EMITECH

RE051-16-103329-1-A Ed. 0

SAR TEST REPORT

According to the standards:
FCC 47 CFR § 2.1093
RF exposure KDB procedures

Equipments under test:
APPI-COM
BS-APC-APC2U-0x/Bx

FCC ID: 2AG7HBSAPC2U01
IC: 21024-BSAPC2U01

Company:
BODYSENS SAS

DISTRIBUTION: Mr. COULON **Company: BODYSENS SAS**

Number of pages: 33 with 3 annexes

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0	Jun. 09, 2016	Creation	Emmanuel TOUTAIN	Olivier ROY

EQUIPMENTS UNDER TEST:	APPI-COM
Reference 1:	BS-APC2U-B0
Serial number (S/N):	000-000-801
Reference 2:	BS-APC2U-B1
Serial number (S/N):	000-000-802
MANUFACTURER:	-
APPLICANT:	
Company:	BODYSENS SAS
Address:	Batiment M2, Parc Innolin 442 rue Georges Besse Espace Innovation 3 30000 Nîmes France
Contact person:	Mr. Denis COULON
Person(s) present(s) during the test:	-
DATE(S) OF TEST(S):	May 30, 2016 & June 02, 2016
TEST SITE:	EMITECH Le Mans 9 rue Maurice Trintignant 72100 Le Mans France
TEST(S) OPERATOR(S):	Emmanuel TOUTAIN

SUMMARY

1. INTRODUCTION

In this test report, Specific Absorption Rate (SAR) measurements for the wireless communication devices BS-APC-APC2U-0x/Bx are presented.

The measurements were made according to the KDB publications for evaluating compliance with FCC Guidelines (FCC 47 CFR § 2.1093 and IEEE Std C95.1).

2. REFERENCE DOCUMENTS

The reference documents referred throughout this report are listed below.
These reference documents are applicable to the entire report, although extensions (version, date and amendment) are not repeated.

Reference	Document title	Date
KDB 447498	D01 General RF Exposure Guidance v06	2015
KDB 447498	D03 Supplement C Cross-Reference v01	2014
FCC 47 CFR	§ 2.1093 Radiofrequency radiation exposure evaluation: portable devices	-
IEEE Std C95.1	IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz.	1999
IEEE Std 1528	IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Technique	2013

3. PRESENTATION OF EQUIPMENT FOR TESTING PURPOSES

The wireless communication devices using the ISM frequency band 915MHz and the Bluetooth standard are shown in Fig. 1.a to Fig. 1.e.

The models types are defined by the antenna reference: "**0**, **1**, **2** or **3**" as shown in the following table.
Bluetooth module option is identified with a "**B**": x = 0 without Bluetooth or B with Bluetooth.

Antenna	**Integrated**	**Short half wave**	**Quarter wave**	**Short quarter wave**
Model	Chip-Antenna WEMCA	SMAP-925S	ANT-916	SMAP 900-1
Manufacturer	WURTH	SAM WOO	LINX	SAM WOO
Gain	-0.7 dBi	2.0 dBi	1.8 dBi	0 dBi
See Fig.	1.a	1.b	1.c	1.d
APPi-COM type	BS-APC2U-x**0**	BS-APC2U-x**1**	BS-APC2U-x**2**	BS-APC2U-x**3**

The equipment under test is intended to be inserted into a protective cover (rubber cover as shown in Fig. 1.e or an attachment clip allowing separation distance of 5mm to the body) to be used with the neck strap so that its rear side is facing the body of the user as defined by the applicant.

As specified in the user guide (Version 2.0), APPI-COM must be used with the provided Clip or Rubber cover, allowing a minimum distance of 5 mm with the body.

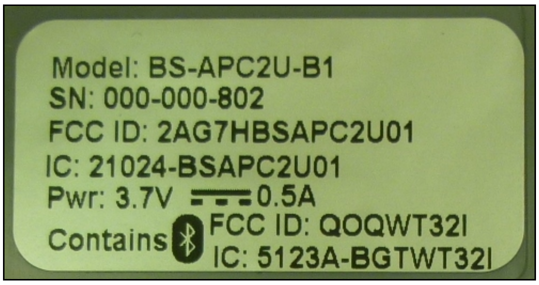
Note: the external antennas are non-detachable as defined by the applicant for the end-users. For this testing purpose, the 3 external antennas were removable and tested on the same sample.

Front and rear sides

Product marking (tested sample)

Fig. 1.a: APPI-COM version BS-APC2U-x0 (Antenna integrated)

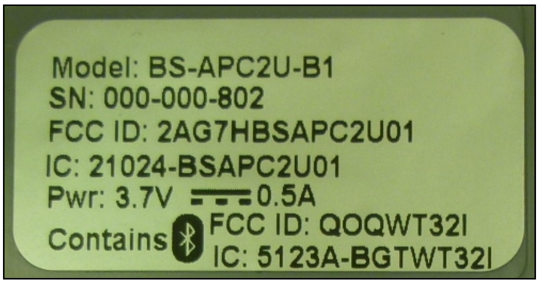
Front and rear sides



Product marking (tested sample)

Fig. 1.b: APPI-COM version BS-APC2U-x1 (Antenna 2.0 dBi)

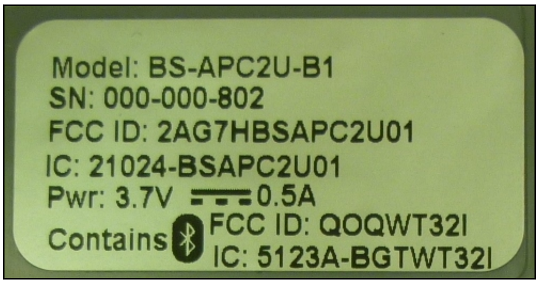
Front and rear sides



Product marking (tested sample)

Fig. 1.c: APPI-COM version BS-APC2U-x2 (Antenna 1.8 dBi)

Front and rear sides



Product marking (tested sample)

Fig. 1.d: APPI-COM version BS-APC2U-x3 (Antenna 0 dBi)

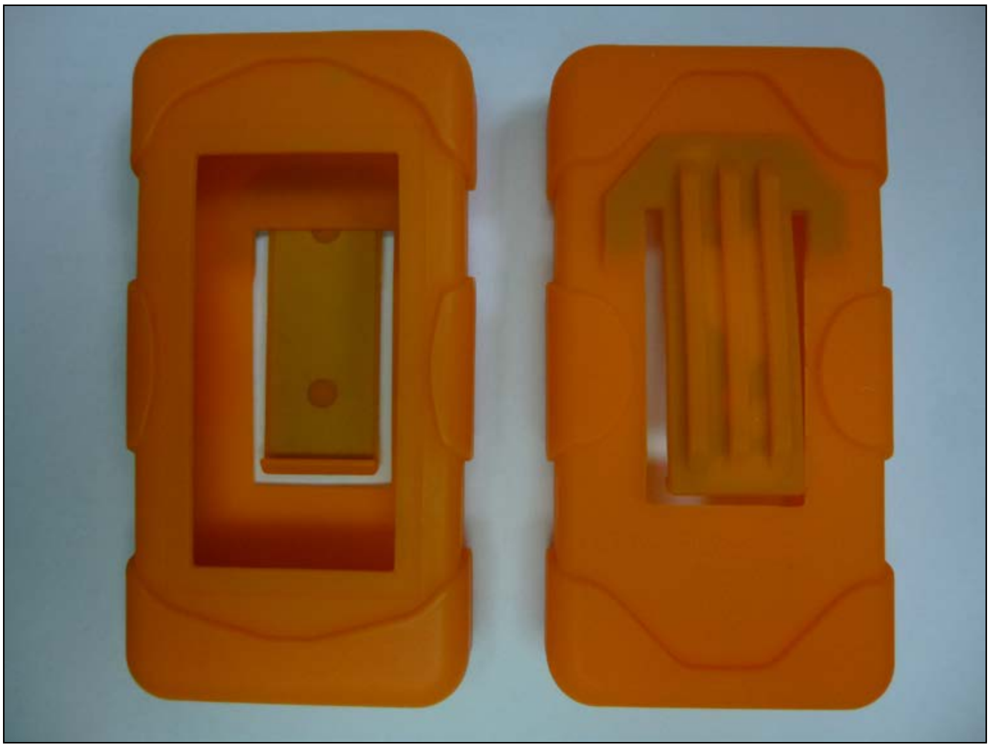


Fig. 1.e: Rubber cover

4. TESTS RESULTS SUMMARY

Object	Respected Standard ? ≤ 1.6W/kg in 1g		Remarks
	Yes	No	
BS-APC-APC2U-0x SAR measurements at 0.5cm from the body using the rubber cover	X		SAR value measured: 1.11 W/kg (1.39 W/kg without rubber cover)
BS-APC-APC2U-Bx SAR measurements at 0.5cm from the body using the rubber cover including Bluetooth	X		SAR value calculated: 1.235 W/kg (1.515 W/kg without rubber cover)

Conclusion:

The sample APPI-COM BS-APC-APC2U-0x/Bx submitted to test when worn at 0.5 cm from the body is in conformity with the FCC Guidelines, for general population/uncontrolled exposure, according to the FCC published RF exposure KDB procedures.

To declare, or not, the compliance with the specifications, it was not explicitly taken into account of uncertainty associated with the result(s).

5. ENVIRONNEMENTAL CONDITIONS

Condition	Measured Value
Liquid Temperature	*See Graphical Representations and §14*
Ambient Temperature	*See Graphical Representations and §14*

6. EQUIPMENT USED FOR THE TESTING

Plateform ID	Emitech N°	Category	Brand	Type	Last calibration	Next calibration
1 -						
2 DASY4	7321	Software	Speag	DASY4	-	-
	9485	E-Field Probe	Speag	ES3DV3	Aug. 21, 15	Aug. 21, 16
	7192	Data acquisition	Speag	DAE3	Aug. 13, 15	Aug. 13, 16
	7194	Dipole 900MHz	Speag	D900V2	May 30, 16	May 30, 17
	7324	Phantom	Speag	ELI4	-	-
3 Liquid Measure	-	Software	Hewlett-Packard	HP85070C	-	-
	1402	Network analyzer	Hewlett-Packard	HP8753C	May 07, 15	Jul. 07, 16
	9777	S-Parameter	Hewlett-Packard	HP85047A	May 07, 15	Jul. 07, 16
	7218	Dielectric probe	Hewlett-Packard	HP85070C	-	-
	6980	Thermometer	Testo	922	Mar. 11, 16	Mar. 11, 18
4 System Validation	7215	Signal generator	Marconi	2024	Feb. 11, 16	Feb. 11, 18
	7209	Amplifier	Mini-circuits	ZHL42	-	-
	7214	Power Supply	Kikusui	PMC18-2	-	-
	7212	Power meter	Rohde-Schwarz	NRVS	Feb. 18, 15	Feb. 18, 17
	7211	Probe power meter	Rohde-Schwarz	NRV-Z31	Feb. 18, 15	Feb. 18, 17
	7035	Power meter	Rohde-Schwarz	NRVD	Sep. 19, 14	Sep. 19, 16
	7034	Probe power meter	Rohde-Schwarz	NRV-Z1	Sep. 19, 14	Sep. 19, 16
	7210	Coupler	MEB	RK100	Feb. 11, 16	Feb. 11, 18
	7213	Attenuator	Weinschel Engineering	33-3-34	Feb. 11, 16	Feb. 11, 18
	7315	Attenuator	Radiall	R411810124 R411806124	Feb. 11, 16	Feb. 11, 18
	9161	50 ohms load	Diconex	17-0193	Feb. 11, 16	Feb. 11, 18
	7313	50 ohms load	Radiall	R404563000	Feb. 11, 16	Feb. 11, 18

ES3DV3 Isotropic E-Field Probe Overview:

Construction Symmetrical design with triangular core
Calibration Conversion Factors (CF) for head and body liquid
Frequency 10 MHz to 4 GHz; Linearity: ± 0.2 dB (30 MHz to 4 GHz)
Directivity ± 0.2 dB in HSL (rotation around probe axis)
± 0.3 dB in tissue material (rotation normal to probe axis)
Dynamic Range 5 µW/g to > 100 mW/g; Linearity: ± 0.2 dB
Dimensions Overall length: 337 mm (Tip: 20 mm)
Tip diameter: 3.9 mm (Body: 12 mm)
Distance from probe tip to dipole centers: 2.0 mm

ELI4 Elliptical phantom Overview:

Dimensions	Length 600 mm ± 5 mm and width 400 mm ± 5 mm
Shape	Ellipse
Thickness	2.0 mm with a tolerance of ± 0.2 mm
Liquid depth	150 mm

System Validation Kit Overview:

Construction	Symmetrical dipole with l/4 balun Enables measurement of feedpoint impedance with NWA Matched for use near flat phantoms filled with head/body simulating solutions
Return Loss	> 20 dB at specified validation position
Dimensions	D2450V3 dipole length: 51.8 mm

Mounting Device for Transmitters Overview:

Construction	Enables the position of the mounted transmitter device according to IEEE and IEC specifications
Material	POM

7. MEASUREMENT RESULTS

The wireless communication device antennas and batteries are those specified by the manufacturer. The battery is fully charged before each measurement.
The output power and frequency are controlled using a test program supplied by the applicant. The wireless communication device is set to transmit at its highest output peak power level.
The SAR test was performed for each antenna at the centre frequency. Then the configuration giving rise to the maximum mass-averaged SAR was used to test the low-end and the high-end frequencies of the transmitting band.

