TEST REPORT

No. I17D00260-SAR01

For

Client:	**Realtek Semiconductor Corp.**
Brand name:	**REALTEK**
Production:	**802.11a/b/g/n/ac RTL8821CE Combo module**
Model Name:	**RTL8821CE**
Standard:	**ANSI C95.1-1999**
	FCC 47 CFR Part 2 (2.1093)
	RSS 102 issue 5
FCC ID:	**TX2-RTL8821CE**
IC:	**6317A-RTL8821CE**
Hardware Version:	**N/A**
Software Version:	**N/A**
Issued date:	**2017-12-14**

Note:

The test results in this test report relate only to the devices specified in this report. This report shall not be reproduced except in full without the written approval of ECIT Shanghai.

Test Laboratory:

ECIT Shanghai, East China Institute of Telecommunications
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Revision Version

Report Number	Revision	Date	Memo
I17D00260-SAR01	00	2017-12-14	Initial creation of test report

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1. Test Laboratory

1.1. Testing Location

Company Name:	ECIT Shanghai, East China Institute of Telecommunications
Address:	7-8F, G Area, No. 668, Beijing East Road, Huangpu District, Shanghai, P. R. China
Postal Code:	200001
Telephone:	(+86)-021-63843300
Fax:	(+86)-021-63843301
IC OAT'S Teat Site Registration Number:	10766A-1

1.2. Testing Environment

Normal Temperature:	18-25℃
Relative Humidity:	30-70%
Ambient noise & Reflection:	< 0.012 W/kg

1.3. Project Data

Project Leader:	Lu Fang
Testing Start Date:	2017-11-26
Testing End Date:	2017-11-28

1.4. Signature

Yan Hang
(Prepared this test report)

Fu Erliang
(Reviewed this test report)

Zheng Zhongbin
(Approved this test report)

2. Statement of Compliance

The maximum results of Specific Absorption Rate (SAR) found during testing for **RTL8821CE** are as follows (with expanded uncertainty 23.02%)

Equipment Class	Frequency Band	Highest SAR Summary	
		Body 1g SAR (W/kg)	Simultaneous Transmission 1g SAR (W/kg)
DTS	2.4GHz WLAN	0.721	--
NII	5.2GHz WLAN	--	0.936
	5.3GHz WLAN	0.839	
	5.5GHz WLAN	0.670	
	5.8GHz WLAN	0.672	
DSSS(BT)	2.4GHz	0.216	

The SAR values found for the EUT are below the maximum recommended levels of 1.6 W/Kg as averaged over any 1g tissue according to the ANSI C95.1-1999 and RSS 102 issue 5 .

For body worn operation, this device has been tested and meets FCC RF exposure guidelines when used with any accessory that contains no metal. Use of other accessories may not ensure compliance with FCC RF exposure guidelines.

3. Client Information

3.1. Applicant Information

Company Name:	Realtek Semiconductor Corp.
Address:	No.2,Innovation Road II, Hsinchu Science Park, Hsinchu 300, Taiwan
Email:	danaliaw@realtek.com

3.2. Manufacturer Information

Company Name:	Realtek Semiconductor Corp.
Address:	No.2,Innovation Road II, Hsinchu Science Park, Hsinchu 300, Taiwan
Email:	danaliaw@realtek.com

4. Equipment Under Test (EUT) and Ancillary Equipment (AE)

4.1. About EUT

<table>
<tr><td>Description:</td><td colspan="5">802.11a/b/g/n/ac RTL8821CE Combo module</td></tr>
<tr><td>Model name:</td><td colspan="5">RTL8821CE</td></tr>
<tr><td>Operation Model(s):</td><td colspan="5">802.11a/b/g/n HT20/HT40/VHT20/VHT40/VHT80
Bluetooth:2.1 + EDR, 8-DPSK
Bluetooth:4.1</td></tr>
<tr><td>Tx Frequency:</td><td colspan="5">WLAN 2.4GHz Band: 2412 MHz ~ 2462 MHz
WLAN 5.2GHz Band: 5180 MHz ~ 5240 MHz
WLAN 5.3GHz Band: 5260 MHz ~ 5320 MHz
WLAN 5.5GHz Band: 5500 MHz ~ 5720 MHz
WLAN 5.8GHz Band: 5745 MHz ~ 5825 MHz
Bluetooth: 2402 MHz ~ 2480 MHz</td></tr>
<tr><td>Test device Production information:</td><td colspan="5">Production unit</td></tr>
<tr><td>Device type:</td><td colspan="5">Portable device</td></tr>
<tr><td>Antenna type:</td><td colspan="5">Inner antenna</td></tr>
<tr><td>Accessories/Body-worn configurations:</td><td colspan="5">N/A</td></tr>
<tr><td>Dimensions:</td><td colspan="5">29.5cm × 20.5 cm</td></tr>
<tr><td>FCC ID:</td><td colspan="5">TX2-RTL8821CE</td></tr>
<tr><td>IC:</td><td colspan="5">6317A-RTL8821CE</td></tr>
<tr><td rowspan="8">Antenna Specification:</td><td rowspan="3">Brand</td><td colspan="4">Gain(dBi)</td></tr>
<tr><td>2.4GHz</td><td>5GHz</td><td>2.4GHz</td><td>5GHz</td></tr>
<tr><td>ANT1</td><td>ANT1</td><td>ANT2</td><td>ANT2</td></tr>
<tr><td>INPAQ</td><td>1.05</td><td>2.87</td><td>0.86</td><td>2.9</td></tr>
<tr><td>Part Number</td><td colspan="2">ANT1: 64451203800070</td><td colspan="2">ANT2: 64451203800050</td></tr>
<tr><td>South Star</td><td>0.85</td><td>1.31</td><td>0.37</td><td>0.95</td></tr>
<tr><td>Part Number</td><td colspan="2">ANT1: 64451203800020</td><td colspan="2">ANT2: 64451203800010</td></tr>
<tr><td colspan="5">Note: ANT1 is Main Antenna; ANT2 is Aux Antenna.</td></tr>
</table>

4.2. Internal Identification of EUT used during the test

EUT ID*	SN or IMEI	HW Version	SW Version:	Received of date
N01	N/A	N/A	N/A	2017-11-23

*EUT ID: is used to identify the test sample in the lab internally.

4.3. Internal Identification of AE used during the test

AE ID*	Description	Model	SN	Manufacturer
C01	Notebook / Tablet Computer	Lenovo FLEX 6-11IGM,81A7	N/A	LENOVO

*AE ID: is used to identify the test sample in the lab internally.

5. TEST METHODOLOGY

5.1. Applicable Limit Regulations

ANSI C95.1–1999:IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz.

FCC 47 CFR Part 2 (2.1093): Radiofrequency radiation exposure evaluation: portable devices.

RSS-102 issue 5: 2015: Radio Frequency (RF) Exposure Compliance of Radio communication Apparatus (All Frequency Bands)

It specifies the maximum exposure limit of **1.6 W/kg** as averaged over any 1 gram of tissue for portable devices being used within 20 cm of the user in the uncontrolled environment.

5.2. Applicable Measurement Standards

IEEE 1528–2013: Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communications Devices: Experimental Techniques.

KDB248227 D01 802 11 Wi-Fi SAR v02r02: SAR measurement procedures for 802.112abg transmitters.

KDB447498 D01 General RF Exposure Guidance v06: Mobile and Portable Devices RF Exposure Procedures and Equipment Authorization Policies.

KDB865664 D01 SAR Measurement 100 MHz to 6 GHz v01r04:SAR Measurement Requirements for 100 MHz to 6 GHz

KDB616217 D04 v01r02: SAR for laptop and tablets

KDB865664 D02 RF Exposure Reporting v01r02:provides general reporting requirements as well as certain specific information required to support MPE and SAR compliance.

NOTE: KDB and FCC 47 CFR Part 2 (2.1093) is not in A2LA Scope List.

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:

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

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

SAR measurement can be either related to the temperature elevation in tissue by

$$SAR = c\left(\frac{\delta T}{\delta t}\right)$$

Where: C is the specific head capacity, δT is the temperature rise and δt is the exposure duration, or related to the electrical field in the tissue by

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

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

However for evaluating SAR of low power transmitter, electrical field measurement is typically applied.

7. Tissue Simulating Liquids

7.1. Targets for tissue simulating liquid

Table 7.1: Targets for tissue simulating liquid

Frequency (MHz)	Liquid Type	Conductivity(σ)	± 5% Range	Permittivity(ε)	± 5% Range
2450	Body	1.95	1.85~2.05	52.7	50.1~55.3
5200	Body	5.35	5.08~5.62	49.03	46.58~51.48
5300	Body	5.46	5.19~5.73	48.9	46.46~51.35
5500	Body	5.68	5.40~5.96	48.62	46.19~51.05
5600	Body	5.79	5.50~6.08	48.48	46.06~50.90
5800	Body	6	5.70~6.3	48.2	45.79~50.61

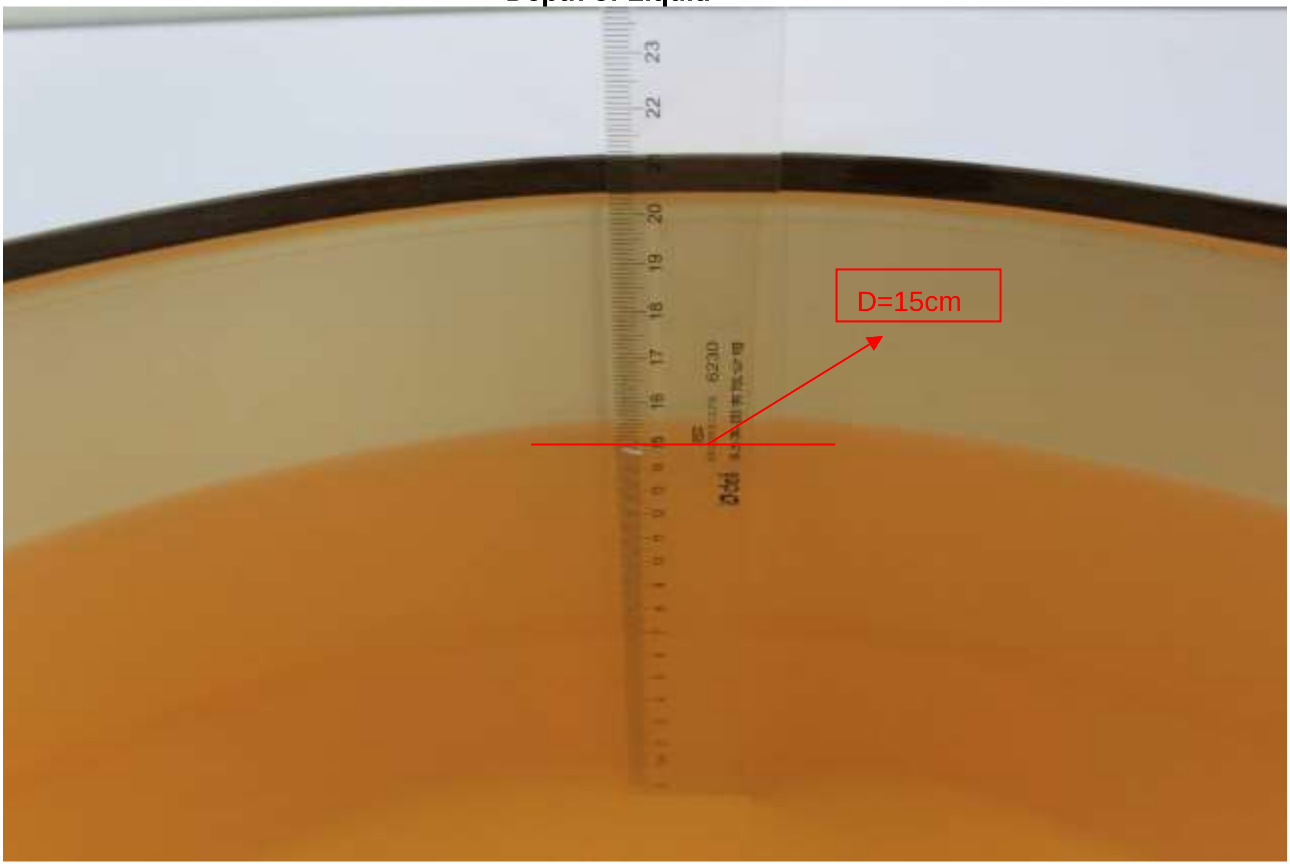
7.2. Dielectric Performance

Table 7.2: Dielectric Performance of Tissue Simulating Liquid

Measurement Value						
Liquid Temperature: 22 ℃						
Type	**Frequency（MHz）**	**Permittivity ε**	**Drift (%)**	**Conductivity σ**	**Drift (%)**	Test Date
Body	2402	53.03	0.50%	1.922	1.93%	2017-11-28
Body	2441	52.905	0.37%	1.967	1.49%	2017-11-28
Body	2480	52.773	0.21%	2.014	1.20%	2017-11-28
Body	2412	53.003	0.48%	1.933	1.69%	2017-11-28
Body	2437	52.916	0.38%	1.963	1.56%	2017-11-28
Body	2462	52.834	0.28%	1.992	1.32%	2017-11-28
Body	5260	49.975	2.09%	5.257	-3.02%	2017-11-26
Body	5280	49.935	2.07%	5.285	-2.90%	2017-11-26
Body	5300	49.906	2.06%	5.31	-2.84%	2017-11-26
Body	5320	49.876	2.06%	5.335	-2.76%	2017-11-26
Body	5500	49.514	1.84%	5.592	-1.59%	2017-11-27
Body	5580	49.373	1.78%	5.697	-1.23%	2017-11-27
Body	5640	49.231	1.67%	5.79	-0.72%	2017-11-27
Body	5720	49.042	1.51%	5.911	-0.09%	2017-11-27

Body	5745	48.991	1.48%	5.948	0.09%	2017-11-27
Body	5785	48.921	1.45%	6.006	0.36%	2017-11-27
Body	5825	48.82	1.35%	6.066	0.76%	2017-11-27

Depth of Liquid

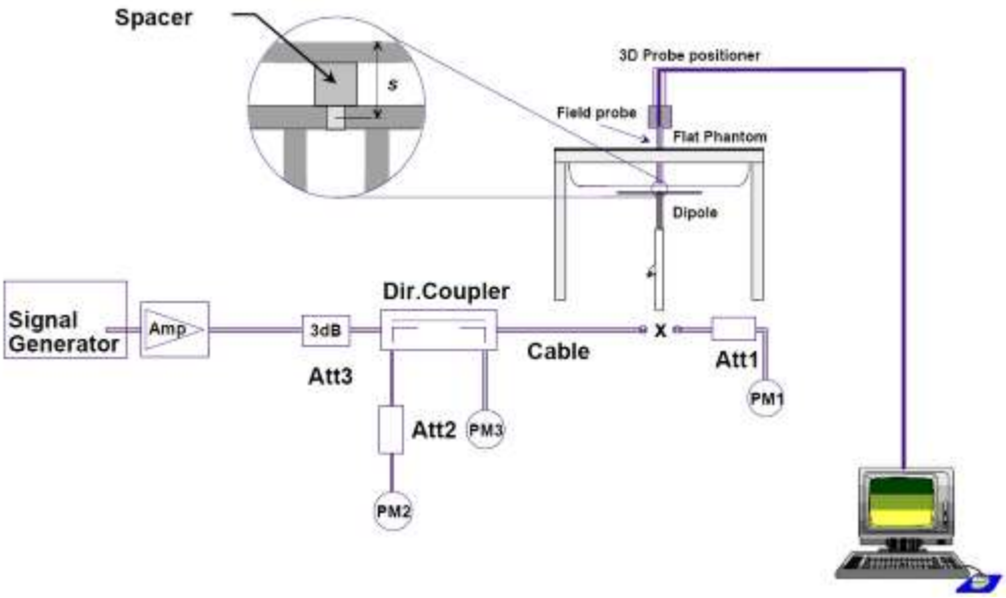


- Note: For SAR testing, the liquid depth is 15cm shown above

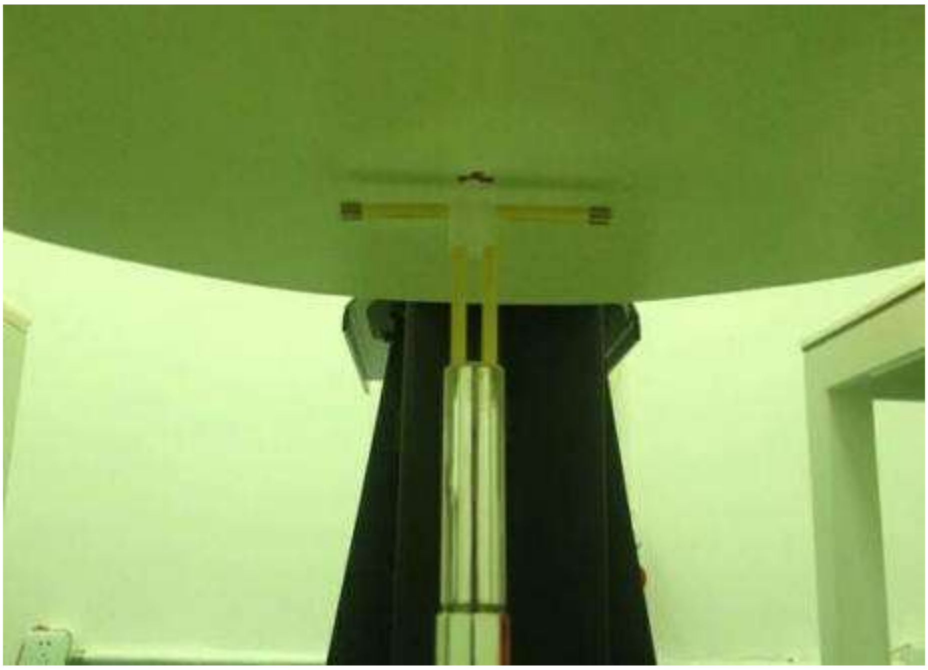
8. System verification

8.1. System Setup

In the simplified setup for system evaluation, the DUT is replaced by a calibrated dipole and the power source is replaced by a continuous wave that comes from a signal generator. The calibrated dipole must be placed beneath the flat phantom section of the SAM twin phantom with the correct distance holder. The distance holder should touch the phantom surface with a light pressure at the reference marking and be oriented parallel to the long side of the phantom. The equipment setup is shown below:



Picture 8.1 System Setup for System Evaluation



Picture 8.2 Photo of Dipole Setup

8.2. System Verification

SAR system verification is required to confirm measurement accuracy, according to the tissue dielectric media, probe calibration points and other system operating parameters required for measuring the SAR of test device. The system verification must be performed for each frequency band and within the valid range of each probe calibration point required for testing the device.

Table 8.1: System Verification of Body

Verification Results							
Input power level: 1W							
Frequency	**Target value (W/kg)**		**Measured value (W/kg)**		**Deviation**		**Test date**
	10 g Average	**1 g Average**	**10 g Average**	**1 g Average**	**10 g Average**	**1 g Average**	
2450 MHz	24.7	53.1	25.48	55.2	3.16%	3.95%	2017-11-28
5200 MHz	20.2	72.3	20.4	72.8	0.99%	0.69%	2017-11-26
5300 MHz	21.3	76.4	19.9	71.4	-6.57%	-6.54%	2017-11-26
5500 MHz	22.2	80	21.1	75.6	-4.95%	-5.50%	2017-11-27
5600 MHz	22.3	79.4	22.3	80.7	0.00%	1.64%	2017-11-27
5800 MHz	21.2	76.4	22	79.8	3.77%	4.45%	2017-11-27

9. Measurement Procedures

9.1. Tests to be performed

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

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

a) all device positions (cheek and tilt, for both left and right sides of the SAM phantom, as described in Chapter 8),

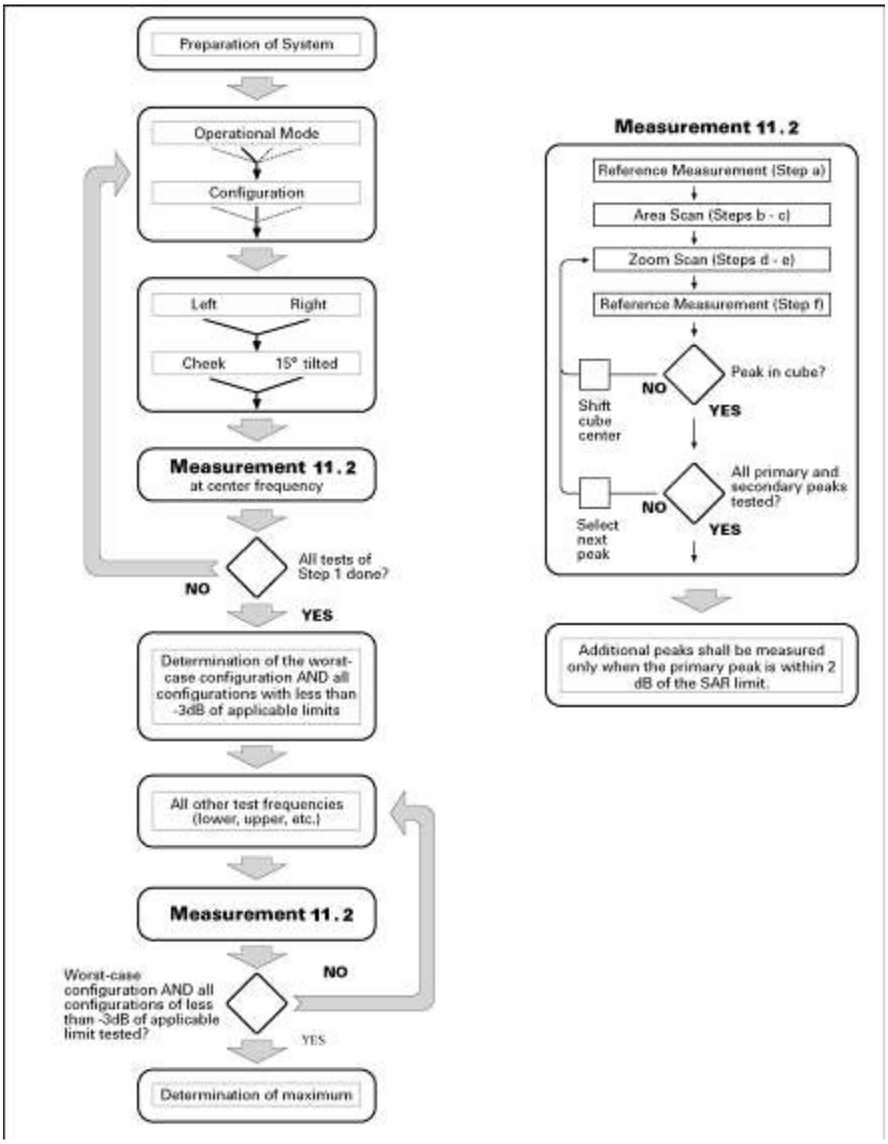
b) all configurations for each device position in a), e.g., antenna extended and retracted, and

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

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

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

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



Picture 9.1Block diagram of the tests to be performed

9.2. General Measurement Procedure

The following procedure shall be performed for each of the test conditions (see Picture 11.1) described in 11.1:

a) Measure the local SAR at a test point within 8 mm or less in the normal direction from the inner surface of the phantom.

b) Measure the two-dimensional SAR distribution within the phantom (area scan procedure). The boundary of the measurement area shall not be closer than 20 mm from the phantom side walls. The distance between the measurement points should enable the detection of the location of local maximum with an accuracy of better than half the linear dimension of the tissue cube after interpolation. A maximum grip spacing of 20 mm for frequencies below 3 GHz and (60/f [GHz]) mm for frequencies of 3GHz and greater is recommended. The maximum distance between the geometrical centre of the probe detectors and the inner surface of the phantom shall be 5 mm for frequencies below 3 GHz and δ In(2)/2 mm for frequencies of 3 GHz and greater, where δ is the plane wave skin depth and In(x) is the natural logarithm. The maximum variation of the sensor-phantom surface shall be ±1 mm for frequencies below 3 GHz and ±0.5 mm for frequencies of 3 GHz and greater. At all measurement points the angle of the probe with respect to the line normal to the surface should be less than 5° . If this cannot be achieved for a measurement distance to the phantom inner surface shorter than the probe diameter, additional uncertainty evaluation is needed.

c) From the scanned SAR distribution, identify the position of the maximum SAR value, in addition identify the positions of any local maxima with SAR values within 2 dB of the maximum value that are not within the zoom-scan volume; additional peaks shall be measured only when the primary peak is within 2 dB of the SAR limit. This is consistent with the 2 dB threshold already stated;

d) Measure the three-dimensional SAR distribution at the local maxima locations identified in step c). The horizontal grid step shall be (24/f[GHz]) mm or less but not more than 8 mm. The minimum zoom size of 30 mm by 30 mm and 30 mm for frequencies below 3 GHz. For higher frequencies, the minimum zoom size of 22 mm by 22 mm and 22 mm. The grip step in the vertical direction shall be (8-f[GHz]) mm or less but not more than 5 mm, if uniform spacing is used. If variable spacing is used in the vertical direction, the maximum spacing between the two closest measured points to the phantom shell shall be (12 / f[GHz]) mm or less but not more than 4 mm, and the spacing between father points shall increase by an incremental factor not exceeding 1.5. When variable spacing is used, extrapolation routines shall be tested with the same spacing as used in measurements. The maximum distance between the geometrical centre of the probe detectors and the inner surface of the phantom shall be 5 mm for frequencies below 3 GHz and δ In(2)/2 mm for frequencies of 3 GHz and greater, where δ is the plane wave skin depth and In(x) is the natural logarithm. Separate grids shall be centered on each of the local SAR maxima found in step c). Uncertainties due to field distortion between the media boundary and the dielectric enclosure of the probe should also be minimized, which is achieved is the distance between the phantom surface and physical tip of the probe is larger than probe tip diameter. Other methods may utilize correction procedures for these boundary effects that enable high precision measurements closer than half the probe diameter. For all measurement points, the angle of the probe with respect to the flat phantom surface shall be less than 5° . If this cannot be achieved an additional uncertainty evaluation is needed.

e) Use post processing(e.g. interpolation and extrapolation) procedures to determine the local SAR values at the spatial resolution needed for mass averaging.

