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Body SAR Test Report

Report Number: M160544

Test Sample: Cellsafe Lif3 for Samsung Galaxy S7 Edge and Apple iPhone 6 phones

Phone Types: Samsung Galaxy S7 Edge, and Apple iPhone 6

Tested For: Cellsafe Pty Ltd

Date of Issue: 22nd June 2016

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Accreditation No. 5292

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Body SAR Test Report
Cellsafe Lif3 for Samsung Galaxy S7 Edge and Apple iPhone 6 phones,
Type: Samsung Galaxy S7 Edge, Apple iPhone 6 **Report Number:** M160544

1.0 GENERAL INFORMATION

Test Sample: Cellsafe Lif3 for Samsung Galaxy S7 Edge and Apple iPhone 6 phones

Type:	Samsung Galaxy S7 Edge	IPhone 6
Serial Number:	R28H32JAVSP	C39NX1YRG5MW
Model Number:	SM-G9350	A1586

Manufacturer: Samsung Electronics, and Apple Inc

Device Category: Portable Transmitter
Test Device: Production Unit
RF exposure Category: General Public/Unaware user

Tested for: Cellsafe Pty Ltd
Address: 14/1866 Princes Hwy, Clayton, Vic 3168
Contact: Nicole Bennett
Phone: +61 3 9544 4886
Email: sales@cellsafe.com.au

Test Standard/s:

1. Maximum Exposure Levels to Lif3ofrequency Fields – 3kHz to 300GHz, ARPANSA
2. **EN 62209-1:2006 and EN 62209-2:2010**
   Human exposure to Lif3o frequency fields from hand-held and body-mounted devices-Human models, instrumentation and procedures.
   Part 1: Procedure to determine the specific absorption rate (SAR) for hand- held devices used in close proximity to the ear (frequency range 300 MHz to 3 GHz)
   Part 2: Procedure to determine the specific absorption rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz

Results Statement: The Cellsafe Lif3 for Samsung Galaxy S7 Edge and Apple iPhone 6 phones, Types: Samsung Galaxy S7 Edge, Apple iPhone 6, was tested according to EN 50360, New Zealand and Australian Communications and Media Authority requirements for human exposure to radio frequencies. The Cellsafe Lif3 device was found to decrease SAR in the configurations described in this report by up to 78%.

Test Dates: 8th of June 2016

Test Officer: [signature]
Peter Jakubiec

Authorised Signature: [signature]
Chris Zombolas
Technical Director

2.0 DESCRIPTION OF DEVICE

2.1 Description of Test Sample

The devices tested were Samsung Galaxy S7 Edge and Apple iPhone 6 mobile phones fitted with Cellsafe Lif3 RF reduction chip, and they were tested in the 1900 MHz WCDMA frequency band. They will be referred to as the Devices Under Test (DUT) throughout this report. The DUTs were tested in the Body back of phone positions.

Table: DUT (Device Under Test) Parameters

Operating Mode During Testing	:See Clause 2.3
Operating Mode Production Sample	: UMTS
Modulation:	: QPSK
Antenna type	: Internal
Applicable Head Configurations	: None
Applicable Body Worn-Configurations	: Body back
Battery Options	: Internal non removable Li-ion

2.2 Test sample Accessories

2.2.1 Battery Types

SAR measurements were performed with the standard Li-ion battery.

2.3 Test Signal, Frequency and Output Power

The DUTs were provided by Cellsafe Pty Ltd and put into operation using a Rhodes & Schwarz Communication Tester CMU200. The channels and power classes utilised in the measurements are listed in the tables below.

The SAR level of the test sample was measured for the frequency bands as shown in the table below. Communication between the tester and the DUT was maintained by an air link.

Table: Test Frequencies and Power Classes

Band	Frequency (MHz)			Traffic Channels			Band Power Class	Nominal Power (dBm)
	Low	Mid	High	Low	Mid	High		
UMTS Band 2	N/A	1880.0	N/A	N/A	9400	N/A	3	24

2.4 Conducted Power Measurements

The conducted power of the DUT was not measured because the devices do not have an accessible RF test port.

2.5 Battery Status

The DUT battery was fully charged prior to commencement of each measurement. The battery condition was monitored by measuring the RF power at a defined position inside the phantom before the commencement of each test and again after the completion of the test.

2.6 Details of Test Laboratory

2.6.1 Location

EMC Technologies Pty Ltd
176 Harrick Road
Keilor Park, (Melbourne) Victoria
Australia 3042

Telephone: +61 3 9365 1000
Facsimile: +61 3 9331 7455
email: melb@emctech.com.au
website: www.emctech.com.au

2.6.2 Accreditations

EMC Technologies Pty. Ltd. is accredited by the National Association of Testing Authorities, Australia (NATA). **NATA Accredited Laboratory Number: 5292**
Last assessed in February 2014, next scheduled assessment in February 2017

EMC Technologies Pty Ltd is NATA accredited for the following RF Human Exposure standards:

AS/NZS 2772.2 2011:	Lif3ofrequency Fields. **Part 2:** Principles and methods of measurement and computation - 3kHz to 300 GHz.
ACMA:	Radiocommunications (Electromagnetic Radiation — Human Exposure) Standard
EN 50360: 2001	Product standard to demonstrate the compliance of Mobile Phones with the basic restrictions related to human exposure to electromagnetic fields (300 MHz – 3 GHz)
EN 62209-1:2006	Human exposure to Lif3o frequency fields from hand-held and body-mounted devices-Human models, instrumentation and procedures. **Part 1:** Procedure to determine the specific absorption rate (SAR) for hand-held devices used in close proximity to the ear (frequency range 300 MHz to 3 GHz)
EN 62209-2:2010	Human Exposure to Lif3o frequency fields from hand-held and body-mounted wireless communication devices - Human models instrumentation and procedures **Part 2:** Procedure to determine the specific absorption rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz
IEEE 1528: 2013	Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head Due to Wireless Communications Devices: Measurement Techniques.

Refer to NATA website www.nata.asn.au for the full scope of accreditation.

2.6.3 Environmental Factors

The measurements were performed in a shielded room with no background RF signals. The temperature in the laboratory was controlled to within 21± 1 °C, the humidity was 45%. See section 3.1.2 for measured temperature and humidity. The liquid parameters were measured daily prior to the commencement of each test. Tests were performed to check that reflections within the environment did not influence the SAR measurements. The noise floor of the DASY5 SAR measurement system using the ET3DV6 E-field probe is less than 5µV in both air and liquid mediums.

3.0 CALIBRATION AND VERIFICATION PROCEDURES AND DATA

Prior to the SAR assessment, the system verification kit was used to verify that the DASY5 was operating within its specifications. The system check was performed at the frequencies listed below using the SPEAG calibrated dipoles. The reference dipoles are highly symmetric and matched at the centre frequency for the specified liquid and distance to the phantom. The accurate distance between the liquid surface and the dipole centre is achieved with a distance holder that snaps onto the dipole. System verification is performed by feeding a known power level into a reference dipole, set at a known distance from the phantom. The measured SAR is compared to the theoretically derived level, and must be within ±10%.

3.1.1 Deviation from reference values

The EN62209 reference SAR values are derived numerically for a given phantom and dipole construction, at the frequencies listed below. These reference SAR values are obtained from the EN62209 standard and are normalized to 1W.

The SPEAG calibration reference SAR value is the SAR validation result obtained in a specific dielectric liquid using the verification dipole during calibration. The measured ten-gram SAR should be within ±10% of the expected target reference values shown in table below.

Table: Deviation from reference validation values

Date	Frequency (MHz)	Measured SAR 10g (input power = 250mW)	Measured SAR 10g (Normalized to 1W)	SPEAG Calibration Reference SAR Value 10g (mW/g)	Deviation From SPEAG 10g (%)	EN62209 Reference SAR Value 10g (mW/g)	Deviation From EN62209 10g (%)
19th June 16	1800	5.09	20.36	20.1	1.29	20.1	1.29

Note: All reference SAR values are normalized to 1W input power.

3.1.2 Temperature and Humidity

The humidity and dielectric/ambient temperatures are recorded during the assessment of the tissue material dielectric parameters. The difference between the ambient temperature of the liquid during the dielectric measurement and the temperature during tests was less than |2|°C.

Table: Temperature and Humidity recorded for each day

Date	Ambient Temperature (°C)	Liquid Temperature (°C)	Humidity (%)
8th June 2016	21.5	21.2	45

4.0 SAR MEASUREMENT PROCEDURE USING DASY5

The SAR evaluation was performed with the SPEAG DASY5 System (**Version 52**). A summary of the procedure follows:

a) A measurement of the SAR value at a fixed location is used as a reference value for assessing the power drop of the DUT. The SAR at this point is measured at the start of the test and then again at the end of the test.

b) The SAR distribution at the exposed side of the head or the flat section of the flat phantom is measured at a distance of 4.0 mm from the inner surface of the shell. The area covers the entire dimension of the DUT and the horizontal grid spacing is 15 mm x 15 mm. The actual largest Area Scan has dimensions of 120 mm x 210 mm surrounding the test device. Based on this data, the area of the maximum absorption is determined by Spline interpolation.

c) Around this point, a volume of 32 mm x 32 mm x 30 mm is assessed by measuring 5 x 5 x 7 points. On the basis of this data set, the spatial peak SAR value is evaluated with the following procedure:

(i) The data at the surface are extrapolated, since the centre of the dipoles is 2.7 mm away from the tip of the probe and the distance between the surface and the lowest measuring point is 4 mm. The extrapolation is based on a least square algorithm. A polynomial of the fourth order is calculated through the points in z-axes. This polynomial is then used to evaluate the points between the surface and the probe tip.

