



# SAR TEST REPORT

**Test Report No. : 11624584H-F**

**Applicant : VAIO Corporation**

**Type of Equipment : Digital Music Score**

**Model No. : DMS-W1**

**FCC ID : 2AL4MDMS-W1**


**Test regulation : FCC47CFR 2.1093**

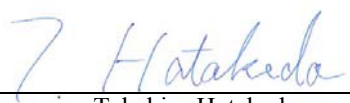
**Test Result : Complied**

**Reported SAR(1g) Value      The highest reported SAR(1g)**  
Body : 1.13 W/kg

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2. The results in this report apply only to the sample tested.
3. This sample tested is in compliance with the limits of the above regulation.
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5. This test report must not be used by the customer to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the Federal Government.
6. This test report covers SAR technical requirements. It does not cover administrative issues such as Manual or non-SAR test related Requirements. (if applicable)

**Date of test:** June 26 and 27, 2017

**Representative test engineer:**   
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**Approved by :**   
Takahiro Hatakeda  
Leader  
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## REVISION HISTORY

**Original Test Report No.: 11624584H-F**

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<b>CONTENTS</b>	<b>PAGE</b>
<b>SECTION1: Customer information.....</b>	<b>4</b>
<b>SECTION2: Equipment under test (E.U.T.).....</b>	<b>4</b>
2.1 Identification of E.U.T.....	4
2.2 Product description .....	4
<b>SECTION3: Test standard information.....</b>	<b>5</b>
3.1 Test Specification .....	5
3.2 Procedure .....	5
3.3 Exposure limit.....	6
3.4 Test Location .....	6
<b>SECTION4: Test result.....</b>	<b>7</b>
4.1 Stand-alone SAR result.....	7
4.2 Simultaneous transmission SAR result.....	7
<b>SECTION5: Tune-up tolerance information and software information.....</b>	<b>8</b>
<b>SECTION6: RF Exposure Conditions (Test Configurations).....</b>	<b>9</b>
6.1 Summary of the distance between antenna and surface of EUT .....	9
6.2 SAR test exclusion considerations according to KDB447498 D01 .....	9
<b>SECTION7: Description of the Body setup .....</b>	<b>11</b>
7.1 Procedure for SAR test position determination .....	11
7.2 Test position for Body setup .....	11
<b>SECTION8: Description of the operating mode.....</b>	<b>12</b>
8.1 Output Power and SAR test required.....	12
<b>SECTION9: Test surrounding .....</b>	<b>14</b>
9.1 Measurement uncertainty .....	14
<b>SECTION10: Parameter Check.....</b>	<b>16</b>
10.1 For SAR system check.....	17
10.2 For SAR measurement.....	18
<b>SECTION11: System Check confirmation.....</b>	<b>19</b>
<b>SECTION12: Measured and Reported (Scaled) SAR Results .....</b>	<b>20</b>
12.1 WLAN 2.4GHz Band .....	21
12.2 WLAN 5.3GHz Band .....	22
12.3 WLAN 5.5GHz Band .....	22
12.4 Repeated measurement .....	22
<b>SECTION13: Test instruments .....</b>	<b>23</b>
<b>APPENDIX 1 : System Check.....</b>	<b>24</b>
<b>APPENDIX 2 : SAR Measurement data .....</b>	<b>30</b>
<b>APPENDIX 3 : System specifications.....</b>	<b>46</b>
<b>APPENDIX 4 : Photographs of test setup.....</b>	<b>154</b>

## **SECTION1: Customer information**

Company Name : VAIO Corporation  
Address : 5432 Toyoshina, Azumino-shi  
City : Nagano  
Country : Japan  
Zip code : 399-8282  
Contact Person : Masami Ogawa  
Telephone Number : +81-263-50-7391  
Facsimile Number : +81-263-50-7015

## **SECTION2: Equipment under test (E.U.T.)**

### **2.1 Identification of E.U.T.**

#### **<Information of the EUT>**

Type of Equipment : Digital Music Score  
Model No. : DMS-W1  
Serial No. : 19  
Rating : Li-ion battery  
M/N: VJ8BPS54  
DC 3.7 V  
1720 mAh 6.4 Wh  
Receipt Date of Sample : April 17, 2017  
Country of Mass-production : Japan  
Condition of EUT : Production prototype  
(Not for Sale: This sample is equivalent to mass-produced items.)  
Modification of EUT : No Modification by the test lab

### **2.2 Product description**

Model: DMS-W1 (referred to as the EUT in this report) is a Digital Music Score.

#### **General Specification**

Clock frequency(ies) in the system : 996 MHz, 630 MHz, 650 MHz, 528 MHz, 480 MHz, 26 MHz, 24 MHz,  
32.768 KHz  
Operating Temperature : 5 deg. C - +35 deg. C

#### **Radio Specification**

Radio Type : Transceiver  
Power Supply (inner) : DC 1.8 V / DC 3.15 V

	IEEE802.11b	IEEE802.11g/n (20 M band)	IEEE802.11a/n (20 M band)	IEEE802.11n (40 M band)	Bluetooth Ver.3.0 with EDR function
Frequency of operation	2412 MHz -2462 MHz	2412 MHz -2462 MHz	5180 MHz - 5240 MHz 5260 MHz - 5320 MHz 5500 MHz - 5580 MHz 5660 MHz - 5700 MHz *	5190 MHz -5230 MHz 5270 MHz -5310 MHz 5510 MHz -5550 MHz 5670 MHz *	2402 MHz -2480MHz
Type of modulation	DSSS (CCK, DQPSK, DBPSK)	OFDM-CCK (64QAM, 16QAM, QPSK, BPSK)	OFDM (64QAM, 16QAM, QPSK, BPSK)		FHSS (GFSK, $\pi/4$ -DQPSK, 8-DPSK)
Channel spacing	5 MHz		20MHz	40MHz	1MHz
Antenna type	monopole pattern antenna				
Antenna Gain	0.3 dBi		2.6 dBi		0.3 dBi
Antenna Connector type	Surface mounted coaxial connector				Surface mounted coaxial connector

\* 5600MHz-5650MHz is not used.

\*Wireless LAN and Bluetooth do not transmit simultaneously.

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### **SECTION3: Test standard information**

#### **3.1 Test Specification**

Title : **FCC47CFR 2.1093**

Radiofrequency radiation exposure evaluation: portable devices.

: **IEEE Std 1528-2013:**

IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques.

: **Published RF exposure KDB procedures**

- ☒ **KDB447498D01(v06)** RF Exposure Procedures and Equipment Authorization Policies for Mobile and Portable Devices
- ☐ **KDB447498D02(v02r01)** SAR Measurement Procedures for USB Dongle Transmitters
- ☐ **KDB648474D04(v01r03)** SAR Evaluation Considerations for Wireless Handsets
- ☐ **KDB941225D01(v03r01)** 3G SAR Measurement Procedures
- ☐ **KDB941225D05(v02r05)** SAR Evaluation Considerations for LTE Devices
- ☐ **KDB941225D06(v02r01)** SAR Evaluation Procedures for Portable Devices with Wireless Router Capabilities (Hot Spot SAR)
- ☐ **KDB941225D07(v01r02)** SAR Evaluation Procedures for UMPC Mini-Tablet Devices
- ☒ **KDB616217D04(v01r02)** SAR Evaluation Considerations for Laptop, Notebook, Netbook and Tablet Computers
- ☒ **KDB865664D01(v01r04)** SAR Measurement Requirements for 100MHz to 6 GHz
- ☒ **KDB248227D01(v02r02)** SAR Guidance for 802.11(Wi-Fi) Transmitters

#### **Reference**

[1]SPEAG uncertainty document (AN 15-7/AN19-17) for DASY 5 System from SPEAG (Schmid & Partner Engineering AG).

#### **3.2 Procedure**

Transmitter	WLAN and Bluetooth
Test Procedure	Published RF exposure KDB procedures
Category	FCC47CFR 2.1093
Note: UL Japan, Inc. 's SAR Work Procedures 13-EM-W0429 and 13-EM-W0430	

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### **3.3 Exposure limit**

(A) Limits for Occupational/Controlled Exposure (W/kg)

Spatial Average (averaged over the whole body)	Spatial Peak (averaged over any 1g of tissue)	Spatial Peak (hands/wrists/feet/ankles averaged over 10g)
0.4	8.0	20.0

(B) Limits for General population/Uncontrolled Exposure (W/kg)

Spatial Average (averaged over the whole body)	Spatial Peak (averaged over any 1g of tissue)	Spatial Peak (hands/wrists/feet/ankles averaged over 10g)
0.08	1.6	4.0

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

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

<p><b>NOTE:GENERAL POPULATION/UNCONTROLLED EXPOSURE SPATIAL PEAK(averaged over any 1g of tissue) LIMIT 1.6 W/kg</b></p>
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### **3.4 Test Location**

\*Shielded room for SAR testings

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## **SECTION4: Test result**

### **4.1 Stand-alone SAR result**

#### **Reported SAR**

Measured SAR is scaled to the maximum tune-up tolerance limit by the following formulas.

Reported SAR= Measured SAR [W/kg] · Scaled factor

Maximum tune-up tolerance limit is by the specification from a customer.

\* Scaled factor = Maximum tune-up tolerance limit [mW] / Measured power [mW]

#### **Body SAR**

Mode	Frequency	Measured power (Burst power) [dBm]	Maximum tune-up tolerance limit [dBm]	Measured power (Burst power) [mW]	Maximum tune-up tolerance limit [mW]	Measured SAR [W/kg]	Scaled factor	Reported SAR [W/kg]
WLAN11b	2437MHz	14.41	15.50	27.61	35.48	0.881	1.285	1.132
WLAN11n40	5310MHz	9.33	10.00	8.57	10.00	0.762	1.167	0.889
WLAN11n40	5550MHz	9.34	10.00	8.59	10.00	0.900	1.164	1.048

#### **Note(s):**

The sample used by the SAR test is not more than 2 dB lower than the maximum tune-up tolerance limit. That is, measured power is included the tune-up tolerance range.

For WLAN Maximum tune-up tolerance limit is defined by a customer as duty100%.

### **4.2 Simultaneous transmission SAR result**

Wireless LAN and Bluetooth do not transmit simultaneously.

## **SECTION5: Tune-up tolerance information and software information**

Maximum tune-up tolerance limit

Mode	Band	Maximum tune-up tolerance limit [dBm]	Maximum tune-up tolerance limit [mW]
WLAN 11b	2.4GHz	15.50	35.48
WLAN 11g	2.4GHz	11.50	14.13
WLAN 11n20	2.4GHz	11.50	14.13
Bluetooth DH5 BDR	2.4GHz	1.20	1.32
Bluetooth 3DH5 EDR	2.4GHz	1.20	1.32
WLAN 11a	5GHz	10.00	10.00
WLAN 11n20	5GHz	10.00	10.00
WLAN 11n40	5GHz	10.00	10.00

For WLAN Maximum tune-up tolerance limit is defined by a customer as duty100%.

<b>Software setting</b>
<p>*The power value of the EUT was set for testing as follows  (setting value might be different from product specification value)</p> <p>Power settings: WLAN: 11b: 15 dBm, 11g/11n: 11 dBm  WLAN: W52/W53: 8 dBm, W56: 9 dBm</p> <p>Software: MAC F/W version : Rev. 8.9.0.0.48  PHY F/W version : Rev. 8.2.0.0.232 (FDSP: 1.162)</p> <p>*This setting of software is the worst case.  Any conditions under the normal use do not exceed the condition of setting.  In addition, end users cannot change the settings of the output power of the product.</p>



## SECTION6: RF Exposure Conditions (Test Configurations)

### 6.1 Summary of the distance between antenna and surface of EUT

Test position	Distance
Front	1.7 mm *1
Rear	2.2 mm
Rear tilt	2.3 mm
Right	146.2 mm
Left	79.7 mm
Top	4.5 mm
Bottom	301.2 mm

\*1 This is not a typical use scenario  
Details are shown in appendix 4

### 6.2 SAR test exclusion considerations according to KDB447498 D01

The following is based on KDB447498D01.

1) The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances  $\leq 50$  mm are determined by:

$[(\text{max. power of channel, including tune-up tolerance, mW})/(\text{min. test separation distance, mm})] \cdot [\sqrt{f}(\text{GHz})] \leq 3.0$   
for 1-g SAR and  $\leq 7.5$  for 10-g extremity SAR

- The upper frequency of the frequency band was used in order to calculate standalone SAR test exclusion considerations.
- Power and distance are rounded to the nearest mW and mm before calculation
- The result is rounded to one decimal place for comparison
- The test exclusions are applicable only when the minimum test separation distance is  $\leq 50$  mm and for transmission frequencies between 100 MHz and 6 GHz. When the minimum test separation distance is  $< 5$  mm, a distance of 5 mm is applied to determine SAR test exclusion. When the separation of antenna to EUT's surfaces and edges are  $\leq 50$  mm, the separation distance used for the SAR exclusion calculations is 5 mm.
- "N/A" displayed on below exclusion calculation means not applicable this formula since distance between antenna and surface is  $> 50$  mm.

When the calculated threshold value by a numerical formula above-mentioned in the following table is 3.0 or less, SAR test is excluded.

SAR exclusion calculations for antenna  $< 50$  mm from the user

Antenna	Tx Interface	Frequency (MHz)	Output Power		Calculated Threshold Value						
			dBm	mW	Front	Rear	Rear tilt	Right	Left	Top	Bottom
Fixed	11b	2462	15.50	35	N/A	11.1 -MEASURE-	11.1 -MEASURE-	N/A	N/A	11.1 -MEASURE-	N/A
Fixed	11g	2462	11.50	14	N/A	4.4 -MEASURE-	4.4 -MEASURE-	N/A	N/A	4.4 -MEASURE-	N/A
Fixed	11n20	2462	11.50	14	N/A	4.4 -MEASURE-	4.4 -MEASURE-	N/A	N/A	4.4 -MEASURE-	N/A
Fixed	BT	2480	1.20	1	N/A	0.4 -EXEMPT-	0.4 -EXEMPT-	N/A	N/A	0.4 -EXEMPT-	N/A
Fixed	11a	5700	10.00	10	N/A	4.8 -MEASURE-	4.8 -MEASURE-	N/A	N/A	4.8 -MEASURE-	N/A
Fixed	11n20	5700	10.00	10	N/A	4.8 -MEASURE-	4.8 -MEASURE-	N/A	N/A	4.8 -MEASURE-	N/A
Fixed	11n40	5700	10.00	10	N/A	4.8 -MEASURE-	4.8 -MEASURE-	N/A	N/A	4.8 -MEASURE-	N/A

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2) 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)  $[(3 \cdot 50) / (\sqrt{f(\text{GHz})})] + (\text{test separation distance} - 50 \text{ mm}) \cdot (f(\text{MHz}) / 150)] \text{ mW}$  at > 100 MHz and ≤ 1500 MHz  
b)  $[(3 \cdot 50) / (\sqrt{f(\text{GHz})})] + (\text{test separation distance} - 50 \text{ mm}) \cdot 10] \text{ mW}$  at > 1500 MHz and ≤ 6 GHz

1. The upper frequency of the frequency band was used in order to calculate standalone SAR test exclusion considerations.
2. Power and distance are rounded to the nearest mW and mm before calculation
3. “N/A” displayed on below exclusion calculation means not applicable this formula since distance between antenna and surface is < 50 mm.

When output power is less than the calculated threshold value by a numerical formula above-mentioned in the following table, SAR test is excluded.

#### SAR exclusion calculations for antenna >50mm from the user

Antenna	Tx Interface	Frequency (MHz)	Output Power		Calculated Threshold Value						
			dBm	mW	Front	Rear	Rear tilt	Right	Left	Top	Bottom
Fixed	11b	2462	15.50	35	N/A	N/A	N/A	1057.6 mW -EXEMPT-	392.6 mW -EXEMPT-	N/A	2607.6 mW -EXEMPT-
Fixed	11g	2462	11.50	14	N/A	N/A	N/A	1057.6 mW -EXEMPT-	392.6 mW -EXEMPT-	N/A	2607.6 mW -EXEMPT-
Fixed	11n20	2462	11.50	14	N/A	N/A	N/A	1057.6 mW -EXEMPT-	392.6 mW -EXEMPT-	N/A	2607.6 mW -EXEMPT-
Fixed	BT	2480	1.20	1	N/A	N/A	N/A	1057.3 mW -EXEMPT-	392.3 mW -EXEMPT-	N/A	2607.3 mW -EXEMPT-
Fixed	11a	5700	10.00	10	N/A	N/A	N/A	1024.8 mW -EXEMPT-	359.8 mW -EXEMPT-	N/A	2574.8 mW -EXEMPT-
Fixed	11n20	5700	10.00	10	N/A	N/A	N/A	1024.8 mW -EXEMPT-	359.8 mW -EXEMPT-	N/A	2574.8 mW -EXEMPT-
Fixed	11n40	5700	10.00	10	N/A	N/A	N/A	1024.8 mW -EXEMPT-	359.8 mW -EXEMPT-	N/A	2574.8 mW -EXEMPT-

## **SECTION7: Description of the Body setup**

### **7.1 Procedure for SAR test position determination**

-The tested procedure was performed according to the KDB 447498 D01 (Mobile and Portable Device RF Exposure Procedures and Equipment Authorization Policies) and the KDB 616217 D04.

### **7.2 Test position for Body setup**

No.	Position	Test distance	WLAN	Bluetooth
			Tested	Tested
1	Front	0mm	<input type="checkbox"/>	<input type="checkbox"/>
2	Rear	0mm	<input checked="" type="checkbox"/>	<input type="checkbox"/>
3	Rear tilt	0mm	<input checked="" type="checkbox"/>	<input type="checkbox"/>
4	Right	0mm	<input type="checkbox"/>	<input type="checkbox"/>
5	Left	0mm	<input type="checkbox"/>	<input type="checkbox"/>
6	Top	0mm	<input checked="" type="checkbox"/>	<input type="checkbox"/>
7	Bottom	0mm	<input type="checkbox"/>	<input type="checkbox"/>

## SECTION8: Description of the operating mode

### 8.1 Output Power and SAR test required

According to KDB248227D01, The initial test configuration for 2.4 GHz and 5 GHz OFDM transmission modes is determined by the 802.11 configuration with the highest maximum output power specified for production units, including tune-up tolerance, in each standalone and aggregated frequency band. SAR for the initial test configuration is measured using the highest maximum output power channel determined by the default power measurement procedures. When multiple configurations in a frequency band have the same specified maximum output power, the initial test configuration is determined according to the following steps applied sequentially.

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

#### Wi-Fi 2.4GHz (DTS Band)

Band (GHz)	Mode	Data Rate	Ch #	Freq. (MHz)	Measured average Power (dBm)	Tune-up upper Power (dBm)	Initial test configuration	Note(s)
2.4	11b	1 Mbps	1	2412	14.36	15.50		
			6	2437	14.41	15.50	Yes	
			11	2462	14.21	15.50		
	11g	6 Mbps	1	2412	10.35	11.50		
			6	2437	10.22	11.50		
			11	2462	10.07	11.50		
	11n20	6.5 Mbps	1	2412	10.46	11.50		
			6	2437	10.49	11.50		
			11	2462	10.21	11.50		

#### Note(s):

1. SAR test channel was chosen. (shaded blue frame)

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### Wi-Fi 5GHz (U-NII-1 and U-NII-2A Bands)

Band (GHz)	Mode	Data Rate	Ch #	Freq. (MHz)	Measured average Power (dBm)	Tune-up upper Power (dBm)	SAR Test (Yes/No)	Note(s)
5.2	802.11a	6 Mbps	36	5180	8.94	10.0	No	3
			44	5220	9.07			
			48	5240	9.37			
	802.11n (HT20)	6.5 Mbps	36	5180	8.98	10.0	No	3
			44	5220	9.18			
			48	5240	9.20			
	802.11n (HT40)	13.5 Mbps	38	5190	9.04	10.0	No	3
			46	5230	9.30			
			52	5260	9.06			
5.3	802.11a	6 Mbps	60	5300	9.38	10.0	No	1,2
			64	5320	9.10			
			52	5260	9.22			
	802.11n (HT20)	6.5 Mbps	60	5300	9.10	10.0	No	1,2
			64	5320	9.36			
			54	5270	9.17			
	802.11n (HT40)	13.5 Mbps	62	5310	9.33	10.0	Yes	

### Wi-Fi 5GHz (U-NII-2C Band)

Band (GHz)	Mode	Data Rate	Ch #	Freq. (MHz)	Measured average Power (dBm)	Tune-up upper Power (dBm)	SAR Test (Yes/No)	Note(s)
5.5	802.11a	6 Mbps	100	5500	9.05	10.0	No	1,2
			116	5580	9.17			
			140	5700	8.81			
	802.11n	6.5 Mbps	100	5500	9.06	10.0	No	1,2
			116	5580	9.30			
			140	5700	8.92			
	802.11n (HT40)	13.5 Mbps	102	5510	9.09	10.0	Yes	
			110	5550	9.34			
			134	5670	9.10			

#### Note(s):

- SAR measurement is not required for 802.11a/n HT20 channels when the specified tune-up tolerances for 802.11a/n HT20 are lower than 802.11n HT40 and the measured SAR is  $\leq 1.2$  W/Kg.
- When the same transmission mode configurations have the same maximum output power on the same channel for the 802.11 a/g/n modes, the channel with the largest bandwidth and lowest data rate is selected (i.e. 802.11n HT40).
- When the specified maximum output power is the same for both UNII band I and UNII band 2A, begin SAR measurement in UNII band 2A; and if the highest reported SAR for UNII band 2A is
  - $\leq 1.2$  W/kg, SAR is not required for UNII band I
  - $> 1.2$  W/kg, both bands should be tested independently for SAR.
- SAR test channel was chosen according to KDB248227D01. (shaded blue frame)

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## SECTION9: Test surrounding

### 9.1 Measurement uncertainty

This measurement uncertainty budget is suggested by IEEE Std 1528(2013) and IEC62209-2:2010, and determined by Schmid & Partner Engineering AG (DASY5 Uncertainty Budget). Per KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz Section 2.8.1., when the highest measured SAR(1g) within a frequency band is < 1.5W/kg, the extensive SAR measurement uncertainty analysis described in IEEE Std.1528 (2013) is not required in SAR reports submitted for equipment approval.

