TEST REPORT

No.I19N01941-SAR

For

Yulong Computer Telecommunication Scientific (Shenzhen) Co., Ltd

Tracker

Model Name: cp311A-CT

With

Hardware Version: V1.01

Software Version: 3.18.004.P0.190809.cp311A-CT

FCC ID: R38YLCP311A-CT

Issued Date: 2019-09-25

Designation Number: CN1210

Note:

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

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REPORT HISTORY

Report Number	Revision	Issue Date	Description
I19N01941-SAR	Rev.0	2019-09-25	Initial creation of test report

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1 Test Laboratory

1.1 Testing Location

Company Name:	Shenzhen Academy of Information and Communications Technology
Address:	Building G, Shenzhen International Innovation Center, No.1006 Shennan Road, Futian District, Shenzhen, Guangdong, P. R. China
Postal Code:	518026
Telephone:	+86-755-33322000
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1.2 Testing Environment

Temperature:	18°C~25 °C
Relative humidity:	30%~ 70%
Ground system resistance:	<4Ω
Ambient noise & Reflection:	< 0.012 W/kg

1.3 Project Data

Testing Start Date:	September 16, 2019
Testing End Date:	September 19, 2019

1.4 Signature

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2 Statement of Compliance

The maximum results of Specific Absorption Rate (SAR) found during testing for Yulong Computer Telecommunication Scientific (Shenzhen) Co., Ltd Tracker cp311A-CT are as follows:

Table 2.1: Highest Reported SAR for Body-worn (1g)

Exposure Configuration	Technology Band	Highest Reported SAR 1g(W/Kg)	Equipment Class
Body-worn（0mm）	LTE Band 2	**0.88**	PCB
	LTE Band 4	0.70	
	LTE Band 12	0.71	
	LTE Band 13	0.62	
	WLAN 2.4GHz	0.86	DTS

The SAR values found for the Mobile Phone are below the maximum recommended levels of 1.6 W/Kg as averaged over any 1g tissue according to the ANSI C95.1-1992.

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

The measurement together with the test system set-up is described in annex C of this test report. A detailed description of the equipment under test can be found in chapter 4 of this test report.

The highest reported SAR value is obtained at the case of **(Table 2.1),** and the value is**: 0.88 W/kg (1g).**

Table 2.2: The sum of reported SAR values for main antenna and Wi-Fi

/	Position	Main antenna	Wi-Fi	Sum
Highest reported SAR value for Body-worn	Left	0.65	0.86	**1.51**

According to the above tables, the highest sum of reported SAR value is **1.51 W/kg (1g)**. The detail for simultaneous transmission consideration is described in chapter 12.

3 Client Information

3.1 Applicant Information

Company Name:	Yulong Computer Telecommunication Scientific (Shenzhen) Co., Ltd
Address /Post:	Building B, Boton Science Park, Chaguang Road, Xili Town, Nanshan District, Shenzhen
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3.2 Manufacturer Information

Company Name:	Yulong Computer Telecommunication Scientific (Shenzhen) Co., Ltd
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Email:	chenyanting@yulong.com
Telephone:	+86 15927320221
Fax:	/

4 Equipment under Test (EUT) and Ancillary Equipment (AE)

4.1 About EUT

Description:	Tracker
Model Name:	cp311A-CT
Frequency Bands:	LTE Band 2/4/12/13, Wi-Fi 2.4G
Operating Mode:	LTE: QPSK、16QAM WIFI: 802.11b、802.11g、802.11n(HT20)、802.11n(HT40)
Condition of EUT as received	No obvious damage in appearance
Tested Tx Frequency:	1850.7 – 1909.3MHz (LTE Band 2)
	1710.7 – 1754.3MHz (LTE Band 4)
	699.7 – 715.3MHz (LTE Band 12)
	779.5 – 784.5MHz (LTE Band 13)
	2412 – 2462MHz (Wi-Fi 2.4G)
Test device Production information:	Production unit
Device type:	Portable device
Antenna type:	Integrated antenna

4.2 Internal Identification of EUT used during the test

EUT ID*	IMEI	HW Version	SW Version
EUT1	860778040000119	V1.01	3.18.004.P0.190809.cp311A-CT
EUT2	860778040000333	V1.01	3.18.004.P0.190809.cp311A-CT

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

Note: It is performed to test SAR with the EUT 1, and conducted power with the EUT 2.

4.3 Internal Identification of AE used during the test

AE ID*	Description	Type	Manufacturer
AE1	Battery	Li-polymer	Ningbo Veken

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

5 Test Methodology

5.1 Applicable Limit Regulations

ANSI C95.1–1992: IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz.

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

5.2 Applicable Measurement Standards

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

KDB 447498 D01 General RF Exposure Guidance v06: Mobile and Portable Devices RF Exposure Procedures and Equipment Authorization Policies.

KDB 941225 D05 SAR for LTE Devices v02r05: SAR Evaluation Considerations for LTE Devices

KDB 248227 D01 802.11 Wi-Fi SAR v02r02: SAR Guidance for IEEE 802.11 (Wi-Fi) Transmitters.

KDB 865664 D01SAR measurement 100 MHz to 6 GHz v01r04: SAR Measurement Requirements for 100 MHz to 6 GHz.

KDB 865664 D02 RF Exposure Reporting v01r02: RF Exposure Compliance Reporting and Documentation Considerations

TCB workshop April 2019; RF Exposure Procedures (Tissue Simulating Liquids)

6 Specific Absorption Rate (SAR)

6.1 Introduction

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

6.2 SAR Definition

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

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

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

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

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

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

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

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

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

7 Tissue Simulating Liquids

7.1 Targets for tissue simulating liquid

Table 7.1: Targets for tissue simulating liquid

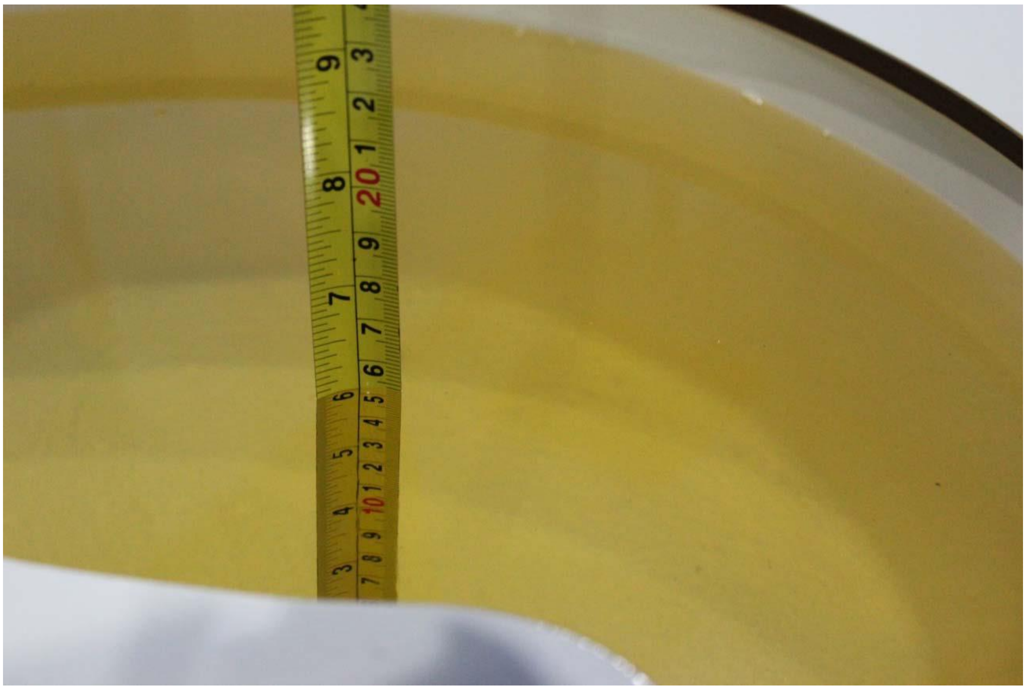
Frequency (MHz)	Liquid Type	Conductivity (σ)	± 5% Range	Permittivity (ε)	± 5% Range
750	Head	0.89	0.85～0.93	41.9	39.8～44.0
1750	Head	1.37	1.30～1.44	40.1	38.1～42.1
1900	Head	1.40	1.33～1.47	40.0	38.0～42.0
2450	Head	1.80	1.71～1.89	39.2	37.2～41.2

7.2 Dielectric Performance

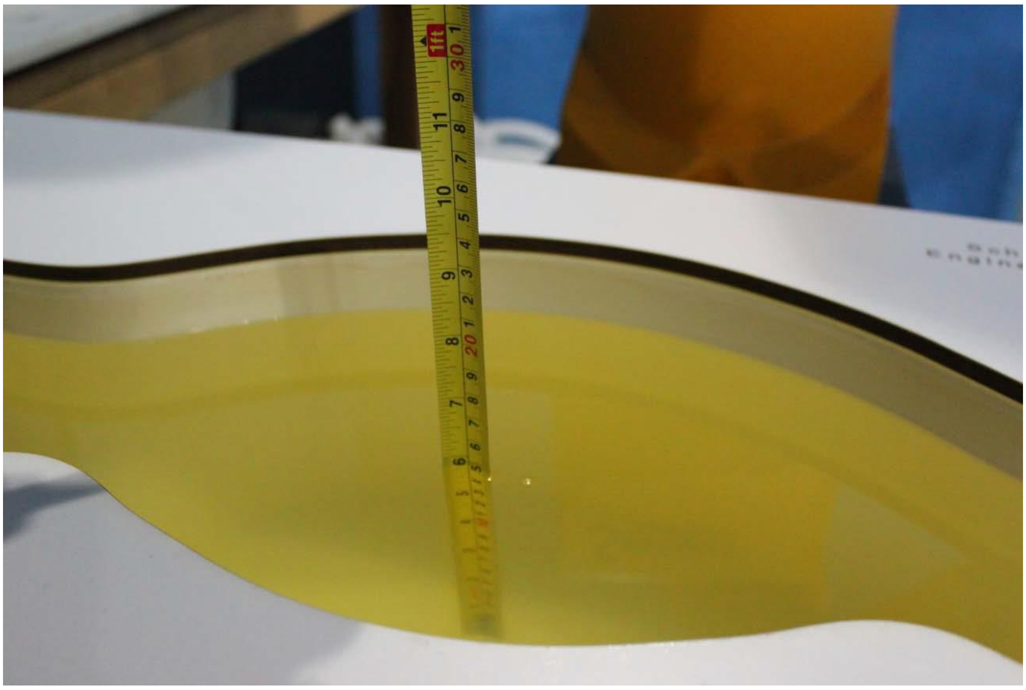
Table 7.2: Dielectric Performance of Tissue Simulating Liquid

Measurement Date (yyyy-mm-dd)	Type	Frequency	Conductivity σ (S/m)	Drift (%)	Permittivity ε	Drift (%)
2019-9-16	Head	750	0.898	0.90	41.08	-1.96
2019-9-16	Head	1750	1.363	-0.51	39.26	-2.09
2019-9-16	Head	1900	1.416	1.14	38.85	-2.88
2019-9-19	Head	2450	1.837	2.06	37.94	-3.21

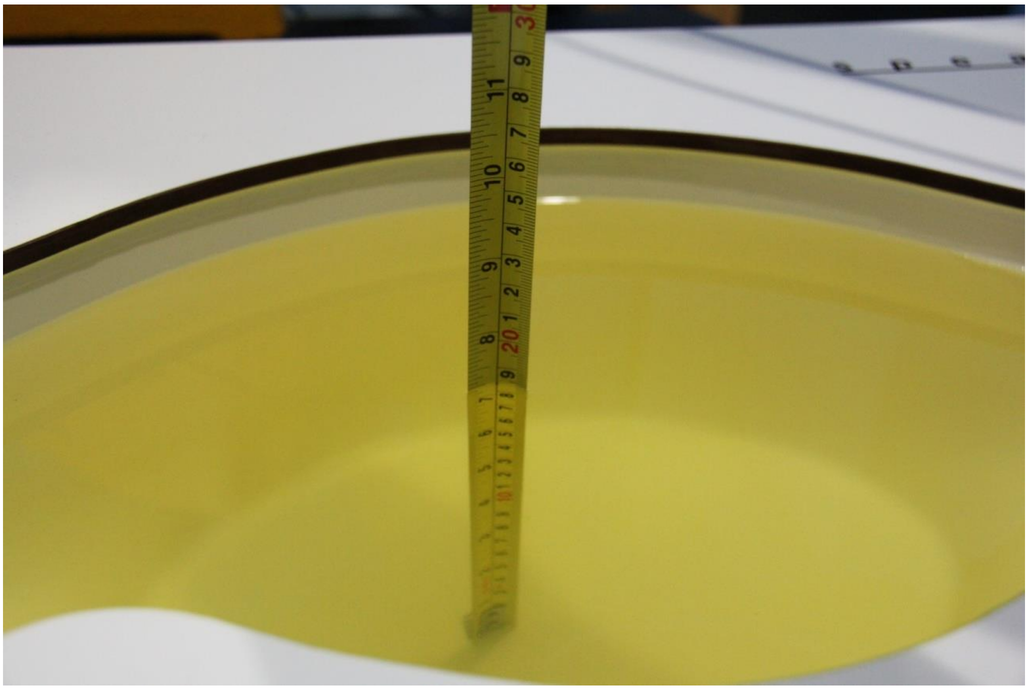
Note: The liquid temperature is 22.0^{o}C.