The wireless communication was placed against the flat phantom at 0 cm with its rear side in order to define a worst case. Then the measurements were repeated at 0.5 cm as specified in the user guide and in the KDB 447498 for the devices that are designed to operate on the body of users using a conservative minimum test separation distance ≤ 0.5 cm.

Measurement results (SAR values averaged over a mass of 1g):

Configuration	Test Position	SAR 1g (W/kg) - Limit = 1.6 W/kg			Meas. date
		Low channel 903 MHz	Middle channel 915 MHz	High channel 927 MHz	
Integrated antenna	Rear side at 0cm	0.095	**0.179**	0.104	May 30, 2016
Antenna 0 dBi Short quarter wave	Rear side at 0cm	0.902	1.03	1.03	
Antenna 1.8 dBi Quarter wave	Rear side at 0cm	-	0.633	-	
Antenna 2.0 dBi Short half wave	Rear side at 0cm	1.33	1.47	**1.54**	
	Rear side at 0.5cm	**1.39**	1.38	1.33	June 02, 2016
	Rear side + rubber cover at 0.5cm	**1.11**	0.985	0.955	

Simultaneous transmission

The equipment under test is intended to operate simultaneously with 915MHz and Bluetooth.

Per KDB 447498, the SAR exclusion threshold for distances < 50 mm is defined by the following equation:

[(*max. power of channel, including tune-up tolerance, mW*) / (*min. test separation distance, mm*)] · [√f(GHz)] ≤ 3.0 for 1-g SAR

Based on the maximum conducted power of the Bluetooth (BlueGiga Technologies, Model WT32i, output power = 5.7 mW, FCC ID: QOQWT32I) and the antenna to user separation distance (10 mm as defined by the applicant), Bluetooth SAR measurements are not required: [(6/10)* √2.441] = 0.9 < 3.0.

Per KDB 447498, the estimated SAR value is defined by the following equation:

[(*max. power of channel, including tune-up tolerance, mW*) / (*min. test separation distance, mm*)]·[√f(GHz) / *x*] W/kg where *x* = 7.5 for 1-g SAR

Secondary Transmitter	Frequency (GHz)	Max output power (mW)	Separation distance (mm)	Estimated SAR value (W/kg)
Bluetooth	2.441	6	10	**0.125**

Note: the maximum power (5.7mW) was rounded to the nearest mW (6) before calculation.

Simultaneous transmission results

Configuration (worst case at 0.5 cm)	Test Position	SAR meas. (W/kg)	Bluetooth SAR (W/kg)	SAR sum (W/kg)
Antenna 2.0 dBi Short half wave	Rear side at 0.5cm	1.39	0.125	**1.515**
	Rear side + rubber cover at 0.5cm	1.11	0.125	**1.235**

The sum of 1-g SAR of all simultaneously transmission mode (ISM 915 MHz and Bluetooth) is within the SAR limit (< 1.6 W/kg).

8. GRAPHICAL REPRESENTATIONS OF THE COARSE SCAN

The graphical representations of the coarse scan for the worst case are shown in Fig. 2 to Fig. 7.

DUT: APPI-COM

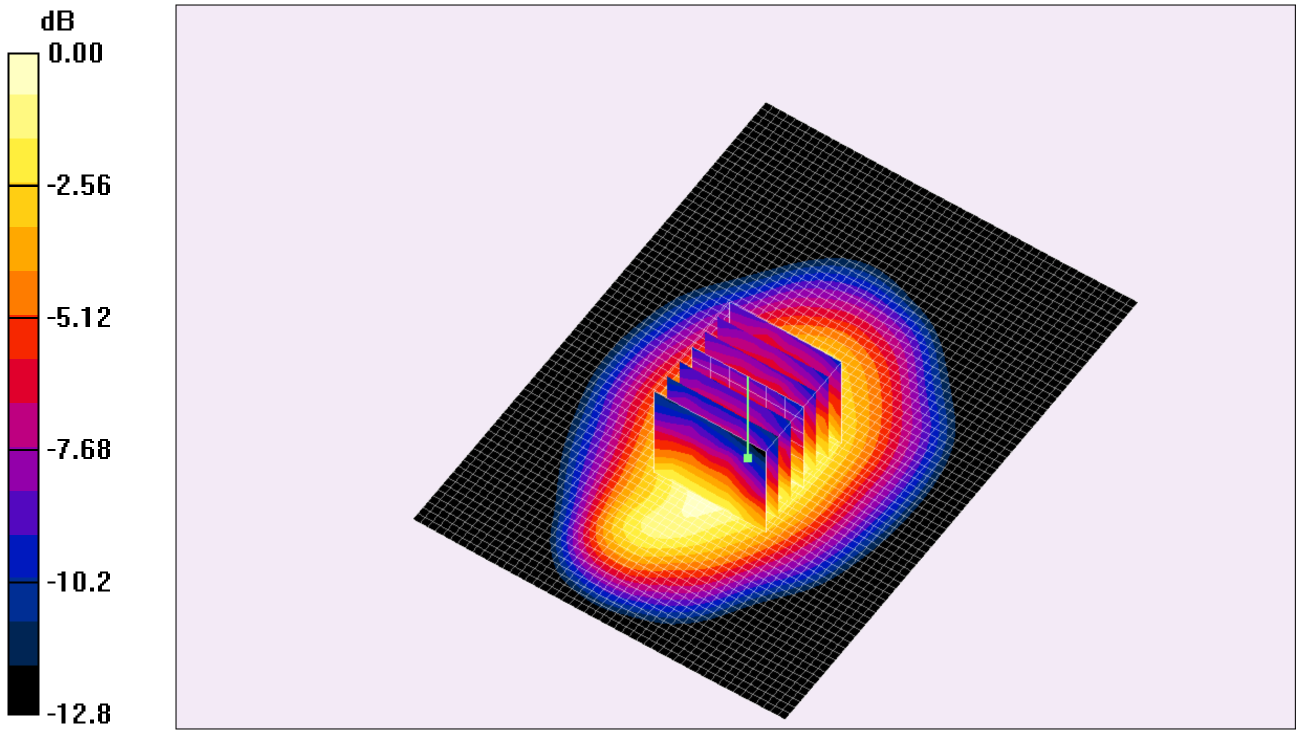
Communication System: APPI-COM; Frequency: 915 MHz; Duty Cycle: 1:4.43
Medium parameters used: σ = 1.04 mho/m, ε_r = 52.8; ρ = 1000 kg/m^3
Phantom section: Flat Section

Program Notes: Ambient temperature: 22.5°C, Liquid temperature: 21.1°C

DASY4 Configuration:
- Probe: ES3DV3 - SN3303; ConvF(5.92, 5.92, 5.92); Calibrated: 8/21/2015
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn402; Calibrated: 8/13/2015
- Phantom: ELI 4.0; Type: QDOVA001BA; Serial: 1067
- Measurement SW: DASY4, V4.5 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 145

Position 0cm, Middle channel/Area Scan (51x71x1): Measurement grid: dx=20mm, dy=20mm
Maximum value of SAR (interpolated) = 0.224 mW/g

Position 0cm, Middle channel/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 12.8 V/m; Power Drift = -0.112 dB
Peak SAR (extrapolated) = 0.286 W/kg
SAR(1 g) = 0.179 mW/g; SAR(10 g) = 0.121 mW/g
Maximum value of SAR (measured) = 0.207 mW/g



0 dB = 0.207mW/g

Fig. 2: SAR distribution for BS-APC2U-B0
Integrated antenna: middle channel (915 MHz), rear side at 0cm

DUT: APPI-COM

Communication System: APPI-COM; Frequency: 915 MHz; Duty Cycle: 1:4.43
Medium parameters used: σ = 1.04 mho/m, ε_r = 52.8; ρ = 1000 kg/m^3
Phantom section: Flat Section

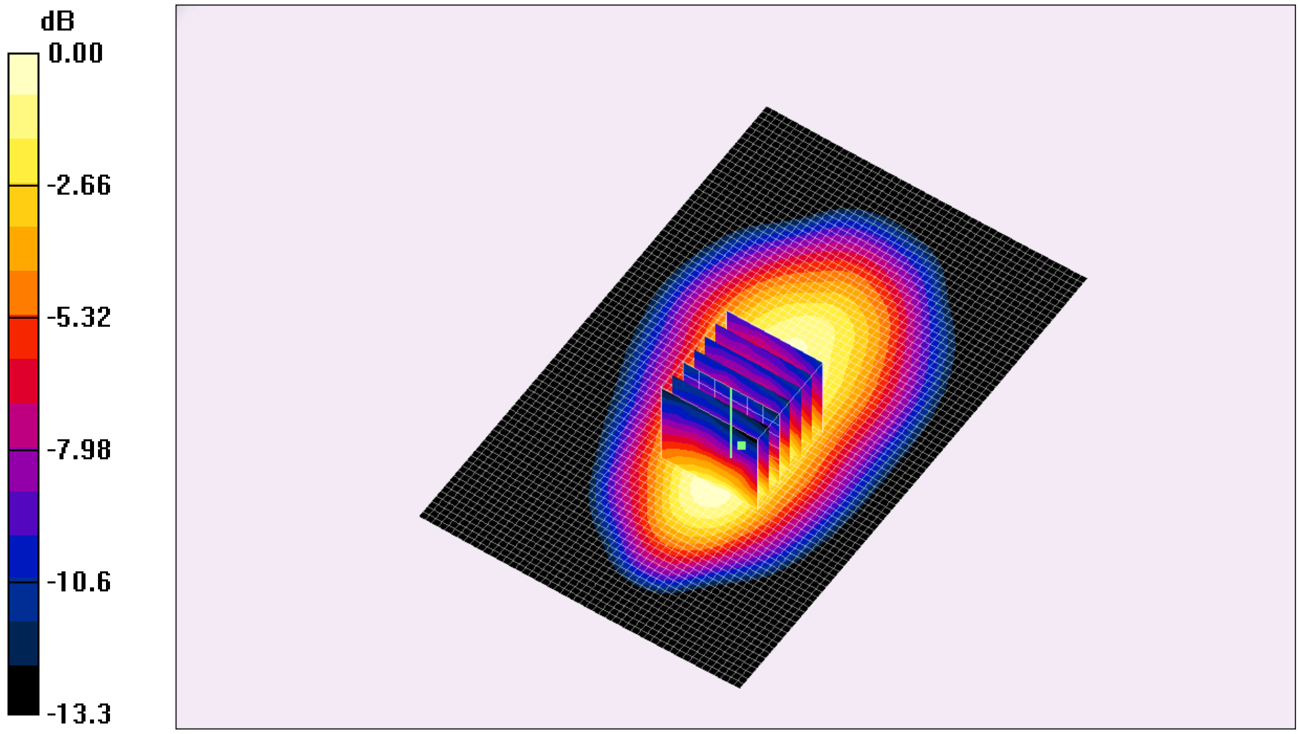
Program Notes: Ambient temperature: 22.7°C, Liquid temperature: 21.2°C

DASY4 Configuration:
- Probe: ES3DV3 - SN3303; ConvF(5.92, 5.92, 5.92); Calibrated: 8/21/2015
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn402; Calibrated: 8/13/2015
- Phantom: ELI 4.0; Type: QDOVA001BA; Serial: 1067
- Measurement SW: DASY4, V4.5 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 145

Position 0cm, Middle channel/Area Scan (51x81x1): Measurement grid: dx=20mm, dy=20mm
Maximum value of SAR (interpolated) = 1.29 mW/g