9.3. Bluetooth & Wi-Fi Measurement Procedures for SAR

Normal network operating configurations are not suitable for measuring the SAR of 802.11 transmitters in general. Unpredictable fluctuations in network traffic and antenna diversity conditions can introduce undesirable variations in SAR results. The SAR for these devices should be measured using chipset based test mode software to ensure that the results are consistent and reliable.

Chipset based test mode software is hardware dependent and generally varies among manufacturers. The device operating parameters established in a test mode for SAR measurements must be identical to those programmed in production units, including output power levels, amplifier gain settings and other RF performance tuning parameters. The test frequencies should correspond to actual channel frequencies defined for domestic use. SAR for devices with switched diversity should be measured with only one antenna transmitting at a time during each SAR measurement, according to a fixed modulation and data rate. The same data pattern should be used for all measurements.

9.4. Power Drift

To control the output power stability during the SAR test, DASY4 system calculates the power drift by measuring the E-field at the same location at the beginning and at the end of the measurement for each test position. These drift values can be found in Section 12 labeled as: (Power Drift [dB]). This ensures that the power drift during one measurement is within 5%.

10. Conducted Output Power

10.1. Manufacturing tolerance

Table 10.1: WiFi

Mode	Channel	Frequency	Target power	Tolerance
b	1	2412	16.5	15±1.5
	6	2437	16.5	15±1.5
	11	2462	16.5	15±1.5
g	1	2412	15.5	14±1.5
	6	2437	15.5	14±1.5
	11	2462	15.5	14±1.5
20n	1	2412	14.5	13±1.5
	6	2437	14.5	13±1.5
	11	2462	14.5	13±1.5
40n	3	2422	13	11.5±1.5
	6	2437	13	11.5±1.5
	9	2452	13	11.5±1.5

Mode	Channel	Frequency	Target power	Tolerance
a	36	5180	14	12±2
	40	5200	14	12±2
	44	5220	14	12±2
	48	5240	14	12±2
	52	5260	14.5	12.5±2
	56	5280	14.5	12.5±2
	60	5300	14.5	12.5±2
	64	5320	14.5	12.5±2
	100	5500	14	12±2
	112	5560	14	12±2
	116	5580	14	12±2
	128	5640	14	12±2
	144	5720	14	12±2
	149	5745	13	11±2
	157	5785	13	11±2
	165	5825	13	11±2
n 20	36	5180	13.5	11.5±2
	40	5200	13.5	11.5±2
	44	5220	13.5	11.5±2
	48	5240	13.5	11.5±2
	52	5260	14	12±2
	56	5280	14	12±2

	60	5300	14	12±2
	64	5320	14	12±2
	100	5500	13.5	11.5±2
	112	5560	13.5	11.5±2
	116	5580	13.5	11.5±2
	128	5640	13.5	11.5±2
	144	5720	13.5	11.5±2
	149	5745	12.5	10.5±2
	157	5785	12.5	10.5±2
	165	5825	12.5	10.5±2
n40	38	5190	13.5	11.5±2
	46	5230	13.5	11.5±2
	54	5270	14	12±2
	62	5310	14	12±2
	102	5510	13.5	11.5±2
	110	5550	13.5	11.5±2
	118	5590	13.5	11.5±2
	126	5630	13.5	11.5±2
	134	5670	13.5	11.5±2
	142	5710	13.5	11.5±2
	151	5755	12.5	10.5±2
	159	5795	12.5	10.5±2
AC80	42	5210	13	11±2
	58	5290	13.5	11.5±2
	106	5530	13	11±2
	122	5610	13	11±2
	138	5690	13	11±2
	155	5775	12.5	10.5±2

Table 10.2: Bluetooth

Band / Mode	Target Power(dBm)		
	V3.0 + EDR, GFSK	V3.0 + EDR, π/4-DQPSK	V3.0 + EDR, 8-DPSK
Bluetooth	6	6	6

Band / Mode	Target Power(dBm)
	BLE4.0, GFSK
Bluetooth	6

10.2. Wi-Fi and BT Measurement result

Table 10.3: The conducted power for Bluetooth

Bluetooth Chain0

Band	Mode	Channel	Frequency	Averaged Power (dBm)
2.4 GHz	Bluetooth BR (GFSK)	0	2402	3.49
		39	2441	3.28
		78	2480	3.11
	Bluetooth EDR2 (π/4-DQPSK)	0	2402	2.39
		39	2441	2.46
		78	2480	1.96
	Bluetooth EDR3 (8-DPSK)	0	2402	2.29
		39	2441	2.37
		78	2480	2.02
	Bluetooth LE	0	2402	2.98
		19	2440	2.80
		39	2480	2.87

Bluetooth Chain1

Band	Mode	Channel	Frequency	Averaged Power (dBm)
2.4 GHz	Bluetooth BR (GFSK)	0	2402	3
		39	2441	3.01
		78	2480	3.2
	Bluetooth EDR2 (π/4-DQPSK)	0	2402	2.92
		39	2441	2.82
		78	2480	2.67
	Bluetooth EDR3 (8-DPSK)	0	2402	2.95
		39	2441	2.9
		78	2480	2.67
	Bluetooth LE	0	2402	3.02
		19	2440	2.82
		39	2480	2.85

NOTE: According to KDB447498 D01 BT standalone SAR are not required, because maximum average output power is less than 10mW.

According to RSS 102 issue5 section 2.5.1 Exemption Limits for Routine Evaluation – SAR Evaluation, BT standalone SAR are required, because tune up output power is greater than 4mW.

Frequency (MHz)	Exemption Limits (mW)				
	At separation distance of ≤5 mm	At separation distance of 10 mm	At separation distance of 15 mm	At separation distance of 20 mm	At separation distance of 25 mm
≤300	71 mW	101 mW	132 mW	162 mW	193 mW
450	52 mW	70 mW	88 mW	106 mW	123 mW
835	17 mW	30 mW	42 mW	55 mW	67 mW
1900	7 mW	10 mW	18 mW	34 mW	60 mW
2450	4 mW	7 mW	15 mW	30 mW	52 mW
3500	2 mW	6 mW	16 mW	32 mW	55 mW
5800	1 mW	6 mW	15 mW	27 mW	41 mW

The default power measurement procedures are:

a) Power must be measured at each transmit antenna port according to the DSSS and OFDM transmission configurations in each standalone and aggregated frequency band.

b) Power measurement is required for the transmission mode configuration with the highest maximum output power specified for production units.

1) When the same highest maximum output power specification applies to multiple transmission modes, the largest channel bandwidth configuration with the lowest order modulation and lowest data rate is measured.

2) When the same highest maximum output power is specified for multiple largest channel bandwidth configurations with the same lowest order modulation or lowest order modulation and lowest data rate, power measurement is required for all equivalent 802.11 configurations with the same maximum output power.

c) For each transmission mode configuration, power must be measured for the highest and lowest channels; and at the mid-band channel(s) when there are at least 3 channels. For configurations with multiple mid-band channels, due to an even number of channels, both channels should be measured.

d) Apply the default power measurement procedures to measure maximum output power for each standalone and aggregated frequency band.

1) When band gap channels between U-NII-2C band and U-NII-3 band or §15.247 5.8 GHz band are supported and the bands are aggregated for SAR testing according to KDB 248227D01 sections 2.3 and 3.3, apply the following to determine high, middle and low channels for power measurement and SAR test reduction.

i) channels in U-NII-2C band below 5.65 GHz are considered as one band

ii) channels above 5.65 GHz, together with channels in 5.8 GHz U-NII-3 or §15.247 band, are considered as a separate band

2) The maximum output power of band gap channels is limited to the lowest maximum output power certified for the adjacent bands regardless of whether band aggregation is applied for SAR testing.

3) The measured maximum output power results are used to reduce the number of channels that need testing.

During WLAN SAR testing EUT is configured with the WLAN continuous TX tool, and the transmission duty factor was monitored on the spectrum analyzer with zero-span setting.
For WLAN SAR testing, WLAN engineering test software installed on the EUT can provide continuous transmitting RF signal.

Duty cycle Form

Band	Mode	Duty cycle(100%)
2.4GHz	Bluetooth2.1	100
	802.11b	100
	802.11g	100
	802.11n 20MHz	100
	802.11n 40MHz	100
5GHz	802.11a	100

	802.11 20MHz	100
	802.11 40MHz	100
	802.11 ac80	100

Table 10.4: The average conducted power for WiFi

WLAN 2.4G

Mode	Channel	Frequency (MHZ)	Target power(dBm)	Tune up tolerance (dBm)	Chain0	Chain1
					Average power (dBm)	
802.11 b	1	2412	16.5	15±1.5	16.47	16.46
	6	2437	16.5	15±1.5	15.95	15.99
	11	2462	16.5	15±1.5	15.88	15.91
802.11 g	1	2412	15.5	14±1.5	Not required	Not required
	6	2437	15.5	14±1.5		
	11	2462	15.5	14±1.5		
802.11 n 20MHz	1	2412	14.5	13±1.5		
	6	2437	14.5	13±1.5		
	11	2462	14.5	13±1.5		
802.11 n 40MHz	3	2422	13	11.5±1.5		
	6	2437	13	11.5±1.5		
	9	2452	13	11.5±1.5		

U-NII-1 Chain0

Mode	Channel	Frequency (MHZ)	Target power(dBm)	Tune up tolerance (dBm)	Chain0	Chain1
					Average Power (dBm)	
802.11 a	36	5180	14	12±2	13.91	13.21
	40	5200	14	12±2	13.98	13.57
	44	5220	14	12±2	13.74	13.42
	48	5240	14	12±2	13.85	13.68
802.11 n 20MHz	36	5180	13.5	11.5±2	Not required	Not required
	40	5200	13.5	11.5±2		
	44	5220	13.5	11.5±2		
	48	5240	13.5	11.5±2		
802.11 n 40MHz	38	5190	13.5	11.5±2		
	46	5230	13.5	11.5±2		
802.11 ac80	42	5210	13	11±2		

U-NII-2A Chain0

Mode	Channel	Frequency (MHZ)	Target power(dBm)	Tune up tolerance (dBm)	Chain0	Chain1
					Average Power (dBm)	
802.11 a	52	5260	14.5	12.5±2	14.50	14.27
	56	5280	14.5	12.5±2	14.49	14.19
	60	5300	14.5	12.5±2	14.39	14.29
	64	5320	14.5	12.5±2	14.39	14.10
802.11 n 20MHz	52	5260	14	12±2	Not required	Not required
	56	5280	14	12±2		
	60	5300	14	12±2		
	64	5320	14	12±2		
802.11 n 40MHz	54	5270	14	12±2		
	62	5310	14	12±2		
802.11 ac80	58	5290	13.5	11.5±2		

U-NII-2C Chain0

Mode	Channel	Frequency (MHZ)	Target power(dBm)	Tune up tolerance (dBm)	Chain0	Chain1
					Average Power (dBm)	
802.11 a	100	5500	14	12±2	14.00	13.20
	112	5560	14	12±2	13.90	13.59
	116	5580	14	12±2	13.99	13.51
	128	5640	14	12±2	13.29	13.57
	144	5720	14	12±2	12.37	12.95
802.11 n 20MHz	100	5500	13.5	11.5±2	Not required	Not required
	112	5560	13.5	11.5±2		
	116	5580	13.5	11.5±2		
	128	5640	13.5	11.5±2		
	144	5720	13.5	11.5±2		
802.11 n 40MHz	102	5510	13.5	11.5±2		
	110	5550	13.5	11.5±2		
	118	5590	13.5	11.5±2		
	126	5630	13.5	11.5±2		
	134	5670	13.5	11.5±2		
	142	5710	13.5	11.5±2		
802.11 ac80	106	5530	13	11±2		
	122	5610	13	11±2		
	138	5690	13	11±2		

U-NII-3

Mode	Channel	Frequency	Target power(dBm)	Tune up tolerance (dBm)	Chain0	Chain1
					Average power (dBm)	
802.11 a	149	5745	13	11±2	12.15	12.64
	157	5785	13	11±2	12.36	12.01
	165	5825	13	11±2	12.64	12.19
802.11 n 20MHz	149	5745	12.5	10.5±2	Not required	Not required
	157	5785	12.5	10.5±2		
	165	5825	12.5	10.5±2		
802.11 n 40MHz	151	5755	12.5	10.5±2		
	159	5795	12.5	10.5±2		
802.11 ac80	155	5775	12.5	10.5±2		

11. Simultaneous TX SAR Considerations

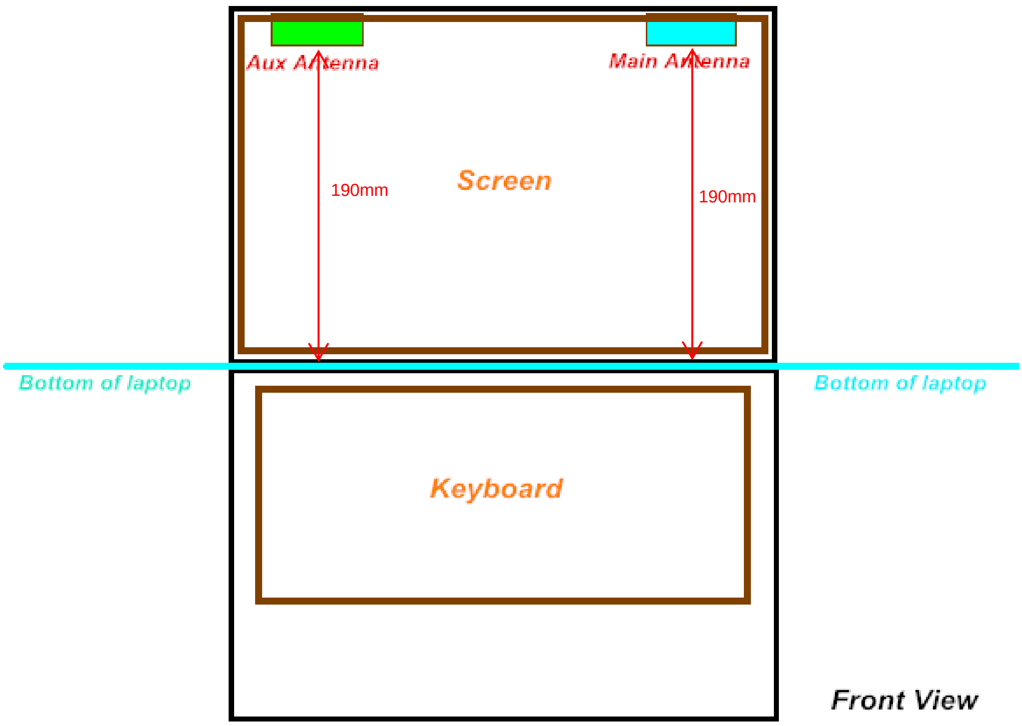
11.1. Introduction

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

For this device, the BT and Wi-Fi can transmit simultaneous with other transmitters.

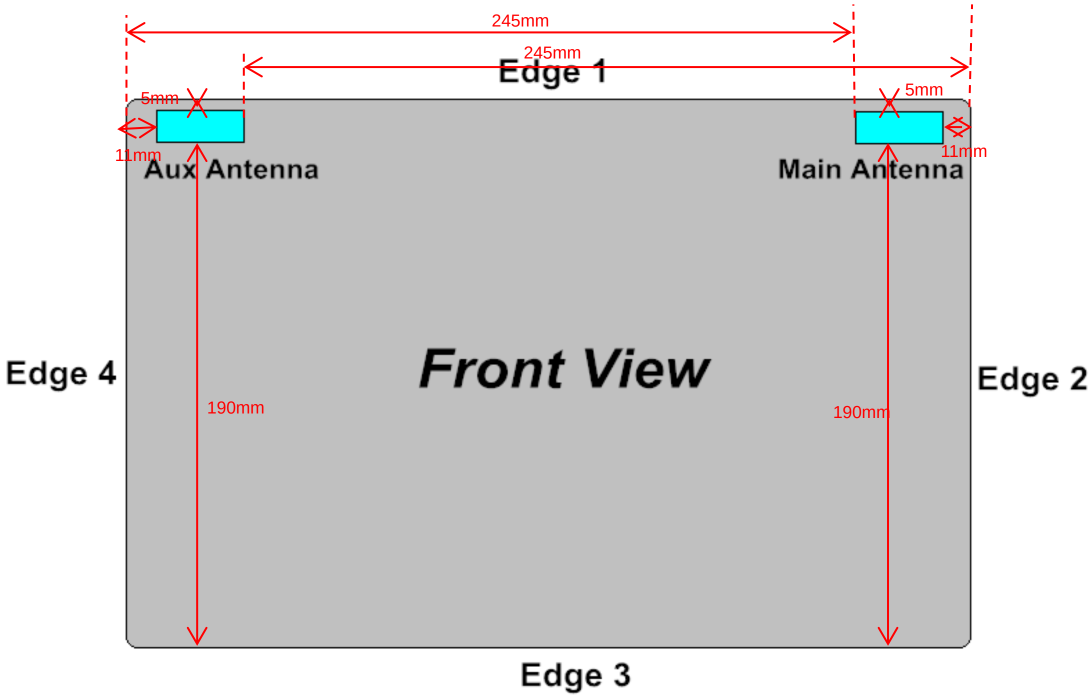
11.2. Transmit Antenna Separation Distances

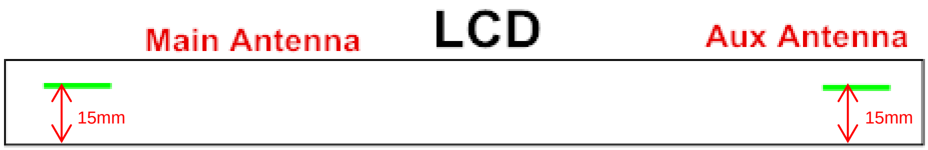
<Notebook>

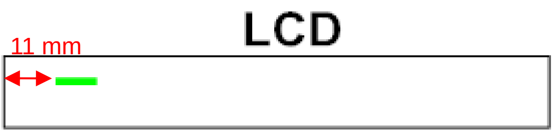


Picture 11.1 Antenna Locations

<Tablet>







11.3. Standalone SAR Test Exclusion Considerations

According to KDB447498 D01 Standalone 1-g head or body SAR evaluation by measurement or numerical simulation is not required when the corresponding SAR Exclusion Threshold condition, listed below, is satisfied.

The 1-g SAR test exclusion threshold 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, where

- f(GHz) is the RF channel transmit frequency in GHz
- Power and distance are rounded to the nearest mW and mm before calculation
- The result is rounded to one decimal place for comparison

According to the KDB447498 appendix A, the SAR test exclusion threshold for 2450MHz at 5mm test separation distances is 10mW.

$$\frac{\text{(max. power of channel, including tune-up tolerance, mW)}}{\text{(min. test separation distance, mm)}} * \sqrt{\text{Frequency (GHz)}} \leq 3.0$$

Based on the above equation, Bluetooth SAR was not required:

Evaluation=0.625 ＜3.0

Based on the above equation, WiFi 2.4GHz SAR was required:

Evaluation=7.009 > 3.0

Based on the above equation, WiFi 5GHz SAR was required:

Evaluation=6.788 > 3.0

According to RSS 102 issue5 section 2.5.1 Exemption Limits for Routine Evaluation – SAR Evaluation, BT standalone SAR are required, because tune up output power is than 4mW. Wifi standalone SAR is required, because maximum average output power is greater than 4mW.

Frequency (MHz)	Exemption Limits (mW)				
	At separation distance of ≤5 mm	At separation distance of 10 mm	At separation distance of 15 mm	At separation distance of 20 mm	At separation distance of 25 mm
≤300	71 mW	101 mW	132 mW	162 mW	193 mW
450	52 mW	70 mW	88 mW	106 mW	123 mW
835	17 mW	30 mW	42 mW	55 mW	67 mW
1900	7 mW	10 mW	18 mW	34 mW	60 mW
2450	4 mW	7 mW	15 mW	30 mW	52 mW
3500	2 mW	6 mW	16 mW	32 mW	55 mW
5800	1 mW	6 mW	15 mW	27 mW	41 mW

Frequency (MHz)	Exemption Limits (mW)				
	At separation distance of 30 mm	At separation distance of 35 mm	At separation distance of 40 mm	At separation distance of 45 mm	At separation distance of ≥50 mm
≤300	223 mW	254 mW	284 mW	315 mW	345 mW
450	141 mW	159 mW	177 mW	195 mW	213 mW
835	80 mW	92 mW	105 mW	117 mW	130 mW
1900	99 mW	153 mW	225 mW	316 mW	431 mW
2450	83 mW	123 mW	173 mW	235 mW	309 mW
3500	86 mW	124 mW	170 mW	225 mW	290 mW
5800	56 mW	71 mW	85 mW	97 mW	106 mW

11.4. SAR Measurement Positions

The following SAR test exclusion Thresholds based on KDB 447498 D01 General RF Exposure Guidance v06 4.3.1

Exposure Position	Wireless Interface	WLAN		WLAN		Bluetooth	
		802.11 b Main	802.11 b Aux	802.11 a Main	802.11 a Aux	GFSK Main	GFSK Aux
	Maximum power	16.5	16.5	14.5	14.5	6	6
	Maximum rated power(mW)	44.67	44.67	28.18	28.18	3.98	3.98
Rear view	Antenna to user (mm)	15	15	15	15	15	15
	SAR exclusion threshold	28.75	28.75	18.69	18.69	28.75	28.75
	SAR testing required?	Yes	Yes	Yes	Yes	No	No
Edge1	Antenna to user (mm)	5	5	5	5	5	5
	SAR exclusion threshold	9.58	9.58	6.23	6.23	9.58	9.58
	SAR testing required?	Yes	Yes	Yes	Yes	No	No
Edge2	Antenna to user (mm)	11	245	11	245	11	245
	SAR exclusion threshold	21.08	2046	13.7	2046	21.08	2046
	SAR testing required?	Yes	No	Yes	No	No	No
Edge3	Antenna to user (mm)	190	190	190	190	190	190
	SAR exclusion threshold	364.16	364.16	236.68	236.68	364.16	364.16
	SAR testing required?	No	No	No	No	No	No
Edge4	Antenna to user (mm)	245	11	245	11	245	11
	SAR exclusion threshold	2046	21.08	2046	13.7	2046	21.08
	SAR testing required?	No	Yes	No	Yes	No	No

Note:

1. Maximum power is the source-based time-average power and represents the maximum RF output power among production units
2. Per KDB 447498 D01v06, for larger devices, the test separation distance of adjacent edge configuration is determined by the closest separation between the antenna and the user.
3. Per KDB 447498 D01v06, standalone SAR test exclusion threshold is applied; If the distance of the antenna to the user is < 5mm, 5mm is used to determine SAR exclusion threshold
4. Per KDB 447498 D01v06, 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

   For < 50 mm distance, we just calculate mW of the exclusion threshold value (3.0) to do compare.

This formula is [3.0] / [√f(GHz)] ·[(*min. test separation distance, mm*)] = exclusion threshold of mW.