(ii) The maximum interpolated value is searched with a straightforward algorithm. Around this maximum the SAR values averaged over the spatial volumes (1 g and 10 g) are computed using the 3D-Spline interpolation algorithm. The 3D-Spline is composed of three one-dimensional splines with the “Not a knot”- condition (in x, y and z-direction). The volume is integrated with the trapezoidal – algorithm. One thousand points (10 x 10 x 10) are interpolated to calculate the averages.

(iii) All neighbouring volumes are evaluated until no neighbouring volume with a higher average value is found.

(iv) The SAR value at the same location as in Step (a) is again measured and the power drift is recorded.

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5.0 MEASUREMENT UNCERTAINTY

The uncertainty analysis is based on the template listed in the EN 62209-1 and EN62209-2 for both Handset SAR tests and Validation uncertainty. The measurement uncertainty of a specific device is evaluated independently and the total uncertainty for both evaluations (95% confidence level) must be less than 30%.

Table: Uncertainty Budget for DASY5 Version 52 – DUT SAR test

Error Description	Uncert. Value	Prob. Dist.	Div.	C_i (1g)	C_i (10g)	1g u_i	10g u_i	v_i
Measurement System								
Probe Calibration	6	N	1.00	1	1	6.00	6.00	∞
Axial Isotropy	4.7	R	1.73	0.7	0.7	1.90	1.90	∞
Hemispherical Isotropy	9.6	R	1.73	0.7	0.7	3.88	3.88	∞
Boundary Effects	1	R	1.73	1	1	0.58	0.58	∞
Linearity	4.7	R	1.73	1	1	2.71	2.71	∞
System Detection Limits	1	R	1.73	1	1	0.58	0.58	∞
Modulation response	2.4	R	1.73	1	1	1.39	1.39	∞
Readout Electronics	0.3	N	1.00	1	1	0.30	0.30	∞
Response Time	0.8	R	1.73	1	1	0.46	0.46	∞
Integration Time	2.6	R	1.73	1	1	1.50	1.50	∞
RF Ambient Noise	3	R	1.73	1	1	1.73	1.73	∞
RF Ambient Reflections	3	R	1.73	1	1	1.73	1.73	∞
Probe Positioner	0.4	R	1.73	1	1	0.23	0.23	∞
Probe Positioning	2.9	R	1.73	1	1	1.67	1.67	∞
Post Processing	2	R	1.73	1	1	1.15	1.15	∞
Test Sample Related								
Power Scaling	0	R	1.73	1	1	0.00	0.00	∞
Test Sample Positioning	2.9	N	1.00	1	1	2.90	2.90	145
Device Holder Uncertainty	3.6	N	1.00	1	1	3.60	3.60	∞
Output Power Variation – SAR Drift Measurement	2.73	R	1.73	1	1	1.57	1.57	∞
Phantom and Setup								
Phantom Uncertainty	7.6	R	1.73	1	1	4.39	4.39	∞
Liquid Conductivity – Deviation from target values	5	R	1.73	0.64	0.43	1.85	1.24	∞
Liquid Permittivity – Deviation from target values	5	R	1.73	0.6	0.49	1.73	1.41	∞
Liquid Conductivity – Measurement uncertainty	2.5	N	1.00	0.64	0.43	1.60	1.08	∞
Liquid Permittivity – Measurement uncertainty	2.5	N	1.00	0.6	0.49	1.50	1.23	∞
Temp.unc. - Conductivity	3.4	R	1.73	0.78	0.71	1.53	1.39	∞
Temp. unc. - Permittivity	0.4	R	1.73	0.23	0.26	0.05	0.06	∞
Combined standard Uncertainty (u_c)						11.58	11.34	
Expanded Uncertainty (95% CONFIDENCE LEVEL)			k=	2		23.15	22.68	

Estimated total measurement uncertainty for the DASY5 measurement system was ±11.34%. The expanded uncertainty (K = 2) was assessed to be ±22.68% based on 95% confidence level. The uncertainty is not added to the measurement result.

Table: Uncertainty Budget for DASY5 Version 52 – Validation

Error Description	Uncert. Value	Prob. Dist.	Div.	C_i (1g)	C_i (10g)	1g u_i	10g u_i	v_i
Measurement System								
Probe Calibration	6	N	1.00	1	1	6.00	6.00	∞
Axial Isotropy	4.7	R	1.73	1	1	2.71	2.71	∞
Hemispherical Isotropy	9.6	R	1.73	0	0	0.00	0.00	∞
Boundary Effects	1	R	1.73	1	1	0.58	0.58	∞
Linearity	4.7	R	1.73	1	1	2.71	2.71	∞
System Detection Limits	1	R	1.73	1	1	0.58	0.58	∞
Modulation response	0	R	1.73	1	1	0.00	0.00	∞
Readout Electronics	0.3	N	1.00	1	1	0.30	0.30	∞
Response Time	0	R	1.73	1	1	0.00	0.00	∞
Integration Time	0	R	1.73	1	1	0.00	0.00	∞
RF Ambient Noise	1	R	1.73	1	1	0.58	0.58	∞
RF Ambient Reflections	1	R	1.73	1	1	0.58	0.58	∞
Probe Positioner	0.8	R	1.73	1	1	0.46	0.46	∞
Probe Positioning	6.7	R	1.73	1	1	3.87	3.87	∞
Post Processing	2	R	1.73	1	1	1.15	1.15	∞
Dipole Related								
Deviation of exp. dipole	5.5	R	1.73	1	1	3.18	3.18	∞
Dipole Axis to Liquid Dist.	2	R	1.73	1	1	1.15	1.15	∞
Input power & SAR drift	3.40	R	1.73	1	1	1.96	1.96	∞
Phantom and Setup								
Phantom Uncertainty	4	R	1.73	1	1	2.31	2.31	∞
Liquid Conductivity – Deviation from target values	5	R	1.73	0.64	0.43	1.85	1.24	∞
Liquid Permittivity – Deviation from target values	5	R	1.73	0.6	0.49	1.73	1.41	∞
Liquid Conductivity – Measurement uncertainty	2.5	N	1.00	0.64	0.43	1.60	1.08	∞
Liquid Permittivity – Measurement uncertainty	2.5	N	1.00	0.26	0.26	0.65	0.65	∞
Temp.unc. - Conductivity	3.4	R	1.73	0.78	0.71	1.53	1.39	∞
Temp. unc. - Permittivity	0.4	R	1.73	0.23	0.26	0.05	0.06	∞
Combined standard Uncertainty (u_c)						10.05	9.81	
Expanded Uncertainty (95% CONFIDENCE LEVEL)			k=	2		20.10	19.63	

Estimated total measurement uncertainty for the DASY5 measurement system was ±9.81%. The expanded uncertainty (K = 2) was assessed to be ±19.63% based on 95% confidence level. The uncertainty is not added to the Validation measurement result.

6.0 EQUIPMENT LIST AND CALIBRATION DETAILS

Table: SPEAG DASY5 Version 52

Equipment Type	Manufacturer	Model Number	Serial Number	Calibration Due	Used For this Test?
Robot - Six Axes	Staubli	RX90BL	N/A	Not applicable	✓
Robot Remote Control	SPEAG	CS7MB	RX90B	Not applicable	✓
SAM Phantom	SPEAG	N/A	1260	Not applicable	
SAM Phantom	SPEAG	N/A	1060	Not applicable	✓
Flat Phantom	AndreT	10.1	P 10.1	Not Applicable	
Flat Phantom	AndreT	9.1	P 9.1	Not Applicable	
Flat Phantom	SPEAG	ELI 4.0	1101	Not Applicable	
Data Acquisition Electronics	SPEAG	DAE3 V1	359	11-Jan-2017	
Data Acquisition Electronics	SPEAG	DAE3 V1	442	07-Dec-2016	✓
Probe E-Field - Dummy	SPEAG	DP1	N/A	Not applicable	
Probe E-Field	SPEAG	ET3DV6	1380	10-Dec-2016	✓
Probe E-Field	SPEAG	ET3DV6	1377	11-June-2016	
Probe E-Field	SPEAG	ES3DV6	3029	Not Used	
Probe E-Field	SPEAG	EX3DV4	3956	15-June-2016	
Probe E-Field	SPEAG	EX3DV4	7358	11-Dec-2016	
Validation Source 150 MHz	SPEAG	CLA150	4003	3-Dec-2016	
Antenna Dipole 300 MHz	SPEAG	D300V3	1012	09-Dec-2016	
Antenna Dipole 450 MHz	SPEAG	D450V3	1074	09-Dec-2016	
Antenna Dipole 600 MHz	SPEAG	D600V3	1008	16-Oct-2018	
Antenna Dipole 750 MHz	SPEAG	D750V2	1051	13-Dec-2016	
Antenna Dipole 900 MHz	SPEAG	D900V2	047	09-Dec-2017	
Antenna Dipole 1640 MHz	SPEAG	D1640V2	314	05-Dec-2017	
Antenna Dipole 1800 MHz	SPEAG	D1800V2	242	05-Dec-2017	✓
Antenna Dipole 1950 MHz	SPEAG	D1950V3	1113	09-Dec-2016	
Antenna Dipole 2300 MHz	SPEAG	D2300V2	1032	10-Dec-2016	
Antenna Dipole 2450 MHz	SPEAG	D2450V2	724	10-Dec-2016	
Antenna Dipole 2600 MHz	SPEAG	D2600V2	1044	13-Dec-2016	
Antenna Dipole 3500 MHz	SPEAG	D3500V2	1002	13-July-2013	
Antenna Dipole 5600 MHz	SPEAG	D5GHzV2	1008	16-Dec-2016	
RF Amplifier	EIN	603L	N/A	*In test	
RF Amplifier	Mini-Circuits	ZHL-42	N/A	*In test	✓
RF Amplifier	Mini-Circuits	ZVE-8G	N/A	*In test	
Synthesized signal generator	Hewlett Packard	86630A	3250A00328	*In test	✓
RF Power Meter	Hewlett Packard	437B	3125012786	*In test	✓
RF Power Sensor 0.01 - 18 GHz	Hewlett Packard	8481H	1545A01634	06-Oct-2016	✓
RF Power Meter	Rohde & Schwarz	NRP	101415	16-Oct-2016	
RF Power Sensor	Rohde & Schwarz	NRP - Z81	100174	19-Oct-2017	
RF Power Meter Dual	Hewlett Packard	435A	1733A05847	*In test	✓
RF Power Sensor	Hewlett Packard	8482A	2349A10114	*In test	✓
Network Analyser	Hewlett Packard	8714B	GB3510035	03-Oct-2016	
Network Analyser	Hewlett Packard	8753ES	JP39240130	03-Dec-2016	
Network Analyser	Hewlett Packard	8753D	3410A04122	04-Feb-2017	✓
Dual Directional Coupler	Hewlett Packard	778D	1144 04700	*In test	
Dual Directional Coupler	NARDA	3022	75453	*In test	✓
Thermometer	Digitech	QM7217	T-103	27-Aug-2016	
Thermometer	Digitech	QM7217	T-104	15-Jan-2017	✓