Picture 7-1: Liquid depth in the Flat Phantom (750 MHz)



Picture 7-2: Liquid depth in the Flat Phantom (1750 MHz)



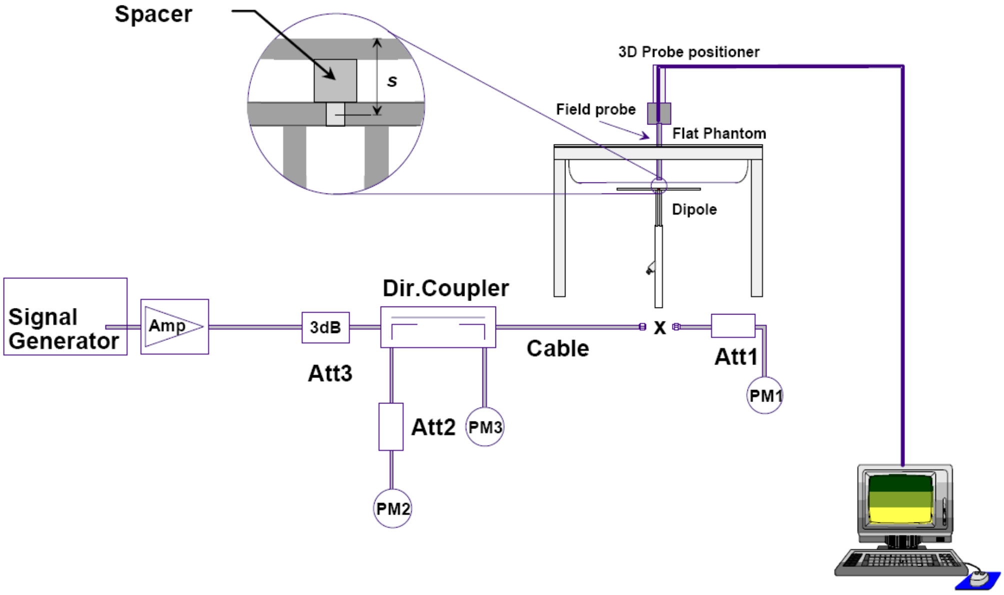
Picture 7-3: Liquid depth in the Flat Phantom (1900 MHz)

Picture 7-4: Liquid depth in the Flat Phantom(2450MHz)

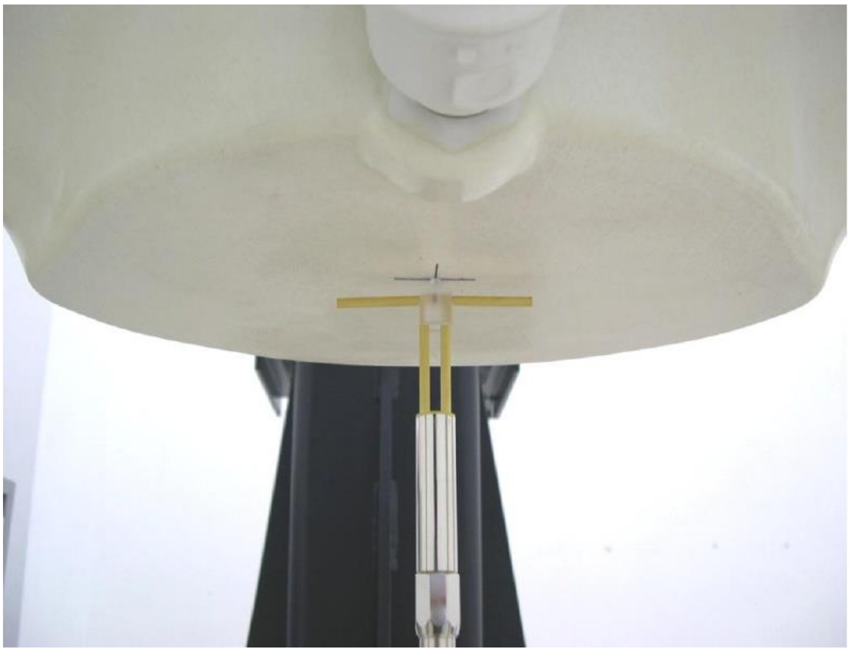
8 System verification

8.1 System Setup

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



Picture 8.1 System Setup for System Evaluation



Picture 8.2 Photo of Dipole Setup

8.2 System Verification

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

Table 8.1: System Verification of Head

Measurement Date (yyyy-mm-dd)	Frequency	Target value (W/kg)		Measured value (W/kg)		Deviation (%)	
		10 g Average	1 g Average	10 g Average	1 g Average	10 g Average	1 g Average
2019-9-16	750 MHz	5.70	8.53	5.84	8.88	2.46	4.10
2019-9-16	1750 MHz	19.3	36.4	18.84	35.08	-2.38	-3.63
2019-9-16	1900 MHz	21.0	40.5	21.48	42.00	2.29	3.70
2019-9-19	2450 MHz	24.1	52.0	24.64	54.40	2.24	4.62

9 Measurement Procedures

9.1 Tests to be performed

In order to determine the highest value of the peak spatial-average SAR of a handset, all device positions, configurations and operational modes shall be tested for each frequency band according to steps 1 to 3 below. A flowchart of the test process is shown in picture 9.1.

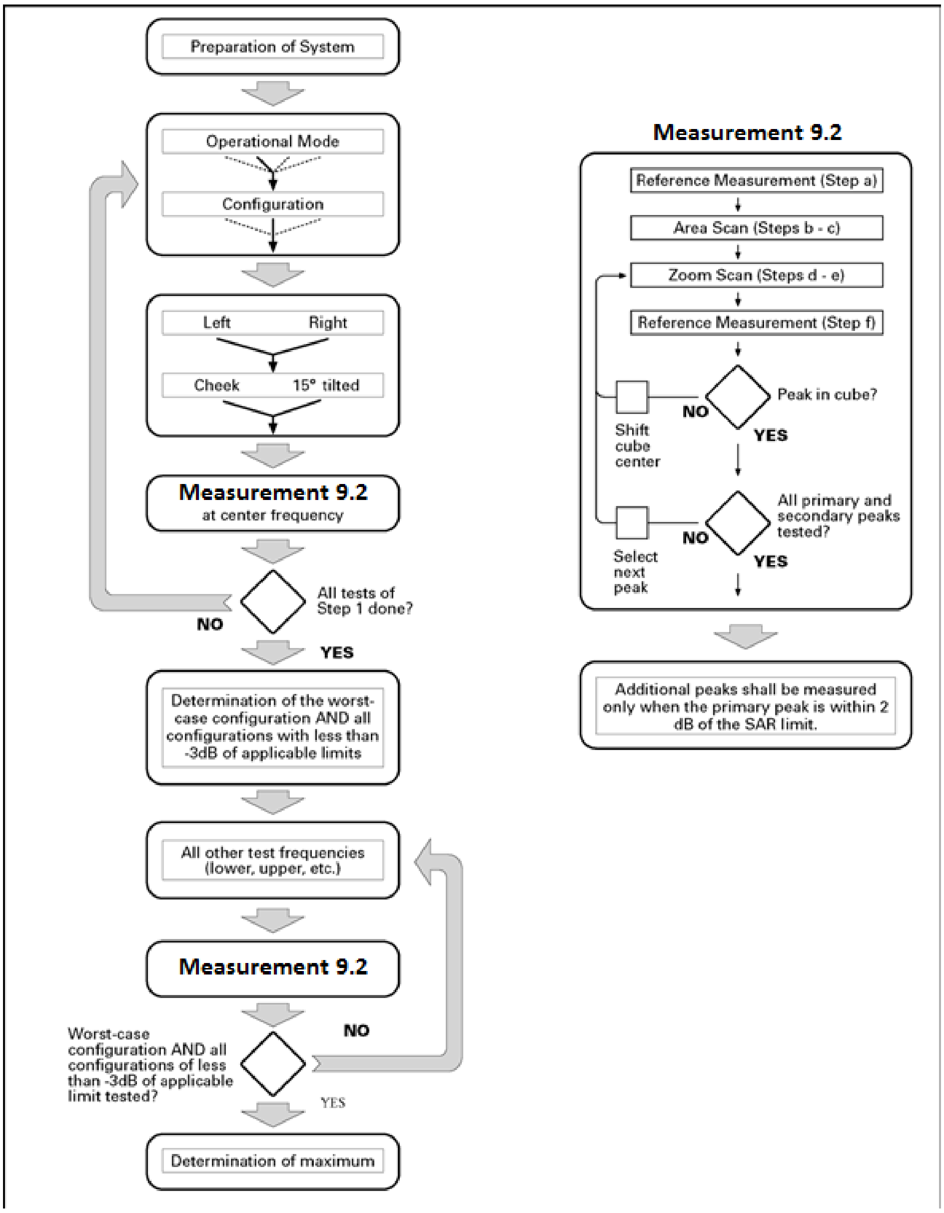
Step 1: The tests described in 9.2 shall be performed at the channel that is closest to the center of the transmit frequency band (f_c) for:

a) all device positions (cheek and tilt, for both left and right sides of the SAM phantom, as described in annex D),
b) all configurations for each device position in a), e.g., antenna extended and retracted, and
c) all operational modes, e.g., analogue and digital, for each device position in a) and configuration in b) in each frequency band.

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

Step 2: For the condition providing highest peak spatial-average SAR determined in Step 1, perform all tests described in 9.2 at all other test frequencies, i.e., lowest and highest frequencies. In addition, for all other conditions (device position, configuration and operational mode) where the peak spatial-average SAR value determined in Step 1 is within 3 dB of the applicable SAR limit, it is recommended that all other test frequencies shall be tested as well.

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



Picture 9.1 Block diagram of the tests to be performed

9.2 General Measurement Procedure

The area and zoom scan resolutions specified in the table below must be applied to the SAR measurements and fully documented in SAR reports to qualify for TCB approval. Probe boundary effect error compensation is required for measurements with the probe tip closer than half a probe tip diameter to the phantom surface. Both the probe tip diameter and sensor offset distance must satisfy measurement protocols; to ensure probe boundary effect errors are minimized and the higher fields closest to the phantom surface can be correctly measured and extrapolated to the phantom surface for computing 1-g SAR. Tolerances of the post-processing algorithms must be verified by the test laboratory for the scan resolutions used in the SAR measurements, according to the reference distribution functions specified in IEEE Std 1528-2013. The results should be documented as part of the system validation records and may be requested to support test results when all the measurement parameters in the following table are not satisfied.

			$\le$ 3 GHz	> 3 GHz
Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface			5 ± 1 mm	½·δ·ln(2) ± 0.5 mm
Maximum probe angle from probe axis to phantom surface normal at the measurement location			30° ± 1°	20° ± 1°
Maximum area scan spatial resolution: Δx_{Area}, Δy_{Area}			$\le$ 2 GHz: $\le$ 15 mm 2 – 3 GHz: $\le$ 12 mm	3 – 4 GHz: $\le$ 12 mm 4 – 6 GHz: $\le$ 10 mm
			When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be $\le$ the corresponding x or y dimension of the test device with at least one measurement point on the test device.	
Maximum zoom scan spatial resolution: Δx_{Zoom}, Δy_{Zoom}			$\le$ 2 GHz: $\le$ 8 mm 2 – 3 GHz: $\le$ 5 mm*	3 – 4 GHz: $\le$ 5 mm* 4 – 6 GHz: $\le$ 4 mm*
Maximum zoom scan spatial resolution, normal to phantom surface	uniform grid: $\Delta z_{Zoom}(n)$		$\le$ 5 mm	3 – 4 GHz: $\le$ 4 mm 4 – 5 GHz: $\le$ 3 mm 5 – 6 GHz: $\le$ 2 mm
	graded grid	$\Delta z_{Zoom}(1)$: between 1st two points closest to phantom surface	$\le$ 4 mm	3 – 4 GHz: $\le$ 3 mm 4 – 5 GHz: $\le$ 2.5 mm 5 – 6 GHz: $\le$ 2 mm
		$\Delta z_{Zoom}(n>1)$: between subsequent points	$\le 1.5 \cdot \Delta z_{Zoom}(n-1)$	
Minimum zoom scan volume	x, y, z		$\ge$ 30 mm	3 – 4 GHz: $\ge$ 28 mm 4 – 5 GHz: $\ge$ 25 mm 5 – 6 GHz: $\ge$ 22 mm

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

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

9.3 SAR Measurement for LTE

SAR tests for LTE are performed with a base station simulator, Anristu MT8820C. Closed loop power control was used so the UE transmits with maximum output power during SAR testing. All powers were measured with the Anristu MT8820C.It is performed for conducted power and SAR based on the KDB941225 D05.

SAR is evaluated separately according to the following procedures for the different test positions in each exposure condition – head, body, body-worn accessories and other use conditions. The procedures in the following subsections are applied separately to test each LTE frequency band.

1) QPSK with 1 RB allocation

   Start with the largest channel bandwidth and measure SAR for QPSK with 1 RB allocation, using the RB offset and required test channel combination with the highest maximum output power among RB offsets at the upper edge, middle and lower edge of each required test channel. When the reported SAR is ≤ 0.8 W/kg, testing of the remaining RB offset configurations and required test channels is not required for 1 RB allocation; otherwise, SAR is required for the remaining required test channels and only for the RB offset configuration with the highest output power for that channel. When the reported SAR of a required test channel is > 1.45 W/kg, SAR is required for all three RB offset configurations for that required test channel.

2) QPSK with 50% RB allocation

   The procedures required for 1 RB allocation in 1) are applied to measure the SAR for QPSK with 50% RB allocation.

3) QPSK with 100% RB allocation

   For QPSK with 100% RB allocation, SAR is not required when the highest maximum output power for 100 % RB allocation is less than the highest maximum output power in 50% and 1 RB allocations and the highest reported SAR for 1 RB and 50% RB allocation in 1) and 2) are ≤ 0.8 W/kg. Otherwise, SAR is measured for the highest output power channel; and if the reported SAR is > 1.45 W/kg, the remaining required test channels must also be tested.

9.4 WI-FI Measurement Procedures for SAR

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

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

9.5 Power Drift

To control the output power stability during the SAR test, DASY5 system calculates the power drift by measuring the E-field at the same location at the beginning and at the end of the measurement for each test position. These drift values can be found in Section 14 labeled as: (Power Drift [dB]). This ensures that the power drift during one measurement is within 5%.