5. Per KDB 447498 D01v06, at 100 MHz to 6 GHz and for *test separation distances* > 50 mm, the SAR test exclusion threshold is determined according to the following

a) [Threshold at 50 mm in step 1) + (test separation distance - 50 mm)·(f(MHz)/150)] mW, at 100 MHz to 1500 MHz

b) [Threshold at 50 mm in step 1) + (test separation distance - 50 mm)·10] mW at > 1500 MHz and ≤ 6 GHz

6. When the minimum *test separation distance* is < 5 mm, a distance of 5 mm according to 5) in section 4.1 is applied to determine SAR test exclusion.

The following SAR test exclusion Thresholds based on RSS102 issue5 2.5.1

Exposure Position	Wireless Interface	WLAN		WLAN		Bluetooth	
		802.11 b Main	**802.11 b Aux**	**802.11 a Main**	**802.11 a Aux**	**GFSK Main**	**GFSK Aux**
	Maximum power	16.5	16.5	14.5	14.5	7.07	7.05
	Maximum rated power(mW)	44.67	44.67	28.18	28.18	5.09	5.07
Rear view	Antenna to user (mm)	15	15	15	15	15	15
	SAR exclusion threshold	15	15	15	15	15	15
	SAR testing required?	Yes	Yes	Yes	Yes	No	No
Edge1	Antenna to user (mm)	5	5	5	5	5	5
	SAR exclusion threshold	4	4	1	1	4	4
	SAR testing required?	Yes	Yes	Yes	Yes	Yes	Yes
Edge2	Antenna to user (mm)	11	245	11	245	11	245
	SAR exclusion threshold	7	309	6	106	7	309
	SAR testing required?	Yes	No	Yes	No	No	No
Edge3	Antenna to user (mm)	190	190	190	190	190	190
	SAR exclusion threshold	309	309	106	106	309	309
	SAR testing required?	No	No	No	No	No	No
Edge4	Antenna to user (mm)	245	11	245	11	245	11
	SAR exclusion threshold	309	7	309	6	309	7
	SAR testing required?	No	No	No	No	No	No

Note:

SAR evaluation is required if the separation distance between the user and/or bystander and the antenna and/or radiating element of the device is less than or equal to 20 cm, except when the device operates at or below the applicable output power level (adjusted for tune-up tolerance) for the specified separation distance .

12. SAR Test Result

Note:

1. Per KDB 447498 D01, 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 WLAN: Reported SAR(W/kg)= Measured SAR(W/kg)* Duty Cycle scaling factor * Tune-up scaling factor
2. Per KDB 447498 D01, for each exposure position, if the highest output channel reported SAR ≤0.8W/kg, other channels SAR testing is not necessary.
3. Per KDB 447498 D01, 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

2.4GHz SAR Results for Test Records
South Star Antenna

Band	Mode	Configure	Test Position	Dist. (mm)	Freq. (MHZ)	Ant	max Power (dBm)	Tune-Up Limit (dBm)	Scaling Factor	Duty Cycle Scaling Factor	SAR1g (W/kg)	Scaled SAR1g (W/kg)	Power Drift (dB)	Fig
WLAN 2.4Ghz	802.11b	TB	Edge 1	0	2412	Main	16.47	16.5	1.007	1	0.658	0.663	0.06	--
		TB	Edge 1	0	2437	Main	15.95	16.5	1.135	1	0.624	0.708	0.10	--
		TB	Edge 1	0	2462	Main	15.88	16.5	1.153	1	0.625	0.721	-0.13	1
		TB	Rear	0	2412	Main	16.47	16.5	1.007	1	0.0481	0.048	-0.06	--
		TB	Edge2	0	2412	Main	16.47	16.5	1.007	1	0.131	0.132	-0.14	--
		NB	Bystander	20	2412	Main	16.47	16.5	1.007	1	0.0824	0.083	0.18	--
WLAN 2.4Ghz	802.11b	TB	Edge 1	0	2412	Aux	16.46	16.5	1.009	1	0.238	0.240	0.12	--
		TB	Edge 1	0	2437	Aux	15.99	16.5	1.125	1	0.233	0.262	0.08	--
		TB	Edge 1	0	2462	Aux	15.91	16.5	1.146	1	0.331	0.379	-0.10	2
		TB	Rear	0	2412	Aux	16.46	16.5	1.009	1	0.0259	0.026	-0.15	--
		TB	Edge4	0	2412	Aux	16.46	16.5	1.009	1	0.0474	0.048	0.03	--
		NB	Bystander	20	2412	Aux	16.46	16.5	1.009	1	0.0869	0.088	0.12	--
2.4Ghz	GFSK	TB	Edge 1	0	2402	Main	3.49	6	1.782	1	0.048	0.086	-0.05	--
		TB	Edge 1	0	2441	Main	3.28	6	1.871	1	0.058	0.108	-0.15	--
		TB	Edge 1	0	2480	Main	3.11	6	1.945	1	0.111	0.216	0.15	3
2.4Ghz	GFSK	TB	Edge 1	1	2402	Aux	3	6	1.995	1	0.042	0.084	-0.15	--
		TB	Edge 1	1	2441	Aux	3.01	6	1.991	1	0.044	0.088	0.03	--
		TB	Edge 1	1	2480	Aux	3.2	6	1.905	1	0.051	0.097	0.18	4

2.4GHz SAR Results for INPAQ Antenna- Worst case

Band	Mode	Configure	Test Position	Dist. (mm)	Freq. (MHZ)	Ant	max Power (dBm)	Tune-Up Limit (dBm)	Scaling Factor	Duty Cycle Scaling Factor	SAR1g (W/kg)	Scaled SAR1g (W/kg)	Power Drift (dB)	Fig
WLAN 2.4Ghz	802.11b	TB	Edge 1	0	2462	Main	15.88	16.5	1.153	1	0.146	0.168	0.04	--
WLAN 2.4Ghz	802.11b	TB	Edge 1	0	2462	Aux	15.91	16.5	1.146	1	0.316	0.362	-0.05	--
2.4Ghz	GFSK	TB	Edge 1	0	2480	Main	3.11	6	1.945	1	0.0327	0.064	0.13	--
2.4Ghz	GFSK	TB	Edge 1	0	2480	Aux	3.2	6	1.905	1	0.0133	0.025	0.04	--

Remark: SAR is not required for the following 2.4 GHz OFDM conditions.

1) When KDB Publication 447498 SAR test exclusion applies to the OFDM configuration.

2) When the highest reported SAR for DSSS is adjusted by the ratio of OFDM to DSSS specified maximum output power and the adjusted SAR is ≤ 1.2 W/kg.

The highest reported SAR for DSSS is adjusted by the ratio of OFDM to DSSS specified maximum output power and the adjusted SAR is ≤ 1.2 W/kg. So 2.4 GHz OFDM mode is not required.

5GHz SAR Results for Test Records for South Star Antenna
U-NII-2A Test configuration

Band	Mode	Configure	Test Position	Dist. (mm)	Freq. (MHZ)	Ant	max Power (dBm)	Tune-Up Limit (dBm)	Scaling Factor	Duty Cycle Scaling Factor	SAR1g (W/kg)	Scaled SAR1g (W/kg)	Power Drift (dB)	Fig
U-NII-2A	802.11a	TB	Edge 1	0	5260	Main	14.50	14.5	1.000	1	0.839	0.839	-0.03	5
		TB	Edge 1	0	5300	Main	14.49	14.5	1.002	1	0.836	0.838	0.13	--
		TB	Edge 1	0	5320	Main	14.39	14.5	1.026	1	0.676	0.693	-0.02	--
		TB	Rear	0	5260	Main	14.50	14.5	1.000	1	0.032	0.032	0.04	--
		TB	Edge2	0	5260	Main	14.50	14.5	1.000	1	0.358	0.358	-0.05	--
		NB	Bystander	20	5260	Main	14.50	14.5	1.000	1	0.005	0.005	0.13	--
Repeated														
U-NII-2A	802.11a	TB	Edge 1	0	5260	Main	14.50	14.5	1.000	1	0.743	0.743	-0.07	--
U-NII-2A	802.11a	TB	Edge 1	0	5260	Aux	14.27	14.5	1.054	1	0.507	0.535	0.11	--
		TB	Edge 1	0	5280	Aux	14.29	14.5	1.050	1	0.519	0.545	0.05	--
		TB	Edge 1	0	5320	Aux	14.10	14.5	1.096	1	0.559	0.613	0.12	--
		TB	Rear	0	5280	Aux	14.29	14.5	1.050	1	0.0374	0.039	0.09	--
		TB	Edge4	0	5280	Aux	14.29	14.5	1.050	1	0.0877	0.092	0.05	--
		NB	Bystander	20	5280	Aux	14.29	14.5	1.050	1	0.0529	0.056	-0.07	--

U-NII-2C Test configuration

Band	Mode	Configure	Test Position	Dist. (mm)	Freq. (MHZ)	Ant	max Power (dBm)	Tune-Up Limit (dBm)	Scaling Factor	Duty Cycle Scaling Factor	SAR1g (W/kg)	Scaled SAR1g (W/kg)	Power Drift (dB)	Fig
U-NII-2C	802.11a	TB	Edge 1	0	5500	Main	14.00	14	1.000	1	0.554	0.554	0.13	--
		TB	Edge 1	0	5580	Main	13.99	14	1.002	1	0.521	0.522	0.17	--
		TB	Edge 1	0	5720	Main	12.37	14	1.455	1	0.46	0.670	-0.17	7
		TB	Rear	0	5500	Main	14.00	14	1.000	1	0.0268	0.027	0.12	--
		TB	Edge 2	0	5500	Main	14.00	14	1.000	1	0.554	0.554	0.09	--
		NB	Bystander	20	5500	Main	14.00	14	1.000	1	0.066	0.066	0.16	--
U-NII-2C	802.11a	TB	Edge 1	0	5500	Aux	13.20	14	1.202	1	0.436	0.524	0.05	--
		TB	Edge 1	0	5640	Aux	13.57	14	1.104	1	0.577	0.637	-0.11	--
		TB	Edge 1	0	5720	Aux	12.95	14	1.274	1	0.518	0.660	-0.13	8
		TB	Rear	0	5640	Aux	13.57	14	1.104	1	0.0353	0.039	0.09	--
		TB	Edge4	0	5640	Aux	13.57	14	1.104	1	0.198	0.219	0.01	--
		NB	Bystander	20	5640	Aux	13.57	14	1.104	1	0.108	0.119	0.14	--

U-NII-3 Test configuration

Band	Mode	Configure	Test Position	Dist. (mm)	Freq. (MHZ)	Ant	max Power (dBm)	Tune-Up Limit (dBm)	Scaling Factor	Duty Cycle Scaling Factor	SAR1g (W/kg)	Scaled SAR1g (W/kg)	Power Drift (dB)	Fig
U-NII-3	802.11a	TB	Edge 1	0	5745	Main	12.15	13	1.216	1	0.481	0.585	0.14	9
		TB	Edge 1	0	5785	Main	12.36	13	1.159	1	0.496	0.575	-0.14	--
		TB	Edge 1	0	5825	Main	12.64	13	1.086	1	0.526	0.571	0.10	--
		TB	Rear	0	5825	Main	12.64	13	1.086	1	0.0136	0.015	-0.06	--
		TB	Edge2	0	5825	Main	12.64	13	1.086	1	0.369	0.401	-0.14	--
		NB	Bystander	20	5825	Main	12.64	13	1.086	1	0.06	0.065	0.13	--
		TB	Edge 1	0	5745	Aux	12.64	13	1.086	1	0.487	0.529	0.11	--
		TB	Edge 1	0	5785	Aux	12.01	13	1.256	1	0.535	0.672	0.15	10
		TB	Edge 1	0	5825	Aux	12.19	13	1.205	1	0.436	0.525	-0.04	--
		TB	Rear	0	5745	Aux	12.64	13	1.086	1	0.0201	0.022	-0.07	--
		TB	Edge4	0	5745	Aux	12.64	13	1.086	1	0.0568	0.062	-0.14	--
		NB	Bystander	20	5745	Aux	12.64	13	1.086	1	0.049	0.053	0.12	--

5GHz SAR Results for Test Records for INPAQ Antenna

Band	Mode	Configure	Test Position	Dist. (mm)	Freq. (MHZ)	Ant	max Power (dBm)	Tune-Up Limit (dBm)	Scaling Factor	Duty Cycle Scaling Factor	SAR1g (W/kg)	Scaled SAR1g (W/kg)	Power Drift (dB)	Fig
U-NII-2A	802.11a	TB	Edge 1	0	5260	Main	14.50	14.5	1.000	1	0.638	0.638	0.16	--
U-NII-2C		TB	Edge 1	0	5720	Main	12.37	14	1.455	1	0.260	0.378	-0.05	--
U-NII-3		TB	Edge2	0	5745	Main	12.15	13	1.216	1	0.278	0.338	0.13	--
U-NII-2A	802.11a	TB	Edge 1	0	5320	Aux	14.10	14.5	1.096	1	0.624	0.684	-0.16	6
U-NII-2C		TB	Edge 1	0	5720	Aux	12.95	14	1.274	1	0.402	0.512	0.16	--
U-NII-3		TB	Edge 1	0	5785	Aux	12.01	13	1.256	1	0.296	0.372	-0.05	--

Remark: For devices that operate in both U-NII-1 and U-NII-2A bands using the same transmitter and antenna(s), SAR test reduction is determined according to the following

1) When the same maximum output power is specified for both bands, begin SAR measurement in U-NII-2A band by applying the OFDM SAR requirements. If the highest reported SAR for a test configuration is ≤ 1.2 W/kg, SAR is not required for U-NII-1 band for that configuration (802.11 mode and exposure condition); otherwise, each band is tested independently for SAR.

2) When different maximum output power is specified for the bands, begin SAR measurement in the band with higher specified maximum output power. The highest reported SAR for the tested configuration is adjusted by the ratio of lower to higher specified maximum output power for the two bands. When the adjusted SAR is ≤ 1.2 W/kg, SAR is not required for the band with lower maximum output power in that test configuration; otherwise, each band is tested independently for SAR.

3) The highest reported SAR for main/aux antenna is adjusted by the ratio of U-NII-1 to U-NII-2A specified maximum output power and the adjusted SAR is ≤ 1.2 W/kg . So U-NII-1 mode is not required.

13. SAR Measurement Variability

SAR measurement variability must be assessed for each frequency band, which is determined by the SAR probe calibration point and tissue-equivalent medium used for the device measurements. When both head and body tissue-equivalent media are required for SAR measurements in a frequency band, the variability measurement procedures should be applied to the tissue medium with the highest measured SAR, using the highest measured SAR configuration for that tissue-equivalent medium.

The following procedures are applied to determine if repeated measurements are required.

1) Repeated measurement is not required when the original highest measured SAR is < 0.80 W/kg; steps2) through 4) do not apply.

2) When the original highest measured SAR is ≥ 0.80 W/kg, repeat that measurement once.

3) Perform a second repeated measurement only if the ratio of largest to smallest SAR for the original and first repeated measurements is > 1.20 or when the original or repeated measurement is ≥ 1.45W/kg (~ 10% from the 1-g SAR limit).

4) Perform a third repeated measurement only if the original, first or second repeated measurement is ≥1.5 W/kg and the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 1.20.

Table 13.1: SAR Measurement Variability for Body Value (1g)

Frequency		Test Position	Original SAR (W/kg)	First Repeated SAR (W/kg)	The Ratio	second repeated (1g)(W/kg)
MHz	Ch.					
5260	52	Edge 1	0.839	0.743	1.13	--

Note: According to the KDB 865664 D01repeated measurement is not required when the original highest measured SAR is < 0.8 W/kg.

14. Evaluation of Simultaneous

	Position	Applicable Combination
Simultaneous Transmission	Body	WLAN 5GHz+ Bluetooth

The EUT only one TX antenna, So simultaneous transmission SAR evaluation is not required。

Note:

1. The EUT supports the Main antenna with TX/RX diversity function for WLAN and Bluetooth, the Auxiliary antenna with TX/RX diversity function for WLAN and Bluetooth.
2. WLAN 2.4GHz and Bluetooth will not be transmitting at same time.
3. WLAN 2.4GHz and WLAN 5GHz will not be transmitting at same time.
4. The reported SAR summation is calculated based on the same configuration and test position.
5. Per KDB 447498 D01v06, simultaneous transmission SAR is compliant if,
   1) Scalar SAR summation < 1.6W/kg.
   2) SPLSR = (SAR1 + SAR2)1.5 / (min. separation distance, mm), and the peak separation distance is determined from the square root of [(x1-x2)2 + (y1-y2)2 + (z1-z2)2], where (x1, y1, z1) and (x2, y2, z2) are the coordinates of the extrapolated peak SAR locations in the zoom scan
   If SPLSR ≤ 0.04, simultaneously transmission SAR is compliant
   3) Simultaneously transmission SAR measurement, and the reported multi-band SAR < 1.6W/kg

SUM ∑SAR1g Chain0 WLAN 5GHz + Chain1 Bluetooth				
Position	Distance	Standalone SAR(1g) [W/kg]		SUM SAR(1g)[W/kg]
	[mm]	Main Antenna WLAN 5G	Aux Antenna Bluetooth	Main ant 5G+ Aux ant BT
Edge 1	0	0.839	0.097	0.936

SUM ∑SAR1g Chain1 WLAN 5GHz + Chain0 Bluetooth				
Position	Distance	Standalone SAR(1g) [W/kg]		SUM SAR(1g)[W/kg]
	[mm]	Aux Antenna WLAN 5G	Main Antenna Bluetooth	Aux ant 5G+ Main ant BT
Edge 1	0	0.684	0.216	0.900

15. Measurement Uncertainty

Measurement uncertainty for 30 MHz to 3 GHz averaged over 1 gram						
Uncertainty Component	Uncertainty	Prob.	Div.	$c_{i\,(1g)}$	Std. Unc. (1-g)	v_i or Veff
Measurement System						
Probe Calibration (*k*=1)	6.00	Normal	1	1	6.00	∞
Probe Isotropy	0.50	Rectangular	√3	0.7	0.20	∞
Modulation Response	2.40	Rectangular	√3	1	1.39	∞
Hemispherical Isotropy	2.60	Rectangular	√3	0.7	1.05	∞
Boundary Effect	0.80	Rectangular	√3	1	0.46	∞
Linearity	0.60	Rectangular	√3	1	0.35	∞
System Detection Limit	1.00	Rectangular	√3	1	0.58	∞
Readout Electronics	0.70	Normal	1	1	0.70	∞
Response Time	0.00	Rectangular	√3	1	0.00	∞
Integration Time	2.60	Rectangular	√3	1	1.50	∞
RF Ambient Noise	3.00	Rectangular	√3	1	1.73	∞
RF Ambient Reflections	3.00	Rectangular	√3	1	1.73	∞
Probe Positioner	1.50	Rectangular	√3	1	0.87	∞
Probe Positioning	2.90	Rectangular	√3	1	1.67	∞
Max. SAR Evaluation	1.00	Rectangular	√3	1	0.58	∞
Test sample Related						
Test sample Positioning	2.9	Normal	1	1	2.9	145
Device Holder Uncertainty	3.6	Normal	1	1	3.6	5
Dipole						
Power drift	5	Rectangular	√3	1	2.89	∞
Dipole Positioning	2	Normal	1	1	2.00	∞
Dipole Input Power	5	Normal	1	1	5.00	∞
Power Scaling	0	Rectangular	√3	1	0.00	∞
Phantom and Tissue Parameters						
Phantom Uncertainty	6.1	Rectangular	√3	1	3.52	∞
SAR correction	1.9	Rectangular	√3	1	1.10	∞
Liquid Conductivity (target)	5	Rectangular	√3	0.64	1.85	∞
Liquid Conductivity (meas)	2.5	Rectangular	√3	0.78	1.13	∞
Liquid Permittivity (target)	5	Rectangular	√3	0.6	1.73	∞
Liquid Permittivity (meas)	2.5	Rectangular	√3	0.26	0.38	∞
Temp. unc. - Conductivity	0.18	Rectangular	√3	0.78	0.08	∞
Temp. unc. - Permittivity	0.54	Rectangular	√3	0.23	0.07	∞
Combined Std.		RSS			11.51	387

Uncertainty						
Expanded STD Uncertainty		*k*=2			23.02%	

16. Main Test Instrument

Table 16.1: List of Main Instruments

No.	Name	Type	Serial Number	Calibration Date	Valid Period
01	Network analyzer	N5242A	MY51221755	Jan 6, 2017	1 year
02	Power meter	NRVD	102257	May 11, 2017	1 year
03	Power sensor	NRV-Z5	100644		
			100241		
04	Signal Generator	E4438C	MY49072044	May 11, 2017	1 Year
05	Amplifier	NTWPA-0086010F	12023024	No Calibration Requested	
06	Coupler	778D	MY4825551	May 11, 2017	1 year
07	BTS	E5515C	MY50266468	Jan 6, 2017	1 year
08	E-field Probe	EX3DV4	3798	July 26, 2017	1 year
09	DAE	SPEAG DAE4	1245	July 20, 2017	1 year
10	Dipole	SPEAG D2450V2	858	Oct 30.2015	3 year
11	Dipole	SPEAG D5GHzV2	1121	March 24,2017	1 year

ANNEX A. GRAPH RESULTS

IEEE802.11b Body Edge 1 CH11 Chain0

Date/Time: 2017/11/28

Electronics: DAE4 Sn1245

Medium parameters used: f = 2462 MHz; σ = 1.992 S/m; ε_r = 52.834; ρ = 1000 kg/m^3

Ambient Temperature:22°C Liquid Temperature:22°C

Communication System: Wifi 2450 2450; Frequency: 2462 MHz; Duty Cycle: 1:1

Probe: EX3DV4 - SN3798ConvF(7.32, 7.32, 7.32); Calibrated: 7/26/2017

IEEE802.11b Body Edge 1 CH11 Chain0/Area Scan (91x121x1):

Measurement grid: dx=10 mm, dy=10 mm

Maximum value of SAR (Measurement) = 1.08 W/kg

IEEE802.11b Body Edge 1 CH11 Chain0/Zoom Scan (7x7x7)/Cube 0:

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

Reference Value = 5.056 V/m; Power Drift = -0.13 dB

Peak SAR (extrapolated) = 1.61 W/kg

SAR(1 g) = 0.625 W/kg; SAR(10 g) = 0.242 W/kg

Maximum value of SAR (measured) = 1.07 W/kg

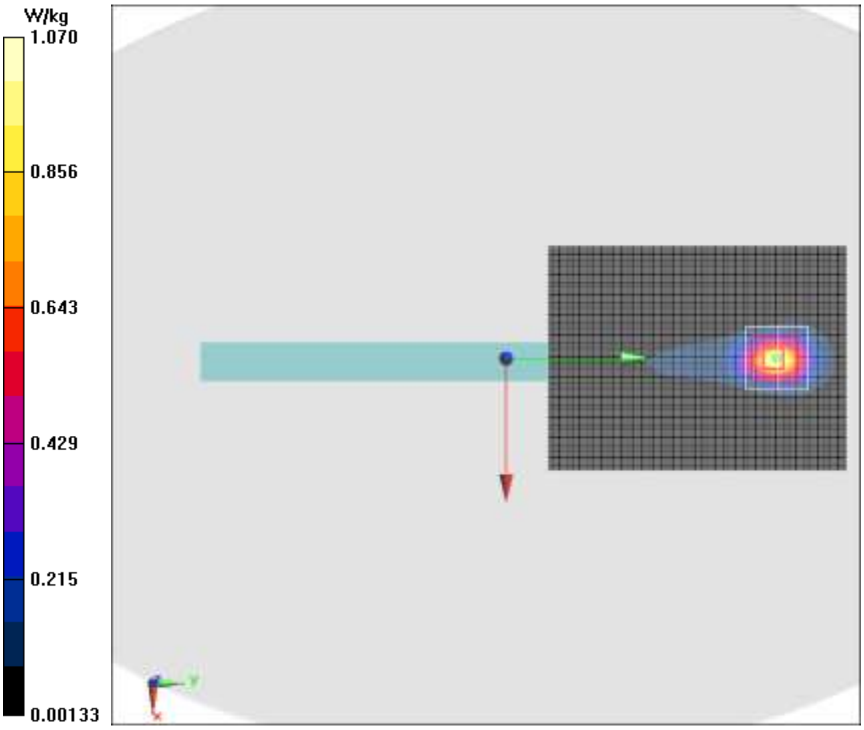


Fig.1 IEEE802.11b Body Edge 1 CH11 Chain0

IEEE802.11b Body Edge 1 CH11 Chain1

Date/Time: 2017/11/28

Electronics: DAE4 Sn1245

Medium parameters used: f = 2462 MHz; σ = 1.992 S/m; ε_r = 52.834; ρ = 1000 kg/m^3

