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SAR TEST REPORT

Report Reference No..... :	**CTL1412163034-SAR**
FCC ID..... :	**2AD4JGOLDKEYC320**
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Date of issue.....:	Dec 29, 2014
Representative Laboratory Name .:	**Shenzhen CTL Testing Technology Co., Ltd.**
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Testing Laboratory Name .....:	**The Testing and Technology Center for Industrial Products of Shenzhen Entry-Exit Inspection and Quarantine Bureau**
Address.....:	No.289, 8th Industry Road, NanshanDistrict,Shenzhen,Guangdong
Applicant's name.....:	**Dongguan Aoke Electronic Co., Ltd.**
Address.....:	Wanhe Mansion, No. 826, Meijing Middle Rd., Dalang Town, Dongguan, Guangdong China(Mainland)
Test specification ..... **:**	
Standard .....:	**ANSI C95.1–1999** **47CFR §2.1093**
TRF Originator.....:	Shenzhen CTL Testing Technology Co., Ltd.
Master TRF.....:	Dated 2011-01

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Test item description .....:	Smart watch
Trade Mark .....:	GoldKey
Model/Type reference.....:	GoldKey C320 (AK-S8)
Operation Frequency.....	GSM 850MHz/PCS1900MHz/WiFi2450/BT
Modulation Type	GSM(GMSK, 8PSK), Bluetooth(GFSK,8DPSK,Π/4DQPSK), DSSS(CCK,DQPSK,DBPSK),OFDM(64QAM,16QAM,QPSK, BPSK)
Hardware version .....:	MOLY.WR8.W1315.MD.WG.MP.V4
Software version .....:	3.4.67
Rating .....:	DC 3.70V
Android version.....:	Android 4.4.2
Result.....:	**PASS**

TEST REPORT

Test Report No. :	CTL1412163034-SAR	Dec 29, 2014 Date of issue

Equipment under Test	:	Smart watch
Model /Type	:	GoldKey C320 (AK-S8)
Applicant	:	**Dongguan Aoke Electronic Co., Ltd.**
Address	:	Wanhe Mansion, No. 826, Meijing Middle Rd., Dalang Town, Dongguan, Guangdong China(Mainland)
Manufacturer	:	**Dongguan Aoke Electronic Co., Ltd.**
Address	:	Wanhe Mansion, No. 826, Meijing Middle Rd., Dalang Town, Dongguan, Guangdong China(Mainland)

Test Result:	**PASS**

The test report merely corresponds to the test sample.
It is not permitted to copy extracts of these test result without the written permission of the test laboratory.

** Modifited History **

Revison	Description	Issued Data	Remark
Revsion 1.0	Initial Test Report Release	2014-12-29	Tracy Qi

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1. TEST STANDARDS

The tests were performed according to following standards:

IEEE Std C95.1, 1999: IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 KHz to 300 GHz. It specifies the maximum exposure limit of 1.6 W/kg as averaged over any 1 gram of tissue for portable devices being used within 20 cm of the user in the uncontrolled environment.
IEEE Std 1528™-2013: IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques.
KDB 447498 D01 Mobile Portable RF Exposure v05r02: Mobile and Portable Device RF Exposure Procedures and Equipment Authorization Policies
KDB865664 D01 SAR measurement 100 MHz to 6 GHz v02: SAR Measurement Requirements for 100 MHz to 6 GHz
KDB865664 D02 SAR Reporting v01: RF Exposure Compliance Reporting and Documentation Considerations
KDB248227: SAR measurement procedures for 802.112abg transmitters
FCC Part 2.1093 Radiofrequency Radiation Exposure Evaluation:Portable Devices
KDB941225 D01 Test Reduction GSM_GPRS_EDGE V01 : 3G SAR MEAUREMENT PROCEDURES
KDB941225 D06 Hot Spot SAR v02 : SAR EVALUATION PROCEDURES FOR PORTABLE DEVICES WITH WIRELESS ROUTER CAPABILITIES
KDB648474 D04, Handset SAR v01r02: SAR Evaluation Considerations for Wireless Handsets

2. SUMMARY

2.1. General Remarks

Date of receipt of test sample	:	Dec 20, 2014
Testing commenced on	:	Dec 25, 2014
Testing concluded on	:	Dec 27, 2014

2.2. Product Description

The **Dongguan Aoke Electronic Co., Ltd.**'s Model: GoldKey C320 (AK-S8) or the "EUT" as referred to in this report; more general information as follows, for more details, refer to the user's manual of the EUT.

General Description	
Name of EUT	Smart watch
Brand	GoldKey
Model	GoldKey C320 (AK-S8)
Hardware version	MOLY.WR8.W1315.MD.WG.MP.V4
Software version	3.4.67
IMEI	352585060680067
Device category	Portable Device
Exposure category	General population/uncontrolled environment
EUT Type	Production Unit
Rated Vlotage	DC 3.70 Battery
Hotsopt	Supported, power not reduced when Hotspot open
The EUT is GSM850/900/DCS1800/PCS1900, WCDMA Band I smartwatch. the smartwatch is intended for speech and Multimedia Message Service (MMS) transmission. It is equipped with GPRS/EDGE class 12 for GSM850 and PCS1900 and Bluetooth, WiFi, and camera functions. For more information see the following datasheet	

Technical Characteristics	
2G	
Support Networks	GSM, GPRS, EDGE
Support Band	GSM850/PCS1900
Uplink Frequency	GSM/GPRS/EDGE 850: 824~849MHz GSM/GPRS/EDGE 1900: 1850~1910MHz
Downlink Frequency	GSM/GPRS/EDGE 850: 869~894MHz GSM/GPRS/EDGE 1900: 1930~1990MHz
Type of Modulation	GMSK, 8PSK
Antenna Type	Internal Antenna
GPRS/EDGE Class	Class 12
GSM Release Version	R99
GPRS operation mode	Class B
DTM Mode	Not Supported
3G	
Support Networks	WCDMA
Support Band	WCDMA Band I 2100MHz
Type of Modulation	QPSK
Antenna Type	Internal Antenna
WiFi	
Support Standards	802.11b, 802.11g, 802.11n
Frequency Range	2412-2462MHz for 11b/g/n(HT20) 2422-2452MHz for 11n(HT40)
Type of Modulation	CCK, OFDM, QPSK, BPSK, 16QAM, 64QAM
Data Rate	1-11Mbps, 6-54Mbps, up to 150Mbps
Quantity of Channels	11 for 11b/g/n(HT20), 7 for 11n(HT40)
Channel Separation	5MHz
Antenna Type	Internal Antenna

Bluetooth	
Bluetooth Version	V3.0+EDR/V4.0
Frequency Range	2402-2480MHz
Data Rate	1Mbps, 2Mbps, 3Mbps
Modulation	GFSK, π/4 QDPSK, 8DPSK
Quantity of Channels	79/40
Channel Separation	1MHz/2MHz
Antenna Type	Internal Antenna
The EUT is only support WCDMA Band I and cannot use 3G function in USA, only use 2G in USA market.	

2.3. Statement of Compliance

The maximum of results of SAR found during testing for GoldKey C320 (AK-S8) are follows:

Next to the mouth Configuration

Mode	Test Position	Channel /Frequency(MHz)	Limit SAR_{1g} 1.6 W/kg	
			Measured SAR_{1g} (W/kg)	Reported SAR_{1g} (W/kg)
GSM 850	Next to the mouth (10mm distance)	190/836.6	0.484	0.525
GSM 1900	Next to the mouth (10mm distance)	661/1880	0.553	**0.592**
WiFi(802.11b)	Next to the mouth (10mm distance)	6/2437	0.020	0.0214

Wrist-worn Configuration

Mode	Test Position	Channel /Frequency(MHz)	Limit SAR_{10g} 4.0 W/kg	
			Measured SAR_{10g} (W/kg)	Reported SAR_{10g} (W/kg)
GSM 850	Wrist-worn (0mm distance)	190/836.6	1.120	**1.210**
GSM 1900	Wrist-worn (0mm distance)	661/1880	1.080	1.156
WiFi(802.11b)	Wrist-worn (0mm distance)	6/2437	0.532	0.569

Hotspot Configuration

Mode	Test Position	Channel /Frequency(MHz)	Limit SAR_{10g} 4.0 W/kg	
			Measured SAR_{10g} (W/kg)	Reported SAR_{10g} (W/kg)
GPRS 850, 4 Txslots	Wrist-worn (0mm distance)	190/836.6	1.920	2.320
GPRS 1900, 4 Txslots	Wrist-worn (0mm distance)	661/1880	2.080	**2.351**
WiFi(802.11b)	Wrist-worn (0mm distance)	6/2437	0.532	0.569

The SAR values found for the Smart watch are below the maximum recommended levels of 1.6W/Kg as averaged over any 1g tissue for Next to the mouth and 4.0W/Kg averaged over any 10g tissue for Wirst-worn as accordintg to the ANSI C95.1-1999.
For body worn operation,this devices has been tested and meets FCC RF exposure guidelines when used with any accessory that conrtains no metal and which provides a minimum separation distance of 0mm between this devices and the body of the user.User of other accessories may not ensure compliance with FCC RF exposure guidelines.
The EUT battery must be fully charged and checked periodically during the test to ascertain iniform power output.

2.4. Equipment under Test

Power supply system utilised

Power supply voltage	:	○	120V / 60 Hz	○	115V / 60Hz
		○	12 V DC	○	24 V DC
		●	Other (specified in blank below)		

DC 3.70 V

2.5. EUT configuration

The following peripheral devices and interface cables were connected during the measurement:

● - supplied by the manufacturer

○ - supplied by the lab

○	Power Cable	Length (m) :	/
		Shield :	/
		Detachable :	/
○	Multimeter	Manufacturer :	/
		Model No. :	/

3. TEST ENVIRONMENT

3.1. Address of the test laboratory

The Testing and Technology Center for Industrial Products of Shenzhen Entry-Exit Inspection and Quarantine Bureau
No.289, 8th Industry Road, Nanshan District, Shenzhen, Guangdong, China

The sites are constructed in conformance with the requirements of ANSI C63.7, ANSI C63.4 (2009) and CISPR Publication 22.

3.2. Test Facility

The test facility is recognized, certified, or accredited by the following organizations:

CNAS-Lab Code: L2872

The Testing and Technology Center for Industrial Products of Shenzhen Entry-Exit Inspection and Quarantine Bureau has been assessed and proved to be in compliance with CNAS-CL01 Accreditation Criteria for Testing and Calibration Laboratories (identical to ISO/IEC 17025: 2005 General Requirements) for the Competence of Testing and Calibration Laboratories, Date of Registration: May 11, 2014. Valid time is until May 12, 2017.
Environmental conditions

3.3. Environmental conditions

During the measurement the environmental conditions were within the listed ranges:

Temperature:	18-25 ° C
Humidity:	40-65 %
Atmospheric pressure:	950-1050mbar

3.4. SAR Limits

FCC Limit (1g Tissue)

EXPOSURE LIMITS	SAR (W/kg)	
	(General Population /Uncontrolled Exposure Environment)	(Occupational /Controlled Exposure Environment)
Spatial Average (averaged over the whole body)	0.08	0.4
Spatial Peak (averaged over any 1 g of tissue)	1.60	8.0
Spatial Peak (hands/wrists/feet/ankles averaged over 10 g)	4.0	20.0

Population/Uncontrolled Environments are defined as locations where there is the exposure of individual who have no knowledge or control of their exposure.

Occupational/Controlled Environments are defined as locations where there is exposure that may be incurred by people who are aware of the potential for exposure (i.e. as a result of employment or occupation).

3.5. Equipments Used during the Test

Test Equipment	Manufacturer	Type/Model	Serial Number	Calibration	
				Last Calibration	Calibration Interval
Data Acquisition Electronics DAEx	SPEAG	DAE4	1315	2014/07/22	1
E-field Probe	SPEAG	ES3DV3	3292	2014/08/15	1
System Validation Dipole D835V2	SPEAG	D835V2	4d134	2014/07/24	3
System Validation Dipole 1900V2	SPEAG	D1900V2	5d072	2013/12/12	3
System Validation Dipole 2450V2	SPEAG	D2450V2	884	2014/09/01	3
Network analyzer	Agilent	8753E	US37390562	2014/03/18	1
Universal Radio Communication Tester	ROHDE & SCHWARZ	CMU200	112012	2014/10/22	1
Dielectric Probe Kit	Agilent	85070E	US44020288	/	/
Power meter	Agilent	E4417A	GB41292254	2014/10/22	1
Power sensor	Agilent	8481H	MY41095360	2014/10/22	1
Signal generator	IFR	2032	203002/100	2014/10/22	1
Amplifier	AR	75A250	302205	2014/10/22	1

Note:

1) Per KDB865664D01 requirements for dipole calibration, the test laboratory has adopted three year extended calibration interval. Each measured dipole is expected to evalute with following criteria at least on annual interval.
   a) There is no physical damage on the dipole;
   b) System check with specific dipole is within 10% of calibrated values;
   c) The most recent return-loss results,measued at least annually,deviates by no more than 20% from the previous measurement;
   d) The most recent measurement of the real or imaginary parts of the impedance, measured at least annually is within 50 Ω from the provious measurement.
2) Network analyzer probe calibration against air, distilled water and a shorting block performed before measuring liquid parameters.

Justification of the extended calibration Dipole 1900V2

Head						
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
December 12, 2013	-30.0		50.3		3.17j	
December 10, 2014	-28.8	4%	48.2	2.1	1.99j	1.18

Body						
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
December 12, 2013	-27.7		48.8		3.92j	
December 10, 2014	-29.4	6.1%	46.5	2.3	2.86j	1.06

The return loss is < -20dB, and within 20% of prior calibration; the impedance is within 5 ohm of prior calibration. Therefore the verification result should support extended calibration.

4. SAR Measurements System configuration

4.1. SAR Measurement Set-up

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

A standard high precision 6-axis robot (Stäubli RX family) with controller and software. An arm extension for accommodating the data acquisition electronics (DAE).

A dosimetric probe, i.e. an isotropic E-field probe optimized and calibrated for usage in tissue simulating liquid. The probe is equipped with an optical surface detector system.

A data acquisition electronic (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.

A unit to operate the optical surface detector which is connected to the EOC.

The Electro-Optical Coupler (EOC) performs the conversion from the optical into a digital electric signal of the DAE. The EOC is connected to the DASY5 measurement server.

The DASY5 measurement server, which performs all real-time data evaluation for field measurements and surface detection, controls robot movements and handles safety operation. A computer operating Windows 2003.

DASY5 software and SEMCAD data evaluation software.

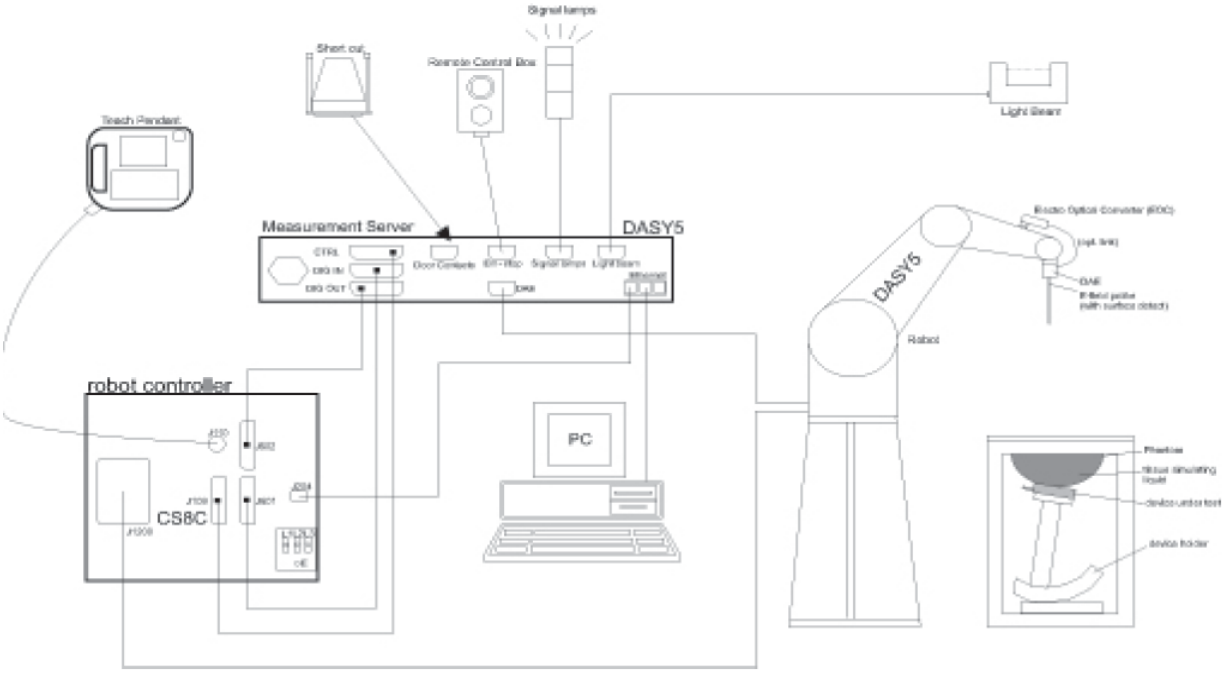
Remote control with teach panel and additional circuitry for robot safety such as warning lamps, etc.

The generic twin phantom enabling the testing of left-hand and right-hand usage.

The device holder for handheld mobile phones.

Tissue simulating liquid mixed according to the given recipes.

System validation dipoles allowing to validate the proper functioning of the system.



4.2. DASY5 E-field Probe System

The SAR measurements were conducted with the dosimetric probe ES3DV3 (manufactured by SPEAG), designed in the classical triangular configuration and optimized for dosimetric evaluation.

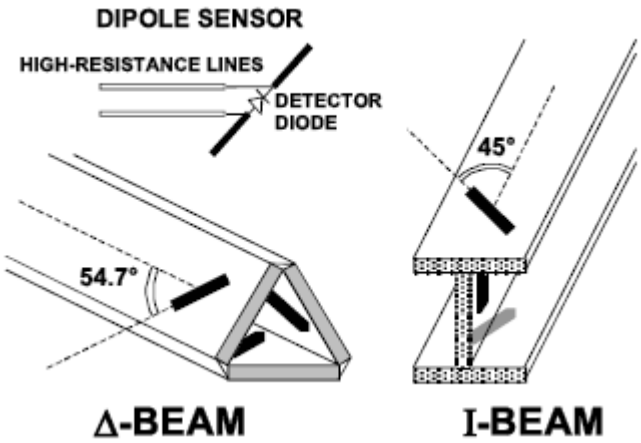
Probe Specification

Construction	Symmetrical design with triangular core Interleaved sensors Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)
Calibration	ISO/IEC 17025 calibration service available.
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
Application	General dosimetry up to 4 GHz Dosimetry in strong gradient fields Compliance tests of mobile phones
Compatibility	DASY3, DASY4, DASY52 SAR and higher, EASY4/MRI

Isotropic E-Field Probe

The isotropic E-Field probe has been fully calibrated and assessed for isotropicity, and boundary effect within a controlled environment. Depending on the frequency for which the probe is calibrated the method utilized for calibration will change.

