	38.0	2.81	1.9	1.2
3500	**38.6**	**15.00**	**2.92**	**37.9**	**2.91**	**1.8**	**0.3**
3600	38.5	14.98	3.00	37.8	3.02	1.7	-0.5
3700	**38.4**	**14.97**	**3.08**	**37.7**	**3.12**	**1.7**	**-1.2**
3800	38.2	14.95	3.16	37.6	3.22	1.7	-1.8
3900	38.1	14.96	3.25	37.5	3.32	1.7	-2.3
4000	38.0	14.99	3.34	37.4	3.43	1.8	-2.6
4100	37.9	15.03	3.43	37.2	3.53	1.8	-2.8
4200	37.8	15.06	3.52	37.1	3.63	1.8	-3.0
4300	37.7	15.13	3.62	37.0	3.73	1.8	-3.1
4400	37.6	15.20	3.72	36.9	3.84	1.8	-3.0
4500	37.4	15.23	3.81	36.8	3.94	1.7	-3.2
4600	37.3	15.30	3.92	36.7	4.04	1.6	-3.1
4700	37.1	15.35	4.01	36.6	4.14	1.5	-3.1
4800	37.0	15.41	4.11	36.4	4.25	1.5	-3.1
4850	36.9	15.45	4.17	36.4	4.30	1.5	-3.0
4900	36.8	15.49	4.22	36.3	4.35	1.4	-2.9
4950	36.8	15.51	4.27	36.3	4.40	1.4	-2.9
5000	36.7	15.54	4.32	36.2	4.45	1.4	-2.9
5050	36.6	15.57	4.37	36.2	4.50	1.3	-2.8
5100	36.6	15.60	4.42	36.1	4.55	1.3	-2.8
5150	36.5	15.63	4.48	36.0	4.60	1.2	-2.7
5200	**36.4**	**15.67**	**4.53**	**36.0**	**4.66**	**1.2**	**-2.6**
5250	36.3	15.68	4.58	35.9	4.71	1.1	-2.7
5300	36.2	15.71	4.63	35.9	4.76	1.0	-2.6
5350	36.2	15.74	4.68	35.8	4.81	1.0	-2.6
5400	36.1	15.78	4.74	35.8	4.86	0.9	-2.5
5450	36.0	15.78	4.78	35.7	4.91	0.9	-2.6
5500	**36.0**	**15.79**	**4.83**	**35.6**	**4.96**	**0.9**	**-2.6**
5550	35.9	15.84	4.89	35.6	5.01	0.9	-2.5
5600	35.8	15.86	4.94	35.5	5.07	0.8	-2.5
5650	35.8	15.91	5.00	35.5	5.12	0.8	-2.2
5700	35.7	15.91	5.05	35.4	5.17	0.8	-2.4
5750	35.6	15.97	5.11	35.4	5.22	0.7	-2.1
5800	**35.5**	**15.98**	**5.16**	**35.3**	**5.27**	**0.7**	**-2.1**
5850	35.5	16.01	5.21	35.3	5.34	0.5	-2.4
5900	35.4	16.05	5.27	35.3	5.40	0.3	-2.4





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Zeughausstrasse 43, 8004 Zurich, Switzerland
Phone +41 44 245 9700, Fax +41 44 245 9779
info@speag.com, http://www.speag.com

Measurement Certificate / Material Test

Item Name	**Body Tissue Simulating Liquid (MSL750V2)**
Product No.	SL AAM 075 (Charge: 120831-2)
Manufacturer	SPEAG

Measurement Method

TSL dielectric parameters measured using calibrated OCP probe.

Setup Validation

Validation results were within ± 2.5% towards the target values of Methanol.

Target Parameters

Target parameters as defined in the IEEE 1528 and IEC 62209 compliance standards.

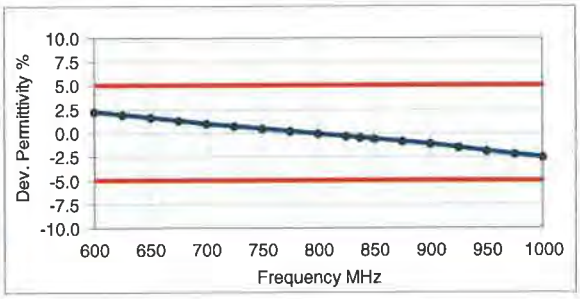
Test Condition

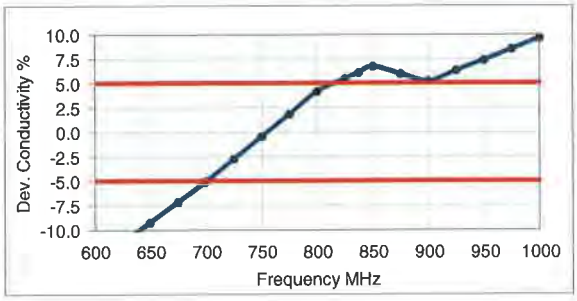
Ambient	Environment temperatur (22 ± 3)°C and humidity < 70%.
TSL Temperature	22°C
Test Date	5-Sep-12
Operator	CL

Additional Information

TSL Density	1.212 g/cm^3
TSL Heat-capacity	3.006 kJ/(kg*K)

	Measured			Target		Diff.to Target [%]	
f [MHz]	HP-e'	HP-e''	sigma	eps	sigma	Δ-eps	Δ-sigma
600	57.4	24.67	0.82	56.1	0.95	2.2	-13.5
625	57.1	24.34	0.85	56.0	0.95	1.9	-11.3
650	56.8	24.01	0.87	55.9	0.96	1.6	-9.1
675	56.6	23.71	0.89	55.8	0.96	1.3	-7.1
700	56.3	23.41	0.91	55.7	0.96	1.0	-5.0
725	56.0	23.20	0.94	55.6	0.96	0.7	-2.7
750	55.8	22.99	0.96	55.5	0.96	0.5	-0.4
775	55.5	22.81	0.98	55.4	0.97	0.2	1.9
800	55.3	22.64	1.01	55.3	0.97	-0.1	4.2
825	55.1	22.47	1.03	55.2	0.98	-0.3	5.5
838	54.9	22.39	1.04	55.2	0.98	-0.5	6.1
850	54.8	22.31	1.05	55.2	0.99	-0.6	6.7
875	54.6	22.19	1.08	55.1	1.02	-0.9	6.0
900	54.4	22.07	1.10	55.0	1.05	-1.1	5.2
925	54.1	21.96	1.13	55.0	1.06	-1.5	6.3
950	53.9	21.85	1.15	54.9	1.08	-1.9	7.4
975	53.7	21.75	1.18	54.9	1.09	-2.2	8.5
1000	53.5	21.64	1.20	54.8	1.10	-2.5	9.6





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Zeughausstrasse 43, 8004 Zurich, Switzerland
Phone +41 44 245 9700, Fax +41 44 245 9779
info@speag.com, http://www.speag.com

Measurement Certificate / Material Test

Item Name	**Body Tissue Simulating Liquid (MSL900V2)**
Product No.	SL AAM 090 CA (Charge: 140124-1)
Manufacturer	SPEAG

Measurement Method

TSL dielectric parameters measured using calibrated OCP probe.

Setup Validation

Validation results were within ± 2.5% towards the target values of Methanol.

Target Parameters

Target parameters as defined in the IEEE 1528 and IEC 62209 compliance standards.

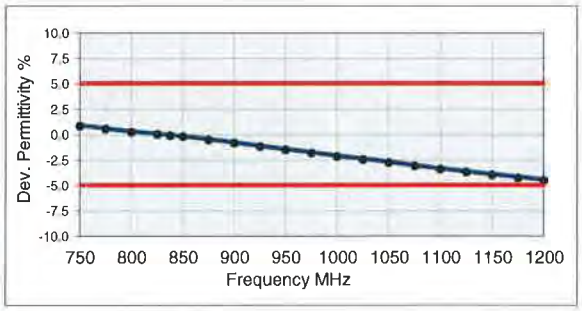
Test Condition

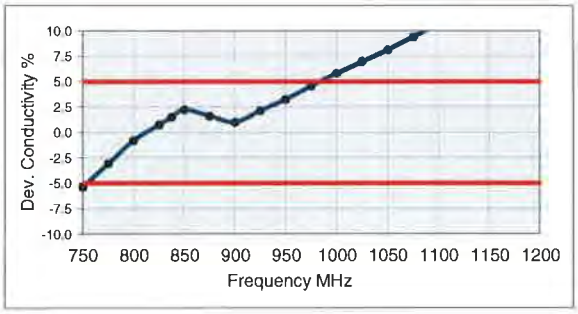
Ambient	Environment temperatur (22 ± 3)°C and humidity < 70%.
TSL Temperature	22°C
Test Date	29-Jan-14
Operator	IEN

Additional Information

TSL Density	1.208 g/cm3
TSL Heat-capacity	3.113 kJ/(kg*K)

	Measured			Target		Diff.to Target [%]	
f [MHz]	HP-e'	HP-e''	sigma	eps	sigma	Δ-eps	Δ-sigma
700	56.5	22.21	0.86	55.7	0.96	1.4	-9.9
725	56.3	22.03	0.89	55.6	0.96	1.1	-7.6
750	56.0	21.85	0.91	55.5	0.96	0.9	-5.4
775	55.8	21.71	0.94	55.4	0.97	0.6	-3.1
800	55.5	21.57	0.96	55.3	0.97	0.3	-0.8
825	55.3	21.47	0.99	55.2	0.98	0.1	0.8
838	**55.2**	**21.42**	**1.00**	**55.2**	**0.98**	**-0.1**	**1.5**
850	55.1	21.37	1.01	55.2	0.99	-0.2	2.2
875	54.8	21.28	1.04	55.1	1.02	-0.5	1.6
900	**54.6**	**21.19**	**1.06**	**55.0**	**1.05**	**-0.8**	**1.0**
925	54.3	21.10	1.09	55.0	1.06	-1.1	2.1
950	54.1	21.01	1.11	54.9	1.08	-1.5	3.2
975	53.9	20.96	1.14	54.9	1.09	-1.8	4.6
1000	53.7	20.90	1.16	54.8	1.10	-2.1	5.9
1025	53.5	20.82	1.19	54.8	1.11	-2.4	7.0
1050	53.3	20.75	1.21	54.7	1.12	-2.7	8.1
1075	53.0	20.70	1.24	54.7	1.13	-3.0	9.4
1100	52.8	20.66	1.26	54.7	1.14	-3.4	10.6
1125	52.6	20.57	1.29	54.6	1.15	-3.7	11.5
1150	52.4	20.48	1.31	54.6	1.17	-3.9	12.4
1175	52.2	20.47	1.34	54.5	1.18	-4.2	13.7
1200	52.0	20.46	1.37	54.5	1.19	-4.5	15.0





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Zeughausstrasse 43, 8004 Zurich, Switzerland
Phone +41 44 245 9700, Fax +41 44 245 9779
info@speag.com, http://www.speag.com

Measurement Certificate / Material Test

Item Name	**Body Tissue Simulating Liquid (MSL1750V2)**
Product No.	SL AAM 175 (Charge: 120919-3)
Manufacturer	SPEAG

Measurement Method

TSL dielectric parameters measured using calibrated OCP probe.