Ambient Temperature:22°C Liquid Temperature:22°C

Communication System: Wifi 2450 2450; Frequency: 2462 MHz; Duty Cycle: 1:1

Probe: EX3DV4 - SN3798ConvF(7.32, 7.32, 7.32); Calibrated: 7/26/2017

IEEE802.11b Body Edge 1 CH11 Chain1/Area Scan (91x121x1):

Measurement grid: dx=10 mm, dy=10 mm

Maximum value of SAR (Measurement) = 0.610 W/kg

IEEE802.11b Body Edge 1 CH11 Chain1/Zoom Scan (7x7x7)/Cube 0:

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

Reference Value = 6.852 V/m; Power Drift = -0.10 dB

Peak SAR (extrapolated) = 0.843 W/kg

SAR(1 g) = 0.331 W/kg; SAR(10 g) = 0.140 W/kg

Maximum value of SAR (measured) = 0.558 W/kg

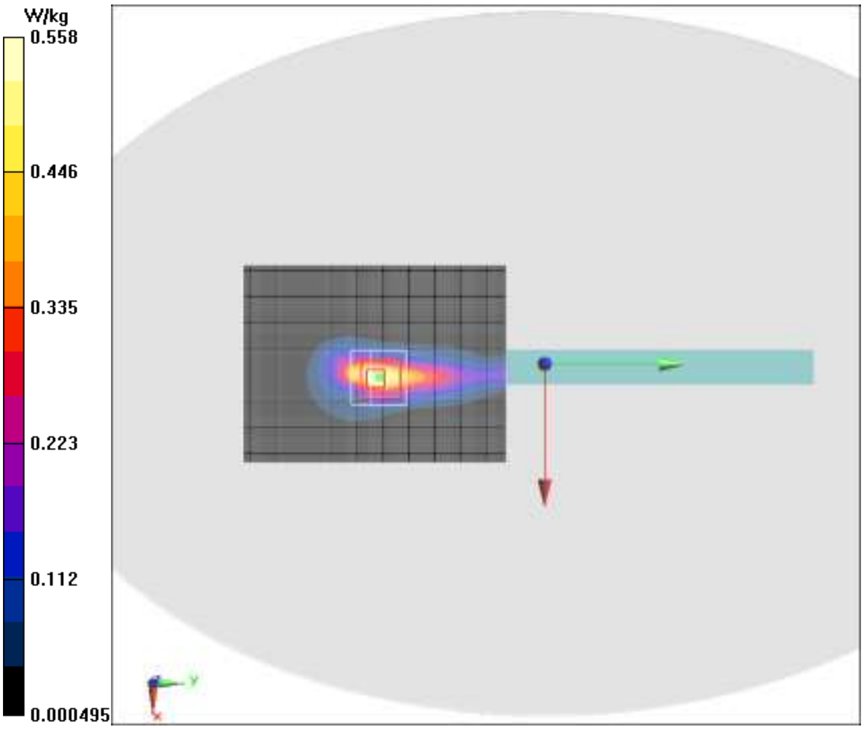


Fig.2 IEEE802.11b Body Edge 1 CH11 Chain1

BT2.1 Body Edge 1 CH78 Chain0

Date/Time: 2017/11/28

Electronics: DAE4 Sn1245

Medium parameters used: f = 2480 MHz; σ = 2.014 S/m; ε_r = 52.773; ρ = 1000 kg/m^3

Ambient Temperature:22°C Liquid Temperature:22°C

Communication System: BT 2450; Frequency: 2480 MHz; Duty Cycle: 1:1

Probe: EX3DV4 - SN3798ConvF(7.32, 7.32, 7.32); Calibrated: 7/26/2017

BT2.1 Body Edge 1 CH78 Chain0/Area Scan (91x121x1):

Measurement grid: dx=10 mm, dy=10 mm

Maximum value of SAR (Measurement) = 0.160 W/kg

BT2.1 Body Edge 1 CH78 Chain0/Zoom Scan (7x7x7)/Cube 0:

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

Reference Value = 2.462 V/m; Power Drift = 0.15 dB

Peak SAR (extrapolated) = 0.295 W/kg

SAR(1 g) = 0.111 W/kg; SAR(10 g) = 0.042 W/kg

Maximum value of SAR (measured) = 0.219 W/kg

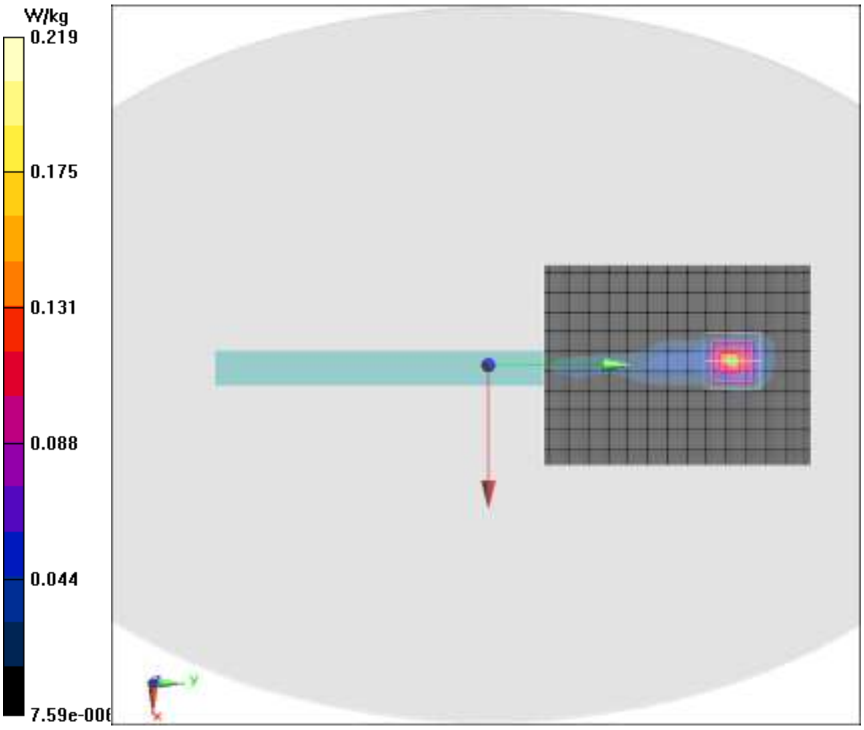


Fig.3 BT2.1 Body Edge 1 CH78 Chain0

BT2.1 Body Edge 1 CH78 Chain1

Date/Time: 2017/11/28

Electronics: DAE4 Sn1245

Medium parameters used: f = 2480 MHz; σ = 2.014 S/m; ε_r = 52.773; ρ = 1000 kg/m^3

Ambient Temperature:22°C Liquid Temperature:22°C

Communication System: BT 2450; Frequency: 2480 MHz; Duty Cycle: 1:1

Probe: EX3DV4 - SN3798ConvF(7.32, 7.32, 7.32); Calibrated: 7/26/2017

BT2.1 Body Edge 1 CH78 Chain1/Area Scan (91x121x1):

Measurement grid: dx=10 mm, dy=10 mm

Maximum value of SAR (Measurement) = 0.0928 W/kg

BT2.1 Body Edge 1 CH78 Chain1/Zoom Scan (7x7x7)/Cube 0:

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

Reference Value = 3.359 V/m; Power Drift = 0.18 dB

Peak SAR (extrapolated) = 0.119 W/kg

SAR(1 g) = 0.051 W/kg; SAR(10 g) = 0.023 W/kg

Maximum of SAR (measured) = 0.0898 W/kg

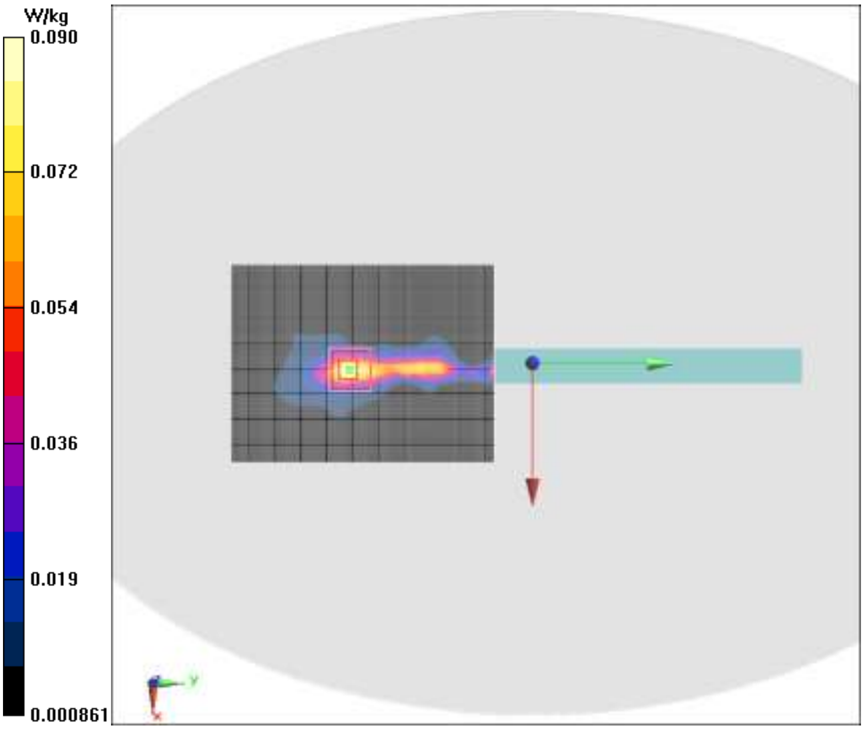


Fig.4 BT2.1 Body Edge 1 CH78 Chain1

IEEE802.11a Body Edge 1 CH52 Chain0

Date/Time: 2017/11/26

Electronics: DAE4 Sn1245

Medium parameters used: f = 5260 MHz; σ = 5.257 S/m; ε_r = 49.975; ρ = 1000 kg/m^3

Ambient Temperature:22°C Liquid Temperature:22°C

Communication System: 5GHz U-NII-2A 5G; Frequency: 5260 MHz; Duty Cycle: 1:1

Probe: EX3DV4 - SN3798ConvF(4.67, 4.67, 4.67); Calibrated: 7/26/2017

IEEE802.11a Body Edge 1 CH52 Chain0/Area Scan (101x131x1):

Measurement grid: dx=10 mm, dy=10 mm

Maximum value of SAR (Measurement) = 2.40 W/kg

IEEE802.11a Body Edge 1 CH52 Chain0/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 3.337 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 4.33 W/kg

SAR(1 g) = 0.839 W/kg; SAR(10 g) = 0.215 W/kg

Maximum of SAR (measured) = 2.17 W/kg

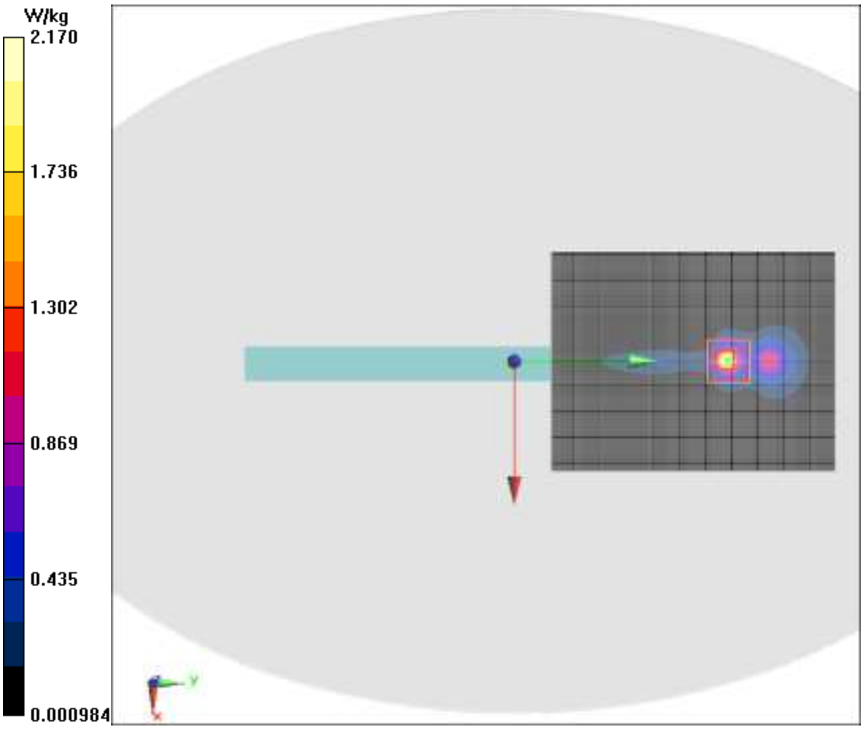


Fig.5 IEEE802.11a Body Edge 1 CH52 Chain0

IEEE802.11a Body Edge 1 CH64 Chain1

Date/Time: 2017/11/26

Electronics: DAE4 Sn1245

Medium parameters used: f = 5320 MHz; σ = 5.335 S/m; ε_r = 49.876; ρ = 1000 kg/m^3

Ambient Temperature:22°C Liquid Temperature:22°C

Communication System: 5GHz U-NII-2A 5G; Frequency: 5320 MHz; Duty Cycle: 1:1

Probe: EX3DV4 - SN3798ConvF(4.67, 4.67, 4.67); Calibrated: 7/26/2017

IEEE802.11a Body Edge 1 CH64 Chain1/Area Scan (91x121x1):

Measurement grid: dx=10 mm, dy=10 mm

Maximum value of SAR (Measurement) = 1.13 W/kg

IEEE802.11a Body Edge 1 CH64 Chain1/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 6.374 V/m; Power Drift = -0.16 dB

Peak SAR (extrapolated) = 3.17 W/kg

SAR(1 g) = 0.624 W/kg; SAR(10 g) = 0.179 W/kg

Maximum of SAR (measured) = 1.67 W/kg

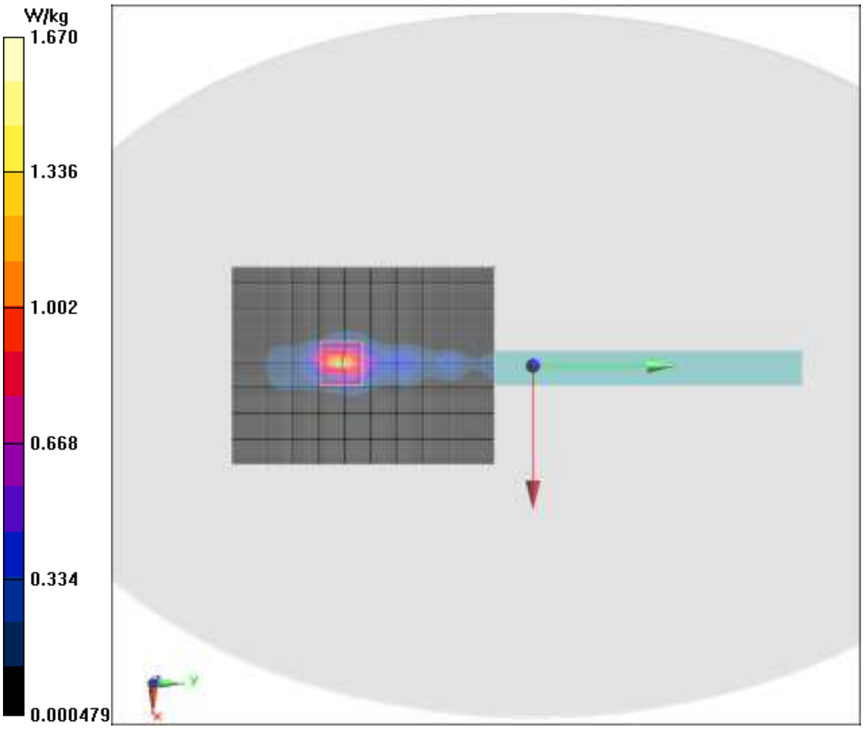


Fig.6 IEEE802.11a Body Edge 1 CH64 Chain1

IEEE802.11a Body Edge 1 CH144 Chain0

Date/Time: 2017/11/27

Electronics: DAE4 Sn1245

Medium parameters used: f = 5720 MHz; σ = 5.911 S/m; ε_r = 49.042; ρ = 1000 kg/m^3

Ambient Temperature:22°C Liquid Temperature:22°C

Communication System: 5GHz U-NII-2C 5G; Frequency: 5720 MHz; Duty Cycle: 1:1

Probe: EX3DV4 - SN3798ConvF(4.45, 4.45, 4.45); Calibrated: 7/26/2017

IEEE802.11a Body Edge 1 CH144 Chain0/Area Scan (101x131x1):

Measurement grid: dx=10 mm, dy=10 mm

Maximum value of SAR (Measurement) = 0.870 W/kg

IEEE802.11a Body Edge 1 CH144 Chain0/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 3.524 V/m; Power Drift = -0.17 dB

Peak SAR (extrapolated) = 2.55 W/kg

SAR(1 g) = 0.460 W/kg; SAR(10 g) = 0.114 W/kg

Maximum of SAR (measured) = 1.31 W/kg

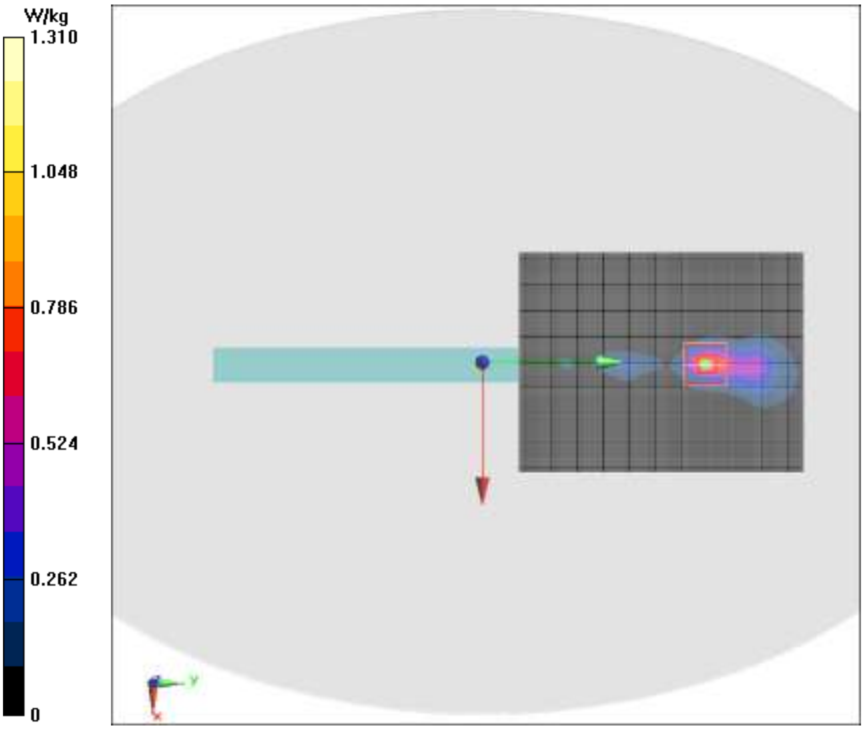


Fig.7 IEEE802.11a Body Edge 1 CH144 Chain0

IEEE802.11a Body Edge 1 CH144 Chain1

Date/Time: 2017/11/27

Electronics: DAE4 Sn1245

Medium parameters used: f = 5720 MHz; σ = 5.911 S/m; ε_r = 49.042; ρ = 1000 kg/m^3

Ambient Temperature:22°C Liquid Temperature:22°C

Communication System: 5GHz U-NII-2C 5G; Frequency: 5720 MHz; Duty Cycle: 1:1

Probe: EX3DV4 - SN3798ConvF(4.45, 4.45, 4.45); Calibrated: 7/26/2017

IEEE802.11a Body Edge 1 CH144 Chain1/Area Scan (91x121x1):

Measurement grid: dx=10 mm, dy=10 mm

Maximum value of SAR (Measurement) = 1.30 W/kg

IEEE802.11a Body Edge 1 CH144 Chain1/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 3.212 V/m; Power Drift = -0.13 dB

Peak SAR (extrapolated) = 2.89 W/kg

SAR(1 g) = 0.518 W/kg; SAR(10 g) = 0.145 W/kg

Maximum of SAR (measured) = 1.41 W/kg

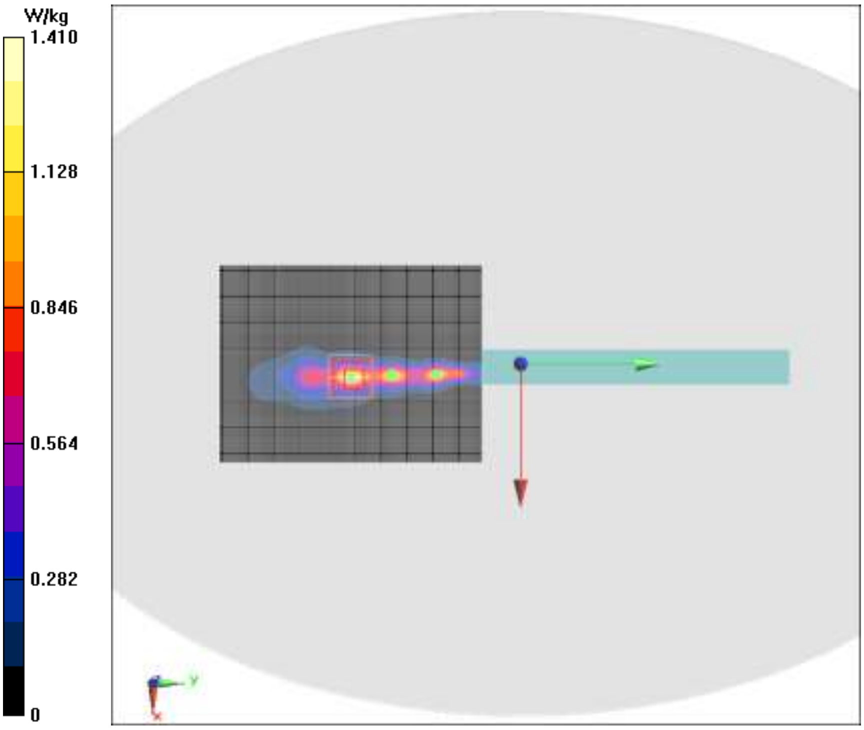


Fig.8 IEEE802.11a Body Edge 1 CH144 Chain0

IEEE802.11a Body Edge 1 CH149 Chain0

Date/Time: 2017/11/27

Electronics: DAE4 Sn1245

Medium parameters used: f = 5745 MHz; σ = 5.948 S/m; ε_r = 48.991; ρ = 1000 kg/m^3

Ambient Temperature:22°C Liquid Temperature:22°C

Communication System: 5GHz U-NII-3 5G; Frequency: 5745 MHz; Duty Cycle: 1:1

Probe: EX3DV4 - SN3798ConvF(4.45, 4.45, 4.45); Calibrated: 7/26/2017

IEEE802.11a Body Edge 1 CH149 Chain0/Area Scan (101x131x1):

Measurement grid: dx=10 mm, dy=10 mm

Maximum value of SAR (Measurement) = 0.896 W/kg

IEEE802.11a Body Edge 1 CH149 Chain0/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 3.199 V/m; Power Drift = 0.14 dB

Peak SAR (extrapolated) = 2.75 W/kg

SAR(1 g) = 0.481 W/kg; SAR(10 g) = 0.115 W/kg

Maximum of SAR (measured) = 1.35 W/kg

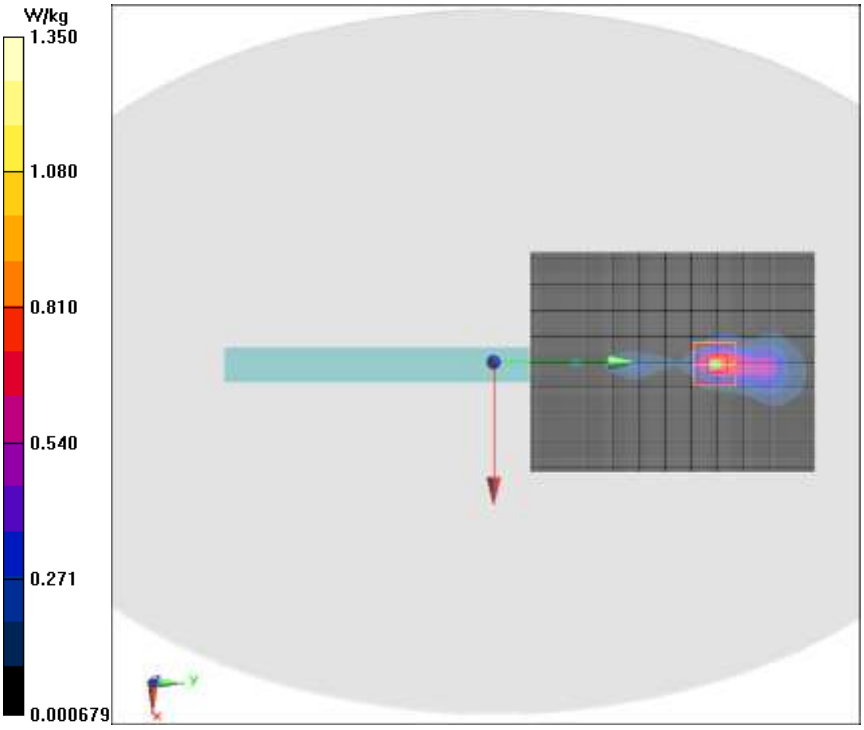


Fig.9 IEEE802.11a Body Edge 1 CH149 Chain0

IEEE802.11a Body Edge 1 CH157 Chain1

Date/Time: 2017/11/27

Electronics: DAE4 Sn1245

Medium parameters used: f = 5785 MHz; σ = 6.006 S/m; ε_r = 48.92; ρ = 1000 kg/m^3

