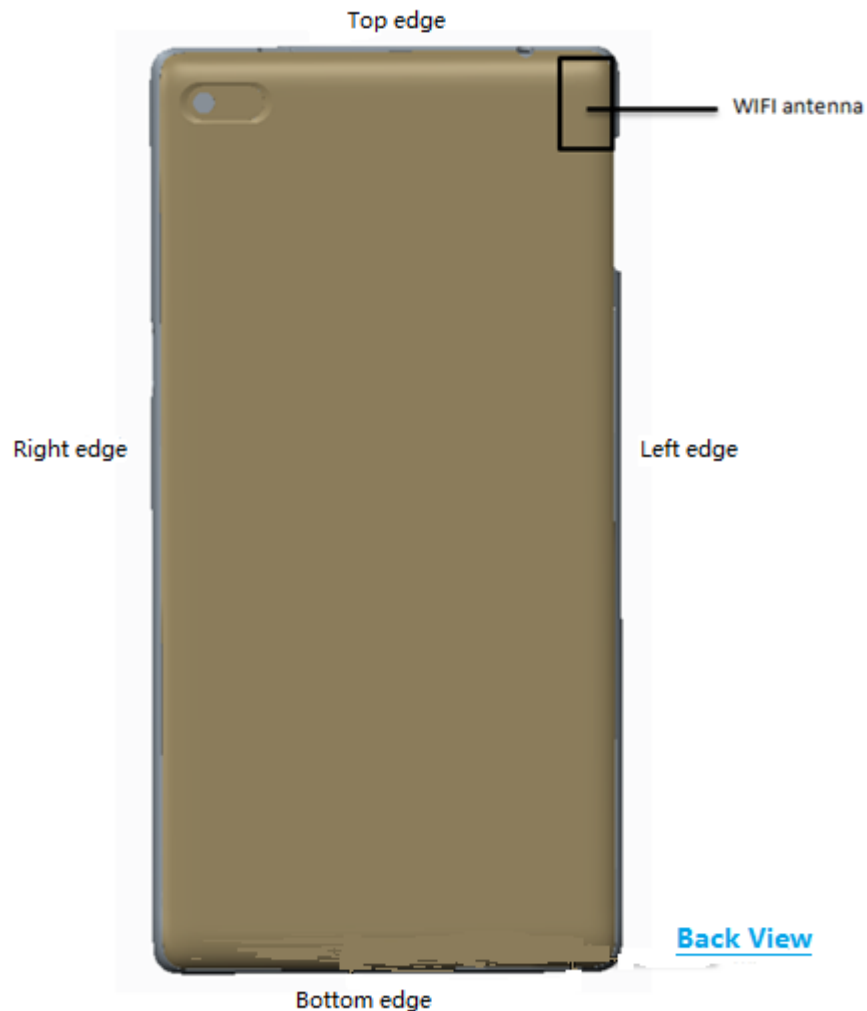


## 11 Standalone SAR Considerations

### 11.1 Transmit Antenna Separation Distances



Picture 11.1 Antenna Locations

### 11.2 SAR Measurement Positions

According to the KDB941225 D06 Hot Spot SAR v01, the edges with less than 2.5 cm distance to the antennas need to be tested for SAR.

SAR measurement positions						
Mode	Front	Rear	Left edge	Right edge	Top edge	Bottom edge
WLAN	No	Yes	Yes	No	Yes	No

### 11.3 Standalone SAR Test Exclusion Considerations

Standalone 1-g head or body SAR evaluation by measurement or numerical simulation is not required when the corresponding SAR Exclusion Threshold condition, listed below, is satisfied. The 1-g SAR test exclusion threshold for 100 MHz to 6 GHz at test separation distances  $\leq 50$  mm are determined by:

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

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

**Table 11.1: Standalone SAR test exclusion considerations**

Band/Mode	F(GHz)	Position	SAR test exclusion threshold (mW)	RF output power		SAR test exclusion
				dBm	mW	
Bluetooth	2.441	Body	19.2	6	3.98	Yes
WLAN 802.11 b	2.45	Body	19.17	18	63.10	No

## 12 SAR Test Result

It is determined by user manual for the distance between the EUT and the phantom bottom.

The distance is 0 mm and just applied to the condition of body worn accessory.

The calculated SAR is obtained by the following formula:

$$\text{Reported SAR} = \text{Measured SAR} \times 10^{(P_{\text{Target}} - P_{\text{Measured}})/10}$$

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

$P_{\text{Measured}}$  is the measured power in chapter 10.

We'll perform the SAR measurement with SKU1 and retest on highest value point with SKU3.