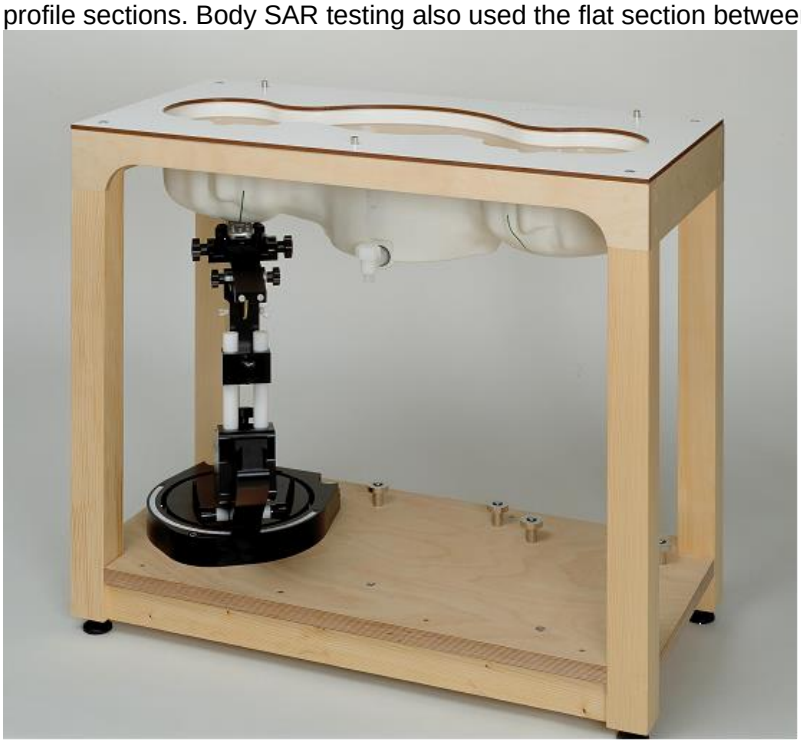
The E-Field probe utilizes a triangular sensor arrangement as detailed in the diagram below:



4.3. Phantoms

The phantom used for all tests i.e. for both system checks and device testing, was the twin-headed "SAM Phantom", manufactured by SPEAG. The SAM twin phantom is a fiberglass shell phantom with 2mm shell thickness (except the ear region, where shell thickness increases to 6mm).

System checking was performed using the flat section, whilst Head SAR tests used the left and right head profile sections. Body SAR testing also used the flat section between the head profiles.



SAM Twin Phantom

4.4. Device Holder

The device was placed in the device holder (illustrated below) that is supplied by SPEAG as an integral part of the DASY system.
The DASY device holder is designed to cope with the different positions given in the standard. It has two scales for device rotation (with respect to the body axis) and device inclination (with respect to the line between the ear reference points). The rotation centers for both scales is the ear reference point (ERP). Thus the device needs no repositioning when changing the angles.

Device holder supplied by SPEAG

4.5. Scanning Procedure

The DASY5 installation includes predefined files with recommended procedures for measurements and validation. They are read-only document files and destined as fully defined but unmeasured masks. All test positions (head or body-worn) are tested with the same configuration of test steps differing only in the grid definition for the different test positions.

The “reference” and “drift” measurements are located at the beginning and end of the batch process. They

measure the field drift at one single point in the liquid over the complete procedure. The indicated drift is mainly the variation of the DUT's output power and should vary max. ± 5 %.
The "surface check" measurement tests the optical surface detection system of the DASY5 system by repeatedly detecting the surface with the optical and mechanical surface detector and comparing the results. The output gives the detecting heights of both systems, the difference between the two systems and the standard deviation of the detection repeatability. Air bubbles or refraction in the liquid due to separation of the sugar-water mixture gives poor repeatability (above ± 0.1mm). To prevent wrong results tests are only executed when the liquid is free of air bubbles. The difference between the optical surface detection and the actual surface depends on the probe and is specified with each probe (It does not depend on the surface reflectivity or the probe angle to the surface within ± 30°.)

Area Scan
The Area Scan is used as a fast scan in two dimensions to find the area of high field values before running a detailed measurement around the hot spot.Before starting the area scan a grid spacing of 15 mm x 15 mm is set. During the scan the distance of the probe to the phantom remains unchanged. After finishing area scan, the field maxima within a range of 2 dB will be ascertained.

Zoom Scan
Zoom Scans are used to estimate the peak spatial SAR values within a cubic averaging volume containing 1 g and 10 g of simulated tissue. The default Zoom Scan is done by 7x7x7 points within a cube whose base is centered around the maxima found in the preceding area scan.

Spatial Peak Detection
The procedure for spatial peak SAR evaluation has been implemented and can determine values of masses of 1g and 10g, as well as for user-specific masses.The DASY5 system allows evaluations that combine measured data and robot positions, such as: • maximum search • extrapolation • boundary correction • peak search for averaged SAR During a maximum search, global and local maxima searches are automatically performed in 2-D after each Area Scan measurement with at least 6 measurement points. It is based on the evaluation of the local SAR gradient calculated by the Quadratic Shepard's method. The algorithm will find the global maximum and all local maxima within -2 dB of the global maxima for all SAR distributions.

Extrapolation routines are used to obtain SAR values between the lowest measurement points and the inner phantom surface. The extrapolation distance is determined by the surface detection distance and the probe sensor offset. Several measurements at different distances are necessary for the extrapolation. Extrapolation routines require at least 10 measurement points in 3-D space. They are used in the Zoom Scan to obtain SAR values between the lowest measurement points and the inner phantom surface. The routine uses the modified Quadratic Shepard's method for extrapolation. For a grid using 7x7x7 measurement points with 5mm resolution amounting to 343 measurement points, the uncertainty of the extrapolation routines is less than 1% for 1g and 10g cubes.

A Z-axis scan measures the total SAR value at the x-and y-position of the maximum SAR value found during the cube 7x7x7 scan. The probe is moved away in z-direction from the bottom of the SAM phantom in 5mm steps.

Table 1: Area and Zoom Scan Resolutions per FCC KDB Publication 865664 D01

Frequency	Maximum Area Scan Resolution (mm) (Δx_{area}, Δy_{area})	Maximum Zoom Scan Resolution (mm) (Δx_{zoom}, Δy_{zoom})	Maximum Zoom Scan Spatial Resolution (mm) $\Delta z_{zoom}(n)$	Minimum Zoom Scan Volume (mm) (x,y,z)
≤ 2 GHz	≤ 15	≤ 8	≤ 5	≥ 30
2-3 GHz	≤ 12	≤ 5	≤ 5	≥ 30
3-4 GHz	≤ 12	≤ 5	≤ 4	≥ 28
4-5 GHz	≤ 10	≤ 4	≤ 3	≥ 25
5-6 GHz	≤ 10	≤ 4	≤ 2	≥ 22

4.6. Data Storage and Evaluation

Data Storage
The DASY5 software stores the acquired data from the data acquisition electronics as raw data (in microvolt readings from the probe sensors), together with all necessary software parameters for the data evaluation (probe calibration data, liquid parameters and device frequency and modulation data) in measurement files with the extension ".DA4". The software evaluates the desired unit and format for output each time the data is visualized or exported. This allows verification of the complete software setup even after the measurement and allows correction of incorrect parameter settings. For example, if a measurement has been performed with a wrong crest factor parameter in the device setup, the parameter can be corrected afterwards and the

data can be re-evaluated.

The measured data can be visualized or exported in different units or formats, depending on the selected probe type ([V/m], [A/m], [°C], [mW/g], [mW/cm²], [dBrel], etc.). Some of these units are not available in certain situations or show meaningless results, e.g., a SAR output in a lossless media will always be zero. Raw data can also be exported to perform the evaluation with other software packages.

Data Evaluation
The SEMCAD software automatically executes the following procedures to calculate the field units from the microvolt readings at the probe connector. The parameters used in the evaluation are stored in the configuration modules of the software:

Probe parameters:	- Sensitivity	Normi, ai0, ai1, ai2
	- Conversion factor	ConvFi
	- Diode compression point	Dcpi
Device parameters:	- Frequency	f
	- Crest factor	cf
Media parameters:	- Conductivity	σ
	- Density	ρ

These parameters must be set correctly in the software. They can be found in the component documents or they can be imported into the software from the configuration files issued for the DASY5 components. In the direct measuring mode of the multimeter option, the parameters of the actual system setup are used. In the scan visualization and export modes, the parameters stored in the corresponding document files are used.

The first step of the evaluation is a linearization of the filtered input signal to account for the compression characteristics of the detector diode. The compensation depends on the input signal, the diode type and the DC-transmission factor from the diode to the evaluation electronics. If the exciting field is pulsed, the crest factor of the signal must be known to correctly compensate for peak power. The formula for each channel can be given as:

$$V_i = U_i + U_i^2 \cdot \frac{cf}{dcp_i}$$

With Vi = compensated signal of channel i (i = x, y, z)
Ui = input signal of channel i (i = x, y, z)
cf = crest factor of exciting field (DASY parameter)
dcpi = diode compression point (DASY parameter)

From the compensated input signals the primary field data for each channel can be evaluated:

$$\text{E} - \text{fieldprobes}: \qquad E_i = \sqrt{\frac{V_i}{Norm_i \cdot ConvF}}$$

$$\text{H} - \text{fieldprobes}: \qquad H_i = \sqrt{V_i} \cdot \frac{a_{i0} + a_{i1} f + a_{i2} f^2}{f}$$

With Vi = compensated signal of channel i (i = x, y, z)
Normi = sensor sensitivity of channel i (i = x, y, z)
[mV/(V/m)2] for E-field Probes
ConvF = sensitivity enhancement in solution
aij = sensor sensitivity factors for H-field probes
f = carrier frequency [GHz]
Ei = electric field strength of channel i in V/m
Hi = magnetic field strength of channel i in A/m

The RSS value of the field components gives the total field strength (Hermitian magnitude):

$$E_{tot} = \sqrt{E_x^2 + E_y^2 + E_z^2}$$

The primary field data are used to calculate the derived field units.

$$SAR = E_{tot}^2 \cdot \frac{\sigma}{\rho \cdot 1'000}$$

with SAR = local specific absorption rate in mW/g
Etot = total field strength in V/m
σ = conductivity in [mho/m] or [Siemens/m]
ρ = equivalent tissue density in g/cm3

Note that the density is normally set to 1 (or 1.06), to account for actual brain density rather than the density of the simulation liquid.

4.7. Tissue Dielectric Parameters for Head and Body Phantoms

The liquid is consisted of water,salt,Glycol,Sugar,Preventol and Cellulose.The liquid has previously been proven to be suited for worst-case.It's satisfying the latest tissue dielectric parameters requirements proposed by the KDB865664.

The composition of the tissue simulating liquid

Ingredient	835MHz		1900MHz		1750 MHz		2450MHz		2600MHz	
(% Weight)	Head	Body	Head	Body	Head	Body	Head	Body	Head	Body
Water	41.45	52.5	55.242	69.91	55.782	69.82	62.7	73.2	62.3	72.6
Salt	1.45	1.40	0.306	0.13	0.401	0.12	0.50	0.10	0.20	0.10
Sugar	56	45.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Preventol	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HEC	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DGBE	0.00	0.00	44.452	29.96	43.817	30.06	36.8	26.7	37.5	27.3

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

4.8. Tissue equivalent liquid properties

Dielectric performance of Head and Body tissue simulating liquid

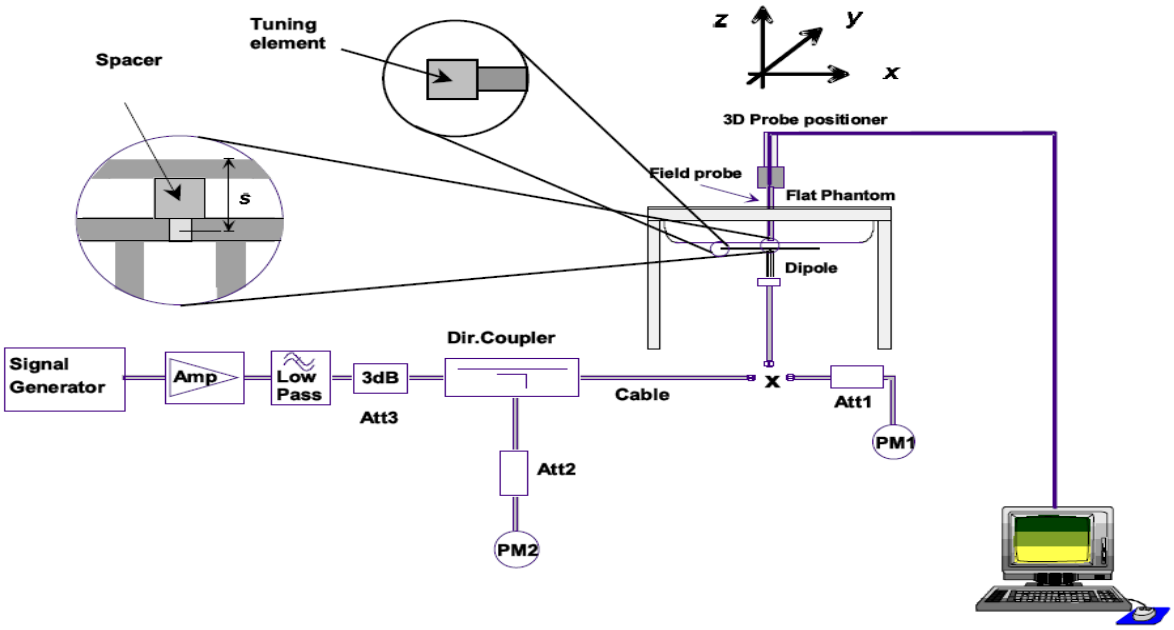
Tissue Type	Measured Frequency (MHz)	Target Tissue		Measured Tissue				Liquid Temp.	Test Data
		ε_r	σ	ε_r	Dev. %	σ	Dev. %		
850H	824	41.56	0.90	41.78	0.53%	0.92	2.22%	22 degree	2014-12-25
	835	41.50	0.90	41.61	0.27%	0.91	1.11%		
	837	41.50	0.90	41.64	0.34%	0.92	2.22%		
	849	41.50	0.92	41.39	-0.27%	0.95	3.26%		
1900H	1850	40.00	1.40	39.95	-0.12%	1.41	0.71%	22 degree	2014-12-26
	1880	40.00	1.40	39.97	-0.08%	1.45	3.57%		
	1900	40.00	1.40	39.88	-0.30%	1.45	3.57%		
	1910	40.00	1.40	39.73	-0.68%	1.47	5.00%		
2450H	2412	39.27	1.77	39.46	0.48%	1.79	1.13%	22 degree	2014-12-27
	2437	39.22	1.79	39.28	0.15%	1.84	2.79%		
	2450	39.20	1.80	39.25	0.13%	1.86	3.33%		
	2462	39.18	1.81	39.21	0.08%	1.86	2.76%		
850B	824	55.24	0.97	53.77	-2.66%	0.98	1.03%	22 degree	2014-12-25
	835	55.20	0.97	53.51	-3.06%	0.99	2.06%		
	837	55.19	0.97	53.51	-3.04%	0.99	2.06%		
	849	55.16	0.99	53.46	-3.08%	1.02	3.03%		
1900B	1850	53.30	1.52	53.30	0.00	1.48	-2.63%	22 degree	2014-12-26
	1880	53.30	1.52	53.10	-0.38%	1.50	-1.32%		
	1900	53.30	1.52	53.10	-0.38%	1.53	0.66%		
	1910	53.30	1.52	53.00	-0.56%	1.53	0.66%		
2450B	2412	52.75	1.91	52.80	0.09%	2.00	4.71%	22 degree	2014-12-27
	2437	52.72	1.94	52.65	-0.13%	2.03	4.64%		
	2450	52.70	1.95	52.70	0.00%	2.03	4.10%		
	2462	52.68	1.97	52.70	0.04%	2.06	4.57%		

4.9. System Check

The purpose of the system check is to verify that the system operates within its specifications at the decice test frequency.The system check is simple check of repeatability to make sure that the system works correctly at the time of the compliance test;

System check results have to be equal or near the values determined during dipole calibration with the relevant liquids and test system (±10 %).

System check is performed regularly on all frequency bands where tests are performed with the DASY5 system.



The output power on dipole port must be calibrated to 30 dBm (1000mW) before dipole is connected.

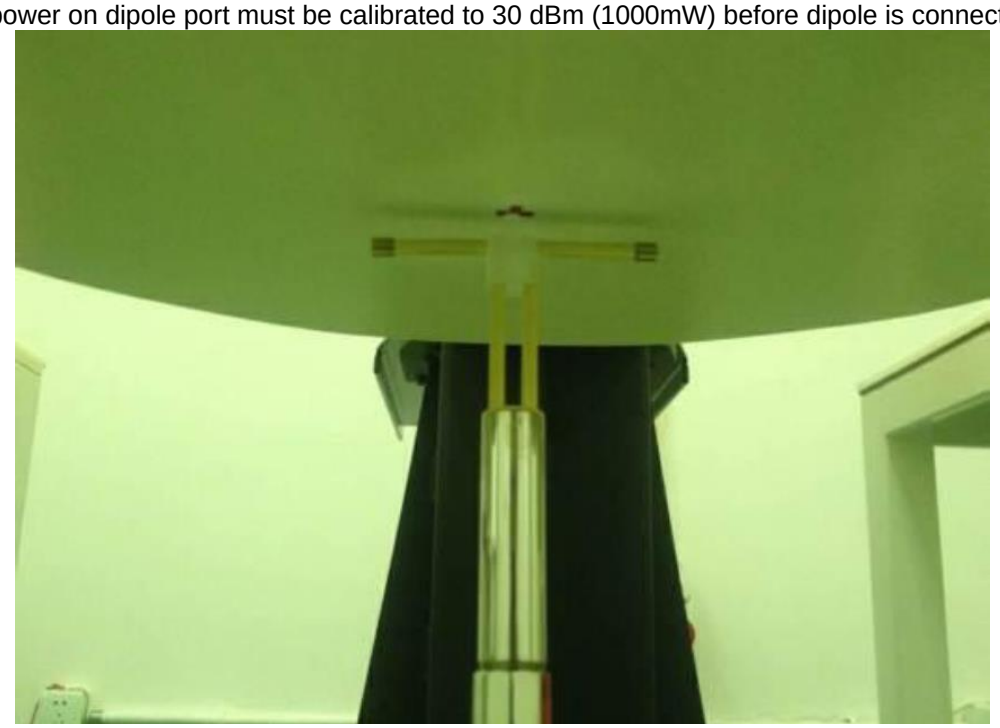


Photo of Dipole Setup

System Validation of Head

Measurement is made at temperature 22.0 ℃ and relative humidity 55%.							
Liquid temperature during the test: 22.0℃							
Measurement Date: 835MHz Dec 25th, 2014;1900MHz Dec 26th;2014, 2450MHz Dec 27th;2014							
Verification results	Frequency (MHz)	Target value (W/kg)		Measured value (W/kg)		Deviation	
		10 g Average	1 g Average	10 g Average	1 g Average	10 g Average	1 g Average
	835	6.27	9.62	6.25	9.60	-0.32%	-0.21%
	1900	20.20	38.30	20.60	38.90	1.98%	1.57%
	2450	24.60	52.10	25.10	54.00	2.03%	3.65%

System Validation of Body

Measurement is made at temperature 22.0 ℃ and relative humidity 55%.							
Liquid temperature during the test: 22.0℃							
Measurement Date: 835MHz Dec 25th, 2014;1900MHz Dec 26th;2014, 2450MHz Dec 27th;2014							
Verification results	Frequency (MHz)	Target value (W/kg)		Measured value (W/kg)		Deviation	
		10 g Average	1 g Average	10 g Average	1 g Average	10 g Average	1 g Average
	835	6.50	9.77	6.44	9.63	-0.92%	-1.43%
	1900	21.00	39.90	20.80	39.10	-0.95%	-2.01%
	2450	24.20	51.60	24.30	53.00	0.41%	2.71%

4.10. SAR measurement procedure

4.10.1 Tests to be performed

In order to determine the highest value of the peak spatial-average SAR of a handset, all device positions, configurations and operational modes shall be tested for each frequency band according to steps 1 to 3 below. A flowchart of the test process is shown in Picture 11.1.