Ambient Temperature:22°C Liquid Temperature:22°C

Communication System: 5GHz U-NII-3 5G; Frequency: 5785 MHz; Duty Cycle: 1:1

Probe: EX3DV4 - SN3798ConvF(4.45, 4.45, 4.45); Calibrated: 7/26/2017

IEEE802.11a Body Edge 1 CH157 Chain1/Area Scan (91x121x1):

Measurement grid: dx=10 mm, dy=10 mm

Maximum value of SAR (Measurement) = 1.46 W/kg

IEEE802.11a Body Edge 1 CH157 Chain1/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 7.971 V/m; Power Drift = 0.15 dB

Peak SAR (extrapolated) = 3.23 W/kg

SAR(1 g) = 0.535 W/kg; SAR(10 g) = 0.154 W/kg

Maximum of SAR (measured) = 1.52 W/kg

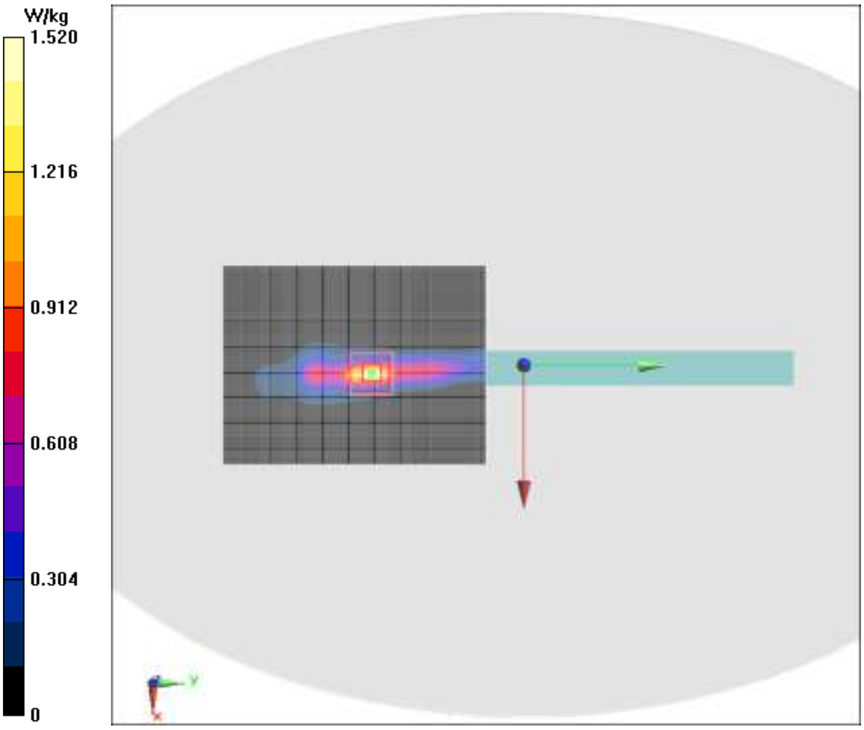


Fig.10 IEEE802.11a Body Edge 1 CH157 Chain1

ANNEX B. SYSTEM VALIDATION RESULTS

Body 2450 MHz

Date/Time: 2017/11/28

Electronics: DAE4 Sn1245

Medium parameters used: f = 2450 MHz; σ = 1.978 S/m; ε_r = 52.879; ρ = 1000 kg/m^3

Ambient Temperature:22°C Liquid Temperature:22°C

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

Probe: EX3DV4 - SN3798ConvF(7.32, 7.32, 7.32); Calibrated: 7/26/2017

System Validation (Ex-Probe)/Area Scan (71x61x1):

Measurement grid: dx=10 mm, dy=10 mm

Maximum value of SAR (Measurement) = 21.7 W/kg

System Validation (Ex-Probe)/Zoom Scan (7x7x7)/Cube 0:

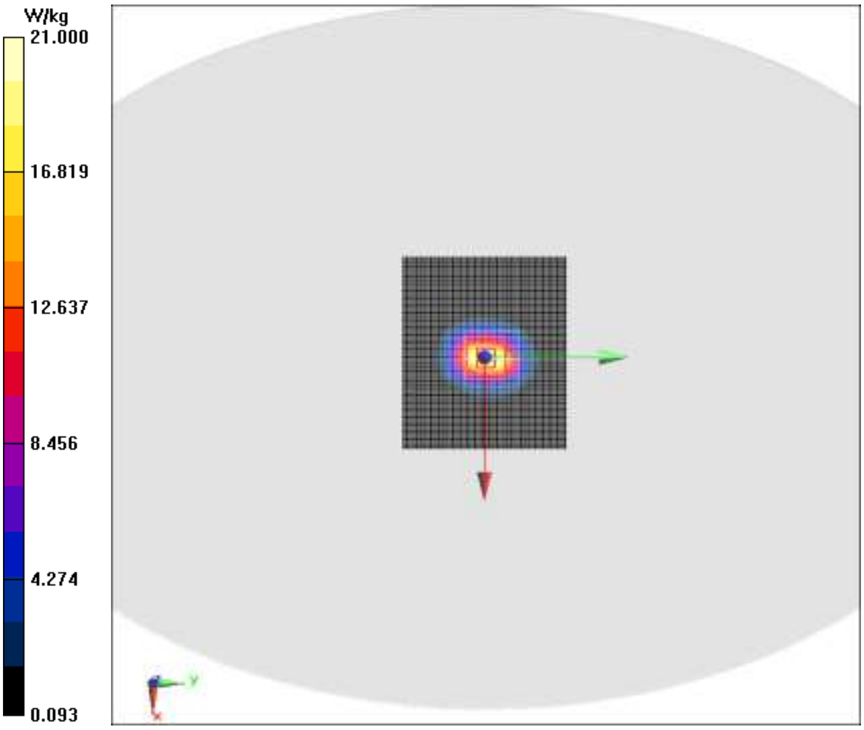
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 90.14 V/m; Power Drift = -0.05 dB

Peak SAR (extrapolated) = 28.2 W/kg

SAR(1 g) = 13.8 W/kg; SAR(10 g) = 6.37 W/kg

Maximum value of SAR (measured) = 21.0 W/kg



Body 5200 MHz

Date/Time: 2017/11/26

Electronics: DAE4 Sn1245

Medium parameters used: f = 5200 MHz; σ = 5.13 S/m; ε_r = 50.153; ρ = 1000 kg/m^3

Ambient Temperature:22°C Liquid Temperature:22°C

Communication System: 5000MHz; Frequency: 5200 MHz; Duty Cycle: 1:1

Probe: EX3DV4 - SN3798ConvF(4.81, 4.81, 4.81); Calibrated: 7/26/2017

d=10mm, Pin=100mW, f=5200 MHz /Area Scan (91x91x1):

Measurement grid: dx=10 mm, dy=10 mm

Maximum value of SAR (Measurement) = 17.3 W/kg

d=10mm, Pin=100mW, f=5200 MHz/Zoom Scan (4x4x1.4mm, graded), dist=1.4mm (7x7x7)/Cube 0:

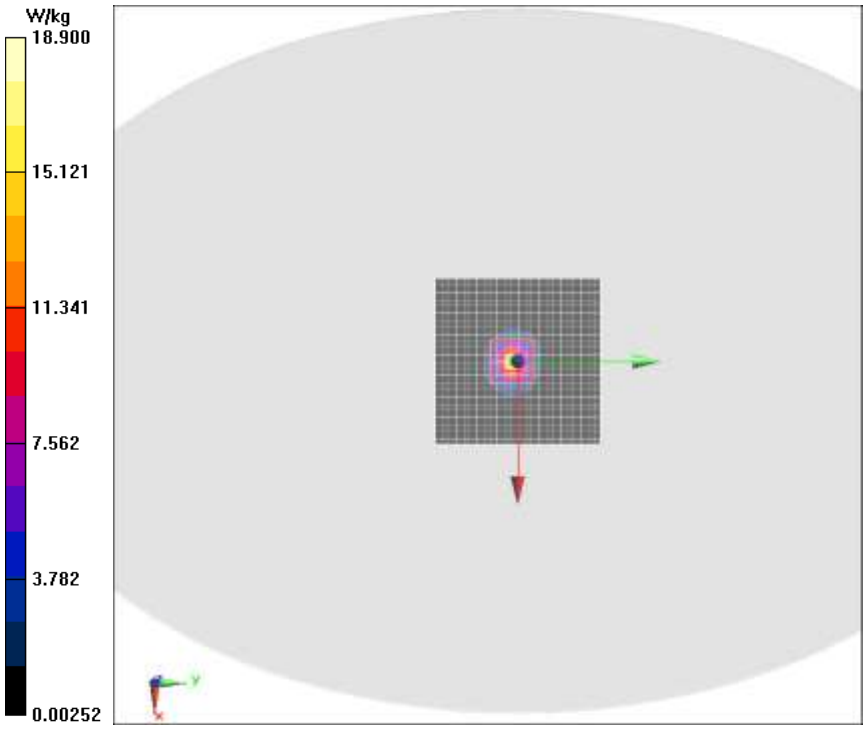
Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 63.82 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 32.8 W/kg

SAR(1 g) = 7.28 W/kg; SAR(10 g) = 2.04 W/kg

Maximum value of SAR (measured) = 18.9 W/kg



Body 5300 MHz

Date/Time: 2017/11/26

Electronics: DAE4 Sn1245

Medium parameters used: f = 5300 MHz; σ = 5.31 S/m; ε_r = 49.906; ρ = 1000 kg/m^3

Ambient Temperature:22°C Liquid Temperature:22°C

Communication System: CW 5000MHz; Frequency: 5300 MHz; Duty Cycle: 1:1

Probe: EX3DV4 - SN3798ConvF(4.67, 4.67, 4.67); Calibrated: 7/26/2017

d=10mm, Pin=100mW, f=5300 MHz/Area Scan (91x91x1):

Measurement grid: dx=10 mm, dy=10 mm

Maximum value of SAR (Measurement) = 17.1 W/kg

d=10mm, Pin=100mW, f=5300 MHz/Zoom Scan dist=1.4mm (7x7x7)/Cube 0:

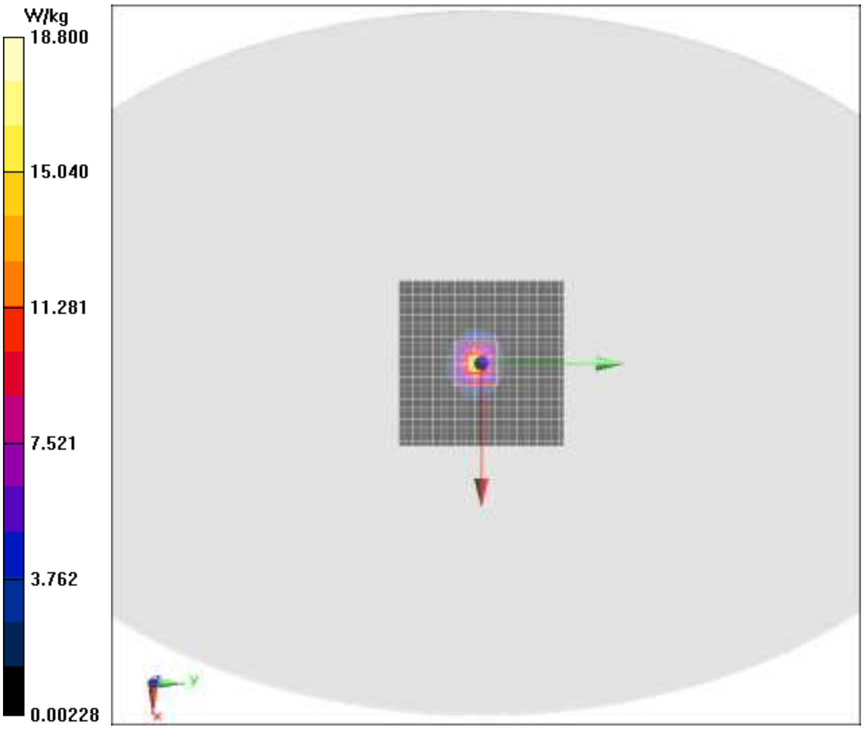
Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 63.10 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 33.3 W/kg

SAR(1 g) = 7.14 W/kg; SAR(10 g) = 1.99 W/kg

Maximum value of SAR (measured) = 18.8 W/kg



Body 5500 MHz

Date/Time: 2017/11/27

Electronics: DAE4 Sn1245

Medium parameters used: f = 5500 MHz; σ = 5.592 S/m; ε_r = 49.514; ρ = 1000 kg/m^3

Ambient Temperature:22°C Liquid Temperature:22°C

Communication System: CW 5000MHz; Frequency: 5500 MHz; Duty Cycle: 1:1

Probe: EX3DV4 - SN3798ConvF(4.26, 4.26, 4.26); Calibrated: 7/26/2017

d=10mm, Pin=100mW, f=5500 MHz/Area Scan (91x91x1):

Measurement grid: dx=10 mm, dy=10 mm

Maximum value of SAR (Measurement) = 18.3 W/kg

d=10mm, Pin=100mW, f=5500 MHz/Zoom Scan dist=1.4mm (7x7x7)/Cube 0:

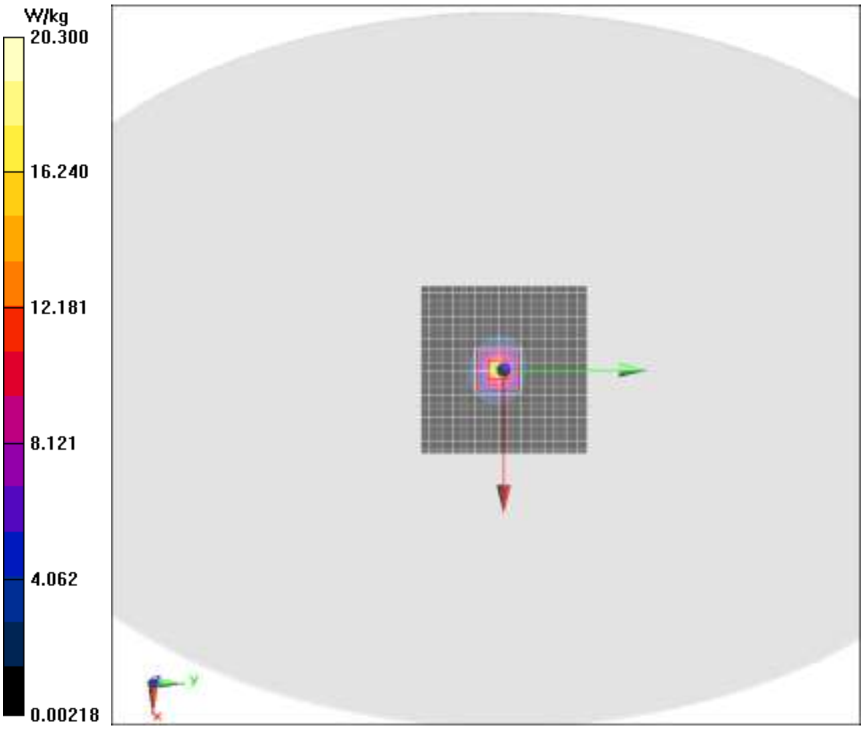
Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 63.53 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 36.3 W/kg

SAR(1 g) = 7.56 W/kg; SAR(10 g) = 2.11 W/kg

Maximum value of SAR (measured) = 20.3 W/kg



Body 5600 MHz

Date/Time: 2017/11/27

Electronics: DAE4 Sn1245

Medium parameters used: f = 5600 MHz; σ = 5.685 S/m; ε_r = 49.362; ρ = 1000 kg/m^3

Ambient Temperature:22°C Liquid Temperature:22°C

Communication System: CW 5000MHz; Frequency: 5600 MHz; Duty Cycle: 1:1

Probe: EX3DV4 - SN3798ConvF(4.18, 4.18, 4.18); Calibrated: 7/26/2017

d=10mm, Pin=100mW, f=5600 MHz/Area Scan (91x91x1):

Measurement grid: dx=10 mm, dy=10 mm

Maximum value of SAR (Measurement) = 20.3 W/kg

d=10mm, Pin=100mW, f=5600 MHz/Zoom Scan dist=1.4mm (7x7x7)/Cube 0:

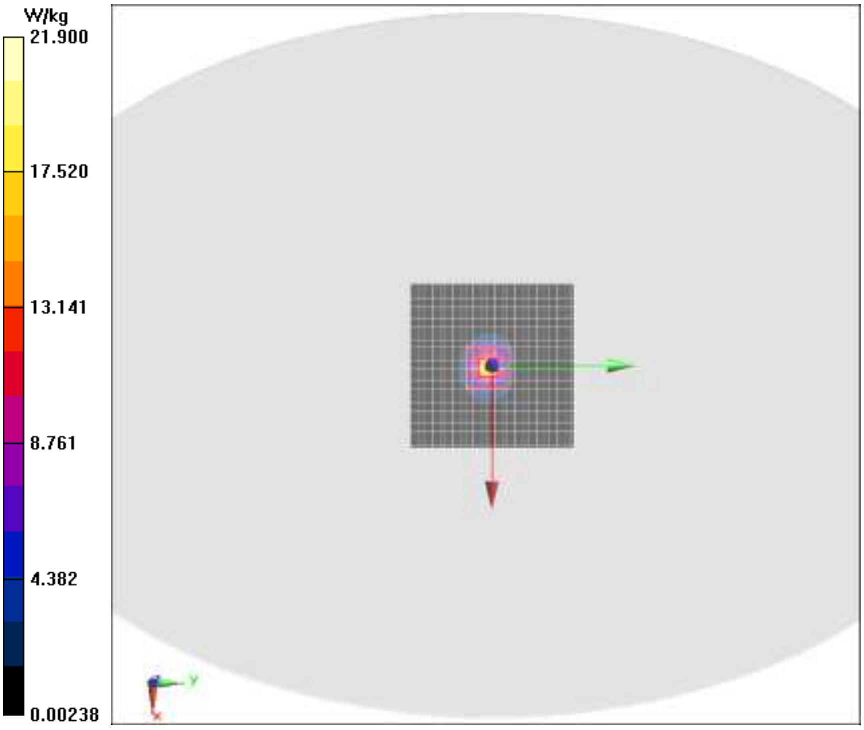
Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 67.09 V/m; Power Drift = -0.14 dB

Peak SAR (extrapolated) = 40.2 W/kg

SAR(1 g) = 8.07 W/kg; SAR(10 g) = 2.23 W/kg

Maximum value of SAR (measured) = 21.9 W/kg



Body 5800 MHz

Date/Time: 2017/11/27

Electronics: DAE4 Sn1245

Medium parameters used: f = 5800 MHz; σ = 6.035 S/m; ε_r = 48.901; ρ = 1000 kg/m^3

Ambient Temperature:22°C   Liquid Temperature:22°C

Communication System: CW 5000MHz; Frequency: 5800 MHz; Duty Cycle: 1:1

Probe: EX3DV4 - SN3798ConvF(4.45, 4.45, 4.45); Calibrated: 7/26/2017

d=10mm, Pin=100mW, f=5800 MHz/Area Scan (91x91x1):

Measurement grid: dx=10 mm, dy=10 mm

Maximum value of SAR (Measurement) = 20.1 W/kg

d=10mm, Pin=100mW, f=5800 MHz/Zoom Scan dist=1.4mm (7x7x7)/Cube 0:

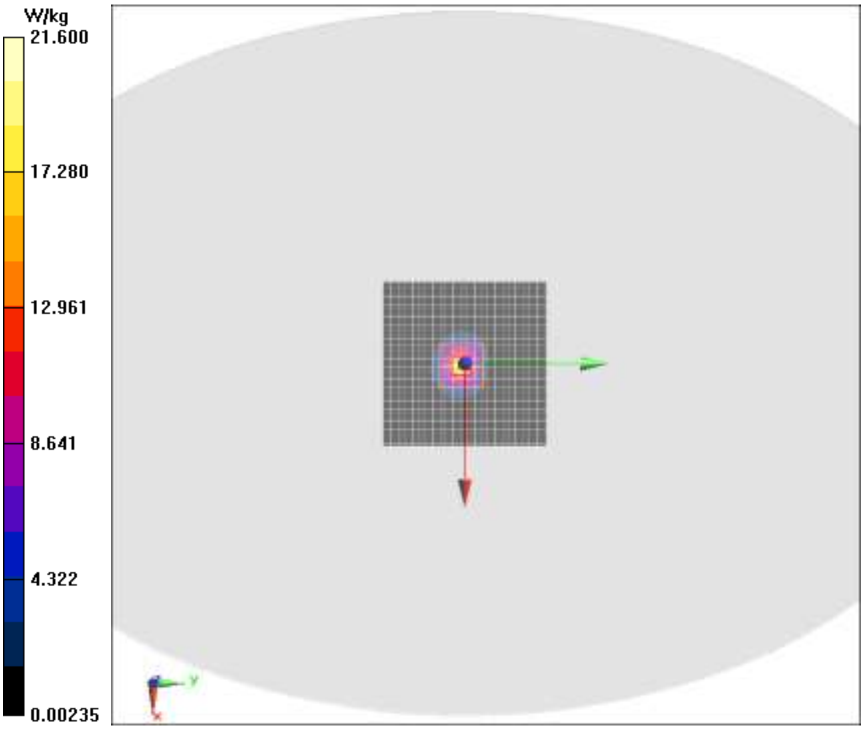
Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 65.03 V/m; Power Drift = -0.14 dB

Peak SAR (extrapolated) = 39.8 W/kg

SAR(1 g) = 7.98 W/kg; SAR(10 g) = 2.2 W/kg

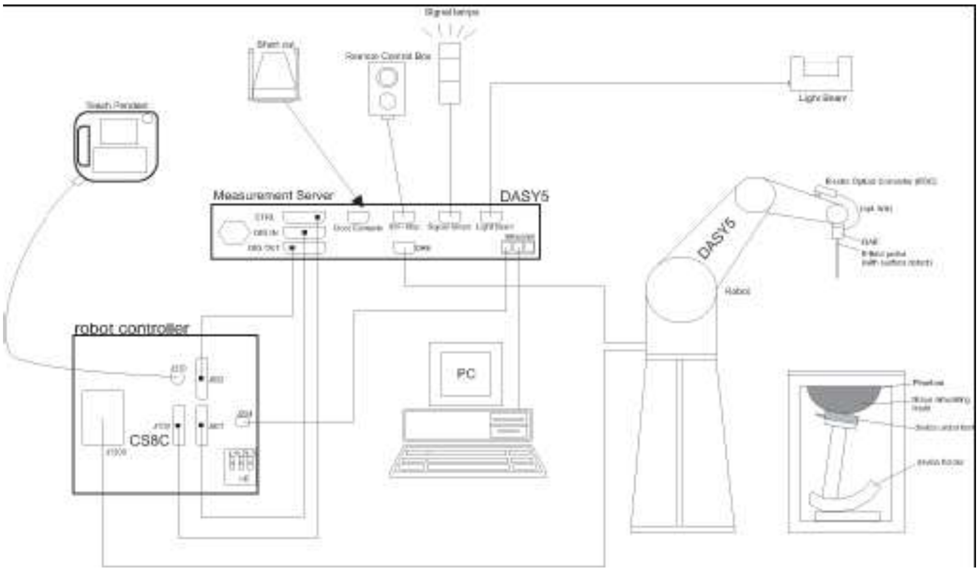
Maximum value of SAR (measured) = 21.6 W/kg



ANNEX C. SAR Measurement Setup

C.1. Measurement Set-up

The DASY5 system for performing compliance tests is illustrated above graphically. This system consists of the following items:



Picture C.1 SAR Lab Test Measurement Set-up

- A standard high precision 6-axis robot (Stäubli TX=RX family) 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 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.