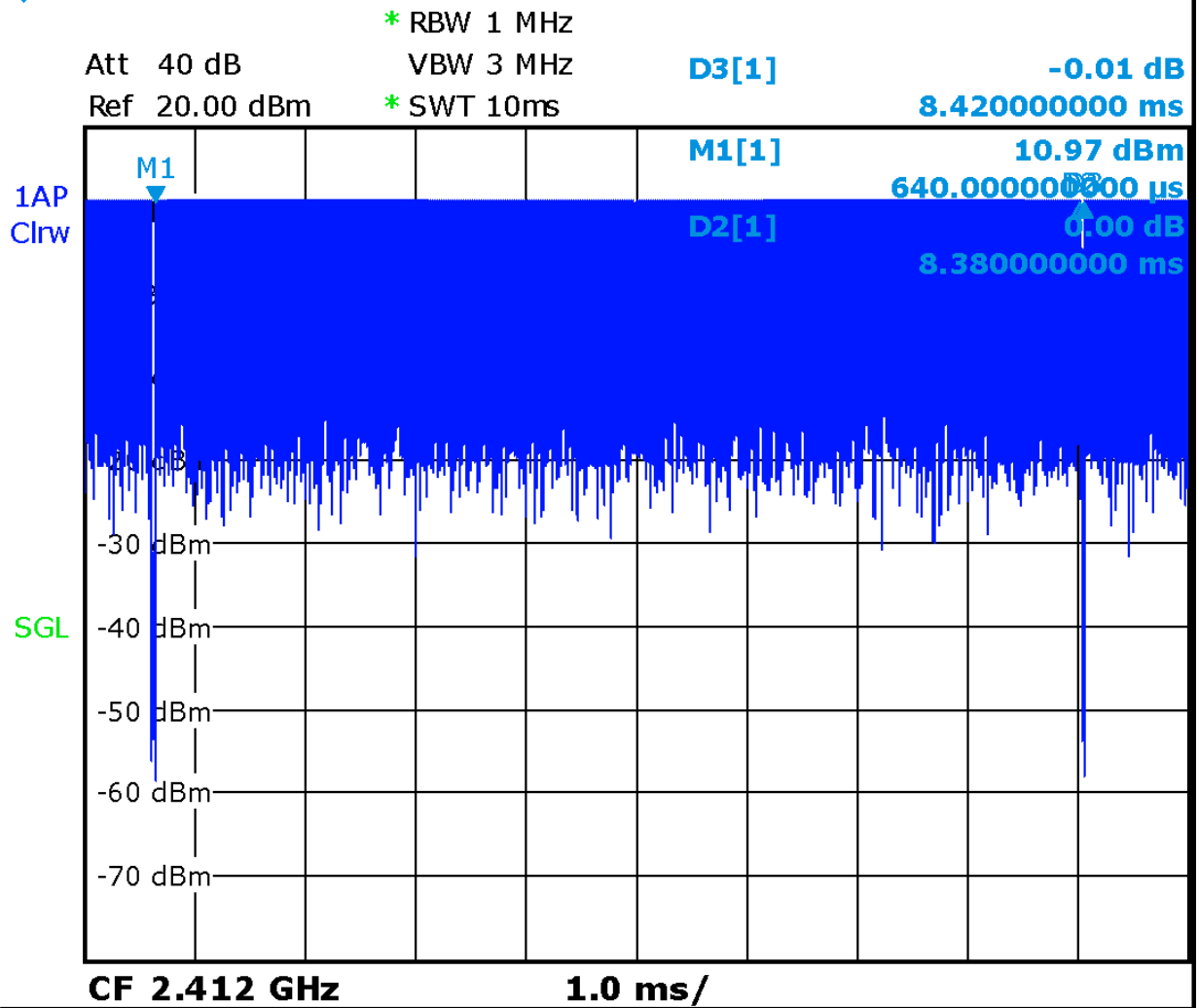
**Table 12-1: SAR Values (WLAN - Body) – 802.11b 2Mbps**

Ambient Temperature: 22.5 °C						Liquid Temperature: 22.0 °C						
Frequency		Test Position	Distance (mm)	Figure No.	Note	Conducted Power (dBm)	Max. tune-up Power (dBm)	Measured SAR(10g) (W/kg)	Reported SAR(10g) (W/kg)	Measured SAR(1g) (W/kg)	Reported SAR(1g) (W/kg)	Power Drift (dB)
MHz	Ch.											
2437	6	Rear	0	/	SKU1	11.90	12	0.178	<b>0.18</b>	0.372	<b>0.38</b>	0.05
2437	6	Rear	7	/	SKU1	17.75	18	0.254	<b>0.27</b>	0.515	<b>0.55</b>	0.19
2437	6	Left	0	/	SKU1	17.75	18	0.246	<b>0.26</b>	0.608	<b>0.64</b>	0.07
2462	11	Top	0	/	SKU1	17.46	18	0.217	<b>0.25</b>	0.558	<b>0.63</b>	0.01
2437	6	Top	0	/	SKU1	17.75	18	0.282	<b>0.30</b>	0.726	<b>0.77</b>	-0.07
2412	1	Top	0	/	SKU1	17.10	18	0.303	<b>0.37</b>	0.772	<b>0.95</b>	-0.07
2462	11	Top	0	/	SKU3	17.46	18	0.316	<b>0.36</b>	0.779	<b>0.88</b>	-0.16
2437	6	Top	0	/	SKU3	17.75	18	0.336	<b>0.36</b>	0.812	<b>0.86</b>	-0.11
2412	1	Top	0	Fig.1	SKU3	17.10	18	0.341	<b>0.42</b>	0.822	<b>1.01</b>	-0.19

According to the KDB248227 D01, The reported SAR must be scaled to 100% transmission duty factor to determine compliance at the maximum tune-up tolerance limit. The scaled reported SAR is presented as below.

**Table 12-2: SAR Values (WLAN - Body) – 802.11b 2Mbps (Scaled Reported SAR)**

Ambient Temperature: 22.5 °C				Liquid Temperature: 22.0 °C		
Frequency		Test Position	Actual duty factor	maximum duty factor	Reported SAR (1g)(W/kg)	Scaled reported SAR (1g)(W/kg)
MHz	Ch.					
2412	1	Top	99.52%	100%	<b>1.01</b>	<b>1.01</b>



Picture 12.1 Duty factor plot

### 13 SAR Measurement Variability

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

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

- 1) Repeated measurement is not required when the original highest measured SAR is  $< 0.80$  W/kg; 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  $> 1.20$ .

