

## SAR TEST REPORT

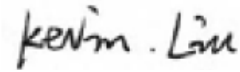
**Report Reference No.**..... : **MWR150600507**

**FCC ID**..... : **2AFAP0AX1**

Compiled by  
( position+printed name+signature)..: File administrators Martin Ao



Supervised by  
( position+printed name+signature)..: Test Engineer Kevin Liu



Approved by  
( position+printed name+signature)..: Manager Dixon Hao



Date of issue.....: Aug 26, 2015

**Representative Laboratory Name** ..: **Maxwell International Co., Ltd.**

Address.....: Room 509,Hongfacenter building, Baoan District, Shenzhen, Guangdong, China

**Testing Laboratory Name** .....: **Shenzhen Sunway Communication Co., Ltd. Testing Center**

Address.....: 1/F., Building A, SDG Info Port, Kefeng Road, Hi-Tech Park, Nanshan District, Shenzhen, Guangdong, China

**Applicant's name**.....: **ALPHA EXPORT AND IMPORT CO.,LIMITED**

Address.....: Room 4d, Huashang Block, NO.3, Biezhan Road, Shenzhen , China

**Test specification** .....

Standard .....: **ANSI C95.1-1999**

.....: **47CFR §2.1093**

TRF Originator.....: **Maxwell International Co., Ltd.**

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**Test item description** .....

Trade Mark .....: ALPHARD

**Manufacturer**.....: **ALPHA EXPORT AND IMPORT CO.,LIMITED**

Model/Type reference.....: AX1

Listed Models .....: AX2, AX3, AX4, AX5, AX6, AX7, AX8, AX9, AX10

Operation Frequency..... GSM 850MHz/PCS1900MHz/WiFi2450/BT/UMTS Band V

Modulation Type ..... GSM(GMSK, 8PSK), Bluetooth(GFSK,8DPSK,II/4DQPSK), DSSS(CCK,DQPSK,DBPSK),OFDM(64QAM,16QAM,QPSK, BPSK), UMTS(QPSK)

Hardware version .....: S9-V2.3

Software version .....: S9\_72KK\_KK\_3G\_EMMC\_32\_4\_XX\_ZXMD\_20150604-114737

Rating .....: DC 3.70V

Result.....: **PASS**

**TEST REPORT**

<b>Test Report No. :</b>	<b>MWR150600407</b>	Aug 26, 2015
		Date of issue

Equipment under Test : Mobile Phone

Model /Type : AX1

Listed Models : AX2, AX3, AX4, AX5, AX6, AX7, AX8, AX9, AX10

**Applicant** : **ALPHA EXPORT AND IMPORT CO.,LIMITED**

Address : Room 4d, Huashang Block, NO.3, Biezhan Road, Shenzhen , China

**Manufacturer** : **ALPHA EXPORT AND IMPORT CO.,LIMITED**

Address : Room 4d, Huashang Block, NO.3, Biezhan Road, Shenzhen , China

<b>Test Result:</b>	<b>PASS</b>
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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.

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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.

[KDB447498 D01 General RF Exposure Guidance v05r02](#) : Mobile and Portable Device RF Exposure Procedures and Equipment Authorization Policies

[KDB865664 D01 SAR Measurement 100 MHz to 6 GHz v01r03](#) : SAR Measurement Requirements for 100 MHz to 6 GHz

[KDB865664 D02 RF Exposure Reporting v01r01](#): RF Exposure Compliance Reporting and Documentation Considerations

[KDB248227 D01 802.11 Wi-Fi SAR v02r01](#): SAR GUIDANCE FOR IEEE 802.11 (Wi-Fi) TRANSMITTERS

[FCC KDB 941225D06](#): Hotspot Mode SAR v01r01

[FCC Part 2.1093 Radiofrequency Radiation Exposure Evaluation](#): Portable Devices

[KDB941225 D01 3G SAR Procedures v03](#): 3G SAR MEAUREMENT PROCEDURES

[KDB648474 D04, Handset SAR v01r02](#): SAR Evaluation Considerations for Wireless Handsets

## 2. SUMMARY

### 2.1. General Remarks

Date of receipt of test sample	:	Aug 20, 2015
Testing commenced on	:	Aug 21, 2015
Testing concluded on	:	Aug 24, 2015

### 2.2. Product Description

The **ALPHA EXPORT AND IMPORT CO.,LIMITED's** Model: AX1 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	
Model Number	AX1
Serial Number	AX8745B485
Modulation Type	GMSK for GSM/GPRS and 8PSK for EGPRS;QPSK for UMTS
Antenna Type	Internal
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
<i>The EUT is GSM850 /PCS1900, UMTS Band I,V mobile phone. the mobile phone is intended for speech and Multimedia Message Service (MMS) transmission. It is equipped with GPRS/EDGE class 12 for GSM850, PCS1900, UMTS Band II, Band V and Bluetooth, WiFi, and camera functions. For more information see the following datasheet</i>	

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
HSDPA UE Category	7
HSUPA UE Category	6
GSM Release Version	R99
GPRS operation mode	Class B
DTM Mode	Not Supported
3G	
Support Networks	UMTS
Support Band	UMTS Band I, Band V
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, $\pi/4$ QDPSK, 8DPSK
Quantity of Channels	79/40
Channel Separation	1MHz/2MHz
Antenna Type	Internal Antenna

### 2.3. Statement of Compliance

The maximum of results of SAR found during testing for AX1 are follows:

Classment Class	Frequency Band	The Highest SAR Summary			MAX Simultaneous transmission SAR(W/Kg)
		Head 1g SAR(W/Kg)	Hotspot 1g SAR(W/Kg) (Gap 1cm)	Body-worn 1g SAR(W/Kg) (Gap 1cm)	
PCE	GSM 850	0.361	0.701	0.497	1.077
	GSM1900	<b>0.504</b>	<b>0.783</b>	0.643	
	UMTS Band V	0.350	0.689	<b>0.689</b>	
DTS	WiFi(802.11)	0.179	0.294	0.294	
DSS	Bluetooth	0.105	0.052	0.052	

The SAR values found for the smart phone are below the maximum recommended levels of 1.6W/Kg as averaged over any 1g tissue according to the ANSI C95.1-1999.

For body worn operation, this device has been tested and meets FCC RF exposure guidelines when used with any accessory that contains no metal and which provides a minimum separation distance of 10mm between this device and the body of the user. User of other accessories may not ensure compliance with FCC RF exposure guidelines. And the test distance of Hotspot mode is 10mm.

The EUT battery must be fully charged and checked periodically during the test to ascertain uniform power output.

#### Simultaneous transmission:

#### Head Exposure Conditions

##### Simultaneous transmission SAR for WiFi and GSM/UMTS

Test Position	SAR Type	GSM850 Reported SAR <sub>1-g</sub> (W/Kg)	GSM1900 Reported SAR <sub>1-g</sub> (W/Kg)	UMTS Band V Reported SAR <sub>1-g</sub> (W/Kg)	WiFi Reported SAR <sub>1-g</sub> (W/Kg)	MAX. $\Sigma$ SAR <sub>1-g</sub> (W/Kg)	SAR <sub>1-g</sub> Limit (W/Kg)	Peak location separation ratio	Simut. Meas. Required
Left/Cheek	1-g	0.361	<b>0.504</b>	0.350	<b>0.179</b>	<b>0.683</b>	1.6	no	no
Left/Tilt	1-g	0.313	0.389	0.206	0.114	0.503	1.6	no	no
Right/Cheek	1-g	0.342	0.481	0.303	0.160	0.641	1.6	no	no
Right/Tilt	1-g	0.308	0.352	0.143	0.089	0.441	1.6	no	no

##### Simultaneous transmission SAR for Bluetooth and GSM/UMTS

Test Position	SAR Type	GSM850 Reported SAR <sub>1-g</sub> (W/Kg)	GSM1900 Reported SAR <sub>1-g</sub> (W/Kg)	UMTS Band V Reported SAR <sub>1-g</sub> (W/Kg)	Bluetooth Estimated SAR <sub>1-g</sub> (W/Kg)	MAX. $\Sigma$ SAR <sub>1-g</sub> (W/Kg)	SAR <sub>1-g</sub> Limit (W/Kg)	Peak location separation ratio	Simut. Meas. Required
Left/Cheek	1-g	0.361	<b>0.504</b>	0.350	<b>0.105</b>	<b>0.609</b>	1.6	no	no
Left/Tilt	1-g	0.313	0.389	0.206	0.105	0.494	1.6	no	no
Right/Cheek	1-g	0.342	0.481	0.303	0.105	0.586	1.6	no	no
Right/Tilt	1-g	0.308	0.352	0.143	0.105	0.457	1.6	no	no

**Body-Worn Accessory Exposure Conditions****Simultaneous transmission SAR for WiFi and GSM/UMTS**

Test Position	SAR Type	GSM850 Reported SAR <sub>1-g</sub> (W/Kg)	GSM1900 Reported SAR <sub>1-g</sub> (W/Kg)	UMTS Band V Reported SAR <sub>1-g</sub> (W/Kg)	WiFi Reported SAR <sub>1-g</sub> (W/Kg)	MAX. $\Sigma$ SAR <sub>1-g</sub> (W/Kg)	SAR <sub>1-g</sub> Limit (W/Kg)	Peak location separation ratio	Simut. Meas. Required
Rear Side	1-g	0.497	0.643	0.689	<b>0.294</b>	<b>0.983</b>	1.6	no	no
Front Side	1-g	0.345	0.472	0.502	0.201	0.703	1.6	no	no

**Simultaneous transmission SAR for Bluetooth and GSM/UMTS**

Test Position	SAR Type	GSM850 Reported SAR <sub>1-g</sub> (W/Kg)	GSM1900 Reported SAR <sub>1-g</sub> (W/Kg)	UMTS Band V Reported SAR <sub>1-g</sub> (W/Kg)	Bluetooth Estimated SAR <sub>1-g</sub> (W/Kg)	MAX. $\Sigma$ SAR <sub>1-g</sub> (W/Kg)	SAR <sub>1-g</sub> Limit (W/Kg)	Peak location separation ratio	Simut. Meas. Required
Rear Side	1-g	0.497	0.643	0.689	<b>0.052</b>	<b>0.741</b>	1.6	no	no
Front Side	1-g	0.345	0.472	0.502	0.052	0.554	1.6	no	no

**Hotspot SAR****Simultaneous transmission SAR for WiFi and GSM/UMTS (Hotspot Open)**

Test Position	SAR Type	GSM850 Reported SAR <sub>1-g</sub> (W/Kg)	GSM1900 Reported SAR <sub>1-g</sub> (W/Kg)	UMTS Band V Reported SAR <sub>1-g</sub> (W/Kg)	WiFi Reported SAR <sub>1-g</sub> (W/Kg)	MAX. $\Sigma$ SAR <sub>1-g</sub> (W/Kg)	SAR <sub>1-g</sub> Limit (W/Kg)	Peak location separation ratio	Simut. Meas. Required
Rear Side	1-g	0.701	<b>0.783</b>	0.689	<b>0.294</b>	<b>1.077</b>	1.6	no	no
Front Side	1-g	0.566	0.588	0.502	0.201	0.789	1.6	no	no
Left Side	1-g	0.682	0.697	0.659	0.207	0.904	1.6	no	no
Top Side	1-g	0.316	0.381	0.353	/	0.381	1.6	no	no
Bottom Side	1-g	/	/	/	0.181	0.181	1.6	no	no

**Simultaneous transmission SAR for Bluetooth and GSM/UMTS (Hotspot Open)**

Test Position	SAR Type	GSM850 Reported SAR <sub>1-g</sub> (W/Kg)	GSM1900 Reported SAR <sub>1-g</sub> (W/Kg)	UMTS Band V Reported SAR <sub>1-g</sub> (W/Kg)	Bluetooth Estimated SAR <sub>1-g</sub> (W/Kg)	MAX. $\Sigma$ SAR <sub>1-g</sub> (W/Kg)	SAR <sub>1-g</sub> Limit (W/Kg)	Peak location separation ratio	Simut. Meas. Required
Rear Side	1-g	0.701	<b>0.783</b>	0.689	<b>0.052</b>	<b>0.835</b>	1.6	no	no
Front Side	1-g	0.566	0.588	0.502	0.052	0.640	1.6	no	no
Left Side	1-g	0.682	0.697	0.659	0.052	0.749	1.6	no	no
Top Side	1-g	0.316	0.381	0.353	0.052	0.433	1.6	no	no

Note:

1. The WiFi and BT share same antenna, so cannot transmit at same time.
2. The value with block color is the maximum values of standalone
3. The value with blue color is the maximum values of  $\Sigma$ SAR<sub>1-g</sub>

**2.4. Equipment under Test****Power supply system utilised**

Power supply voltage	:	<input type="radio"/> 120V / 60 Hz	<input type="radio"/> 115V / 60Hz
		<input type="radio"/> 12 V DC	<input type="radio"/> 24 V DC
		<input checked="" type="radio"/> 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

<input type="radio"/>	Power Cable	Length (m) :	/
		Shield :	/
		Detachable :	/
<input type="radio"/>	Multimeter	Manufacturer :	/
		Model No. :	/

## 2.6. Note

- The EUT is a Mobile Phone with UMTS/GSM/GPRS/EDGE, WiFi and Bluetooth function, The functions of the EUT listed as below:

	Test Standards	Reference Report
GSM/GPRS/EDGE	FCC Part 22/FCC Part 24	MWR150600501
WCDMA	FCC Part 22	MWR150600502
Bluetooth	FCC Part 15 C 15.247	MWR150600503
BLE	FCC Part 15 C 15.247	MWR150600504
WiFi	FCC Part 15 C 15.247	MWR150600505
USB Port	FCC Part 15 B	MWR150600506
SAR	FCC Part 2 §2.1093	MWR150600507



### 3. TEST ENVIRONMENT

#### 3.1. Address of the test laboratory

##### **Shenzhen Sunway Communication Co., Ltd. Testing Center**

1/F., Building A, SDG Info Port, Kefeng Road, Hi-Tech Park, Nanshan District, Shenzhen, Guangdong, China

#### 3.2. Test Facility

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

##### **CNAS-Lab Code: L6487**

The Shenzhen Sunway Communication Co., Ltd. Testing Center 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: Oct 29, 2013. Valid time is until Oct 28, 2016.

#### 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

EXPOSURE LIMITS	FCC Limit (1g Tissue)	
	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	689	2014/10/1	1
E-field Probe	SPEAG	ES3DV3	3028	2014/10/22	1
System Validation Dipole D835V2	SPEAG	D835V2	4d134	2014/07/24	3
System Validation Dipole 1900V2	SPEAG	D1900V2	5d194	2015/01/07	3
System Validation Dipole 2450V2	SPEAG	D2450V2	955	2015/01/08	3
Network analyzer	Agilent	8753E	US37390562	2015/03/15	1
Universal Radio Communication Tester	ROHDE & SCHWARZ	CMU200	112012	2014/10/22	1
Dielectric Probe Kit	Agilent	85070E	US44020288	/	/
Dual Directional Coupler	Agilent	778D	50127	2014/10/23	1
Dual Directional Coupler	Agilent	772D	50348	2014/10/23	1
Attenuator	PE	PE7005-10	E048	2014/10/23	1
Attenuator	PE	PE7005-3	E049	2014/10/23	1
Attenuator	Woken	WK0602-XX	E050	2014/10/23	1
Power meter	Agilent	E4417A	GB41292254	2014/10/22	1
Power Meter	Agilent	E7356A	GB54762536	2014/10/25	1
Power sensor	Agilent	8481H	MY41095360	2014/10/22	1
Power Sensor	Agilent	E9327A	Us40441788	2015/03/18	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 evaluate 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, measured 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  $\Omega$  from the previous measurement.
- 2) Network analyzer probe calibration against air, distilled water and a shorting block performed before measuring liquid parameters.

## 4. SAR Measurements System configuration

### 4.1. SAR Measurement Set-up

The DASY4 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 DASY4 measurement server.

The DASY4 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.

DASY4 software and SEMCAD data evaluation software.

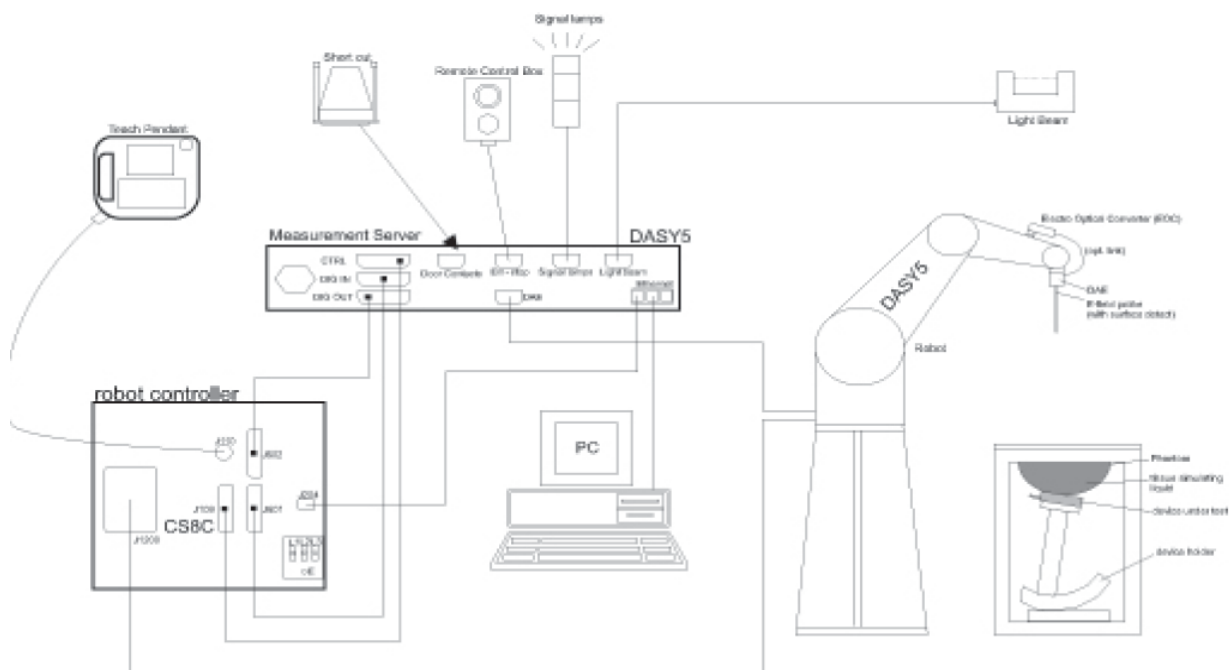
Remote control with teach panel and additional circuitry for robot safety such as warning lamps, etc.

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. DASY4 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

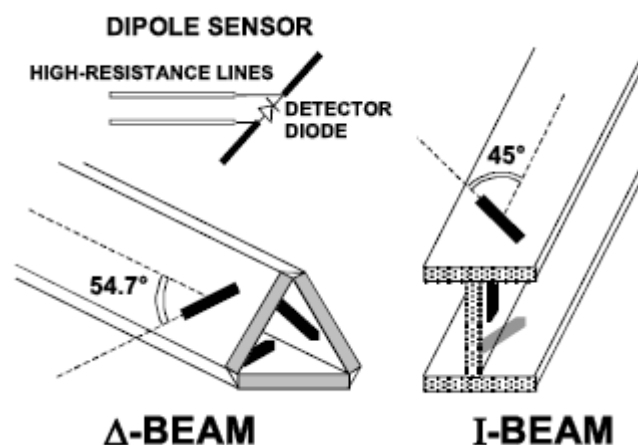
Construction	Symmetrical design with triangular core Interleaved sensors Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)
Calibration	ISO/IEC 17025 calibration service available.
Frequency	10 MHz to 4 GHz; Linearity: $\pm 0.2$ dB (30 MHz to 4 GHz)
Directivity	$\pm 0.2$ dB in HSL (rotation around probe axis) $\pm 0.3$ dB in tissue material (rotation normal to probe axis)
Dynamic Range	5 $\mu$ W/g to > 100 mW/g; Linearity: $\pm 0.2$ 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 DASY4 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.  $\pm 5\%$ .

The “surface check” measurement tests the optical surface detection system of the DASY4 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  $\pm 0.1$  mm). 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  $\pm 30^\circ$ .)

#### 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 DASY4 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) ( $\Delta x_{area}, \Delta y_{area}$ )	Maximum Zoom Scan Resolution (mm) ( $\Delta x_{zoom}, \Delta y_{zoom}$ )	Maximum Zoom Scan Spatial Resolution (mm) $\Delta z_{zoom}(n)$	Minimum Zoom Scan Volume (mm) ( $x, y, z$ )
$\leq 2$ GHz	$\leq 15$	$\leq 8$	$\leq 5$	$\geq 30$
2-3 GHz	$\leq 12$	$\leq 5$	$\leq 5$	$\geq 30$
3-4 GHz	$\leq 12$	$\leq 5$	$\leq 4$	$\geq 28$
4-5 GHz	$\leq 10$	$\leq 4$	$\leq 3$	$\geq 25$
5-6 GHz	$\leq 10$	$\leq 4$	$\leq 2$	$\geq 22$

## 4.6. Data Storage and Evaluation

#### Data Storage

The DASY4 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/cm<sup>2</sup>], [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	$\sigma$
	- Density	$\rho$

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 DASY4 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	$V_i$	= compensated signal of channel i	(i = x, y, z)
	$U_i$	= input signal of channel i	(i = x, y, z)
	cf	= crest factor of exciting field	(DASY parameter)
	dcp <sub>i</sub>	= diode compression point	(DASY parameter)

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

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

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

With	$V_i$	= compensated signal of channel i	(i = x, y, z)
	Norm <sub>i</sub>	= sensor sensitivity of channel i	(i = x, y, z)
		[mV/(V/m) <sup>2</sup> ] for E-field Probes	
	ConvF	= sensitivity enhancement in solution	
	a <sub>ij</sub>	= sensor sensitivity factors for H-field probes	
	f	= carrier frequency [GHz]	
	$E_i$	= electric field strength of channel i in V/m	
	$H_i$	= 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
	$E_{tot}$	= total field strength in V/m
	$\sigma$	= conductivity in [mho/m] or [Siemens/m]
	$\rho$	= equivalent tissue density in g/cm <sup>3</sup>

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 (% Weight)	835MHz		1900MHz		1750 MHz		2450MHz		2600MHz	
	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	
	$\epsilon_r$	$\sigma(S/m)$	$\epsilon_r$	$\sigma(S/m)$
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

Frequency (MHz)	Description	Dielectric Parameters		Tissue Temp. (°C)	Date
		Permittivity ( $\epsilon_r$ )	Conductivity ( $\sigma$ )		
835 (Head)	Reference	41.50 ± 5% (39.425~43.574)	0.90 ± 5% (0.855~0.945)	NA	2015/08/21
	Measurement	41.75	0.92	22.5	
1900 (Head)	Reference	40.00 ± 5% (38.00~42.00)	1.40 ± 5% (1.33~1.47)	NA	2015/08/21
	Measurement	40.3	1.46	22.7	
2450 (Head)	Reference	39.2 ± 5% (37.24~41.16)	1.80 ± 5% (1.71~1.89)	NA	2015/08/21
	Measurement	38.2	1.84	22.1	

835 (Body)	Reference	55.2 ± 5% (52.44~57.96)	0.97 ± 5% (0.9215~1.0185)	NA	2015/08/22
	Measurement	53.51	0.99	22.4	
1900 (Body)	Reference	53.3 ± 5% (50.635~55.965)	1.52 ± 5% (1.444~1.596)	NA	2015/08/23
	Measurement	53.5	1.51	22.8	
2450 (Body)	Reference	52.7 ± 5% (50.065~55.335)	1.95 ± 5% (1.8525~2.0475)	NA	2015/08/24
	Measurement	50.6	1.87	22.6	

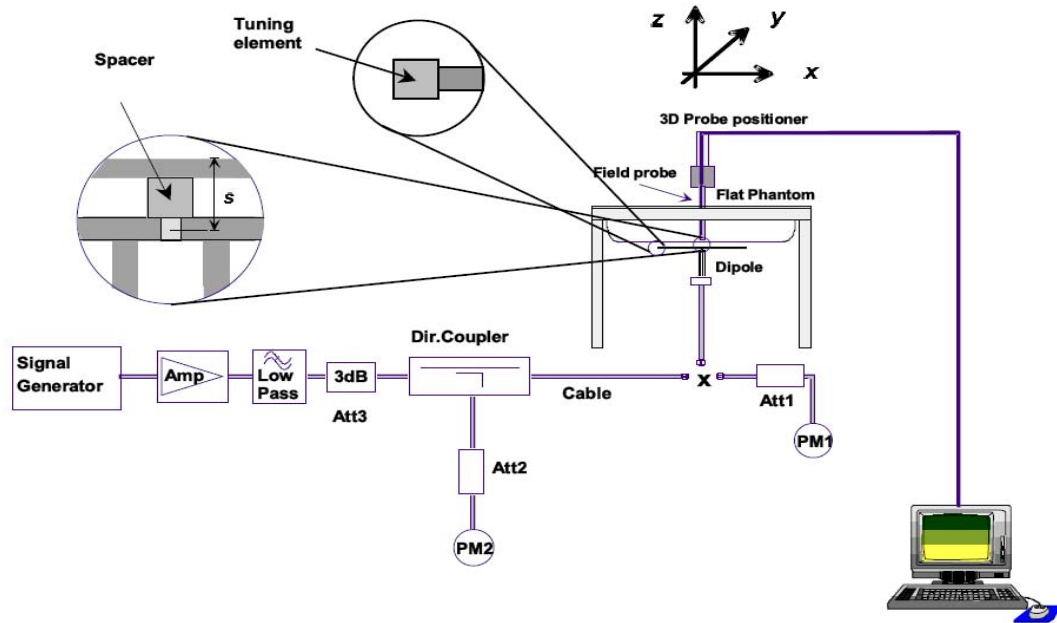


## 4.9. System Check

The purpose of the system check is to verify that the system operates within its specifications at the device test frequency. The system check is a 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 ( $\pm 10\%$ ).

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 24 dBm (250mW) before dipole is connected.