* Calibrated during the test for the relevant parameters.

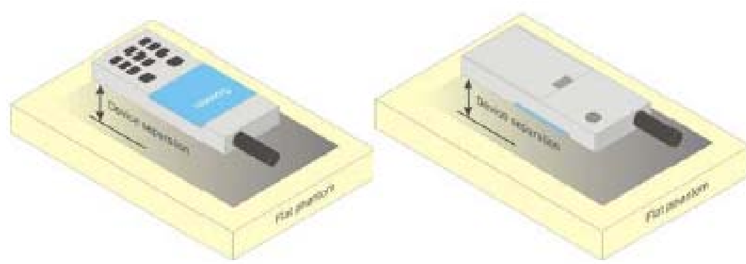
7.0 SAR TEST METHOD

7.1 Description of the Test Positions (Body Section)

The SAR measurements are performed in the Body back of phone position using the centre frequency of each operating band. The testing was performed with the Cellsafe Lif3 RF reduction Chip fitted to the phone, and repeated with no Cellsafe Lif3 RF reduction Chip for direct comparison.
See Appendix A for photos of test positions.

7.1.1 "Body Worn Position"

The body-worn operating configuration was tested with device positioned against the flat section of the phantom in normal use configuration. The position chosen for testing was the "Body Worn Position", this position simulated the DUT placed in the pocket of a user. This type of configuration represents a worst-case SAR assessment due to 0mm separation between the device and the flat phantom. This position was performed with the back of the phone facing the phantom.



7.2 List of All Test Cases (Antenna In/Out, Test Frequencies, User Modes etc)

The SAR was measured at one test channel for each band of operation with the test sample operating at maximum power, as specified in section 2.3.

7.3 ARPANSA RF Exposure Limits for ACMA (Australia) and EN 50360

Table: SAR Exposure Limits

Spatial Peak SAR Limits For	
Head and Partial-Body:	2.0 mW/g (averaged over any 10g cube of tissue)
Hands, Wrists, Feet and Ankles:	4.0 mW/g (averaged over 10g cube of tissue)
Spatial Average SAR Limits For	
Whole Body:	0.08 mW/g

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8.0 SAR EVALUATION RESULTS

The SAR values averaged over 10 g tissue masses were determined for the sample device for the Body Back configuration of the phantom and the results are given in the tables below.

The plots with the corresponding SAR distributions are contained in Appendix B of this report.

Table: SAR Measurement Results – UMTS Band 2 (1880 MHz) Samsung Galaxy S7 Edge

Test Position	Plot No.	Test Mode	Test Ch.	Test Freq. (MHz)	SAR (10g) mW/g	Drift (dB)	∈r (target 40.0 ±5% 38.0 to 42.0)	σ (target 1.40 ±5% 1.33 to 1.47)	Reduction SAR (%)
Body Worn Back 0mm Spacing with no chip 08-06-16	1	UMTS	9400	1880	3.34	0.07	38.97	1.443	78.0
Body Worn Back 0mm Spacing with Cellsafe Lif3 08-06-16	2	UMTS	9400	1880	0.735	-0.11	38.97	1.443	-
System Check 08-06-16	3	CW	1	1950	5.09	-0.03	38.72	1.475	-

Note: The uncertainty of the system (± 22.68%) has not been added to the result.

Table: SAR Measurement Results – UMTS Band 2 (1880 MHz) Apple iPhone 6

Test Position	Plot No.	Test Mode	Test Ch.	Test Freq. (MHz)	SAR (10g) mW/g	Drift (dB)	∈r (target 40.0 ±5% 38.0 to 42.0)	σ (target 1.40 ±5% 1.33 to 1.47)	Reduction SAR (%)
Body Worn Back 0mm Spacing with no chip 08-06-16	4	UMTS	9400	1880	0.9	-0.12	38.97	1.443	62.0
Body Worn Back 0mm Spacing with Cellsafe Lif3 08-06-16	5	UMTS	9400	1880	0.342	0.05	38.97	1.443	-

Note: The uncertainty of the system (± 22.68%) has not been added to the result.

9.0 RESULTS STATEMENT

The Cellsafe Lif3 for Samsung Galaxy S7 Edge and Apple iPhone 6 phones, types: Samsung SM-G9350, and Apple A1586 were tested on behalf of Cellsafe Pty Ltd. Cellsafe Lif3 devices were found to decrease SAR in the configurations described in this report by 62% to 78%.

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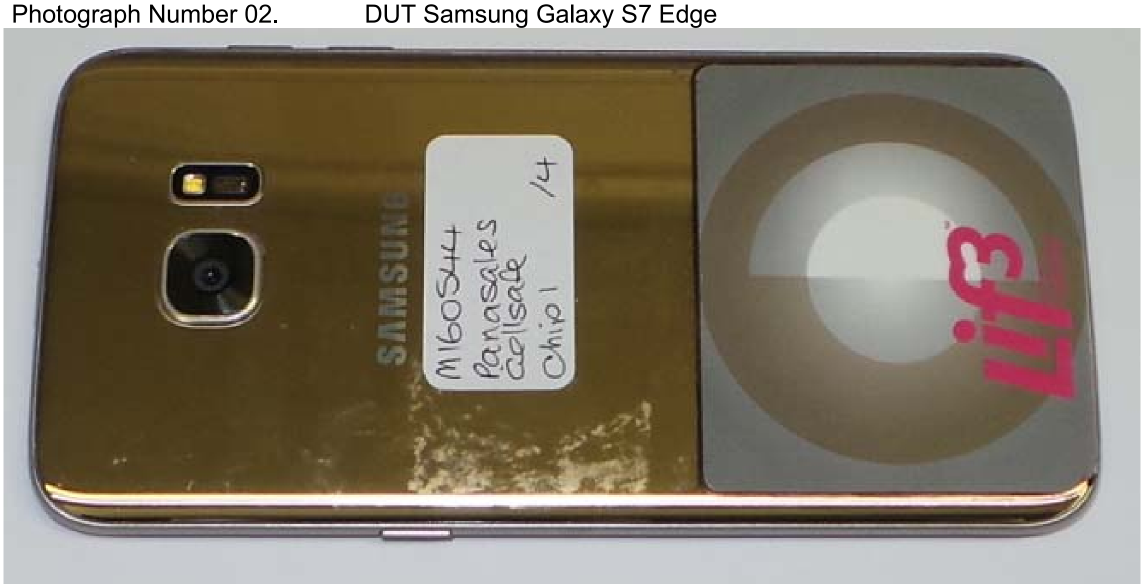
APPENDIX A1 Test Sample Photographs

Photograph Number 01. DUT Samsung Galaxy S7 Edge

Photograph Number 02. DUT Samsung Galaxy S7 Edge



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APPENDIX A2 Test Sample Photographs

Photograph Number 03. DUT Apple iPhone 6

Photograph Number 04. DUT Apple iPhone 6

APPENDIX A3 Test Sample Photographs

Photograph Number 05. Body Back Position Samsung Galaxy S7 Edge

Photograph Number 06. Body Back Position Samsung Galaxy S7 Edge

APPENDIX A4 Test Sample Photographs

Photograph Number 07. Body Back Position Apple iPhone 6

Photograph Number 08. Body Back Position Apple iPhone 6

APPENDIX B Plots Of The SAR Measurements

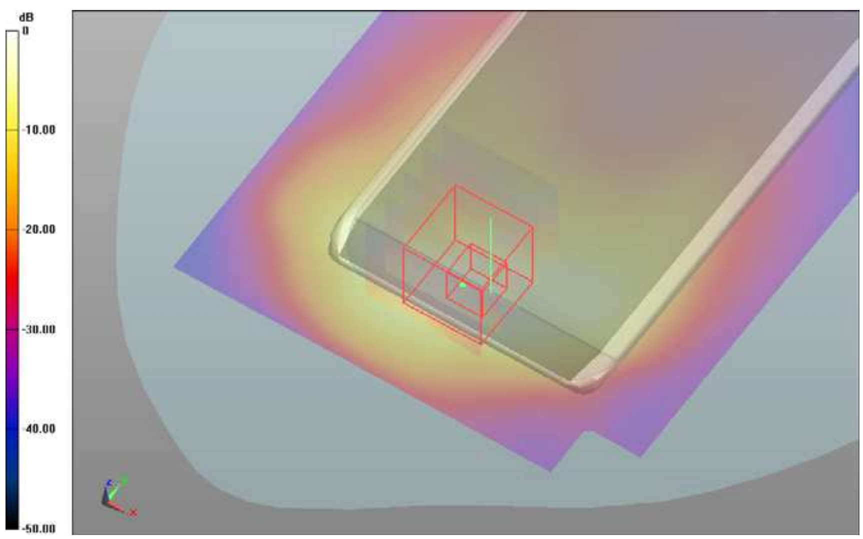
Test Lab: EMCTech Test File: M160544 Samsung Galaxy S7 Edge 1900 MHz 3G EN.da52:0