Step 1: The tests described in 11.2 shall be performed at the channel that is closest to the centre of the transmit frequency band (f_c) for:

a). all device positions (cheek and tilt, for both left and right sides of the SAM phantom;

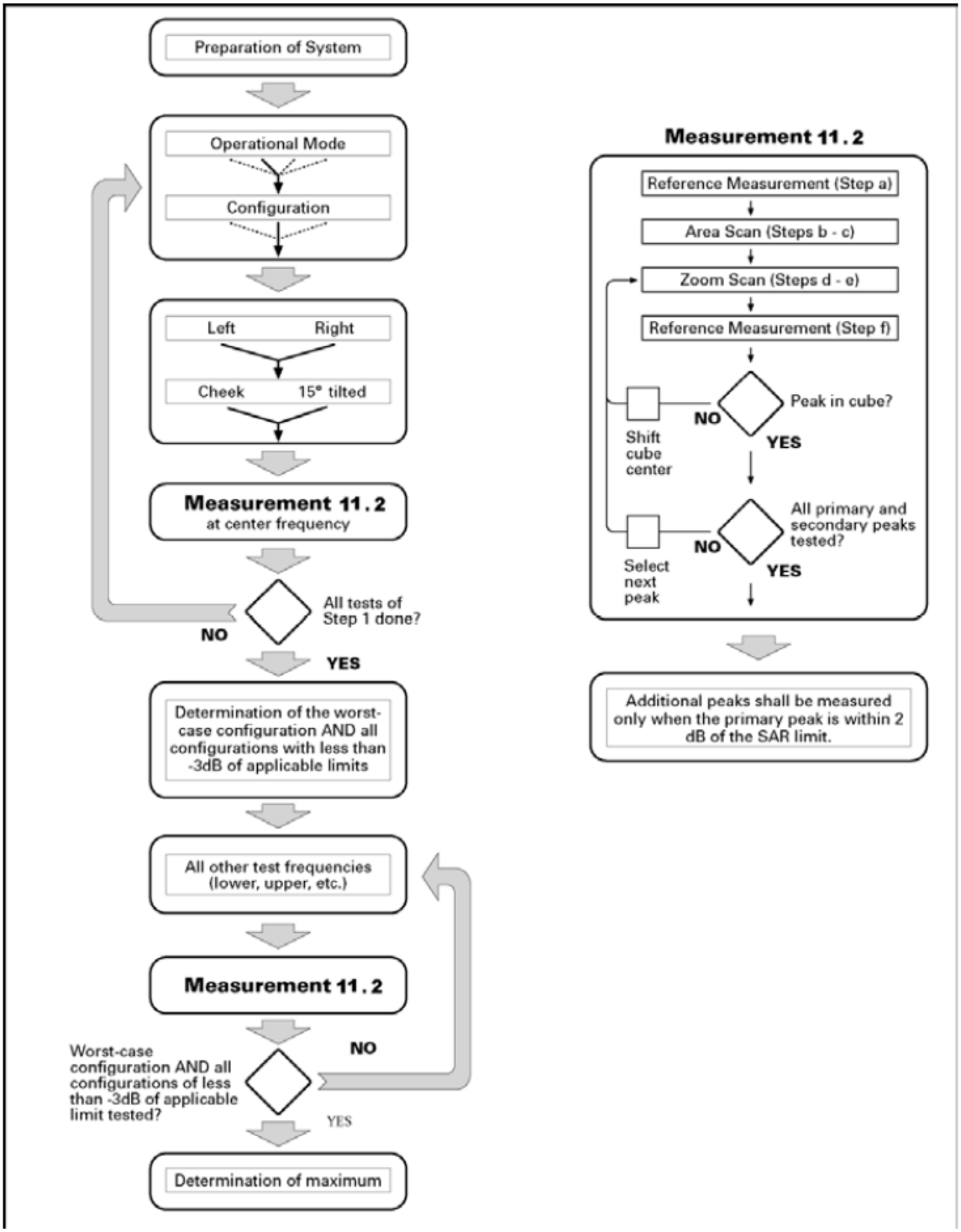
b). all configurations for each device position in a), e.g., antenna extended and retracted, and

c). all operational modes, e.g., analogue and digital, for each device position in a) and configuration in b) in each frequency band.

If more than three frequencies need to be tested according to 11.1 (i.e., $N_c > 3$), then all frequencies, configurations and modes shall be tested for all of the above test conditions.

Step 2: For the condition providing highest peak spatial-average SAR determined in Step 1, perform all tests described in 11.2 at all other test frequencies, i.e., lowest and highest frequencies. In addition, for all other conditions (device position, configuration and operational mode) where the peak spatial-average SAR value determined in Step 1 is within 3 dB of the applicable SAR limit, it is recommended that all other test frequencies shall be tested as well.

Step 3: Examine all data to determine the highest value of the peak spatial-average SAR found in Steps 1 to 2.



Picture 10.1 Block diagram of the tests to be performed

4.10.2 General Measurement Procedure

The area and zoom scan resolutions specified in the table below must be applied to the SAR measurements and fully documented in SAR reports to qualify for TCB approval. Probe boundary effect error compensation is required for measurements with the probe tip closer than half a probe tip diameter to the phantom surface. Both the probe tip diameter and sensor offset distance must satisfy measurement protocols; to ensure probe boundary effect errors are minimized and the higher fields closest to the phantom surface can be correctly measured and extrapolated to the phantom surface for computing 1-g SAR. Tolerances of the post-processing algorithms must be verified by the test laboratory for the scan resolutions used in the SAR measurements,

according to the reference distribution functions specified in IEEE Std 1528-2003. The results should be documented as part of the system validation records and may be requested to support test results when all the measurement parameters in the following table are not satisfied.

			≤ 3 GHz	> 3 GHz
Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface			5 ± 1 mm	½·δ·ln(2) ± 0.5 mm
Maximum probe angle from probe axis to phantom surface normal at the measurement location			30° ± 1°	20° ± 1°
Maximum area scan spatial resolution: Δx_{Area}, Δy_{Area}			≤ 2 GHz: ≤ 15 mm 2 – 3 GHz: ≤ 12 mm	3 – 4 GHz: ≤ 12 mm 4 – 6 GHz: ≤ 10 mm
			When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be ≤ the corresponding x or y dimension of the test device with at least one measurement point on the test device.	
Maximum zoom scan spatial resolution: Δx_{Zoom}, Δy_{Zoom}			≤ 2 GHz: ≤ 8 mm 2 – 3 GHz: ≤ 5 mm*	3 – 4 GHz: ≤ 5 mm* 4 – 6 GHz: ≤ 4 mm*
Maximum zoom scan spatial resolution, normal to phantom surface	uniform grid: $\Delta z_{Zoom}(n)$		≤ 5 mm	3 – 4 GHz: ≤ 4 mm 4 – 5 GHz: ≤ 3 mm 5 – 6 GHz: ≤ 2 mm
	graded grid	$\Delta z_{Zoom}(1)$: between 1st two points closest to phantom surface	≤ 4 mm	3 – 4 GHz: ≤ 3 mm 4 – 5 GHz: ≤ 2.5 mm 5 – 6 GHz: ≤ 2 mm
		$\Delta z_{Zoom}(n>1)$: between subsequent points	$\leq 1.5 \cdot \Delta z_{Zoom}(n-1)$	
Minimum zoom scan volume	x, y, z		≥ 30 mm	3 – 4 GHz: ≥ 28 mm 4 – 5 GHz: ≥ 25 mm 5 – 6 GHz: ≥ 22 mm

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

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

4.10.3 Conducted power measurement

a. For WWAN power measurement, use base station simulator connection with RF cable, at maximum power in each supported wireless interface and frequency band.
b. Read the WWAN RF power level from the base station simulator.
c. For WLAN/BT power measurement, use engineering software to configure EUT WLAN/BT continuously Transmission, at maximum RF power in each supported wireless interface and frequency band.
d. Connect EUT RF port through RF cable to the power meter, and measure WLAN/BT output power.

4.10.4 SAR measurement

4.10.4.1 GSM Test Configuration

SAR tests for GSM 850 and GSM 1900, a communication link is set up with a System Simulator (SS) by air link. Using CMU200 the power level is set to “5” for GSM 850, set to “0” for GSM 1900. Since the GPRS class is 12 for this EUT, it has at most 4 timeslots in uplink and at most 4 timeslots in downlink, the maximum total timeslots is 5. the EGPRS class is 12 for this EUT, it has at most 4 timeslots in uplink and at most 4 timeslots in downlink, the maximum total timeslots is 5.

SAR test reduction for GPRS and EDGE modes is determined by the source-based time-averaged output power specified for production units, including tune-up tolerance. The data mode with highest specified time-averaged output power should be tested for SAR compliance in the applicable exposure conditions. For modes with the same specified maximum output power and tolerance, the higher number time-slot

configuration should be tested. GSM voice and GPRS data use GMSK, which is a constant amplitude modulation with minimal peak to average power difference within the time-slot burst. For EDGE, GMSK is used for MCS 1 – MCS 4 and 8-PSK is used for MCS 5 – MCS 9; where 8-PSK has an inherently higher peak-to-average power ratio. The GMSK and 8-PSK EDGE configurations are considered separately for SAR compliance. The GMSK EDGE configurations are grouped with GPRS and considered with respect to time-averaged maximum output power to determine compliance. The 3G SAR test reduction procedure is applied to 8-PSK EDGE with GMSK GPRS/EDGE as the primary mode.

4.10.4.2 UMTS Test Configuration

3G SAR Test Reduction Procedure
In the following procedures, the mode tested for SAR is referred to as the primary mode. The equivalent modes considered for SAR test reduction are denoted as secondary modes. Both primary and secondary modes must be in the same frequency band. When the maximum output power and tune-up tolerance specified for production units in a secondary mode is ≤ ¼ dB higher than the primary mode or when the highest reported SAR of the primary mode is scaled by the ratio of specified maximum output power and tune-up tolerance of secondary to primary mode and the adjusted SAR is ≤ 1.2 W/kg, SAR measurement is not required for the secondary mode.3 This is referred to as the 3G SAR test reduction procedure in the following SAR test guidance, where the primary mode is identified in the applicable wireless mode test procedures and the secondary mode is wireless mode being considered for SAR test reduction by that procedure. When the 3G SAR test reduction procedure is not satisfied, it is identified as “otherwise” in the applicable procedures; SAR measurement is required for the secondary mode.

Output power Verification

Maximum output power is verified on the high, middle and low channels according to procedures described in section 5.2 of 3GPP TS 34.121, using the appropriate RMC or AMR with TPC (transmit power control) set to all “1’s” for WCDMA/HSDPA or by applying the required inner loop power control procedures to maintain maximum output power while HSUPA is active. Results for all applicable physical channel configurations (DPCCH, DPDCHn and spreading codes, HSDPA, HSPA) are requied in the SAR report. All configurations that are not supported by the handset or cannot be measured due to technical or equipment limitations must be clearly identified.

Head SAR

SAR for next to the ear head exposure is measured using a 12.2 kbps RMC with TPC bits configured to all “1’s”. The 3G SAR test reduction procedure is applied to AMR configurations with 12.2 kbps RMC as the primary mode. Otherwise, SAR is measured for 12.2 kbps AMR in 3.4 kbps SRB (signaling radio bearer) using the highest reported SAR configuration in 12.2 kbps RMC for head exposure.

Body-Worn Accessory SAR

SAR for body-worn accessory configurations is measured using a 12.2 kbps RMC with TPC bits configured to all “1’s”. The 3G SAR test reduction procedure is applied to other spreading codes and multiple DPDCHn configurations supported by the handset with 12.2 kbps RMC as the primary mode. Otherwise, SAR is measured using an applicable RMC configuration with the corresponding spreaing code or DPDCHn, for the highest reported body-worn accessory exposure SAR configuration in 12.2 kbps RMC. When more than 2 DPDCHn are supported by the handset, it may be necessary to configure additional DPDCHn using FTM (Factory Test Mode) or other chipset based test approaches with parameters similar to those used in 384 kbps and 768 kbps RMC.

Handsets with Release 5 HSDPA

The 3G SAR test reduction procedure is applied to HSDPA body-worn accessory configurations with 12.2 kbps RMC as the primary mode. Otherwise, SAR is measured for HSDPA using the HSDPA body SAR procedures in the “Release 5 HSDPA Data Devices” section of this document, for the highest reported SAR body-worn accessory exposure configuration in 12.2 kbps RMC. Handsets with both HSDPA and HSUPA are tested according to Release 6 HSPA test procedures.

HSDPA should be configured according to the UE category of a test device.The number of HSDSCH/ HS-PDSCHs, HARQ processes, minimum inter-TTI interval, transport block sizes and RV coding sequence are defined by the H-set. To maintain a consistent test configuration and stable transmission conditions, QPSK is used in the H-set for SAR testing. HS-DPCCH should be configured with a CQI feedback cycle of 4 ms with a CQI repetition factor of 2 to maintain a constant rate of active CQI slots. DPCCH and DPDCH gain factors(βc, βd), and HS-DPCCH power offset parameters (ΔACK, ΔNACK, ΔCQI) should be set according to

values indicated in the Table below. The CQI value is determined by the UE category, transport block size, number of HS-PDSCHs and modulation used in the H-set.

Table 2: Subtests for UMTS Release 5 HSDPA

Sub-set	β_c	β_d	β_d (SF)	β_c/β_d	β_{hs} (note 1, note 2)	CM(dB) (note 3)	MPR(dB)
1	2/15	15/15	64	2/15	4/15	0.0	0.0
2	12/15 (note 4)	15/15 (note 4)	64	12/15 (note 4)	24/15	1.0	0.0
3	15/15	8/15	64	15/8	30/15	1.5	0.5
4	15/15	4/15	64	15/4	30/15	1.5	0.5

Note1: $\triangle_{ACK}$, $\triangle_{NACK}$ and $\triangle_{CQI}$= 8⇔ $A_{hs} = \beta_{hs}/\beta_c$=30/15⇔ β_{hs}=30/15*β_c
Note2: CM=1 for β_c/β_d =12/15, β_{hs}/β_c=24/15.
Note3: For subtest 2 the $\beta_c\beta_d$ ratio of 12/15 for the TFC during the measurement period(TF1,TF0) is achieved by setting the signaled gain factors for the reference TFC (TFC1,TF1) to β_c=11/15 and β_d=15/15.

HSUPA Test Configuration

The 3G SAR test reduction procedure is applied to HSPA (HSUPA/HSDPA with RMC) body-worn accessory configurations with 12.2 kbps RMC as the primary mode. Otherwise, SAR is measured for HSPA using the HSPA body SAR procedures in the “Release 6 HSPA Data Devices” section of this document, for the highest reported body-worn accessory exposure SAR configuration in 12.2 kbps RMC. When VOIP is applicable for next to the ear head exposure in HSPA, the 3G SAR test reduction procedure is applied to HSPA with 12.2 kbps RMC as the primary mode; otherwise, the same HSPA configuration used for body-worn accessory measurements is tested for next to the ear head exposure.

Due to inner loop power control requirements in HSPA, a communication test set is required for output power and SAR tests. The 12.2 kbps RMC, FRC H-set 1 and E-DCH configurations for HSPA are configured according to the β values indicated in Table 2 and other applicable procedures described in the ‘WCDMA Handset’ and ‘Release 5 HSDPA Data Devices’ sections of this document

Table 3: Sub-Test 5 Setup for Release 6 HSUPA

Sub-set	β_c	β_d	β_d (SF)	β_c/β_d	β_{hs} (1)	β_{ec}	β_{ed}	β_{ed} (SF)	β_{ed} (codes)	CM (2) (dB)	MPR (dB)	AG (4) Index	E-TFCI
1	11/15(3)	15/15(3)	64	11/15(3)	22/15	209/225	1039/225	4	1	1.0	0.0	20	75
2	6/15	15/15	64	6/15	12/15	12/15	94/75	4	1	3.0	2.0	12	67
3	15/15	9/15	64	15/9	30/15	30/15	β_{ed1}:47/15 β_{ed2}:47/15	4	2	2.0	1.0	15	92
4	2/15	15/15	64	2/15	4/15	2/15	56/75	4	1	3.0	2.0	17	71
5	15/15(4)	15/15(4)	64	15/15(4)	30/15	24/15	134/15	4	1	1.0	0.0	21	81

Note 1: Δ_{ACK}, ΔNACK and Δ_{CQI} = 8 ⇔ $A_{hs} = \underline{\beta}_{hs}/\underline{\beta}_c$ = 30/15 ⇔ $\underline{\beta}_{hs}$= 30/15 *β_c.
Note 2: CM = 1 for βc/βd =12/15, $\underline{\beta}_{hs}/\underline{\beta}_c$ =24/15. For all other combinations of DPDCH, DPCCH, HS- DPCCH, E-DPDCH and E-DPCCH the MPR is based on the relative CM difference.
Note 3: For subtest 1 the βc/βd ratio of 11/15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signaled gain factors for the reference TFC (TF1, TF1) to βc = 10/15 and βd = 15/15.
Note 4: For subtest 5 the βc/βd ratio of 15/15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signaled gain factors for the reference TFC (TF1, TF1) to βc = 14/15 and βd = 15/15.
Note 5: Testing UE using E-DPDCH Physical Layer category 1 Sub-test 3 is not required according to TS 25.306 Figure 5.1g.
Note 6: βed can not be set directly; it is set by Absolute Grant Value.

Table 4: HSUPA UE category

UE E-DCH Category	Maximum E-DCH Codes Transmitted	Number of HARQ Processes	E-DCH TTI (ms)	Minimum Spreading Factor	Maximum E-DCH Transport Block Bits	Max Rate (Mbps)
1	1	4	10	4	7110	0.7296
2	2	8	2	4	2798	1.4592
	2	4	10	4	14484	
3	2	4	10	4	14484	1.4592
4	2	8	2	2	5772	2.9185
	2	4	10	2	20000	2.00
5	2	4	10	2	20000	2.00
6 (No DPDCH)	4	8	2	2 SF2 & 2 SF4	11484	5.76
	4	4	10		20000	2.00
7 (No DPDCH)	4	8	2	2 SF2 & 2 SF4	22996	?
	4	4	10		20000	?
NOTE: When 4 codes are transmitted in parallel, two codes shall be transmitted with SF2 and two with SF4. UE Categories 1 to 6 supports QPSK only. UE Category 7 supports QPSK and 16QAM. (TS25.306-7.3.0)						

HSPA, HSPA+ and DC-HSDPA Test Configuration

measurement is required for HSPA, HSPA+ or DC-HSDPA, a KDB inquiry is required to confirm that the wireless mode configurations in the test setup have remained stable throughout the SAR measurements.35 Without prior KDB confirmation to determine the SAR results are acceptable, a PBA is required for TCB approval.
SAR test exclusion for HSPA, HSPA+ and DC-HSDPA is determined according to the following:
1) The HSPA procedures are applied to configure 3GPP Rel. 6 HSPA devices in the required sub-test mode(s) to determine SAR test exclusion.
2) SAR is required for Rel. 7 HSPA+ when SAR is required for Rel. 6 HSPA; otherwise, the 3G SAR test reduction procedure is applied to (uplink) HSPA+ with 12.2 kbps RMC as the primary mode.36 Power is measured for HSPA+ that supports uplink 16 QAM according to configurations in Table C.11.1.4 of 3GPP TS 34.121-1 to determine SAR test reduction.
3) SAR is required for Rel. 8 DC-HSDPA when SAR is required for Rel. 5 HSDPA; otherwise, the 3G SAR test reduction procedure is applied to DC-HSDPA with 12.2 kbps RMC as the primary mode. Power is measured for DC-HSDPA according to the H-Set 12, FRC configuration in Table C.8.1.12 of 3GPP TS 34.121-1 to determine SAR test reduction. A primary and a secondary serving HS-DSCH Cell are required to perform the power measurement and for the results to be acceptable.
4) Regardless of whether a PBA is required, the following information must be verified and included in the SAR report for devices supporting HSPA, HSPA+ or DC-HSDPA: a) The output power measurement results and applicable release version(s) of 3GPP TS 34.121.

i) Power measurement difficulties due to test equipment setup or availability must be resolved between the grantee and its test lab.

b) The power measurement results are in agreement with the individual device implementation and specifications. When Enhanced MPR (E-MPR) applies, the normal MPR targets may be modified according to the Cubic Metric (CM) measured by the device, which must be taken into consideration.
c) The UE category, operating parameters, such as the β and Δ values used to configure the device for testing, power setback procedures described in 3GGPP TS 34.121 for the power measurements, and HSPA/HSPA+ channel conditions (active and stable) for the entire duration of the measurement according to the required E-TFCI and AG index values.