Photo of Dipole Setup

Justification for Extended SAR Dipole Calibrations Usage of SAR dipoles calibrated less than 3 years ago but more than 1 year ago were confirmed in maintaining return loss ( $< -20$  dB, within 20% of prior calibration) and impedance (within 5 ohm from prior calibration) requirements per extended calibrations in KDB 865664 D01:

Justification of Extended Calibration SAR Dipole D835V2– serial no.4d134

Head						
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
2014-7-24	-28.9		48.8		3.34j	
2015-7-19	-29.3	-1.38	50.5	1.7	3.78j	0.44j

Body						
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
2014-7-24	-23.0		50.9		7.08j	
2015-7-19	-24.6	-6.96	52.1	1.3	7.91j	0.83j

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

#### System Check in Head Tissue Simulating Liquid

Frequency	Test Date	Dielectric Parameters		Temp (°C)	250mW Measured SAR <sub>1g</sub>	1W Normalized SAR <sub>1g</sub>	1W Target SAR <sub>1g</sub>	Limit (±10% Deviation)
		ε <sub>r</sub>	σ(s/m)		(W/Kg)			
835MHz	2015/08/21	41.75	0.92	22.5	2.42	9.68	9.62	0.62%
1900MHz	2015/08/21	40.30	1.46	22.5	9.88	39.52	40.60	-2.66%
2450MHz	2015/08/21	38.20	1.84	22.5	13.40	53.60	51.60	3.88%

#### System Check in Body Tissue Simulating Liquid

Frequency	Test Date	Dielectric Parameters		Temp (°C)	250mW Measured SAR <sub>1g</sub>	1W Normalized SAR <sub>1g</sub>	1W Target SAR <sub>1g</sub>	Limit (±10% Deviation)
		ε <sub>r</sub>	σ(s/m)		(W/Kg)			
835MHz	2015/08/22	53.51	0.99	22.4	2.41	9.64	9.77	-1.33%
1900MHz	2015/08/23	41.60	21.72	22.7	10.10	40.40	40.10	0.75%
2450MHz	2015/08/24	54.40	25.40	22.1	13.60	54.40	51.80	5.02%

Note:

1. The graph results see system check.
2. Target Values used derive from the calibration certificate

#### 4.10. SAR measurement procedure

The procedure for assessing the average SAR value consists of the following steps:

- Power Reference Measurement
 

The Power Reference Measurement and Power Drift Measurement jobs are useful jobs for monitoring the power drift of the device under test in the batch process. Both jobs measure the field at a specified reference position, at a selectable distance from the phantom surface. The reference position can be either the selected section's grid reference point or a user point in this section. The reference job projects the selected point onto the phantom surface, orients the probe perpendicularly to the surface, and approaches the surface using the selected detection method.
- Area Scan
 

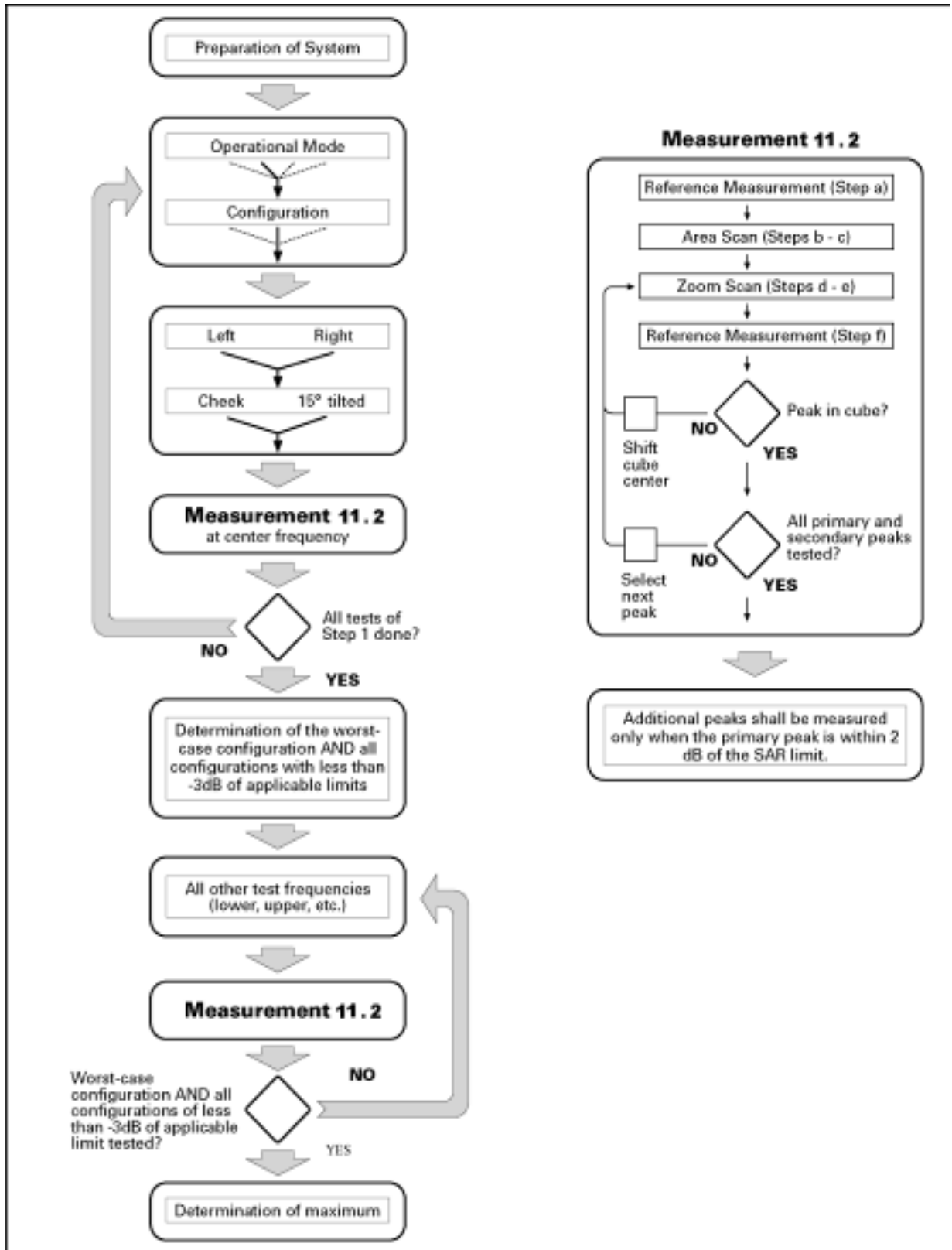
The Area Scan is used as a fast scan in two dimensions to find the area of high field values, before doing a finer measurement around the hot spot. The sophisticated interpolation routines implemented in DAS4 software can find the maximum locations even in relatively coarse grids. The scanning area is defined by an editable grid. This grid is anchored at the grid reference point of the selected section in the phantom. When the Area Scan's property sheet is brought-up, grid settings can be edited by a user.
- Zoom Scan
 

Zoom Scans are used to assess the peak spatial SAR values within a cubic averaging volume containing 1 g and 10 g of simulated tissue. The default Zoom Scan measures 7 x 7 x 7 points (5mmx5mmx5mm)

within a cube whose base faces are centered on the maxima found in a preceding area scan job within the same procedure.

➤ Power Drift Measurement

The Power Drift Measurement job measures the field at the same location as the most recent power reference measurement job within the same procedure, and with the same settings. The Power Drift Measurement gives the field difference in dB from the reading conducted within the last Power Reference Measurement.



Block diagram of the tests to be performed

## 4.11 Operational Conditions during Test

### 4.11.1. General Description of Test Procedures

A communication link is set up with a System Simulator (SS) by air link, and a call is established. The EUT is commanded to operate at maximum transmitting power.

Connection to the EUT is established via air interface with CMU 200, and the EUT is set to maximum output power by CMU 200. The EUT battery must be fully charged and checked periodically during the test to ascertain uniform power output. The antenna connected to the output of the base station simulator shall be placed at least 50 cm away from the EUT. The signal transmitted by the simulator to the antenna feeding point shall be lower than the output power level of the EUT by at least 30 dB.

### 4.11.2. Test Positions

#### 4.11.2.1 Against Phantom Head

Measurements were made in "cheek" and "tilt" positions on both the left hand and right hand sides of the phantom.

The positions used in the measurements were according to IEEE 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".

#### 4.11.2.2. Body Worn Configuration

Body-worn operating configurations should be tested with the belt-clips and holsters attached to the device and positioned against a flat phantom in normal use configurations.

Body-worn operating configurations are tested with the belt-clips and holsters attached to the device and positioned against a flat phantom in a normal use configuration. Per FCC KDB Publication 648474 D04, Body-worn accessory exposure is typically related to voice mode operations when handsets are carried in body-worn accessories. The body-worn accessory procedures in FCC KDB Publication 447498 D01 should be used to test for body-worn accessory SAR compliance, without a headset connected to it. This enables the test results for such configuration to be compatible with that required for hotspot mode when the body-worn accessory test separation distance is greater than or equal to that required for hotspot mode, when applicable. When the reported SAR for a body-worn accessory, measured without a headset connected to the handset, is  $> 1.2$  W/kg, the highest reported SAR configuration for that wireless mode and frequency band should be repeated for that body-worn accessory with a headset attached to the handset.

Accessories for Body-worn operation configurations are divided into two categories: those that do not contain metallic components and those that do contain metallic components. When multiple accessories that do not contain metallic components are supplied with the device, the device is tested with only the accessory that dictates the closest spacing to the body. Then multiple accessories that contain metallic components are tested with the device with each accessory. If multiple accessories share an identical metallic component (i.e. the same metallic belt-clip used with different holsters with no other metallic components) only the accessory that dictates the closest spacing to the body is tested.

Body-worn accessories may not always be supplied or available as options for some devices intended to be authorized for body-worn use. In this case, a test configuration with a separation distance between the back of the device and the flat phantom is used. Test position spacing was documented. Transmitters that are designed to operate in front of a person's face, as in push-to-talk configurations, are tested for SAR compliance with the front of the device positioned to face the flat phantom in head fluid. For devices that are carried next to the body such as a shoulder, waist or chest-worn transmitters, SAR compliance is tested with the accessories, including headsets and microphones, attached to the device and positioned against a flat phantom in a normal use configuration.

## 4.12 Measurement Variability

Per FCC KDB Publication 865664 D01, SAR measurement variability was assessed for each frequency band, which was determined by the SAR probe calibration point and tissue-equivalent medium used for the device measurements. When both head and body tissue-equivalent media were required for SAR measurements in a frequency band, the variability measurement procedures were applied to the tissue medium with the highest measured SAR, using the highest measured SAR configuration for that tissue-equivalent medium. These additional measurements were repeated after the completion of all measurements requiring the same head or body tissue-equivalent medium in a frequency band. The test device was returned to ambient conditions (normal room temperature) with the battery fully charged before it was re-mounted on the device holder for the repeated measurement(s) to minimize any unexpected variations in the repeated results.

SAR Measurement Variability was assessed using the following procedures for each frequency band:

- 1) When the original highest measured SAR is  $\geq 0.80$  W/kg, the measurement was repeated once.
- 2) A second repeated measurement was performed only if the ratio of largest to smallest SAR for the original and first repeated measurements was  $> 1.20$  or when the original or repeated measurement was  $\geq 1.45$  W/kg ( $\sim 10\%$  from the 1-g SAR limit).

3) A third repeated measurement was performed only if the original, first or second repeated measurement was  $\geq 1.5$  W/kg and the ratio of largest to smallest SAR for the original, first and second repeated measurements is  $> 1.20$ .

4) Repeated measurements are not required when the original highest measured SAR is  $< 0.80$  W/kg. 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.

#### 4.13 Test Configuration

##### 4.13.1. 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 CMW 500 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. Since 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.

When SAR tests for EGPRS mode is necessary, GMSK modulation should be used to minimize SAR measurement error due to higher peak-to-average power (PAR) ratios inherent in 8-PSK.

According to specification 3GPP TS 51.010, the maximum power of the GSM can do the power reduction for the multi-slot. The allowed power reduction in the multi-slot configuration is as following: Output power of reductions:

The allowed power reduction in the multi-slot configuration

Number of timeslots in uplink assignment	Permissible nominal reduction of maximum output power, (dB)
1	0
2	0 to 3.0
3	1.8 to 4.8
4	3.0 to 6.0

##### 4.13.2. UMTS Test Configuration

###### 4.13.2.1. Output power Verification

Maximum output power is verified on the High, Middle and Low channel according to the 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 up bits for WCDMA/HSDPA or applying the required inner loop power control procedures to the maximum output power while HSUPA is active. Results for all applicable physical channel configuration (DPCCH, DPDCH<sub>n</sub> and spreading codes, HSDPA, HSPA) should be tabulated in the SAR report. All configuration that are not supported by the DUT or can not be measured due to technical or equipment limitations should be clearly identified.

###### 4.13.2.2. Head SAR Measurements

SAR for head exposure configurations in voice mode is measured using a 12.2kbps RMC with TPC bits configured to all up bits. SAR in AMR configurations is not required when the maximum average output of each RF channel for 12.2kbps AMR is less than 1/4 dB higher than that measured in 12.2 kbps RMC. Otherwise, SAR is measured on the maximum output channel in 12.2kbps AMR with a 3.4 kbps SRB( Signaling radio bearer) using the exposure configuration that results in the highest SAR in 12.2kbps RMC for that RF channel.

###### 4.13.2.3. Body SAR Measurements

SAR for body exposure configurations in voice and data modes is measured using 12.2kbps RMC with TPC bits configured to all up bits. SAR for other spreading codes and multiple DPDCH<sub>n</sub>, when supported by the DUT, are not required when the maximum average output of each RF channel, for each spreading code and DPDCH<sub>n</sub> configuration, are less than 1/4 dB higher than those measured in 12.2kbps RMC. Otherwise, SAR is measured on the maximum output channel with an applicable RMC configuration for the corresponding spreading code or DPDCH<sub>n</sub> using the exposure configuration that results in the highest SAR with 12.2 kbps RMC. When more than 2 DPDCH<sub>n</sub> are supported by the DUT, it may be necessary to configure additional DPDCH<sub>n</sub> for a DUT using FTM (Factory Test Mode) or other chipset based test approaches with parameters similar to those used in 384 kbps and 768 kbps RMC.

###### 4.13.2.4 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 ( $\beta_c$ ,  $\beta_d$ ), and HS-DPCCH power offset parameters ( $\Delta_{ACK}$ ,  $\Delta_{NACK}$ ,  $\Delta_{CQI}$ ) 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	$\beta_c$	$\beta_d$	$\beta_d$ (SF)	$\beta_c/\beta_d$	$\beta_{hs}$ (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:  $\Delta_{ACK}$ ,  $\Delta_{NACK}$  and  $\Delta_{CQI} = 8 \Leftrightarrow A_{hs} = \beta_{hs}/\beta_c = 30/15 \Leftrightarrow \beta_{hs} = 30/15 * \beta_c$   
 Note2: CM=1 for  $\beta_c/\beta_d = 12/15$ ,  $\beta_{hs}/\beta_c = 24/15$ .  
 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  $\beta_c = 11/15$  and  $\beta_d = 15/15$ .

**4.13.2.5 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  $\beta$  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	$\beta_c$	$\beta_d$	$\beta_d$ (SF)	$\beta_c/\beta_d$	$\beta_{hs}^{(1)}$	$\beta_{ec}$	$\beta_{ed}$	$\beta_{ed}$ (SF)	$\beta_{ed}$ (codes)	CM <sup>(2)</sup> (dB)	MPR (dB)	AG <sup>(4)</sup> Index	E-TFCI
1	11/15 <sup>(3)</sup>	15/15 <sup>(3)</sup>	64	11/15 <sup>(3)</sup>	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	$\beta_{ed1}: 47/15$ $\beta_{ed2}: 47/15$	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 <sup>(4)</sup>	15/15 <sup>(4)</sup>	64	15/15 <sup>(4)</sup>	30/15	24/15	134/15	4	1	1.0	0.0	21	81

Note 1:  $\Delta_{ACK}$ ,  $\Delta_{NACK}$  and  $\Delta_{CQI} = 8 \Leftrightarrow A_{hs} = \beta_{hs}/\beta_c = 30/15 \Leftrightarrow \beta_{hs} = 30/15 * \beta_c$ .  
 Note 2: CM = 1 for  $\beta_c/\beta_d = 12/15$ ,  $\beta_{hs}/\beta_c = 24/15$ . 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  $\beta_c/\beta_d$  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  $\beta_c = 10/15$  and  $\beta_d = 15/15$ .  
 Note 4: For subtest 5 the  $\beta_c/\beta_d$  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  $\beta_c = 14/15$  and  $\beta_d = 15/15$ .  
 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:  $\beta_{ed}$  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)

#### 4.13.2.6 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.<sup>35</sup> 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.<sup>36</sup> 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  $\beta$  and  $\Delta$  values used to configure the device for testing, power setback procedures described in 3GPP 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				QPSK, 16QAM, 64QAM
Category 13	15	1	35280	259200				
Category 14	15	1	42192	259200				
Category 15	15	1	23370	345600	QPSK, 16QAM			
Category 16	15	1	27952	345600	QPSK, 16QAM, 64QAM			
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	QPSK, 16QAM, 64QAM			
Category 21	15	1	23370	345600				
Category 22	15	1	27952	345600				
Category 23	15	1	35280	518400	-	-		
Category 24	15	1	42192	518400			QPSK, 16QAM, 64QAM	

#### 4.13.3 WIFI Test Configuration

For WiFi SAR testing, WiFi engineering testing software installed on the DUT can provide continuous transmitting RF signal. The Tx power is set to 11.5 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.

The SAR measurement and test reduction procedures are structured according to either the DSSS or OFDM transmission mode configurations used in each standalone frequency band and aggregated band. For devices that operate in exposure configurations that require multiple test positions, additional SAR test reduction may be applied. The maximum output power specified for production units, including tune-up tolerance, are used to determine initial SAR test requirements for the 802.11 transmission modes in a frequency band. SAR is measured using the highest measured maximum output power channel for the initial test configuration (section 5.1). SAR measurement and test reduction for the remaining 802.11 modes and test channels are determined according to measured or specified maximum output power and reported SAR of the initial measurements. The general test reduction and SAR measurement approaches are summarized in the following:

1. The maximum output power specified for production units are determined for all applicable 802.11 transmission modes in each standalone and aggregated frequency band. Maximum output power is measured for the highest maximum output power configuration(s) in each frequency band according to the default power measurement procedures.
2. For OFDM transmission configurations in the 2.4 GHz and 5 GHz bands, an "initial test configuration" (section 5.3.2) is first determined for each standalone and aggregated frequency band according to the maximum output power and tune-up tolerance specified for production units.
  - a. When the same maximum power is specified for multiple transmission modes in a frequency band, the largest channel bandwidth, lowest order modulation, lowest data rate and lowest order 802.11a/g/n/ac mode is



used for SAR measurement, on the highest measured output power channel in the initial test configuration, for each frequency band (section 5.3.2)

b. SAR is measured for OFDM configurations using the initial test configuration procedures (section 5.3.3). Additional frequency band specific SAR test reduction may be considered for individual frequency bands (sections 5.2 and 5.3).

c. Depending on the reported SAR of the highest maximum output power channel tested in the initial test configuration, SAR test reduction may apply to subsequent highest output channels in the initial test configuration to reduce the number of SAR measurements.

3. The Initial test configuration does not apply to DSSS. The 2.4 GHz band SAR test requirements (section 3.1) and 802.11b DSSS procedures (section 5.2.1) are used to establish the transmission configurations required for SAR measurement.

4. An "initial test position" (section 5.1) is applied to further reduce the number of SAR tests for devices operating in next to the ear, UMPC mini-tablet or hotspot mode exposure configurations that require multiple test positions .

a. SAR is measured for 802.11b according to the 2.4 GHz DSSS procedure (section 5.2.1) using the exposure condition established by the initial test position.

b. SAR is measured for 2.4 GHz and 5 GHz OFDM configurations using the initial test configuration. 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.

5. The Initial test position does not apply to devices that require a fixed exposure test position. SAR is measured in a fixed exposure test position for these devices in 802.11b according to the 2.4 GHz DSSS procedure (section 5.2.1) or in 2.4 GHz and 5 GHz OFDM configurations using the initial test configuration procedures (section 5.3.3).

6. The "subsequent test configuration" (section 5.3.4) procedures are applied to determine if additional SAR measurements are required for the remaining OFDM transmission modes that have not been tested in the initial test configuration. SAR test exclusion is determined according to reported SAR in the initial test configuration and maximum output power specified or measured for these other OFDM configurations.

#### 2.4 GHz Band (§15.247)

The maximum output power permitted for devices authorized under §15.247 is 1 W conducted and 36 dBm EIRP.<sup>6</sup> Within the frequency range of 2400 – 2483.5 MHz, currently a total of 13 channels may be used in the U.S. However, non-overlapping frequency channels are necessary to minimize interference degradation; therefore, channels 1, 6 and 11 are used most often. Channels 12 and 13, in general, require reduced output power to satisfy bandedge radiated field strength requirements at 2483.5 MHz. Provided higher maximum output power is not specified for the other channels, channels 1, 6 and 11 are used to configure 22 MHz DSSS and 20 MHz OFDM channels for SAR measurements; otherwise, the closest adjacent channel with the highest maximum output power specified for production units should be tested instead of channels 1, 6 or 11.<sup>7</sup> When 40 MHz channels are supported, and provided higher maximum output power is not specified for other applicable 40 MHz channels, channel 6 is used to measure SAR; otherwise, the channel with highest specified maximum output power should be tested instead. In addition, SAR test reduction with respect to reported SAR and transmission band width according to section 4.3.3 of KDB Publication 447498 may also be applied.

#### U-NII-1 and U-NII-2A Bands (§15.407)

The maximum output power permitted for devices authorized under §15.407 U-NII-1 band (5.15 – 5.25 GHz), is 250 - 1000 mW conducted and 21 – 36 dBm EIRP, depending on transmitter configurations and antenna operating requirements.<sup>8</sup> For U-NII-2A band (5.25 – 5.35 GHz), the maximum output power is 250 mW conducted and 30 dBm EIRP. When applicable, a lower maximum output power may be required to satisfy emission bandwidth restrictions for these bands. When both bands apply to a device, SAR test reduction may be considered for each exposure configuration according to procedures in section 5.3.1.

#### U-NII-2C, U-NII-3 Bands (§15.407) and 5.8 GHz Band (§15.247)

The maximum output power permitted for devices authorized under §15.407 U-NII-2C band (5.470 – 5.725) is 250 mW conducted and 30 dBm EIRP. For U-NII-3 band (5.725 – 5.850 GHz) the maximum output power permitted is 1 W conducted and 36 dBm EIRP.<sup>9</sup> When applicable, a lower maximum output power may be required due to emission bandwidth restrictions for these bands. In addition, when Terminal Doppler Weather Radar (TDWR) restriction applies, the channels at 5.60 – 5.65 GHz in U-NII-2C band must be disabled with acceptable mechanisms and documented in the equipment certification to avoid SAR requirements.<sup>10</sup> TDWR restriction does not apply under the new rules; all channels that operate at 5.60 – 5.65 GHz must be included to apply the SAR test reduction and measurement procedures.

#### 2.4 GHz SAR Procedures

Separate SAR procedures are applied to DSSS and OFDM configurations in the 2.4 GHz band to simplify DSSS test requirements. For 802.11b DSSS SAR measurements, DSSS SAR procedure applies to fixed exposure test position and initial test position procedure applies to multiple exposure test positions. When SAR measurement is required for an OFDM configuration, the initial test configuration, subsequent test

configuration and initial test position procedures are applied. The SAR test exclusion requirements for 802.11g/n OFDM configurations are described in section 5.2.2.

### 1. SAR TEST PROCEDURES

SAR test reduction is determined according to 802.11 transmission mode configurations and certain exposure conditions with multiple test positions. In the 2.4 GHz band, separate SAR procedures are applied to DSSS and OFDM configurations to simplify DSSS test requirements. For OFDM, in both 2.4 and 5 GHz bands, an initial test configuration must be determined for each standalone and aggregated frequency band, according to the transmission mode configuration with the highest maximum output power specified for production units to perform SAR measurements. If the same highest maximum output power applies to different combinations of channel bandwidths, modulations and data rates, additional procedures (see section 5.3.2) are applied to determine which test configurations require SAR measurement. When applicable, an initial test position may be applied to reduce the number of SAR measurements required for next to the ear, UMPC mini-tablet or hotspot mode configurations with multiple test positions. For 2.4 GHz 802.11b DSSS, either the initial test position procedure for multiple exposure test positions or the DSSS procedure for fixed exposure position is applied; these are mutually exclusive. For 2.4 GHz and 5 GHz OFDM configurations, the initial test configuration is applied to measure SAR using either the initial test position procedure for multiple exposure test position configurations or the initial test configuration procedures for fixed exposure test conditions. Based on the reported SAR of the measured configurations and maximum output power of the transmission mode configurations that are not included in the initial test configuration, the subsequent test configuration and initial test position procedures are applied to determine if SAR measurements are required for the remaining OFDM transmission configurations. In general, the number of test channels that require SAR measurement is minimized based on maximum output power measured for the test sample(s)

### 2. Multiple Exposure Test Position SAR Test Reduction

The following procedures are applied to select an initial test position for handsets operating next to the ear, hotspot mode or UMPC mini-tablet configurations to minimize the number of SAR measurements normally required for the multiple test positions.<sup>14</sup> SAR is measured for the highest measured maximum output power channel using the initial test position. The reported SAR and power measurement results are used to determine if SAR measurements are required for the other exposure positions and test channels. The relative SAR levels of multiple exposure test positions can be established by area scan measurements on the highest measured output power channel to determine the initial test position.<sup>15</sup> The area scans must be measured using the same SAR measurement configurations, including test channel, maximum output power, probe sensor to phantom shell distance, scan resolution etc. for the results to be comparable. The highest SAR at each peak SAR location is extrapolated to the phantom surface. The exposure test position with the highest extrapolated SAR is used for the initial test position. Instead of extrapolated SAR, the 1-g estimated SAR procedures (fast SAR) in KDB Publication 447498 may be used instead. The extrapolated or 1-g estimated SAR must be scaled according to reported SAR requirements to determine the most conservative exposure test position.

- a. Head Exposure Configuration: The left, right, touch and tilt test positions for next to ear exposure testing using the SAM phantom may be considered collectively as one head exposure configuration to facilitate initial test position SAR test reduction. The initial test position is determined according to area scans or by the side (left or right) of the SAM phantom and test position (touch or tilt) with the smallest test separation distance from the device outer surface, at the Wi-Fi antenna location, to the SAM phantom and maximum antenna to phantom RF coupling conditions.
- b. Hotspot mode and UMPC mini-tablets: The surfaces and edges that require SAR measurement in hotspot mode or UMPC mini-tablet configuration may be considered collectively as one exposure configuration to facilitate SAR test reduction. The initial test position is determined according to area scans or by the test position with the smallest test separation distance from the device outer surface, at the Wi-Fi antenna location, to the flat phantom and maximum antenna to phantom RF coupling conditions.

### 3. Initial Test Position SAR Test Reduction Procedure

DSSS and OFDM configurations are considered separately according to the required SAR procedures. SAR is measured in the initial test position using the 802.11 transmission mode configuration required by the DSSS procedure or initial test configuration and subsequent test configuration(s) according to the OFDM procedures. The initial test position procedure is described in the following:

- a. When the reported SAR of the initial test position is  $\leq 0.4$  W/kg, further SAR measurement is not required for the other (remaining) test positions in that exposure configuration and 802.11 transmission mode combinations within the frequency band or aggregated band. SAR is also not required for that exposure configuration in the subsequent test configuration(s).
- b. When the reported SAR of the initial test position is  $> 0.4$  W/kg, SAR is repeated for the 802.11 transmission mode configuration tested in the initial test position using subsequent highest extrapolated or estimated 1-g SAR conditions determined by area scans or next closest/smallest test separation distance and maximum RF coupling test positions based on manufacturer justification, on the highest maximum output power channel, until the reported SAR is  $\leq 0.8$  W/kg or all required test positions (left, right, touch, tilt or subsequent surfaces and edges) are tested.

- c. For all positions/configurations tested using the initial test position and subsequent test positions, when the reported SAR is  $> 0.8$  W/kg, SAR is measured for these test positions/configurations on the subsequent next highest measured output power channel(s) until the reported SAR is  $\leq 1.2$  W/kg or all required channels are tested.
  - a) Additional power measurements may be required for this step, which should be limited to those necessary for identifying the subsequent highest output power channels.

#### 802.11b DSSS SAR Test Requirements

SAR is measured for 2.4 GHz 802.11b DSSS using either a fixed test position or, when applicable, the initial test position procedure. SAR test reduction is determined according to the following:

- a. When the reported SAR of the highest measured maximum output power channel (section 3.1) for the exposure configuration is  $\leq 0.8$  W/kg, no further SAR testing is required for 802.11b DSSS in that exposure configuration.
- b. When the reported SAR is  $> 0.8$  W/kg, SAR is required for that exposure configuration using the next highest measured output power channel. When any reported SAR is  $> 1.2$  W/kg, SAR is required for the third channel; i.e., all channels require testing.

#### 4. 2.4 GHz 802.11g/n OFDM SAR Test Exclusion Requirements

When SAR measurement is required for 2.4 GHz 802.11g/n OFDM configurations, the measurement and test reduction procedures for OFDM are applied (section 5.3). SAR is not required for the following 2.4 GHz OFDM conditions.

- a. When KDB Publication 447498 SAR test exclusion applies to the OFDM configuration
- b. When the highest reported SAR for DSSS is adjusted by the ratio of OFDM to DSSS specified maximum output power and the adjusted SAR is  $\leq 1.2$  W/kg.

#### 5. SAR Test Requirements for OFDM Configurations

When SAR measurement is required for 802.11 a/g/n/ac OFDM configurations, each standalone and frequency aggregated band is considered separately for SAR test reduction. When the same transmitter and antenna(s) are used for U-NII-1 and U-NII-2A bands, additional SAR test reduction applies. When band gap channels between U-NII-2C band and 5.8 GHz U-NII-3 or §15.247 band are supported, the highest maximum output power transmission mode configuration and maximum output power channel across the bands must be used to determine SAR test reduction, according to the initial test configuration and subsequent test configuration requirements.<sup>20</sup> In applying the initial test configuration and subsequent test configuration procedures, the 802.11 transmission configuration with the highest specified maximum output power and the channel within a test configuration with the highest measured maximum output power should be clearly distinguished to apply the procedures.

#### 6. U-NII-1 and U-NII-2A Bands

For devices that operate in only one of the U-NII-1 and U-NII-2A bands, the normally required SAR procedures for OFDM configurations are applied. For devices that operate in both U-NII bands using the same transmitter and antenna(s), SAR test reduction is determined according to the following, with respect to the highest reported SAR and maximum output power specified for production units. The procedures are applied independently to each exposure configuration; for example, head, body, hotspot mode etc.

- a. When the same maximum output power is specified for both bands, begin SAR measurement in U-NII-2A band by applying the OFDM SAR requirements.<sup>21</sup> If the highest reported SAR for a test configuration is  $\leq 1.2$  W/kg, SAR is not required for U-NII-1 band for that configuration (802.11 mode and exposure condition); otherwise, both bands are tested independently for SAR.
- b. When different maximum output power is specified for the bands, begin SAR measurement in the band with higher specified maximum output power. The highest reported SAR for the tested configuration is adjusted by the ratio of lower to higher specified maximum output power for the two bands. When the adjusted SAR is  $\leq 1.2$  W/kg, SAR is not required for the band with lower maximum output power in that test configuration; otherwise, both bands are tested independently for SAR.
- c. The two U-NII bands may be aggregated to support a 160 MHz channel on channel number 50. Without additional testing, the maximum output power for this is limited to the lower of the maximum output power certified for the two bands. When SAR measurement is required for at least one of the bands and the highest reported SAR adjusted by the ratio of specified maximum output power of aggregated to standalone band is  $> 1.2$  W/kg, SAR is required for the 160 MHz channel. This procedure does not apply to an aggregated band with maximum output higher than the standalone band(s); the aggregated band must be tested independently for SAR. SAR is not required when the 160 MHz channel is operating at a reduced maximum power and also qualifies for SAR test exclusion.

