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SAR TEST REPORT

FCC 47 CFR Part 2.1093
Industry Canada RSS-102

RF-Exposure evaluation of portable equipment

Report Reference No. .... :	G0M-1212-2506-TFC093S-V01
Testing Laboratory .... :	Eurofins Product Service GmbH
Address .... :	Storkower Str. 38c 15526 Reichenwalde Germany
Accreditation .... :	ilac-MRA / A2LA ACCREDITED TESTING CERT# 1983.01 A2LA Accredited Testing Laboratory, Certificate No.: 1983.01 FCC Filed Test Laboratory, Reg.-No.: 96970 IC OATS Filing assigned code: 3470A
Applicant's name .... :	ecom instruments GmbH
Address .... :	Industriestaße 2 97959 Assamstadt Germany
Test specification:	
Standard.. :	FCC 47 CFR Part 2 §2.1093 FCC OET Bulletin 65 Supplement C 01-01 IEEE Std. 1528 - 2003 IC RSS-102 Issue 4 Safety Code 6 (2009)
Non-standard test method…………..:	None
Test scope………….. .... :	complete Radio compliance test
Equipment under test (EUT):	
Product description	Handheld Computer with WLAN (abgn) & bluetooth , Scanner and RFID
Model No.	Ci70AN2XX00 (Numeric) Ci70AQ2XX00 (Alpha)
Additional Models	None
Hardware version	A
Firmware / Software version	1.50.19.0013
Contains	FCC-ID: XAM300011GR01 IC: 8311A-300011GR01
Test result	**Passed**

Possible test case verdicts:	
- neither assessed nor tested ....:	N/N
- required by standard but not appl. to test object........:	N/A
- required by standard but not tested............................:	N/T
- not required by standard for the test object ....:	N/R
- test object does meet the requirement.......................:	P (Pass)
- test object does not meet the requirement.................:	F (Fail)
Testing:	
Date of receipt of test item ....:	2013-01-09
Date (s) of performance of tests ....:	2013-01-010 - 2013-07-12
Compiled by .... :	Christian Weber
Tested by (+ signature).................... : (Testing Manager)	Burkhard Pudell
Approved by (+ signature) .... : (Test Lab Manager)	Jens Zimmermann
Date of issue .... :	2013-08-16
Total number of pages .... :	103

General remarks:

The test results presented in this report relate only to the object tested.

The results contained in this report reflect the results for this particular model and serial number. It is the responsibility of the manufacturer to ensure that all production models meet the intent of the requirements detailed within this report.

This report shall not be reproduced, except in full, without the written approval of the Issuing testing laboratory.

Additional comments:

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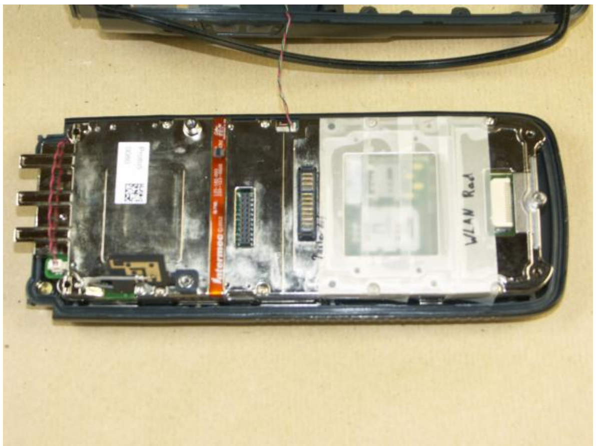
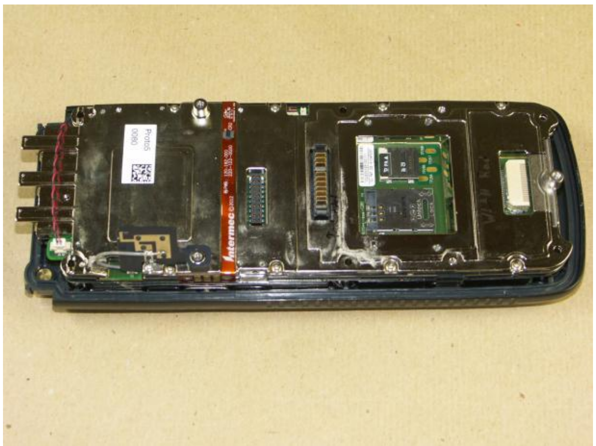
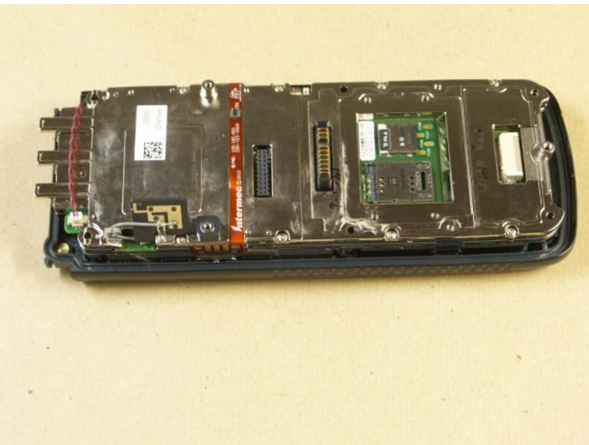
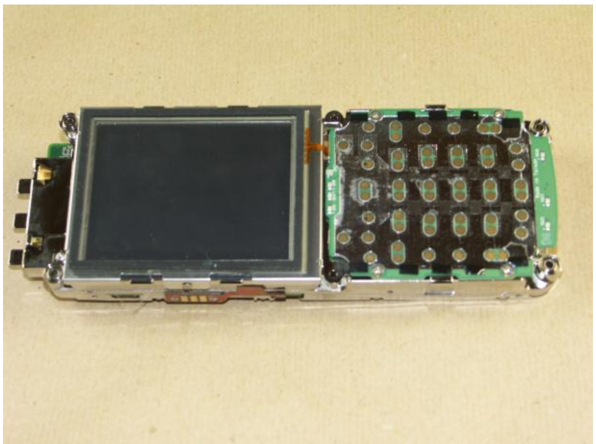
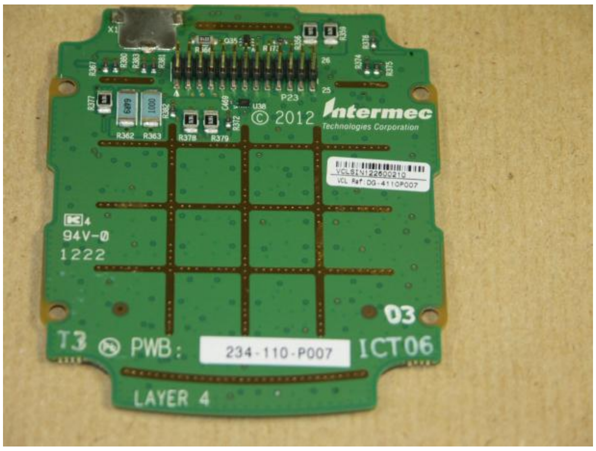
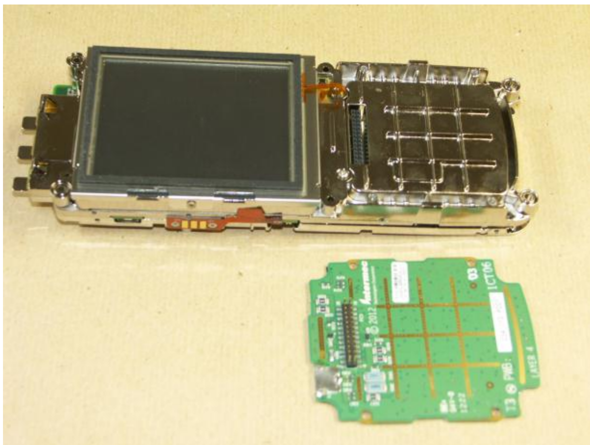
1 Equipment (Test item) Description

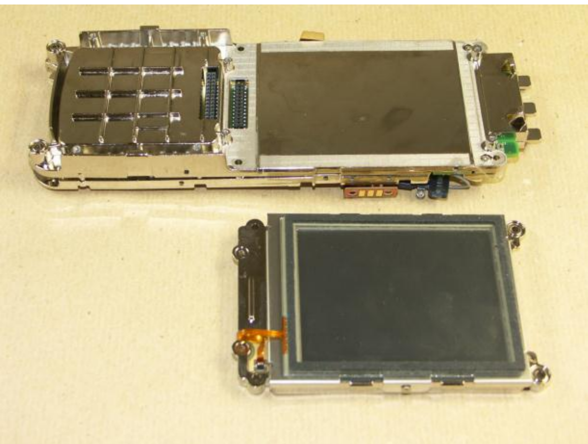
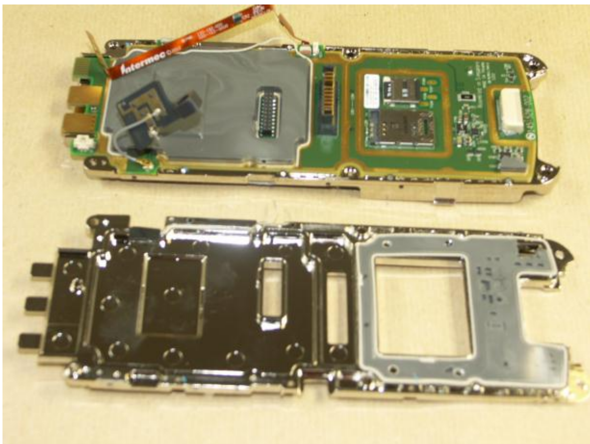
Description	Handheld Computer with WLAN (abgn)&bluetooth , Scanner and RFID	
Model	Ci70AN2XX00 (Numeric) Ci70AQ2XX00 (Alpha)	
Additional Models	None	
Serial number	None	
Hardware version	A	
Software / Firmware version	1.50.19.0013	
Contains FCC-ID	XAM300011GR01	
Contains IC	8311A-300011GR01	
Equipment type	End product	
Prototype or production unit	Identical Prototype	
Device category	Handset	
Environment	General public	
Radio technologies	Bluetooth, WLAN IEEE 802.11a,b,g,n	
Operating frequency ranges	2.4 GHz : 2.4 GHz : 5 GHz :	2402 – 2480 MHz (Bluetooth) 2412 – 2472 MHz (WLAN 20 MHz / 1 Stream) 5180 – 5320 MHz (WLAN 20 MHz / 1 Stream) 5500 – 5700 MHz (WLAN 20 MHz / 1 Stream) 5745 – 5825 MHz (WLAN 20 MHz / 1 Stream)
Modulations	Bluetooth: GFSK / PI/4-DQPSK / 8-DPSK WLAN: CCK / DSSS / OFDM	
Antenna	Type	integrated
	Model	unspecified
	Manufacturer	unspecified
	Gain	3.3 dBi
Power supply	V_{NOM}	3.7 VDC (Lithium Battery)
AC/DC-Adaptor	Model	N/A
	Vendor	N/A
	Input	N/A
	Output	N/A
Accessories	None	
Manufacturer	ecom instruments GmbH Industriestaße 2 97959 Assamstadt Germany	

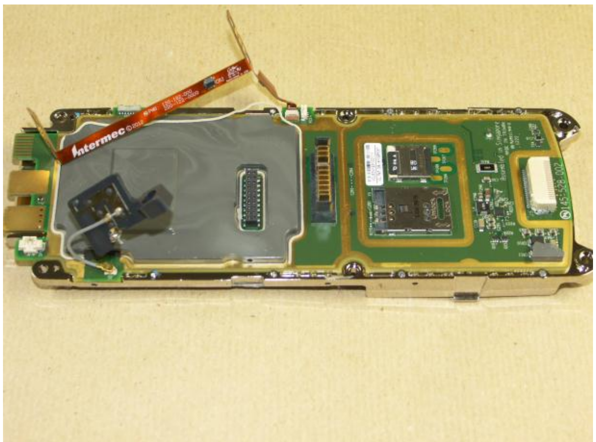
1.1 Equipment photos

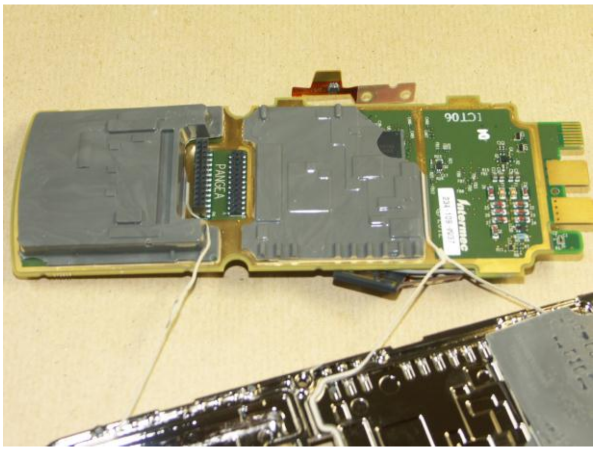
EUT TOP	EUT BOTTOM
	
EUT RIGHT	**EUT LEFT**
	
EUT REAR	**EUT OPEN BOTTOM**
	

EUT OPEN BOTTOM	EUT OPEN BOTTOM
	
EUT OPEN BOTTOM	**EUT OPEN BOTTOM**
	
EUT OPEN TOP	**EUT PCB**
	

EUT PCB	EUT PCB
	

EUT PCB	EUT PCB
	

EUT PCB	EUT PCB
	

EUT PCB	EUT BATTERY
	

1.2 Equipment setup photos

TESTSETUP EUT FRONT	TESTSETUP EUT BACK
	

1.3 Reference Documents

Document
KDB Publication 447498 : Mobile and Portable Device RF Exposure Procedures and Equipment Authorization Polices
KDB Publication 648474 : SAR Evaluation Considerations for Handsets with Multiple Transmitters and Antennas
KDB Publication 648474 : Review and Approval Policies for SAR Evaluation of Handsets with Multiple Transmitters and Antennas
KDB Publication 865664 : SAR measurement procedures for devices operating between 100 MHz to 6 GHz
KDB Publication 941225: SAR Measurement Procedures for 3G Devices
KDB Publication 941225: 3GPP R6 HSPA and R7 HSPA+ SAR Guidance
KDB Publication 941225: Recommended SAR Test Reduction Procedures for GSM/GPRS/EDGE
KDB Publication 941225: SAR Test Consideration for LTE Handsets and Data Modems
KDB Publication 447498 : SAR Measurement Procedures for USB Dongle Transmitters
KDB Publication 248227 : SAR Measurement Procedures for 802.11 a/b/g Transmitters
KDB Publication 450824 : SAR Probe Calibration and System Verification considerations for measurements from 150 MHz to 3 GHz