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

Frequency		Test Position	Spacing (mm)	Original SAR (W/kg)	First Repeated SAR (W/kg)	The Ratio	Second Repeated SAR (W/kg)	The Ratio
Ch.	MHz							
1	2412	Top	0	0.822	0.815	1.01	/	/

## 14 Measurement Uncertainty

No.	Error Description	Type	Uncertainty value	Probably Distribution	Div.	(Ci) 1g	(Ci) 10g	Std. Unc. (1g)	Std. Unc. (10g)	Degree of freedom
<b>Measurement system</b>										
1	Probe calibration	B	6.0	N	1	1	1	6.0	6.0	$\infty$
2	Isotropy	B	4.7	R	$\sqrt{3}$	0.7	0.7	1.9	1.9	$\infty$
3	Boundary effect	B	1.0	R	$\sqrt{3}$	1	1	0.6	0.6	$\infty$
4	Linearity	B	4.7	R	$\sqrt{3}$	1	1	2.7	2.7	$\infty$
5	Detection limit	B	1.0	N	1	1	1	0.6	0.6	$\infty$
6	Readout electronics	B	0.3	R	$\sqrt{3}$	1	1	0.3	0.3	$\infty$
7	Response time	B	0.8	R	$\sqrt{3}$	1	1	0.5	0.5	$\infty$
8	Integration time	B	2.6	R	$\sqrt{3}$	1	1	1.5	1.5	$\infty$
9	RF ambient conditions-noise	B	0	R	$\sqrt{3}$	1	1	0	0	$\infty$
10	RF ambient conditions-reflection	B	0	R	$\sqrt{3}$	1	1	0	0	$\infty$
11	Probe positioned mech. restrictions	B	0.4	R	$\sqrt{3}$	1	1	0.2	0.2	$\infty$
12	Probe positioning with respect to phantom shell	B	2.9	R	$\sqrt{3}$	1	1	1.7	1.7	$\infty$
13	Post-processing	B	1.0	R	$\sqrt{3}$	1	1	0.6	0.6	$\infty$
<b>Test sample related</b>										
14	Test sample positioning	A	3.3	N	1	1	1	3.3	3.3	71
15	Device holder uncertainty	A	3.4	N	1	1	1	3.4	3.4	5
16	Drift of output power	B	5.0	R	$\sqrt{3}$	1	1	2.9	2.9	$\infty$
<b>Phantom and set-up</b>										
17	Phantom uncertainty	B	4.0	R	$\sqrt{3}$	1	1	2.3	2.3	$\infty$
18	Liquid conductivity (target)	B	5.0	R	$\sqrt{3}$	0.64	0.43	1.8	1.2	$\infty$
19	Liquid conductivity (meas.)	A	2.06	N	1	0.64	0.43	1.32	0.89	43
20	Liquid permittivity (target)	B	5.0	R	$\sqrt{3}$	0.6	0.49	1.7	1.4	$\infty$
21	Liquid permittivity (meas.)	A	1.6	N	1	0.6	0.49	1.0	0.8	521

Combined standard uncertainty	$u_c = \sqrt{\sum_{i=1}^{21} c_i^2 u_i^2}$					9.55	9.43	257
Expanded uncertainty (confidence interval of 95 %)	$u_e = 2u_c$					19.1	18.9	

## 15 MAIN TEST INSTRUMENTS

**Table 15.1: List of Main Instruments**

No.	Name	Type	Serial Number	Calibration Date	Valid Period
01	Network analyzer	E5071C	MY46110673	January 13, 2017	One year
02	Dielectric Probe Kit	85070E	Agilent	No Calibration Requested	
03	Power meter	NRVD	102083	September 22, 2016	One year
04	Power sensor	NRV-Z5	100595		
05	Signal Generator	E4438C	MY49071430	January 13, 2017	One Year
06	Amplifier	60S1G4	0331848	No Calibration Requested	
07	Directional Coupler	778D	MY48220584	No Calibration Requested	
08	E-field Probe	SPEAG EX3DV4	3846	January 13, 2017	One year
09	DAE	SPEAG DAE4	1331	January 19, 2017	One year
10	Dipole Validation Kit	SPEAG D2450V2	835	June 27, 2017	One year

\*\*\*END OF REPORT BODY\*\*\*

## ANNEX A Graph Results

### WLAN\_CH1 Top

Date: 2017-7-18

Electronics: DAE4 Sn1331

Medium: Body 2450 MHz

Medium parameters used (interpolated):  $f = 2412$  MHz;  $\sigma = 1.902$  mho/m;  $\epsilon_r = 51.991$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature: 22.5°C, Liquid Temperature: 22.0°C

Communication System: WLAN Duty Cycle: 1:1

Probe: EX3DV4 – SN3846 ConvF(7.31,7.31,7.31)

**Area Scan (151x91x1):** Interpolated grid:  $dx=1.000$  mm,  $dy=1.000$  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 = 9.141 V/m; Power Drift = -0.19 dB

