FCC SAR Test Report

APPLICANT	:	ZTE CORPORATION
EQUIPMENT	:	LTE uFi
BRAND NAME	:	ZTE
MODEL NAME	:	MF97B
FCC ID	:	SRQ-MF97B
STANDARD	:	FCC 47 CFR Part 2 (2.1093) ANSI/IEEE C95.1-1992 IEEE 1528-2003

We, SPORTON INTERNATIONAL (KUNSHAN) INC., would like to declare that the tested sample has been evaluated in accordance with the procedures and had been in compliance with the applicable technical standards.

The test results in this report apply exclusively to the tested model / sample. Without written approval of SPORTON INTERNATIONAL (KUNSHAN) INC., the test report shall not be reproduced except in full.

Reviewed by: Eric Huang / Deputy Manager

Approved by: Jones Tsai / Manager

Testing Laboratory 2627

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Revision History

REPORT NO.	VERSION	DESCRIPTION	ISSUED DATE
FA4O2101	Rev. 01	Initial issue of report	Jan. 26, 2015
FA4O2101	Rev. 02	Update report for revising hardware version	Jan. 30, 2015

1. Statement of Compliance

The maximum results of Specific Absorption Rate (SAR) found during testing for **ZTE CORPORATION, LTE uFi, MF97B** are as follows.

Equipment Class	Frequency Band	Operating Mode	Highest SAR Summary	
			Body 1g SAR (W/kg) Gap(1cm)	Simultaneous Transmission SAR (W/kg)
PCB	WCDMA Band V	Data	0.53	1.48
	WCDMA Band II	Data	1.19	
	LTE Band 17	Data	0.42	
	LTE Band 5	Data	0.55	
	LTE Band 4	Data	**1.42**	
	LTE Band 2	Data	1.18	
DTS	WLAN 2.4GHz Band	Data	0.39	1.42
NII	WLAN 5.2GHz Band	Data	0.14	1.42
	WLAN 5.8GHz Band	Data	0.24	
DSS	Bluetooth	Data		1.48
Date of Testing:			Nov. 10, 2014 ~ Jan. 05, 2015	

This device is in compliance with Specific Absorption Rate (SAR) for general population/uncontrolled exposure limits (1.6 W/kg) specified in FCC 47 CFR part 2 (2.1093) and ANSI/IEEE C95.1-1992, and had been tested in accordance with the measurement methods and procedures specified in IEEE 1528-2003.

2. Administration Data

Testing Laboratory	
Test Site	SPORTON INTERNATIONAL (KUNSHAN) INC.
Test Site Location	No. 3-2, PingXiang Road, Kunshan, Jiangsu Province, P.R.C. TEL: +86-0512-5790-0158 FAX: +86-0512-5790-0958

Applicant	
Company Name	ZTE CORPORATION
Address	ZTE Plaza, Keji Road South, Hi-Tech Industrial Park, Nanshan District, Shenzhen, Guangdong, 518057, P. R. China

Manufacturer	
Company Name	ZTE CORPORATION
Address	ZTE Plaza, Keji Road South, Hi-Tech Industrial Park, Nanshan District, Shenzhen, Guangdong, 518057, P. R. China

3. Guidance Standard

The Specific Absorption Rate (SAR) testing specification, method, and procedure for this device is in accordance with the following standards:

- FCC 47 CFR Part 2 (2.1093)
- ANSI/IEEE C95.1-1992
- IEEE 1528-2003
- FCC KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz v01r03
- FCC KDB 865664 D02 SAR Reporting v01r01
- FCC KDB 447498 D01 General RF Exposure Guidance v05r02
- FCC KDB 248227 D01 SAR meas for 802 11abg v01r02
- FCC KDB 941225 D01 3G SAR Procedures v03
- FCC KDB 941225 D05 SAR for LTE Devices v02r03
- FCC KDB 941225 D05A Rel.10 LTE SAR Test Guidance v01r01
- FCC KDB 941225 D06 Hotspot Mode SAR v02

4. Equipment Under Test (EUT)

4.1 General Information

Product Feature & Specification	
Equipment Name	LTE uFi
Brand Name	ZTE
Model Name	MF97B
FCC ID	SRQ-MF97B
IMEI Code	866179020000522
Wireless Technology and Frequency Range	WCDMA Band V: 826.4 MHz ~ 846.6 MHz WCDMA Band II: 1852.4 MHz ~ 1907.6 MHz LTE Band 17: 706.5 MHz ~ 713.5 MHz LTE Band 5: 824.7 MHz ~ 848.3 MHz LTE Band 4: 1710.7 MHz ~ 1754.3 MHz LTE Band 2: 1850.7 MHz ~ 1909.3 MHz WLAN 2.4GHz Band: 2412 MHz ~ 2462 MHz WLAN 5.2GHz Band: 5180 MHz ~ 5240 MHz WLAN 5.8GHz Band: 5745 MHz ~ 5825 MHz Bluetooth: 2402 MHz ~ 2480 MHz
Mode	•RMC 12.2Kbps •HSDPA •HSUPA •HSPA+ (Downlink Only) •LTE •LTE Carrier Aggregation (Downlink only) •802.11a/b/g/n HT20/HT40 •Bluetooth v2.1+EDR, Bluetooth v4.0 LE
HW Version	d96C
SW Version	MF97BV1.0.0B01
EUT Stage	Identical Prototype

Remark:

1. The above EUT's information was declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.
2. This device 2.4GHz WLAN supports Hotspot operation, and 5.8GHz WLAN supports WiFi Direct (GC/GO), and 5.2GHz supports WiFi Direct (GC only).
3. This device has no voice function.
4. This device supports inter-band LTE carrier aggregation (CA) in the downlink only. Uplink maximum output power measurement with downlink carrier aggregation active was measured to confirm that uplink maximum output power with downlink carrier aggregation active remains within the specified tune-up tolerance limits and not more than 1⁄4 dB higher than the maximum output measured without downlink carrier aggregation active.

4.2 Maximum Tune-up Limit

Mode	Average power(dBm)	
	WCDMA Band V	WCDMA Band II
RMC 12.2Kbps	24.0	24.0
HSDPA Subtest-1	21.5	21.5
HSDPA Subtest-2	21.5	21.5
HSDPA Subtest-3	21.5	21.5
HSDPA Subtest-4	21.5	21.5
HSUPA Subtest-1	23.0	23.0
HSUPA Subtest-2	22.5	22.0
HSUPA Subtest-3	22.5	22.0
HSUPA Subtest-4	22.5	22.5
HSUPA Subtest-5	23.0	22.5

LTE Band 17				
Average Power (dBm)				
Modulation	BW (MHz)	RB size	MPR	Target Power
QPSK	10	≤ 12	0	24.0
QPSK	10	> 12	1	23.0
16QAM	10	≤ 12	1	23.0
16QAM	10	> 12	2	22.0
QPSK	5	≤ 8	0	24.0
QPSK	5	> 8	1	23.0
16QAM	5	≤ 8	1	23.0
16QAM	5	> 8	2	22.0

LTE Band 4				
Average Power (dBm)				
Modulation	BW (MHz)	RB size	MPR	Target Power
QPSK	20	≤ 18	0	23.5
QPSK	20	> 18	1	22.5
16QAM	20	≤ 18	1	22.5
16QAM	20	> 18	2	21.5
QPSK	15	≤ 16	0	23.5
QPSK	15	> 16	1	22.5
16QAM	15	≤ 16	1	22.5
16QAM	15	> 16	2	21.5
QPSK	10	≤ 12	0	23.5
QPSK	10	> 12	1	22.5
16QAM	10	≤ 12	1	22.5
16QAM	10	> 12	2	21.5
QPSK	5	≤ 8	0	23.5
QPSK	5	> 8	1	22.5
16QAM	5	≤ 8	1	22.5
16QAM	5	> 8	2	21.5
QPSK	3	≤ 4	0	23.5
QPSK	3	> 4	1	22.5
16QAM	3	≤ 4	1	22.5
16QAM	3	> 4	2	21.5
QPSK	1.4	≤ 5	0	23.5
QPSK	1.4	> 5	1	22.5
16QAM	1.4	≤ 5	1	22.5
16QAM	1.4	> 5	2	21.5

LTE Band 5				
Average Power (dBm)				
Modulation	BW (MHz)	RB size	MPR	Target Power
QPSK	10	≤ 12	0	24.0
QPSK	10	> 12	1	23.0
16QAM	10	≤ 12	1	23.0
16QAM	10	> 12	2	22.0
QPSK	5	≤ 8	0	24.0
QPSK	5	> 8	1	23.0
16QAM	5	≤ 8	1	23.0
16QAM	5	> 8	2	22.0
QPSK	3	≤ 4	0	24.0
QPSK	3	> 4	1	23.0
16QAM	3	≤ 4	1	23.0
16QAM	3	> 4	2	22.0
QPSK	1.4	≤ 5	0	24.0
QPSK	1.4	> 5	1	23.0
16QAM	1.4	≤ 5	1	23.0
16QAM	1.4	> 5	2	22.0

LTE Band 2				
Average Power (dBm)				
Modulation	BW (MHz)	RB size	MPR	Target Power
QPSK	20	≤ 18	0	23.5
QPSK	20	> 18	1	22.5
16QAM	20	≤ 18	1	22.5
16QAM	20	> 18	2	21.5
QPSK	15	≤ 16	0	23.5
QPSK	15	> 16	1	22.5
16QAM	15	≤ 16	1	22.5
16QAM	15	> 16	2	21.5
QPSK	10	≤ 12	0	23.5
QPSK	10	> 12	1	22.5
16QAM	10	≤ 12	1	22.5
16QAM	10	> 12	2	21.5
QPSK	5	≤ 8	0	23.5
QPSK	5	> 8	1	22.5
16QAM	5	≤ 8	1	22.5
16QAM	5	> 8	2	21.5
QPSK	3	≤ 4	0	23.5
QPSK	3	> 4	1	22.5
16QAM	3	≤ 4	1	22.5
16QAM	3	> 4	2	21.5
QPSK	1.4	≤ 5	0	23.5
QPSK	1.4	> 5	1	22.5
16QAM	1.4	≤ 5	1	22.5
16QAM	1.4	> 5	2	21.5

Mode				Maximum Average Power (dBm)
2.4GHz	802.11b	Chain Port 0	CH 01	15.5
			CH 06	15.0
			CH 11	15.0
		Chain Port 1	CH 01	14.5
			CH 06	15.5
			CH 11	15.0
	802.11g	Chain Port 0	CH 01	14.5
			CH 06	13.5
			CH 11	13.0
		Chain Port 1	CH 01	14.0
			CH 06	15.0
			CH 11	15.5
	802.11n HT20	Chain Port 0	CH 01	13.5
			CH 06	14.0
			CH 11	13.0
		Chain Port 1	CH 01	13.5
			CH 06	15.0
			CH 11	14.5
		Chain Port 0+1	CH 01	14.0
			CH 06	15.0
			CH 11	14.0
	802.11n HT40	Chain Port 0	CH 03	12.5
			CH 06	13.5
			CH 09	12.5
		Chain Port 1	CH 03	12.0
			CH 06	13.5
			CH 09	12.5
		Chain Port 0+1	CH 03	13.0
			CH 06	13.5
			CH 09	13.5
5.2GHz	802.11a	Chain Port 0		16.0
		Chain Port 1		13.0
	802.11n HT20	Chain Port 0		16.0
		Chain Port 1		13.0
		Chain Port 0+1		17.5
	802.11n HT40	Chain Port 0		14.0
		Chain Port 1		11.0
		Chain Port 0+1		15.5
5.8GHz	802.11a	Chain Port 0		12.0
		Chain Port 1		11.0
	802.11n HT20	Chain Port 0		12.0
		Chain Port 1		11.0
		Chain Port 0+1		14.5
	802.11n HT40	Chain Port 0		10.0
		Chain Port 1		10.0
		Chain Port 0+1		12.0
Bluetooth v2.1+EDR				3.0
Bluetooth v4.0 LE				4.0

4.3 General LTE SAR Test and Reporting Considerations

Summarized necessary items addressed in KDB 941225 D05 v02r03			
FCC ID	SRQ-MF97B		
Equipment Name	LTE uFi		
Operating Frequency Range of each LTE transmission band	LTE Band 17: 706.5 MHz ~ 713.5 MHz LTE Band 5: 824.7 MHz ~ 848.3 MHz LTE Band 4: 1710.7 MHz ~ 1754.3 MHz LTE Band 2: 1850.7 MHz ~ 1909.3 MHz		
Channel Bandwidth	1.4MHz, 3MHz, 5MHz, 10MHz, 15MHz, 20MHz(LTE Band 2/4) 1.4MHz, 3MHz, 5MHz, 10MHz(LTE Band 5) 5MHz, 10MHz, (LTE Band 17)		
uplink modulations used	QPSK, and 16QAM		
LTE Voice / Data requirements	Data only		
LTE MPR permanently built-in by design	Table 6.2.3-1: Maximum Power Reduction (MPR) for Power Class 3		

Modulation	Channel bandwidth / Transmission bandwidth (RB)						MPR (dB)
	1.4 MHz	3.0 MHz	5 MHz	10 MHz	15 MHz	20 MHz	
QPSK	> 5	> 4	> 8	> 12	> 16	> 18	≤ 1
16 QAM	≤ 5	≤ 4	≤ 8	≤ 12	≤ 16	≤ 18	≤ 1
16 QAM	> 5	> 4	> 8	> 12	> 16	> 18	≤ 2

LTE A-MPR	In the base station simulator configuration, Network Setting value is set to NS_01 to disable A-MPR during SAR testing and the LTE SAR tests was transmitting on all TTI frames (Maximum TTI)		
Spectrum plots for RB configuration	A properly configured base station simulator was used for the SAR and power measurement; therefore, spectrum plots for each RB allocation and offset configuration are not included in the SAR report.		
LTE Carrier Aggregation Combinations	Intra Band	Not support	
	Inter Band	B2(PCC)+B17(SCC)	5MHz(B2)+5MHz(B17)
			5MHz(B2)+10MHz(B17)
			10MHz(B2)+5MHz(B17)
			10MHz(B2)+10MHz(B17)
		B2(PCC)+B29(SCC)	5MHz(B2)+5MHz(B29)
			5MHz(B2)+10MHz(B29)
			10MHz(B2)+5MHz(B29)
			10MHz(B2)+10MHz(B29)
		B4(PCC)+B17(SCC)	5MHz(B4)+5MHz(B17)
			5MHz(B4)+10MHz(B17)
			10MHz(B4)+5MHz(B17)
			10MHz(B4)+10MHz(B17)
		B4(PCC)+B29(SCC)	5MHz(B4)+5MHz(B29)
			5MHz(B4)+10MHz(B29)
			10MHz(B4)+5MHz(B29)
			10MHz(B4)+10MHz(B29)
		B17(PCC)+B2(SCC)	5MHz(B17)+5MHz(B2)
			5MHz(B17)+10MHz(B2)
			10MHz(B17)+5MHz(B2)
			10MHz(B17)+10MHz(B2)
		B17(PCC)+B4(SCC)	5MHz(B17)+5MHz(B4)
			5MHz(B17)+10MHz(B4)
			10MHz(B17)+5MHz(B4)
			10MHz(B17)+10MHz(B4)

Transmission (H, M, L) channel numbers and frequencies in each LTE band								
LTE Band 17								
	Bandwidth 5 MHz				Bandwidth 10 MHz			
	Channel #		Freq.(MHz)		Channel #		Freq. (MHz)	
L	23755		706.5		23780		709	
M	23790		710		23790		710	
H	23825		713.5		23800		711	
LTE Band 5								
	Bandwidth 1.4 MHz		Bandwidth 3 MHz		Bandwidth 5 MHz		Bandwidth 10 MHz	
	Ch. #	Freq. (MHz)	Ch. #	Freq. (MHz)	Ch. #	Freq. (MHz)	Ch. #	Freq. (MHz)
L	20407	824.7	20415	825.5	20425	826.5	20450	829
M	20525	836.5	20525	836.5	20525	836.5	20525	836.5
H	20643	848.3	20635	847.5	20625	846.5	20600	844

LTE Band 4												
	Bandwidth 1.4 MHz		Bandwidth 3 MHz		Bandwidth 5 MHz		Bandwidth 10 MHz		Bandwidth 15 MHz		Bandwidth 20 MHz	
	Ch. #	Freq. (MHz)	Ch. #	Freq. (MHz)	Ch. #	Freq. (MHz)	Ch. #	Freq. (MHz)	Ch. #	Freq. (MHz)	Ch. #	Freq. (MHz)
L	19957	1710.7	19965	1711.5	19975	1712.5	20000	1715	20025	1717.5	20050	1720
M	20175	1732.5	20175	1732.5	20175	1732.5	20175	1732.5	20175	1732.5	20175	1732.5
H	20393	1754.3	20385	1753.5	20375	1752.5	20350	1750	20325	1747.5	20300	1745

LTE Band 2												
	Bandwidth 1.4 MHz		Bandwidth 3 MHz		Bandwidth 5 MHz		Bandwidth 10 MHz		Bandwidth 15 MHz		Bandwidth 20 MHz	
	Ch. #	Freq. (MHz)	Ch. #	Freq. (MHz)	Ch. #	Freq. (MHz)	Ch. #	Freq. (MHz)	Ch. #	Freq. (MHz)	Ch. #	Freq. (MHz)
L	18607	1850.7	18615	1851.5	18625	1852.5	18650	1855	18675	1857.5	18700	1860
M	18900	1880	18900	1880	18900	1880	18900	1880	18900	1880	18900	1880
H	19193	1909.3	19185	1908.5	19175	1907.5	19150	1905	19125	1902.5	19100	1900

5. RF Exposure Limits

5.1 Uncontrolled Environment

Uncontrolled Environments are defined as locations where there is the exposure of individuals who have no knowledge or control of their exposure. The general population/uncontrolled exposure limits are applicable to situations in which the general public may be exposed or in which persons who are exposed as a consequence of their employment may not be made fully aware of the potential for exposure or cannot exercise control over their exposure. Members of the general public would come under this category when exposure is not employment-related; for example, in the case of a wireless transmitter that exposes persons in its vicinity.

5.2 Controlled Environment

Controlled Environments are defined as locations where there is exposure that may be incurred by persons who are aware of the potential for exposure, (i.e. as a result of employment or occupation). In general, occupational/controlled exposure limits are applicable to situations in which persons are exposed as a consequence of their employment, who have been made fully aware of the potential for exposure and can exercise control over their exposure. The exposure category is also applicable when the exposure is of a transient nature due to incidental passage through a location where the exposure levels may be higher than the general population/uncontrolled limits, but the exposed person is fully aware of the potential for exposure and can exercise control over his or her exposure by leaving the area or by some other appropriate means.

Limits for Occupational/Controlled Exposure (W/kg)

Whole-Body	Partial-Body	Hands, Wrists, Feet and Ankles
0.4	8.0	20.0

Limits for General Population/Uncontrolled Exposure (W/kg)

Whole-Body	Partial-Body	Hands, Wrists, Feet and Ankles
0.08	1.6	4.0

1. Whole-Body SAR is averaged over the entire body, partial-body SAR is averaged over any 1gram of tissue defined as a tissue volume in the shape of a cube. SAR for hands, wrists, feet and ankles is averaged over any 10 grams of tissue defined as a tissue volume in the shape of a cube.

6. Specific Absorption Rate (SAR)

6.1 Introduction

SAR is related to the rate at which energy is absorbed per unit mass in an object exposed to a radio field. The SAR distribution in a biological body is complicated and is usually carried out by experimental techniques or numerical modeling. The standard recommends limits for two tiers of groups, occupational/controlled and general population/uncontrolled, based on a person's awareness and ability to exercise control over his or her exposure. In general, occupational/controlled exposure limits are higher than the limits for general population/uncontrolled.

6.2 SAR Definition

The SAR definition is the time derivative (rate) of the incremental energy (dW) absorbed by (dissipated in) an incremental mass (dm) contained in a volume element (dv) of a given density (ρ). The equation description is as below:

$$\mathbf{SAR} = \frac{\mathbf{d}}{\mathbf{dt}}\left(\frac{\mathbf{dW}}{\mathbf{dm}}\right) = \frac{\mathbf{d}}{\mathbf{dt}}\left(\frac{\mathbf{dW}}{\boldsymbol{\rho}\mathbf{dv}}\right)$$

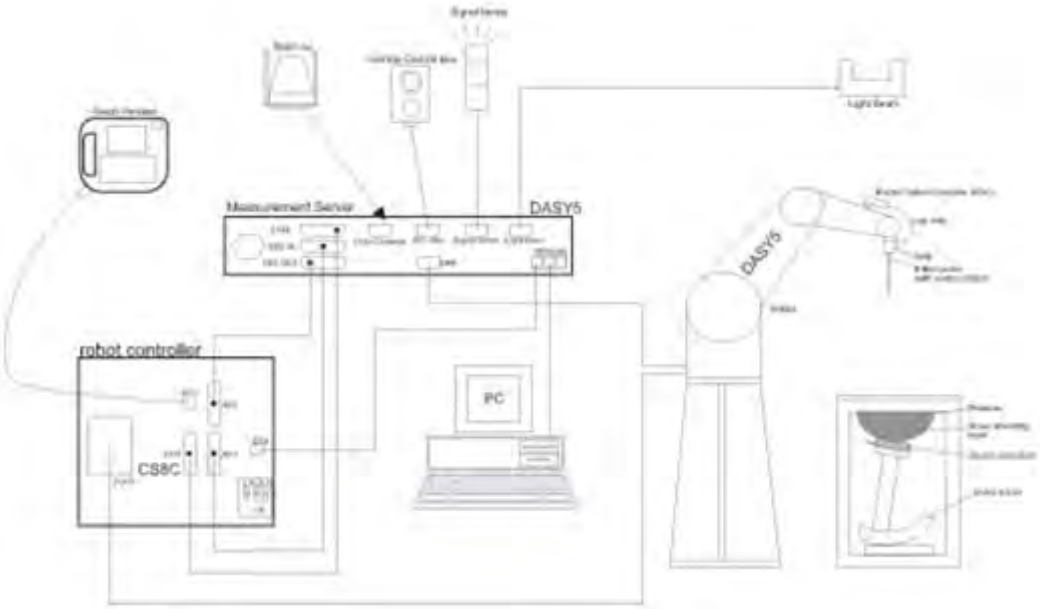
SAR is expressed in units of Watts per kilogram (W/kg)

$$\mathbf{SAR} = \frac{\boldsymbol{\sigma}|\mathbf{E}|^{\mathbf{2}}}{\boldsymbol{\rho}}$$

Where: σ is the conductivity of the tissue, ρ is the mass density of the tissue and E is the RMS electrical field strength.

7. System Description and Setup

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



- A standard high precision 6-axis robot with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- An isotropic Field probe optimized and calibrated for the targeted measurement.
- A data acquisition electronics (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
- The Electro-optical converter (EOC) performs the conversion from optical to electrical signals for the digital communication to the DAE. To use optical surface detection, a special version of the EOC is required. The EOC signal is transmitted to the measurement server.
- The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- The Light Beam used is for probe alignment. This improves the (absolute) accuracy of the probe positioning.
- A computer running WinXP or Win7 and the DASY5 software.
- Remote control and teach pendant as well as additional circuitry for robot safety such as warning lamps, etc.
- The phantom, the device holder and other accessories according to the targeted measurement.

8. Measurement Procedures

The measurement procedures are as follows:

<Conducted power measurement>

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

<SAR measurement>

(a) Use base station simulator to configure EUT WWAN transmission in radiated connection, and engineering software to configure EUT WLAN/BT continuously transmission, at maximum RF power, in the highest power channel.
(b) Place the EUT in the positions as Appendix D demonstrates.
(c) Set scan area, grid size and other setting on the DASY software.
(d) Measure SAR results for the highest power channel on each testing position.
(e) Find out the largest SAR result on these testing positions of each band
(f) Measure SAR results for other channels in worst SAR testing position if the reported SAR of highest power channel is larger than 0.8 W/kg

According to the test standard, the recommended procedure for assessing the peak spatial-average SAR value consists of the following steps:

(a) Power reference measurement
(b) Area scan
(c) Zoom scan
(d) Power drift measurement

8.1 Spatial Peak SAR Evaluation

The procedure for spatial peak SAR evaluation has been implemented according to the test standard. It can be conducted for 1g and 10g, as well as for user-specific masses. The DASY software includes all numerical procedures necessary to evaluate the spatial peak SAR value.

The base for the evaluation is a "cube" measurement. The measured volume must include the 1g and 10g cubes with the highest averaged SAR values. For that purpose, the center of the measured volume is aligned to the interpolated peak SAR value of a previously performed area scan.

The entire evaluation of the spatial peak values is performed within the post-processing engine (SEMCAD). The system always gives the maximum values for the 1g and 10g cubes. The algorithm to find the cube with highest averaged SAR is divided into the following stages:

(a) Extraction of the measured data (grid and values) from the Zoom Scan
(b) Calculation of the SAR value at every measurement point based on all stored data (A/D values and measurement parameters)
(c) Generation of a high-resolution mesh within the measured volume
(d) Interpolation of all measured values form the measurement grid to the high-resolution grid
(e) Extrapolation of the entire 3-D field distribution to the phantom surface over the distance from sensor to surface
(f) Calculation of the averaged SAR within masses of 1g and 10g

8.2 Power Reference Measurement

The Power Reference Measurement and Power Drift Measurements are for monitoring the power drift of the device under test in the batch process. The minimum distance of probe sensors to surface determines the closest measurement point to phantom surface. This distance cannot be smaller than the distance of sensor calibration points to probe tip as defined in the probe properties.

8.3 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 fine measurement around the hot spot. The sophisticated interpolation routines implemented in DASY software can find the maximum found in the scanned area, within a range of the global maximum. The range (in dB0 is specified in the standards for compliance testing. For example, a 2 dB range is required in IEEE standard 1528 and IEC 62209 standards, whereby 3 dB is a requirement when compliance is assessed in accordance with the ARIB standard (Japan), if only one zoom scan follows the area scan, then only the absolute maximum will be taken as reference. For cases where multiple maximums are detected, the number of zoom scans has to be increased accordingly.

Area scan parameters extracted from FCC KDB 865664 D01v01r03 SAR measurement 100 MHz to 6 GHz.

	≤ 3 GHz	> 3 GHz
Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface	5 ± 1 mm	½·δ·ln(2) ± 0.5 mm
Maximum probe angle from probe axis to phantom surface normal at the measurement location	30° ± 1°	20° ± 1°
Maximum area scan spatial resolution: Δx_{Area}, Δy_{Area}	≤ 2 GHz: ≤ 15 mm 2 – 3 GHz: ≤ 12 mm	3 – 4 GHz: ≤ 12 mm 4 – 6 GHz: ≤ 10 mm
	When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be ≤ the corresponding x or y dimension of the test device with at least one measurement point on the test device.	

8.4 Zoom Scan

Zoom scans are used assess the peak spatial SAR values within a cubic averaging volume containing 1 gram and 10 gram of simulated tissue. The zoom scan measures points (refer to table below) within a cube shoes base faces are centered on the maxima found in a preceding area scan job within the same procedure. When the measurement is done, the zoom scan evaluates the averaged SAR for 1 gram and 10 gram and displays these values next to the job's label.

Zoom scan parameters extracted from FCC KDB 865664 D01v01r03 SAR measurement 100 MHz to 6 GHz.

			≤ 3 GHz	> 3 GHz
Maximum zoom scan spatial resolution: Δx_{Zoom}, Δy_{Zoom}			≤ 2 GHz: ≤ 8 mm 2 – 3 GHz: ≤ 5 mm*	3 – 4 GHz: ≤ 5 mm* 4 – 6 GHz: ≤ 4 mm*
Maximum zoom scan spatial resolution, normal to phantom surface	uniform grid: $\Delta z_{Zoom}(n)$		≤ 5 mm	3 – 4 GHz: ≤ 4 mm 4 – 5 GHz: ≤ 3 mm 5 – 6 GHz: ≤ 2 mm
	graded grid	$\Delta z_{Zoom}(1)$: between 1st two points closest to phantom surface	≤ 4 mm	3 – 4 GHz: ≤ 3 mm 4 – 5 GHz: ≤ 2.5 mm 5 – 6 GHz: ≤ 2 mm
		$\Delta z_{Zoom}(n>1)$: between subsequent points	$\leq 1.5 \cdot \Delta z_{Zoom}(n-1)$	
Minimum zoom scan volume	x, y, z		≥ 30 mm	3 – 4 GHz: ≥ 28 mm 4 – 5 GHz: ≥ 25 mm 5 – 6 GHz: ≥ 22 mm

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

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

8.5 Volume Scan Procedures

The volume scan is used for assess overlapping SAR distributions for antennas transmitting in different frequency bands. It is equivalent to an oversized zoom scan used in standalone measurements. The measurement volume will be used to enclose all the simultaneous transmitting antennas. For antennas transmitting simultaneously in different frequency bands, the volume scan is measured separately in each frequency band. In order to sum correctly to compute the 1g aggregate SAR, the EUT remain in the same test position for all measurements and all volume scan use the same spatial resolution and grid spacing. When all volume scan were completed, the software, SEMCAD postprocessor can combine and subsequently superpose these measurement data to calculating the multiband SAR.

8.6 Power Drift Monitoring

All SAR testing is under the EUT install full charged battery and transmit maximum output power. In DASY measurement software, the power reference measurement and power drift measurement procedures are used for monitoring the power drift of EUT during SAR test. Both these procedures measure the field at a specified reference position before and after the SAR testing. The software will calculate the field difference in dB. If the power drifts more than 5%, the SAR will be retested.

9. Test Equipment List

Manufacturer	Name of Equipment	Type/Model	Serial Number	Calibration	
				Last Cal.	Due Date
SPEAG	750MHz System Validation Kit	D750V3	1012	May 16, 2014	May 15, 2015
SPEAG	835MHz System Validation Kit	D835V2	499	Mar. 24, 2014	Mar. 23, 2015
SPEAG	1750MHz System Validation Kit	D1750V2	1090	Mar. 27, 2013	Mar. 25, 2015
SPEAG	1900MHz System Validation Kit	D1900V2	5d041	Mar. 21, 2014	Mar. 20, 2015
SPEAG	2450MHz System Validation Kit	D2450V2	736	Aug. 21, 2014	Aug. 20, 2015
SPEAG	5000MHz System Validation Kit	D5GHzV2	1128	Jul. 22, 2014	Jul. 21, 2015
SPEAG	Data Acquisition Electronics	DAE4	1210	May 19, 2014	May 18, 2015
SPEAG	Dosimetric E-Field Probe	EX3DV4	3857	May 23, 2014	May 22, 2015
SPEAG	SAM Twin Phantom	QD 000 P40 CB	TP-1477	NCR	NCR
SPEAG	SAM Twin Phantom	QD 000 P40 CB	TP-1479	NCR	NCR
SPEAG	Phone Positioner	N/A	N/A	NCR	NCR
Anritsu	Radio communication analyzer	MT8820C	6201091028	Jul, 10, 2014	Jul, 09, 2015
Agilent	Wireless Communication Test Set	E5515C	MY52102706	May 03, 2014	May 02, 2015
Agilent	ENA Series Network Analyzer	E5071C	MY46111157	May 04, 2014	May 03, 2015
Agilent	Dielectric Probe Kit	85070E	MY44300475	NCR	NCR
R&S	Signal Generator	SMBV100A	258305	Feb. 07, 2014	Feb. 06, 2015
Anritsu	Power Senor	MA2411B	0917070	Feb. 27, 2014	Feb. 26, 2015
Anritsu	Power Meter	ML2495A	1005002	Feb. 27, 2014	Feb. 26, 2015
R&S	CBT BLUETOOTH TESTER	CBT	100783	Aug. 11, 2014	Aug. 10, 2015
R&S	Spectrum Analyzer	FSP40	100319	Oct. 28, 2014	Oct. 27, 2015
Agilent	Dual Directional Coupler	778D	50422	Note1	
Woken	Attenuator 1	WK0602-XX	N/A	Note1	
PE	Attenuator 2	PE7005-10	N/A	Note1	
PE	Attenuator 3	PE7005- 3	N/A	Note1	
AR	Power Amplifier	5S1G4M2	0328767	Note1	
Mini-Circuits	Power Amplifier	ZVE-3W	162601250	Note1	
Mini-Circuits	Power Amplifier	ZHL-42W+	13440021344	Note1	

General Note:

1. Prior to system verification and validation, the path loss from the signal generator to the system check source and the power meter, which includes the amplifier, cable, attenuator and directional coupler, was measured by the network analyzer. The reading of the power meter was offset by the path loss difference between the path to the power meter and the path to the system check source to monitor the actual power level fed to the system check source.
2. Referring to KDB 865664 D01v01r03, the dipole calibration interval can be extended to 3 years with justification. The dipoles are also not physically damaged, or repaired during the interval.
3. The justification data of dipole D1750V2, SN: 1090 can be found in appendix C. The return loss is < -20dB, within 20% of prior calibration, the impedance is within 5 ohm of prior calibration.

10. System Verification

10.1 Tissue Verification

The following tissue formulations are provided for reference only as some of the parameters have not been thoroughly verified. The composition of ingredients may be modified accordingly to achieve the desired target tissue parameters required for routine SAR evaluation.

Frequency (MHz)	Water (%)	Sugar (%)	Cellulose (%)	Salt (%)	Preventol (%)	DGBE (%)	Conductivity (σ)	Permittivity (εr)
For Head								
750	41.1	57.0	0.2	1.4	0.2	0	0.89	41.9
835	40.3	57.9	0.2	1.4	0.2	0	0.90	41.5
1800, 1900, 2000	55.2	0	0	0.3	0	44.5	1.40	40.0
2450	55.0	0	0	0	0	45.0	1.80	39.2
For Body								
750	51.7	47.2	0	0.9	0.1	0	0.96	55.5
835	50.8	48.2	0	0.9	0.1	0	0.97	55.2
1800, 1900, 2000	70.2	0	0	0.4	0	29.4	1.52	53.3
2450	68.6	0	0	0	0	31.4	1.95	52.7

Simulating Liquid for 5GHz, Manufactured by SPEAG

Ingredients	(% by weight)
Water	64~78%
Mineral oil	11~18%
Emulsifiers	9~15%
Additives and Salt	2~3%

<Tissue Dielectric Parameter Check Results>

Frequency (MHz)	Tissue Type	Liquid Temp. (℃)	Conductivity (σ)	Permittivity (ε_r)	Conductivity Target (σ)	Permittivity Target (ε_r)	Delta (σ) (%)	Delta (ε_r) (%)	Limit (%)	Date
750	Body	22.7	0.963	54.228	0.96	55.50	0.31	-2.29	±5	Nov. 13, 2014
835	Body	22.7	0.976	54.382	0.97	55.20	0.62	-1.48	±5	Nov. 13, 2014
1750	Body	22.7	1.513	55.500	1.49	53.40	1.54	3.93	±5	Nov. 10, 2014
1900	Body	22.7	1.554	53.519	1.52	53.30	2.24	0.41	±5	Nov. 10, 2014
2450	Body	22.8	1.942	50.943	1.95	52.70	-0.41	-3.33	±5	Jan. 04, 2015
5200	Body	22.7	5.162	48.492	5.30	49.00	-2.60	-1.04	±5	Jan. 05, 2015
5800	Body	22.7	5.976	47.158	6.00	48.20	-0.40	-2.16	±5	Jan. 05, 2015

10.2 System Performance Check Results

Comparing to the original SAR value provided by SPEAG, the verification data should be within its specification of 10 %. Below table shows the target SAR and measured SAR after normalized to 1W input power. The table below indicates the system performance check can meet the variation criterion and the plots can be referred to Appendix A of this report.

Date	Frequency (MHz)	Tissue Type	Input Power (mW)	Dipole S/N	Probe S/N	DAE S/N	Measured SAR (W/kg)	Targeted SAR (W/kg)	Normalized SAR (W/kg)	Deviation (%)
Nov. 13, 2014	750	Body	250	1012	3857	1210	2.08	8.65	8.32	-3.82
Nov. 13, 2014	835	Body	250	499	3857	1210	2.23	9.46	8.92	-5.71
Nov. 10, 2014	1750	Body	250	1090	3857	1210	9.14	38.10	36.56	-4.04
Nov. 10, 2014	1900	Body	250	5d041	3857	1210	10.40	41.00	41.6	1.46
Jan. 04, 2015	2450	Body	250	736	3857	1210	12.20	50.60	48.8	-3.56
Jan. 05, 2015	5200	Body	100	1128	3857	1210	7.56	76.20	75.6	-0.79
Jan. 05, 2015	5800	Body	100	1128	3857	1210	7.13	75.90	71.3	-6.06

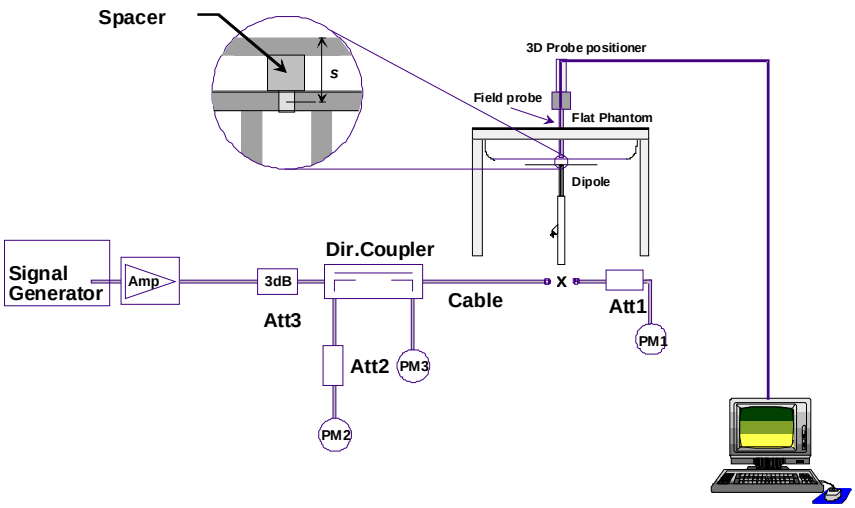


Fig 8.3.1 System Performance Check Setup

Fig 8.3.2 Setup Photo

11. RF Exposure Positions

11.1 Body Position

(a) To position the device parallel to the phantom surface with all sides and either keypad up or down.
(b) To adjust the device parallel to the flat phantom.
(c) To adjust the distance between the device and the flat phantom to 1 cm.

<EUT Setup Photos>

Please refer to Appendix D for the test setup photos.

12. Conducted RF Output Power (Unit: dBm)

<WCDMA Conducted Power>

1. The following tests were conducted according to the test requirements outlines in 3GPP TS 34.121 specification.
2. The procedures in KDB 941225 D01 are applied for 3GPP Rel. 6 HSPA to configure the device in the required sub-test mode(s) to determine SAR test exclusion.

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 (β_c and β_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: β values for transmitter characteristics tests with HS-DPCCH

Sub-test	β_c	β_d	β_d (SF)	β_c/β_d	β_{HS} (Note1, 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: Δ_{ACK}, Δ_{NACK} and Δ_{CQI} = 30/15 with β_{hs} = 30/15 * β_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, Δ_{ACK} and Δ_{NACK} = 30/15 with β_{hs} = 30/15 * β_c, and Δ_{CQI} = 24/15 with β_{hs} = 24/15 * β_c.