Setup Validation

Validation results were within ± 2.5% towards the target values of Methanol.

Target Parameters

Target parameters as defined in the IEEE 1528 and IEC 62209 compliance standards.

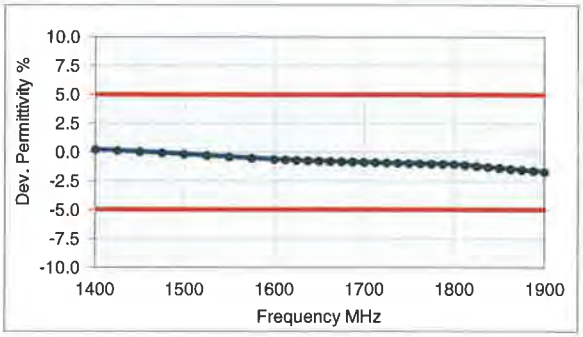
Test Condition

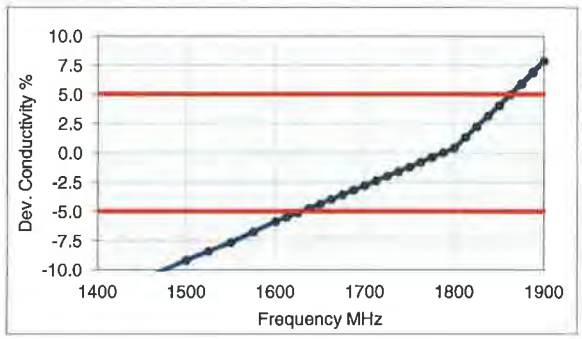
Ambient	Environment temperatur (22 ± 3)°C and humidity < 70%.
TSL Temperature	22°C
Test Date	20-Sep-12
Operator	CL

Additional Information

TSL Density	0.998 g/cm^3
TSL Heat-capacity	3.893 kJ/(kg*K)

	Measured			Target		Diff.to Target [%]	
f [MHz]	HP-e'	HP-e''	sigma	eps	sigma	Δ-eps	Δ-sigma
1400	54.2	14.23	1.11	54.1	1.28	0.2	-13.2
1425	54.1	14.30	1.13	54.0	1.29	0.1	-12.1
1450	54.0	14.36	1.16	54.0	1.30	0.0	-10.9
1475	53.9	14.42	1.18	54.0	1.32	-0.1	-10.0
1500	53.8	14.49	1.21	53.9	1.33	-0.2	-9.2
1525	53.7	14.54	1.23	53.9	1.35	-0.3	-8.4
1550	53.7	14.59	1.26	53.9	1.36	-0.4	-7.7
1575	53.6	14.67	1.29	53.8	1.38	-0.5	-6.8
1600	53.5	14.74	1.31	53.8	1.39	-0.6	-5.9
1613	53.4	14.77	1.32	53.8	1.40	-0.7	-5.5
1625	53.4	14.79	1.34	53.8	1.41	-0.7	-5.1
1638	53.3	14.82	1.35	53.7	1.42	-0.7	-4.7
1650	53.3	14.85	1.36	53.7	1.43	-0.8	-4.4
1663	53.2	14.88	1.38	53.7	1.43	-0.8	-4.0
1675	53.2	14.91	1.39	53.6	1.44	-0.8	-3.6
1688	53.1	14.94	1.40	53.6	1.45	-0.8	-3.2
1700	53.1	14.97	1.42	53.6	1.46	-0.9	-2.8
1713	53.1	15.01	1.43	53.5	1.46	-0.9	-2.4
1725	53.0	15.04	1.44	53.5	1.47	-0.9	-2.0
1738	53.0	15.07	1.46	53.5	1.48	-1.0	-1.6
1750	52.9	15.10	1.47	53.4	1.49	-1.0	-1.2
1763	52.9	15.14	1.48	53.4	1.50	-1.0	-0.8
1775	52.8	15.17	1.50	53.4	1.50	-1.0	-0.4
1788	52.8	15.21	1.51	53.3	1.51	-1.0	0.0
1800	52.7	15.24	1.53	53.3	1.52	-1.1	0.4
1813	52.7	15.27	1.54	53.3	1.52	-1.1	1.3
1825	52.7	15.30	1.55	53.3	1.52	-1.2	2.2
1838	52.6	15.33	1.57	53.3	1.52	-1.3	3.1
1850	52.6	15.37	1.58	53.3	1.52	-1.4	4.0
1863	52.5	15.40	1.60	53.3	1.52	-1.5	5.0
1875	52.5	15.44	1.61	53.3	1.52	-1.5	6.0
1888	52.4	15.48	1.63	53.3	1.52	-1.6	6.9
1900	52.4	15.51	1.64	53.3	1.52	-1.7	7.9





Schmid & Partner Engineering AG

Zeughausstrasse 43, 8004 Zurich, Switzerland
Phone +41 44 245 9700, Fax +41 44 245 9779
info@speag.com, http://www.speag.com

Measurement Certificate / Material Test

Item Name	**Body Tissue Simulating Liquid (MSL1900V2)**
Product No.	SL AAM 190 (Charge: 120913-1)
Manufacturer	SPEAG

Measurement Method

TSL dielectric parameters measured using calibrated OCP probe.

Setup Validation

Validation results were within ± 2.5% towards the target values of Methanol.

Target Parameters

Target parameters as defined in the IEEE 1528 and IEC 62209 compliance standards.

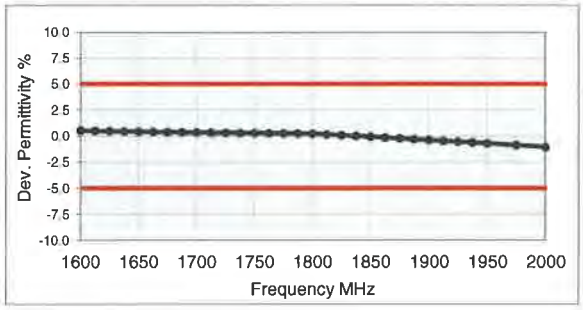
Test Condition

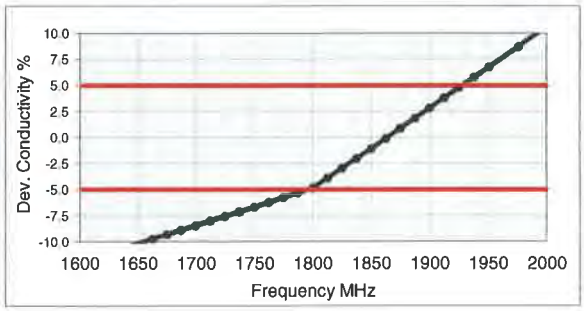
Ambient	Environment temperatur (22 ± 3)°C and humidity < 70%.
TSL Temperature	22°C
Test Date	20-Sep-12
Operator	CL

Additional Information

TSL Density	0.996 g/cm^3
TSL Heat-capacity	3.947 kJ/(kg*K)

	Measured			Target		Diff.to Target [%]	
f [MHz]	HP-e'	HP-e''	sigma	eps	sigma	Δ-eps	Δ-sigma
1600	54.1	13.80	1.23	53.8	1.39	0.5	-11.8
1613	54.1	13.84	1.24	53.8	1.40	0.5	-11.4
1625	54.0	13.87	1.25	53.8	1.41	0.5	-11.0
1638	54.0	13.91	1.27	53.7	1.42	0.5	-10.6
1650	53.9	13.95	1.28	53.7	1.43	0.4	-10.2
1663	53.9	13.99	1.29	53.7	1.43	0.4	-9.7
1675	53.8	14.02	1.31	53.6	1.44	0.4	-9.3
1688	53.8	14.06	1.32	53.6	1.45	0.4	-8.9
1700	53.8	14.10	1.33	53.6	1.46	0.4	-8.4
1713	53.7	14.14	1.35	53.5	1.46	0.3	-8.0
1725	53.7	14.19	1.36	53.5	1.47	0.3	-7.6
1738	53.6	14.23	1.38	53.5	1.48	0.3	-7.1
1750	53.6	14.27	1.39	53.4	1.49	0.3	-6.7
1763	53.5	14.31	1.40	53.4	1.50	0.3	-6.2
1775	53.5	14.35	1.42	53.4	1.50	0.3	-5.8
1788	53.5	14.40	1.43	53.3	1.51	0.2	-5.3
1800	53.4	14.44	1.45	53.3	1.52	0.2	-4.9
1813	53.4	14.48	1.46	53.3	1.52	0.2	-3.9
1825	53.3	14.52	1.47	53.3	1.52	0.1	-3.0
1838	53.3	14.56	1.49	53.3	1.52	0.0	-2.0
1850	53.3	14.61	1.50	53.3	1.52	-0.1	-1.1
1863	53.2	14.65	1.52	53.3	1.52	-0.1	-0.1
1875	53.2	14.69	1.53	53.3	1.52	-0.2	0.8
1888	53.1	14.74	1.55	53.3	1.52	-0.3	1.8
1900	53.1	14.78	1.56	53.3	1.52	-0.4	2.8
1913	53.0	14.83	1.58	53.3	1.52	-0.5	3.8
1925	53.0	14.87	1.59	53.3	1.52	-0.5	4.8
1938	53.0	14.91	1.61	53.3	1.52	-0.6	5.7
1950	52.9	14.95	1.62	53.3	1.52	-0.7	6.7
1975	52.8	15.03	1.65	53.3	1.52	-0.9	8.7
2000	52.7	15.11	1.68	53.3	1.52	-1.0	10.6





Schmid & Partner Engineering AG

Zeughausstrasse 43, 8004 Zurich, Switzerland
Phone +41 44 245 9700, Fax +41 44 245 9779
info@speag.com, http://www.speag.com

Measurement Certificate / Material Test

Item Name	**Body Tissue Simulating Liquid (MSL1950V2)**
Product No.	SL AAM 195 (Charge: 120919-2)
Manufacturer	SPEAG

Measurement Method

TSL dielectric parameters measured using calibrated OCP probe.