<0.3 – 3GHz range Body>

Error Description	Uncertai value ±	Probability distribution	divisor	(ci) 1g	Standard (1g)
<b>Measurement System</b>					
Probe calibration	± 6.00	Normal	1	1	± 6.00
Axial isotropy of the probe	± 4.7	Rectangular	√3	0.7	± 1.9
Spherical isotropy of the probe	± 9.6	Rectangular	√3	0.7	± 3.9
Boundary effects	± 1.0	Rectangular	√3	1	± 0.6
Probe linearity	± 4.7	Rectangular	√3	1	± 2.7
Detection limit	± 1.0	Rectangular	√3	1	± 0.6
Modulation response	± 2.4	Rectangular	√3	1	± 1.4
Readout electronics	± 0.3	Normal	1	1	± 0.3
Response time	± 0.8	Rectangular	√3	1	± 0.5
Integration time	± 2.6	Rectangular	√3	1	± 1.5
RF ambient Noise	± 3.0	Rectangular	√3	1	± 1.7
RF ambient Reflections	± 3.0	Rectangular	√3	1	± 1.7
Probe Positioner	± 0.4	Rectangular	√3	1	± 0.2
Probe positioning	± 2.9	Rectangular	√3	1	± 1.7
Max.SAR Eval.	± 2.0	Rectangular	√3	1	± 1.2
<b>Test Sample Related</b>					
Device positioning	± 2.9	Normal	1	1	± 2.9
Device holder uncertainty	± 3.6	Normal	1	1	± 3.6
Power drift	± 5.0	Rectangular	√3	1	± 2.9
Power Scaling	+ 0.0	Rectangular	√3	1	± 0.0
<b>Phantom and Setup</b>					
Phantom uncertainty	± 6.1	Rectangular	√3	1	± 3.5
Algorithm for correcting SAR for deviations in permittivity and conductivity	± 1.9	Rectangular	√3	1	± 1.1
Liquid conductivity (meas.)	- 2.3	Rectangular	√3	0.78	+ 1.0
Liquid permittivity (meas.)	- 3.2	Rectangular	√3	0.26	- 0.5
Liquid conductivity - temp.unc (below 2deg.C.)	± 5.2	Rectangular	√3	0.78	± 2.3
Liquid permittivity - temp.unc (below 2deg.C.)	± 0.8	Rectangular	√3	0.23	± 0.1
<b>Combined Standard Uncertainty</b>					
					± 11.212
<b>Expanded Uncertainty (k=2)</b>					
					± 22.4

\*. Table of uncertainties are listed for ISO/IEC 17025.

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<3 – 6GHz range Body>

Error Description	Uncerta value ±	Probability distribution	divisor	(ci) 1g	Standard (1g)
<b>Measurement System</b>					
Probe calibration	± 6.55	Normal	1	1	± 6.55
Axial isotropy of the probe	± 4.7	Rectangular	√3	0.7	± 1.9
Spherical isotropy of the probe	± 9.6	Rectangular	√3	0.7	± 3.9
Boundary effects	± 1.0	Rectangular	√3	1	± 0.6
Probe linearity	± 4.7	Rectangular	√3	1	± 2.7
Detection limit	± 1.0	Rectangular	√3	1	± 0.6
Modulation response	± 2.4	Rectangular	√3	1	± 1.4
Readout electronics	± 0.3	Normal	1	1	± 0.3
Response time	± 0.8	Rectangular	√3	1	± 0.5
Integration time	± 2.6	Rectangular	√3	1	± 1.5
RF ambient Noise	± 3.0	Rectangular	√3	1	± 1.7
RF ambient Reflections	± 3.0	Rectangular	√3	1	± 1.7
Probe Positioner	± 0.4	Rectangular	√3	1	± 0.2
Probe positioning	± 2.9	Rectangular	√3	1	± 1.7
Max.SAR Eval.	± 2.0	Rectangular	√3	1	± 1.2
<b>Test Sample Related</b>					
Device positioning	± 2.9	Normal	1	1	± 2.9
Device holder uncertainty	± 3.6	Normal	1	1	± 3.6
Power drift	± 5.0	Rectangular	√3	1	± 2.9
Power Scaling	+ 0.0	Rectangular	√3	1	± 0.0
<b>Phantom and Setup</b>					
Phantom uncertainty	± 6.1	Rectangular	√3	1	± 3.5
Algorithm for correcting SAR for deviations in permittivity and conductivity	± 1.9	Rectangular	√3	1	± 1.1
Liquid conductivity (meas.)	+ 3.7	Rectangular	√3	0.78	+ 1.7
Liquid permittivity (meas.)	- 3.4	Rectangular	√3	0.26	- 0.5
Liquid conductivity - temp.unc (below 2deg.C.)	± 5.2	Rectangular	√3	0.78	± 2.3
Liquid permittivity - temp.unc (below 2deg.C.)	± 0.8	Rectangular	√3	0.23	± 0.1
<b>Combined Standard Uncertainty</b>					
					± <b>11.591</b>
<b>Expanded Uncertainty (k=2)</b>					
					± <b>23.2</b>

\*. Table of uncertainties are listed for ISO/IEC 17025.

## **SECTION10: Parameter Check**

The dielectric parameters were checked prior to assessment using the DAK dielectric probe kit.  
The dielectric parameters measurement is reported in each correspondent section.

According to KDB865664 D01, +/- 5% tolerances are required for  $\epsilon_r$  and  $\sigma$  and then below table which is the target value of the simulated tissue liquid is quoted from KDB865664 D01.

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

( $\epsilon_r$  = relative permittivity,  $\sigma$  = conductivity and  $\rho = 1000 \text{ kg/m}^3$ )



### 10.1 For SAR system check

$\sigma$  : Conductivity /  $\epsilon_r$ : Relative Permittivity

\*1 The Target value is a parameter defined in KDB 865664D01.

\*2 The dielectric parameters should be linearly interpolated between the closest pair of target frequencies to determine the applicable dielectric parameters corresponding to the device test frequency.

#### Correlation confirmation with measured TSL parameters of the calibration certificate of system validation dipoles (Refer to Appendix 2)

+/- 6% limit for deviation provided by manufacture tolerances are required for  $\epsilon_r$  and  $\sigma$  and then below table which is the target value of the simulated tissue liquid is quoted from data measured TSL parameters of dipole calibration.

Freq [MHz]	Model,S/N	Body	
		$\sigma$	$\epsilon_r$
2450	D2450,713	2.04	51.6
5250	D5GHV2,1020	5.52	47.0
5600	D5GHV2,1020	6.00	46.4

DIELECTRIC PARAMETERS MEASUREMENT RESULTS											
Date	Ambient Temp. [deg.c]	Relative Humidity [%]	Liquid type	Liquid Temp. [deg.c]	Measured Frequency [MHz]	Parameters	Target Value*1	Measured	Deviation [%]	Limit [%]	Remark
2017/6/26	24.0	49	MSL 2450	23.5	2450	$\sigma$ [mho/m]	2.04	1.92	-5.9	+/-6	
						$\epsilon_r$	51.6	51.0	-1.2	+/-6	
2017/6/27	24.0	53	MBBL 3.5-5.8	23.5	5250	$\sigma$ [mho/m]	5.52	5.50	-0.5	+/-6	
						$\epsilon_r$	47.0	47.6	1.2	+/-6	
2017/6/27	24.0	53	MBBL 3.5-5.8	23.5	5600	$\sigma$ [mho/m]	6.00	5.92	-1.4	+/-6	
						$\epsilon_r$	46.4	47.1	1.5	+/-6	

$\epsilon_r$ : Relative Permittivity /  $\sigma$  : Conductivity

\*1 The Target value is a parameter defined in each Dipole.

## 10.2 For SAR measurement

DIELECTRIC PARAMETERS MEASUREMENT RESULTS											
Date	Ambient Temp. [deg.c]	Relative Humidity [%]	Liquid type	Liquid Temp. [deg.c]	Measured Frequency [MHz]	Parameters	Target Value	Measured	Deviation [%]	Limit [%]	Remark
2017/6/26	24.0	49	MSL 2450	23.5	2412	$\sigma$ [mho/m]	1.91	1.87	-2.3	+/-5	*2
						$\epsilon_r$	52.8	51.1	-3.2	+/-5	
2017/6/26	24.0	49	MSL 2450	23.5	2437	$\sigma$ [mho/m]	1.94	1.90	-1.9	+/-5	*2
						$\epsilon_r$	52.7	51.0	-3.2	+/-5	
2017/6/27	24.0	53	MBBL 3.5-5.8	23.5	5270	$\sigma$ [mho/m]	5.38	5.58	<b>3.7</b>	+/-5	*2
						$\epsilon_r$	48.9	47.4	-3.1	+/-5	
2017/6/27	24.0	53	MBBL 3.5-5.8	23.5	5310	$\sigma$ [mho/m]	5.43	5.58	2.9	+/-5	*2
						$\epsilon_r$	48.9	47.2	<b>-3.4</b>	+/-5	
2017/6/27	24.0	53	MBBL 3.5-5.8	23.5	5550	$\sigma$ [mho/m]	5.71	5.83	2.2	+/-5	*2
						$\epsilon_r$	48.5	47.3	-2.6	+/-5	
2017/6/27	24.0	53	MBBL 3.5-5.8	23.5	5670	$\sigma$ [mho/m]	5.85	6.01	2.8	+/-5	*2
						$\epsilon_r$	48.4	46.9	-3.0	+/-5	

$\sigma$  : Conductivity /  $\epsilon_r$ : Relative Permittivity

\*1 The Target value is a parameter defined in KDB 865664D01.

\*2 The dielectric parameters should be linearly interpolated between the closest pair of target frequencies to determine the applicable dielectric parameters corresponding to the device test frequency.

#### SECTION11: System Check confirmation

The measurements were performed in the flat section of the TWIN SAM or ELI phantom, shell thickness:  $2.0 \pm 0.2$  mm (bottom plate) filled with Body or Head simulating liquid of the following parameters.

The depth of tissue-equivalent liquid in a phantom must be  $\geq 15.0$  cm  $\pm 0.5$  cm for SAR measurements  $\leq 3$  GHz and  $\geq 10.0$  cm  $\pm 0.5$  cm for measurements  $> 3$  GHz.

The DASY system with an E-Field Probe was used for the measurements.

The dipole was mounted on the small tripod so that the dipole feed point was positioned below the center marking of the flat phantom section and the dipole was oriented parallel to the body axis (the long side of the phantom).

The standard measuring distance was 10 mm (above 1GHz to 6GHz) and 15 mm (below 1GHz) from dipole center to the simulating liquid surface.

The coarse grid with a grid spacing of 12 mm (1GHz to 3GHz) and 15 mm (below 1GHz) was aligned with the dipole.

For 5 GHz band - The coarse grid with a grid spacing of 10 mm was aligned with the dipole.

Special 7x7x7 (below 3 GHz) and/or 8x8x7 (above 3 GHz) fine cube was chosen for the cube.

Distance between probe sensors and phantom surface was set to 3 mm.

For 5 GHz band - Distance between probe sensors and phantom surface was set to 2.5 mm

The dipole input power (forward power) was 100 mW(For 5GHz band) or 250 mW(For other band).

The results are normalized to 1 W input power.

Freq [MHz]	Model,S/N	Body	
		(SPEAG) 1g [W/kg]	(SPEAG) 10g[W/kg]
2450	D2450,713	52.00	24.44
5250	D5GHV2,1020	75.60	21.30
5600	D5GHV2,1020	79.70	22.40

\*1 The target(reference) SAR values can be obtained from the calibration certificate of system validation dipoles(Refer to Appendix 2). The target SAR values are SAR measured value in the calibration certificate scaled to 1W.

Date Tested	Test Freq	Model,S/N	T.S. Liquid	Measured Results		Target (Ref. Value)	Delta $\pm 10\%$
				Zoom Scan	Normalize to 1 W		
2017/6/26	2450	D2450,713	Body	1g	13.80	52.00	6.2
				10g	6.43	24.44	5.2
2017/6/27	5250	D5GHV2,1020	Body	1g	8.28	75.60	9.5
				10g	2.31	21.30	8.5
2017/6/27	5600	D5GHV2,1020	Body	1g	8.18	79.70	2.6
				10g	2.25	22.40	0.4

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## **SECTION12: Measured and Reported (Scaled) SAR Results**

SAR Test Reduction criteria are as follows

### ● **KDB 248227 D01 (SAR Guidance for 802.11(Wi-Fi) Transmitters):**

SAR test reduction for 802.11 WLAN transmission mode configurations are considered separately for DSSS and OFDM. An initial test position is determined to reduce the number of tests required for certain exposure configurations with multiple test positions. An initial test configuration is determined for each frequency band and aggregated band according to maximum output power, channel bandwidth, wireless mode configurations and other operating parameters to streamline the measurement requirements. For 2.4 GHz DSSS, either the initial test position or DSSS procedure is applied to reduce the number of SAR tests; these are mutually exclusive. For OFDM, an initial test position is only applicable to next to the ear, UMPC mini-tablet and hotspot mode configurations, which is tested using the initial test configuration to facilitate test reduction. For other exposure conditions with a fixed test position, SAR test reduction is determined using only the initial test configuration.

The multiple test positions require SAR measurements in head, hotspot mode or UMPC mini-tablet configurations may be reduced according to the highest reported SAR determined using the initial test position(s) by applying the DSSS or OFDM SAR measurement procedures in the required wireless mode test configuration(s). The initial test position(s) is measured using the highest measured maximum output power channel in the required wireless mode test configuration(s). When the reported SAR for the initial test position is:

- ✧  $\leq 0.4$  W/kg, further SAR measurement is not required for the other test positions in that exposure configuration and wireless mode combination within the frequency band or aggregated band. DSSS and OFDM configurations are considered separately according to the required SAR procedures.
- ✧  $> 0.4$  W/kg, SAR is repeated using the same wireless mode test configuration tested in the initial test position to measure the subsequent next closet/smallest test separation distance and maximum coupling test position, on the highest maximum output power channel, until the reported SAR is  $\leq 0.8$  W/kg or all required test positions are tested.
  - For subsequent test positions with equivalent test separation distance or when exposure is dominated by coupling conditions, the position for maximum coupling condition should be tested.
  - When it is unclear, all equivalent conditions must be tested.
- ✧ For all positions/configurations tested using the initial test position and subsequent test positions, when the reported SAR is  $> 0.8$  W/kg, measure the SAR for these positions/configurations on the subsequent next highest measured output power channel(s) until the reported SAR is  $\leq 1.2$  W/kg or all required test channels are considered.
  - The additional power measurements required for this step should be limited to those necessary for identifying subsequent highest output power channels to apply the test reduction.
- ✧ When the specified maximum output power is the same for both UNII 1 and UNII 2A, begin SAR measurements in UNII 2A with the channel with the highest measured output power. If the reported SAR for UNII 2A is  $\leq 1.2$  W/kg, SAR is not required for UNII 1; otherwise treat the remaining bands separately and test them independently for SAR.
- ✧ When the specified maximum output power is different between UNII 1 and UNII 2A, begin SAR with the band that has the higher specified maximum output. If the highest reported SAR for the band with the highest specified power is  $\leq 1.2$  W/kg, testing for the band with the lower specified output power is not required; otherwise test the remaining bands independently for SAR.

To determine the initial test position, Area Scans were performed to determine the position with the *Maximum Value of SAR (measured)*. The position that produced the highest *Maximum Value of SAR* is considered the worst case position; thus used as the initial test position.

- When reported SAR value is exceed 1.2W/kg(if any), device holder perturbation verification is required; however, since distance between device holder and antenna of EUT is enough, it was not conducted.
- Reported SAR= Measured SAR [W/kg] · Scaled factor  
\* Scaled factor = Maximum tune-up tolerance limit [mW] / Measured power [mW]
- Maximum tune-up tolerance limit is by the specification from a customer.

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## 12.1 WLAN 2.4GHz Band

Test Position	Mode	Dist. (mm)	Ch #.	Freq. (MHz)	Power (dBm)		Scaled factor	1-g SAR (W/kg)	
					Tune-up limit	Meas.		Meas.	Reported
Top	802.11b	0	1	2412	15.50	14.36	1.30		
			6	2437	15.50	14.41	1.29	0.252	0.324
			11	2462	15.50	14.21	1.35		
Bottom	802.11b	0	1	2412	15.50	14.36	1.30	0.818	1.064
			6	2437	15.50	14.41	1.29	0.881	1.132
			11	2462	15.50	14.21	1.35		
Bottom tilt	802.11b	0	1	2412	15.50	14.36	1.30	0.757	0.984
			6	2437	15.50	14.41	1.29	0.775	0.996
			11	2462	15.50	14.21	1.35		

**OFDM was excluded from the following table according to KDB248227D01.**

SAR is not required for the following 2.4 GHz OFDM conditions according to KDB248227D01.

- 1) When KDB447498D01 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  $\leq 1.2$  W/kg.

Maximum tune-up tolerance limit		Maximum tune-up tolerance limit		OFDM scaled factor *4	Position	DSSS Reported SAR value [W/kg]	OFDM Estimated SAR value [W/kg]	Exclusion limit [W/kg]
DSSS		OFDM						
[dBm]	[mW]	[dBm]	[mW]					
15.50	35.48	11.50	14.13	0.398	Bottom	1.132	0.451	< 1.2

### Note(s):

- OFDM scaled factor = Maximum tune-up tolerance limit of OFDM [mW] / Maximum tune-up tolerance limit of DSSS [mW]
- Estimated SAR of OFDM= Reported SAR of DSSS[W/kg] · OFDM scaled factor

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## 12.2 WLAN 5.3GHz Band

Test Position	Mode	Dist. (mm)	Ch #.	Freq. (MHz)	Power (dBm)		Scaled factor	1-g SAR (W/kg)	
					Tune-up limit	Meas.		Meas.	Reported
Top	802.11n40	0	54	5270	10.00	9.17	1.21		
			62	5310	10.00	9.33	1.17	0.262	0.306
Bottom	802.11n40	0	54	5270	10.00	9.17	1.21		
			62	5310	10.00	9.33	1.17	0.424	0.495
Bottom tilt	802.11n40	0	54	5270	10.00	9.17	1.21	0.719	0.870
			62	5310	10.00	9.33	1.17	0.762	0.889

## 12.3 WLAN 5.5GHz Band

Test Position	Mode	Dist. (mm)	Ch #.	Freq. (MHz)	Power (dBm)		Scaled factor	1-g SAR (W/kg)	
					Tune-up limit	Meas.		Meas.	Reported
Top	802.11n40	0	102	5510	10.00	9.09	1.23		
			110	5550	10.00	9.34	1.16	0.319	0.371
			134	5670	10.00	9.10	1.23		
Bottom	802.11n40	0	102	5510	10.00	9.09	1.23		
			110	5550	10.00	9.34	1.16	0.489	0.569
			134	5670	10.00	9.10	1.23		
Bottom tilt	802.11n40	0	102	5510	10.00	9.09	1.23		
			110	5550	10.00	9.34	1.16	0.900	1.048
			134	5670	10.00	9.10	1.23	0.741	0.912

## 12.4 Repeated measurement

According to KDB865664 D1.

- 1) Repeated measurement is not required when the original highest measured SAR is  $< 0.80$  W/kg; steps 2) through 4) do not apply.
- 2) When the original highest measured SAR is  $\geq 0.80$  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  $\geq 1.45$  W/kg ( $\sim 10\%$  from the 1-g SAR limit).
- 4) Perform a third repeated measurement only if the original, first or second repeated measurement is  $\geq 1.5$  W/kg and the ratio of largest to smallest SAR for the original, first and second repeated measurements is  $> 1.20$ .

Wireless Technologies	Test Configuration			Mode	Dist. (mm)	Ch #.	Freq. (MHz)	Meas. SAR (W/kg)		Largest to Smallest SAR Ratio
	Transmit Antenna	Exposure	Position					Original	Repeated	
Wi-Fi 2.4 GHz	Fixed	Body	Bottom	802.11b	0	6	2437	0.881	0.819	1.076
Wi-Fi 5.3 GHz	Fixed	Body	Bottom tilt	802.11n40 HT0	0	62	5310	0.762	N/A	N/A
Wi-Fi 5.5 GHz	Fixed	Body	Bottom tilt	802.11n40 HT0	0	110	5550	0.900	0.862	1.044

### Note(s):

N/A: Repeated Measurement is not required since the original highest measured SAR for all bands are  $< 0.80$  W/kg.