1.4 Supporting Equipment Used During Testing

Product Type*	Device	Manufacturer	Model No.	Comments
None				

***Note:** Use the following abbreviations:

AE : Auxiliary/Associated Equipment, or

SIM : Simulator (Not Subjected to Test)

CABL : Connecting cables

1.5 Supported standalone operating modes

Mode	Modulation	Frequency range	Maximum Duty cycle
Bluetooth	FHSS, GFSK	2402 – 2480 MHz	0.775
Bluetooth	FHSS, PI/4-DQPSK	2402 – 2480 MHz	0.775
Bluetooth	FHSS, 8-DPSK	2402 – 2480 MHz	0.775
802.11b/n 20MHz	DSSS	2412 – 2472 MHz	1.0
802.11g/n 20MHz	OFDM	2412 – 2472 MHz	1.0
802.11a/n 20 MHz	OFDM	5180 – 5320 MHz	1.0
802.11a/n 20 MHz	OFDM	5500 – 5700 MHz	1.0
802.11a/n 20 MHz	OFDM	5745 – 5825 MHz	1.0

1.6 Supported concurrent (multi-transmitter) operating modes

The EUT contains a fixed WLAN transceiver, a Bluetooth BR+EDR transceiver and one RFID reader. The RFID reader can be either model TLB30 (FCC-ID: XAM300011GR03 / IC: 8311A-300011GR03), UNI13 (FCC-ID: XAM300011GR04 / IC: 8311A-300011GR04) or LID (FCC-ID: XAM300011GR05 / IC: 8311A-300011GR05). Each of the RFID reader can operate on either 125 khz, 134 kHz or 13.56 MHz.

All three transceiver (WLAN, Bluetooth and RFID) can operate simultaneously.

Due to the fact that the RFID reader are categorically excluded from RF-Exposure evaluation according to 47 CFR §2.1093 the RFID readers are excluded from the RF-Exposure evaluation.

According to KDB 447498 D01 v05 for standalone SAR evaluation the test exclusion power condition is given by

$$\frac{\max Power, mW}{test\ distance, mm} \cdot \sqrt{f_{GHz}} \leq 3.0$$

With the maximum source-base time averaged conducted power level of 5.21 dBm the test exclusion condition gives (test distance 5 mm for distances ≤ 5 mm)

$$\frac{max\ Power, mW}{test\ distance, mm} \cdot \sqrt{f_{GHz}} = \frac{3.3}{5} \cdot \sqrt{2.441} = 1.0 \leq 3.0$$

Hence the test exclusion condition for the Bluetooth transmitter for standalone operation is fulfilled.

For simultaneous transmission SAR the following SAR estimation exists:

$$\frac{\max Power,\ mW}{test\ distance, mm} \cdot \frac{\sqrt{f_{GHz}}}{7.5}$$

For the maximum power level and the test distance of 5 mm the following SAR value estimation is given:

$$\frac{max\ Power, mW}{test\ distance, mm} \cdot \frac{\sqrt{f_{GHz}}}{7.5} = \frac{3.3}{5} \cdot \frac{\sqrt{2.441}}{7.5} = 0.137\, \frac{W}{kg}$$

Taking this SAR estimation into account the maximum SAR value for the WLAN transceiver has to be lower or equal to 1.6 – 0.137 = 1.463. As long as the maximum SAR value for the WLAN transmitter is lower than 1.463 W/kg that WLAN transmitter complies with the SAR limit.

1.7 Supported use cases

Use case	Distance to human body	corresponding test configuration
EUT placed at human body	0 mm (worst case)	body-worn device

1.8 Radio Test Modes

Mode	Settings
Bluetooth DH5	Mode = Bluetooth Modulation = FHSS, GFSK Duty cycle = 77.5% Data rate = 1 Mbps Power level = maximum Antenna = integrated
Bluetooth 2-DH5	Mode = Bluetooth Modulation = FHSS, PI/4-DQPSK Duty cycle = 77.5% Data rate = 2 Mbps Power level = maximum Antenna = integrated
Bluetooth 3-DH5	Mode = Bluetooth Modulation = FHSS, 8-DPSK Duty cycle = 77.5% Data rate = 3 Mbps Power level = maximum Antenna = integrated
IEEE 802.11b	Mode = 802.11b/n 20MHz Modulation = DSSS Duty cycle = 100% Data rate = 1, 2, 5.5, 11 Mbps Power level = maximum Antenna = integrated
IEEE 802.11g	Mode = 802.11g/n 20MHz Modulation = OFDM Duty cycle = 100% Data rate = 6, 9, 12, 18, 24, 36, 48, 54 Mbps Power level = maximum Antenna = integrated
IEEE 802.11g/n	Mode = 802.11g/n 20MHz Modulation = OFDM Duty cycle = 100% Data rate = MCS0-7 Power level = maximum Antenna = integrated

IEEE 802.11a	Mode = 802.11a/n 20MHz Modulation = OFDM Duty cycle = 100% Data rate = 6, 9, 12, 18, 24, 36, 48, 54 Mbps Power level = maximum Antenna = integrated
IEEE 802.11a/n	Mode = 802.11a/n 20MHz Modulation = OFDM Duty cycle = 100% Data rate = MCS0-7 Power level = maximum Antenna = integrated

1.9 Conducted Power Values Bluetooth

Bluetooth							
Channel	Frequency [MHz]	Peak (Burst) RMS Power [dBm]			Source-based time averaged Power [dBm]		
		BR (GFSK)	EDR (PI/4-DQPSK)	EDR (8-DPSK)	BR (GFSK)	EDR (PI/4-DQPSK)	EDR (8-DPSK)
		DH5	2-DH5	3-DH5	DH5	2-DH5	3-DH5
0	2402	6.27	3.81	3.72	5.16	2.70	2.61
39	2441	6.32	3.99	4.09	**5.21**	2.88	2.98
78	2480	6.14	3.95	4.03	5.13	2.75	2.92

1.10 Conducted Power Values WLAN 2.4 GHz

The conducted power values for the various operating modes of the Wireless LAN transmitter were measured according to KDB 248227 v01r02:

IEEE 802.11b						
Mode	Channel	Frequency	Source-based time average power [dBm]			
			Data Rate [Mbps]			
			1	2	5.5	11
IEEE 802.11b	1	2412	16.78	16.93	16.68	16.62
	6	2437	**17.52**	17.55	17.48	17.39
	11	2462	17.32	17.24	17.15	17.02

IEEE 802.11g										
Mode	Channel	Frequency	Source-based time average power [dBm]							
			Data Rate [Mbps]							
			6	9	12	18	24	36	48	54
IEEE 802.11g	1	2412	13.48	13.51	13.44	13.54	13.48	13.52	13.51	13.42
	6	2437	**13.99**	13.92	13.80	13.99	13.74	13.60	13.84	13.68
	11	2462	13.89	13.87	13.81	13.86	13.79	13.72	13.65	13.55

IEEE 802.11n / 20 MHz / 1 Stream												
Mode	Channel	Frequency	Bandwidth [MHz]	Guard Interval [ns]	Source-based time average power [dBm]							
					Data Rate [Mbps]							
					MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
					6.5/7.2	13/14.4	19.5/21.7	26/28.9	39/43.3	52/57.8	58.5/65	65/72.2
IEEE 802.11n	1	2412	20	800/400	13.55	13.55	13.49	13.45	13.40	13.33	13.33	12.76
	6	2437	20	800/400	**14.05**	14.00	13.83	13.85	13.74	13.76	13.62	13.13
	11	2462	20	800/400	14.02	14.01	13.96	13.99	14.01	13.93	13.81	13.35

According to KDB 248227 v01r02 SAR measurements for 802.11g are not necessary because the conducted power values are not more than ¼ dB higher than the power values for 802.11b.

According to KDB 248227 v01r02 SAR measurements for 802.11n are not necessary because the conducted power values are not more than ¼ dB higher than the power values for 802.11b.

According to KDB 248227 v01r02 SAR measurements are performed for 802.11b and the lowest data rate of 1 Mbps.

1.11 Conducted Power Values WLAN 5 GHz

The conducted power values for the various operating modes of the Wireless LAN transmitter were measured according to KDB 248227 v01r02:

IEEE 802.11a											
Mode	Band	Channel	Frequency	Source-based time average power [dBm]							
				Data Rate [Mbps]							
				6	9	12	18	24	36	48	54
IEEE 802.11a	U-NII-1	36	5180	10.03	9.92	9.96	9.91	9.74	9.80	9.15	9.12
		40	5200	9.98	9.99	9.98	10.02	9.88	9.85	9.27	9.24
		44	5220	10.00	9.96	9.98	9.90	9.89	9.86	9.31	9.32
		48	5240	**10.17**	10.01	10.06	10.03	9.97	9.80	9.43	9.33
	U-NII-2	52	5260	10.28	10.21	10.23	10.17	10.11	10.07	9.53	9.53
		56	5280	10.22	10.26	10.30	10.23	10.20	10.03	9.62	9.63
		60	5300	10.34	10.33	10.34	10.26	10.25	10.09	9.63	9.56
		64	5320	**10.43**	10.46	10.51	10.28	10.24	10.21	9.78	9.61
	U-NII-2e	100	5500	**10.32**	10.30	10.20	10.21	10.14	10.14	9.52	9.57
		104	5520	10.11	10.06	10.05	10.06	9.96	9.91	9.41	9.39
		108	5540	9.92	9.92	9.93	9.94	9.92	9.86	9.28	9.17
		112	5560	9.95	9.93	9.78	9.90	9.84	9.75	9.11	9.09
		116	5580	9.60	9.54	9.32	9.29	9.19	9.24	8.53	7.98
		120	5600	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		124	5620	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		128	5640	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		132	5660	8.68	8.47	8.45	8.18	8.20	8.29	7.77	7.66
		136	5680	8.76	8.42	8.45	8.41	8.53	8.43	7.95	7.82
		140	5700	8.36	8.42	8.33	8.18	8.23	8.37	7.91	7.81
	U-NII-3	149	5745	**8.58**	8.21	8.25	8.23	8.20	8.12	7.77	7.70
		153	5765	8.48	8.08	8.10	8.03	7.91	7.83	7.70	7.71
		157	5785	8.32	8.24	8.27	8.16	8.15	8.07	7.52	7.56
		161	5805	8.40	8.10	8.14	8.09	7.97	7.83	7.44	7.25
		165	5825	7.81	7.94	7.80	7.85	7.79	7.78	7.24	7.19

IEEE 802.11n / 20 MHz / 1 Stream													
Mode	Band	Channel	Frequency	Bandwidth [MHz]	Guard Interval [ns]	Source-based time average power [dBm]							
						Data Rate [Mbps]							
						MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
						6.5/7.2	13/14.4	19.5/21.7	26/28.9	39/43.3	52/57.8	58.5/65	65/72.2
IEEE 802.11n	U-NII-1	36	5180	20	800/400	9.99	9.90	9.85	9.81	9.83	9.15	9.12	7.80
		40	5200			9.92	9.85	9.92	9.83	9.82	9.30	9.22	7.77
		44	5220			10.04	9.99	9.93	9.91	9.86	9.29	9.18	7.81
		48	5240			**10.14**	9.98	9.89	9.94	9.91	9.44	9.33	7.98
	U-NII-2	52	5260	20	800/400	10.33	10.18	10.23	10.19	10.13	9.63	9.58	8.11
		56	5280			10.22	10.36	10.28	10.23	10.19	9.58	9.59	8.15
		60	5300			10.45	10.42	10.38	10.30	10.25	9.67	9.70	8.23
		64	5320			**10.53**	10.50	10.47	10.36	10.29	9.83	9.81	8.33
	U-NII-2e	100	5500	20	800/400	**10.33**	10.30	10.31	10.34	10.23	9.61	9.50	8.11
		104	5520			10.24	10.22	10.19	10.07	10.04	9.57	9.35	7.87
		108	5540			10.11	10.13	10.01	10.05	9.95	9.46	9.27	7.83
		112	5560			10.04	9.96	9.92	9.90	9.85	9.25	9.06	7.65
		116	5580			9.83	9.71	9.76	9.62	9.62	9.14	8.88	7.52
		120	5600			N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		124	5620			N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		128	5640			N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		132	5660			9.32	9.20	9.23	9.21	9.12	8.55	8.37	6.92
		136	5680			9.14	8.99	8.90	8.91	8.86	8.44	8.25	6.80
		140	5700			8.91	8.83	8.85	8.85	8.77	8.10	7.96	6.64
	U-NII-3	149	5745	20	800/400	**8.42**	8.41	8.36	8.44	8.32	7.79	7.76	6.34
		153	5765			8.26	8.27	8.28	8.32	8.17	7.69	7.65	6.26
		157	5785			8.19	8.20	8.22	8.22	8.15	7.53	7.46	6.15
		161	5805			8.15	7.94	8.10	7.99	7.83	7.44	7.34	5.84
		165	5825			8.04	7.94	7.83	7.75	7.67	7.08	7.12	5.77

According to KDB 248227 v01r02 SAR measurements for 802.11n are not necessary because the conducted power values are not more than ¼ dB higher than the power values for 802.11a.