Setup Validation

Validation results were within ± 2.5% towards the target values of Methanol.

Target Parameters

Target parameters as defined in the IEEE 1528 and IEC 62209 compliance standards.

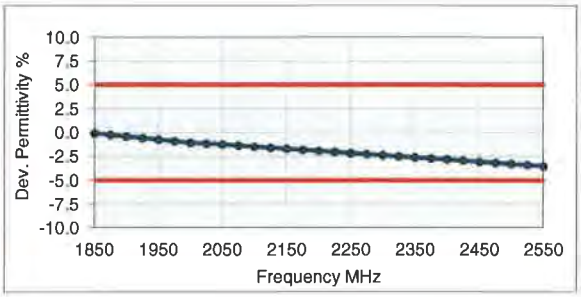
Test Condition

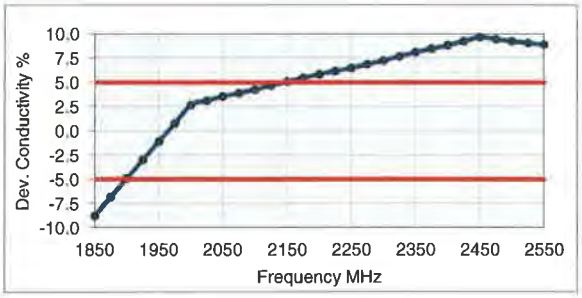
Ambient	Environment temperatur (22 ± 3)°C and humidity < 70%.
TSL Temperature	22°C
Test Date	20-Sep-12
Operator	CL

Additional Information

TSL Density	0.997 g/cm^3
TSL Heat-capacity	3.970 kJ/(kg*K)

	Measured			Target		Diff.to Target [%]	
f [MHz]	HP-e'	HP-e''	sigma	eps	sigma	Δ-eps	Δ-sigma
1850	53.3	13.47	1.39	53.3	1.52	-0.1	-8.8
1875	53.2	13.58	1.42	53.3	1.52	-0.2	-6.8
1900	53.1	13.68	1.45	53.3	1.52	-0.4	-4.9
1925	53.0	13.77	1.47	53.3	1.52	-0.6	-3.0
1950	52.9	13.86	1.50	53.3	1.52	-0.7	-1.1
1975	52.8	13.94	1.53	53.3	1.52	-0.9	0.8
2000	52.7	14.03	1.56	53.3	1.52	-1.1	2.7
2025	52.6	14.13	1.59	53.3	1.54	-1.2	3.1
2050	52.6	14.23	1.62	53.2	1.57	-1.3	3.5
2075	52.5	14.32	1.65	53.2	1.59	-1.4	3.9
2100	52.4	14.41	1.68	53.2	1.62	-1.5	4.2
2125	52.3	14.51	1.72	53.1	1.64	-1.6	4.7
2150	52.2	14.61	1.75	53.1	1.66	-1.7	5.1
2175	52.1	14.70	1.78	53.1	1.69	-1.8	5.5
2200	52.0	14.79	1.81	53.0	1.71	-1.9	5.8
2225	51.9	14.88	1.84	53.0	1.74	-2.0	6.1
2250	51.8	14.96	1.87	53.0	1.76	-2.2	6.5
2275	51.7	15.05	1.91	52.9	1.78	-2.3	6.9
2300	51.6	15.14	1.94	52.9	1.81	-2.4	7.2
2325	51.5	15.24	1.97	52.9	1.83	-2.5	7.7
2350	51.4	15.33	2.00	52.8	1.85	-2.6	8.1
2375	51.4	15.42	2.04	52.8	1.88	-2.7	8.5
2400	51.3	15.50	2.07	52.8	1.90	-2.8	8.8
2425	51.2	15.60	2.10	52.7	1.93	-2.9	9.2
2450	51.1	15.69	2.14	52.7	1.95	-3.1	9.7
2475	51.0	15.78	2.17	52.7	1.99	-3.2	9.4
2500	50.9	15.87	2.21	52.6	2.02	-3.3	9.2
2525	50.8	15.96	2.24	52.6	2.06	-3.4	9.1
2550	50.7	16.06	2.28	52.6	2.09	-3.5	8.9
2575	50.6	16.14	2.31	52.5	2.13	-3.7	8.7
2600	50.5	16.23	2.35	52.5	2.16	-3.9	8.6





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Zeughausstrasse 43, 8004 Zurich, Switzerland
Phone +41 44 245 9700, Fax +41 44 245 9779
info@speag.com, http://www.speag.com

Measurement Certificate / Material Test

Item Name	**Body Tissue Simulating Liquid (MSL2450V2)**
Product No.	SL AAM 245 BA (Charge: 130510-2)
Manufacturer	SPEAG

Measurement Method

TSL dielectric parameters measured using calibrated OCP probe.

Setup Validation

Validation results were within ± 2.5% towards the target values of Methanol.

Target Parameters

Target parameters as defined in the IEEE 1528 and IEC 62209 compliance standards.

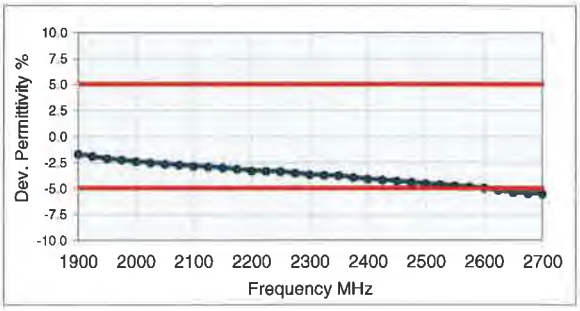
Test Condition

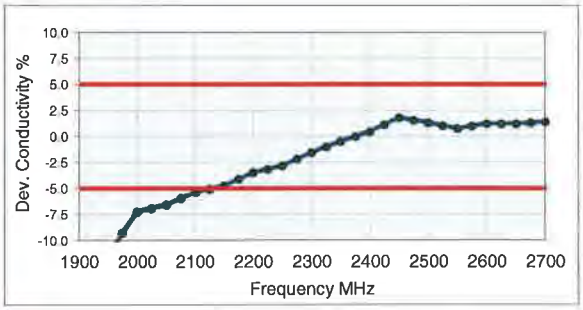
Ambient	Environment temperatur (22 ± 3)°C and humidity < 70%.
TSL Temperature	22°C
Test Date	15-May-13
Operator	IEN

Additional Information

TSL Density	0.996 g/cm^3
TSL Heat-capacity	3.987 kJ/(kg*K)

	Measured			Target		Diff.to Target [%]	
f [MHz]	HP-e'	HP-e''	sigma	eps	sigma	Δ-eps	Δ-sigma
1900	52.4	12.21	1.29	53.3	1.52	-1.7	-15.1
1925	52.3	12.32	1.32	53.3	1.52	-1.9	-13.2
1950	52.2	12.43	1.35	53.3	1.52	-2.1	-11.3
1975	52.1	12.55	1.38	53.3	1.52	-2.2	-9.3
2000	52.0	12.67	1.41	53.3	1.52	-2.4	-7.3
2025	51.9	12.75	1.44	53.3	1.54	-2.5	-6.9
2050	51.8	12.84	1.46	53.2	1.57	-2.6	-6.6
2075	51.7	12.96	1.50	53.2	1.59	-2.7	-6.0
2100	51.7	13.09	1.53	53.2	1.62	-2.8	-5.4
2125	51.6	13.17	1.56	53.1	1.64	-2.9	-5.0
2150	51.5	13.25	1.58	53.1	1.66	-3.0	-4.7
2175	51.4	13.37	1.62	53.1	1.69	-3.1	-4.1
2200	51.3	13.50	1.65	53.0	1.71	-3.3	-3.5
2225	51.2	13.58	1.68	53.0	1.74	-3.3	-3.1
2250	51.2	13.65	1.71	53.0	1.76	-3.3	-2.8
2275	51.1	13.78	1.74	52.9	1.78	-3.5	-2.2
2300	51.0	13.90	1.78	52.9	1.81	-3.6	-1.5
2325	50.9	14.01	1.81	52.9	1.83	-3.7	-1.0
2350	50.9	14.12	1.85	52.8	1.85	-3.8	-0.5
2375	50.7	14.21	1.88	52.8	1.88	-3.9	0.0
2400	50.6	14.31	1.91	52.8	1.90	-4.1	0.5
2425	50.5	14.44	1.95	52.7	1.93	-4.2	1.1
2450	50.5	14.56	1.99	52.7	1.95	-4.3	1.8
2475	50.4	14.64	2.02	52.7	1.99	-4.4	1.6
2500	50.3	14.72	2.05	52.6	2.02	-4.5	1.3
2525	50.2	14.79	2.08	52.6	2.06	-4.6	1.0
2550	50.1	14.86	2.11	52.6	2.09	-4.7	0.7
2575	50.0	15.00	2.15	52.5	2.13	-4.8	1.0
2600	49.9	15.14	2.19	52.5	2.16	-4.9	1.2
2625	49.8	15.23	2.22	52.5	2.20	-5.1	1.2
2650	49.6	15.33	2.26	52.4	2.23	-5.3	1.2
2675	49.6	15.45	2.30	52.4	2.27	-5.4	1.3
2700	49.5	15.56	2.34	52.4	2.30	-5.5	1.4





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Zeughausstrasse 43, 8004 Zurich, Switzerland
Phone +41 44 245 9700, Fax +41 44 245 9779
info@speag.com, http://www.speag.com

Measurement Certificate / Material Test

Item Name	**Body Tissue Simulating Liquid (MBBL1550-1950V3)**
Product No.	SL AAM 181 AA (Charge: 140218-3)
Manufacturer	SPEAG

Measurement Method

TSL dielectric parameters measured using calibrated OCP probe.

Setup Validation

Validation results were within ± 2.5% towards the target values of Methanol.

Target Parameters

Target parameters as defined in the IEEE 1528 and IEC 62209 compliance standards.