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### SECTION13: Test instruments

Control No.	Instrument	Manufacturer	Model No	Serial No	Test Item	Calibration Date * Interval(month)
MNA-03	Vector Reflectometer	Copper Mountain Technologies	PLANAR R140	0030913	SAR	2017/04/22 * 12
MDPK-03	Dielectric assessment kit	Schmid&Partner Engineering AG	DAK-3.5	0008	SAR	2017/04/18 * 12
MOS-37	Digital thermometer	LKM electronic	DTM3000	-	SAR	2016/07/28 * 12
COTS-MSAR-04	Dielectric assessment software	Schmid&Partner Engineering AG	DAK		SAR	-
MDAE-02	Data Acquisition Electronics	Schmid&Partner Engineering AG	DAE4	1369	SAR	-
MPB-08	Dosimetric E-Field Probe	Schmid&Partner Engineering AG	EX3DV4	3917	SAR	2017/05/16 * 12
MPF-03	2mm Oval Flat Phantom	Schmid&Partner Engineering AG	QDOVA001BB	1203	SAR	2017/05/29 * 12
MDH-04	Device holder	Schmid&Partner Engineering AG	Mounting device for transmitter	-	SAR	Pre Check
MOS-35	Digital thermometer	HANNA	Checktemp 4	-	SAR	2016/07/28 * 12
COTS-MSAR-03	Dasy5	Schmid&Partner Engineering AG	DASY5	-	SAR	-
MRBT-03	SAR robot	Schmid&Partner Engineering AG	TX60 Lspeag	F13/5PPLD1/A/01	SAR	2016/06/30 * 12
MPB-07	Dosimetric E-Field Probe	Schmid&Partner Engineering AG	EX3DV4	3825	SAR	2016/12/12 * 12
MPM-11	Dual Power Meter	Agilent	E4419B	MY45102060	SAR	2016/08/24 * 12
MPSE-15	Power sensor	Agilent	E9301A	MY41498311	SAR	2016/08/24 * 12
MPSE-16	Power sensor	Agilent	E9301A	MY41498313	SAR	2016/08/24 * 12
MRFA-24	Pre Amplifier	R&K	R&K CGA020M602-2633R	B30550	SAR	2017/06/12 * 12
MSG-10	Signal Generator	Agilent	N5181A	MY47421098	SAR	2016/11/09 * 12
MAT-78	Attenuator	Telegrartner	J01156A0011	0042294119	SAR	Pre Check
MPM-15	Power Meter	Agilent	N1914A	MY53060017	SAR	2017/06/21 * 12
MPSE-21	Power sensor	Agilent	N8482H	MY52460010	SAR	2017/06/21 * 12
MHDC-12	Dual Directional Coupler	Hewlett Packard	772D	2839A0016	SAR(2-18GHz)	Pre Check
MDA-07	Dipole Antenna	Schmid&Partner Engineering AG	D2450V2	713	SAR(D2450)	2016/09/13 * 12
MMSL2450	Tissue simulation liquid (Body)	Schmid&Partner Engineering AG	MSL2450V2	SL AA 245 BA	SAR*Daily Check Target Value $\pm 5\%$	Pre Check
MDA-08	Dipole Antenna	Schmid&Partner Engineering AG	D5GHzV2	1020	SAR(D5G)	2017/01/06 * 12
MMBBL3.5-5.8	Tissue simulation liquid (Body)	Schmid&Partner Engineering AG	MBBL3500-5800V5	SL AAM 501 DA	SAR*Daily Check Target Value $\pm 5\%$	Pre Check

\*1) This test equipment was used for the tests before the expiration date of the calibration.

The expiration date of the calibration is the end of the expired month.

All equipment is calibrated with valid calibrations. Each measurement data is traceable to the national or international standards.

As for some calibrations performed after the tested dates, those test equipment have been controlled by means of an unbroken chains of calibrations.

SAR room is checked before every testing and ambient noise is  $<0.012\text{W/kg}$

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## **APPENDIX 1 : System Check**

### **System check result Body 2450MHz**

#### **BODY 2450MHz System Check DATA / Dipole 2450MHz / Forward Conducted Power : 250mW**

Communication System: UID 0, CW (0); Communication System Band: D2450 (2450.0 MHz); Frequency: 2450 MHz;  
Duty Cycle: 1:1

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.919$  S/m;  $\epsilon_r = 50.993$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY5 Configuration

Probe: EX3DV4 - SN3917; ConvF(7.68, 7.68, 7.68); Calibrated: 2017/05/16;

Sensor-Surface: 2mm (Mechanical Surface Detection), Sensor-Surface: 0mm (Fix Surface)

Electronics: DAE4 Sn1369; Calibrated: 2017/05/12

Phantom: ELI v5.0 (30deg probe tilt); Type: QDOVA002AA; Serial: TP:1203

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Area Scan (81x71x1):** Interpolated grid: dx=1.200 mm, dy=1.200 mm

Maximum value of SAR (interpolated) = 21.8 W/kg

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

Reference Value = 106.1 V/m; Power Drift = -0.07 dB

Peak SAR (extrapolated) = 27.7 W/kg

**SAR(1 g) = 13.8 W/kg; SAR(10 g) = 6.43 W/kg**

Maximum value of SAR (measured) = 20.8 W/kg

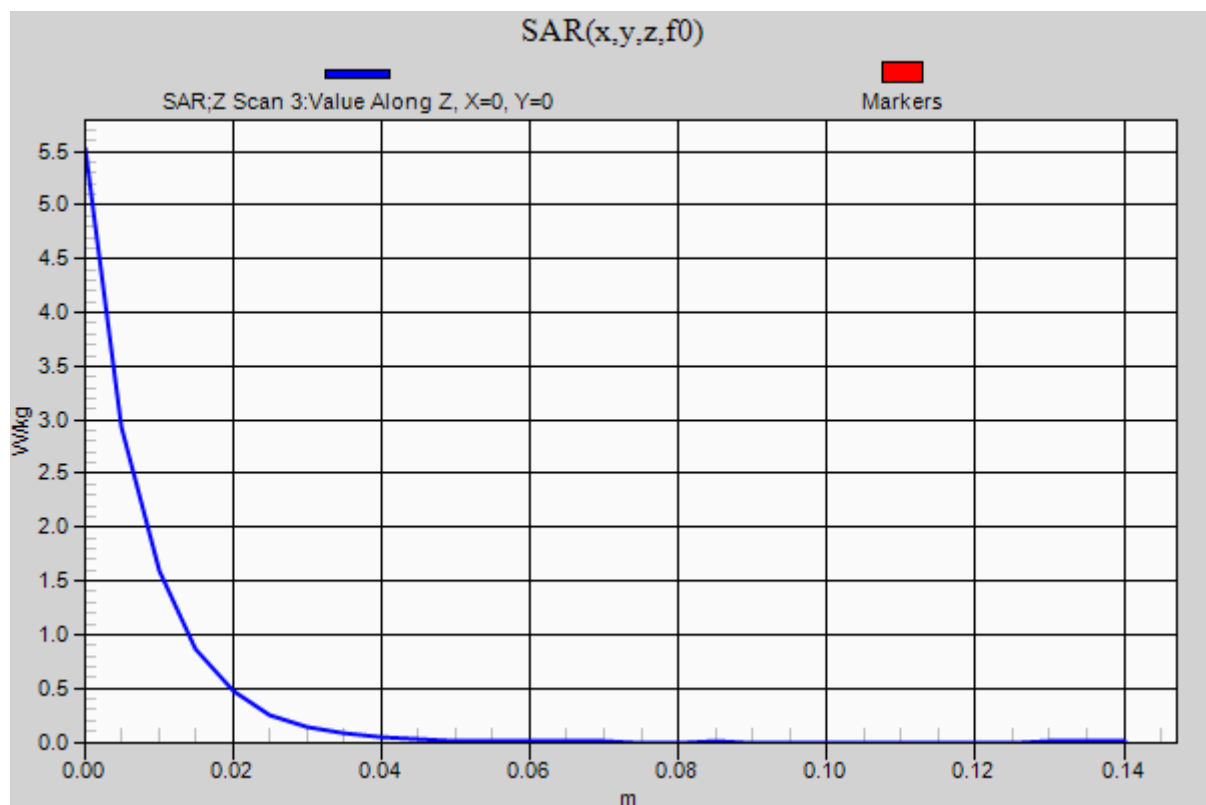
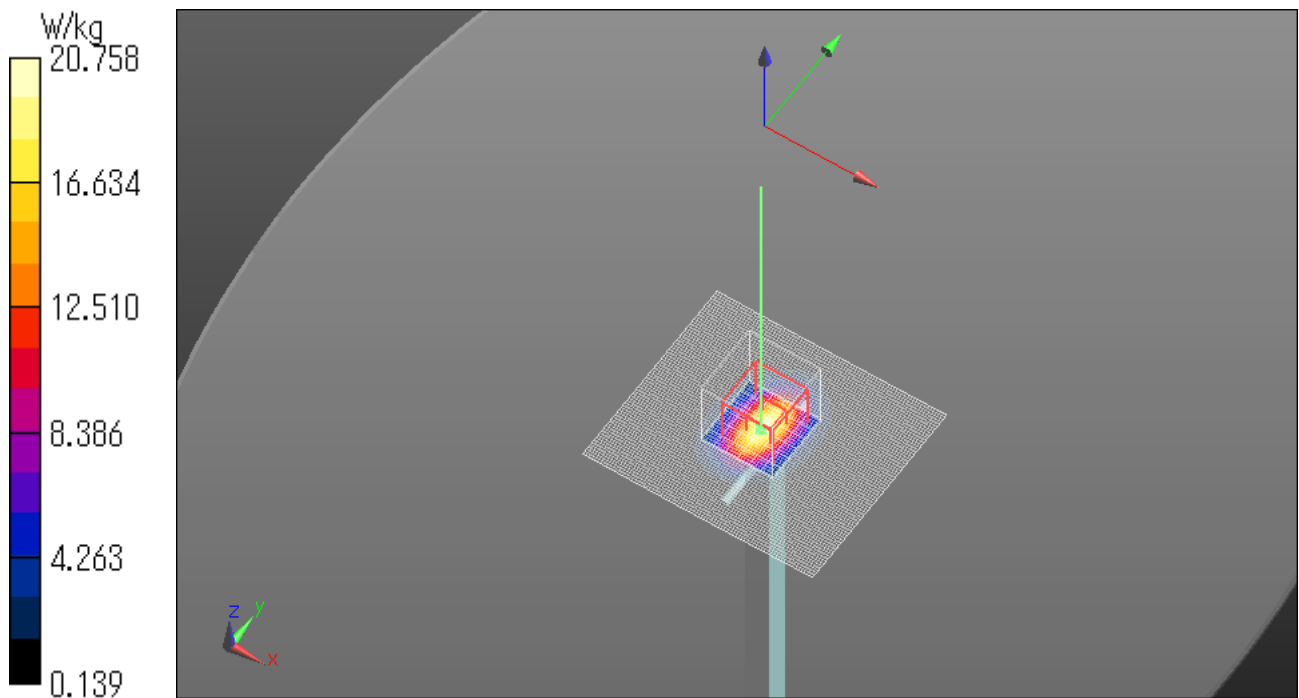
**Z Scan (1x1x31):** Measurement grid: dx=20mm, dy=20mm, dz=5mm

Maximum value of SAR (measured) = 5.53 W/kg

Date: 2017/06/26

Ambient Temp. : 24.0 degree.C.    Liquid Temp.; 23.5 degree.C.





### System check result Body 5250MHz

#### **BODY 5250MHz System Check DATA / Dipole 5GHz / Forward Conducted Power : 100mW**

Communication System: UID 0, CW; Communication System Band: D5GHz (5000.0 - 6000.0 MHz); Frequency: 5250 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 5250$  MHz;  $\sigma = 5.495$  S/m;  $\epsilon_r = 47.558$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY5 Configuration

Probe: EX3DV4 - SN3825; ConvF(4.48, 4.48, 4.48); Calibrated: 2016/12/12;

Sensor-Surface: 1.4mm (Mechanical Surface Detection), Sensor-Surface: 0mm (Fix Surface)

Electronics: DAE4 Sn1369; Calibrated: 2017/05/12

Phantom: ELI v5.0 (30deg probe tilt); Type: QDOVA002AA; Serial: TP:1203

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Area Scan (91x91x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 19.2 W/kg

**Zoom Scan (4x4x1.4mm, graded), dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 70.97 V/m; Power Drift = 0.05 dB

Peak SAR (extrapolated) = 32.9 W/kg

**SAR(1 g) = 8.28 W/kg; SAR(10 g) = 2.31 W/kg**

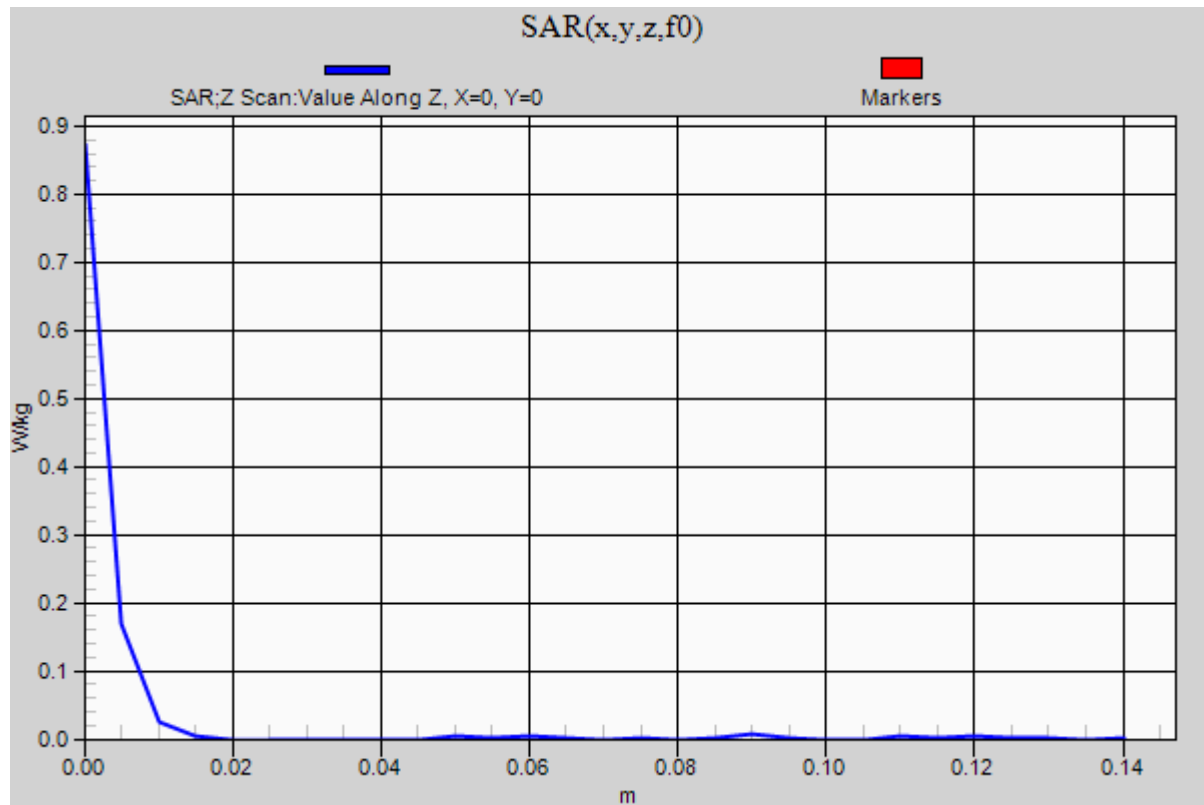
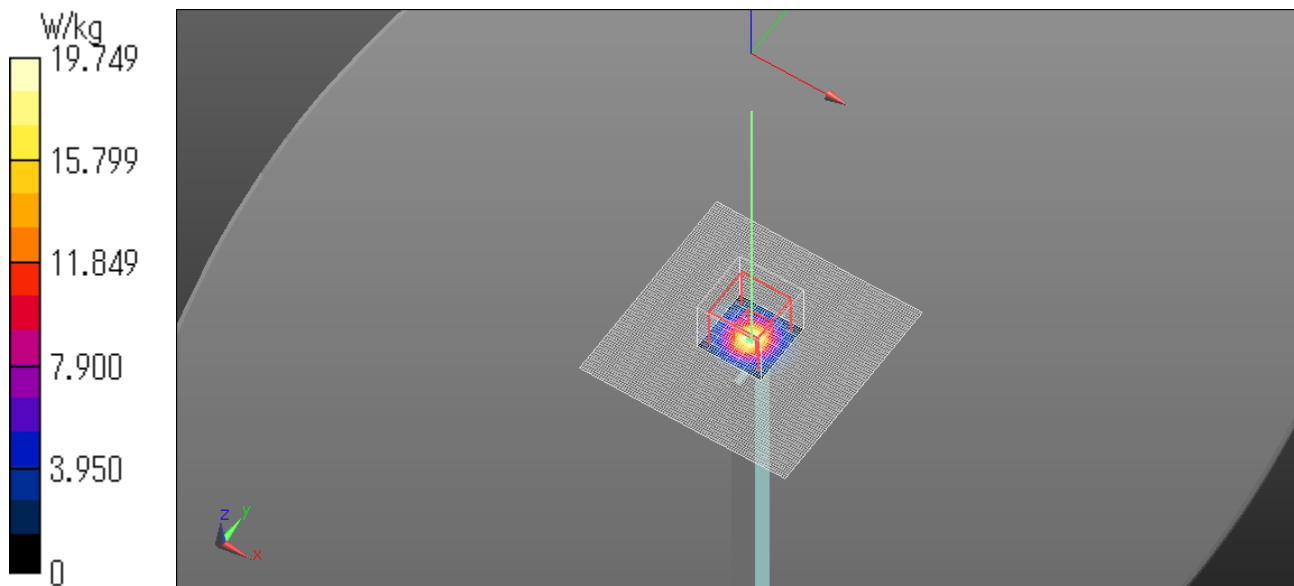
Maximum value of SAR (measured) = 19.7 W/kg

**Z Scan (1x1x31):** Measurement grid: dx=20mm, dy=20mm, dz=5mm

Maximum value of SAR (measured) = 0.872 W/kg

Date: 2017/06/27

Ambient Temp. : 24.0 degree.C.    Liquid Temp.; 23.5 degree.C.