Position 0cm, Middle channel/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 29.9 V/m; Power Drift = -0.102 dB
Peak SAR (extrapolated) = 2.03 W/kg
SAR(1 g) = 1.03 mW/g; SAR(10 g) = 0.639 mW/g

Maximum value of SAR (measured) = 1.33 mW/g



0 dB = 1.33mW/g

Fig. 3: SAR distribution for BS-APC2U-B1
Antenna 0 dBi: middle channel (915 MHz), rear side at 0cm

DUT: APPI-COM

Communication System: APPI-COM; Frequency: 915 MHz; Duty Cycle: 1:4.43
Medium parameters used: σ = 1.04 mho/m, ε_r = 52.8; ρ = 1000 kg/m^3
Phantom section: Flat Section

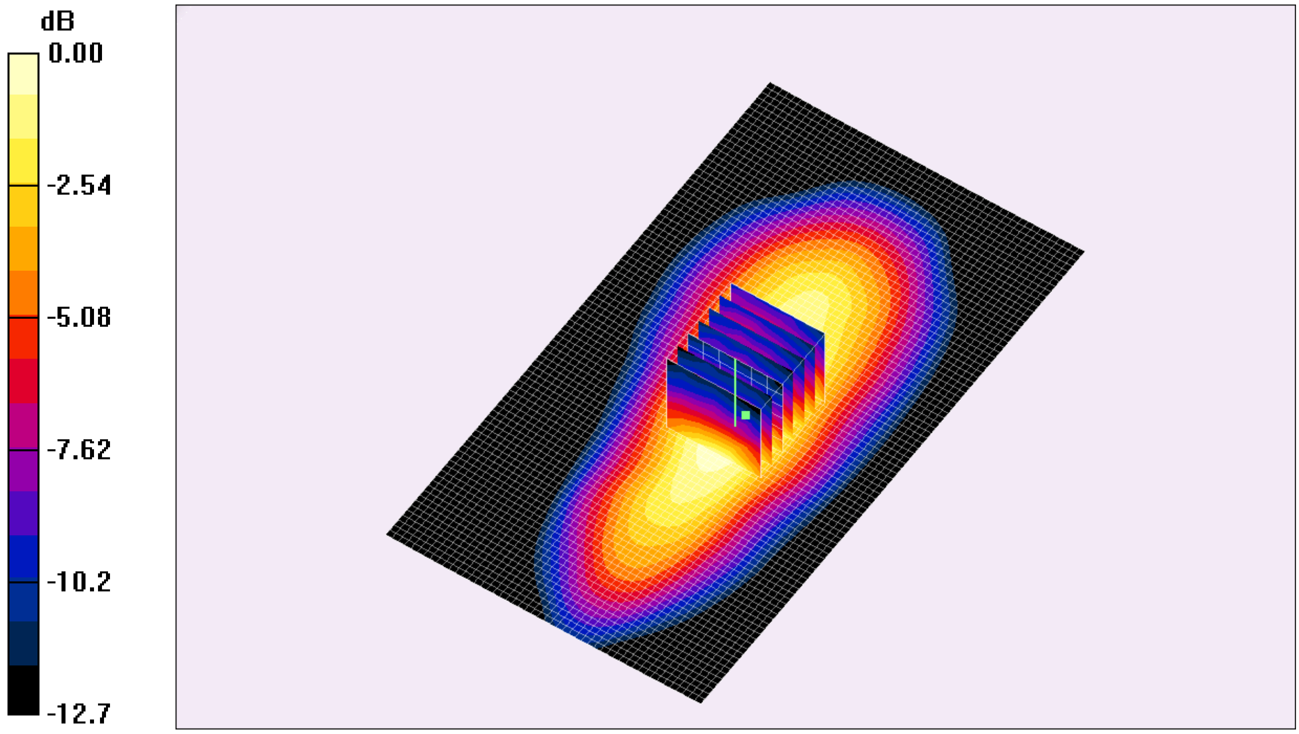
Program Notes: Ambient temperature: 22.8°C, Liquid temperature: 21.4°C

DASY4 Configuration:
- Probe: ES3DV3 - SN3303; ConvF(5.92, 5.92, 5.92); Calibrated: 8/21/2015
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn402; Calibrated: 8/13/2015
- Phantom: ELI 4.0; Type: QDOVA001BA; Serial: 1067
- Measurement SW: DASY4, V4.5 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 145

Position 0cm, Middle channel/Area Scan (51x91x1): Measurement grid: dx=20mm, dy=20mm
Maximum value of SAR (interpolated) = 0.850 mW/g

Position 0cm, Middle channel/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 24.9 V/m; Power Drift = 0.104 dB
Peak SAR (extrapolated) = 1.20 W/kg
SAR(1 g) = 0.633 mW/g; SAR(10 g) = 0.394 mW/g

Maximum value of SAR (measured) = 0.834 mW/g



0 dB = 0.834mW/g

Fig. 4: SAR distribution for BS-APC2U-B1
Antenna 1.8 dBi: middle channel (915 MHz), rear side at 0cm

DUT: APPI-COM

Communication System: APPI-COM; Frequency: 927 MHz; Duty Cycle: 1:4.43
Medium parameters used: σ = 1.05 mho/m, ε_r = 52.7; ρ = 1000 kg/m^3
Phantom section: Flat Section

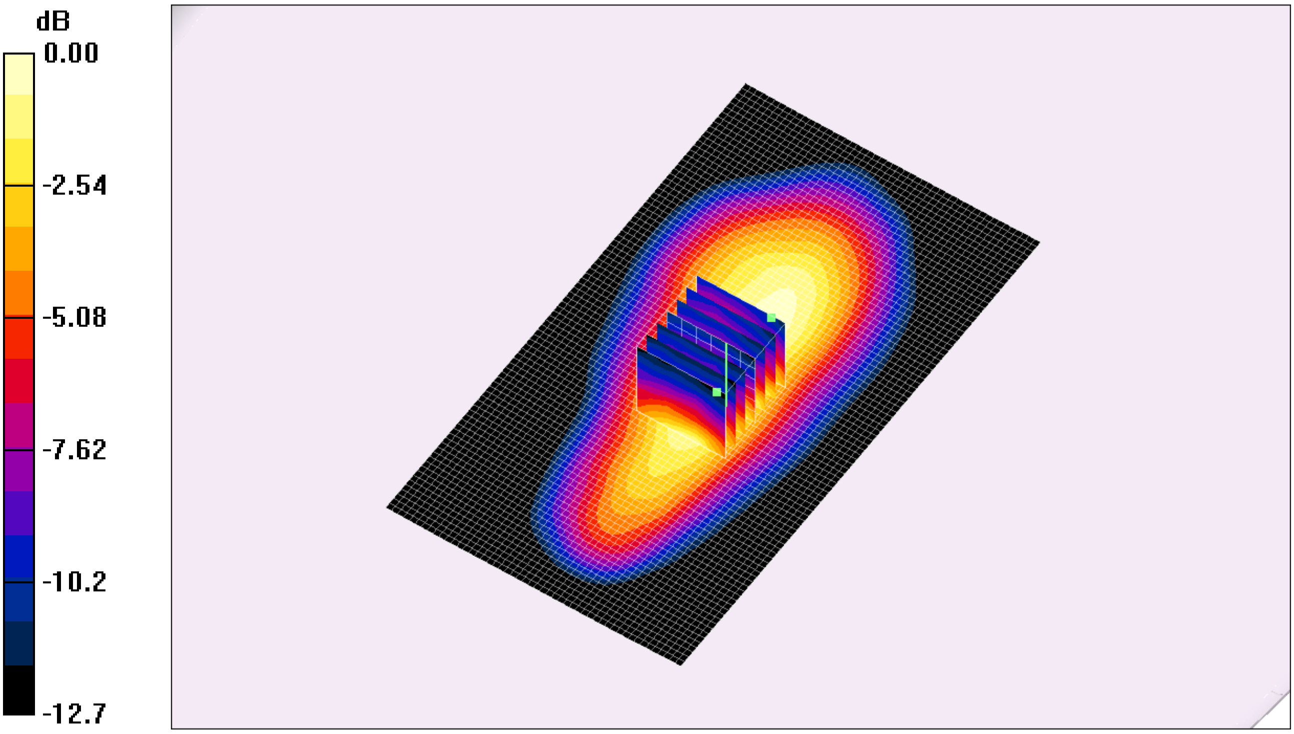
Program Notes: Ambient temperature: 22.9°C, Liquid temperature: 21.3°C

DASY4 Configuration:
- Probe: ES3DV3 - SN3303; ConvF(5.92, 5.92, 5.92); Calibrated: 8/21/2015
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn402; Calibrated: 8/13/2015
- Phantom: ELI 4.0; Type: QDOVA001BA; Serial: 1067
- Measurement SW: DASY4, V4.5 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 145

Position 0cm, High channel/Area Scan (51x91x1): Measurement grid: dx=20mm, dy=20mm
Maximum value of SAR (interpolated) = 1.83 mW/g

Position 0cm, High channel/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 30.1 V/m; Power Drift = 0.088 dB
Peak SAR (extrapolated) = 2.90 W/kg
SAR(1 g) = 1.54 mW/g; SAR(10 g) = 0.955 mW/g

Maximum value of SAR (measured) = 1.95 mW/g



0 dB = 1.95mW/g

Fig. 5: SAR distribution for BS-APC2U-B1
Antenna 2.0 dBi: high channel (927 MHz), rear side at 0cm

DUT: APPI-COM

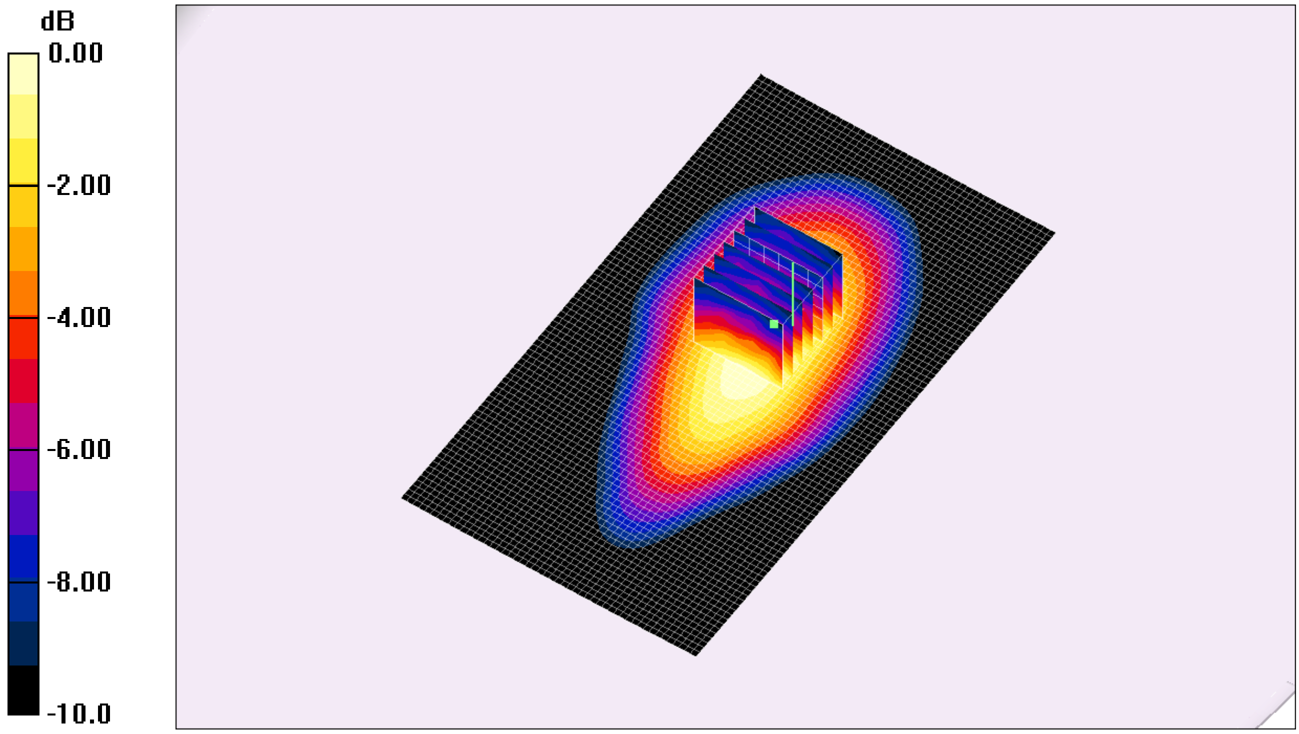
Communication System: APPI-COM; Frequency: 903 MHz; Duty Cycle: 1:4.43
Medium parameters used: σ = 1.02 mho/m, ε_r = 53.7; ρ = 1000 kg/m^3
Phantom section: Flat Section