#### 7. OFDM Transmission Mode SAR Test Configuration and Channel Selection Requirements

The initial test configuration for 2.4 GHz and 5 GHz OFDM transmission modes is determined by the 802.11 configuration with the highest maximum output power specified for production units, including tune-up tolerance, in each standalone and aggregated frequency band. SAR for the initial test configuration is measured using the highest maximum output power channel determined by the default power measurement procedures (section 4). When multiple configurations in a frequency band have the same specified maximum output power, the initial test configuration is determined according to the following steps applied sequentially.

- a. The largest channel bandwidth configuration is selected among the multiple configurations with the same specified maximum output power.

- b. If multiple configurations have the same specified maximum output power and largest channel bandwidth, the lowest order modulation among the largest channel bandwidth configurations is selected.
- c. If multiple configurations have the same specified maximum output power, largest channel bandwidth and lowest order modulation, the lowest data rate configuration among these configurations is selected.
- d. When multiple transmission modes (802.11a/g/n/ac) have the same specified maximum output power, largest channel bandwidth, lowest order modulation and lowest data rate, the lowest order 802.11 mode is selected; i.e., 802.11a is chosen over 802.11n then 802.11ac or 802.11g is chosen over 802.11n.

After an initial test configuration is determined, if multiple test channels have the same measured maximum output power, the channel chosen for SAR measurement is determined according to the following. These channel selection procedures apply to both the initial test configuration and subsequent test configuration(s), with respect to the default power measurement procedures or additional power measurements required for further SAR test reduction. The same procedures also apply to subsequent highest output power channel(s) selection.

- a. When there are multiple test channels with the same measured maximum output power, the channel closest to mid-band frequency is selected for SAR measurement.
  - b. When there are multiple test channels with the same measured maximum output power and equal separation from mid-band frequency; for example, high and low channels or two mid-band channels, the higher frequency (number) channel is selected for SAR measurement.
8. Initial Test Configuration Procedures

An initial test configuration is determined for OFDM transmission modes according to the channel bandwidth, modulation and data rate combination(s) with the highest maximum output power specified for production units in each standalone and aggregated frequency band. SAR is measured using the highest measured maximum output power channel. For configurations with the same specified or measured maximum output power, additional transmission mode and test channel selection procedures are required (see section 5.3.2). SAR test reduction of subsequent highest output test channels is based on the reported SAR of the initial test configuration.

For next to the ear, hotspot mode and UMC mini-tablet exposure configurations where multiple test positions are required, the initial test position procedure is applied to minimize the number of test positions required for SAR measurement using the initial test configuration transmission mode.<sup>23</sup> For fixed exposure conditions that do not have multiple SAR test positions, SAR is measured in the transmission mode determined by the initial test configuration. When the reported SAR of the initial test configuration is  $> 0.8$  W/kg, SAR measurement is required for the subsequent next highest measured output power channel(s) in the initial test configuration until the reported SAR is  $\leq 1.2$  W/kg or all required channels are tested.

#### 9. Subsequent Test Configuration Procedures

SAR measurement requirements for the remaining 802.11 transmission mode configurations that have not been tested in the initial test configuration are determined separately for each standalone and aggregated frequency band, in each exposure condition, according to the maximum output power specified for production units. The initial test position procedure is applied to next to the ear, UMPC mini-tablet and hotspot mode configurations. When the same maximum output power is specified for multiple transmission modes, the procedures in section 5.3.2 are applied to determine the test configuration. Additional power measurements may be required to determine if SAR measurements are required for subsequent highest output power channels in a subsequent test configuration. The subsequent test configuration and SAR measurement procedures are described in the following.

- a. When SAR test exclusion provisions of KDB Publication 447498 are applicable and SAR measurement is not required for the initial test configuration, SAR is also not required for the next highest maximum output power transmission mode subsequent test configuration(s) in that frequency band or aggregated band and exposure configuration.
- b. When the highest reported SAR for the initial test configuration (when applicable, include subsequent highest output channels), according to the initial test position or fixed exposure position requirements, is adjusted by the ratio of the subsequent test configuration to initial test configuration specified maximum output power and the adjusted SAR is  $\leq 1.2$  W/kg, SAR is not required for that subsequent test configuration.
- c. The number of channels in the initial test configuration and subsequent test configuration can be different due to differences in channel bandwidth. When SAR measurement is required for a subsequent test configuration and the channel bandwidth is smaller than that in the initial test configuration, all channels in the subsequent test configuration that overlap with the larger bandwidth channel tested in the initial test configuration should be used to determine the highest maximum output power channel. This step requires additional power measurement to identify the highest maximum output power channel in the subsequent test configuration to determine SAR test reduction.
  - 1). SAR should first be measured for the channel with highest measured output power in the subsequent test configuration.
  - 2). SAR for subsequent highest measured maximum output power channels in the subsequent test configuration is required only when the reported SAR of the preceding higher maximum output power channel(s) in the subsequent test configuration is  $> 1.2$  W/kg or until all required channels are tested.

- a) For channels with the same measured maximum output power, SAR should be measured using the channel closest to the center frequency of the larger channel bandwidth channel in the initial test configuration.
- d. SAR measurements for the remaining highest specified maximum output power OFDM transmission mode configurations that have not been tested in the initial test configuration (highest maximum output) or subsequent test configuration(s) (subsequent next highest maximum output power) is determined by applying the subsequent test configuration procedures in this section to the remaining configurations according to the following:
- 1) replace "subsequent test configuration" with "next subsequent test configuration" (i.e., subsequent next highest specified maximum output power configuration)
  - 2) replace "initial test configuration" with "all tested higher output power configurations"

#### **4.13 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%.

#### **4.13 Power Reduction**

The product without any power reduction.

## 5. TEST CONDITIONS AND RESULTS

### 5.1. Conducted Power Results

#### <GSM Conducted Power>

General Note:

1. Per KDB 447498 D01v05r02, the maximum output power channel is used for SAR testing and for further SAR test reduction.
2. According to October 2013TCB Workshop, for GSM / GPRS / EGPRS, the number of time slots to test for SAR should correspond to the highest frame-average maximum output power configuration, considering the possibility of e.g. 3rd party VoIP operation for head and body-worn SAR testing, the EUT was set in GPRS (4Tx slot) for GSM850/GSM1900 band due to their highest frame-average power.
3. For hotspot mode SAR testing, GPRS / EDGE should be evaluated, therefore the EUT was set in GPRS (4 Tx slots) for GSM850/GSM1900 band due to its highest frame-average power.

**Conducted Power Measurement Results(GSM 850/1900)**

GSM 850		Burst Conducted power (dBm)			/	Average power (dBm)		
		Channel/Frequency(MHz)				Channel/Frequency(MHz)		
		128/824.2	190/836.6	251/848.8		128/824.2	190/836.6	251/848.8
GSM		31.05	31.85	<b>31.94</b>	-9.03dB	22.02	22.82	22.91
GPRS (GMSK)	1TX slot	31.06	31.79	31.87	-9.03dB	22.03	22.76	22.84
	2TX slot	29.35	29.66	29.74	-6.02dB	23.33	23.64	23.72
	3TX slot	28.21	28.46	28.62	-4.26dB	23.95	24.2	24.36
	4TX slot	<b>27.35</b>	<b>27.57</b>	<b>27.81</b>	<b>-3.01dB</b>	<b>24.34</b>	<b>24.56</b>	<b>24.8</b>
EGPRS (8PSK)	1TX slot	26.05	26.14	26.36	-9.03dB	17.02	17.11	17.33
	2TX slot	24.43	25.62	25.77	-6.02dB	18.41	19.6	19.75
	3TX slot	23.05	23.22	23.36	-4.26dB	18.79	18.96	19.1
	4TX slot	<b>22.24</b>	<b>22.52</b>	<b>22.63</b>	<b>-3.01dB</b>	<b>19.23</b>	<b>19.51</b>	<b>19.62</b>
GSM 1900		Burst Conducted power (dBm)			/	Average power (dBm)		
		Channel/Frequency(MHz)				Channel/Frequency(MHz)		
		512/ 1850.2	661/ 1880	810/ 1909.8		512/ 1850.2	661/ 1880	810/ 1909.8
GSM		28.85	28.77	<b>29.22</b>	-9.03dB	19.82	19.74	20.19
GPRS (GMSK)	1TX slot	28.78	28.68	29.19	-9.03dB	19.75	19.65	20.16
	2TX slot	26.63	26.52	26.89	-6.02dB	20.61	20.5	20.87
	3TX slot	25.34	25.47	25.62	-4.26dB	21.08	21.21	21.36
	4TX slot	<b>24.22</b>	<b>24.36</b>	<b>24.64</b>	<b>-3.01dB</b>	<b>21.21</b>	<b>21.35</b>	<b>21.63</b>
EGPRS (8PSK)	1TX slot	26.01	26.22	26.46	-9.03dB	16.98	17.19	17.43
	2TX slot	24.35	24.52	24.62	-6.02dB	18.33	18.5	18.6
	3TX slot	23.00	23.12	23.35	-4.26dB	18.74	18.86	19.09
	4TX slot	<b>22.34</b>	<b>22.49</b>	<b>22.52</b>	<b>-3.01dB</b>	<b>19.33</b>	<b>19.48</b>	<b>19.51</b>

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.

#### <UMTS Conducted Power>

The following tests were conducted according to the test requirements outlines in 3GPP TS 34.121 specification. A summary of these settings are illustrated below:

#### HSDPA Setup Configuration:

- a. The EUT was connected to Base Station Agilent E5515C referred to the Setup Configuration.
- b. The RF path losses were compensated into the measurements.
- c. A call was established between EUT and Base Station with following setting:
  - i. Set Gain Factors ( $\beta_c$  and  $\beta_d$ ) and parameters were set according to each
  - ii. Specific sub-test in the following table, C10.1.4, quoted from the TS 34.121
  - iii. Set RMC 12.2Kbps + HSDPA mode.

- iv. Set Cell Power = -86 dBm
  - v. Set HS-DSCH Configuration Type to FRC (H-set 1, QPSK)
  - vi. Select HSDPA Uplink Parameters
  - vii. Set Delta ACK, Delta NACK and Delta CQI = 8
  - viii. Set Ack-Nack Repetition Factor to 3
  - ix. Set CQI Feedback Cycle (k) to 4 ms
  - x. Set CQI Repetition Factor to 2
  - xi. Power Ctrl Mode = All Up bits
- d. The transmitted maximum output power was recorded.

**Table C.10.1.4:  $\beta$  values for transmitter characteristics tests with HS-DPCCH**

Sub-test	$\beta_c$	$\beta_d$	$\beta_d$ (SF)	$\beta_c/\beta_d$	$\beta_{HS}$ (Note 1, Note 2)	CM (dB) (Note 3)	MPR (dB) (Note 3)
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

Note 1:  $\Delta_{ACK}$ ,  $\Delta_{NACK}$  and  $\Delta_{CQI} = 30/15$  with  $\beta_{HS} = 30/15 * \beta_c$ .

Note 2: For the HS-DPCCH power mask requirement test in clause 5.2C, 5.7A, and the Error Vector Magnitude (EVM) with HS-DPCCH test in clause 5.13.1A, and HSDPA EVM with phase discontinuity in clause 5.13.1AA,  $\Delta_{ACK}$  and  $\Delta_{NACK} = 30/15$  with  $\beta_{HS} = 30/15 * \beta_c$ , and  $\Delta_{CQI} = 24/15$  with  $\beta_{HS} = 24/15 * \beta_c$ .

Note 3: CM = 1 for  $\beta_c/\beta_d = 12/15$ ,  $\beta_{HS}/\beta_c = 24/15$ . For all other combinations of DPDCH, DPCCH and HS-DPCCH the MPR is based on the relative CM difference. This is applicable for only UEs that support HSDPA in release 6 and later releases.

Note 4: 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 signalled gain factors for the reference TFC (TF1, TF1) to  $\beta_c = 11/15$  and  $\beta_d = 15/15$ .

**Setup Configuration****HSUPA Setup Configuration:**

- a. The EUT was connected to Base Station Agilent E5515C referred to the Setup Configuration.
- b. The RF path losses were compensated into the measurements.
- c. A call was established between EUT and Base Station with following setting \* :
  - i. Call Configs = 5.2B, 5.9B, 5.10B, and 5.13.2B with QPSK
  - ii. Set the Gain Factors ( $\beta_c$  and  $\beta_d$ ) and parameters (AG Index) were set according to each specific sub-test in the following table, C11.1.3, quoted from the TS 34.121
  - iii. Set Cell Power = -86 dBm
  - iv. Set Channel Type = 12.2k + HSPA
  - v. Set UE Target Power
  - vi. Power Ctrl Mode= Alternating bits
  - vii. Set and observe the E-TFCI
  - viii. Confirm that E-TFCI is equal to the target E-TFCI of 75 for sub-test 1, and other subtest's E-TFCI
- d. The transmitted maximum output power was recorded.

Table C.11.1.3:  $\beta$  values for transmitter characteristics tests with HS-DPCCH and E-DCH

Sub-test	$\beta_c$	$\beta_d$	$\beta_d$ (SF)	$\beta_c/\beta_d$	$\beta_{HS}$ (Note 1)	$\beta_{ec}$	$\beta_{ed}$ (Note 5) (Note 6)	$\beta_{ed}$ (SF)	$\beta_{ed}$ (Codes)	CM (dB) (Note 2)	MPR (dB) (Note 2)	AG Index (Note 6)	E-TFCI
1	11/15 (Note 3)	15/15 (Note 3)	64	11/15 (Note 3)	22/15	209/25	1309/225	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	$\beta_{ed1}$ : 47/15 $\beta_{ed2}$ : 47/15	4 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 (Note 4)	15/15 (Note 4)	64	15/15 (Note 4)	30/15	24/15	134/15	4	1	1.0	0.0	21	81

Note 1:  $\Delta_{ACK}$ ,  $\Delta_{NACK}$  and  $\Delta_{CQI} = 30/15$  with  $\beta_{HS} = 30/15 * \beta_c$ .

Note 2: CM = 1 for  $\beta_c/\beta_d=12/15$ ,  $\beta_{HS}/\beta_c=24/15$ . 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  $\beta_c/\beta_d$  ratio of 11/15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signalled gain factors for the reference TFC (TF1, TF1) to  $\beta_c = 10/15$  and  $\beta_d = 15/15$ .

Note 4: For subtest 5 the  $\beta_c/\beta_d$  ratio of 15/15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signalled gain factors for the reference TFC (TF1, TF1) to  $\beta_c = 14/15$  and  $\beta_d = 15/15$ .

Note 5: In case of testing by UE using E-DPDCH Physical Layer category 1, Sub-test 3 is omitted according to TS25.306 Table 5.1g.

Note 6:  $\beta_{ed}$  can not be set directly, it is set by Absolute Grant Value.

### Setup Configuration

#### General Note

1. Per KDB 941225 D01 v02, RMC 12.2kbps setting is used to evaluate SAR. If AMR 12.2kbps power is < 0.25dB higher than RMC 12.2kbps, SAR tests with AMR 12.2kbps can be excluded.
2. By design, AMR and HSDPA/HSUPA RF power will not be larger than RMC 12.2kbps, detailed information is included in Tune-up Procure exhibit.
3. It is expected by the manufacturer that MPR for some HSDPA/HSUPA subtests may differ from the specification of 3GPP, according to the chipset implementation in this model. The implementation and expected deviation are detailed in tune-up procedure exhibit.

Band	WCDMA V		
	4132/4357	4182/4407	4233/4458
TX/RX Channel	4132/4357	4182/4407	4233/4458
Frequency (MHz)	826.4	836.4	846.6
AMR 12.2Kbps	22.04	22.05	21.67
RMC 12.2Kbps	<b>22.09</b>	<b>22.24</b>	<b>21.87</b>
HSDPA Subtest-1	21.64	21.93	20.55
HSDPA Subtest-2	21.58	21.89	20.62
HSDPA Subtest-3	21.20	21.67	20.73
HSDPA Subtest-4	21.42	21.71	20.15
HSUPA Subtest-1	20.28	20.95	20.32
HSUPA Subtest-2	20.66	20.77	20.63
HSUPA Subtest-3	20.66	20.55	20.67
HSUPA Subtest-4	20.53	20.37	20.54
HSUPA Subtest-5	20.51	20.66	20.45



## &lt;WLAN 2.4GHz Conducted Power&gt;

Mode	Channel	Frequency (MHz)	Data rate (Mbps)	Average Output Power (dBm)
802.11b	1	2412	1	17.92
			2	17.85
			5.5	17.53
			11	17.22
	6	2437	1	<b>18.30</b>
			2	18.05
			5.5	17.88
			11	17.64
	11	2462	1	17.88
			2	17.71
			5.5	17.44
			11	17.15
802.11g	1	2412	6	16.15
			9	16.02
			12	15.84
			18	15.69
			24	15.46
			36	15.21
			48	15.08
			54	14.82
	6	2437	6	15.91
			9	15.76
			12	15.43
			18	15.22
			24	15.10
			36	14.96
			48	14.78
			54	14.69
	11	2462	6	15.74
			9	15.58
			12	15.37
			18	15.16
			24	15.00
			36	14.86
			48	14.67
			54	14.53
802.11n HT20	1	2412	MCS0	16.27
			MCS1	16.05
			MCS2	15.88
			MCS3	15.62
			MCS4	15.41
			MCS5	15.20
			MCS6	15.03
			MCS7	14.87
	6	2437	MCS0	16.12
			MCS1	16.00
			MCS2	15.81
			MCS3	15.57
			MCS4	15.36
			MCS5	15.14
			MCS6	15.00
			MCS7	14.82
	11	2462	MCS0	16.40
			MCS1	16.09
			MCS2	15.91
			MCS3	15.67
			MCS4	15.45
			MCS5	15.28
			MCS6	15.09

			MCS7	14.92
802.11n HT40	3	2422	MCS0	14.61
			MCS1	14.49
			MCS2	14.30
			MCS3	14.15
			MCS4	14.03
			MCS5	13.93
			MCS6	13.77
			MCS7	13.52
	6	2437	MCS0	14.26
			MCS1	14.12
			MCS2	14.00
			MCS3	13.92
			MCS4	13.78
			MCS5	13.66
			MCS6	13.60
	9	2452	MCS0	14.43
			MCS1	14.16
			MCS2	14.05
			MCS3	13.91
			MCS4	13.83
			MCS5	13.70
MCS6			13.68	
			MCS7	13.60

## &lt;Bluetooth Conducted Power&gt;

Mode	Channel	Frequency (MHz)	Conducted Average Power (dBm)
BLE-GFSK	00	2402	-4.89
	19	2440	-4.85
	39	2480	-5.01
GFSK	00	2402	2.87
	39	2441	<b>3.08</b>
	78	2480	2.66
8DPSK	00	2402	1.68
	39	2441	1.93
	78	2480	1.70
$\pi/4$ DQPSK	00	2402	1.95
	39	2441	2.07
	78	2480	1.90

## Manufacturing tolerance

## GSM Speech

GSM 850 (GMSK) (Burst Average Power)			
Channel	Channel 251	Channel 190	Channel 190
Target (dBm)	31.50	31.50	31.50
Tolerance $\pm$ (dB)	1	1	1
GSM 1900 (GMSK) (Burst Average Power)			
Channel	Channel 810	Channel 661	Channel 512
Target (dBm)	29.00	29.00	29.00
Tolerance $\pm$ (dB)	1	1	1

GSM 850 GPRS (GMSK) (Burst Average Power)				
Channel		251	190	128
1 Txslot	Target (dBm)	31.00	31.00	31.00
	Tolerance $\pm$ (dB)	1	1	1
2 Txslot	Target (dBm)	29.0	29.0	29.0
	Tolerance $\pm$ (dB)	1	1	1
3 Txslot	Target (dBm)	28.0	28.0	28.0
	Tolerance $\pm$ (dB)	1	1	1

4 Txslot	Target (dBm)	27.0	27.0	27.0
	Tolerance $\pm$ (dB)	1	1	1
<b>GSM 850 EDGE (8PSK) (Burst Average Power)</b>				
Channel		251	190	128
1 Txslot	Target (dBm)	26.0	26.0	26.0
	Tolerance $\pm$ (dB)	1	1	1
2 Txslot	Target (dBm)	25.0	25.0	25.0
	Tolerance $\pm$ (dB)	1	1	1
3 Txslot	Target (dBm)	23.0	23.0	23.0
	Tolerance $\pm$ (dB)	1	1	1
4 Txslot	Target (dBm)	22.0	22.0	22.0
	Tolerance $\pm$ (dB)	1	1	1
<b>GSM 1900 GPRS (GMSK) (Burst Average Power)</b>				
Channel		810	661	512
1 Txslot	Target (dBm)	29.0	29.0	29.0
	Tolerance $\pm$ (dB)	1	1	1
2 Txslot	Target (dBm)	26.0	26.0	26.0
	Tolerance $\pm$ (dB)	1	1	1
3 Txslot	Target (dBm)	25.0	25.0	25.0
	Tolerance $\pm$ (dB)	1	1	1
4 Txslot	Target (dBm)	24.0	24.0	24.0
	Tolerance $\pm$ (dB)	1	1	1
<b>GSM 1900 EDGE (8PSK) (Burst Average Power)</b>				
Channel		810	661	512
1 Txslot	Target (dBm)	26.0	26.0	26.0
	Tolerance $\pm$ (dB)	1	1	1
2 Txslot	Target (dBm)	24.0	24.0	24.0
	Tolerance $\pm$ (dB)	1	1	1
3 Txslot	Target (dBm)	23.0	23.0	23.0
	Tolerance $\pm$ (dB)	1	1	1
4 Txslot	Target (dBm)	22.0	22.0	22.0
	Tolerance $\pm$ (dB)	1	1	1

**UMTS**

<b>UMTS Band V</b>			
Channel	Channel 4132	Channel 4182	Channel 4233
Target (dBm)	22.5	22.5	22.5
Tolerance $\pm$ (dB)	1	1	1
<b>UMTS Band V HSDPA(sub-test 1)</b>			
Channel	Channel 4132	Channel 4182	Channel 4233
Target (dBm)	21.0	21.0	21.0
Tolerance $\pm$ (dB)	1	1	1
<b>UMTS Band V HSDPA(sub-test 2)</b>			
Channel	Channel 4132	Channel 4182	Channel 4233
Target (dBm)	21.0	21.0	21.0
Tolerance $\pm$ (dB)	1	1	1
<b>UMTS Band V HSDPA(sub-test 3)</b>			
Channel	Channel 4132	Channel 4182	Channel 4233
Target (dBm)	21.0	21.0	21.0
Tolerance $\pm$ (dB)	1	1	1
<b>UMTS Band V HSDPA(sub-test 4)</b>			
Channel	Channel 4132	Channel 4182	Channel 4233
Target (dBm)	21.0	21.0	21.0
Tolerance $\pm$ (dB)	1	1	1
<b>UMTS Band V HSUPA(sub-test 1)</b>			
Channel	Channel 4132	Channel 4182	Channel 4233
Target (dBm)	20.0	20.0	20.0
Tolerance $\pm$ (dB)	1	1	1
<b>UMTS Band V HSUPA(sub-test 2)</b>			
Channel	Channel 4132	Channel 4182	Channel 4233
Target (dBm)	20.0	20.0	20.0
Tolerance $\pm$ (dB)	1	1	1

<b>UMTS Band V HSUPA(sub-test 3)</b>			
Channel	Channel 4132	Channel 4182	Channel 4233
Target (dBm)	20.0	20.0	20.0
Tolerance $\pm$ (dB)	1	1	1
<b>UMTS Band V HSUPA(sub-test 4)</b>			
Channel	Channel 4132	Channel 4182	Channel 4233
Target (dBm)	20.0	20.0	20.0
Tolerance $\pm$ (dB)	1	1	1
<b>UMTS Band V HSUPA(sub-test 5)</b>			
Channel	Channel 4132	Channel 4182	Channel 4233
Target (dBm)	20.0	20.0	20.0
Tolerance $\pm$ (dB)	1	1	1

**WiFi**

<b>802.11b (Average)</b>			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	17.5	17.5	17.5
Tolerance $\pm$ (dB)	1	1	1
<b>802.11g (Average)</b>			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	15.5	15.5	15.5
Tolerance $\pm$ (dB)	1	1	1
<b>802.11n HT20 (Average)</b>			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	15.5	15.5	15.5
Tolerance $\pm$ (dB)	1	1	1
<b>802.11n HT40 (Average)</b>			
Channel	Channel 3	Channel 6	Channel 9
Target (dBm)	14.0	14.0	14.0
Tolerance $\pm$ (dB)	1	1	1

**Bluetooth**

<b>BLE-GFSK (Average)</b>			
Channel	Channel 00	Channel 19	Channel 39
Target (dBm)	-4.5	-4.5	-4.5
Tolerance $\pm$ (dB)	1	1	1
<b>GFSK (Average)</b>			
Channel	Channel 00	Channel 39	Channel 78
Target (dBm)	3.0	3.0	3.0
Tolerance $\pm$ (dB)	1	1	1
<b>8DPSK (Average)</b>			
Channel	Channel 00	Channel 39	Channel 78
Target (dBm)	2.0	2.0	2.0
Tolerance $\pm$ (dB)	1	1	1
<b><math>\pi/4</math>DQPSK (Average)</b>			
Channel	Channel 00	Channel 39	Channel 78
Target (dBm)	2.0	2.0	2.0
Tolerance $\pm$ (dB)	1	1	1

**5.2. Simultaneous TX SAR Considerations****5.2.1 Introduction**

The following procedures adopted from "FCC SAR Considerations for Cell Phones with Multiple Transmitters" are applicable to handsets with built-in unlicensed transmitters such as 802.11 a/b/g/n and Bluetooth devices which may simultaneously transmit with the licensed transmitter.

For the DUT, the BT and WiFi modules sharing same antenna, GSM and UMTS module sharing a single antenna;

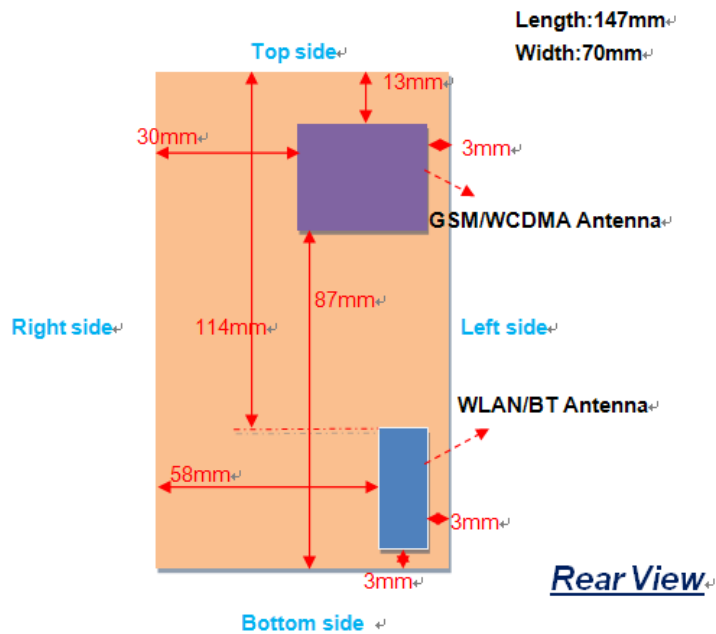
Application Simultaneous Transmission information:

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
UMTS	Band V	DT	Yes,WLAN or BT/BLE	N/A
WLAN	2450	DT	Yes,GSM,GPRS,EDGE,UMTS	Yes
BT/BLE	2450	DT	Yes,GSM,GPRS,EDGE,UMTS	N/A

Note:VO-Voice Service only;DT-Digital Transport

Note: BT and WLAN can be active at the same time, but only with interleaving of packages switched on board level. That means that they don't transmit at the same time.  
 BLE-Bluetooth low energy;  
 BT- Classical Bluetooth

**5.2.2 Transmit Antennas and SAR Measurement Positions**



Note:

- 1). Per KDB648474 D04, because the overall diagonal distance of this devices is 163mm > 160mm, it is considered a "Phablet" device.
- 2). Per KDB648474 D04, 10-g extremity SAR is not required when Body-Worn mode 1-g reported SAR < 1.2 W/Kg.
- 3). According to the KDB941225 D06 Hot Spot SAR v02, the edges with less than 2.5 cm distance to the antennas need to be tested for SAR.

**Hotspot mode SAR measurement positions**

Hotspot mode SAR measurement positions						
mode	front	rear	left egde	right egde	top egde	bottom egde
GSM 850	yes	yes	yes	no	yes	no
GSM 1900	yes	yes	yes	no	yes	no
UMTS FDD Band II	yes	yes	yes	no	yes	no
WiFi2450	yes	yes	yes	no	no	yes

Note:

According to the KDB941225 D06 Hot Spot SAR v02, when the overall device length and width are ≥ 9cm\*5cm, the test distance is 10 mm. SAR must be measured for all sides and surfaces with a transmitting antenna located within 25mm from that surface or edge.