### System check result Body 5600MHz

#### **BODY 5600MHz System Check DATA / Dipole 5GHz / Forward Conducted Power : 100mW**

Communication System: UID 0, CW; Communication System Band: D5GHz (5000.0 - 6000.0 MHz); Frequency: 5600 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 5600$  MHz;  $\sigma = 5.919$  S/m;  $\epsilon_r = 47.08$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY5 Configuration

Probe: EX3DV4 - SN3825; ConvF(3.89, 3.89, 3.89); Calibrated: 2016/12/12;

Sensor-Surface: 1.4mm (Mechanical Surface Detection), Sensor-Surface: 0mm (Fix Surface)

Electronics: DAE4 Sn1369; Calibrated: 2017/05/12

Phantom: ELI v5.0 (30deg probe tilt); Type: QDOVA002AA; Serial: TP:1203

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Area Scan (91x91x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 20.0 W/kg

**Zoom Scan (4x4x1.4mm, graded), dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 69.83 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 34.2 W/kg

**SAR(1 g) = 8.18 W/kg; SAR(10 g) = 2.25 W/kg**

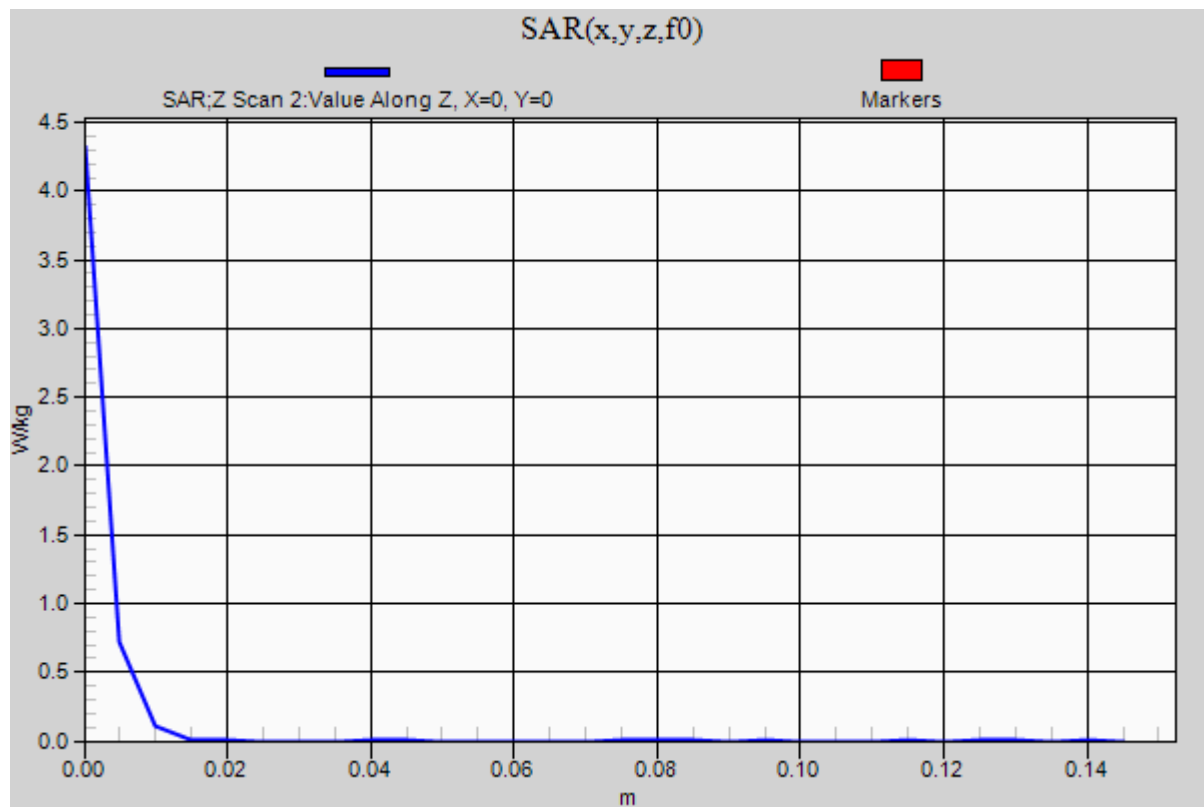
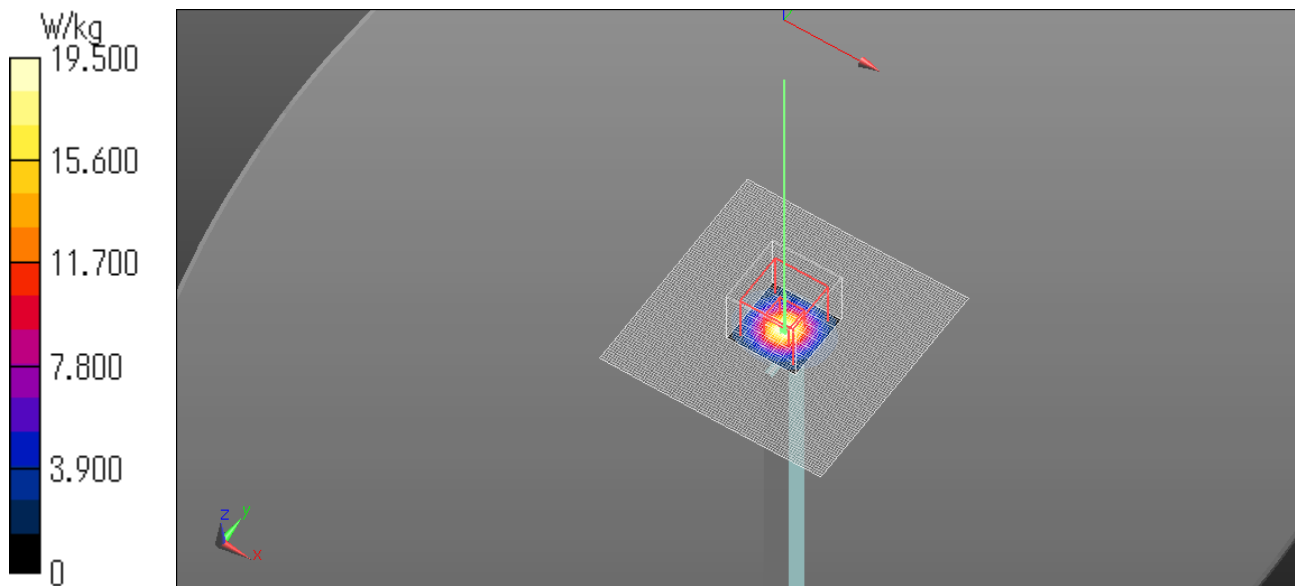
Maximum value of SAR (measured) = 19.5 W/kg

**Z Scan (1x1x31):** Measurement grid: dx=20mm, dy=20mm, dz=5mm

Maximum value of SAR (measured) = 4.32 W/kg

Date: 2017/06/27

Ambient Temp. : 24.0 degree.C. Liquid Temp.; 23.5 degree.C.



## **APPENDIX 2 : SAR Measurement data**

### **Evaluation procedure**

**The evaluation was performed with the following procedure:**

**Step 1:** Measurement of the E-field at a fixed location above the ear point or central position of flat phantom was used as a reference value for assessing the power drop.

**Step 2:** The SAR distribution at the exposed side of head or body position was measured at a distance of each device from the inner surface of the shell. The area covered the entire dimension of the antenna of EUT and the horizontal grid spacing was 15 mm x 15 mm, 12 mm x 12 mm or 10mm x 10mm. Based on these data, the area of the maximum absorption was determined by spline interpolation.

**Step 3:** Around this point found in the Step 2 (area scan), a volume of 30mm x 30mm x 30mm or more was assessed by measuring 7 x 7 x 7 points at least for below 3GHz and a volume of 28 mm x 28mm x 22.5mm or more was assessed by measuring 8 x 8 x 6(ratio step method (\*1)) points at least for 5GHz band.

And for any secondary peaks found in the Step2 which are within 2dB of maximum peak and not with this Step3 (Zoom scan) is repeated. On the basis of this data set, the spatial peak SAR value was evaluated under the following procedure:

(1). The data at the surface were extrapolated, since the center of the dipoles is 1mm(EX3DV4) away from the tip of the probe and the distance between the surface and the lowest measuring point is 1.3 mm. The extrapolation was based on a least square algorithm [4]. A polynomial of the fourth order was calculated through the points in z-axes. This polynomial was then used to evaluate the points between the surface and the probe tip.

(2). The maximum interpolated value was searched with a straightforward algorithm. Around this maximum the SAR values averaged over the spatial volumes (1 g or 10 g) were computed by the 3D-Spline interpolation algorithm. The 3D-Spline is composed of three one-dimensional splines with the "Not a knot"-condition (in x, y and z-directions) [4], [5]. The volume was integrated with the trapezoidal-algorithm. One thousand points (10 x 10 x 10) were interpolated to calculate the average.

(3). All neighboring volumes were evaluated until no neighboring volume with a higher average value was found.

#### **\*1. Ratio step method parameters used;**

**The first measurement point: 2mm from the phantom surface, the initial grid separation: 2mm, subsequent graded grid ratio: 1.5**

**These parameters comply with the requirement of the KDB 865664D01.**

**Step 4:** Re-measurement of the E-field at the same location as in Step 1.

Confirmation after SAR testing

It was checked that the power drift [W] is within +/-5%.The verification of power drift during the SAR test is that DASY5 system calculates the power drift by measuring the e-field at the same location at beginning and the end of the scan measurement for each test position.

DASY5 system calculation Power drift value[dB] =  $20\log(E_a)/(E_b)$

Before SAR testing :  $E_b[V/m]$

After SAR testing :  $E_a[V/m]$

Limit of power drift[W] = +/-5%

$X[dB]=10\log[P]=10\log(1.05/1)=10\log(1.05)-10\log(1)=0.212dB$

from E-field relations with power.

$p=E^2/\eta=E^2/377$

Therefore, The correlation of power and the E-field

$XdB=10\log(P)=10\log(E)^2=20\log(E)$

Therefore,

The calculated power drift of DASY5 System must be the less than +/-0.212dB.

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## Measurement data

### WLAN 2.4G Top 11b 1Mbps 0mm 2437MHz

Communication System: UID 0, WLAN (0); Communication System Band: 11b/g/n; Frequency: 2437 MHz; Duty Cycle: 1:1

Medium parameters used (interpolated):  $f = 2437$  MHz;  $\sigma = 1.901$  S/m;  $\epsilon_r = 51.024$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY5 Configuration

Probe: EX3DV4 - SN3917; ConvF(7.68, 7.68, 7.68); Calibrated: 2017/05/16;

Sensor-Surface: 2mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1369; Calibrated: 2017/05/12

Phantom: ELI v5.0 (30deg probe tilt); Type: QDOVA002AA; Serial: TP:1203

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Area Scan (61x101x1):** Interpolated grid:  $dx=1.200$  mm,  $dy=1.200$  mm

Maximum value of SAR (interpolated) = 0.339 W/kg

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

Reference Value = 16.83 V/m; Power Drift = -0.19 dB

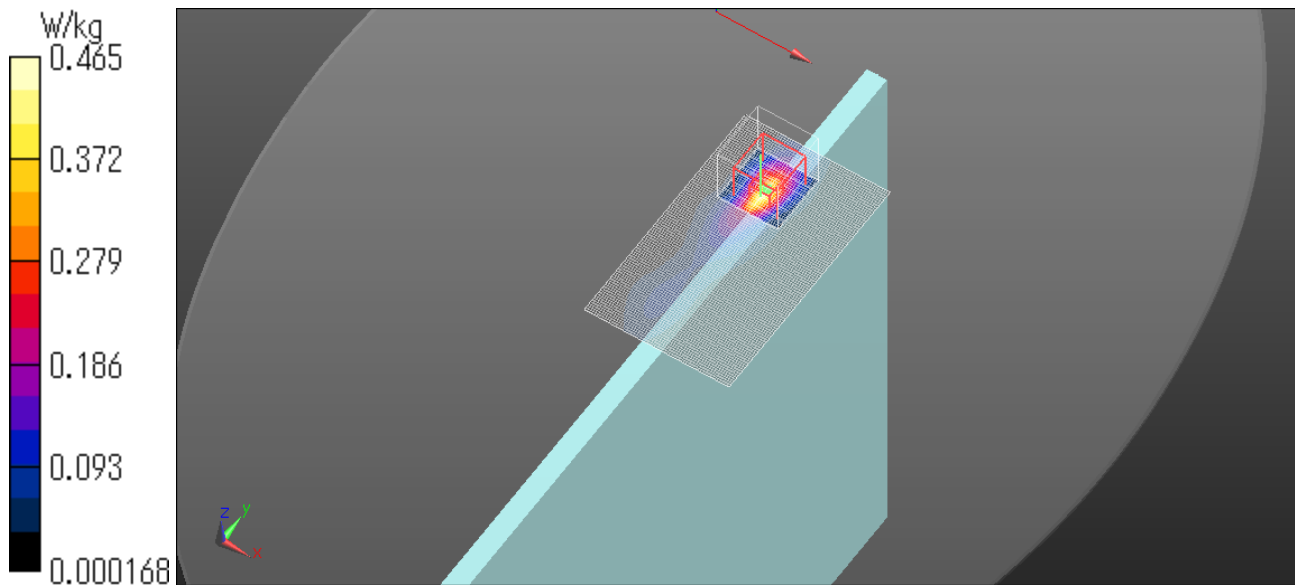
Peak SAR (extrapolated) = 0.673 W/kg

**SAR(1 g) = 0.252 W/kg; SAR(10 g) = 0.101 W/kg**

Maximum value of SAR (measured) = 0.465 W/kg

Date: 2017/06/26

Ambient Temp. : 24.0 degree.C. Liquid Temp.; 23.5 degree.C.



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### WLAN 2.4G Bottom 11b 1Mbps 0mm 2412MHz

Communication System: UID 0, WLAN (0); Communication System Band: 11b/g/n; Frequency: 2412 MHz; Duty Cycle: 1:1

Medium parameters used (interpolated):  $f = 2412$  MHz;  $\sigma = 1.869$  S/m;  $\epsilon_r = 51.08$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY5 Configuration

Probe: EX3DV4 - SN3917; ConvF(7.68, 7.68, 7.68); Calibrated: 2017/05/16;

Sensor-Surface: 2mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1369; Calibrated: 2017/05/12

Phantom: ELI v5.0 (30deg probe tilt); Type: QDOVA002AA; Serial: TP:1203

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Area Scan (61x101x1):** Interpolated grid:  $dx=1.200$  mm,  $dy=1.200$  mm

Maximum value of SAR (interpolated) = 1.45 W/kg

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

Reference Value = 31.07 V/m; Power Drift = -0.11 dB

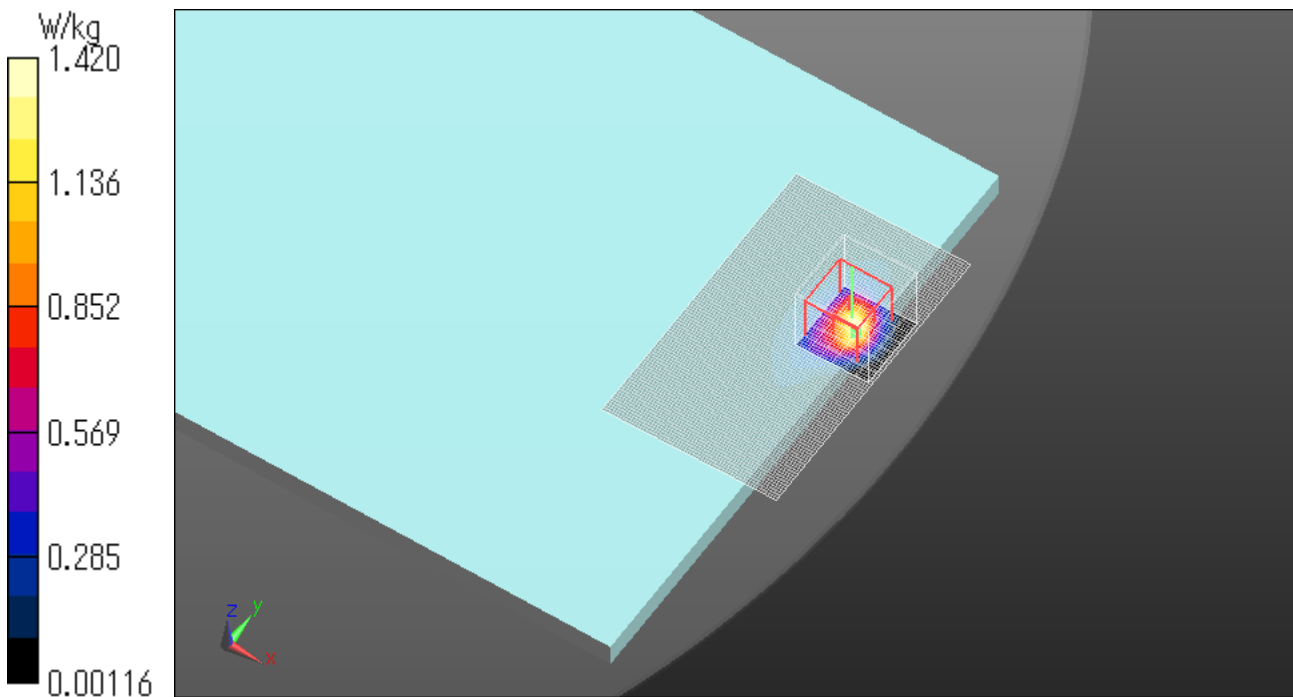
Peak SAR (extrapolated) = 2.48 W/kg

**SAR(1 g) = 0.818 W/kg; SAR(10 g) = 0.324 W/kg**

Maximum value of SAR (measured) = 1.42 W/kg

Date: 2017/06/26

Ambient Temp. : 24.0 degree.C. Liquid Temp.; 23.5 degree.C.



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### WLAN 2.4G Bottom 11b 1Mbps 0mm 2437MHz

Communication System: UID 0, WLAN (0); Communication System Band: 11b/g/n; Frequency: 2437 MHz; Duty Cycle: 1:1

Medium parameters used (interpolated):  $f = 2437$  MHz;  $\sigma = 1.901$  S/m;  $\epsilon_r = 51.024$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY5 Configuration

Probe: EX3DV4 - SN3917; ConvF(7.68, 7.68, 7.68); Calibrated: 2017/05/16;

Sensor-Surface: 2mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1369; Calibrated: 2017/05/12

Phantom: ELI v5.0 (30deg probe tilt); Type: QDOVA002AA; Serial: TP:1203

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Area Scan (61x101x1):** Interpolated grid:  $dx=1.200$  mm,  $dy=1.200$  mm

Maximum value of SAR (interpolated) = 1.53 W/kg

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

Reference Value = 31.74 V/m; Power Drift = -0.06 dB

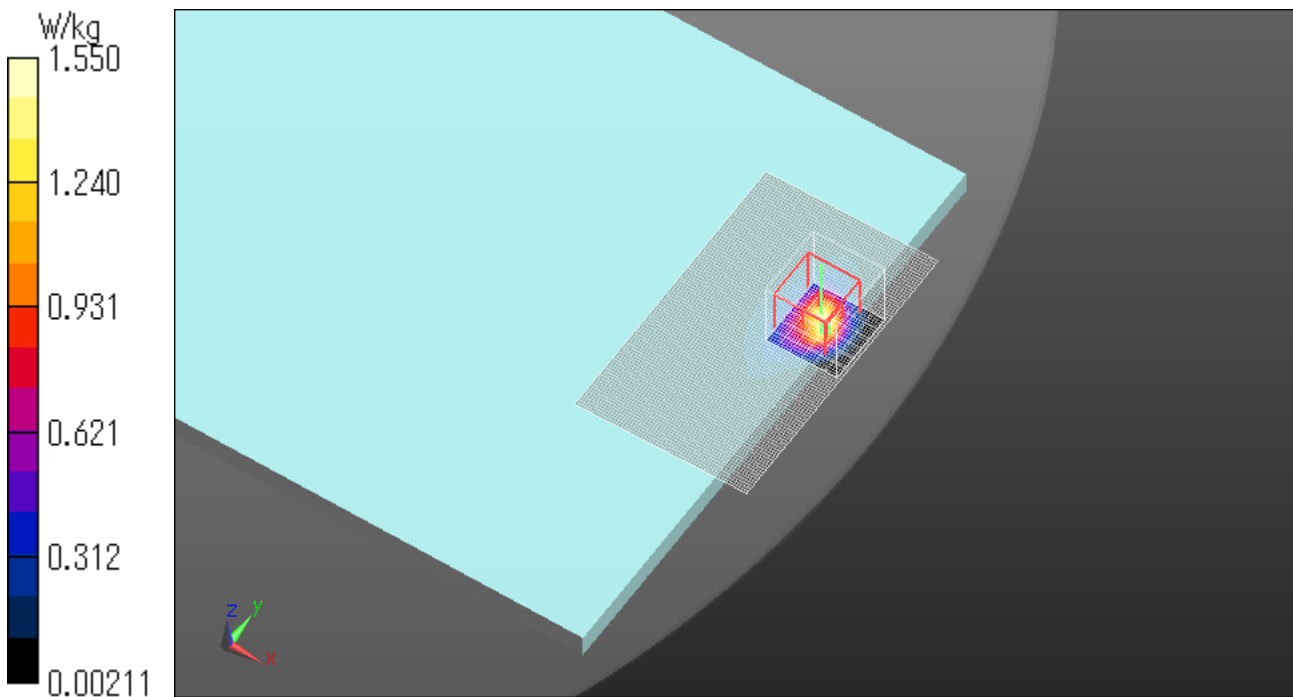
Peak SAR (extrapolated) = 2.67 W/kg

**SAR(1 g) = 0.881 W/kg; SAR(10 g) = 0.347 W/kg**

Maximum value of SAR (measured) = 1.55 W/kg

Date: 2017/06/26

Ambient Temp. : 24.0 degree.C. Liquid Temp.; 23.5 degree.C.