5) When SAR measurement is required, the test configurations, procedures and power measurement results must be clearly described to confirm that the required test parameters are used, including E-TFCI and AG index stability and output power conditions.

Table 5: HS-DSCH UE category

Table 5.1a: FDD HS-DSCH physical layer categories

HS-DSCH category	Maximum number of HS-DSCH codes received	Minimum inter-TTI interval	Maximum number of bits of an HS-DSCH transport block received within an HS-DSCH TTI NOTE 1	Total number of soft channel bits	Supported modulations without MIMO operation or dual cell operation	Supported modulations with MIMO operation and without dual cell operation	Supported modulations with dual cell operation
Category 1	5	3	7298	19200	QPSK, 16QAM	Not applicable (MIMO not supported)	Not applicable (dual cell operation not supported)
Category 2	5	3	7298	28800			
Category 3	5	2	7298	28800			
Category 4	5	2	7298	38400			
Category 5	5	1	7298	57600			
Category 6	5	1	7298	67200			
Category 7	10	1	14411	115200			
Category 8	10	1	14411	134400			
Category 9	15	1	20251	172800			
Category 10	15	1	27952	172800			
Category 11	5	2	3630	14400	QPSK		
Category 12	5	1	3630	28800			
Category 13	15	1	35280	259200	QPSK, 16QAM, 64QAM		
Category 14	15	1	42192	259200			
Category 15	15	1	23370	345600	QPSK, 16QAM		
Category 16	15	1	27952	345600			
Category 17 NOTE 2	15	1	35280	259200	QPSK, 16QAM, 64QAM	–	
			23370	345600	–	QPSK, 16QAM	
Category 18 NOTE 3	15	1	42192	259200	QPSK, 16QAM, 64QAM	–	
			27952	345600	–	QPSK, 16QAM	
Category 19	15	1	35280	518400	QPSK, 16QAM, 64QAM		
Category 20	15	1	42192	518400			
Category 21	15	1	23370	345600	-	-	QPSK, 16QAM
Category 22	15	1	27952	345600			
Category 23	15	1	35280	518400			QPSK, 16QAM, 64QAM
Category 24	15	1	42192	518400			

4.10.5 WIFI Test Configuration

For WLAN SAR testing, WLAN engineering testing software installed on the DUT can provide continuous transmitting RF signal. The Tx power is set to 14.5 for 802.11 b mode by software. This RF signal utilized in SAR measurement has almost 100% duty cycle and its crest factor is 1.

For the 802.11b/g/n SAR tests, a communication link is set up with the test mode software for WIFI mode test. During the test, at the each test frequency channel, the EUT is operated at the RF continuous emission mode. Each channel should be tested at the lowest data rate. Testing at higher data rates is not required when the maximum average output power is less than 0.25dB higher than those measured at the lowest data rate.

802.11b/g/n operating modes are tested independently according to the service requirements in each frequency band. 802.11b/g/n modes are tested on the maximum average output channel.

SAR is not required for 802.11g/n channels when the maximum average output power is less than 0.25dB higher than that measured on the corresponding 802.11b channels.

4.10.5 Power Drift

To control the output power stability during the SAR test, DASY5 system calculates the power drift by measuring the E-field at the same location at the beginning and at the end of the measurement for each test position. These drift values can be found in Table 14.1 to Table 14.11 labeled as: (Power Drift [dB]). This ensures that the power drift during one measurement is within 5%.

4.10.6 Area Scan Based 1-g SAR

4.10.6.1 Requirement of KDB

According to the KDB447498 D01 v05, when the implementation is based the specific polynomial fit algorithm as presented at the 29th Bioelectromagnetics Society meeting (2007) and the estimated 1-g SAR is ≤ 1.2 W/kg, a zoom scan measurement is not required provided it is also not needed for any other purpose; for example, if the peak SAR location required for simultaneous transmission SAR test exclusion can be determined accurately by the SAR system or manually to discriminate between distinctive peaks and scattered noisy SAR distributions from area scans.

There must not be any warning or alert messages due to various measurement concerns identified by the SAR system; for example, noise in measurements, peaks too close to scan boundary, peaks are too sharp, spatial resolution and uncertainty issues etc. The SAR system verification must also demonstrate that the area scan estimated 1-g SAR is within 3% of the zoom scan 1-g SAR (See Annex B). When all the SAR results for each exposure condition in a frequency band and wireless mode are based on estimated 1-g SAR, the 1-g SAR for the highest SAR configuration must be determined by a zoom scan.

4.10.6.2 Fast SAR Algorithms

The approach is based on the area scan measurement applying a frequency dependent attenuation parameter. This attenuation parameter was empirically determined by analyzing a large number of phones. The MOTOROLA FAST SAR was developed and validated by the MOTOROLA Research Group in Ft. Lauderdale.

In the initial study, an approximation algorithm based on Linear fit was developed. The accuracy of the algorithm has been demonstrated across a broad frequency range (136-2450 MHz) and for both 1- and 10-g averaged SAR using a sample of 264 SAR measurements from 55 wireless handsets. For the sample size studied, the root-mean-squared errors of the algorithm are 1.2% and 5.8% for 1- and 10-g averaged SAR, respectively

In the second step, the same research group optimized the fitting algorithm to an Polynomial fit whereby the frequency validity was extended to cover the range 30-6000MHz. Details of this study can be found in the BEMS 2007 Proceedings.

Both algorithms are implemented in DASY software.

4.11. General description of test procedures

1. The DUT is tested using CMU 200 communications testers as controller unit to set test channels and maximum output power to the DUT, as well as for measuring the conducted peak power.
2. Test positions as described in the tables above are in accordance with the specified test standard.
3. Tests in body position were performed in that configuration, which generates the highest time based averaged output power (see conducted power results).
4. Tests in head position with GSM were performed in voice mode with 1 timeslot unless GPRS/EGPRS/DTM function allows parallel voice and data traffic on 2 or more timeslots.
5. MTS was tested in RMC mode with 12.2 kbit/s and TPC bits set to ‘all 1’.
6. WLAN was tested in 802.11a/b mode with 1 MBit/s and 6 MBit/s. According to KDB 248227 the SAR testing for 802.11g/n is not required since the maximum power of 802.11g/n is less ¼ dB higher than maximum power of 802.11a/b.
7. Required WLAN test channels were selected according to KDB 248227
8. According to FCC KDB pub 941225 D06 this device has been tested with 10 mm distance to the phantom for operation in WLAN hot spot mode.
9. Per FCC KDB pub 941225 D06 the edges with antennas within 2.5 cm are required to be evaluated for SAR to cover WLAN hot spot function.
10. According to IEEE 1528 the SAR test shall be performed at middle channel. Testing of top and bottom channel is optional.
11. According to KDB 447498 D01 testing of other required channels within the operating mode of a frequency band is not required when the reported 1-g or 10-g SAR for the mid-band or highest output power channel is:
    - ≤ 0.8 W/kg or 2.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≤ 100 MHz
    - ≤ 0.6 W/kg or 1.5 W/kg, for 1-g or 10-g respectively, when the transmission band is between 100 MHz and 200 MHz
    - ≤ 0.4 W/kg or 1.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≥ 200 MHz
12. IEEE 1528-2003 require the middle channel to be tested first. This generally applies to wireless devices that are designed to operate in technologies with tight tolerances for maximum output power variations across channels in the band. When the maximum output power variation across the required test channels is > ½ dB, instead of the middle channel, the highest output power channel must be used.
13. Per KDB648474 D04 require when the reported SAR for a body-worn accessory, measured without a headset connected to the handset, is < 1.2 W/kg.

14. Per KDB648474 D04 require when the separation distance required for body-worn accessory testing is larger than or equal to that tested for hotspot mode, using the same wireless mode test configuration for voice and data, such as WCDMA, LTE and Wi-Fi, and for the same surface of the phone, the hotspot mode SAR data may be used to support body-worn accessory SAR compliance for that particular configuration (surface)
15. 10-g extremity SAR is required only for the surfaces and edges with hotspot mode 1-g SAR > 1.2 W/kg.
16. Per KDB648474 D04 require for phablet SAR test considerations，For smart phones with a display diagonal dimension > 15.0 cm or an overall diagonal dimension > 16.0 cm, When hotspot mode applies, 10-g extremity SAR is required only for the surfaces and edges with hotspot mode 1-g reported SAR > 1.2 W/kg..

4.12. Power Reduction

The product without any power reduction.

5. TEST CONDITIONS AND RESULTS

5.1. Conducted Power Results

Max Conducted power measurement results and power drift from tune-up tolerance provide by manufacturer:

GSM 850		Burst Conducted power (dBm) Channel/Frequency(MHz)			/	Average power (dBm) Channel/Frequency(MHz)		
		128/824.2	190/836.6	251/848.8		128/824.2	190/836.6	251/848.8
GSM		32.46	33.15	32.71	-9.03dB	23.43	24.12	23.68
GPRS (GMSK)	1TX slot	32.39	33.08	32.69	-9.03dB	23.36	24.05	23.66
	2TX slot	30.26	30.91	30.48	-6.02dB	24.24	24.89	24.46
	3TX slot	28.70	29.22	28.89	-4.26dB	24.44	24.96	24.63
	4TX slot	27.84	28.16	27.96	-3.01dB	24.83	25.15	24.95
EGPRS (GMSK)	1TX slot	32.35	33.01	32.66	-9.03dB	23.32	23.98	23.63
	2TX slot	30.18	30.88	30.47	-6.02dB	24.16	24.86	24.45
	3TX slot	28.61	29.17	28.83	-4.26dB	24.35	24.91	24.57
	4TX slot	27.89	28.12	27.91	-3.01dB	24.88	25.11	24.90
EGPRS (8PSK)	1TX slot	27.01	27.24	27.09	-9.03dB	17.98	18.21	18.06
	2TX slot	26.84	26.98	26.92	-6.02dB	20.82	20.96	20.90
	3TX slot	25.19	25.42	25.25	-4.26dB	20.93	21.16	20.99
	4TX slot	24.02	24.26	24.16	-3.01dB	21.01	21.25	21.15
GSM 1900		Burst Conducted power (dBm) Channel/Frequency(MHz)			/	Average power (dBm) Channel/Frequency(MHz)		
		512/ 1850.2	661/ 1880	810/ 1909.8		512/ 1850.2	661/ 1880	810/ 1909.8
GSM		29.81	29.70	29.52	-9.03dB	20.78	20.67	20.49
GPRS (GMSK)	1TX slot	29.78	29.67	29.48	-9.03dB	20.75	20.64	20.45
	2TX slot	27.69	27.89	27.86	-6.02dB	21.67	21.87	21.84
	3TX slot	26.43	26.55	26.49	-4.26dB	22.17	22.29	22.23
	4TX slot	25.38	25.48	25.41	-3.01dB	22.37	22.47	22.40
EGPRS (GMSK)	1TX slot	29.73	29.61	29.45	-9.03dB	20.70	20.58	20.42
	2TX slot	27.62	27.85	27.72	-6.02dB	21.60	21.83	21.70
	3TX slot	26.38	26.51	26.36	-4.26dB	22.12	22.25	22.10
	4TX slot	25.31	25.43	25.35	-3.01dB	22.30	22.42	22.34
EGPRS (8PSK)	1TX slot	25.28	25.15	25.35	-9.03dB	16.25	16.12	16.32
	2TX slot	25.16	24.89	25.20	-6.02dB	19.14	18.87	19.18
	3TX slot	24.49	24.35	24.56	-4.26dB	20.23	20.09	20.30
	4TX slot	23.34	23.27	23.44	-3.01dB	20.33	20.26	20.43

NOTES:
1) Division Factors
To average the power, the division factor is as follows:
1TX-slot = 1 transmit time slot out of 8 time slots=> conducted power divided by (8/1) => -9.03dB
2TX-slots = 2 transmit time slots out of 8 time slots=> conducted power divided by (8/2) => -6.02dB
3TX-slots = 3 transmit time slots out of 8 time slots=> conducted power divided by (8/3) => -4.26dB
4TX-slots = 4 transmit time slots out of 8 time slots=> conducted power divided by (8/4) => -3.01dB
According to the conducted power as above, the body measurements are performed with 4Txslots for GPRS850 and GPRS1900.

WLAN

Mode	Channel	Frequency (MHz)	Worst case Data rate of worst case	Conducted Output Power (dBm)	
				Peak	Average
802.11b	1	2412	1Mbps	20.45	17.10
	6	2437	1Mbps	20.61	17.22
	11	2462	1Mbps	20.16	17.05
802.11g	1	2412	6Mbps	22.29	15.34
	6	2437	6Mbps	22.80	15.39
	11	2462	6Mbps	21.77	15.27
802.11n(20MHz)	1	2412	6.5 Mbps	22.56	13.89
	6	2437	6.5 Mbps	23.42	14.06
	11	2462	6.5 Mbps	22.08	13.62
802.11n(40MHz)	3	2422	13.5 Mbps	21.36	11.78
	6	2437	13.5 Mbps	22.19	12.00
	9	2452	13.5 Mbps	20.88	11.53

Note: SAR is not required for 802.11b/g/n channels if the output power is less than 0.25dB higher than that measured on the corresponding 802.11b channels, and for each frequency band, testing at higher data rates and higher order modulations is not required when the maximum average output power for each of these configurations is less than 0.25dB higher than those measured at the lowest data rate. According to the above conducted power, the EUT should not be tested for “802.11b/g/n”.

Bluetooth

Mode	Channel	Frequency (MHz)	Conducted Average Power (dBm)
BLE-GFSK	00	2402	0.43
	19	2440	0.68
	39	2480	0.91
GFSK	00	2402	7.25
	39	2441	7.53
	78	2480	7.06
8DPSK	00	2402	6.91
	39	2441	7.08
	78	2480	6.57
π/4DQPSK	00	2402	6.72
	39	2441	6.89
	78	2480	6.36

Manufacturing tolerance

GSM Speech

GSM 850 (GMSK) (Average)			
Channel	Channel 251	Channel 190	Channel 190
Target (dBm)	32.50	32.50	32.50
Tolerance ±(dB)	1	1	1
GSM 1900 (GMSK) (Peak)			
Channel	Channel 810	Channel 661	Channel 512
Target (dBm)	29.00	29.00	29.00
Tolerance ±(dB)	1	1	1

GSM 850 GPRS (GMSK) (Average)				
Channel		251	190	128
1 Txslot	Target (dBm)	32.50	32.50	32.50
	Tolerance ±(dB)	1	1	1
2 Txslot	Target (dBm)	30.0	30.0	30.0
	Tolerance ±(dB)	1	1	1
3 Txslot	Target (dBm)	28.5	28.5	28.5
	Tolerance ±(dB)	1	1	1
4 Txslot	Target (dBm)	28.0	28.0	28.0
	Tolerance ±(dB)	1	1	1
GSM 850 EDGE (GMSK) (Average)				
Channel		251	190	128

1 Txslot	Target (dBm)	32.50	32.50	32.50
	Tolerance ±(dB)	1	1	1
2 Txslot	Target (dBm)	30.0	30.0	30.0
	Tolerance ±(dB)	1	1	1
3 Txslot	Target (dBm)	28.5	28.5	28.5
	Tolerance ±(dB)	1	1	1
4 Txslot	Target (dBm)	28.0	28.0	28.0
	Tolerance ±(dB)	1	1	1
GSM 850 EDGE (8PSK) (Average)				
Channel		251	190	128
1 Txslot	Target (dBm)	27.0	27.0	27.0
	Tolerance ±(dB)	1	1	1
2 Txslot	Target (dBm)	26.0	26.0	26.0
	Tolerance ±(dB)	1	1	1
3 Txslot	Target (dBm)	25.0	25.0	25.0
	Tolerance ±(dB)	1	1	1
4 Txslot	Target (dBm)	24.0	24.0	24.0
	Tolerance ±(dB)	1	1	1
GSM 1900 GPRS (GMSK) (Average)				
Channel		810	661	512
1 Txslot	Target (dBm)	29.0	29.0	29.0
	Tolerance ±(dB)	1	1	1
2 Txslot	Target (dBm)	27.0	27.0	27.0
	Tolerance ±(dB)	1	1	1
3 Txslot	Target (dBm)	26.0	26.0	26.0
	Tolerance ±(dB)	1	1	1
4 Txslot	Target (dBm)	25.0	25.0	25.0
	Tolerance ±(dB)	1	1	1
GSM 1900 EDGE (GMSK) (Peak)				
Channel		810	661	512
1 Txslot	Target (dBm)	29.0	29.0	29.0
	Tolerance ±(dB)	1	1	1
2 Txslot	Target (dBm)	27.0	27.0	27.0
	Tolerance ±(dB)	1	1	1
3 Txslot	Target (dBm)	26.0	26.0	26.0
	Tolerance ±(dB)	1	1	1
4 Txslot	Target (dBm)	25.0	25.0	25.0
	Tolerance ±(dB)	1	1	1
GSM 1900 EDGE (8PSK) (Average)				
Channel	251	190	128	
1 Txslot	Target (dBm)	25.0	25.0	25.0
	Tolerance ±(dB)	1	1	1
2 Txslot	Target (dBm)	25.0	25.0	25.0
	Tolerance ±(dB)	1	1	1
3 Txslot	Target (dBm)	24.0	24.0	24.0
	Tolerance ±(dB)	1	1	1
4 Txslot	Target (dBm)	23.0	23.0	23.0
	Tolerance ±(dB)	1	1	1

WLAN

802.11b (Average)			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	16.5	16.5	16.5
Tolerance ±(dB)	1	1	1
802.11g (Average)			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	15.0	15.0	15.0
Tolerance ±(dB)	1	1	1
802.11n(20MHz) (Average)			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	13.5	13.5	13.5
Tolerance ±(dB)	1	1	1

802.11n(40MHz) (Average)			
Channel	Channel 3	Channel 6	Channel 9
Target (dBm)	12.0	12.0	12.0
Tolerance ±(dB)	1	1	1

Bluetooth

BLE-GFSK (Average)			
Channel	Channel 00	Channel 19	Channel 39
Target (dBm)	0.00	0.00	0.00
Tolerance ±(dB)	1	1	1
GFSK (Average)			
Channel	Channel 00	Channel 39	Channel 78
Target (dBm)	7.00	7.00	7.00
Tolerance ±(dB)	1	1	1
8DPSK (Average)			
Channel	Channel 00	Channel 39	Channel 78
Target (dBm)	7.00	7.00	7.00
Tolerance ±(dB)	1	1	1
π/4DQPSK (Average)			
Channel	Channel 00	Channel 39	Channel 78
Target (dBm)	7.00	7.00	7.00
Tolerance ±(dB)	1	1	1