Program Notes: Ambient temperature: 23.1°C, Liquid temperature: 21.7°C

DASY4 Configuration:
- Probe: ES3DV3 - SN3303; ConvF(5.92, 5.92, 5.92); Calibrated: 8/21/2015
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn402; Calibrated: 8/13/2015
- Phantom: ELI 4.0; Type: QDOVA001BA; Serial: 1067
- Measurement SW: DASY4, V4.5 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 145

Position 0.5cm, Low channel/Area Scan (51x91x1): Measurement grid: dx=20mm, dy=20mm
Maximum value of SAR (interpolated) = 1.72 mW/g

Position 0.5cm, Low channel/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 39.4 V/m; Power Drift = 0.036 dB
Peak SAR (extrapolated) = 2.24 W/kg
SAR(1 g) = 1.39 mW/g; SAR(10 g) = 0.985 mW/g
Maximum value of SAR (measured) = 1.67 mW/g



0 dB = 1.67mW/g

Fig. 6: SAR distribution for BS-APC2U-B1
Antenna 2.0 dBi: low channel (903MHz), rear side at 0.5cm

DUT: APPI-COM

Communication System: APPI-COM; Frequency: 903 MHz; Duty Cycle: 1:4.43
Medium parameters used: σ = 1.02 mho/m, ε_r = 53.7; ρ = 1000 kg/m^3
Phantom section: Flat Section

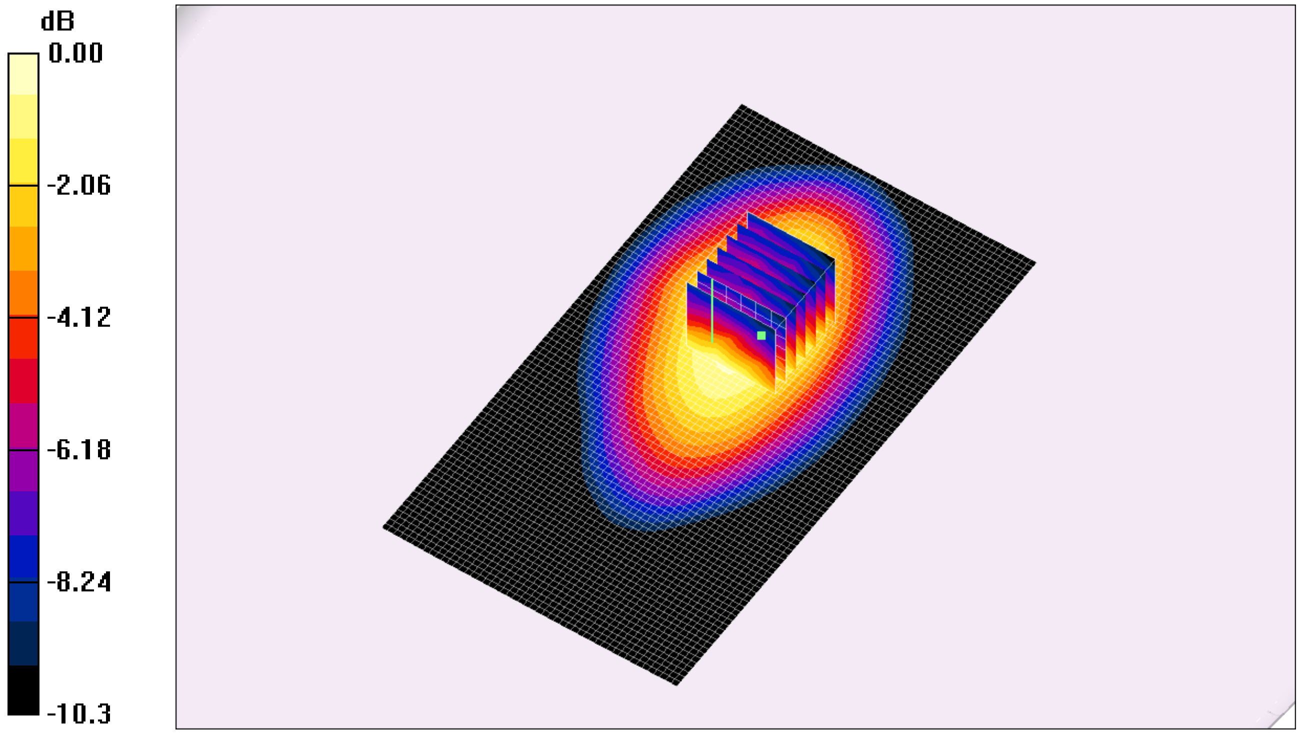
Program Notes: Ambient temperature: 22.9°C, Liquid temperature: 21.3°C

DASY4 Configuration:
- Probe: ES3DV3 - SN3303; ConvF(5.92, 5.92, 5.92); Calibrated: 8/21/2015
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn402; Calibrated: 8/13/2015
- Phantom: ELI 4.0; Type: QDOVA001BA; Serial: 1067
- Measurement SW: DASY4, V4.5 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 145

Position 0.5cm, Low channel/Area Scan (51x91x1): Measurement grid: dx=20mm, dy=20mm
Maximum value of SAR (interpolated) = 1.31 mW/g

Position 0.5cm, Low channel/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 34.9 V/m; Power Drift = -0.186 dB
Peak SAR (extrapolated) = 1.56 W/kg
SAR(1 g) = 1.11 mW/g; SAR(10 g) = 0.798 mW/g

Maximum value of SAR (measured) = 1.33 mW/g



0 dB = 1.33mW/g

Fig. 7: SAR distribution for BS-APC2U-B1
Antenna 2.0 dBi: low channel (903MHz), rear side with the rubber cover at 0.5cm

9. PHOTOGRAPHS OF THE EQUIPMENT UNDER TEST

The photographs of the equipment under test are shown in Fig. 8 to Fig. 13.

Fig. 8: Integrated Antenna, rear side at 0cm from the phantom

Fig. 9: External Antenna 0dBi, rear side at 0cm from the phantom

Fig. 10: External Antenna 1.8dBi, rear side at 0cm from the phantom

Fig. 11: External Antenna 2.0dBi, rear side at 0cm from the phantom

Fig. 12: External Antenna 2.0dBi, rear side at 0.5cm from the phantom

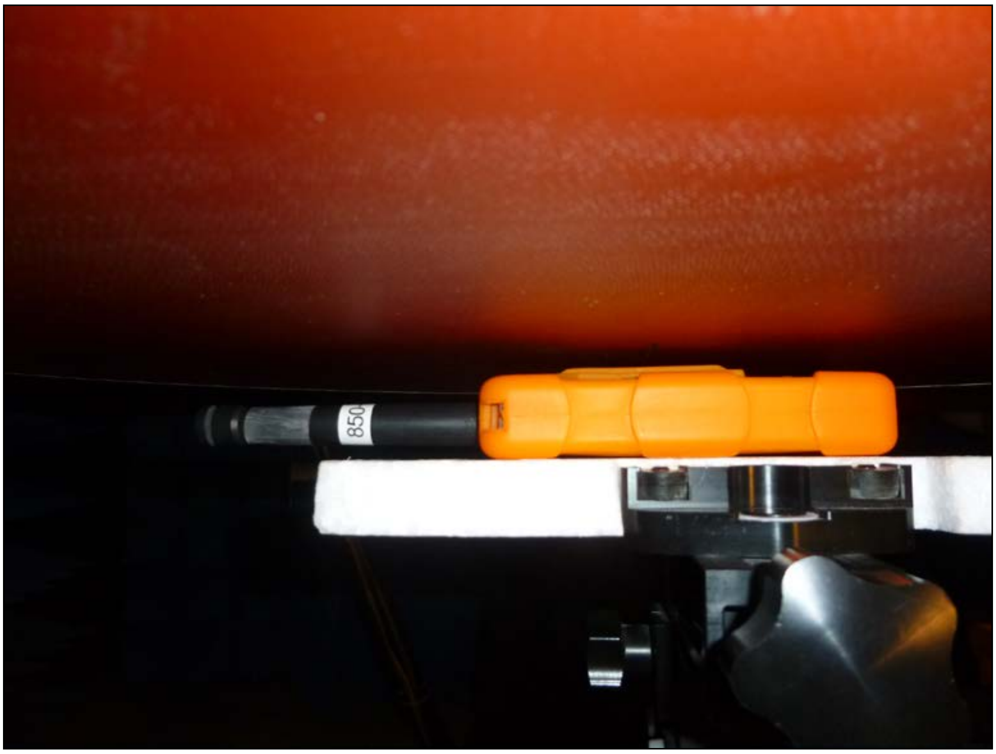


Fig. 13: External Antenna 2.0dBi, rear side with the rubber cover at 0.5cm from the phantom

10. MEASUREMENT UNCERTAINTY

- Measurement uncertainty of SAR evaluations

The uncertainty of the measurements was evaluated according to the IEEE Std 1528: 2013, Tableau 9 (Handset). The expanded uncertainty is ± 22.8 % in 1g.

Uncertainty component	Uncertainty Value (%)	Probability Distribution	Divisor	c_i (1g)	c_i (10g)	1g u_i (%)	10g u_i (%)
Measurement system							
Probe calibration	± 6.0	Normal	1	1	1	± 6.0	± 6.0
Probe calibration drift	± 5.0	Rectangular	2√3	1	1	± 1.4	± 1.4
Axial isotropy	± 4.7	Rectangular	√3	0.7	0.7	± 1.9	± 1.9
Hemispherical isotropy	± 9.6	Rectangular	√3	0.7	0.7	± 3.9	± 3.9
Boundary effect	± 1.0	Rectangular	√3	1	1	± 0.6	± 0.6
Linearity	± 4.7	Rectangular	√3	1	1	± 2.7	± 2.7
System detection limits	± 1.0	Rectangular	√3	1	1	± 0.6	± 0.6
Modulation response	± 2.4	Rectangular	√3	1	1	± 1.4	± 1.4
Readout electronics	± 0.3	Normal	1	1	1	± 0.3	± 0.3
Response time	± 0.8	Rectangular	√3	1	1	± 0.5	± 0.5
Integration time	± 2.6	Rectangular	√3	1	1	± 1.5	± 1.5
RF ambient conditions - noise	± 3.0	Rectangular	√3	1	1	± 1.7	± 1.7
RF ambient conditions - reflections	± 3.0	Rectangular	√3	1	1	± 1.7	± 1.7
Probe positioner mechanical tolerance	± 0.4	Rectangular	√3	1	1	± 0.2	± 0.2
Probe positioning with respect to phantom shell	± 2.9	Rectangular	√3	1	1	± 1.7	± 1.7
Extrapolation, interpolation and integration algorithms for max. SAR evaluation	± 2.0	Rectangular	√3	1	1	± 1.2	± 1.2
Test sample related							
Test sample positioning	± 2.9	Normal	1	1	1	± 2.9	± 2.9
Device holder uncertainty	± 3.6	Normal	1	1	1	± 3.6	± 3.6
Output power variation – SAR drift measurement	± 5.0	Rectangular	√3	1	1	± 2.9	± 2.9
SAR scaling	*± 0.0*	*Rectangular*	√3	*1*	*1*	*± 0.0*	*± 0.0*
Phantom and tissue parameters							
Phantom shell uncertainty – shape, thickness and permittivity	± 6.1	Rectangular	√3	1	1	± 3.5	± 3.5
Uncertainty in SAR correction for deviations in permittivity and conductivity	± 1.9	Normal	1	1	0.84	± 1.9	± 1.6
Liquid conductivity measurement	± 2.5	Normal	1	0.78	0.71	± 2.0	± 1.8
Liquid permittivity measurement	± 2.5	Normal	1	0.23	0.26	± 0.6	± 0.7
Liquid conductivity – temperature uncertainty	± 2.8	Rectangular	√3	0.78	0.71	± 1.3	± 1.2
Liquid permittivity – temperature uncertainty	± 1.9	Rectangular	√3	0.23	0.26	± 0.3	± 0.3
Combined standard uncertainty						± 11.4	± 11.4
Expanded uncertainty (95% confidence interval)						± 22.8	± 22.9

- Uncertainty of SAR system validation

The uncertainty of the system validation was evaluated according to the IEEE Std 1528: 2013, Tableau 10 (System validation). The expanded uncertainty is ± 20.5 % in 1g.