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**WLAN 2.4G Bottom tilt 11b 1Mbps 0mm 2412MHz**

Communication System: UID 0, WLAN (0); Communication System Band: 11b/g/n; Frequency: 2412 MHz; Duty Cycle: 1:1

Medium parameters used (interpolated):  $f = 2412 \text{ MHz}$ ;  $\sigma = 1.869 \text{ S/m}$ ;  $\epsilon_r = 51.08$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

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

DASY5 Configuration

Probe: EX3DV4 - SN3917; ConvF(7.68, 7.68, 7.68); Calibrated: 2017/05/16;

Sensor-Surface: 2mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1369; Calibrated: 2017/05/12

Phantom: ELI v5.0 (30deg probe tilt); Type: QDOVA002AA; Serial: TP:1203

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Area Scan (61x101x1):** Interpolated grid:  $dx=1.200 \text{ mm}$ ,  $dy=1.200 \text{ mm}$

Maximum value of SAR (interpolated) =  $1.22 \text{ W/kg}$

**Zoom Scan (7x7x7)/Cube 0:** Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$

Reference Value =  $27.53 \text{ V/m}$ ; Power Drift =  $-0.04 \text{ dB}$

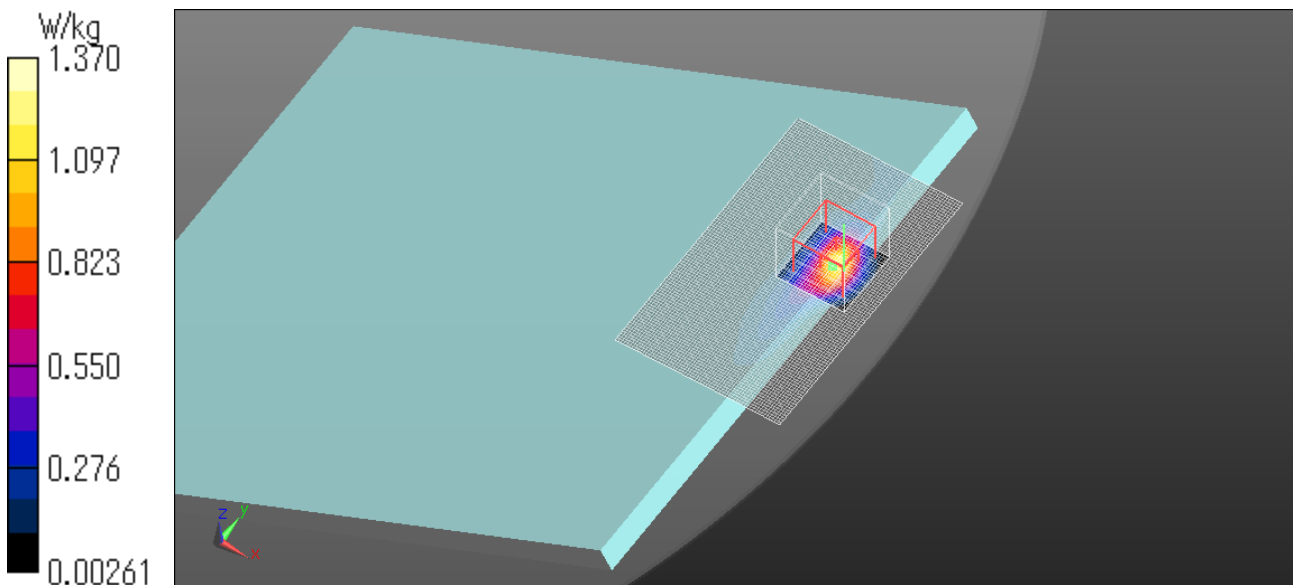
Peak SAR (extrapolated) =  $2.36 \text{ W/kg}$

**SAR(1 g) =  $0.757 \text{ W/kg}$ ; SAR(10 g) =  $0.294 \text{ W/kg}$**

Maximum value of SAR (measured) =  $1.37 \text{ W/kg}$

Date: 2017/06/26

Ambient Temp. :  $24.0 \text{ degree.C.}$  Liquid Temp.;  $23.5 \text{ degree.C.}$



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**WLAN 2.4G Bottom tilt 11b 1Mbps 0mm 2437MHz**

Communication System: UID 0, WLAN (0); Communication System Band: 11b/g/n; Frequency: 2437 MHz; Duty Cycle: 1:1

Medium parameters used (interpolated):  $f = 2437 \text{ MHz}$ ;  $\sigma = 1.901 \text{ S/m}$ ;  $\epsilon_r = 51.024$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

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

DASY5 Configuration

Probe: EX3DV4 - SN3917; ConvF(7.68, 7.68, 7.68); Calibrated: 2017/05/16;

Sensor-Surface: 2mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1369; Calibrated: 2017/05/12

Phantom: ELI v5.0 (30deg probe tilt); Type: QDOVA002AA; Serial: TP:1203

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Area Scan (61x101x1):** Interpolated grid:  $dx=1.200 \text{ mm}$ ,  $dy=1.200 \text{ mm}$

Maximum value of SAR (interpolated) =  $1.25 \text{ W/kg}$

**Zoom Scan (7x7x7)/Cube 0:** Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$

Reference Value =  $27.40 \text{ V/m}$ ; Power Drift =  $-0.05 \text{ dB}$

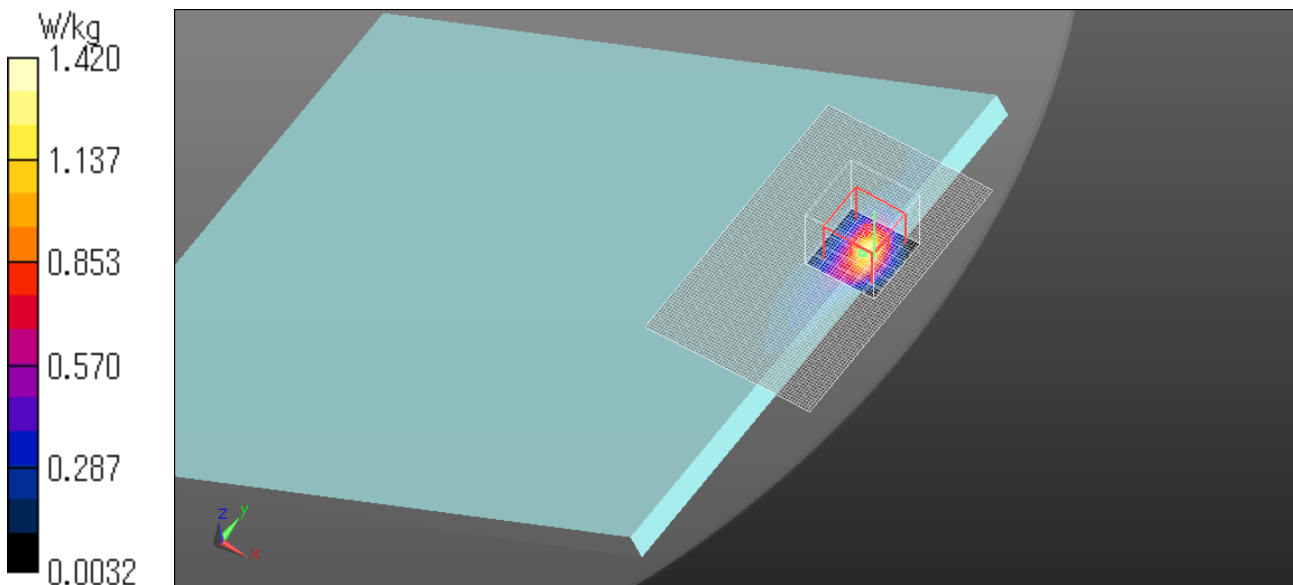
Peak SAR (extrapolated) =  $2.43 \text{ W/kg}$

**SAR(1 g) =  $0.775 \text{ W/kg}$ ; SAR(10 g) =  $0.299 \text{ W/kg}$**

Maximum value of SAR (measured) =  $1.42 \text{ W/kg}$

Date: 2017/06/26

Ambient Temp. :  $24.0 \text{ degree.C}$ . Liquid Temp.;  $23.5 \text{ degree.C}$ .



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### WLAN 5.3G Top 11n40 MCS0 0mm 5310MHz

Communication System: UID 0, WLAN 11a/b/g/n (0); Communication System Band: 11a/n (W52 53); Frequency: 5310 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 5310 \text{ MHz}$ ;  $\sigma = 5.583 \text{ S/m}$ ;  $\epsilon_r = 47.216$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

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

DASY5 Configuration

Probe: EX3DV4 - SN3825; ConvF(4.48, 4.48, 4.48); Calibrated: 2016/12/12;

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1369; Calibrated: 2017/05/12

Phantom: ELI v5.0 (30deg probe tilt); Type: QDOVA002AA; Serial: TP:1203

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Area Scan (71x121x1):** Interpolated grid:  $dx=1.000 \text{ mm}$ ,  $dy=1.000 \text{ mm}$

Maximum value of SAR (interpolated) =  $0.694 \text{ W/kg}$

**Zoom Scan (8x8x7)/Cube 0:** Measurement grid:  $dx=4\text{mm}$ ,  $dy=4\text{mm}$ ,  $dz=1.4\text{mm}$

Reference Value =  $13.72 \text{ V/m}$ ; Power Drift =  $0.03 \text{ dB}$

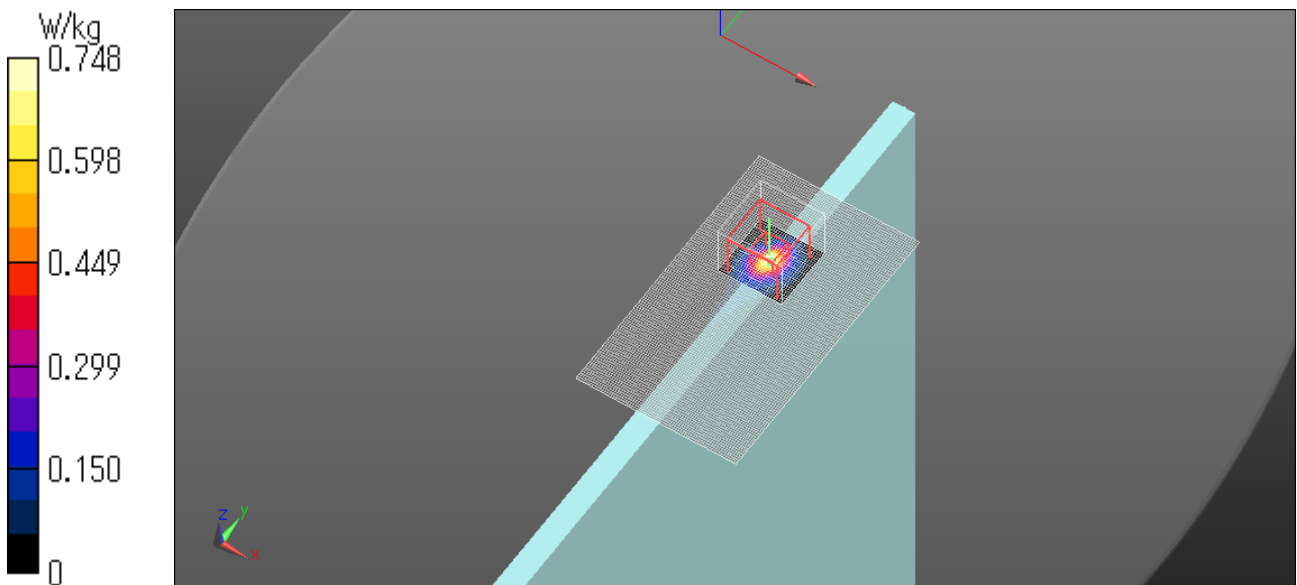
Peak SAR (extrapolated) =  $1.57 \text{ W/kg}$

**SAR(1 g) =  $0.262 \text{ W/kg}$ ; SAR(10 g) =  $0.054 \text{ W/kg}$**

Maximum value of SAR (measured) =  $0.748 \text{ W/kg}$

Date: 2017/06/27

Ambient Temp. :  $24.0 \text{ degree.C}$ . Liquid Temp.;  $23.5 \text{ degree.C}$ .



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### WLAN 5.3G Bottom 11n40 MCS0 0mm 5310MHz

Communication System: UID 0, WLAN 11a/b/g/n (0); Communication System Band: 11a/n (W52 53); Frequency: 5310 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 5310$  MHz;  $\sigma = 5.583$  S/m;  $\epsilon_r = 47.216$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY5 Configuration

Probe: EX3DV4 - SN3825; ConvF(4.48, 4.48, 4.48); Calibrated: 2016/12/12;

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1369; Calibrated: 2017/05/12

Phantom: ELI v5.0 (30deg probe tilt); Type: QDOVA002AA; Serial: TP:1203

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Area Scan (71x121x1):** Interpolated grid:  $dx=1.000$  mm,  $dy=1.000$  mm

Maximum value of SAR (interpolated) = 1.43 W/kg

**Zoom Scan (8x8x7)/Cube 0:** Measurement grid:  $dx=4$ mm,  $dy=4$ mm,  $dz=1.4$ mm

Reference Value = 17.81 V/m; Power Drift = -0.17 dB

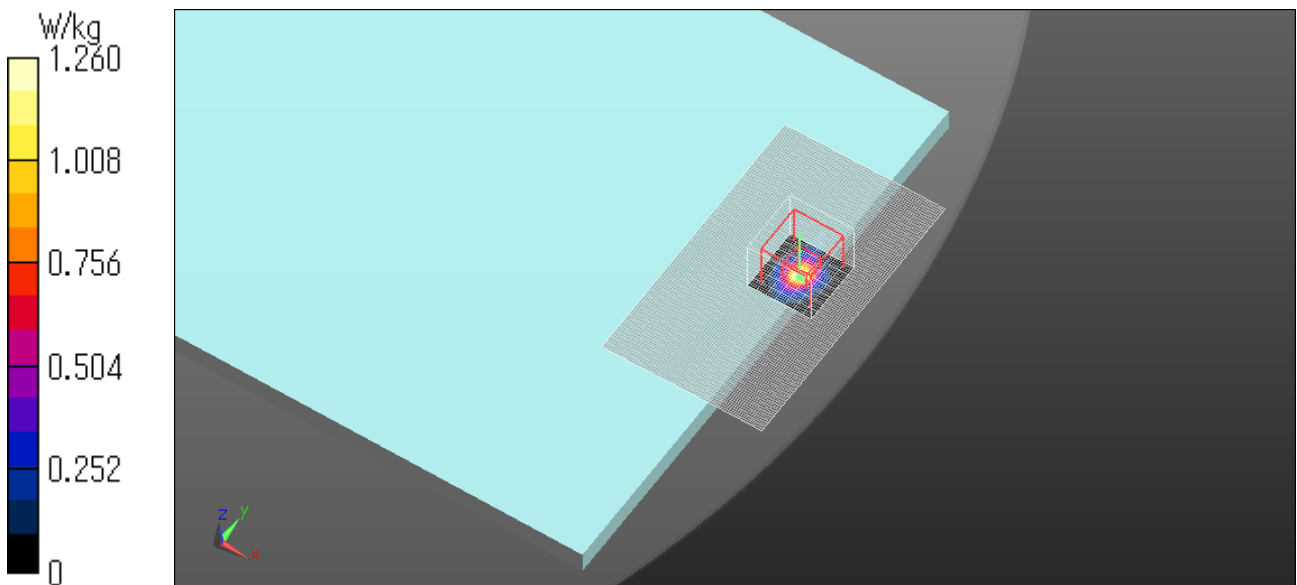
Peak SAR (extrapolated) = 2.53 W/kg

**SAR(1 g) = 0.424 W/kg; SAR(10 g) = 0.084 W/kg**

Maximum value of SAR (measured) = 1.26 W/kg

Date: 2017/06/27

Ambient Temp. : 24.0 degree.C. Liquid Temp.; 23.5 degree.C.



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**WLAN 5.3G Bottom tilt 11n40 MCS0 0mm 5270MHz**

Communication System: UID 0, WLAN 11a/b/g/n (0); Communication System Band: 11a/n (W52 53); Frequency: 5270 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 5270$  MHz;  $\sigma = 5.581$  S/m;  $\epsilon_r = 47.401$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY5 Configuration

Probe: EX3DV4 - SN3825; ConvF(4.48, 4.48, 4.48); Calibrated: 2016/12/12;

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1369; Calibrated: 2017/05/12

Phantom: ELI v5.0 (30deg probe tilt); Type: QDOVA002AA; Serial: TP:1203

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Area Scan (71x121x1):** Interpolated grid:  $dx=1.000$  mm,  $dy=1.000$  mm

Maximum value of SAR (interpolated) = 2.24 W/kg

**Zoom Scan (8x8x7)/Cube 0:** Measurement grid:  $dx=4$ mm,  $dy=4$ mm,  $dz=1.4$ mm

Reference Value = 24.07 V/m; Power Drift = -0.06 dB

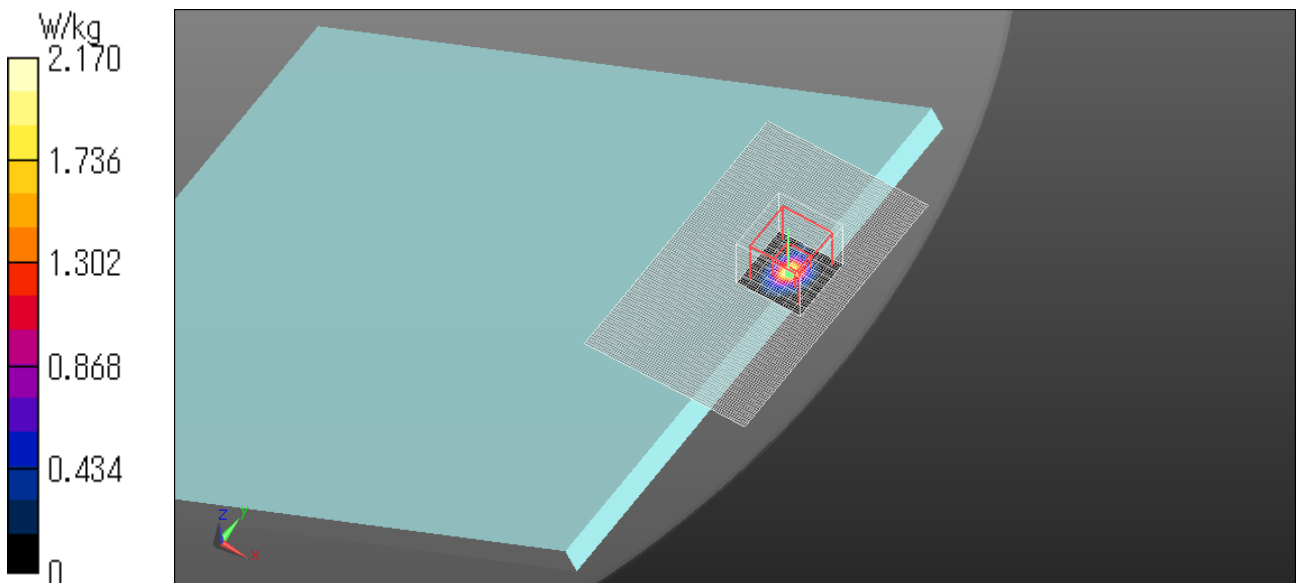
Peak SAR (extrapolated) = 4.75 W/kg

**SAR(1 g) = 0.719 W/kg; SAR(10 g) = 0.127 W/kg**

Maximum value of SAR (measured) = 2.17 W/kg

Date: 2017/06/27

Ambient Temp. : 24.0 degree.C. Liquid Temp.; 23.5 degree.C.



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### WLAN 5.3G Bottom tilt 11n40 MCS0 0mm 5310MHz

Communication System: UID 0, WLAN 11a/b/g/n (0); Communication System Band: 11a/n (W52 53); Frequency: 5310 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 5310$  MHz;  $\sigma = 5.583$  S/m;  $\epsilon_r = 47.216$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY5 Configuration

Probe: EX3DV4 - SN3825; ConvF(4.48, 4.48, 4.48); Calibrated: 2016/12/12;

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1369; Calibrated: 2017/05/12

Phantom: ELI v5.0 (30deg probe tilt); Type: QDOVA002AA; Serial: TP:1203

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Area Scan (71x121x1):** Interpolated grid:  $dx=1.000$  mm,  $dy=1.000$  mm

Maximum value of SAR (interpolated) = 1.73 W/kg

**Zoom Scan (8x8x7)/Cube 0:** Measurement grid:  $dx=4$ mm,  $dy=4$ mm,  $dz=1.4$ mm

Reference Value = 25.30 V/m; Power Drift = -0.10 dB

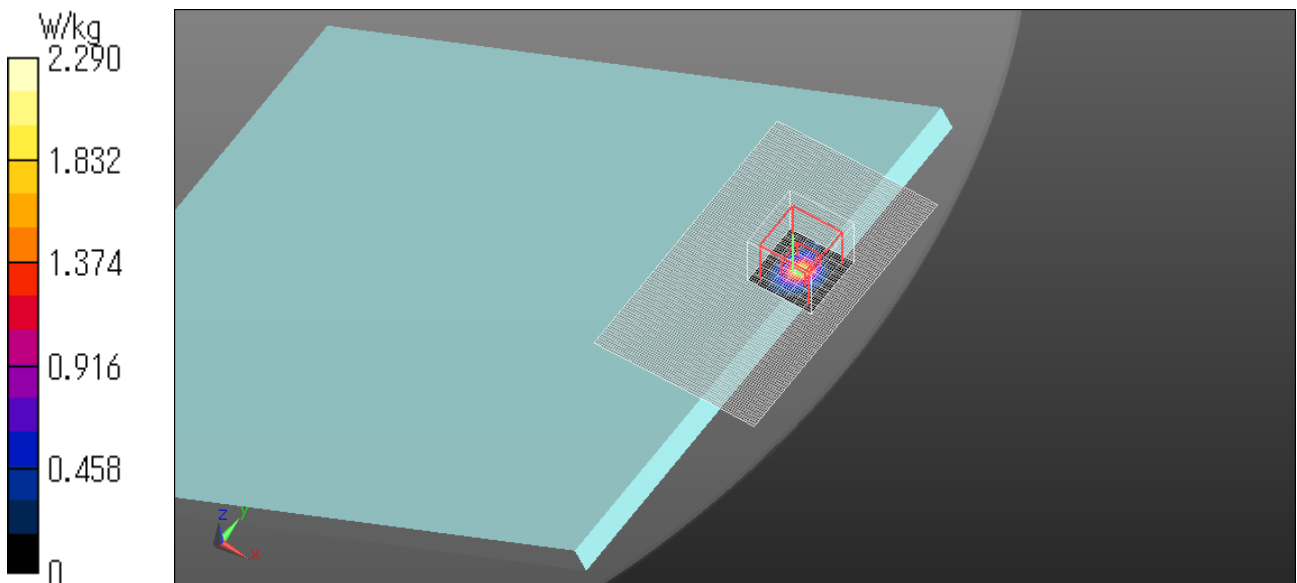
Peak SAR (extrapolated) = 5.11 W/kg

**SAR(1 g) = 0.762 W/kg; SAR(10 g) = 0.133 W/kg**

Maximum value of SAR (measured) = 2.29 W/kg

Date: 2017/06/27

Ambient Temp. : 24.0 degree.C. Liquid Temp.; 23.5 degree.C.