Note 3: CM = 1 for β_c/β_d =12/15, β_{hs}/β_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 β_c/β_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 β_c = 11/15 and β_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 (β_c and β_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: β values for transmitter characteristics tests with HS-DPCCH and E-DCH

Sub-test	β_c	β_d	β_d (SF)	β_c/β_d	β_{HS} (Note1)	β_{ec}	β_{ed} (Note 5) (Note 6)	β_{ed} (SF)	β_{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	209/225	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	β_{ed}1: 47/15 β_{ed}2: 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: Δ_{ACK}, Δ_{NACK} and Δ_{CQI} = 30/15 with β_{hs} = 30/15 * β_c .

Note 2: CM = 1 for β_c/β_d =12/15, β_{hs}/β_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 β_c/β_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 β_c = 10/15 and β_d = 15/15.

Note 4: For subtest 5 the β_c/β_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 β_c = 14/15 and β_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: β_{ed} can not be set directly, it is set by Absolute Grant Value.

Setup Configuration

<WCDMA Conducted Power>

General Note:

1. Per KDB 941225 D01v03, SAR for Head / Hotspot / Body-worn exposure is measured using a 12.2 kbps RMC with TPC bits configured to all "1's".
2. Per KDB 941225 D01v03, RMC 12.2kbps setting is used to evaluate SAR. If the maximum output power and tune-up tolerance specified for production units in HSDPA / HSUPA is ≤ ¼ dB higher than RMC 12.2Kbps or when the highest reported SAR of the RMC12.2Kbps is scaled by the ratio of specified maximum output power and tune-up tolerance of HSDPA / HSUPA to RMC12.2Kbps and the adjusted SAR is ≤ 1.2 W/kg, SAR measurement is not required for HSDPA / HSUPA.

Band			WCDMA Band V				WCDMA Band II			
Tx Channel			4132	4182	4233	Tune-up Limit (dBm)	9262	9400	9538	Tune-up Limit (dBm)
Rx Channel			4357	4407	4458		9662	9800	9938	
Frequency (MHz)			826.4	836.4	846.6		1852.4	1880	1907.6	
MPR (dB)	3GPP Rel 99	RMC 12.2Kbps	22.80	22.77	**22.85**	24.0	22.80	**22.93**	22.69	24.0
0	3GPP Rel 6	HSDPA Subtest-1	21.40	21.34	21.36	21.5	21.42	21.46	21.30	21.5
0	3GPP Rel 6	HSDPA Subtest-2	21.41	21.35	21.35	21.5	21.39	21.45	21.28	21.5
0.5	3GPP Rel 6	HSDPA Subtest-3	21.36	21.29	21.39	21.5	21.40	21.42	21.28	21.5
0.5	3GPP Rel 6	HSDPA Subtest-4	21.40	21.32	21.34	21.5	21.37	21.43	21.26	21.5
0	3GPP Rel 6	HSUPA Subtest-1	22.42	22.56	22.28	23.0	22.62	22.49	22.49	23.0
2	3GPP Rel 6	HSUPA Subtest-2	21.89	22.04	21.65	22.5	21.30	21.69	21.71	22.0
1	3GPP Rel 6	HSUPA Subtest-3	22.14	21.74	21.34	22.5	21.81	21.42	21.35	22.0
2	3GPP Rel 6	HSUPA Subtest-4	22.14	22.29	21.90	22.5	22.27	21.93	21.90	22.5
0	3GPP Rel 6	HSUPA Subtest-5	22.60	22.59	22.56	23.0	22.28	22.30	22.23	22.5

<LTE Conducted Power>

General Note:

1. Anritsu MT8820C base station simulator was used to setup the connection with EUT; the frequency band, channel bandwidth, RB allocation configuration, modulation type are set in the base station simulator to configure EUT transmitting at maximum power and at different configurations which are requested to be reported to FCC, for conducted power measurement and SAR testing.
2. Per KDB 941225 D05v02r03, when a properly configured base station simulator is used for the SAR and power measurements, spectrum plots for each RB allocation and offset configuration is not required.
3. Per KDB 941225 D05v02r03, start with the largest channel bandwidth and measure SAR for QPSK with 1 RB allocation, using the RB offset and required test channel combination with the highest maximum output power for RB offsets at the upper edge, middle and lower edge of each required test channel.
4. Per KDB 941225 D05v02r03, 50% RB allocation for QPSK SAR testing follows 1RB QPSK allocation procedure.
5. Per KDB 941225 D05v02r03, For QPSK with 100% RB allocation, SAR is not required when the highest maximum output power for 100 % RB allocation is less than the highest maximum output power in 50% and 1 RB allocations and the highest reported SAR for 1 RB and 50% RB allocation are ≤ 0.8 W/kg. Otherwise, SAR is measured for the highest output power channel; and if the reported SAR is > 1.45 W/kg, the remaining required test channels must also be tested.
6. Per KDB 941225 D05v02r03, 16QAM output power for each RB allocation configuration is > not ½ dB higher than the same configuration in QPSK and the reported SAR for the QPSK configuration is ≤ 1.45 W/kg; Per KDB 941225 D05v02r03, 16QAM SAR testing is not required.
7. Per KDB 941225 D05v02r03, Smaller bandwidth output power for each RB allocation configuration is > not ½ dB higher than the same configuration in the largest supported bandwidth, and the reported SAR for the largest supported bandwidth is ≤ 1.45 W/kg; Per KDB 941225 D05v02r03, smaller bandwidth SAR testing is not required.

<LTE Band 17>

BW [MHz]	Modulation	RB Size	RB Offset	Power Low Ch. / Freq.	Power Middle Ch. / Freq.	Power High Ch. / Freq.	Tune up Limit (dBm)	MPR (dB)
Channel				23780	23790	23800		
Frequency (MHz)				709	710	711		
10	QPSK	1	0	23.02	23.00	23.10	24.0	0
10	QPSK	1	24	22.98	23.01	23.09		
10	QPSK	1	49	23.11	**23.20**	23.15		
10	QPSK	25	0	22.13	22.18	22.06	23.0	0-1
10	QPSK	25	12	22.10	22.08	22.03		
10	QPSK	25	24	22.10	22.08	22.05		
10	QPSK	50	0	22.06	22.13	22.10		
10	16QAM	1	0	21.76	21.91	21.77	23.0	0-1
10	16QAM	1	24	22.05	21.95	21.61		
10	16QAM	1	49	22.09	21.98	21.85		
10	16QAM	25	0	21.05	21.05	21.09	22.0	0-2
10	16QAM	25	12	21.10	21.11	21.17		
10	16QAM	25	24	20.99	21.06	21.09		
10	16QAM	50	0	21.07	21.05	21.09		
Channel				23755	23790	23825	Tune up Limit (dBm)	MPR (dB)
Frequency (MHz)				706.5	710	713.5		
5	QPSK	1	0	22.97	23.02	23.07	24.0	0
5	QPSK	1	12	22.80	22.94	23.04		
5	QPSK	1	24	23.09	23.14	23.11		
5	QPSK	12	0	22.05	22.10	22.13	23.0	0-1
5	QPSK	12	6	21.98	22.09	22.09		
5	QPSK	12	11	22.09	22.03	22.07		
5	QPSK	25	0	22.22	22.05	22.04		
5	16QAM	1	0	21.88	22.22	22.02	23.0	0-1
5	16QAM	1	12	21.99	22.27	22.15		
5	16QAM	1	24	22.11	22.32	22.19		
5	16QAM	12	0	20.95	21.05	21.09	22.0	0-2
5	16QAM	12	6	21.05	21.13	21.09		
5	16QAM	12	11	21.10	21.04	20.96		
5	16QAM	25	0	21.04	21.05	21.06		

<LTE Band 5>

BW [MHz]	Modulation	RB Size	RB Offset	Power Low Ch. / Freq.	Power Middle Ch. / Freq.	Power High Ch. / Freq.	Tune up Limit (dBm)	MPR (dB)
Channel				20450	20525	20600		
Frequency (MHz)				829	836.5	844		
10	QPSK	1	0	22.98	**23.01**	22.81	24.0	0
10	QPSK	1	24	22.93	22.78	22.79		
10	QPSK	1	49	22.90	22.80	22.80		
10	QPSK	25	0	21.89	21.97	21.80	23.0	0-1
10	QPSK	25	12	21.93	21.90	21.88		
10	QPSK	25	24	21.90	21.87	21.79		
10	QPSK	50	0	21.98	21.93	21.80		
10	16QAM	1	0	22.24	21.85	21.85	23.0	0-1
10	16QAM	1	24	22.23	21.74	21.65		
10	16QAM	1	49	21.71	21.71	21.82		
10	16QAM	25	0	21.05	20.94	20.90	22.0	0-2
10	16QAM	25	12	20.90	20.92	20.92		
10	16QAM	25	24	21.01	20.91	20.92		
10	16QAM	50	0	20.97	20.87	20.80		
Channel				20425	20525	20625	Tune up Limit (dBm)	MPR (dB)
Frequency (MHz)				826.5	836.5	846.5		
5	QPSK	1	0	22.92	22.95	22.81	24.0	0
5	QPSK	1	12	22.78	22.84	22.66		
5	QPSK	1	24	22.87	22.90	22.78		
5	QPSK	12	0	21.96	21.93	21.83	23.0	0-1
5	QPSK	12	6	21.97	21.89	21.80		
5	QPSK	12	11	21.98	21.84	21.79		
5	QPSK	25	0	21.87	21.90	21.83		
5	16QAM	1	0	21.98	21.97	21.65	23.0	0-1
5	16QAM	1	12	21.55	21.94	21.49		
5	16QAM	1	24	21.77	21.84	21.59		
5	16QAM	12	0	21.00	20.93	20.90	22.0	0-2
5	16QAM	12	6	21.08	20.91	20.99		
5	16QAM	12	11	21.05	20.88	20.87		
5	16QAM	25	0	20.87	20.96	20.84		
Channel				20415	20525	20635	Tune up Limit (dBm)	MPR (dB)
Frequency (MHz)				825.5	836.5	847.5		
3	QPSK	1	0	22.98	22.91	22.89	24.0	0
3	QPSK	1	7	22.90	22.78	22.86		
3	QPSK	1	14	22.95	22.81	22.86		
3	QPSK	8	0	22.01	21.93	21.84	23.0	0-1
3	QPSK	8	4	21.97	21.87	21.88		
3	QPSK	8	7	21.95	21.87	21.95		
3	QPSK	15	0	22.02	21.91	21.80		
3	16QAM	1	0	22.10	22.04	21.66	23.0	0-1
3	16QAM	1	7	21.79	21.59	21.37		
3	16QAM	1	14	22.05	21.99	21.54		
3	16QAM	8	0	21.10	20.92	21.01	22.0	0-2
3	16QAM	8	4	21.01	20.97	20.95		
3	16QAM	8	7	21.02	20.96	20.94		
3	16QAM	15	0	21.03	20.73	20.75		

Channel				20407	20525	20643	Tune up Limit (dBm)	Target MPR (dB)
Frequency (MHz)				824.7	836.5	848.3		
1.4	QPSK	1	0	22.98	22.93	22.98	24.0	0
1.4	QPSK	1	2	22.93	22.80	22.86		
1.4	QPSK	1	5	22.94	22.90	22.94		
1.4	QPSK	3	0	22.91	22.85	22.95		
1.4	QPSK	3	1	22.93	22.88	22.90		
1.4	QPSK	3	2	22.95	22.88	22.92		
1.4	QPSK	6	0	22.02	21.91	21.91	23.0	0-1
1.4	16QAM	1	0	22.14	22.13	22.29	23.0	0-1
1.4	16QAM	1	2	21.99	21.78	22.08		
1.4	16QAM	1	5	21.82	21.92	21.52		
1.4	16QAM	3	0	21.85	21.76	21.93		
1.4	16QAM	3	1	22.02	21.86	21.82		
1.4	16QAM	3	2	22.02	21.89	21.93		
1.4	16QAM	6	0	20.95	20.76	20.93	22.0	0-2

<LTE Band 4>

BW [MHz]	Modulation	RB Size	RB Offset	Power Low Ch. / Freq.	Power Middle Ch. / Freq.	Power High Ch. / Freq.	Tune up Limit (dBm)	MPR (dB)
Channel				20050	20175	20300		
Frequency (MHz)				1720	1732.5	1745		
20	QPSK	1	0	22.73	**22.91**	22.69	23.5	0
20	QPSK	1	49	22.68	22.68	22.68		
20	QPSK	1	99	22.58	22.62	22.45		
20	QPSK	50	0	21.76	21.78	21.74	22.5	0-1
20	QPSK	50	24	21.70	21.75	21.70		
20	QPSK	50	49	21.66	21.71	21.57		
20	QPSK	100	0	21.75	21.83	21.71		
20	16QAM	1	0	21.71	21.77	21.68	22.5	0-1
20	16QAM	1	49	21.45	21.67	21.63		
20	16QAM	1	99	21.68	21.36	21.55		
20	16QAM	50	0	20.79	20.76	20.72	21.5	0-2
20	16QAM	50	24	20.71	20.79	20.73		
20	16QAM	50	49	20.68	20.76	20.66		
20	16QAM	100	0	20.74	20.86	20.85		
Channel				20025	20175	20325	Tune up Limit (dBm)	MPR (dB)
Frequency (MHz)				1717.5	1732.5	1747.5		
15	QPSK	1	0	22.88	22.76	22.73	23.5	0
15	QPSK	1	37	22.64	22.69	22.62		
15	QPSK	1	74	22.60	22.56	22.56		
15	QPSK	36	0	21.74	21.73	21.72	22.5	0-1
15	QPSK	36	18	21.66	21.78	21.64		
15	QPSK	36	37	21.72	21.73	21.59		
15	QPSK	75	0	21.69	21.76	21.65		
15	16QAM	1	0	21.97	21.58	21.59	22.5	0-1
15	16QAM	1	37	21.82	21.54	21.27		
15	16QAM	1	74	21.29	21.36	21.43		
15	16QAM	36	0	20.75	20.76	20.70	21.5	0-2
15	16QAM	36	18	20.68	20.70	20.64		
15	16QAM	36	37	20.72	20.66	20.62		
15	16QAM	75	0	20.70	20.73	20.68		
Channel				20000	20175	20350	Tune up Limit (dBm)	MPR (dB)
Frequency (MHz)				1715	1732.5	1750		
10	QPSK	1	0	22.81	22.76	22.62	23.5	0
10	QPSK	1	24	22.62	22.67	22.51		
10	QPSK	1	49	22.71	22.60	22.58		
10	QPSK	25	0	21.70	21.70	21.61	22.5	0-1
10	QPSK	25	12	21.72	21.74	21.58		
10	QPSK	25	24	21.71	21.70	21.58		
10	QPSK	50	0	21.78	21.75	21.70		
10	16QAM	1	0	21.99	21.79	21.72	22.5	0-1
10	16QAM	1	24	21.77	21.41	21.54		
10	16QAM	1	49	21.92	21.74	21.71		
10	16QAM	25	0	20.77	20.79	20.78	21.5	0-2
10	16QAM	25	12	20.66	20.81	20.69		
10	16QAM	25	24	20.81	20.74	20.71		
10	16QAM	50	0	20.81	20.80	20.75		

Channel				19975	20175	20375	Tune up Limit (dBm)	MPR (dB)
Frequency (MHz)				1712.5	1732.5	1752.5		
5	QPSK	1	0	22.90	22.74	22.69	23.5	0
5	QPSK	1	12	22.68	22.55	22.68		
5	QPSK	1	24	22.62	22.57	22.62		
5	QPSK	12	0	21.76	21.74	21.64	22.5	0-1
5	QPSK	12	6	21.69	21.71	21.65		
5	QPSK	12	11	21.70	21.74	21.46		
5	QPSK	25	0	21.72	21.71	21.55		
5	16QAM	1	0	21.68	21.52	21.43	22.5	0-1
5	16QAM	1	12	21.33	21.48	21.29		
5	16QAM	1	24	21.56	21.41	21.36		
5	16QAM	12	0	20.81	20.94	20.76	21.5	0-2
5	16QAM	12	6	20.76	20.79	20.80		
5	16QAM	12	11	20.87	20.79	20.66		
5	16QAM	25	0	20.73	20.74	20.72		
Channel				19965	20175	20385	Tune up Limit (dBm)	MPR (dB)
Frequency (MHz)				1711.5	1732.5	1753.5		
3	QPSK	1	0	22.66	22.77	22.66	23.5	0
3	QPSK	1	7	22.47	22.54	22.47		
3	QPSK	1	14	22.53	22.61	22.53		
3	QPSK	8	0	21.61	21.78	21.61	22.5	0-1
3	QPSK	8	4	21.53	21.70	21.53		
3	QPSK	8	7	21.47	21.75	21.47		
3	QPSK	15	0	21.62	21.77	21.62		
3	16QAM	1	0	22.07	21.89	22.07	22.5	0-1
3	16QAM	1	7	21.63	21.82	21.63		
3	16QAM	1	14	21.31	21.57	21.31		
3	16QAM	8	0	20.57	20.86	20.57	21.5	0-2
3	16QAM	8	4	20.65	20.79	20.65		
3	16QAM	8	7	20.78	20.71	20.78		
3	16QAM	15	0	20.69	20.73	20.69		
Channel				19957	20175	20393	Tune up Limit (dBm)	MPR (dB)
Frequency (MHz)				1710.7	1732.5	1754.3		
1.4	QPSK	1	0	22.81	22.79	22.68	23.5	0
1.4	QPSK	1	2	22.74	22.74	22.64		
1.4	QPSK	1	5	22.77	22.75	22.59		
1.4	QPSK	3	0	22.80	22.65	22.63		
1.4	QPSK	3	1	22.79	22.70	22.62		
1.4	QPSK	3	2	22.76	22.71	22.64		
1.4	QPSK	6	0	21.84	21.78	21.61	22.5	0-1
1.4	16QAM	1	0	21.98	21.73	21.79	22.5	0-1
1.4	16QAM	1	2	21.66	21.64	21.42		
1.4	16QAM	1	5	21.49	21.40	21.74		
1.4	16QAM	3	0	21.78	21.55	21.50		
1.4	16QAM	3	1	21.73	21.69	21.45		
1.4	16QAM	3	2	21.79	21.67	21.55		
1.4	16QAM	6	0	20.81	20.72	20.54	21.5	0-2

<LTE Band 2>

BW [MHz]	Modulation	RB Size	RB Offset	Power Low Ch. / Freq.	Power Middle Ch. / Freq.	Power High Ch. / Freq.	Tune up Limit (dBm)	MPR (dB)
Channel				18700	18900	19100		
Frequency (MHz)				1860	1880	1900		
20	QPSK	1	0	22.82	23.15	23.12	23.5	0
20	QPSK	1	49	22.77	23.01	22.97		
20	QPSK	1	99	22.78	23.04	23.04		
20	QPSK	50	0	21.92	22.09	22.00	22.5	0-1
20	QPSK	50	24	21.90	22.08	21.97		
20	QPSK	50	49	21.90	22.08	21.99		
20	QPSK	100	0	21.87	22.10	22.04		
20	16QAM	1	0	22.03	21.91	21.78	22.5	0-1
20	16QAM	1	49	21.95	21.78	21.58		
20	16QAM	1	99	21.44	21.64	21.72		
20	16QAM	50	0	20.77	21.02	21.04	21.5	0-2
20	16QAM	50	24	20.88	21.07	21.14		
20	16QAM	50	49	20.90	21.12	21.14		
20	16QAM	100	0	20.78	21.08	21.05		
Channel				18675	18900	19125	Tune up Limit (dBm)	MPR (dB)
Frequency (MHz)				1857.5	1880	1902.5		
15	QPSK	1	0	22.78	23.07	23.10	23.5	0
15	QPSK	1	37	22.70	22.98	23.07		
15	QPSK	1	74	22.71	23.06	23.03		
15	QPSK	36	0	21.80	21.97	22.01	22.5	0-1
15	QPSK	36	18	21.83	22.05	21.98		
15	QPSK	36	37	21.86	22.08	21.94		
15	QPSK	75	0	21.88	22.05	22.03		
15	16QAM	1	0	21.85	22.11	22.11	22.5	0-1
15	16QAM	1	37	21.81	21.97	21.69		
15	16QAM	1	74	21.74	21.66	22.09		
15	16QAM	36	0	20.84	20.94	21.07	21.5	0-2
15	16QAM	36	18	20.79	21.06	20.96		
15	16QAM	36	37	20.85	21.08	21.04		
15	16QAM	75	0	20.84	21.08	21.07		
Channel				18650	18900	19150	Tune up Limit (dBm)	MPR (dB)
Frequency (MHz)				1855	1880	1905		
10	QPSK	1	0	22.83	22.97	22.97	23.5	0
10	QPSK	1	24	22.76	22.93	22.91		
10	QPSK	1	49	22.69	22.94	22.91		
10	QPSK	25	0	21.73	22.02	22.06	22.5	0-1
10	QPSK	25	12	21.72	22.06	22.00		
10	QPSK	25	24	21.83	22.09	22.00		
10	QPSK	50	0	21.81	22.09	22.01		
10	16QAM	1	0	21.91	22.25	22.15	22.5	0-1
10	16QAM	1	24	21.88	21.81	21.60		
10	16QAM	1	49	21.67	22.21	21.81		
10	16QAM	25	0	20.80	21.11	21.11	21.5	0-2
10	16QAM	25	12	20.78	21.14	21.16		
10	16QAM	25	24	20.87	21.12	21.16		
10	16QAM	50	0	20.80	21.09	21.12		

Channel				18625	18900	19175	Tune up Limit (dBm)	MPR (dB)
Frequency (MHz)				1852.5	1880	1907.5		
5	QPSK	1	0	22.66	22.99	23.04	23.5	0
5	QPSK	1	12	22.60	22.98	23.01		
5	QPSK	1	24	22.63	22.93	22.93		
5	QPSK	12	0	21.72	22.02	21.97	22.5	0-1
5	QPSK	12	6	21.73	22.01	22.00		
5	QPSK	12	11	21.70	22.01	22.03		
5	QPSK	25	0	21.71	22.05	22.05		
5	16QAM	1	0	21.79	22.24	21.98	22.5	0-1
5	16QAM	1	12	21.30	22.19	21.93		
5	16QAM	1	24	21.76	22.17	21.85		
5	16QAM	12	0	20.78	21.06	21.14	21.5	0-2
5	16QAM	12	6	20.65	21.19	21.06		
5	16QAM	12	11	20.73	21.19	21.09		
5	16QAM	25	0	20.86	21.17	21.10		
Channel				18615	18900	19185	Tune up Limit (dBm)	MPR (dB)
Frequency (MHz)				1851.5	1880	1908.5		
3	QPSK	1	0	22.74	23.01	23.11	23.5	0
3	QPSK	1	7	22.58	22.95	23.02		
3	QPSK	1	14	22.70	22.99	23.09		
3	QPSK	8	0	21.76	22.08	21.98	22.5	0-1
3	QPSK	8	4	21.77	22.11	22.02		
3	QPSK	8	7	21.72	22.09	21.98		
3	QPSK	15	0	21.72	22.07	22.03		
3	16QAM	1	0	21.55	22.02	22.18	22.5	0-1
3	16QAM	1	7	21.37	21.81	21.69		
3	16QAM	1	14	21.31	22.00	21.95		
3	16QAM	8	0	20.85	21.22	20.93	21.5	0-2
3	16QAM	8	4	20.79	21.00	21.15		
3	16QAM	8	7	20.74	21.18	21.14		
3	16QAM	15	0	20.71	21.08	21.19		
Channel				18607	18900	19193	Tune up Limit (dBm)	MPR (dB)
Frequency (MHz)				1850.7	1880	1909.3		
1.4	QPSK	1	0	22.78	23.06	23.08	23.5	0
1.4	QPSK	1	2	22.69	22.95	22.97		
1.4	QPSK	1	5	22.69	23.02	22.98		
1.4	QPSK	3	0	22.65	23.01	23.02		
1.4	QPSK	3	1	22.71	23.05	23.05		
1.4	QPSK	3	2	22.72	23.02	22.97		
1.4	QPSK	6	0	21.82	22.13	22.04	22.5	0-1
1.4	16QAM	1	0	21.84	22.07	22.20	22.5	0-1
1.4	16QAM	1	2	21.61	22.00	21.80		
1.4	16QAM	1	5	21.49	21.85	22.12		
1.4	16QAM	3	0	21.74	21.96	21.91		
1.4	16QAM	3	1	21.73	21.96	21.97		
1.4	16QAM	3	2	21.62	21.99	21.93		
1.4	16QAM	6	0	20.64	21.06	21.05	21.5	0-2

LTE Carrier Aggregation Conducted Power

Note:

1. According to KDB941225 D05A v01, Uplink maximum output power measurement with downlink carrier aggregation active should be measured, using the highest output channel measured without downlink carrier aggregation, to confirm that uplink maximum output power with downlink carrier aggregation active remains within the specified tune-up tolerance limits and not more than ¼ dB higher than the maximum output measured without downlink carrier aggregation active.
2. Uplink maximum output power with downlink carrier aggregation active does not show more than ¼ dB higher than the maximum output power without downlink carrier aggregation active, therefore SAR evaluation with downlink carrier aggregation active can be excluded.

LTE Band 2 with LTE Band17

Frequency (MHz)	Uplink Channel Number	BW(MHz)	RB Size	RB Offset	Mod	Without CA	With CA 2A+17A 5MHz+5MHz	With CA 2A+17A 5MHz+10MHz
						Average Power (dBm)	Average Power (dBm)	Average Power (dBm)
1852.5	18625	5	1	0	QPSK	22.66	22.52	22.54
1852.5	18625	5	1	12		22.60	22.58	22.55
1852.5	18625	5	1	24		22.63	22.55	22.50
1852.5	18625	5	1	0	16QAM	21.79	21.65	21.70
1852.5	18625	5	1	12		21.30	21.31	21.28
1852.5	18625	5	1	24		21.76	21.60	21.63
1880	18900	5	1	0	QPSK	22.99	22.95	22.92
1880	18900	5	1	12		22.98	22.90	22.91
1880	18900	5	1	24		22.93	22.86	22.88
1880	18900	5	1	0	16QAM	22.24	22.23	22.19
1880	18900	5	1	12		22.19	22.20	22.19
1880	18900	5	1	24		22.17	22.15	22.16
1907.5	19175	5	1	0	QPSK	23.04	23.00	22.98
1907.5	19175	5	1	12		23.01	22.96	22.94
1907.5	19175	5	1	24		22.93	22.90	22.84
1907.5	19175	5	1	0	16QAM	21.98	21.98	21.96
1907.5	19175	5	1	12		21.93	21.88	21.89
1907.5	19175	5	1	24		21.85	21.80	21.82

Frequency (MHz)	Uplink Channel Number	BW(MHz)	RB Size	RB Offset	Mod	Without CA	With CA 2A+17A 10MHz+5MHz	With CA 2A+17A 10MHz+10MHz
						Average Power (dBm)	Average Power (dBm)	Average Power (dBm)
1855	18650	10	1	0	QPSK	22.83	22.85	22.84
1855	18650	10	1	24		22.76	22.73	22.68
1855	18650	10	1	49		22.69	22.62	22.59
1855	18650	10	1	0	16QAM	21.91	21.88	21.86
1855	18650	10	1	24		21.88	21.89	21.80
1855	18650	10	1	49		21.67	21.60	21.62
1880	18900	10	1	0	QPSK	22.97	22.96	22.88
1880	18900	10	1	24		22.93	22.94	22.89
1880	18900	10	1	49		22.94	22.89	22.85
1880	18900	10	1	0	16QAM	22.25	22.26	22.11
1880	18900	10	1	24		21.81	21.80	22.69
1880	18900	10	1	49		22.21	22.16	22.19
1905	19150	10	1	0	QPSK	22.97	22.92	22.83
1905	19150	10	1	24		22.91	22.90	22.84
1905	19150	10	1	49		22.91	22.88	22.92
1905	19150	10	1	0	16QAM	22.15	22.15	22.19
1905	19150	10	1	24		21.60	21.58	22.50
1905	19150	10	1	49		21.81	21.82	22.71

LTE Band 2 with LTE Band 29

Frequency (MHz)	Uplink Channel Number	BW(MHz)	RB Size	RB Offset	Mod	Without CA	With CA 2A+29A 5MHz+5MHz	With CA 2A+29A 5MHz+10MHz
						Average Power (dBm)	Average Power (dBm)	Average Power (dBm)
1852.5	18625	5	1	0	QPSK	22.66	22.58	22.62
1852.5	18625	5	1	12		22.60	22.60	22.56
1852.5	18625	5	1	24		22.63	22.61	22.58
1852.5	18625	5	1	0	16QAM	21.79	21.75	22.73
1852.5	18625	5	1	12		21.30	21.28	21.22
1852.5	18625	5	1	24		21.76	21.69	21.72
1880	18900	5	1	0	QPSK	22.99	22.96	22.92
1880	18900	5	1	12		22.98	22.89	22.92
1880	18900	5	1	24		22.93	22.87	22.83
1880	18900	5	1	0	16QAM	22.24	22.20	22.22
1880	18900	5	1	12		22.19	22.18	22.09
1880	18900	5	1	24		22.17	22.19	22.11
1907.5	19175	5	1	0	QPSK	23.04	22.99	22.96
1907.5	19175	5	1	12		23.01	22.96	22.94
1907.5	19175	5	1	24		22.93	22.89	22.88
1907.5	19175	5	1	0	16QAM	21.98	21.99	21.93
1907.5	19175	5	1	12		21.93	21.92	21.95
1907.5	19175	5	1	24		21.85	21.86	21.80

Frequency (MHz)	Uplink Channel Number	BW(MHz)	RB Size	RB Offset	Mod	Without CA	With CA 2A+29A 10MHz+5MHz	With CA 2A+29A 10MHz+10MHz
						Average Power (dBm)	Average Power (dBm)	Average Power (dBm)
1855	18650	10	1	0	QPSK	22.83	22.78	22.80
1855	18650	10	1	24		22.76	22.70	22.72
1855	18650	10	1	49		22.69	22.60	22.65
1855	18650	10	1	0	16QAM	21.91	21.93	21.88
1855	18650	10	1	24		21.88	21.88	21.83
1855	18650	10	1	49		21.67	21.63	21.66
1880	18900	10	1	0	QPSK	22.97	22.99	22.89
1880	18900	10	1	24		22.93	22.88	22.88
1880	18900	10	1	49		22.94	22.86	22.85
1880	18900	10	1	0	16QAM	22.25	22.26	22.22
1880	18900	10	1	24		21.81	21.84	21.77
1880	18900	10	1	49		22.21	22.20	22.24
1905	19150	10	1	0	QPSK	22.97	22.89	22.86
1905	19150	10	1	24		22.91	22.86	22.89
1905	19150	10	1	49		22.91	22.89	22.87
1905	19150	10	1	0	16QAM	22.15	22.16	22.11
1905	19150	10	1	24		21.60	21.53	21.62
1905	19150	10	1	49		21.81	21.76	21.78

LTE Band 4 with LTE Band17

Frequency (MHz)	Uplink Channel Number	BW(MHz)	RB Size	RB Offset	Mod	Without CA	With CA 4A+17A 5MHz+5MHz	With CA 4A+17A 5MHz+10MHz
						Average Power (dBm)	Average Power (dBm)	Average Power (dBm)
1712.5	19975	5	1	0	QPSK	22.90	22.92	22.88
1712.5	19975	5	1	12		22.68	22.63	22.65
1712.5	19975	5	1	24		22.62	22.60	22.56
1712.5	19975	5	1	0	16QAM	21.68	21.69	21.62
1712.5	19975	5	1	12		21.33	21.33	21.28
1712.5	19975	5	1	24		21.56	21.56	21.50
1732.5	20175	5	1	0	QPSK	22.74	22.68	22.71
1732.5	20175	5	1	12		22.55	22.52	22.48
1732.5	20175	5	1	24		22.57	22.52	22.50
1732.5	20175	5	1	0	16QAM	21.52	21.50	21.46
1732.5	20175	5	1	12		21.48	21.49	21.39
1732.5	20175	5	1	24		21.41	21.38	21.40
1752.5	20375	5	1	0	QPSK	22.69	22.65	22.66
1752.5	20375	5	1	12		22.68	22.60	22.65
1752.5	20375	5	1	24		22.62	22.58	22.56
1752.5	20375	5	1	0	16QAM	21.43	21.43	21.40
1752.5	20375	5	1	12		21.29	21.30	21.25
1752.5	20375	5	1	24		21.36	21.33	21.30

Frequency (MHz)	Uplink Channel Number	BW(MHz)	RB Size	RB Offset	Mod	Without CA	With CA 4A+17A 10MHz+5MHz	With CA 4A+17A 10MHz+10MHz
						Average Power (dBm)	Average Power (dBm)	Average Power (dBm)
1715	20000	10	1	0	QPSK	22.81	22.77	22.76
1715	20000	10	1	24		22.62	22.60	22.58
1715	20000	10	1	49		22.71	22.68	22.66
1715	20000	10	1	0	16QAM	21.99	21.92	21.89
1715	20000	10	1	24		21.77	21.76	21.72
1715	20000	10	1	49		21.92	21.90	21.88
1732.5	20175	10	1	0	QPSK	22.76	22.71	22.69
1732.5	20175	10	1	24		22.67	22.65	22.59
1732.5	20175	10	1	49		22.60	22.56	22.56
1732.5	20175	10	1	0	16QAM	21.79	21.75	21.76
1732.5	20175	10	1	24		21.41	21.38	21.39
1732.5	20175	10	1	49		21.74	21.75	21.72
1750	20350	10	1	0	QPSK	22.62	22.62	22.59
1750	20350	10	1	24		22.51	22.50	22.46
1750	20350	10	1	49		22.58	22.49	22.52
1750	20350	10	1	0	16QAM	21.72	21.65	21.66
1750	20350	10	1	24		21.54	21.56	21.49
1750	20350	10	1	49		21.71	21.69	21.66

LTE Band 4 with LTE Band 29

Frequency (MHz)	Uplink Channel Number	BW(MHz)	RB Size	RB Offset	Mod	Without CA	With CA 4A+29A 5MHz+5MHz	With CA 4A+29A 5MHz+10MHz
						Average Power (dBm)	Average Power (dBm)	Average Power (dBm)
1712.5	19975	5	1	0	QPSK	22.90	22.86	22.88
1712.5	19975	5	1	12		22.68	22.70	22.63
1712.5	19975	5	1	24		22.62	22.60	22.59
1712.5	19975	5	1	0	16QAM	21.68	21.66	21.62
1712.5	19975	5	1	12		21.33	21.30	21.29
1712.5	19975	5	1	24		21.56	21.52	21.50
1732.5	20175	5	1	0	QPSK	22.74	22.70	22.67
1732.5	20175	5	1	12		22.55	22.53	22.41
1732.5	20175	5	1	24		22.57	22.55	22.46
1732.5	20175	5	1	0	16QAM	21.52	21.49	21.45
1732.5	20175	5	1	12		21.48	21.43	21.40
1732.5	20175	5	1	24		21.41	21.36	21.40
1752.5	20375	5	1	0	QPSK	22.69	22.65	22.66
1752.5	20375	5	1	12		22.68	22.63	22.59
1752.5	20375	5	1	24		22.62	22.59	22.54
1752.5	20375	5	1	0	16QAM	21.43	21.44	21.40
1752.5	20375	5	1	12		21.29	21.22	21.25
1752.5	20375	5	1	24		21.36	21.30	21.33

Frequency (MHz)	Uplink Channel Number	BW(MHz)	RB Size	RB Offset	Mod	Without CA	With CA 4A+29A 10MHz+5MHz	With CA 4A+29A 10MHz+10MHz
						Average Power (dBm)	Average Power (dBm)	Average Power (dBm)
1715	20000	10	1	0	QPSK	22.81	22.78	22.77
1715	20000	10	1	24		22.62	22.65	22.63
1715	20000	10	1	49		22.71	22.69	22.68
1715	20000	10	1	0	16QAM	21.99	21.95	21.92
1715	20000	10	1	24		21.77	21.75	21.69
1715	20000	10	1	49		21.92	21.88	21.87
1732.5	20175	10	1	0	QPSK	22.76	22.77	22.76
1732.5	20175	10	1	24		22.67	22.63	22.64
1732.5	20175	10	1	49		22.60	22.58	22.55
1732.5	20175	10	1	0	16QAM	21.79	21.75	21.69
1732.5	20175	10	1	24		21.41	21.42	21.35
1732.5	20175	10	1	49		21.74	21.70	21.72
1750	20350	10	1	0	QPSK	22.62	22.59	22.58
1750	20350	10	1	24		22.51	22.48	22.46
1750	20350	10	1	49		22.58	22.55	22.56
1750	20350	10	1	0	16QAM	21.72	21.74	21.69
1750	20350	10	1	24		21.54	21.52	21.50
1750	20350	10	1	49		21.71	21.66	21.68

LTE Band 17 with LTE Band 2

Frequency (MHz)	Uplink Channel Number	BW(MHz)	RB Size	RB Offset	Mod	Without CA	With CA 17A+2A 5MHz+5MHz	With CA 17A+2A 5MHz+10MHz
						Average Power (dBm)	Average Power (dBm)	Average Power (dBm)
706.5	23755	5	1	0	QPSK	22.97	22.89	22.91
706.5	23755	5	1	12		22.80	22.79	22.82
706.5	23755	5	1	24		23.09	23.00	23.05
706.5	23755	5	1	0	16QAM	21.88	21.86	21.88
706.5	23755	5	1	12		21.99	21.95	21.90
706.5	23755	5	1	24		22.11	22.02	22.08
710	23790	5	1	0	QPSK	23.02	22.98	23.03
710	23790	5	1	12		22.94	22.92	22.93
710	23790	5	1	24		23.14	23.02	23.11
710	23790	5	1	0	16QAM	22.22	22.15	22.25
710	23790	5	1	12		22.27	22.20	22.31
710	23790	5	1	24		22.32	22.21	22.30
713.5	23825	5	1	0	QPSK	23.07	23.05	23.02
713.5	23825	5	1	12		23.04	23.01	23.05
713.5	23825	5	1	24		23.11	23.09	23.10
713.5	23825	5	1	0	16QAM	22.02	22.04	22.05
713.5	23825	5	1	12		22.15	22.15	22.18
713.5	23825	5	1	24		22.19	22.18	22.21

Frequency (MHz)	Uplink Channel Number	BW(MHz)	RB Size	RB Offset	Mod	Without CA	With CA 17A+2A 10MHz+5MHz	With CA 17A+2A 10MHz+10MHz
						Average Power (dBm)	Average Power (dBm)	Average Power (dBm)
709	23780	10	1	0	QPSK	23.02	23.05	23.05
709	23780	10	1	24		22.98	22.90	22.95
709	23780	10	1	49		23.11	23.08	23.12
709	23780	10	1	0	16QAM	21.76	21.67	21.70
709	23780	10	1	24		22.05	22.08	22.06
709	23780	10	1	49		22.09	22.11	22.12
710	23790	10	1	0	QPSK	23.00	23.05	23.04
710	23790	10	1	24		23.01	23.04	23.06
710	23790	10	1	49		23.20	23.11	23.18
710	23790	10	1	0	16QAM	21.91	21.85	21.88
710	23790	10	1	24		21.95	21.98	21.92
710	23790	10	1	49		21.98	22.02	22.04
711	23800	10	1	0	QPSK	23.10	23.02	23.08
711	23800	10	1	24		23.09	23.12	23.13
711	23800	10	1	49		23.15	23.18	23.17
711	23800	10	1	0	16QAM	21.77	21.80	21.79
711	23800	10	1	24		21.61	21.60	21.66
711	23800	10	1	49		21.85	21.77	21.86

LTE Band 17 with LTE Band 4

Frequency (MHz)	Uplink Channel Number	BW(MHz)	RB Size	RB Offset	Mod	Without CA	With CA 17A+4A 5MHz+5MHz	With CA 17A+4A 5MHz+10MHz
						Average Power (dBm)	Average Power (dBm)	Average Power (dBm)
706.5	23755	5	1	0	QPSK	22.97	22.92	22.96
706.5	23755	5	1	12		22.80	22.86	22.85
706.5	23755	5	1	24		23.09	23.12	23.11
706.5	23755	5	1	0	16QAM	21.88	21.85	21.88
706.5	23755	5	1	12		21.99	21.92	22.02
706.5	23755	5	1	24		22.11	22.05	22.15
710	23790	5	1	0	QPSK	23.02	22.98	23.05
710	23790	5	1	12		22.94	22.88	22.98
710	23790	5	1	24		23.14	23.16	23.18
710	23790	5	1	0	16QAM	22.22	22.28	22.26
710	23790	5	1	12		22.27	22.18	22.25
710	23790	5	1	24		22.32	22.30	22.36
713.5	23825	5	1	0	QPSK	23.07	23.05	23.02
713.5	23825	5	1	12		23.04	23.08	23.09
713.5	23825	5	1	24		23.11	23.15	23.12
713.5	23825	5	1	0	16QAM	22.02	22.08	22.05
713.5	23825	5	1	12		22.15	22.18	22.19
713.5	23825	5	1	24		22.19	22.11	22.15

Frequency (MHz)	Uplink Channel Number	BW(MHz)	RB Size	RB Offset	Mod	Without CA	With CA 17A+4A 10MHz+5MHz	With CA 17A+4A 10MHz+10MHz
						Average Power (dBm)	Average Power (dBm)	Average Power (dBm)
709	23780	10	1	0	QPSK	23.02	23.05	23.08
709	23780	10	1	24		22.98	22.92	22.95
709	23780	10	1	49		23.11	23.08	23.12
709	23780	10	1	0	16QAM	21.76	21.80	21.82
709	23780	10	1	24		22.05	22.11	22.08
709	23780	10	1	49		22.09	22.13	22.11
710	23790	10	1	0	QPSK	23.00	23.05	23.03
710	23790	10	1	24		23.01	23.00	23.05
710	23790	10	1	49		23.20	23.18	23.15
710	23790	10	1	0	16QAM	21.91	21.92	21.95
710	23790	10	1	24		21.95	21.98	21.92
710	23790	10	1	49		21.98	21.93	21.95
711	23800	10	1	0	QPSK	23.10	23.15	23.11
711	23800	10	1	24		23.09	23.12	23.10
711	23800	10	1	49		23.15	23.18	23.16
711	23800	10	1	0	16QAM	21.77	21.80	21.75
711	23800	10	1	24		21.61	21.62	21.58
711	23800	10	1	49		21.85	21.88	21.89

<WLAN Conducted Power>

General Note:

1. For 2.4GHz SISO WLAN SAR testing, highest average RF output power channel for the lowest data rate for 802.11b were selected for SAR evaluation. 802.11g/n HT20/HT40 were not investigated since the average output powers over all channels and data rates were not more than 0.25 dB higher than the tested channel in the lowest data rate of 802.11b mode.
2. For 2.4 GHz MIMO, 802.11n-HT20MHz was evaluated, 802.11n-HT40 maximum power not more than 0.25 dB higher than 802.11n-HT20MHz, so SAR can be excluded.
3. For 5.2 GHz/5.8 GHz SISO WLAN SAR testing, 802.11a mode were evaluated, 802.11a /n -HT20/HT40 SAR test can be excluded , for maximum power not more than 0.25 dB higher than 802.11a mode.
4. For 5.2GHz/5.8 GHz MIMO SAR testing, 802.11an-HT20MHz were evaluated, 802.11n-HT40 SAR can be excluded for maximum power is not more than 0.25 dB higher than 802.11n-HT20.