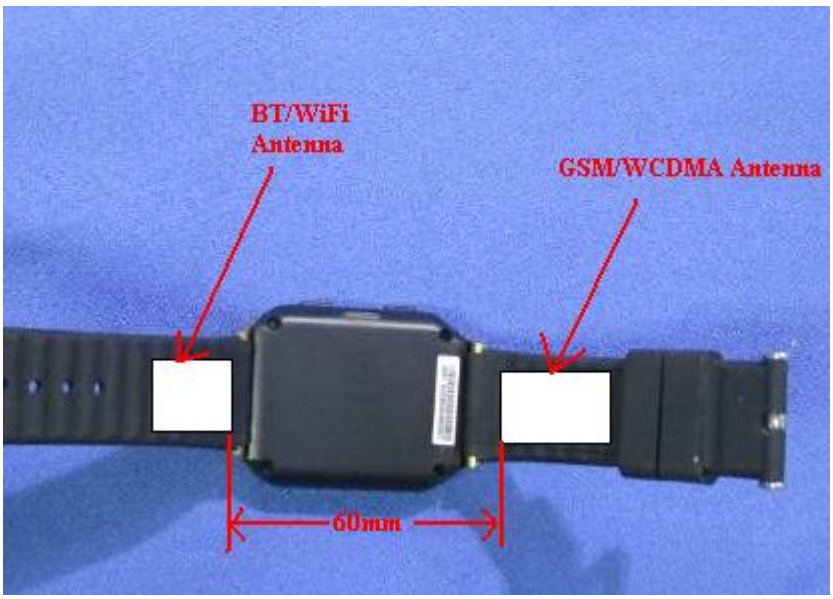
5.2. Simultaneous TX SAR Considerations

5.2.1 Introduction

Application Simultaneous Transmission information:

Air-Interface	Band (MHz)	Type	Simultaneous Transmissions	Voice over Digital Transport(Data)
GSM	850	VO	Yes,WLAN or BT/BLE	N/A
	1900	VO		
	GPRS/EDGE	DT	Yes,WLAN or BT/BLE	N/A
WLAN	2450	DT	Yes,GSM,GPRS,EDGE,WCDMA	Yes
BT	2450	DT	Yes,GSM,GPRS,EDGE,WCDMA	N/A
Note:VO-Voice Service only;DT-Digital Transport				

5.2.2 Transmit Antenna Separation Distances



5.2.2 Standalone SAR Test Exclusion Considerations

Standalone 1-g head or body SAR evaluation by measurement or numerical simulation is not required when the corresponding SAR Exclusion Threshold condition, listed below, is satisfied.
The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by::
[(max. power of channel, including tune-up tolerance, mW) / (min. test separation distance, mm)] ·[√ f(GHz)] ≤ 3.0 for 1-g SAR and ≤ 7.5 for 10-g extremity SAR, where

- f(GHz) is the RF channel transmit frequency in GHz
- Power and distance are rounded to the nearest mW and mm before calculation
- The result is rounded to one decimal place for comparison
- 3.0 and 7.5 are referred to as the numeric thresholds in the step 2 below

The test exclusions are applicable only when the minimum test separation distance is ≤ 50 mm and for transmission frequencies between 100 MHz and 6 GHz. When the minimum test separation distance is < 5 mm, a distance of 5 mm according to 5) in section 4.1 is applied to determine SAR test exclusion.

Standalone SAR test exclusion considerations							
Communication system	Frequency (MHz)	Configuration	Maximum Power (dBm)	Separation Distance (mm)	Calculation Result	SAR Exclusion Thresholds	Standalone SAR Exclusion
GSM 850	835	Next to the mouth	24.02	10	23.1	3.0	no
		Wrist-Worn	25.99	5	72.5	7.5	no
GSM 1900	1900	Next to the mouth	20.97	10	17.2	7.5	no
		Wrist-Worn	22.99	5	54.9	7.5	no
Wifi 2450	2450	Next to the mouth	17.50	10	8.8	3.0	no
		Wrist-Worn	17.50	5	17.6	7.5	no
Bluetooth	2450	Next to the mouth	8.00	10	1.0	3.0	yes
		Wrist-Worn	8.00	5	2.0	7.5	yes

Remark:
1. Maximum power including tune-up tolerance;
2. Bluetooth including BLE and classical Bluetooth;
3. Per KDB447498 requires, for Next to the mouth is 1-g SAR requirement while Wrist-Worn as 10-g SAR requirement;

5.2.4 Standalone SAR Test Exclusion Considerations and Estimated SAR

Per KDB447498 requires when the standalone SAR test exclusion of section 4.3.1 is applied to an antenna that transmits simultaneously with other antennas, the standalone SAR must be estimated according to the following to determine simultaneous transmission SAR test exclusion;

- (max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)] • [√ f(GHz)/x] W/kg for test separation distances ≤ 50 mm;

where x = 7.5 for 1-g SAR, and x = 18.75 for 10-g SAR.

- 0.4 W/kg for 1-g SAR and 1.0 W/kg for 10-g SAR, when the test separation distances is > 50 mm

Per FCC KD B447498 D01,simultaneous transmission SAR test exclusion may be applied when the sum of the 1-g SAR for all the transmitting antenna in a specific a physical test configuration is ≤1.6 W/Kg.When the sum is greater than the SAR limit,SAR test exclusion is determined by the SAR to peak location separation ratio.

$$\text{Ratio}=\frac{(\text{SAR}_1+\text{SAR}_2)^{1.5}}{(\text{peak location separation,mm})}<0.04$$

Estimated stand alone SAR for Next to the mouth					
Communication system	Frequency (MHz)	Configuration	Maximum Power (dBm)	Separation Distance (mm)	Estimated SAR_{1-g} (W/kg)
Bluetooth	2450	Next to the mouth	8.00	10.00	0.131
Estimated stand alone SAR for Wrist-Worn					
Communication system	Frequency (MHz)	Configuration	Maximum Power (dBm)	Separation Distance (mm)	Estimated SAR_{10-g} (W/kg)
Bluetooth	2450	Next to the mouth	8.00	5.00	0.107

5.2.5 Evaluation of Simultaneous SAR

Simultaneous transmission SAR for Bluetooth and GSM (Hotspot Closed)

Configuration	Communication system	SAR Type	Maximum Report SAR (W/Kg)	Estimated BT SAR (W/Kg)	MAX. ΣSAR (W/Kg)	SAR Limit (W/Kg)	Peak location separation ratio
Next to the mouth	GS850	1-g	0.525	0.131	0.656	1.6	Not applied
Next to the mouth	GSM1900	1-g	**0.592**	0.131	**0.723**	1.6	Not applied
Wrist-Worn	GS850	10-g	**1.210**	0.107	**1.317**	4.0	Not applied
Wrist-Worn	GSM1900	10-g	1.156	0.107	1.263	4.0	Not applied

Simultaneous transmission SAR for WiFi2450 and GSM (Hotspot Closed)

Configuration	Communication system	SAR Type	Maximum Report SAR (W/Kg)	Maximum Report WiFi SAR (W/Kg)	MAX. ΣSAR (W/Kg)	SAR Limit (W/Kg)	Peak location separation ratio
Next to the mouth	GS850	1-g	0.525	0.0214	0.546	1.6	Not applied
Next to the mouth	GSM1900	1-g	**0.592**	0.0214	**0.613**	1.6	Not applied
Wrist-Worn	GS850	10-g	**1.210**	0.519	**1.729**	4.0	Not applied
Wrist-Worn	GSM1900	10-g	1.156	0.519	1.675	4.0	Not applied

Simultaneous transmission SAR for WiFi2450 and GSM (Hotspot Open)

Configuration	Communication system	SAR Type	Maximum Report SAR (W/Kg)	Maximum Report WiFi SAR (W/Kg)	MAX. ΣSAR (W/Kg)	SAR Limit (W/Kg)	Peak location separation ratio
Wrist-Worn	GS850	10-g	2.320	0.519	2.839	4.0	Not applied
Wrist-Worn	GSM1900	10-g	**2.351**	0.519	**2.870**	4.0	Not applied

Note:1. The WiFi and BT share same antenna, so cannot transmit at same time.
2.The value with dark color is the maximum values of standalone
3. The value with green color is the maximum values of $\sum SAR_{1g}$

5.3. SAR Measurement Results

The calculated SAR is obtained by the following formula:

Reported SAR=Measured SAR*$10^{(Ptarget-Pmeasured))/10}$

Scaling factor=$10^{(Ptarget-Pmeasured))/10}$

Reported SAR= Measured SAR* Scaling factor

Where P_{target} is the power of manufacturing upper limit;

$P_{measured}$ is the measured power;

Measured SAR is measured SAR at measured power which including power drift)

Reported SAR which including Power Drift and Scaling factor

Duty Cycle

Test Mode	Duty Cycle
Speech for GSM850/1900	1:8.3
GPRS850/1900	1:2
WiFi2450	1:1

Table 5: SAR Values [GSM 850 (GSM/GPRS/EDGE)]

Ch.	Freq. (MHz)	time slots	Test Position	Maximum Allowed Power (dBm)	Conducted Power (dBm)	Power drift	Scaling Factor	SAR_{1-g} results(W/kg)		Graph Results
								Measured	Reported	
measured / reported SAR numbers - Mouth Worn (distance 10mm)										
190	836.60	GSM	Next to the mouth	33.50	33.15	-0.10	1.08	0.484	**0.525**	Plot 1
Ch.	**Freq. (MHz)**	**time slots**	**Test Position**	**Maximum Allowed Power (dBm)**	**Conducted Power (dBm)**	**Power drift**	**Scaling Factor**	**SAR_{10-g} results(W/kg)**		**Graph Results**
								Measured	**Reported**	
measured / reported SAR numbers - Wrist Worn (body-worn, distance 0mm)										
190	836.60	GSM	Wrist-Worn	33.50	33.15	0.14	1.08	1.120	1.210	N/A
measured / reported SAR numbers - Wrist Worn (hotspot open, distance 0mm)										
128	824.20	4Txslots	Wrist-Worn	29.00	27.84	-0.06	1.31	1.370	1.795	N/A
190	836.60	4Txslots	Wrist-Worn	29.00	28.16	0.03	1.21	1.920	**2.320**	Plot 2
251	848.80	4Txslots	Wrist-Worn	29.00	27.96	-0.02	1.27	1.455	1.848	N/A
Worst Case Position of Body with EGPRS (8-PSK) (hotspot open, distance 0mm)										
190	836.60	4Txslots	Wrist-Worn	25.00	24.26	0.14	1.19	1.015	1.208	N/A
Worst Case Position of Body with EGPRS (GMSK) (hotspot open, distance 0mm)										
128	824.20	4Txslots	Wrist-Worn	29.00	27.89	0.06	1.29	1.209	1.560	N/A
190	836.60	4Txslots	Wrist-Worn	29.00	28.12	0.03	1.22	1.880	2.294	N/A
251	848.80	4Txslots	Wrist-Worn	29.00	27.91	0.10	1.29	1.378	1.778	N/A

Table 6: SAR Values [GSM 1900 (GSM/GPRS/EDGE)]

Ch.	Freq. (MHz)	time slots	Test Position	Maximum Allowed Power (dBm)	Conducted Power (dBm)	Power drift	Scaling Factor	SAR_{1-g} results(W/kg)		Graph Results
								Measured	Reported	
measured / reported SAR numbers - Mouth Worn (distance 10mm)										
661	1880.0	GSM	Next to the mouth	30.00	29.70	-0.02	1.07	0.553	**0.592**	Plot 3
Ch.	**Freq. (MHz)**	**time slots**	**Test Position**	**Maximum Allowed Power (dBm)**	**Conducted Power (dBm)**	**Power drift**	**Scaling Factor**	**SAR_{10-g} results(W/kg)**		**Graph Results**
								Measured	**Reported**	
measured / reported SAR numbers - Wrist Worn (body-worn, distance 0mm)										
661	1880.0	GSM	Wrist-Worn	30.00	29.70	0.05	1.07	1.080	1.156	N/A
measured / reported SAR numbers - Wrist Worn (hotspot open, distance 0mm)										
512	1850.2	4Txslots	Wrist-Worn	26.00	25.38	0.14	1.15	1.788	2.056	N/A
661	1880.0	4Txslots	Wrist-Worn	26.00	25.48	-0.09	1.13	2.080	**2.351**	Plot 4
810	1909.8	4Txslots	Wrist-Worn	26.00	25.41	-0.05	1.15	1.850	2.128	N/A
Worst Case Position of Body with EGPRS (8-PSK) (hotspot open, distance 0mm)										
661	1880.0	4Txslots	Wrist-Worn	24.00	23.27	-0.11	1.18	1.133	1.337	N/A
Worst Case Position of Body with EGPRS (GMSK) (hotspot open, distance 0mm)										
512	1850.2	4Txslots	Wrist-Worn	26.00	25.31	-0.01	1.17	1.646	1.926	N/A
661	1880.0	4Txslots	Wrist-Worn	26.00	25.43	0.00	1.14	1.914	2.182	N/A
810	1909.8	4Txslots	Wrist-Worn	26.00	25.35	-0.12	1.16	1.788	2.074	N/A
Worst Case Position of SAR - Wrist Worn (1st Repeated SAR, hotspot open, distance 0mm)										
661	1880.0	4Txslots	Wrist-Worn	26.00	25.48	0.03	1.13	2.010	2.271	N/A

Table 7: SAR Measurement Variability Results [GSM 1900 (GSM/GPRS/EDGE)]

Test Position	Channel/ Frequency (MHz)	Measured SAR_{10g}	1st Repeated SAR_{10-g}	Ratio	2nd Repeated SAR_{10-g}	3rd Repeated SAR_{10g}
Wrist-Worn	661/1880.0	2.080	2.010	0.97	N/A	N/A

Note: 1) When the original highest measured SAR is ≥ 2.00 W/kg for extremity exposure, the measurement was repeated once.
2) A second repeated measurement was preformed only if the ratio of largest to smallest SAR for the original and first repeated measurements was > 3.00 or when the original or repeated measurement was ≥ 3.625 W/kg (~ 10% from the 10-g SAR limit) for extremity exposure.
3) A third repeated measurement was performed only if the original, first or second repeated measurement was ≥ 3.75 W/kg and the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 3.00 for extremity exposure
4) Repeated measurements are not required when the original highest measured SAR is < 2.00 W/kg for extremity exposure

Table 8: SAR Values [WiFi 802.11b/g/n]

Ch.	Freq. (MHz)	Service	Test Position	Maximum Allowed Power (dBm)	Conducted Power (dBm)	Power drift	Scaling Factor	SAR_{1-g} results(W/kg)		Graph Results
								Measured	Reported	
measured / reported SAR numbers - Mouth Worn (distance 10mm)										
6	2437	802.11b	Next to the mouth	17.50	17.22	0.09	1.07	0.020	**0.0214**	Plot 5
Ch.	Freq. (MHz)	time slots	Test Position	Maximum Allowed Power (dBm)	Conducted Power (dBm)	Power drift	Scaling Factor	SAR_{10-g} results(W/kg)		Graph Results
								Measured	Reported	
measured / reportted SAR numbers - Wrist Worn (hotspot open, distance 0mm)										
6	2437	802.11b	Wrist-Worn	17.50	17.22	0.02	1.07	0.532	**0.569**	Plot 6

5.4. SAR Measurement Variability

According to KDB865664, Repeated measurements are required only when the measured SAR is ≥ 0.80 W/kg. If the measured SAR value of the initial repeated measurement is < 1.45 W/kg with ≤ 20% variation, only one repeated measurement is required to reaffirm that the results are not expected to have substantial variations, which may introduce significant compliance concerns. A second repeated measurement is required only if the measured result for the initial repeated measurement is within 10% of the SAR limit and vary by more than 20%, which are often related to device and measurement setup difficulties. The following procedures are applied to determine if repeated measurements are required. The same procedures should be adapted for measurements according to extremity and occupational exposure limits by applying a factor of 2.5 for extremity exposure and a factor of 5 for occupational exposure to the corresponding SAR thresholds.19 The repeated measurement results must be clearly identified in the SAR report. All measured SAR, including the repeated results, must be considered to determine compliance and for reporting according to KDB 690783.Repeated measurement is not required when the original highest measured SAR is < 0.80 W/kg; steps 2) through 4) do not apply.

1) When the original highest measured SAR is ≥ 0.80 W/kg, repeat that measurement once.
2) Perform a second repeated measurement only if the ratio of largest to smallest SAR for the original and first repeated measurements is > 1.20 or when the original or repeated measurement is ≥ 1.45 W/kg (~ 10% from the 1-g SAR limit).
3) Perform a third repeated measurement only if the original, first or second repeated measurement is ≥ 1.5 W/kg and the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 1.20.
4) Perform a third repeated measurement only if the original, first or second repeated measurement is ≥ 1.5 W/kg and the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 1.20

5.5. Measurement Uncertainty (300MHz-3GHz)

According to IEEE 1528:2013										
No.	Error Description	Type	Uncertainty Value	Probably Distribution	Div.	(Ci) 1g	(Ci) 10g	Std. Unc. (1g)	Std. Unc. (10g)	Degree of freedom
Measurement System										
1	Probe calibration	B	5.50%	N	1	1	1	5.50%	5.50%	∞
2	Axial isotropy	B	4.70%	R	$\sqrt{3}$	0.7	0.7	1.90%	1.90%	∞
3	Hemispherical isotropy	B	9.60%	R	$\sqrt{3}$	0.7	0.7	3.90%	3.90%	∞
4	Boundary Effects	B	1.00%	R	$\sqrt{3}$	1	1	0.60%	0.60%	∞
5	Probe Linearity	B	4.70%	R	$\sqrt{3}$	1	1	2.70%	2.70%	∞

6	Detection limit	B	1.00%	R	$\sqrt{3}$	1	1	0.60%	0.60%	∞
7	RF ambient conditions-noise	B	0.00%	R	$\sqrt{3}$	1	1	0.00%	0.00%	∞
8	RF ambient conditions-reflection	B	0.00%	R	$\sqrt{3}$	1	1	0.00%	0.00%	∞
9	Response time	B	0.80%	R	$\sqrt{3}$	1	1	0.50%	0.50%	∞
10	Integration time	B	5.00%	R	$\sqrt{3}$	1	1	2.90%	2.90%	∞
11	RF ambient	B	3.00%	R	$\sqrt{3}$	1	1	1.70%	1.70%	∞
12	Probe positioned mech. restrictions	B	0.40%	R	$\sqrt{3}$	1	1	0.20%	0.20%	∞
13	Probe positioning with respect to phantom shell	B	2.90%	R	$\sqrt{3}$	1	1	1.70%	1.70%	∞
14	Max.SAR evalation	B	3.90%	R	$\sqrt{3}$	1	1	2.30%	2.30%	∞
Test Sample Related										
15	Test sample positioning	A	1.86%	N	1	1	1	1.86%	1.86%	∞
16	Device holder uncertainty	A	1.70%	N	1	1	1	1.70%	1.70%	∞
17	Drift of output power	B	5.00%	R	$\sqrt{3}$	1	1	2.90%	2.90%	∞
Phantom and Set-up										
18	Phantom uncertainty	B	4.00%	R	$\sqrt{3}$	1	1	2.30%	2.30%	∞
19	Liquid conductivity (target)	B	5.00%	R	$\sqrt{3}$	0.64	0.43	1.80%	1.20%	∞
20	Liquid conductivity (meas.)	A	0.50%	N	1	0.64	0.43	0.32%	0.26%	∞
21	Liquid permittivity (target)	B	5.00%	R	$\sqrt{3}$	0.64	0.43	1.80%	1.20%	∞
22	Liquid cpermittivity (meas.)	A	0.16%	N	1	0.64	0.43	0.10%	0.07%	∞
Combined standard uncertainty	$u_c = \sqrt{\sum_{i=1}^{22} c_i^2 u_i^2}$		/	/	/	/	/	10.20%	10.00%	∞
Expanded uncertainty (confidence interval of 95 %)	$u_e = 2u_c$		/	R	K=2	/	/	20.40%	20.00%	∞