10 Conducted Output Power

10.1 LTE Measurement result

LTE-FDD Band 2				Actual output Power (dBm)			Tune up
Band-width	RB allocation	RB offset	Modulation	High	Middle	Low	
1.4 MHz				1909.3MHz	1880MHz	1850.7MHz	
	1RB	High	QPSK	23.29	22.92	22.99	**24**
			16QAM	22.26	21.90	21.96	**23**
		Middle	QPSK	23.36	22.98	23.05	**24**
			16QAM	22.34	21.95	22.03	**23**
		Low	QPSK	23.25	22.92	22.98	**24**
			16QAM	22.22	21.89	21.95	**23**
	3RB	High	QPSK	23.38	23.13	23.39	**24**
			16QAM	22.35	22.10	22.36	**23**
		Middle	QPSK	23.48	23.18	23.38	**24**
			16QAM	22.46	22.15	22.35	**23**
		Low	QPSK	23.32	23.18	23.18	**24**
			16QAM	22.29	22.16	22.16	**23**
	6RB	/	QPSK	22.34	22.07	22.21	**23**
			16QAM	21.31	21.04	21.19	**22**
3 MHz				1908.5MHz	1880MHz	1851.5MHz	/
	1RB	High	QPSK	23.26	22.95	23.21	**24**
			16QAM	22.24	21.92	22.19	**23**
		Middle	QPSK	23.36	23.16	23.24	**24**
			16QAM	22.33	22.13	22.22	**23**
		Low	QPSK	23.27	23.13	23.16	**24**
			16QAM	22.24	22.10	22.14	**23**
	8RB	High	QPSK	22.42	22.20	22.29	**23**
			16QAM	21.39	21.18	21.26	**22**
		Middle	QPSK	22.40	22.10	22.18	**23**
			16QAM	21.38	21.07	21.15	**22**
		Low	QPSK	22.36	22.14	22.30	**23**
			16QAM	21.34	21.12	21.27	**22**
	15RB	/	QPSK	22.27	22.18	22.20	**23**
			16QAM	21.24	21.15	21.17	**22**

LTE-FDD Band 2				Actual output Power (dBm)			Tune up
Band-width	RB allocation	RB offset	Modulation	High	Middle	Low	
5 MHz				1907.5MHz	1880MHz	1852.5MHz	
	1RB	High	QPSK	23.21	22.86	23.04	**24**
			16QAM	22.19	21.83	22.01	**23**
		Middle	QPSK	23.18	23.07	23.11	**24**
			16QAM	22.15	22.04	22.08	**23**
		Low	QPSK	23.14	23.14	23.18	**24**
			16QAM	22.12	22.12	22.15	**23**
	12RB	High	QPSK	22.23	22.09	22.04	**23**
			16QAM	21.20	21.07	21.01	**22**
		Middle	QPSK	22.27	22.09	22.20	**23**
			16QAM	21.24	21.07	21.17	**22**
		Low	QPSK	22.30	22.10	22.19	**23**
			16QAM	21.28	21.08	21.17	**22**
	25RB	/	QPSK	22.16	22.10	22.20	**23**
			16QAM	21.13	21.07	21.18	**22**
10 MHz				1905MHz	1880MHz	1855MHz	/
	1RB	High	QPSK	23.22	23.07	23.12	**24**
			16QAM	22.20	22.04	22.10	**23**
		Middle	QPSK	23.19	23.20	23.08	**24**
			16QAM	22.16	22.17	22.06	**23**
		Low	QPSK	23.12	23.06	23.22	**24**
			16QAM	22.09	22.03	22.19	**23**
	25RB	High	QPSK	22.20	22.11	22.14	**23**
			16QAM	21.17	21.08	21.11	**22**
		Middle	QPSK	22.22	22.24	22.15	**23**
			16QAM	21.19	21.21	21.12	**22**
		Low	QPSK	22.23	22.24	22.24	**23**
			16QAM	21.20	21.21	21.22	**22**
	50RB	/	QPSK	22.17	22.27	22.13	**23**
			16QAM	21.14	21.24	21.10	**22**

LTE-FDD Band 2				Actual output Power (dBm)			Tune up
Band-width	RB allocation	RB offset	Modulation	High	Middle	Low	
15 MHz				1902.5MHz	1880MHz	1857.5MHz	
	1RB	High	QPSK	23.30	23.21	23.04	**24**
			16QAM	22.33	22.24	22.08	**23**
		Middle	QPSK	22.97	23.08	22.93	**24**
			16QAM	22.00	22.11	21.96	**23**
		Low	QPSK	22.93	23.09	23.14	**24**
			16QAM	21.97	22.12	22.17	**23**
	36RB	High	QPSK	22.14	22.13	22.11	**23**
			16QAM	21.17	21.16	21.15	**22**
		Middle	QPSK	22.17	22.22	22.07	**23**
			16QAM	21.21	21.25	21.11	**22**
		Low	QPSK	22.21	22.19	22.17	**23**
			16QAM	21.25	21.22	21.20	**22**
	75RB	/	QPSK	22.18	21.91	22.05	**23**
			16QAM	21.21	20.94	21.08	**22**
20 MHz				1900MHz	1880MHz	1860MHz	/
	1RB	High	QPSK	23.21	23.04	23.13	**24**
			16QAM	22.24	22.07	22.16	**23**
		Middle	QPSK	**23.28**	**23.28**	23.29	**24**
			16QAM	22.31	22.31	22.32	**23**
		Low	QPSK	23.26	23.19	**23.35**	**24**
			16QAM	22.29	22.23	22.38	**23**
	50RB	High	QPSK	22.27	22.26	22.22	**23**
			16QAM	21.31	21.30	21.26	**22**
		Middle	QPSK	**22.33**	22.31	22.21	**23**
			16QAM	21.36	21.34	21.24	**22**
		Low	QPSK	22.26	22.29	22.31	**23**
			16QAM	21.29	21.32	21.34	**22**
	100RB	/	QPSK	**22.11**	22.02	22.03	**23**
			16QAM	21.14	21.05	21.07	**22**

LTE-FDD Band 4				Actual output Power (dBm)			Tune up
Band-width	RB allocation	RB offset	Modulation	High	Middle	Low	
1.4 MHz				1754.3MHz	1732.5MHz	1710.7MHz	
	1RB	High	QPSK	22.98	23.01	23.14	**24**
			16QAM	21.91	21.94	22.08	**23**
		Middle	QPSK	23.33	23.24	23.23	**24**
			16QAM	22.26	22.18	22.17	**23**
		Low	QPSK	23.06	23.12	23.17	**24**
			16QAM	21.99	22.06	22.11	**23**
	3RB	High	QPSK	23.46	23.39	23.33	**24**
			16QAM	22.39	22.33	22.27	**23**
		Middle	QPSK	23.35	23.28	23.38	**24**
			16QAM	22.29	22.22	22.32	**23**
		Low	QPSK	23.31	23.22	23.33	**24**
			16QAM	22.24	22.15	22.27	**23**
	6RB	/	QPSK	22.38	22.34	22.28	**23**
			16QAM	21.32	21.27	21.22	**22**
3 MHz				1753.5MHz	1732.5MHz	1711.5MHz	/
	1RB	High	QPSK	23.15	23.03	23.16	**24**
			16QAM	22.08	21.97	22.09	**23**
		Middle	QPSK	23.13	23.06	23.20	**24**
			16QAM	22.07	22.00	22.13	**23**
		Low	QPSK	23.02	22.93	23.21	**24**
			16QAM	21.96	21.86	22.14	**23**
	8RB	High	QPSK	22.30	22.35	22.32	**23**
			16QAM	21.24	21.29	21.25	**22**
		Middle	QPSK	22.25	22.22	22.37	**23**
			16QAM	21.19	21.16	21.30	**22**
		Low	QPSK	22.28	22.21	22.34	**23**
			16QAM	21.22	21.15	21.28	**22**
	15RB	/	QPSK	22.22	22.29	22.33	**23**
			16QAM	21.15	21.23	21.27	**22**

LTE-FDD Band 4				Actual output Power (dBm)			Tune up
Band-width	RB allocation	RB offset	Modulation	High	Middle	Low	
5 MHz				1752.5MHz	1732.5MHz	1712.5MHz	
	1RB	High	QPSK	23.39	22.93	23.00	**24**
			16QAM	22.33	21.87	21.93	**23**
		Middle	QPSK	23.21	23.08	23.17	**24**
			16QAM	22.14	22.01	22.11	**23**
		Low	QPSK	23.07	22.93	23.07	**24**
			16QAM	22.00	21.87	22.01	**23**
	12RB	High	QPSK	22.37	22.17	22.22	**23**
			16QAM	21.31	21.11	21.16	**22**
		Middle	QPSK	22.22	22.07	22.31	**23**
			16QAM	21.15	21.00	21.25	**22**
		Low	QPSK	22.16	22.03	22.32	**23**
			16QAM	21.10	20.97	21.25	**22**
	25RB	/	QPSK	22.17	22.17	22.26	**23**
			16QAM	21.11	21.10	21.20	**22**
10 MHz				1750MHz	1732.5MHz	1715MHz	/
	1RB	High	QPSK	23.46	23.05	23.29	**24**
			16QAM	22.40	21.99	22.22	**23**
		Middle	QPSK	23.25	23.23	23.34	**24**
			16QAM	22.19	22.17	22.27	**23**
		Low	QPSK	23.21	23.12	23.21	**24**
			16QAM	22.15	22.06	22.15	**23**
	25RB	High	QPSK	22.23	22.16	22.27	**23**
			16QAM	21.17	21.10	21.21	**22**
		Middle	QPSK	22.29	22.16	22.30	**23**
			16QAM	21.22	21.10	21.24	**22**
		Low	QPSK	22.28	22.17	22.17	**23**
			16QAM	21.22	21.10	21.11	**22**
	50RB	/	QPSK	22.24	22.18	22.24	**23**
			16QAM	21.18	21.12	21.18	**22**

LTE-FDD Band 4				Actual output Power (dBm)			Tune up
Band-width	RB allocation	RB offset	Modulation	High	Middle	Low	
15 MHz				1747.5MHz	1732.5MHz	1717.5MHz	
	1RB	High	QPSK	23.25	23.23	23.09	**24**
			16QAM	22.19	22.16	22.02	**23**
		Middle	QPSK	23.31	23.14	23.05	**24**
			16QAM	22.25	22.08	21.99	**23**
		Low	QPSK	23.47	23.22	23.17	**24**
			16QAM	22.40	22.15	22.11	**23**
	36RB	High	QPSK	22.19	22.10	22.33	**23**
			16QAM	21.13	21.03	21.26	**22**
		Middle	QPSK	22.29	22.16	22.34	**23**
			16QAM	21.23	21.09	21.27	**22**
		Low	QPSK	22.27	22.19	22.34	**23**
			16QAM	21.21	21.12	21.27	**22**
	75RB	/	QPSK	22.37	22.32	22.27	**23**
			16QAM	21.30	21.25	21.20	**22**
20 MHz				1745MHz	1732.5MHz	1720MHz	/
	1RB	High	QPSK	23.17	23.17	23.08	**24**
			16QAM	22.11	22.11	22.01	**23**
		Middle	QPSK	**23.26**	**23.28**	**23.47**	**24**
			16QAM	22.20	22.21	22.41	**23**
		Low	QPSK	23.05	23.18	23.27	**24**
			16QAM	21.98	22.11	22.21	**23**
	50RB	High	QPSK	22.32	22.37	22.42	**23**
			16QAM	21.26	21.31	21.35	**22**
		Middle	QPSK	22.41	22.26	22.37	**23**
			16QAM	21.35	21.20	21.31	**22**
		Low	QPSK	**22.50**	22.33	22.44	**23**
			16QAM	21.44	21.26	21.38	**22**
	100RB	/	QPSK	22.20	22.27	22.32	**23**
			16QAM	21.13	21.21	21.25	**22**

LTE-FDD Band 12				Actual output Power (dBm)			Tune up
Band-width	RB allocation	RB offset	Modulation	High	Middle	Low	
1.4 MHz				715.3MHz	707.5MHz	699.7MHz	
	1RB	High	QPSK	23.88	23.58	23.68	**24.5**
			16QAM	22.85	22.59	22.58	**23.5**
		Middle	QPSK	23.97	23.70	23.83	**24.5**
			16QAM	22.77	22.50	22.39	**23.5**
		Low	QPSK	23.90	23.54	23.91	**24.5**
			16QAM	22.44	22.36	22.63	**23.5**
	3RB	High	QPSK	23.94	23.86	23.89	**24.5**
			16QAM	22.90	22.64	22.63	**23.5**
		Middle	QPSK	24.02	23.90	24.05	**24.5**
			16QAM	22.82	22.55	22.44	**23.5**
		Low	QPSK	24.07	23.84	23.95	**24.5**
			16QAM	22.49	22.41	22.68	**23.5**
	6RB	/	QPSK	23.04	22.88	22.96	**23.5**
			16QAM	21.84	21.75	21.56	**22.5**
3 MHz				714.5MHz	707.5MHz	700.5MHz	/
	1RB	High	QPSK	23.87	23.56	23.51	**24.5**
			16QAM	22.80	22.54	22.53	**23.5**
		Middle	QPSK	24.05	23.68	23.90	**24.5**
			16QAM	22.72	22.45	22.34	**23.5**
		Low	QPSK	23.89	23.50	23.91	**24.5**
			16QAM	22.39	22.31	22.58	**23.5**
	8RB	High	QPSK	22.94	22.82	22.67	**23.5**
			16QAM	21.89	21.86	21.66	**22.5**
		Middle	QPSK	22.85	22.81	22.79	**23.5**
			16QAM	21.88	21.64	21.58	**22.5**
		Low	QPSK	22.91	22.71	22.82	**23.5**
			16QAM	21.71	21.53	21.60	**22.5**
	15RB	/	QPSK	22.91	22.77	22.80	**23.5**
			16QAM	21.82	21.73	21.54	**22.5**