<WLAN 2.4GHz>

WLAN 2.4GHz 802.11b Average Power (dBm)								Tune up Limit (dBm)
Power vs. Channel				Power vs. Data Rate				
Channel	Frequency (MHz)	Chain Port	Data Rate 1Mbps	Channel	2Mbps	5.5Mbps	11Mbps	
CH 01	2412	0	**15.12**	CH 01	14.99	15.10	15.06	15.5
CH 06	2437	0	14.46					15.0
CH 11	2462	0	14.14					15.0
CH 01	2412	1	14.32	CH 06	14.96	15.29	15.35	14.5
CH 06	2437	1	**15.39**					15.5
CH 11	2462	1	14.98					15.0

WLAN 2.4GHz 802.11g Average Power (dBm)												Tune up Limit (dBm)
Power vs. Channel				Power vs. Data Rate								
Channel	Frequency (MHz)	Chain Port	Data Rate 6Mbps	Channel	9Mbps	12Mbps	18Mbps	24Mbps	36Mbps	48Mbps	54Mbps	
CH 01	2412	0	**13.96**	CH 01	13.69	13.86	13.89	13.95	13.81	13.62	13.76	14.5
CH 06	2437	0	12.92									13.5
CH 11	2462	0	12.51									13.0
CH 01	2412	1	13.89	CH 11	15.03	14.93	15.06	14.94	14.91	15.07	14.99	14.0
CH 06	2437	1	14.92									15.0
CH 11	2462	1	**15.08**									15.5

WLAN 2.4GHz 802.11n HT20 Average Power (dBm)												Tune up Limit (dBm)
Power vs. Channel				Power vs. MCS Index								
Channel	Frequency (MHz)	Chain Port	MCS Index MCS0	Channel	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7	
CH 01	2412	0	13.08	CH 06	13.42	13.35	13.38	13.54	13.52	13.54	13.45	13.5
CH 06	2437	0	**13.58**									14.0
CH 11	2462	0	12.57									13.0
CH 01	2412	1	13.45	CH 06	14.40	14.38	14.48	14.44	14.47	14.46	14.41	13.5
CH 06	2437	1	**14.50**									15.0
CH 11	2462	1	14.09									14.5
CH 01	2412	0+1	13.93	CH 06	14.11	14.26	14.51	14.59	14.69	14.69	14.68	14.0
CH 06	2437	0+1	**14.71**									15.0
CH 11	2462	0+1	13.73									14.0

WLAN 2.4GHz 802.11n HT40 Average Power (dBm)												Tune up Limit (dBm)
Power vs. Channel				Power vs. MCS Index								
Channel	Frequency (MHz)	Chain Port	MCS Index MCS0	Channel	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7	
CH 03	2422	0	12.15	CH 06	12.84	12.64	12.84	12.80	12.89	12.88	12.90	12.5
CH 06	2437	0	**12.97**									13.5
CH 09	2452	0	12.35									12.5
CH 03	2422	1	11.64	CH 06	12.47	12.75	12.90	12.98	12.90	12.83	12.86	12.0
CH 06	2437	1	**13.06**									13.5
CH 09	2452	1	12.20									12.5
CH 03	2422	0+1	12.64	CH 06	12.96	13.15	13.24	13.24	13.14	12.74	12.53	13.0
CH 06	2437	0+1	**13.25**									13.5
CH 09	2452	0+1	12.98									13.5

<5GHz WLAN>

WLAN 5GHz 802.11a Average Power (dBm)												Tune up Limit (dBm)
Power vs. Channel				Power vs. Data Rate								
Channel	Frequency (MHz)	Chain Port	Data Rate 6Mbps	Channel	9Mbps	12Mbps	18Mbps	24Mbps	36Mbps	48Mbps	54Mbps	
CH 36	5180	0	15.07	CH 48	15.53	15.39	15.46	15.60	15.63	15.54	15.58	16.0
CH 40	5200	0	14.73									
CH 44	5220	0	15.37									
CH 48	5240	0	**15.68**									
CH 149	5745	0	11.55	CH 157	11.64	11.54	11.68	11.84	11.83	11.80	11.82	12.0
CH 153	5765	0	11.44									
CH 157	5785	0	**11.86**									
CH 161	5805	0	11.66									
CH 165	5825	0	11.54									
CH 36	5180	1	**12.58**	CH 36	12.29	12.38	12.46	12.53	12.39	12.48	12.54	13.0
CH 40	5200	1	12.33									
CH 44	5220	1	12.00									
CH 48	5240	1	12.21									
CH 149	5745	1	10.36	CH 165	10.32	10.43	10.53	10.69	10.64	10.58	10.60	11.0
CH 153	5765	1	10.44									
CH 157	5785	1	10.15									
CH 161	5805	1	10.10									
CH 165	5825	1	**10.70**									

WLAN 5GHz 802.11n HT20 Average Power (dBm)												Tune up Limit (dBm)
Power vs. Channel				Power vs. MCS Index								
Channel	Frequency (MHz)	Chain Port	MCS Index MCS0	Channel	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7	
CH 36	5180	0	15.30	CH 48	15.15	15.09	15.37	15.38	15.53	15.45	15.50	16.0
CH 40	5200	0	15.15									
CH 44	5220	0	15.39									
CH 48	5240	0	**15.53**									
CH 149	5745	0	11.03	CH 165	11.26	11.41	11.46	11.72	11.67	11.72	11.71	12.0
CH 153	5765	0	10.96									
CH 157	5785	0	11.19									
CH 161	5805	0	11.38									
CH 165	5825	0	**11.73**									
CH 36	5180	1	**12.70**	CH 36	12.34	12.47	12.56	12.67	12.59	12.65	12.65	13.0
CH 40	5200	1	12.53									
CH 44	5220	1	11.85									
CH 48	5240	1	11.97									
CH 149	5745	1	10.65	CH 165	10.50	10.69	10.74	10.72	10.71	10.66	10.51	11.0
CH 153	5765	1	10.57									
CH 157	5785	1	10.48									
CH 161	5805	1	10.41									
CH 165	5825	1	**10.75**									
CH 36	5180	0+1	17.03	CH 48	17.12	17.07	17.05	17.08	16.89	16.79	16.85	17.5
CH 40	5200	0+1	16.91									
CH 44	5220	0+1	17.12									
CH 48	5240	0+1	**17.35**									
CH 149	5745	0+1	**14.13**	CH 149	13.88	13.77	13.76	13.66	13.45	13.54	13.67	14.5
CH 153	5765	0+1	13.92									
CH 157	5785	0+1	13.82									
CH 161	5805	0+1	13.84									
CH 165	5825	0+1	13.91									

WLAN 5GHz 802.11n HT40 Average Power (dBm)												Tune up Limit (dBm)
Power vs. Channel				Power vs. MCS Index								
Channel	Frequency (MHz)	Chain Port	MCS Index MCS0	Channel	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7	
CH 38	5190	0	13.44	CH 46	13.46	13.55	13.67	13.85	13.65	13.65	13.66	14.0
CH 46	5230	0	**13.89**									
CH 151	5755	0	**9.07**	CH 151	8.73	8.78	8.84	9.04	9.02	8.98	9.05	10.0
CH 159	5795	0	8.88									
CH 38	5190	1	**10.76**	CH 38	10.28	10.39	10.68	10.64	10.71	10.63	10.67	11.0
CH 46	5230	1	10.48									
CH 151	5755	1	**9.04**	CH 151	8.68	8.62	8.95	8.83	8.99	9.00	9.02	10.0
CH 159	5795	1	8.48									
CH 38	5190	0+1	**15.00**	CH 38	14.76	14.69	14.70	14.79	14.76	14.72	14.74	15.5
CH 46	5230	0+1	14.82									
CH 151	5755	0+1	**11.61**	CH 151	11.34	11.36	11.44	11.51	11.53	11.41	11.48	12.0
CH 159	5795	0+1	11.28									

13. Bluetooth Exclusions Applied

Mode Band	Average power(dBm)	
	Bluetooth v2.1+EDR	Bluetooth v4.0 LE
2.4GHz Bluetooth	3.0	4.0

Note:

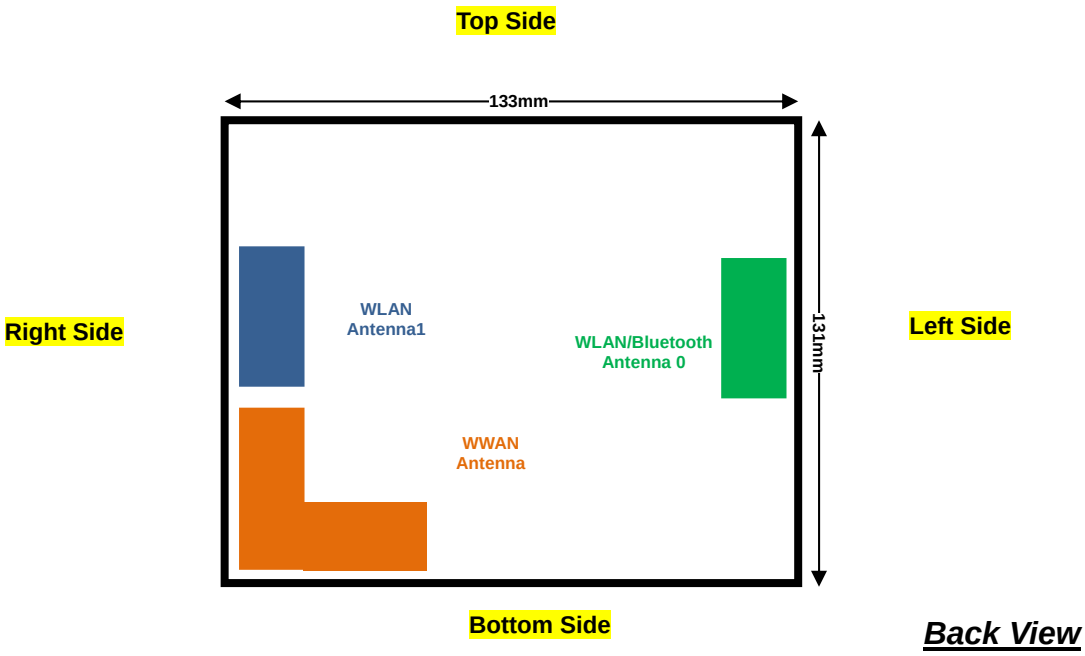
1. Per KDB 447498 D01v05r02, the 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at *test separation distances* ≤ 50 mm are determined by:
   [(*max. power of channel, including tune-up tolerance, mW*)/(*min. test separation distance, mm*)] ·[√f(GHz)] ≤ 3.0 for 1-g SAR and ≤ 7.5 for 10-g extremity SAR
   - 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

Bluetooth Max Power (dBm)	Separation Distance (mm)	Frequency (GHz)	exclusion thresholds
4.0	< 5	2.48	0.5

Note:

Per KDB 447498 D01v05r02, when the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion. The test exclusion threshold is 0.5 which is <= 3, SAR testing is not required.

14. Antenna Location



Distance of the Antenna to the EUT surface/edge						
Antennas	Back	Front	Top Side	Bottom Side	Right Side	Left Side
WWAN	≤ 25mm	≤ 25mm	109mm	≤ 25mm	≤ 25mm	92mm
WLAN/Bluetooth(0)	≤ 25mm	≤ 25mm	77mm	45mm	129mm	≤ 25mm
WLAN(1)	≤ 25mm	≤ 25mm	70mm	43mm	≤ 25mm	123mm

Positions for SAR tests; Hotspot mode						
Antennas	Back	Front	Top Side	Bottom Side	Right Side	Left Side
WWAN	Yes	Yes	No	Yes	Yes	No
WLAN/Bluetooth(0)	Yes	Yes	No	No	No	Yes
WLAN(1)	Yes	Yes	No	No	Yes	No

General Note:

1. This product has three transmitter antenna paths, WWAN Primary Antenna for WCDMA Band 2/5 and LTE Band 2/4/5/17, Antenna 0 for WLAN/Bluetooth, WLAN Antenna 1 for WLAN. Each antenna path can transmit simultaneously.
2. Referring to KDB 941225 D06 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.

15. SAR Test Results

General Note:

1. Per KDB 447498 D01v05r02, the reported SAR is the measured SAR value adjusted for maximum tune-up tolerance.
   a. Tune-up scaling Factor = tune-up limit power (mW) / EUT RF power (mW), where tune-up limit is the maximum rated power among all production units.
   b. For SAR testing of WLAN signal with non-100% duty cycle, the measured SAR is scaled-up by the duty cycle scaling factor which is equal to "1/(duty cycle)"
   c. For WWAN: Reported SAR(W/kg)= Measured SAR(W/kg)*Tune-up Scaling Factor
   d. For WLAN: Reported SAR(W/kg)= Measured SAR(W/kg)* Duty Cycle scaling factor * Tune-up scaling factor
2. Per KDB 447498 D01v05r02, for each exposure position, testing of other required channels within the operating mode of a frequency band is not required when the *reported* 1-g or 10-g SAR for the mid-band or highest output power channel is:
   - ≤ 0.8 W/kg or 2.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≤ 100 MHz
   - ≤ 0.6 W/kg or 1.5 W/kg, for 1-g or 10-g respectively, when the transmission band is between 100 MHz and 200 MHz
   - ≤ 0.4 W/kg or 1.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≥ 200 MHz
3. Per KDB 941225 D01v03, SAR for next to the ear head / Hotspot / Body-worn exposure is measured using a 12.2 kbps RMC with TPC bits configured to all “1’s”.
4. Per KDB 941225 D01v03, RMC 12.2kbps setting is used to evaluate SAR. If the maximum output power and tune-up tolerance specified for production units in HSDPA / HSUPA is ≤ ¼ dB higher than RMC 12.2Kbps or when the highest reported SAR of the RMC12.2Kbps is scaled by the ratio of specified maximum output power and tune-up tolerance of HSDPA / HSUPA to RMC12.2Kbps and the adjusted SAR is ≤ 1.2 W/kg, SAR measurement is not required for HSDPA / HSUPA.
5. Per KDB 941225 D05v02r03, start with the largest channel bandwidth and measure SAR for QPSK with 1 RB allocation, using the RB offset and required test channel combination with the highest maximum output power for RB offsets at the upper edge, middle and lower edge of each required test channel.
6. Per KDB 941225 D05v02r03, 50% RB allocation for QPSK SAR testing follows 1RB QPSK allocation procedure.
7. Per KDB 941225 D05v02r03, For QPSK with 100% RB allocation, SAR is not required when the highest maximum output power for 100 % RB allocation is less than the highest maximum output power in 50% and 1 RB allocations and the highest reported SAR for 1 RB and 50% RB allocation are ≤ 0.8 W/kg. Otherwise, SAR is measured for the highest output power channel; and if the reported SAR is > 1.45 W/kg, the remaining required test channels must also be tested.
8. Per KDB 941225 D05v02r03, 16QAM output power for each RB allocation configuration is > not ½ dB higher than the same configuration in QPSK and the reported SAR for the QPSK configuration is ≤ 1.45 W/kg; Per KDB 941225 D05v02r03, 16QAM SAR testing is not required.
9. Per KDB 941225 D05v02r03, Smaller bandwidth output power for each RB allocation configuration is > not ½ dB higher than the same configuration in the largest supported bandwidth, and the reported SAR for the largest supported bandwidth is ≤ 1.45 W/kg; Per KDB 941225 D05v02r03, smaller bandwidth SAR testing is not required.
10. This device 2.4GHz WLAN supports Hotspot operation, 5.8GHz WLAN supports WiFi Direct (Group Client / Group Owner), and 5.2GHz supports WiFi Direct (Group Client only).

15.1 Body SAR

<WCDMA SAR>

Plot No.	Band	Mode	Test Position	Gap (cm)	Ch.	Freq. (MHz)	Average Power (dBm)	Tune-Up Limit (dBm)	Tune-up Scaling Factor	Power Drift (dB)	Measured 1g SAR (W/kg)	Reported 1g SAR (W/kg)
#01	WCDMA Band V	RMC 12.2K	Front	1	4233	846.6	22.85	24.00	1.303	0.06	0.403	**0.525**
	WCDMA Band V	RMC 12.2K	Back	1	4233	846.6	22.85	24.00	1.303	0.15	0.298	0.388
	WCDMA Band V	RMC 12.2K	Right Side	1	4233	846.6	22.85	24.00	1.303	-0.1	0.306	0.399
	WCDMA Band V	RMC 12.2K	Bottom Side	1	4233	846.6	22.85	24.00	1.303	0.06	0.301	0.392
	WCDMA Band II	RMC 12.2Kbps	Front	1	9400	1800	22.93	24.00	1.279	-0.03	0.406	0.519
	WCDMA Band II	RMC 12.2Kbps	Back	1	9400	1800	22.93	24.00	1.279	-0.1	0.752	0.962
	WCDMA Band II	RMC 12.2Kbps	Back	1	9262	1852.4	22.80	24.00	1.318	-0.1	0.628	0.828
	WCDMA Band II	RMC 12.2Kbps	Back	1	9538	1907.6	22.69	24.00	1.352	0.11	0.699	0.945
	WCDMA Band II	RMC 12.2Kbps	Right Side	1	9400	1800	22.93	24.00	1.279	-0.07	0.279	0.357
	WCDMA Band II	RMC 12.2Kbps	Bottom Side	1	9400	1800	22.93	24.00	1.279	-0.04	0.845	1.081
	WCDMA Band II	RMC 12.2Kbps	Bottom Side	1	9262	1852.4	22.80	24.00	1.318	-0.09	0.828	1.092
#02	WCDMA Band II	RMC 12.2Kbps	Bottom Side	1	9538	1907.6	22.69	24.00	1.352	-0.11	0.879	**1.188**

<LTE SAR>

Plot No.	Band	BW (MHz)	RB Size	RB offest	Modulation	Test Position	Gap (cm)	Ch.	Freq. (MHz)	Average Power (dBm)	Tune-Up Limit (dBm)	Tune-up Scaling Factor	Power Drift (dB)	Measured 1g SAR (W/kg)	Reported 1g SAR (W/kg)
#03	LTE Band 17	10	1	49	QPSK	Front	1	23790	710	23.20	24.00	1.202	-0.11	0.351	**0.422**
	LTE Band 17	10	25	0	QPSK	Front	1	23790	710	22.18	23.00	1.208	-0.1	0.298	0.360
	LTE Band 17	10	1	49	QPSK	Back	1	23790	710	23.20	24.00	1.202	-0.03	0.212	0.255
	LTE Band 17	10	25	0	QPSK	Back	1	23790	710	22.18	23.00	1.208	-0.17	0.175	0.211
	LTE Band 17	10	1	49	QPSK	Right Side	1	23790	710	23.20	24.00	1.202	-0.039	0.175	0.210
	LTE Band 17	10	25	0	QPSK	Right Side	1	23790	710	22.18	23.00	1.208	-0.04	0.138	0.167
	LTE Band 17	10	1	49	QPSK	Bottom Side	1	23790	710	23.20	24.00	1.202	-0.02	0.286	0.344
	LTE Band 17	10	25	0	QPSK	Bottom Side	1	23790	710	22.18	23.00	1.208	0.079	0.226	0.273
#04	LTE Band 5	10	1	0	QPSK	Front	1	20525	836.5	23.01	24.00	1.256	-0.04	0.437	**0.549**
	LTE Band 5	10	25	0	QPSK	Front	1	20525	836.5	21.97	23.00	1.268	0.08	0.345	0.437
	LTE Band 5	10	1	0	QPSK	Back	1	20525	836.5	23.01	24.00	1.256	-0.17	0.385	0.484
	LTE Band 5	10	25	0	QPSK	Back	1	20525	836.5	21.97	23.00	1.268	-0.14	0.331	0.420
	LTE Band 5	10	1	0	QPSK	Right Side	1	20525	836.5	23.01	24.00	1.256	-0.09	0.314	0.394
	LTE Band 5	10	25	0	QPSK	Right Side	1	20525	836.5	21.97	23.00	1.268	-0.11	0.247	0.313
	LTE Band 5	10	1	0	QPSK	Bottom Side	1	20525	836.5	23.01	24.00	1.256	-0.0093	0.220	0.276
	LTE Band 5	10	25	0	QPSK	Bottom Side	1	20525	836.5	21.97	23.00	1.268	-0.01	0.175	0.222

Plot No.	Band	BW (MHz)	RB Size	RB offest	Modulation	Test Position	Gap (cm)	Ch.	Freq. (MHz)	Average Power (dBm)	Tune-Up Limit (dBm)	Tune-up Scaling Factor	Power Drift (dB)	Measured 1g SAR (W/kg)	Reported 1g SAR (W/kg)
	LTE Band 4	20	1	0	QPSK	Front	1	20175	1732.5	22.91	23.50	1.146	0.1	0.591	0.677
	LTE Band 4	20	50	0	QPSK	Front	1	20175	1732.5	21.78	22.50	1.180	-0.01	0.541	0.639
	LTE Band 4	20	1	0	QPSK	Back	1	20175	1732.5	22.91	23.50	1.146	-0.16	0.919	1.053
	LTE Band 4	20	1	0	QPSK	Back	1	20050	1720	22.73	23.50	1.194	-0.03	0.905	1.081
	LTE Band 4	20	1	0	QPSK	Back	1	20300	1745	22.69	23.50	1.205	0.0037	0.932	1.123
	LTE Band 4	20	50	0	QPSK	Back	1	20175	1732.5	21.78	22.50	1.180	-0.03	0.759	0.896
	LTE Band 4	20	50	0	QPSK	Back	1	20050	1720	21.76	22.50	1.186	0.036	0.735	0.872
	LTE Band 4	20	50	0	QPSK	Back	1	20300	1745	21.74	22.50	1.191	-0.089	0.760	0.905
	LTE Band 4	20	100	0	QPSK	Back	1	20175	1732.5	21.83	22.50	1.167	0.02	0.761	0.888
	LTE Band 4	20	1	0	QPSK	Right Side	1	20175	1732.5	22.91	23.50	1.146	-0.12	0.309	0.354
	LTE Band 4	20	50	0	QPSK	Right Side	1	20175	1732.5	21.78	22.50	1.180	0.04	0.255	0.301
	LTE Band 4	20	1	0	QPSK	Bottom Side	1	20175	1732.5	22.91	23.50	1.146	-0.09	1.120	1.283
#05	LTE Band 4	20	1	0	QPSK	Bottom Side	1	20050	1720	22.73	23.50	1.194	-0.13	1.190	**1.421**
	LTE Band 4	20	1	0	QPSK	Bottom Side	1	20300	1745	22.69	23.50	1.205	-0.14	1.120	1.350
	LTE Band 4	20	50	0	QPSK	Bottom Side	1	20175	1732.5	21.78	22.50	1.180	-0.02	0.893	1.054
	LTE Band 4	20	50	0	QPSK	Bottom Side	1	20050	1720	21.76	22.50	1.186	-0.14	0.943	1.118
	LTE Band 4	20	50	0	QPSK	Bottom Side	1	20300	1745	21.74	22.50	1.191	-0.13	0.907	1.080
	LTE Band 4	20	100	0	QPSK	Bottom Side	1	20175	1732.5	21.83	22.50	1.167	-0.16	0.924	1.078

Plot No.	Band	BW (MHz)	RB Size	RB offest	Modulation	Test Position	Gap (cm)	Ch.	Freq. (MHz)	Average Power (dBm)	Tune-Up Limit (dBm)	Tune-up Scaling Factor	Power Drift (dB)	Measured 1g SAR (W/kg)	Reported 1g SAR (W/kg)
	LTE Band 2	20	1	0	QPSK	Front	1	18900	1880	23.15	23.50	1.084	0.19	0.374	0.405
	LTE Band 2	20	50	0	QPSK	Front	1	18900	1880	22.09	22.50	1.099	-0.13	0.353	0.388
	LTE Band 2	20	1	0	QPSK	Back	1	18900	1880	23.15	23.50	1.084	-0.07	0.741	0.803
	LTE Band 2	20	1	0	QPSK	Back	1	18700	1860	22.82	23.50	1.169	-0.007	0.871	1.019
	LTE Band 2	20	1	0	QPSK	Back	1	19100	1900	23.12	23.50	1.091	-0.17	0.813	0.887
	LTE Band 2	20	50	0	QPSK	Back	1	18900	1880	22.09	22.50	1.099	-0.12	0.662	0.728
	LTE Band 2	20	100	0	QPSK	Back	1	18900	1880	22.10	22.50	1.096	-0.03	0.645	0.707
	LTE Band 2	20	1	0	QPSK	Right Side	1	18900	1880	23.15	23.50	1.084	-0.12	0.275	0.298
	LTE Band 2	20	50	0	QPSK	Right Side	1	18900	1880	22.09	22.50	1.099	0.13	0.236	0.259
	LTE Band 2	20	1	0	QPSK	Bottom Side	1	18900	1880	23.15	23.50	1.084	-0.18	0.877	0.951
#06	LTE Band 2	20	1	0	QPSK	Bottom Side	1	18700	1860	22.82	23.50	1.169	-0.12	1.010	**1.181**
	LTE Band 2	20	1	0	QPSK	Bottom Side	1	19100	1900	23.12	23.50	1.091	-0.12	0.885	0.966
	LTE Band 2	20	50	0	QPSK	Bottom Side	1	18900	1880	22.09	22.50	1.099	-0.04	0.691	0.759
	LTE Band 2	20	100	0	QPSK	Bottom Side	1	18900	1880	22.10	22.50	1.096	-0.09	0.649	0.712

<DTS WLAN SAR>

Plot No.	Band	Mode	Test Position	Gap (cm)	Ant.	Ch.	Freq. (MHz)	Average Power (dBm)	Tune-Up Limit (dBm)	Tune-up Scaling Factor	Duty Cycle %	Duty Cycle Scaling Factor	Power Drift (dB)	Measured 1g SAR (W/kg)	Reported 1g SAR (W/kg)
	WLAN 2.4GHz	802.11b 1Mbps	Front	1	0	1	2412	15.12	15.50	1.091	100	1.000	0.02	0.234	0.255
	WLAN 2.4GHz	802.11b 1Mbps	Back	1	0	1	2412	15.12	15.50	1.091	100	1.000	-0.19	0.066	0.072
	WLAN 2.4GHz	802.11b 1Mbps	Left Side	1	0	1	2412	15.12	15.50	1.091	100	1.000	-0.03	0.235	0.256
	WLAN 2.4GHz	802.11b 1Mbps	Front	1	1	6	2437	15.39	15.50	1.026	100	1.000	0.055	0.093	0.095
	WLAN 2.4GHz	802.11b 1Mbps	Back	1	1	6	2437	15.39	15.50	1.026	100	1.000	-0.09	0.088	0.090
#07	WLAN 2.4GHz	802.11b 1Mbps	Right Side	1	1	6	2437	15.39	15.50	1.026	100	1.000	-0.06	0.378	**0.388**
	WLAN 2.4GHz	802.11n HT20 MCS0	Front	1	0+1	6	2437	14.71	15.00	1.069	93.02	1.075	0.11	0.097	0.111
	WLAN 2.4GHz	802.11n HT20 MCS0	Back	1	0+1	6	2437	14.71	15.00	1.069	93.02	1.075	0.11	0.033	0.038
	WLAN 2.4GHz	802.11n HT20 MCS0	Left Side	1	0+1	6	2437	14.71	15.00	1.069	93.02	1.075	0.0052	0.097	0.111
	WLAN 2.4GHz	802.11n HT20 MCS0	Right Side	1	0+1	6	2437	14.71	15.00	1.069	93.02	1.075	-0.17	0.139	0.160

<NII WLAN SAR>

Plot No.	Band	Mode	Test Position	Gap (cm)	Ant.	Ch.	Freq. (MHz)	Average Power (dBm)	Tune-Up Limit (dBm)	Tune-up Scaling Factor	Duty Cycle %	Duty Cycle Scaling Factor	Power Drift (dB)	Measured 1g SAR (W/kg)	Reported 1g SAR (W/kg)
	WLAN 5.2GHz	802.11a 6Mbps	Front	1	0	48	5240	15.68	16.00	1.076	93.46	1.070	0.1	0.069	0.079
	WLAN 5.2GHz	802.11a 6Mbps	Back	1	0	48	5240	15.68	16.00	1.076	93.46	1.070	0.12	0.017	0.020
	WLAN 5.2GHz	802.11a 6Mbps	Left Side	1	0	48	5240	15.68	16.00	1.076	93.46	1.070	-0.17	0.060	0.069
	WLAN 5.2GHz	802.11a 6Mbps	Front	1	1	36	5180	12.58	13.00	1.102	93.46	1.070	0.1	0.033	0.039
	WLAN 5.2GHz	802.11a 6Mbps	Back	1	1	36	5180	12.58	13.00	1.102	93.46	1.070	0.02	0.015	0.018
#08	WLAN 5.2GHz	802.11a 6Mbps	Right Side	1	1	36	5180	12.58	13.00	1.102	93.46	1.070	0.046	0.119	**0.140**
	WLAN 5.2GHz	802.11n HT20 MCS0	Front	1	0+1	48	5240	17.35	17.50	1.035	93.06	1.075	0.03	0.050	0.056
	WLAN 5.2GHz	802.11n HT20 MCS0	Back	1	0+1	48	5240	17.35	17.50	1.035	93.06	1.075	0.12	0.00995	0.011
	WLAN 5.2GHz	802.11n HT20 MCS0	Left Side	1	0+1	48	5240	17.35	17.50	1.035	93.06	1.075	0.023	0.044	0.049
	WLAN 5.2GHz	802.11n HT20 MCS0	Right Side	1	0+1	48	5240	17.35	17.50	1.035	93.06	1.075	0.15	0.106	0.118
	WLAN 5.8GHz	802.11a 6Mbps	Front	1	0	157	5785	11.86	12.00	1.033	93.46	1.070	0.11	0.143	0.158
	WLAN 5.8GHz	802.11a 6Mbps	Back	1	0	157	5785	11.86	12.00	1.033	93.46	1.070	0.12	0.033	0.036
#09	WLAN 5.8GHz	802.11a 6Mbps	Left Side	1	0	157	5785	11.86	12.00	1.033	93.46	1.070	-0.18	0.219	**0.242**
	WLAN 5.8GHz	802.11a 6Mbps	Front	1	1	165	5825	10.70	11.00	1.072	93.46	1.070	0.12	0.067	0.077
	WLAN 5.8GHz	802.11a 6Mbps	Back	1	1	165	5825	10.70	11.00	1.072	93.46	1.070	0.02	0.032	0.037
	WLAN 5.8GHz	802.11a 6Mbps	Right Side	1	1	165	5825	10.70	11.00	1.072	93.46	1.070	0.078	0.16	0.183
	WLAN 5.8GHz	802.11n HT20 MCS0	Front	1	0+1	149	5745	14.13	14.50	1.089	93.06	1.075	0.12	0.133	0.156
	WLAN 5.8GHz	802.11n HT20 MCS0	Back	1	0+1	149	5745	14.13	14.50	1.089	93.06	1.075	0.13	0.048	0.056
	WLAN 5.8GHz	802.11n HT20 MCS0	Left Side	1	0+1	149	5745	14.13	14.50	1.089	93.06	1.075	-0.19	0.164	0.192
	WLAN 5.8GHz	802.11n HT20 MCS0	Right Side	1	0+1	149	5745	14.13	14.50	1.089	93.06	1.075	0.05	0.181	0.212

15.2 Repeated SAR Measurement

No.	Band	BW (MHz)	RB Size	RB offest	Mode	Test Position	Gap (cm)	Ch.	Freq. (MHz)	Average Power (dBm)	Tune-Up Limit (dBm)	Tune-up Scaling Factor	Power Drift (dB)	Measured 1g SAR (W/kg)	Ratio	Reported 1g SAR (W/kg)
1st	LTE Band 4	20	1	0	QPSK	Bottom Side	1	20050	1720	22.73	23.50	1.194	-0.13	1.190	1	1.421
2nd	LTE Band 4	20	1	0	QPSK	Bottom Side	1	20050	1720	22.73	23.50	1.194	-0.03	1.150	1.035	1.373
1st	LTE Band 2	20	1	0	QPSK	Bottom Side	1	18700	1860	22.82	23.50	1.169	-0.12	1.010	1	1.181
2nd	LTE Band 2	20	1	0	QPSK	Bottom Side	1	18700	1860	22.82	23.50	1.169	-0.11	0.997	1.013	1.166

General Note:

1. Per KDB 865664 D01v01r03, for each frequency band, repeated SAR measurement is required only when the measured SAR is ≥0.8W/kg
2. Per KDB 865664 D01v01r03, if the ratio among the repeated measurement is ≤ 1.2 and the measured SAR <1.45W/kg, only one repeated measurement is required.
3. The ratio is the difference in percentage between original and repeated *measured SAR*.
4. All measurement SAR result is scaled-up to account for tune-up tolerance and is compliant.

16. Simultaneous Transmission Analysis

NO.	Simultaneous Transmission Configurations	LTE uFi	Note
		Body	
1.	WCDMA(Data) + WLAN2.4GHz SISO(data)	Yes	2.4GHz Hotspot
2.	WCDMA(Data) + WLAN2.4GHz MIMO(data)	Yes	2.4GHz Hotspot
3.	WCDMA(Data) + WLAN5 GHz SISO(data)	Yes	WiFi Direct
4.	WCDMA(Data) + WLAN5 GHz MIMO(data)	Yes	WiFi Direct
5.	LTE (Data) + WLAN2.4GHz SISO(data)	Yes	2.4GHz Hotspot
6.	LTE (Data) + WLAN2.4GHz MIMO(data)	Yes	2.4GHz Hotspot
7.	LTE (Data) + WLAN5 GHz SISO(data)	Yes	WiFi Direct
8.	LTE (Data) + WLAN5 GHz MIMO(data)	Yes	WiFi Direct
9.	WCDMA(Data) + Bluetooth(data)	Yes	Bluetooth Tethering
10.	LTE(Data) + Bluetooth(data)	Yes	Bluetooth Tethering

General Note:

1. This device has no voice function.
2. This device 2.4GHz WLAN supports hotspot operation, 5.8GHz WLAN supports hotspot /WiFi Direct (GC/GO) and 5.2GHz supports WiFi Direct (GC only).
3. WLAN 2.4GHz antenna0 and Bluetooth share the same antenna, and cannot transmit simultaneously.
   For Bluetooth can't transmission simultaneous with antenna 1 WLAN according to the network signal condition.
4. EUT will choose either WLAN 2.4GHz or WLAN 5GHz according to the network signal condition; therefore, they will not transmit simultaneously.
5. EUT will choose either WCDMA or LTE according to the network signal condition; therefore, they will not transmit simultaneously.
6. The worst case 5 GHz WLAN reported SAR for each configuration was used for SAR summation, regardless of whether the WLAN channel has WiFi Direct(GC/GO). Therefore, the following summations represent the absolute worst cases for simultaneous transmission with 5 GHz WLAN.
7. Per KDB 447498 D01v05r01, simultaneous transmission SAR is compliant if,
   i) Scalar SAR summation < 1.6W/kg.
   ii) SPLSR = $(SAR_1 + SAR_2)^{1.5}$ / (*min. separation distance, mm*), and the peak separation distance is determined from the square root of $[(x_1-x_2)^2 + (y_1-y_2)^2 + (z_1-z_2)^2]$, where (x_1, y_1, z_1) and (x_2, y_2, z_2) are the coordinates of the extrapolated peak SAR locations in the zoom scan
   If SPLSR ≤ 0.04, simultaneously transmission SAR measurement is not necessary
   iii) Simultaneously transmission SAR measurement, and the reported multi-band SAR < 1.6W/kg
8. For simultaneous transmission analysis, Bluetooth SAR is estimated per KDB 447498 D01v05r01 based on the formula below.
   i) (*max. power of channel, including tune-up tolerance, mW*)/(*min. test separation distance, mm*)]·[$\sqrt{f(GHz)/x}$] W/kg for *test separation distances* ≤ 50 mm; where *x* = 7.5 for 1-g SAR, and *x* = 18.75 for 10-g SAR.
   ii) When the minimum test separation distance is < 5mm, the distance is used 5mm to determine SAR test exclusion.
   iii) 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.