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### WLAN 5.5G Top 11n40 MCS0 0mm 5550MHz

Communication System: UID 0, WLAN 11a/b/g/n (0); Communication System Band: 11a/n (W56); Frequency: 5550 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 5550$  MHz;  $\sigma = 5.834$  S/m;  $\epsilon_r = 47.271$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY5 Configuration

Probe: EX3DV4 - SN3825; ConvF(3.89, 3.89, 3.89); Calibrated: 2016/12/12;

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1369; Calibrated: 2017/05/12

Phantom: ELI v5.0 (30deg probe tilt); Type: QDOVA002AA; Serial: TP:1203

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Area Scan (71x121x1):** Interpolated grid:  $dx=1.000$  mm,  $dy=1.000$  mm

Maximum value of SAR (interpolated) = 0.903 W/kg

**Zoom Scan (8x8x7)/Cube 0:** Measurement grid:  $dx=4$ mm,  $dy=4$ mm,  $dz=1.4$ mm

Reference Value = 15.17 V/m; Power Drift = 0.08 dB

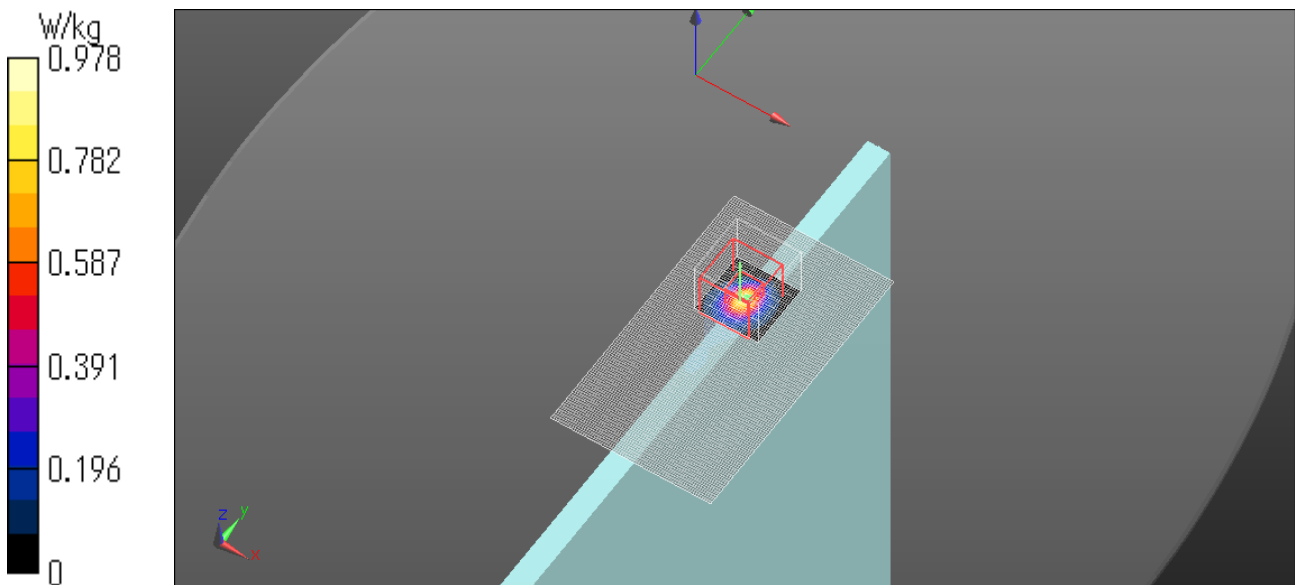
Peak SAR (extrapolated) = 1.70 W/kg

**SAR(1 g) = 0.319 W/kg; SAR(10 g) = 0.066 W/kg**

Maximum value of SAR (measured) = 0.978 W/kg

Date: 2017/06/27

Ambient Temp. : 24.0 degree.C. Liquid Temp.; 23.5 degree.C.



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### WLAN 5.5G Bottom 11n40 MCS0 0mm 5550MHz

Communication System: UID 0, WLAN 11a/b/g/n (0); Communication System Band: 11a/n (W56); Frequency: 5550 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 5550$  MHz;  $\sigma = 5.834$  S/m;  $\epsilon_r = 47.271$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY5 Configuration

Probe: EX3DV4 - SN3825; ConvF(3.89, 3.89, 3.89); Calibrated: 2016/12/12;

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1369; Calibrated: 2017/05/12

Phantom: ELI v5.0 (30deg probe tilt); Type: QDOVA002AA; Serial: TP:1203

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Area Scan (71x121x1):** Interpolated grid:  $dx=1.000$  mm,  $dy=1.000$  mm

Maximum value of SAR (interpolated) = 1.50 W/kg

**Zoom Scan (8x8x7)/Cube 0:** Measurement grid:  $dx=4$ mm,  $dy=4$ mm,  $dz=1.4$ mm

Reference Value = 19.24 V/m; Power Drift = -0.13 dB

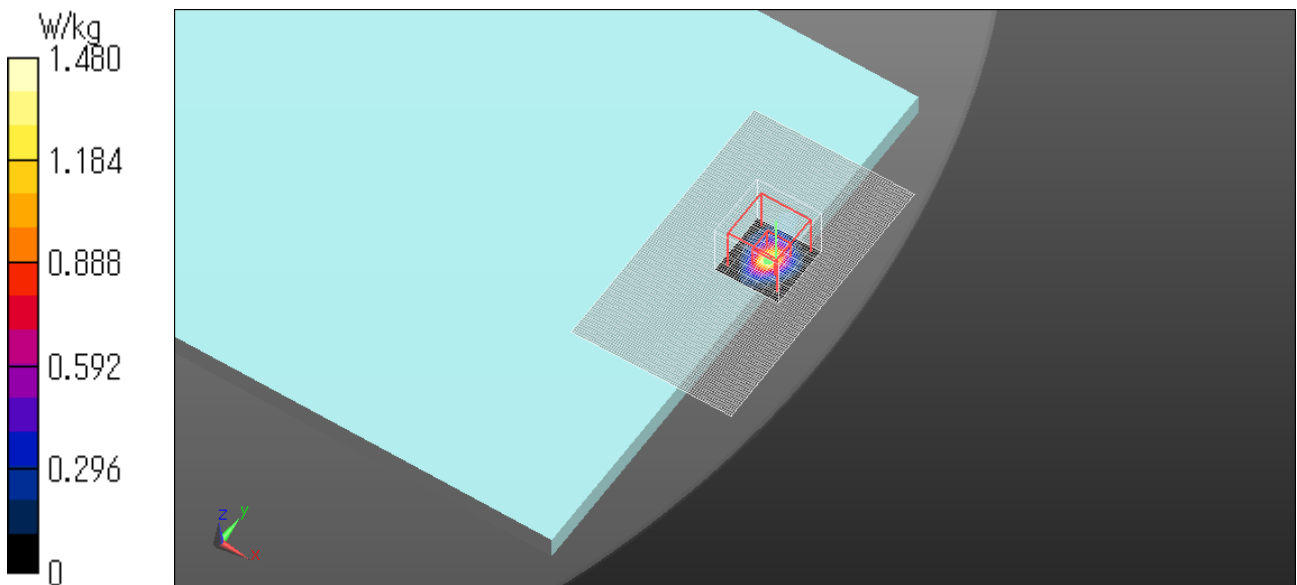
Peak SAR (extrapolated) = 2.95 W/kg

**SAR(1 g) = 0.489 W/kg; SAR(10 g) = 0.099 W/kg**

Maximum value of SAR (measured) = 1.48 W/kg

Date: 2017/06/27

Ambient Temp. : 24.0 degree.C. Liquid Temp.; 23.5 degree.C.



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**WLAN 5.5G Bottom tilt 11n40 MCS0 0mm 5550MHz**

Communication System: UID 0, WLAN 11a/b/g/n (0); Communication System Band: 11a/n (W56); Frequency: 5550 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 5550$  MHz;  $\sigma = 5.834$  S/m;  $\epsilon_r = 47.271$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY5 Configuration

Probe: EX3DV4 - SN3825; ConvF(3.89, 3.89, 3.89); Calibrated: 2016/12/12;

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1369; Calibrated: 2017/05/12

Phantom: ELI v5.0 (30deg probe tilt); Type: QDOVA002AA; Serial: TP:1203

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Area Scan (71x121x1):** Interpolated grid:  $dx=1.000$  mm,  $dy=1.000$  mm

Maximum value of SAR (interpolated) = 2.57 W/kg

**Zoom Scan (8x8x7)/Cube 0:** Measurement grid:  $dx=4$ mm,  $dy=4$ mm,  $dz=1.4$ mm

Reference Value = 26.97 V/m; Power Drift = -0.10 dB

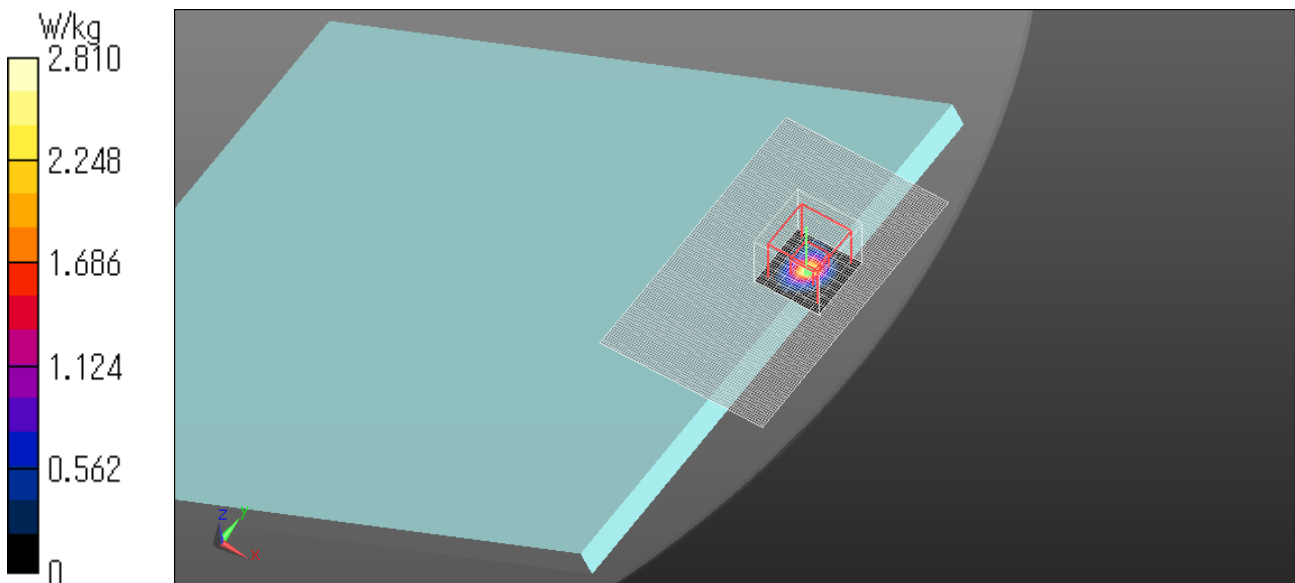
Peak SAR (extrapolated) = 6.17 W/kg

**SAR(1 g) = 0.900 W/kg; SAR(10 g) = 0.159 W/kg**

Maximum value of SAR (measured) = 2.81 W/kg

Date: 2017/06/27

Ambient Temp. : 24.0 degree.C. Liquid Temp.; 23.5 degree.C.



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**WLAN 5.5G Bottom tilt 11n40 MCS0 0mm 5670MHz**

Communication System: UID 0, WLAN 11a/b/g/n (0); Communication System Band: 11a/n (W56); Frequency: 5670 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 5670$  MHz;  $\sigma = 6.012$  S/m;  $\epsilon_r = 46.913$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY5 Configuration

Probe: EX3DV4 - SN3825; ConvF(3.89, 3.89, 3.89); Calibrated: 2016/12/12;

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1369; Calibrated: 2017/05/12

Phantom: ELI v5.0 (30deg probe tilt); Type: QDOVA002AA; Serial: TP:1203

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Area Scan (71x121x1):** Interpolated grid:  $dx=1.000$  mm,  $dy=1.000$  mm

Maximum value of SAR (interpolated) = 2.70 W/kg

**Zoom Scan (8x8x7)/Cube 0:** Measurement grid:  $dx=4$ mm,  $dy=4$ mm,  $dz=1.4$ mm

Reference Value = 24.63 V/m; Power Drift = -0.09 dB

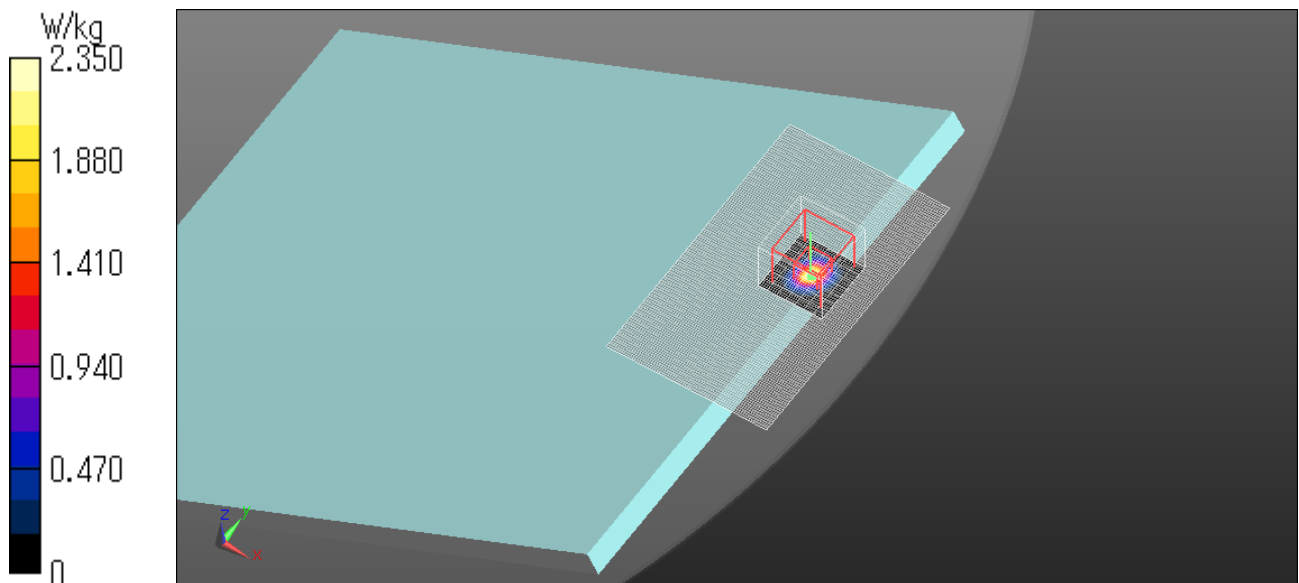
Peak SAR (extrapolated) = 5.56 W/kg

**SAR(1 g) = 0.741 W/kg; SAR(10 g) = 0.124 W/kg**

Maximum value of SAR (measured) = 2.35 W/kg

Date: 2017/06/27

Ambient Temp. : 24.0 degree.C. Liquid Temp.; 23.5 degree.C.



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**WLAN 2.4G Bottom 11b 1Mbps 0mm 2437MHz Repeat**

Communication System: UID 0, WLAN (0); Communication System Band: 11b/g/n; Frequency: 2437 MHz; Duty Cycle: 1:1

Medium parameters used (interpolated):  $f = 2437 \text{ MHz}$ ;  $\sigma = 1.901 \text{ S/m}$ ;  $\epsilon_r = 51.024$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

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

DASY5 Configuration

Probe: EX3DV4 - SN3917; ConvF(7.68, 7.68, 7.68); Calibrated: 2017/05/16;

Sensor-Surface: 2mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1369; Calibrated: 2017/05/12

Phantom: ELI v5.0 (30deg probe tilt); Type: QDOVA002AA; Serial: TP:1203

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Area Scan (61x101x1):** Interpolated grid:  $dx=1.200 \text{ mm}$ ,  $dy=1.200 \text{ mm}$

Maximum value of SAR (interpolated) =  $1.84 \text{ W/kg}$

**Zoom Scan (7x7x7)/Cube 0:** Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$

Reference Value =  $31.03 \text{ V/m}$ ; Power Drift =  $-0.04 \text{ dB}$

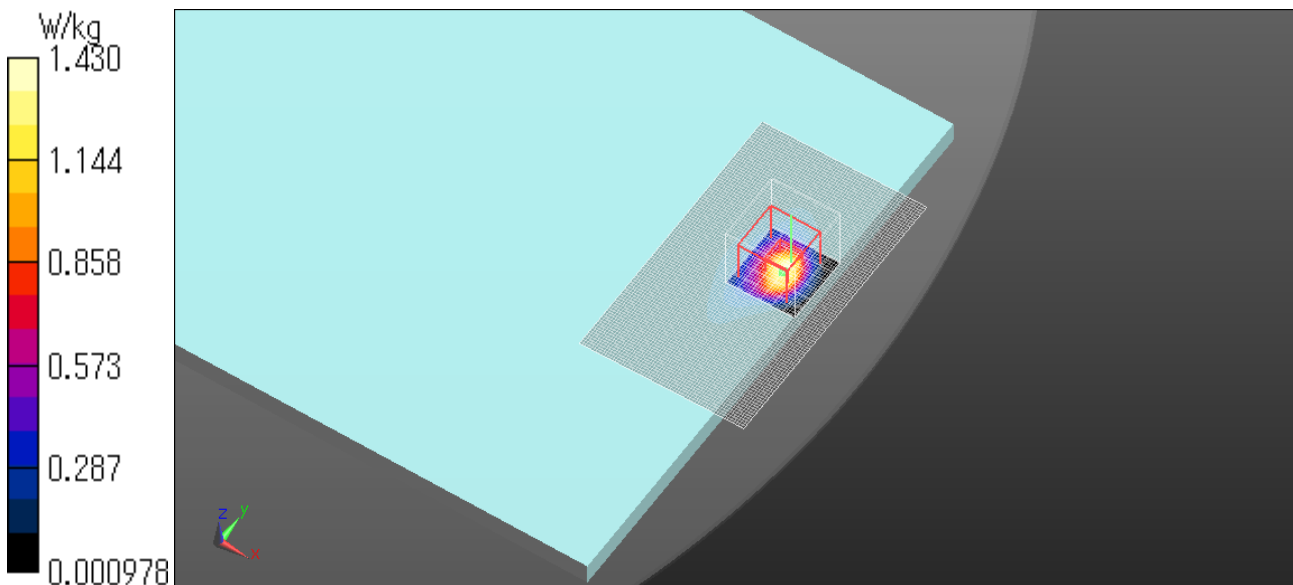
Peak SAR (extrapolated) =  $2.52 \text{ W/kg}$

**SAR(1 g) =  $0.819 \text{ W/kg}$ ; SAR(10 g) =  $0.313 \text{ W/kg}$**

Maximum value of SAR (measured) =  $1.43 \text{ W/kg}$

Date: 2017/06/26

Ambient Temp. :  $24.0 \text{ degree.C}$ . Liquid Temp.;  $23.5 \text{ degree.C}$ .