According to KDB 248227 v01r02 SAR measurements are performed for 802.11a and the lowest data rate of 6 Mbps.

1.12 Test Positions

Position	Description
FRONT-0MM	EUT top side directly touching the phantom.
BACK-0MM	EUT rear side directly touching the phantom.

1.13 Test Equipment Used During Testing

SAR Measurement					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Stäubli Robot	Stäubli	RX90B L	EF00271	functional test	functional test
Stäubli Robot Controller	Stäubli	CS7MB	EF00272	functional test	functional test
DASY 5 Measurement Server	Schmid & Partner		EF00273	functional test	functional test
Control Pendant	Stäubli		EF00274	functional test	functional test
Dell Computer	Schmid & Partner	Intel	EF00275	functional test	functional test
Data Acquisition Electronics	Schmid & Partner	DAE3V1	EF00276	2012-09	2013-09
Dosimetric E-Field Probe	Schmid & Partner	ET3DV6	EF00279	2012-09	2013-09
Dosimetric E-Field Probe	Schmid & Partner	EX3DV4	EF00826	2012-11	2013-11
System Validation Kit	Schmid & Partner	D300V3	EF00299	2012-09	2015-09
System Validation Kit	Schmid & Partner	D450V3	EF00300	2012-09	2015-09
System Validation Kit	Schmid & Partner	D900V2	EF00281	2012-09	2015-09
System Validation Kit	Schmid & Partner	D1800V2	EF00282	2012-09	2015-09
System Validation Kit	Schmid & Partner	D1900V2	EF00283	2012-09	2015-09
System Validation Kit	Schmid & Partner	D2450V2	EF00284	2012-09	2015-09
System Validation Kit	Schmid & Partner	D5GHZV2	EF00827	2012-11	2015-11
Flat phantom	Schmid & Partner	V 4.4	EF00328	no calibration required	no calibration required
Oval flat phantom	Schmid & Partner	ELI 4	EF00289	functional test	functional test
Mounting Device	Schmid & Partner	V 3.1	EF00287	functional test	functional test
Millivoltmeter	Rohde & Schwarz	URV 5	EF00126	2010-07	2013-07
Power sensor	Rohde & Schwarz	NRV-Z2	EF00125	2011-03	2013-03
RF signal generator	Rohde & Schwarz	SMP 02	EF00165	2011-03	2013-03
Insertion unit	Rohde & Schwarz	URV5-Z4	EF00322	2012-07	2013-07
Directional Coupler	HP	HP 87300B	EF00288	functional test	functional test
Radio Communication Tester	Rohde & Schwarz	CMD65	EF00625	ICO (initial calibration only)	ICO (initial calibration only)
Universal Radio Communication Tester	Rohde & Schwarz	CMU 200	EF00304	2012-05	2013-05
Network Analyzer 300 kHz to 3 GHz	Agilent	8752C	EF00140	2012-06	2013-06
Dielectric Probe Kit	Agilent	85070C	EF00291	functional test	functional test

2 Result Summary

OET Bulletin 65 Supplement C, RSS-102					
Product Specific Standard Section	**Requirement – Test**	**Reference Method**	**Maximum SAR [W/kg]**	**Result**	**Remarks**
OET Bulletin 65 Suppl. C Section 2 RSS-102 Section 3	Single-band conformity	KDB Publication 447498 KDB Publication 248227 KDB Publication 865664	0.334	PASS	
OET Bulletin 65 Suppl. C Section 2 RSS-102 Section 3	Multi-band conformity	KDB Publication 447498 KDB Publication 648474 KDB Publication 865664	0.334 + 0.137 = 0.471	PASS	
Remarks:					

3 Definitions

The specific absorption rate (SAR) is defined as the time derivative of the incremental energy (*dW*) absorbed by (dissipated in) an incremental mass (*dm*) contained in a volume element *(dV*) of a given density (ρ_t), expressed in watts per kilogram (W/kg)

$$SAR = d/dt\ (dW/dm) = d/dt\ (dW/\rho_t dV) = \sigma/\rho_t\ |E_t|^2$$

where

$$dW/dt = \int_V E\ J\ dV = \int_V \sigma E^2\ dV$$

3.1 Controlled Exposure

The general population/uncontrolled exposure limits are applicable to situations in which the general public may be exposed or in which persons who are exposed as a consequence of their employment may not be made fully aware of the potential for exposure or cannot exercise control over their exposure. Members of the general public would come under this category when exposure is not employment-related; for example, in the case of a wireless transmitter that exposes persons in its vicinity. Warning labels placed on low-power consumer devices such as cellular telephones are not considered sufficient to allow the device to be considered under the occupational/controlled category and the general population/uncontrolled exposure limits apply to these devices.

3.2 Uncontrolled Exposure

In general, occupational/controlled exposure limits are applicable to situations in which persons are exposed as a consequence of their employment, who have been made fully aware of the potential for exposure and can exercise control over their exposure. This exposure category is also applicable when the exposure is of a transient nature due to incidental passage through a location where the exposure levels may be higher than the general population/uncontrolled limits, but the exposed person is fully aware of the potential for exposure and can exercise control over his or her exposure by leaving the area or by some other appropriate means. Awareness of the potential for RF exposure in a workplace or similar environment can be provided through specific training as part of a RF safety program. If appropriate, warning signs and labels can also be used to establish such awareness by providing prominent information on the risk of potential exposure and instructions on the risk of potential exposure and instructions on methods to minimize such exposure risks.

3.3 Localized SAR

Compliance with the localized SAR limits is demonstrated using the head and trunk limit because this SAR limit is only half the limbs limit value. The values are obtained by SAR measurements according to EN 62209-2.

4 Localized SAR Measurement Equipment

The measurements were performed with Dasy5 automated near-field scanning system comprised of high precision robot, robot controller, computer, e-field probe, probe alignment unit, phantoms, non-conductive phone positioned and software extension.

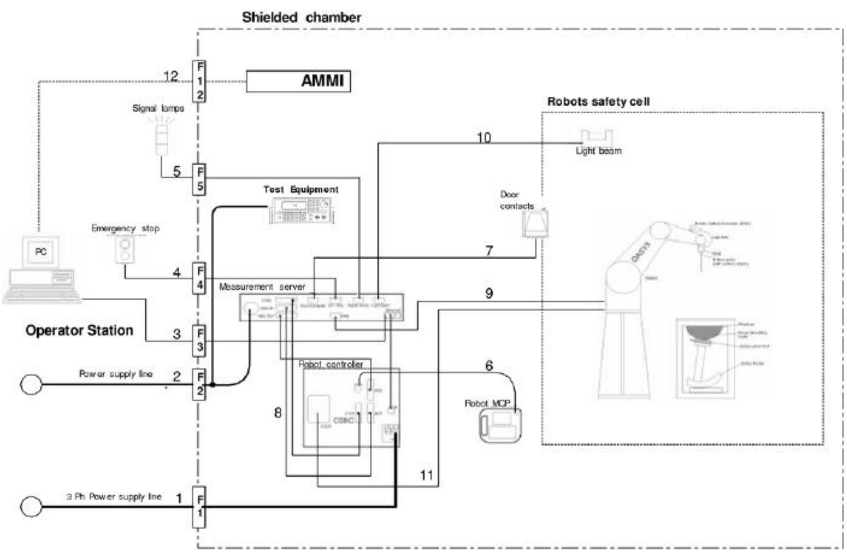
4.1 Complete SAR DASY5 Measurement System

Measurements are performed using the DASY5 automated assessment system made by Schmid & Partner Engineering AG (SPEAG) in Zurich, Switzerland.

DASY 5 SAR Measurement Setup

The following Diagram show the elements involved in the measurement setup.

DASY 5 SAR Measurement Diagram



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

DASY5 SAR Measurement System	
Device	Description:
RX90BL	A standard high precision 6-axis robot (Stäubli RX family) with controller, teach pendant and software.
Probe Alignment Unit	A probe alignment unit which improves the (absolute) accuracy of the probe positioning.
Teach Pendant	The Manual Control Pendant (MCP), also called the manual teach pendant, is the user interface to the robot. In DASY, it is used for certain installation and teach procedures
Signal Lamps	External warning lamp which indicates when the robot arm is powered-on and if the robot is under software control or in manual mode (controlled with the teach pendant).
DAE	The data acquisition electronics (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
E-Field Probes	Isotropic E-Field probe optimized and calibrated for E-field measurements in free space.
EOC	The electro-optical converter (EOC) performs the conversion between optical and electrical signals
Measurement Server	The functions of the measurement server is to perform the time critical task such as signal filtering, surveillance of the robot operation, fast movement interrupts.
Control Computer	A computer operating Windows 2000 or Windows NT with DASY 4 Software.
Control Software	DASY4 and SEMCAD post processing Software
SAM Twin Phantom	The SAM twin phantom enabling testing left-hand and right-hand usage.
Flat Phantom	Flat Phantom (only for body-mounted transceivers operating below 800 MHz).
Tissue simulating liquid	Tissue simulating liquid mixed according to the given recipes.
Device Holder	The device holder for handheld mobile phones.
System Validation Dipoles	System validation dipoles allowing to validate the proper functioning of the system.

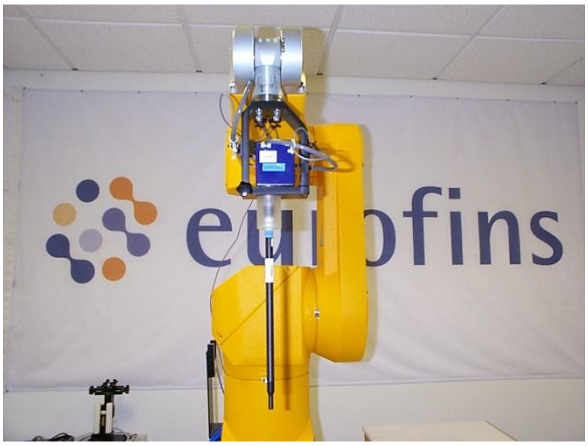
4.2 Robot Arm

The DASY5 system uses the high precision robots RX90BL type out of the newer series from Stäubli SA (France).

The RX robot series have many features that are important for our application:

- High precision (repeatability 0.02 mm)
- High reliability (industrial design)
- Jerk-free straight movements
- Low ELF interference (the closed metallic construction shields against motor control fields)
- 6-axis controller

Robot arm

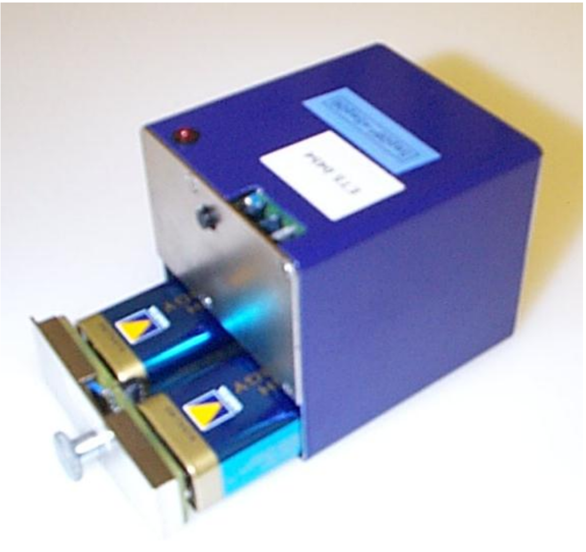


4.3 Data Acquisition Electronics

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. Transmission to the measurement server 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. The input impedance of the DAE3 is 200M Ohm; the inputs are symmetrical and floating. Common mode rejection is above 80dB.

Data Acquisition Electronics



4.4 Isotropic E-Field Probe ≤ 3 GHz

Probe Specifications

Construction:

One dipole parallel, two dipoles normal to probe axis built-in shielding against static charges.

Calibration:

In air from 10 MHz to 2.5 GHz,
In brain and muscle simulating tissue at Frequencies of 835MHz, 900MHz, 1800MHz, 1900 MHz and 2450 MHz

Frequency:

10MHz to > 3GHz,
Linearity ±0.2dB (30MHz to 3GHz)

Directivity:

±0.2dB in HSL (rotation around probe axis)
±0.4dB in HSL (rotation normal to probe axis)

Dynamic Range:

5µW/g to > 100mW/g

Linearity:

±0.2dB

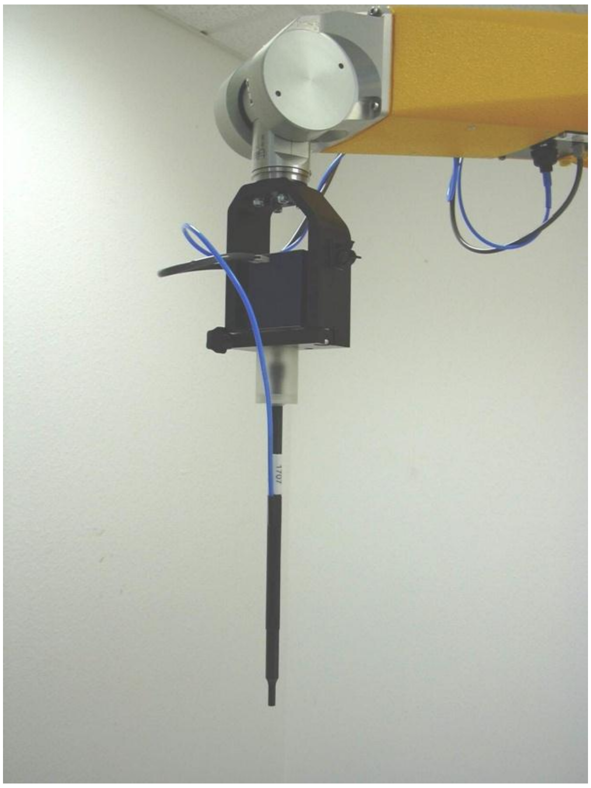
Dimensions:

Overall Length: 330mm (Tip: 16mm),
Tip Diameter: 6.8mm (Body: 12mm),
Distance from probe tip to dipole centers: 2.7mm

Application:

General dosimetry up to 3 GHz
Compliance tests of mobile phones
Fast automatic scanning in arbitrary phantoms

Isotropic E-Field Probe ET3DV6



4.5 Isotropic E-Field Probe ≤ 6 GHz

Probe Specifications

Construction:

One dipole parallel, two dipoles normal to probe axis built-in shielding against static charges.