LTE-FDD Band 12				Actual output Power (dBm)			Tune up
Band-width	RB allocation	RB offset	Modulation	High	Middle	Low	
5 MHz				713.5MHz	707.5MHz	701.5MHz	
	1RB	High	QPSK	23.74	23.63	23.41	**24.5**
			16QAM	22.74	22.48	22.47	**23.5**
		Middle	QPSK	23.85	23.63	23.69	**24.5**
			16QAM	22.66	22.39	22.28	**23.5**
		Low	QPSK	23.71	23.53	23.82	**24.5**
			16QAM	22.33	22.25	22.52	**23.5**
	12RB	High	QPSK	22.77	22.77	22.40	**23.5**
			16QAM	21.83	21.80	21.60	**22.5**
		Middle	QPSK	22.79	22.69	22.52	**23.5**
			16QAM	21.82	21.58	21.52	**22.5**
		Low	QPSK	22.76	22.59	22.78	**23.5**
			16QAM	21.65	21.47	21.54	**22.5**
	25RB	/	QPSK	22.83	22.71	22.64	**23.5**
			16QAM	21.76	21.67	21.48	**22.5**
10 MHz				711MHz	707.5MHz	704MHz	/
	1RB	High	QPSK	23.86	**23.66**	**23.65**	**24.5**
			16QAM	22.83	22.57	22.56	**23.5**
		Middle	QPSK	**24.04**	23.59	23.53	**24.5**
			16QAM	22.75	22.48	22.37	**23.5**
		Low	QPSK	23.33	23.28	23.57	**24.5**
			16QAM	22.42	22.34	22.61	**23.5**
	25RB	High	QPSK	**22.87**	22.69	22.68	**23.5**
			16QAM	21.92	21.89	21.69	**22.5**
		Middle	QPSK	22.82	22.65	22.47	**23.5**
			16QAM	21.91	21.67	21.61	**22.5**
		Low	QPSK	22.61	22.37	22.48	**23.5**
			16QAM	21.74	21.56	21.63	**22.5**
	50RB	/	QPSK	22.75	22.66	22.47	**23.5**
			16QAM	21.85	21.76	21.57	**22.5**

LTE-FDD Band 13				Actual output Power (dBm)			Tune up
Band-width	RB allocation	RB offset	Modulation	High	Middle	Low	
5 MHz				784.5MHz	782MHz	779.5MHz	
	1RB	High	QPSK	23.65	23.55	23.55	**24.5**
			16QAM	22.73	22.77	22.69	**23.5**
		Middle	QPSK	23.53	23.74	23.76	**24.5**
			16QAM	22.87	22.90	22.93	**23.5**
		Low	QPSK	23.64	23.56	23.84	**24.5**
			16QAM	22.89	22.67	22.98	**23.5**
	12RB	High	QPSK	22.80	22.80	22.61	**23.5**
			16QAM	21.83	21.85	21.82	**22.5**
		Middle	QPSK	22.74	22.76	22.75	**23.5**
			16QAM	21.70	21.70	21.67	**22.5**
		Low	QPSK	22.68	22.54	22.86	**23.5**
			16QAM	21.77	21.80	21.75	**22.5**
	25RB	/	QPSK	22.65	22.78	22.72	**23.5**
			16QAM	21.76	21.87	21.84	**22.5**
10 MHz				/	782MHz	/	/
	1RB	High	QPSK	/	23.68	/	**24.5**
			16QAM	/	22.79	/	**23.5**
		Middle	QPSK	/	**23.81**	/	**24.5**
			16QAM	/	22.92	/	**23.5**
		Low	QPSK	/	23.57	/	**24.5**
			16QAM	/	22.68	/	**23.5**
	25RB	High	QPSK	/	**22.76**	/	**23.5**
			16QAM	/	21.86	/	**22.5**
		Middle	QPSK	/	22.61	/	**23.5**
			16QAM	/	21.71	/	**22.5**
		Low	QPSK	/	22.71	/	**23.5**
			16QAM	/	21.82	/	**22.5**
	50RB	/	QPSK	/	22.77	/	**23.5**
			16QAM	/	21.88	/	**22.5**

10.2 Wi-Fi Measurement result

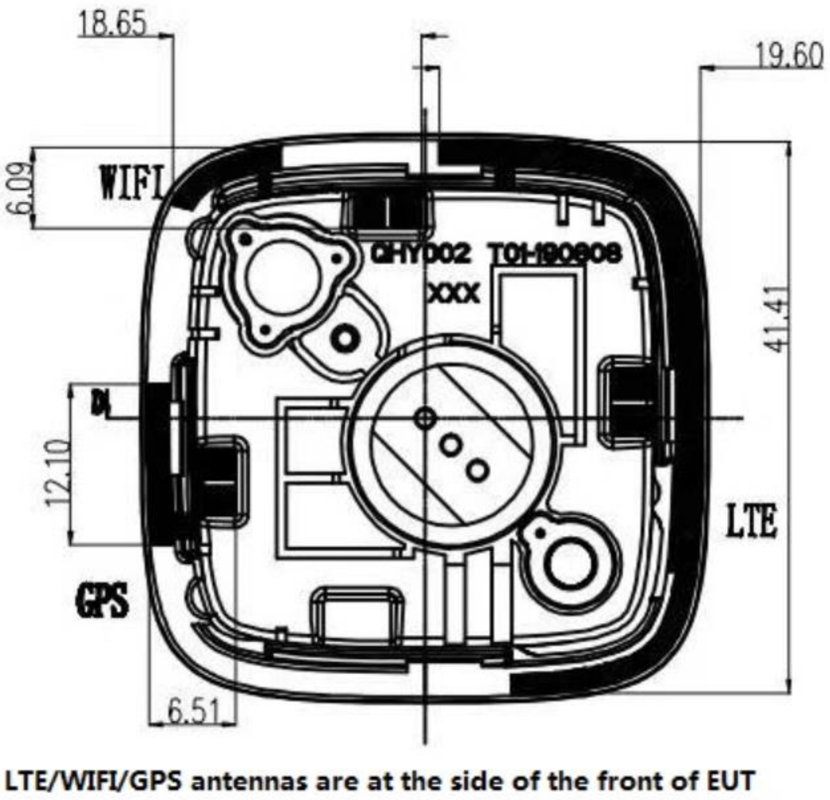
WiFi 2.4GHz	Tune up	Averaged Power (dBm) Duty Cycle: **100%**		
Mode		Ch.1(2412 MHz)	Ch.6(2437Mhz)	Ch.11(2462MHz)
802.11b	**16**	15.65	15.15	15.52
802.11g	**13**	12.64	12.74	12.53
802.11n(20MHz)	**11**	10.65	10.79	10.56
/	**/**	Ch.3(2422 MHz)	Ch.6(2437Mhz)	Ch.9(2452MHz)
802.11n(40MHz)	**11**	10.53	10.59	10.28

11 Simultaneous TX SAR Considerations

11.1 Introduction

The following procedures adopted from “FCC SAR Considerations for Cell Phones with Multiple Transmitters” are applicable to handsets with built-in unlicensed transmitters such as 802.11 a/b/g devices which may simultaneously transmit with the licensed transmitter.
For this device, the Wi-Fi can transmit simultaneous with other transmitters.

11.2 Transmit Antenna Separation Distances



Picture 11.1 Antenna Locations

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 ≤ 50 mm are determined by:

[(max. power of channel, including tune-up tolerance, mW) / (min. test separation distance, mm)] · [√f(GHz)] ≤ 3.0 for 1-g SAR, where

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

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	
2.4GHz WLAN	2.45	Body	10	16	39.81	No

12 Evaluation of Simultaneous

Table 12.1: The sum of reported SAR values for main antenna and Wi-Fi

/	Position	Main antenna	Wi-Fi	Sum
Highest reported SAR value for Body-worn	Left	0.65	0.86	**1.51**

Note: the test positions of above tables are for the worse case that has been evaluated.

Conclusion:

According to the above tables, the sum of reported SAR values is < 1.6W/kg. So the simultaneous transmission SAR with volume scans is not required.

13 Summary of Test Results

According to the client's decision rule in the test registration form, which is "based on the measurement results as the basis of the conformity statement", the test conclusion of this report meets the limit requirements.

13.1 SAR results

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_{Target} is the power of manufacturing upper limit;

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

Duty Cycle

Mode	Duty Cycle
FDD_LTE Band 2/4/12/13	1:1

Table 13.1: SAR Values (LTE Band 2 - Body)

Ambient Temperature: 22.6°C Liquid Temperature: 22.2°C									
Frequency		Test Mode	Test Position	Figure No.	Conducted Power (dBm)	Max. tune-up Power (dBm)	Measured SAR(1g) (W/kg)	Reported SAR(1g) (W/kg)	Power Drift(dB)
MHz	Ch.								
1860	18700	1RB_Low	Front	/	23.35	24	0.322	0.37	0.03
1900	19100	50RB_Mid	Front	/	22.33	23	0.285	0.33	0.06
1860	18700	1RB_Low	Rear	/	23.35	24	0.157	0.18	0.11
1900	19100	50RB_Mid	Rear	/	22.33	23	0.047	0.05	0.11
1860	18700	1RB_Low	Left	/	23.35	24	0.086	0.10	0.08
1900	19100	50RB_Mid	Left	/	22.33	23	0.079	0.09	0.11
1860	18700	1RB_Low	Right	/	23.35	24	0.154	0.18	0.06
1900	19100	50RB_Mid	Right	/	22.33	23	0.137	0.16	0.01
1860	18700	1RB_Low	Top	/	23.35	24	0.025	0.03	0.08
1900	19100	50RB_Mid	Top	/	22.33	23	0.024	0.03	0.07
1860	18700	1RB_Low	Bottom	**Fig.1**	23.35	24	**0.755**	**0.88**	0.09
1900	19100	50RB_Mid	Bottom	/	22.33	23	0.681	0.79	0.12
1900	19100	1RB_Mid	Bottom	/	23.28	24	0.522	0.62	0.11
1880	18900	1RB_Mid	Bottom	/	23.28	24	0.617	0.73	0.02
1900	19100	100RB	Bottom	/	22.11	23	0.547	0.67	0.08

Table 13.2: SAR Values (LTE Band 4 - Body)

Ambient Temperature: 22.6°C Liquid Temperature: 22.2°C									
Frequency		Test Mode	Test Position	Figure No.	Conducted Power (dBm)	Max. tune-up Power (dBm)	Measured SAR(1g) (W/kg)	Reported SAR(1g) (W/kg)	Power Drift(dB)
MHz	Ch.								
1720	20050	1RB_Mid	Front	/	23.47	24	0.560	0.63	0.11
1745	20300	50RB_Low	Front	/	22.50	23	0.456	0.51	0.07
1720	20050	1RB_Mid	Rear	/	23.47	24	0.266	0.30	0.10
1745	20300	50RB_Low	Rear	/	22.50	23	0.152	0.17	0.02
1720	20050	1RB_Mid	Left	/	23.47	24	0.199	0.22	0.06
1745	20300	50RB_Low	Left	/	22.50	23	0.182	0.20	0.11
1720	20050	1RB_Mid	Right	/	23.47	24	0.143	0.16	0.06
1745	20300	50RB_Low	Right	/	22.50	23	0.128	0.14	0.01
1720	20050	1RB_Mid	Top	/	23.47	24	0.430	0.49	0.09
1745	20300	50RB_Low	Top	/	22.50	23	0.396	0.44	0.01
1720	20050	1RB_Mid	Bottom	/	23.47	24	0.541	0.61	0.03
1745	20300	50RB_Low	Bottom	/	22.50	23	0.489	0.55	0.15
1745	20300	1RB_Mid	Front	/	23.26	24	0.418	0.50	0.05
1732.5	20175	1RB_Mid	Front	**Fig.2**	23.28	24	**0.590**	**0.70**	0.09

Table 13.3: SAR Values (LTE Band 12 - Body)

Ambient Temperature: 22.6°C Liquid Temperature: 22.2°C									
Frequency		Test Mode	Test Position	Figure No.	Conducted Power (dBm)	Max. tune-up Power (dBm)	Measured SAR(1g) (W/kg)	Reported SAR(1g) (W/kg)	Power Drift(dB)
MHz	Ch.								
711	23130	1RB_Mid	Front	**Fig.3**	24.04	24.5	**0.619**	0.69	0.04
711	23130	25RB_High	Front	/	22.87	23.5	0.588	0.68	0.03
711	23130	1RB_Mid	Rear	/	24.04	24.5	0.364	0.40	0.06
711	23130	25RB_High	Rear	/	22.87	23.5	0.354	0.41	0.03
711	23130	1RB_Mid	Left	/	24.04	24.5	0.588	0.65	0.09
711	23130	25RB_High	Left	/	22.87	23.5	0.527	0.61	0.12
711	23130	1RB_Mid	Right	/	24.04	24.5	0.609	0.68	0.01
711	23130	25RB_High	Right	/	22.87	23.5	0.524	0.61	-0.08
711	23130	1RB_Mid	Top	/	24.04	24.5	0.208	0.23	0.07
711	23130	25RB_High	Top	/	22.87	23.5	0.187	0.22	-0.13
711	23130	1RB_Mid	Bottom	/	24.04	24.5	0.597	0.66	0.01
711	23130	25RB_High	Bottom	/	22.87	23.5	0.564	0.65	0.16
707.5	23095	1RB_High	Front	/	23.66	24.5	0.573	0.70	0.09
704	23060	1RB_High	Front	/	23.65	24.5	0.587	**0.71**	0.10

Table 13.4: SAR Values (LTE Band 13 - Body)

Ambient Temperature: 22.6°C Liquid Temperature: 22.2°C									
Frequency		Test Mode	Test Position	Figure No.	Conducted Power (dBm)	Max. tune-up Power (dBm)	Measured SAR(1g) (W/kg)	Reported SAR(1g) (W/kg)	Power Drift(dB)
MHz	Ch.								
782	23230	1RB_Mid	Front	/	23.81	24.5	0.397	0.47	-0.11
782	23230	25RB_High	Front	/	22.76	23.5	0.356	0.42	0.06
782	23230	1RB_Mid	Rear	/	23.81	24.5	0.196	0.23	0.10
782	23230	25RB_High	Rear	/	22.76	23.5	0.148	0.18	0.01
782	23230	1RB_Mid	Left	/	23.81	24.5	0.287	0.34	0.12
782	23230	25RB_High	Left	/	22.76	23.5	0.261	0.31	-0.14
782	23230	1RB_Mid	Right	/	23.81	24.5	0.415	0.49	0.01
782	23230	25RB_High	Right	/	22.76	23.5	0.383	0.45	0.12
782	23230	1RB_Mid	Top	/	23.81	24.5	0.129	0.15	0.07
782	23230	25RB_High	Top	/	22.76	23.5	0.113	0.13	0.05
782	23230	1RB_Mid	Bottom	**Fig.4**	23.81	24.5	**0.529**	**0.62**	0.04
782	23230	25RB_High	Bottom	/	22.76	23.5	0.468	0.55	0.06

13.2 WLAN Evaluation for 2.4G

According to the KDB248227 D01, SAR is measured for 2.4GHz 802.11b DSSS using the initial test position procedure.