Peak SAR (extrapolated) = 2.04 W/kg

**SAR(1 g) = 0.822 W/kg; SAR(10 g) = 0.341 W/kg**

Maximum value of SAR (measured) = 1.49 W/kg

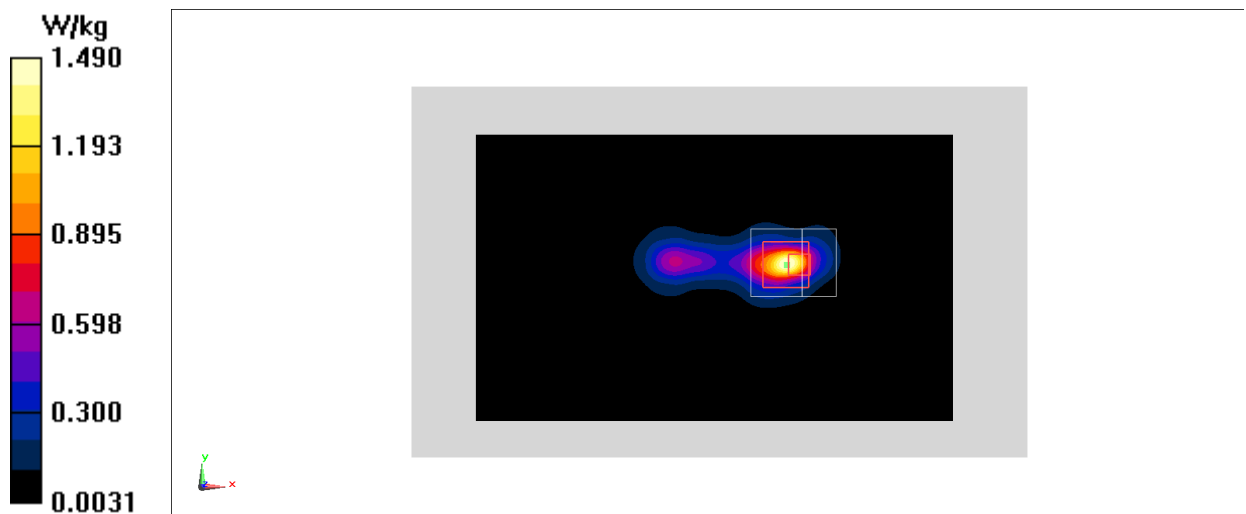
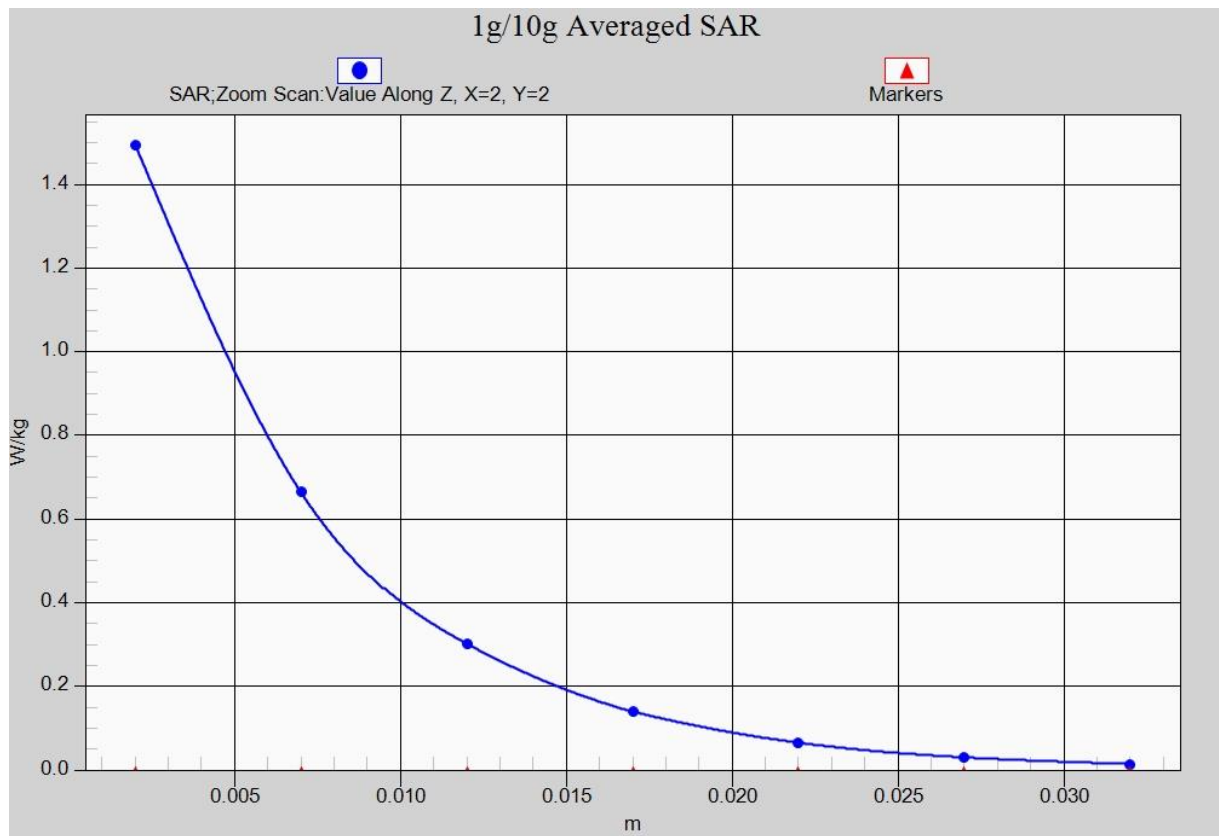


Figure 1





**Figure 1-1**

## ANNEX B SystemVerification Results

### 2450 MHz

Date: 2017-7-18

Electronics: DAE4 Sn1331

Medium: Body2450 MHz

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.915$  mho/m;  $\epsilon_r = 51.92$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature: 22.5°C Liquid Temperature: 22.0°C

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

Probe: EX3DV4 – SN7307 ConvF(7.31,7.31,7.31)

**System Validation /Area Scan (81x191x1):** Interpolated grid:  $dx=1.000$  mm,  $dy=1.000$  mm  
Maximum value of SAR (interpolated) = 21.4 W/kg