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### WLAN 5.5G Bottom tilt 11n40 MCS0 0mm 5550MHz Repeat

Communication System: UID 0, WLAN 11a/b/g/n (0); Communication System Band: 11a/n (W56); Frequency: 5550 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 5550$  MHz;  $\sigma = 5.834$  S/m;  $\epsilon_r = 47.271$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY5 Configuration

Probe: EX3DV4 - SN3825; ConvF(3.89, 3.89, 3.89); Calibrated: 2016/12/12;

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1369; Calibrated: 2017/05/12

Phantom: ELI v5.0 (30deg probe tilt); Type: QDOVA002AA; Serial: TP:1203

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Area Scan (71x121x1):** Interpolated grid:  $dx=1.000$  mm,  $dy=1.000$  mm

Maximum value of SAR (interpolated) = 2.84 W/kg

**Zoom Scan (8x8x7)/Cube 0:** Measurement grid:  $dx=4$ mm,  $dy=4$ mm,  $dz=1.4$ mm

Reference Value = 26.39 V/m; Power Drift = -0.07 dB

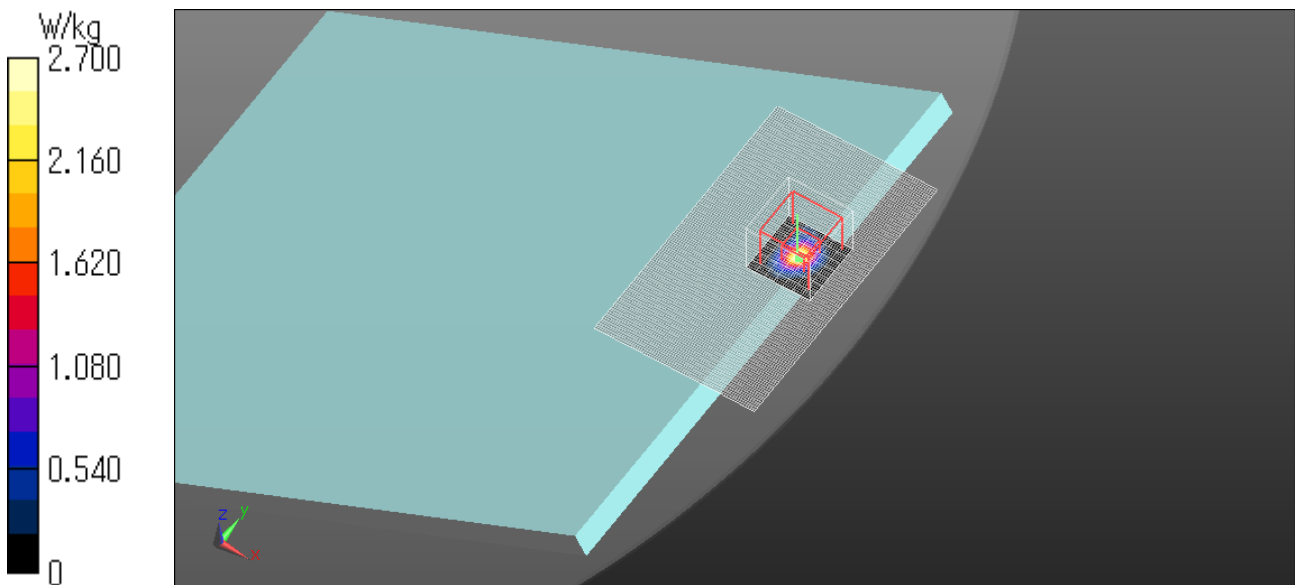
Peak SAR (extrapolated) = 5.96 W/kg

**SAR(1 g) = 0.862 W/kg; SAR(10 g) = 0.151 W/kg**

Maximum value of SAR (measured) = 2.70 W/kg

Date: 2017/06/27

Ambient Temp. : 24.0 degree.C. Liquid Temp.; 23.5 degree.C.



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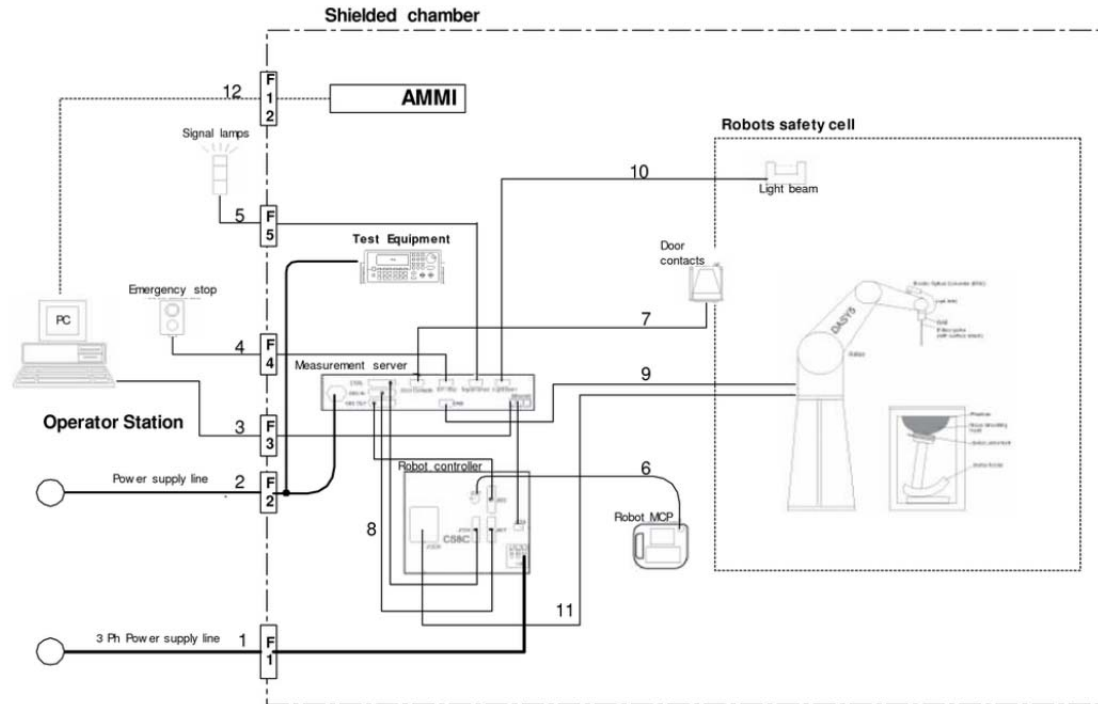
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## APPENDIX 3 : System specifications

### Configuration and peripherals



The DASYS system for performing compliance tests consist of the following items:

- A standard high precision 6-axis robot (Stäubli RX family) with controller and software.  
An arm extension for accommodating the data acquisition electronics (DAE).
- An isotropic field probe optimized and calibrated for the targeted measurement.
- A data acquisition electronic (DAE), which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
- The Electro-optical converter (EOC) performs the conversion between optical and electrical of the signals for the digital communication to the DAE and for the analog signal from the optical surface detection.  
The EOC is connected 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 DASYS software.
- Remote control with teaches pendant and additional circuitry for robot safety such as warning lamps, etc.
- The phantom, the device holder and other accessories according to the targeted measurement.

## Specifications

### **a)Robot TX60L**

Number of Axes	:	6
Nominal Load	:	2 kg
Maximum Load	:	5kg
Reach	:	920mm
Repeatability	:	+/-0.03mm
Control Unit	:	CS8c
Programming Language	:	VAL3
Weight	:	52.2kg
Manufacture	:	Stäubli Robotics

### **b)E-Field Probe**

Model	:	EX3DV4
Construction	:	Symmetrical design with triangular core Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., glycol ether)
Frequency	:	10 MHz to > 6 GHz Linearity: $\pm 0.2$ dB (30 MHz to 6 GHz)
Directivity	:	+/-0.3 dB in HSL (rotation around probe axis) +/-0.5 dB in tissue material (rotation normal probe axis)
Dynamic Range	:	10uW/g to > 100 mW/g;Linearity +/-0.2 dB(noise: typically < 1uW/g)
Dimensions	:	Overall length: 337 mm (Tip: 20 mm) Tip diameter: 2.5mm (Body: 12 mm) Typical distance from probe tip to dipole centers: 1 mm
Application	:	Highprecision dosimetric measurement in any exposure scenario (e.g., very strong gradient fields).Only probe which enables compliance testing for frequencies up to 6GHz with precision of better 30%.
Manufacture	:	Schmid & Partner Engineering AG



**EX3DV4 E-field Probe**

#### **c)Data Acquisition Electronic (DAE4)**

<b>Features</b>	:	Signal amplifier, multiplexer, A/D converter and control logic Serial optical link for communication with DASY5 embedded system (fully remote controlled) Two step probe touch detector for mechanical surface detection and emergency robot stop
<b>Measurement Range</b>	:	-100 to +300 mV (16 bit resolution and two range settings: 4mV, 400mV)
<b>Input Offset voltage</b>	:	< 5 $\mu$ V (with auto zero)
<b>Input Resistance</b>	:	200 M $\Omega$
<b>Input Bias Current</b>	:	< 50 fA
<b>Battery Power</b>	:	> 10 h of operation (with two 9.6 V NiMH accus)
<b>Dimension</b>	:	60 x 60 x 68 mm
<b>Manufacture</b>	:	Schmid & Partner Engineering AG

#### **d)Electro-Optic Converter (EOC)**

<b>Version</b>	:	EOC 61
<b>Description</b>	:	for TX60 robot arm, including proximity sensor
<b>Manufacture</b>	:	Schmid & Partner Engineering AG

#### **e)DASY5 Measurement server**

<b>Features</b>	:	Intel ULV Celeron 400MHz 128MB chip disk and 128MB RAM 16 Bit A/D converter for surface detection system Vacuum Fluorescent Display Robot Interface Serial link to DAE (with watchdog supervision) Door contact port (Possibility to connect a light curtain) Emergency stop port (to connect the remote control) Signal lamps port Light beam port Three Ethernet connection ports Two USB 2.0 Ports Two serial links Expansion port for future applications
<b>Dimensions (L x W x H)</b>	:	440 x 241 x 89 mm
<b>Manufacture</b>	:	Schmid & Partner Engineering AG

#### **f) Light Beam Switches**

<b>Version</b>	:	LB5
<b>Dimensions (L x H)</b>	:	110 x 80 mm
<b>Thickness</b>	:	12 mm
<b>Beam-length</b>	:	80 mm
<b>Manufacture</b>	:	Schmid & Partner Engineering AG

#### **g)Software**

<b>Item</b>	:	Dosimetric Assessment System DASY5
<b>Type No.</b>	:	SD 000 401A, SD 000 402A
<b>Software version No.</b>	:	DASY52, Version 52.6 (1)
<b>Manufacture / Origin</b>	:	Schmid & Partner Engineering AG

#### **h)Robot Control Unit**

<b>Weight</b>	:	70 Kg
<b>AC Input Voltage</b>	:	selectable
<b>Manufacturer</b>	:	Stäubli Robotics



## **i)Phantom and Device Holder**

### **Phantom**

<b>Type</b>	:	SAM Twin Phantom V4.0
<b>Description</b>	:	The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (SAM) phantom defined in IEEE 1528 and IEC 62209-1. It enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region. A cover prevents evaporation of the liquid. Reference markings on the phantom allow the complete setup of all predefined phantom positions and measurement grids by teaching three points with the robot.
<b>Material</b>	:	Vinylester, glass fiber reinforced (VE-GF)
<b>Shell Material</b>	:	Fiberglass
<b>Thickness</b>	:	2.0 +/-0.2 mm
<b>Dimensions</b>	:	Length: 1000 mm Width: 500 mm Height: adjustable feet
<b>Volume</b>	:	Approx. 25 liters
<b>Manufacture</b>	:	Schmid & Partner Engineering AG

<b>Type</b>	:	2mm Flat phantom ERI4.0
<b>Description</b>	:	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 DASY4.5 and higher and is compatible with all SPEAG dosimetric probes and dipoles.
<b>Material</b>	:	Vinylester, glass fiber reinforced (VE-GF)
<b>Shell Thickness</b>	:	2.0 ± 0.2 mm (sagging: <1%)
<b>Filling Volume</b>	:	approx. 30 liters
<b>Dimensions</b>	:	Major ellipse axis: 600 mm Minor axis: 400 mm
<b>Manufacture</b>	:	Schmid & Partner Engineering AG

### **Device Holder**

In combination with the Twin SAM Phantom V4.0/V4.0c or ELI4, the Mounting Device enables the rotation of the mounted transmitter device in spherical coordinates. Rotation point is the ear opening point. Transmitter devices can be easily and accurately positioned according to IEC, IEEE, FCC or other specifications. The device holder can be locked for positioning at different phantom sections (left head, right head, flat).

<b>Material</b>	:	POM
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### **Laptio Extensions kit**

Simple but effective and easy-to-use extension for Mounting Device that facilitates the testing of larger devices according to IEC 62209-2 (e.g., laptops, cameras, etc.). It is lightweight and 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, ELI4 Phantoms.

<b>Material</b>	:	POM, Acrylic glass, Foam
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### **Urethane**

For this measurement, the urethane foam was used as device holder.

#### j) Simulated Tissues (Liquid)

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

Mixture (%)	Frequency (MHz)									
	450		900		1800		1950		2450	
Tissue Type	Head	Body	Head	Body	Head	Body	Head	Body	Head	Body
Water	38.91	46.21	40.29	50.75	55.24	70.17	55.41	69.79	55.0	68.64
Sugar	56.93	51.17	57.90	48.21	-	-	-	-	-	-
Cellulose	0.25	0.18	0.24	0.00	-	-	-	-	-	-
Salt (NaCl)	3.79	2.34	1.38	0.94	0.31	0.39	0.08	0.2	-	-
Preventol	0.12	0.08	0.18	0.10	-	-	-	-	-	-
DGMBE	-	-	-	-	44.45	29.44	44.51	30.0	45.0	31.37
Dielectric Constant	43.42	58.0	42.54	56.1	42.0	56.8	39.9	54.0	39.8	52.5
Conductivity (S/m)	0.85	0.83	0.91	0.95	1.0	1.07	1.42	1.45	1.88	1.78

Note: DGMBE (Diethylenglycol-monobutyl ether)

The simulated tissue (liquid) of 1800MHz was used for the test frequency of 1700MHz to 1800MHz.

Mixture (%)	Frequency (MHz)	
	650&750	1450
Tissue Type	Head and Body	Head and Body
Water	35-58%	52-75%
Sugar	40-60%	-
Cellulose	<0.3%	-
Salt (NaCl)	0-6%	<1%
Preventol	0.1-0.7%	-
DGMBE	-	25-48%

Mixture (%)	Frequency (MHz)	
	5800	
Tissue Type	Head	Body
Water	64.0	78.0
Mineral Oil	18.0	11.0
Emulsifiers	15.0	9.0
Additives and salt	3.0	2.0

## System Check Dipole SAR Calibration Certificate -Dipole 2450MHz(D2450V2,S/N:713)

**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

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

Accreditation No.: **SCS 0108**

Client **UL Japan (Vitec)**

Certificate No: **D2450V2-713\_Sep16**

### CALIBRATION CERTIFICATE

Object **D2450V2 - SN:713**

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

Calibration date: **September 13, 2016**

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter 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: 7349	15-Jun-16 (No. EX3-7349_Jun16)	Jun-17
DAE4	SN: 601	30-Dec-15 (No. DAE4-601_Dec15)	Dec-16
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter EPM-442A	SN: GB37480704	07-Oct-15 (No. 217-02222)	In house check: Oct-16
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (No. 217-02222)	In house check: Oct-16
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (No. 217-02223)	In house check: Oct-16
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Jun-15)	In house check: Oct-16
Network Analyzer HP 8753E	SN: US37390585	18-Oct-01 (in house check Oct-15)	In house check: Oct-16

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

Issued: September 13, 2016

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

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



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

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

Accreditation No.: **SCS 0108**

**Glossary:**

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

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

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

**Additional Documentation:**

- DASY4/5 System Handbook

**Methods Applied and Interpretation of Parameters:**

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

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

### Measurement Conditions

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

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

### Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.2	1.80 mho/m
Measured Head TSL parameters	(22.0 $\pm$ 0.2) °C	37.9 $\pm$ 6 %	1.88 mho/m $\pm$ 6 %
Head TSL temperature change during test	< 0.5 °C	----	-----

### SAR result with Head TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.4 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	52.1 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.23 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	24.5 W/kg $\pm$ 16.5 % (k=2)

### Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	52.7	1.95 mho/m
Measured Body TSL parameters	(22.0 $\pm$ 0.2) °C	51.6 $\pm$ 6 %	2.04 mho/m $\pm$ 6 %
Body TSL temperature change during test	< 0.5 °C	----	-----

### SAR result with Body TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	13.0 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	50.7 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR measured	250 mW input power	6.11 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	24.1 W/kg $\pm$ 16.5 % (k=2)

#### Appendix (Additional assessments outside the scope of SCS 0108)

##### Antenna Parameters with Head TSL

Impedance, transformed to feed point	$53.0\ \Omega + 2.3\ j\Omega$
Return Loss	- 28.8 dB

##### Antenna Parameters with Body TSL

Impedance, transformed to feed point	$49.6\ \Omega + 3.7\ j\Omega$
Return Loss	- 28.5 dB

##### General Antenna Parameters and Design

Electrical Delay (one direction)	1.158 ns
----------------------------------	----------

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

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

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

##### Additional EUT Data

Manufactured by	SPEAG
Manufactured on	July 05, 2002

## DASY5 Validation Report for Head TSL

Date: 13.09.2016

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:713**

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

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.88$  S/m;  $\epsilon_r = 37.9$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.72, 7.72, 7.72); Calibrated: 15.06.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

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

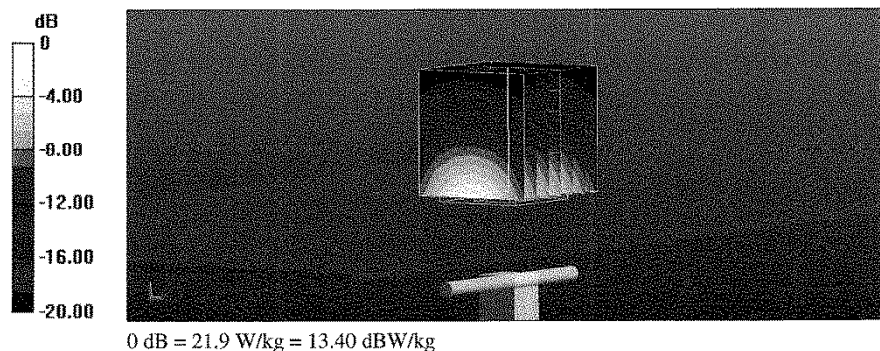
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 113.5 V/m; Power Drift = -0.01 dB

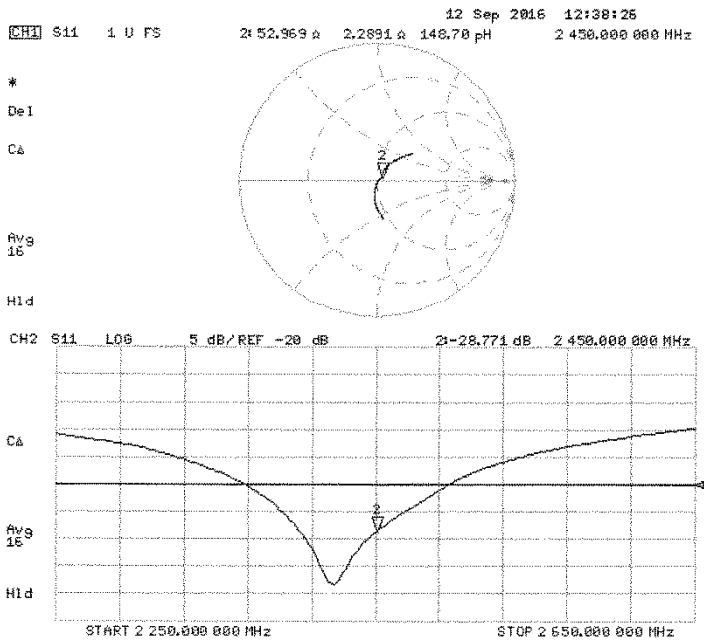
Peak SAR (extrapolated) = 26.7 W/kg

**SAR(1 g) = 13.4 W/kg; SAR(10 g) = 6.23 W/kg**

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



Impedance Measurement Plot for Head TSL





## DASY5 Validation Report for Body TSL

Date: 13.09.2016

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:713**

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

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 2.04$  S/m;  $\epsilon_r = 51.6$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.79, 7.79, 7.79); Calibrated: 15.06.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

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

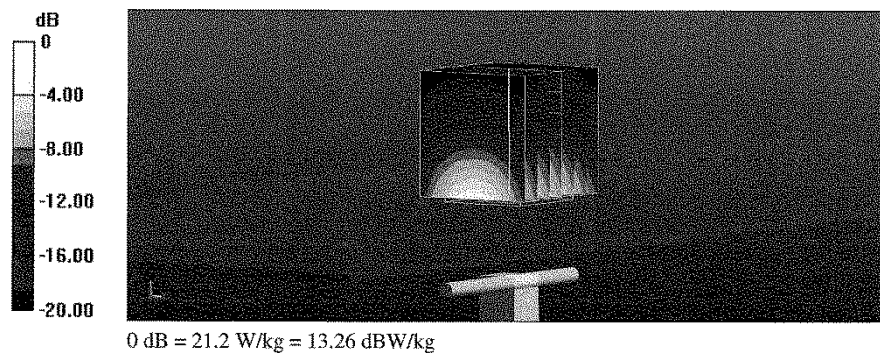
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 106.4 V/m; Power Drift = -0.03 dB

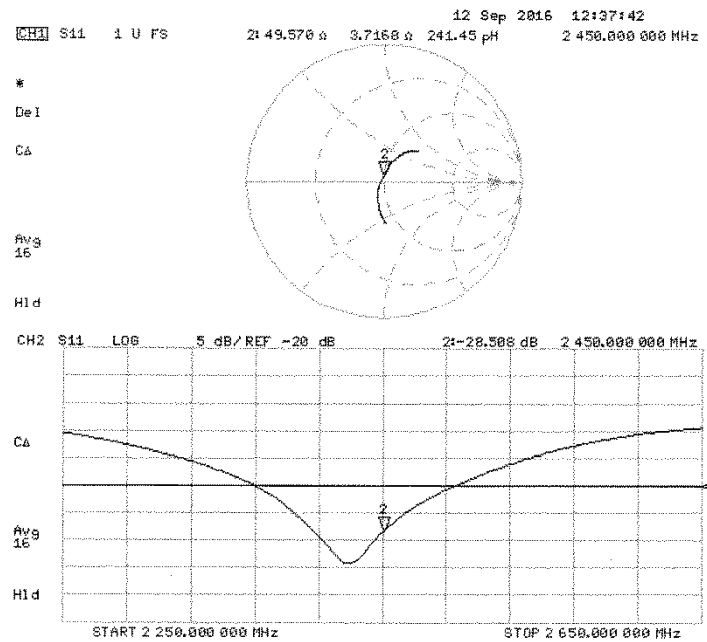
Peak SAR (extrapolated) = 25.5 W/kg

**SAR(1 g) = 13 W/kg; SAR(10 g) = 6.11 W/kg**

Maximum value of SAR (measured) = 21.2 W/kg



# Impedance Measurement Plot for Body TSL



## System Check Dipole SAR Calibration Certificate -Dipole 5GHz(D5GHzV2,S/N:1020)

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



**S** Schweizerischer Kalibrierdienst  
**C** Service suisse d'étalonnage  
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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Client **UL Japan HQ (Vitec)**

Certificate No: **D5GHzV2-1020\_Jan17**

### CALIBRATION CERTIFICATE

Object **D5GHzV2 - SN:1020**

Calibration procedure(s) **QA CAL-22.v2**  
**Calibration procedure for dipole validation kits between 3-6 GHz**

Calibration date: **January 06, 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
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

Calibrated by: **Johannes Kurikka** Function **Laboratory Technician**

Approved by: **Katja Pokovic** Technical Manager

Signature

Issued: January 12, 2017

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

Certificate No: D5GHzV2-1020\_Jan17

Page 1 of 17

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



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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%.