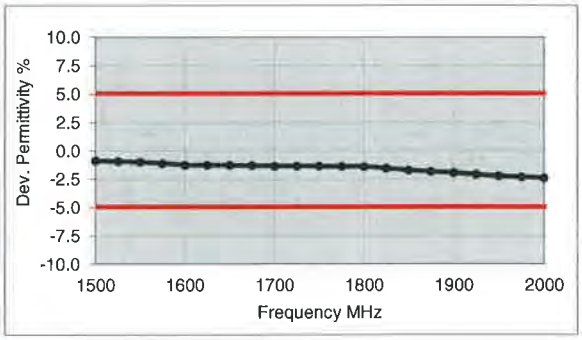
Test Condition

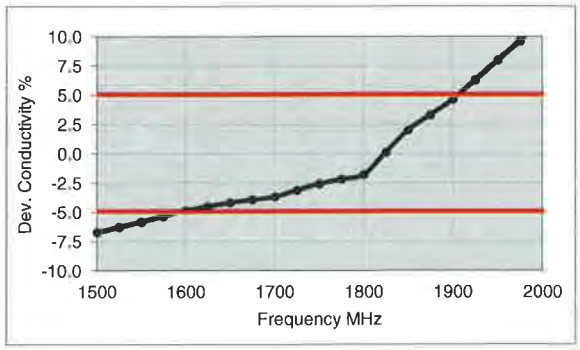
Ambient	Environment temperatur (22 ± 3)°C and humidity < 70%.
TSL Temperature	22°C
Test Date	19-Feb-14
Operator	IEN

Additional Information

TSL Density	1.042 g/cm^3
TSL Heat-capacity	3.475 kJ/(kg*K)

	Measured			Target		Diff.to Target [%]	
f [MHz]	HP-e'	HP-e''	sigma	eps	sigma	Δ-eps	Δ-sigma
1500	53.5	14.88	1.24	53.9	1.33	-0.9	-6.7
1525	53.4	14.88	1.26	53.9	1.35	-0.9	-6.2
1550	53.4	14.89	1.28	53.9	1.36	-1.0	-5.8
1575	53.2	14.89	1.30	53.8	1.38	-1.1	-5.3
1600	53.1	14.90	1.33	53.8	1.39	-1.2	-4.8
1625	53.1	14.89	1.35	53.8	1.41	-1.2	-4.5
1650	53.0	14.88	1.37	53.7	1.43	-1.3	-4.2
1675	52.9	14.86	1.38	53.6	1.44	-1.3	-3.9
1700	52.9	14.84	1.40	53.6	1.46	-1.3	-3.7
1725	52.8	14.87	1.43	53.5	1.47	-1.3	-3.1
1750	52.7	14.90	1.45	53.4	1.49	-1.4	-2.6
1775	52.6	14.90	1.47	53.4	1.50	-1.4	-2.2
1800	52.6	14.91	1.49	53.3	1.52	-1.4	-1.8
1825	52.5	14.99	1.52	53.3	1.52	-1.5	0.1
1850	52.4	15.07	1.55	53.3	1.52	-1.7	2.0
1875	52.3	15.06	1.57	53.3	1.52	-1.8	3.3
1900	52.3	15.05	1.59	53.3	1.52	-1.9	4.6
1925	52.2	15.09	1.62	53.3	1.52	-2.1	6.3
1950	52.1	15.13	1.64	53.3	1.52	-2.2	8.0
1975	52.1	15.17	1.67	53.3	1.52	-2.3	9.7
2000	52.0	15.21	1.69	53.3	1.52	-2.4	11.3





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Zeughausstrasse 43, 8004 Zurich, Switzerland
Phone +41 44 245 9700, Fax +41 44 245 9779
info@speag.com, http://www.speag.com

Measurement Certificate / Material Test

Item Name	**Body Tissue Simulating Liquid (MBBL1900-3800V3)**
Product No.	SL AAM 196 AB (Charge: 140219-3)
Manufacturer	SPEAG

Measurement Method

TSL dielectric parameters measured using calibrated OCP probe.

Setup Validation

Validation results were within ± 2.5% towards the target values of Methanol.

Target Parameters

Target parameters as defined in the IEEE 1528 and IEC 62209 compliance standards.

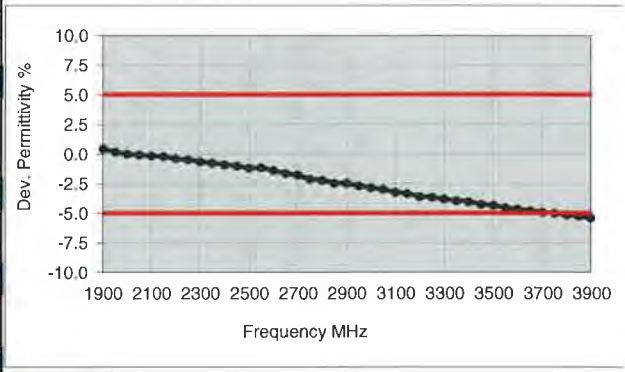
Test Condition

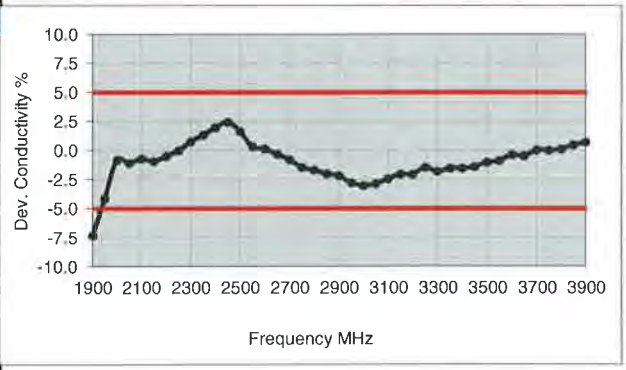
Ambient	Environment temperatur (22 ± 3)°C and humidity < 70%.
TSL Temperature	22°C
Test Date	19-Feb-14
Operator	IEN

Additional Information

TSL Density	1.036 g/cm^3
TSL Heat-capacity	3.508 kJ/(kg*K)

	Measured			Target		Diff.to Target [%]	
f [MHz]	HP-e'	HP-e"	sigma	eps	sigma	Δ-eps	Δ-sigma
1900	53.5	13.3	1.41	53.3	1.52	0.5	-7.3
1950	53.4	13.4	1.46	53.3	1.52	0.2	-4.1
2000	53.3	13.5	1.51	53.3	1.52	0.0	-0.8
2050	53.2	13.6	1.55	53.2	1.57	0.0	-1.1
2100	53.1	13.7	1.60	53.2	1.62	-0.1	-0.7
2150	53.0	13.8	1.65	53.1	1.66	-0.2	-0.9
2200	52.8	13.9	1.70	53.0	1.71	-0.4	-0.5
2250	52.7	14.0	1.76	53.0	1.76	-0.4	0.0
2300	52.6	14.2	1.82	52.9	1.81	-0.6	0.7
2350	52.4	14.4	1.88	52.8	1.85	-0.7	1.3
2400	52.3	14.5	1.94	52.8	1.90	-0.9	2.0
2450	52.2	14.7	2.00	52.7	1.95	-1.0	2.4
2500	52.0	14.8	2.05	52.6	2.02	-1.1	1.6
2550	52.0	14.8	2.10	52.6	2.09	-1.1	0.3
2600	51.8	15.0	2.17	52.5	2.16	-1.4	0.1
2650	51.6	15.1	2.23	52.4	2.23	-1.6	-0.3
2700	51.5	15.2	2.29	52.4	2.30	-1.8	-0.8
2750	51.2	15.3	2.34	52.3	2.38	-2.1	-1.5
2800	51.1	15.4	2.40	52.3	2.45	-2.2	-1.7
2850	50.9	15.6	2.47	52.2	2.52	-2.4	-2.0
2900	50.8	15.7	2.53	52.1	2.59	-2.5	-2.2
2950	50.7	15.8	2.59	52.1	2.66	-2.7	-2.8
3000	50.5	15.9	2.65	52.0	2.73	-2.8	-3.0
3050	50.4	16.0	2.71	51.9	2.79	-3.0	-2.9
3100	50.2	16.1	2.78	51.9	2.85	-3.2	-2.4
3150	50.1	16.2	2.85	51.8	2.91	-3.3	-2.0
3200	49.9	16.3	2.90	51.7	2.96	-3.6	-2.1
3250	49.8	16.5	2.98	51.7	3.02	-3.6	-1.5
3300	49.6	16.5	3.02	51.6	3.08	-3.8	-1.8
3350	49.5	16.6	3.09	51.5	3.14	-3.9	-1.5
3400	49.4	16.6	3.15	51.5	3.20	-4.0	-1.5
3450	49.2	16.7	3.21	51.4	3.26	-4.2	-1.4
3500	49.1	16.8	3.28	51.3	3.31	-4.3	-1.0
3550	48.9	16.9	3.34	51.3	3.37	-4.5	-0.9
3600	48.8	17.1	3.42	51.2	3.43	-4.6	-0.4
3650	48.7	17.1	3.47	51.1	3.49	-4.8	-0.5
3700	48.5	17.2	3.55	51.1	3.55	-4.9	0.0
3750	48.4	17.3	3.61	51.0	3.61	-5.0	0.0
3800	48.3	17.4	3.67	50.9	3.66	-5.1	0.1
3850	48.2	17.5	3.74	50.8	3.72	-5.2	0.5





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Zeughausstrasse 43, 8004 Zurich, Switzerland
Phone +41 44 245 9700, Fax +41 44 245 9779
info@speag.com, http://www.speag.com

Measurement Certificate / Material Test

Item Name	**Body Tissue Simulating Liquid (MBBL3500-5800V5)**
Product No.	SL AAM 501 EA (Charge: 140114-1)
Manufacturer	SPEAG

Measurement Method

TSL dielectric parameters measured using calibrated OCP probe.

Setup Validation

Validation results were within ± 2.5% towards the target values of Methanol.

Target Parameters

Target parameters as defined in the IEEE 1528 and IEC 62209 compliance standards.