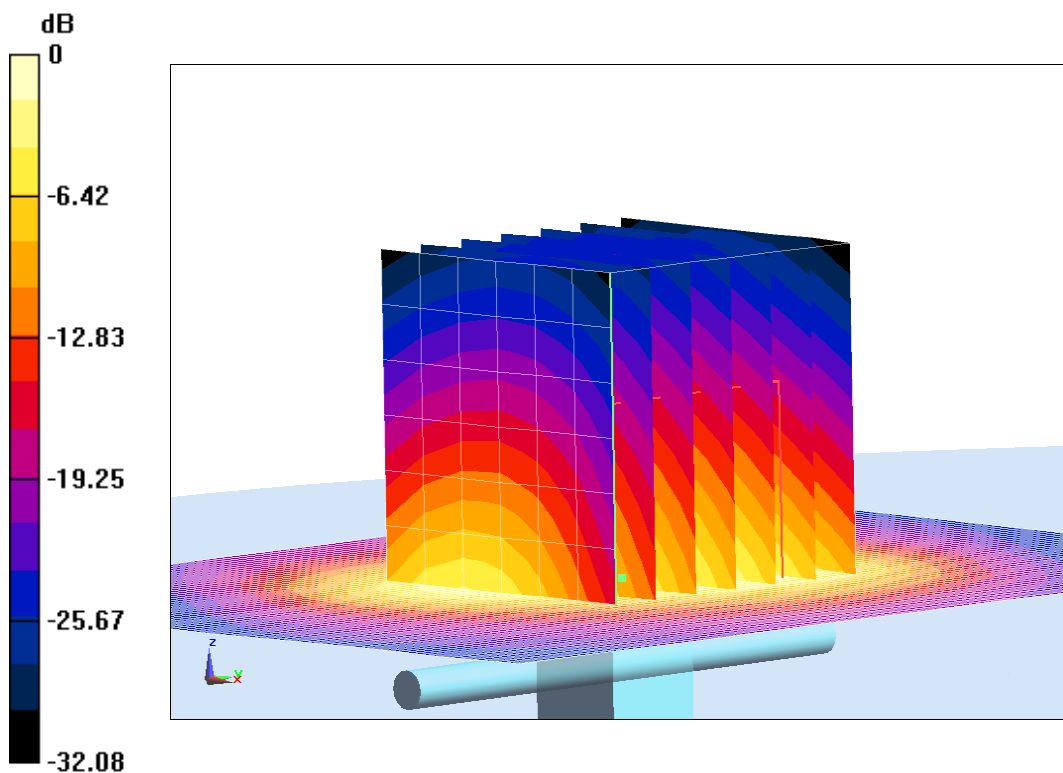
**System Validation /Zoom Scan (7x7x7)/Cube 0:** Measurement grid:  $dx=5$ mm,  $dy=5$ mm,  $dz=5$ mm

Reference Value = 103.3 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 25.93 W/kg

**SAR(1 g) = 13.1 W/kg; SAR(10 g) = 6.22 W/kg**

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



0 dB = 21.2 W/kg = 13.26 dB W/kg

**Fig.B.1 validation 2450 MHz 250mW**

### C.1 Measurement Set-up

The diagram illustrates the system architecture for the robot control. At the center is the **Measurement Server**, which is connected to a **PC** and a **robot controller**. The **robot controller** is a CS8C unit with various ports (J1, J2, J3, J4, J5, J6, J7, J8, J9, J10, J11, J12, J13, J14, J15, J16, J17, J18, J19, J20, J21, J22, J23, J24, J25, J26, J27, J28, J29, J30, J31, J32, J33, J34, J35, J36, J37, J38, J39, J40, J41, J42, J43, J44, J45, J46, J47, J48, J49, J50, J51, J52, J53, J54, J55, J56, J57, J58, J59, J60, J61, J62, J63, J64, J65, J66, J67, J68, J69, J70, J71, J72, J73, J74, J75, J76, J77, J78, J79, J80, J81, J82, J83, J84, J85, J86, J87, J88, J89, J90, J91, J92, J93, J94, J95, J96, J97, J98, J99, J100, J101, J102, J103, J104, J105, J106, J107, J108, J109, J110, J111, J112, J113, J114, J115, J116, J117, J118, J119, J120, J121, J122, J123, J124, J125, J126, J127, J128, J129, J130, J131, J132, J133, J134, J135, J136, J137, J138, J139, J140, J141, J142, J143, J144, J145, J146, J147, J148, J149, J150, J151, J152, J153, J154, J155, J156, J157, J158, J159, J160, J161, J162, J163, J164, J165, J166, J167, J168, J169, J170, J171, J172, J173, J174, J175, J176, J177, J178, J179, J180, J181, J182, J183, J184, J185, J186, J187, J188, J189, J190, J191, J192, J193, J194, J195, J196, J197, J198, J199, J200, J201, J202, J203, J204, J205, J206, J207, J208, J209, J210, J211, J212, J213, J214, J215, J216, J217, J218, J219, J220, J221, J222, J223, J224, J225, J226, J227, J228, J229, J230, J231, J232, J233, J234, J235, J236, J237, J238, J239, J240, J241, J242, J243, J244, J245, J246, J247, J248, J249, J250, J251, J252, J253, J254, J255, J256, J257, J258, J259, J260, J261, J262, J263, J264, J265, J266, J267, J268, J269, J270, J271, J272, J273, J274, J275, J276, J277, J278, J279, J280, J281, J282, J283, J284, J285, J286, J287, J288, J289, J290, J291, J292, J293, J294, J295, J296, J297, J298, J299, J300, J301, J302, J303, J304, J305, J306, J307, J308, J309, J310, J311, J312, J313, J314, J315, J316, J317, J318, J319, J320, J321, J322, J323, J324, J325, J326, J327, J328, J329, J330, J331, J332, J333, J334, J335, J336, J337, J338, J339, J340, J341, J342, J343, J344, J345, J346, J347, J348, J349, J350, J351, J352, J353, J354, J355, J356, J357, J358, J359, J360, J361, J362, J363, J364, J365, J366, J367, J368, J369, J370, J371, J372, J373, J374, J375, J376, J377, J378, J379, J380, J381, J382, J383, J384, J385, J386, J387, J388, J389, J390, J391, J392, J393, J394, J395, J396, J397, J398, J399, J400, J401, J402, J403, J404, J405, J406, J407, J408, J409, J410, J411, J412, J413, J414, J415, J416, J417, J418, J419, J420, J421, J422, J423, J424, J425, J426, J427, J428, J429, J430, J431, J432, J433, J434, J435, J436, J437, J438, J439, J440, J441, J442, J443, J444, J445, J446, J447, J448, J449, J450, J451, J452, J453, J454, J455, J456, J457, J458, J459, J460, J461, J462, J463, J464, J465, J466, J467, J468, J469, J470, J471, J472, J473, J474, J475, J476, J477, J478, J479, J480, J481, J482, J483, J484, J485, J486, J487, J488, J489, J490, J491, J492, J493, J494, J495, J496, J497, J498, J499, J500, J501, J502, J503, J504, J505, J506, J507, J508, J509, J510, J511, J512, J513, J514, J515, J516, J517, J518, J519, J520, J521, J522, J523, J524, J525, J526, J527, J528, J529, J530, J531, J532, J533, J534, J535, J536, J537, J538, J539, J540, J541, J542, J543, J544, J545, J546, J547, J548, J549, J550, J551, J552, J553, J554, J555, J556, J557, J558, J559, J560, J561, J562, J563, J564, J565, J566, J567, J568, J569, J570, J571, J572, J573, J574, J575, J576, J577, J578, J579, J580, J581, J582, J583, J584, J585, J586, J587, J588, J589, J590, J591, J592, J593, J594, J595, J596, J597, J598, J599, J600, J601, J602, J603, J604, J605, J606, J607, J608, J609, J610, J611, J612, J613, J614, J615, J616, J617, J618, J619, J620, J621, J622, J623, J624, J625, J626, J627, J628, J629, J630, J631, J632, J633, J634, J635, J636, J637, J638, J639, J640, J641, J642, J643, J644, J645, J646, J647, J648, J649, J650, J651, J652, J653, J654, J655, J656, J657, J658, J659, J660, J661, J662, J663, J664, J665, J666, J667, J668, J669, J670, J671, J672, J673, J674, J675, J676, J677, J678, J679, J680, J681, J682, J683, J684, J685, J686, J687, J688, J689, J690, J691, J692, J693, J694, J695, J696, J697, J698, J699, J700, J701, J702, J703, J704, J705, J706, J707, J708, J709, J710, J711, J712, J713, J714, J715, J716, J717, J718, J719, J720, J721, J722, J723, J724, J725, J726, J727, J728, J729, J730, J731, J732, J733, J734, J735, J736, J737, J738, J739, J740, J741, J742, J743, J744, J745, J746, J747, J748, J749, J750, J751, J752, J753, J754, J755, J756, J757, J758, J759, J760, J761, J762, J763, J764, J765, J766, J767, J768, J769, J770, J771, J772, J773, J774, J775, J776, J777, J778, J779, J780, J781, J782, J783, J784, J785, J786, J787, J788, J789, J790, J791, J792, J793, J794, J795, J796, J797, J798, J799, J800, J801, J802, J803, J804, J805, J806, J807, J808, J809, J810, J811, J812, J813, J814, J815, J816, J817, J818, J819, J820, J821, J822, J823, J824, J82