Bluetooth Max Power	Exposure Position	Body worn
	Test separation	10 mm
4.0 dBm	Estimated SAR (W/kg)	0.063 W/kg

16.1 Body Exposure Conditions

<WWAN PCB + WLAN (Antenna 0) DTS>

WWAN Band		Exposure Position	WWAN PCB Max. WWAN SAR (W/kg)	WLAN DTS Max. WLAN SAR (W/kg)	Summed SAR (W/kg)	SPLSR	Case No
WCMDA	Band V	Front	0.525	0.255	0.78		
		Back	0.388	0.072	0.46		
		Left side		0.256	0.26		
		Right side	0.399		0.40		
		Bottom side	0.392		0.39		
	Band II	Front	0.519	0.255	0.77		
		Back	0.962	0.072	1.03		
		Left side		0.256	0.26		
		Right side	0.357		0.36		
		Bottom side	1.188		1.19		
LTE	Band 17	Front	0.422	0.255	0.68		
		Back	0.255	0.072	0.33		
		Left side		0.256	0.26		
		Right side	0.210		0.21		
		Bottom side	0.344		0.34		
	Band 5	Front	0.549	0.255	0.80		
		Back	0.484	0.072	0.56		
		Left side		0.256	0.26		
		Right side	0.394		0.39		
		Bottom side	0.276		0.28		
	Band 4	Front	0.677	0.255	0.93		
		Back	1.123	0.072	1.20		
		Left side		0.256	0.26		
		Right side	0.354		0.35		
		Bottom side	1.421		**1.42**		
	Band 2	Front	0.405	0.255	0.66		
		Back	1.019	0.072	1.09		
		Left side		0.256	0.26		
		Right side	0.298		0.30		
		Bottom side	1.181		1.18		

<WWAN PCB + WLAN (Antenna 1) DTS>

WWAN Band		Exposure Position	WWAN PCB Max. WWAN SAR (W/kg)	WLAN DTS Max. WLAN SAR (W/kg)	Summed SAR (W/kg)	SPLSR	Case No
WCMDA	Band V	Front	0.525	0.095	0.62		
		Back	0.388	0.09	0.48		
		Right side	0.399	0.388	0.79		
		Bottom side	0.392		0.39		
	Band II	Front	0.519	0.095	0.61		
		Back	0.962	0.09	1.05		
		Right side	0.357	0.388	0.75		
		Bottom side	1.188		1.19		
LTE	Band 17	Front	0.422	0.095	0.52		
		Back	0.255	0.09	0.35		
		Right side	0.21	0.388	0.60		
		Bottom side	0.344		0.34		
	Band 5	Front	0.549	0.095	0.64		
		Back	0.484	0.09	0.57		
		Right side	0.394	0.388	0.78		
		Bottom side	0.276		0.28		
	Band 4	Front	0.677	0.095	0.77		
		Back	1.123	0.09	1.21		
		Right side	0.354	0.388	0.74		
		Bottom side	1.421		**1.42**		
	Band 2	Front	0.405	0.095	0.50		
		Back	1.019	0.09	1.11		
		Right side	0.298	0.388	0.69		
		Bottom side	1.181		1.18		

<WWAN PCB + WLAN (Antenna 0+1) DTS>

WWAN Band		Exposure Position	WWAN PCB Max. WWAN SAR (W/kg)	WLAN DTS Max. WLAN SAR (W/kg)	Summed SAR (W/kg)	SPLSR	Case No
WCMDA	Band V	Front	0.525	0.111	0.64		
		Back	0.388	0.038	0.43		
		Left side		0.111	0.11		
		Right side	0.399	0.16	0.56		
		Bottom side	0.392		0.39		
	Band II	Front	0.519	0.111	0.63		
		Back	0.962	0.038	1.00		
		Left side		0.111	0.11		
		Right side	0.357	0.16	0.52		
		Bottom side	1.188		1.19		
LTE	Band 17	Front	0.422	0.111	0.53		
		Back	0.255	0.038	0.29		
		Left side		0.111	0.11		
		Right side	0.210	0.16	0.37		
		Bottom side	0.344		0.34		
	Band 5	Front	0.549	0.111	0.66		
		Back	0.484	0.038	0.52		
		Left side		0.111	0.11		
		Right side	0.394	0.16	0.55		
		Bottom side	0.276		0.28		
	Band 4	Front	0.677	0.111	0.79		
		Back	1.123	0.038	1.16		
		Left side		0.111	0.11		
		Right side	0.354	0.16	0.51		
		Bottom side	1.421		**1.42**		
	Band 2	Front	0.405	0.111	0.52		
		Back	1.019	0.038	1.06		
		Left side		0.111	0.11		
		Right side	0.298	0.16	0.46		
		Bottom side	1.181		1.18		

<WWAN PCE+ Bluetooth DSS>

WWAN Band		Exposure Position	WWAN PCE WWAN SAR (W/kg)	Bluetooth DSS Estimated SAR (W/kg)	Summed SAR (W/kg)	SPLSR	Case No
WCMDA	Band V	Front	0.525	0.063	0.59		
		Back	0.388	0.063	0.45		
		Left side		0.063	0.06		
		Right side	0.399	0.063	0.46		
		Bottom side	0.392	0.063	0.46		
	Band II	Front	0.519	0.063	0.58		
		Back	0.962	0.063	1.03		
		Left side		0.063	0.06		
		Right side	0.357	0.063	0.42		
		Bottom side	1.188	0.063	1.25		
LTE	Band 17	Front	0.422	0.063	0.49		
		Back	0.255	0.063	0.32		
		Left side		0.063	0.06		
		Right side	0.210	0.063	0.27		
		Bottom side	0.344	0.063	0.41		
	Band 5	Front	0.549	0.063	0.61		
		Back	0.484	0.063	0.55		
		Left side		0.063	0.06		
		Right side	0.394	0.063	0.46		
		Bottom side	0.276	0.063	0.34		
	Band 4	Front	0.677	0.063	0.74		
		Back	1.123	0.063	1.19		
		Left side		0.063	0.06		
		Right side	0.354	0.063	0.42		
		Bottom side	1.421	0.063	**1.48**		
	Band 2	Front	0.405	0.063	0.47		
		Back	1.019	0.063	1.08		
		Left side		0.063	0.06		
		Right side	0.298	0.063	0.36		
		Bottom side	1.181	0.063	1.24		

<WWAN PCB + WLAN (Antenna 0) NII>

WWAN Band		Exposure Position	WWAN PCB Max. WWAN SAR (W/kg)	WLAN NII Max. WLAN SAR (W/kg)	Summed SAR (W/kg)	SPLSR	Case No
WCMDA	Band V	Front	0.525	0.158	0.68		
		Back	0.388	0.036	0.42		
		Left side		0.242	0.24		
		Right side	0.399		0.40		
		Bottom side	0.392		0.39		
	Band II	Front	0.519	0.158	0.68		
		Back	0.962	0.036	1.00		
		Left side		0.242	0.24		
		Right side	0.357		0.36		
		Bottom side	1.188		1.19		
LTE	Band 17	Front	0.422	0.158	0.58		
		Back	0.255	0.036	0.29		
		Left side		0.242	0.24		
		Right side	0.210		0.21		
		Bottom side	0.344		0.34		
	Band 5	Front	0.549	0.158	0.71		
		Back	0.484	0.036	0.52		
		Left side		0.242	0.24		
		Right side	0.394		0.39		
		Bottom side	0.276		0.28		
	Band 4	Front	0.677	0.158	0.84		
		Back	1.123	0.036	1.16		
		Left side		0.242	0.24		
		Right side	0.354		0.35		
		Bottom side	1.421		**1.42**		
	Band 2	Front	0.405	0.158	0.56		
		Back	1.019	0.036	1.06		
		Left side		0.242	0.24		
		Right side	0.298		0.30		
		Bottom side	1.181		1.18		

<WWAN PCB + WLAN (Antenna 1) NII>

WWAN Band		Exposure Position	WWAN PCB Max. WWAN SAR (W/kg)	WLAN NII Max. WLAN SAR (W/kg)	Summed SAR (W/kg)	SPLSR	Case No
WCMDA	Band V	Front	0.525	0.077	0.60		
		Back	0.388	0.037	0.43		
		Right side	0.399	0.183	0.58		
		Bottom side	0.392		0.39		
	Band II	Front	0.519	0.077	0.60		
		Back	0.962	0.037	1.00		
		Right side	0.357	0.183	0.54		
		Bottom side	1.188		1.19		
LTE	Band 17	Front	0.422	0.077	0.50		
		Back	0.255	0.037	0.29		
		Right side	0.210	0.183	0.39		
		Bottom side	0.344		0.34		
	Band 5	Front	0.549	0.077	0.63		
		Back	0.484	0.037	0.52		
		Right side	0.394	0.183	0.58		
		Bottom side	0.276		0.28		
	Band 4	Front	0.677	0.077	0.75		
		Back	1.123	0.037	1.16		
		Right side	0.354	0.183	0.54		
		Bottom side	1.421		**1.42**		
	Band 2	Front	0.405	0.077	0.48		
		Back	1.019	0.037	1.06		
		Right side	0.298	0.183	0.48		
		Bottom side	1.181		1.18		

<WWAN PCB + WLAN (Antenna 0+1) NII>

WWAN Band		Exposure Position	WWAN PCB Max. WWAN SAR (W/kg)	WLAN NII Max. WLAN SAR (W/kg)	Summed SAR (W/kg)	SPLSR	Case No
WCMDA	Band V	Front	0.525	0.156	0.68		
		Back	0.388	0.056	0.44		
		Left side		0.192	0.19		
		Right side	0.399	0.212	0.61		
		Bottom side	0.392		0.39		
	Band II	Front	0.519	0.156	0.68		
		Back	0.962	0.056	1.02		
		Left side		0.192	0.19		
		Right side	0.357	0.212	0.57		
		Bottom side	1.188		1.19		
LTE	Band 17	Front	0.422	0.156	0.58		
		Back	0.255	0.056	0.31		
		Left side		0.192	0.19		
		Right side	0.210	0.212	0.42		
		Bottom side	0.344		0.34		
	Band 5	Front	0.549	0.156	0.71		
		Back	0.484	0.056	0.54		
		Left side		0.192	0.19		
		Right side	0.394	0.212	0.61		
		Bottom side	0.276		0.28		
	Band 4	Front	0.677	0.156	0.83		
		Back	1.123	0.056	1.18		
		Left side		0.192	0.19		
		Right side	0.354	0.212	0.57		
		Bottom side	1.421		**1.42**		
	Band 2	Front	0.405	0.156	0.56		
		Back	1.019	0.056	1.08		
		Left side		0.192	0.19		
		Right side	0.298	0.212	0.51		
		Bottom side	1.181		1.18		

Test Engineer： Fulu Hu

17. Uncertainty Assessment

The component of uncertainly may generally be categorized according to the methods used to evaluate them. The evaluation of uncertainly by the statistical analysis of a series of observations is termed a Type An evaluation of uncertainty. The evaluation of uncertainty by means other than the statistical analysis of a series of observation is termed a Type B evaluation of uncertainty. Each component of uncertainty, however evaluated, is represented by an estimated standard deviation, termed standard uncertainty, which is determined by the positive square root of the estimated variance.

A Type A evaluation of standard uncertainty may be based on any valid statistical method for treating data. This includes calculating the standard deviation of the mean of a series of independent observations; using the method of least squares to fit a curve to the data in order to estimate the parameter of the curve and their standard deviations; or carrying out an analysis of variance in order to identify and quantify random effects in certain kinds of measurement.

A type B evaluation of standard uncertainty is typically based on scientific judgment using all of the relevant information available. These may include previous measurement data, experience, and knowledge of the behavior and properties of relevant materials and instruments, manufacture's specification, data provided in calibration reports and uncertainties assigned to reference data taken from handbooks. Broadly speaking, the uncertainty is either obtained from an outdoor source or obtained from an assumed distribution, such as the normal distribution, rectangular or triangular distributions indicated in table below.

Uncertainty Distributions	Normal	Rectangular	Triangular	U-Shape
Multi-plying Factor[(a)]	1/k[(b)]	1/√3	1/√6	1/√2

(a) standard uncertainty is determined as the product of the multiplying factor and the estimated range of variations in the measured quantity

(b) κ is the coverage factor

Table 17.1. Standard Uncertainty for Assumed Distribution

The combined standard uncertainty of the measurement result represents the estimated standard deviation of the result. It is obtained by combining the individual standard uncertainties of both Type A and Type B evaluation using the usual "root-sum-squares" (RSS) methods of combining standard deviations by taking the positive square root of the estimated variances.

Expanded uncertainty is a measure of uncertainty that defines an interval about the measurement result within which the measured value is confidently believed to lie. It is obtained by multiplying the combined standard uncertainty by a coverage factor. Typically, the coverage factor ranges from 2 to 3. Using a coverage factor allows the true value of a measured quantity to be specified with a defined probability within the specified uncertainty range. For purpose of this document, a coverage factor two is used, which corresponds to confidence interval of about 95 %. The DASY uncertainty Budget is shown in the following tables.

Error Description	Uncertainty Value (±%)	Probability Distribution	Divisor	Ci (1g)	Ci (10g)	Standard Uncertainty (1g)	Standard Uncertainty (10g)
Measurement System							
Probe Calibration	6.0	Normal	1	1	1	± 6.0 %	± 6.0 %
Axial Isotropy	4.7	Rectangular	√3	0.7	0.7	± 1.9 %	± 1.9 %
Hemispherical Isotropy	9.6	Rectangular	√3	0.7	0.7	± 3.9 %	± 3.9 %
Boundary Effects	1.0	Rectangular	√3	1	1	± 0.6 %	± 0.6 %
Linearity	4.7	Rectangular	√3	1	1	± 2.7 %	± 2.7 %
System Detection Limits	1.0	Rectangular	√3	1	1	± 0.6 %	± 0.6 %
Readout Electronics	0.3	Normal	1	1	1	± 0.3 %	± 0.3 %
Response Time	0.8	Rectangular	√3	1	1	± 0.5 %	± 0.5 %
Integration Time	2.6	Rectangular	√3	1	1	± 1.5 %	± 1.5 %
RF Ambient Noise	3.0	Rectangular	√3	1	1	± 1.7 %	± 1.7 %
RF Ambient Reflections	3.0	Rectangular	√3	1	1	± 1.7 %	± 1.7 %
Probe Positioner	0.4	Rectangular	√3	1	1	± 0.2 %	± 0.2 %
Probe Positioning	2.9	Rectangular	√3	1	1	± 1.7 %	± 1.7 %
Max. SAR Eval.	1.0	Rectangular	√3	1	1	± 0.6 %	± 0.6 %
Test Sample Related							
Device Positioning	2.9	Normal	1	1	1	± 2.9 %	± 2.9 %
Device Holder	3.6	Normal	1	1	1	± 3.6 %	± 3.6 %
Power Drift	5.0	Rectangular	√3	1	1	± 2.9 %	± 2.9 %
Phantom and Setup							
Phantom Uncertainty	4.0	Rectangular	√3	1	1	± 2.3 %	± 2.3 %
Liquid Conductivity (Target)	5.0	Rectangular	√3	0.64	0.43	± 1.8 %	± 1.2 %
Liquid Conductivity (Meas.)	2.5	Normal	1	0.64	0.43	± 1.6 %	± 1.1 %
Liquid Permittivity (Target)	5.0	Rectangular	√3	0.6	0.49	± 1.7 %	± 1.4 %
Liquid Permittivity (Meas.)	2.5	Normal	1	0.6	0.49	± 1.5 %	± 1.2 %
Combined Standard Uncertainty						± 11.0 %	± 10.8 %
Coverage Factor for 95 %						K=2	
Expanded Uncertainty						**± 22.0 %**	**± 21.5 %**

Table 17.2. Uncertainty Budget for frequency range 300 MHz to 3 GHz

Error Description	Uncertainty Value (±%)	Probability Distribution	Divisor	Ci (1g)	Ci (10g)	Standard Uncertainty (1g)	Standard Uncertainty (10g)
Measurement System							
Probe Calibration	6.55	Normal	1	1	1	± 6.55 %	± 6.55 %
Axial Isotropy	4.7	Rectangular	√3	0.7	0.7	± 1.9 %	± 1.9 %
Hemispherical Isotropy	9.6	Rectangular	√3	0.7	0.7	± 3.9 %	± 3.9 %
Boundary Effects	2.0	Rectangular	√3	1	1	± 1.2 %	± 1.2 %
Linearity	4.7	Rectangular	√3	1	1	± 2.7 %	± 2.7 %
System Detection Limits	1.0	Rectangular	√3	1	1	± 0.6 %	± 0.6 %
Readout Electronics	0.3	Normal	1	1	1	± 0.3 %	± 0.3 %
Response Time	0.8	Rectangular	√3	1	1	± 0.5 %	± 0.5 %
Integration Time	2.6	Rectangular	√3	1	1	± 1.5 %	± 1.5 %
RF Ambient Noise	3.0	Rectangular	√3	1	1	± 1.7 %	± 1.7 %
RF Ambient Reflections	3.0	Rectangular	√3	1	1	± 1.7 %	± 1.7 %
Probe Positioner	0.8	Rectangular	√3	1	1	± 0.5 %	± 0.5 %
Probe Positioning	9.9	Rectangular	√3	1	1	± 5.7 %	± 5.7 %
Max. SAR Eval.	4.0	Rectangular	√3	1	1	± 2.3 %	± 2.3 %
Test Sample Related							
Device Positioning	2.9	Normal	1	1	1	± 2.9 %	± 2.9 %
Device Holder	3.6	Normal	1	1	1	± 3.6 %	± 3.6 %
Power Drift	5.0	Rectangular	√3	1	1	± 2.9 %	± 2.9 %
Phantom and Setup							
Phantom Uncertainty	4.0	Rectangular	√3	1	1	± 2.3 %	± 2.3 %
Liquid Conductivity (Target)	5.0	Rectangular	√3	0.64	0.43	± 1.8 %	± 1.2 %
Liquid Conductivity (Meas.)	2.5	Normal	1	0.64	0.43	± 1.6 %	± 1.1 %
Liquid Permittivity (Target)	5.0	Rectangular	√3	0.6	0.49	± 1.7 %	± 1.4 %
Liquid Permittivity (Meas.)	2.5	Normal	1	0.6	0.49	± 1.5 %	± 1.2 %
Combined Standard Uncertainty						± 12.8 %	± 12.6 %
Coverage Factor for 95 %						K=2	
Expanded Uncertainty						**± 25.6 %**	**± 25.2 %**

Table 17.3. Uncertainty Budget for frequency range 3 GHz to 6 GHz

18. References

[1] FCC 47 CFR Part 2 “Frequency Allocations and Radio Treaty Matters; General Rules and Regulations”

[2] ANSI/IEEE Std. C95.1-1992, “IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz”, September 1992

[3] IEEE Std. 1528-2003, “Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques”, December 2003

[4] SPEAG DASY System Handbook

[5] FCC KDB 248227 D01 v01r02, “SAR Measurement Procedures for 802.11 a/b/g Transmitters”, May 2007

[6] FCC KDB 447498 D01 v05r02, “Mobile and Portable Device RF Exposure Procedures and Equipment Authorization Policies”, Feb 2014

[7] FCC KDB 941225 D01 v03, “3G SAR MEAUREMENT PROCEDURES”, Oct 2014

[8] FCC KDB 941225 D05 v02r03, “SAR Evaluation Considerations for LTE Devices”, Dec 2013

[9] FCC KDB 941225 D05A v01r01, “Rel. 10 LTE SAR Test Guidance and KDB Inquiries”, Aug 2014

[10] FCC KDB 941225 D06 v02, "SAR Evaluation Procedures for Portable Devices with Wireless Router Capabilities", Oct 2014.

[11] FCC KDB 865664 D01 v01r03, "SAR Measurement Requirements for 100 MHz to 6 GHz", Feb 2014.

[12] FCC KDB 865664 D02 v01r01, “RF Exposure Compliance Reporting and Documentation Considerations” May 2013.

Appendix A. Plots of System Performance Check

The plots are shown as follows.

Test Laboratory: Sporton International Inc. SAR/HAC Testing Lab Date: 2014.11.13

System Check_Body_750MHz-141113

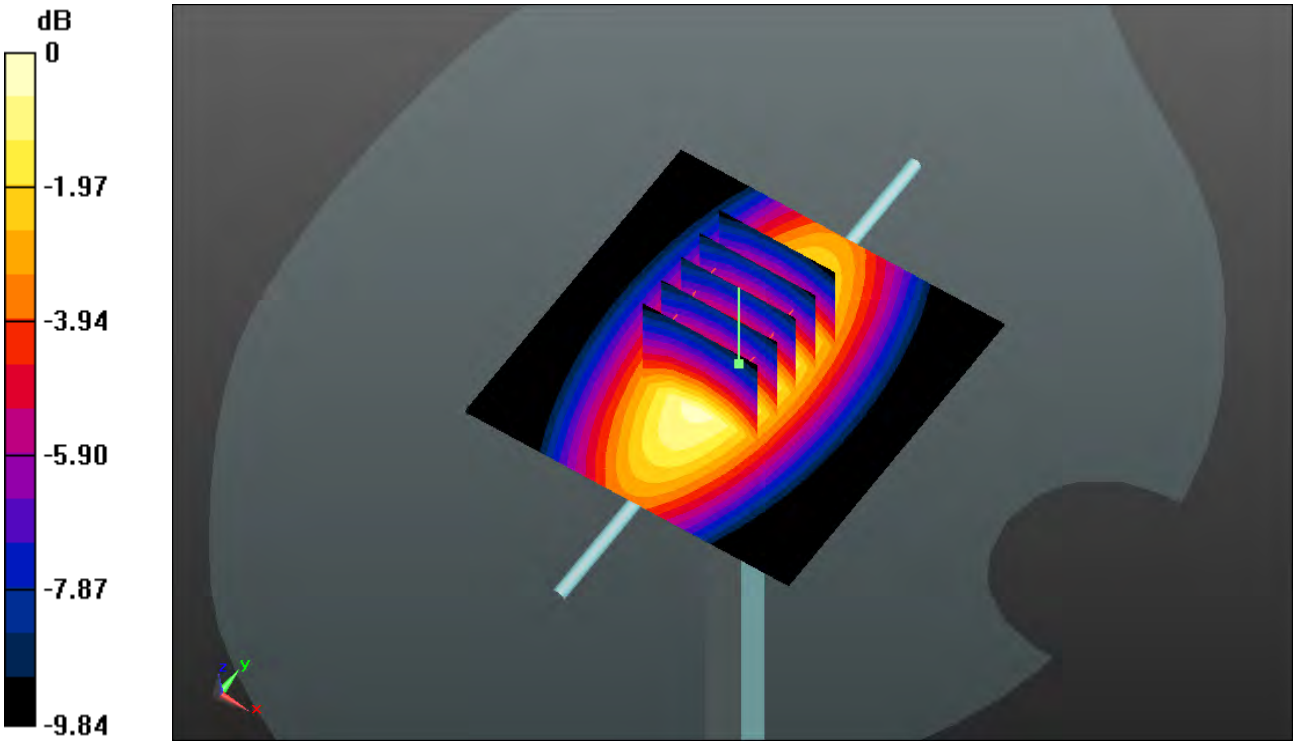
DUT: D750V3 - SN:1012

Communication System: CW; Frequency: 750 MHz;Duty Cycle: 1:1
Medium: MSL_750_141113 Medium parameters used: f = 750 MHz; σ = 0.963 mho/m; ε_r = 54.228; ρ = 1000 kg/m^3
Ambient Temperature：23.4 ℃； Liquid Temperature：22.7 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN3857; ConvF(9.46, 9.46, 9.46); Calibrated: 2014.05.23
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1210; Calibrated: 2014.05.19
- Phantom: SAM2; Type: SAM; Serial: TP-1477
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.4.5 (3634)

Pin=250mW/Area Scan (61x61x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 2.598 mW/g

Pin=250mW/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 48.426 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 2.982 W/kg
SAR(1 g) = 2.08 mW/g; SAR(10 g) = 1.39 mW/g
Maximum value of SAR (measured) = 2.586 mW/g



0 dB = 2.590mW/g

Test Laboratory: Sporton International Inc. SAR/HAC Testing Lab Date: 2014.11.13

System Check_Body_835MHz_141113

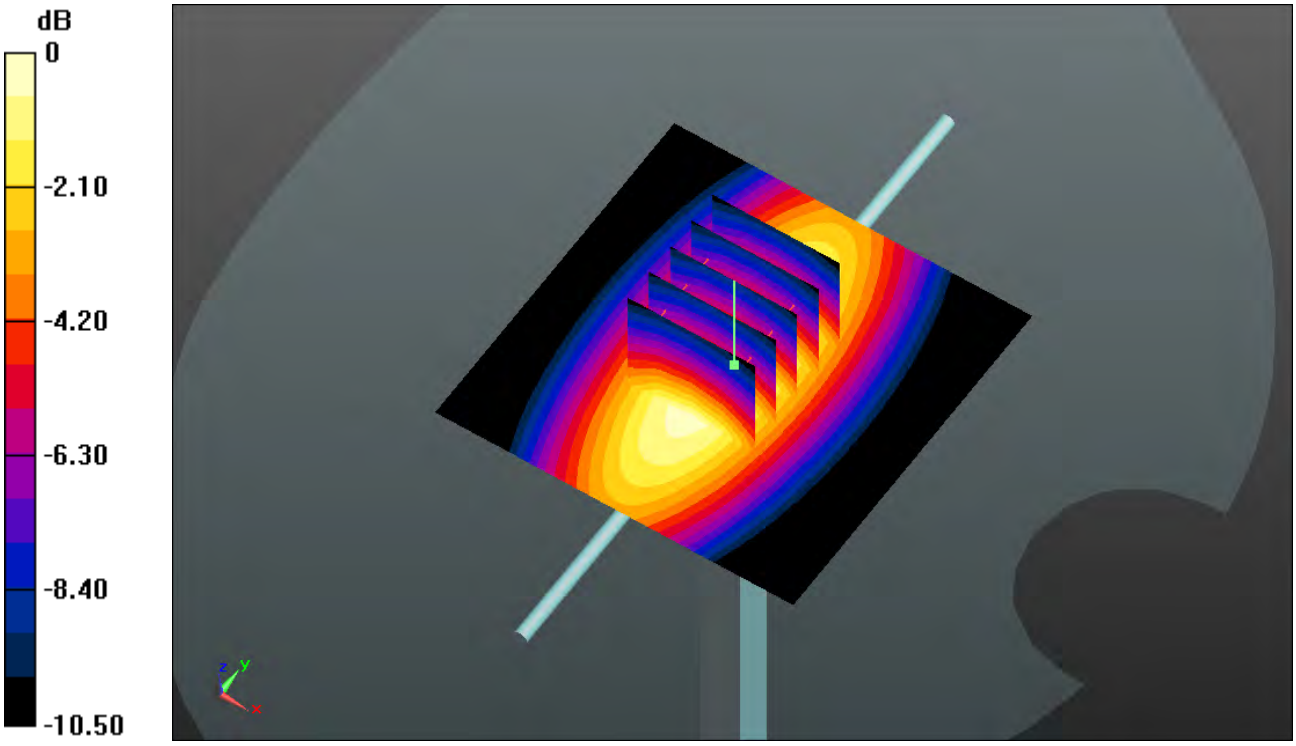
DUT: D835V2 - SN:499

Communication System: CW; Frequency: 835 MHz;Duty Cycle: 1:1
Medium: MSL_835_141113 Medium parameters used: f = 835 MHz; σ = 0.976 mho/m; ε_r = 54.382; ρ = 1000 kg/m^3
Ambient Temperature：23.4 ℃； Liquid Temperature：22.7 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN3857; ConvF(9.31, 9.31, 9.31); Calibrated: 2014.05.23
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1210; Calibrated: 2014.05.19
- Phantom: SAM2; Type: SAM; Serial: TP-1477
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.4.5 (3634)

Pin=250mW/Area Scan (61x61x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 2.840 mW/g

Pin=250mW/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 50.007 V/m; Power Drift = -0.03 dB
Peak SAR (extrapolated) = 3.282 W/kg
SAR(1 g) = 2.23 mW/g; SAR(10 g) = 1.47 mW/g
Maximum value of SAR (measured) = 2.821 mW/g



0 dB = 2.820mW/g

Test Laboratory: Sporton International Inc. SAR/HAC Testing Lab Date: 2014.11.10

System Check_Body_1750MHz-141110

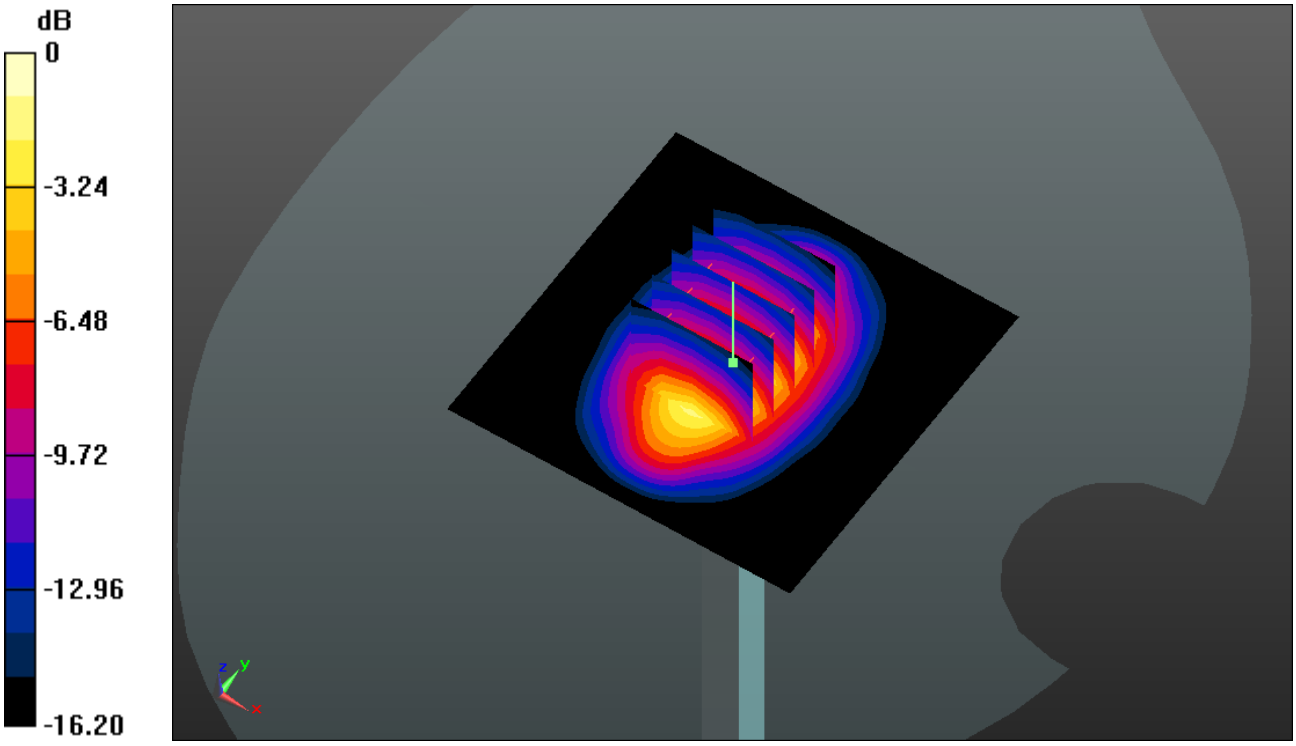
DUT: D1750V2 - SN:1090

Communication System: CW; Frequency: 1750 MHz;Duty Cycle: 1:1
Medium: MSL_1750_141110 Medium parameters used: f = 1750 MHz; σ = 1.513 mho/m; ε_r = 55.5; ρ = 1000 kg/m^3
Ambient Temperature：23.5 ℃； Liquid Temperature：22.7 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN3857; ConvF(7.89, 7.89, 7.89); Calibrated: 2014.05.23
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1210; Calibrated: 2014.05.19
- Phantom: SAM2; Type: SAM; Serial: TP-1477
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.4.5 (3634)

Pin=250mW/Area Scan (61x61x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 12.815 mW/g

Pin=250mW/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 82.327 V/m; Power Drift = 0.02 dB
Peak SAR (extrapolated) = 15.994 W/kg
SAR(1 g) = 9.14 mW/g; SAR(10 g) = 4.9 mW/g
Maximum value of SAR (measured) = 12.889 mW/g



0 dB = 12.890mW/g

Test Laboratory: Sporton International Inc. SAR/HAC Testing Lab Date: 2014.11.10

System Check_Body_1900MHz-141110

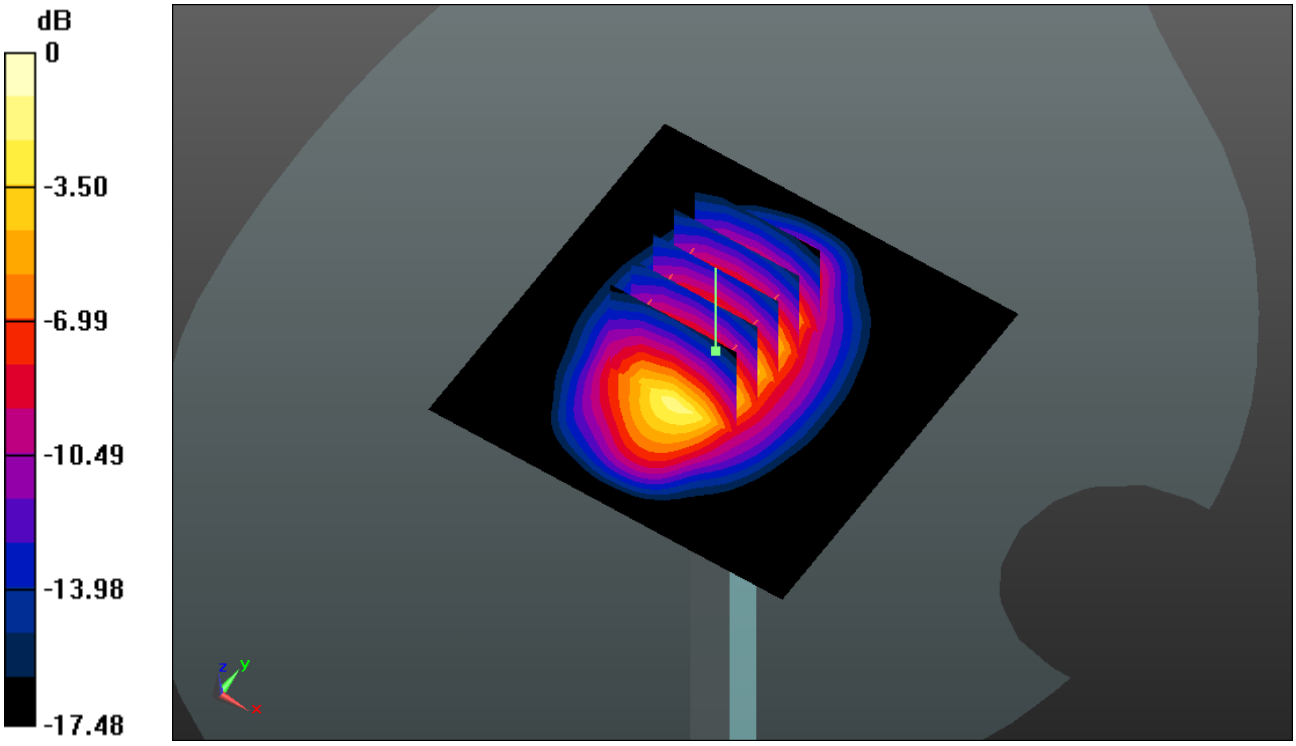
DUT: D1900V2 - SN:5d041

Communication System: CW; Frequency: 1900 MHz;Duty Cycle: 1:1
Medium: MSL_1900_141110 Medium parameters used: f = 1900 MHz; σ = 1.554 mho/m; ε_r = 53.519; ρ = 1000 kg/m^3
Ambient Temperature：23.5 ℃； Liquid Temperature：22.7 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN3857; ConvF(7.56, 7.56, 7.56); Calibrated: 2014.05.23
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1210; Calibrated: 2014.05.19
- Phantom: SAM2; Type: SAM; Serial: TP-1477
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.4.5 (3634)

Pin=250mW/Area Scan (61x61x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 14.462 mW/g

Pin=250mW/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 84.874 V/m; Power Drift = 0.11 dB
Peak SAR (extrapolated) = 18.088 W/kg
SAR(1 g) = 10.4 mW/g; SAR(10 g) = 5.42 mW/g
Maximum value of SAR (measured) = 14.749 mW/g