Uncertainty component	Uncertainty Value (%)	Probability Distribution	Divisor	c_i (1g)	c_i (10g)	1g u_i (%)	10g u_i (%)
Measurement system							
Probe calibration	± 6.0	Normal	1	1	1	± 6.0	± 6.0
Probe calibration drift	± 5.0	Rectangular	2√3	1	1	± 1.4	± 1.4
Axial isotropy	± 4.7	Rectangular	√3	1	1	± 2.7	± 2.7
Hemispherical isotropy	± 9.6	Rectangular	√3	0	0	± 0.0	± 0.0
Boundary effect	± 1.0	Rectangular	√3	1	1	± 0.6	± 0.6
Linearity	± 4.7	Rectangular	√3	1	1	± 2.7	± 2.7
System detection limits	± 1.0	Rectangular	√3	1	1	± 0.6	± 0.6
Modulation response	± 0.0	Rectangular	√3	1	1	± 0.0	± 0.0
Readout electronics	± 0.3	Normal	1	1	1	± 0.3	± 0.3
Response time (CW)	± 0.0	Rectangular	√3	1	1	± 0.0	± 0.0
Integration time	± 0.0	Rectangular	√3	1	1	± 0.0	± 0.0
RF ambient conditions - noise	± 1.0	Rectangular	√3	1	1	± 0.6	± 0.6
RF ambient conditions - reflections	± 1.0	Rectangular	√3	1	1	± 0.6	± 0.6
Probe positioner mechanical tolerance	± 0.4	Rectangular	√3	1	1	± 0.2	± 0.2
Probe positioning with respect to phantom shell	± 2.9	Rectangular	√3	1	1	± 1.7	± 1.7
Extrapolation, interpolation and integration algorithms for max. SAR evaluation	± 2.0	Rectangular	√3	1	1	± 1.2	± 1.2
System validation source							
Deviation of experimental source from numerical source	± 4.0	Normal	1	1	1	± 4.0	± 4.0
Input power and SAR drift measurement	± 3.4	Rectangular	√3	1	1	± 2.0	± 2.0
Other source contributions	± 2.0	Normal	1	1	1	± 2.0	± 2.0
Phantom and tissue parameters							
Phantom shell uncertainty – shape, thickness and permittivity	± 6.1	Rectangular	√3	1	1	± 3.5	± 3.5
Uncertainty in SAR correction for deviations in permittivity and conductivity	± 1.9	Normal	1	1	0.84	± 1.9	± 1.6
Liquid conductivity measurement	± 2.5	Normal	1	0.78	0.71	± 2.0	± 1.8
Liquid permittivity measurement	± 2.5	Normal	1	0.23	0.26	± 0.6	± 0.7
Liquid conductivity – temperature uncertainty	± 2.8	Rectangular	√3	0.78	0.71	± 1.3	± 1.2
Liquid permittivity – temperature uncertainty	± 1.9	Rectangular	√3	0.23	0.26	± 0.3	± 0.3
Combined standard uncertainty						± 10.2	± 10.1
Expanded uncertainty (95% confidence interval)						± 20.5	± 20.3

11. SPATIAL PEAK SAR EVALUATION

From Schmid & Partner Engineering AG, [DASY4 Manual, March 2003, Application Note: Spatial Peak SAR Evaluation].

Spatial Peak SAR

The DASY4 software includes all numerical procedures necessary to evaluate the spatial peak SAR values.
The spatial-peak SAR can be computed over any required mass.
The base for the evaluation is a “cube” measurement in a volume of 30mm^3 (7x7x7 points). The measured volume includes the 1g and 10g cubes with the highest averaged SAR values. For that purpose, the center of the measured volume is aligned to the interpolated peak SAR value of a previously performed area scan. The entire evaluation of the spatial peak values is performed within the post-processing engine (SEMCAD). The system always gives the maximum values for the 1g and 10g cubes. The algorithm to find the cube with highest averaged SAR is divided into the following stages:
1. Extraction of the measured data (grid and values) from the Zoom Scan,
2. Calculation of the SAR value at every measurement point based on all stored data (A/D values and measurement parameters),
3. Generation of a high-resolution mesh within the measured volume,
4. Interpolation of all measured values from the measurement grid to the high-resolution grid,
5. Extrapolation of the entire 3-D field distribution to the phantom surface over the distance from sensor to surface,
6. Calculation of the averaged SAR within masses of 1g and 10g.

Interpolation, Extrapolation and Detection of Maxima

The probe is calibrated at the center of the dipole sensors which is located 2 mm away from the probe tip. During measurements, the dipole sensors are 3 mm above the phantom surface. Both distances are included as parameters in the probe configuration file. The software always knows exactly how far away the measured point is from the surface. As the probe cannot directly measure at the surface, the values between the deepest measured point and the surface must be extrapolated.

The interpolation, extrapolation and maximum search routines are all based on the modified Quadratic Shepard’s method [Robert J. Renka, “Multivariate Interpolation Of Large Sets Of Scattered Data”, University of North Texas ACM Transactions on Mathematical Software, vol. 14, no. 2, June 1988, pp. 139-148.].

Averaging and Determination of Spatial Peak SAR

The interpolated data is used to average the SAR over the 1g and 10g cubes by spatially discretizing the entire measured volume. The resolution of this spatial grid used to calculate the averaged SAR is 1mm or about 42875 interpolated points. The resulting volumes are defined as cubical volumes containing the appropriate tissue parameters that are centered at the location. The location is defined as the center of the incremental volume (voxel).

12. EQUIPMENT TEST CONDITIONS

The following test conditions are given for information; the maximum output powers were measured.

Frequency range: 902MHz – 928MHz, FHSS
Modulation: FM
Crest factor: 4.43 (Tx duration is 27.11ms within a frame length of 120ms)
Test program: supplied by the applicant
Max output power: EMITECH test report reference: R041-15-107354-1A Ed.0

Frequency (MHz)	Conducted maximum peak power (dBm)
902.184	27.9
905.087	28.1
924.844	28.5
927.829	28.3

Secondary transmitter: Bluetooth Module Bluegiga Technologies, Model WT32i, FCC ID: QOQWT32I
Output power = 5.7 mW from SGS test report reference: 273079-2

13. MEASUREMENT SYSTEM DESCRIPTION

The automated near-field scanning system Dosimetric Assessment System DASY4 from Schmid & Partner Engineering AG was used. The measurement is performed using platform n° 2 (DASY4) referenced in paragraph 6 of this test report. The system consists of a computer controlled, high precision robotics system, robot controller, extreme near-field probes and the phantom containing the liquid. The six axis robot precisely positions the probe at the points of maximum electromagnetic field. A device holder made of low-loss dielectric material is used to maintain the test position of the equipment under test against the phantom. The measurements were conducted in an RF controlled environment (i.e. semi anechoic room). Fig. 14 shows the system.

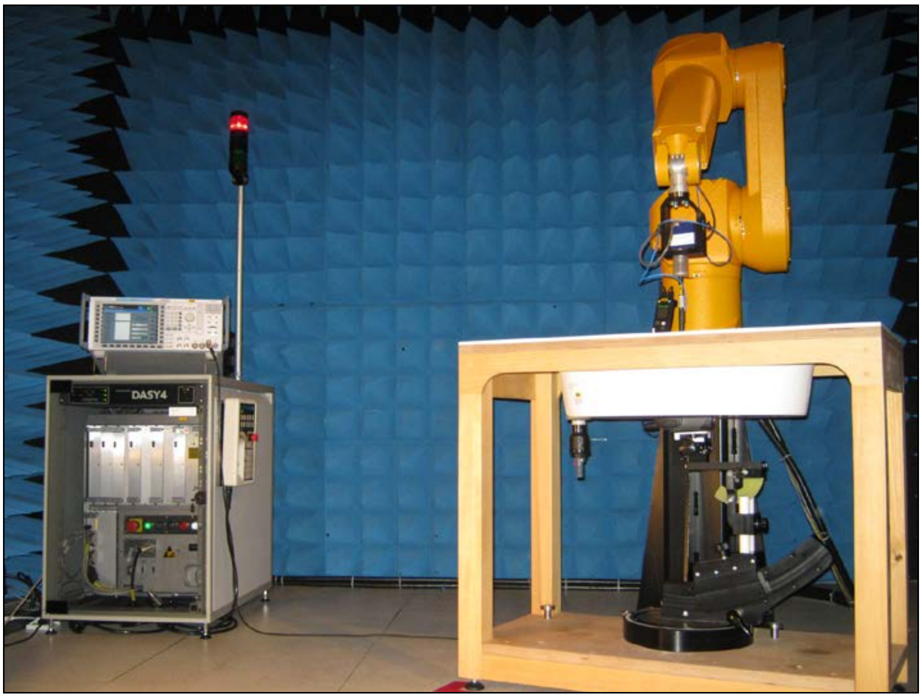


Fig. 14: The measurement setup with equipment under test.

14. LIQUID MEASUREMENT: TEST CONDITIONS & RESULTS

The liquid measurement is performed using platform n° 3 (Liquid measure) referenced in paragraph 6 of this test report. The following ingredients (in % by weight) are theoretical and given for information.

900 MHz liquid:
Sugar 41.76 %
De-ionised water 56.0 %
NaCl salt 0.76 %
HEC 1.21 %
Bactericide 0.27 %

The dielectric parameters of the liquid were controlled prior to assessment (contact probe method).

Dielectric properties measured (Meas. Date: May 30, 2016):

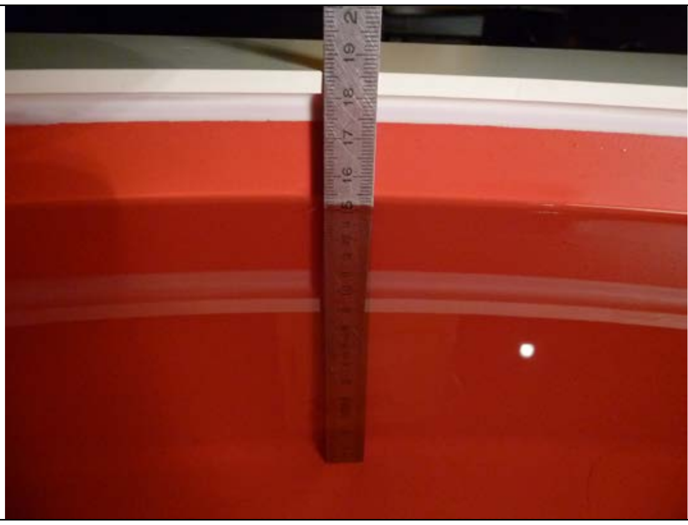
Frequency (MHz)	ε_r (F/m) Targeted value	ε_r (F/m) Measured value	σ (S/m) Targeted value	σ (S/m) Measured value	Liquid temperature (°C)	Ambient temperature (°C)
900	55.0 ± 5 %	53.1	1.05 ± 5 %	1.02	21.0	22.1
905	55.0 ± 5 %	52.9	1.05 ± 5 %	1.03		
915	55.0 ± 5 %	52.8	1.06 ± 5 %	1.04		
925	55.0 ± 5 %	52.7	1.06 ± 5 %	1.05		

Dielectric properties measured (Meas. Date: June 02, 2016):

Frequency (MHz)	**ε_r (F/m)** Targeted value	**ε_r (F/m)** Measured value	**σ (S/m)** Targeted value	**σ (S/m)** Measured value	**Liquid temperature (°C)**	**Ambient temperature (°C)**
900	55.0 ± 5 %	53.8	1.05 ± 5 %	1.01	21.6	22.7
905	55.0 ± 5 %	53.7	1.05 ± 5 %	1.02		
915	55.0 ± 5 %	53.6	1.06 ± 5 %	1.03		
925	55.0 ± 5 %	53.5	1.06 ± 5 %	1.04		

The phantom shall be filled with tissue-equivalent liquid to a depth of at least 15cm.

The liquid depth measured in the phantom was 15.2cm as shown in the attached photograph.



15. SYSTEM VALIDATION: TEST CONDITIONS & RESULTS

The system validation is performed using platform n° 4 (System validation) referenced in paragraph 6 of this test report.

Measurement conditions: The measurements were performed with the ELI4 phantom filled with liquids. The validation dipole input power was 250mW.
Prior to the assessment, the validation dipole were used to check whether the system was operating within its specification of ± 10 %.

Measurement results: The results are hereafter below and shown in Fig. 15 to Fig. 16.