DUT Name: Samsung Galxy S7 Edge Mobile Phone, Type: SM-G9350, Serial: R28H32JAVSP

Configuration: Body Worn Back 0mm Spacing with no chip 08-06-16
Communication System: 0 - WCDMA - UMTS; Communication System Band: Band 2 1850 MHz;
Frequency: 1880 MHz, Communication System PAR: 0.00 dB; PMF: 1.00; Duty Cycle: 1:1.00
Medium Parameters used: f=1880 MHz; σ = 1.44 S/m; ε_r = 39.0; ρ = 1000.0g/cm^3
Phantom section: Flat Section

DASY Configuration:
Probe: ET3DV6 - SN1380; ConvF: (5.12,5.12,5.12); Calibrated: 10/12/2015;
Sensor-Surface: 4 mm (Mechanical Surface Detection)
Electronics: DAE3 Sn442; Calibrated: 7/12/2015
Phantom: SAM 22; Type: SAM 22; Serial: 1260
DASY52 52.8.8(1222); SEMCAD X Version 14.6.10 (7331)

Body Worn Back 0mm Spacing with no chip 08-06-16/Channel 9400 Test/Area Scan (81x141x1):
Interpolated grid: dx=1.5 mm, dy=1.5 mm; Maximum value of SAR (interpolated) = 8.070 W/kg
Body Worn Back 0mm Spacing with no chip 08-06-16/Channel 9400 Test/Zoom Scan (21x21x36)/Cube 0: Interpolated grid: dx=1.6 mm, dy=1.6 mm, dz=1.0 mm; Reference Value = 2.735 V/m; **Power Drift = 0.07 dB**
Averaged SAR: SAR(1g) = 9.130 W/kg; SAR(10g) = 3.340 W/kg
Maximum value of SAR (interpolated) = 28.500 W/kg



0 dB = 8.07 W/kg = 9.07 dBW/kg

SAR Measurement Plot 1

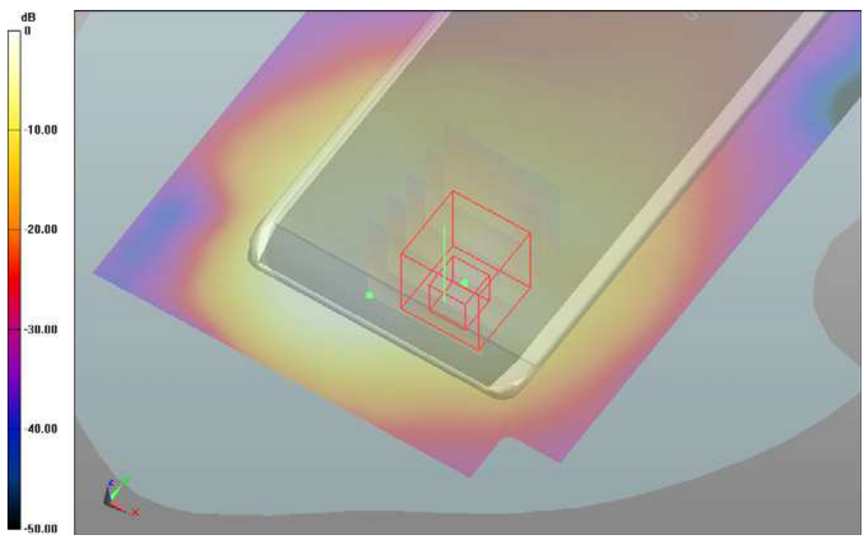
Test Lab: EMCTech Test File: M160544 Samsung Galaxy S7 Edge 1900 MHz 3G EN.da52:1

DUT Name: Samsung Galxy S7 Edge Mobile Phone, Type: SM-G9350, Serial: R28H32JAVSP

Configuration: Body Worn Back 0mm Spacing with Cellsafe Lif3 08-06-16
Communication System: 0 - WCDMA - UMTS; Communication System Band: Band 2 1850 MHz;
Frequency: 1880 MHz, Communication System PAR: 0.00 dB; PMF: 1.00; Duty Cycle: 1:1.00
Medium Parameters used: f=1880 MHz; σ = 1.44 S/m; ε_r = 39.0; ρ = 1000.0g/cm^3
Phantom section: Flat Section

DASY Configuration:
Probe: ET3DV6 - SN1380; ConvF: (5.12,5.12,5.12); Calibrated: 10/12/2015;
Sensor-Surface: 4 mm (Mechanical Surface Detection)
Electronics: DAE3 Sn442; Calibrated: 7/12/2015
Phantom: SAM 22; Type: SAM 22; Serial: 1260
DASY52 52.8.8(1222); SEMCAD X Version 14.6.10 (7331)

Body Worn Back 0mm Spacing with Cellsafe Lif3 08-06-16/Channel 9400 Test/Area Scan (81x141x1):
Interpolated grid: dx=1.5 mm, dy=1.5 mm; Maximum value of SAR (interpolated) = 2.190 W/kg
Body Worn Back 0mm Spacing with Cellsafe Lif3 08-06-16/Channel 9400 Test/Zoom Scan (21x21x36)/Cube 0: Interpolated grid: dx=1.6 mm, dy=1.6 mm, dz=1.0 mm; Reference Value = 32.093 V/m; **Power Drift = -0.11 dB**
Averaged SAR: SAR(1g) = 1.860 W/kg; SAR(10g) = 0.735 W/kg
Maximum value of SAR (interpolated) = 6.110 W/kg



0 dB = 2.19 W/kg = 3.40 dBW/kg

SAR Measurement Plot 2

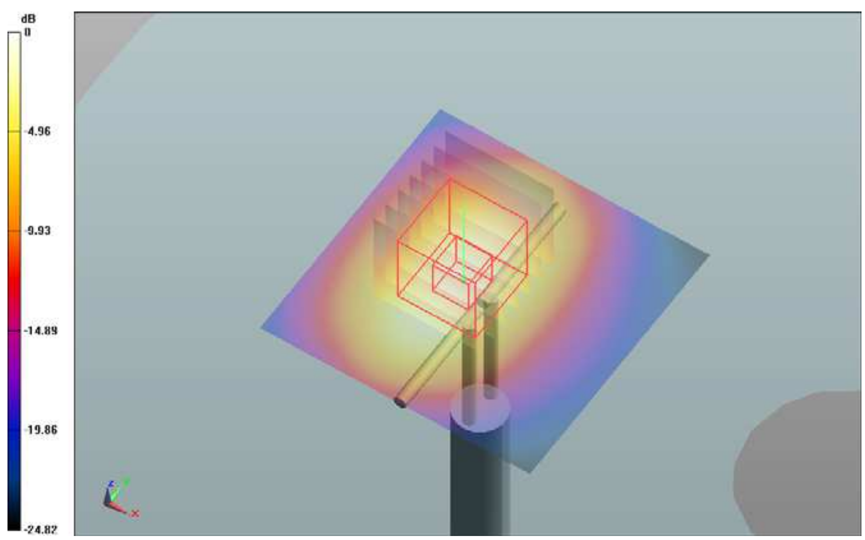
Test Lab: EMCTech Test File: M160544 Samsung Galaxy S7 Edge 1900 MHz 3G EN.da52:2

DUT Name: Dipole 1950 MHz, Type: DV1950V3, Serial: 1113

Configuration: System Check 08-06-16
Communication System: 0 - CW (0); Communication System Band: 1950 MHz; Frequency: 1950 MHz, Communication System PAR: 0.00 dB; PMF: 0.00; Duty Cycle: 1:1.00
Medium Parameters used: f=1950.2 MHz; σ = 1.48 S/m; ε_r = 38.7; ρ = 1000.0g/cm^3
Phantom section: Flat Section

DASY Configuration:
Probe: ET3DV6 - SN1380; ConvF: (4.94,4.94,4.94); Calibrated: 10/12/2015;
Sensor-Surface: 4 mm (Mechanical Surface Detection)
Electronics: DAE3 Sn442; Calibrated: 7/12/2015
Phantom: SAM 22; Type: SAM 22; Serial: 1260
DASY52 52.8.8(1222); SEMCAD X Version 14.6.10 (7331)

System Check 08-06-16/Channel 1 Test/Area Scan (51x51x1): Interpolated grid: dx=1.5 mm, dy=1.5 mm;
Maximum value of SAR (interpolated) = 11.800 W/kg
System Check 08-06-16/Channel 1 Test/Zoom Scan (31x31x36)/Cube 0: Interpolated grid: dx=1.0 mm, dy=1.0 mm, dz=1.0 mm; Reference Value = 88.832 V/m; **Power Drift = -0.03 dB**
Averaged SAR: SAR(1g) = 9.570 W/kg; SAR(10g) = 5.090 W/kg
Maximum value of SAR (interpolated) = 16.500 W/kg