Calibration:

In air from 10 MHz to 6 GHz,
In brain and muscle simulating tissue at
Frequencies of 5200, 5500, 5800

Frequency:

10MHz to 6GHz,
Linearity ±0.2dB (30MHz to 6GHz)

Directivity:

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

Dynamic Range:

10µW/g to > 100mW/g

Linearity:

±0.2dB

Dimensions:

Overall Length: 337mm (Tip: 20mm),
Tip Diameter: 2.5mm (Body: 12mm),
Distance from probe tip to dipole centers: 1mm

Application:

General dosimetry up to 6 GHz
Compliance tests of mobile phones
Fast automatic scanning in arbitrary phantoms

Isotropic E-Field Probe EX3DV4

4.6 Test phantom and positioner

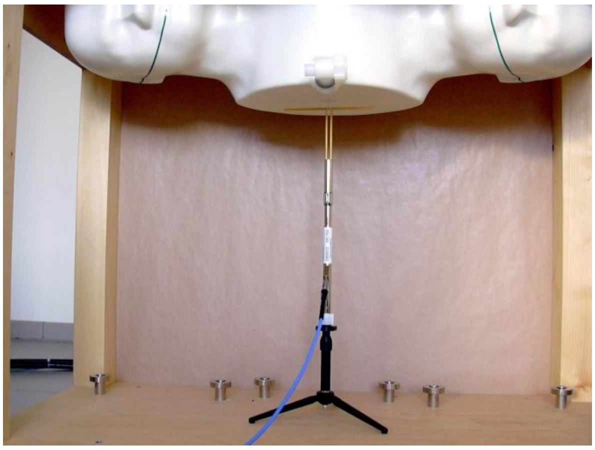
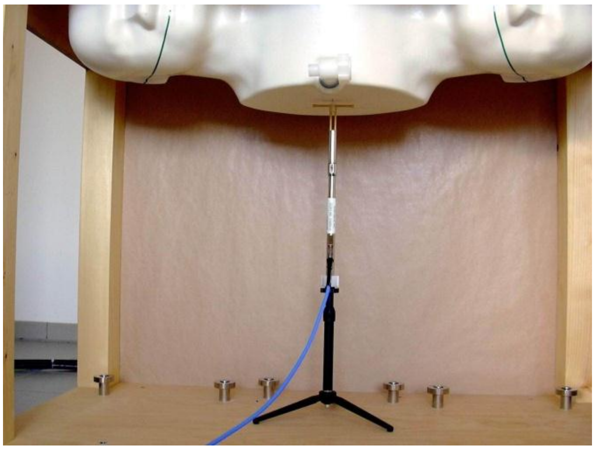
The positioner and test phantoms are manufactured by SPEAG. The test phantoms are used for all tests i.e. for both validation testing and device testing. The positioner and test phantom conforms to the requirements of EN 62209 and IEEE 1528.

The SPEAG device holder was used to position the test device in all tests whilst a tripod was used to position the validation dipoles in the test arch.

Probe Positioner	SAM Twin Phantom
	
ELI4 phantom	**Flat phantom**
	

4.7 System Validation Dipoles

A set of calibration dipoles (D900V2, D1900V2, D2450V2, D5GHzV2) is included as a part of the SAR measurement setup. These are used for the validation of the test setup after its installation and prior to the EUT measurements. The calibration dipole is placed in the position normally occupied by the EUT. All calibration dipoles have the same height which allows an exact fitting below the center point of the test phantom. The dipole center is 10mm below the surface of the test phantom.

900MHz Dipole	1900MHz Dipole
	
2450MHz Dipole	**5000MHz Dipole**
	

5 Single-band SAR Measurement

After successful completion of the tissue and system verification the SAR values of the EUT are measured according to the following description.

5.1 General measurement description

The measurement is performed for each frequency band of the device. If the width of the transmit frequency band exceeds 1% of its center frequency, than the channels at the lowest and highest frequencies should also be tested. Furthermore, if the width of the transmit band exceeds 10% of its center frequency the following formula is used to determine the number of channels:

$$N_C = 2 \cdot \text{roundup}[10 \cdot (f_{high} - f_{low})/f_c] + 1$$

First the device is tested on the center channel of each frequency band used by the device. An operation mode and configuration with maximum transmit power is established. If battery operated equipment is used, the batteries are fully charged.

SAR measurements are performed using the steps outlined in the next section for all relevant operational modes, EUT configurations and measurement positions.

For the condition (position, configuration, operational mode) that provides the highest spatial-average SAR value on the center channel, the other channels are also tested.

Additionally all other conditions where the spatial-average SAR value is within 3dB of the SAR limit are also tested on all determined test frequencies.

5.2 SAR measurement description

First the local SAR value at a test point within 10mm or less in normal direction from the inner surface of the phantom is measured. This SAR value is used to determine the measurement drift during SAR measurement.

Next an area scan is performed over an area larger than the projection of the EUT with antenna on the surface of the phantom with a spatial grid step of 10mm.

From the scanned SAR distribution the position of maximum SAR value is identified as well as any local SAR maxima within 2dB of the maximum value that are not within the zoom scan volume. (The additional peaks are only measured when the primary peak is within 2dB of the SAR limit.)

The zoom-scan volume constructed on the peak SAR position is scanned with a grid step of 5mm. The measured data are extracted and the local SAR value for each measurement point is calculated. The measured values are interpolated over a fine-mesh within the scan volume and the average SAR value over 10g mass is calculated.

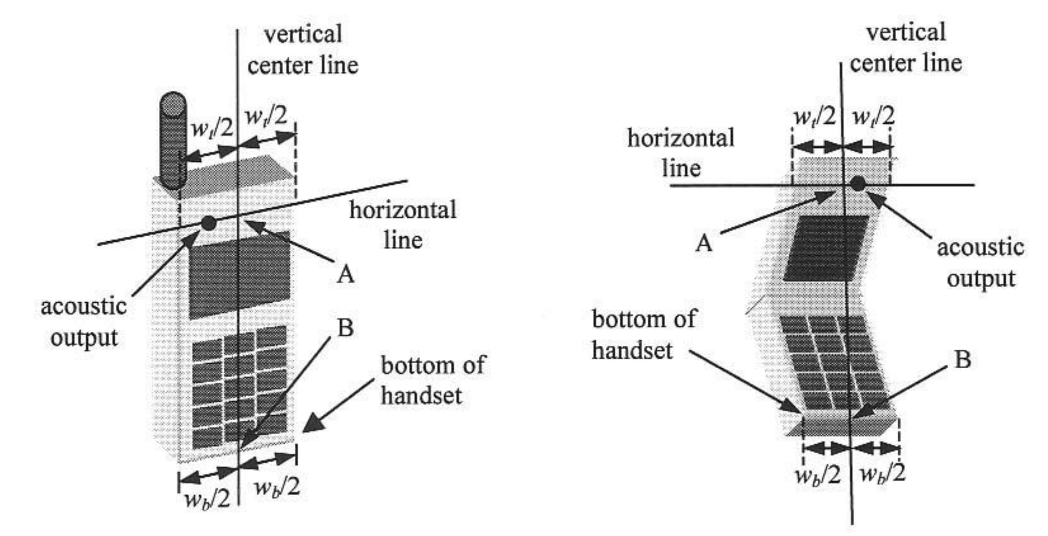
At the end of the measurement the reference point measured at the beginning of the measurement is measured again and from the difference the drift is calculated.

5.3 Reference lines and points for Handsets

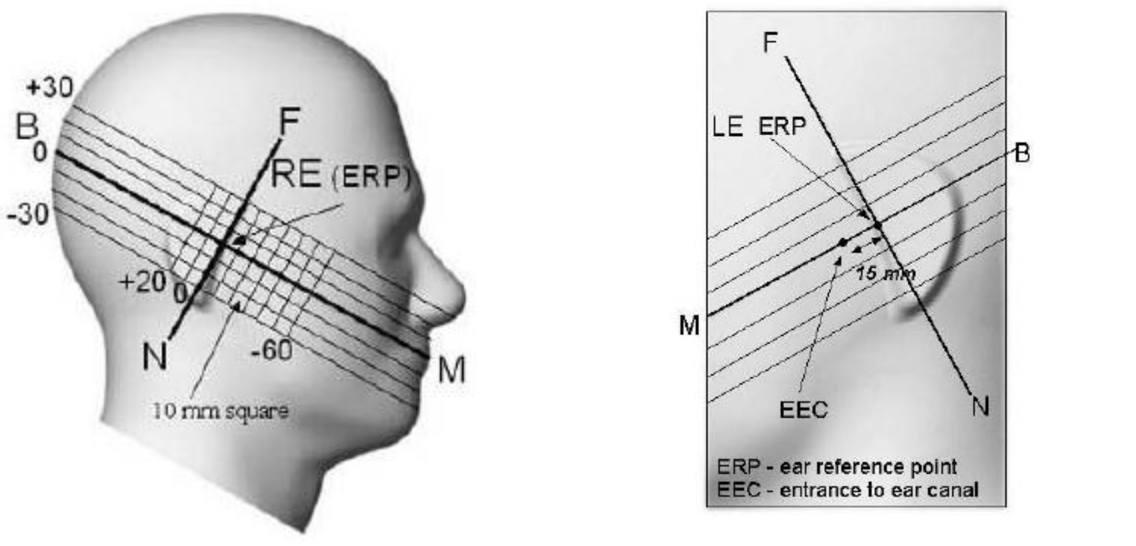
For all measurement positions of the EUT, the EUT has to be place in a specific orientation with respect to the phantom. The orientation of the EUT relative to the phantom is defined by reference lines and points.

According to IEEE 1528, the reference lines and points shall be positioned at the EUT as shown in the following figure.

Reference lines and points on EUT acc. to IEEE 1528

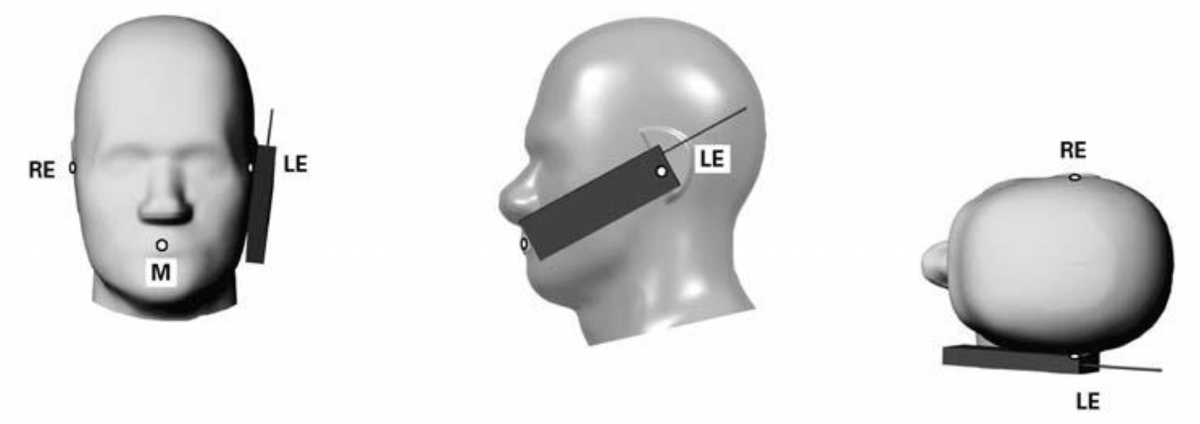


Reference lines and points on human head acc. to IEEE 1528



5.4 Test positions relative to the Head

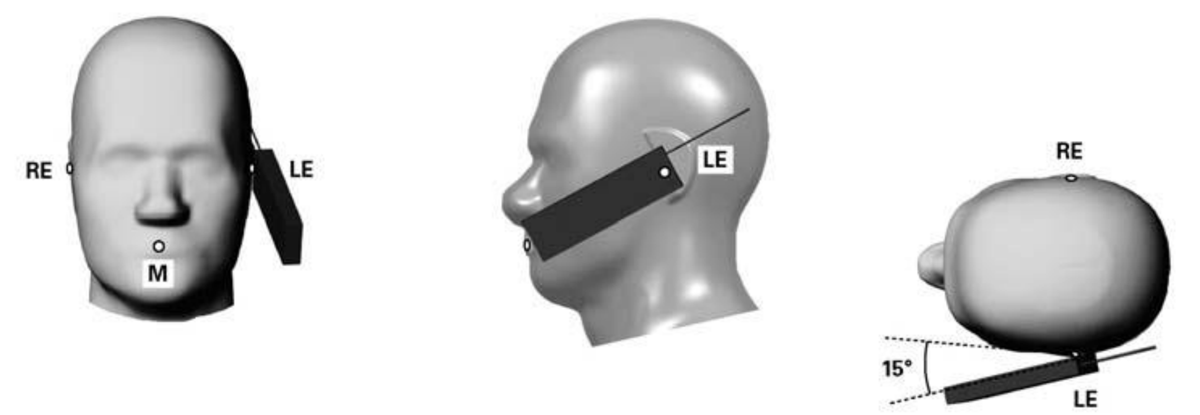
Cheek position

Cheek positions according to IEEE 1528


The handset is positioned close to the surface of the phantom such that point A is on the (virtual) extension of the line passing through points RE and LE on the phantom (see Figure), such that the plane defined by the vertical centerline and the horizontal line of the handset is approximately parallel to the sagittal plane of the phantom. Next the handset is translated towards the phantom along the line passing through RE and LE until handset point A touches the pinna at the ERP.