Frequency (MHz)	**SAR 1g (W/kg)** Targeted value	**SAR 1g (W/kg)** Measured value	**Meas. date**
900	2.775 ± 10%	2.75	May 30, 2016
900	2.775 ± 10%	2.70	June 02, 2016

DUT: Dipole 900 MHz

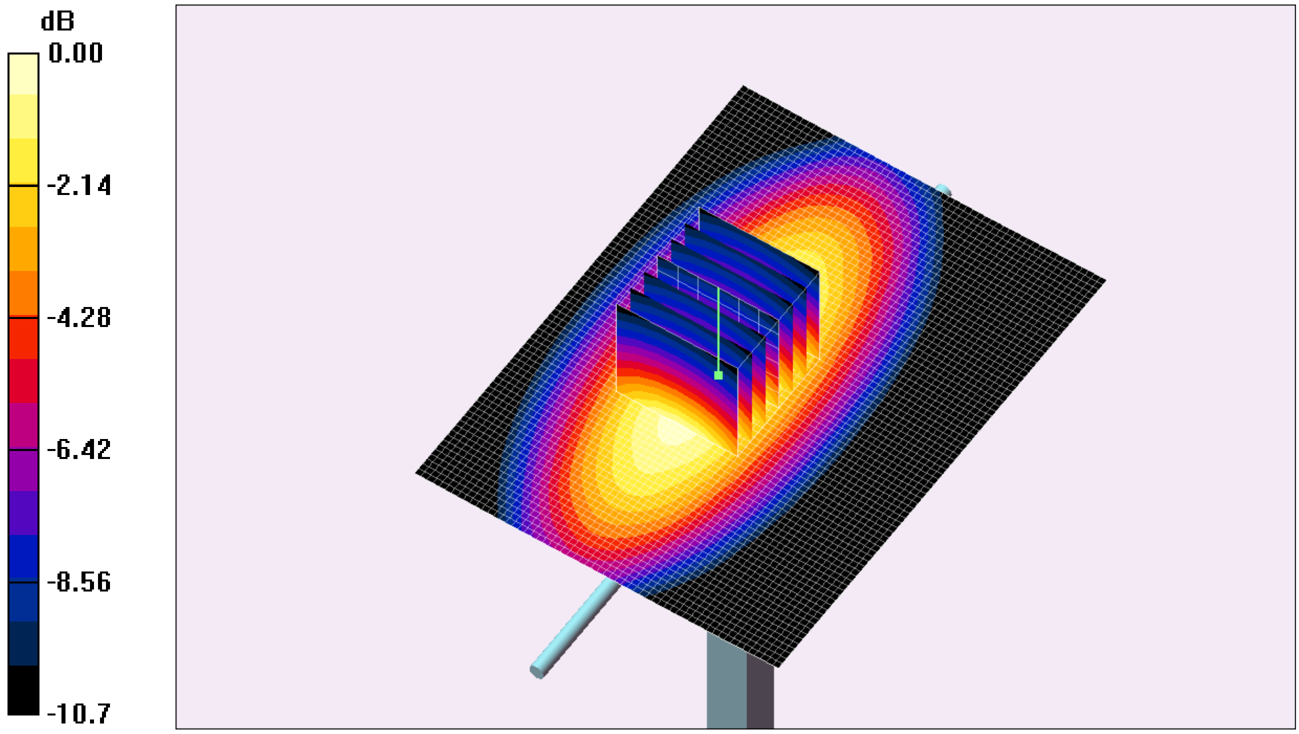
Communication System: CW; Frequency: 900 MHz; Duty Cycle: 1:1
Medium parameters used: σ = 1.02 mho/m, ε_r = 53.1; ρ = 1000 kg/m^3
Phantom section: Flat Section

Program Notes: Ambient temperature: 22.3°C, Liquid temperature: 21.0°C

DASY4 Configuration:
- Probe: ES3DV3 - SN3303; ConvF(5.92, 5.92, 5.92); Calibrated: 8/21/2015
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn402; Calibrated: 8/13/2015
- Phantom: ELI 4.0; Type: QDOVA001BA; Serial: 1067
- Measurement SW: DASY4, V4.5 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 145

d=15mm, Pin=250mW/Area Scan (61x81x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 3.20 mW/g

d=15mm, Pin=250mW/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 57.3 V/m; Power Drift = -0.034 dB
Peak SAR (extrapolated) = 4.13 W/kg
SAR(1 g) = 2.75 mW/g; SAR(10 g) = 1.78 mW/g
Maximum value of SAR (measured) = 3.23 mW/g



0 dB = 3.23mW/g

Fig. 15: 900MHz validation result
Meas. date: May 30, 2016

DUT: Dipole 900 MHz

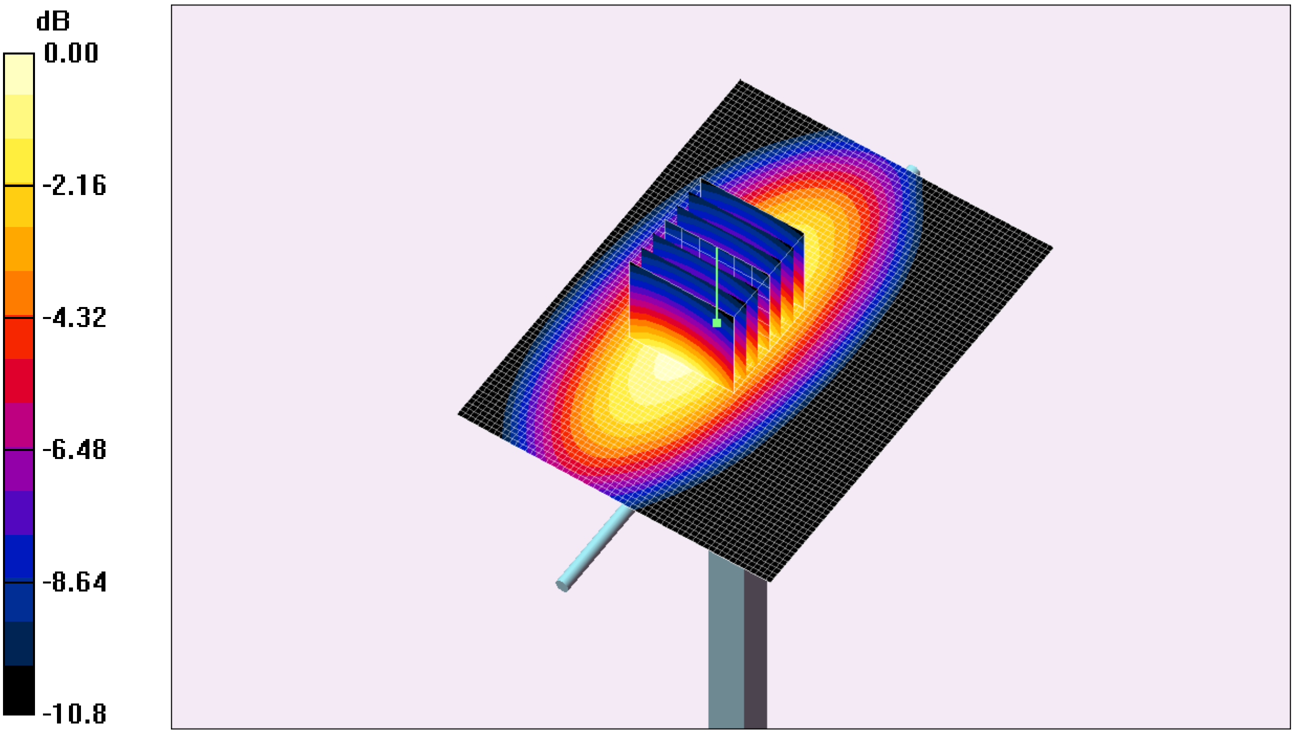
Communication System: CW; Frequency: 900 MHz; Duty Cycle: 1:1
Medium parameters used: σ = 1.01 mho/m, ε_r = 53.8; ρ = 1000 kg/m^3
Phantom section: Flat Section

Program Notes: Ambient temperature: 22.9°C, Liquid temperature: 21.7°C

DASY4 Configuration:
- Probe: ES3DV3 - SN3303; ConvF(5.92, 5.92, 5.92); Calibrated: 8/21/2015
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn402; Calibrated: 8/13/2015
- Phantom: ELI 4.0; Type: QDOVA001BA; Serial: 1067
- Measurement SW: DASY4, V4.5 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 145

d=15mm, Pin=250mW/Area Scan (61x81x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 3.13 mW/g

d=15mm, Pin=250mW/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 55.8 V/m; Power Drift = -0.00 dB
Peak SAR (extrapolated) = 4.05 W/kg
SAR(1 g) = 2.7 mW/g; SAR(10 g) = 1.75 mW/g
Maximum value of SAR (measured) = 3.17 mW/g



0 dB = 3.17mW/g

Fig. 16: 900MHz validation result
Meas. date: June 02, 2016

□□□ End of report, 3 annexes to be forwarded □□□

ANNEX 1: ES3DV3 CALIBRATION CERTIFICATE

ANNEX 2: DAE3 CALIBRATION CERTIFICATE

ANNEX 3: D900V2 CALIBRATION CERTIFICATE

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

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 Emitech

Certificate No: ES3-3303_Aug15

CALIBRATION CERTIFICATE

Object	ES3DV3 - SN:3303
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:	August 21, 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-14)	In house check: Oct-15

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

Issued: August 22, 2015

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 ES3DV3

SN:3303

Manufactured: August 27, 2010
Calibrated: August 21, 2015

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

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3303

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu V/(V/m)^2$)[A]	1.37	1.39	1.40	± 10.1 %
DCP (mV)[B]	102.8	103.6	101.8	

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	224.5	±3.5 %
		Y	0.0	0.0	1.0		223.7	
		Z	0.0	0.0	1.0		221.8	

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: ES3DV3 - SN:3303

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)
450	43.5	0.87	6.87	6.87	6.87	0.18	2.20	± 13.3 %
750	41.9	0.89	6.41	6.41	6.41	0.43	1.60	± 12.0 %
900	41.5	0.97	6.12	6.12	6.12	0.74	1.22	± 12.0 %
1810	40.0	1.40	5.04	5.04	5.04	0.80	1.16	± 12.0 %
1950	40.0	1.40	4.91	4.91	4.91	0.60	1.34	± 12.0 %
2150	39.7	1.53	4.84	4.84	4.84	0.64	1.41	± 12.0 %
2300	39.5	1.67	4.78	4.78	4.78	0.67	1.41	± 12.0 %
2450	39.2	1.80	4.45	4.45	4.45	0.80	1.26	± 12.0 %
2600	39.0	1.96	4.39	4.39	4.39	0.80	1.29	± 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.

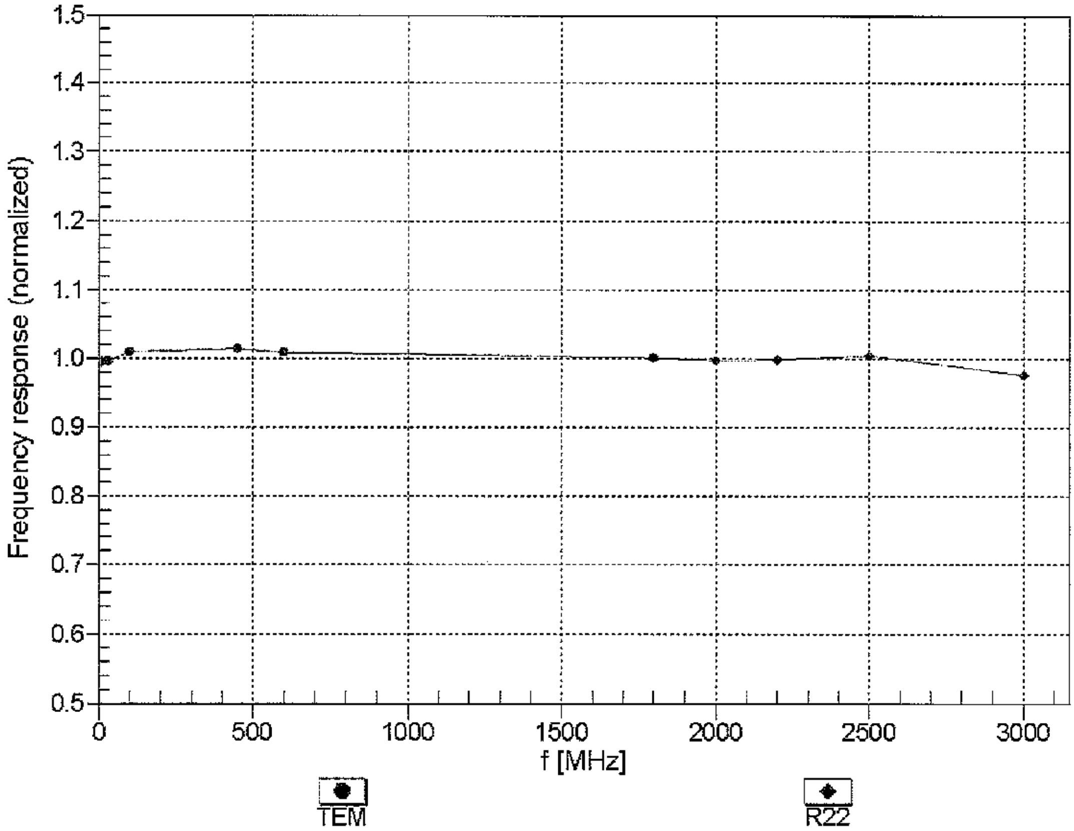
DASY/EASY - Parameters of Probe: ES3DV3 - SN:3303

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	6.08	6.08	6.08	0.55	1.35	± 12.0 %
900	55.0	1.05	5.92	5.92	5.92	0.61	1.30	± 12.0 %
1810	53.3	1.52	4.76	4.76	4.76	0.68	1.34	± 12.0 %
2000	53.3	1.52	4.79	4.79	4.79	0.63	1.38	± 12.0 %
2450	52.7	1.95	4.31	4.31	4.31	0.80	1.17	± 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.