0 dB = 11.8 W/kg = 10.72 dBW/kg

SAR Measurement Plot 3

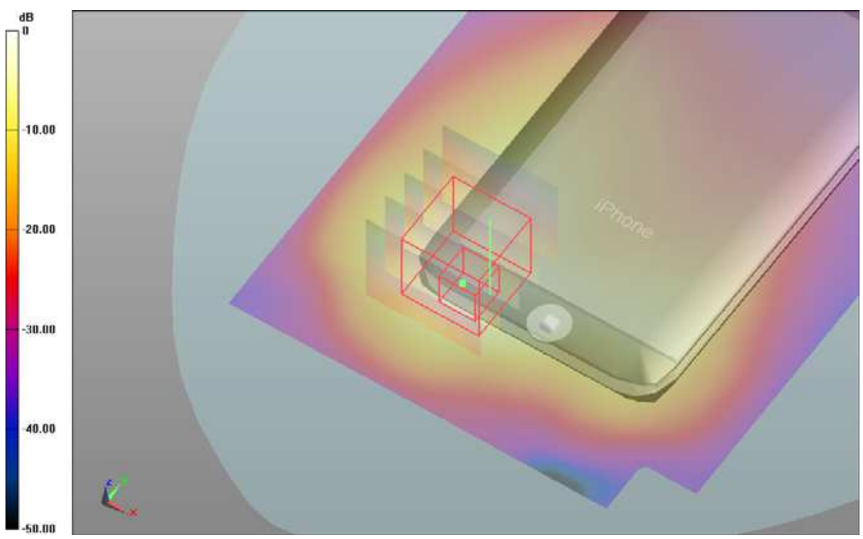
Test Lab: EMCTech Test File: M160544 Apple iPhone 6 1900 MHz 3G EN.da52:0

DUT Name: Apple Mobile Phone, Type: iPhone 6, Serial: C39NX1YRG5MW

Configuration: Body Worn Back 0mm Spacing with no chip 08-06-16
Communication System: 0 - WCDMA - UMTS; Communication System Band: Band 2 1850 MHz;
Frequency: 1880 MHz, Communication System PAR: 0.00 dB; PMF: 1.00; Duty Cycle: 1:1.00
Medium Parameters used: f=1880 MHz; σ = 1.44 S/m; ε_r = 39.0; ρ = 1000.0g/cm^3
Phantom section: Flat Section

DASY Configuration:
Probe: ET3DV6 - SN1380; ConvF: (5.12,5.12,5.12); Calibrated: 10/12/2015;
Sensor-Surface: 4 mm (Mechanical Surface Detection)
Electronics: DAE3 Sn442; Calibrated: 7/12/2015
Phantom: SAM 22; Type: SAM 22; Serial: 1260
DASY52 52.8.8(1222); SEMCAD X Version 14.6.10 (7331)

Body Worn Back 0mm Spacing with no chip 08-06-16/Channel 9400 Test/Area Scan (81x141x1):
Interpolated grid: dx=1.5 mm, dy=1.5 mm; Maximum value of SAR (interpolated) = 2.730 W/kg
Body Worn Back 0mm Spacing with no chip 08-06-16/Channel 9400 Test/Zoom Scan (21x21x36)/Cube 0: Interpolated grid: dx=1.6 mm, dy=1.6 mm, dz=1.0 mm; Reference Value = 40.077 V/m; **Power Drift = -0.12 dB**
Averaged SAR: SAR(1g) = 2.070 W/kg; SAR(10g) = 0.900 W/kg
Maximum value of SAR (interpolated) = 4.810 W/kg



0 dB = 2.73 W/kg = 4.36 dBW/kg

SAR Measurement Plot 4

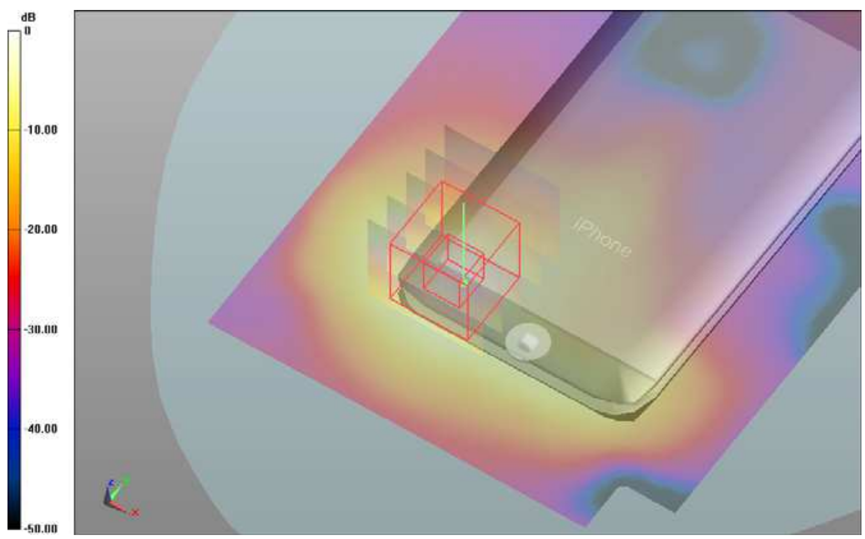
Test Lab: EMCTech Test File: M160544 Apple iPhone 6 1900 MHz 3G EN.da52:1

DUT Name: Apple Mobile Phone, Type: iPhone 6, Serial: C39NX1YRG5MW

Configuration: Body Worn Back 0mm Spacing with Cellsafe Lif3 08-06-16
Communication System: 0 - WCDMA - UMTS; Communication System Band: Band 2 1850 MHz;
Frequency: 1880 MHz, Communication System PAR: 0.00 dB; PMF: 1.00; Duty Cycle: 1:1.00
Medium Parameters used: f=1880 MHz; σ = 1.44 S/m; ε_r = 39.0; ρ = 1000.0g/cm^3
Phantom section: Flat Section

DASY Configuration:
Probe: ET3DV6 - SN1380; ConvF: (5.12,5.12,5.12); Calibrated: 10/12/2015;
Sensor-Surface: 4 mm (Mechanical Surface Detection)
Electronics: DAE3 Sn442; Calibrated: 7/12/2015
Phantom: SAM 22; Type: SAM 22; Serial: 1260
DASY52 52.8.8(1222); SEMCAD X Version 14.6.10 (7331)

Body Worn Back 0mm Spacing with Cellsafe Lif3 08-06-16/Channel 9400 Test/Area Scan (81x141x1):
Interpolated grid: dx=1.5 mm, dy=1.5 mm; Maximum value of SAR (interpolated) = 1.200 W/kg
Body Worn Back 0mm Spacing with Cellsafe Lif3 08-06-16/Channel 9400 Test/Zoom Scan (21x21x36)/Cube 0: Interpolated grid: dx=1.6 mm, dy=1.6 mm, dz=1.0 mm; Reference Value = 21.589 V/m; **Power Drift = 0.05 dB**
Averaged SAR: SAR(1g) = 0.828 W/kg; SAR(10g) = 0.342 W/kg
Maximum value of SAR (interpolated) = 2.370 W/kg



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

SAR Measurement Plot 5

APPENDIX C DESCRIPTION OF SAR MEASUREMENT SYSTEM

Probe Positioning System

The measurements were performed with the state of the art automated near-field scanning system **DASY5 Version 52** from Schmid & Partner Engineering AG (SPEAG). The system is based on a high precision 6-axis robot (working range greater than 1.1m), which positions the SAR measurement probes with a positional repeatability of better than ±0.02 mm. The DASY5 fully complies with the IEEE 1528 and EN62209 SAR measurement requirements.

E-Field Probe Type and Performance

The SAR measurements were conducted with the dosimetric probe ET3DV6 was used (manufactured by SPEAG). The SAR probes are designed in the classical triangular configuration and optimised for dosimetric evaluation. The probe has been calibrated and found to be accurate to better than ±0.25 dB. The probe is suitable for measurements close to material discontinuity at the surface of the phantom.

Data Acquisition Electronics

The data acquisition electronics (DAE3) consists of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain switching multiplexer, a fast 16 bit AD-converter and a command decoder and control logic unit. The input impedance of the DAE3 box is 200 MΩ; the inputs are symmetrical and floating. Common mode rejection is above 80dB.Transmission to the PC-card is accomplished through an optical downlink for data and status information as well as an optical uplink for commands and the clock.

The mechanical probe-mounting device includes two different sensor systems for frontal and sideways probe contacts. They are used for mechanical surface detection and probe collision detection.

Device Holder for DASY5

The DASY5 device holder supplied by SPEAG is designed to cope with different positions given in the standard. It has two scales for the device rotation (with respect to the body axis) and the device inclination (with respect to the line between the ear openings). The rotation centres for both scales is the ear opening. Thus the device needs no repositioning when changing the angles.

The DASY5 device holder is made of low-loss material having the following dielectric parameters: relative permittivity ε=3 and loss tangent δ=0.02. The amount of dielectric material has been reduced in the closest vicinity of the device, to reduce the influence on the clamp on the test results.

Refer to Appendix A for photograph of device positioning.

Liquid Depth 15cm

During the SAR measurement process the liquid level was maintained to a level of a least 15cm with a tolerance of ± 0.5cm.

Phantom Properties (Size, Shape, Shell Thickness, Tissue Material Properties)

The phantom used during the SAR testing and validation was the “SAM” phantom from SPEAG. The phantom thickness is 2.0mm+/-0.2 mm and was filled with the required tissue simulating liquid.

The dielectric parameters of the simulating liquid were measured prior to SAR assessment using the HP85070A dielectric probe kit and HP8753ES Network Analyser. The target dielectric parameters are shown in the following table.