C.2. DASY5 E-field Probe System

The SAR measurements were conducted with the dosimetric probe designed in the classical triangular configuration and optimized for dosimetric evaluation. The probe is constructed using the thick film technique; with printed resistive lines on ceramic substrates. The probe is equipped with an optical multifiber line ending at the front of the probe tip. It is connected to the EOC box on the robot arm and provides an automatic detection of the phantom surface. Half of the fibers are connected to a pulsed infrared transmitter, the other half to a synchronized receiver. As the probe approaches the surface, the reflection from the surface produces a coupling from the transmitting to the receiving fibers. This reflection increases first during the approach, reaches maximum and then decreases. If the probe is flatly touching the surface, the coupling is zero. The distance of the coupling maximum to the surface is independent of the surface reflectivity and largely independent of the surface to probe angle. The DASY5 software reads the reflection durning a software approach and looks for the maximum using 2^{nd}ord curve fitting. The approach is stopped at reaching the maximum.

Probe Specifications:

Model: **EX3DV4**

Frequency Range: **700MHz — 6GHz**

Calibration: **In head and body simulating tissue at Frequencies from 835 up to 6000MHz**

Linearity: **± 0.2 dB(700MHz — 6.0GHz)**

Dynamic Range: 10 mW/kg — 100W/kg

Probe Length: **330 mm**

Probe Tip Length: **20 mm**

Body Diameter: **12 mm**

Tip Diameter: **2.5 mm**

Tip-Center: **1 mm**

Application:SAR Dosimetry Testing

Compliance tests of mobile phones

Dosimetry in strong gradient fields

Picture C.2 Near-field Probe

Picture C.3 E-field Probe

C.3. E-field Probe Calibration

Each E-Probe/Probe Amplifier combination has unique calibration parameters. A TEM cell calibration procedure is conducted to determine the proper amplifier settings to enter in the probe parameters. The amplifier settings are determined for a given frequency by subjecting the probe to a known E-field density (1 mW/cm^2) using an RF Signal generator, TEM cell, and RF Power Meter.

The free space E-field from amplified probe outputs is determined in a test chamber. This calibration can be performed in a TEM cell if the frequency is below 1 GHz and inn a waveguide or other methodologies above 1 GHz for free space. For the free space calibration, the probe is placed in the volumetric center of the cavity and at the proper orientation with the field. The probe is then rotated 360 degrees until the three channels show the maximum reading. The power density readings equates to 1 mW/ cm^2.

E-field temperature correlation calibration is performed in a flat phantom filled with the appropriate simulated brain tissue. The E-field in the medium correlates with the temperature rise in the dielectric medium. For temperature correlation calibration a RF transparent thermistor-based temperature probe is used in conjunction with the E-field probe.

$$SAR = C\frac{\Delta T}{\Delta t}$$

Where:

Δt = Exposure time (30 seconds),

C = Heat capacity of tissue (brain or muscle),

ΔT = Temperature increase due to RF exposure.

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

Where:

σ = Simulated tissue conductivity,

ρ = Tissue density (kg/m^3).

C.4. Other Test Equipment

C.4.1. Data Acquisition Electronics(DAE)

The data acquisition electronics consist of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD-converter and a command decoder with a control logic unit. Transmission to the measurement server is accomplished through an optical downlink for data and status information, as well as an optical uplink for commands and the clock.

The mechanical probe mounting device includes two different sensor systems for frontal and sideways probe contacts. They are used for mechanical surface detection and probe collision detection.

The input impedance of the DAE is 200 MOhm; the inputs are symmetrical and floating. Common mode rejection is above 80 dB.

PictureC.4: DAE

C.4.2. Robot

The SPEAG DASY system uses the high precision robots (DASY5: RX90L) type from Stäubli SA (France). For the 6-axis controller system, the robot controller version from Stäubli is used. The Stäubli robot series have many features that are important for our application:

- High precision (repeatability 0.02mm)
- High reliability (industrial design)
- Low maintenance costs (virtually maintenance free due to direct drive gears; no belt drives)
- Jerk-free straight movements (brushless synchron motors; no stepper motors)
- Low ELF interference (motor control fields shielded via the closed metallic construction shields)

Picture C.5 DASY5

C.4.3. Measurement Server

The Measurement server is based on a PC/104 CPU broad with CPU (DASY5: 400 MHz, Intel Celeron), chipdisk (DASY5: 128MB), RAM (DASY5: 128MB). The necessary circuits for communication with the DAE electronic box, as well as the 16 bit AD converter system for optical detection and digital I/O interface are contained on the DASY I/O broad, which is directly connected to the PC/104 bus of the CPU broad.

The measurement server performs all real-time data evaluation of field measurements and surface detection, controls robot movements and handles safety operation. The PC operating system cannot interfere with these time critical processes. All connections are supervised by a watchdog, and disconnection of any of the cables to the measurement server will automatically disarm the robot and disable all program-controlled robot movements. Furthermore, the measurement server is equipped with an expansion port which is reserved for future applications. Please note that this expansion port does not have a standardized pinout, and therefore only devices provided by SPEAG can be connected. Devices from any other supplier could seriously damage the measurement server.

Picture C.6 Server for DASY 5

C.4.4. Device Holder for Phantom

The SAR in the phantom is approximately inversely proportional to the square of the distance between the source and the liquid surface. For a source at 5mm distance, a positioning uncertainty of ±0.5mm would produce a SAR uncertainty of ±20%. Accurate device positioning is therefore crucial for accurate and repeatable measurements. The positions in which the devices must be measured are defined by the standards.

The DASY device holder is designed to cope with the different positions given in the standard. It has two scales for device rotation (with respect to the body axis) and device inclination (with respect to the line between the ear reference points). The rotation centers for both scales is the ear reference point (ERP). Thus the device needs no

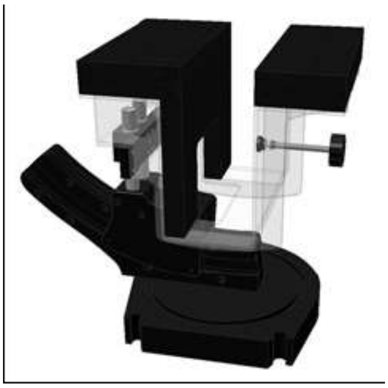
repositioning when changing the angles.

The DASY device holder is constructed of low-loss POM material having the following dielectric parameters: relative permittivity ε =3 and loss tangent δ =0.02. The amount of dielectric material has been reduced in the closest vicinity of the device, since measurements have suggested that the influence of the clamp on the test results could thus be lowered.

<Laptop Extension Kit>

The extension is lightweight and made of POM, acrylic glass and foam. It fits easily on the upper part of the Mounting Device in place of the phone positioner. The extension is fully compatible with the Twin-SAM and ELI phantoms.

Picture C.7: Device Holder



Picture C.8: Laptop Extension Kit

C.4.5. Phantom

Phantom for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30 MHz to 6 GHz. ELI4 is fully compatible with the latest draft of the standard IEC 62209 Part II and all known tissue simulating liquids. ELI4 has been optimized regarding its performance and can be integrated into our standard phantom tables. A cover prevents evaporation of the liquid. Reference markings on the phantom allow installation of the complete setup, including all predefined phantom positions and measurement grids, by teaching three points. The phantom is supported by software version DASY5.5 and higher and is compatible with all SPEAG dosimetric probes and dipoles

Shell Thickness: 2 ± 0. 2 mm

Filling Volume: Approx. 25 liters

Dimensions: 600 x 400 x 500 mm (H x L x W)

Available: Special

Picture C.9: ELI4 Phantom

ANNEX D. Position of the wireless device in relation to the phantom

D.1. Tablet mode considerations

This EUT was tested in four different positions. They are rear side of tablet, Edge 1, Edge 2, Edge 4.In these positions, the surface of EUT is touching with phantom 0cm.

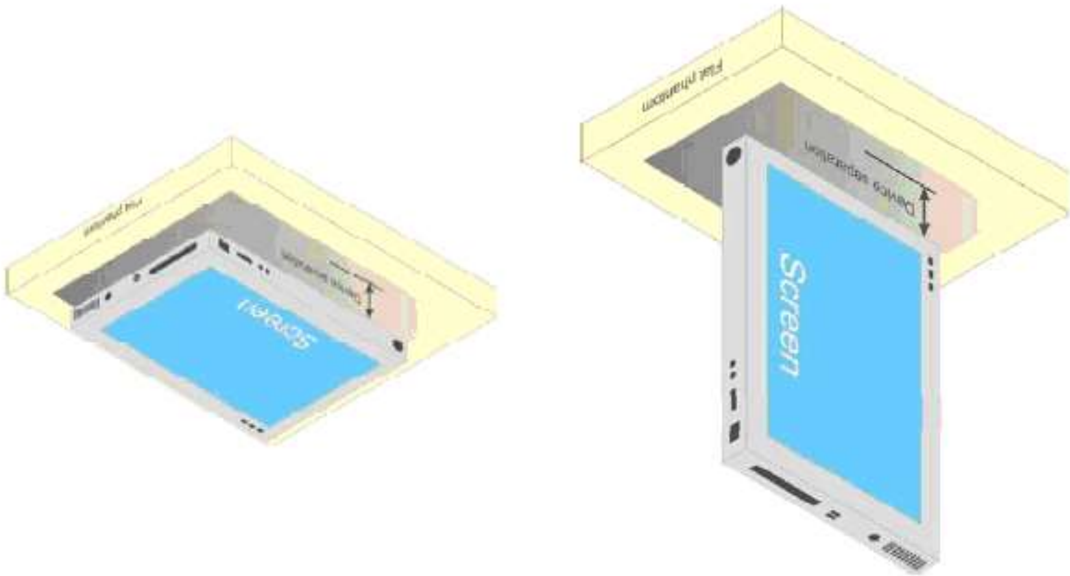
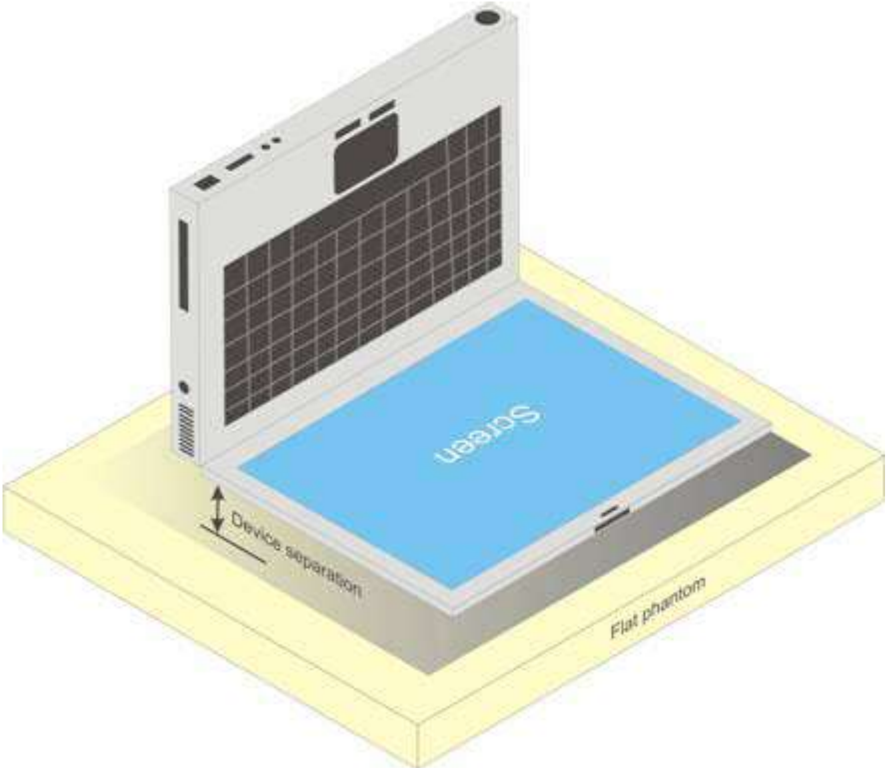


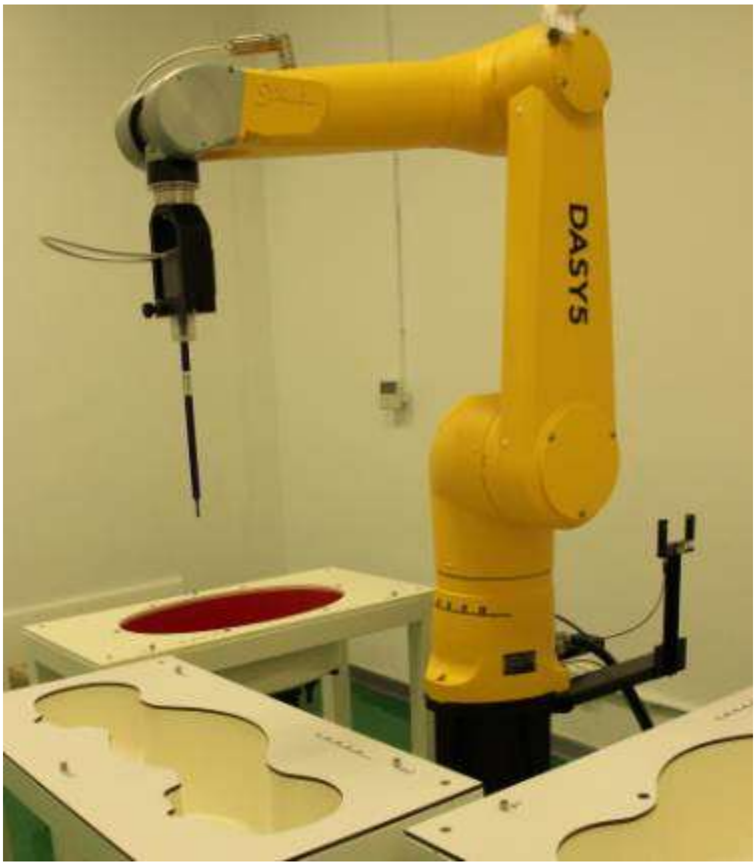
Fig Illustration for Lap-touching Position

D.2. Notebook bystanders mode considerations

The integrated antenna(s) are located in the back side of the display screen, the back side shall be facing towards the flat phantom at a distance is 20 mm.



D.4. DUT Setup Photos



Picture D.6 DSY5 system Set-up

Note:

The photos of test sample and test positions show in additional document.

ANNEX E. Equivalent Media Recipes

The liquid used for the frequency range of 800-3000 MHz consisted of water, sugar, salt, preventol, glycol monobutyl and Cellulose. The liquid has been previously proven to be suited for worst-case. The Table E.1 shows the detail solution. It’s satisfying the latest tissue dielectric parameters requirements proposed by the IEEE 1528 and IEC 62209.

Table E.1: Composition of the Tissue Equivalent Matter

Frequency (MHz)	835 Head	835 Body	1900 Head	1900 Body	2450 Head	2450 Body
Ingredients (% by weight)						
Water	41.45	52.5	55.242	69.91	58.79	72.60
Sugar	56.0	45.0	\	\	\	\
Salt	1.45	1.4	0.306	0.13	0.06	0.18
Preventol	0.1	0.1	\	\	\	\
Cellulose	1.0	1.0	\	\	\	\
Glycol Monobutyl	\	\	44.452	29.96	41.15	27.22
Dielectric Parameters Target Value	ε=41.5 σ=0.90	ε=55.2 σ=0.97	ε=40.0 σ=1.40	ε=53.3 σ=1.52	ε=39.2 σ=1.80	ε=52.7 σ=1.95

Table E.2: Simulating Liquids for 5 GHz, Manufactured by SPEAG

Ingredients	**(% by weight)**
Water	78
Mineral oil	11
Emulsifiers	9
Additives and Salt	2

ANNEX F. System Validation

The SAR system must be validated against its performance specifications before it is deployed. When SAR probes, system components or software are changed, upgraded or recalibrated, these must bevalidated with the SAR system(s) that operates with such components.

Table F.1: System Validation Part 1

System No.	Probe SN.	Liquid name	Validation date	Frequency point	**Permittivity ε**	**Conductivity σ (S/m)**
1	3798	Body 2450MHz	2017-11-28	2402MHz	53.03	1.922
2	3798	Body 2450MHz	2017-11-28	2441 MHz	52.905	1.967
3	3798	Body 2450MHz	2017-11-28	2480 MHz	52.773	2.014
4	3798	Body 2450MHz	2017-11-28	2412 MHz	53.003	1.933
5	3798	Body 2450MHz	2017-11-28	2437 MHz	52.916	1.963
6	3798	Body 2450MHz	2017-11-28	2462 MHz	52.834	1.992
7	3798	Body 5000MHz	2017-11-26	5260 MHz	49.975	5.257
8	3798	Body 5000MHz	2017-11-26	5260 MHz	49.935	5.285
9	3798	Body 5000MHz	2017-11-26	5280 MHz	49.906	5.31
10	3798	Body 5000MHz	2017-11-26	5300 MHz	49.876	5.335
11	3798	Body 5000MHz	2017-11-27	5320 MHz	49.514	5.592
12	3798	Body 5000MHz	2017-11-27	5500 MHz	49.373	5.697
13	3798	Body 5000MHz	2017-11-27	5580 MHz	49.231	5.79
14	3798	Body 5000MHz	2017-11-27	5640 MHz	49.042	5.911
15	3798	Body 5000MHz	2017-11-27	5720 MHz	48.991	5.948
16	3798	Body 5000MHz	2017-11-27	5745 MHz	48.921	6.006
17	3798	Body 5000MHz	2017-11-27	5785 MHz	48.82	6.066

Table F.2: System Validation Part 2

CW Validation	Sensitivity	PASS	PASS
	Probe linearity	PASS	PASS
	Probe Isotropy	PASS	PASS
Mod Validation	MOD.type	GMSK	GMSK
	MOD.type	OFDM	OFDM

	Duty factor	PASS	PASS
	PAR	PASS	PASS

ANNEX G. Probe and DAE Calibration Certificate

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

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

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

Accreditation No.: SCS 0108

Client CCS-CN (Auden)

Certificate No: DAE4-1245_Jul17

CALIBRATION CERTIFICATE

Object	DAE4 - SD 000 D04 BM - SN: 1245
Calibration procedure(s)	QA CAL-06.v29 Calibration procedure for the data acquisition electronics (DAE)
Calibration date:	July 20, 2017

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	09-Sep-16 (No:19065)	Sep-17
Secondary Standards	**ID #**	**Check Date (in house)**	**Scheduled Check**
Auto DAE Calibration Unit	SE UWS 053 AA 1001	05-Jan-17 (in house check)	In house check: Jan-18
Calibrator Box V2.1	SE UMS 006 AA 1002	05-Jan-17 (in house check)	In house check: Jan-18

	Name	Function	Signature
Calibrated by:	Dominique Steffen	Laboratory Technician	[signature]
Approved by:	Sven Kühn	Deputy Manager	i.V. [signature]

Issued: July 20, 2017

Certificate No: DAE4-1245_Jul17 Page 1 of 5

Schmid & Partner Engineering AG

s p e a g

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info@speag.com, http://www.speag.com

IMPORTANT NOTICE

USAGE OF THE DAE 4

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

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

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

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

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

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

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

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

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

Schmid & Partner Engineering

TN_BR040315AD DAE4.doc 11.12.2009

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	405.976 ± 0.02% (k=2)	404.686 ± 0.02% (k=2)	405.823 ± 0.02% (k=2)
Low Range	4.00366 ± 1.50% (k=2)	3.98422 ± 1.50% (k=2)	4.02584 ± 1.50% (k=2)

Connector Angle

Connector Angle to be used in DASY system	29.5 ° ± 1 °

Certificate No: DAE4-1245_Jul17 Page 3 of 5

Appendix (Additional assessments outside the scope of SCS0108)

1. DC Voltage Linearity

High Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	199993.34	-3.72	-0.00
Channel X	+ Input	20003.85	2.28	0.01
Channel X	- Input	-19999.42	1.70	-0.01
Channel Y	+ Input	199991.78	-5.46	-0.00
Channel Y	+ Input	20002.02	0.30	0.00
Channel Y	- Input	-20000.26	0.73	-0.00
Channel Z	+ Input	199994.14	-3.09	-0.00
Channel Z	+ Input	20000.91	-0.57	-0.00
Channel Z	- Input	-20000.60	0.62	-0.00

Low Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	2001.47	0.29	0.01
Channel X	+ Input	202.09	0.42	0.21
Channel X	- Input	-197.15	1.05	-0.53
Channel Y	+ Input	2001.46	0.25	0.01
Channel Y	+ Input	201.47	-0.31	-0.16
Channel Y	- Input	-198.81	-0.64	0.32
Channel Z	+ Input	2001.57	0.41	0.02
Channel Z	+ Input	201.30	-0.28	-0.14
Channel Z	- Input	-200.23	-1.77	0.89

2. Common mode sensitivity

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

	Common mode Input Voltage (mV)	High Range Average Reading (μV)	Low Range Average Reading (μV)
Channel X	200	-7.70	-8.90
	- 200	9.15	8.20
Channel Y	200	-7.22	-7.45
	- 200	6.67	6.20
Channel Z	200	-5.90	-6.14
	- 200	3.91	4.23

3. Channel separation

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

	Input Voltage (mV)	Channel X (μV)	Channel Y (μV)	Channel Z (μV)
Channel X	200	-	3.52	-3.41
Channel Y	200	9.08	-	4.30
Channel Z	200	9.44	7.03	-

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	15881	17340
Channel Y	16455	16613
Channel Z	15938	16783

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	0.84	-0.23	1.93	0.43
Channel Y	-0.31	-1.54	0.85	0.43
Channel Z	-0.47	-1.92	0.51	0.47

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

Certificate No: DAE4-1245_Jul17 Page 5 of 5

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

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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Client **CCS-CN (Auden)**

Certificate No: **EX3-3798_Jul17**

CALIBRATION CERTIFICATE

Object	EX3DV4 - SN:3798
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:	July 26, 2017

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 NRP	SN: 104778	04-Apr-17 (No. 217-02521/02522)	Apr-18
Power sensor NRP-Z91	SN: 103244	04-Apr-17 (No. 217-02521)	Apr-18
Power sensor NRP-Z91	SN: 103245	04-Apr-17 (No. 217-02525)	Apr-18
Reference 20 dB Attenuator	SN: S5277 (20x)	07-Apr-17 (No. 217-02528)	Apr-18
Reference Probe ES3DV2	SN: 3013	31-Dec-16 (No. ES3-3013_Dec16)	Dec-17
DAE4	SN: 660	7-Dec-16 (No. DAE4-660_Dec16)	Dec-17
Secondary Standards	ID	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB41293874	06-Apr-16 (in house check Jun-16)	In house check: Jun-18
Power sensor E4412A	SN: MY41498087	06-Apr-16 (in house check Jun-16)	In house check: Jun-18
Power sensor E4412A	SN: 000110210	06-Apr-16 (in house check Jun-16)	In house check: Jun-18
RF generator HP 8648C	SN: US3642U01700	04-Aug-99 (in house check Jun-16)	In house check: Jun-18
Network Analyzer HP 8753E	SN: US37390585	18-Oct-01 (in house check Oct-16)	In house check: Oct-17

	Name	Function	Signature
Calibrated by:	Michael Weber	Laboratory Technician	M.Weber
Approved by:	Katja Pokovic	Technical Manager	

Issued: July 26, 2017

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

Certificate No: EX3-3798_Jul17 Page 1 of 11

Calibration Laboratory of
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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

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, ", "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
c) IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Methods Applied and Interpretation of Parameters:

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

Certificate No: EX3-3798_Jul17 Page 2 of 11

Probe EX3DV4

SN:3798

Manufactured: April 5, 2011
Calibrated: July 26, 2017

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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3798

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu V/(V/m)^2$)[A]	0.53	0.49	0.57	± 10.1 %
DCP (mV)[B]	100.5	98.4	99.6	

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	150.9	±2.7 %
		Y	0.0	0.0	1.0		149.9	
		Z	0.0	0.0	1.0		140.8	

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

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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3798

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unc (k=2)
835	41.5	0.90	9.65	9.65	9.65	0.46	0.86	± 12.0 %
900	41.5	0.97	9.39	9.39	9.39	0.48	0.83	± 12.0 %
1810	40.0	1.40	8.15	8.15	8.15	0.36	0.80	± 12.0 %
1900	40.0	1.40	8.07	8.07	8.07	0.32	0.85	± 12.0 %
2450	39.2	1.80	7.40	7.40	7.40	0.32	0.90	± 12.0 %
5200	36.0	4.66	5.20	5.20	5.20	0.35	1.80	± 13.1 %
5300	35.9	4.76	4.94	4.94	4.94	0.35	1.80	± 13.1 %
5500	35.6	4.96	4.78	4.78	4.78	0.40	1.80	± 13.1 %
5600	35.5	5.07	4.72	4.72	4.72	0.40	1.80	± 13.1 %
5800	35.3	5.27	4.79	4.79	4.79	0.40	1.80	± 13.1 %

[C] Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.