0 dB = 14.750mW/g

Test Laboratory: Sporton International Inc. SAR/HAC Testing Lab Date: 2015.01.04

System Check_Body_2450MHz_150104

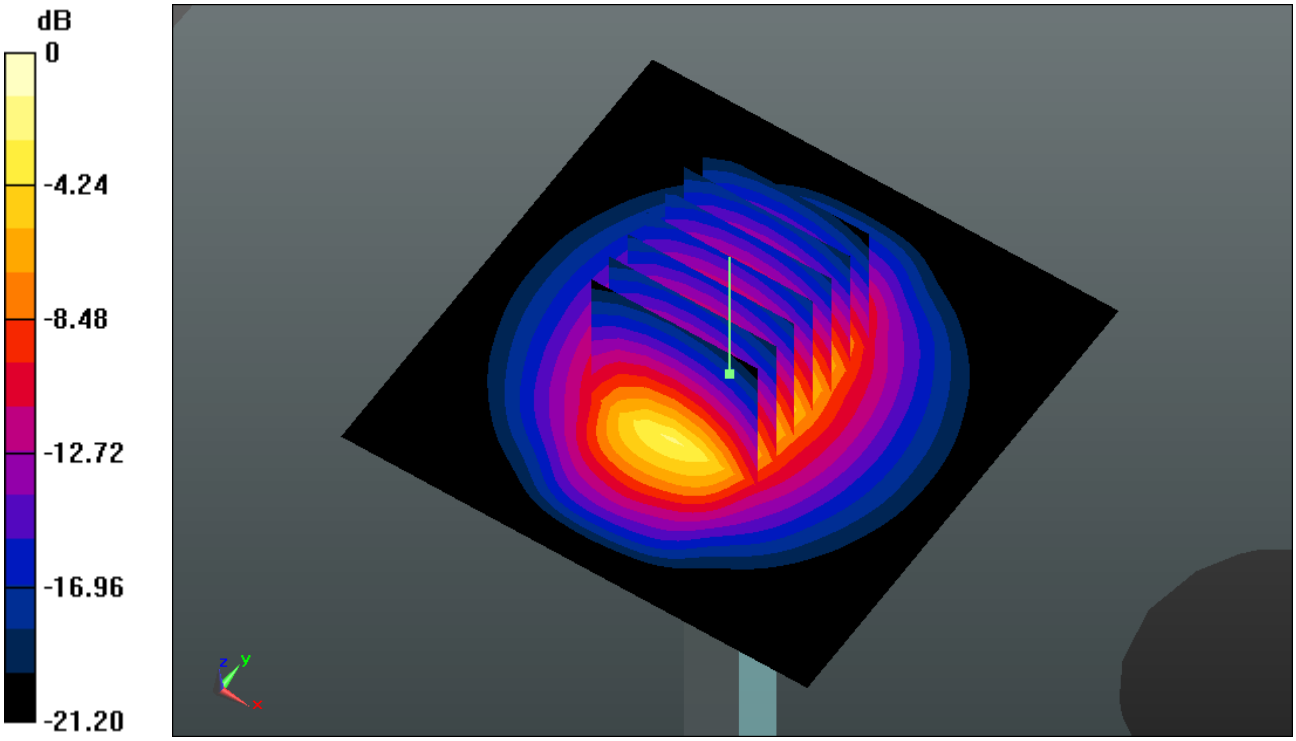
DUT: D2450V2 - SN:736

Communication System: CW; Frequency: 2450 MHz;Duty Cycle: 1:1
Medium: MSL_2450_150104 Medium parameters used: f = 2450 MHz; σ = 1.942 mho/m; ε_r = 50.943; ρ = 1000 kg/m^3
Ambient Temperature：23.4 ℃； Liquid Temperature：22.8 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN3857; ConvF(7.14, 7.14, 7.14); Calibrated: 2014.05.23
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1210; Calibrated: 2014.05.19
- Phantom: SAM1; Type: SAM; Serial: TP-1479
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.4.5 (3634)

Pin=250mW/Area Scan (71x71x1): Measurement grid: dx=12mm, dy=12mm
Maximum value of SAR (interpolated) = 19.161 mW/g

Pin=250mW/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 85.577 V/m; Power Drift = -0.08 dB
Peak SAR (extrapolated) = 24.867 W/kg
SAR(1 g) = 12.2 mW/g; SAR(10 g) = 5.68 mW/g
Maximum value of SAR (measured) = 18.631 mW/g



0 dB = 18.630mW/g

Test Laboratory: Sporton International Inc. SAR/HAC Testing Lab Date: 2015.01.05

System Check_Body_5200MHz_150105

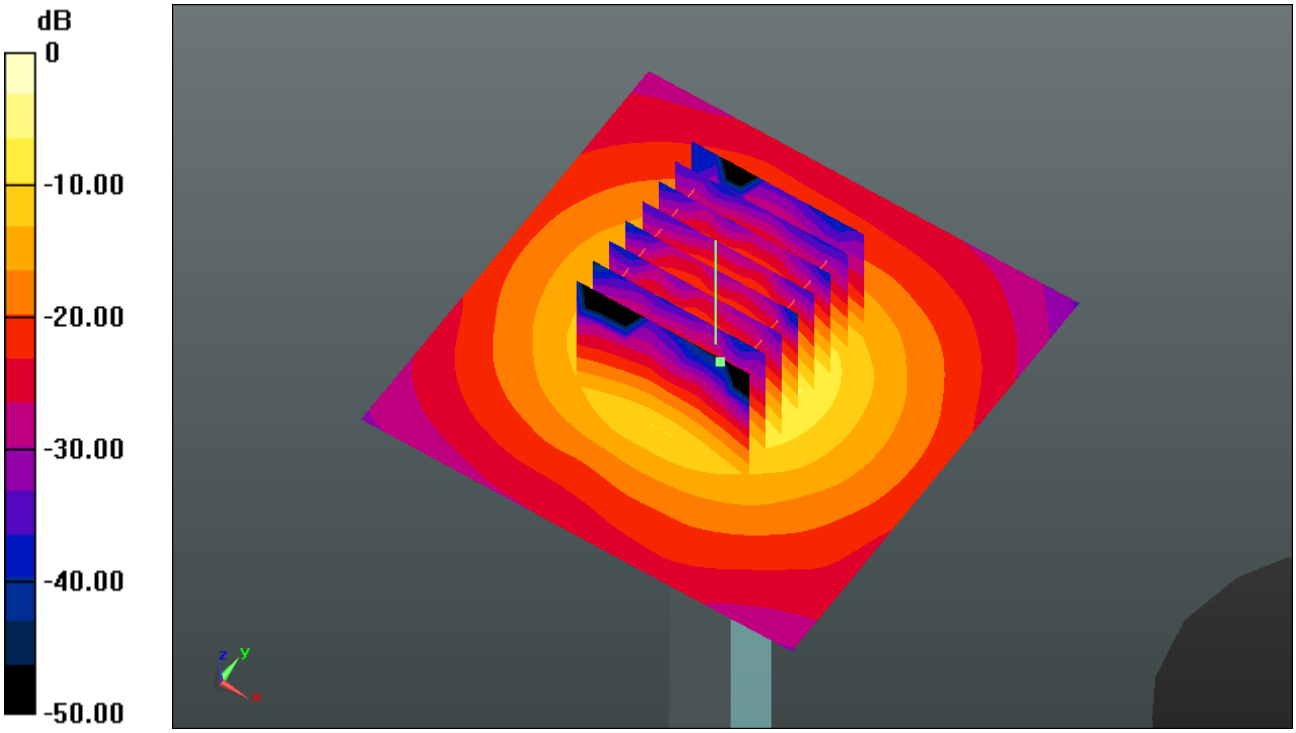
DUT: D5GHzV2-SN:1128

Communication System: CW; Frequency: 5200 MHz;Duty Cycle: 1:1
Medium: MSL_5000_150105 Medium parameters used: f = 5200 MHz; σ = 5.162 mho/m; ε_r = 48.492; ρ = 1000 kg/m^3
Ambient Temperature：23.4 ℃； Liquid Temperature：22.7 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN3857; ConvF(4.54, 4.54, 4.54); Calibrated: 2014.05.23
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1210; Calibrated: 2014.05.19
- Phantom: SAM1; Type: SAM; Serial: TP-1479
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.4.5 (3634)

Pin=100mW/Area Scan (71x71x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 15.324 mW/g

Pin=100mW/Zoom Scan (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 41.624 V/m; Power Drift = 0.05 dB
Peak SAR (extrapolated) = 24.959 W/kg
SAR(1 g) = 7.56 mW/g; SAR(10 g) = 2.04 mW/g
Maximum value of SAR (measured) = 15.396 mW/g



0 dB = 15.400mW/g

Test Laboratory: Sporton International Inc. SAR/HAC Testing Lab Date: 2015.01.05

System Check_Body_5800MHz_150105

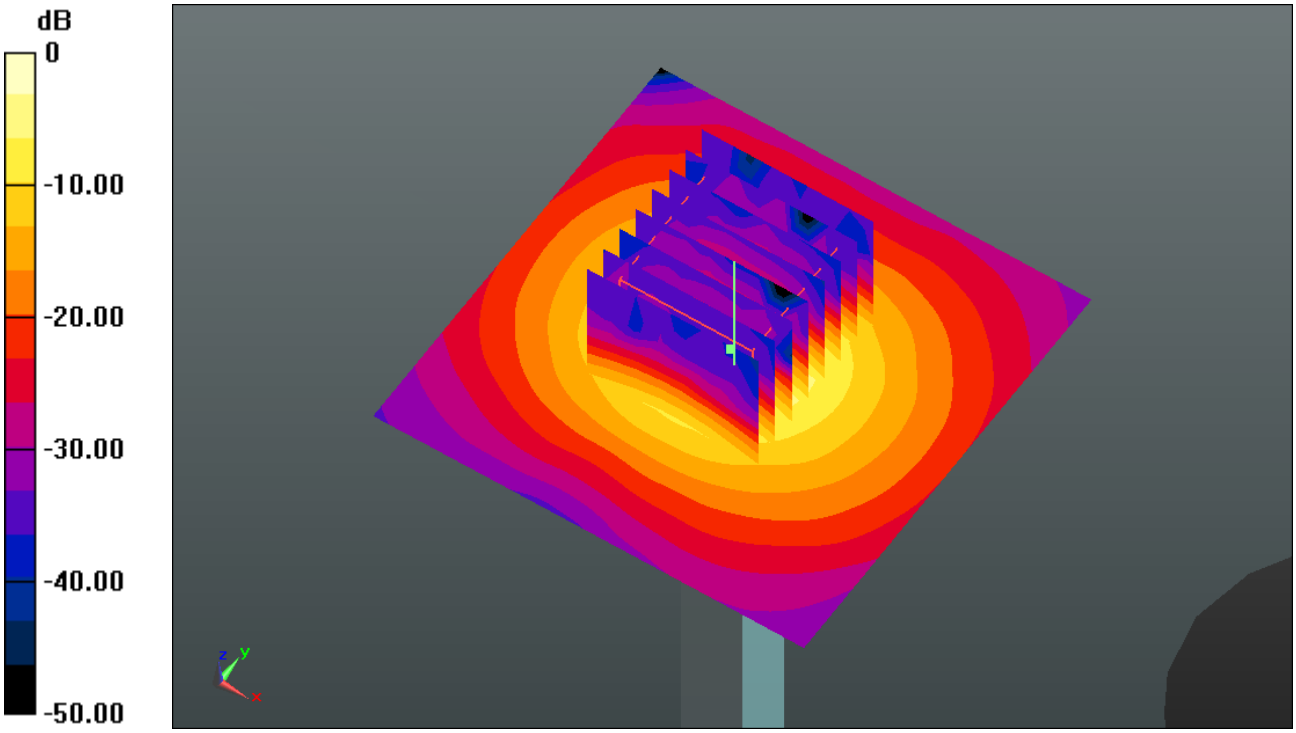
DUT: D5GHzV2-SN:1128

Communication System: CW; Frequency: 5800 MHz;Duty Cycle: 1:1
Medium: MSL_5000_150105 Medium parameters used: f = 5800 MHz; σ = 5.976 mho/m; ε_r = 47.158; ρ = 1000 kg/m^3
Ambient Temperature：23.4 ℃； Liquid Temperature：22.7 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN3857; ConvF(4.21, 4.21, 4.21); Calibrated: 2014.05.23
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1210; Calibrated: 2014.05.19
- Phantom: SAM1; Type: SAM; Serial: TP-1479
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.4.5 (3634)

Pin=100mW/Area Scan (71x71x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 17.427 mW/g

Pin=100mW/Zoom Scan (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 37.282 V/m; Power Drift = 0.0097 dB
Peak SAR (extrapolated) = 32.295 W/kg
SAR(1 g) = 7.13 mW/g; SAR(10 g) = 1.98 mW/g
Maximum value of SAR (measured) = 17.426 mW/g



0 dB = 17.430mW/g

Appendix B. Plots of High SAR Measurement

The plots are shown as follows.

Test Laboratory: Sporton International Inc. SAR/HAC Testing Lab Date: 2014.11.13

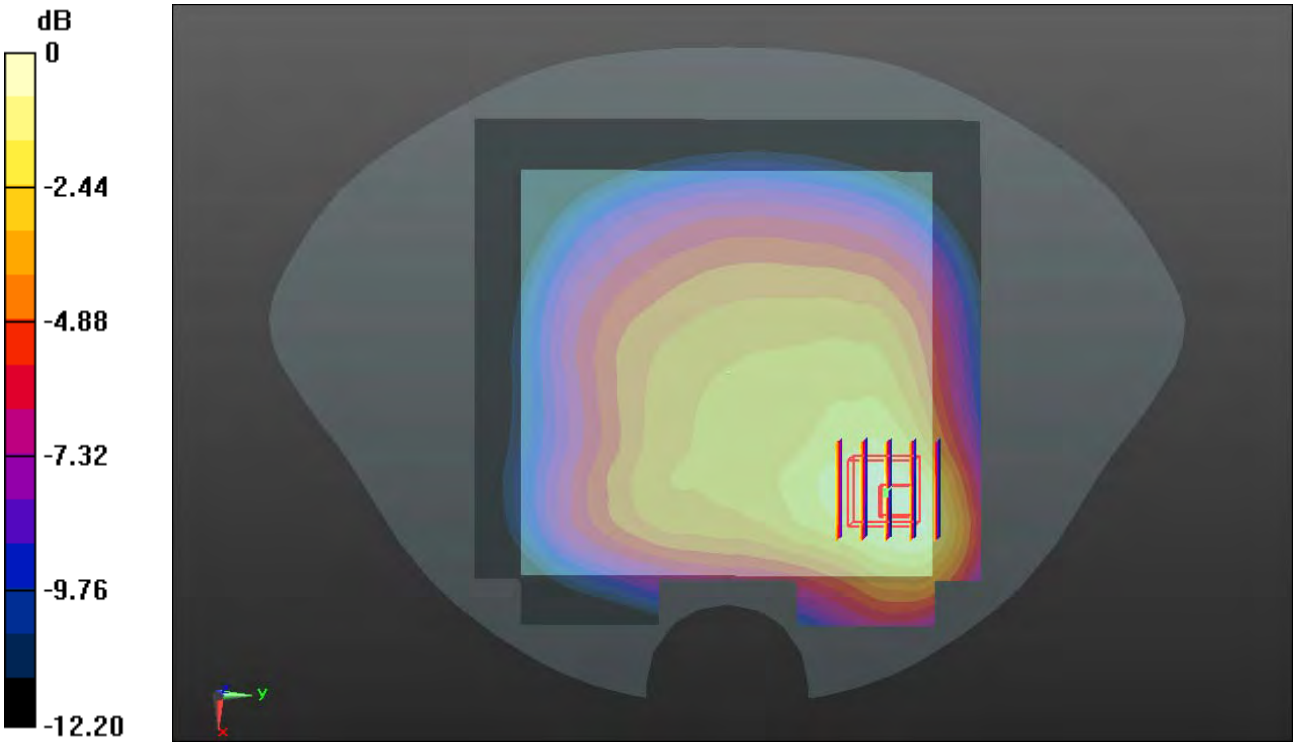
#01_WCDMA Band V_RMC12.2k_Front_1cm_Ch4233

Communication System: UMTS (0); Frequency: 846.6 MHz;Duty Cycle: 1:1
Medium: MSL_835_141113 Medium parameters used: f = 846.6 MHz; σ = 0.987 mho/m; ε_r = 54.279; ρ = 1000 kg/m^3
Ambient Temperature：23.4 ℃; Liquid Temperature：22.7 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN3857; ConvF(9.31, 9.31, 9.31); Calibrated: 2014.05.23
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1210; Calibrated: 2014.05.19
- Phantom: SAM2; Type: SAM; Serial: TP-1477
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.4.5 (3634)

Ch4233/Area Scan (111x111x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 0.528 mW/g

Ch4233/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 15.113 V/m; Power Drift = 0.06 dB
Peak SAR (extrapolated) = 0.662 W/kg
SAR(1 g) = 0.403 mW/g; SAR(10 g) = 0.252 mW/g
Maximum value of SAR (measured) = 0.518 mW/g



0 dB = 0.520mW/g

Test Laboratory: Sporton International Inc. SAR/HAC Testing Lab Date: 2014.11.10

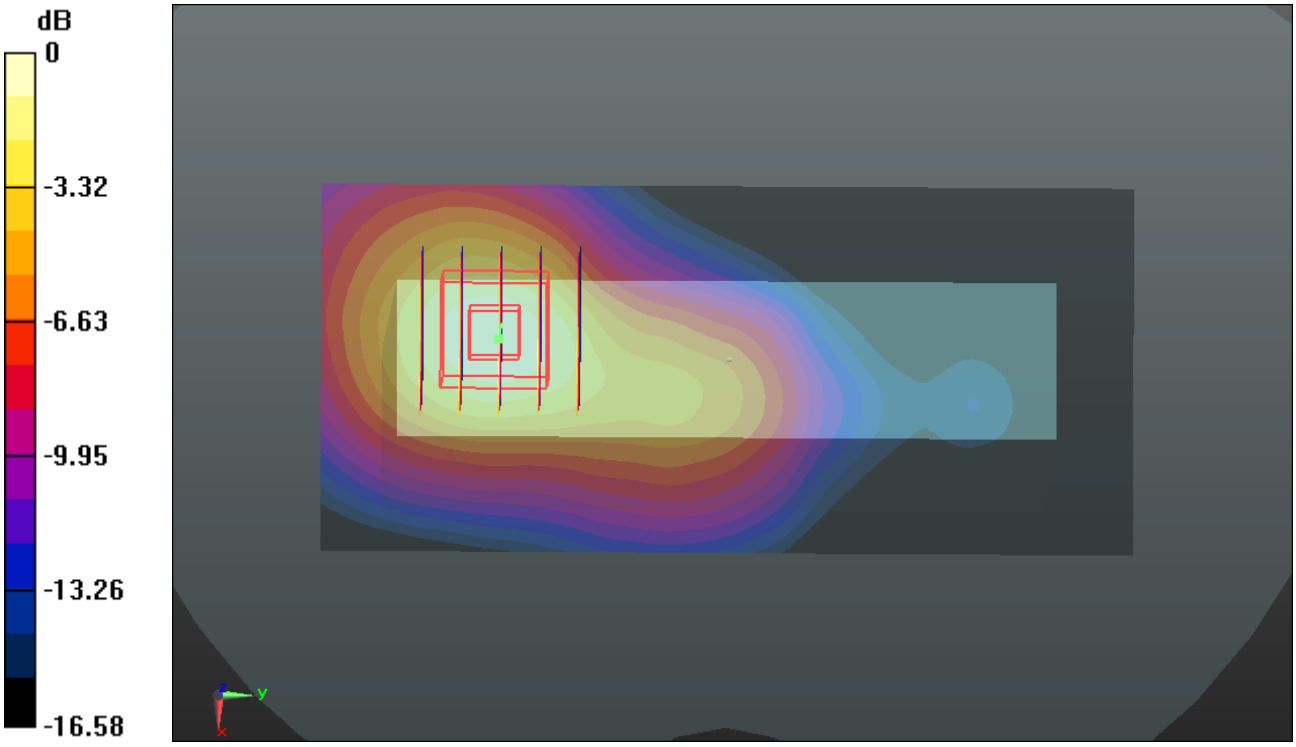
#02_WCDMA Band II_RMC12.2k_Bottom Side_1cm_Ch9538

Communication System: UMTS (0); Frequency: 1907.6 MHz;Duty Cycle: 1:1
Medium: MSL_1900_141110 Medium parameters used: f = 1907.6 MHz; σ = 1.563 mho/m; ε_r = 53.493; ρ = 1000 kg/m^3
Ambient Temperature：23.5 ℃； Liquid Temperature：22.7 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN3857; ConvF(7.56, 7.56, 7.56); Calibrated: 2014.05.23
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1210; Calibrated: 2014.05.19
- Phantom: SAM2; Type: SAM; Serial: TP-1477
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.4.5 (3634)

Ch9538/Area Scan (51x111x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 1.172 mW/g

Ch9538/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 12.969 V/m; Power Drift = -0.11 dB
Peak SAR (extrapolated) = 1.411 W/kg
SAR(1 g) = 0.879 mW/g; SAR(10 g) = 0.509 mW/g
Maximum value of SAR (measured) = 1.166 mW/g



0 dB = 1.170mW/g

Test Laboratory: Sporton International Inc. SAR/HAC Testing Lab Date: 2014.11.13

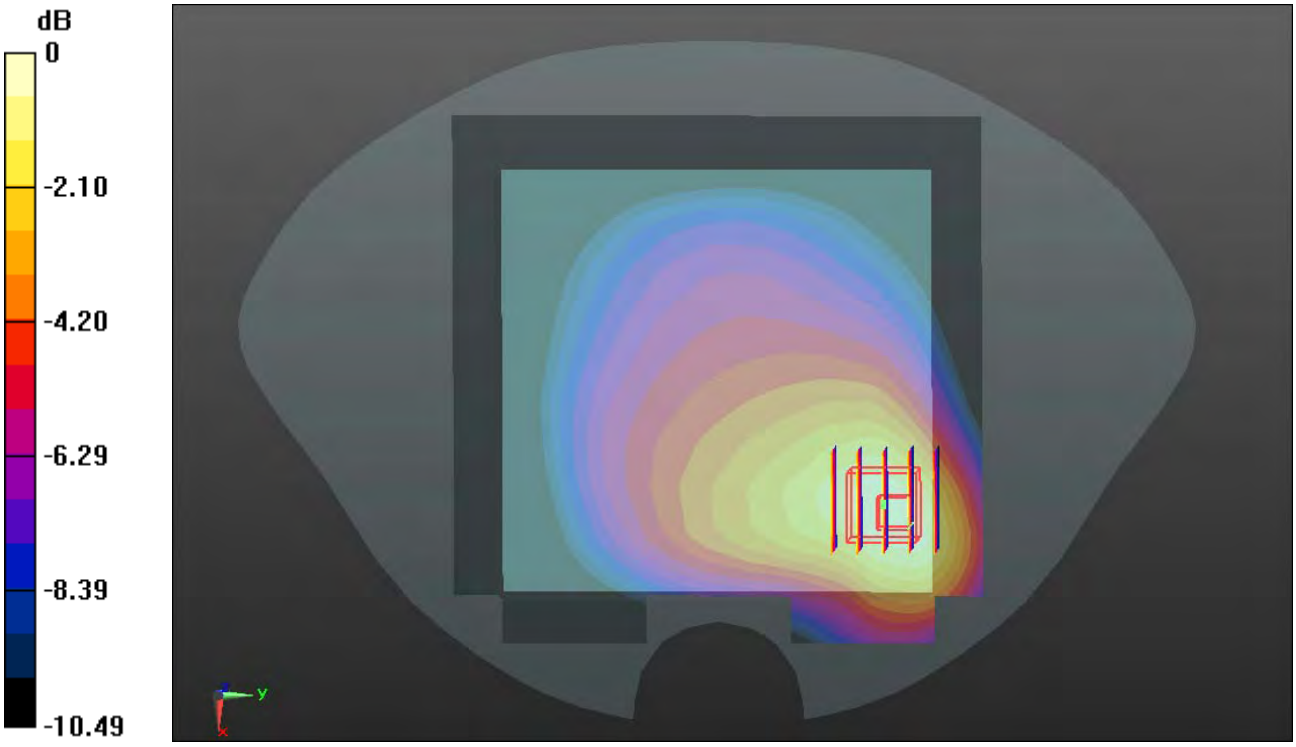
#03_LTE Band17_10M_QPSK(1,49)_Front_1cm_Ch23790

Communication System: FDD_LTE (0); Frequency: 710 MHz;Duty Cycle: 1:1
Medium: MSL_750_141113 Medium parameters used: f = 710 MHz; σ = 0.936 mho/m; ε_r = 55.151; ρ = 1000 kg/m^3
Ambient Temperature：23.4 ℃; Liquid Temperature：22.7 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN3857; ConvF(9.46, 9.46, 9.46); Calibrated: 2014.05.23
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1210; Calibrated: 2014.05.19
- Phantom: SAM2; Type: SAM; Serial: TP-1477
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.4.5 (3634)

Ch23790/Area Scan (111x111x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 0.448 mW/g

Ch23790/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 11.961 V/m; Power Drift = -0.11 dB
Peak SAR (extrapolated) = 0.546 W/kg
SAR(1 g) = 0.351 mW/g; SAR(10 g) = 0.233 mW/g
Maximum value of SAR (measured) = 0.441 mW/g



0 dB = 0.440mW/g

Test Laboratory: Sporton International Inc. SAR/HAC Testing Lab Date: 2014.11.13

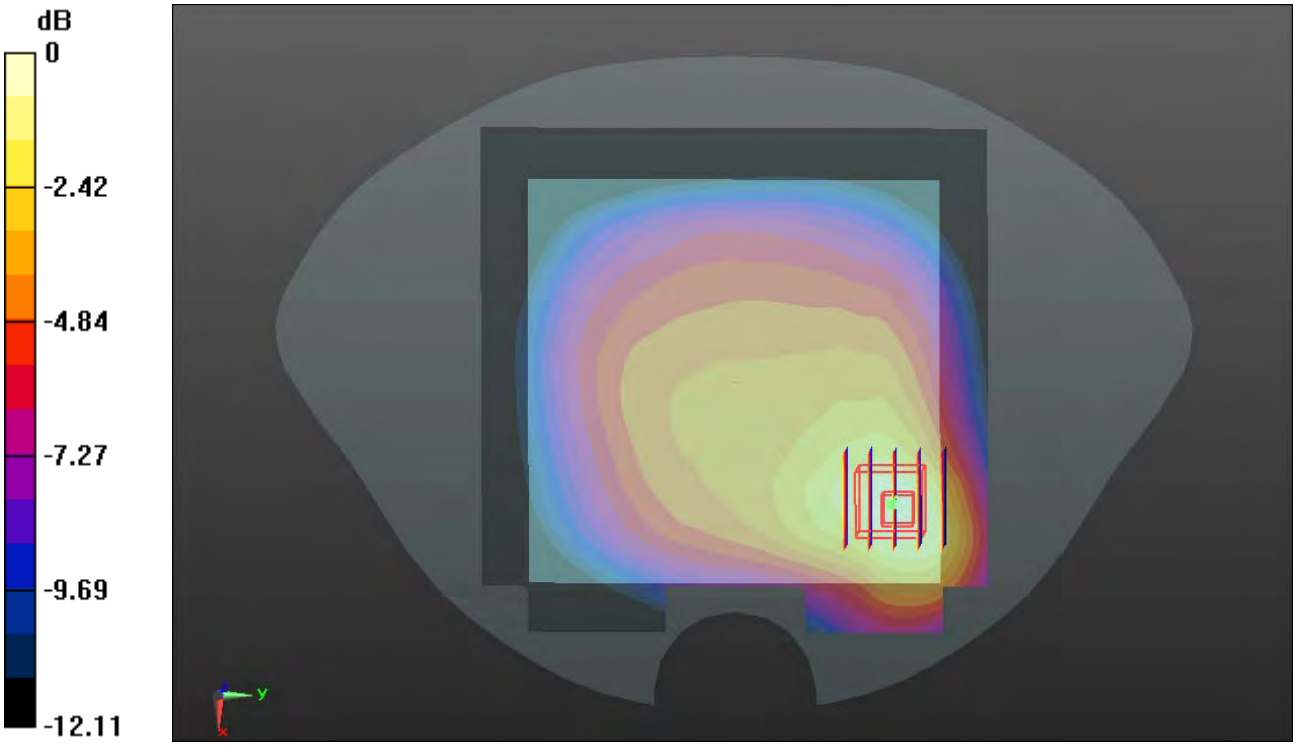
#04_LTE Band5_10M_QPSK(1,0)_Front_1cm_Ch20525

Communication System: FDD_LTE (0); Frequency: 836.5 MHz;Duty Cycle: 1:1
Medium: MSL_835_141113 Medium parameters used: f = 836.5 MHz; σ = 0.978 mho/m; ε_r = 54.37; ρ = 1000 kg/m^3
Ambient Temperature：23.4 ℃； Liquid Temperature：22.7 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN3857; ConvF(9.31, 9.31, 9.31); Calibrated: 2014.05.23
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1210; Calibrated: 2014.05.19
- Phantom: SAM2; Type: SAM; Serial: TP-1477
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.4.5 (3634)

Ch20525/Area Scan (111x111x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 0.564 mW/g

Ch20525/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 14.870 V/m; Power Drift = -0.04 dB
Peak SAR (extrapolated) = 0.706 W/kg
SAR(1 g) = 0.437 mW/g; SAR(10 g) = 0.273 mW/g
Maximum value of SAR (measured) = 0.568 mW/g



0 dB = 0.570mW/g

Test Laboratory: Sporton International Inc. SAR/HAC Testing Lab Date: 2014.11.10

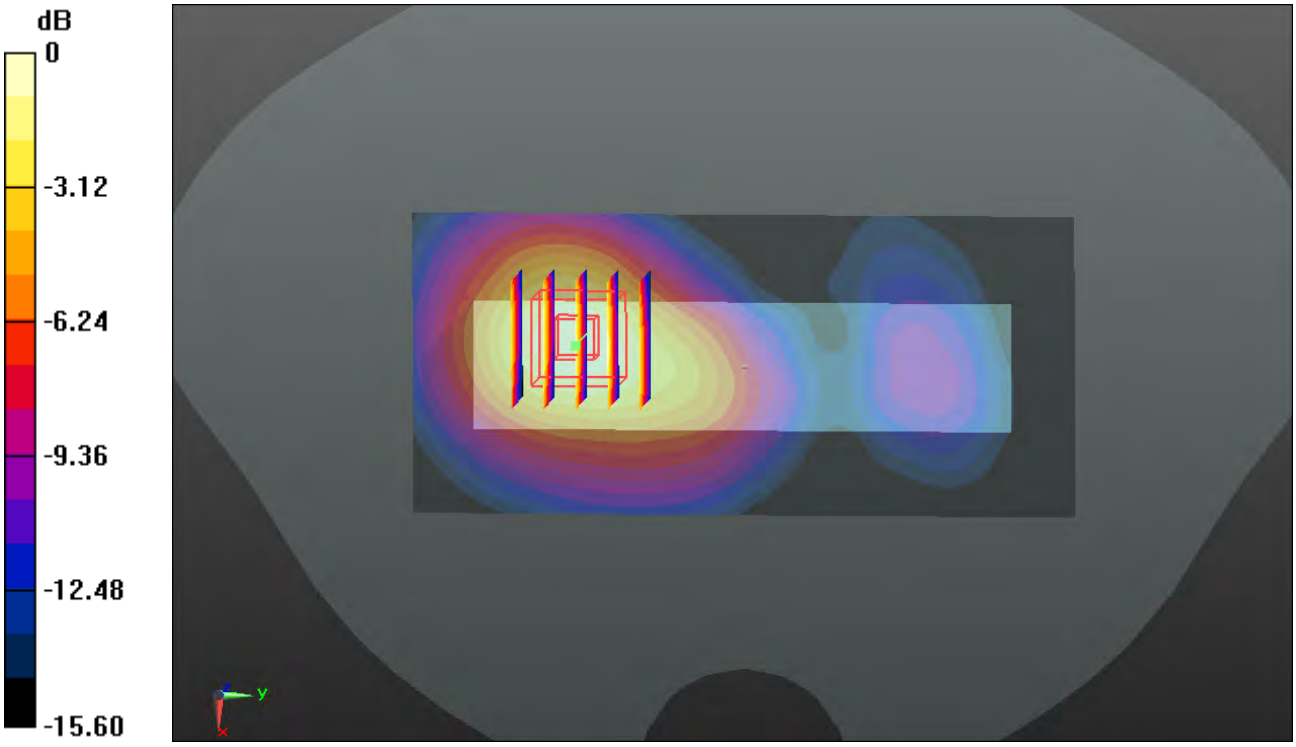
#05_LTE Band4_20M_QPSK(1,0)_Botton Side_1cm_Ch20050

Communication System: FDD_LTE (0); Frequency: 1720 MHz;Duty Cycle: 1:1
Medium: MSL_1750_141110 Medium parameters used: f = 1720 MHz; σ = 1.48 mho/m; ε_r = 55.549; ρ = 1000 kg/m^3
Ambient Temperature：23.5 ℃； Liquid Temperature：22.7 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN3857; ConvF(7.89, 7.89, 7.89); Calibrated: 2014.05.23
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1210; Calibrated: 2014.05.19
- Phantom: SAM2; Type: SAM; Serial: TP-1477
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.4.5 (3634)

Ch20050/Area Scan (51x111x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 1.588 mW/g

Ch20050/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 13.609 V/m; Power Drift = -0.13 dB
Peak SAR (extrapolated) = 1.889 W/kg
SAR(1 g) = 1.19 mW/g; SAR(10 g) = 0.701 mW/g
Maximum value of SAR (measured) = 1.561 mW/g



0 dB = 1.560mW/g

Test Laboratory: Sporton International Inc. SAR/HAC Testing Lab Date: 2014.11.10

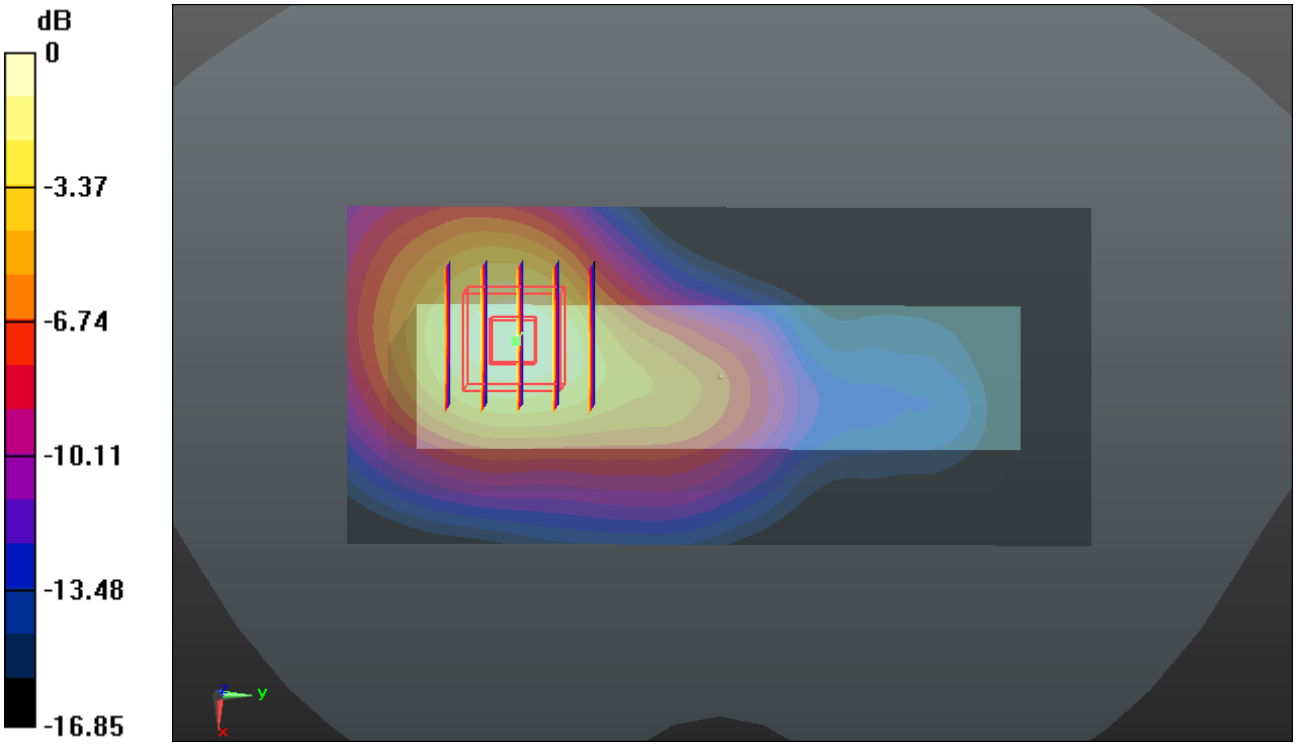
#06_LTE Band2_20M_QPSK(1,0)_Botton Side_1cm_Ch18700

Communication System: FDD_LTE (0); Frequency: 1860 MHz;Duty Cycle: 1:1
Medium: MSL_1900_141110 Medium parameters used: f = 1860 MHz; σ = 1.506 mho/m; ε_r = 53.609; ρ = 1000 kg/m^3
Ambient Temperature：23.5 ℃； Liquid Temperature：22.7 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN3857; ConvF(7.56, 7.56, 7.56); Calibrated: 2014.05.23
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1210; Calibrated: 2014.05.19
- Phantom: SAM2; Type: SAM; Serial: TP-1477
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.4.5 (3634)

Ch18700/Area Scan (51x111x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 1.350 mW/g

Ch18700/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 13.277 V/m; Power Drift = -0.12 dB
Peak SAR (extrapolated) = 1.623 W/kg
SAR(1 g) = 1.01 mW/g; SAR(10 g) = 0.580 mW/g
Maximum value of SAR (measured) = 1.341 mW/g



0 dB = 1.340mW/g

Test Laboratory: Sporton International Inc. SAR/HAC Testing Lab Date: 2015.01.04

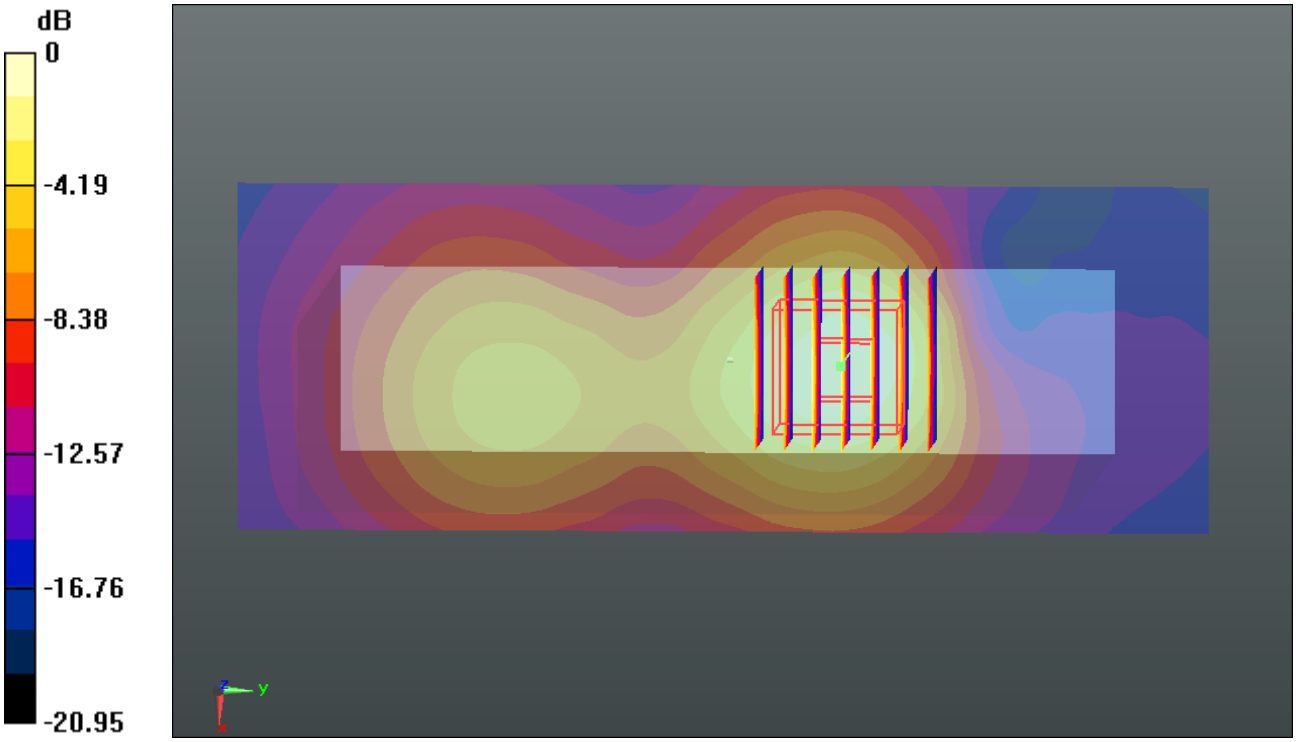
#07_WLAN 2.4G_802.11b_1M_Right Side_1cm_Ch6_Ant.1