While the handset is maintained in this plane, it is rotated around the LE-RE line until the vertical centerline is in the plane normal to the plane containing B-M and N-F lines, i.e., the Reference Plane. Then it is rotated around the vertical centerline until the handset (horizontal line) is parallel to the N-F line. While the vertical centerline is maintained in the Reference Plane, point A is kept on the line passing through RE and LE, and the handset is maintained in contact with the pinna, the handset is rotated about the N-F line until any point on the handset is in contact with a phantom point below the pinna on the cheek.

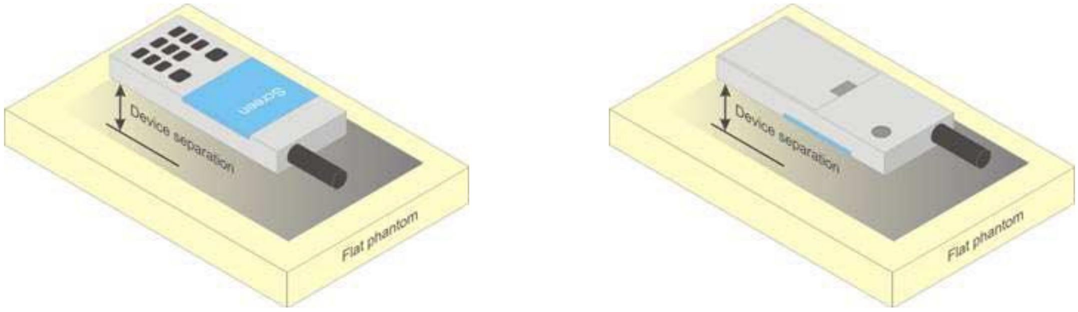
Tilt position

Tilt positions according to IEEE 1528


First the EUT is placed in the cheek position. Next the handset is moved away from the pinna along the line passing through RE and LE far enough to allow a rotation of the handset away from the cheek by 15°. Then the handset is rotated around the horizontal line by 15°.

The handset is moved towards the phantom on the line passing through RE and LE until any part of the handset touches the ear. The tilt position is obtained when the contact point is on the pinna. See Figure. If contact occurs at any location other than the pinna, e.g., the antenna at the back of the phantom head, the angle of the handset should be reduced. In this case, the tilt position is obtained if any point on the handset is in contact with the pinna and a second point on the handset is in contact with the phantom, e.g., the antenna with the back of the head

5.5 Test positions relative to the human body

Body positions according to IEEE 1528


In body worn configuration the device is positioned parallel to the phantom surface with either top or bottom side of the EUT facing against the phantom.

The separation distance of the EUT is selected according to the use case of the EUT (e.g. with belt clip or holster).

5.6 Measurement Uncertainty

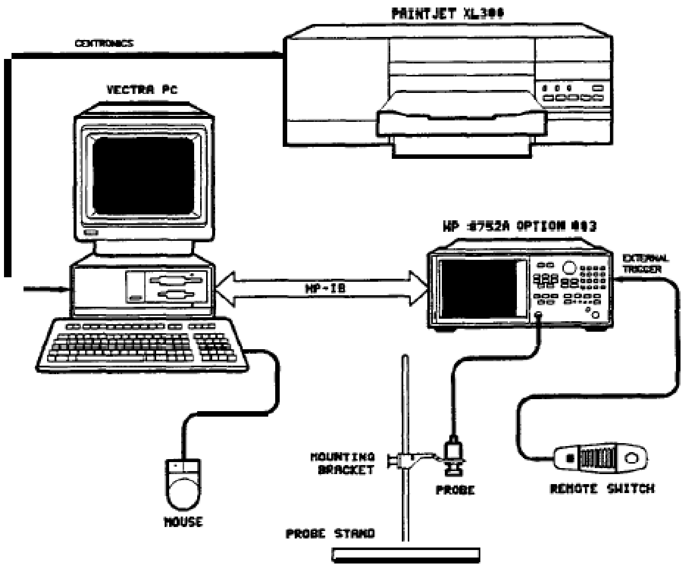
Measurement Uncertainty according to IEEE 1528							
Error Description	**Uncertainty Value**	**Probability Distribution**	**Div.**	**c_i (1g)**	**c_i (10g)**	**Std. Unc. 1g**	**Std. Unc. 10g**
Measurement System							
Probe Calibration	±6.55%	N	1	1	1	±6.55%	±6.55%
Axial Isotropy	±4.7%	R	$\sqrt{3}$	0.7	0.7	±1.9%	±1.9%
Hemispherical Isotropy	±9.6%	R	$\sqrt{3}$	0.7	0.7	±3.9%	±3.9%
Linearity	±4.7%	R	$\sqrt{3}$	1	1	±2.7%	±2.7%
Modulation Response	±2.4%	R	$\sqrt{3}$	1	1	±1.4%	±1.4%
System Detection Limits	±1.0%	R	$\sqrt{3}$	1	1	±0.6%	±0.6%
Boundary effects	±2.0%	R	$\sqrt{3}$	1	1	±1.2%	±1.2%
Readout Electronics	±0.3%	N	1	1	1	±0.3%	±0.3%
Response Time	±0.8%	R	$\sqrt{3}$	1	1	±0.5%	±0.5%
Integration Time	±2.6%	R	$\sqrt{3}$	1	1	±1.5%	±1.5%
RF Ambient Noise	±3.0%	R	$\sqrt{3}$	1	1	±1.7%	±1.7%
RF Ambient Reflections	±3.0%	R	$\sqrt{3}$	1	1	±1.7%	±1.7%
Probe Positioner	±0.8%	R	$\sqrt{3}$	1	1	±0.5%	±0.5%
Probe Positioning	±6.7%	R	$\sqrt{3}$	1	1	±3.9%	±3.9%
Post processing	±4.0%	R	$\sqrt{3}$	1	1	±2.3%	±2.3%
Test Sample Related							
Device Holder	±3.6%	N	1	1	1	±3.6%	±3.6%
Test Sample Positioning	±2.9%	N	1	1	1	±2.9%	±2.9%
Power Scaling	±0%	R	$\sqrt{3}$	1	1	±0%	±0%
Power Drift	±5.0%	R	$\sqrt{3}$	1	1	±2.9%	±2.9%
Phantom and Setup Related							
Phantom Uncertainty	±7.9%	R	$\sqrt{3}$	1	1	±4.6%	±4.6%
SAR correction	±1.9%	R	$\sqrt{3}$	1	0.84	±1.1%	±0.9%
Liquid conductivity (measured)	±2.5%	N	1	0.78	0.71	±2.0%	±1.8%
Liquid permittivity (measured)	±2.5%	N	1	0.26	0.26	±0.1%	±0.1%
Temperature uncertainty - Conductivity	±5.2%	R	$\sqrt{3}$	0.78	0.71	±2.3%	±2.1%
Temperature uncertainty - Permittivity	±0.8%	R	$\sqrt{3}$	0.23	0.26	±0.1%	±0.1%
Combined Standard Uncertainty						±12.8%	±12.7%
Expanded Standard Uncertainty						**±25.6%**	**±25.4%**

6 Test Conditions and Results

6.1 Test Conditions and Results – Tissue Validation

Tissue Validation acc. to FCC OET Bulletin 65 Suppl. C / IC RSS-102					Verdict: PASS
Test according to measurement reference	Reference Method				
	OET Bulletin 65 Supplement C				
Target Values					
Frequency [MHz]	Head		Body		Permitted tolerance [%]
	Relative dielectric constant ε_r	Conductivity σ [S/m]	Relative dielectric constant ε_r	Conductivity σ [S/m]	
150	52.3	0.76	61.9	0.80	≤ ±5
300	45.3	0.87	58.2	0.92	≤ ±5
450	43.5	0.87	56.7	0.94	≤ ±5
835	41.5	0.90	55.2	0.97	≤ ±5
900	41.5	0.97	55.0	1.05	≤ ±5
915	41.5	0.98	55.0	1.06	≤ ±5
1450	40.5	1.20	54.0	1.30	≤ ±5
1610	40.3	1.29	53.8	1.40	≤ ±5
1800 – 2000	40.0	1.40	53.3	1.52	≤ ±5
2450	39.2	1.80	52.7	1.95	≤ ±5
3000	38.5	2.40	52.0	2.73	≤ ±5
5200	36.0	4.66	49.0	5.30	≤ ±5
5500	35.6	4.96	48.6	5.65	≤ ±5
5800	35.3	5.27	48.2	6.00	≤ ±5

Test setup



Test procedure

1. The dielectric probe kit is calibrated using the standards air, short circuit and deionized water
2. The tissue simulating liquid is measured using the dielectric probe
3. Target values are compared to the measurement values and deviations are determined

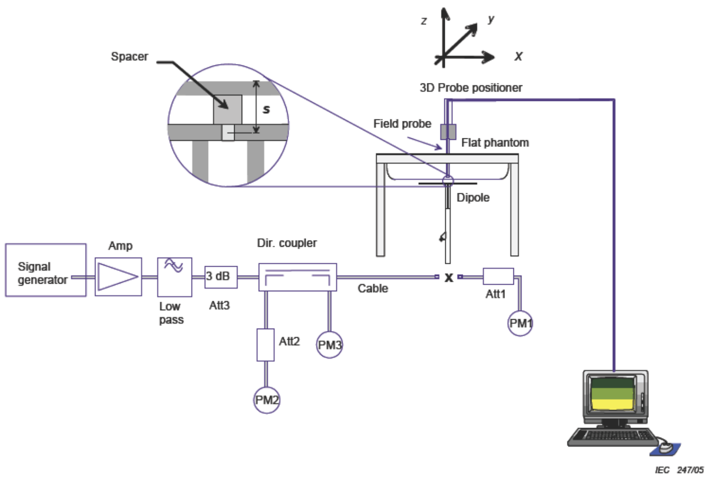
Test results

Frequency [MHz]	Tissue	Measured ε_r	Target ε_r	Delta ε_r [%]	Measured σ [S/m]	Target σ [S/m]	Delta σ [%]
2450	Body	52.93	52.7	00.44	2.00	1.95	02.56
5200	Body	49.15	49.0	00.31	5.47	5.30	03.21
5500	Body	48.9	48.6	00.62	5.86	5.65	03.72
5800	Body	48.4	48.2	00.41	6.29	6.00	04.83

Comments:

6.2 Test Conditions and Results – System Validation

System Validation acc. to FCC OET Bulletin 65 Suppl. C / IC RSS-102		Verdict: PASS
Test according to measurement reference	Reference Method	
	OET Bulletin 65 Supplement C / IEEE 1528	
Test frequency range	Tested frequencies	
	2450 MHz , 5200 MHz, 5500 MHz, 5800 MHz	
Test mode	unmodulated CW	
Target Values		
Frequency [MHz]	Target SAR value [W/kg (1g)]	Permitted tolerance [%]
2450	12.9 @ 250mW	≤ ±10
5200	7.42 @ 100mW	≤ ±10
5500	7.97 @ 100mW	≤ ±10
5800	7.43 @ 100mW	≤ ±10
The target reference values are taken from the calibration sheets (see annex)		
Test setup		



Test procedure

1. The dipole antenna input power is set to 250mW
2. The reference dipole is positioned under the phantom
3. With the dipole antenna powered the SAR value is measured
4. The measured SAR values are compared to the target SAR values

Test results				
Frequency [MHz]	Input power [mW]	Measured SAR value [W/kg (1g)]	Target SAR value [W/kg (1g)]	Delta [%]
2450	250	12.8	12.9	-00.78
5200	100	7.47	7.42	00.67
5500	100	8.67	7.97	08.78
5800	100	8.04	7.43	08.21
Comments:				

6.3 Test Conditions and Results – Standalone SAR Measurement

Standalone SAR acc. to FCC OET Bulletin 65 Suppl. C / IC RSS-102						Verdict: PASS
Test according to measurement reference			Reference Method			
			FCC OET Bulletin 65 Supplement C / IC RSS-102 Issue 4			
Room temperature			22.0 – 22.6 °C			
Liquid depth			15.5 cm			
Environment			general public			
Limits						
Region			Occupational SAR values [W/kg]		General public SAR values [W/kg]	
Whole body average SAR			0.4		0.08	
Localized SAR (Head and trunk) SAR averaging mass = 10g			8		1.6	
Localized SAR (Limbs) SAR averaging mass = 10g			20		4	
Test results						
Mode	Position	Channel	Frequency [MHz]	Drift [dB]	Average SAR [W/kg (1g)]	SAR Limit [W/kg (1g)]
IEEE 802.11b	FRONT-0MM	6	2437	-0.05	0.098	1.463*
IEEE 802.11b	BACK-0MM	6	2437	-0.16	0.134	1.463*
IEEE 802.11a	BACK-0MM	48	5240	-0.09	0.260	1.463*
IEEE 802.11a	BACK-0MM	64	5320	0.09	0.334	1.463*
IEEE 802.11a	FRONT-0MM	100	5500	0.06	0.0002	1.463*
IEEE 802.11a	BACK-0MM	100	5500	0.05	0.101	1.463*
IEEE 802.11a	FRONT-0MM	149	5745	0.1	0.0003	1.463*
IEEE 802.11a	BACK-0MM	149	5745	-0.01	0.019	1.463*
Overall maximum SAR value [W/kg (1g)]					**0.334**	1.463*

Comments: * See section 1.6 multi-transmitter operation modes
Result plots entitled front 2_0mm show results measured with 0mm separation distance. The “2” is not related to the measurement distance.