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

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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3798

Calibration Parameter Determined in Body Tissue Simulating Media

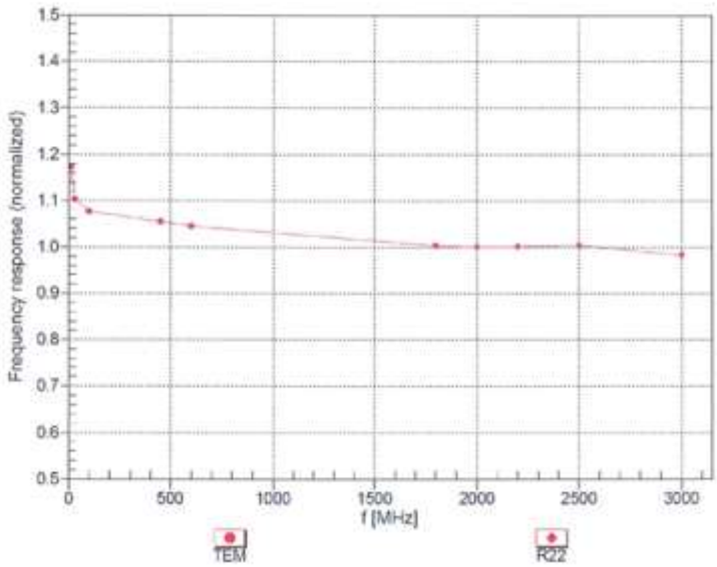
f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unc (k=2)
835	55.2	0.97	9.35	9.35	9.35	0.55	0.80	± 12.0 %
900	55.0	1.05	9.17	9.17	9.17	0.42	0.86	± 12.0 %
1810	53.3	1.52	7.81	7.81	7.81	0.44	0.80	± 12.0 %
1900	53.3	1.52	7.75	7.75	7.75	0.45	0.80	± 12.0 %
2450	52.7	1.95	7.32	7.32	7.32	0.43	0.92	± 12.0 %
5200	49.0	5.30	4.81	4.81	4.81	0.35	1.90	± 13.1 %
5300	48.9	5.42	4.67	4.67	4.67	0.35	1.90	± 13.1 %
5500	48.6	5.65	4.26	4.26	4.26	0.40	1.90	± 13.1 %
5600	48.5	5.77	4.18	4.18	4.18	0.40	1.90	± 13.1 %
5800	48.2	6.00	4.45	4.45	4.45	0.40	1.90	± 13.1 %

[C] Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.
[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.
[G] Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

EX3DV4– SN:3798 July 26, 2017

Frequency Response of E-Field

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



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

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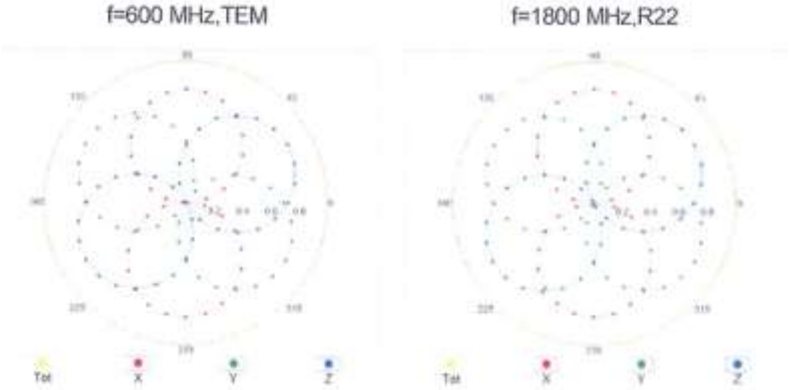
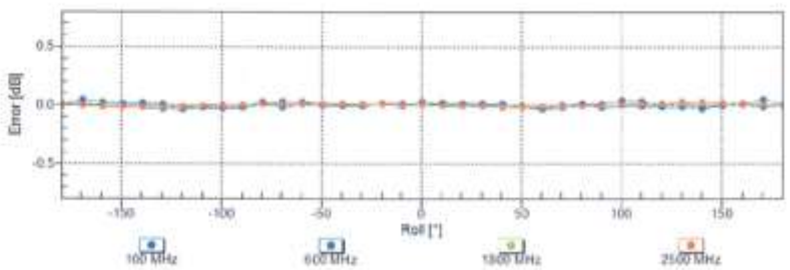
Receiving Pattern (ϕ), $\vartheta = 0°$





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

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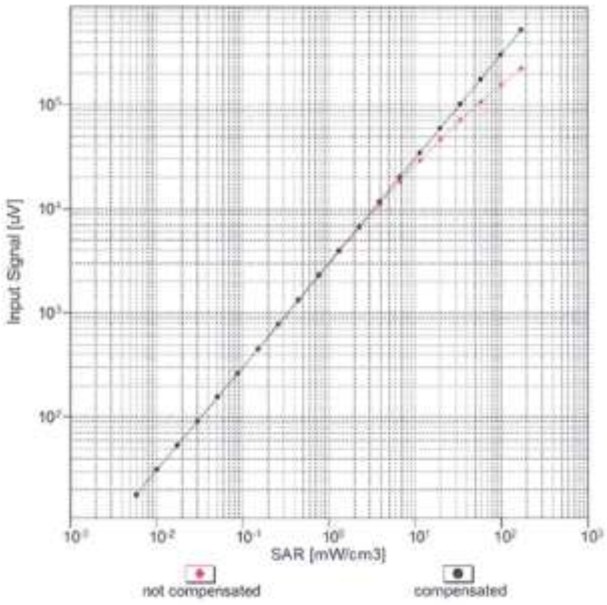
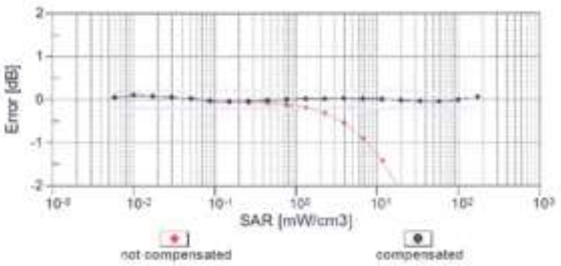
Dynamic Range f(SAR_{head})
(TEM cell , f_{eval}= 1900 MHz)

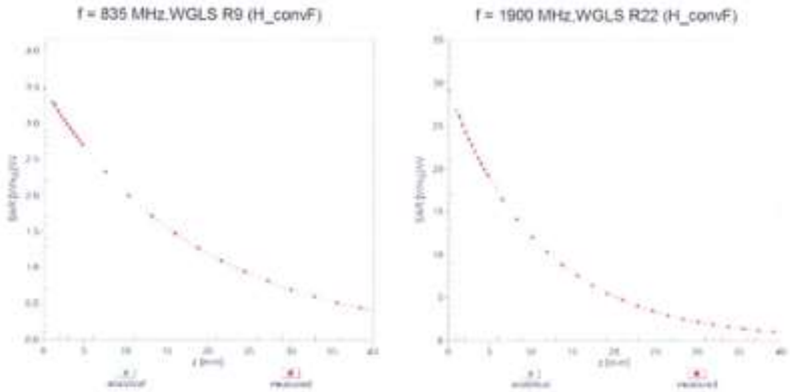




Uncertainty of Linearity Assessment: ± 0.6% (k=2)

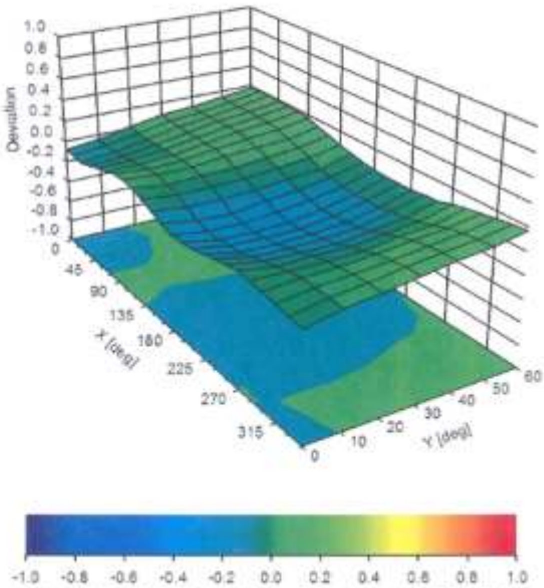
EX3DV4– SN:3798 July 26, 2017

Conversion Factor Assessment



Deviation from Isotropy in Liquid

Error (ϕ, ϑ), f = 900 MHz



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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3798

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	-39.5
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	1.4 mm

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CALIBRATION No. L0570

Client ECIT Certificate No: Z15-97171

CALIBRATION CERTIFICATE

Object	D2450V2 - SN: 858
Calibration Procedure(s)	FD-Z11-2-003-01 Calibration Procedures for dipole validation kits
Calibration date:	October 30, 2015

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
Power Meter NRP2	101919	01-Jul-15 (CTTL, No.J15X04256)	Jun-16
Power sensor NRP-Z91	101547	01-Jul-15 (CTTL, No.J15X04256)	Jun-16
Reference Probe EX3DV4	SN 3617	26-Aug-15(SPEAG,No.EX3-3617_Aug15)	Aug-16
DAE4	SN 777	26-Aug-15(SPEAG,No.DAE4-777_Aug15)	Aug-16
Secondary Standards	**ID #**	**Cal Date(Calibrated by, Certificate No.)**	**Scheduled Calibration**
Signal Generator E4438C	MY49071430	02-Feb-15 (CTTL, No.J15X00729)	Feb-16
Network Analyzer E5071C	MY46110673	03-Feb-15 (CTTL, No.J15X00728)	Feb-16

	Name	Function	Signature
Calibrated by:	Zhao Jing	SAR Test Engineer	[signature]
Reviewed by:	Qi Dianyuan	SAR Project Leader	[signature]
Approved by:	Lu Bingsong	Deputy Director of the laboratory	[signature]

Issued: November 6, 2015

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Glossary:

TSL	tissue simulating liquid
ConvF	sensitivity in TSL / NORMx,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 300MHz to 3GHz)", February 2005

c) KDB865664, 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%.

Certificate No: Z15-97171 Page 2 of 8

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Measurement Conditions

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

DASY Version	DASY52	52.8.8.1222
Extrapolation	Advanced Extrapolation	
Phantom	Triple Flat Phantom 5.1C	
Distance Dipole Center - TSL	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	40.1 ± 6 %	1.82 mho/m ± 6 %
Head TSL temperature change during test	<1.0 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.2 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	**52.9 mW /g ± 20.8 % (k=2)**
SAR averaged over 10 cm^3 (10 g) of Head TSL	Condition	
SAR measured	250 mW input power	6.06 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	**24.3 mW /g ± 20.4 % (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	53.1 ± 6 %	1.94 mho/m ± 6 %
Body TSL temperature change during test	<1.0 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	13.2 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	**53.1 mW /g ± 20.8 % (k=2)**
SAR averaged over 10 cm^3 (10 g) of Body TSL	Condition	
SAR measured	250 mW input power	6.16 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	**24.7 mW /g ± 20.4 % (k=2)**

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Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	53.2Ω+ 6.03jΩ
Return Loss	- 23.6dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	49.9Ω+ 7.39jΩ
Return Loss	- 22.6dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.261 ns

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

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.
No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

Additional EUT Data

Manufactured by	SPEAG

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DASY5 Validation Report for Head TSL Date: 10.30.2015

Test Laboratory: CTTL, Beijing, China

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 858

Communication System: UID 0, CW; Frequency: 2450 MHz; Duty Cycle: 1:1

Medium parameters used: f = 2450 MHz; σ = 1.816 S/m; εr = 40.14; ρ = 1000 kg/m3

Phantom section: Left Section

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

DASY5 Configuration:

- Probe: EX3DV4 - SN3617; ConvF(7.24, 7.24, 7.24); Calibrated: 8/26/2015;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn777; Calibrated: 8/26/2015
- Phantom: Triple Flat Phantom 5.1C; Type: QD 000 P51 CA; Serial: 1161/1
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

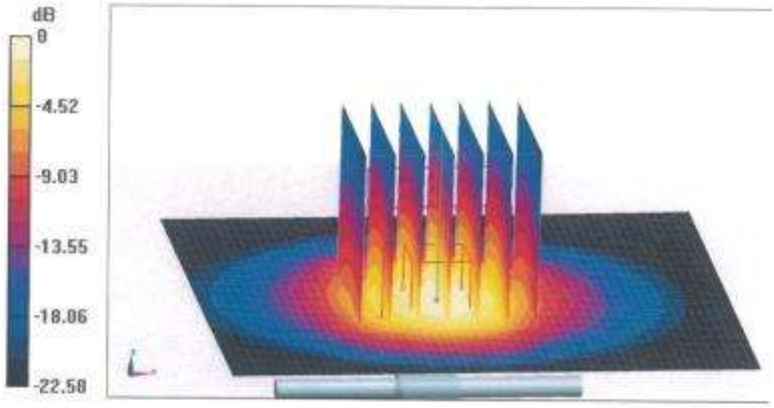
Dipole Calibration/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 106.3 V/m; Power Drift = -0.04 dB

Peak SAR (extrapolated) = 27.5 W/kg

SAR(1 g) = 13.2 W/kg; SAR(10 g) = 6.06 W/kg

Maximum value of SAR (measured) = 20.3 W/kg



0 dB = 20.3 W/kg = 13.07 dBW/kg

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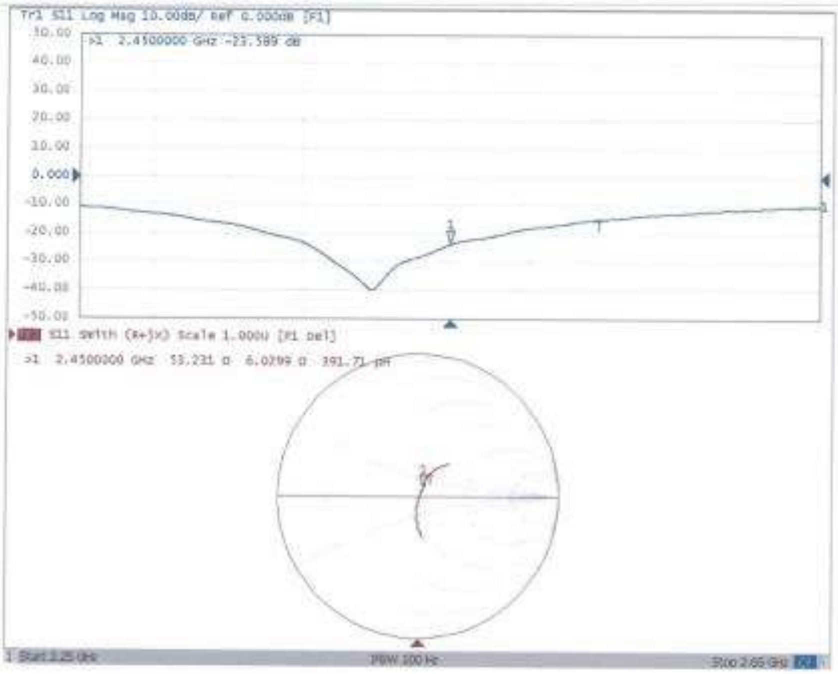
Impedance Measurement Plot for Head TSL



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E-mail: cttl@chinattl.com Http://www.chinattl.cn

DASY5 Validation Report for Body TSL Date: 10.30.2015

Test Laboratory: CTTL, Beijing, China

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 858

Communication System: UID 0, CW; Frequency: 2450 MHz; Duty Cycle: 1:1

Medium parameters used: f = 2450 MHz; σ = 1.936 S/m; ε_r = 53.11; ρ = 1000 kg/m^3

Phantom section: Center Section

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

DASY5 Configuration:

- Probe: EX3DV4 - SN3617; ConvF(7.35, 7.35, 7.35); Calibrated: 8/26/2015;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn777; Calibrated: 8/26/2015
- Phantom: Triple Flat Phantom 5.1C; Type: QD 000 P51 CA; Serial: 1161/1
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

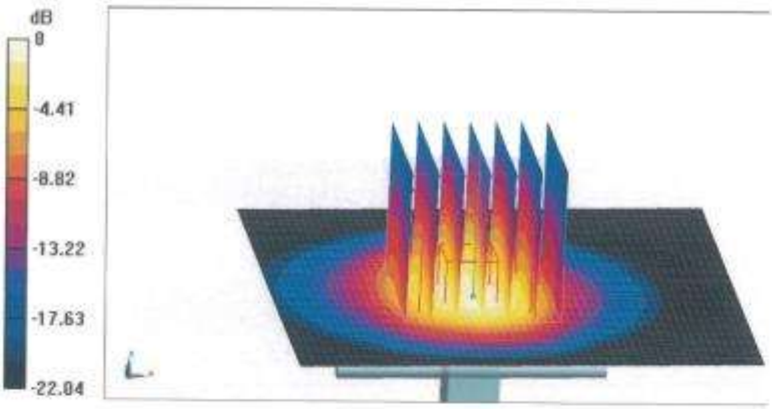
Dipole Calibration/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 99.98 V/m; Power Drift = 0.07 dB

Peak SAR (extrapolated) = 26.6 W/kg

SAR(1 g) = 13.2 W/kg; SAR(10 g) = 6.16 W/kg

Maximum value of SAR (measured) = 19.8 W/kg



0 dB = 19.8 W/kg = 12.97 dBW/kg

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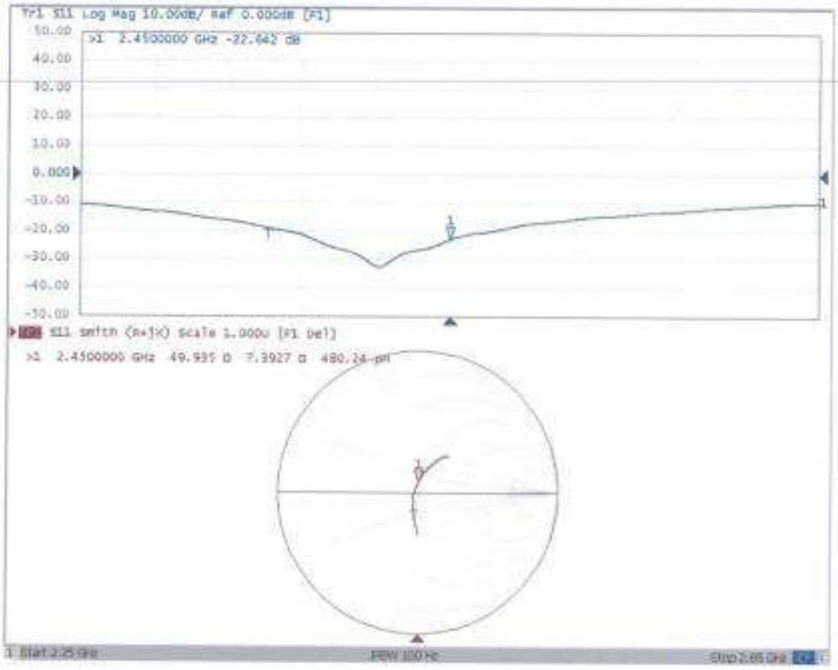
Impedance Measurement Plot for Body TSL



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D2450V2,Serial No.858 Extended Dipole Calibrations

Per IEEE Std 1528-2013,the dipole should have a return loss better than -20dB at the test frequency to reduce uncertainty in the power measurement.
Per KDB 865664 D01,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.

Justification of the extended calibration

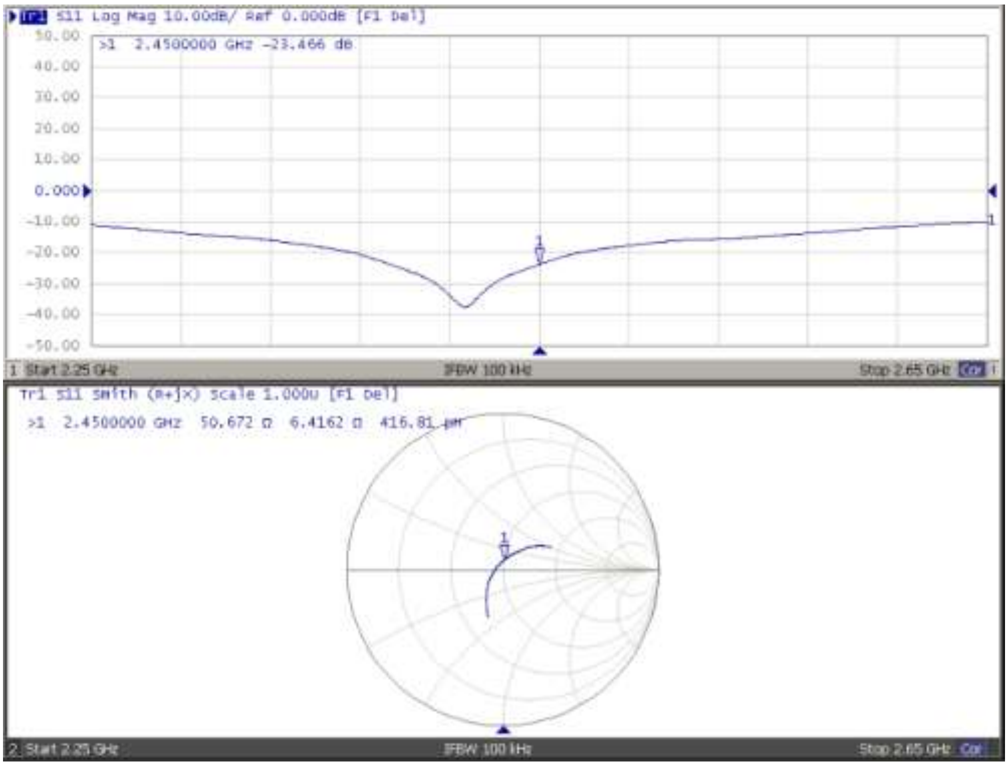
D2450V2 Serial No.858						
2450 Head						
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
10.30.2015	-23.589	--	53.231	--	6.0299	--
10.29.2016	-23.466	0.52	50.672	2.559	6.4162	0.386

D2450V2 Serial No.858						
2450 Body						
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
10.30.2015	-22.642	--	49.935	--	7.3927	--
10.29.2016	-23.075	1.91	46.903	3.032	5.6814	1.711

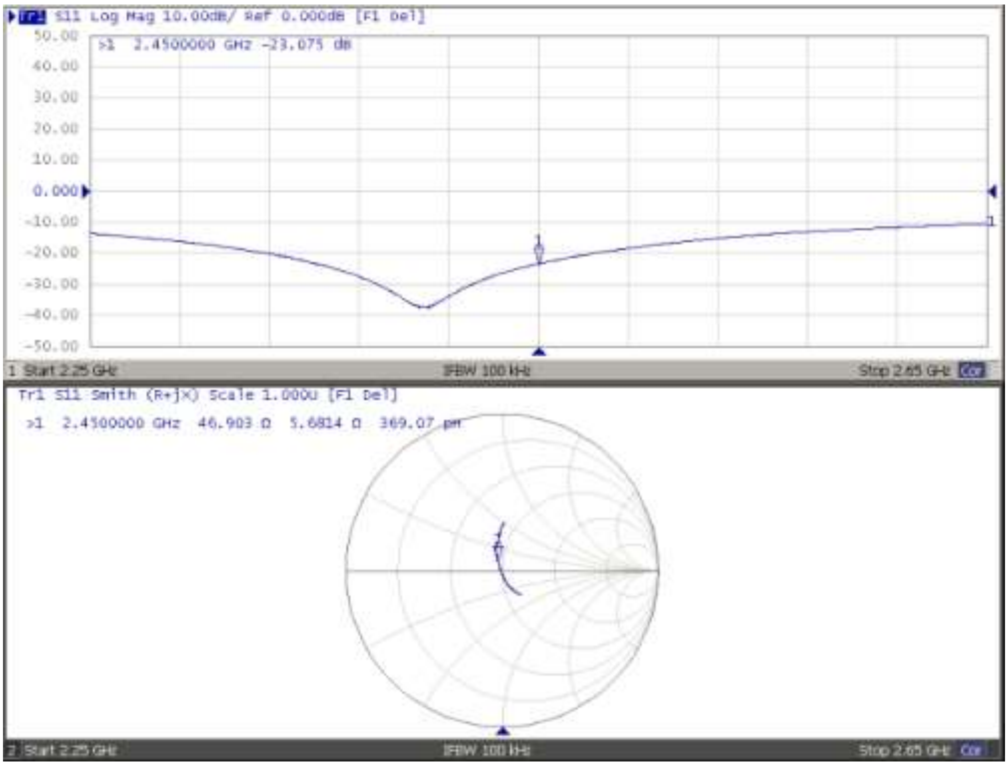
The return loss is < -20dB, within 20% of prior calibration; the impedance is within 5 ohm of prior calibration. Therefore the verification result should support extended calibration.