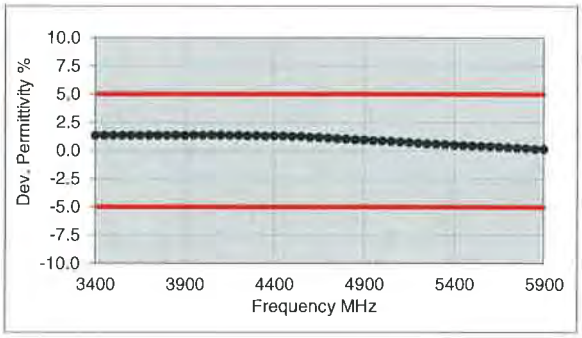
Test Condition

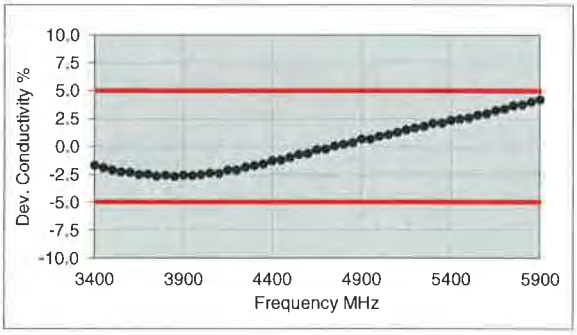
Ambient	Environment temperatur (22 ± 3)°C and humidity < 70%.
TSL Temperature	22°C
Test Date	15-Jan-14
Operator	IEN

Additional Information

TSL Density	0.996 g/cm3
TSL Heat-capacity	3.765 kJ/(kg*K)

	Measured			Target		Diff.to Target [%]	
f [MHz]	HP-e'	HP-e''	sigma	eps	sigma	Δ-eps	Δ-sigma
3400	52.2	16.63	3.14	51.5	3.20	1.4	-1.8
3500	**52.0**	**16.67**	**3.25**	**51.3**	**3.31**	**1.3**	**-1.9**
3600	51.9	16.74	3.35	51.2	3.43	1.4	-2.4
3700	**51.7**	**16.81**	**3.46**	**51.1**	**3.55**	**1.3**	**-2.5**
3800	51.6	16.90	3.57	50.9	3.66	1.3	-2.6
3900	51.5	16.99	3.69	50.8	3.78	1.4	-2.4
4000	51.3	17.08	3.80	50.6	3.90	1.3	-2.5
4100	51.2	17.18	3.92	50.5	4.01	1.4	-2.4
4200	51.1	17.32	4.05	50.4	4.13	1.4	-2.0
4300	50.9	17.47	4.18	50.2	4.25	1.3	-1.6
4400	50.8	17.61	4.31	50.1	4.37	1.4	-1.3
4500	50.6	17.73	4.44	50.0	4.48	1.3	-0.9
4600	50.4	17.86	4.57	49.8	4.60	1.1	-0.6
4700	50.3	18.00	4.71	49.7	4.72	1.2	-0.1
4800	50.1	18.14	4.84	49.6	4.83	1.1	0.2
4850	50.0	18.20	4.91	49.5	4.89	1.0	0.4
4900	49.9	18.28	4.98	49.4	4.95	1.0	0.6
4950	49.8	18.31	5.04	49.4	5.01	0.9	0.7
5000	49.7	18.38	5.11	49.3	5.07	0.8	0.9
5050	49.6	18.44	5.18	49.2	5.12	0.8	1.1
5100	49.5	18.50	5.25	49.2	5.18	0.7	1.3
5150	49.4	18.57	5.32	49.1	5.24	0.6	1.5
5200	**49.4**	**18.63**	**5.39**	**49.0**	**5.30**	**0.8**	**1.7**
5250	49.3	18.68	5.46	48.9	5.36	0.7	1.9
5300	49.2	18.75	5.53	48.9	5.42	0.7	2.1
5350	49.1	18.79	5.59	48.8	5.47	0.6	2.1
5400	49.0	18.86	5.66	48.7	5.53	0.5	2.3
5450	48.9	18.90	5.73	48.7	5.59	0.5	2.5
5500	**48.8**	**18.94**	**5.80**	**48.6**	**5.65**	**0.4**	**2.7**
5550	48.7	19.01	5.87	48.5	5.71	0.3	2.8
5600	48.7	19.06	5.94	48.5	5.77	0.5	3.0
5650	48.6	19.13	6.01	48.4	5.82	0.4	3.2
5700	48.5	19.18	6.08	48.3	5.88	0.3	3.3
5750	48.4	19.26	6.16	48.3	5.94	0.3	3.7
5800	**48.3**	**19.30**	**6.23**	**48.2**	**6.00**	**0.2**	**3.8**
5850	48.2	19.37	6.30	48.1	6.06	0.1	4.0
5900	48.1	19.43	6.38	48.1	6.12	0.1	4.3





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Schmid & Partner
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Accreditation No.: SCS 0108

Client UL CCS USA

Certificate No: EX3-3989_Feb16

CALIBRATION CERTIFICATE

Object: EX3DV4 - SN:3989

Calibration procedure(s): QA CAL-01.v9, QA CAL-14.v4, QA CAL-23.v5, QA CAL-25.v6
Calibration procedure for dosimetric E-field probes

Calibration date: February 23, 2016

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

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 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	01-Apr-15 (No. 217-02128)	Mar-16
Power sensor E4412A	MY41498087	01-Apr-15 (No. 217-02128)	Mar-16
Reference 3 dB Attenuator	SN: S5054 (3c)	01-Apr-15 (No. 217-02129)	Mar-16
Reference 20 dB Attenuator	SN: S5277 (20x)	01-Apr-15 (No. 217-02132)	Mar-16
Reference 30 dB Attenuator	SN: S5129 (30b)	01-Apr-15 (No. 217-02133)	Mar-16
Reference Probe ES3DV2	SN: 3013	31-Dec-15 (No. ES3-3013_Dec15)	Dec-16
DAE4	SN: 660	23-Dec-15 (No. DAE4-660_Dec15)	Dec-16
Secondary Standards	ID	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Apr-13)	In house check: Apr-16
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-15)	In house check: Oct-16

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

Issued: February 24, 2016

Calibration Laboratory of
Schmid & Partner
Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland

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Accreditation No.: SCS 0108

Glossary:

TSL	tissue simulating liquid
NORMx,y,z	sensitivity in free space
ConvF	sensitivity in TSL / NORMx,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., ϑ = 0 is normal to probe axis
Connector Angle	information used in DASY system to align probe sensor X to the robot coordinate system

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, "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
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"

Methods Applied and Interpretation of Parameters:

- *NORMx,y,z:* Assessed for E-field polarization ϑ = 0 (f ≤ 900 MHz in TEM-cell; f > 1800 MHz: R22 waveguide). NORMx,y,z are only intermediate values, i.e., the uncertainties of NORMx,y,z does not affect the E^2-field uncertainty inside TSL (see below *ConvF*).
- *NORM(f)x,y,z = NORMx,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*.
- *DCPx,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
- *Ax,y,z; Bx,y,z; Cx,y,z; Dx,y,z; VRx,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 ≤ 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 *NORMx,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.
- *Connector Angle*: The angle is assessed using the information gained by determining the *NORMx* (no uncertainty required).

Probe EX3DV4

SN:3989

Manufactured: November 11, 2013
Calibrated: February 23, 2016

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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3989

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu V/(V/m)^2$)[A]	0.56	0.53	0.49	± 10.1 %
DCP (mV)[B]	98.9	97.6	98.8	

Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB√μV	C	D dB	VR mV	Unc[E] (k=2)
0	CW	X	0.0	0.0	1.0	0.00	128.6	±3.0 %
		Y	0.0	0.0	1.0		146.1	
		Z	0.0	0.0	1.0		136.4	

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 Norm X,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:3989

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unc (k=2)
750	41.9	0.89	10.35	10.35	10.35	0.52	0.80	± 12.0 %
900	41.5	0.97	9.84	9.84	9.84	0.38	0.92	± 12.0 %
1750	40.1	1.37	8.75	8.75	8.75	0.35	0.85	± 12.0 %
1900	40.0	1.40	8.43	8.43	8.43	0.32	0.88	± 12.0 %
2300	39.5	1.67	8.00	8.00	8.00	0.34	0.85	± 12.0 %
2450	39.2	1.80	7.66	7.66	7.66	0.37	0.87	± 12.0 %
2600	39.0	1.96	7.41	7.41	7.41	0.47	0.81	± 12.0 %
5250	35.9	4.71	5.38	5.38	5.38	0.35	1.80	± 13.1 %
5600	35.5	5.07	4.86	4.86	4.86	0.40	1.80	± 13.1 %
5750	35.4	5.22	4.82	4.82	4.82	0.45	1.80	± 13.1 %

[C] Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.

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

[G] Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3989

Calibration Parameter Determined in Body Tissue Simulating Media

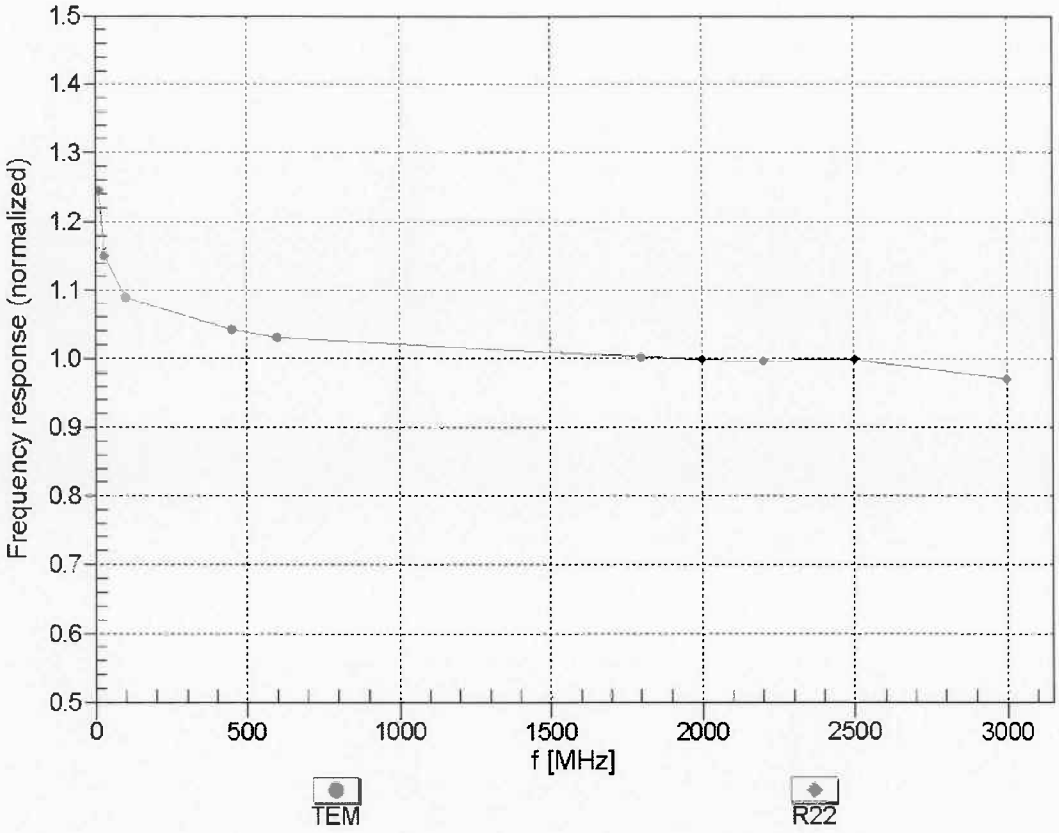
f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unc (k=2)
750	55.5	0.96	10.09	10.09	10.09	0.38	0.95	± 12.0 %
900	55.0	1.05	10.01	10.01	10.01	0.30	1.10	± 12.0 %
1750	53.4	1.49	8.36	8.36	8.36	0.46	0.80	± 12.0 %
1900	53.3	1.52	8.05	8.05	8.05	0.43	0.80	± 12.0 %
2300	52.9	1.81	7.76	7.76	7.76	0.45	0.84	± 12.0 %
2450	52.7	1.95	7.65	7.65	7.65	0.37	0.88	± 12.0 %
2600	52.5	2.16	7.32	7.32	7.32	0.30	0.95	± 12.0 %
5250	48.9	5.36	4.56	4.56	4.56	0.50	1.90	± 13.1 %
5600	48.5	5.77	3.85	3.85	3.85	0.60	1.90	± 13.1 %
5750	48.3	5.94	4.15	4.15	4.15	0.60	1.90	± 13.1 %

[C] Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.