Table 13.5: SAR Values (WLAN 2.4G - Body)

Ambient Temperature: 22.6°C Liquid Temperature: 22.0°C									
Frequency		Test Mode	Test Position	Figure No.	Conducted Power (dBm)	Max. tune-up Power (dBm)	Measured SAR(1g) (W/kg)	Reported SAR(1g) (W/kg)	Power Drift(dB)
MHz	Ch.								
2412	1	802.11 b	Front	**Fig.5**	15.65	16	0.490	0.53	0.06
2412	1	802.11 b	Rear	/	15.65	16	0.394	0.43	0.02
2412	1	802.11 b	Left		15.65	16	**0.789**	**0.86**	0.02
2412	1	802.11 b	Right		15.65	16	0.229	0.25	0.02
2412	1	802.11 b	Top		15.65	16	0.773	0.84	0.16
2412	1	802.11 b	Bottom		15.65	16	0.274	0.30	0.09
2462	11	802.11 b	Left		15.52	16	0.750	0.84	0.10

Note1: For all positions/configurations tested using the initial test position and subsequent test positions, when the reported SAR is > 0.8 W/kg, SAR is measured for these test positions/configurations on the subsequent next highest measured output power channel until the reported SAR is ≤ 1.2 W/kg or all required channels are tested.

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..

Table 13.6: SAR Values (WLAN - Body) – 802.11b (Scaled Reported SAR)

Ambient Temperature: 22.6°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	Left	100%	100%	0.86	**0.86**

SAR is not required for OFDM because the 802.11b adjusted SAR ≤ 1.2 W/kg.

14 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 ≥ 0.80 W/kg, repeat that measurement once.

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

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

15 Measurement Uncertainty

15.1 Measurement Uncertainty for Normal SAR Tests (300MHz~3GHz)

No.	Error Description	Type	Uncertainty value	Probably Distribution	Div.	(Ci) 1g	(Ci) 10g	Std. Unc. (1g)	Std. Unc. (10g)	Degree of freedom
Measurement system										
1	Probe calibration	B	12	N	2	1	1	6.0	6.0	∞
2	Isotropy	B	7.4	R	$\sqrt{3}$	1	1	4.3	4.3	∞
3	Boundary effect	B	1.1	R	$\sqrt{3}$	1	1	0.6	0.6	∞
4	Linearity	B	4.7	R	$\sqrt{3}$	1	1	2.7	2.7	∞
5	Detection limit	B	1.0	R	$\sqrt{3}$	1	1	0.6	0.6	∞
6	Readout electronics	B	1.0	N	1	1	1	1.0	1.0	∞
7	Response time	B	0.0	R	$\sqrt{3}$	1	1	0.0	0.0	∞
8	Integration time	B	1.7	R	$\sqrt{3}$	1	1	1.0	1.0	∞
9	RF ambient conditions-noise	B	3.0	R	$\sqrt{3}$	1	1	1.7	1.7	∞
10	RF ambient conditions-reflection	B	3.0	R	$\sqrt{3}$	1	1	1.7	1.7	∞
11	Probe positioned mech. restrictions	B	0.35	R	$\sqrt{3}$	1	1	0.2	0.2	∞
12	Probe positioning with respect to phantom shell	B	2.9	R	$\sqrt{3}$	1	1	1.7	1.7	∞
13	Post-processing	B	1.0	R	$\sqrt{3}$	1	1	0.6	0.6	∞
Test sample related										
14	Test sample positioning	A	3.3	N	1	1	1	3.3	3.3	5
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	∞
Phantom and set-up										
17	Phantom uncertainty	B	1.0	R	$\sqrt{3}$	1	1	0.6	0.6	∞
18	Liquid conductivity (target)	B	5.0	R	$\sqrt{3}$	0.64	0.43	1.8	1.2	∞
19	Liquid conductivity (meas.)	A	1.3	N	1	0.64	0.43	0.83	0.56	9
20	Liquid permittivity (target)	B	5.0	R	$\sqrt{3}$	0.6	0.49	1.7	1.4	∞
21	Liquid permittivity (meas.)	A	1.6	N	1	0.6	0.49	0.96	0.78	9
Combined standard uncertainty		$u_c^{'}=\sqrt{\sum_{i=1}^{21}c_i^2u_i^2}$						10.4	10.3	95.5
Expanded uncertainty (Confidence interval of 95 %)		$u_e=2u_c$						20.8	20.6	

16 Main Test Instruments

Table 16.1: List of Main Instruments

No.	Name	Type	Serial Number	Calibration Date	Valid Period
01	Network analyzer	Agilent E5071C	MY46103759	2018-11-16	One year
02	Dielectric probe	85070E	MY44300317	/	/
03	Power meter	E4418B	MY50000366	2018-12-14	One year
04	Power sensor	E9304A	MY50000188		
05	Power meter	NRP	101460	2019-02-04	One year
06	Power sensor	NRP-Z91	100553		
07	Signal Generator	E8257D	MY47461211	2019-06-03	One year
08	Amplifier	VTL5400	0404	/	/
09	E-field Probe	SPEAG EX3DV4	3633	2019-02-26	One year
10	DAE	SPEAG DAE4	786	2019-01-11	One year
11	Dipole Validation Kit	SPEAG D750V3	1163	2019-09-03	One year
12	Dipole Validation Kit	SPEAG D1750V2	1152	2019-08-30	One year
13	Dipole Validation Kit	SPEAG D1900V2	5d088	2018-10-24	One year
14	Dipole Validation Kit	SPEAG D2450V2	873	2018-10-26	One year
15	Radio Communication Analyzer	Anristu MT8820C	6201341853	2019-03-07	One year

END OF REPORT BODY

ANNEX A Graph Results

LTE Band 2 Body
Date: 2019-9-16
Electronics: DAE4 Sn786
Medium: Head 1900MHz
Medium parameters used: f = 1860 MHz; σ = 1.381 S/m; ε_r = 39.007; ρ = 1000 kg/m^3
Ambient Temperature: 22.0^{o}C   Liquid Temperature: 21.5^{o}C
Communication System: UID 0, LTE_FDD (0) Frequency: 1860 MHz Duty Cycle: 1:1
Probe: EX3DV4 – SN3633 ConvF (7.63, 7.63, 7.63);

Bottom Side Low 1RB_Low/Area Scan (61x61x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 0.750 W/kg

Bottom Side Low 1RB_Low /Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 5.393 V/m; Power Drift = 0.09 dB
Peak SAR (extrapolated) = 1.90 W/kg
SAR(1 g) = 0.755 W/kg; SAR(10 g) = 0.283 W/kg
Maximum value of SAR (measured) = 1.06 W/kg

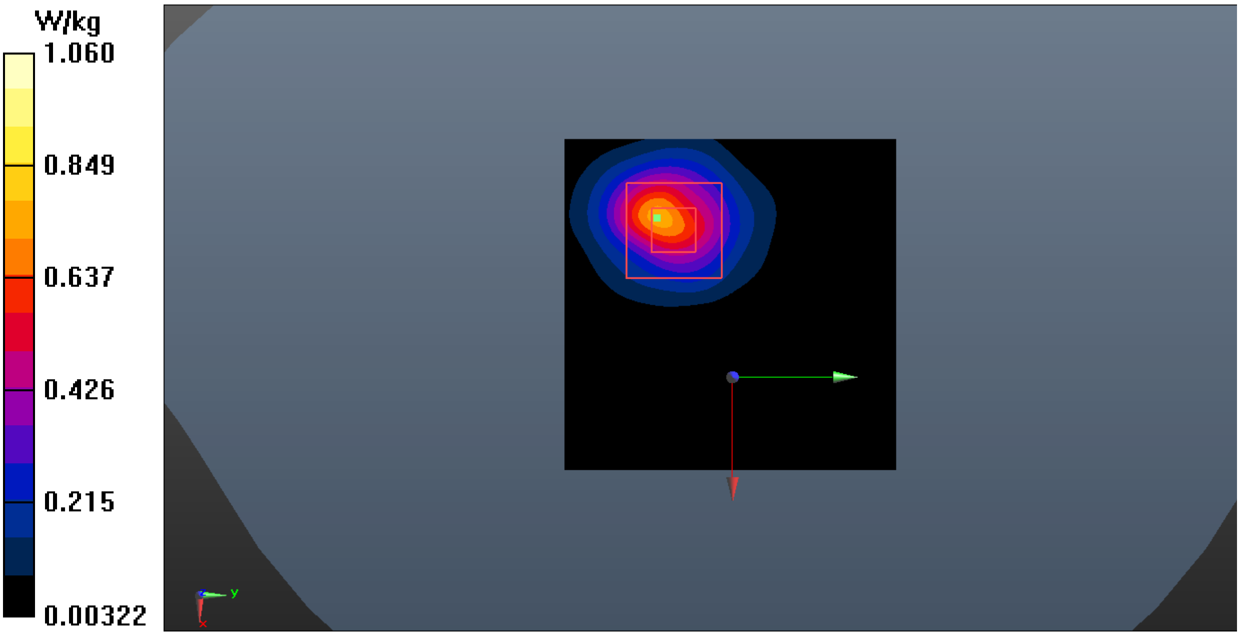


Fig.1 LTE Band 2

LTE Band 4 Body

Date: 2019-9-16

Electronics: DAE4 Sn786

Medium: Head 1750MHz

Medium parameters used (interpolated): f = 1732.5 MHz; σ = 1.348 S/m; ε_r = 39.328; ρ = 1000 kg/m^3

Ambient Temperature: 22.0°C Liquid Temperature: 21.5°C

Communication System: UID 0, LTE_FDD (0) Frequency: 1732.5 MHz Duty Cycle: 1:1

Probe: EX3DV4 – SN3633 ConvF (8.07, 8.07, 8.07);

Front Side Mid 1RB_Mid/Area Scan (61x61x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 0.658 W/kg

Front Side Mid 1RB_Mid /Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 8.082 V/m; Power Drift = 0.09 dB

Peak SAR (extrapolated) = 1.45 W/kg

SAR(1 g) = 0.590 W/kg; SAR(10 g) = 0.270 W/kg

Maximum value of SAR (measured) = 0.854 W/kg

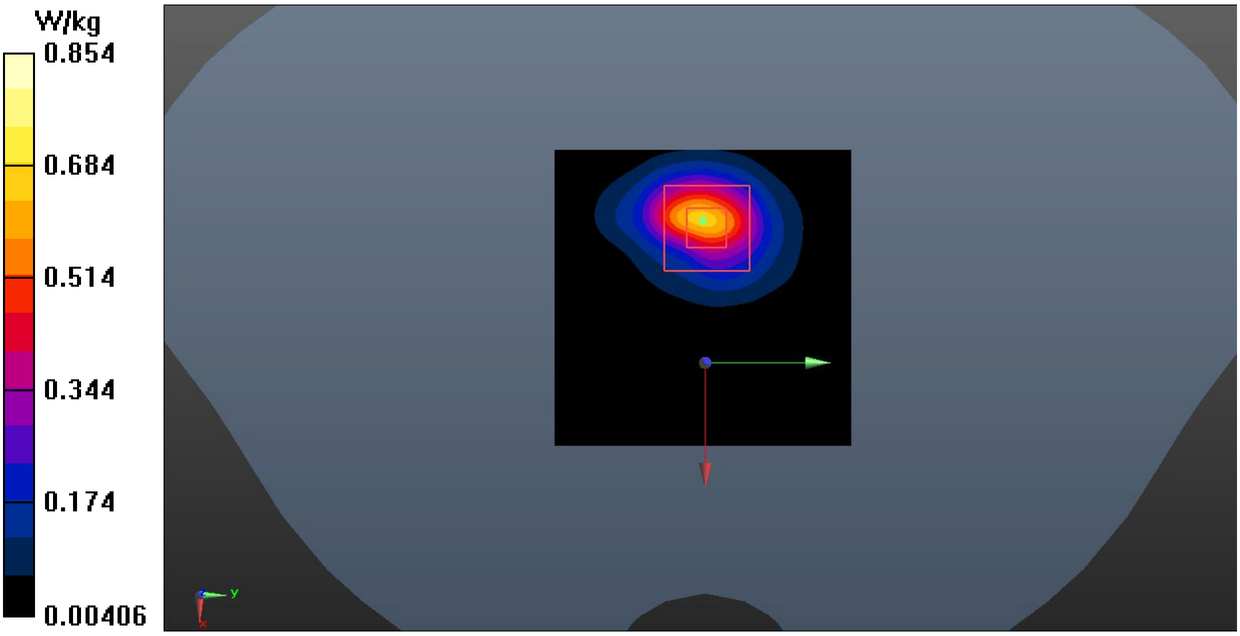


Fig.2 LTE Band 4

LTE Band 12 Body

Date: 2019-9-16

Electronics: DAE4 Sn786

Medium: Head 750MHz

Medium parameters used (interpolated): f = 711 MHz; σ = 0.862 S/m; ε_r = 41.548; ρ = 1000 kg/m^3

Ambient Temperature: 22.0°C   Liquid Temperature: 21.5°C

Communication System: UID 0, LTE_FDD (0) Frequency: 711 MHz Duty Cycle: 1:1

Probe: EX3DV4 – SN3633 ConvF (9.51, 9.51, 9.51);

Front Side High 1RB_Mid/Area Scan (61x61x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 0.833 W/kg

Front Side High 1RB_Mid/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 9.235 V/m; Power Drift = 0.04 dB