Communication System: WIFI (0); Frequency: 2437 MHz;Duty Cycle: 1:1
Medium: MSL_2450_150104 Medium parameters used: f = 2437 MHz; σ = 1.923 mho/m; ε_r = 50.999; ρ = 1000 kg/m^3
Ambient Temperature：23.4 ℃； Liquid Temperature：22.8 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN3857; ConvF(7.14, 7.14, 7.14); Calibrated: 2014.05.23
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1210; Calibrated: 2014.05.19
- Phantom: SAM1; Type: SAM; Serial: TP-1479
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.4.5 (3634)

Ch6/Area Scan (51x141x1): Measurement grid: dx=12mm, dy=12mm
Maximum value of SAR (interpolated) = 0.596 mW/g

Ch6/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 9.453 V/m; Power Drift = -0.06 dB
Peak SAR (extrapolated) = 0.744 W/kg
SAR(1 g) = 0.378 mW/g; SAR(10 g) = 0.192 mW/g
Maximum value of SAR (measured) = 0.553 mW/g



0 dB = 0.550mW/g

Test Laboratory: Sporton International Inc. SAR/HAC Testing Lab Date: 2015.01.05

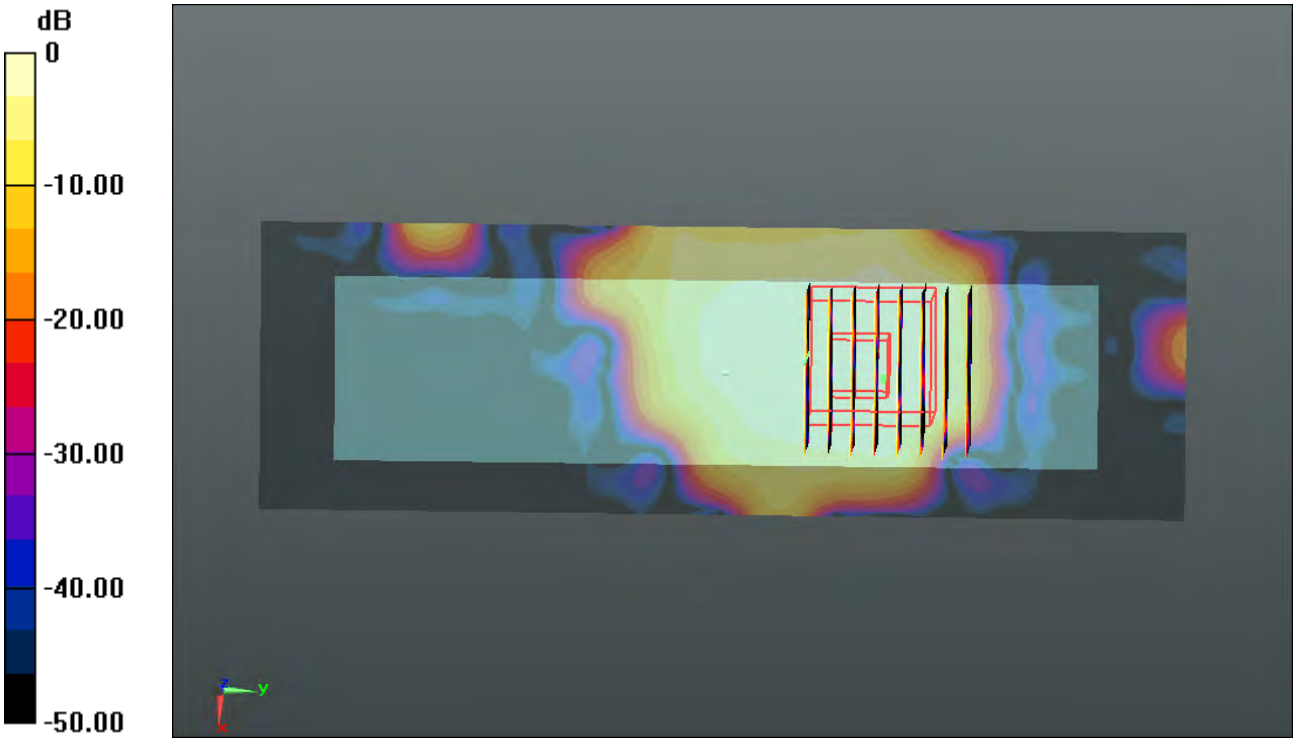
#08_WLAN 5G_Band 1_802.11a_6M_Right Side_1cm_Ch36_Ant.1

Communication System: WIFI (0); Frequency: 5180 MHz;Duty Cycle: 1:1.07
Medium: MSL_5000_150105 Medium parameters used: f = 5180 MHz; σ = 5.134 mho/m; ε_r = 48.523; ρ = 1000 kg/m^3
Ambient Temperature：23.4 ℃； Liquid Temperature：22.7 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN3857; ConvF(4.54, 4.54, 4.54); Calibrated: 2014.05.23
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1210; Calibrated: 2014.05.19
- Phantom: SAM1; Type: SAM; Serial: TP-1479
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.4.5 (3634)

Ch36/Area Scan (51x161x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 0.297 mW/g

Ch36/Zoom Scan (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 3.516 V/m; Power Drift = 0.046 dB
Peak SAR (extrapolated) = 0.393 W/kg
SAR(1 g) = 0.119 mW/g; SAR(10 g) = 0.045 mW/g
Maximum value of SAR (measured) = 0.259 mW/g



0 dB = 0.260mW/g

Test Laboratory: Sporton International Inc. SAR/HAC Testing Lab Date: 2015.01.05

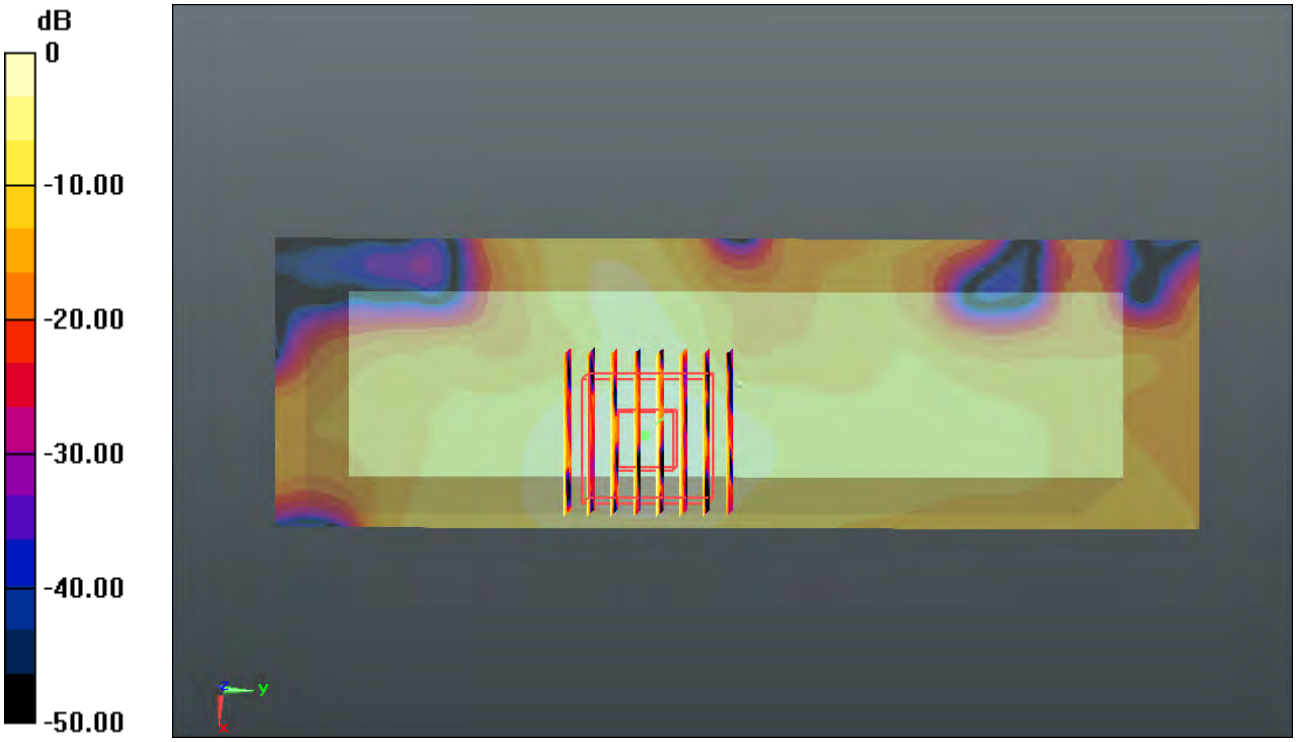
#09_WLAN 5G_Band 4_802.11a_6M_Left Side_1cm_Ch157_Ant.0

Communication System: WIFI (0); Frequency: 5785 MHz;Duty Cycle: 1:1.07
Medium: MSL_5000_150105 Medium parameters used: f = 5785 MHz; σ = 5.961 mho/m; ε_r = 47.221; ρ = 1000 kg/m^3
Ambient Temperature：23.4 ℃; Liquid Temperature：22.7 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN3857; ConvF(4.21, 4.21, 4.21); Calibrated: 2014.05.23
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1210; Calibrated: 2014.05.19
- Phantom: SAM1; Type: SAM; Serial: TP-1479
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.4.5 (3634)

Ch157/Area Scan (51x161x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 0.516 mW/g

Ch157/Zoom Scan (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 1.897 V/m; Power Drift = -0.18 dB
Peak SAR (extrapolated) = 0.770 W/kg
SAR(1 g) = 0.219 mW/g; SAR(10 g) = 0.074 mW/g
Maximum value of SAR (measured) = 0.481 mW/g



0 dB = 0.480mW/g

Appendix C. DASY Calibration Certificate

The DASY calibration certificates are shown as follows.

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

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

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

Accreditation No.: SCS 108

Client **Sporton-TW (Auden)**

Certificate No: D750V3-1012_May14

CALIBRATION CERTIFICATE

Object	D750V3 - SN: 1012
Calibration procedure(s)	QA CAL-05.v9 Calibration procedure for dipole validation kits above 700 MHz
Calibration date:	May 16, 2014

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	09-Oct-13 (No. 217-01827)	Oct-14
Power sensor HP 8481A	US37292783	09-Oct-13 (No. 217-01827)	Oct-14
Power sensor HP 8481A	MY41092317	09-Oct-13 (No. 217-01828)	Oct-14
Reference 20 dB Attenuator	SN: 5058 (20k)	03-Apr-14 (No. 217-01918)	Apr-15
Type-N mismatch combination	SN: 5047.2 / 06327	03-Apr-14 (No. 217-01921)	Apr-15
Reference Probe ES3DV3	SN: 3205	30-Dec-13 (No. ES3-3205_Dec13)	Dec-14
DAE4	SN: 601	30-Apr-14 (No. DAE4-601_Apr14)	Apr-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-13)	In house check: Oct-14

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

Issued: May 20, 2014

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

Glossary:

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

Calibration is Performed According to the Following Standards:

a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
c) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

d) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

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	15 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	750 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	**Permittivity**	**Conductivity**
Nominal Head TSL parameters	22.0 °C	41.9	0.89 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	40.4 ± 6 %	0.92 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	2.10 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**8.12 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	250 mW input power	1.36 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**5.30 W/kg ± 16.5 % (k=2)**

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	**Permittivity**	**Conductivity**
Nominal Body TSL parameters	22.0 °C	55.5	0.96 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	56.8 ± 6 %	1.00 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	2.22 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**8.65 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	250 mW input power	1.45 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**5.68 W/kg ± 16.5 % (k=2)**

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	54.1 Ω + 0.8 jΩ
Return Loss	- 28.0 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	48.2 Ω - 1.9 jΩ
Return Loss	- 31.5 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.035 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	September 29, 2009

DASY5 Validation Report for Head TSL

Date: 16.05.2014

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 750 MHz; Type: D750V3; Serial: D750V3 - SN: 1012

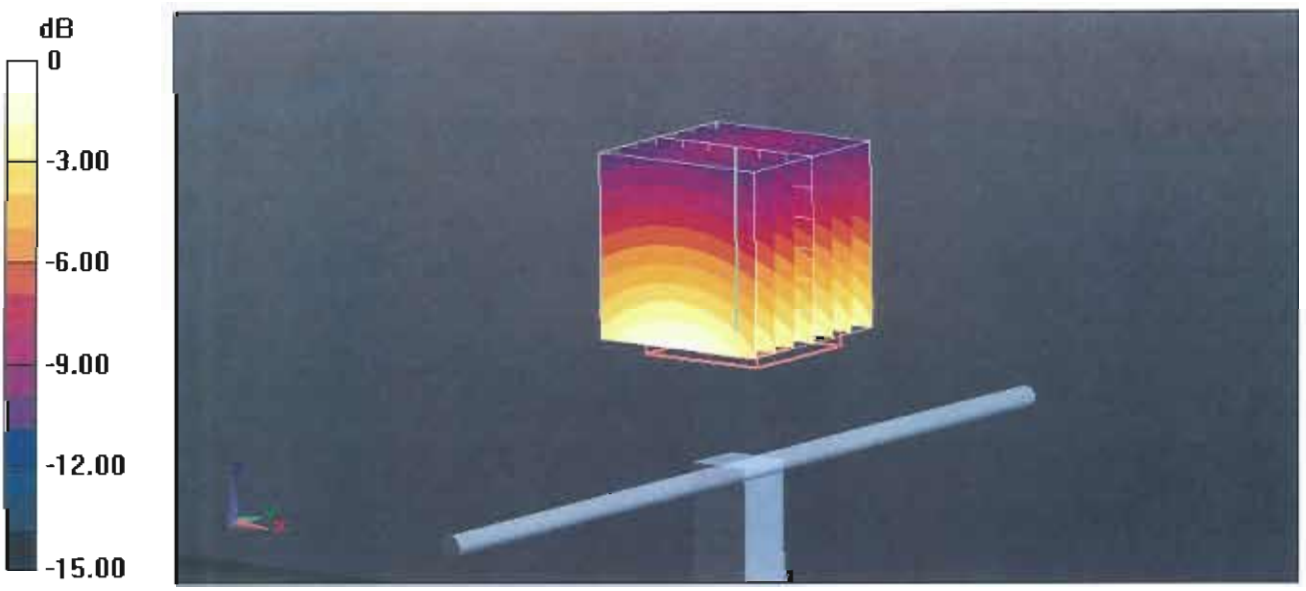
Communication System: UID 0 - CW; Frequency: 750 MHz
Medium parameters used: f = 750 MHz; σ = 0.92 S/m; ε_r = 40.4; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(6.37, 6.37, 6.37); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.04.2014
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

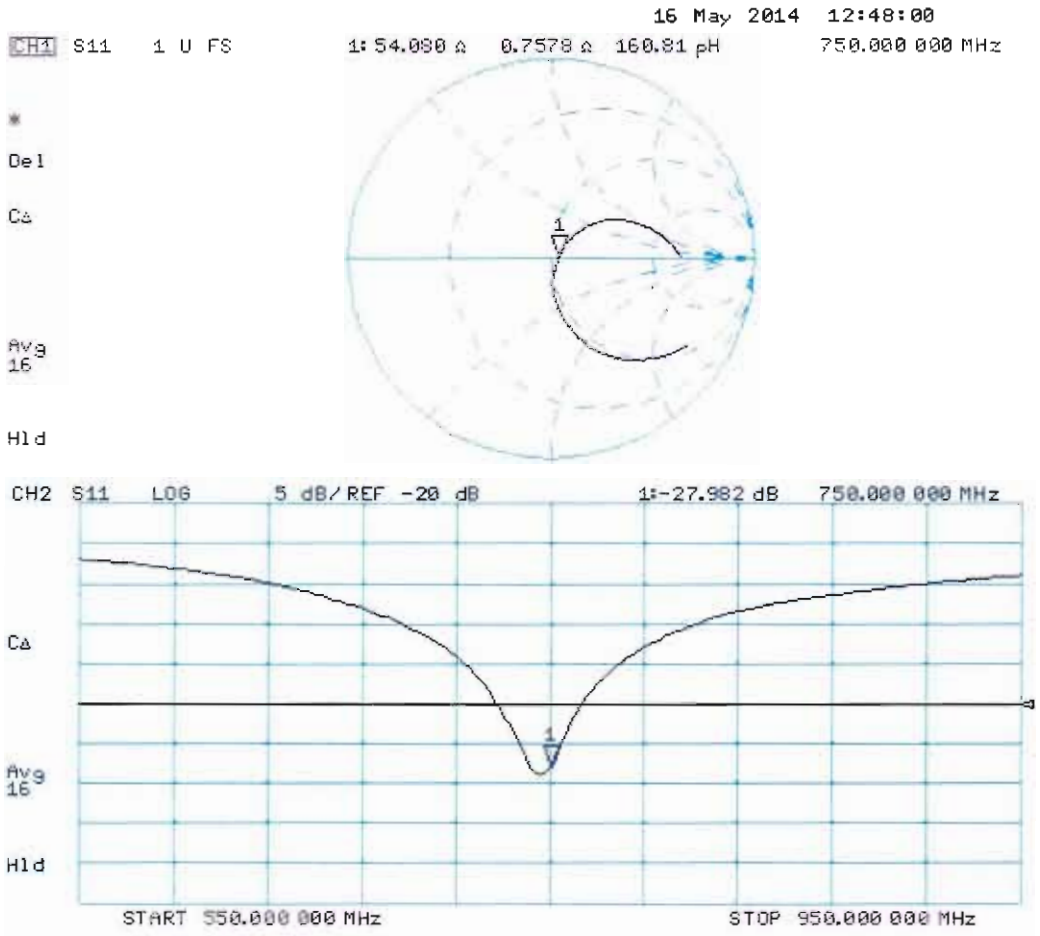
Dipole Calibration for Head Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 53.52 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 3.18 W/kg
SAR(1 g) = 2.1 W/kg; SAR(10 g) = 1.36 W/kg
Maximum value of SAR (measured) = 2.46 W/kg



0 dB = 2.46 W/kg = 3.91 dBW/kg

Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 15.05.2014

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 750 MHz; Type: D750V3; Serial: D750V3 - SN: 1012

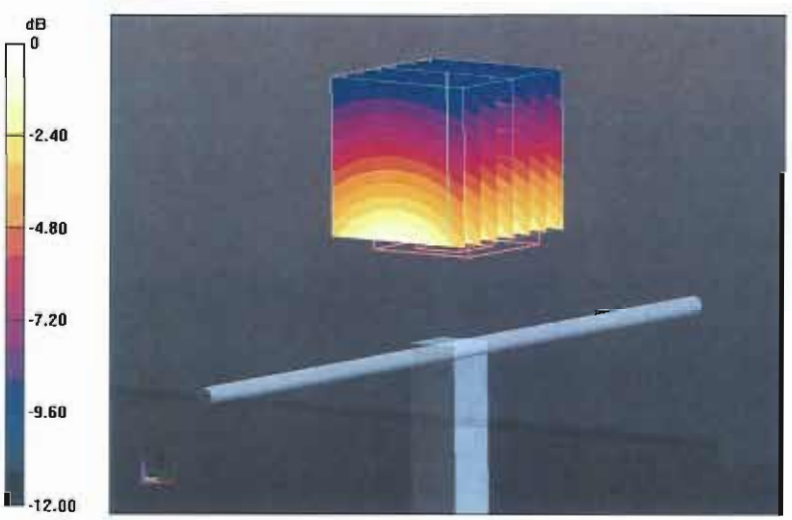
Communication System: UID 0 - CW; Frequency: 750 MHz
Medium parameters used: f = 750 MHz; σ = 1 S/m; ε_r = 56.8; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(6.13, 6.13, 6.13); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.04.2014
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

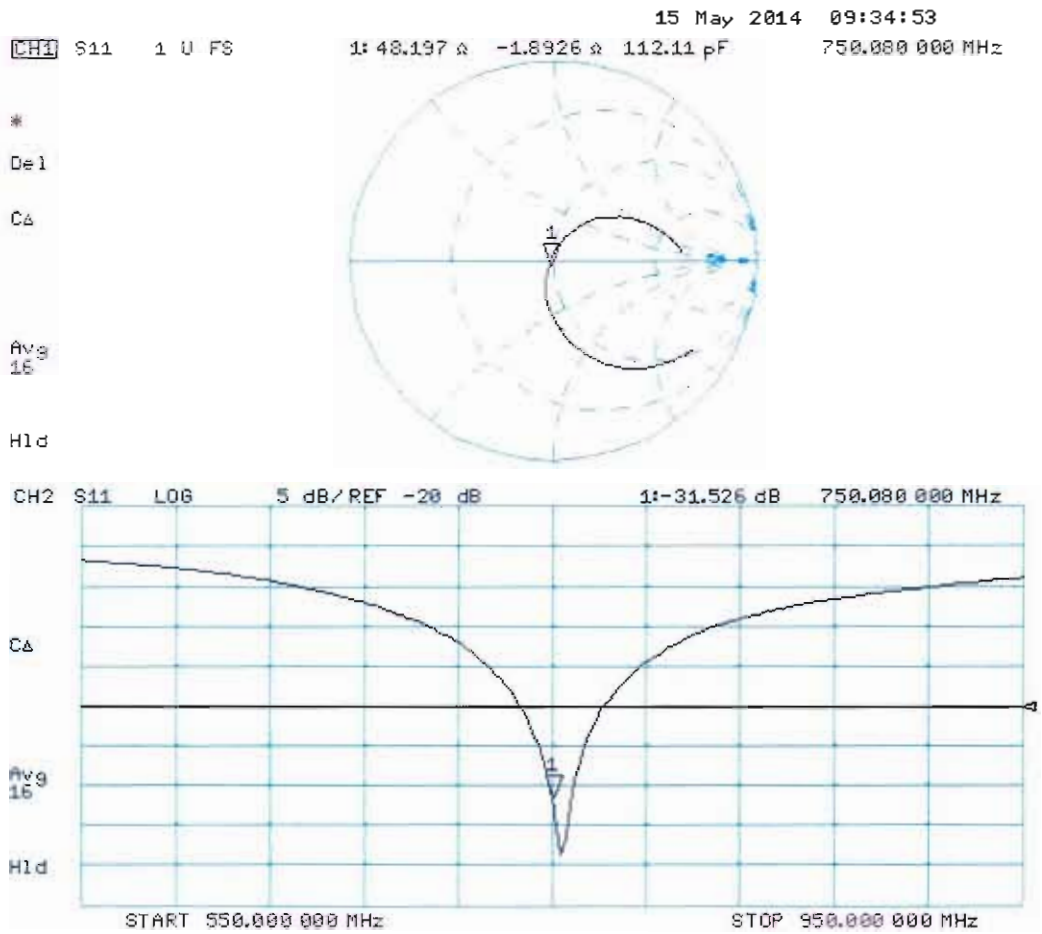
Dipole Calibration for Body Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 52.79 V/m; Power Drift = 0.00 dB
Peak SAR (extrapolated) = 3.30 W/kg
SAR(1 g) = 2.22 W/kg; SAR(10 g) = 1.45 W/kg
Maximum value of SAR (measured) = 2.60 W/kg



0 dB = 2.60 W/kg = 4.15 dBW/kg

Impedance Measurement Plot for Body TSL



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

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

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

Accreditation No.: **SCS 108**

Client **Sporton-TW (Auden)**

Certificate No: **D835V2-499_Mar14**

CALIBRATION CERTIFICATE

Object	D835V2 - SN: 499
Calibration procedure(s)	QA CAL-05.v9 Calibration procedure for dipole validation kits above 700 MHz
Calibration date:	March 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 (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	09-Oct-13 (No. 217-01827)	Oct-14
Power sensor HP 8481A	US37292783	09-Oct-13 (No. 217-01827)	Oct-14
Power sensor HP 8481A	MY41092317	09-Oct-13 (No. 217-01828)	Oct-14
Reference 20 dB Attenuator	SN: 5058 (20k)	04-Apr-13 (No. 217-01736)	Apr-14
Type-N mismatch combination	SN: 5047.3 / 06327	04-Apr-13 (No. 217-01739)	Apr-14
Reference Probe ES3DV3	SN: 3205	30-Dec-13 (No. ES3-3205_Dec13)	Dec-14
DAE4	SN: 601	25-Apr-13 (No. DAE4-601_Apr13)	Apr-14

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-13)	In house check: Oct-14

	Name	Function	Signature
Calibrated by:	Israe El-Naouq	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: March 24, 2014

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

Glossary:

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

Calibration is Performed According to the Following Standards:

a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
c) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

d) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Measurement Conditions

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

DASY Version	DASY5	V52.8.7
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	15 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	835 MHz ± 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 ± 0.2) °C	40.5 ± 6 %	0.94 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	2.37 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**9.13 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	250 mW input power	1.53 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**5.94 W/kg ± 16.5 % (k=2)**

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	55.2	0.97 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	55.0 ± 6 %	1.01 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	2.44 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**9.46 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	250 mW input power	1.58 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**6.17 W/kg ± 16.5 % (k=2)**

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	52.7 Ω - 2.8 jΩ
Return Loss	- 28.5 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	47.2 Ω - 5.6 jΩ
Return Loss	- 23.8 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.391 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	July 10, 2003

DASY5 Validation Report for Head TSL

Date: 24.03.2014

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 499

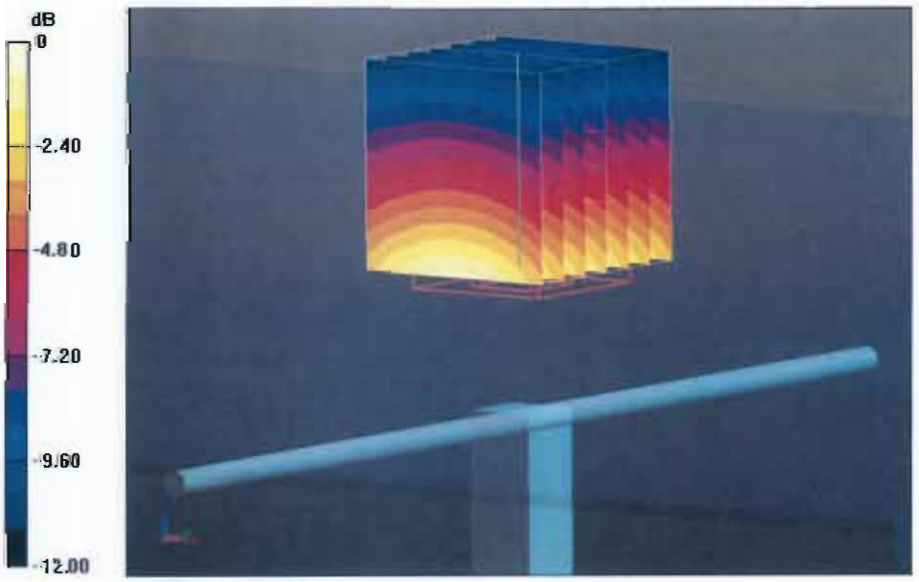
Communication System: UID 0 - CW; Frequency: 835 MHz
Medium parameters used: f = 835 MHz; σ = 0.94 S/m; ε_r = 40.5; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(6.22, 6.22, 6.22); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

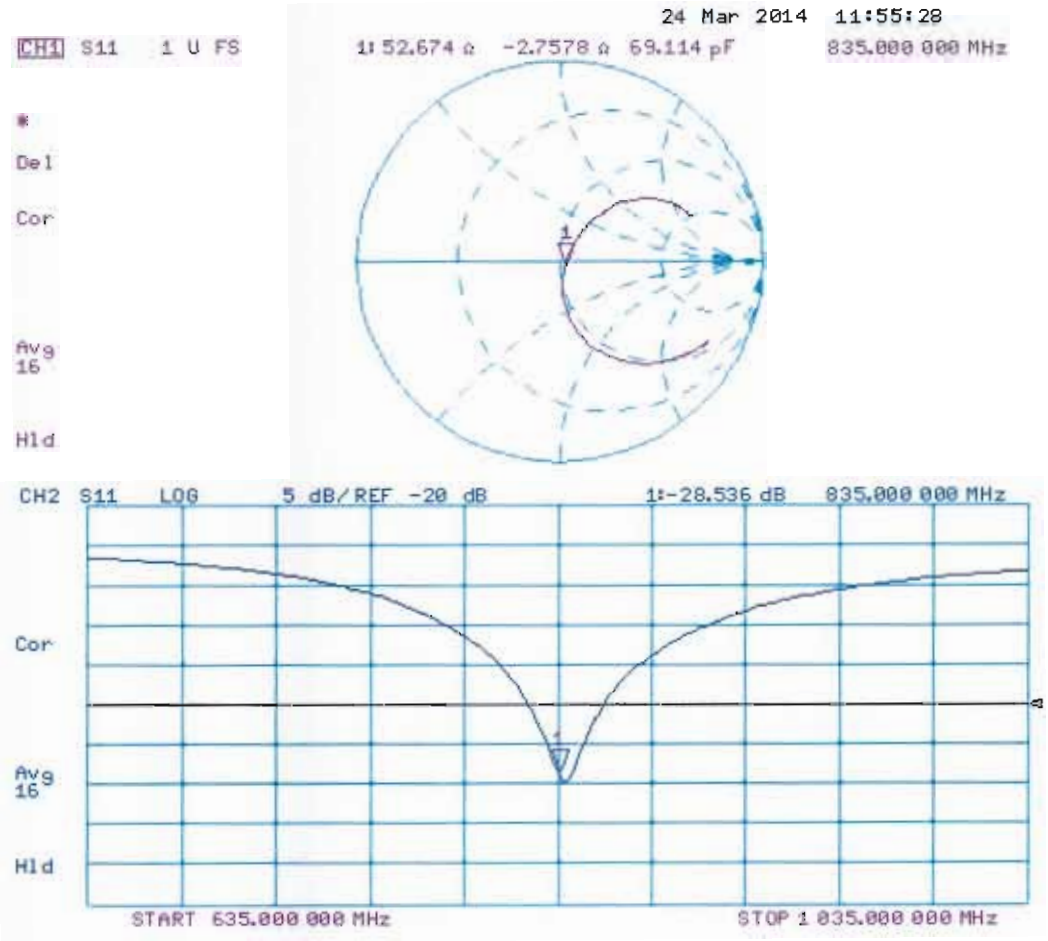
Dipole Calibration for Head Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 56.333 V/m; Power Drift = -0.00 dB
Peak SAR (extrapolated) = 3.60 W/kg
SAR(1 g) = 2.37 W/kg; SAR(10 g) = 1.53 W/kg
Maximum value of SAR (measured) = 2.80 W/kg



0 dB = 2.80 W/kg = 4.47 dBW/kg

Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 24.03.2014

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 499

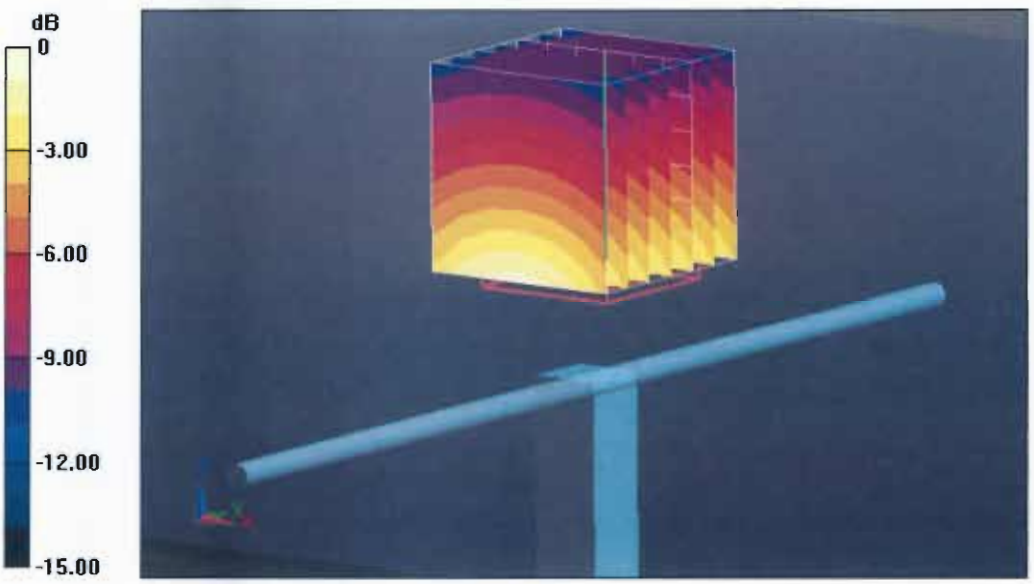
Communication System: UID 0 - CW; Frequency: 835 MHz
Medium parameters used: f = 835 MHz; σ = 1.01 S/m; ε_r = 55; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(6.09, 6.09, 6.09); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

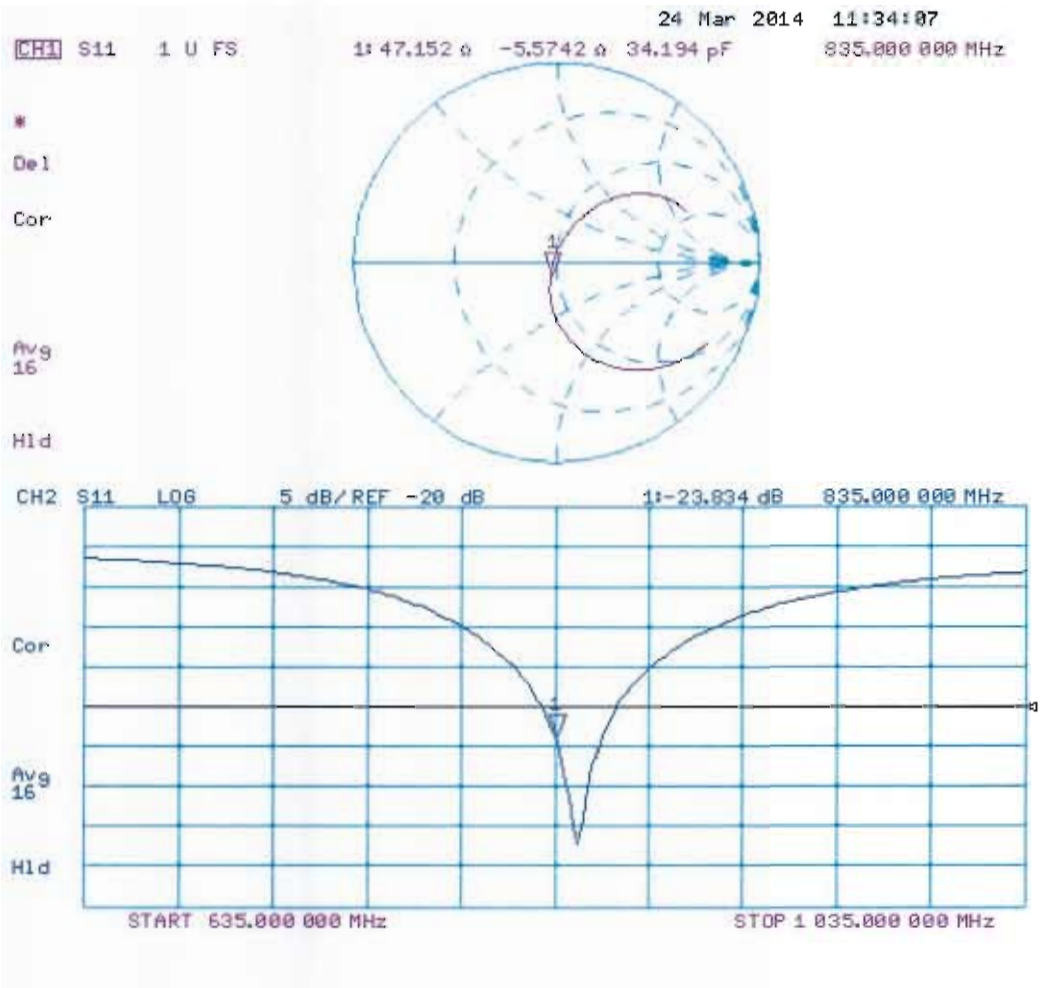
Dipole Calibration for Body Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 54.909 V/m; Power Drift = -0.02 dB
Peak SAR (extrapolated) = 3.65 W/kg
SAR(1 g) = 2.44 W/kg; SAR(10 g) = 1.58 W/kg
Maximum value of SAR (measured) = 2.86 W/kg



0 dB = 2.86 W/kg = 4.56 dBW/kg

Impedance Measurement Plot for Body TSL



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

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

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

Accreditation No.: SCS 108

Client **Sporton KS (Auden)**

Certificate No: D1750V2-1090_Mar13

CALIBRATION CERTIFICATE

Object	D1750V2 - SN: 1090
Calibration procedure(s)	QA CAL-05.v9 Calibration procedure for dipole validation kits above 700 MHz
Calibration date:	March 27, 2013

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	01-Nov-12 (No. 217-01640)	Oct-13
Power sensor HP 8481A	US37292783	01-Nov-12 (No. 217-01640)	Oct-13
Reference 20 dB Attenuator	SN: 5058 (20k)	27-Mar-12 (No. 217-01530)	Apr-13
Type-N mismatch combination	SN: 5047.3 / 06327	27-Mar-12 (No. 217-01533)	Apr-13
Reference Probe ES3DV3	SN: 3205	28-Dec-12 (No. ES3-3205_Dec12)	Dec-13
DAE4	SN: 601	27-Jun-12 (No. DAE4-601_Jun12)	Jun-13

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

	Name	Function	Signature
Calibrated by:	Leif Klysner	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: March 27, 2013

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

Glossary:

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

Calibration is Performed According to the Following Standards:

a) IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
c) Federal Communications Commission Office of Engineering & Technology (FCC OET), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields; Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Supplement C (Edition 01-01) to Bulletin 65

Additional Documentation:

d) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Measurement Conditions

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

DASY Version	DASY5	V52.8.5
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	1750 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	**Permittivity**	**Conductivity**
Nominal Head TSL parameters	22.0 °C	40.1	1.37 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	39.1 ± 6 %	1.35 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	9.20 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**36.9 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	250 mW input power	4.90 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**19.6 W/kg ± 16.5 % (k=2)**

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	**Permittivity**	**Conductivity**
Nominal Body TSL parameters	22.0 °C	53.4	1.49 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	51.5 ± 6 %	1.48 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	9.57 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**38.1 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.14 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**20.5 W/kg ± 16.5 % (k=2)**

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	49.8 Ω - 0.8 jΩ
Return Loss	- 41.8 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	45.3 Ω + 0.2 jΩ
Return Loss	- 26.2 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.221 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	November 07, 2012

DASY5 Validation Report for Head TSL

Date: 27.03.2013

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1750 MHz; Type: D1750V2; Serial: D1750V2 - SN: 1090