**5.2.3 Standalone SAR Test Exclusion Considerations**

Per KDB447498 for 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  $\leq 50$  mm are determined by::

$[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}] \leq 3.0$  for 1-g SAR and  $\leq 7.5$  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

Standalone SAR test exclusion considerations							
Communication system	Frequency (MHz)	Configuration	Maximum Average Power (dBm)	Separation Distance (mm)	Calculation Result	SAR Exclusion Thresholds	Standalone SAR Exclusion
GSM 850	835	Head	23.47	5	40.6	3.0	no
		Body*	24.99	10	28.8	3.0	no
GSM 1900	1900	Head	20.97	5	34.5	3.0	no
		Body*	20.99	10	17.3	3.0	no
UMTS Band V	850	Head	23.50	5	40.9	3.0	no
		Body*	23.50	10	20.5	3.0	no

Remark:

1. WiFi 2450 and Bluetooth Standalone SAR Test Exclusion Considerations for another table per KDB248227 D01.
2. Maximum average power including tune-up tolerance;
3. When the minimum test separation distance is  $< 5$  mm, a distance of 5 mm is applied to determine SAR test exclusion
4. Body including Hotspot mode as body use distance is 10mm from manufacturer declaration of user manual.

Standalone SAR test exclusion considerations							
Modulation	Frequency (MHz)	Configuration	Maximum Average Power (dBm)	Separation Distance (mm)	Calculation Result	SAR Exclusion Thresholds	Standalone SAR Exclusion
802.11b	2450	Head	18.5	5	22.2	3.0	no
		Body*	18.5	10	11.1	3.0	no
802.11g	2450	Head	16.5	5	14.1	3.0	no
		Body*	16.5	10	7.0	3.0	no
802.11n HT20	2450	Head	16.5	5	14.1	3.0	no
		Body*	16.5	10	7.0	3.0	no
802.11n HT40	2450	Head	15.0	5	12.4	3.0	no
		Body*	15.0	10	6.2	3.0	no
Bluetooth*	2450	Head	4.0	5	1.6	3.0	yes
		Body*	4.0	10	0.8	3.0	yes

Remark:

1. Maximum average power including tune-up tolerance;
2. Bluetooth including BLE and classical Bluetooth;
3. When the minimum test separation distance is  $< 5$  mm, a distance of 5 mm is applied to determine SAR test exclusion
4. Body including Hotspot mode as body use distance is 10mm from manufacturer declaration of user manual.

#### 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;

- $(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm}) \cdot [\sqrt{f(\text{GHz})} / x] \leq 0.4$  W/kg for test separation distances  $\leq 50$  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.

$$\text{Ratio} = \frac{(SAR_1 + SAR_2)^{1.5}}{(\text{peak location separation, mm})} < 0.04$$

Estimated stand alone SAR					
Communication system	Frequency (MHz)	Configuration	Maximum Power (including tune-up tolerance) (dBm)	Separation Distance (mm)	Estimated SAR <sub>1-g</sub> (W/kg)
Bluetooth*	2450	Head	4.00	5	0.105
Bluetooth*	2450	Hotspot	4.00	10	0.052
Bluetooth*	2450	Body Worn	4.00	10	0.052

Bluetooth\*- Including Lower power Bluetooth

### 5.2.5 Evaluation of Simultaneous SAR

#### Head Exposure Conditions

##### Simultaneous transmission SAR for WiFi and GSM/UMTS

Test Position	SAR Type	GSM850 Reported SAR <sub>1-g</sub> (W/Kg)	GSM1900 Reported SAR <sub>1-g</sub> (W/Kg)	UMTS Band V Reported SAR <sub>1-g</sub> (W/Kg)	WiFi Reported SAR <sub>1-g</sub> (W/Kg)	MAX. ΣSAR <sub>1-g</sub> (W/Kg)	SAR <sub>1-g</sub> Limit (W/Kg)	Peak location separation ratio	Simut. Meas. Required
Left/Cheek	1-g	0.361	<b>0.504</b>	0.350	<b>0.179</b>	<b>0.683</b>	1.6	no	no
Left/Tilt	1-g	0.313	0.389	0.206	0.114	0.503	1.6	no	no
Right/Cheek	1-g	0.342	0.481	0.303	0.160	0.641	1.6	no	no
Right/Tilt	1-g	0.308	0.352	0.143	0.089	0.441	1.6	no	no

##### Simultaneous transmission SAR for Bluetooth and GSM/UMTS

Test Position	SAR Type	GSM850 Reported SAR <sub>1-g</sub> (W/Kg)	GSM1900 Reported SAR <sub>1-g</sub> (W/Kg)	UMTS Band V Reported SAR <sub>1-g</sub> (W/Kg)	Bluetooth Estimated SAR <sub>1-g</sub> (W/Kg)	MAX. ΣSAR <sub>1-g</sub> (W/Kg)	SAR <sub>1-g</sub> Limit (W/Kg)	Peak location separation ratio	Simut. Meas. Required
Left/Cheek	1-g	0.361	<b>0.504</b>	0.350	<b>0.105</b>	<b>0.609</b>	1.6	no	no
Left/Tilt	1-g	0.313	0.389	0.206	0.105	0.494	1.6	no	no
Right/Cheek	1-g	0.342	0.481	0.303	0.105	0.586	1.6	no	no
Right/Tilt	1-g	0.308	0.352	0.143	0.105	0.457	1.6	no	no

#### Body-Worn Accessory Exposure Conditions

##### Simultaneous transmission SAR for WiFi and GSM/UMTS

Test Position	SAR Type	GSM850 Reported SAR <sub>1-g</sub> (W/Kg)	GSM1900 Reported SAR <sub>1-g</sub> (W/Kg)	UMTS Band V Reported SAR <sub>1-g</sub> (W/Kg)	WiFi Reported SAR <sub>1-g</sub> (W/Kg)	MAX. ΣSAR <sub>1-g</sub> (W/Kg)	SAR <sub>1-g</sub> Limit (W/Kg)	Peak location separation ratio	Simut. Meas. Required
Rear Side	1-g	0.497	0.643	0.689	<b>0.294</b>	<b>0.983</b>	1.6	no	no
Front Side	1-g	0.345	0.472	0.502	0.201	0.703	1.6	no	no

##### Simultaneous transmission SAR for Bluetooth and GSM/UMTS

Test Position	SAR Type	GSM850 Reported SAR <sub>1-g</sub> (W/Kg)	GSM1900 Reported SAR <sub>1-g</sub> (W/Kg)	UMTS Band V Reported SAR <sub>1-g</sub> (W/Kg)	Bluetooth Estimated SAR <sub>1-g</sub> (W/Kg)	MAX. ΣSAR <sub>1-g</sub> (W/Kg)	SAR <sub>1-g</sub> Limit (W/Kg)	Peak location separation ratio	Simut. Meas. Required
Rear Side	1-g	0.497	0.643	0.689	<b>0.052</b>	<b>0.741</b>	1.6	no	no
Front Side	1-g	0.345	0.472	0.502	0.052	0.554	1.6	no	no

**Hotspot SAR****Simultaneous transmission SAR for WiFi and GSM/UMTS (Hotspot Open)**

Test Position	SAR Type	GSM850 Reported SAR <sub>1-g</sub> (W/Kg)	GSM1900 Reported SAR <sub>1-g</sub> (W/Kg)	UMTS Band V Reported SAR <sub>1-g</sub> (W/Kg)	WiFi Reported SAR <sub>1-g</sub> (W/Kg)	MAX. $\Sigma$ SAR <sub>1-g</sub> (W/Kg)	SAR <sub>1-g</sub> Limit (W/Kg)	Peak location separation ratio	Simut. Meas. Required
Rear Side	1-g	0.701	<b>0.783</b>	0.689	<b>0.294</b>	<b>1.077</b>	1.6	no	no
Front Side	1-g	0.566	0.588	0.502	0.201	0.789	1.6	no	no
Left Side	1-g	0.682	0.697	0.659	0.207	0.904	1.6	no	no
Top Side	1-g	0.316	0.381	0.353	/	0.381	1.6	no	no
Bottom Side	1-g	/	/	/	0.181	0.181	1.6	no	no

**Simultaneous transmission SAR for Bluetooth and GSM/UMTS (Hotspot Open)**

Test Position	SAR Type	GSM850 Reported SAR <sub>1-g</sub> (W/Kg)	GSM1900 Reported SAR <sub>1-g</sub> (W/Kg)	UMTS Band V Reported SAR <sub>1-g</sub> (W/Kg)	Bluetooth Estimated SAR <sub>1-g</sub> (W/Kg)	MAX. $\Sigma$ SAR <sub>1-g</sub> (W/Kg)	SAR <sub>1-g</sub> Limit (W/Kg)	Peak location separation ratio	Simut. Meas. Required
Rear Side	1-g	0.701	<b>0.783</b>	0.689	<b>0.052</b>	<b>0.835</b>	1.6	no	no
Front Side	1-g	0.566	0.588	0.502	0.052	0.640	1.6	no	no
Left Side	1-g	0.682	0.697	0.659	0.052	0.749	1.6	no	no
Top Side	1-g	0.316	0.381	0.353	0.052	0.433	1.6	no	no

Note:

1. The WiFi and BT share same antenna, so cannot transmit at same time.
2. The value with block color is the maximum values of standalone
3. The value with blue color is the maximum values of  $\Sigma$ SAR<sub>1-g</sub>

**5.3. SAR Measurement Results**

The calculated SAR is obtained by the following formula:

$$\text{Reported SAR} = \text{Measured SAR} * 10^{(P_{\text{target}} - P_{\text{measured}})/10}$$

$$\text{Scaling factor} = 10^{(P_{\text{target}} - P_{\text{measured}})/10}$$

$$\text{Reported SAR} = \text{Measured SAR} * \text{Scaling factor}$$

Where

$P_{\text{target}}$  is the power of manufacturing upper limit;

$P_{\text{measured}}$  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

The product with 2 SIMs and 2 SIMs(SIM1 and SIM2) can not used Simultaneous, we tested 2 SIMs(SIM1 and SIM2) and recorded worst case at SIM 1

**Duty Cycle**

Test Mode	Duty Cycle
Speech for GSM850/1900	1:8
GPRS850/1900	1:2
UMTS	1:1
WiFi2450	1:1



Table 5: SAR Values [GSM 850]

Ch.	Freq. (MHz)	Time slots	Test Position	Maximum Allowed Power (dBm)	Conducted Power (dBm)	Power drift	Scaling Factor	SAR <sub>1-g</sub> results(W/Kg)		Graph Results
								Measured	Reported	
<b>measured / reported SAR numbers - Head</b>										
251	848.8	GSM	Left/Cheek	32.50	31.94	-0.05	1.138	0.317	<b>0.361</b>	Plot 1
251	848.8	GSM	Left/Tilt	32.50	31.94	-0.04	1.138	0.275	0.313	
251	848.8	GSM	Right/Cheek	32.50	31.94	-0.06	1.138	0.301	0.342	
251	848.8	GSM	Right/Tilt	32.50	31.94	0.02	1.138	0.271	0.308	
<b>measured / reported SAR numbers - Body (hotspot open, distance 10mm)</b>										
251	848.8	4Txslots	Rear Side	28.00	27.81	0.06	1.045	0.671	<b>0.701</b>	Plot 2
251	848.8	4Txslots	Front Side	28.00	27.81	-0.04	1.045	0.542	0.566	
251	848.8	4Txslots	Left Side	28.00	27.81	-0.11	1.045	0.653	0.682	
251	848.8	4Txslots	Top Side	28.00	27.81	-0.09	1.045	0.302	0.316	
<b>measured / reported SAR numbers – Body worn (distance 10mm)</b>										
251	848.8	GSM	Rear Side	32.50	31.94	0.03	1.138	0.437	0.497	
251	848.8	GSM	Front Side	32.50	31.94	-0.10	1.138	0.303	0.345	

Table 6: SAR Values [GSM 1900]

Ch.	Freq. (MHz)	Time slots	Test Position	Maximum Allowed Power (dBm)	Conducted Power (dBm)	Power drift	Scaling Factor	SAR <sub>1-g</sub> results(W/Kg)		Graph Results
								Measured	Reported	
<b>measured / reported SAR numbers - Head</b>										
810	1909.8	GSM	Left/Cheek	30.00	29.22	-0.05	1.197	0.421	<b>0.504</b>	Plot 3
810	1909.8	GSM	Left/Tilt	30.00	29.22	-0.04	1.197	0.325	0.389	
810	1909.8	GSM	Right/Cheek	30.00	29.22	-0.06	1.197	0.402	0.481	
810	1909.8	GSM	Right/Tilt	30.00	29.22	0.02	1.197	0.294	0.352	
<b>measured / reported SAR numbers - Body (hotspot open, distance 10mm)</b>										
810	1909.8	4Txslots	Rear Side	25.00	24.64	0.06	1.086	0.721	<b>0.783</b>	Plot 4
810	1909.8	4Txslots	Front Side	25.00	24.64	-0.04	1.086	0.541	0.588	
810	1909.8	4Txslots	Left Side	25.00	24.64	-0.11	1.086	0.642	0.697	
810	1909.8	4Txslots	Top Side	25.00	24.64	-0.09	1.086	0.351	0.381	
<b>measured / reported SAR numbers – Body worn (distance 10mm)</b>										
810	1909.8	GSM	Rear Side	30.00	29.22	0.03	1.197	0.537	0.643	
810	1909.8	GSM	Front Side	30.00	29.22	-0.10	1.197	0.394	0.472	

Table 7: SAR Values [WCDMA Band V]

Ch.	Freq. (MHz)	Channel Type	Test Position	Maximum Allowed Power (dBm)	Conducted Power (dBm)	Power drift	Scaling Factor	SAR <sub>1-g</sub> results(W/Kg)		Graph Results
								Measured	Reported	
<b>measured / reported SAR numbers - Head</b>										
4182	836.4	RMC	Left/Cheek	23.00	22.24	-0.11	1.191	0.294	<b>0.350</b>	Plot 5
4182	836.4	RMC	Left/Tilt	23.00	22.24	-0.06	1.191	0.173	0.206	
4182	836.4	RMC	Right/Cheek	23.00	22.24	-0.05	1.191	0.254	0.303	
4182	836.4	RMC	Right/Tilt	23.00	22.24	-0.08	1.191	0.120	0.143	
<b>measured / reported SAR numbers - Body (hotspot open, distance 10mm)</b>										
4182	836.4	RMC	Rear Side	23.00	22.24	-0.01	1.191	0.578	<b>0.689</b>	Plot 6
4182	836.4	RMC	Front Side	23.00	22.24	0.05	1.191	0.421	0.502	
4182	836.4	RMC	Left Side	23.00	22.24	-0.09	1.191	0.553	0.659	
4182	836.4	RMC	Top Side	23.00	22.24	-0.04	1.191	0.296	0.353	
<b>measured / reported SAR numbers – Body worn (distance 10mm)</b>										
4182	836.4	RMC	Rear Side	23.00	22.09	-0.11	1.191	0.578	0.689	
4182	836.4	RMC	Front Side	23.00	22.24	-0.03	1.191	0.421	0.502	

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 <sub>1-g</sub> results(W/Kg)		Graph Results
								Measured	Reported	
<b>measured / reported SAR numbers - Head</b>										
6	2437	DSSS	Left/Cheek	18.50	18.30	0.10	1.047	0.171	<b>0.179</b>	Plot 7
6	2437	DSSS	Left/Tilt	18.50	18.30	-0.05	1.047	0.109	0.114	
6	2437	DSSS	Right/Cheek	18.50	18.30	-0.11	1.047	0.153	0.160	
6	2437	DSSS	Right/Tilt	18.50	18.30	-0.08	1.047	0.085	0.089	
<b>measured / reported SAR numbers - Body (hotspot open, distance 10mm)</b>										
6	2437	DSSS	Rear Side	18.50	18.30	-0.17	1.047	0.281	<b>0.294</b>	Plot 8
6	2437	DSSS	Front Side	18.50	18.30	-0.03	1.047	0.192	0.201	
6	2437	DSSS	Left Side	18.50	18.30	-0.06	1.047	0.198	0.207	
6	2437	DSSS	Bottom Side	18.50	18.30	-0.06	1.047	0.173	0.181	
<b>measured / reported SAR numbers – Body worn (distance 10mm)</b>										
6	2437	DSSS	Rear Side	18.50	18.30	-0.10	1.047	0.281	0.294	
6	2437	DSSS	Front Side	18.50	18.30	-0.05	1.047	0.192	0.201	

## Note:

1. The value with black color is the maximum Reported SAR Value of each test band.
2. Per FCC KDB Publication 447498 D01, if the reported (scaled) SAR measured at the middle channel or highest output power channel for each test configuration is  $\leq 0.8$  W/kg then testing at the other channels is optional for such test configuration(s).
3. Per KDB 248227-When the reported SAR of the highest measured maximum output power channel (section 3.1) for the exposure configuration is  $\leq 0.8$  W/kg, no further SAR testing is required for 802.11b DSSS in that exposure configuration, When the reported SAR is  $> 0.8$  W/kg, SAR is required for that exposure configuration using the next highest measured output power channel. When any reported SAR is  $> 1.2$  W/kg, SAR is required for the third channel; i.e., all channels require testing
3. Per KDB 248227-SAR is measured using the highest measured maximum output power channel for the initial test configuration.
4. Per KDB 248227- Channels with measured maximum output power within  $\frac{1}{4}$  dB of each other are considered to have the same maximum output, When there are multiple test channels with the same measured maximum output power, the channel closest to mid-band frequency is selected for SAR measurement. And when there are multiple test channels with the same measured maximum output power and equal separation from mid-band frequency; for example, high and low channels or two mid-band channels, the higher frequency (number) channel is selected for SAR measurement.
5. Per KDB 248227- When the highest reported SAR for DSSS is adjusted by the ratio of OFDM to DSSS specified maximum output power and the adjusted SAR is  $\leq 1.2$  W/kg OFDM SAR test is not required.

**5.4. Measurement Uncertainty (300MHz-3GHz)**

Not required as SAR measurement uncertainty analysis is required in SAR reports only when the highest measured SAR in a frequency band is  $\geq 1.5$  W/kg for 1-g SAR according to KDB865664D01.

## 5.5. System Check Results

Date: 8/21/2015

**DUT: Dipole 835MHz; Type: D835V2; Serial: D835V2 - SN: 4d134**  
**Program Name: System Performance Check at 835 MHz Head**

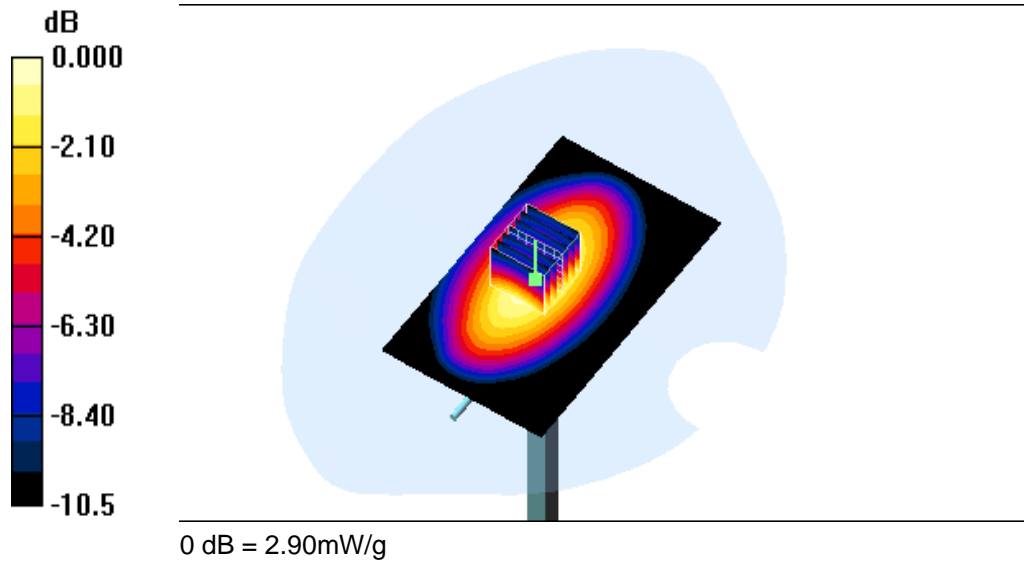
Communication System: CW; Frequency: 835 MHz; Duty Cycle: 1:1  
 Medium parameters used:  $f = 835 \text{ MHz}$ ;  $\sigma = 0.92 \text{ mho/m}$ ;  $\epsilon_r = 41.75$ ;  $\rho = 1000 \text{ kg/m}^3$   
 Phantom section: Flat Section

DASY5 Configuration:

- Probe: ES3DV3 - SN3028; ConvF(6.19, 6.19, 6.19); Calibrated:10/22/2014
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn689; Calibrated: 10/1/2014
- Phantom: SAM 2; Type: SAM; Serial: TP-1432
- Measurement SW: DASY5, V4.7 Build 53; Postprocessing SW: SEMCAD, V1.8 Build 172

**d=15mm, Pin=250mW/Area Scan (61x61x1):** Measurement grid: dx=15mm, dy=15mm  
 Maximum value of SAR (interpolated) = 2.82 mW/g

**d=15mm, Pin=250mW/Zoom Scan (7x7x7) (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm  
 Reference Value = 54.523 V/m; Power Drift = -0.01dB  
 Peak SAR (extrapolated) = 4.068 W/kg  
**SAR(1 g) = 2.42 mW/g; SAR(10 g) = 1.58 mW/g**  
 Maximum value of SAR (measured) = 2.90 mW/g



Date: 8/21/2015

**DUT: Dipole 1900MHz; Type: D1900V2; Serial: 5d194**  
**Program Name: System Performance Check at 1900 MHz Head**

Communication System: CW; Frequency: 1900 MHz; Duty Cycle: 1:1  
 Medium parameters used:  $f = 1900$  MHz;  $\sigma = 1.46$  mho/m;  $\epsilon_r = 40.3$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
 Phantom section: Flat Section

DASY5 Configuration:

- Probe: ES3DV3 - SN3028; ConvF(4.68, 4.68, 4.68); Calibrated: 10/22/2014
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn689; Calibrated: 10/1/2014
- Phantom: SAM 1; Type: SAM; Serial: TP-1360
- Measurement SW: DASY5, V4.7 Build 53; Postprocessing SW: SEMCAD, V1.8 Build 172

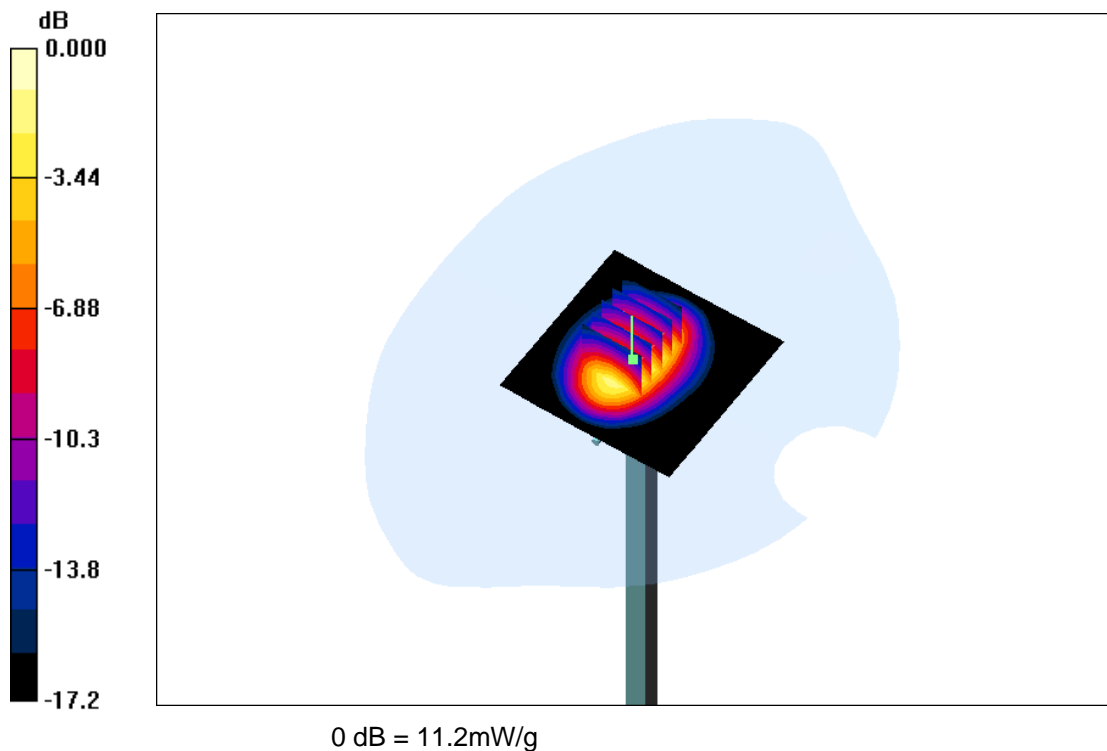
**d=10mm, Pin=250mW/Area Scan (91x91x1):** Measurement grid: dx=10mm, dy=10mm  
 Maximum value of SAR (interpolated) = 11.3 mW/g

**d=10mm, Pin=250mW/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm  
 Reference Value = 80.6 V/m; Power Drift = -0.005 dB

Peak SAR (extrapolated) = 17.5 W/kg

**SAR(1 g) = 9.88 mW/g; SAR(10 g) = 5.27 mW/g**

Maximum value of SAR (measured) = 11.2 mW/g



Date: 8/21/2015

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: 955**  
**Program Name: System Performance Check at 2450 MHz Head**

Communication System: CW; Frequency: 2450 MHz; Duty Cycle: 1:1  
 Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.84$  mho/m;  $\epsilon_r = 38.2$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
 Phantom section: Flat Section

DASY4 Configuration:

- Probe: ES3DV3 - SN3028; ConvF(4.21, 4.21, 4.21); Calibrated: 10/22/2014
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn689; Calibrated: 10/1/2014
- Phantom: SAM 1; Type: SAM; Serial: TP-1360
- Measurement SW: DASY4, V4.7 Build 53; Postprocessing SW: SEMCAD, V1.8 Build 172

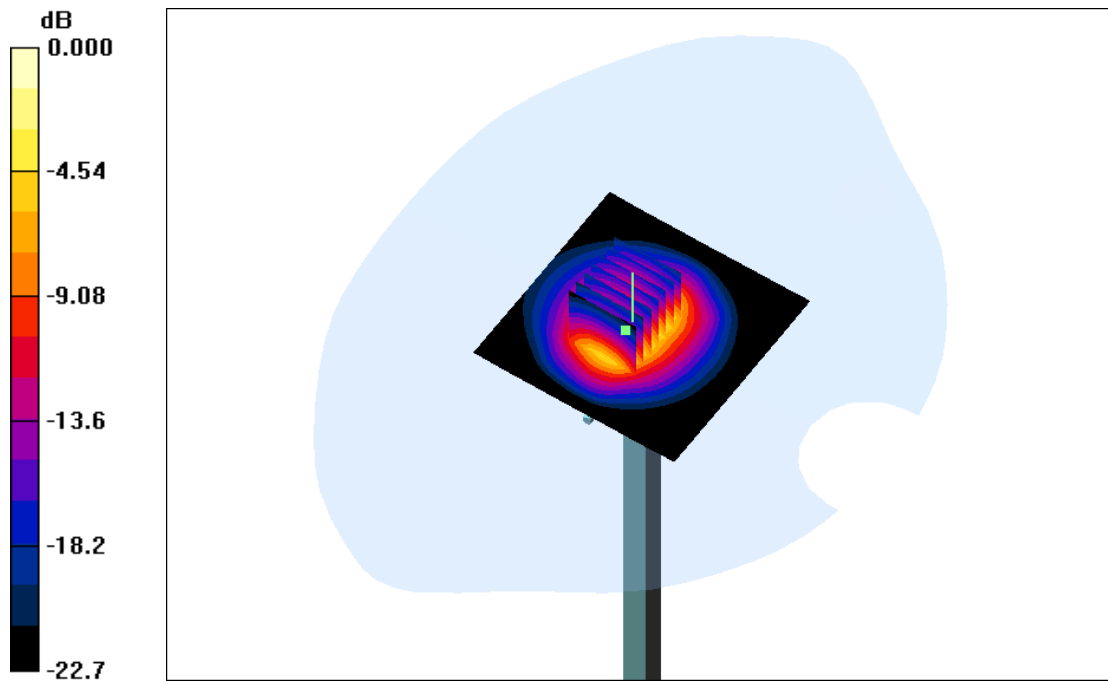
**d=10mm, Pin=250mW/Area Scan (61x61x1):** Measurement grid: dx=15mm, dy=15mm  
 Maximum value of SAR (interpolated) = 16.7 mW/g

**d=10mm, Pin=250mW/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm  
 Reference Value = 87.0 V/m; Power Drift = 0.019 dB

Peak SAR (extrapolated) = 30.7 W/kg

**SAR(1 g) = 13.4 mW/g; SAR(10 g) = 6.46 mW/g**

Maximum value of SAR (measured) = 16.2 mW/g



0 dB = 16.2mW/g

Date: 8/22/2015

**DUT: Dipole 835MHz; Type: D835V2; Serial: D835V2 - SN: 4d134**  
**Program Name: System Performance Check at 835 MHz Body**

Communication System: CW; Frequency: 835 MHz; Duty Cycle: 1:1  
 Medium parameters used:  $f = 835 \text{ MHz}$ ;  $\sigma = 0.99 \text{ mho/m}$ ;  $\epsilon_r = 53.51$ ;  $\rho = 1000 \text{ kg/m}^3$   
 Phantom section: Flat Section

DASY4 Configuration:

- Probe: ES3DV3 - SN3028; ConvF(6.02, 6.02, 6.02); Calibrated:10/22/2014
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn689; Calibrated: 10/1/2014
- Phantom: SAM 2; Type: SAM; Serial: TP-1432
- Measurement SW: DASY4, V4.7 Build 53; Postprocessing SW: SEMCAD, V1.8 Build 172

**d=15mm, Pin=250mW/Area Scan (61x61x1):** Measurement grid: dx=15mm, dy=15mm  
 Maximum value of SAR (interpolated) = 2.72 mW/g

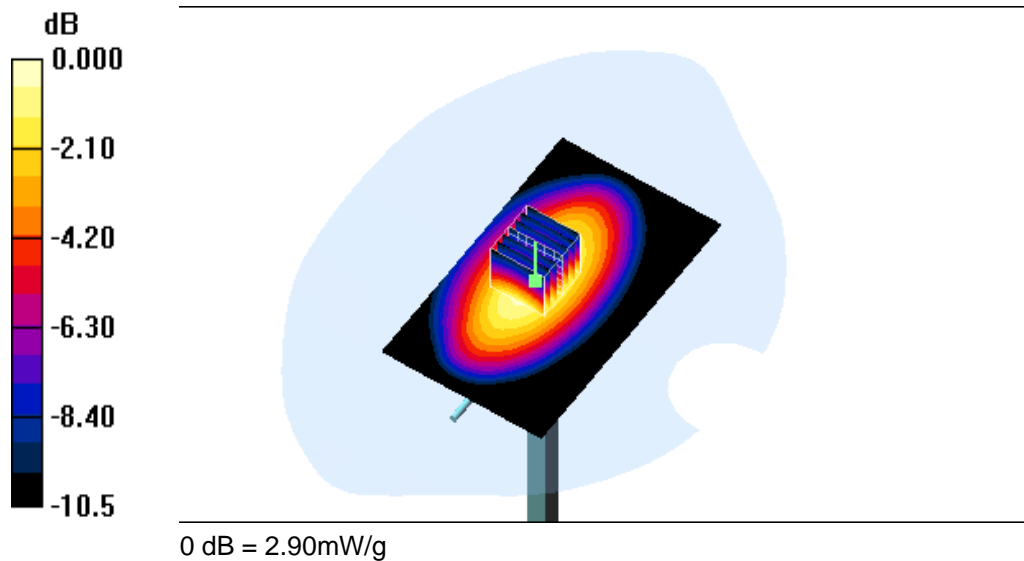
**d=15mm, Pin=250mW/Zoom Scan (7x7x7) (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 54.523 V/m; Power Drift = -0.01dB

Peak SAR (extrapolated) = 4.068 W/kg

**SAR(1 g) = 2.41 mW/g; SAR(10 g) = 1.61 mW/g**

Maximum value of SAR (measured) = 2.80 mW/g



Date: 8/23/2015

**DUT: Dipole 1900MHz; Type: D1900V2; Serial: 5d194**  
**Program Name: System Performance Check at 1900 MHz Body**

Communication System: CW; Frequency: 1900 MHz; Duty Cycle: 1:1  
 Medium parameters used:  $f = 1900$  MHz;  $\sigma = 1.51$  mho/m;  $\epsilon_r = 53.5$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
 Phantom section: Flat Section

DASY4 Configuration:

- Probe: ES3DV3 - SN3028; ConvF(4.48, 4.48, 4.48); Calibrated: 10/22/2014
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn689; Calibrated: 10/1/2014
- Phantom: SAM 1; Type: SAM; Serial: TP-1360
- Measurement SW: DASY4, V4.7 Build 53; Postprocessing SW: SEMCAD, V1.8 Build 172

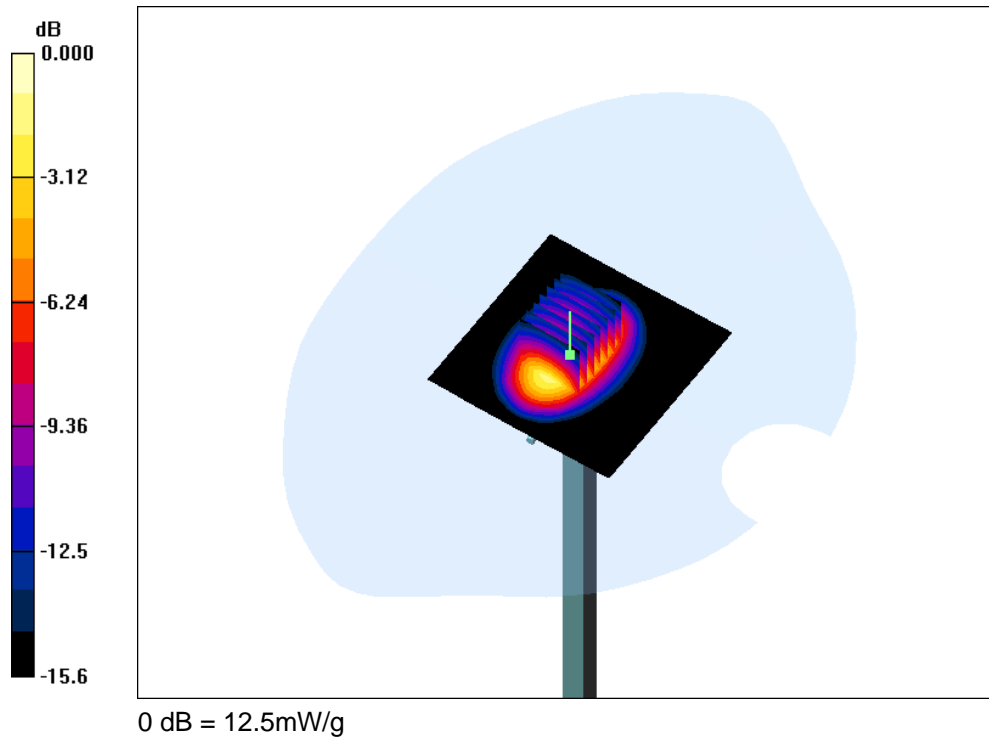
**d=10mm, Pin=250mW/Area Scan (91x91x1):** Measurement grid: dx=10mm, dy=10mm  
 Maximum value of SAR (interpolated) = 12.8 mW/g

**d=10mm, Pin=250mW/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm  
 Reference Value = 85.9 V/m; Power Drift = 0.109 dB

Peak SAR (extrapolated) = 19.7 W/kg

**SAR(1 g) = 10.1 mW/g; SAR(10 g) = 5.43 mW/g**

Maximum value of SAR (measured) = 12.5 mW/g



Date: 8/24/2015

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: 955**  
**Program Name: System Performance Check at 2450 MHz Body**

Communication System: CW; Frequency: 2450 MHz; Duty Cycle: 1:1  
 Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.87$  mho/m;  $\epsilon_r = 50.6$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
 Phantom section: Flat Section

DASY4 Configuration:

- Probe: ES3DV3 - SN3028; ConvF(4.14, 4.14, 4.14); Calibrated: 10/22/2014
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn689; Calibrated: 10/1/2014
- Phantom: SAM 1; Type: SAM; Serial: TP-1360
- Measurement SW: DASY4, V4.7 Build 53; Postprocessing SW: SEMCAD, V1.8 Build 172

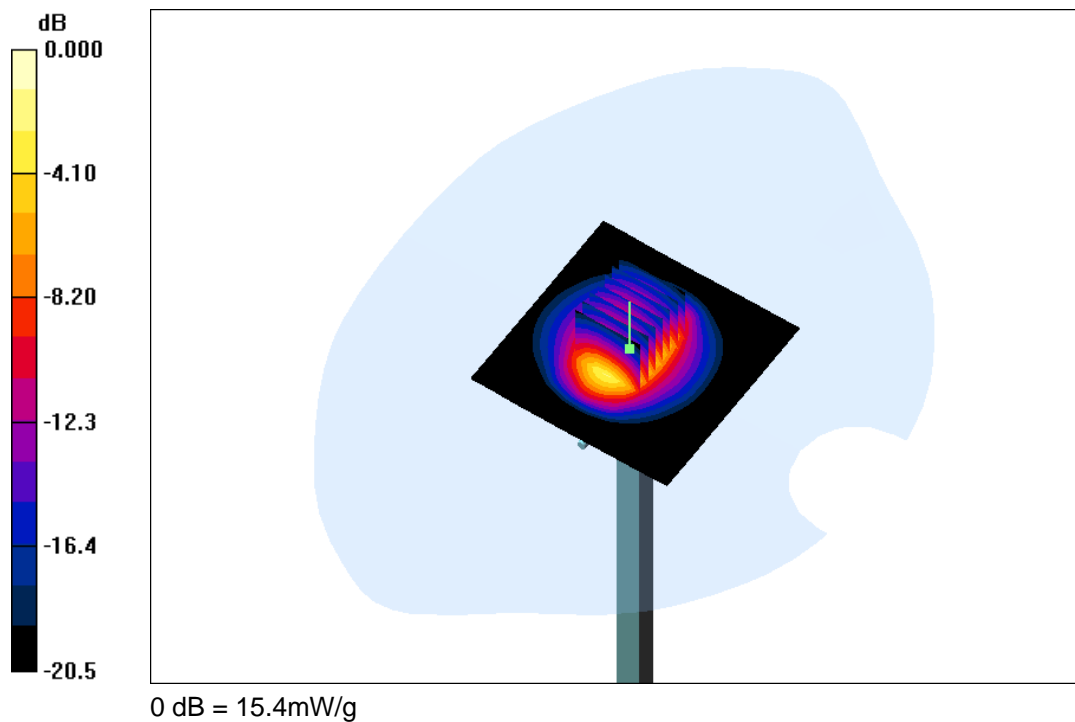
**d=10mm, Pin=250mW/Area Scan (91x91x1):** Measurement grid: dx=10mm, dy=10mm  
 Maximum value of SAR (interpolated) = 16.2 mW/g

**d=10mm, Pin=250mW/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm  
 Reference Value = 89.5 V/m; Power Drift = 0.017 dB

Peak SAR (extrapolated) = 27.0 W/kg

**SAR(1 g) = 13.6 mW/g; SAR(10 g) = 6.35 mW/g**

Maximum value of SAR (measured) = 15.4 mW/g





## 5.6. 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

### Plot 1

Date: 8/21/2015

**DUT: AX1; Type: SI PIN; Serial: IMEI Number**

**Program Name: AX1**

Communication System: GSM 850; Frequency: 836.4 MHz; Duty Cycle: 1:8.3

Medium parameters used:  $f = 836.41$  MHz;  $\sigma = 0.89$  mho/m;  $\epsilon_r = 41.5$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Left Section

DASY5 Configuration:

- Probe: ES3DV3 - SN3028; ConvF(6.19, 6.19, 6.19); Calibrated: 10/22/2014

- Sensor-Surface: 4mm (Mechanical Surface Detection)

- Electronics: DAE4 Sn689; Calibrated: 10/1/2014

- Phantom: SAM 2; Type: SAM; Serial: TP-1432

- Measurement SW: DASY5, V4.7 Build 53; Postprocessing SW: SEMCAD, V1.8 Build 172

**left Cheek/Area Scan (71x121x1):** Measurement grid: dx=15mm, dy=15mm

Maximum value of SAR (interpolated) = 0.578 mW/g

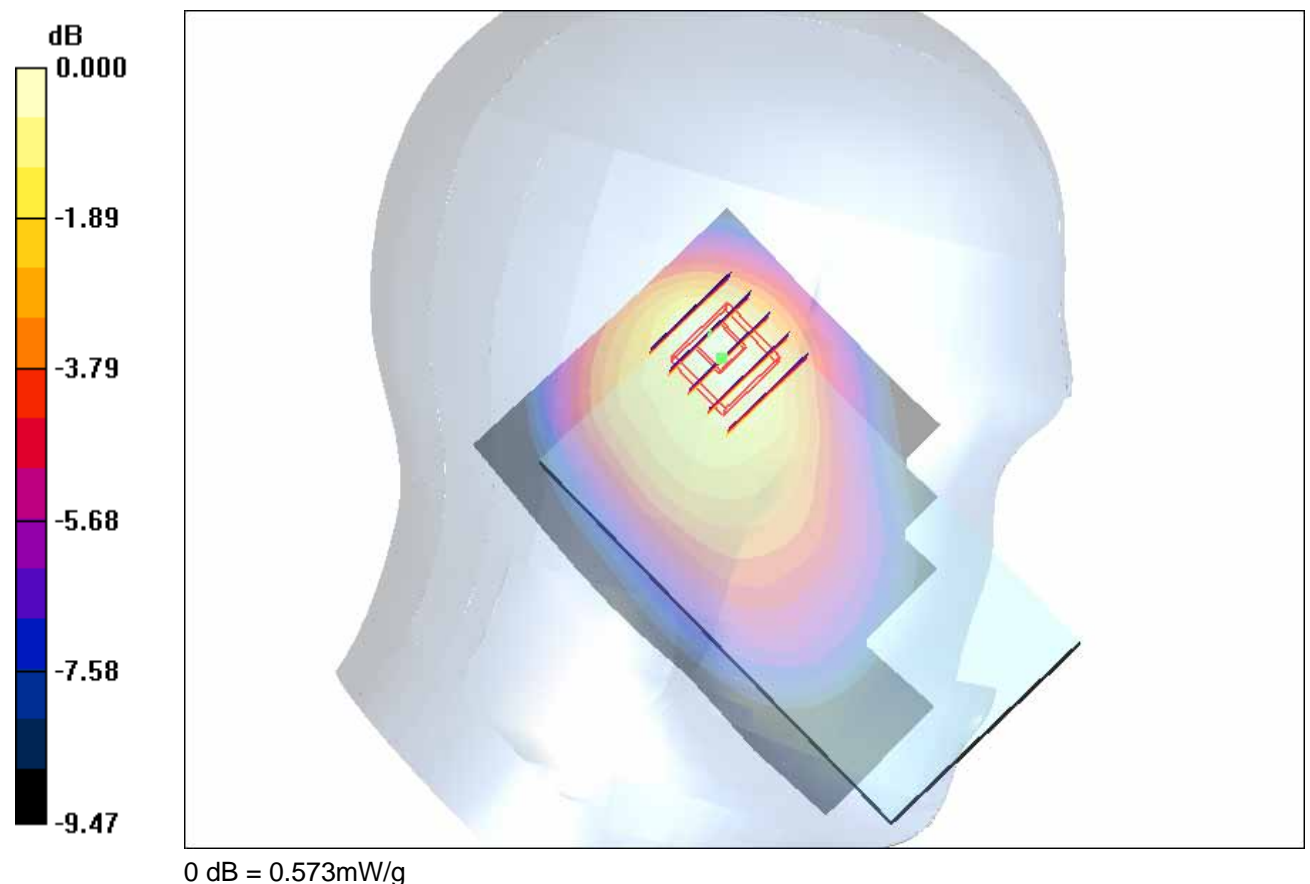
**left Cheek/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 6.74 V/m; Power Drift = -0.05 dB

Peak SAR (extrapolated) = 0.634 W/kg

**SAR(1 g) = 0.317 mW/g; SAR(10 g) = 0.201 mW/g**

Maximum value of SAR (measured) = 0.573 mW/g



**Plot 2**

Date: 8/22/2015

**DUT: AX1; Type: SI PIN; Serial: IMEI Number**  
**Program Name: AX1**

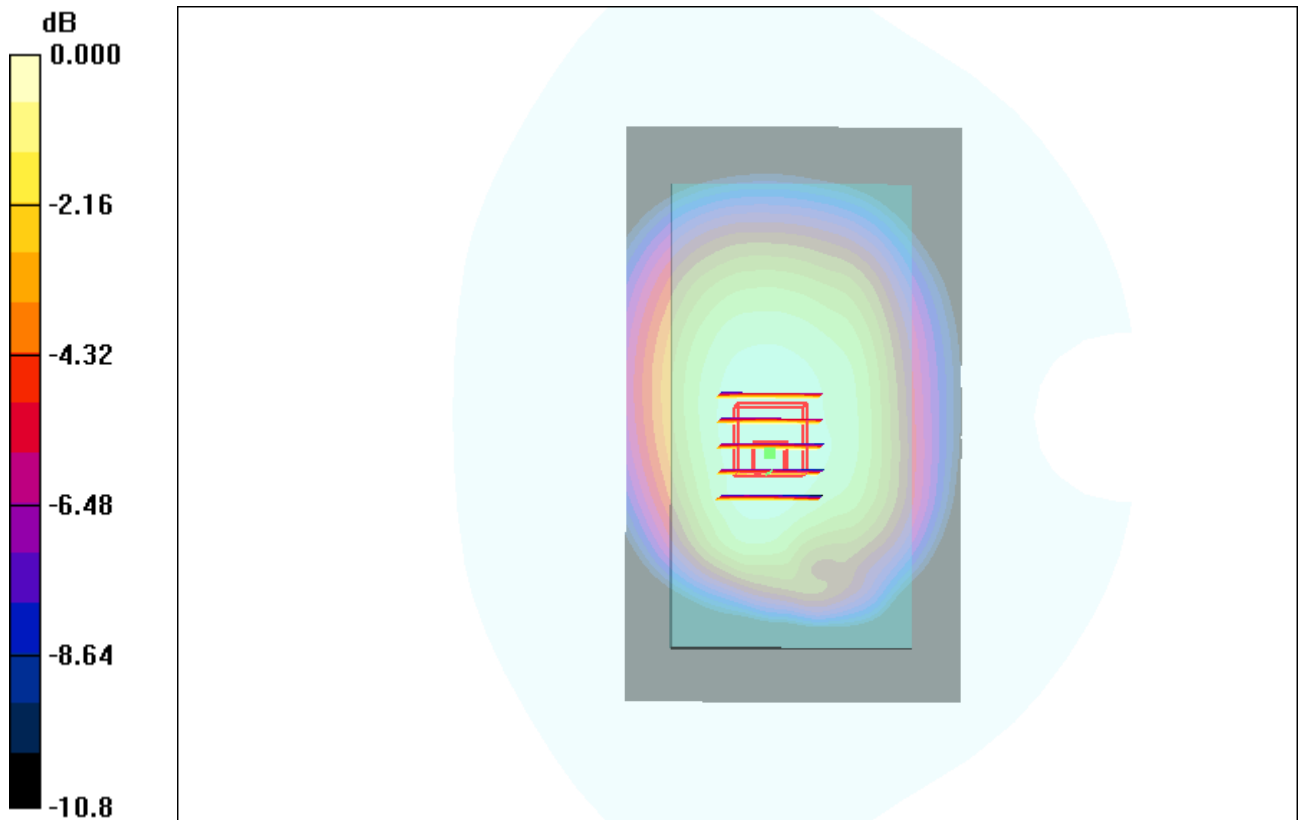
Communication System: GPRS850; Frequency: 848.8 MHz; Duty Cycle: 1:2  
Medium parameters used:  $f = 849$  MHz;  $\sigma = 1$  mho/m;  $\epsilon_r = 55.4$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
Phantom section: Flat Section

**DASY5 Configuration:**

- Probe: ES3DV3 - SN3028; ConvF(6.02, 6.02, 6.02); Calibrated: 10/22/2014
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn689; Calibrated: 10/1/2014
- Phantom: SAM 2; Type: SAM; Serial: TP-1432
- Measurement SW: DASY5, V4.7 Build 53; Postprocessing SW: SEMCAD, V1.8 Build 172

**Rear/Area Scan (71x121x1):** Measurement grid: dx=15mm, dy=15mm  
Maximum value of SAR (interpolated) = 0.833 mW/g

**Rear/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm  
Reference Value = 22.6 V/m; Power Drift = 0.06 dB  
Peak SAR (extrapolated) = 0.832 W/kg  
**SAR(1 g) = 0.671 mW/g; SAR(10 g) = 0.391 mW/g**  
Maximum value of SAR (measured) = 0.827 mW/g



0 dB = 0.827mW/g

**Plot 3**

Date: 8/21/2015

**DUT: AX1; Type: SI PIN; Serial: IMEI Number**  
**Program Name: AX1**

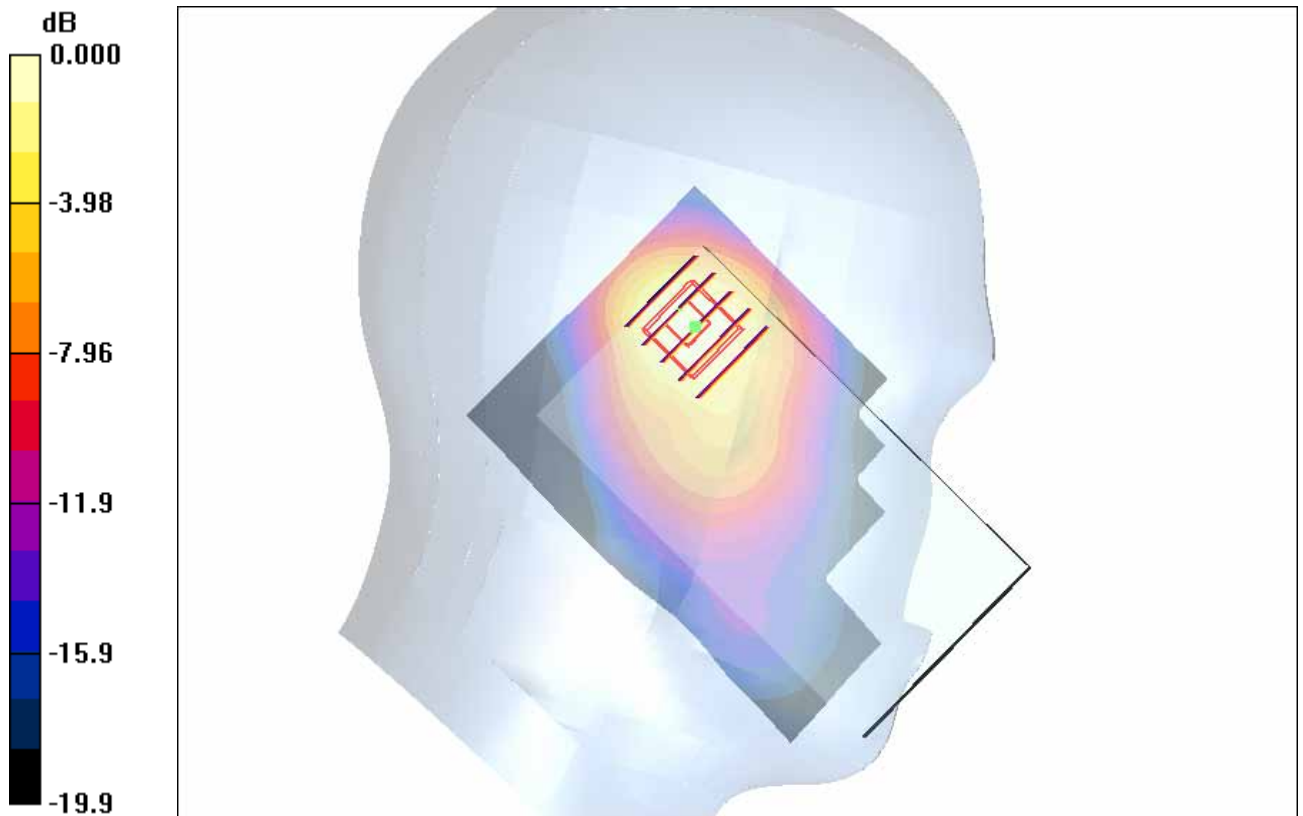
Communication System: GSM 1900; Frequency: 1909.8 MHz; Duty Cycle: 1:8.3  
 Medium parameters used:  $f = 1909.8 \text{ MHz}$ ;  $\sigma = 1.45 \text{ mho/m}$ ;  $\epsilon_r = 40.5$ ;  $\rho = 1000 \text{ kg/m}^3$   
 Phantom section: Left Section

DASY5 Configuration:

- Probe: ES3DV3 - SN3028; ConvF(4.68, 4.68, 4.68); Calibrated: 10/22/2014
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn689; Calibrated: 10/1/2014
- Phantom: SAM 1; Type: SAM; Serial: TP-1360
- Measurement SW: DASY5, V4.7 Build 53; Postprocessing SW: SEMCAD, V1.8 Build 172

**Left Cheek 2/Area Scan (71x121x1):** Measurement grid: dx=15mm, dy=15mm  
 Maximum value of SAR (interpolated) = 0.736 mW/g

**Left Cheek 2/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm  
 Reference Value = 14.1 V/m; Power Drift = -0.05 dB  
 Peak SAR (extrapolated) = 0.79 W/kg  
**SAR(1 g) = 0.421 mW/g; SAR(10 g) = 0.242 mW/g**  
 Maximum value of SAR (measured) = 0.710 mW/g



0 dB = 0.710mW/g

**Plot 4**

Date: 8/23/2015

**DUT: AX1; Type: SI PIN; Serial: IMEI Number**  
**Program Name: AX1**

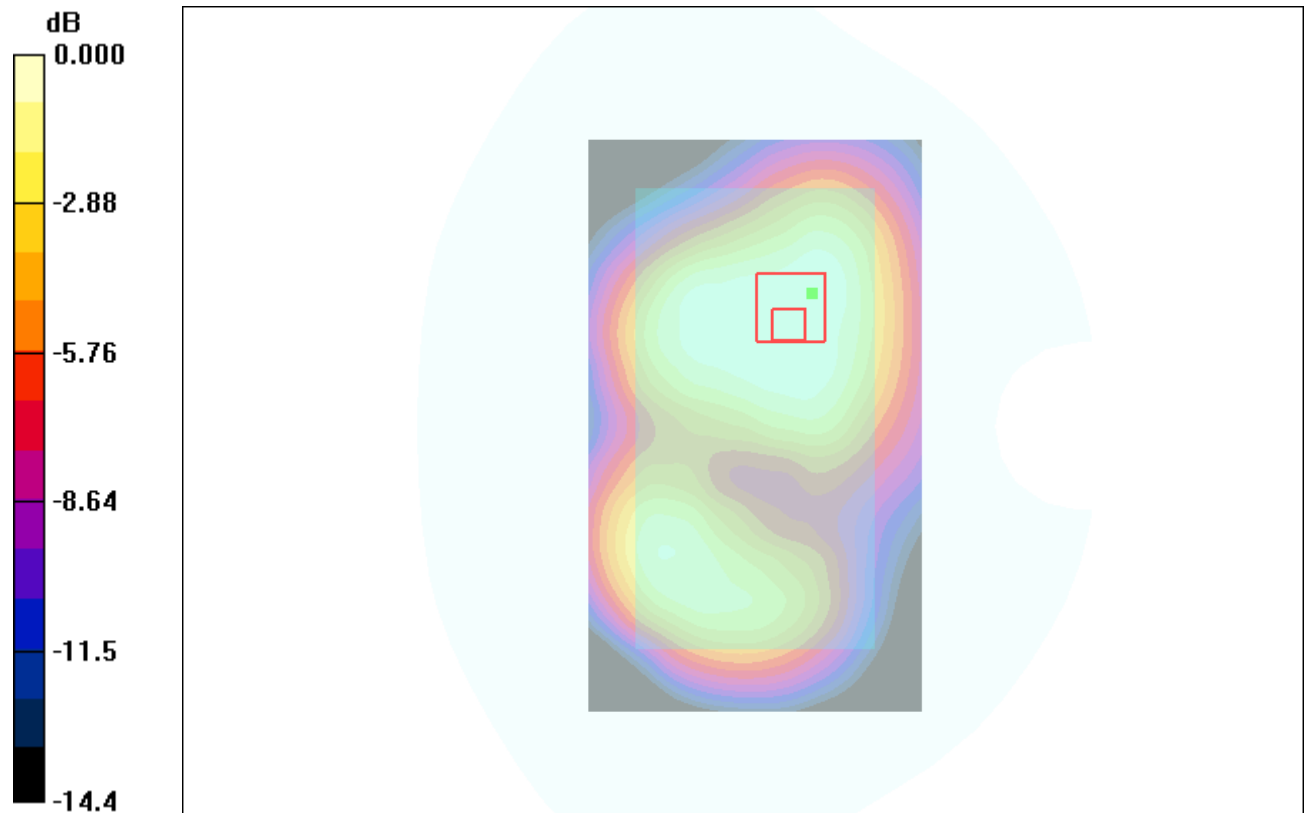
Communication System: GPRS1900; Frequency: 1909.8 MHz; Duty Cycle: 1:2  
Medium parameters used:  $f = 1909.8 \text{ MHz}$ ;  $\sigma = 1.51 \text{ mho/m}$ ;  $\epsilon_r = 53.35$ ;  $\rho = 1000 \text{ kg/m}^3$   
Phantom section: Flat Section

DASY5 Configuration:

- Probe: ES3DV3 - SN3028; ConvF(4.48, 4.48, 4.48); Calibrated: 10/22/2014
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn689; Calibrated: 10/1/2014
- Phantom: SAM 1; Type: SAM; Serial: TP-1360
- Measurement SW: DASY5, V4.7 Build 53; Postprocessing SW: SEMCAD, V1.8 Build 172

**Rear/Area Scan (71x121x1):** Measurement grid:  $dx=15\text{mm}$ ,  $dy=15\text{mm}$   
Maximum value of SAR (interpolated) = 0.938 mW/g