Peak SAR (extrapolated) = 1.29 W/kg

SAR(1 g) = 0.619 W/kg; SAR(10 g) = 0.343 W/kg

Maximum value of SAR (measured) = 0.862 W/kg

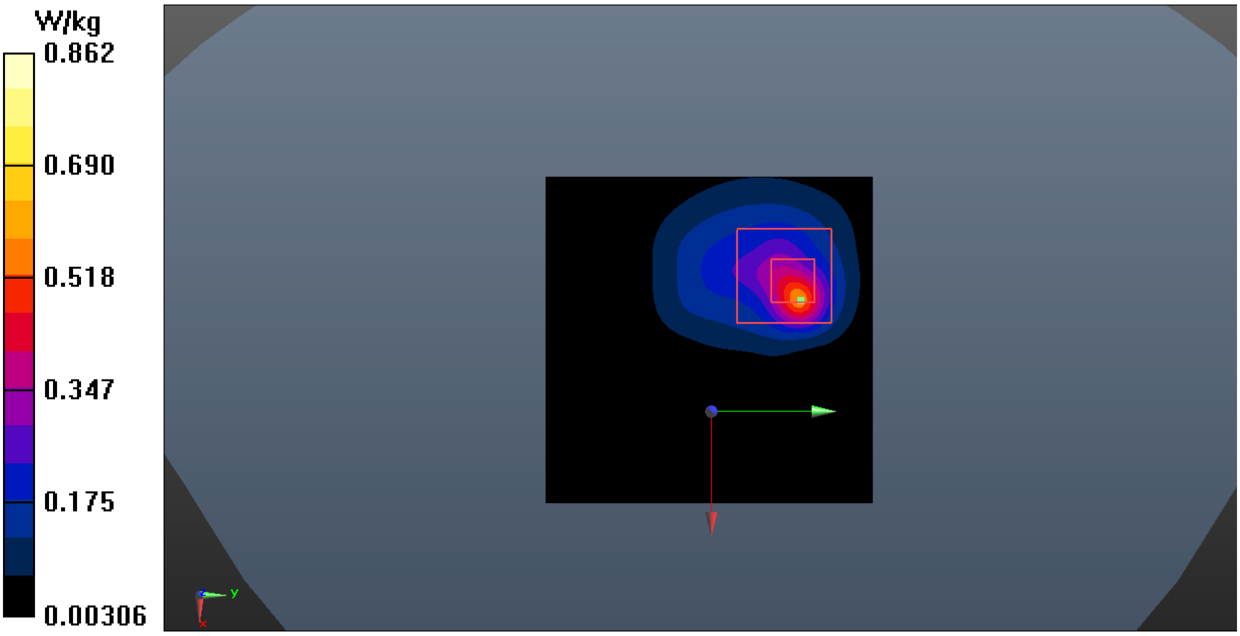


Fig.3 LTE Band 12

LTE Band 13 Body

Date: 2019-9-16

Electronics: DAE4 Sn786

Medium: Head 750MHz

Medium parameters used: f = 782 MHz; σ = 0.927 S/m; ε_r = 40.696; ρ = 1000 kg/m^3

Ambient Temperature: 22.0°C Liquid Temperature: 21.5°C

Communication System: UID 0, LTE_FDD (0) Frequency: 782 MHz Duty Cycle: 1:1

Probe: EX3DV4 – SN3633 ConvF (9.51, 9.51, 9.51);

Bottom Side Middle 1RB_Mid/Area Scan (61x61x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 0.815 W/kg

Bottom Side Middle 1RB_Mid/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 10.25 V/m; Power Drift = 0.04 dB

Peak SAR (extrapolated) = 0.912 W/kg

SAR(1 g) = 0.529 W/kg; SAR(10 g) = 0.237 W/kg

Maximum value of SAR (measured) = 0.833 W/kg

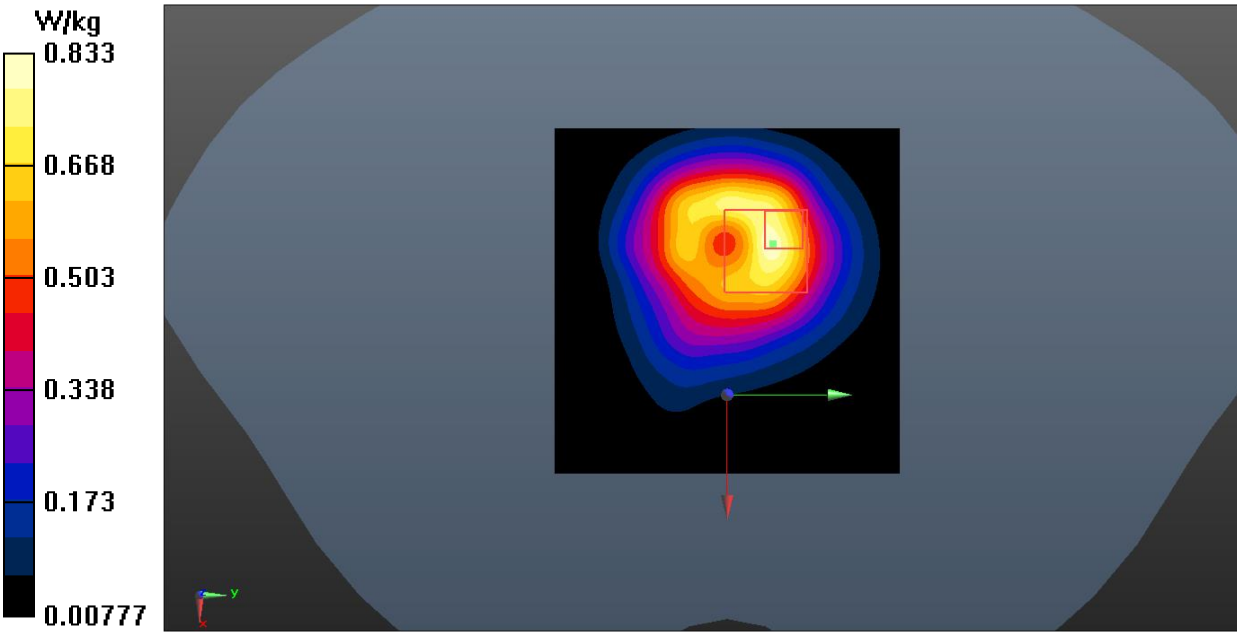


Fig.4 LTE Band 13

Wi-Fi 2.4G Body

Date: 2019-9-19

Electronics: DAE4 Sn786

Medium: Head 2450MHz

Medium parameters used: f = 2412 MHz; σ = 1.792 S/m; ε_r = 38.067; ρ = 1000 kg/m^3

Ambient Temperature: 22.0°C Liquid Temperature: 21.5°C

Communication System: UID 0, WiFi (0) Frequency: 2412 MHz Duty Cycle: 1:1

Probe: EX3DV4 – SN3633 ConvF (7.33, 7.33, 7.33);

Left Side Low/(101x101x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 1.01 W/kg

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

Reference Value = 11.18 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 2.26 W/kg

SAR(1 g) = 0.789 W/kg; SAR(10 g) = 0.296 W/kg

Maximum value of SAR (measured) = 1.03 W/kg

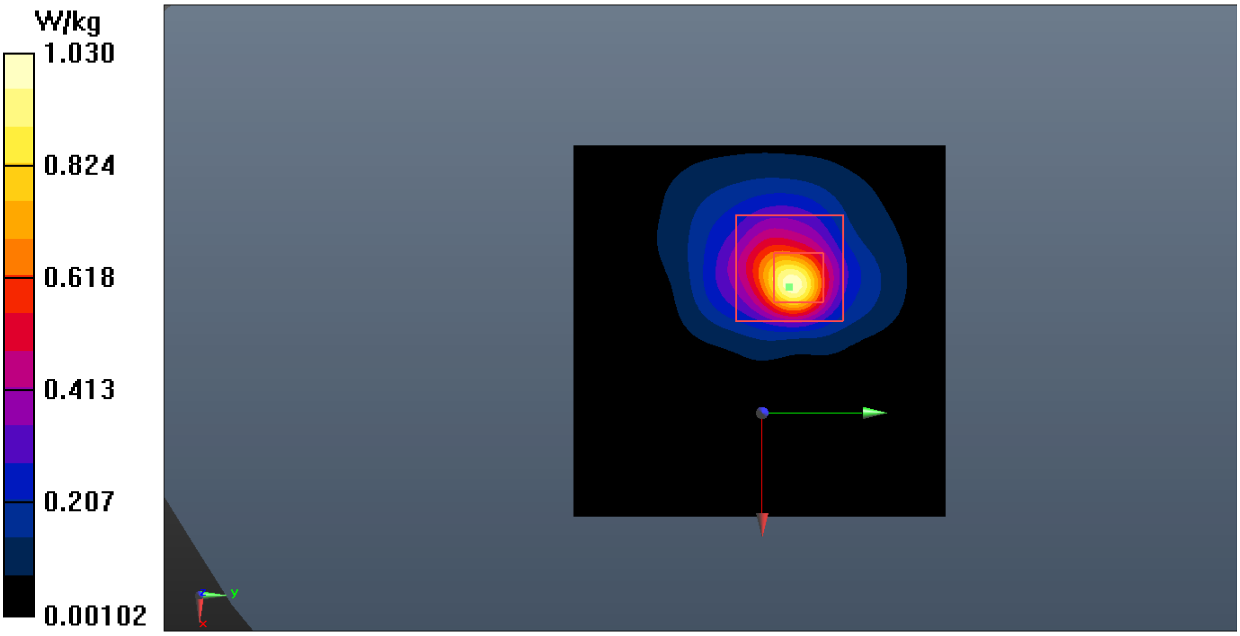


Fig.5 Wi-Fi 2.4G

ANNEX B SystemVerification Results

750MHz

Date: 2019-9-16

Electronics: DAE4 Sn786

Medium: Head 750MHz

Medium parameters used: f = 750 MHz; σ = 0.898 S/m; εr = 41.076.; ρ = 1000 kg/m3

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

Communication System: CW Frequency: 750 MHz Duty Cycle: 1:1

Probe: EX3DV4 – SN3633 ConvF (9.51, 9.51, 9.51);

System Validation /Area Scan (81x191x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Reference Value = 58.842 V/m; Power Drift = 0.09 dB

SAR(1 g) = 2.19 W/kg; SAR(10 g) = 1.44 W/kg

Maximum value of SAR (interpolated) = 2.33 W/kg

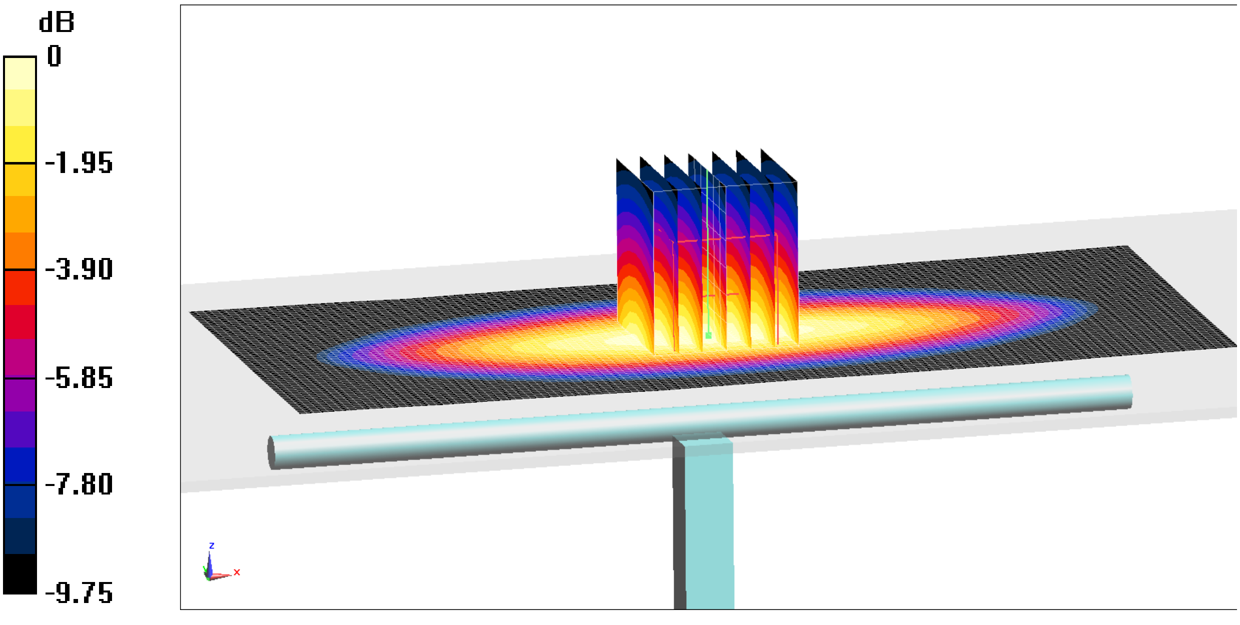
System Validation /Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 58.842 V/m; Power Drift = 0.09 dB