### 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 5250 MHz ± 1 MHz 5300 MHz ± 1 MHz 5500 MHz ± 1 MHz 5600 MHz ± 1 MHz 5750 MHz ± 1 MHz 5800 MHz ± 1 MHz	

### Head TSL parameters at 5200 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	36.0	4.66 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.8 ± 6 %	4.53 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 <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.80 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	77.4 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.24 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.2 W/kg ± 19.5 % (k=2)

#### Head TSL parameters at 5250 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.9	4.71 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.7 ± 6 %	4.58 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

#### SAR result with Head TSL at 5250 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.00 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>79.4 W / kg ± 19.9 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.29 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>22.7 W/kg ± 19.5 % (k=2)</b>

#### 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	34.6 ± 6 %	4.63 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

#### SAR result with Head TSL at 5300 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.41 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>83.4 W/kg ± 19.9 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (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	<b>23.8 W/kg ± 19.5 % (k=2)</b>

#### 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	34.4 ± 6 %	4.82 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

#### SAR result with Head TSL at 5500 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.37 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>83.0 W/kg ± 19.9 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.39 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>23.7 W/kg ± 19.5 % (k=2)</b>

#### 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	34.2 ± 6 %	4.93 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 <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.39 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>83.2 W/kg ± 19.9 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.39 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>23.6 W/kg ± 19.5 % (k=2)</b>

#### Head TSL parameters at 5750 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.4	5.22 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.0 ± 6 %	5.08 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

#### SAR result with Head TSL at 5750 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.96 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	78.8 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.27 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.4 W/kg ± 19.5 % (k=2)

#### Head TSL parameters at 5800 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.3	5.27 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	33.9 ± 6 %	5.13 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

#### SAR result with Head TSL at 5750 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.94 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	78.7 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (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	22.3 W/kg ± 19.5 % (k=2)



#### Body TSL parameters at 5250 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.9	5.36 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	47.0 ± 6 %	5.52 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

#### SAR result with Body TSL at 5250 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.56 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	75.0 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (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	21.1 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	46.4 ± 6 %	6.00 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

#### SAR result with Body TSL at 5600 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.97 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	79.1 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (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	22.2 W/kg ± 19.5 % (k=2)

#### Body TSL parameters at 5750 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.3	5.94 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	46.1 ± 6 %	6.21 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

#### SAR result with Body TSL at 5750 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.59 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	75.3 W/kg ± 19.9 % (k=2)

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

**Appendix (Additional assessments outside the scope of SCS 0108)**

**Antenna Parameters with Head TSL at 5200 MHz**

Impedance, transformed to feed point	51.8 $\Omega$ - 9.4 j $\Omega$
Return Loss	- 20.6 dB

**Antenna Parameters with Head TSL at 5250 MHz**

Impedance, transformed to feed point	51.0 $\Omega$ - 6.1 j $\Omega$
Return Loss	- 24.2 dB

**Antenna Parameters with Head TSL at 5300 MHz**

Impedance, transformed to feed point	51.9 $\Omega$ - 3.3 j $\Omega$
Return Loss	- 28.5 dB

**Antenna Parameters with Head TSL at 5500 MHz**

Impedance, transformed to feed point	50.4 $\Omega$ - 2.4 j $\Omega$
Return Loss	- 32.4 dB

**Antenna Parameters with Head TSL at 5600 MHz**

Impedance, transformed to feed point	54.0 $\Omega$ - 1.4 j $\Omega$
Return Loss	- 27.7 dB

**Antenna Parameters with Head TSL at 5750 MHz**

Impedance, transformed to feed point	56.5 $\Omega$ + 1.0 j $\Omega$
Return Loss	- 24.2 dB

**Antenna Parameters with Head TSL at 5800 MHz**

Impedance, transformed to feed point	55.5 $\Omega$ - 2.0 j $\Omega$
Return Loss	- 25.1 dB

**Antenna Parameters with Body TSL at 5250 MHz**

Impedance, transformed to feed point	51.0 $\Omega$ - 4.9 j $\Omega$
Return Loss	- 26.0 dB

**Antenna Parameters with Body TSL at 5600 MHz**

Impedance, transformed to feed point	56.2 $\Omega$ - 0.3 j $\Omega$
Return Loss	- 24.6 dB

#### Antenna Parameters with Body TSL at 5750 MHz

Impedance, transformed to feed point	57.6 $\Omega$ + 3.3 j $\Omega$
Return Loss	- 22.3 dB

#### General Antenna Parameters and Design

Electrical Delay (one direction)	1.201 ns
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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	February 05, 2004

## DASY5 Validation Report for Head TSL

Date: 06.01.2017

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1020**

Communication System: UID 0 - CW; Frequency: 5200 MHz, Frequency: 5250 MHz, Frequency: 5300 MHz, Frequency: 5500 MHz, Frequency: 5600 MHz, Frequency: 5750 MHz, Frequency: 5800 MHz  
Medium parameters used:  $f = 5200$  MHz;  $\sigma = 4.53$  S/m;  $\epsilon_r = 34.8$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used:  $f = 5250$  MHz;  $\sigma = 4.58$  S/m;  $\epsilon_r = 34.7$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used:  $f = 5300$  MHz;  $\sigma = 4.63$  S/m;  $\epsilon_r = 34.6$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used:  $f = 5500$  MHz;  $\sigma = 4.82$  S/m;  $\epsilon_r = 34.4$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used:  $f = 5600$  MHz;  $\sigma = 4.93$  S/m;  $\epsilon_r = 34.2$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used:  $f = 5750$  MHz;  $\sigma = 5.08$  S/m;  $\epsilon_r = 34$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used:  $f = 5800$  MHz;  $\sigma = 5.13$  S/m;  $\epsilon_r = 33.9$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
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(5.58, 5.58, 5.58); 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(5.02, 5.02, 5.02); 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: QD000P50AA; Serial: 1001
- DASY52 52.8(1258); SEMCAD X 14.6.10(7331)

**Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5200 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 69.57 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 28.8 W/kg

**SAR(1 g) = 7.8 W/kg; SAR(10 g) = 2.24 W/kg**

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

**Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5250 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 70.19 V/m; Power Drift = -0.06 dB

Peak SAR (extrapolated) = 29.6 W/kg

**SAR(1 g) = 8 W/kg; SAR(10 g) = 2.29 W/kg**

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

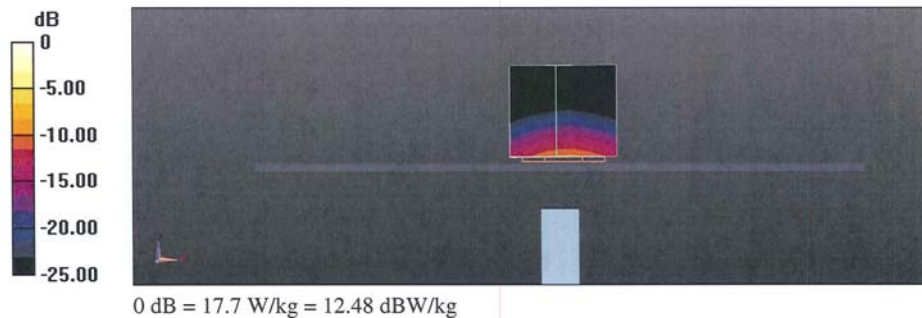
**Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5300 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm  
Reference Value = 71.34 V/m; Power Drift = -0.04 dB  
Peak SAR (extrapolated) = 32.0 W/kg  
**SAR(1 g) = 8.41 W/kg; SAR(10 g) = 2.41 W/kg**  
Maximum value of SAR (measured) = 19.4 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 = 70.28 V/m; Power Drift = -0.06 dB  
Peak SAR (extrapolated) = 33.4 W/kg  
**SAR(1 g) = 8.37 W/kg; SAR(10 g) = 2.39 W/kg**  
Maximum value of SAR (measured) = 19.7 W/kg

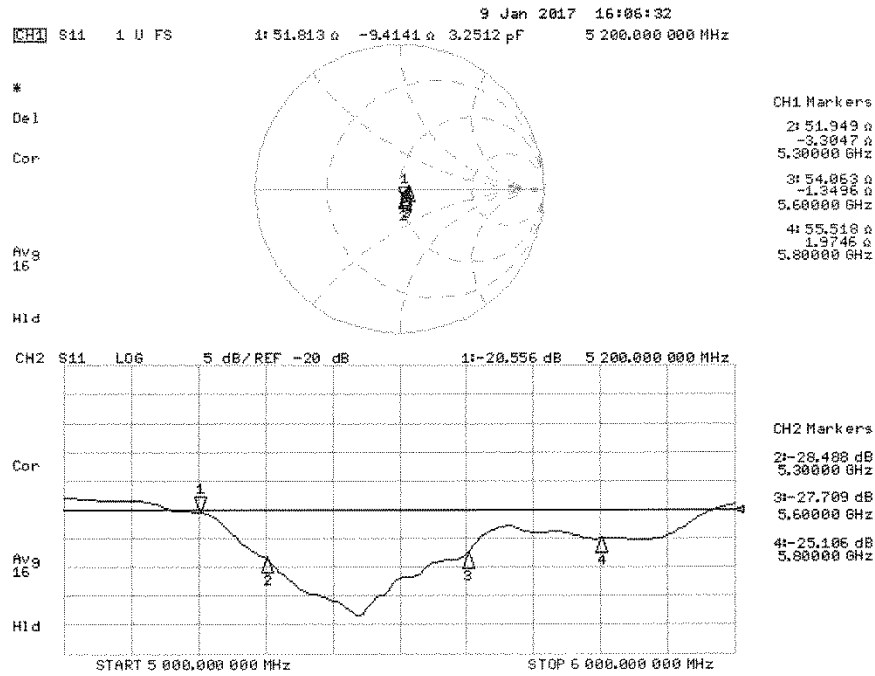
**Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm  
Reference Value = 70.48 V/m; Power Drift = -0.06 dB  
Peak SAR (extrapolated) = 33.7 W/kg  
**SAR(1 g) = 8.39 W/kg; SAR(10 g) = 2.39 W/kg**  
Maximum value of SAR (measured) = 17.9 W/kg

**Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5750 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm  
Reference Value = 67.85 V/m; Power Drift = -0.05 dB  
Peak SAR (extrapolated) = 33.1 W/kg  
**SAR(1 g) = 7.96 W/kg; SAR(10 g) = 2.27 W/kg**  
Maximum value of SAR (measured) = 19.1 W/kg

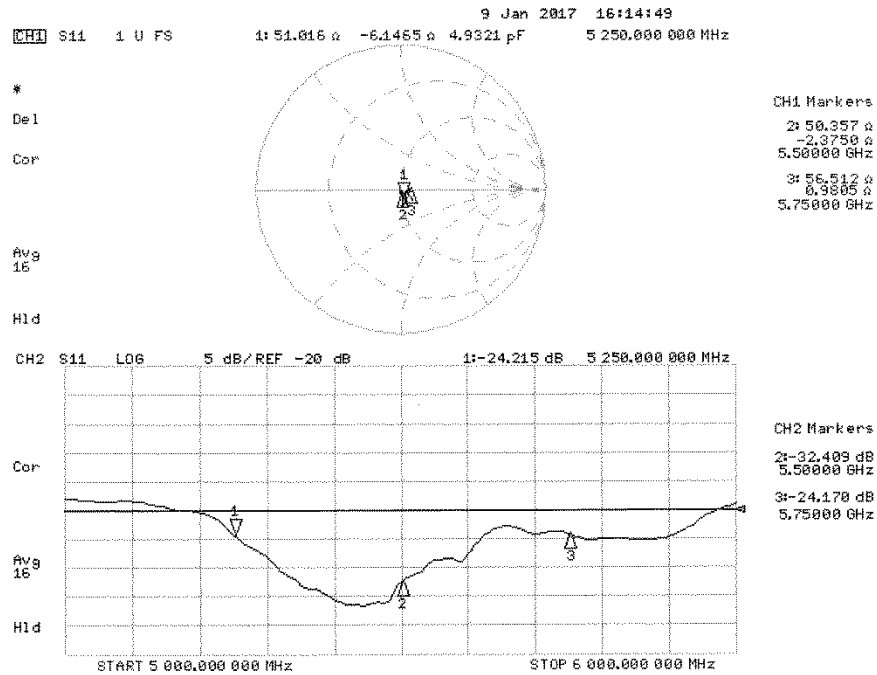
**Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm  
Reference Value = 68.14 V/m; Power Drift = -0.07 dB  
Peak SAR (extrapolated) = 33.3 W/kg  
**SAR(1 g) = 7.94 W/kg; SAR(10 g) = 2.26 W/kg**  
Maximum value of SAR (measured) = 19.0 W/kg



Impedance Measurement Plot for Head TSL (5200, 5300, 5600, 5800)



Impedance Measurement Plot for Head TSL (5250, 5500, 5750)





## DASY5 Validation Report for Body TSL

Date: 06.01.2017

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1020**

Communication System: UID 0 - CW; Frequency: 5250 MHz, Frequency: 5600 MHz, Frequency: 5750 MHz  
Medium parameters used:  $f = 5250$  MHz;  $\sigma = 5.52$  S/m;  $\epsilon_r = 47$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used:  $f = 5600$  MHz;  $\sigma = 6$  S/m;  $\epsilon_r = 46.4$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used:  $f = 5750$  MHz;  $\sigma = 6.21$  S/m;  $\epsilon_r = 46.1$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(5.14, 5.14, 5.14); Calibrated: 31.12.2016, ConvF(4.57, 4.57, 4.57); Calibrated: 31.12.2016, ConvF(4.52, 4.52, 4.52); Calibrated: 31.12.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.01.2017
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7331)

### **Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5250MHz/Zoom Scan,**

**dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 66.31 V/m; Power Drift = -0.07 dB

Peak SAR (extrapolated) = 29.2 W/kg

**SAR(1 g) = 7.56 W/kg; SAR(10 g) = 2.13 W/kg**

Maximum value of SAR (measured) = 17.9 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 = 65.45 V/m; Power Drift = -0.08 dB

Peak SAR (extrapolated) = 33.7 W/kg

**SAR(1 g) = 7.97 W/kg; SAR(10 g) = 2.24 W/kg**

Maximum value of SAR (measured) = 19.5 W/kg

### **Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5750 MHz/Zoom Scan,**

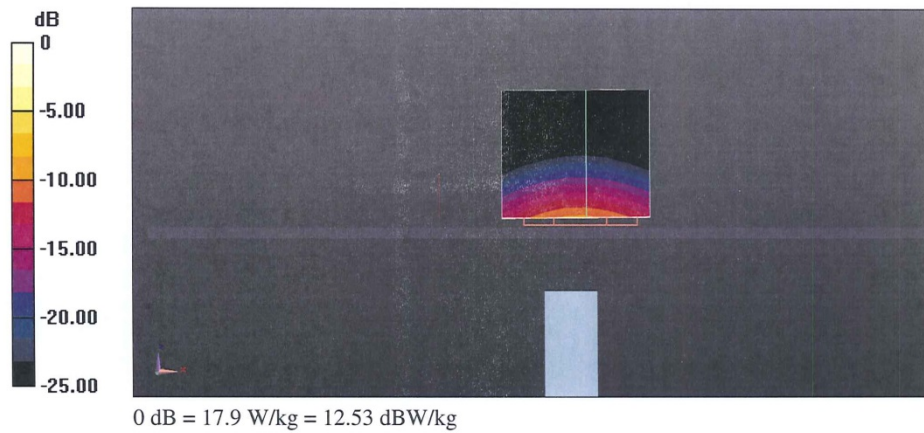
**dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 63.34 V/m; Power Drift = -0.09 dB

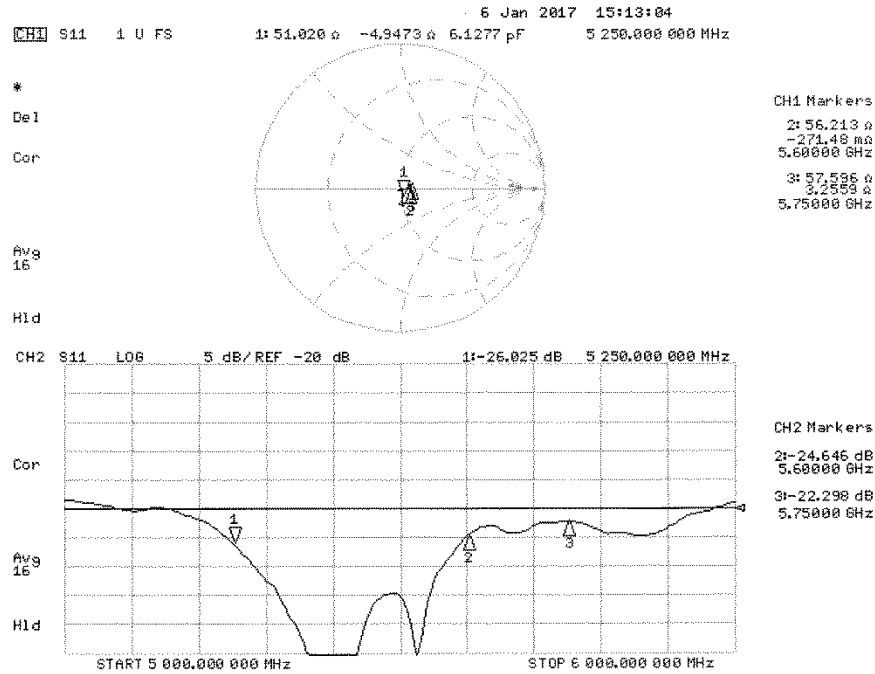
Peak SAR (extrapolated) = 33.5 W/kg

**SAR(1 g) = 7.59 W/kg; SAR(10 g) = 2.12 W/kg**

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



### Impedance Measurement Plot for Body TSL



## Dosimetric E-Field Probe Calibration Certificate (EX3DV4, S/N: 3825)

**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 **UL Japan (Vitec)**

Certificate No: **EX3-3825\_Dec16**

### CALIBRATION CERTIFICATE

Object **EX3DV4 - SN:3825**

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: **December 12, 2016**

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: S5277 (20x)	05-Apr-16 (No. 217-02293)	Apr-17
Reference Probe ES3DV2	SN: 3013	31-Dec-15 (No. ES3-3013_Dec15)	Dec-16
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:	Leif Klysner	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	
Issued: December 13, 2016			
This calibration certificate shall not be reproduced except in full without written approval of the laboratory.			

Certificate No: EX3-3825\_Dec16

Page 1 of 38

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



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

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

Accreditation No.: SCS 0108

#### Glossary:

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

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

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

#### Methods Applied and Interpretation of Parameters:

- NORM<sub>x,y,z</sub>**: Assessed for E-field polarization  $\vartheta = 0$  ( $f \leq 900$  MHz in TEM-cell;  $f > 1800$  MHz: R22 waveguide). NORM<sub>x,y,z</sub> are only intermediate values, i.e., the uncertainties of NORM<sub>x,y,z</sub> does not affect the E<sup>2</sup>-field uncertainty inside TSL (see below ConvF).
- NORM(f)<sub>x,y,z</sub>** = NORM<sub>x,y,z</sub> \* frequency\_response (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of ConvF.
- DCP<sub>x,y,z</sub>**: DCP are numerical linearization parameters assessed based on the data of power sweep 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
- A<sub>x,y,z</sub>; B<sub>x,y,z</sub>; C<sub>x,y,z</sub>; D<sub>x,y,z</sub>; VR<sub>x,y,z</sub>**: 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  $f \leq 800$  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 NORM<sub>x,y,z</sub> \* ConvF whereby the uncertainty corresponds to that given for ConvF. A frequency dependent ConvF is used in DASY version 4.4 and higher which allows extending the validity from  $\pm 50$  MHz to  $\pm 100$  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 NORM<sub>x</sub> (no uncertainty required).