**Rear/Zoom Scan (5x5x7)/Cube 0:** Measurement grid:  $dx=8\text{mm}$ ,  $dy=8\text{mm}$ ,  $dz=5\text{mm}$   
Reference Value = 10.3 V/m; Power Drift = 0.06 dB  
Peak SAR (extrapolated) = 0.967 W/kg  
**SAR(1 g) = 0.721 mW/g; SAR(10 g) = 0.503 mW/g**  
Maximum value of SAR (measured) = 0.927 mW/g



0 dB = 0.927mW/g

**Plot 5**

Date: 8/21/2015

**DUT: AX1; Type: SI PIN; Serial: IMEI Number**  
**Program Name: AX1**

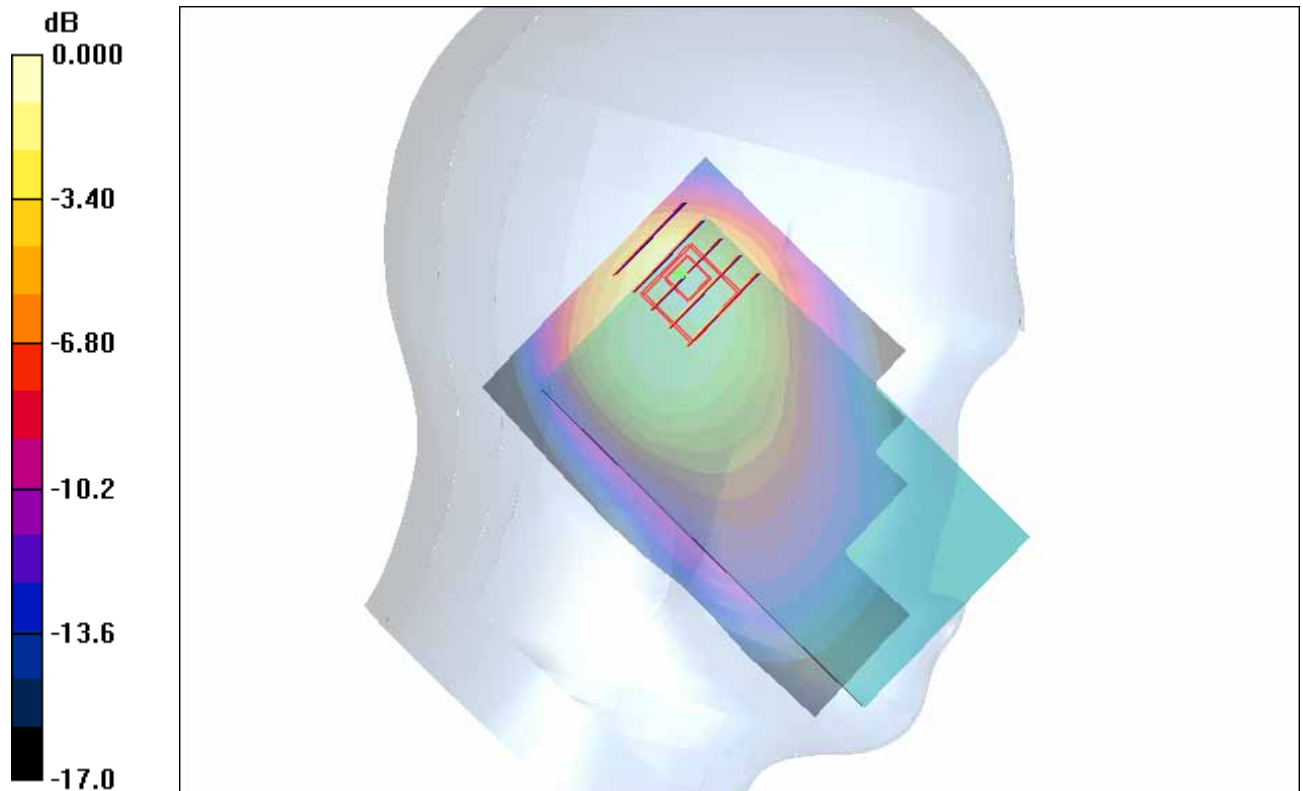
Communication System: W850; Frequency: 836.4 MHz; Duty Cycle: 1:1  
 Medium parameters used (interpolated):  $f = 836.4$  MHz;  $\sigma = 0.878$  mho/m;  $\epsilon_r = 41.4$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
 Phantom section: Left Section

## DASY5 Configuration:

- Probe: ES3DV3 - SN3028; ConvF(6.19, 6.19, 6.19); Calibrated: 10/22/2014
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn689; Calibrated: 10/1/2014
- Phantom: SAM 2; Type: SAM; Serial: TP-1432
- Measurement SW: DASY5, V4.7 Build 53; Postprocessing SW: SEMCAD, V1.8 Build 172

**Left cheek/Area Scan (71x121x1):** Measurement grid: dx=15mm, dy=15mm  
 Maximum value of SAR (interpolated) = 0.587 mW/g

**Left cheek/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm  
 Reference Value = 11.2 V/m; Power Drift = -0.11 dB  
 Peak SAR (extrapolated) = 0.643 W/kg  
**SAR(1 g) = 0.294 mW/g; SAR(10 g) = 0.109 mW/g**  
 Maximum value of SAR (measured) = 0.483 mW/g



**Plot 6**

Date: 8/22/2015

**DUT: AX1; Type: SI PIN; Serial: IMEI Number**  
**Program Name: AX1**

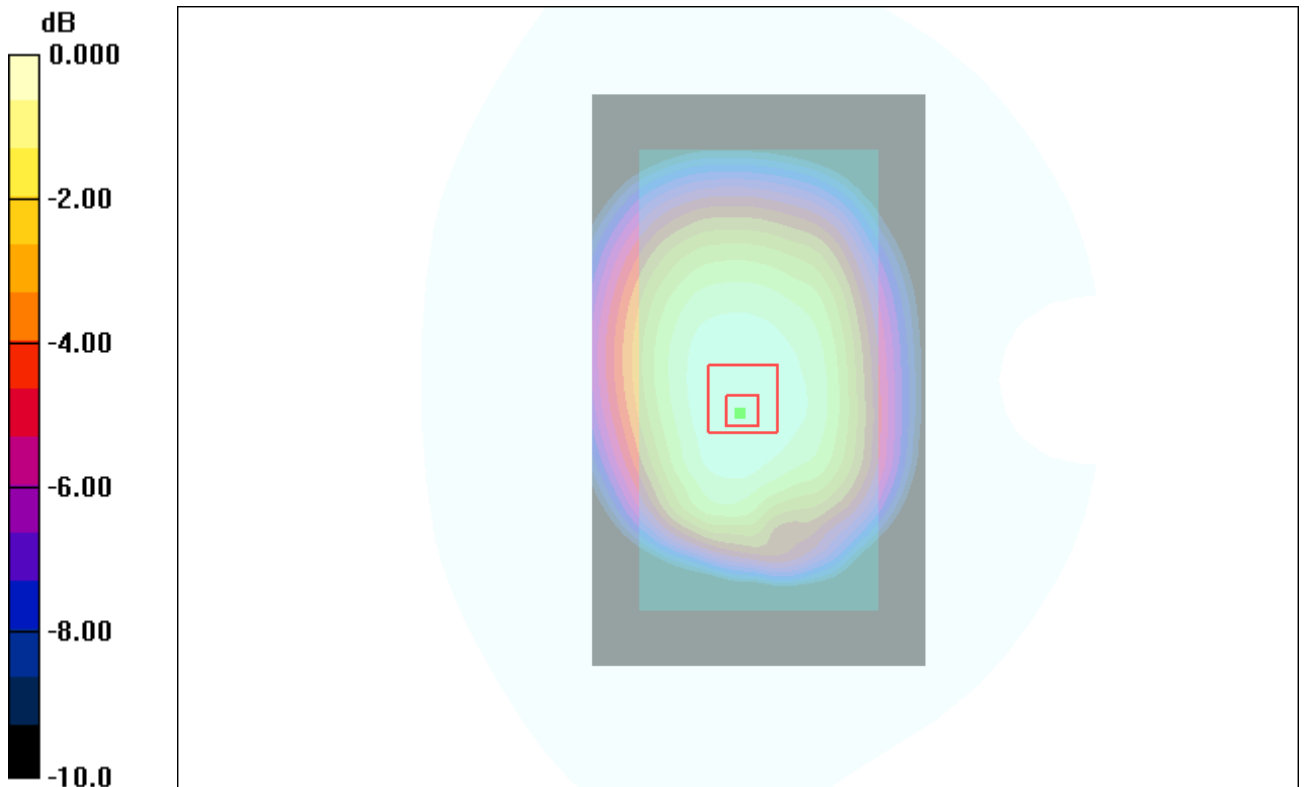
Communication System: W850; Frequency: 836.4 MHz; Duty Cycle: 1:1  
Medium parameters used (interpolated):  $f = 836.4$  MHz;  $\sigma = 0.982$  mho/m;  $\epsilon_r = 55.6$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
Phantom section: Flat Section

DASY5 Configuration:

- Probe: ES3DV3 - SN3028; ConvF(6.02, 6.02, 6.02); Calibrated: 10/22/2014
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn689; Calibrated: 10/1/2014
- Phantom: SAM 2; Type: SAM; Serial: TP-1432
- Measurement SW: DASY5, V4.7 Build 53; Postprocessing SW: SEMCAD, V1.8 Build 172

**Rear/Area Scan (71x121x1):** Measurement grid: dx=15mm, dy=15mm  
Maximum value of SAR (interpolated) = 0.809 mW/g

**Rear/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm  
Reference Value = 14.6 V/m; Power Drift = -0.01 dB  
Peak SAR (extrapolated) = 0.942 W/kg  
**SAR(1 g) = 0.578 mW/g; SAR(10 g) = 0.250 mW/g**  
Maximum value of SAR (measured) = 0.706 mW/g



0 dB = 0.706mW/g

**Plot 7**

Date: 8/21/2015

**DUT: AX1; Type: SI PIN; Serial: IMEI Number**  
**Program Name: AX1**

Communication System: 802.11; Frequency: 2437 MHz; Duty Cycle: 1:1  
 Medium parameters used:  $f = 2437$  MHz;  $\sigma = 1.82$  mho/m;  $\epsilon_r = 38.2$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
 Phantom section: Left Section

## DASY5 Configuration:

- Probe: ES3DV3 - SN3028; ConvF(4.21, 4.21, 4.21); Calibrated: 10/22/2014
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn689; Calibrated: 10/1/2014
- Phantom: SAM 1; Type: SAM; Serial: TP-1360
- Measurement SW: DASY5, V4.7 Build 53; Postprocessing SW: SEMCAD, V1.8 Build 172

**Left cheek/Area Scan (101x181x1):** Measurement grid: dx=12mm, dy=12mm  
 Maximum value of SAR (interpolated) = 0.320 mW/g

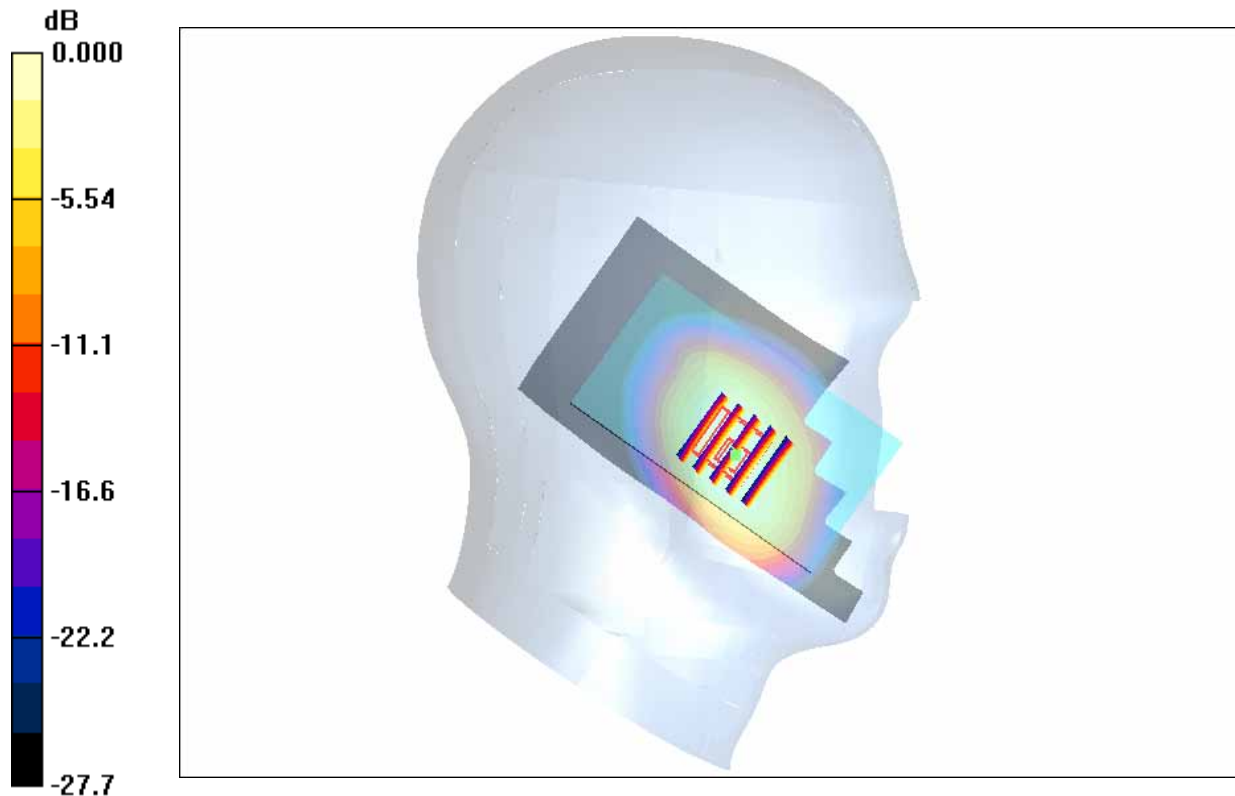
**Left cheek/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 7.65 V/m; Power Drift = 0.10 dB

Peak SAR (extrapolated) = 0.335 W/kg

**SAR(1 g) = 0.171 mW/g; SAR(10 g) = 0.064 mW/g**

Maximum value of SAR (measured) = 0.317 mW/g



0 dB = 0.317mW/g

**Plot 8**

Date: 8/24/2015

**DUT: AX1; Type: SI PIN; Serial: IMEI Number**  
**Program Name: AX1**

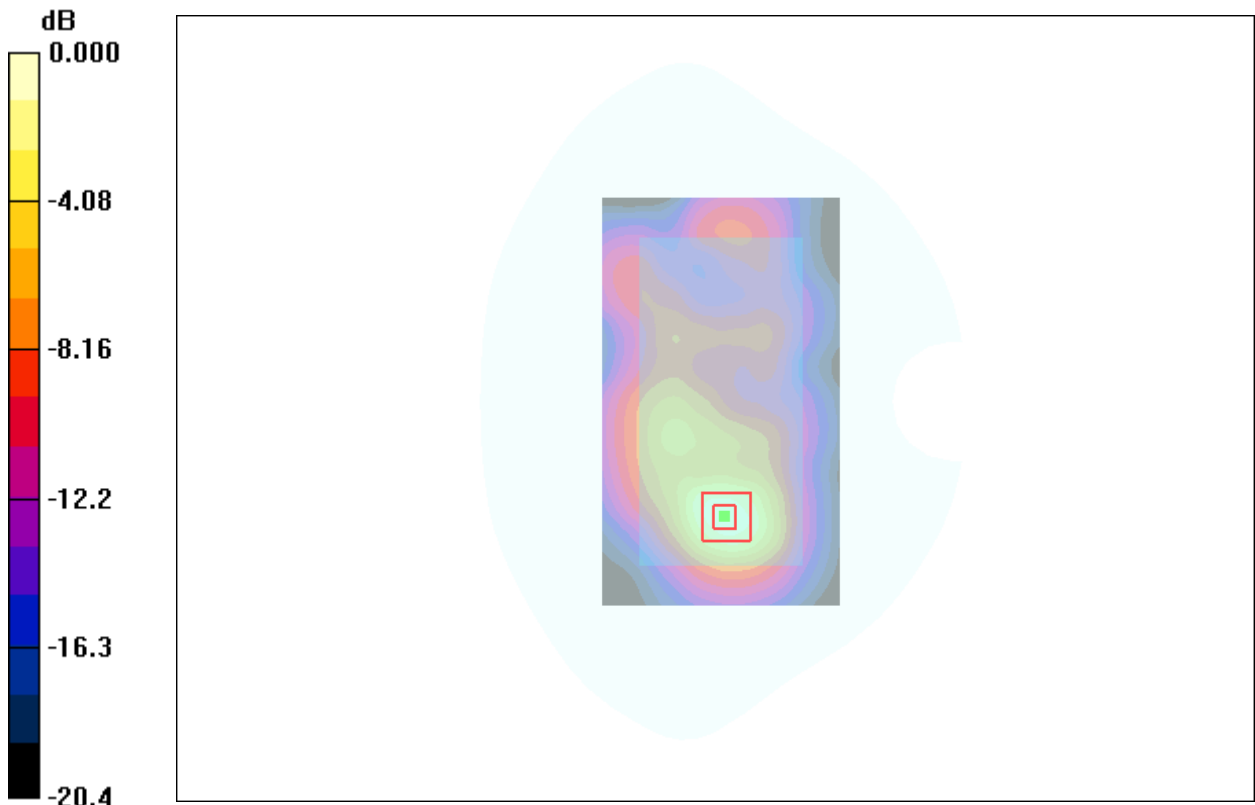
Communication System: 802.11; Frequency: 2437 MHz; Duty Cycle: 1:1  
Medium parameters used (interpolated):  $f = 2437$  MHz;  $\sigma = 1.81$  mho/m;  $\epsilon_r = 50.6$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
Phantom section: Flat Section

DASY5 Configuration:

- Probe: ES3DV3 - SN3028; ConvF(4.14, 4.14, 4.14); Calibrated: 10/22/2014
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn689; Calibrated: 10/1/2014
- Phantom: SAM 1; Type: SAM; Serial: TP-1360
- Measurement SW: DASY5, V4.7 Build 53; Postprocessing SW: SEMCAD, V1.8 Build 172

**Back/Area Scan (101x181x1):** Measurement grid: dx=12mm, dy=12mm  
Maximum value of SAR (interpolated) = 0.480 mW/g

**Back/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm  
Reference Value = 2.80 V/m; Power Drift = -0.17 dB  
Peak SAR (extrapolated) = 0.531 W/kg  
**SAR(1 g) = 0.281 mW/g; SAR(10 g) = 0.140 mW/g**  
Maximum value of SAR (measured) = 0.479 mW/g



0 dB = 0.479mW/g



## 6. Calibration Certificate

### 6.1. Probe Calibration Certificate



Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China  
Tel: +86-10-62304633-2079 Fax: +86-10-62304633-2504  
E-mail: cttl@chinattl.com [Http://www.chinattl.cn](http://www.chinattl.cn)

Client **AUDEN**Certificate No: **Z14-97115**

### CALIBRATION CERTIFICATE

Object **ES3DV3 - SN:3028**Calibration Procedure(s) **TMC-OS-E-02-195  
Calibration Procedures for Dosimetric E-field Probes**Calibration date: **October 22, 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%.

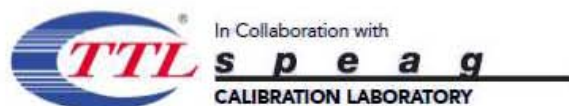
Calibration Equipment used (M&amp;TE critical for calibration)

Primary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
Power Meter NRP2	101919	01-Jul-14 (CTTL, No.J14X02146)	Jun-15
Power sensor NRP-Z91	101547	01-Jul-14 (CTTL, No.J14X02146)	Jun-15
Power sensor NRP-Z91	101548	01-Jul-14 (CTTL, No.J14X02146)	Jun-15
Reference10dBAttenuator	BT0520	12-Dec-12(TMC,No.JZ12-867)	Dec-14
Reference20dBAttenuator	BT0267	12-Dec-12(TMC,No.JZ12-866)	Dec-14
Reference Probe EX3DV4	SN 3617	28-Aug-14(SPEAG,No.EX3-3617_Aug14)	Aug-15
DAE4	SN 1331	23-Jan-14 (SPEAG, DAE4-1331_Jan14)	Jan-15
Secondary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
SignalGeneratorMG3700A	6201052605	01-Jul-14 (CTTL, No.J14X02145)	Jun-15
Network Analyzer E5071C	MY46110673	15-Feb-14 (TMC, No.JZ14-781)	Feb-15

	Name	Function	Signature
Calibrated by:	Yu Zongying	SAR Test Engineer	
Reviewed by:	Qi Diaryuan	SAR Project Leader	
Approved by:	Lu Bingsong	Deputy Director of the laboratory	

Issued: October 23, 2014

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



Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China  
 Tel: +86-10-62304633-2079 Fax: +86-10-62304633-2504  
 E-mail: [ctl@chinattl.com](mailto:ctl@chinattl.com) [Http://www.chinattl.cn](http://www.chinattl.cn)

### Glossary:

TSL	tissue simulating liquid
NORM <sub>x,y,z</sub>	sensitivity in free space
ConvF	sensitivity in TSL / NORM <sub>x,y,z</sub>
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A,B,C,D	modulation dependent linearization parameters
Polarization $\Phi$	$\Phi$ rotation around probe axis
Polarization $\theta$	$\theta$ rotation around an axis that is in the plane normal to probe axis (at measurement center), i $\theta=0$ 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:

- 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
- 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 300MHz to 3GHz)", February 2005

### Methods Applied and Interpretation of Parameters:

- NORM<sub>x,y,z</sub>**: Assessed for E-field polarization  $\theta=0$  ( $f \leq 900\text{MHz}$  in TEM-cell;  $f > 1800\text{MHz}$ : waveguide). NORM<sub>x,y,z</sub> are only intermediate values, i.e., the uncertainties of NORM<sub>x,y,z</sub> does not effect the  $E^2$ -field uncertainty inside TSL (see below ConvF).
- NORM(f)<sub>x,y,z</sub>** = NORM<sub>x,y,z</sub> \* 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.
- DCP<sub>x,y,z</sub>**: DCP are numerical linearization parameters assessed based on the data of power sweep (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.
- A<sub>x,y,z</sub>; B<sub>x,y,z</sub>; C<sub>x,y,z</sub>; VR<sub>x,y,z</sub>**: A,B,C are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- ConvF and Boundary Effect Parameters**: Assessed in flat phantom using E-field (or Temperature Transfer Standard for  $f \leq 800\text{MHz}$ ) and inside waveguide using analytical field distributions based on power measurements for  $f > 800\text{MHz}$ . The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty valued are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to NORM<sub>x,y,z</sub> \* 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  $\pm 50\text{MHz}$  to  $\pm 100\text{MHz}$ .
- 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 NORM<sub>x</sub> (no uncertainty required).



Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China  
Tel: +86-10-62304633-2079 Fax: +86-10-62304633-2504  
E-mail: [ctl@chinattl.com](mailto:ctl@chinattl.com) [Http://www.chinattl.cn](http://www.chinattl.cn)

# Probe ES3DV3

SN: 3028

Calibrated: October 22, 2014

Calibrated for DASY/EASY Systems

(Note: non-compatible with DASY2 system!)



In Collaboration with  
 Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China  
 Tel: +86-10-62304633-2079 Fax: +86-10-62304633-2504  
 E-mail: cttl@chinattl.com [Http://www.zcchinattl.cn](http://www.zcchinattl.cn)

## DASY – Parameters of Probe: ES3DV3 - SN: 3028

### Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm( $\mu V/(V/m)^2$ ) <sup>A</sup>	1.16	1.27	1.21	±10.8%
DCP(mV) <sup>B</sup>	105.8	103.2	103.8	

### Modulation Calibration Parameters

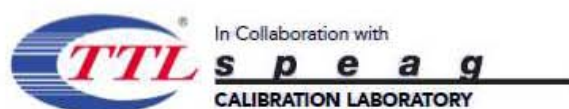
UID	Communication System Name		A dB	B dB/ $\mu V$	C	D dB	VR mV	Unc <sup>E</sup> (k=2)
0	CW	X	0.0	0.0	1.0	0.00	282.9	±2.2%
		Y	0.0	0.0	1.0		292.0	
		Z	0.0	0.0	1.0		290.3	

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%.

<sup>A</sup> The uncertainties of Norm X, Y, Z do not affect the E<sup>2</sup>-field uncertainty inside TSL (see Page 5 and Page 6).

<sup>B</sup> Numerical linearization parameter: uncertainty not required.

<sup>E</sup> Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.



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## DASY – Parameters of Probe: ES3DV3 - SN: 3028

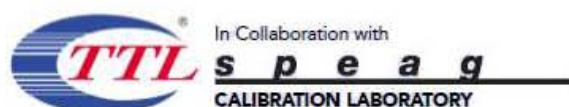
### Calibration Parameter Determined in Head Tissue Simulating Media

f [MHz] <sup>C</sup>	Relative Permittivity <sup>F</sup>	Conductivity (S/m) <sup>F</sup>	ConvF X	ConvF Y	ConvF Z	Alpha <sup>G</sup>	Depth <sup>G</sup> (mm)	Unct (k=2)
750	41.9	0.89	6.36	6.36	6.36	0.37	1.44	±12%
835	41.5	0.90	6.19	6.19	6.19	0.39	1.42	±12%
1750	40.1	1.37	4.97	4.97	4.97	0.55	1.34	±12%
1900	40.0	1.40	4.68	4.68	4.68	0.70	1.23	±12%
2300	39.5	1.67	4.52	4.52	4.52	0.80	1.17	±12%
2450	39.2	1.80	4.21	4.21	4.21	0.98	1.04	±12%
2600	39.0	1.96	4.06	4.06	4.06	0.86	1.11	±12%

<sup>C</sup> Frequency validity of ±100MHz only applies for DASY v4.4 and higher (Page 2), else it is restricted to ±50MHz. The uncertainty is the RSS of ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

<sup>F</sup> At frequency below 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) 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 ( $\epsilon$  and  $\sigma$ ) is restricted to ±5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

<sup>G</sup> 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 the frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.