Peak SAR (extrapolated) = 2.85 W/kg

SAR(1 g) = 2.22 W/kg; SAR(10 g) = 1.46 W/kg

Maximum value of SAR (measured) = 2.38 W/kg



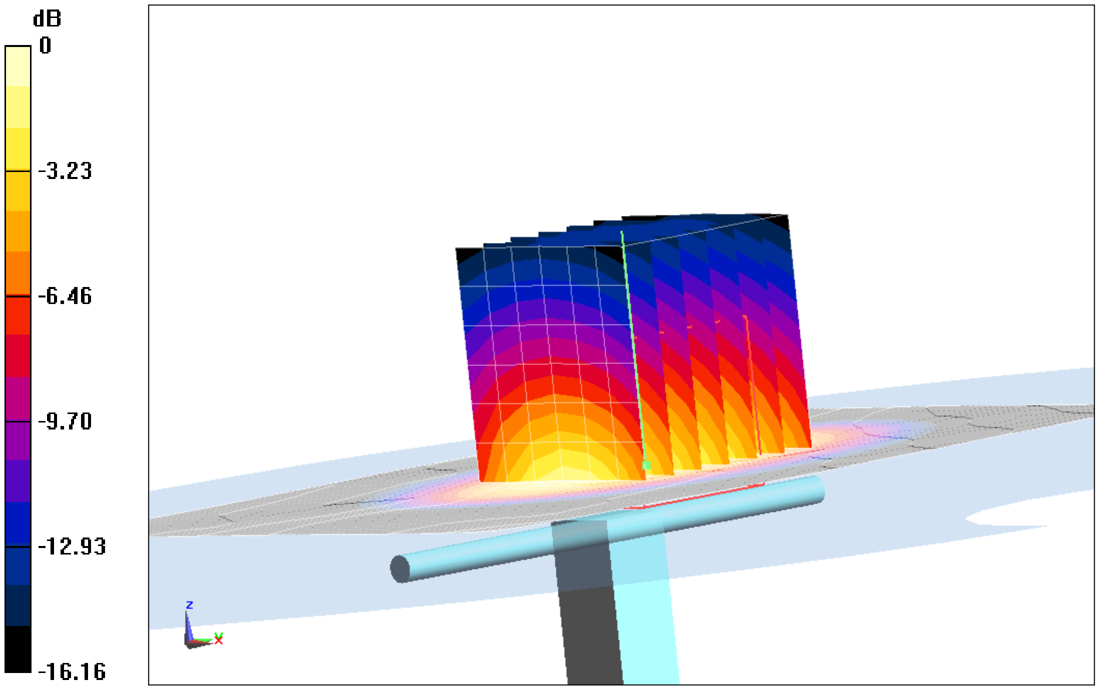
0 dB = 2.38 W/kg = 3.77 dB W/kg

Fig.B.1. Validation 750MHz 250mW

1750MHz
Date: 2019-9-16
Electronics: DAE4 Sn786
Medium: Head 1750MHz
Medium parameters used: f = 1750 MHz; σ = 1.363 S/m; ε_r = 39.263; ρ = 1000 kg/m^3
Ambient Temperature: 22.5^{o}C Liquid Temperature: 22.0^{o}C
Communication System: CW Frequency: 1750 MHz Duty Cycle: 1:1
Probe: EX3DV4 – SN3633 ConvF (8.07, 8.07, 8.07);

System Validation/Area Scan (61x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Reference Value = 77.212 V/m; Power Drift = -0.03 dB
SAR(1 g) = 8.94 W/kg; SAR(10 g) = 4.79 W/kg
Maximum value of SAR (interpolated) = 10.9 W/kg

System Validation/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 77.212 V/m; Power Drift = -0.03 dB
Peak SAR (extrapolated) = 16.8 W/kg
SAR(1 g) = 8.77 W/kg; SAR(10 g) = 4.71 W/kg
Maximum value of SAR (measured) = 10.6 W/kg



0 dB = 10.6 W/kg = 10.25 dB W/kg

Fig.B.2. Validation 1750MHz 250mW

1900MHz

Date: 2019-9-16

Electronics: DAE4 Sn786

Medium: Head 1900MHz

Medium parameters used: f = 1900 MHz; σ = 1.416 S/m; ε_r = 38.852; ρ = 1000 kg/m^3

Ambient Temperature: 22.5^{o}C Liquid Temperature: 22.0^{o}C

Communication System: CW Frequency: 1900 MHz Duty Cycle: 1:1

Probe: EX3DV4 – SN3633 ConvF (7.63, 7.63, 7.63);

System Validation /Area Scan (81x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Reference Value = 90.118 V/m; Power Drift = 0.06 dB

SAR(1 g) = 10.3 W/kg; SAR(10 g) = 5.28 W/kg

Maximum value of SAR (interpolated) = 12.5 W/kg

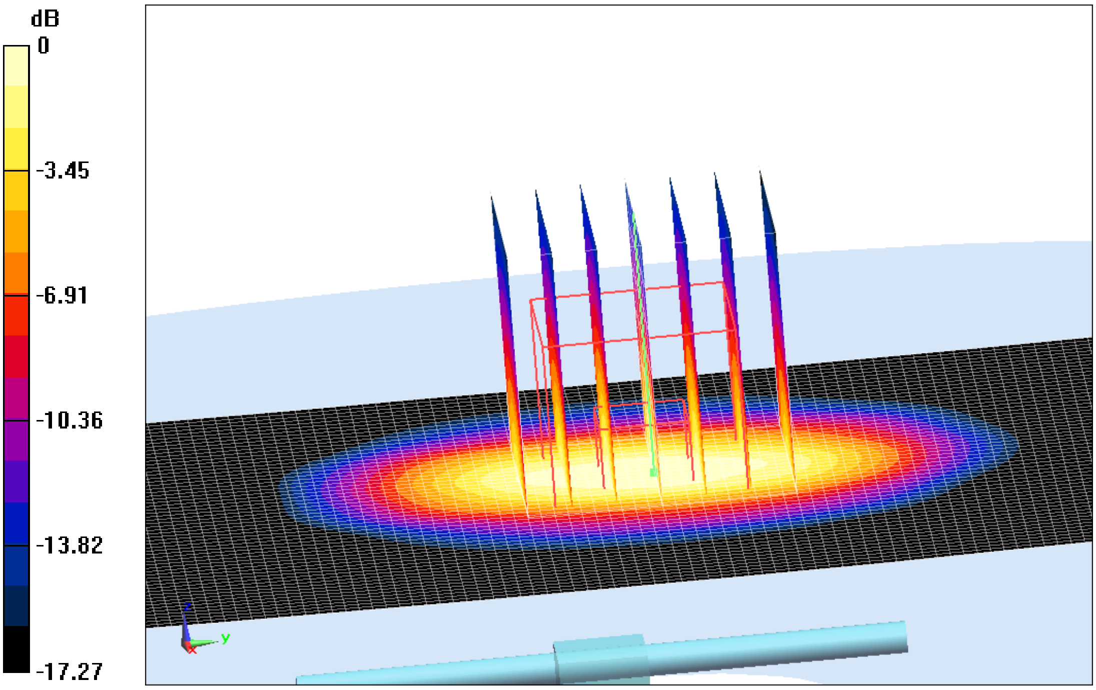
System Validation /Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 90.118 V/m; Power Drift = 0.06 dB

Peak SAR (extrapolated) = 21.7 W/kg

SAR(1 g) = 10.5 W/kg; SAR(10 g) = 5.37 W/kg

Maximum value of SAR (measured) = 12.8 W/kg



0 dB = 12.8 W/kg = 11.07 dB W/kg

Fig.B.3. Validation 1900MHz 250mW

2450MHz

Date: 2019-9-19

Electronics: DAE4 Sn786

Medium: Head 2450MHz

Medium parameters used: f = 2450 MHz; σ = 1.837 S/m; ε_r = 37.944; ρ = 1000 kg/m^3

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

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

Probe: EX3DV4 – SN3633 ConvF (7.33, 7.33, 7.33);

System Validation /Area Scan (61x81x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Reference Value = 92.028 V/m; Power Drift = 0.02 dB

SAR(1 g) = 13.4 W/kg; SAR(10 g) = 6.10 W/kg

Maximum value of SAR (interpolated) = 15.2 W/kg

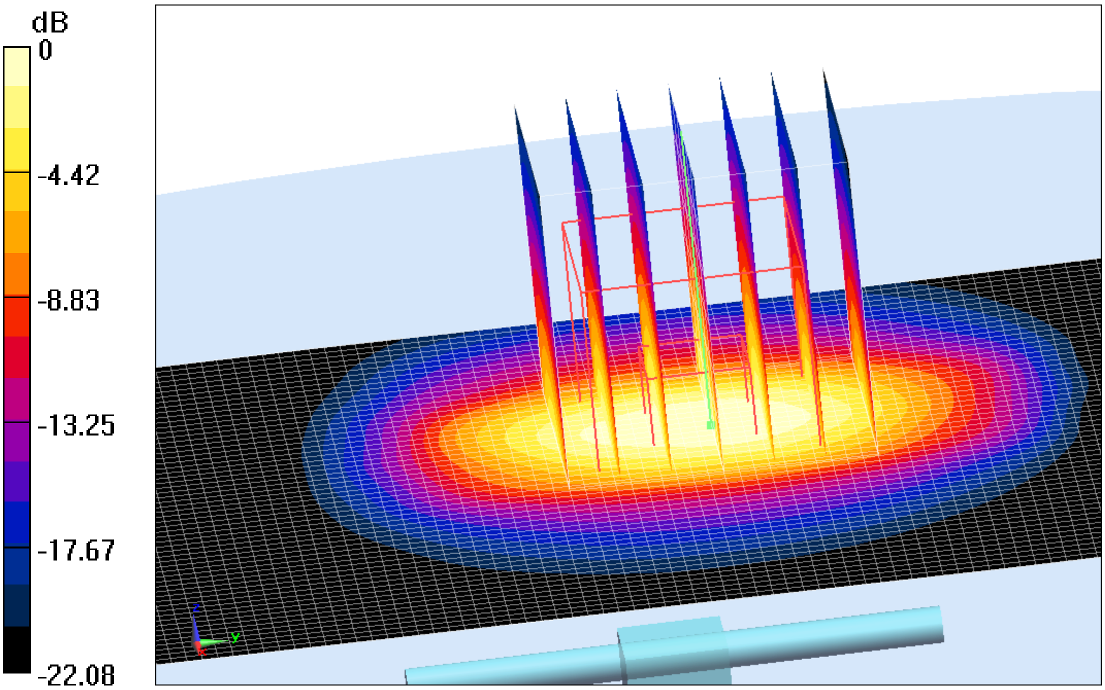
System Validation /Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 92.028 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 27.1 W/kg

SAR(1 g) = 13.6 W/kg; SAR(10 g) = 6.16 W/kg

Maximum value of SAR (measured) = 15.5 W/kg



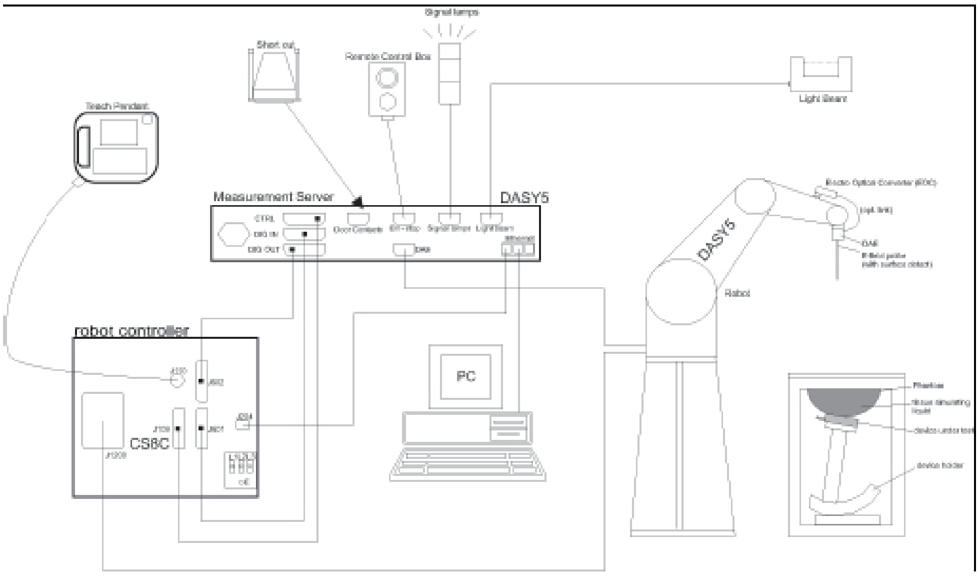
0 dB = 15.5 W/kg = 11.90 dB W/kg

Fig.B.4. Validation 2450MHz 250mW

ANNEX C SAR Measurement Setup

C.1 Measurement Set-up

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



Picture C.1 SAR Lab Test Measurement Set-up

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

C.2 DASY5 E-field Probe System

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

Probe Specifications:

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

Picture C.2 Near-field Probe

Picture C.3 E-field Probe

C.3 E-field Probe Calibration

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

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

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

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

Where:

Δt = Exposure time (30 seconds),

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

ΔT = Temperature increase due to RF exposure.

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

Where:

σ = Simulated tissue conductivity,

ρ = Tissue density (kg/m^3).

C.4 Other Test Equipment

C.4.1 Data Acquisition Electronics (DAE)

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

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

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

PictureC.4: DAE

C.4.2 Robot

The SPEAG DASY system uses the high precision robots (DASY5: 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 5

C.4.3 Measurement Server

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

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

Picture C.6 Server for DASY 5

C.4.4 Device Holder for Phantom

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

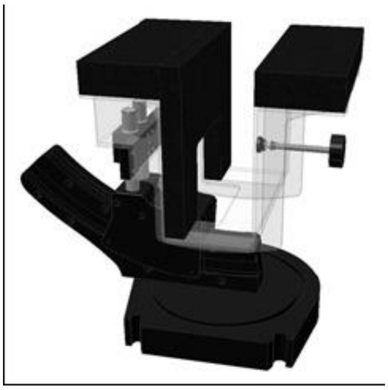
The DASY device holder is designed to cope with the different positions given in the standard. It has two scales for device rotation (with respect to the body axis) and device inclination (with respect to the line between the ear reference points). The rotation centers for both scales is the ear reference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

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

<Laptop Extension Kit>

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

Picture C.7-1: Device Holder



Picture C.7-2: 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 90th 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).