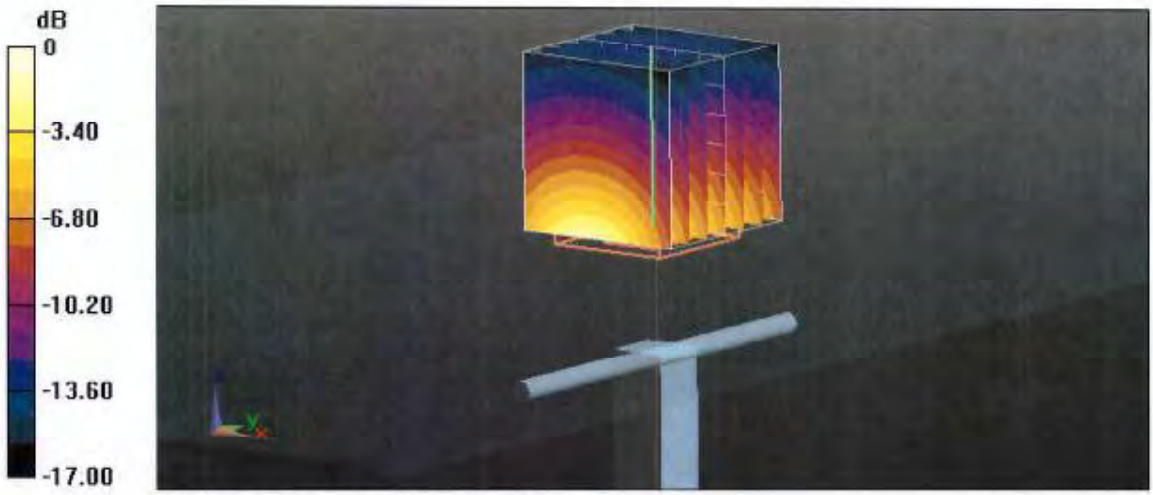
Communication System: CW; Frequency: 1750 MHz
Medium parameters used: f = 1750 MHz; σ = 1.35 S/m; ε_r = 39.1; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(5.18, 5.18, 5.18); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 27.06.2012
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.5(1059); SEMCAD X 14.6.8(7028)

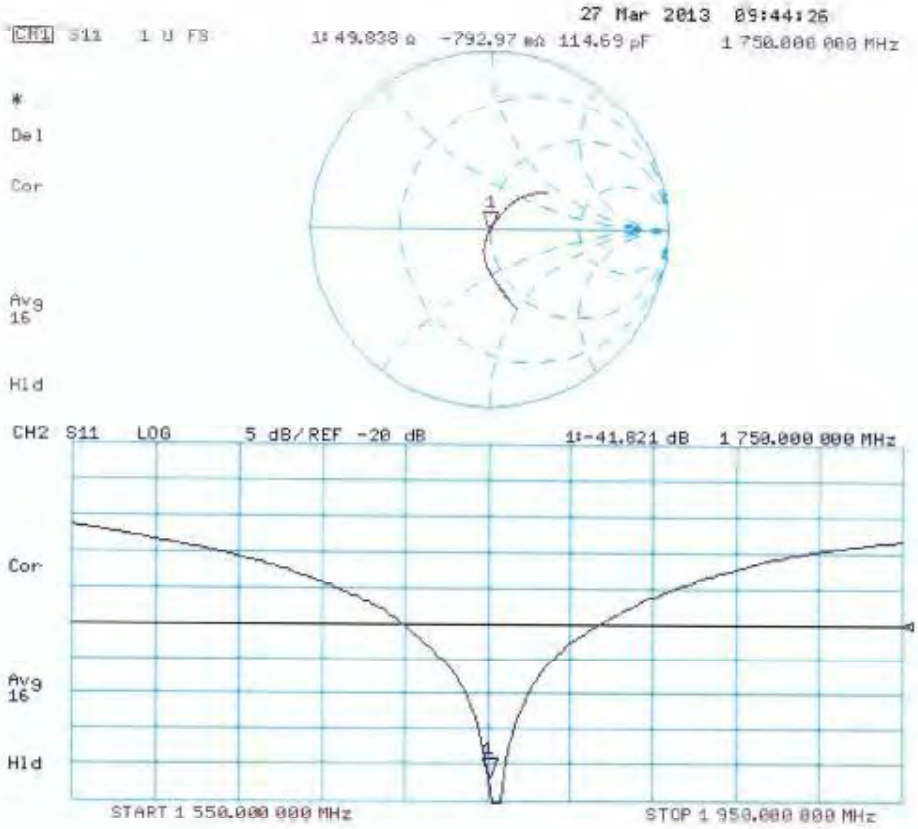
Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 94.130 V/m; Power Drift = 0.00 dB
Peak SAR (extrapolated) = 16.6 W/kg
SAR(1 g) = 9.2 W/kg; SAR(10 g) = 4.9 W/kg
Maximum value of SAR (measured) = 11.3 W/kg



0 dB = 11.3 W/kg = 10.53 dBW/kg

Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 27.03.2013

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1750 MHz; Type: D1750V2; Serial: D1750V2 - SN: 1090

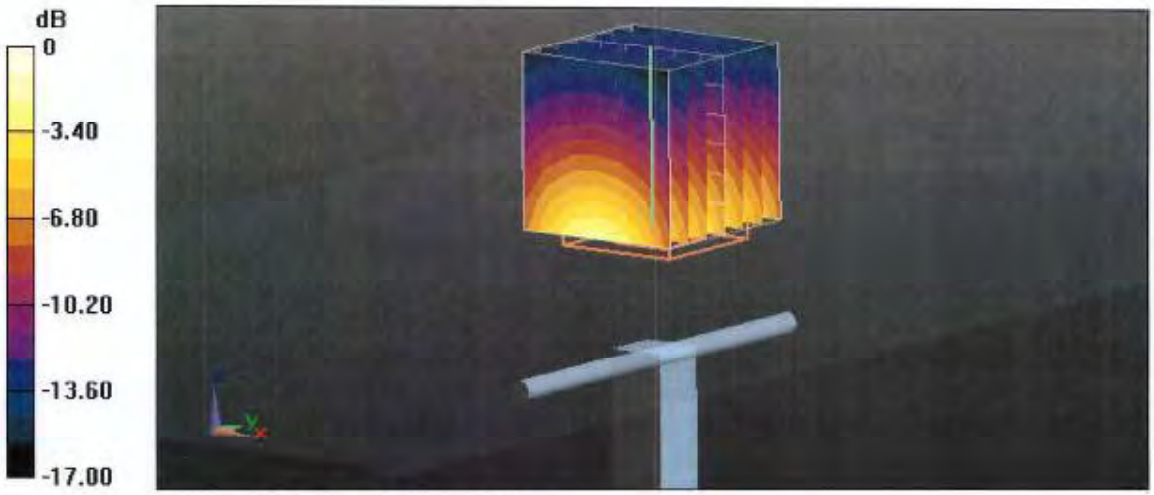
Communication System: CW; Frequency: 1750 MHz
Medium parameters used: f = 1750 MHz; σ = 1.48 S/m; ε_r = 51.5; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.83, 4.83, 4.83); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 27.06.2012
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.5(1059); SEMCAD X 14.6.8(7028)

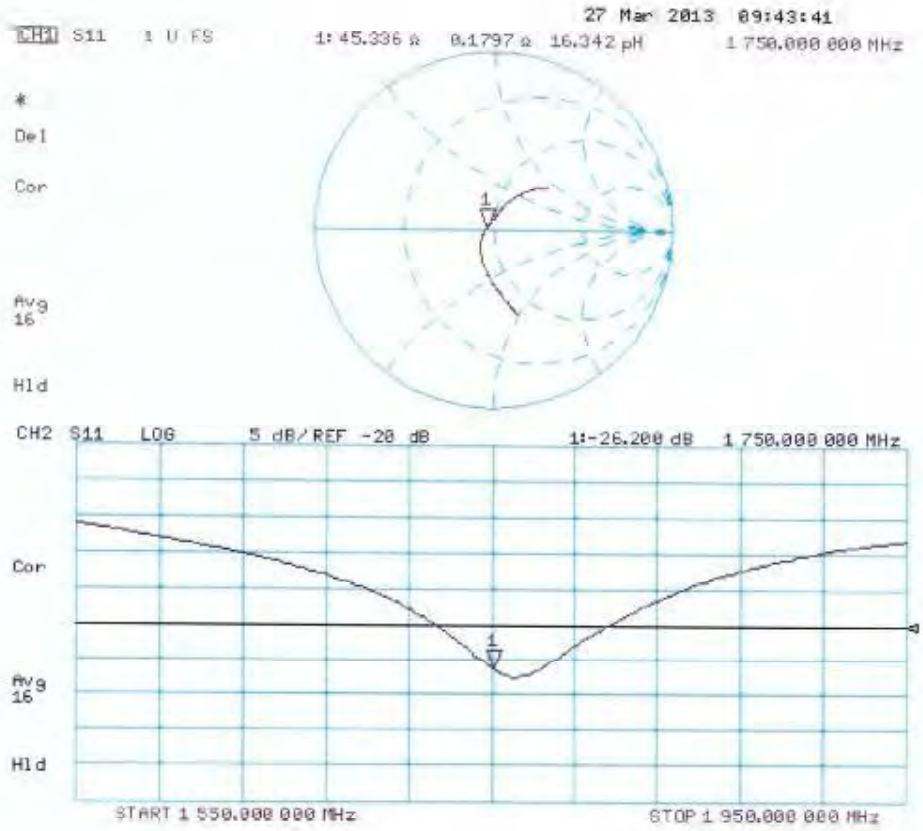
Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 94.130 V/m; Power Drift = 0.00 dB
Peak SAR (extrapolated) = 16.5 W/kg
SAR(1 g) = 9.57 W/kg; SAR(10 g) = 5.14 W/kg
Maximum value of SAR (measured) = 12.0 W/kg



0 dB = 12.0 W/kg = 10.79 dBW/kg

Impedance Measurement Plot for Body TSL

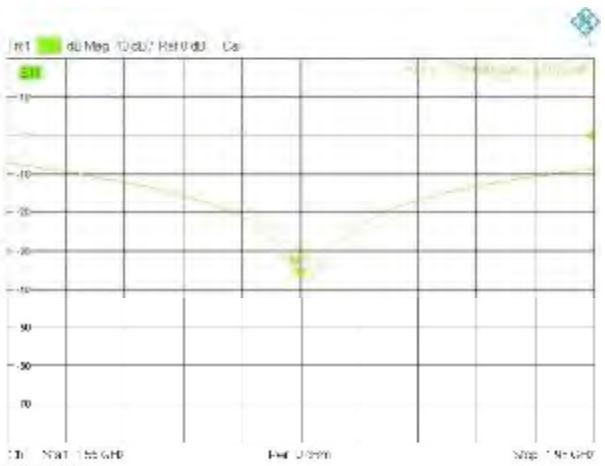


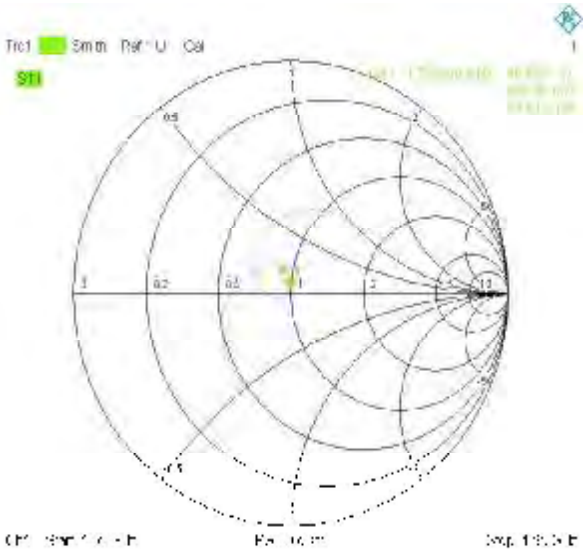
Extended Dipole Calibrations

Referring to KDB 865664 D01 v01r03, if dipoles are verified in return loss (<-20dB, within 20% of prior calibration), and in impedance (within 5 ohm of prior calibration), the annual calibration is not necessary and the calibration interval can be extended.

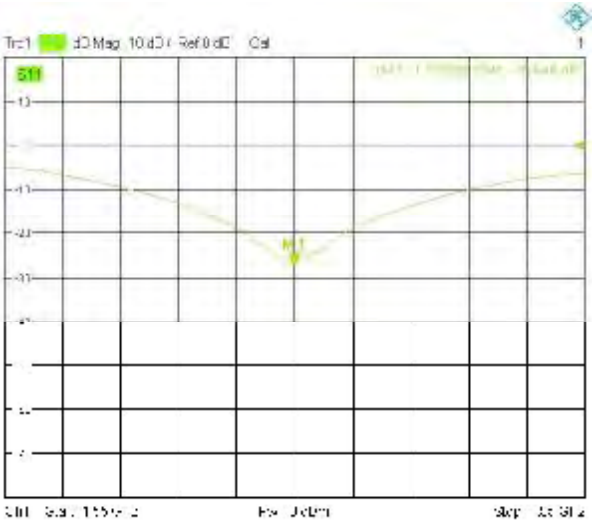
<Dipole Verification Data> - D1750V2, serial no. 1090(Date of Measurement 03.26.2014)

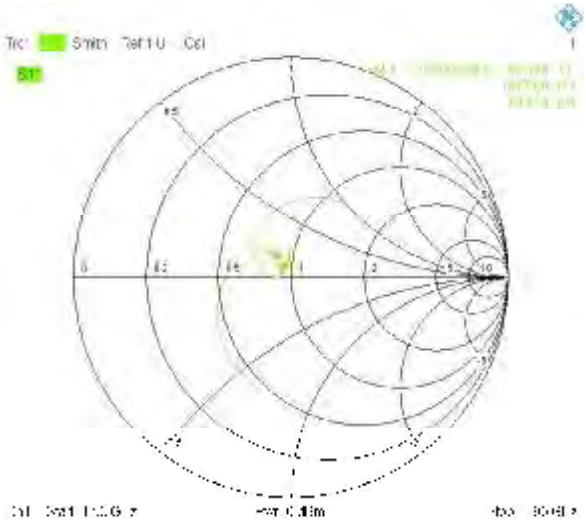
1750MHz - Head





1750MHz – Body





SPORTON INTERNATIONAL INC.
TEL : 886-3-327-3456
FAX : 886-3-328-4978

<Justification of the extended calibration>

D1750V2 – serial no. 1090												
TSL	Head						Body					
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
03.27.2013	-41.821		49.838		-0.793		-26.2		45.336		0.1797	
03.26.2014	-37.025	11.45	49.553	-0.285	0.808	1.601	-26.949	-2.86	46.183	0.874	0.8776	0.698

The return loss is < -20dB, within 20% of prior calibration; the impedance is within 5 ohm of prior calibration.

Therefore the verification result should support extended calibration.

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

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Servizio svizzero di taratura
S Swiss Calibration Service

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

Accreditation No.: SCS 108

Client **Sporton (Auden)**

Certificate No: D1900V2-5d041_Mar14

CALIBRATION CERTIFICATE

Object	D1900V2 - SN: 5d041
Calibration procedure(s)	QA CAL-05.v9 Calibration procedure for dipole validation kits above 700 MHz
Calibration date:	March 21, 2014

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	09-Oct-13 (No. 217-01827)	Oct-14
Power sensor HP 8481A	US37292783	09-Oct-13 (No. 217-01827)	Oct-14
Power sensor HP 8481A	MY41092317	09-Oct-13 (No. 217-01828)	Oct-14
Reference 20 dB Attenuator	SN: 5058 (20k)	04-Apr-13 (No. 217-01736)	Apr-14
Type-N mismatch combination	SN: 5047.3 / 06327	04-Apr-13 (No. 217-01739)	Apr-14
Reference Probe ES3DV3	SN: 3205	30-Dec-13 (No. ES3-3205_Dec13)	Dec-14
DAE4	SN: 601	25-Apr-13 (No. DAE4-601_Apr13)	Apr-14

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-13)	In house check: Oct-14

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

Issued: March 21, 2014

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

Glossary:

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

Calibration is Performed According to the Following Standards:

a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
c) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

d) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Measurement Conditions

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

DASY Version	DASY5	V52.8.7
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 ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	40.0	1.40 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	38.8 ± 6 %	1.37 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	10.2 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**41.0 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	250 mW input power	5.32 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**21.4 W/kg ± 16.5 % (k=2)**

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	53.3	1.52 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	52.5 ± 6 %	1.50 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	10.2 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**41.0 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.40 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**21.7 W/kg ± 16.5 % (k=2)**

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	53.9 Ω + 6.6 jΩ
Return Loss	- 22.6 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	49.2 Ω + 6.4 jΩ
Return Loss	- 23.8 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	July 04, 2003

DASY5 Validation Report for Head TSL

Date: 21.03.2014

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d041

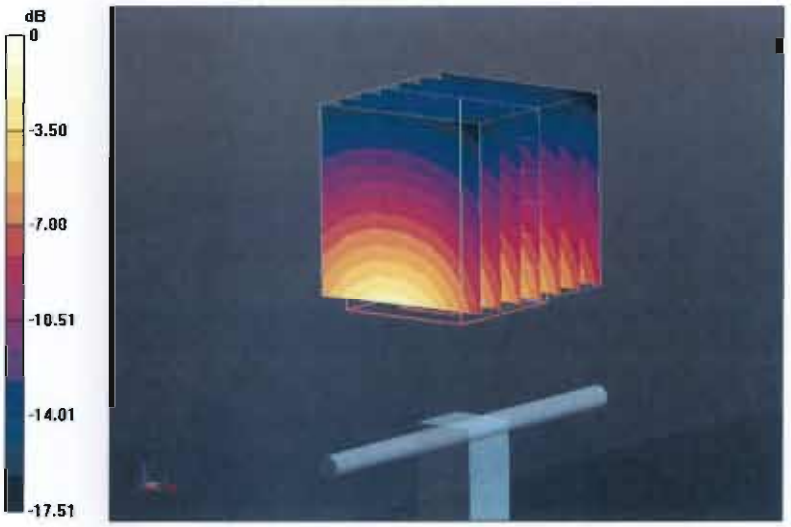
Communication System: UID 0 - CW; Frequency: 1900 MHz
Medium parameters used: f = 1900 MHz; σ = 1.37 S/m; ε_r = 38.8; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(5.06, 5.06, 5.06); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

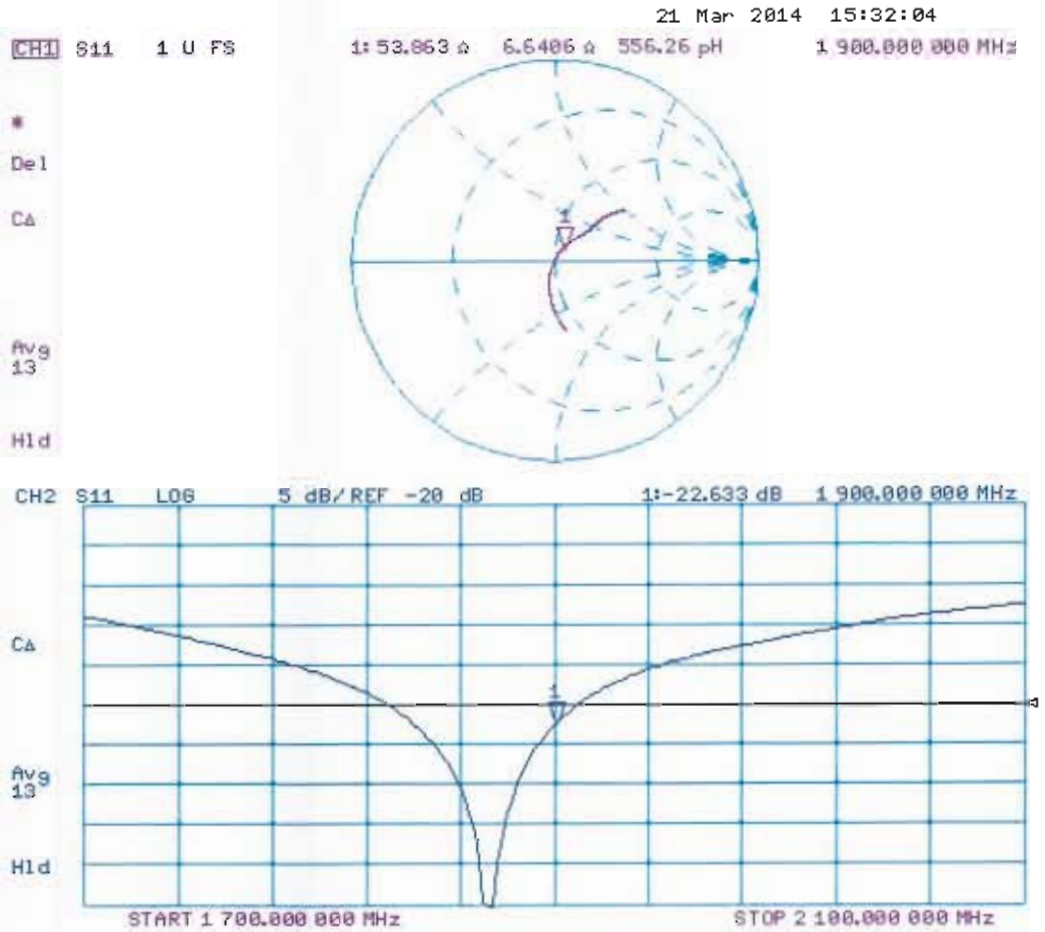
Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 98.04 V/m; Power Drift = 0.05 dB
Peak SAR (extrapolated) = 18.6 W/kg
SAR(1 g) = 10.2 W/kg; SAR(10 g) = 5.32 W/kg
Maximum value of SAR (measured) = 12.4 W/kg



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

Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 21.03.2014

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d041

Communication System: UID 0 - CW; Frequency: 1900 MHz
Medium parameters used: f = 1900 MHz; σ = 1.5 S/m; ε_r = 52.5; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

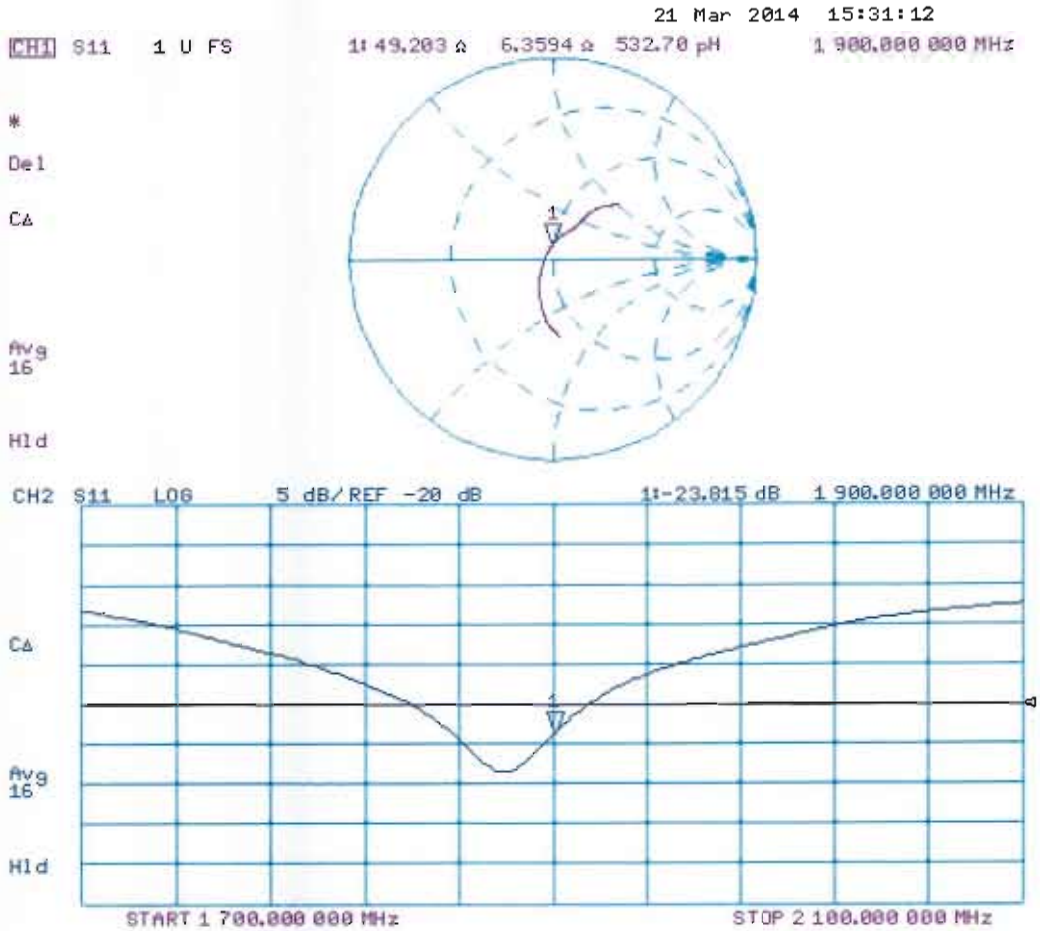
- Probe: ES3DV3 - SN3205; ConvF(4.76, 4.76, 4.76); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

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 = 96.439 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 17.7 W/kg
SAR(1 g) = 10.2 W/kg; SAR(10 g) = 5.4 W/kg
Maximum value of SAR (measured) = 12.9 W/kg

0 dB = 12.9 W/kg = 11.11 dBW/kg

Impedance Measurement Plot for Body TSL



Calibration Laboratory of
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Accreditation No.: SCS 108

Client **Sporton-TW (Auden)**

Certificate No: D2450V2-736_Aug14

CALIBRATION CERTIFICATE

Object	D2450V2 - SN: 736
Calibration procedure(s)	QA CAL-05.v9 Calibration procedure for dipole validation kits above 700 MHz
Calibration date:	August 21, 2014

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	09-Oct-13 (No. 217-01827)	Oct-14
Power sensor HP 8481A	US37292783	09-Oct-13 (No. 217-01827)	Oct-14
Power sensor HP 8481A	MY41092317	09-Oct-13 (No. 217-01828)	Oct-14
Reference 20 dB Attenuator	SN: 5058 (20k)	03-Apr-14 (No. 217-01918)	Apr-15
Type-N mismatch combination	SN: 5047.2 / 06327	03-Apr-14 (No. 217-01921)	Apr-15
Reference Probe ES3DV3	SN: 3205	30-Dec-13 (No. ES3-3205_Dec13)	Dec-14
DAE4	SN: 601	18-Aug-14 (No. DAE4-601_Aug14)	Aug-15

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

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

Issued: August 21, 2014

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

Glossary:

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

Calibration is Performed According to the Following Standards:

a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
c) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

d) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

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 ± 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 ± 0.2) °C	38.0 ± 6 %	1.82 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.1 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**51.8 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.06 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**24.0 W/kg ± 16.5 % (k=2)**

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	**Permittivity**	**Conductivity**
Nominal Body TSL parameters	22.0 °C	52.7	1.95 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	50.5 ± 6 %	2.02 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	13.0 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**50.6 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.99 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**23.6 W/kg ± 16.5 % (k=2)**

Appendix (Additional assessments outside the scope of SCS108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	55.5 Ω + 1.6 jΩ
Return Loss	- 25.3 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	51.6 Ω + 3.4 jΩ
Return Loss	- 28.6 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.158 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 26, 2003

DASY5 Validation Report for Head TSL

Date: 21.08.2014

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 736

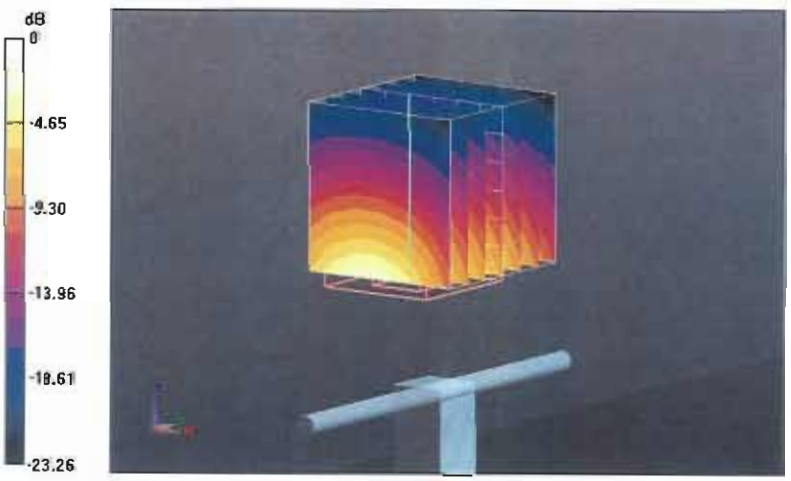
Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; σ = 1.82 S/m; ε_r = 38; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.53, 4.53, 4.53); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 18.08.2014
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

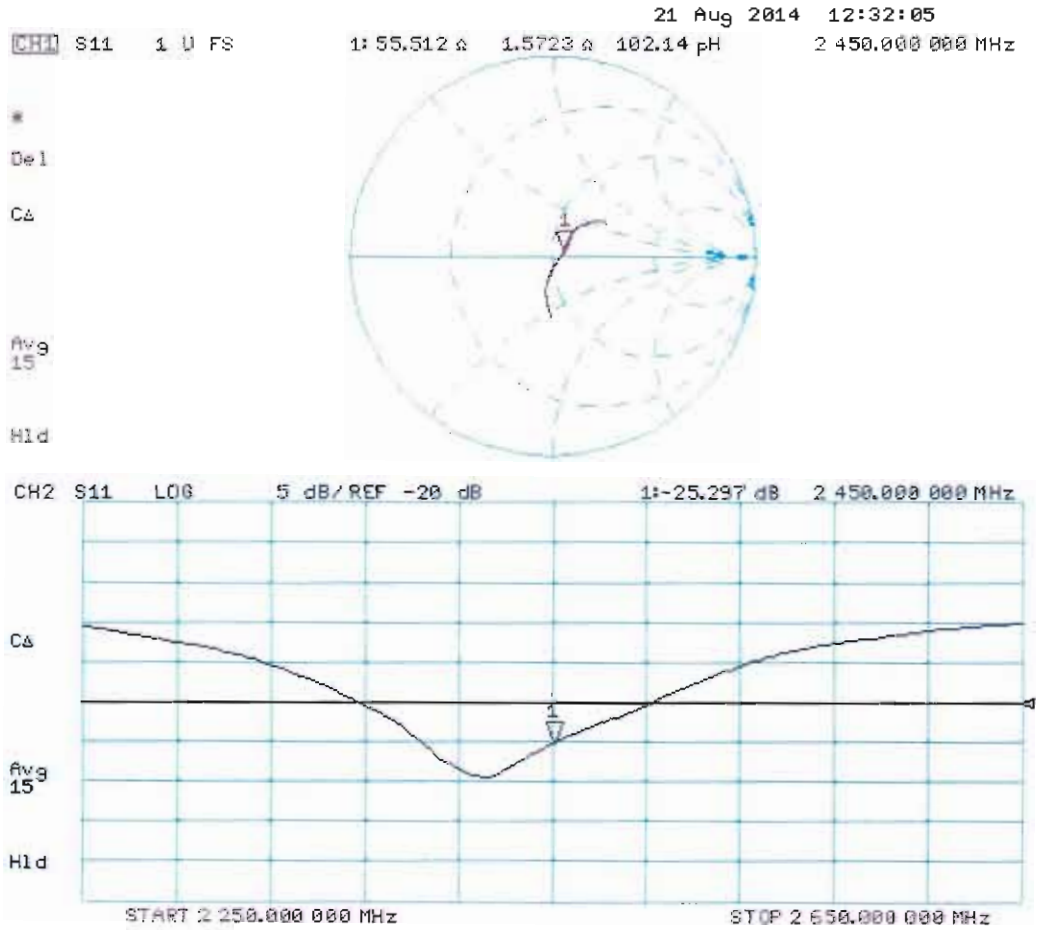
Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 98.62 V/m; Power Drift = 0.07 dB
Peak SAR (extrapolated) = 27.1 W/kg
SAR(1 g) = 13.1 W/kg; SAR(10 g) = 6.06 W/kg
Maximum value of SAR (measured) = 16.7 W/kg



0 dB = 16.7 W/kg = 12.23 dBW/kg

Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 21.08.2014

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 736

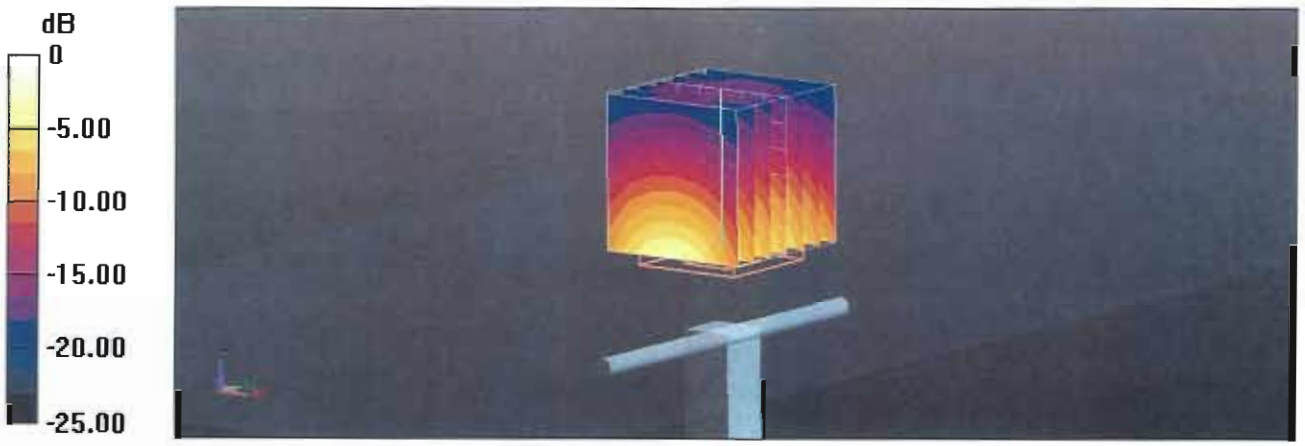
Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; σ = 2.02 S/m; ε_r = 50.5; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.35, 4.35, 4.35); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 18.08.2014
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

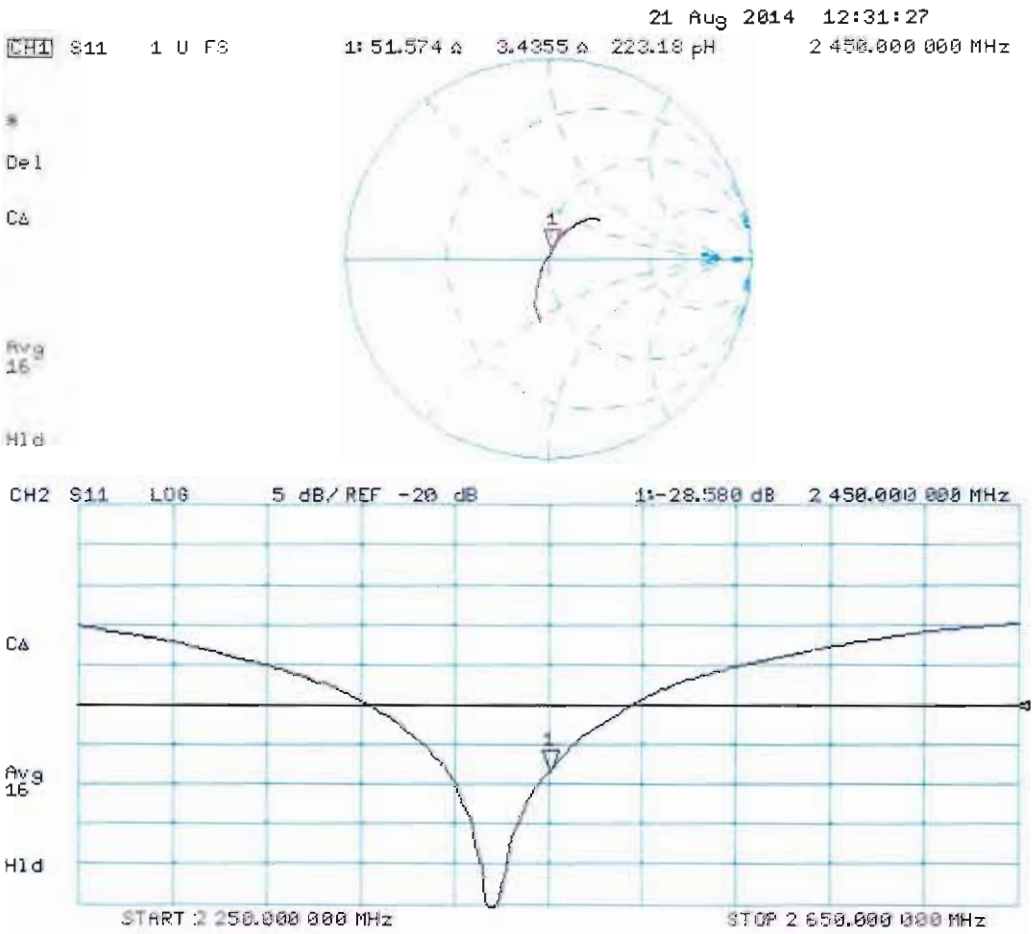
Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 95.24 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 26.9 W/kg
SAR(1 g) = 13 W/kg; SAR(10 g) = 5.99 W/kg
Maximum value of SAR (measured) = 17.1 W/kg



0 dB = 17.1 W/kg = 12.33 dBW/kg

Impedance Measurement Plot for Body TSL



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

Accreditation No.: SCS 108

Client **Sporton-TW (Auden)**

Certificate No: D5GHzV2-1128_Jul14

CALIBRATION CERTIFICATE

Object	D5GHzV2 - SN: 1128
Calibration procedure(s)	QA CAL-22.v2 Calibration procedure for dipole validation kits between 3-6 GHz
Calibration date:	July 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&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	09-Oct-13 (No. 217-01827)	Oct-14
Power sensor HP 8481A	US37292783	09-Oct-13 (No. 217-01827)	Oct-14
Power sensor HP 8481A	MY41092317	09-Oct-13 (No. 217-01828)	Oct-14
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 EX3DV4	SN: 3503	30-Dec-13 (No. EX3-3503_Dec13)	Dec-14
DAE4	SN: 601	30-Apr-14 (No. DAE4-601_Apr14)	Apr-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-13)	In house check: Oct-14

	Name	Function	Signature
Calibrated by:	Israe El-Naouq	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: July 23, 2014

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

Glossary:

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

Calibration is Performed According to the Following Standards:

a) IEC 62209-2, "Evaluation of Human Exposure to Radio Frequency Fields from Handheld and Body-Mounted Wireless Communication Devices in the Frequency Range of 30 MHz to 6 GHz: Human models, Instrumentation, and Procedures"; Part 2: "Procedure to determine the Specific Absorption Rate (SAR) for including accessories and multiple transmitters", March 2010
b) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"
c) 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

Additional Documentation:

d) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

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 V5.0	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy = 4.0 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	5200 MHz ± 1 MHz 5300 MHz ± 1 MHz 5600 MHz ± 1 MHz 5800 MHz ± 1 MHz	

Head TSL parameters at 5200 MHz

The following parameters and calculations were applied.