### Picture C.1 SAR Lab Test Measurement Set-up

- A standard high precision 6-axis robot (StäubliTX=RX family) with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- An isotropic field probe optimized and calibrated for the targeted measurement.
- A data acquisition electronics (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
- The Electro-optical converter (EOC) performs the conversion from optical to electrical signals for the digital communication to the DAE. To use optical surface detection, a special version of the EOC is required. The EOC signal is transmitted to the measurement server.
- The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- The Light Beam used is for probe alignment. This improves the (absolute) accuracy of the probe positioning.
- A computer running WinXP and the DASY4 or DASY5 software.
- Remote control and teach pendant as well as additional circuitry for robot safety such as warning lamps, etc.
- The phantom, the device holder and other accessories according to the targeted measurement.

## C.2 Dasy4 or DASY5 E-field Probe System

The SAR measurements were conducted with the dosimetric probe designed in the classical triangular configuration and optimized for dosimetric evaluation. The probe is constructed using the thick film technique; with printed resistive lines on ceramic substrates. The probe is equipped with an optical multifiber line ending at the front of the probe tip. It is connected to the EOC box on the robot arm and provides an automatic detection of the phantom surface. Half of the fibers are connected to a pulsed infrared transmitter, the other half to a synchronized receiver. As the probe approaches the surface, the reflection from the surface produces a coupling from the transmitting to the receiving fibers. This reflection increases first during the approach, reaches maximum and then decreases. If the probe is flatly touching the surface, the coupling is zero. The distance of the coupling maximum to the surface is independent of the surface reflectivity and largely independent of the surface to probe angle. The DASY4 or DASY5 software reads the reflection during a software approach and looks for the maximum using 2<sup>nd</sup> order curve fitting. The approach is stopped at reaching the maximum.

### Probe Specifications:

<b>Model:</b>	<b>ES3DV3, EX3DV4</b>
<b>Frequency</b>	<b>10MHz — 6.0GHz(EX3DV4)</b>
<b>Range:</b>	<b>10MHz — 4GHz(ES3DV3)</b>
<b>Calibration:</b>	<b>In head and body simulating tissue at Frequencies from 835 up to 5800MHz</b>
<b>Linearity:</b>	<b>± 0.2 dB(30 MHz to 6 GHz) for EX3DV4 ± 0.2 dB(30 MHz to 4 GHz) for ES3DV3</b>
<b>Dynamic Range:</b>	<b>10 mW/kg — 100W/kg</b>
<b>Probe Length:</b>	<b>330 mm</b>
<b>Probe Tip</b>	
<b>Length:</b>	<b>20 mm</b>
<b>Body Diameter:</b>	<b>12 mm</b>
<b>Tip Diameter:</b>	<b>2.5 mm (3.9 mm for ES3DV3)</b>
<b>Tip-Center:</b>	<b>1 mm (2.0mm for ES3DV3)</b>
<b>Application:</b>	<b>SAR Dosimetry Testing Compliance tests of mobile phones Dosimetry in strong gradient fields</b>



Picture C.2 Near-field Probe



Picture C.3 E-field Probe

## C.3 E-field Probe Calibration

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

The free space E-field from amplified probe outputs is determined in a test chamber. This calibration can be performed in a TEM cell if the frequency is below 1 GHz and in a waveguide or other methodologies above 1 GHz for free space. For the free space calibration, the probe is placed

in the volumetric center of the cavity and at the proper orientation with the field. The probe is then rotated 360 degrees until the three channels show the maximum reading. The power density readings equates to 1 mW/ cm<sup>2</sup>.