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## DASY – Parameters of Probe: ES3DV3 - SN: 3028

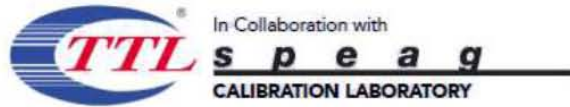
### Calibration Parameter Determined in Body Tissue Simulating Media

f [MHz] <sup>C</sup>	Relative Permittivity <sup>F</sup>	Conductivity (S/m) <sup>F</sup>	ConvF X	ConvF Y	ConvF Z	Alpha <sup>G</sup>	Depth <sup>G</sup> (mm)	Unct (k=2)
750	55.5	0.96	6.02	6.02	6.02	0.33	1.68	± 12%
835	55.2	0.97	6.02	6.02	6.02	0.34	1.79	± 12%
1750	53.4	1.49	4.69	4.69	4.69	0.63	1.30	± 12%
1900	53.3	1.52	4.48	4.48	4.48	0.60	1.34	± 12%
2300	52.9	1.81	4.37	4.37	4.37	0.74	1.25	± 12%
2450	52.7	1.95	4.14	4.14	4.14	0.68	1.35	± 12%
2600	52.5	2.16	4.02	4.02	4.02	0.84	1.16	± 12%

<sup>C</sup> Frequency validity of ±100MHz only applies for DASY v4.4 and higher (Page 2), else it is restricted to ±50MHz. The uncertainty is the RSS of ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

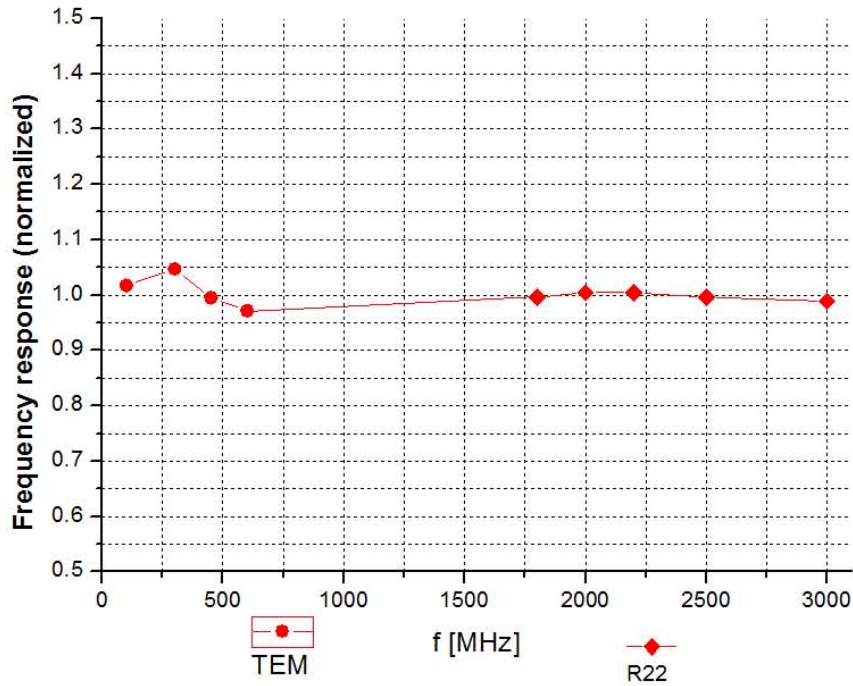
<sup>F</sup> At frequency below 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) can be relaxed to ±10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) is restricted to ±5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

<sup>G</sup> 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 the frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

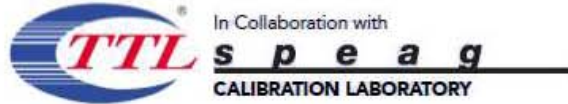


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### Frequency Response of E-Field (TEM-Cell: ifi110 EXX, Waveguide: R22)



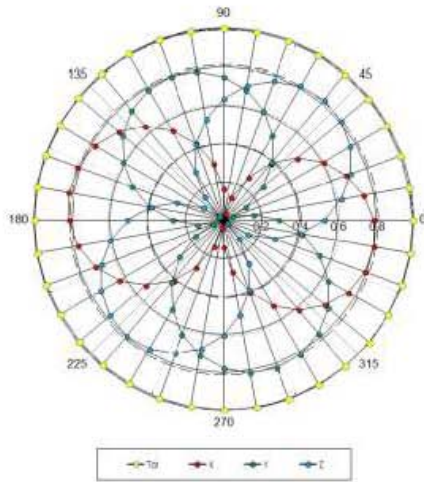
Uncertainty of Frequency Response of E-field:  $\pm 7.5\%$  (k=2)



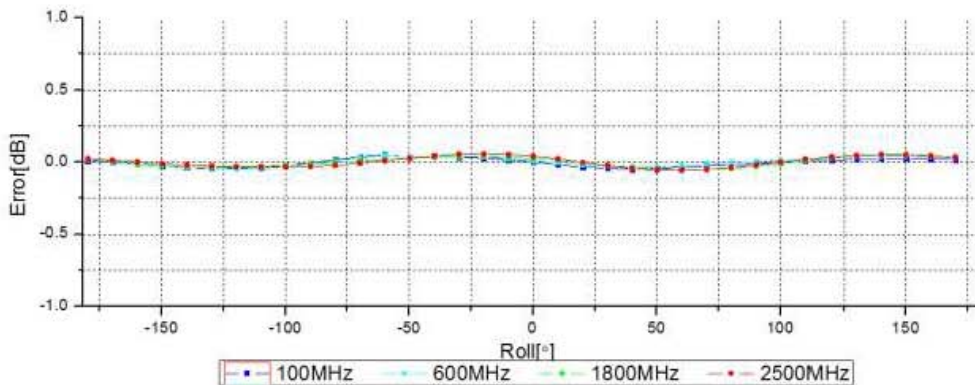
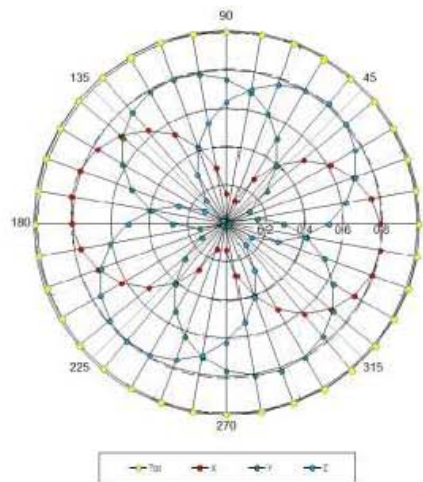
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### Receiving Pattern ( $\Phi$ ), $\theta=0^\circ$

f=600 MHz, TEM

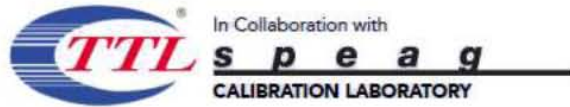


f=1800 MHz, R22



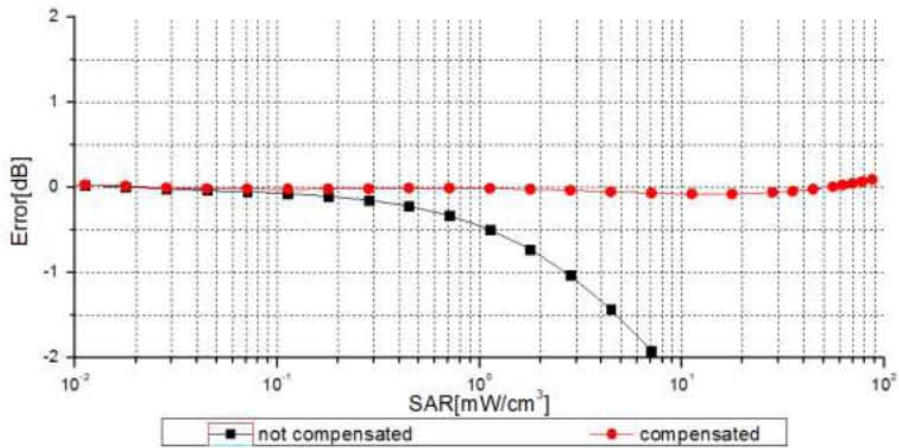
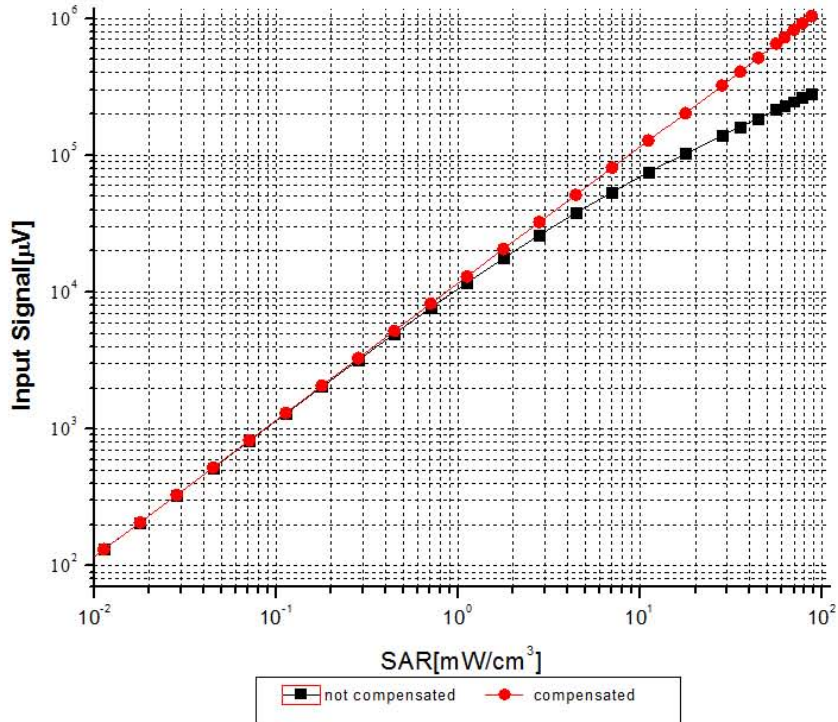
Uncertainty of Axial Isotropy Assessment:  $\pm 0.9\%$  (k=2)



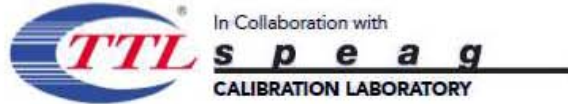


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### Dynamic Range f(SAR<sub>head</sub>) (TEM cell, f = 900 MHz)



Uncertainty of Linearity Assessment: ±0.9% (k=2)

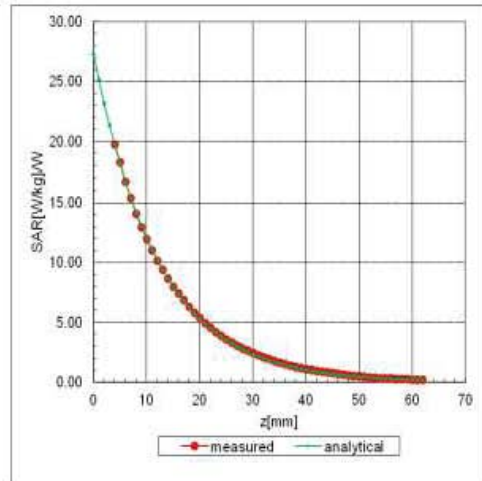
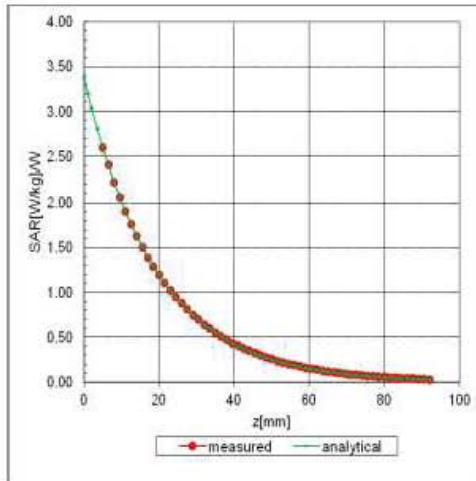


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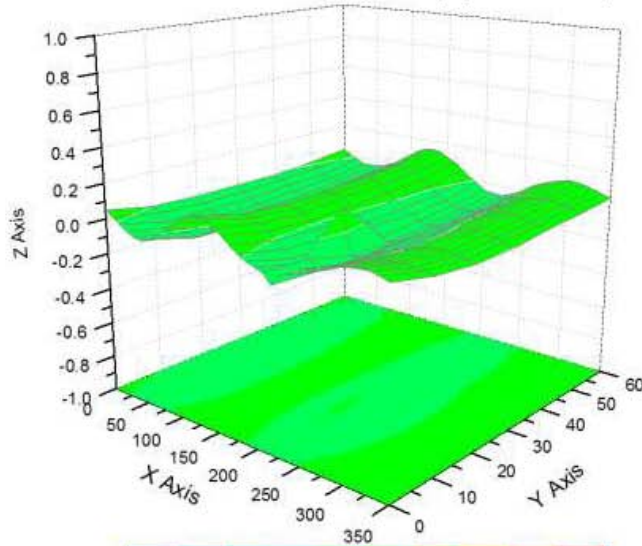
### Conversion Factor Assessment

f=835 MHz, WGLS R9(H\_convF)

f=1750 MHz, WGLS R22(H\_convF)



### Deviation from Isotropy in Liquid



Uncertainty of Spherical Isotropy Assessment:  $\pm 2.8\%$  (K=2)





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## DASY - Parameters of Probe: ES3DV3 - SN: 3208

### Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	54.8
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disable
Probe Overall Length	337mm
Probe Body Diameter	10mm
Tip Length	10mm
Tip Diameter	4mm
Probe Tip to Sensor X Calibration Point	2mm
Probe Tip to Sensor Y Calibration Point	2mm
Probe Tip to Sensor Z Calibration Point	2mm
Recommended Measurement Distance from Surface	3mm

6.2. D835V2 Dipole Calibration Certificate


s p e a g


In Collaboration with  
**CALIBRATION LABORATORY**

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Client **CIQ-SZ(Auden)** Certificate No: **Z14-97067**

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### CALIBRATION CERTIFICATE

Object: **D835V2 - SN: 4d134**

Calibration Procedure(s): **TMC-OS-E-02-194  
Calibration procedure for dipole validation kits**

Calibration date: **July 24, 2014**

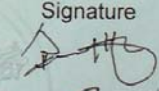
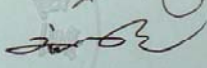
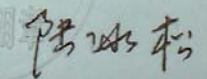
This calibration Certificate documents the traceability to national standards, which realize the physical units of measurements(SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

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(Calibrated by, Certificate No.)	Scheduled Calibration
Power Meter NRVD	102083	11-Sep-13 (TMC, No.JZ13-443)	Sep-14
Power sensor NRV-Z5	100595	11-Sep-13 (TMC, No. JZ13-443)	Sep -14
Reference Probe EX3DV4	SN 3846	3- Sep-13 (SPEAG, No.EX3-3846_Sep13)	Sep-14
DAE4	SN 1331	23-Jan-14 (SPEAG, DAE4-1331_Jan14)	Jan -15
Signal Generator E4438C	MY49070393	13-Nov-13 (TMC, No.JZ13-394)	Nov-14
Network Analyzer E8362B	MY43021135	19-Oct-13 (TMC, No.JZ13-278)	Oct-14

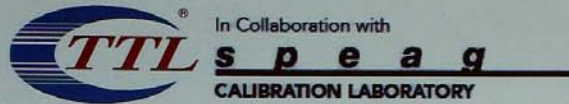
  

	Name	Function	Signature
Calibrated by:	Yu Zongying	SAR Test Engineer	
Reviewed by:	Qi Dianyuan	SAR Project Leader	
Approved by:	Lu Bingsong	Deputy Director of the laboratory	

Issued: July 28, 2014

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

Certificate No: Z14-97067
Page 1 of 8



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**Glossary:**

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

**Calibration is Performed According to the Following Standards:**

- 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
- 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 300MHz to 3GHz)", February 2005
- KDB865664, SAR Measurement Requirements for 100 MHz to 6 GHz

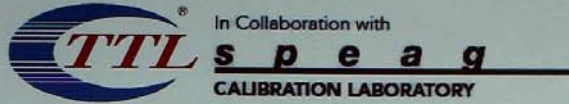
**Additional Documentation:**

- DASY4/5 System Handbook

**Methods Applied and Interpretation of Parameters:**

- Measurement Conditions:* Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- Antenna Parameters with TSL:* The dipole is mounted with the spacer to position its feed point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis.
- Feed Point Impedance and Return Loss:* These parameters are measured with the dipole positioned under the liquid filled phantom. The impedance stated is transformed from the measurement at the SMA connector to the feed point. The Return Loss ensures low reflected power. No uncertainty required.
- Electrical Delay:* One-way delay between the SMA connector and the antenna feed point. No uncertainty required.
- SAR measured:* SAR measured at the stated antenna input power.
- SAR normalized:* SAR as measured, normalized to an input power of 1 W at the antenna connector.
- SAR for nominal TSL parameters:* The measured TSL parameters are used to calculate the nominal SAR result.

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



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### Measurement Conditions

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

DASY Version	DASY52	52.8.8.1222
Extrapolation	Advanced Extrapolation	
Phantom	Triple Flat Phantom 5.1C	
Distance Dipole Center - TSL	15 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	835 MHz $\pm$ 1 MHz	

### Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	41.5	0.90 mho/m
Measured Head TSL parameters	(22.0 $\pm$ 0.2) °C	41.7 $\pm$ 6 %	0.90 mho/m $\pm$ 6 %
Head TSL temperature change during test	<1.0 °C	---	---

### SAR result with Head TSL

SAR averaged over 1 $cm^3$ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	2.41 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	9.62 mW /g $\pm$ 20.8 % (k=2)
SAR averaged over 10 $cm^3$ (10 g) of Head TSL	Condition	
SAR measured	250 mW input power	1.57 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	6.27 mW /g $\pm$ 20.4 % (k=2)

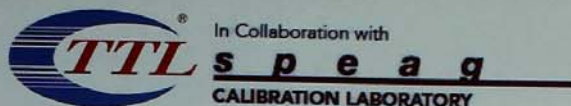
### Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	55.2	0.97 mho/m
Measured Body TSL parameters	(22.0 $\pm$ 0.2) °C	55.6 $\pm$ 6 %	0.99 mho/m $\pm$ 6 %
Body TSL temperature change during test	<1.0 °C	---	---

### SAR result with Body TSL

SAR averaged over 1 $cm^3$ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	2.47 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	9.77 mW /g $\pm$ 20.8 % (k=2)
SAR averaged over 10 $cm^3$ (10 g) of Body TSL	Condition	
SAR measured	250 mW input power	1.64 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	6.50 mW /g $\pm$ 20.4 % (k=2)



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## Appendix

### Antenna Parameters with Head TSL

Impedance, transformed to feed point	$48.8\Omega + 3.34j\Omega$
Return Loss	- 28.9dB

### Antenna Parameters with Body TSL

Impedance, transformed to feed point	$50.9\Omega + 7.08j\Omega$
Return Loss	- 23.0dB

### General Antenna Parameters and Design

Electrical Delay (one direction)	1.261 ns
----------------------------------	----------

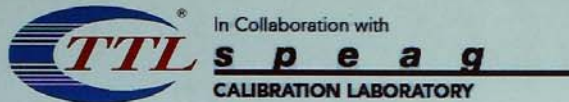
After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

### Additional EUT Data

Manufactured by	SPEAG
-----------------	-------



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### DASY5 Validation Report for Head TSL

Date: 24.07.2014

Test Laboratory: TMC, Beijing, China

**DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d134**

Communication System: UID 0, CW (0); Frequency: 835 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 835 \text{ MHz}$ ;  $\sigma = 0.904 \text{ S/m}$ ;  $\epsilon_r = 41.7$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Center Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

- Probe: EX3DV4 - SN3846; ConvF(9.32, 9.32, 9.32); Calibrated: 2013-09-03;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1331; Calibrated: 2014-01-23
- Phantom: Triple Flat Phantom 5.1C; Type: QD 000 P51 CA; Serial: 1161/2
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**System Performance Check at Frequencies below 1 GHz/d=15mm, Pin=250 mW, dist=2.0mm (EX-Probe)/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid:**

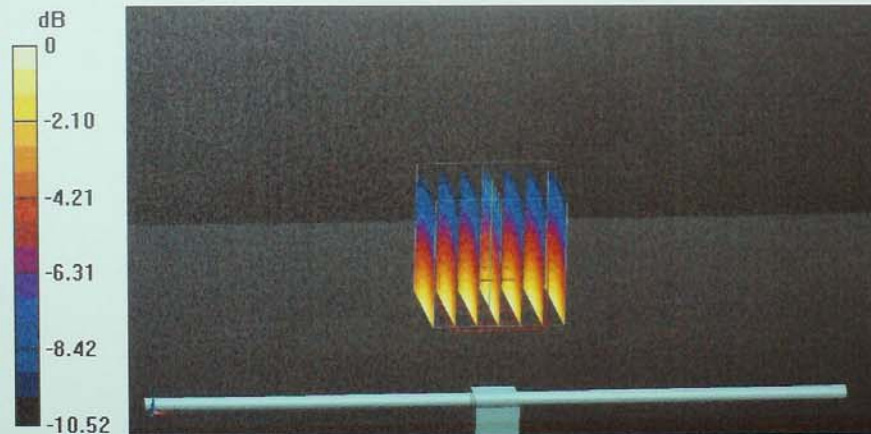
$dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$

Reference Value = 58.91 V/m; Power Drift = -0.05 dB

Peak SAR (extrapolated) = 3.60 W/kg

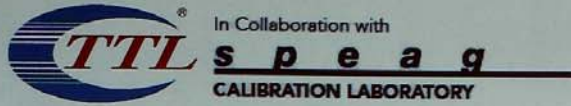
**SAR(1 g) = 2.41 W/kg; SAR(10 g) = 1.57 W/kg**

Maximum value of SAR (measured) = 3.05 W/kg



0 dB = 3.05 W/kg = 4.84 dBW/kg

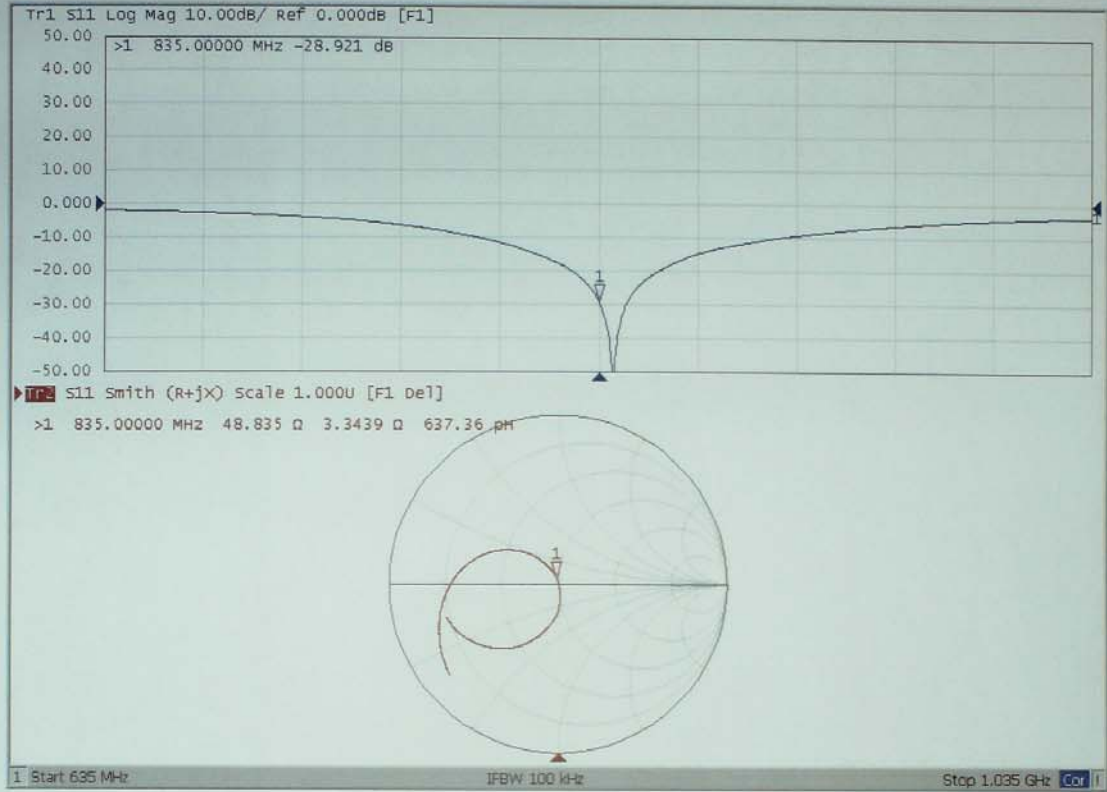


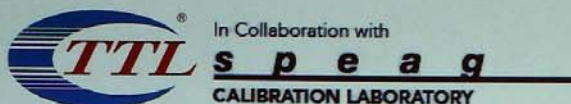


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### Impedance Measurement Plot for Head TSL





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### DASY5 Validation Report for Body TSL

Date: 24.07.2014

Test Laboratory: TMC, Beijing, China

**DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d134**

Communication System: UID 0, CW (0); Frequency: 835 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 835 \text{ MHz}$ ;  $\sigma = 0.986 \text{ S/m}$ ;  $\epsilon_r = 55.6$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Left Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

- Probe: EX3DV4 - SN3846; ConvF(8.96, 8.96, 8.96); Calibrated: 2013-09-03;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1331; Calibrated: 2014-01-23
- Phantom: Triple Flat Phantom 5.1C; Type: QD 000 P51 CA; Serial: 1161/1
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

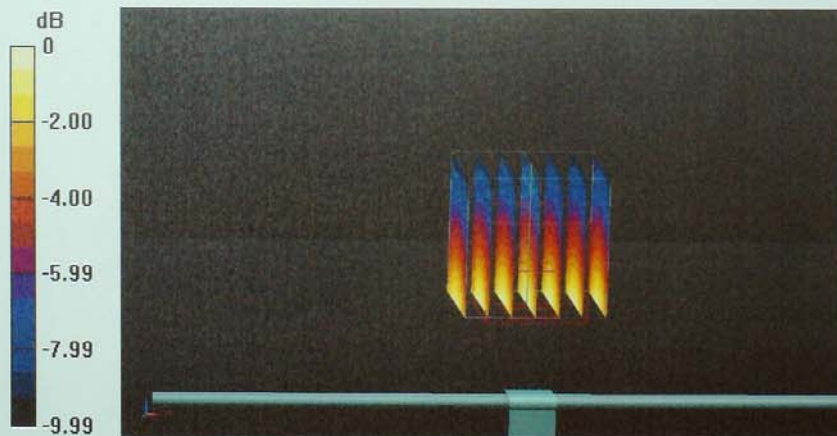
**System Performance Check at Frequencies below 1 GHz/d=15mm, Pin=250 mW, dist=2.0mm (EX-Probe)/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm**

Reference Value = 57.01 V/m; Power Drift = 0.01 dB

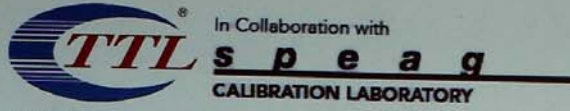
Peak SAR (extrapolated) = 3.66 W/kg

**SAR(1 g) = 2.47 W/kg; SAR(10 g) = 1.64 W/kg**

Maximum value of SAR (measured) = 3.10 W/kg



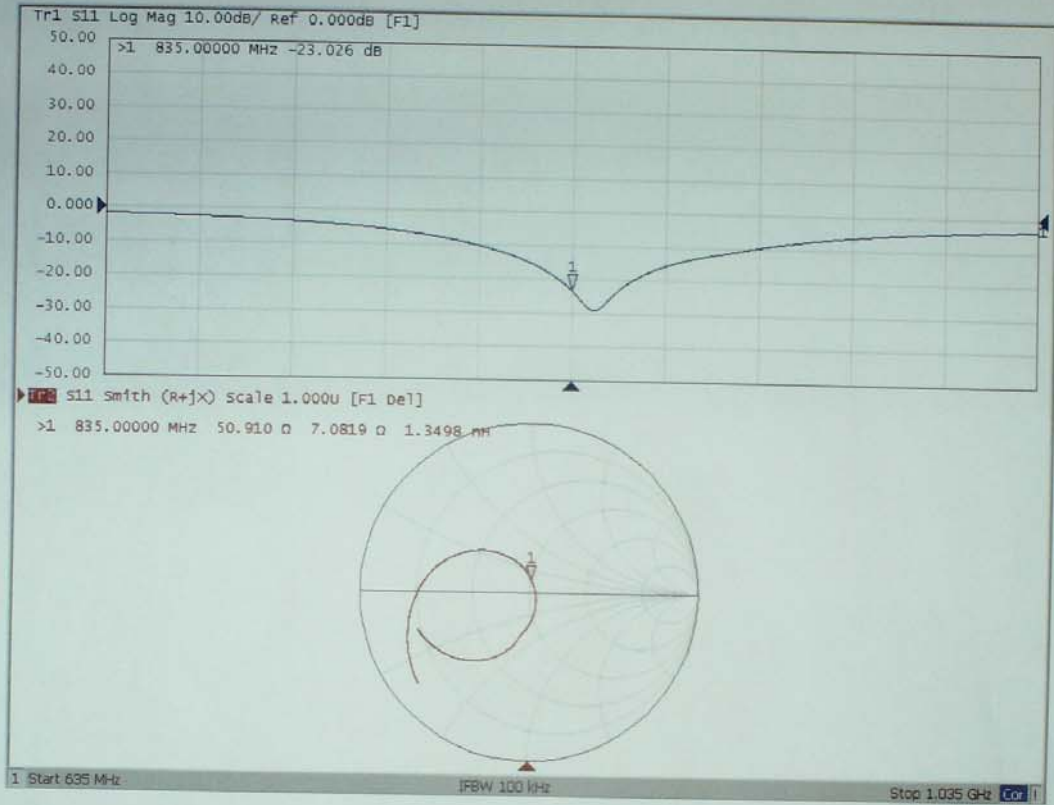
0 dB = 3.10 W/kg = 4.91 dBW/kg



Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China  
Tel: +86-10-62304633-2079 Fax: +86-10-62304633-2504  
E-mail: cttl@chinattl.com Http://www.chinattl.cn



### Impedance Measurement Plot for Body TSL



## 6.3. D1900V2 Dipole 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  
**S** Swiss Calibration Service

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

Accreditation No.: **SCS 0108**

Client **SMQ (Auden)**

Certificate No: **D1900V2-5d194\_Jan15**

## CALIBRATION CERTIFICATE

Object **D1900V2 - SN: 5d194**

Calibration procedure(s) **QA CAL-05.v9  
Calibration procedure for dipole validation kits above 700 MHz**


Calibration date: **January 07, 2015**


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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	07-Oct-14 (No. 217-02020)	Oct-15
Power sensor HP 8481A	US37292783	07-Oct-14 (No. 217-02020)	Oct-15
Power sensor HP 8481A	MY41092317	07-Oct-14 (No. 217-02021)	Oct-15
Reference 20 dB Attenuator	SN: 5058 (20k)	03-Apr-14 (No. 217-01918)	Apr-15
Type-N mismatch combination	SN: 5047.2 / 06327	03-Apr-14 (No. 217-01921)	Apr-15
Reference Probe ES3DV3	SN: 3205	30-Dec-14 (No. ES3-3205_Dec14)	Dec-15
DAE4	SN: 601	18-Aug-14 (No. DAE4-601_Aug14)	Aug-15
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-13)	In house check: Oct-16
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-14)	In house check: Oct-15

Calibrated by: **Claudio Leubler** (Name), **Laboratory Technician** (Function),  (Signature)

Approved by: **Katja Pokovic** (Name), **Technical Manager** (Function),  (Signature)

Issued: January 7, 2015

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



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

Accredited by the Swiss Accreditation Service (SAS)

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

Accreditation No.: SCS 0108

**Glossary:**

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

**Calibration is Performed According to the Following Standards:**

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

**Additional Documentation:**

- DASY4/5 System Handbook

**Methods Applied and Interpretation of Parameters:**

- Measurement Conditions:* Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- Antenna Parameters with TSL:* The dipole is mounted with the spacer to position its feed point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis.
- Feed Point Impedance and Return Loss:* These parameters are measured with the dipole positioned under the liquid filled phantom. The impedance stated is transformed from the measurement at the SMA connector to the feed point. The Return Loss ensures low reflected power. No uncertainty required.
- Electrical Delay:* One-way delay between the SMA connector and the antenna feed point. No uncertainty required.
- SAR measured:* SAR measured at the stated antenna input power.
- SAR normalized:* SAR as measured, normalized to an input power of 1 W at the antenna connector.
- SAR for nominal TSL parameters:* The measured TSL parameters are used to calculate the nominal SAR result.