Table: Target Simulating Liquid Dielectric Values UMTS Bands

Band	UMTS Band 2			
Frequency (MHz)	1852.4	40.0 ±5% (38.0 to 42.0)	1.40 ±5% (1.33 to 1.47)	1000
	1880	40.0 ±5% (38.0 to 42.0)	1.40 ±5% (1.33 to 1.47)	1000
	1907.6	40.0 ±5% (38.0 to 42.0)	1.40 ±5% (1.33 to 1.47)	1000

Note: The liquid parameters were within the required tolerances of ±5%.

Simulated Tissue Composition Used for SAR Test

The tissue simulating liquids are created prior to the SAR evaluation and often require slight modification each day to obtain the correct dielectric parameters.

Table: Tissue Type: @ 1800/1950MHz
Volume of Liquid: 30 Litres

Approximate Composition	% By Weight
Distilled Water	61.17
Salt	0.31
Bactericide	0.29
Triton X-100	38.23

APPENDIX D CALIBRATION DOCUMENTS

1. ET3DV6 SN: 1380 Probe Calibration Certificate
2. SN: 242 D1800V2 Dipole Calibration Certificate
3. SN: 442 DAE3 Data Acquisition Electronics Calibration Certificate

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

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

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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 **EMC Technologies**

Certificate No: **ET3-1380_Dec15**

CALIBRATION CERTIFICATE

Object	ET3DV6 - SN:1380
Calibration procedure(s)	QA CAL-01.v9, QA CAL-12.v9, QA CAL-23.v5, QA CAL-25.v6 Calibration procedure for dosimetric E-field probes
Calibration date:	December 10, 2015

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	30-Dec-14 (No. ES3-3013_Dec14)	Dec-15
DAE4	SN: 660	14-Jan-15 (No. DAE4-660_Jan15)	Jan-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: December 10, 2015

This calibration certificate shall not be reproduced except in full without written approval of the laboratory.

Accreditation No. 5292

Accredited for compliance with ISO/IEC 17025. The results of the test, calibrations and/or measurement included in this document are traceable to Australian/national standards. NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing, calibration and inspection reports.

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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
Swiss Calibration Service

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The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

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., $\vartheta = 0$ 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 $\vartheta = 0$ (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).

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Probe ET3DV6

SN:1380

Manufactured: August 16, 1999
Calibrated: December 10, 2015

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

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DASY/EASY - Parameters of Probe: ET3DV6 - SN:1380

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu V/(V/m)^2$)[A]	1.65	1.59	1.69	± 10.1 %
DCP (mV)[B]	96.4	95.6	96.5	

Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB$\sqrt{\mu V}$	C	D dB	VR mV	Unc[E] (k=2)
0	CW	X	0.0	0.0	1.0	0.00	250.1	±3.5 %
		Y	0.0	0.0	1.0		227.8	
		Z	0.0	0.0	1.0		253.2	

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.

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DASY/EASY - Parameters of Probe: ET3DV6 - SN:1380

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)
300	45.3	0.87	7.96	7.96	7.96	0.24	2.85	± 13.3 %
450	43.5	0.87	7.17	7.17	7.17	0.27	2.85	± 13.3 %
750	41.9	0.89	6.49	6.49	6.49	0.31	3.00	± 12.0 %
900	41.5	0.97	6.08	6.08	6.08	0.32	3.00	± 12.0 %
1640	40.3	1.29	5.35	5.35	5.35	0.69	2.25	± 12.0 %
1810	40.0	1.40	5.12	5.12	5.12	0.80	2.11	± 12.0 %
1950	40.0	1.40	4.94	4.94	4.94	0.80	2.07	± 12.0 %
2450	39.2	1.80	4.56	4.56	4.56	0.80	1.79	± 12.0 %

[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.

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ET3DV6– SN:1380 December 10, 2015

DASY/EASY - Parameters of Probe: ET3DV6 - SN:1380

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)
300	58.2	0.92	7.55	7.55	7.55	0.22	2.30	± 13.3 %
450	56.7	0.94	7.57	7.57	7.57	0.21	2.30	± 13.3 %
750	55.5	0.96	6.31	6.31	6.31	0.32	3.00	± 12.0 %
900	55.0	1.05	6.08	6.08	6.08	0.36	3.00	± 12.0 %
1810	53.3	1.52	4.73	4.73	4.73	0.80	2.21	± 12.0 %
1950	53.3	1.52	4.78	4.78	4.78	0.80	2.10	± 12.0 %
2450	52.7	1.95	4.18	4.18	4.18	0.90	0.90	± 12.0 %

[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.

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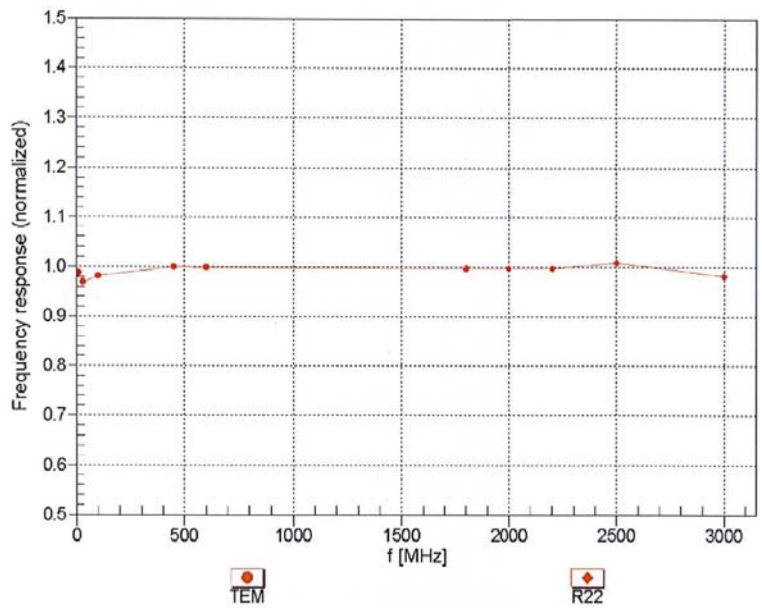
ET3DV6– SN:1380 December 10, 2015

Frequency Response of E-Field

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



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

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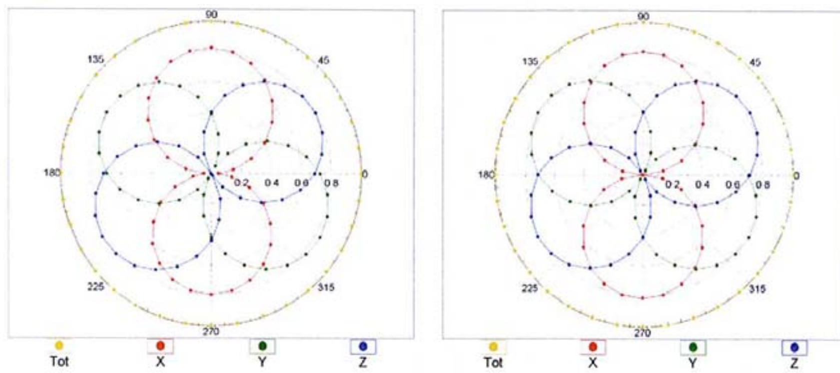
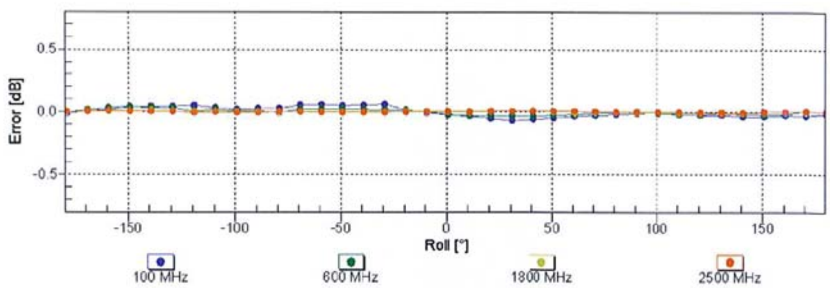
ET3DV6– SN:1380 December 10, 2015

Receiving Pattern (ϕ), $\vartheta = 0°$

f=600 MHz,TEM f=1800 MHz,R22





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

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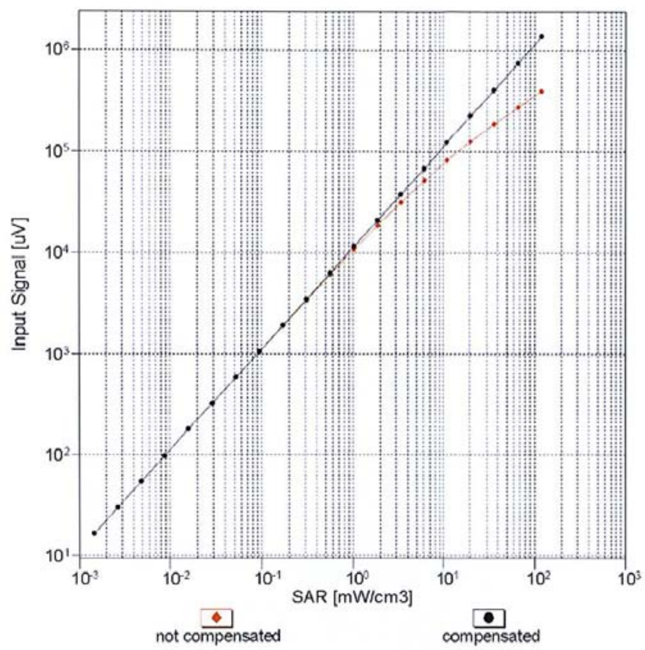
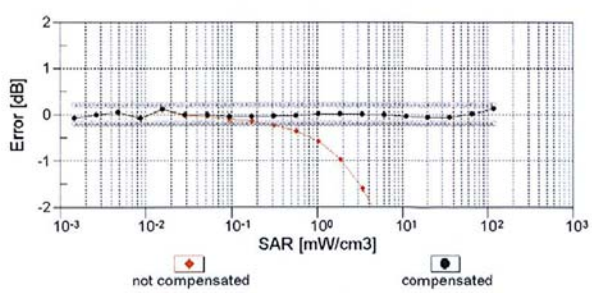
Dynamic Range f(SAR_{head})
(TEM cell , f_{eval}= 1900 MHz)