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

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

Where:

$\Delta t$  = Exposure time (30 seconds),

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

$\Delta T$  = Temperature increase due to RF exposure.

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

Where:

$\sigma$  = Simulated tissue conductivity,

$\rho$  = Tissue density (kg/m<sup>3</sup>).

## C.4 Other Test Equipment

### C.4.1 Data Acquisition Electronics(DAE)

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

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

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



PictureC.4: DAE

### C.4.2 Robot

The SPEAG DASY system uses the high precision robots (DASY4: RX90XL; DASY5: RX160L) type from Stäubli SA (France). For the 6-axis controller system, the robot controller version from Stäubli is used. The Stäubli robot series have many features that are important for our application:

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



Picture C.5 DASY 4



Picture C.6 DASY 5

### C.4.3 Measurement Server

The Measurement server is based on a PC/104 CPU board with CPU (dasy4: 166 MHz, Intel Pentium; DASY5: 400 MHz, Intel Celeron), chip disk (DASY4: 32 MB; DASY5: 128MB), RAM (DASY4: 64 MB, DASY5: 128MB). The necessary circuits for communication with the DAE electronic box, as well as the 16 bit AD converter system for optical detection and digital I/O interface are contained on the DASY I/O board, which is directly connected to the PC/104 bus of the CPU board.

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





Picture C.7 Server for DASY 4



Picture C.8 Server for DASY 5

#### C.4.4 Device Holder for Phantom

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

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

The DASY device holder is constructed of low-loss

POM material having the following dielectric

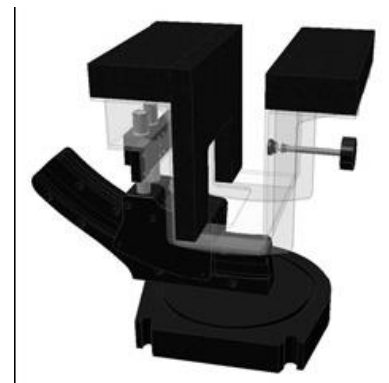
parameters: relative permittivity  $\epsilon = 3$  and loss tangent  $\delta = 0.02$ . The amount of dielectric material has been reduced in the closest vicinity of the device, since measurements have suggested that the influence of the clamp on the test results could thus be lowered.

<Laptop Extension Kit>

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



Picture C.9-1: Device Holder



Picture C.9-2: Laptop Extension Kit

### C.4.5 Phantom

The SAM Twin Phantom V4.0 is constructed of a fiberglass shell integrated in a table. The shape of the shell is based on data from an anatomical study designed to represent the 90<sup>th</sup> percentile of the population. The phantom enables the dissymmetric evaluation of SAR for both left and right handed handset usage, as well as body-worn usage using the flat phantom region. Reference markings on the Phantom allow the complete setup of all predefined phantom positions and measurement grids by manually teaching three points in the robot. The shell phantom has a 2mm shell thickness (except the ear region where shell thickness increases to 6 mm).

Shell Thickness:  $2 \pm 0.2$  mm

Filling Volume: Approx. 25 liters

Dimensions: 810 x 1000 x 500 mm (H x L x W)

Available: Special



**Picture C.10: SAM Twin Phantom**



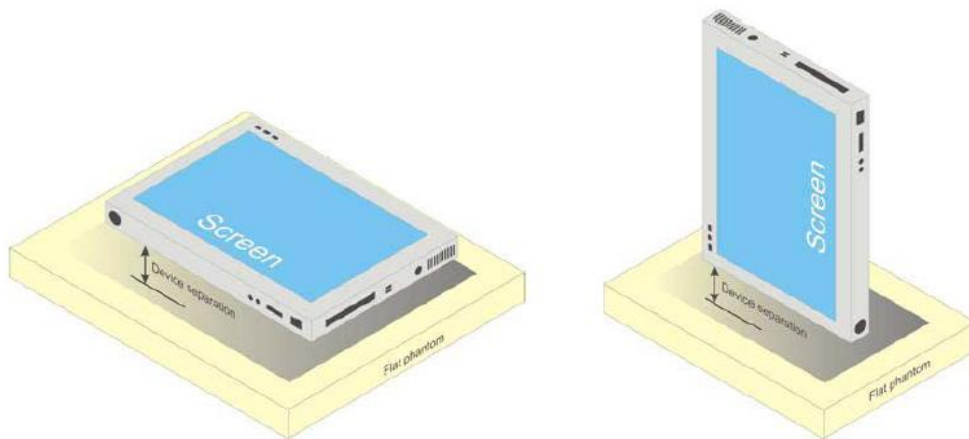
## ANNEX D Position of the wireless device in relation to the phantom

### D.1 Body-supported device

Other devices that fall into this category include tablet type portable computers and credit card transaction authorisation terminals, point-of-sale and/or inventory terminals. Where these devices may be torso or limb-supported, the same principles for body-supported devices are applied. The example in Picture D.1 shows a tablet form factor portable computer for which SAR should be separately assessed with

- a) each surface and
- b) the separation distances

positioned against the flat phantom that correspond to the intended use as specified by the manufacturer. If the intended use is not specified in the user instructions, the device shall be tested directly against the flat phantom in all usable orientations.