5.6. System Check Results

System Performance Check at 835 MHz Head

DUT: Dipole 835 MHz; Type: D835V2; Serial: 4d134

Date/Time: 12/25/2014 AM

Communication System: CW; Frequency: 835 MHz;Duty Cycle: 1:1

Medium parameters used (interpolated): f = 835 MHz; σ = 0.91 S/m; ε_r = 41.61; ρ = 1000 kg/m^3

Phantom section: Flat Section

DASY5 Configuration:

Probe: ES3DV3 – SN3292; ConvF(6.23,6.23, 6.23); Calibrated: 08/15/2014;

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1315; Calibrated: 07/22/2014;

Phantom: SAM 1; Type: SAM;

Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.5 (6469)

Area Scan (71x71x1): Measurement grid: dx=15.00 mm, dy=15.00 mm

Maximum value of SAR (interpolated) = 10.3 W/Kg

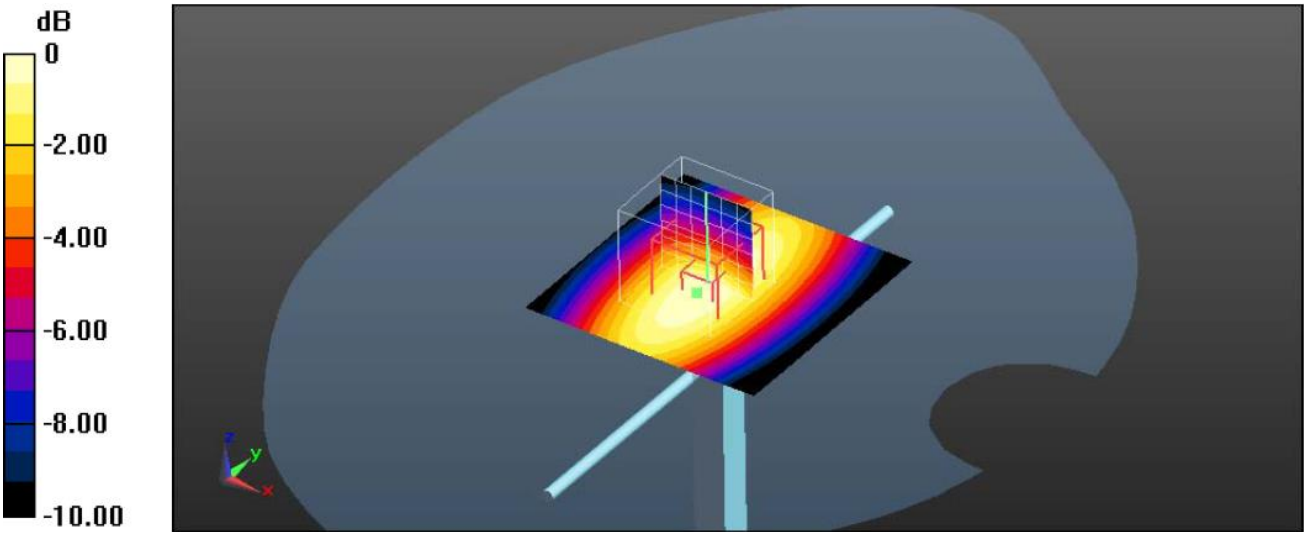
Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 100.3 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 11.40 W/kg

SAR(1 g) = 9.60 W/Kg; SAR(10 g) = 6.25 W/Kg

Maximum value of SAR (measured) = 11.3 W/Kg



0 dB = 11.3 W/Kg=10.53dB W/Kg

System Performance Check 835MHz Head 1000 mW

System Performance Check at 835 MHz Body

DUT: Dipole 835 MHz; Type: D835V2; Serial: 4d134

Date/Time: 12/25/2014 PM

Communication System: CW; Frequency: 835 MHz;Duty Cycle: 1:1

Medium parameters used (interpolated): f = 835 MHz; σ = 0.99 S/m; ε_r = 53.51; ρ = 1000 kg/m^3

Phantom section: Flat Section

DASY5 Configuration:

Probe: ES3DV3 – SN3292; ConvF(6.11,6.11, 6.11); Calibrated: 08/15/2014;

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1315; Calibrated: 07/22/2014;

Phantom: SAM 1; Type: SAM;

Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.5 (6469)

Area Scan (71x71x1): Measurement grid: dx=15.00 mm, dy=15.00 mm

Maximum value of SAR (interpolated) = 10.3 W/Kg

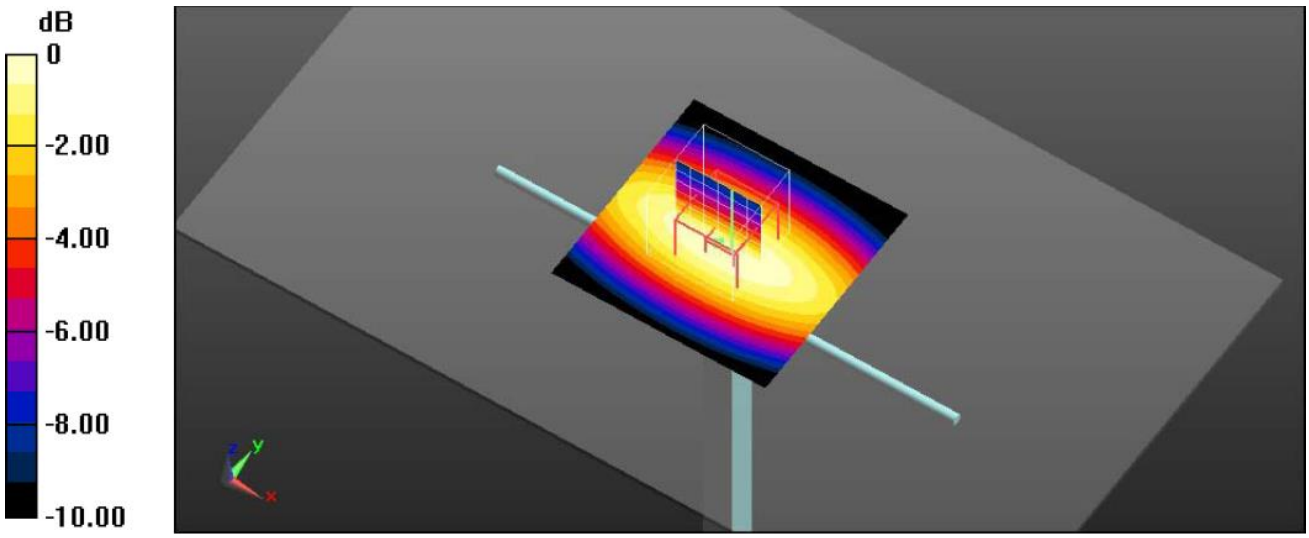
Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 109.9 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 13.1 W/kg

SAR(1 g) = 9.63 W/Kg; SAR(10 g) = 6.44 W/Kg

Maximum value of SAR (measured) = 10.8 W/Kg



0 dB = 10.80 W/Kg = 10.33 dB W/Kg

System Performance Check 835MHz Body 1000mW

System Performance Check at 1900 MHz Head

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: 5d072

Date/Time: 12/26/2014 AM

Communication System: CW; Frequency: 1900 MHz;Duty Cycle: 1:1

Medium parameters used (interpolated): f = 1900 MHz; σ = 1.45 S/m; ε_r = 39.88; ρ = 1000 kg/m^3

Phantom section: Flat Section

DASY5 Configuration:

Probe: ES3DV3 – SN3292; ConvF(5.03,5.03, 5.03); Calibrated: 08/15/2014;

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1315; Calibrated: 07/22/2014;

Phantom: SAM 1; Type: SAM;

Measurement SW: DASY52, Version 52.8 (1); SEMCAD X Version 14.6.5 (6469)

Area Scan (71x71x71): Measurement grid: dx=15.00 mm, dy=15.00 mm

Maximum value of SAR (interpolated) = 48.9 W/Kg

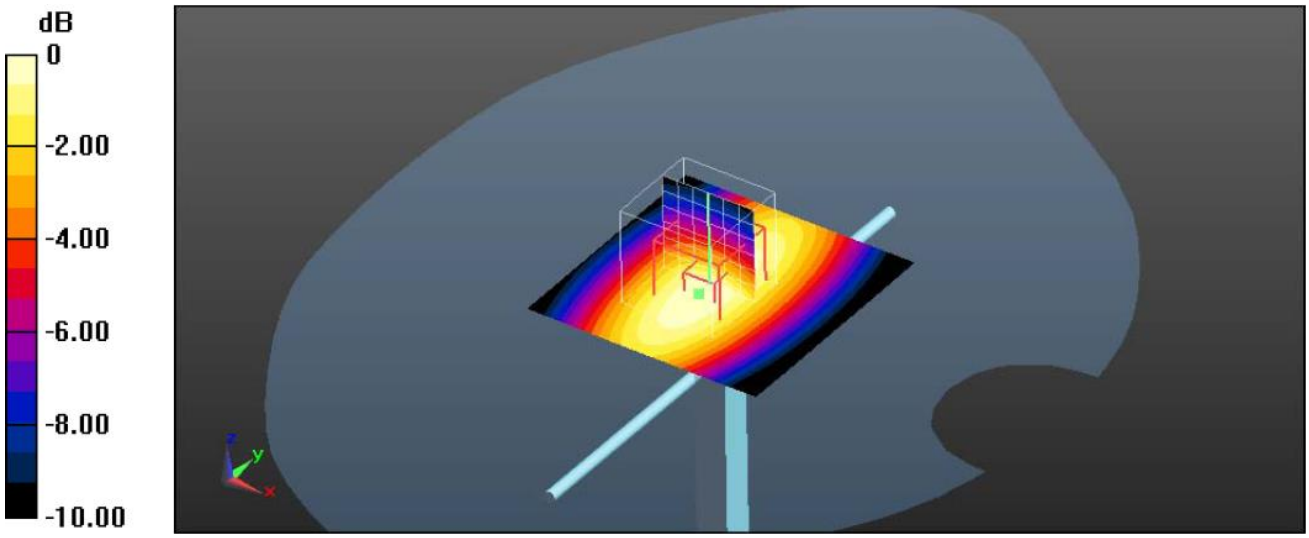
Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 178.7 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 69.8 W/Kg

SAR(1 g) = 38.90 W/Kg; SAR(10 g) = 20.60 W/Kg

Maximum value of SAR (measured) = 44.2 W/Kg



0 dB = 44.20 W/Kg = 16.45 dB W/Kg

System Performance Check 1900MHz Body 1000mW

System Performance Check at 1900 MHz Body

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: 5d072

Date/Time: 12/26/2014 PM

Communication System: CW; Frequency: 1900 MHz;Duty Cycle: 1:1

Medium parameters used (interpolated): f = 1900 MHz; σ = 1.53 S/m; ε_r =53.10; ρ = 1000 kg/m^3

Phantom section: Flat Section

DASY5 Configuration:

Probe: ES3DV3 – SN3292; ConvF(4.66,4.66, 4.66); Calibrated: 08/15/2014;

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1315; Calibrated: 07/22/2014;

Phantom: SAM 1; Type: SAM;

Measurement SW: DASY52, Version 52.8 (1); SEMCAD X Version 14.6.5 (6469)

Area Scan (71x71x71): Measurement grid: dx=15.00 mm, dy=15.00 mm

Maximum value of SAR (interpolated) = 51.50 W/Kg

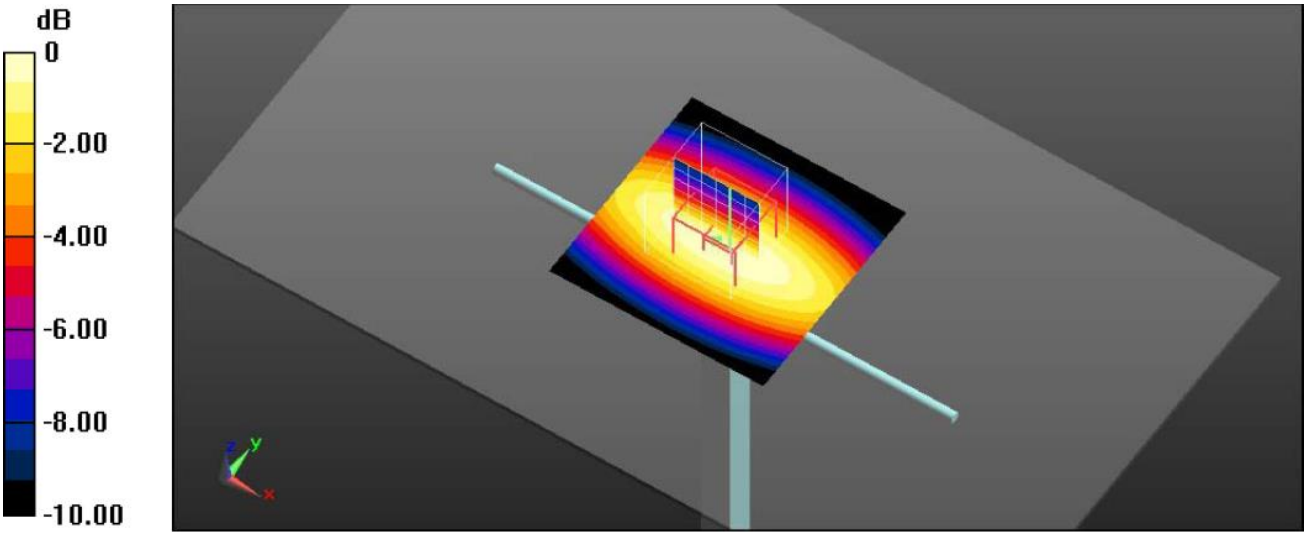
Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 175.60 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 59.8 W/Kg

SAR(1 g) = 39.10 W/Kg; SAR(10 g) = 20.80 W/Kg

Maximum value of SAR (measured) = 45.20 W/Kg



0 dB = 45.20 W/Kg = 16.55 dB W/Kg

System Performance Check 1900MHz Body 1000mW

System Performance Check at 2450 MHz Head

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: 884

Date/Time: 12/27/2014 AM

Communication System: CW; Frequency: 2450 MHz;Duty Cycle: 1:1

Medium parameters used (interpolated): f = 2450 MHz; σ = 1.86 S/m; ε_r = 39.25; ρ = 1000 kg/m^3

Phantom section: Flat Section

DASY5 Configuration:

Probe: ES3DV3 – SN3292; ConvF(4.43,4.43, 4.43); Calibrated: 08/15/2014;

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1315; Calibrated: 07/22/2014;

Phantom: SAM 1; Type: SAM;

Measurement SW: DASY52, Version 52.8 (1); SEMCAD X Version 14.6.5 (6469)

Area Scan (71x71x71): Measurement grid: dx=15.00 mm, dy=15.00 mm

Maximum value of SAR (interpolated) = 63.8 W/Kg

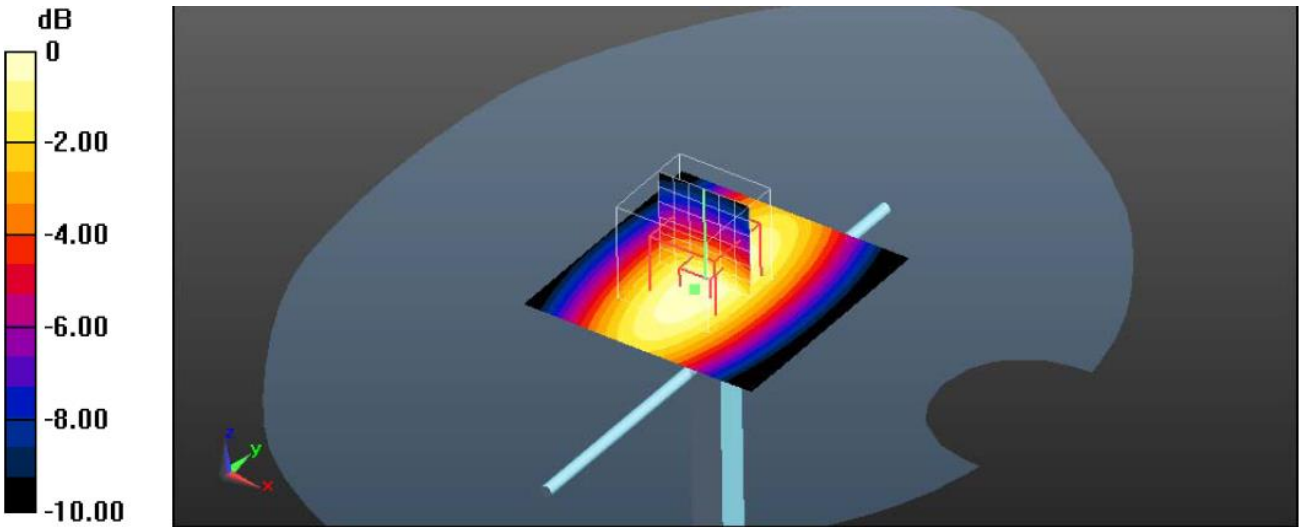
Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 188.8 V/m; Power Drift = -0.11 dB

Peak SAR (extrapolated) = 120.10 W/Kg

SAR(1 g) = 54.10 W/Kg; SAR(10 g) = 25.10 W/Kg

Maximum value of SAR (measured) = 61.9 W/Kg



0 dB = 61.9 W/Kg = 17.92 dB W/Kg

System Performance Check 2450MHz Head 1000mW

System Performance Check at 2450 MHz Body

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: 884

Date/Time: 12/27/2014 PM

Communication System: CW; Frequency: 2450 MHz;Duty Cycle: 1:1

Medium parameters used (interpolated): f = 2450 MHz; σ = 2.03 S/m; ε_r = 52.70; ρ = 1000 kg/m^3

Phantom section: Flat Section

DASY5 Configuration:

Probe: ES3DV3 – SN3292; ConvF(4.23,4.23, 4.23); Calibrated: 08/15/2014;

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1315; Calibrated: 07/22/2014;

Phantom: SAM 1; Type: SAM;

Measurement SW: DASY52, Version 52.8 (1); SEMCAD X Version 14.6.5 (6469)