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

[G] Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

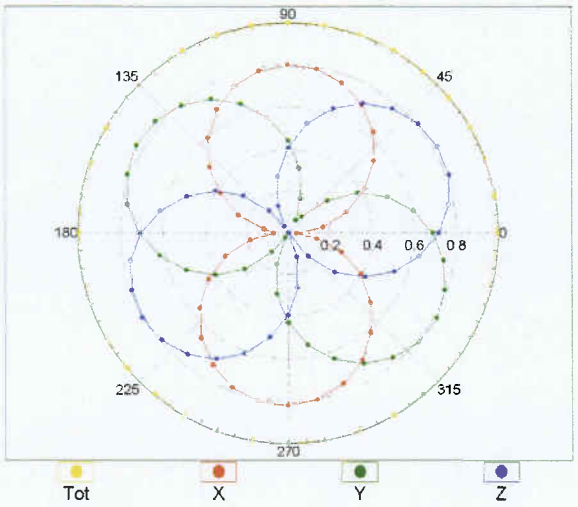
Frequency Response of E-Field
(TEM-Cell:ifi110 EXX, Waveguide: R22)



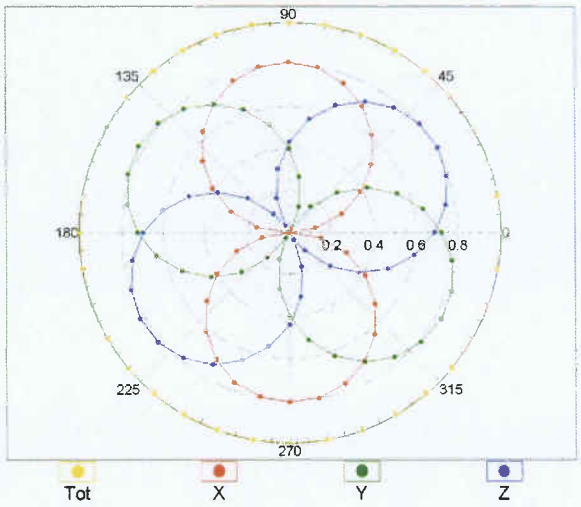
Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

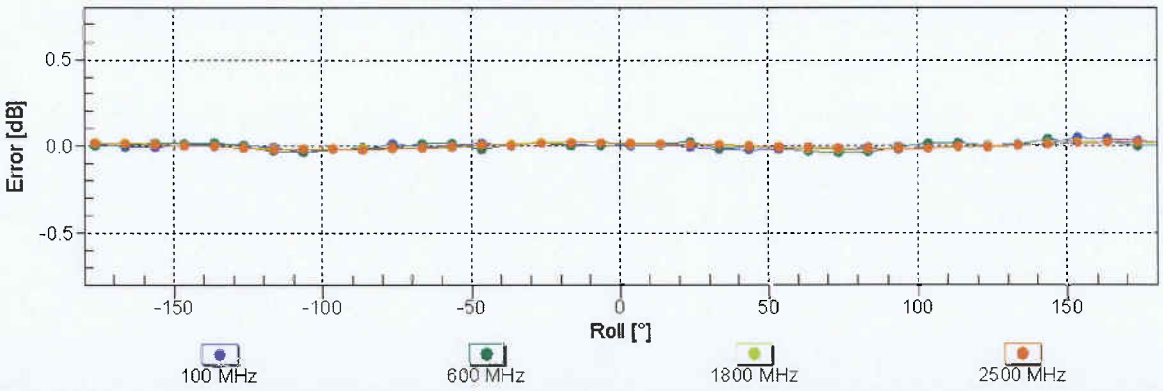
Receiving Pattern (ϕ), ϑ = 0°

f=600 MHz,TEM



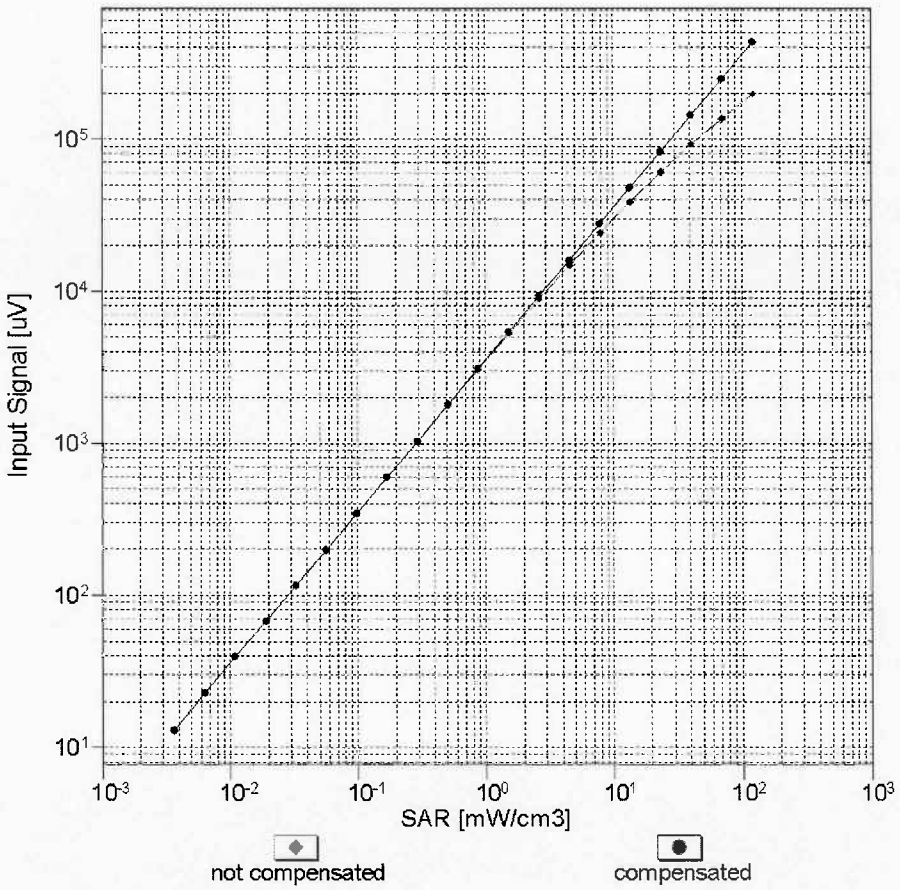
f=1800 MHz,R22

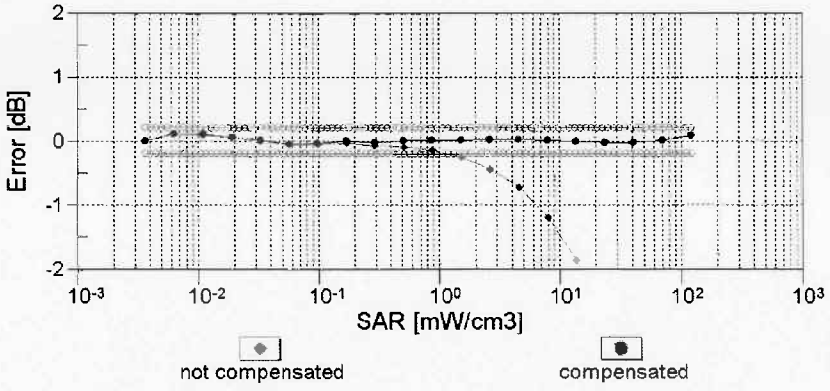




Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

Dynamic Range f(SAR$_{head}$)
(TEM cell , f_{eval}= 1900 MHz)

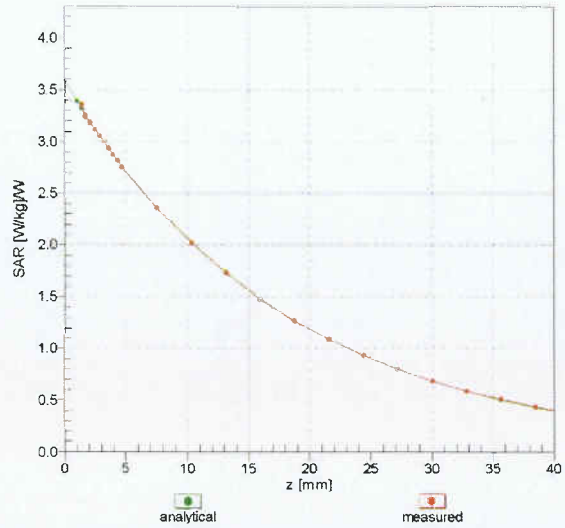




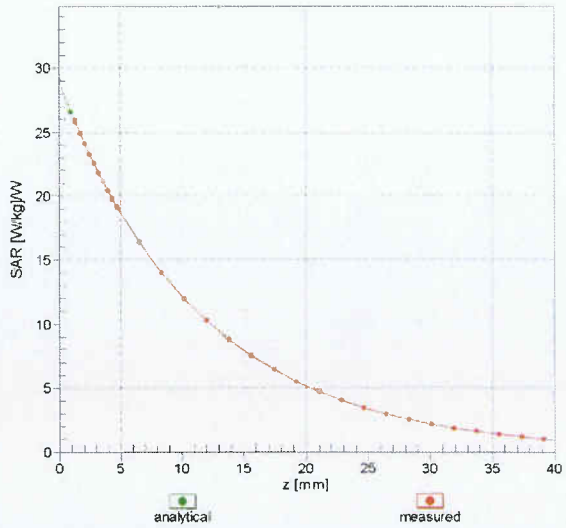
Uncertainty of Linearity Assessment: ± 0.6% (k=2)