SAR measurements were started with the highest power channel of the transmission band under investigation. Other measurement channels were omitted when the SAR value of the highest power channel was below 0.8 W/kg according to KDB 248227 v01r02.

ANNEX A Calibration Documents

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 108

Client Eurofins

Certificate No: DAE3-522_Sep12

CALIBRATION CERTIFICATE

Object	DAE3 - SD 000 D03 AA - SN: 522
Calibration procedure(s)	QA CAL-06.v25 Calibration procedure for the data acquisition electronics (DAE)
Calibration date:	September 13, 2012

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Keithley Multimeter Type 2001	SN: 0810278	28-Sep-11 (No:11450)	Sep-12

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Calibrator Box V2.1	SE UWS 053 AA 1001	05-Jan-12 (in house check)	In house check: Jan-13

	Name	Function	Signature
Calibrated by:	Eric Hainfeld	Technician	
Approved by:	Fin Bomholt	R&D Director	

Issued: September 13, 2012

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

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	404.217 ± 0.1% (k=2)	403.888 ± 0.1% (k=2)	404.717 ± 0.1% (k=2)
Low Range	3.96459 ± 0.7% (k=2)	3.95751 ± 0.7% (k=2)	3.97359 ± 0.7% (k=2)

Connector Angle

Connector Angle to be used in DASY system	58.5 ° ± 1 °

Appendix

1. DC Voltage Linearity

High Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	199991.81	-4.03	-0.00
Channel X	+ Input	20002.27	2.17	0.01
Channel X	- Input	-19995.43	5.20	-0.03
Channel Y	+ Input	199993.43	-2.55	-0.00
Channel Y	+ Input	20001.04	0.99	0.00
Channel Y	- Input	-19995.47	5.03	-0.03
Channel Z	+ Input	199994.05	-2.30	-0.00
Channel Z	+ Input	19999.35	-0.75	-0.00
Channel Z	- Input	-19999.80	0.84	-0.00

Low Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	2001.10	0.62	0.03
Channel X	+ Input	200.14	-0.87	-0.43
Channel X	- Input	-199.18	-0.19	0.09
Channel Y	+ Input	2001.44	0.83	0.04
Channel Y	+ Input	201.16	0.07	0.03
Channel Y	- Input	-199.16	-0.37	0.19
Channel Z	+ Input	2000.47	-0.05	-0.00
Channel Z	+ Input	201.05	-0.08	-0.04
Channel Z	- Input	-199.85	-0.99	0.50

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	-3.67	-5.85
	- 200	6.43	4.78
Channel Y	200	0.13	-0.43
	- 200	0.44	-0.00
Channel Z	200	15.39	15.59
	- 200	-17.30	-17.70

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	-	-1.27	-2.12
Channel Y	200	7.68	-	-1.36
Channel Z	200	5.92	5.53	-

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	15740	16746
Channel Y	15716	14973
Channel Z	16056	16442

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	1.32	-0.05	3.02	0.63
Channel Y	-0.52	-1.56	1.04	0.55
Channel Z	0.13	-1.29	1.70	0.60

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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Engineering AG
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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 108

Client Eurofins

Certificate No: ET3-1711_Sep12

CALIBRATION CERTIFICATE

Object: ET3DV6 - SN:1711

Calibration procedure(s): QA CAL-01.v8, QA CAL-12.v7, QA CAL-23.v4, QA CAL-25.v4
Calibration procedure for dosimetric E-field probes

Calibration date: September 19, 2012

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	29-Mar-12 (No. 217-01508)	Apr-13
Power sensor E4412A	MY41498087	29-Mar-12 (No. 217-01508)	Apr-13
Reference 3 dB Attenuator	SN: S5054 (3c)	27-Mar-12 (No. 217-01531)	Apr-13
Reference 20 dB Attenuator	SN: S5086 (20b)	27-Mar-12 (No. 217-01529)	Apr-13
Reference 30 dB Attenuator	SN: S5129 (30b)	27-Mar-12 (No. 217-01532)	Apr-13
Reference Probe ES3DV2	SN: 3013	29-Dec-11 (No. ES3-3013_Dec11)	Dec-12
DAE4	SN: 660	20-Jun-12 (No. DAE4-660_Jun12)	Jun-13
Secondary Standards	ID	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Apr-11)	In house check: Apr-13
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-11)	In house check: Oct-12

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

Issued: September 19, 2012

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

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	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

Calibration is Performed According to the Following Standards:

a) IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
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

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, VRx,y,z: A, B, C* 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.

Probe ET3DV6

SN:1711

Manufactured: August 7, 2002
Calibrated: September 19, 2012

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

DASY/EASY - Parameters of Probe: ET3DV6 - SN:1711

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu V/(V/m)^2$)[A]	1.87	1.88	2.07	± 10.1 %
DCP (mV)[B]	98.8	95.1	97.4	

Modulation Calibration Parameters

UID	Communication System Name	PAR		A dB	B dB	C dB	VR mV	Unc[E] (k=2)
0	CW	0.00	X	0.00	0.00	1.00	151.8	±3.3 %
			Y	0.00	0.00	1.00	148.9	
			Z	0.00	0.00	1.00	159.4	

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

[A] The uncertainties of NormX,Y,Z do not affect the E^2-field uncertainty inside TSL (see Pages 5 and 6).
[B] Numerical linearization parameter: uncertainty not required.
[E] Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

DASY/EASY - Parameters of Probe: ET3DV6 - SN:1711

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
450	43.5	0.87	7.14	7.14	7.14	0.21	2.26	± 13.4 %
900	41.5	0.97	6.15	6.15	6.15	0.30	2.88	± 12.0 %
1810	40.0	1.40	5.21	5.21	5.21	0.80	2.08	± 12.0 %
1950	40.0	1.40	4.95	4.95	4.95	0.80	2.05	± 12.0 %
2450	39.2	1.80	4.34	4.34	4.34	0.80	1.86	± 12.0 %

[C] Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.
[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

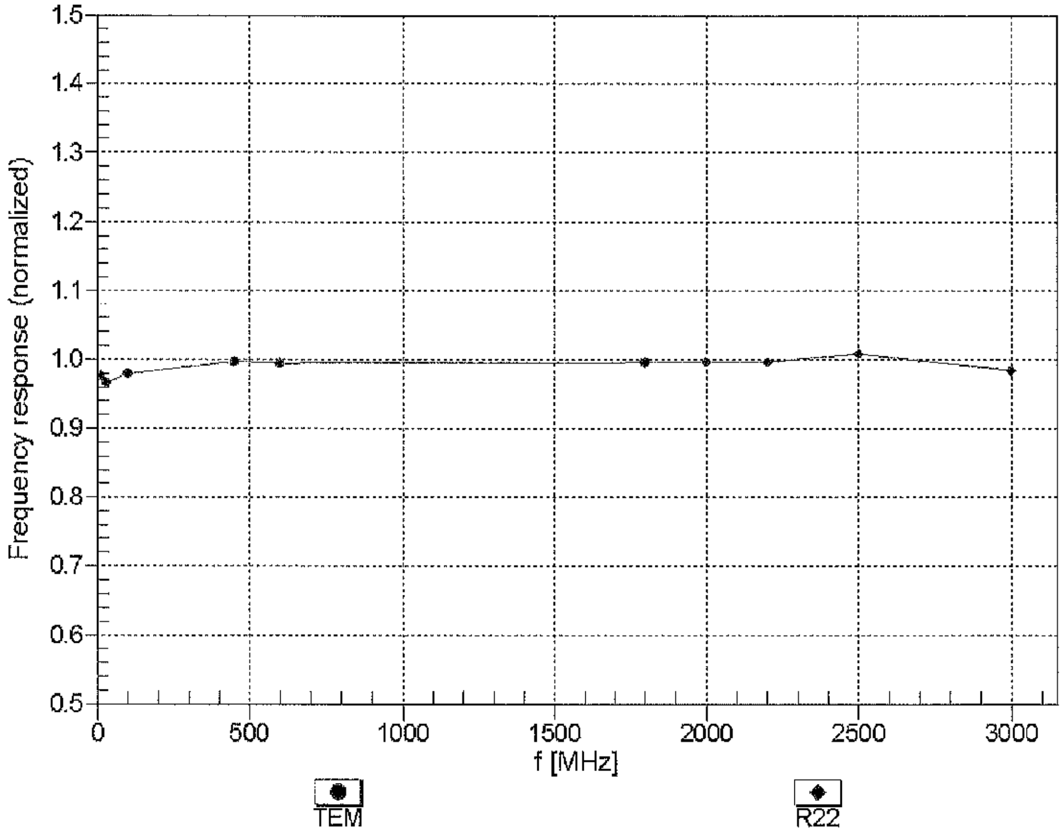
DASY/EASY - Parameters of Probe: ET3DV6 - SN:1711

Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
450	56.7	0.94	7.58	7.58	7.58	0.15	2.25	± 13.4 %
900	55.0	1.05	6.07	6.07	6.07	0.35	3.00	± 12.0 %
1810	53.3	1.52	4.73	4.73	4.73	0.80	2.49	± 12.0 %
1950	53.3	1.52	4.72	4.72	4.72	0.80	2.36	± 12.0 %
2450	52.7	1.95	4.07	4.07	4.07	0.56	0.87	± 12.0 %

[C] Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.
[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

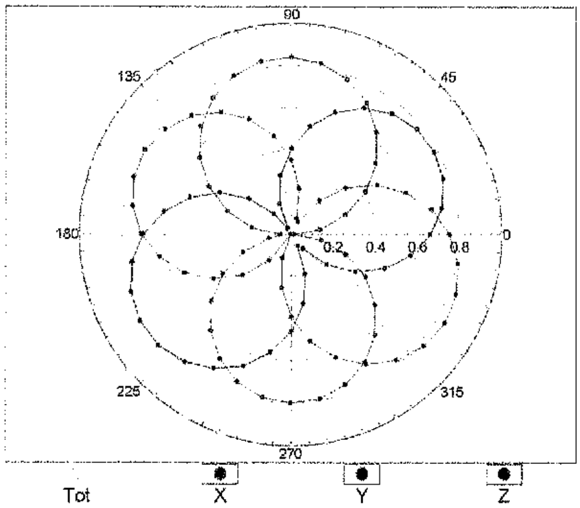
Frequency Response of E-Field
(TEM-Cell:ifi110 EXX, Waveguide: R22)



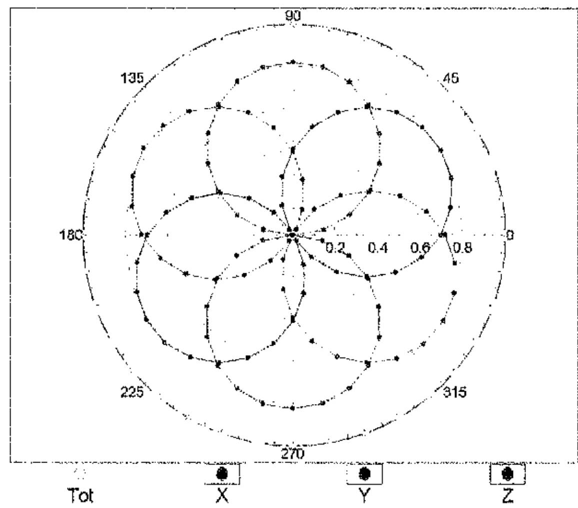
Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