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

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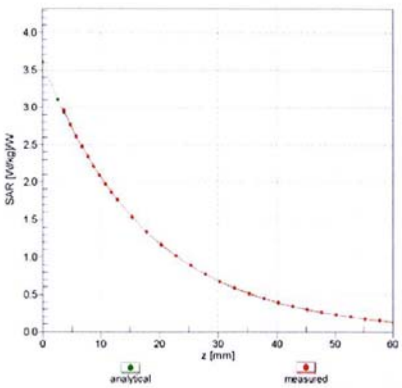
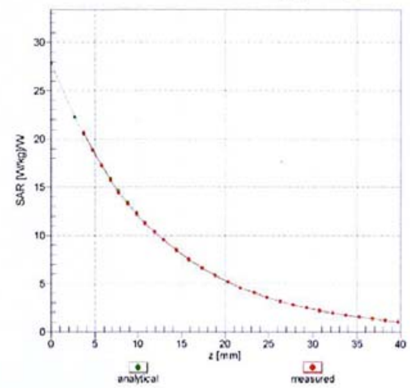
ET3DV6– SN:1380 December 10, 2015

Conversion Factor Assessment

f = 900 MHz,WGLS R9 (H_convF)

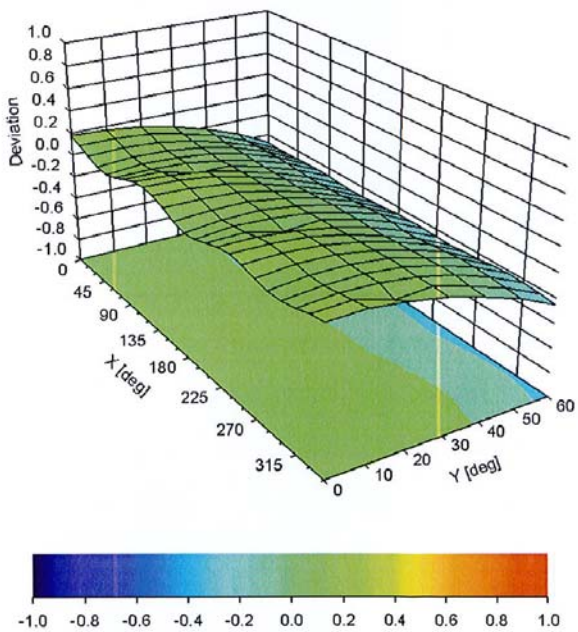


f = 1810 MHz,WGLS R22 (H_convF)



Deviation from Isotropy in Liquid

Error (ϕ, ϑ), f = 900 MHz



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

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DASY/EASY - Parameters of Probe: ET3DV6 - SN:1380

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	-19.2
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	10 mm
Tip Diameter	6.8 mm
Probe Tip to Sensor X Calibration Point	2.7 mm
Probe Tip to Sensor Y Calibration Point	2.7 mm
Probe Tip to Sensor Z Calibration Point	2.7 mm
Recommended Measurement Distance from Surface	4 mm

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Accreditation No.: **SCS 108**

Client **EMC Technologies**

Certificate No: **D1800V2-242_Dec14**

CALIBRATION CERTIFICATE

Object	D1800V2 - SN: 242
Calibration procedure(s)	QA CAL-05.v9 Calibration procedure for dipole validation kits above 700 MHz
Calibration date:	December 05, 2014

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-14 (No. 217-02020)	Oct-15
Power sensor HP 8481A	US37292783	07-Oct-14 (No. 217-02020)	Oct-15
Power sensor HP 8481A	MY41092317	07-Oct-14 (No. 217-02021)	Oct-15
Reference 20 dB Attenuator	SN: 5058 (20k)	03-Apr-14 (No. 217-01918)	Apr-15
Type-N mismatch combination	SN: 5047.2 / 06327	03-Apr-14 (No. 217-01921)	Apr-15
Reference Probe ES3DV3	SN: 3205	30-Dec-13 (No. ES3-3205_Dec13)	Dec-14
DAE4	SN: 601	18-Aug-14 (No. DAE4-601_Aug14)	Aug-15

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-13)	In house check: Oct-16
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-14)	In house check: Oct-15

	Name	Function	Signature
Calibrated by:	Michael Weber	Laboratory Technician	M.Weber
Approved by:	Katja Pokovic	Technical Manager	

Issued: December 8, 2014

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Accreditation No.: **SCS 108**

Glossary:

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

Calibration is Performed According to the Following Standards:

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) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

d) 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%.

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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 mm	
Frequency	1800 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	**Permittivity**	**Conductivity**
Nominal Head TSL parameters	22.0 °C	40.0	1.40 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	39.0 ± 6 %	1.41 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	9.73 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**38.5 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	250 mW input power	5.06 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**20.1 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	53.3	1.52 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	51.9 ± 6 %	1.53 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	9.64 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**38.2 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.08 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**20.2 W/kg ± 16.5 % (k=2)**

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Appendix (Additional assessments outside the scope of SCS108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	47.6 Ω - 5.7 jΩ
Return Loss	- 24.0 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	44.3 Ω - 5.9 jΩ
Return Loss	- 21.2 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.196 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 10, 1998

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DASY5 Validation Report for Head TSL

Date: 05.12.2014

Test Laboratory: SPEAG, Zurich, Switzerland

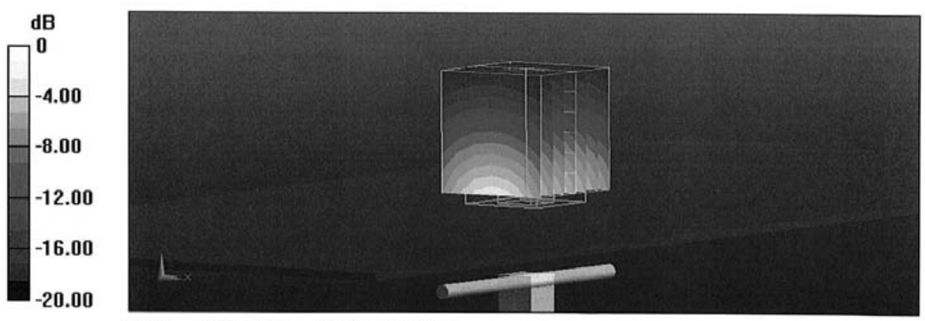
DUT: Dipole 1800 MHz; Type: D1800V2; Serial: D1800V2 - SN: 242

Communication System: UID 0 - CW; Frequency: 1800 MHz
Medium parameters used: f = 1800 MHz; σ = 1.41 S/m; ε_r = 39; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(5.09, 5.09, 5.09); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 18.08.2014
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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 = 96.91 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 18.1 W/kg
SAR(1 g) = 9.73 W/kg; SAR(10 g) = 5.06 W/kg
Maximum value of SAR (measured) = 12.4 W/kg



0 dB = 12.4 W/kg = 10.93 dBW/kg

Certificate No: D1800V2-242_Dec14 Page 5 of 8

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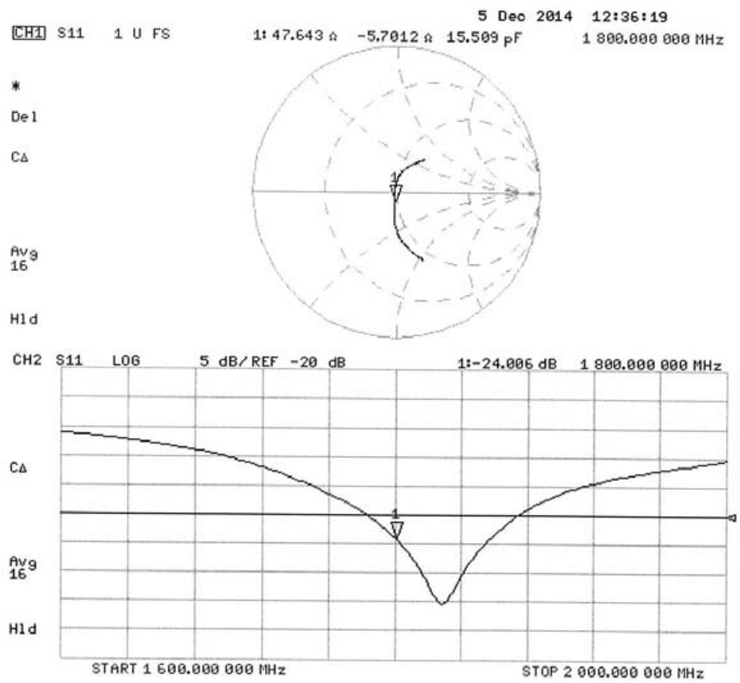
Impedance Measurement Plot for Head TSL