Conversion Factor Assessment

f = 900 MHz,WGLS R9 (H_convF)

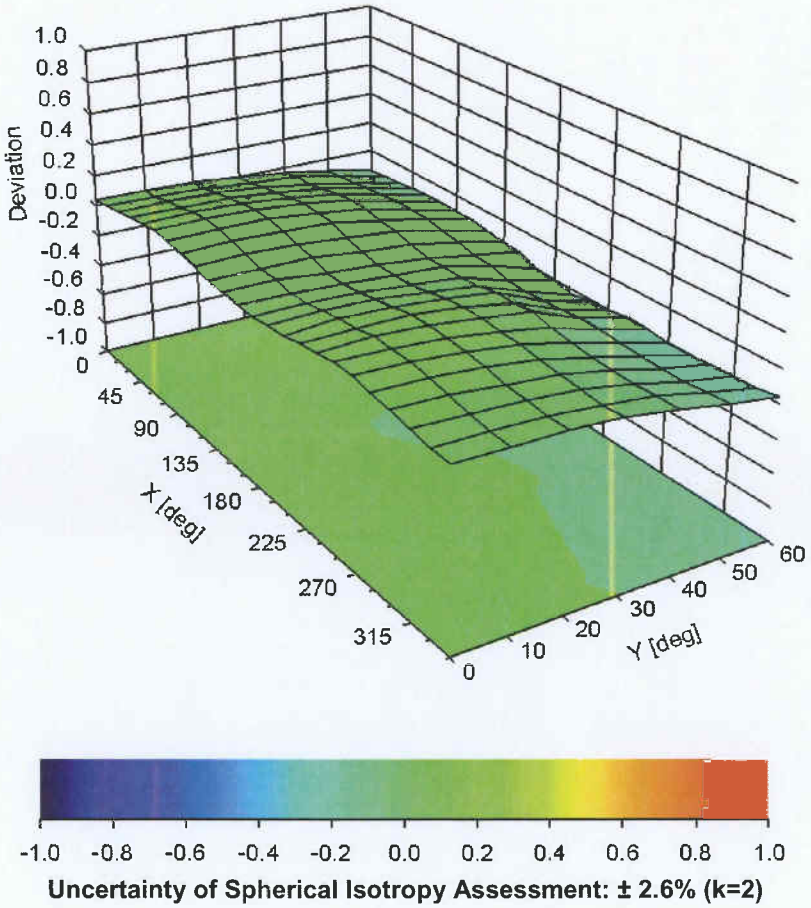


f = 1900 MHz,WGLS R22 (H_convF)



Deviation from Isotropy in Liquid

Error (ϕ, ϑ), f = 900 MHz



Uncertainty of Spherical Isotropy Assessment: ± 2.6% (k=2)

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3989

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	83.5
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	1.4 mm

Calibration Laboratory of
Schmid & Partner
Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland

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

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

Accreditation No.: SCS 0108

Client UL CCS USA

Certificate No: D2450V2-748_Feb16

CALIBRATION CERTIFICATE

Object	D2450V2 - SN: 748
Calibration procedure(s)	QA CAL-05.v9 Calibration procedure for dipole validation kits above 700 MHz
Calibration date:	February 22, 2016

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

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 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	07-Oct-15 (No. 217-02222)	Oct-16
Power sensor HP 8481A	US37292783	07-Oct-15 (No. 217-02222)	Oct-16
Power sensor HP 8481A	MY41092317	07-Oct-15 (No. 217-02223)	Oct-16
Reference 20 dB Attenuator	SN: 5058 (20k)	01-Apr-15 (No. 217-02131)	Mar-16
Type-N mismatch combination	SN: 5047.2 / 06327	01-Apr-15 (No. 217-02134)	Mar-16
Reference Probe EX3DV4	SN: 7349	31-Dec-15 (No. EX3-7349_Dec15)	Dec-16
DAE4	SN: 601	30-Dec-15 (No. DAE4-601_Dec15)	Dec-16

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator R&S SMT-06	100972	15-Jun-15 (in house check Jun-15)	In house check: Jun-18
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-15)	In house check: Oct-16

	Name	Function	Signature
Calibrated by:	Claudio Leubler	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: February 25, 2016

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, "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
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	V52.8.8
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5.0 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	38.7 ± 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	12.9 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**50.9 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	250 mW input power	5.98 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**23.7 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	52.9 ± 6 %	2.00 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	12.6 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**49.8 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.84 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**23.2 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	54.7 Ω + 0.2 jΩ
Return Loss	- 26.9 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	50.6 Ω + 2.5 jΩ
Return Loss	- 31.7 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.156 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 01, 2003

Appendix (Additional assessments outside the scope of SCS 0108)

Measurement Conditions

DASY system configuration, as far as not given on page 1 and 3.

Phantom	SAM Head Phantom	For usage with cSAR3DV1-R/L

SAR result with SAM Head (Top)

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.6 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**54.0 W/kg ± 17.5 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.35 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**25.3 W/kg ± 16.9 % (k=2)**

SAR result with SAM Head (Mouth)

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	14.0 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**55.6 W/kg ± 17.5 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.64 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**26.4 W/kg ± 16.9 % (k=2)**

SAR result with SAM Head (Neck)

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.4 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**53.2 W/kg ± 17.5 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.24 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**24.9 W/kg ± 16.9 % (k=2)**

SAR result with SAM Head (Ear)

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	8.66 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**34.4 W/kg ± 17.5 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	250 mW input power	4.32 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**17.2 W/kg ± 16.9 % (k=2)**

Date: 18.02.2016

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 748

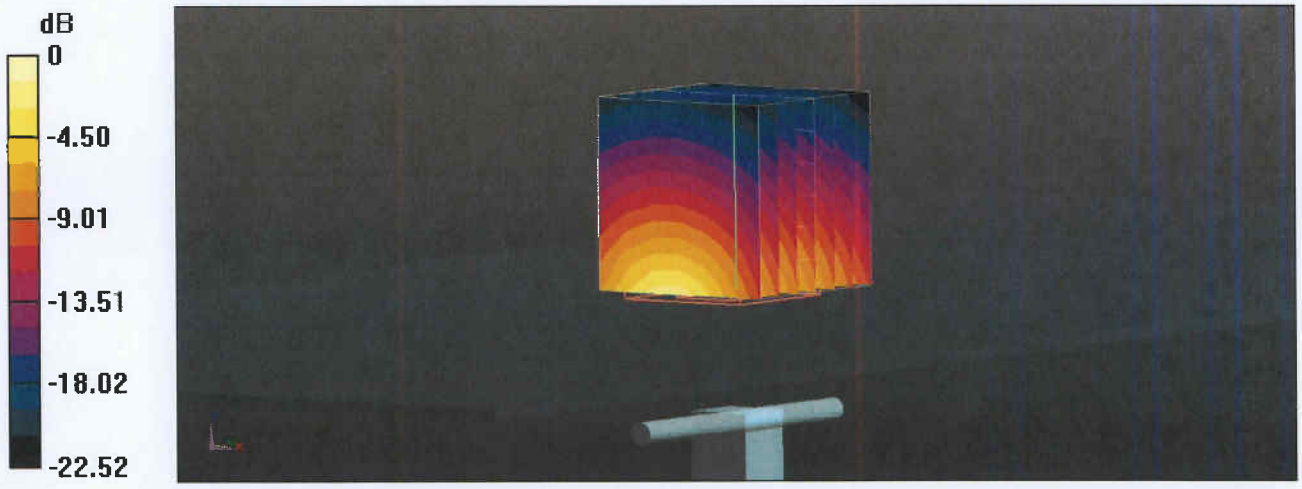
Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; σ = 1.84 S/m; ε_r = 38.7; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.76, 7.76, 7.76); Calibrated: 31.12.2015;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

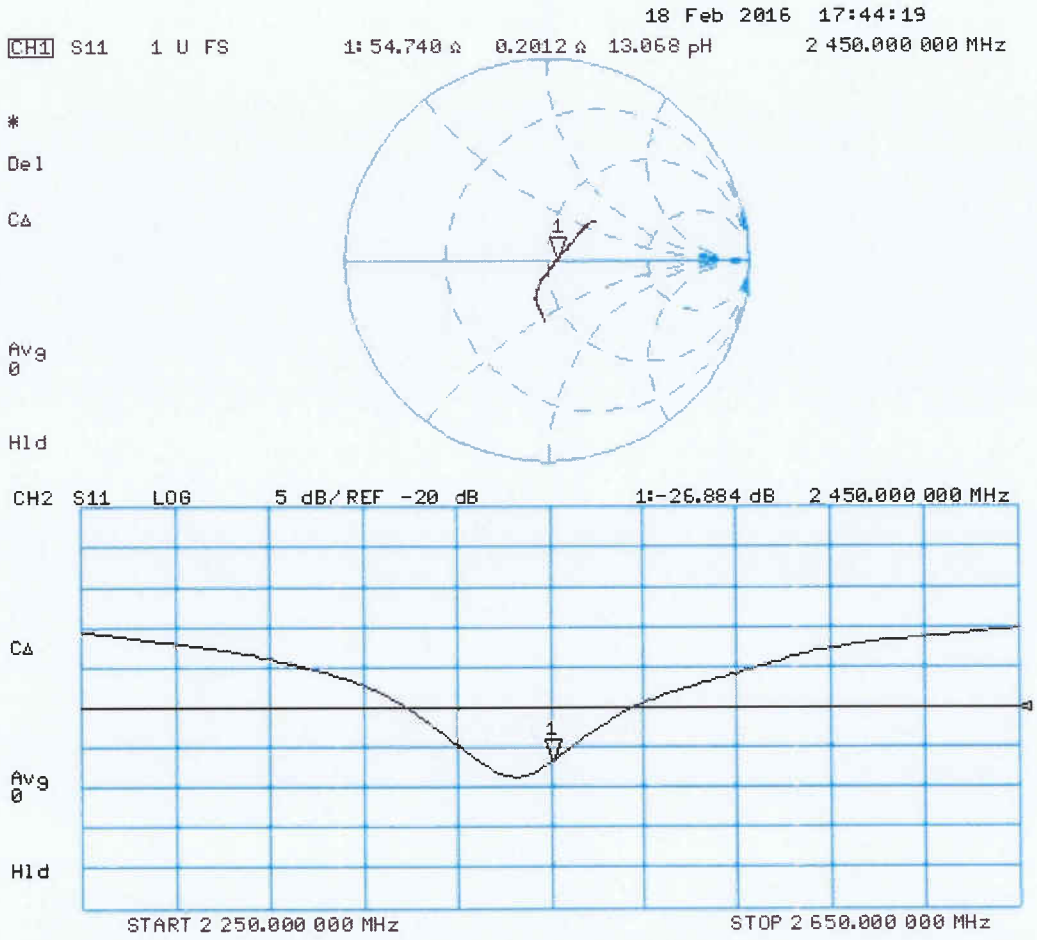
Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 110.2 V/m; Power Drift = 0.06 dB
Peak SAR (extrapolated) = 25.7 W/kg
SAR(1 g) = 12.9 W/kg; SAR(10 g) = 5.98 W/kg
Maximum value of SAR (measured) = 20.2 W/kg