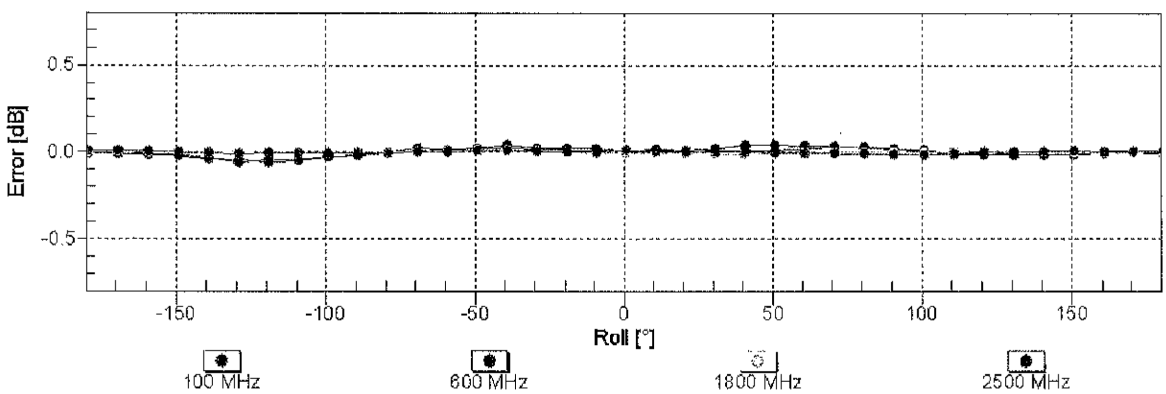
Receiving Pattern (ϕ), ϑ = 0°

f=600 MHz,TEM



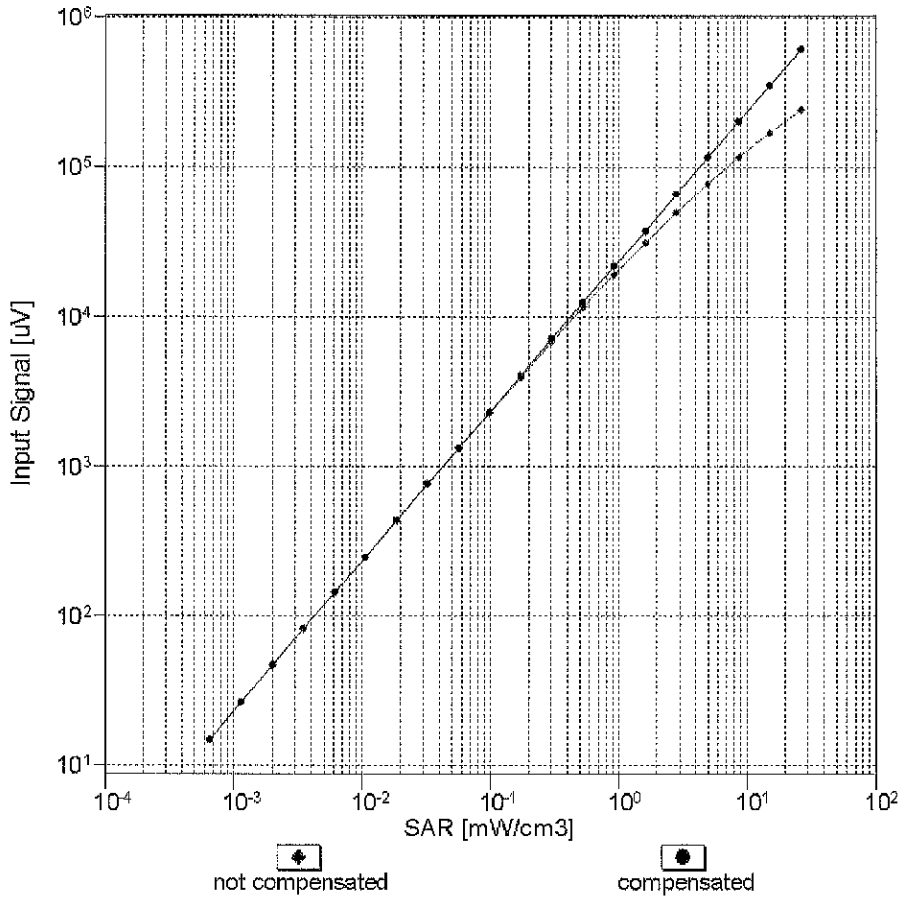
f=1800 MHz,R22

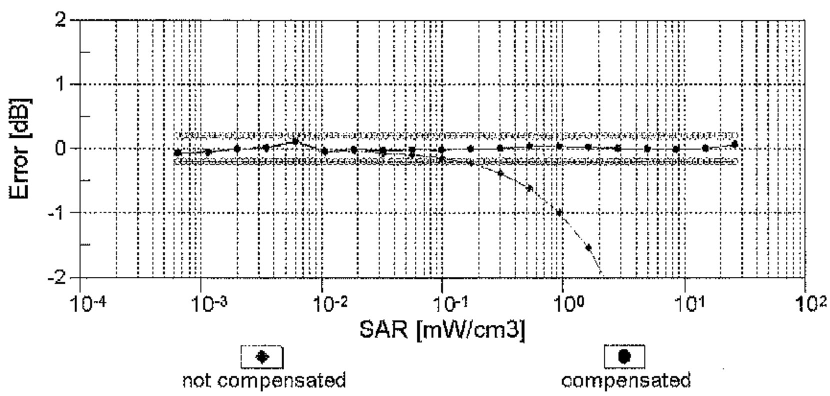




Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

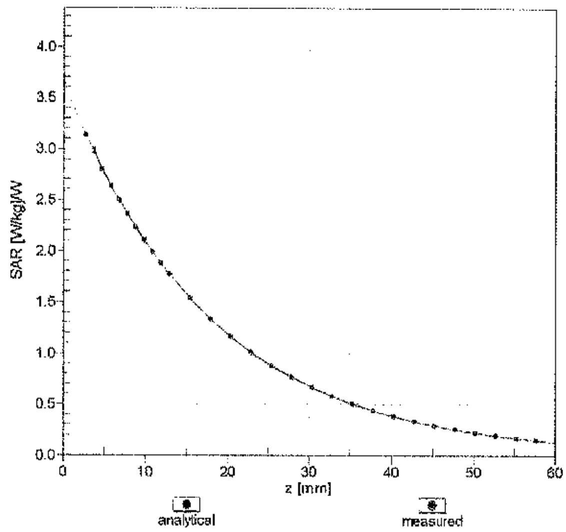
Dynamic Range f(SAR_{head})
(TEM cell , f = 900 MHz)

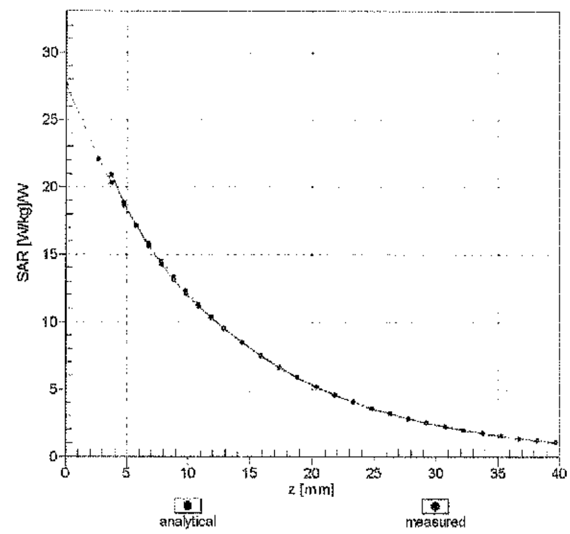




Uncertainty of Linearity Assessment: ± 0.6% (k=2)

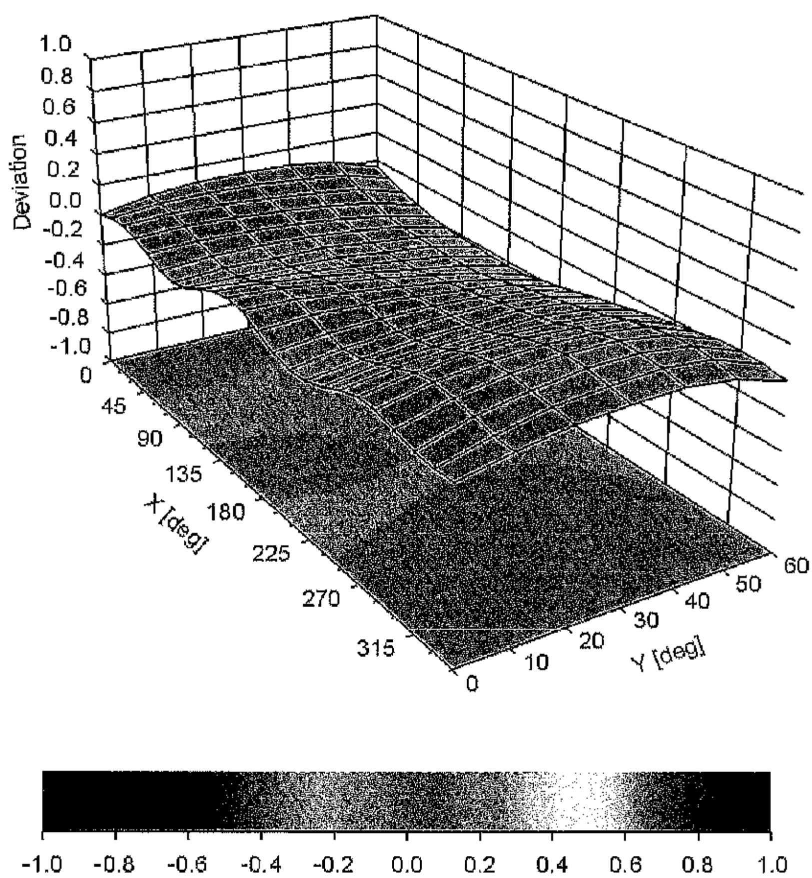
Conversion Factor Assessment





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: ET3DV6 - SN:1711

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	70.8
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	enabled
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 **Eurofins**

Certificate No: EX3-3893_Nov12

CALIBRATION CERTIFICATE

Object	EX3DV4 - SN:3893
Calibration procedure(s)	QA CAL-01.v8, QA CAL-14.v3, QA CAL-23.v4, QA CAL-25.v4 Calibration procedure for dosimetric E-field probes
Calibration date:	November 26, 2012

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	29-Mar-12 (No. 217-01508)	Apr-13
Power sensor E4412A	MY41498087	29-Mar-12 (No. 217-01508)	Apr-13
Reference 3 dB Attenuator	SN: S5054 (3c)	27-Mar-12 (No. 217-01531)	Apr-13
Reference 20 dB Attenuator	SN: S5086 (20b)	27-Mar-12 (No. 217-01529)	Apr-13
Reference 30 dB Attenuator	SN: S5129 (30b)	27-Mar-12 (No. 217-01532)	Apr-13
Reference Probe ES3DV2	SN: 3013	29-Dec-11 (No. ES3-3013_Dec11)	Dec-12
DAE4	SN: 660	20-Jun-12 (No. DAE4-660_Jun12)	Jun-13
Secondary Standards	ID	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Apr-11)	In house check: Apr-13
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-12)	In house check: Oct-13

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

Issued: November 26, 2012

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

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	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

Calibration is Performed According to the Following Standards:

a) IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
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

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, VRx,y,z: A, B, C* 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.

Probe EX3DV4

SN:3893

Manufactured: October 9, 2012
Calibrated: November 26, 2012

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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3893

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm (µV/(V/m)^2)[A]	0.56	0.42	0.33	± 10.1 %
DCP (mV)[B]	100.3	104.2	99.9	

Modulation Calibration Parameters

UID	Communication System Name	PAR		A dB	B dB	C dB	VR mV	Unc[E] (k=2)
0	CW	0.00	X	0.00	0.00	1.00	174.8	±3.0 %
			Y	0.00	0.00	1.00	147.0	
			Z	0.00	0.00	1.00	167.2	

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 NormX,Y,Z do not affect the E^2-field uncertainty inside TSL (see Pages 5 and 6).
[B] Numerical linearization parameter: uncertainty not required.
[E] Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3893

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
5200	36.0	4.66	5.46	5.46	5.46	0.30	1.80	± 13.1 %
5500	35.6	4.96	5.13	5.13	5.13	0.30	1.80	± 13.1 %
5800	35.3	5.27	4.65	4.65	4.65	0.45	1.80	± 13.1 %

[C] Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.
[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

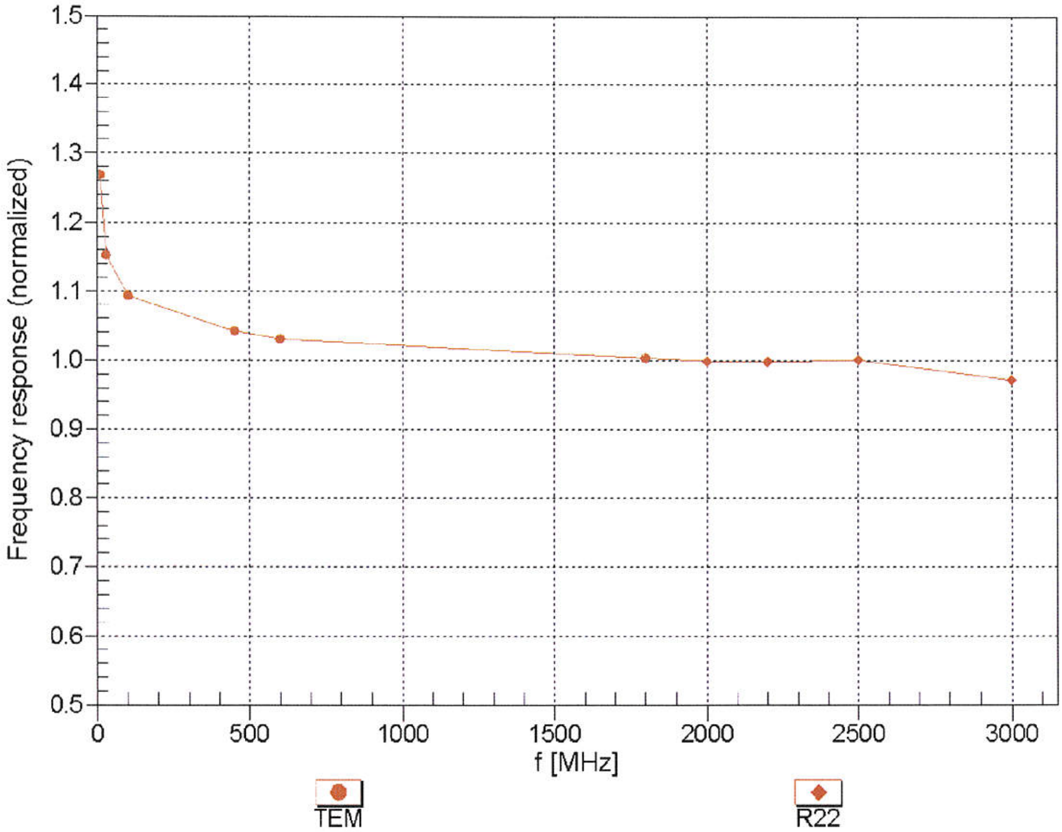
DASY/EASY - Parameters of Probe: EX3DV4 - SN:3893

Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
5200	49.0	5.30	4.33	4.33	4.33	0.57	1.90	± 13.1 %
5500	48.6	5.65	4.10	4.10	4.10	0.55	1.90	± 13.1 %
5800	48.2	6.00	4.08	4.08	4.08	0.59	1.90	± 13.1 %