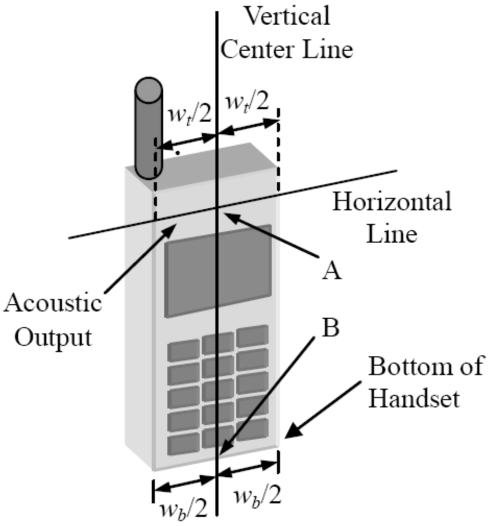
Shell Thickness:	2 ± 0. 2 mm
Filling Volume:	Approx. 25 liters
Dimensions:	810 x l000 x 500 mm (H x L x W)
Available:	Special

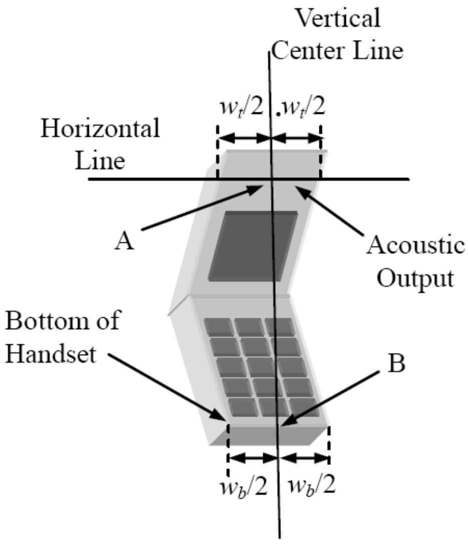
Picture C.8: SAM Twin Phantom

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

D.1 General considerations

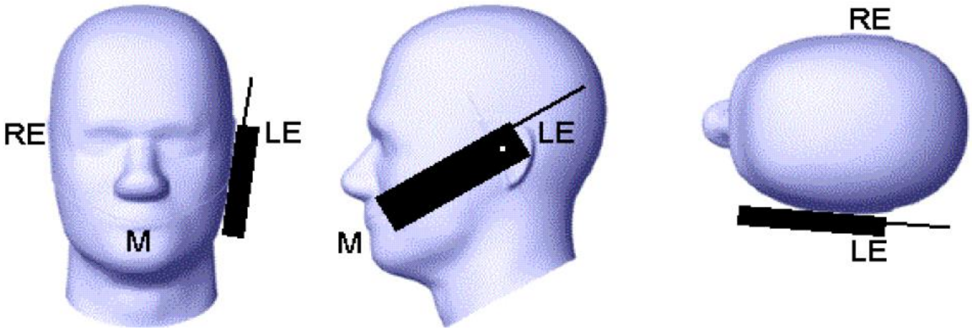
This standard specifies two handset test positions against the head phantom – the “cheek” position and the “tilt” position.



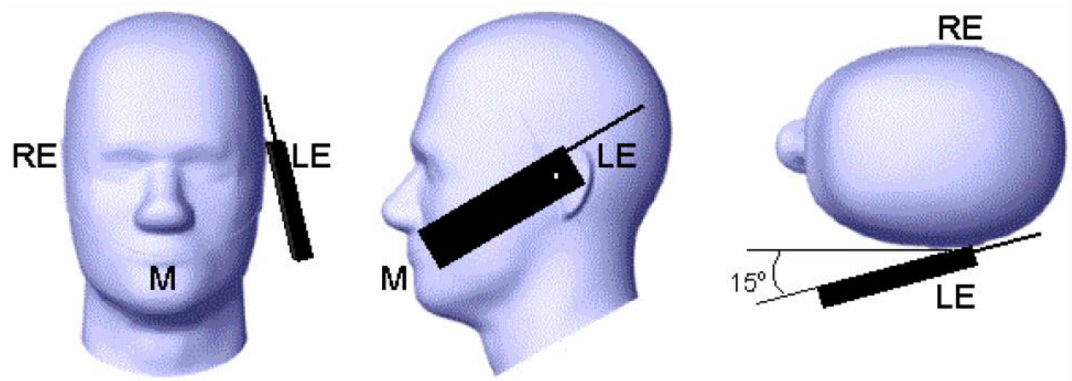


w_t	Width of the handset at the level of the acoustic
w_b	Width of the bottom of the handset
A	Midpoint of the width w_t of the handset at the level of the acoustic output
B	Midpoint of the width w_b of the bottom of the handset

Picture D.1-a Typical “fixed” case handset **Picture D.1-b Typical “clam-shell” case handset**



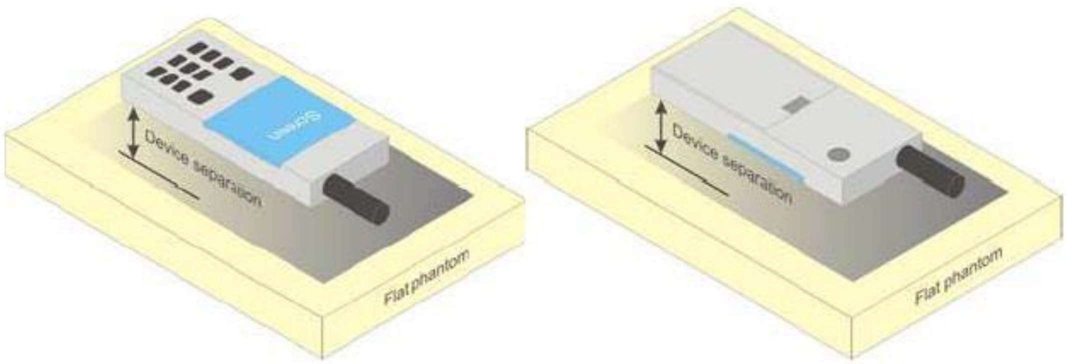
Picture D.2 Cheek position of the wireless device on the left side of SAM



Picture D.3 Tilt position of the wireless device on the left side of SAM

D.2 Body-worn device

A typical example of a body-worn device is a mobile phone, wireless enabled PDA or other battery operated wireless device with the ability to transmit while mounted on a person's body using a carry accessory approved by the wireless device manufacturer.

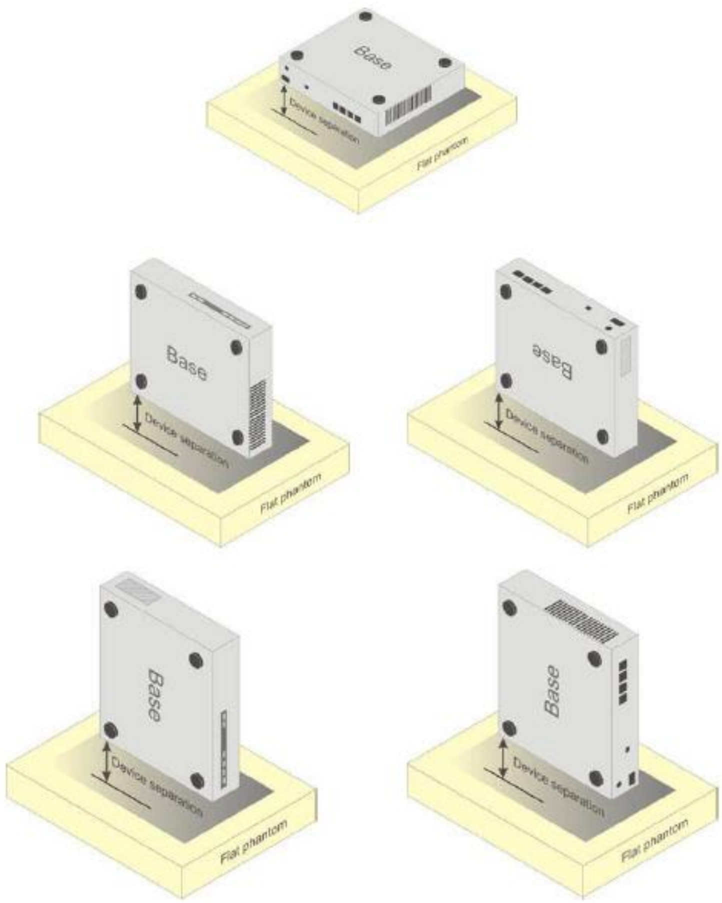


Picture D.4 Test positions for body-worn devices

D.3 Desktop device

A typical example of a desktop device is a wireless enabled desktop computer placed on a table or desk when used.

The DUT shall be positioned at the distance and in the orientation to the phantom that corresponds to the intended use as specified by the manufacturer in the user instructions. For devices that employ an external antenna with variable positions, tests shall be performed for all antenna positions specified. Picture 8.5 show positions for desktop device SAR tests. If the intended use is not specified, the device shall be tested directly against the flat phantom.



Picture D.5 Test positions for desktop devices

D.4 DUT Setup Photos

Picture D.6

ANNEX E Equivalent Media Recipes

The liquid used for the frequency range of 700-6000 MHz consisted of water, sugar, salt, preventol, glycol monobutyl and Cellulose. The liquid has been previously proven to be suited for worst-case. The Table E.1 shows the detail solution. It's satisfying the latest tissue dielectric parameters requirements proposed by the IEEE 1528 and IEC 62209.

Table E.1: Composition of the Tissue Equivalent Matter

Frequency (MHz)	835 Head	835 Body	1900 Head	1900 Body	2450 Head	2450 Body	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	ε=41.5 σ=0.90	ε=55.2 σ=0.97	ε=40.0 σ=1.40	ε=53.3 σ=1.52	ε=39.2 σ=1.80	ε=52.7 σ=1.95	ε=35.3 σ=5.27	ε=48.2 σ=6.00

Note: There is a little adjustment respectively for 750, 1800, 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

Probe SN.	Liquid name	Validation date	Frequency point	Status (OK or Not)
3633	Head 750MHz	2019-03-02	750 MHz	OK
3633	Head 835MHz	2019-03-02	835 MHz	OK
3633	Head 1750MHz	2019-03-02	1800 MHz	OK
3633	Head 1900MHz	2019-03-02	1900 MHz	OK
3633	Head 2450MHz	2019-03-02	2450 MHz	OK
3633	Head 2550MHz	2019-03-02	2550 MHz	OK
3633	Head 5200MHz	2019-03-02	5200 MHz	OK
3633	Head 5300MHz	2019-03-02	5300 MHz	OK
3633	Head 5600MHz	2019-03-02	5600 MHz	OK
3633	Head 5800MHz	2019-03-02	5800 MHz	OK
3633	Body 750MHz	2019-03-03	750 MHz	OK
3633	Body 835MHz	2019-03-03	835 MHz	OK
3633	Body 1750MHz	2019-03-03	1800 MHz	OK
3633	Body 1900MHz	2019-03-03	1900 MHz	OK
3633	Body 2450MHz	2019-03-03	2450 MHz	OK
3633	Body 2550MHz	2019-03-03	5200 MHz	OK
3633	Body 5200MHz	2019-03-03	5200 MHz	OK
3633	Body 5300MHz	2019-03-03	5300 MHz	OK
3633	Body 5600MHz	2019-03-03	5600 MHz	OK
3633	Body 5800MHz	2019-03-03	5800 MHz	OK

ANNEX G DAE Calibration Certificate

DAE4 SN: 786 Calibration Certificate

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校准
CALIBRATION
CNAS L0570

Client : CTTL(South Branch)

Certificate No: Z19-60016

CALIBRATION CERTIFICATE

Object	DAE4 - SN: 786
Calibration Procedure(s)	FF-Z11-002-01 Calibration Procedure for the Data Acquisition Electronics (DAEx)
Calibration date:	January 11, 2019

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
Process Calibrator 753	1971018	20-Jun-18 (CTTL, No.J18X05034)	June-19

	Name	Function	Signature
Calibrated by:	Yu Zongying	SAR Test Engineer	
Reviewed by:	Lin Hao	SAR Test Engineer	
Approved by:	Qi Dianyuan	SAR Project Leader	

Issued: January 14, 2019

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

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Glossary:

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

Methods Applied and Interpretation of Parameters:

- *DC Voltage Measurement*: Calibration Factor assessed for use in DASY system by comparison with a calibrated instrument traceable to national standards. The figure given corresponds to the full scale range of the voltmeter in the respective range.

- *Connector angle*: The angle of the connector is assessed measuring the angle mechanically by a tool inserted. Uncertainty is not required.

- The report provide only calibration results for DAE, it does not contain other performance test results.

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DC Voltage Measurement

A/D - Converter Resolution nominal

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

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

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

Calibration Factors	X	Y	Z
High Range	404.064 ± 0.15% (k=2)	404.247 ± 0.15% (k=2)	404.629 ± 0.15% (k=2)
Low Range	3.97273 ± 0.7% (k=2)	3.97435 ± 0.7% (k=2)	3.95858 ± 0.7% (k=2)

Connector Angle

Connector Angle to be used in DASY system	229.5° ± 1 °

ANNEX H Probe Calibration Certificate

Probe EX3DV4-SN: 3633 Calibration Certificate

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CALIBRATION
CNAS L0570

Client CTTL(South Branch) Certificate No: Z19-60033

CALIBRATION CERTIFICATE

Object	EX3DV4 - SN:3633
Calibration Procedure(s)	FF-Z11-004-01 Calibration Procedures for Dosimetric E-field Probes
Calibration date:	February 26, 2019

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
Power Meter NRP2	101919	20-Jun-18 (CTTL, No.J18X05032)	Jun-19
Power sensor NRP-Z91	101547	20-Jun-18 (CTTL, No.J18X05032)	Jun-19
Power sensor NRP-Z91	101548	20-Jun-18 (CTTL, No.J18X05032)	Jun-19
Reference10dBAttenuator	18N50W-10dB	09-Feb-18(CTTL, No.J18X01133)	Feb-20
Reference20dBAttenuator	18N50W-20dB	09-Feb-18(CTTL, No.J18X01132)	Feb-20
Reference Probe EX3DV4	SN 7514	27-Aug-18(SPEAG,No.EX3-7514_Aug18/2)	Aug-19
DAE4	SN 1555	20-Aug-18(SPEAG, No.DAE4-1555_Aug18)	Aug -19
Secondary Standards	**ID #**	**Cal Date(Calibrated by, Certificate No.)**	**Scheduled Calibration**
SignalGeneratorMG3700A	6201052605	21-Jun-18 (CTTL, No.J18X05033)	Jun-19
Network Analyzer E5071C	MY46110673	24-Jan-18 (CTTL, No.J18X00561)	Jan -19

	Name	Function	Signature
Calibrated by:	Yu Zongying	SAR Test Engineer	
Reviewed by:	Lin Hao	SAR Test Engineer	
Approved by:	Qi Dianyuan	SAR Project Leader	

Issued: February 28, 2019

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Certificate No: Z19-60033 Page 1 of 11

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Glossary:

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

Calibration is Performed According to the Following Standards:

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

b) IEC 62209-1, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016

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

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

Methods Applied and Interpretation of Parameters:

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

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Probe EX3DV4

SN: 3633

Calibrated: February 26, 2019

Calibrated for DASY/EASY Systems

(Note: non-compatible with DASY2 system!)