Certificate No: D1800V2-242_Dec14 Page 6 of 8

DASY5 Validation Report for Body TSL

Date: 05.12.2014

Test Laboratory: SPEAG, Zurich, Switzerland

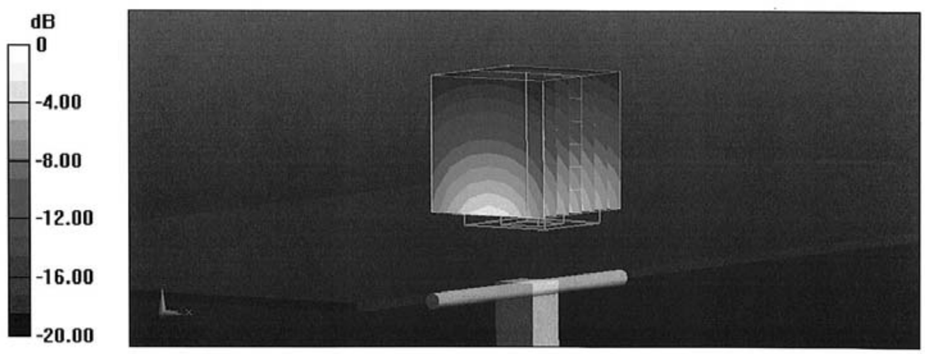
DUT: Dipole 1800 MHz; Type: D1800V2; Serial: D1800V2 - SN: 242

Communication System: UID 0 - CW; Frequency: 1800 MHz
Medium parameters used: f = 1800 MHz; $\sigma = 1.53$ S/m; $\varepsilon_r = 51.9$; $\rho = 1000$ kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.86, 4.86, 4.86); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 18.08.2014
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

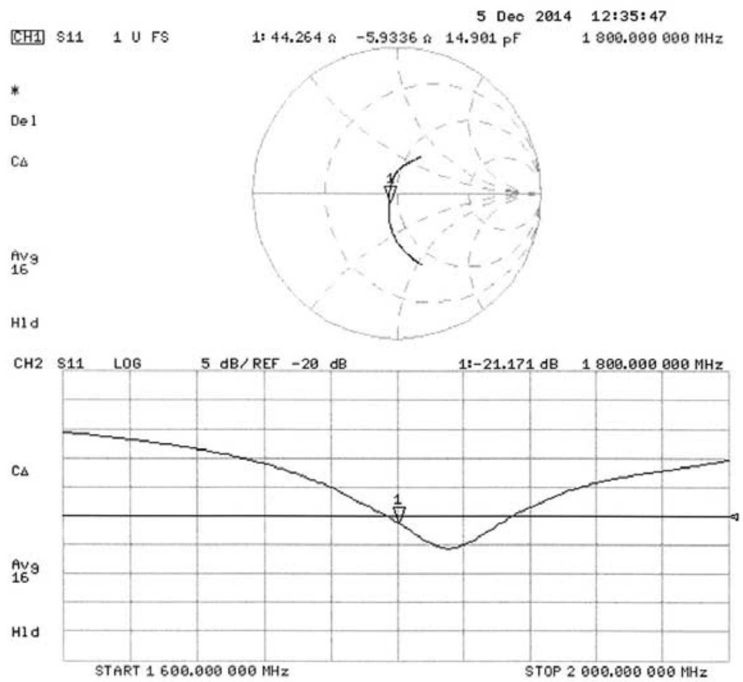
Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 93.17 V/m; Power Drift = -0.02 dB
Peak SAR (extrapolated) = 17.0 W/kg
SAR(1 g) = 9.64 W/kg; SAR(10 g) = 5.08 W/kg
Maximum value of SAR (measured) = 12.2 W/kg



0 dB = 12.2 W/kg = 10.86 dBW/kg

Certificate No: D1800V2-242_Dec14 Page 7 of 8

Impedance Measurement Plot for Body TSL



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Accreditation No.: **SCS 0108**

Client **EMC Technologies**

Certificate No: **DAE3-442_Dec15**

CALIBRATION CERTIFICATE

Object	DAE3 - SD 000 D03 AE - SN: 442
Calibration procedure(s)	QA CAL-06.v29 Calibration procedure for the data acquisition electronics (DAE)
Calibration date:	December 07, 2015

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
Keithley Multimeter Type 2001	SN: 0810278	09-Sep-15 (No:17153)	Sep-16
Secondary Standards	**ID #**	**Check Date (in house)**	**Scheduled Check**
Auto DAE Calibration Unit	SE UWS 053 AA 1001	06-Jan-15 (in house check)	In house check: Jan-16
Calibrator Box V2.1	SE UMS 006 AA 1002	06-Jan-15 (in house check)	In house check: Jan-16

	Name	Function	Signature
Calibrated by:	Dominique Steffen	Technician	[signature]
Approved by:	Fin Bomholt	Deputy Technical Manager	i.V. [signature]

Issued: December 7, 2015

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Accreditation No.: SCS 0108

Glossary

DAE — data acquisition electronics
Connector angle — information used in DASY system to align probe sensor X to the robot coordinate system.

Methods Applied and Interpretation of Parameters

- *DC Voltage Measurement:* Calibration Factor assessed for use in DASY system by comparison with a calibrated instrument traceable to national standards. The figure given corresponds to the full scale range of the voltmeter in the respective range.
- *Connector angle*: The angle of the connector is assessed measuring the angle mechanically by a tool inserted. Uncertainty is not required.
- The following parameters as documented in the Appendix contain technical information as a result from the performance test and require no uncertainty.
  - *DC Voltage Measurement Linearity:* Verification of the Linearity at +10% and -10% of the nominal calibration voltage. Influence of offset voltage is included in this measurement.
  - *Common mode sensitivity:* Influence of a positive or negative common mode voltage on the differential measurement.
  - *Channel separation:* Influence of a voltage on the neighbor channels not subject to an input voltage.
  - *AD Converter Values with inputs shorted:* Values on the internal AD converter corresponding to zero input voltage
  - *Input Offset Measurement*: Output voltage and statistical results over a large number of zero voltage measurements.
  - *Input Offset Current:* Typical value for information; Maximum channel input offset current, not considering the input resistance.
  - *Input resistance:* Typical value for information: DAE input resistance at the connector, during internal auto-zeroing and during measurement.
  - *Low Battery Alarm Voltage:* Typical value for information. Below this voltage, a battery alarm signal is generated.
  - *Power consumption:* Typical value for information. Supply currents in various operating modes.

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DC Voltage Measurement

A/D - Converter Resolution nominal

High Range: 1LSB = 6.1μV , full range = -100...+300 mV

Low Range: 1LSB = 61nV , full range = -1.......+3mV

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

Calibration Factors	X	Y	Z
High Range	404.405 ± 0.02% (k=2)	405.045 ± 0.02% (k=2)	405.266 ± 0.02% (k=2)
Low Range	3.98819 ± 1.50% (k=2)	3.98159 ± 1.50% (k=2)	3.99102 ± 1.50% (k=2)

Connector Angle

Connector Angle to be used in DASY system	108.0 ° ± 1 °

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Appendix (Additional assessments outside the scope of SCS0108)

1. DC Voltage Linearity

High Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	200038.67	1.67	0.00
Channel X	+ Input	20004.63	-0.23	-0.00
Channel X	- Input	-20002.69	2.89	-0.01
Channel Y	+ Input	200037.29	0.28	0.00
Channel Y	+ Input	20002.85	-1.92	-0.01
Channel Y	- Input	-20003.71	1.95	-0.01
Channel Z	+ Input	200037.94	1.15	0.00
Channel Z	+ Input	20004.04	-0.80	-0.00
Channel Z	- Input	-20005.37	0.28	-0.00

Low Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	2001.81	0.64	0.03
Channel X	+ Input	201.21	0.18	0.09
Channel X	- Input	-198.79	0.14	-0.07
Channel Y	+ Input	2000.92	-0.05	-0.00
Channel Y	+ Input	200.36	-0.57	-0.28
Channel Y	- Input	-199.07	-0.02	0.01
Channel Z	+ Input	2001.64	0.66	0.03
Channel Z	+ Input	199.61	-1.30	-0.65
Channel Z	- Input	-201.18	-2.14	1.08

2. Common mode sensitivity

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	Common mode Input Voltage (mV)	High Range Average Reading (μV)	Low Range Average Reading (μV)
Channel X	200	-8.87	-10.24
	- 200	12.75	10.95
Channel Y	200	0.20	0.18
	- 200	-1.34	-1.61
Channel Z	200	-5.09	-5.43
	- 200	3.49	3.23

3. Channel separation

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	Input Voltage (mV)	Channel X (μV)	Channel Y (μV)	Channel Z (μV)
Channel X	200	-	-0.29	-4.08
Channel Y	200	9.19	-	0.16
Channel Z	200	6.35	6.29	-

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4. AD-Converter Values with inputs shorted

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	High Range (LSB)	Low Range (LSB)
Channel X	15808	17128
Channel Y	15771	16023
Channel Z	15577	15276

5. Input Offset Measurement

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

Input 10MΩ

	Average (μV)	min. Offset (μV)	max. Offset (μV)	Std. Deviation (μV)
Channel X	0.15	-1.33	2.08	0.67
Channel Y	-0.50	-2.34	1.49	0.59
Channel Z	-0.96	-3.35	1.51	0.80

6. Input Offset Current

Nominal Input circuitry offset current on all channels: <25fA

7. Input Resistance (Typical values for information)

	Zeroing (kOhm)	Measuring (MOhm)
Channel X	200	200
Channel Y	200	200
Channel Z	200	200

8. Low Battery Alarm Voltage (Typical values for information)

Typical values	Alarm Level (VDC)
Supply (+ Vcc)	+7.9
Supply (- Vcc)	-7.6

9. Power Consumption (Typical values for information)

Typical values	Switched off (mA)	Stand by (mA)	Transmitting (mA)
Supply (+ Vcc)	+0.01	+6	+14
Supply (- Vcc)	–0.01	-8	-9

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