0 dB = 20.2 W/kg = 13.05 dBW/kg

Impedance Measurement Plot for Head TSL



Date: 18.02.2016

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 748

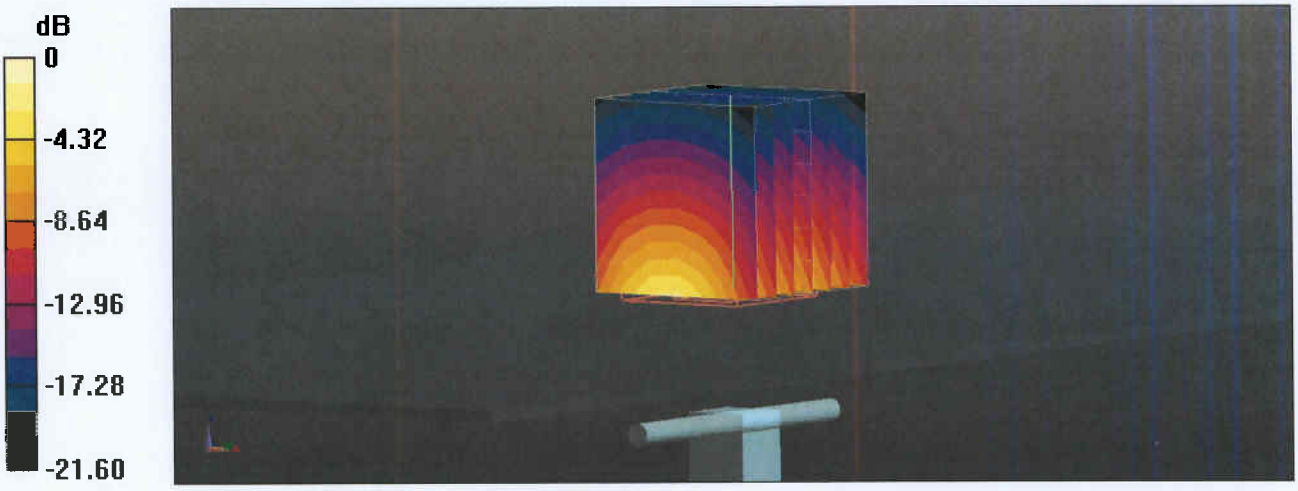
Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; σ = 2 S/m; ε_r = 52.9; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.79, 7.79, 7.79); Calibrated: 31.12.2015;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

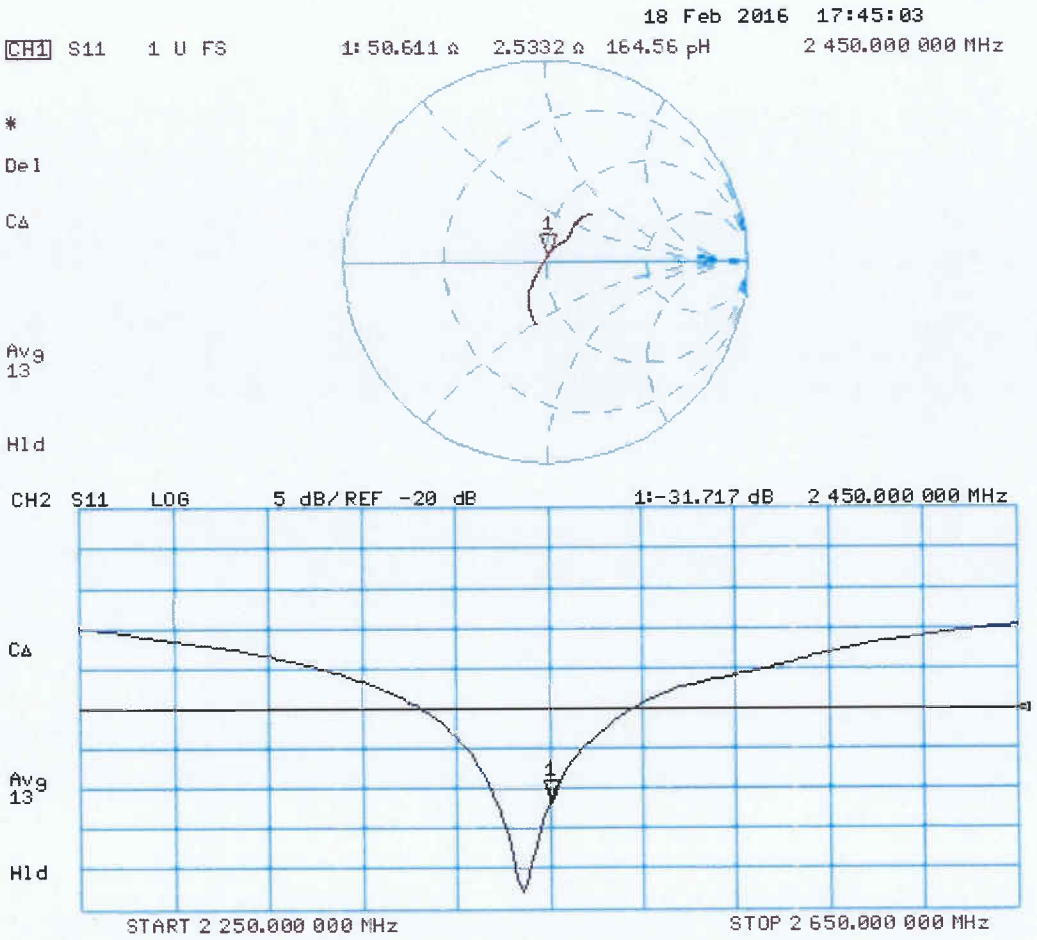
Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 104.5 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 24.9 W/kg
SAR(1 g) = 12.6 W/kg; SAR(10 g) = 5.84 W/kg
Maximum value of SAR (measured) = 20.1 W/kg



0 dB = 20.1 W/kg = 13.03 dBW/kg

Impedance Measurement Plot for Body TSL



DASY5 Validation Report for SAM Head

Date: 22.02.2016

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 748

Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; σ = 1.83 S/m; ε_r = 39.2; ρ = 1000 kg/m^3
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

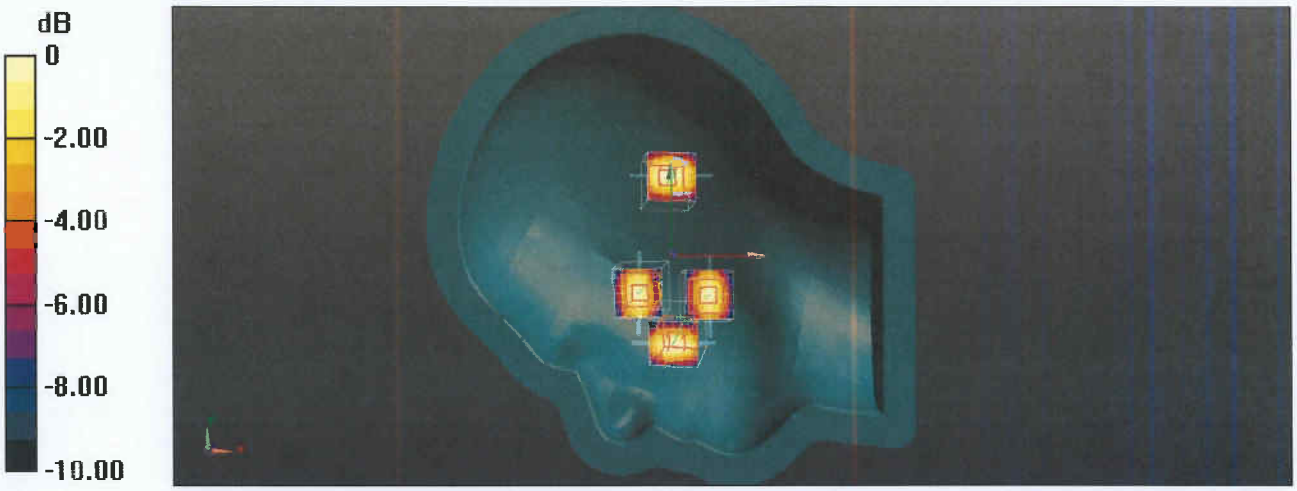
- Probe: EX3DV4 - SN7349; ConvF(7.76, 7.76, 7.76); Calibrated: 31.12.2015;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom: Type: SAM Head
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7372)

SAM/Head/Top/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 116.0 V/m; Power Drift = -0.00 dB
Peak SAR (extrapolated) = 26.6 W/kg
SAR(1 g) = 13.6 W/kg; SAR(10 g) = 6.35 W/kg
Maximum value of SAR (measured) = 22.1 W/kg

SAM/Head/Mouth/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 116.0 V/m; Power Drift = 0.02 dB
Peak SAR (extrapolated) = 26.8 W/kg
SAR(1 g) = 14 W/kg; SAR(10 g) = 6.64 W/kg
Maximum value of SAR (measured) = 22.3 W/kg

SAM/Head/Neck/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 114.5 V/m; Power Drift = 0.03 dB
Peak SAR (extrapolated) = 25.9 W/kg
SAR(1 g) = 13.4 W/kg; SAR(10 g) = 6.24 W/kg
Maximum value of SAR (measured) = 21.9 W/kg

SAM/Head/Ear/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 89.53 V/m; Power Drift = 0.00 dB
Peak SAR (extrapolated) = 15.9 W/kg
SAR(1 g) = 8.66 W/kg; SAR(10 g) = 4.32 W/kg
Maximum value of SAR (measured) = 13.2 W/kg



0 dB = 22.1 W/kg = 13.44 dBW/kg