[C] Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.
[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

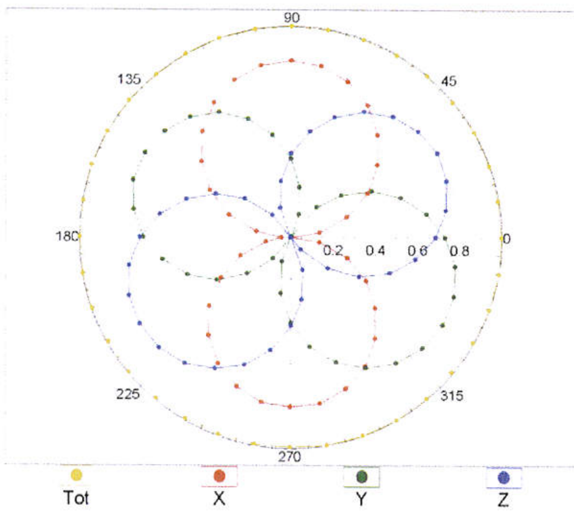
Frequency Response of E-Field
(TEM-Cell:ifi110 EXX, Waveguide: R22)



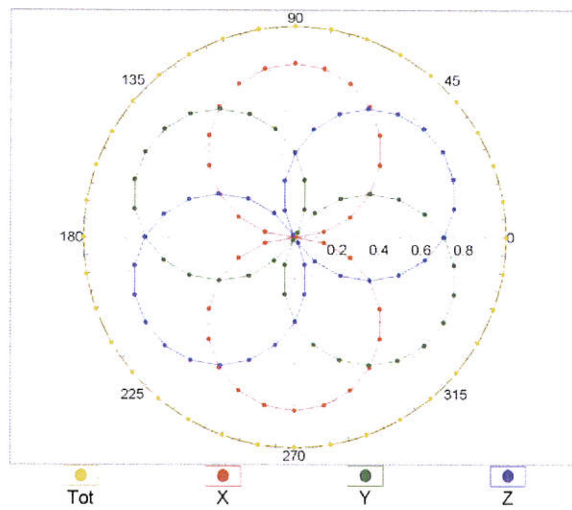
Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

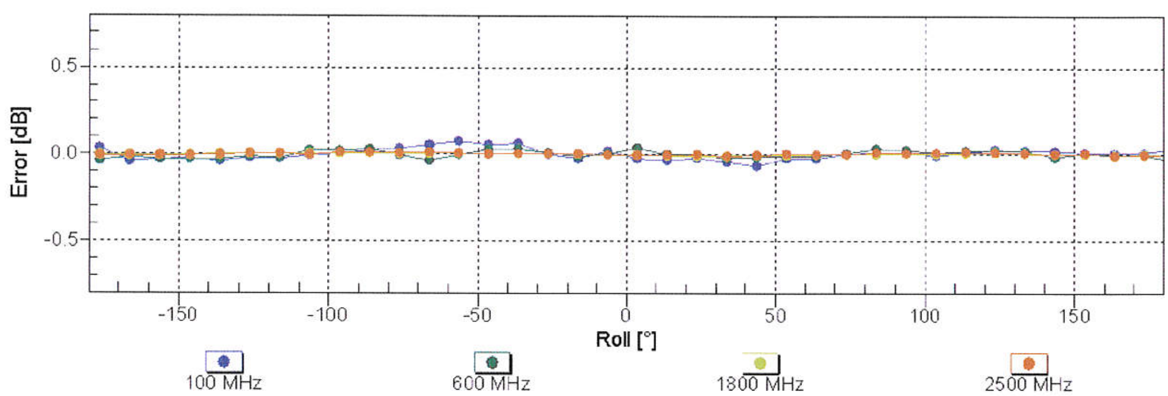
Receiving Pattern (ϕ), ϑ = 0°

f=600 MHz,TEM



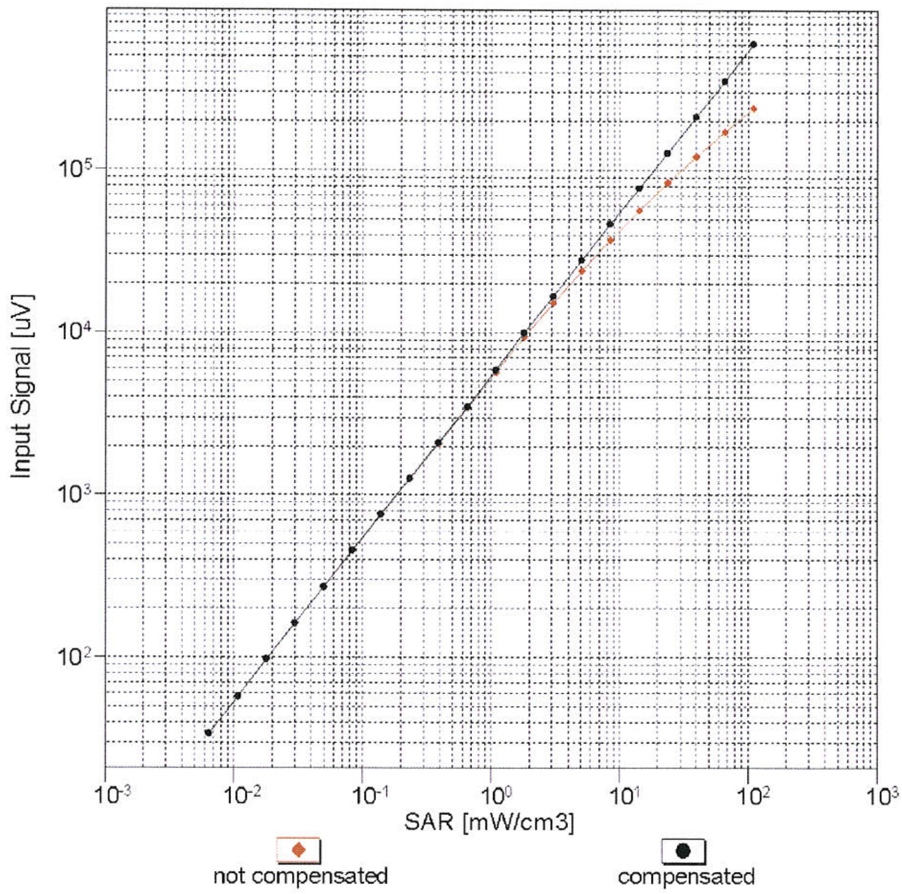
f=1800 MHz,R22

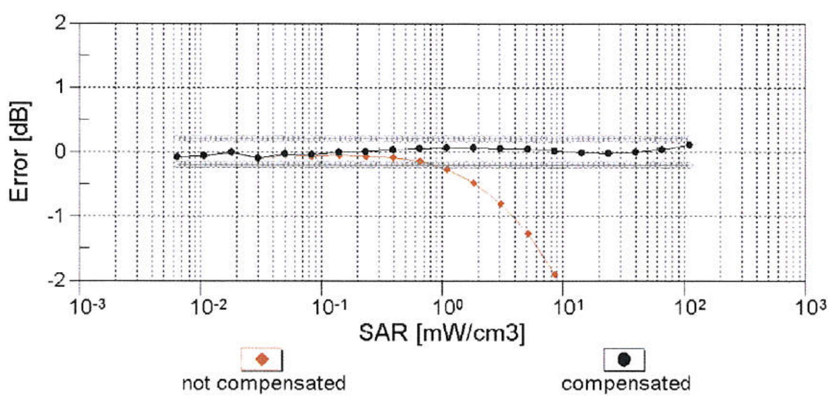




Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

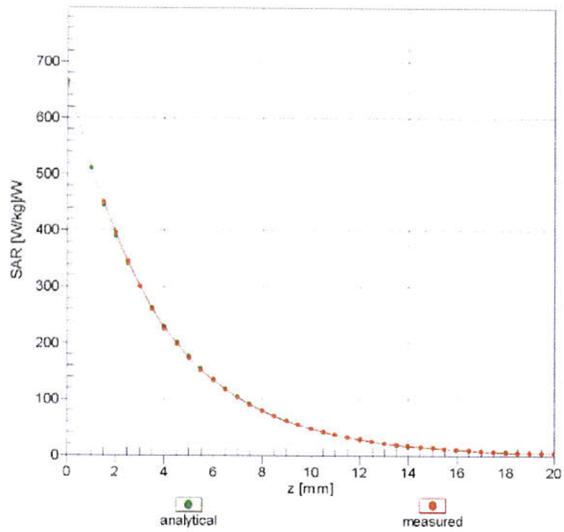
Dynamic Range f(SAR_{head})
(TEM cell , f = 900 MHz)

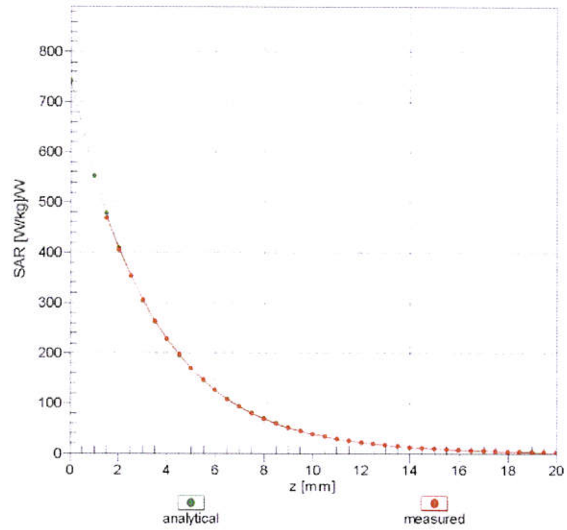




Uncertainty of Linearity Assessment: ± 0.6% (k=2)

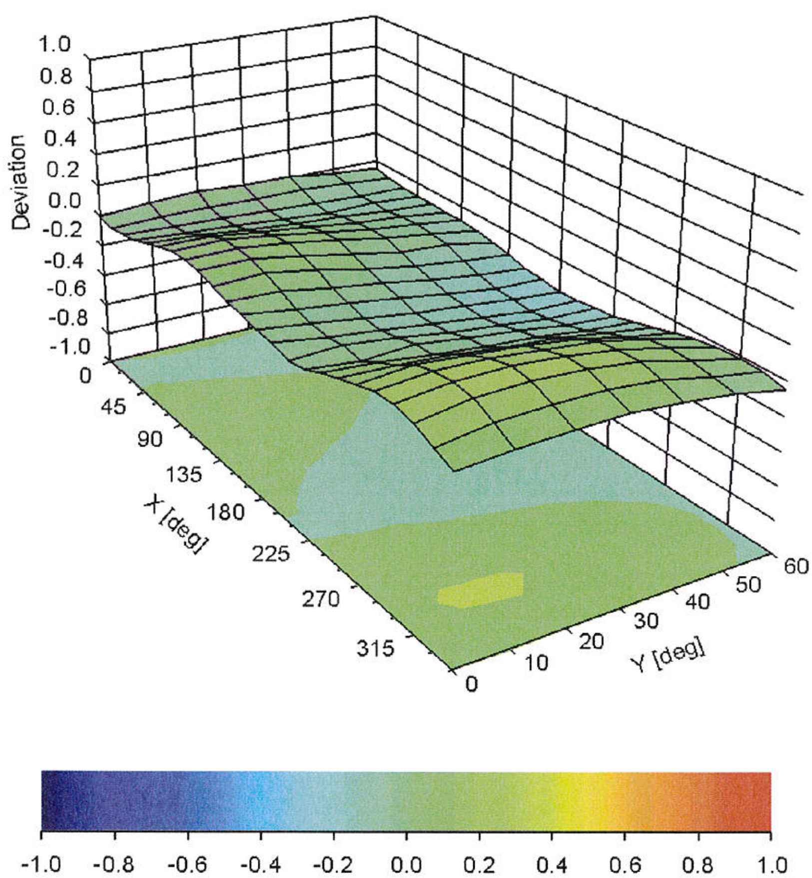
Conversion Factor Assessment





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: EX3DV4 - SN:3893

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	-26.4
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	9 mm
Tip Diameter	2.5 mm
Probe Tip to Sensor X Calibration Point	1 mm
Probe Tip to Sensor Y Calibration Point	1 mm
Probe Tip to Sensor Z Calibration Point	1 mm
Recommended Measurement Distance from Surface	2 mm

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 108

Client **Eurofins**

Certificate No: D2450V2-722_Sep12

CALIBRATION CERTIFICATE

Object	D2450V2 - SN: 722
Calibration procedure(s)	QA CAL-05.v8 Calibration procedure for dipole validation kits above 700 MHz
Calibration date:	September 13, 2012

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	05-Oct-11 (No. 217-01451)	Oct-12
Power sensor HP 8481A	US37292783	05-Oct-11 (No. 217-01451)	Oct-12
Reference 20 dB Attenuator	SN: 5058 (20k)	27-Mar-12 (No. 217-01530)	Apr-13
Type-N mismatch combination	SN: 5047.2 / 06327	27-Mar-12 (No. 217-01533)	Apr-13
Reference Probe ES3DV3	SN: 3205	30-Dec-11 (No. ES3-3205_Dec11)	Dec-12
DAE4	SN: 601	27-Jun-12 (No. DAE4-601_Jun12)	Jun-13

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power sensor HP 8481A	MY41092317	18-Oct-02 (in house check Oct-11)	In house check: Oct-13
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-11)	In house check: Oct-13
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-11)	In house check: Oct-12

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

Issued: September 13, 2012

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

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 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
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) Federal Communications Commission Office of Engineering & Technology (FCC OET), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields; Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Supplement C (Edition 01-01) to Bulletin 65

Additional Documentation:

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%.