	Temperature	**Permittivity**	**Conductivity**
Nominal Head TSL parameters	22.0 °C	36.0	4.66 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.6 ± 6 %	4.46 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5200 MHz

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.05 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**79.8 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.31 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**22.8 W/kg ± 19.5 % (k=2)**

Head TSL parameters at 5300 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.9	4.76 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.4 ± 6 %	4.56 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5300 MHz

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.24 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**81.6 W / kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.37 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**23.4 W/kg ± 19.5 % (k=2)**

Head TSL parameters at 5600 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.5	5.07 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.0 ± 6 %	4.84 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5600 MHz

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.49 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**84.0 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.42 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**23.9 W/kg ± 19.5 % (k=2)**

Head TSL parameters at 5800 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.3	5.27 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	33.8 ± 6 %	5.04 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5800 MHz

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.98 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**78.9 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.28 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**22.5 W/kg ± 19.5 % (k=2)**

Body TSL parameters at 5200 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	49.0	5.30 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	47.7 ± 6 %	5.38 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5200 MHz

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.66 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**76.2 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.15 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**21.4 W/kg ± 19.5 % (k=2)**

Body TSL parameters at 5300 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.9	5.42 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	47.6 ± 6 %	5.51 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5300 MHz

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.81 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**77.7 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.20 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**21.9 W/kg ± 19.5 % (k=2)**

Body TSL parameters at 5600 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.5	5.77 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	47.1 ± 6 %	5.91 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5600 MHz

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	8.19 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**81.5 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.28 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**22.6 W/kg ± 19.5 % (k=2)**

Body TSL parameters at 5800 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.2	6.00 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	46.7 ± 6 %	6.18 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5800 MHz

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.63 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**75.9 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.12 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**21.0 W/kg ± 19.5 % (k=2)**

Appendix (Additional assessments outside the scope of SCS108)

Antenna Parameters with Head TSL at 5200 MHz

Impedance, transformed to feed point	48.8 Ω - 5.8 jΩ
Return Loss	- 24.5 dB

Antenna Parameters with Head TSL at 5300 MHz

Impedance, transformed to feed point	49.7 Ω - 1.7 jΩ
Return Loss	- 35.3 dB

Antenna Parameters with Head TSL at 5600 MHz

Impedance, transformed to feed point	55.5 Ω - 2.5 jΩ
Return Loss	- 24.9 dB

Antenna Parameters with Head TSL at 5800 MHz

Impedance, transformed to feed point	53.4 Ω - 1.2 jΩ
Return Loss	- 29.1 dB

Antenna Parameters with Body TSL at 5200 MHz

Impedance, transformed to feed point	51.3 Ω - 4.6 jΩ
Return Loss	- 26.6 dB

Antenna Parameters with Body TSL at 5300 MHz

Impedance, transformed to feed point	50.7 Ω + 0.3 jΩ
Return Loss	- 42.1 dB

Antenna Parameters with Body TSL at 5600 MHz

Impedance, transformed to feed point	56.8 Ω + 1.7 jΩ
Return Loss	- 23.7 dB

Antenna Parameters with Body TSL at 5800 MHz

Impedance, transformed to feed point	54.5 Ω + 2.6 jΩ
Return Loss	- 26.1 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.209 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	September 08, 2011

DASY5 Validation Report for Head TSL

Date: 21.07.2014

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1128

Communication System: UID 0 - CW; Frequency: 5200 MHz, Frequency: 5300 MHz, Frequency: 5600 MHz, Frequency: 5800 MHz
Medium parameters used: f = 5200 MHz; σ = 4.46 S/m; ε_r = 34.6; ρ = 1000 kg/m^3 , Medium parameters used: f = 5300 MHz; σ = 4.56 S/m; ε_r = 34.4; ρ = 1000 kg/m^3 , Medium parameters used: f = 5600 MHz; σ = 4.84 S/m; ε_r = 34; ρ = 1000 kg/m^3 , Medium parameters used: f = 5800 MHz; σ = 5.04 S/m; ε_r = 33.8; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

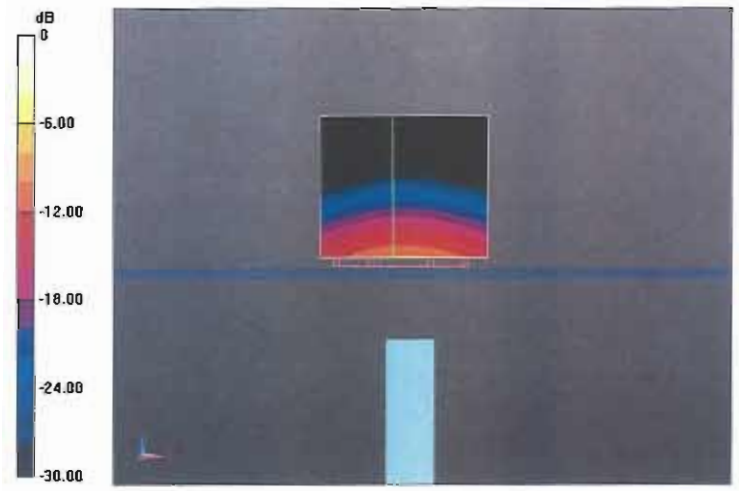
- Probe: EX3DV4 - SN3503; ConvF(5.52, 5.52, 5.52); Calibrated: 30.12.2013, ConvF(5.2, 5.2, 5.2); Calibrated: 30.12.2013, ConvF(4.86, 4.86, 4.86); Calibrated: 30.12.2013, ConvF(4.91, 4.91, 4.91); Calibrated: 30.12.2013;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.04.2014
- 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=100mW, dist=10mm, f=5200 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 64.76 V/m; Power Drift = 0.02 dB
Peak SAR (extrapolated) = 29.1 W/kg
SAR(1 g) = 8.05 W/kg; SAR(10 g) = 2.31 W/kg
Maximum value of SAR (measured) = 18.9 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5300 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 64.86 V/m; Power Drift = 0.04 dB
Peak SAR (extrapolated) = 30.8 W/kg
SAR(1 g) = 8.24 W/kg; SAR(10 g) = 2.37 W/kg
Maximum value of SAR (measured) = 19.5 W/kg

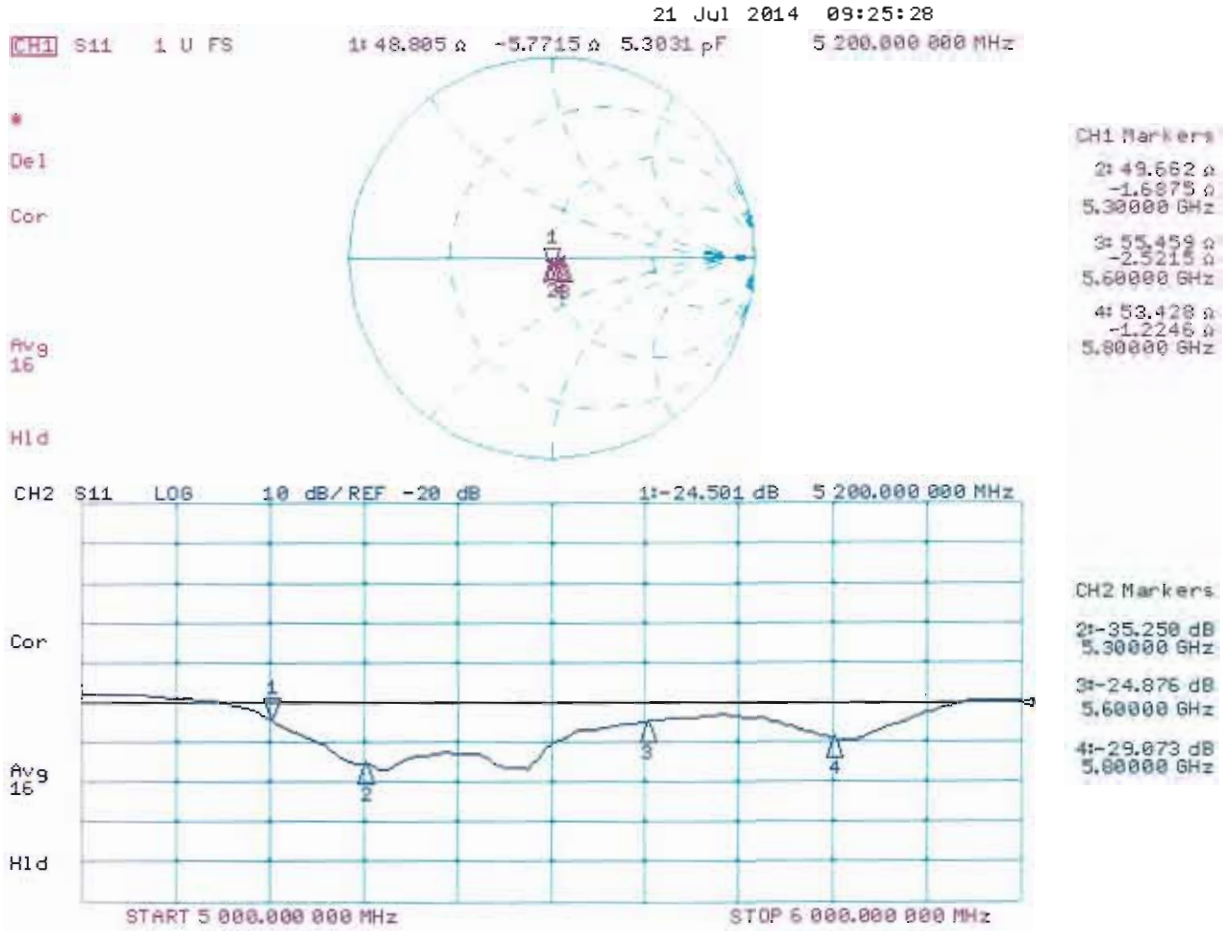
Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 64.74 V/m; Power Drift = 0.09 dB
Peak SAR (extrapolated) = 33.7 W/kg
SAR(1 g) = 8.49 W/kg; SAR(10 g) = 2.42 W/kg
Maximum value of SAR (measured) = 20.5 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 62.12 V/m; Power Drift = 0.03 dB
Peak SAR (extrapolated) = 32.7 W/kg
SAR(1 g) = 7.98 W/kg; SAR(10 g) = 2.28 W/kg
Maximum value of SAR (measured) = 19.2 W/kg



0 dB = 19.2 W/kg = 12.83 dBW/kg

Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 22.07.2014

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1128

Communication System: UID 0 - CW; Frequency: 5200 MHz, Frequency: 5300 MHz, Frequency: 5600 MHz, Frequency: 5800 MHz
Medium parameters used: f = 5200 MHz; σ = 5.38 S/m; ε_r = 47.7; ρ = 1000 kg/m^3 , Medium parameters used: f = 5300 MHz; σ = 5.51 S/m; ε_r = 47.6; ρ = 1000 kg/m^3 , Medium parameters used: f = 5600 MHz; σ = 5.91 S/m; ε_r = 47.1; ρ = 1000 kg/m^3 , Medium parameters used: f = 5800 MHz; σ = 6.18 S/m; ε_r = 46.7; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

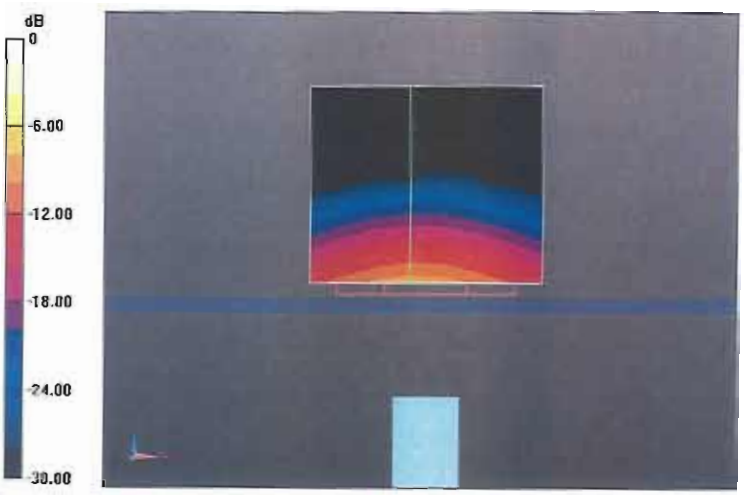
- Probe: EX3DV4 - SN3503; ConvF(5.01, 5.01, 5.01); Calibrated: 30.12.2013, ConvF(4.76, 4.76, 4.76); Calibrated: 30.12.2013, ConvF(4.3, 4.3, 4.3); Calibrated: 30.12.2013, ConvF(4.47, 4.47, 4.47); Calibrated: 30.12.2013;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.04.2014
- 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=100mW, dist=10mm, f=5200 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 59.96 V/m; Power Drift = -0.03 dB
Peak SAR (extrapolated) = 29.8 W/kg
SAR(1 g) = 7.66 W/kg; SAR(10 g) = 2.15 W/kg
Maximum value of SAR (measured) = 17.8 W/kg

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5300 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 59.52 V/m; Power Drift = 0.00 dB
Peak SAR (extrapolated) = 31.2 W/kg
SAR(1 g) = 7.81 W/kg; SAR(10 g) = 2.2 W/kg
Maximum value of SAR (measured) = 18.2 W/kg

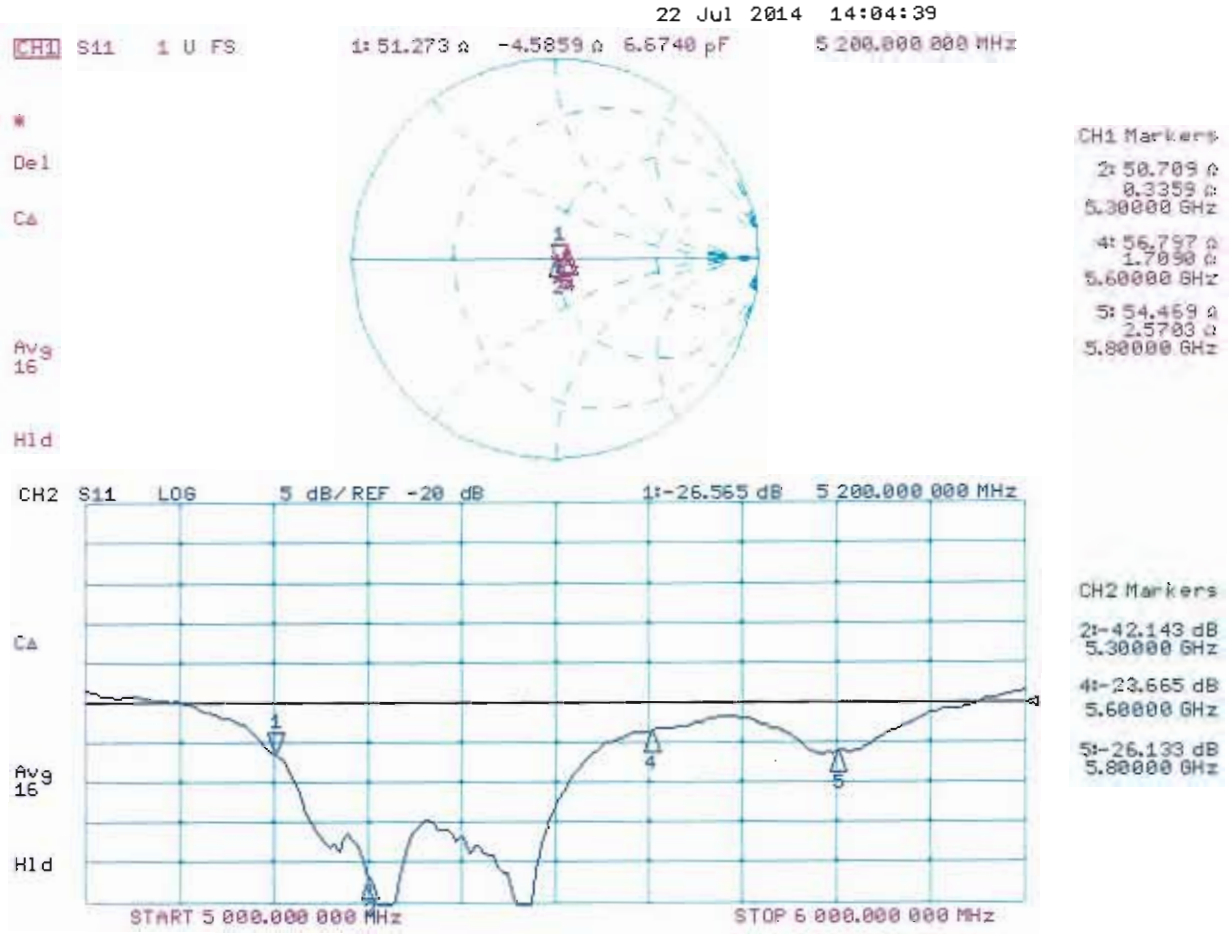
Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 59.28 V/m; Power Drift = -0.02 dB
Peak SAR (extrapolated) = 35.8 W/kg
SAR(1 g) = 8.19 W/kg; SAR(10 g) = 2.28 W/kg
Maximum value of SAR (measured) = 20.0 W/kg

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 56.21 V/m; Power Drift = -0.03 dB
Peak SAR (extrapolated) = 34.9 W/kg
SAR(1 g) = 7.63 W/kg; SAR(10 g) = 2.12 W/kg
Maximum value of SAR (measured) = 18.7 W/kg



0 dB = 18.7 W/kg = 12.72 dBW/kg

Impedance Measurement Plot for Body TSL



Schmid & Partner Engineering AG

s p e a g

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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.

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

S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
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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 **Sporton-CN (Auden)**

Certificate No: DAE4-1210_May14

CALIBRATION CERTIFICATE

Object	DAE4 - SD 000 D04 BM - SN: 1210
Calibration procedure(s)	QA CAL-06.v26 Calibration procedure for the data acquisition electronics (DAE)
Calibration date:	May 19, 2014

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
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	i.V.

Issued: May 20, 2014

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

Glossary

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

Methods Applied and Interpretation of Parameters

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

DC Voltage Measurement

A/D - Converter Resolution nominal

High Range:	1LSB =	6.1μV ,	full range =	-100...+300 mV
Low Range:	1LSB =	61nV ,	full range =	-1.....+3mV

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

Calibration Factors	X	Y	Z
High Range	404.126 ± 0.02% (k=2)	404.956 ± 0.02% (k=2)	405.065 ± 0.02% (k=2)
Low Range	4.00002 ± 1.50% (k=2)	3.98327 ± 1.50% (k=2)	4.00021 ± 1.50% (k=2)

Connector Angle

Connector Angle to be used in DASY system	123.5 ° ± 1 °

Appendix

1. DC Voltage Linearity

High Range		Reading (µV)	Difference (µV)	Error (%)
Channel X	+ Input	199993.16	-3.08	-0.00
Channel X	+ Input	20001.58	0.86	0.00
Channel X	- Input	-19997.88	2.96	-0.01
Channel Y	+ Input	199997.46	1.25	0.00
Channel Y	+ Input	20001.02	0.31	0.00
Channel Y	- Input	-20000.67	0.41	-0.00
Channel Z	+ Input	199997.96	1.16	0.00
Channel Z	+ Input	20000.22	-0.47	-0.00
Channel Z	- Input	-20000.31	0.71	-0.00

Low Range		Reading (µV)	Difference (µV)	Error (%)
Channel X	+ Input	2001.44	0.40	0.02
Channel X	+ Input	201.65	0.25	0.12
Channel X	- Input	-198.86	-0.60	0.30
Channel Y	+ Input	2001.05	0.10	0.01
Channel Y	+ Input	200.89	-0.51	-0.25
Channel Y	- Input	-198.70	-0.35	0.18
Channel Z	+ Input	2001.15	0.23	0.01
Channel Z	+ Input	200.32	-1.08	-0.54
Channel Z	- Input	-199.61	-1.14	0.57

2. Common mode sensitivity

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

	Common mode Input Voltage (mV)	High Range Average Reading (µV)	Low Range Average Reading (µV)
Channel X	200	-5.19	-7.07
	- 200	7.82	6.50
Channel Y	200	-3.56	-3.90
	- 200	4.19	4.35
Channel Z	200	12.21	11.95
	- 200	-14.51	-14.28

3. Channel separation

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

	Input Voltage (mV)	Channel X (µV)	Channel Y (µV)	Channel Z (µV)
Channel X	200	-	1.78	-3.94
Channel Y	200	8.13	-	2.67
Channel Z	200	9.14	6.43	-

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	15954	15797
Channel Y	15962	16451
Channel Z	15874	16936

5. Input Offset Measurement

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec
Input 10MΩ

	Average (µV)	min. Offset (µV)	max. Offset (µV)	Std. Deviation (µV)
Channel X	-0.85	-1.82	-0.15	0.34
Channel Y	-0.27	-1.81	0.54	0.39
Channel Z	-0.30	-1.29	0.94	0.43

6. Input Offset Current

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

7. Input Resistance (Typical values for information)

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

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

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

9. Power Consumption (Typical values for information)

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

Calibration Laboratory of
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Accreditation No.: **SCS 108**

Client **Sporton-CN (Auden)**

Certificate No: **EX3-3857_May14**

CALIBRATION CERTIFICATE

Object	EX3DV4 - SN:3857
Calibration procedure(s)	QA CAL-01.v9, QA CAL-14.v4, QA CAL-23.v5, QA CAL-25.v6 Calibration procedure for dosimetric E-field probes
Calibration date:	May 23, 2014

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	03-Apr-14 (No. 217-01911)	Apr-15
Power sensor E4412A	MY41498087	03-Apr-14 (No. 217-01911)	Apr-15
Reference 3 dB Attenuator	SN: S5054 (3c)	03-Apr-14 (No. 217-01918)	Apr-15
Reference 20 dB Attenuator	SN: S5277 (20x)	03-Apr-14 (No. 217-01919)	Apr-15
Reference 30 dB Attenuator	SN: S5129 (30b)	03-Apr-14 (No. 217-01920)	Apr-15
Reference Probe ES3DV2	SN: 3013	30-Dec-13 (No. ES3-3013_Dec13)	Dec-14
DAE4	SN: 660	13-Dec-13 (No. DAE4-660_Dec13)	Dec-14
Secondary Standards	**ID**	**Check Date (in house)**	**Scheduled Check**
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Apr-13)	In house check: Apr-16
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-13)	In house check: Oct-14

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

Issued: May 23, 2014

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

Glossary:

TSL	tissue simulating liquid
NORMx,y,z	sensitivity in free space
ConvF	sensitivity in TSL / NORMx,y,z
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C, D	modulation dependent linearization parameters
Polarization φ	φ rotation around probe axis
Polarization ϑ	ϑ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., ϑ = 0 is normal to probe axis
Connector Angle	information used in DASY system to align probe sensor X to the robot coordinate system

Calibration is Performed According to the Following Standards:

a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013

b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005

Methods Applied and Interpretation of Parameters:

- *NORMx,y,z:* Assessed for E-field polarization ϑ = 0 (f ≤ 900 MHz in TEM-cell; f > 1800 MHz: R22 waveguide). NORMx,y,z are only intermediate values, i.e., the uncertainties of NORMx,y,z does not affect the E^2-field uncertainty inside TSL (see below *ConvF*).
- *NORM(f)x,y,z = NORMx,y,z * frequency_response* (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of *ConvF*.
- *DCPx,y,z:* DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- *PAR:* PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- *Ax,y,z; Bx,y,z; Cx,y,z; Dx,y,z; VRx,y,z: A, B, C, D* are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. *VR* is the maximum calibration range expressed in RMS voltage across the diode.
- *ConvF and Boundary Effect Parameters:* Assessed in flat phantom using E-field (or Temperature Transfer Standard for f ≤ 800 MHz) and inside waveguide using analytical field distributions based on power measurements for f > 800 MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to *NORMx,y,z * ConvF* whereby the uncertainty corresponds to that given for *ConvF*. A frequency dependent *ConvF* is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 100 MHz.
- *Spherical isotropy (3D deviation from isotropy):* in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- *Sensor Offset:* The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- *Connector Angle:* The angle is assessed using the information gained by determining the *NORMx* (no uncertainty required).

Probe EX3DV4

SN:3857

Manufactured: January 23, 2012
Calibrated: May 23, 2014

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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3857

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu V/(V/m)^2$)[A]	0.18	0.44	0.46	± 10.1 %
DCP (mV)[B]	94.2	98.6	99.4	

Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB√µV	C	D dB	VR mV	Unc[E] (k=2)
0	CW	X	0.0	0.0	1.0	0.00	132.0	±3.8 %
		Y	0.0	0.0	1.0		149.4	
		Z	0.0	0.0	1.0		149.1	

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

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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3857

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unct. (k=2)
750	41.9	0.89	9.92	9.92	9.92	0.44	0.82	± 12.0 %
835	41.5	0.90	9.41	9.41	9.41	0.30	1.01	± 12.0 %
900	41.5	0.97	9.20	9.20	9.20	0.80	0.50	± 12.0 %
1750	40.1	1.37	8.55	8.55	8.55	0.80	0.59	± 12.0 %
1900	40.0	1.40	8.40	8.40	8.40	0.69	0.65	± 12.0 %
2000	40.0	1.40	8.31	8.31	8.31	0.77	0.56	± 12.0 %
2450	39.2	1.80	7.48	7.48	7.48	0.78	0.58	± 12.0 %
2600	39.0	1.96	7.30	7.30	7.30	0.42	0.87	± 12.0 %
5200	36.0	4.66	5.35	5.35	5.35	0.30	1.80	± 13.1 %
5300	35.9	4.76	5.12	5.12	5.12	0.30	1.80	± 13.1 %
5500	35.6	4.96	4.99	4.99	4.99	0.35	1.80	± 13.1 %
5600	35.5	5.07	4.56	4.56	4.56	0.45	1.80	± 13.1 %
5800	35.3	5.27	4.79	4.79	4.79	0.40	1.80	± 13.1 %

[C] Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. Above 5 GHz frequency validity can be extended to ± 110 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

[G] Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3857

Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unct. (k=2)
750	55.5	0.96	9.46	9.46	9.46	0.47	0.84	± 12.0 %
835	55.2	0.97	9.31	9.31	9.31	0.31	1.06	± 12.0 %
900	55.0	1.05	9.13	9.13	9.13	0.80	0.61	± 12.0 %
1750	53.4	1.49	7.89	7.89	7.89	0.80	0.60	± 12.0 %
1900	53.3	1.52	7.56	7.56	7.56	0.59	0.71	± 12.0 %
2000	53.3	1.52	7.73	7.73	7.73	0.29	1.00	± 12.0 %
2450	52.7	1.95	7.14	7.14	7.14	0.76	0.57	± 12.0 %
2600	52.5	2.16	6.82	6.82	6.82	0.73	0.61	± 12.0 %
5200	49.0	5.30	4.54	4.54	4.54	0.40	1.90	± 13.1 %
5300	48.9	5.42	4.37	4.37	4.37	0.40	1.90	± 13.1 %
5500	48.6	5.65	4.15	4.15	4.15	0.40	1.90	± 13.1 %
5600	48.5	5.77	3.98	3.98	3.98	0.40	1.90	± 13.1 %
5800	48.2	6.00	4.21	4.21	4.21	0.50	1.90	± 13.1 %

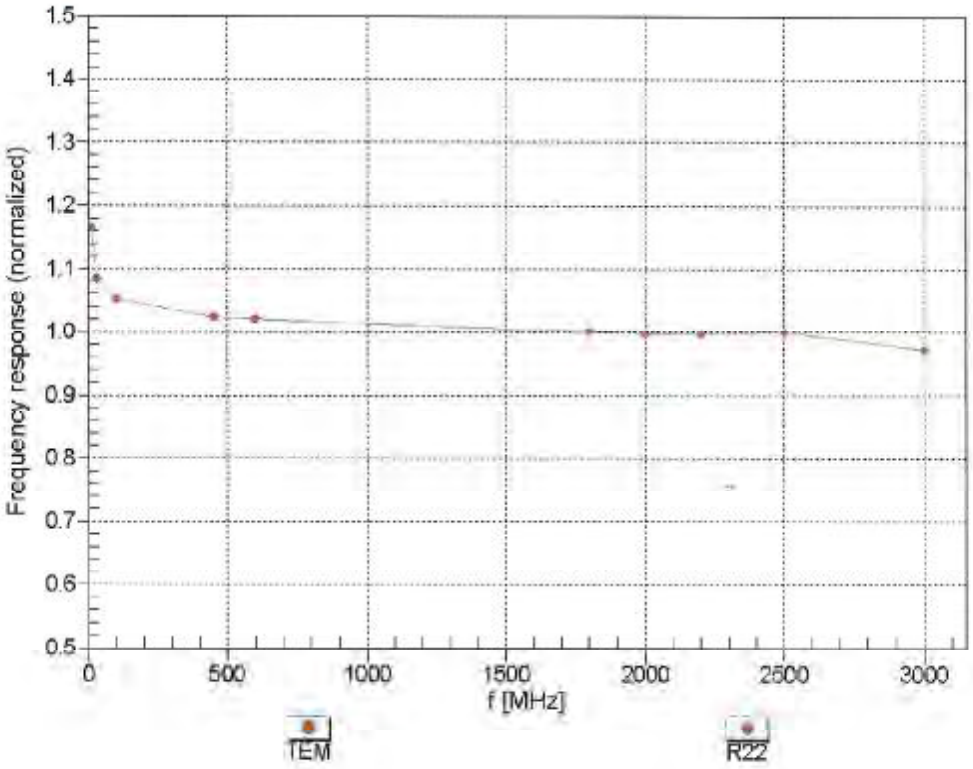
[C] Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. Above 5 GHz frequency validity can be extended to ± 110 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

[G] Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

Frequency Response of E-Field

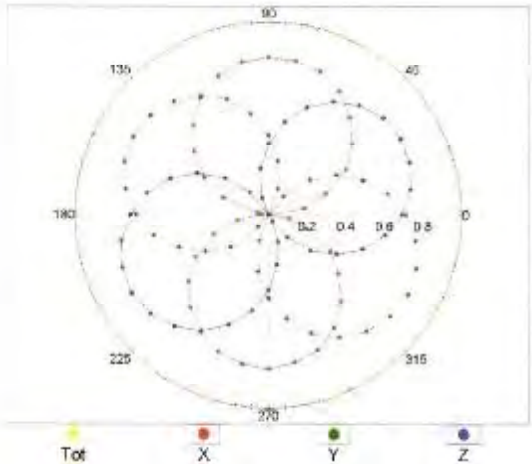
(TEM-Cell:ifi110 EXX, Waveguide: R22)



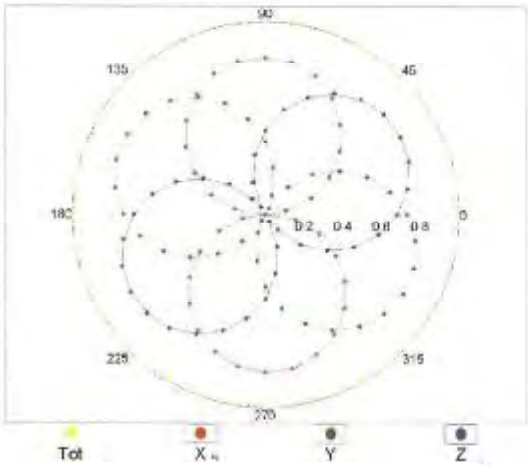
Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

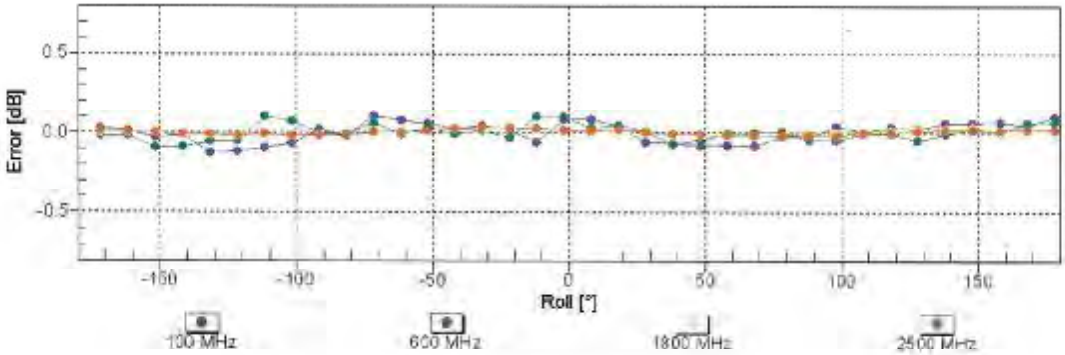
Receiving Pattern (ϕ), ϑ = 0°

f=600 MHz,TEM



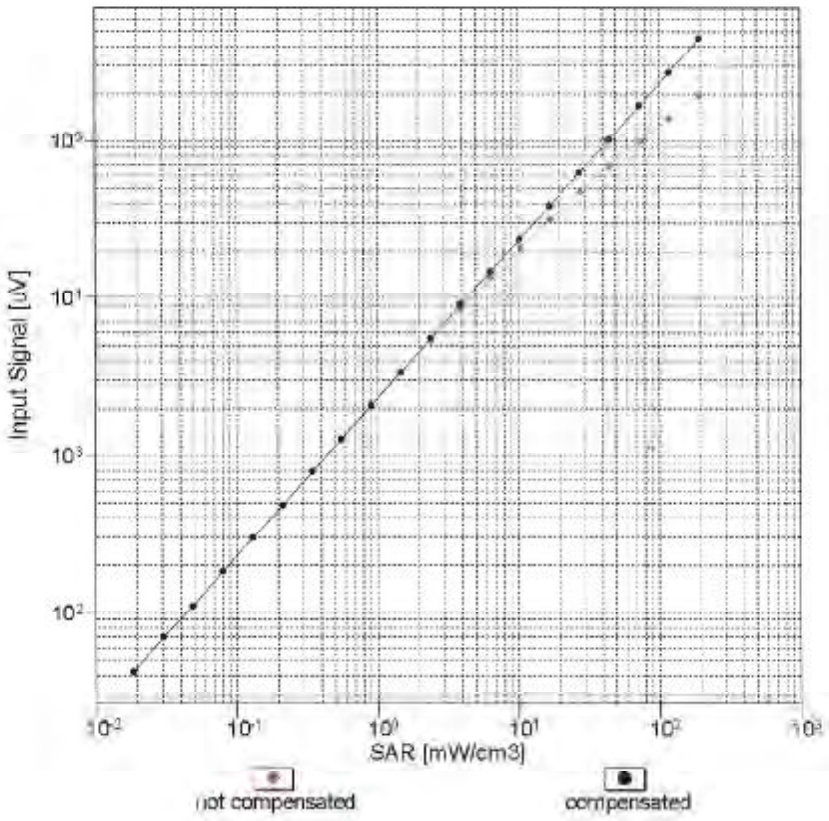
f=1800 MHz,R22

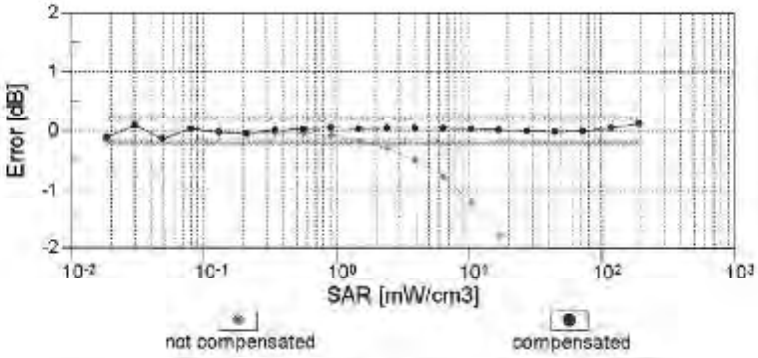




Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

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

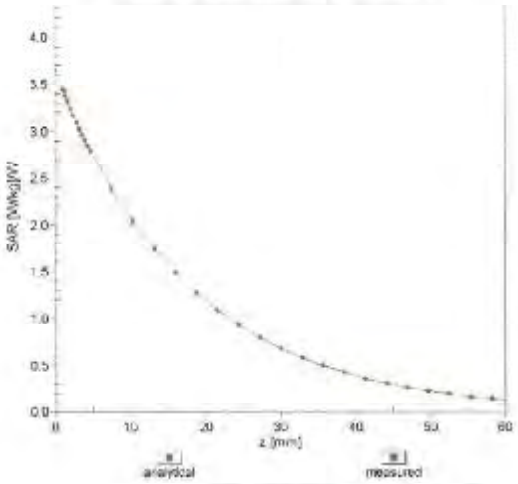




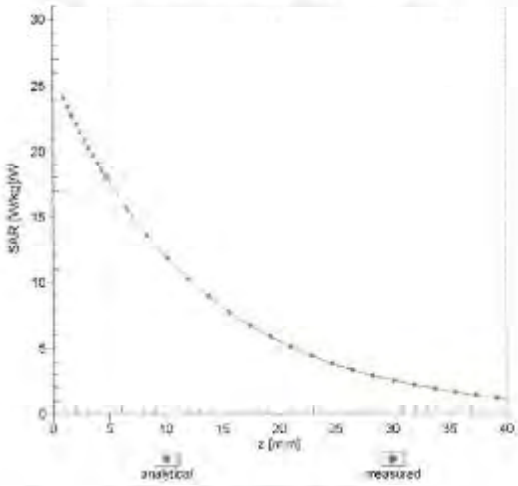
Uncertainty of Linearity Assessment: ± 0.6% (k=2)

Conversion Factor Assessment

f = 900 MHz,WGLS R9 (H_convF)

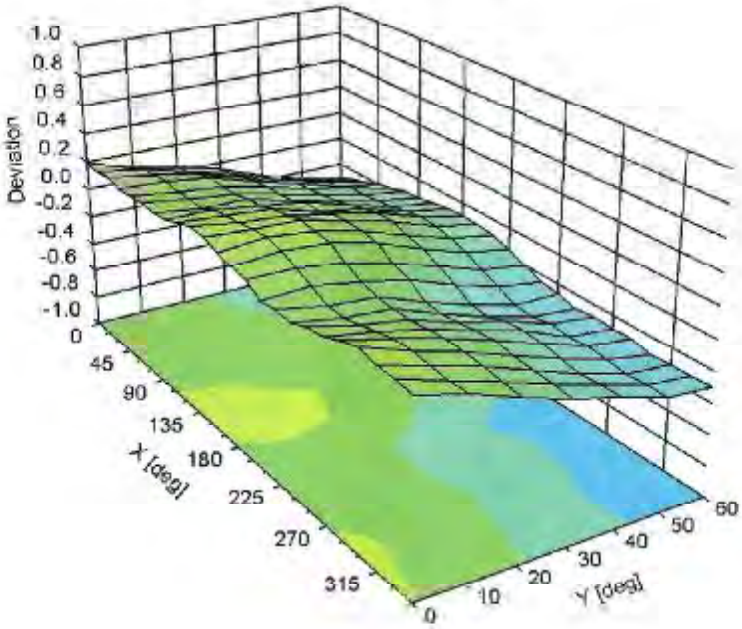


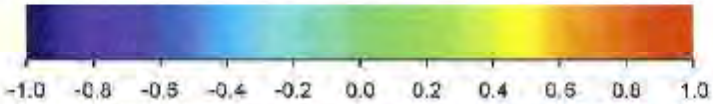
f = 1750 MHz,WGLS R22 (H_convF)



Deviation from Isotropy in Liquid

Error (ϕ, ϑ), f = 900 MHz





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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3857

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	-41.9
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	9 mm
Tip Diameter	2.5 mm
Probe Tip to Sensor X Calibration Point	1 mm
Probe Tip to Sensor Y Calibration Point	1 mm
Probe Tip to Sensor Z Calibration Point	1 mm
Recommended Measurement Distance from Surface	2 mm