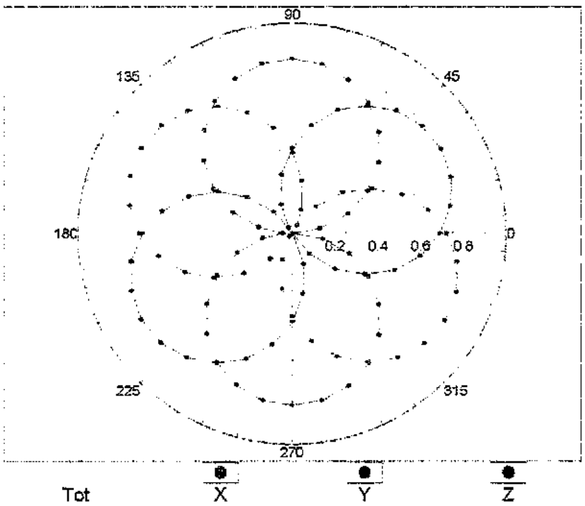
Frequency Response of E-Field
(TEM-Cell:ifi110 EXX, Waveguide: R22)



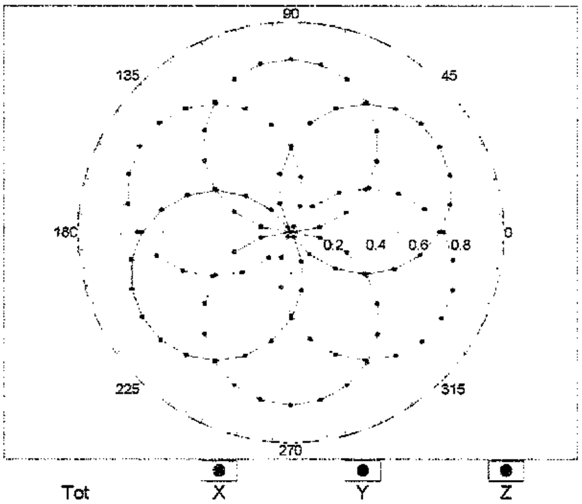
Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

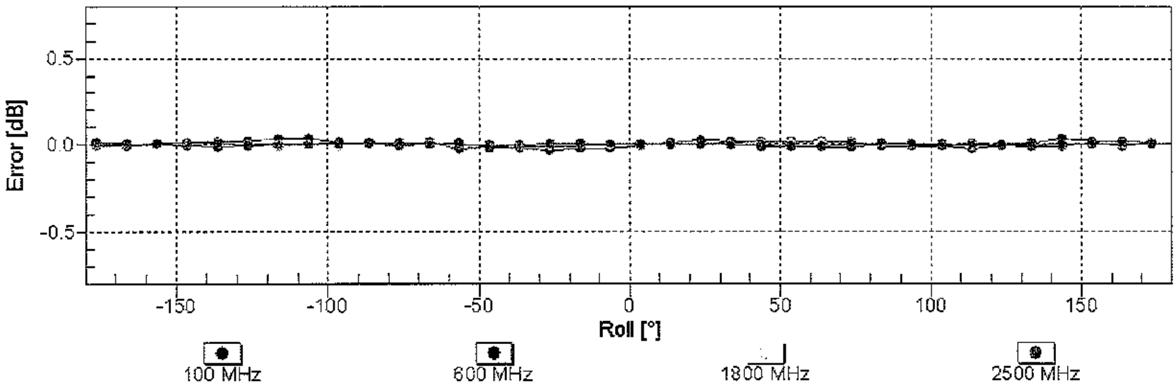
Receiving Pattern (ϕ), ϑ = 0°

f=600 MHz,TEM



f=1800 MHz,R22

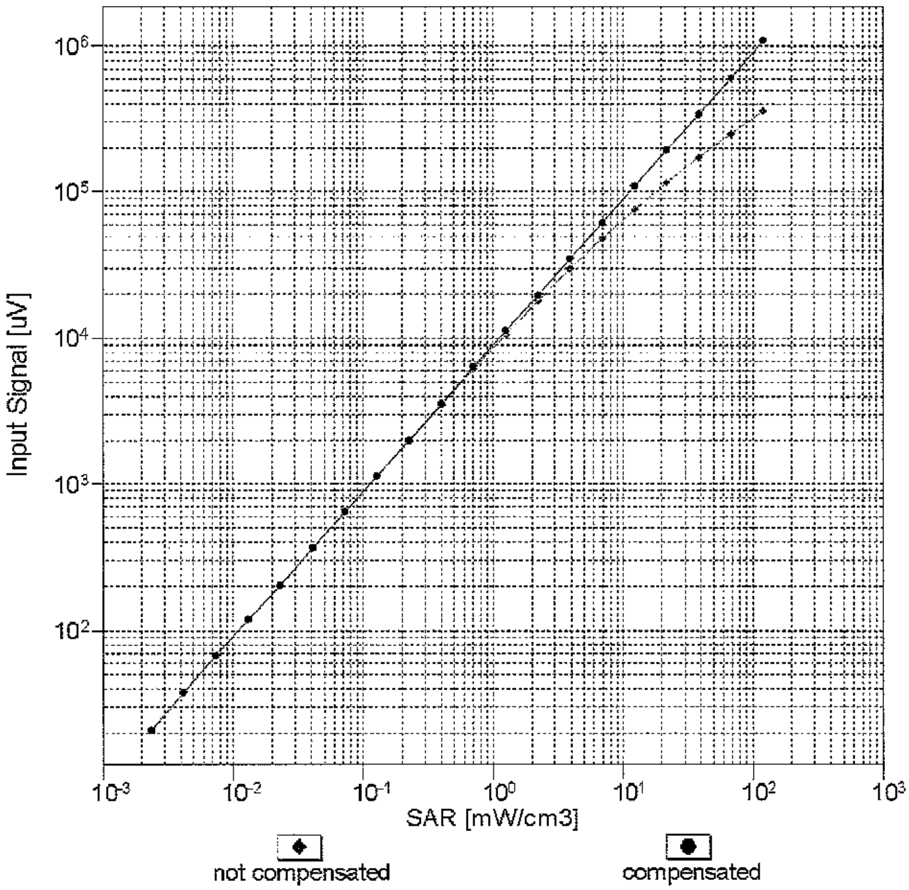


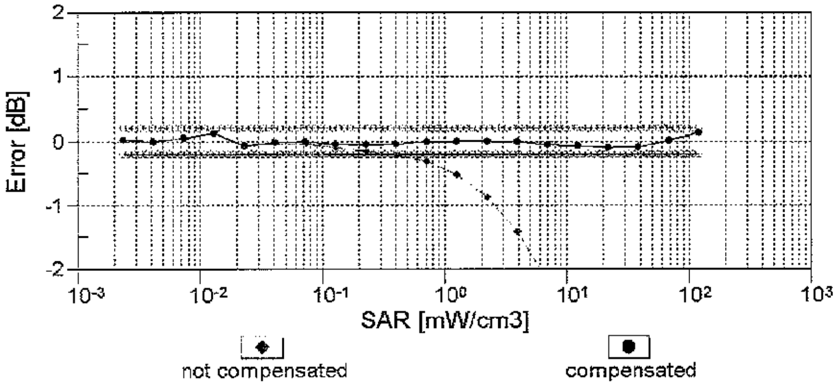


Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

Dynamic Range f(SAR$_{head}$)

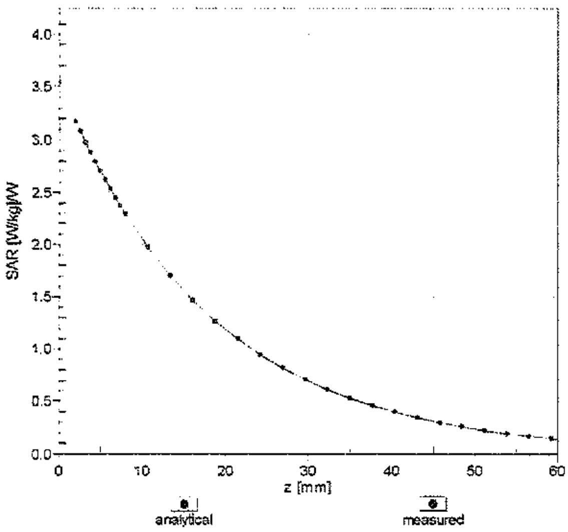
(TEM cell , f_{eval}= 1900 MHz)

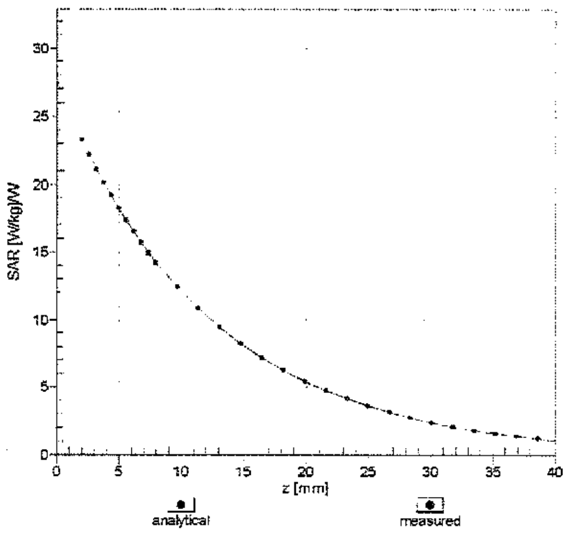




Uncertainty of Linearity Assessment: ± 0.6% (k=2)

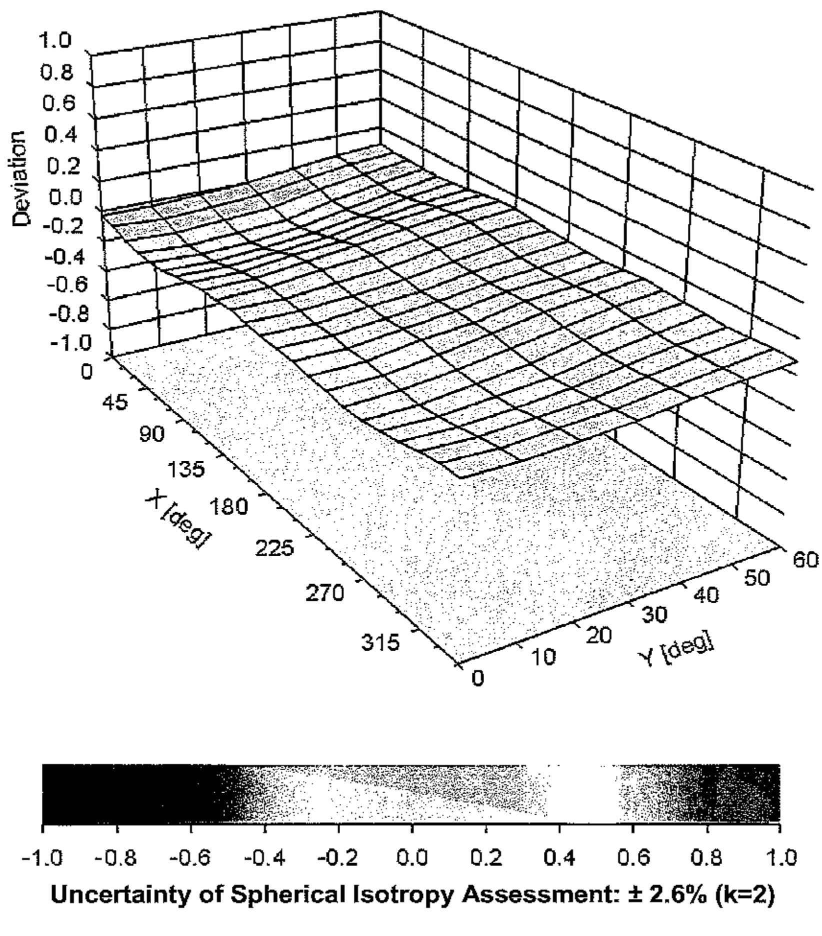
Conversion Factor Assessment





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: ES3DV3 - SN:3303

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	43.6
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	4 mm
Probe Tip to Sensor X Calibration Point	2 mm
Probe Tip to Sensor Y Calibration Point	2 mm
Probe Tip to Sensor Z Calibration Point	2 mm
Recommended Measurement Distance from Surface	3 mm

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**

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 **EMITECH Le Mans**

Certificate No: DAE3-402_Aug15

CALIBRATION CERTIFICATE

Object	DAE3 - SD 000 D03 AA - SN: 402
Calibration procedure(s)	QA CAL-06.v29 Calibration procedure for the data acquisition electronics (DAE)
Calibration date:	August 13, 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	03-Oct-14 (No:15573)	Oct-15
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:	Eric Hainfeld	Technician	
Approved by:	Fin Bomholt	Deputy Technical Manager	

Issued: August 13, 2015

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.