Area Scan (71x71x71): Measurement grid: dx=15.00 mm, dy=15.00 mm

Maximum value of SAR (interpolated) = 66.2 W/Kg

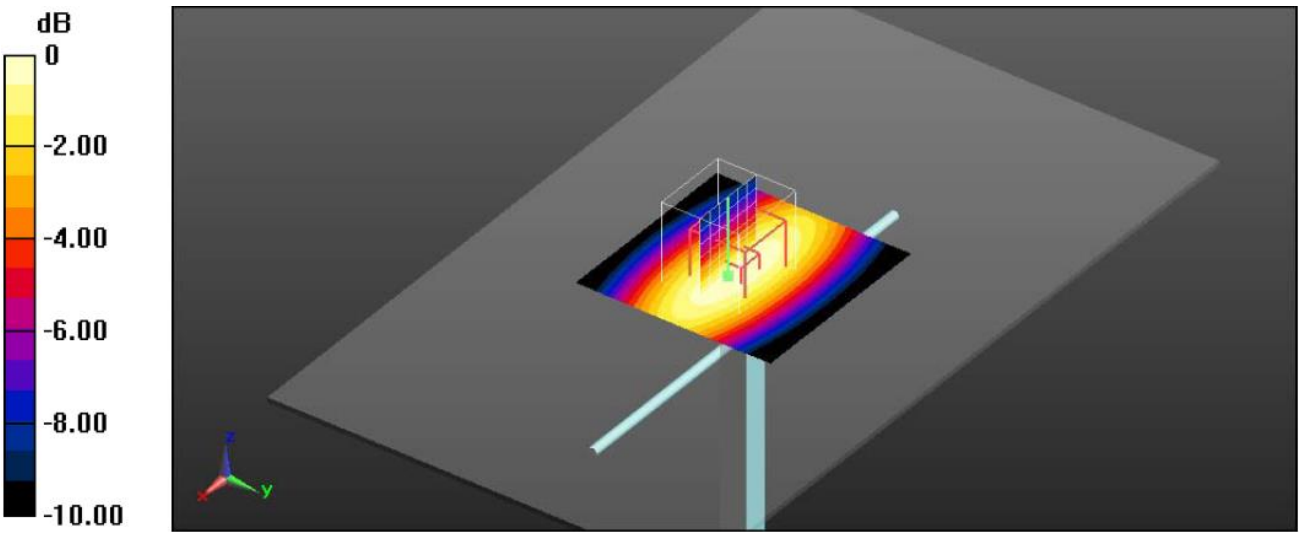
Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 176.6 V/m; Power Drift = -0.06 dB

Peak SAR (extrapolated) = 111.6 W/Kg

SAR(1 g) = 53.00 W/Kg; SAR(10 g) = 24.30 W/Kg

Maximum value of SAR (measured) = 60.9 W/Kg



0 dB = 60.9 W/Kg = 17.85 dB W/Kg

System Performance Check 2450MHz Body 1000mW

5.7. SAR Test Graph Results

SAR plots for **the highest measured SAR** in each exposure configuration, wireless mode and frequency band combination according to FCC KDB 865664 D02

GSM850 Next to the mouth Middle Channel

Communication System: Customer System; Frequency: 836.6 MHz;Duty Cycle:1:8.3

Medium parameters used (interpolated): f = 836.6 MHz; σ = 0.92 S/m; ε_r = 41.64; ρ = 1000 kg/m^3

Phantom section : Body- worn

Probe: ES3DV3 – SN3292; ConvF(6.23,6.23, 6.23); Calibrated: 08/15/2014;

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1315; Calibrated: 07/22/2014;

Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.6 (6824)

Area Scan (91x91x91): Measurement grid: dx=1.50 mm, dy=1.50 mm

Maximum value of SAR (interpolated) =0.561 W/Kg

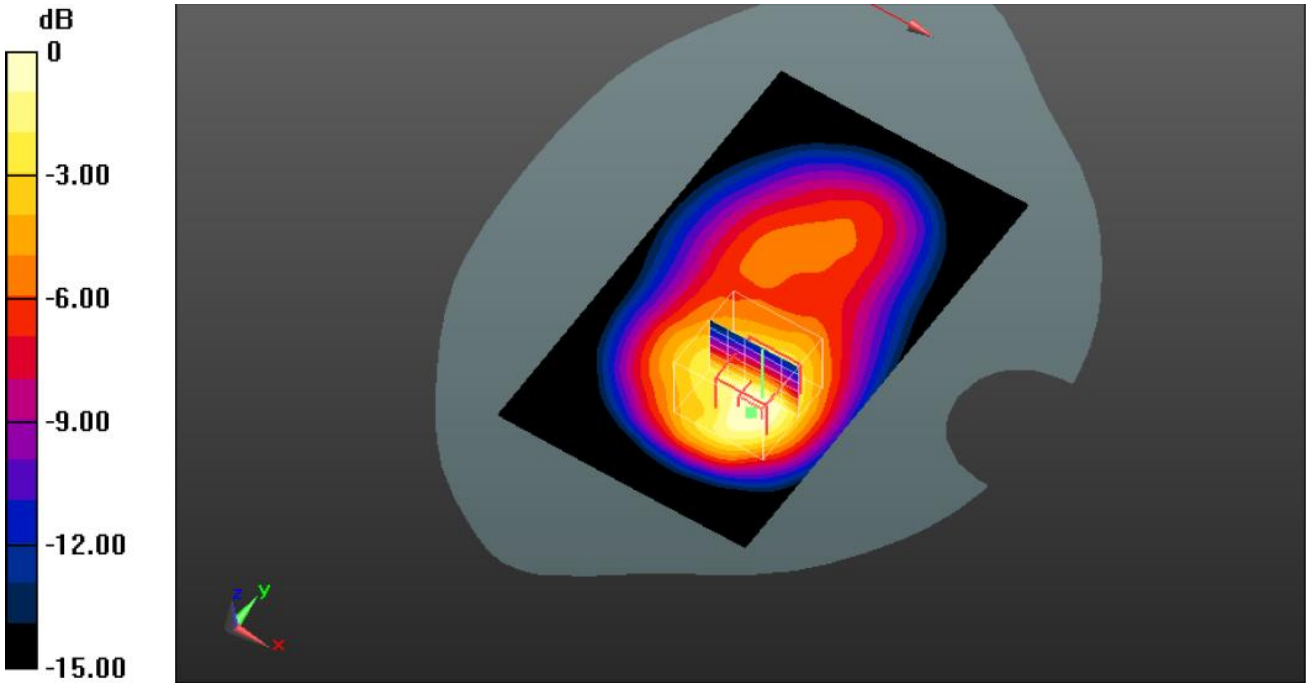
Zoom Scan (5x5x5)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 19.274 V/m; Power Drift = -0.10 dB

Peak SAR (extrapolated) = 0.812 W/Kg

SAR(1 g) = 0.484 W/Kg; SAR(10 g) = 0.336 W/Kg

Maximum value of SAR (measured) = 0.560 W/Kg



0 dB = 0.560 W/Kg = -2.52 dB W/Kg

Plot 1: Next to the mouth (GSM850 Middle Channel)

GSM850 GPRS 4TS Body Wrist Worn Middle Channel

Communication System: Customer System; Frequency: 836.6 MHz;Duty Cycle:1:2.07

Medium parameters used (interpolated): f = 836.6 MHz; σ = 0.99 S/m; ε_r = 53.51; ρ = 1000 kg/m^3

Phantom section : Body- worn

Probe: ES3DV3 – SN3292; ConvF(6.11,6.11, 6.11); Calibrated: 08/15/2014;

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1315; Calibrated: 07/22/2014;

Phantom: SAM 1; Type: SAM;

Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.6 (6824)

Area Scan (81x81x81): Measurement grid: dx=1.50 mm, dy=1.50 mm

Maximum value of SAR (interpolated) = 4.70 W/kg

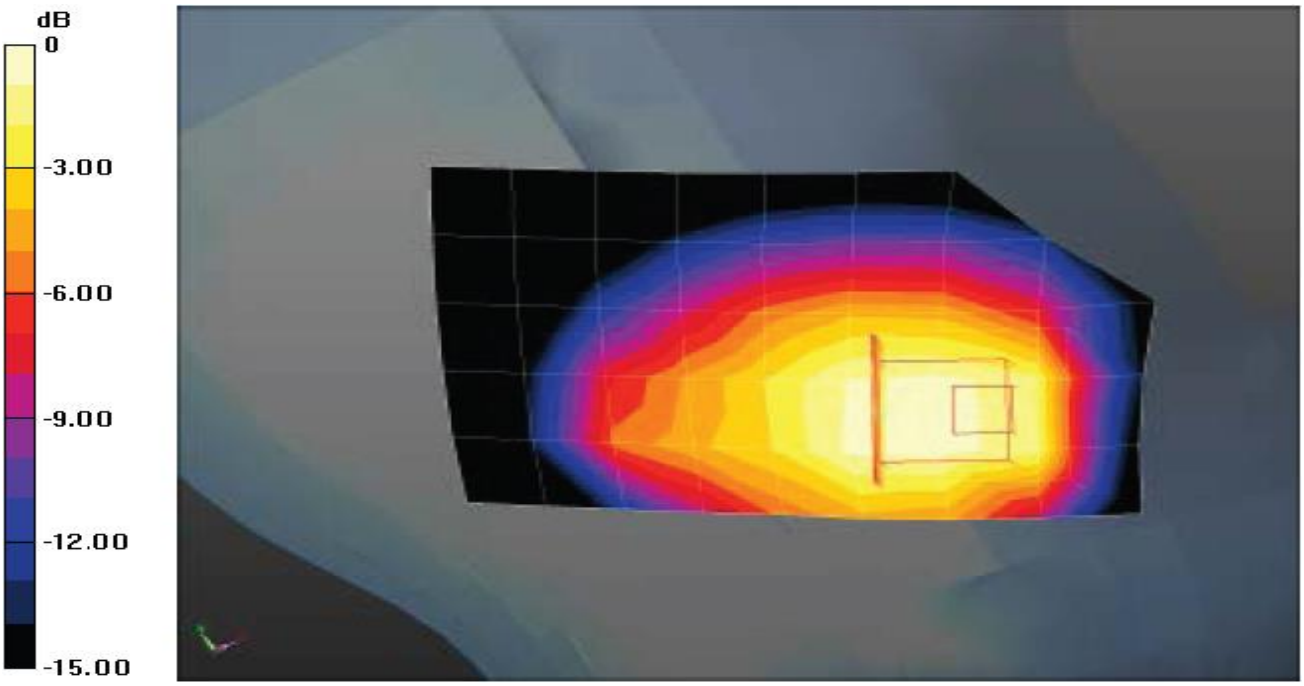
Zoom Scan (5x5x5)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 48.174 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 15.10 W/kg

SAR(1 g) = 4.67 W/kg; SAR(10 g) = 1.92 W/kg

Maximum value of SAR (measured) = 5.64 W/kg



0dB = 5.64 W/kg = 7.51 dBW/kg

Plot 2: Body Wrist Worn (GSM850 GPRS 4TS Middle Channel)

GSM1900 Next to the mouth Middle Channel

Communication System: Customer System; Frequency: 1880.0 MHz;Duty Cycle:1:8.3

Medium parameters used (interpolated): f = 1880.0 MHz; σ =1.45 S/m; ε_r = 39.97; ρ = 1000 kg/m^3

Phantom section : Body- worn

Probe: ES3DV3 – SN3292; ConvF(5.03,5.03, 5.03); Calibrated: 08/15/2014;

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1315; Calibrated: 07/22/2014;

Phantom: SAM 1; Type: SAM;

Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.6 (6824)

Area Scan (91x91x91): Measurement grid: dx=1.50 mm, dy=1.50 mm

Maximum value of SAR (interpolated) = 0.588 W/Kg

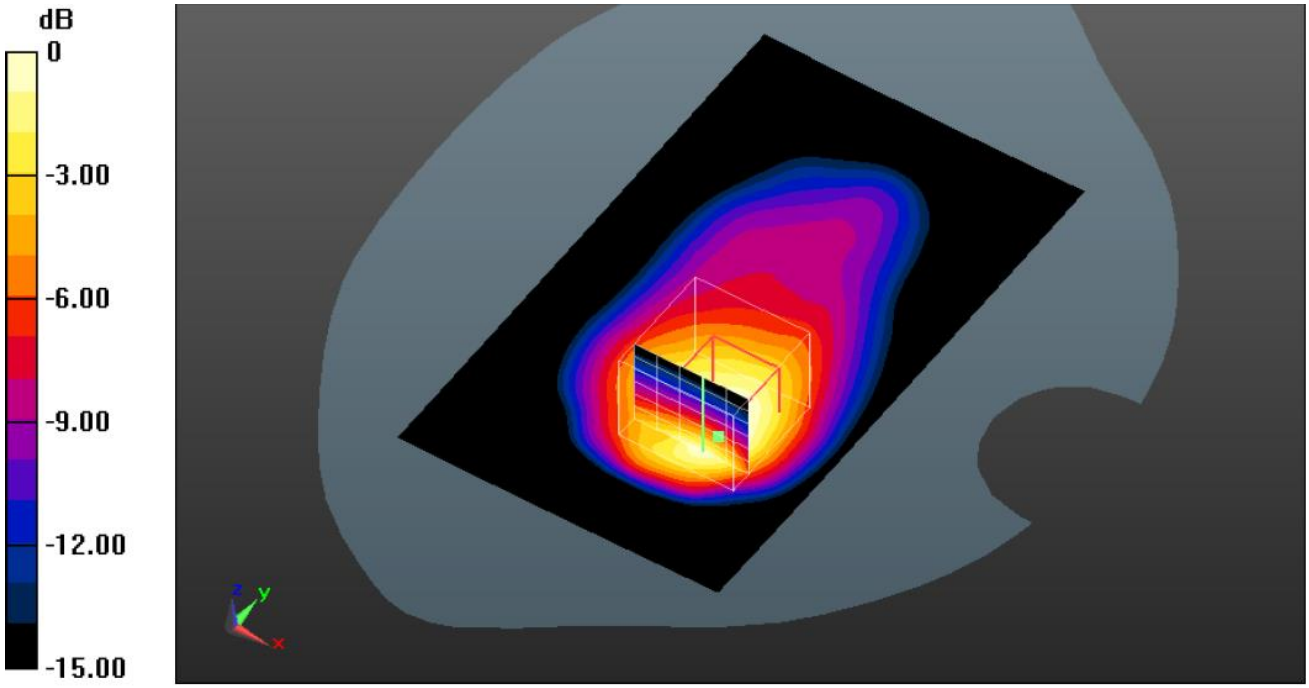
Zoom Scan (5x5x5)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 19.969 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 0.772 W/Kg

SAR(1 g) = 0.553 W/Kg; SAR(10 g) = 0.306 W/Kg

Maximum value of SAR (measured) = 0.560 W/Kg



0dB = 0.560 W/kg = -2.52 dB W/Kg

Plot 3: Next to the mouth (GSM1900 Middle Channel)

GSM1900 GPRS 4TS Body Wrist Worn Middle Channel

Communication System: Customer System; Frequency: 1880.0 MHz;Duty Cycle:1:2.07

Medium parameters used (interpolated): f = 1880.0 MHz; σ = 1.50 S/m; ε_r = 53.10; ρ = 1000 kg/m^3

Phantom section : Body- worn

Probe: ES3DV3 – SN3292; ConvF(4.66,4.66, 4.66); Calibrated: 08/15/2014;

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1315; Calibrated: 07/22/2014;

Phantom: SAM 1; Type: SAM;

Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.6 (6824)

Area Scan (81x81x81): Measurement grid: dx=1.50 mm, dy=1.50 mm

Maximum value of SAR (interpolated) = 5.43 W/Kg

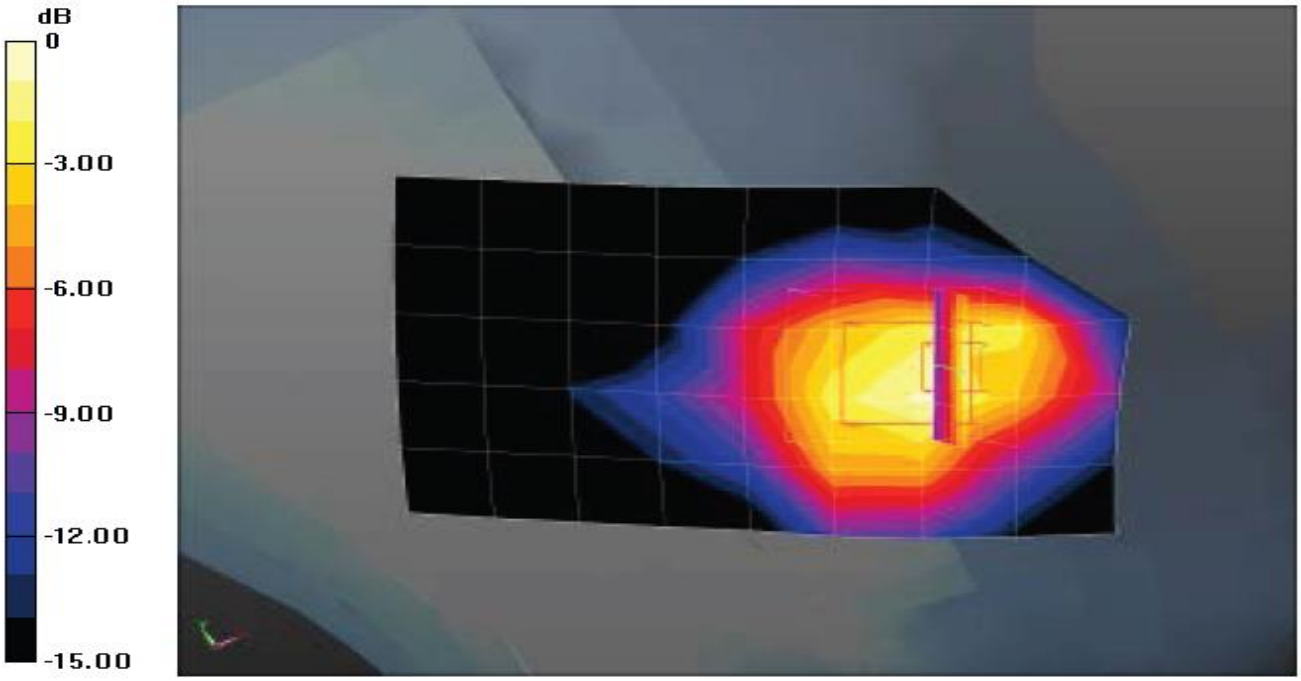
Zoom Scan (5x5x5)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 49.782 V/m; Power Drift = -0.09 dB

Peak SAR (extrapolated) = 9.63 W/Kg

SAR(1 g) = 4.43 W/Kg; SAR(10 g) = 2.08 W/Kg

Maximum value of SAR (measured) = 4.86 W/Kg



0dB = 4.86 W/Kg = 6.87 dBW/Kg

Plot 4: Body Wrist Worn (GSM1900 GPRS 4TS Middle Channel)

802.11b Next to the mouth Middle Channel (WiFi2450 Middle Channel-Channel 6-2437MHz (1Mbps))

Communication System: Customer System; Frequency: 2437.0 MHz;Duty Cycle:1:1

Medium parameters used (interpolated): f = 2437.0 MHz; σ = 1.84 S/m; ε_r = 39.28; ρ = 1000 kg/m^3

Phantom section : Body- worn

Probe: ES3DV3 – SN3292; ConvF(4.43,4.43, 4.43); Calibrated: 08/15/2014;

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1315; Calibrated: 07/22/2014;

Phantom: SAM 1; Type: SAM;

Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.6 (6824)