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

**Measurement Conditions**

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

DASY Version	DASY5	V52.8.8
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	1900 MHz $\pm$ 1 MHz	

**Head TSL parameters**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	40.0	1.40 mho/m
Measured Head TSL parameters	(22.0 $\pm$ 0.2) °C	40.1 $\pm$ 6 %	1.39 mho/m $\pm$ 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

**SAR result with Head TSL**

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	10.1 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>40.6 W/kg <math>\pm</math> 17.0 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	250 mW input power	5.32 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>21.3 W/kg <math>\pm</math> 16.5 % (k=2)</b>

**Body TSL parameters**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	53.3	1.52 mho/m
Measured Body TSL parameters	(22.0 $\pm$ 0.2) °C	53.3 $\pm$ 6 %	1.50 mho/m $\pm$ 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

**SAR result with Body TSL**

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	9.95 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	<b>40.1 W/kg <math>\pm</math> 17.0 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.31 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	<b>21.3 W/kg <math>\pm</math> 16.5 % (k=2)</b>

**Appendix (Additional assessments outside the scope of SCS108)****Antenna Parameters with Head TSL**

Impedance, transformed to feed point	53.7 $\Omega$ + 4.9 j $\Omega$
Return Loss	- 24.5 dB

**Antenna Parameters with Body TSL**

Impedance, transformed to feed point	48.9 $\Omega$ + 5.1 j $\Omega$
Return Loss	- 25.6 dB

**General Antenna Parameters and Design**

Electrical Delay (one direction)	1.201 ns
----------------------------------	----------

After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

**Additional EUT Data**

Manufactured by	SPEAG
Manufactured on	May 06, 2014

**DASY5 Validation Report for Head TSL**

Date: 07.12.2015

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d194**

Communication System: UID 0 - CW; Frequency: 1900 MHz

Medium parameters used:  $f = 1900$  MHz;  $\sigma = 1.39$  S/m;  $\epsilon_r = 40.1$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(5, 5, 5); Calibrated: 30.12.2014;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 18.08.2014
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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

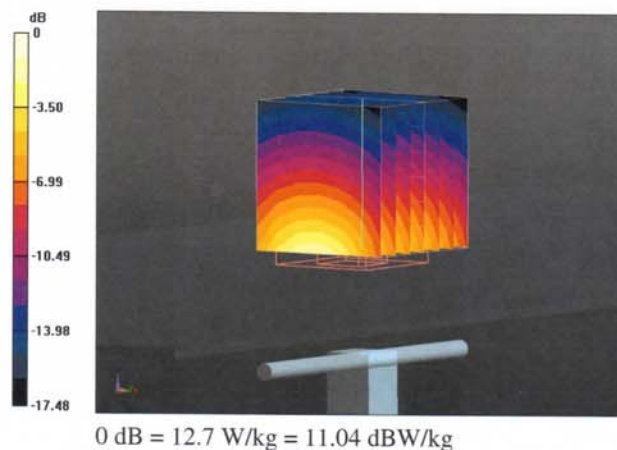
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 98.35 V/m; Power Drift = 0.04 dB

Peak SAR (extrapolated) = 18.5 W/kg

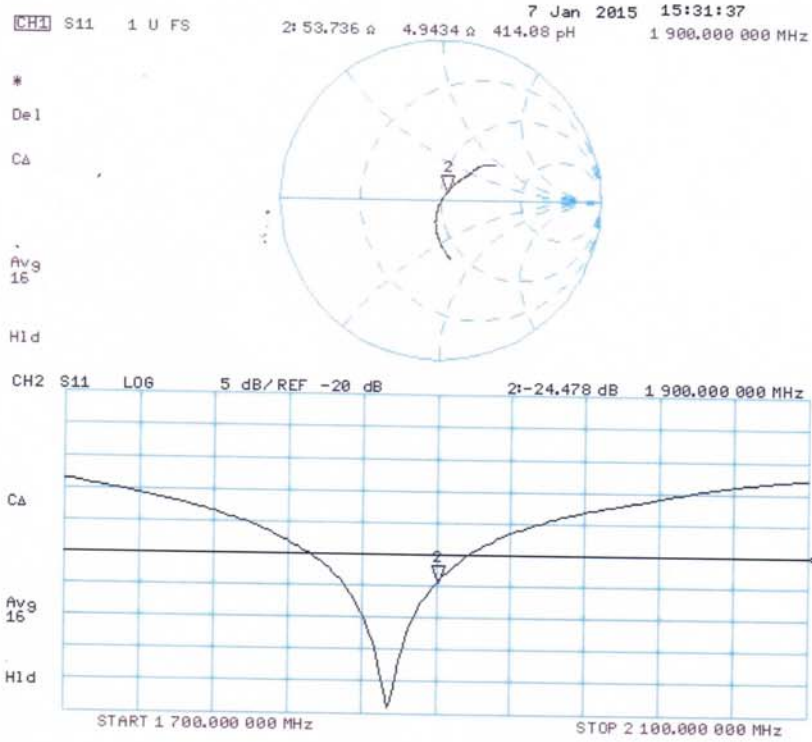
**SAR(1 g) = 10.1 W/kg; SAR(10 g) = 5.32 W/kg**

Maximum value of SAR (measured) = 12.7 W/kg





### Impedance Measurement Plot for Head TSL



**DASY5 Validation Report for Body TSL**

Date: 07.01.2015

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d194**

Communication System: UID 0 - CW; Frequency: 1900 MHz

Medium parameters used:  $f = 1900$  MHz;  $\sigma = 1.5$  S/m;  $\epsilon_r = 53.3$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.65, 4.65, 4.65); Calibrated: 30.12.2014;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 18.08.2014
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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

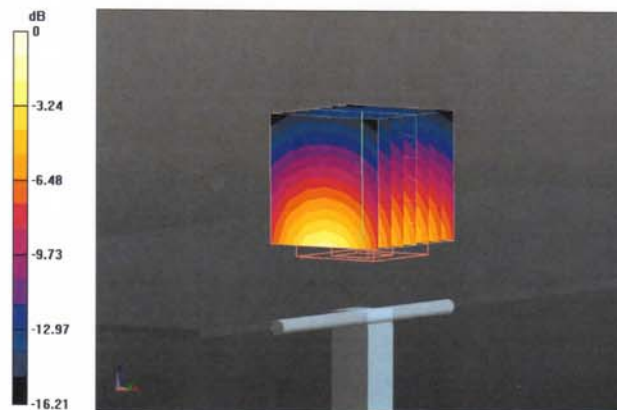
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 95.88 V/m; Power Drift = -0.00 dB

Peak SAR (extrapolated) = 16.8 W/kg

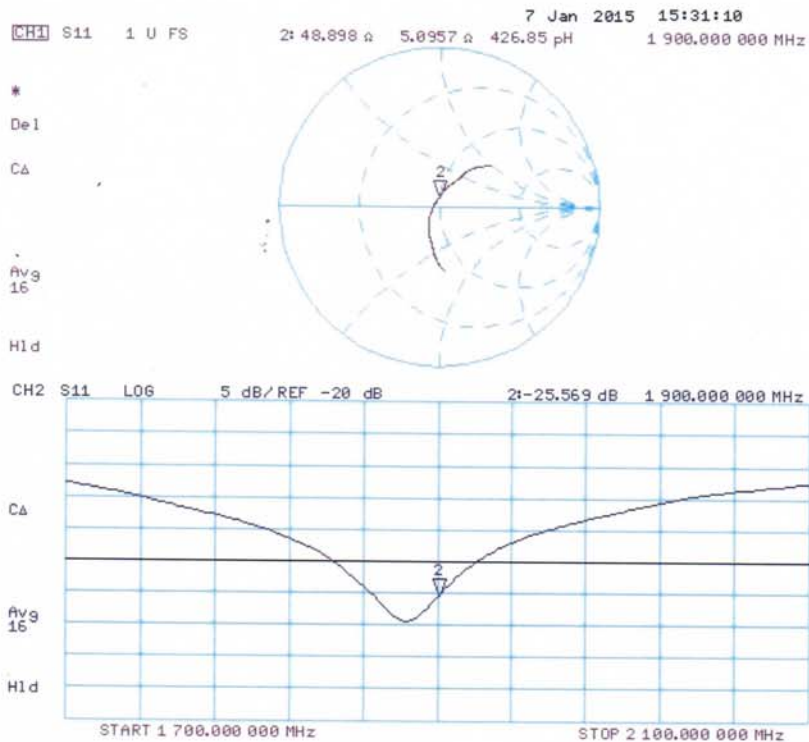
**SAR(1 g) = 9.95 W/kg; SAR(10 g) = 5.31 W/kg**

Maximum value of SAR (measured) = 12.6 W/kg



0 dB = 12.6 W/kg = 11.00 dBW/kg

### Impedance Measurement Plot for Body TSL



## 6.4. D2450V2 Dipole 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  
**S** Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 0108**

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

Client **SMQ (Auden)**

Certificate No: **D2450V2-955\_Jan15**

## CALIBRATION CERTIFICATE

Object **D2450V2 - SN: 955**

Calibration procedure(s) **QA CAL-05.v9  
Calibration procedure for dipole validation kits above 700 MHz**

Calibration date: **January 08, 2015**

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	07-Oct-14 (No. 217-02020)	Oct-15
Power sensor HP 8481A	US37292783	07-Oct-14 (No. 217-02020)	Oct-15
Power sensor HP 8481A	MY41092317	07-Oct-14 (No. 217-02021)	Oct-15
Reference 20 dB Attenuator	SN: 5058 (20k)	03-Apr-14 (No. 217-01918)	Apr-15
Type-N mismatch combination	SN: 5047.2 / 06327	03-Apr-14 (No. 217-01921)	Apr-15
Reference Probe ES3DV3	SN: 3205	30-Dec-14 (No. ES3-3205_Dec14)	Dec-15
DAE4	SN: 601	18-Aug-14 (No. DAE4-601_Aug14)	Aug-15

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

Calibrated by: **Claudio Leubler** Laboratory Technician

Approved by: **Katja Pokovic** Technical Manager

Signature

Issued: January 8, 2015

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**Calibration Laboratory of**  
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Engineering AG  
Zeughausstrasse 43, 8004 Zurich, Switzerland



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

Accredited by the Swiss Accreditation Service (SAS)

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

Accreditation No.: **SCS 0108**

**Glossary:**

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

**Calibration is Performed According to the Following Standards:**

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

**Additional Documentation:**

- DASY4/5 System Handbook

**Methods Applied and Interpretation of Parameters:**

- Measurement Conditions:* Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- Antenna Parameters with TSL:* The dipole is mounted with the spacer to position its feed point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis.
- Feed Point Impedance and Return Loss:* These parameters are measured with the dipole positioned under the liquid filled phantom. The impedance stated is transformed from the measurement at the SMA connector to the feed point. The Return Loss ensures low reflected power. No uncertainty required.
- Electrical Delay:* One-way delay between the SMA connector and the antenna feed point. No uncertainty required.
- SAR measured:* SAR measured at the stated antenna input power.
- SAR normalized:* SAR as measured, normalized to an input power of 1 W at the antenna connector.
- SAR for nominal TSL parameters:* The measured TSL parameters are used to calculate the nominal SAR result.

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

### Measurement Conditions

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

DASY Version	DASY5	V52.8.8
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2450 MHz $\pm$ 1 MHz	

### Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.2	1.80 mho/m
Measured Head TSL parameters	(22.0 $\pm$ 0.2) °C	39.7 $\pm$ 6 %	1.84 mho/m $\pm$ 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

### SAR result with Head TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.0 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>51.6 W/kg <math>\pm</math> 17.0 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.00 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>23.9 W/kg <math>\pm</math> 16.5 % (k=2)</b>

### Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	52.7	1.95 mho/m
Measured Body TSL parameters	(22.0 $\pm$ 0.2) °C	51.0 $\pm$ 6 %	2.03 mho/m $\pm$ 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

### SAR result with Body TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	13.3 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	<b>51.8 W/kg <math>\pm</math> 17.0 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR measured	250 mW input power	6.14 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	<b>24.2 W/kg <math>\pm</math> 16.5 % (k=2)</b>

**Appendix (Additional assessments outside the scope of SCS108)****Antenna Parameters with Head TSL**

Impedance, transformed to feed point	54.8 $\Omega$ + 3.5 j $\Omega$
Return Loss	- 24.9 dB

**Antenna Parameters with Body TSL**

Impedance, transformed to feed point	51.2 $\Omega$ + 4.9 j $\Omega$
Return Loss	- 26.0 dB

**General Antenna Parameters and Design**

Electrical Delay (one direction)	1.165 ns
----------------------------------	----------

After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

**Additional EUT Data**

Manufactured by	SPEAG
Manufactured on	August 05, 2014

**DASY5 Validation Report for Head TSL**

Date: 08.01.2015

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 955**

Communication System: UID 0 - CW; Frequency: 2450 MHz

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.84$  S/m;  $\epsilon_r = 39.7$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.54, 4.54, 4.54); Calibrated: 30.12.2014;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 18.08.2014
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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

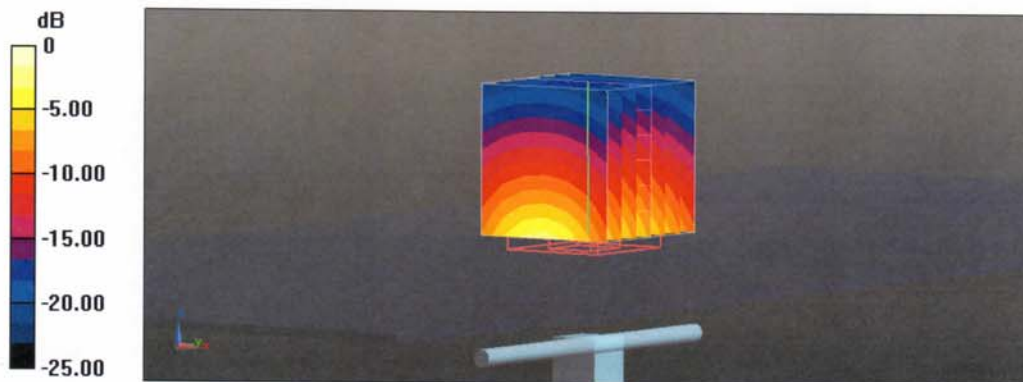
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 100.1 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 27.0 W/kg

**SAR(1 g) = 13 W/kg; SAR(10 g) = 6 W/kg**

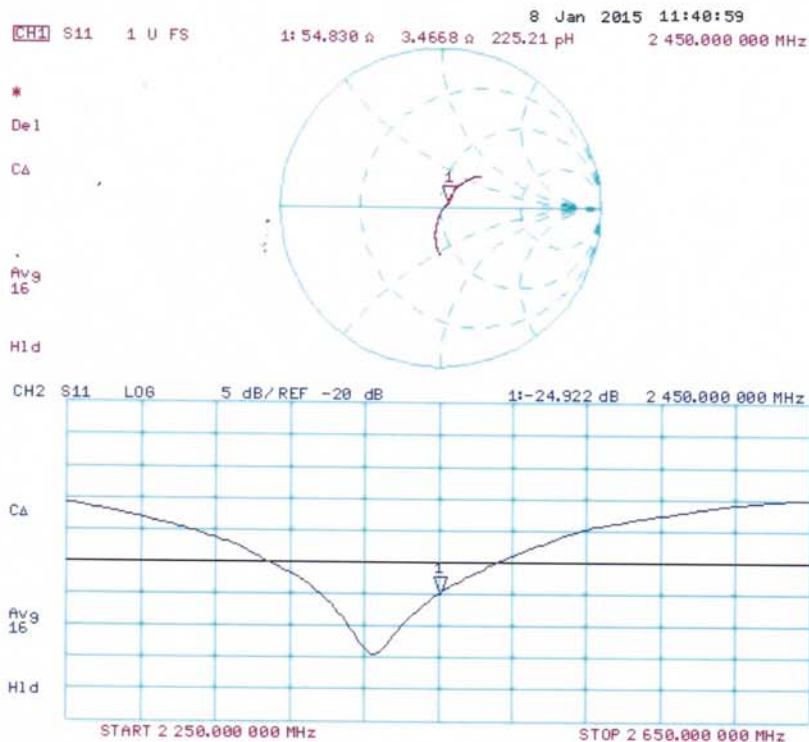
Maximum value of SAR (measured) = 17.2 W/kg



0 dB = 17.2 W/kg = 12.36 dBW/kg



### Impedance Measurement Plot for Head TSL



**DASY5 Validation Report for Body TSL**

Date: 08.01.2015

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 955**

Communication System: UID 0 - CW; Frequency: 2450 MHz

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 2.03$  S/m;  $\epsilon_r = 51$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.32, 4.32, 4.32); Calibrated: 30.12.2014;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 18.08.2014
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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

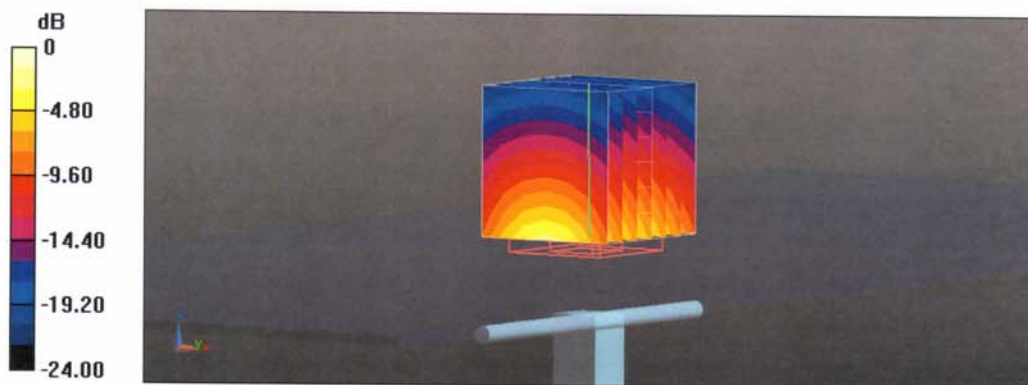
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 96.24 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 27.8 W/kg

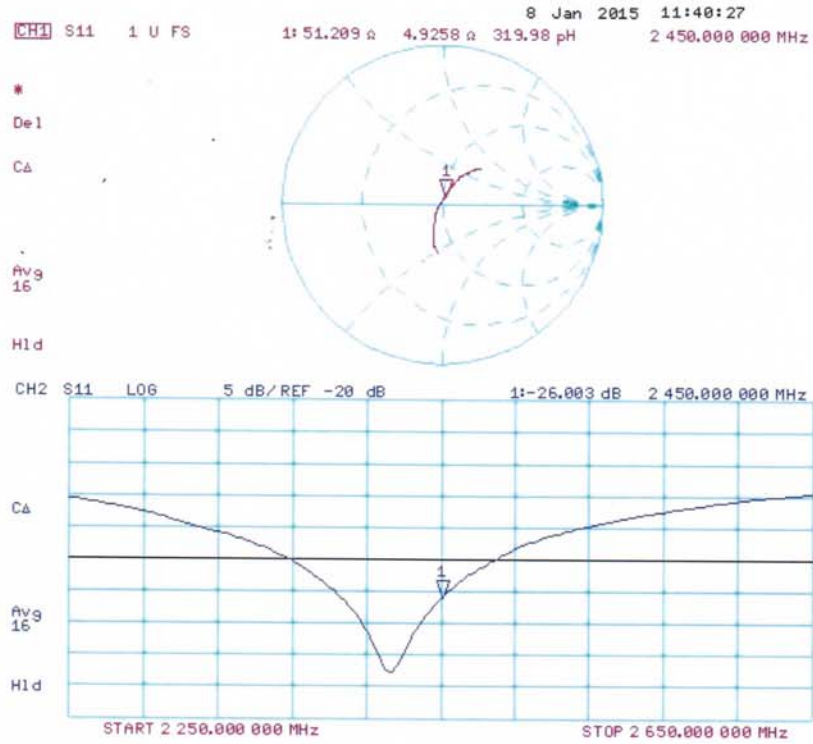
**SAR(1 g) = 13.3 W/kg; SAR(10 g) = 6.14 W/kg**

Maximum value of SAR (measured) = 17.7 W/kg



0 dB = 17.7 W/kg = 12.48 dBW/kg

### Impedance Measurement Plot for Body TSL



## 6.5. DAE4 Calibration Certificate

Schmid & Partner Engineering AG

**s p e a g**

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

### IMPORTANT NOTICE

#### USAGE OF THE DAE 4

The DAE unit is a delicate, high precision instrument and requires careful treatment by the user. There are no serviceable parts inside the DAE. Special attention shall be given to the following points:

**Battery Exchange:** The battery cover of the DAE4 unit is closed using a screw, over tightening the screw may cause the threads inside the DAE to wear out.

**Shipping of the DAE:** Before shipping the DAE to SPEAG for calibration, remove the batteries and pack the DAE in an antistatic bag. This antistatic bag shall then be packed into a larger box or container which protects the DAE from impacts during transportation. The package shall be marked to indicate that a fragile instrument is inside.

**E-Stop Failures:** Touch detection may be malfunctioning due to broken magnets in the E-stop. Rough handling of the E-stop may lead to damage of these magnets. Touch and collision errors are often caused by dust and dirt accumulated in the E-stop. To prevent E-stop failure, the customer shall always mount the probe to the DAE carefully and keep the DAE unit in a non-dusty environment if not used for measurements.

**Repair:** Minor repairs are performed at no extra cost during the annual calibration. However, SPEAG reserves the right to charge for any repair especially if rough unprofessional handling caused the defect.

**DASY Configuration Files:** Since the exact values of the DAE input resistances, as measured during the calibration procedure of a DAE unit, are not used by the DASY software, a nominal value of 200 MOhm is given in the corresponding configuration file.

**Important Note:**

**Warranty and calibration is void if the DAE unit is disassembled partly or fully by the Customer.**

**Important Note:**

**Never attempt to grease or oil the E-stop assembly. Cleaning and readjusting of the E-stop assembly is allowed by certified SPEAG personnel only and is part of the annual calibration procedure.**

**Important Note:**

**To prevent damage of the DAE probe connector pins, use great care when installing the probe to the DAE. Carefully connect the probe with the connector notch oriented in the mating position. Avoid any rotational movement of the probe body versus the DAE while turning the locking nut of the connector. The same care shall be used when disconnecting the probe from the DAE.**

Schmid & Partner Engineering

TN\_BR040315AD DAE4.doc

11.12.2009

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



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

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

Accreditation No.: **SCS 108**

Client **Sunway-SZ (Auden)**

Certificate No: **DAE4-689\_Oct14**

## CALIBRATION CERTIFICATE

Object **DAE4 -SD 000 D04 BM - SN: 689**

Calibration procedure(s) **QA CAL-06.v28  
Calibration procedure for the data acquisition electronics (DAE)**

Calibration date: **October 01, 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 ( $22 \pm 3$ )°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Keithley Multimeter Type 2001	SN: 0810278	01-Oct-13 (No:13976)	Oct-14
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Auto DAE Calibration Unit	SE UWS 053 AA 1001	07-Jan-14 (in house check)	In house check: Jan-15
Calibrator Box V2.1	SE UMS 006 AA 1002	07-Jan-14 (in house check)	In house check: Jan-15

	Name	Function	Signature
Calibrated by:	Dominique Steffen	Technician	
Approved by:	Fin Bomholt	Deputy Technical Manager	

Issued: October 1, 2014

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

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### Glossary

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

### Methods Applied and Interpretation of Parameters

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

**DC Voltage Measurement**

A/D - Converter Resolution nominal

High Range: 1LSB = 6.1 $\mu$ V , full range = -100...+300 mV

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

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

Calibration Factors	X	Y	Z
High Range	404.239 $\pm$ 0.02% (k=2)	404.156 $\pm$ 0.02% (k=2)	404.835 $\pm$ 0.02% (k=2)
Low Range	3.94871 $\pm$ 1.50% (k=2)	3.98364 $\pm$ 1.50% (k=2)	4.00706 $\pm$ 1.50% (k=2)

**Connector Angle**

Connector Angle to be used in DASY system	83.0 $^{\circ}$ $\pm$ 1 $^{\circ}$
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## Appendix (Additional assessments outside the scope of SCS108)

### 1. DC Voltage Linearity

High Range	Reading ( $\mu\text{V}$ )	Difference ( $\mu\text{V}$ )	Error (%)
Channel X + Input	200037.45	-2.43	-0.00
Channel X + Input	20004.97	0.89	0.00
Channel X - Input	-20004.37	1.76	-0.01
Channel Y + Input	200038.83	1.40	0.00
Channel Y + Input	20005.93	1.88	0.01
Channel Y - Input	-20004.16	1.95	-0.01
Channel Z + Input	200036.92	-0.75	-0.00
Channel Z + Input	20003.46	-0.50	-0.00
Channel Z - Input	-20002.36	3.79	-0.02

Low Range	Reading ( $\mu\text{V}$ )	Difference ( $\mu\text{V}$ )	Error (%)
Channel X + Input	2000.93	0.43	0.02
Channel X + Input	200.65	0.11	0.05
Channel X - Input	-198.95	0.46	-0.23
Channel Y + Input	2000.28	0.04	0.00
Channel Y + Input	200.24	-0.14	-0.07
Channel Y - Input	-199.88	-0.36	0.18
Channel Z + Input	2000.87	0.60	0.03
Channel Z + Input	199.31	-1.12	-0.56
Channel Z - Input	-200.09	-0.51	0.25

### 2. Common mode sensitivity

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

	Common mode Input Voltage (mV)	High Range Average Reading ( $\mu\text{V}$ )	Low Range Average Reading ( $\mu\text{V}$ )
Channel X	200	22.24	21.85
	- 200	-19.90	-22.18
Channel Y	200	1.27	-0.05
	- 200	4.06	3.25
Channel Z	200	16.18	15.97
	- 200	-18.12	-18.54

### 3. Channel separation

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

	Input Voltage (mV)	Channel X ( $\mu\text{V}$ )	Channel Y ( $\mu\text{V}$ )	Channel Z ( $\mu\text{V}$ )
Channel X	200	-	-1.25	-1.10
Channel Y	200	4.48	-	-0.80
Channel Z	200	7.05	3.04	-



**4. AD-Converter Values with inputs shorted**

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

	High Range (LSB)	Low Range (LSB)
Channel X	15681	16385
Channel Y	16252	16126
Channel Z	16131	16597

**5. Input Offset Measurement**

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

Input 10M $\Omega$ 

	Average ( $\mu$ V)	min. Offset ( $\mu$ V)	max. Offset ( $\mu$ V)	Std. Deviation ( $\mu$ V)
Channel X	1.41	0.05	2.73	0.67
Channel Y	0.68	-1.71	2.71	0.60
Channel Z	-0.36	-1.58	0.75	0.46

**6. Input Offset Current**

Nominal Input circuitry offset current on all channels: &lt;25fA

**7. Input Resistance** (Typical values for information)

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

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

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

**9. Power Consumption** (Typical values for information)

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

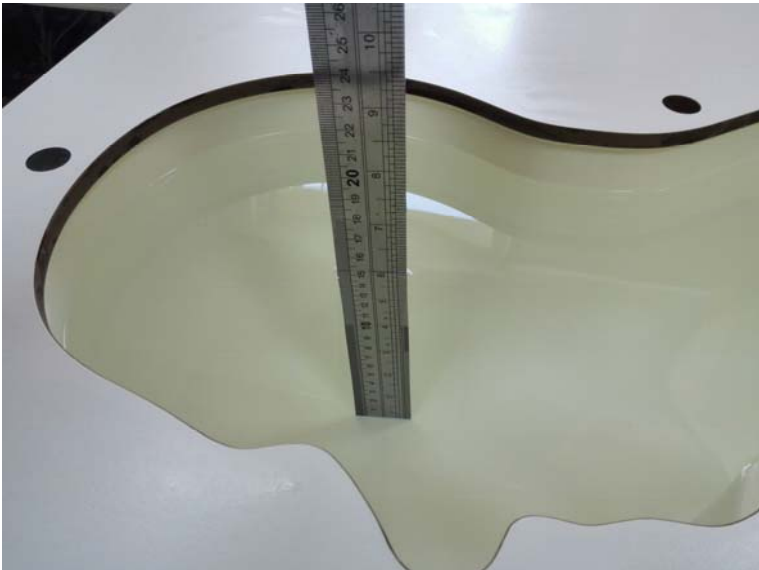
**7. Liquid depth**



**Photograph of the depth in the Head Phantom (850MHz)**



**Photograph of the depth in the Body Phantom (850MHz)**



**Photograph of the depth in the Head Phantom (1900MHz)**



**Photograph of the depth in the Body Phantom (1900MHz)**



**Photograph of the depth in the Head Phantom (2450MHz)**



**Photograph of the depth in the Body Phantom (2450MHz)**

## **8. Test Setup Photos**

Please refer to separated files for Test Setup Photos of the EUT.

**.....End of Report.....**