Picture D.1 Tablet form factor portable computer

### D.2 DUT Setup Photos



Picture D.2

## ANNEX E Equivalent Media Recipes

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

**TableE.1: Composition of the Tissue Equivalent Matter**

Frequency (MHz)	835Head	835Body	1900 Head	1900 Body	2450 Head	2450 Body	5800 Head	5800 Body
Ingredients (% by weight)								
Water	41.45	52.5	55.242	69.91	58.79	72.60	65.53	65.53
Sugar	56.0	45.0	\	\	\	\	\	\
Salt	1.45	1.4	0.306	0.13	0.06	0.18	\	\
Preventol	0.1	0.1	\	\	\	\	\	\
Cellulose	1.0	1.0	\	\	\	\	\	\
Glycol Monobutyl	\	\	44.452	29.96	41.15	27.22	\	\
Diethylenglycol monohexylether	\	\	\	\	\	\	17.24	17.24
Triton X-100	\	\	\	\	\	\	17.24	17.24
Dielectric Parameters Target Value	$\epsilon=41.5$ $\sigma=0.90$	$\epsilon=55.2$ $\sigma=0.97$	$\epsilon=40.0$ $\sigma=1.40$	$\epsilon=53.3$ $\sigma=1.52$	$\epsilon=39.2$ $\sigma=1.80$	$\epsilon=52.7$ $\sigma=1.95$	$\epsilon=35.3$ $\sigma=5.27$	$\epsilon=48.2$ $\sigma=6.00$

**Note:** There are a little adjustment respectively for 750, 1750, 2600, 5200, 5300 and 5600 based on the recipe of closest frequency in table E.1.

## ANNEX F System Validation

The SAR system must be validated against its performance specifications before it is deployed.

When SAR probes, system components or software are changed, upgraded or recalibrated, these must be validated with the SAR system(s) that operates with such components.

**Table F.1: System Validation for 3846**

Probe SN.	Liquid name	Validation date	Frequency point	Status (OK or Not)
3846	Head 750MHz	Jan.19,2017	750 MHz	OK
3846	Head 850MHz	Jan.19,2017	850 MHz	OK
3846	Head 900MHz	Jan.18,2017	900 MHz	OK
3846	Head 1750MHz	Jan.17,2017	1750 MHz	OK
3846	Head 1810MHz	Jan.17,2017	1810 MHz	OK
3846	Head 1900MHz	Jan.16,2017	1900 MHz	OK
3846	Head 1950MHz	Jan.16,2017	1950 MHz	OK
3846	Head 2000MHz	Jan.16,2017	2000 MHz	OK
3846	Head 2100MHz	Jan.16,2017	2100 MHz	OK
3846	Head 2300MHz	Jan.15,2017	2300 MHz	OK
3846	Head 2450MHz	Jan.15,2017	2450 MHz	OK
3846	Head 2550MHz	Jan.15,2017	2550 MHz	OK
3846	Head 2600MHz	Jan.15,2017	2600 MHz	OK
3846	Head 3500MHz	Jan.14,2017	3500 MHz	OK
3846	Head 3700MHz	Jan.14,2017	3700 MHz	OK
3846	Head 5200MHz	Jan.13,2017	5200 MHz	OK
3846	Head 5500MHz	Jan.13,2017	5500 MHz	OK
3846	Head 5800MHz	Jan.13,2017	5800 MHz	OK
3846	Body 750MHz	Jan.19,2017	750 MHz	OK
3846	Body 850MHz	Jan.19,2017	850 MHz	OK
3846	Body 900MHz	Jan.18,2017	900 MHz	OK
3846	Body 1750MHz	Jan.17,2017	1750 MHz	OK
3846	Body 1810MHz	Jan.17,2017	1810 MHz	OK
3846	Body 1900MHz	Jan.16,2017	1900 MHz	OK
3846	Body 1950MHz	Jan.16,2017	1950 MHz	OK
3846	Body 2000MHz	Jan.16,2017	2000 MHz	OK
3846	Body 2100MHz	Jan.16,2017	2100 MHz	OK
3846	Body 2300MHz	Jan.15,2017	2300 MHz	OK
3846	Body 2450MHz	Jan.15,2017	2450 MHz	OK
3846	Body 2550MHz	Jan.15,2017	2550 MHz	OK
3846	Body 2600MHz	Jan.15,2017	2600 MHz	OK
3846	Body 3500MHz	Jan.14,2017	3500 MHz	OK
3846	Body 3700MHz	Jan.14,2017	3700 MHz	OK
3846	Body 5200MHz	Jan.13,2017	5200 MHz	OK
3846	Body 5500MHz	Jan.13,2017	5500 MHz	OK
3846	Body 5800MHz	Jan.13,2017	5800 MHz	OK

**ANNEX G Probe Calibration Certificate****Probe 3846 Calibration Certificate**

In Collaboration with  
**s p e a g**  
CALIBRATION LABORATORY

Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China  
Tel: +86-10-62304633-2218 Fax: +86-10-62304633-2209  
E-mail: [ctl@chinattl.com](mailto:ctl@chinattl.com) [Http://www.chinattl.cn](http://www.chinattl.cn)



中国认可  
国际互认  
校准  
CALIBRATION  
CNAS L0570

Client

CTTL

Certificate No: Z16-97251

**CALIBRATION CERTIFICATE**

Object EX3DV4 - SN:3846

Calibration Procedure(s) FD-Z11-004-01  
Calibration Procedures for Dosimetric E-field Probes

Calibration date: January 13, 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(Calibrated by, Certificate No.)	Scheduled Calibration
Power Meter NRP2	101919	27-Jun-16 (CTTL, No.J16X04777)	Jun-17
Power sensor NRP-Z91	101547	27-Jun-16 (CTTL, No.J16X04777)	Jun-17
Power sensor NRP-Z91	101548	27-Jun-16 (CTTL, No.J16X04777)	Jun-17
Reference10dBAttenuator	18N50W-10dB	13-Mar-16(CTTL,No.J16X01547)	Mar-18
Reference20dBAttenuator	18N50W-20dB	13-Mar-16(CTTL, No.J16X01548)	Mar-18
Reference Probe EX3DV4	SN 7433	26-Sep-16(SPEAG,No.EX3-7433_Sep16)	Sep-17
DAE4	SN 1331	21-Jan-16(SPEAG, No.DAE4-1331_Jan16)	Jan -17
Secondary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
SignalGeneratorMG3700A	6201052605	27-Jun-16 (CTTL, No.J16X04776)	Jun-17
Network Analyzer E5071C	MY46110673	26-Jan-16 (CTTL, No.J16X00894)	Jan -17

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

Issued: January 14, 2017

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

Certificate No: Z16-97251

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