Area Scan (91x91x91): Measurement grid: dx=1.50 mm, dy=1.50 mm

Maximum value of SAR (interpolated) =0.0171 W/Kg

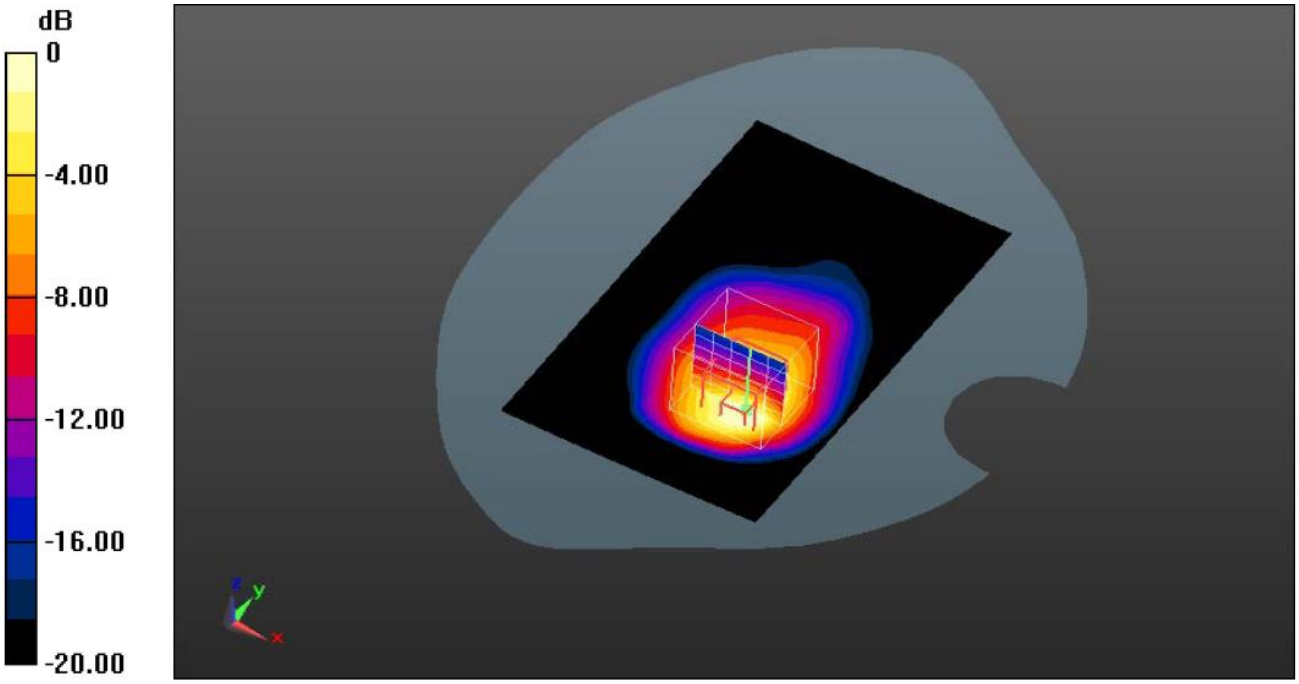
Zoom Scan (5x5x5)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 2.749 V/m; Power Drift = 0.09 dB

Peak SAR (extrapolated) = 0.0220 W/Kg

SAR(1 g) = 0.020 W/Kg; SAR(10 g) = 0.019 W/Kg

Maximum value of SAR (measured) = 0.0216 W/Kg



0 dB = 0.0216 W/Kg = -16.65 dB W/Kg

Plot 5: Next to the mouth (WiFi2450 Middle Channel-Channel 6-2437MHz (1Mbps))

802.11b Body Wrist Worn Middle Channel (WiFi2450 Middle Channel-Channel 6-2437MHz (1Mbps))

Communication System: Customer System; Frequency: 2437.0 MHz;Duty Cycle:1:1

Medium parameters used (interpolated): f = 2437.0 MHz; σ = 2.03 S/m; ε_r = 52.65; ρ = 1000 kg/m^3

Phantom section : Body- worn

Probe: ES3DV3 – SN3292; ConvF(4.23,4.23, 4.23); Calibrated: 08/15/2014;

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1315; Calibrated: 07/22/2014;

Phantom: SAM 1; Type: SAM;

Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.6 (6824)

Area Scan (81x81x81): Measurement grid: dx=1.50 mm, dy=1.50 mm

Maximum value of SAR (interpolated) = 1.65 W/Kg

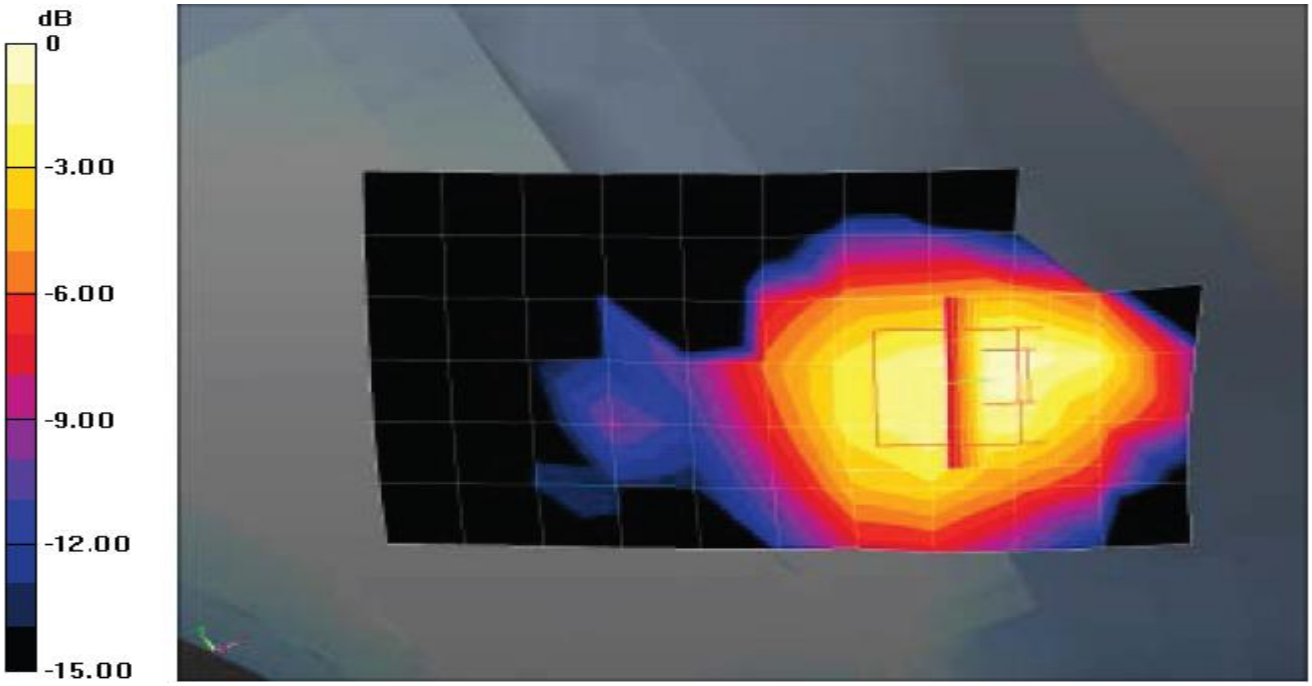
Zoom Scan (5x5x5)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 16.241 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 2.12 W/kg

SAR(1 g) = 1.43 W/Kg; SAR(10 g) = 0.532 W/Kg

Maximum value of SAR (measured) = 1.60 W/kg



0 dB = 1.60 W/Kg = 2.04 dB W/Kg

Plot 6: Body Wrist Worn (WiFi2450 Middle Channel-Channel 6-2437MHz (1Mbps))

6. Calibration Certificate

6.1. Probe 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 108

Client CIQ (Auden)

Certificate No: ES3-3292_Aug14

CALIBRATION CERTIFICATE

Object	ES3DV3 - SN:3292
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 15, 2014

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	03-Apr-14 (No. 217-01911)	Apr-15
Power sensor E4412A	MY41498087	03-Apr-14 (No. 217-01911)	Apr-15
Reference 3 dB Attenuator	SN: S5054 (3c)	03-Apr-14 (No. 217-01915)	Apr-15
Reference 20 dB Attenuator	SN: S5277 (20x)	03-Apr-14 (No. 217-01919)	Apr-15
Reference 30 dB Attenuator	SN: S5129 (30b)	03-Apr-14 (No. 217-01920)	Apr-15
Reference Probe ES3DV2	SN: 3013	30-Dec-13 (No. ES3-3013_Dec13)	Dec-14
DAE4	SN: 660	13-Dec-13 (No. DAE4-660_Dec13)	Dec-14
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-13)	In house check: Oct-14

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

Issued: August 15, 2014

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

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 108

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

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).

In Collaboration with
s p e a g
CALIBRATION LABORATORY
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Tel: +86-10-62304633-2079 Fax: +86-10-62304633-2504
E-mail: Info@emcite.com Http://www.emcite.com

Probe ES3DV3

SN: 3109

Calibrated: November 29, 2013

Calibrated for DASY/EASY Systems

(Note: non-compatible with DASY2 system!)

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3292

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu V/(V/m)^2$)[A]	0.89	0.95	1.46	± 10.1 %
DCP (mV)[B]	107.1	106.1	103.9	

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	209.7	±3.8 %
		Y	0.0	0.0	1.0		218.8	
		Z	0.0	0.0	1.0		198.5	

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: ES3DV3 - SN:3292

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)	Unct. (k=2)
450	43.5	0.87	6.71	6.71	6.71	0.18	1.80	± 13.3 %
835	41.5	0.90	6.23	6.23	6.23	0.80	1.11	± 12.0 %
900	41.5	0.97	6.71	6.71	6.71	0.71	1.17	± 12.0 %
1810	40.0	1.40	5.07	5.07	5.07	0.61	1.36	± 12.0 %
1900	40.0	1.40	5.03	5.03	5.03	0.45	1.55	± 12.0 %
2100	39.8	1.49	5.04	5.04	5.04	0.77	1.17	± 12.0 %
2450	39.2	1.80	4.43	4.43	4.43	0.73	1.23	± 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:3292

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)	Unct. (k=2)
450	56.7	0.94	7.10	7.10	7.10	0.13	1.00	± 13.3 %
835	55.2	0.97	6.11	6.11	6.11	0.36	1.78	± 12.0 %
900	55.0	1.05	5.97	5.97	5.97	0.73	1.22	± 12.0 %
1810	53.3	1.52	4.79	4.79	4.79	0.59	1.45	± 12.0 %
1900	53.3	1.52	4.66	4.66	4.66	0.41	1.79	± 12.0 %
2100	53.2	1.62	4.77	4.77	4.77	0.63	1.42	± 12.0 %
2450	52.7	1.95	4.23	4.23	4.23	0.66	0.98	± 12.0 %

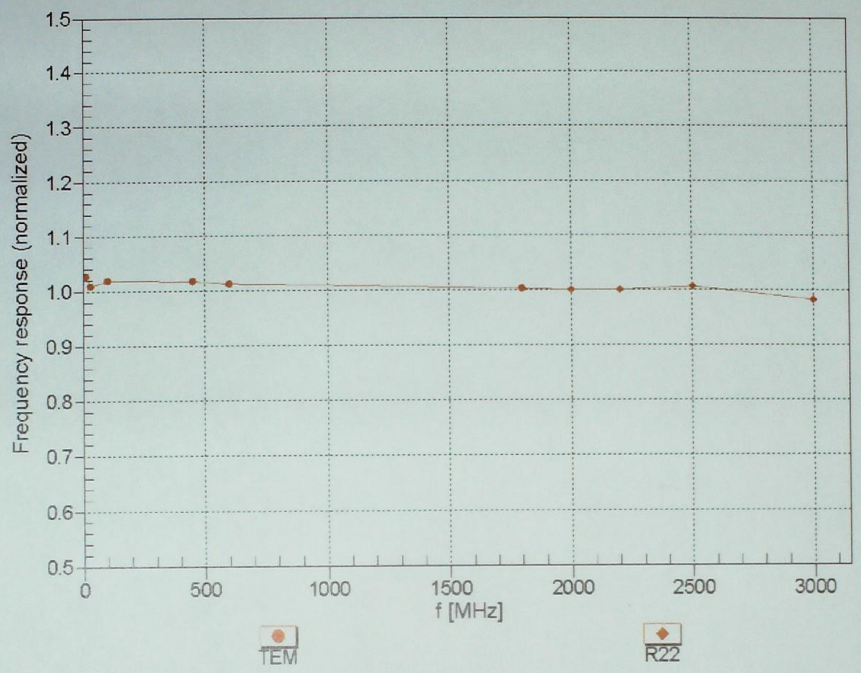
[C] Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz 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

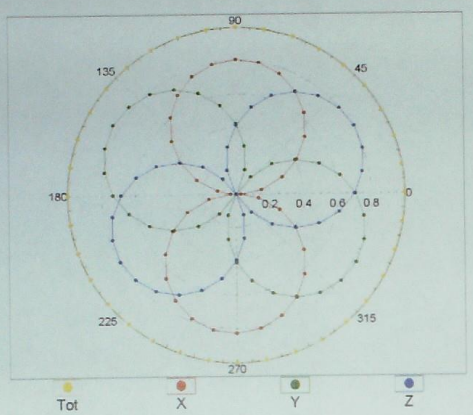
(TEM-Cell:ifi110 EXX, Waveguide: R22)



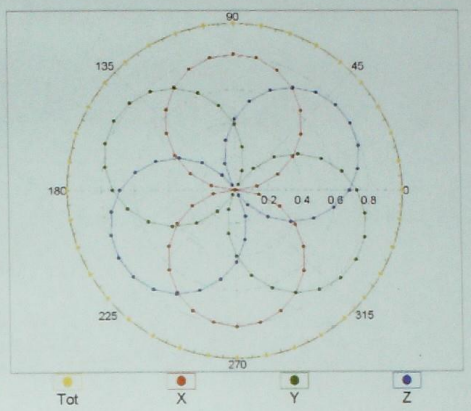
Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

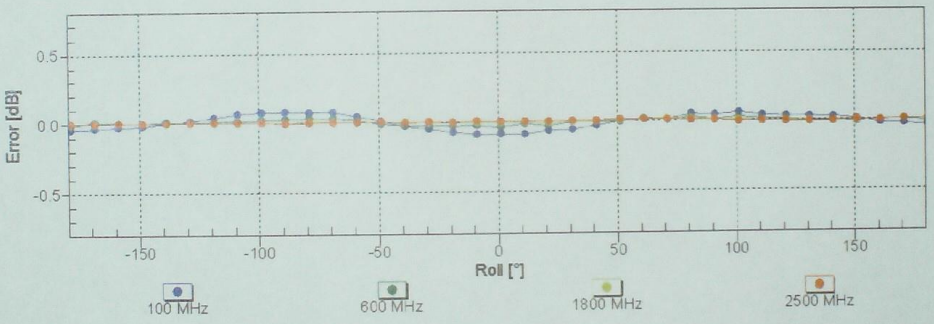
Receiving Pattern (ϕ), ϑ = 0°

f=600 MHz,TEM



f=1800 MHz,R22

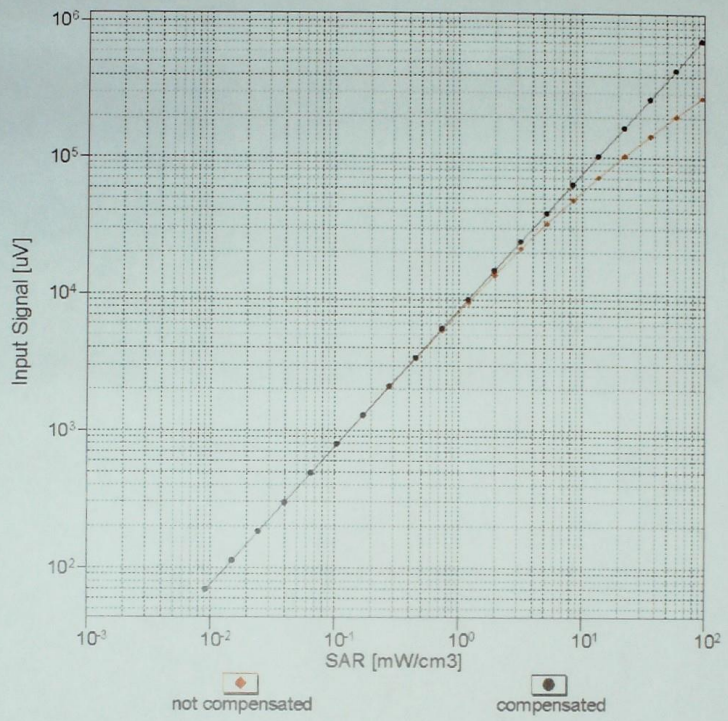


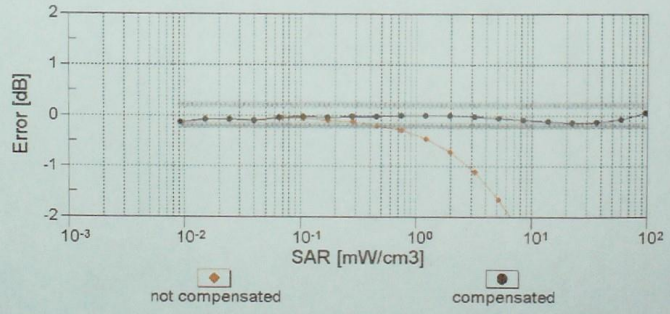


Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

Dynamic Range f(SAR_{head})

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

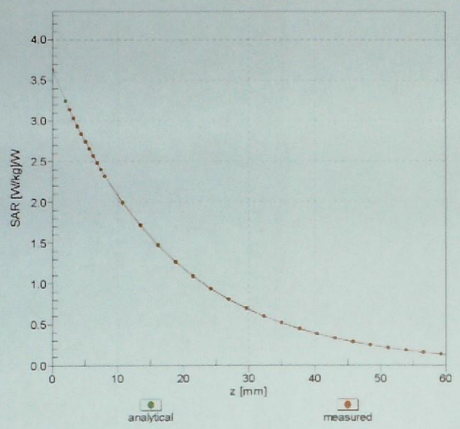




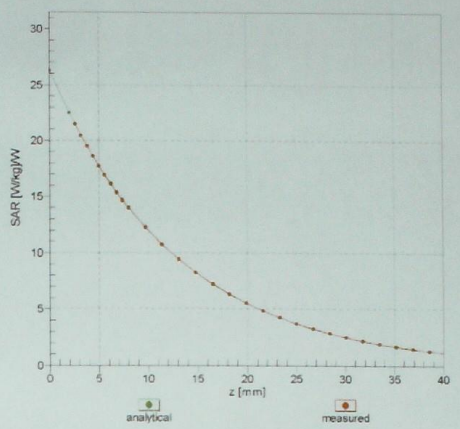
Uncertainty of Linearity Assessment: ± 0.6% (k=2)

Conversion Factor Assessment

f = 900 MHz,WGLS R9 (H_convF)

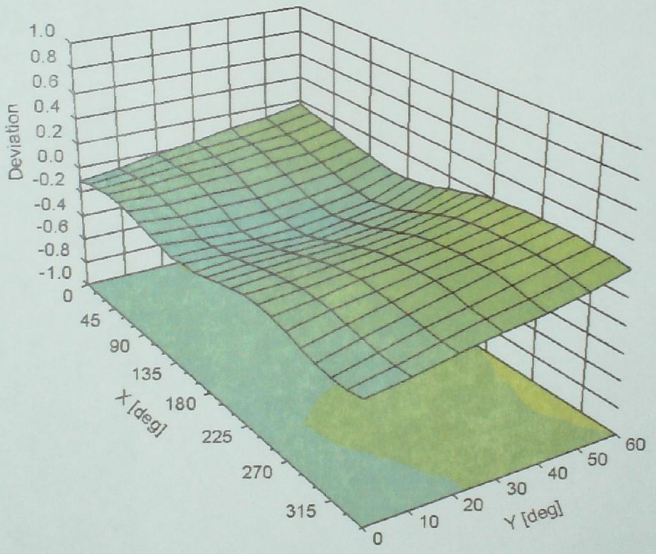


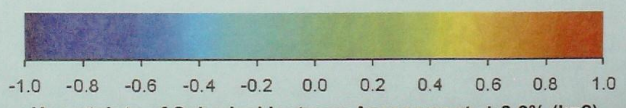
f = 1810 MHz,WGLS R22 (H_convF)



Deviation from Isotropy in Liquid

Error (ϕ, ϑ), f = 900 MHz





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