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	403.413 ± 0.02% (k=2)	403.326 ± 0.02% (k=2)	403.896 ± 0.02% (k=2)
Low Range	3.93614 ± 1.50% (k=2)	3.96076 ± 1.50% (k=2)	3.96564 ± 1.50% (k=2)

Connector Angle

Connector Angle to be used in DASY system	241.5 ° ± 1 °

Appendix (Additional assessments outside the scope of SCS0108)

1. DC Voltage Linearity

High Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	199996.18	-0.02	-0.00
Channel X	+ Input	20009.97	8.77	0.04
Channel X	- Input	-19995.07	5.69	-0.03
Channel Y	+ Input	199997.64	1.44	0.00
Channel Y	+ Input	20004.89	3.55	0.02
Channel Y	- Input	-19999.87	0.79	-0.00
Channel Z	+ Input	199998.51	2.21	0.00
Channel Z	+ Input	19999.97	-1.22	-0.01
Channel Z	- Input	-20008.99	-8.17	0.04

Low Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	2001.59	0.48	0.02
Channel X	+ Input	202.20	0.78	0.39
Channel X	- Input	-198.38	0.07	-0.04
Channel Y	+ Input	2001.14	0.02	0.00
Channel Y	+ Input	201.19	-0.32	-0.16
Channel Y	- Input	-198.67	-0.33	0.16
Channel Z	+ Input	2000.93	-0.11	-0.01
Channel Z	+ Input	200.68	-0.72	-0.36
Channel Z	- Input	-199.16	-0.70	0.35

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	7.13	5.00
	- 200	-4.05	-6.00
Channel Y	200	-1.18	-1.41
	- 200	1.18	0.70
Channel Z	200	0.83	0.82
	- 200	-2.48	-2.76

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	-	3.34	-2.47
Channel Y	200	7.78	-	4.22
Channel Z	200	8.29	5.64	-

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	16293	16445
Channel Y	15883	16533
Channel Z	16454	17086

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	0.66	-0.12	1.39	0.34
Channel Y	-0.21	-1.54	0.97	0.32
Channel Z	-0.29	-1.16	0.86	0.37

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

EMITECH GROUPE

CALIBRATION CERTIFICATE

Equipment under calibration:
Designation: 900MHz dipole
Brand: Schmid & Partner Engineering AG
Type: D900V2
Serial number: 086
Emitech number: 7194

Calibration date: May 30, 2016

Operator: Emmanuel TOUTAIN

Calibration procedure: PRTFIC000MET00050

Environnemental conditions :
Ambient Temperature: 22.3°C
Liquid Temperature: 21.0°C
Hygrometry: 30% HR

Equipment used:

EMITECH N°	DESIGNATION	BRAND	TYPE	CALIBRATION PERIODICITY	CALIBRATION DUE DATE
1402	Network Analyser	Hewlett Packard	8753C	12 months	Jul. 07, 2016
7217	Calibration kit	Hewlett Packard	85033D	24 months	Jul. 07, 2016

Liquid measurements:

Frequency (MHz)	Liquid : Head		Liquid : Body (1)	
	Sigma	Epsilon	Sigma	Epsilon
900	-	-	1.02	53.1

Note (1): dielectric properties according to KDB865664, A.1. Tissue Dielectric Parameters

Return loss measurements:

Dipole	Frequency (MHz)	Liquid : Head		Liquid : Body	
		Return loss (dB)	Verdict (2) ≤ -20dB	Return loss (dB)	Verdict (2) ≤ -20dB
D900V2	900	-	-	-23.1	**PASS**

Note (2): The reference dipole shall have a return loss better than –20 dB.

Conclusion: In Tolerance

Visa:

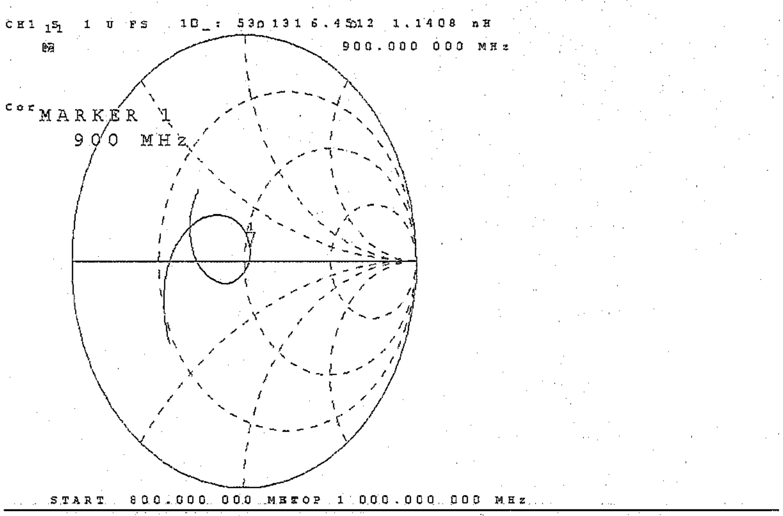
SAR measurements:

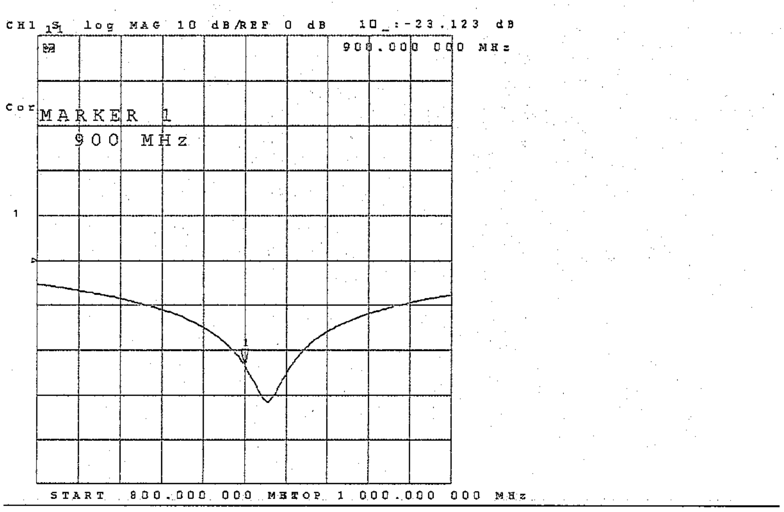
2450MHz at 10mm	Liquid : Head		Liquid : Body	
	SAR1g (W/kg)	SAR10g (W/kg)	SAR1g (W/kg)	SAR10g (W/kg)
SAR measured (Pin = 250mW)	-	-	2.75	1.78
SAR normalized to 1 W	-	-	11.0	7.12

The expanded uncertainty (k=2) is ±18.4 % in 1g and ± 17.8 % in 10g.

Impedance measurement:

Impedance	53.1 Ω + 6.5 jΩ





DUT: Dipole 900 MHz

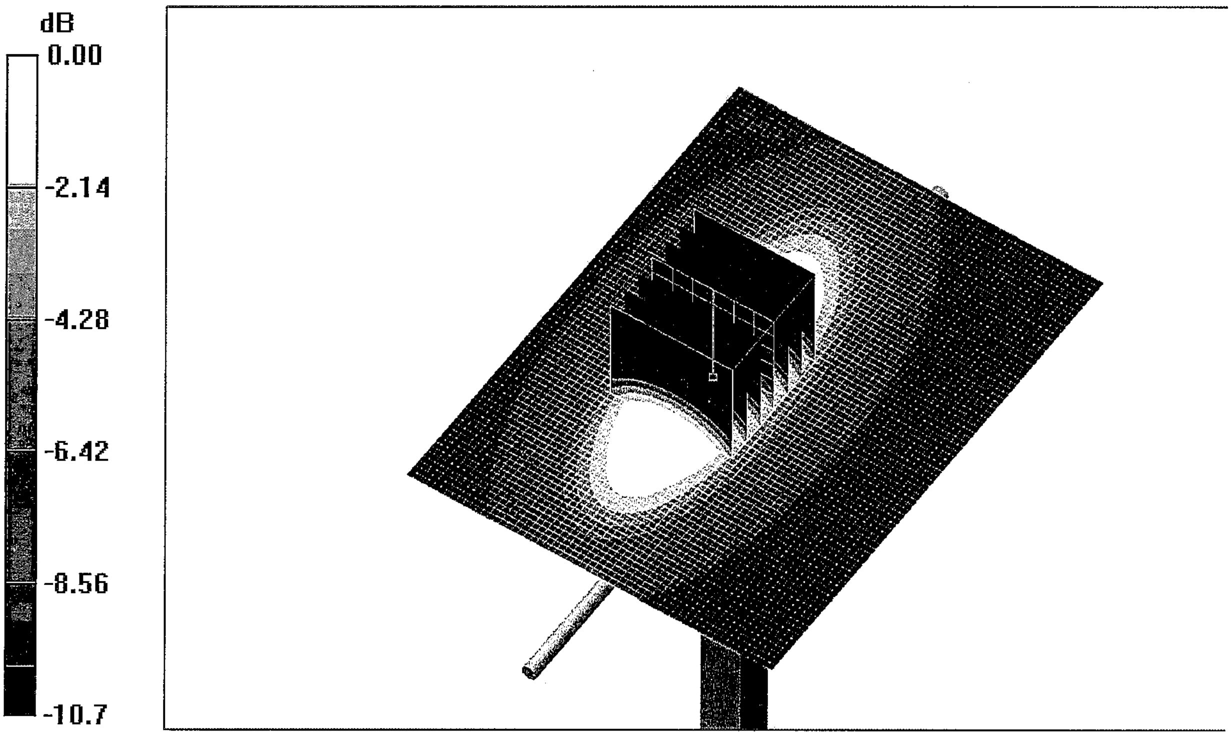
Communication System: CW; Frequency: 900 MHz; Duty Cycle: 1:1
Medium parameters used: $\sigma = 1.02$ mho/m, $\varepsilon_r = 53.1$; $\rho = 1000$ kg/m^3
Phantom section: Flat Section

Program Notes: Ambient temperature: 22.3°C, Liquid temperature: 21.0°C

DASY4 Configuration:
- Probe: ES3DV3 - SN3303; ConvF(5.92, 5.92, 5.92); Calibrated: 8/21/2015
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn402; Calibrated: 8/13/2015
- Phantom: ELI 4.0; Type: QDOVA001BA; Serial: 1067
- Measurement SW: DASY4, V4.5 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 145

d=15mm, Pin=250mW/Area Scan (61x81x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 3.20 mW/g

d=15mm, Pin=250mW/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 57.3 V/m; Power Drift = -0.034 dB
Peak SAR (extrapolated) = 4.13 W/kg
SAR(1 g) = 2.75 mW/g; SAR(10 g) = 1.78 mW/g
Maximum value of SAR (measured) = 3.23 mW/g



0 dB = 3.23mW/g