Dipole Verification Data D2450V2 Serial No.858

2450MHz-Head



2450MHz - Body



Justification of the extended calibration

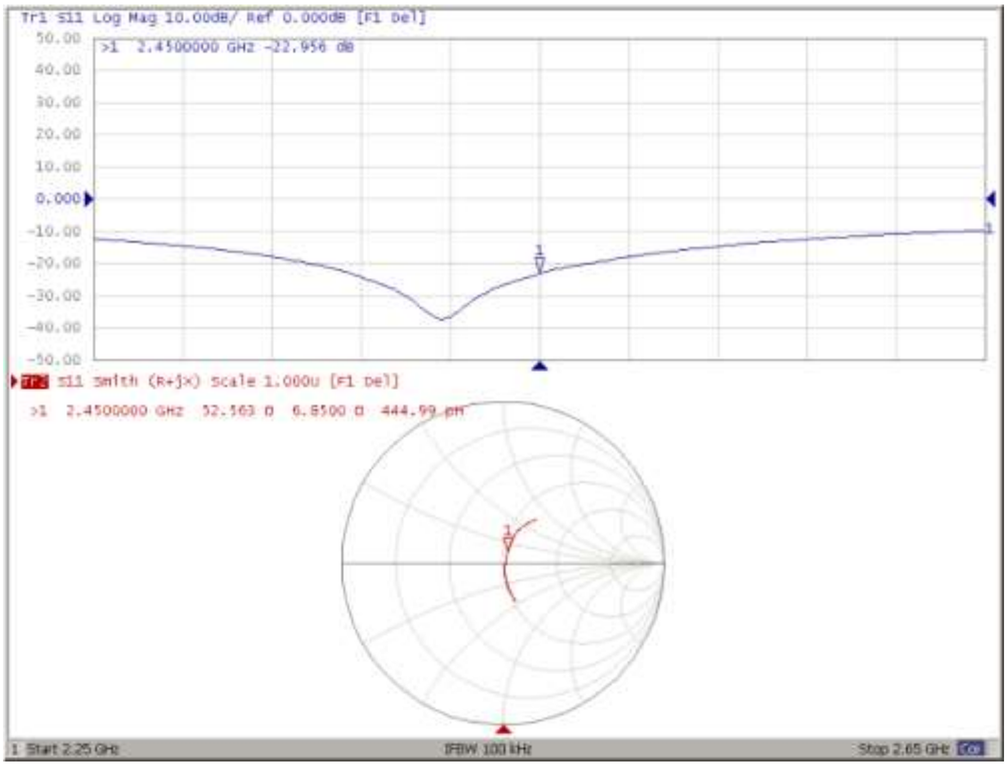
D2450V2 Serial No.858						
2450 Head						
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
10.30.2015	-23.589	--	53.231	--	6.0299	--
10.29.2016	-23.466	0.52	50.672	2.559	6.4162	0.386
10.27.2017	-22.956	2.17	52.563	1.891	6.85	0.434

D2450V2 Serial No.858						
2450 Body						
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
10.30.2015	-22.642	--	49.935	--	7.3927	--
10.29.2016	-23.075	1.91	46.903	3.032	5.6814	1.711
10.27.2017	-22.414	2.86	50.694	3.791	7.616	1.935

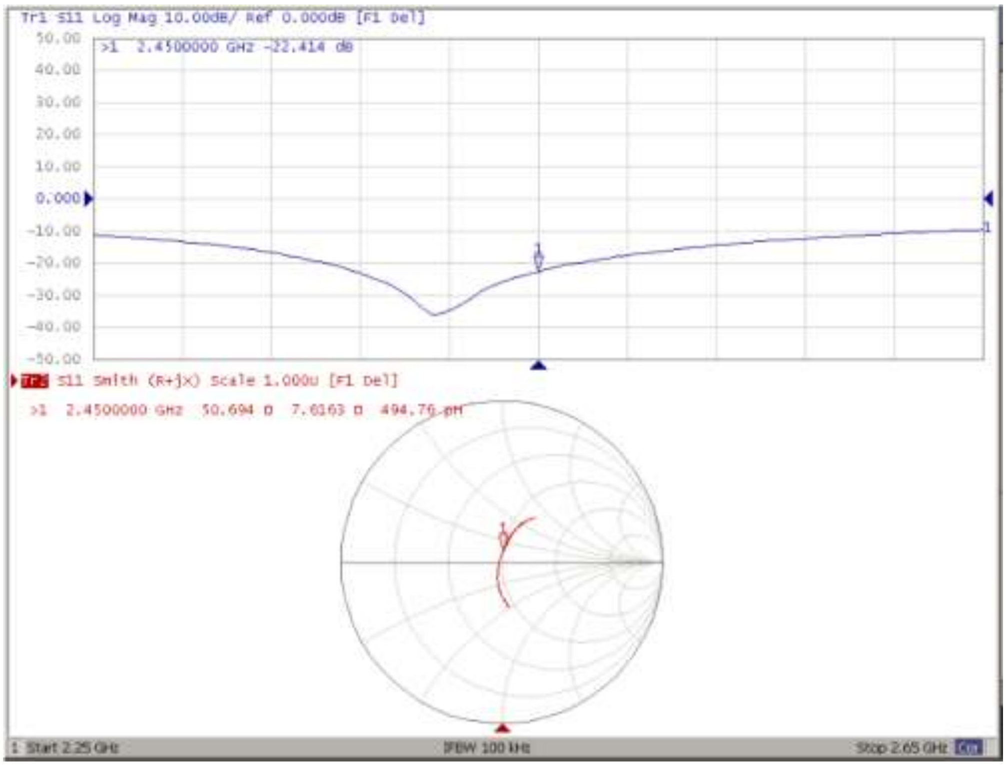
The return loss is < -20dB, within 20% of prior calibration; the impedance is within 5 ohm of prior calibration. Therefore the verification result should support extended calibration.

Dipole Verification Data D2450V2 Serial No.858

2450MHz-Head



2450MHz – Body



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Accreditation No.: **SCS 0108**

Client **TMC-CQ (Auden)**

Certificate No: **D5GHzV2-1121_Mar17**

CALIBRATION CERTIFICATE

Object	D5GHzV2 - SN:1121
Calibration procedure(s)	QA CAL-22.v2 Calibration procedure for dipole validation kits between 3-6 GHz
Calibration date:	March 24, 2017

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 NRP	SN: 104778	06-Apr-16 (No. 217-02288/02289)	Apr-17
Power sensor NRP-Z91	SN: 103244	06-Apr-16 (No. 217-02288)	Apr-17
Power sensor NRP-Z91	SN: 103245	06-Apr-16 (No. 217-02289)	Apr-17
Reference 20 dB Attenuator	SN: 5058 (20k)	05-Apr-16 (No. 217-02292)	Apr-17
Type-N mismatch combination	SN: 5047.2 / 06327	05-Apr-16 (No. 217-02295)	Apr-17
Reference Probe EX3DV4	SN: 3503	31-Dec-16 (No. EX3-3503_Dec16)	Dec-17
DAE4	SN: 601	04-Jan-17 (No. DAE4-601_Jan17)	Jan-18
DAE4	SN: 660	07-Dec-16 (No. DAE4-601_Dec16)	Dec-17

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter EPM-442A	SN: GB37480704	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-16)	In house check: Oct-18
Network Analyzer HP 8753E	SN: US37390585	18-Oct-01 (in house check Oct-16)	In house check: Oct-17

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

Issued: March 24, 2017

Certificate No: D5GHzV2-1121_Mar17 Page 1 of 16

Calibration Laboratory of
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Accreditation No.: **SCS 0108**

Glossary:

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

Calibration is Performed According to the Following Standards:

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 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
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%.

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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 5500 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	35.0 ± 6 %	4.52 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	7.91 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**78.6 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.26 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**22.4 W/kg ± 19.5 % (k=2)**

Certificate No: D5GHzV2-1121_Mar17 Page 3 of 16

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	34.8 ± 6 %	4.62 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5300 MHz

SAR averaged over 1 cm³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.40 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**83.4 W / kg ± 19.9 % (k=2)**

SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.41 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**23.9 W/kg ± 19.5 % (k=2)**

Head TSL parameters at 5500 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.6	4.96 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.5 ± 6 %	4.81 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5500 MHz

SAR averaged over 1 cm³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.40 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**83.4 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.38 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**23.6 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	34.4 ± 6 %	4.92 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	8.42 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**83.6 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.40 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**23.8 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	34.1 ± 6 %	5.13 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	8.10 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**80.3 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.30 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**22.8 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	48.2 ± 6 %	5.45 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	7.25 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**72.3 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.03 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**20.2 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	48.0 ± 6 %	5.58 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	7.66 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**76.4 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.14 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**21.3 W/kg ± 19.5 % (k=2)**

Body TSL parameters at 5500 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.6	5.65 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	47.7 ± 6 %	5.85 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5500 MHz

SAR averaged over 1 cm³ (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	8.02 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**80.0 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm³ (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.23 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**22.2 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	47.5 ± 6 %	5.99 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5600 MHz

SAR averaged over 1 cm³ (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.96 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**79.4 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm³ (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.24 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**22.3 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	47.2 ± 6 %	6.28 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	7.66 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**76.4 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.13 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**21.2 W/kg ± 19.5 % (k=2)**

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Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL at 5200 MHz

Impedance, transformed to feed point	50.0 Ω - 7.1 jΩ
Return Loss	- 23.0 dB

Antenna Parameters with Head TSL at 5300 MHz

Impedance, transformed to feed point	48.9 Ω - 4.0 jΩ
Return Loss	- 27.6 dB

Antenna Parameters with Head TSL at 5500 MHz

Impedance, transformed to feed point	51.8 Ω - 2.3 jΩ
Return Loss	- 30.9 dB

Antenna Parameters with Head TSL at 5600 MHz

Impedance, transformed to feed point	54.0 Ω - 0.4 jΩ
Return Loss	- 28.2 dB

Antenna Parameters with Head TSL at 5800 MHz

Impedance, transformed to feed point	55.8 Ω - 2.3 jΩ
Return Loss	- 24.6 dB

Antenna Parameters with Body TSL at 5200 MHz

Impedance, transformed to feed point	50.5 Ω - 6.2 jΩ
Return Loss	- 24.2 dB

Antenna Parameters with Body TSL at 5300 MHz

Impedance, transformed to feed point	49.6 Ω - 3.0 jΩ
Return Loss	- 30.4 dB

Antenna Parameters with Body TSL at 5500 MHz

Impedance, transformed to feed point	52.3 Ω - 0.6 jΩ
Return Loss	- 32.7 dB

Antenna Parameters with Body TSL at 5600 MHz

Impedance, transformed to feed point	56.3 Ω + 1.6 jΩ
Return Loss	- 24.3 dB

Antenna Parameters with Body TSL at 5800 MHz

Impedance, transformed to feed point	56.4 Ω - 1.8 jΩ
Return Loss	- 24.1 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.203 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: 17.03.2017

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1121

Communication System: UID 0 - CW; Frequency: 5200 MHz, Frequency: 5300 MHz, Frequency: 5500 MHz, Frequency: 5600 MHz, Frequency: 5800 MHz
Medium parameters used: f = 5200 MHz; σ = 4.52 S/m; ε_r = 35; ρ = 1000 kg/m^3 ,
Medium parameters used: f = 5300 MHz; σ = 4.62 S/m; ε_r = 34.8; ρ = 1000 kg/m^3 ,
Medium parameters used: f = 5500 MHz; σ = 4.81 S/m; ε_r = 34.5; ρ = 1000 kg/m^3 ,
Medium parameters used: f = 5600 MHz; σ = 4.92 S/m; ε_r = 34.4; ρ = 1000 kg/m^3 ,
Medium parameters used: f = 5800 MHz; σ = 5.13 S/m; ε_r = 34.1; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(5.76, 5.76, 5.76); Calibrated: 31.12.2016, ConvF(5.35, 5.35, 5.35); Calibrated: 31.12.2016, ConvF(5.2, 5.2, 5.2); Calibrated: 31.12.2016, ConvF(5.09, 5.09, 5.09); Calibrated: 31.12.2016, ConvF(5.01, 5.01, 5.01); Calibrated: 31.12.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.01.2017
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

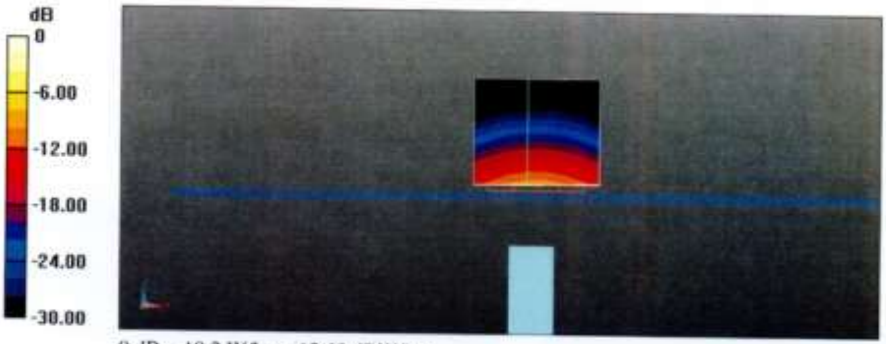
Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5200 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 72.36 V/m; Power Drift = -0.03 dB
Peak SAR (extrapolated) = 29.1 W/kg
SAR(1 g) = 7.91 W/kg; SAR(10 g) = 2.26 W/kg
Maximum value of SAR (measured) = 18.2 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 = 74.73 V/m; Power Drift = -0.07 dB
Peak SAR (extrapolated) = 30.4 W/kg
SAR(1 g) = 8.4 W/kg; SAR(10 g) = 2.41 W/kg
Maximum value of SAR (measured) = 19.5 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5500 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 73.51 V/m; Power Drift = -0.06 dB
Peak SAR (extrapolated) = 33.2 W/kg
SAR(1 g) = 8.4 W/kg; SAR(10 g) = 2.38 W/kg
Maximum value of SAR (measured) = 19.9 W/kg

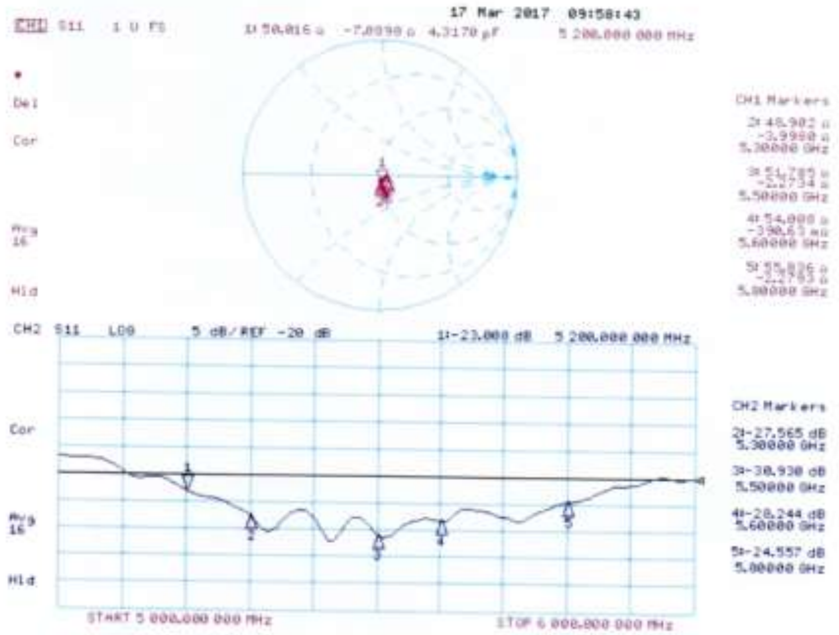
Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 73.79 V/m; Power Drift = -0.09 dB
Peak SAR (extrapolated) = 33.3 W/kg
SAR(1 g) = 8.42 W/kg; SAR(10 g) = 2.4 W/kg
Maximum value of SAR (measured) = 20.1 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 = 71.38 V/m; Power Drift = -0.05 dB
Peak SAR (extrapolated) = 33.4 W/kg
SAR(1 g) = 8.1 W/kg; SAR(10 g) = 2.3 W/kg
Maximum value of SAR (measured) = 19.6 W/kg



0 dB = 18.2 W/kg = 12.60 dBW/kg

Impedance Measurement Plot for Head TSL



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DASY5 Validation Report for Body TSL

Date: 24.03.2017

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1121

Communication System: UID 0 - CW; Frequency: 5200 MHz, Frequency: 5300 MHz, Frequency: 5500 MHz, Frequency: 5600 MHz, Frequency: 5800 MHz
Medium parameters used: f = 5200 MHz; σ = 5.45 S/m; ε_r = 48.2; ρ = 1000 kg/m^3 ,
Medium parameters used: f = 5300 MHz; σ = 5.58 S/m; ε_r = 48; ρ = 1000 kg/m^3 ,
Medium parameters used: f = 5500 MHz; σ = 5.85 S/m; ε_r = 47.7; ρ = 1000 kg/m^3 ,
Medium parameters used: f = 5600 MHz; σ = 5.99 S/m; ε_r = 47.5; ρ = 1000 kg/m^3 ,
Medium parameters used: f = 5800 MHz; σ = 6.28 S/m; ε_r = 47.2; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(5.29, 5.29, 5.29); Calibrated: 31.12.2016, ConvF(5.04, 5.04, 5.04); Calibrated: 31.12.2016, ConvF(4.62, 4.62, 4.62); Calibrated: 31.12.2016, ConvF(4.57, 4.57, 4.57); Calibrated: 31.12.2016, ConvF(4.48, 4.48, 4.48); Calibrated: 31.12.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn660; Calibrated: 07.12.2016
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

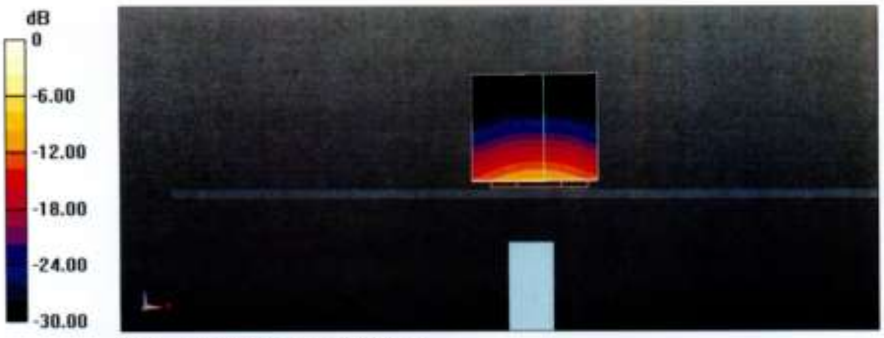
Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5200 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 65.01 V/m; Power Drift = -0.05 dB
Peak SAR (extrapolated) = 28.2 W/kg
SAR(1 g) = 7.25 W/kg; SAR(10 g) = 2.03 W/kg
Maximum value of SAR (measured) = 17.1 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 = 66.88 V/m; Power Drift = -0.06 dB
Peak SAR (extrapolated) = 30.4 W/kg
SAR(1 g) = 7.66 W/kg; SAR(10 g) = 2.14 W/kg
Maximum value of SAR (measured) = 18.3 W/kg

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5500 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 67.16 V/m; Power Drift = -0.06 dB
Peak SAR (extrapolated) = 33.8 W/kg
SAR(1 g) = 8.02 W/kg; SAR(10 g) = 2.23 W/kg
Maximum value of SAR (measured) = 19.4 W/kg

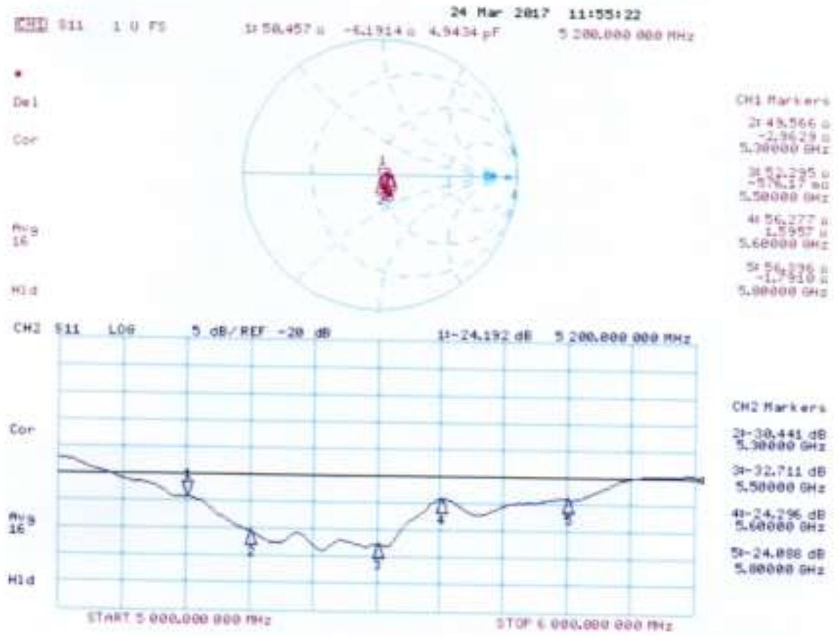
Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 66.44 V/m; Power Drift = -0.09 dB
Peak SAR (extrapolated) = 33.9 W/kg
SAR(1 g) = 7.96 W/kg; SAR(10 g) = 2.24 W/kg
Maximum value of SAR (measured) = 19.1 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 = 64.47 V/m; Power Drift = -0.07 dB
Peak SAR (extrapolated) = 34.8 W/kg
SAR(1 g) = 7.66 W/kg; SAR(10 g) = 2.13 W/kg
Maximum value of SAR (measured) = 19.1 W/kg



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

Impedance Measurement Plot for Body TSL



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June 26, 2013

3) The SPEAG-TMC agreement includes specific protocols identified in the following to ensure the quality of calibration services provided by TMC under this SPEAG-TMC Dual-Logo calibration agreement are equivalent to the calibration services provided by SPEAG. TMC shall, upon request, provide copies of documentation to the FCC to substantiate program implementation.
   a) The Inter-laboratory Calibration Evaluation (ILCE) stated in the TMC QA protocol shall be performed between SPEAG and TMC at least once every 12 months. The ILCE acceptance criteria defined in the TMC QA protocol shall be satisfied for the TMC, SPEAG and FCC agreements to remain valid.
   b) Check of Calibration Certificate (CCC) shall be performed by SPEAG for all calibrations performed by TMC. Written confirmation from SPEAG is required for TMC to issue calibration certificates under the SPEAG-TMC Dual-Logo calibration program. Quarterly reports for all calibrations performed by TMC under the program are also issued by SPEAG.
   c) The calibration equipment and measurement system used by TMC shall be verified before each calibration service according to the specific reference SAR probes, dipoles, and DAE calibrated by SPEAG. The results shall be reproducible and within the defined acceptance criteria specified in the TMC QA protocol before each actual calibration can commence. TMC shall maintain records of the measurement and calibration system verification results for all calibrations.
   d) Quality Check of Calibration (QCC) certificates shall be performed by SPEAG at least once every 12 months. SPEAG shall visit TMC facilities to verify the laboratory, equipment, applied procedures and plausibility of randomly selected certificates.
4) A copy of this document, to be updated annually, shall be provided to TMC clients that accept calibration services according to the SPEAG-TMC Dual-Logo calibration program, which should be presented to a TCB (*Telecommunication Certification Body*), to facilitate FCC equipment approval.
5) TMC shall address any questions raised by its clients or TCBs relating to the SPEAG-TMC Dual-Logo calibration program and inform the FCC and SPEAG of any critical issues.

Change Note: Revised on June 26 to clarify the applicability of PMR and Bundled probe calibrations according to the requirements of KDB 865664.

2

ANNEX H. Accreditation Certificate

Accredited Laboratory

A2LA has accredited

EAST CHINA INSTITUTE OF TELECOMMUNICATIONS

Shanghai, People's Republic of China

for technical competence in the field of

Electrical Testing

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005 *General requirements for the competence of testing and calibration laboratories*. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (*refer to joint ISO-ILAC-IAF Communiqué dated 8 January 2009*).

Presented this 15th day of March 2017.

President and CEO
For the Accreditation Council
Certificate Number 3682.01
Valid to February 28, 2019

For the tests to which this accreditation applies, please refer to the laboratory's Electrical Scope of Accreditation.

**********END OF REPORT**********