SAR TEST REPORT

No. I21Z70040-SEM01

For

Samsung Electronics Co., Ltd

Tablet PC

Model Name: SM-T220

with

Hardware Version: REV1.0

Software Version: T220.001

FCC ID: ZCASMT220

Issued Date: 2021-3-12

Note:

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The report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the U.S.Government.

Test Laboratory:

CTTL, Telecommunication Technology Labs, CAICT
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REPORT HISTORY

Report Number	Revision	Issue Date	Description
I21Z70040-SEM01	Rev.0	2021-3-1	Initial creation of test report
I21Z70040-SEM01	Rev.1	2021-3-5	1. Revise the test distance on page 6. 2. Revise the test start/End date on section 1.3. 3.Remove the simultaneous information on Section 12.1 Page 25. 4.Revise SAR test exclusion for WiFi2.4G on Table 12.1. 5.Remove the antenna photo in SAR test report. Then it’s shown in the file of SAR photos.
I21Z70040-SEM01	Rev.2	2021-3-12	1.Revise SAR result of WIFI5G on Table2.1.

TABLE OF CONTENT

1 Test Laboratory

1.1 Testing Location

Company Name:	CTTL
Address:	No. 52, Huayuan North Road, Haidian District, Beijing, P. R. China 100191.

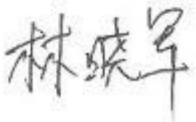
1.2 Testing Environment

Temperature:	18°C~25 °C,
Relative humidity:	30%~ 70%
Ground system resistance:	< 0.5 Ω
Ambient noise & Reflection:	< 0.012 W/kg

1.3 Project Data

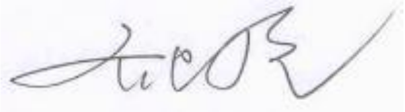
Project Leader:	Qi Dianyuan
Test Engineer:	Lin Xiaojun
Testing Start Date:	February 22, 2021
Testing End Date:	February 25, 2021

1.4 Signature



Lin Xiaojun

(Prepared this test report)



Qi Dianyuan

(Reviewed this test report)

Lu Bingsong

Deputy Director of the laboratory

(Approved this test report)

2 Statement of Compliance

The maximum results of Specific Absorption Rate (SAR) found during testing for Samsung Electronics Co., Ltd Tablet PC Lenovo SM-T220 are as follows:

Table 2.1: Highest Reported SAR (1g)

Mode	Body 1g SAR(W/Kg)	Equipment Class	1g SAR Limits (W/kg)
WLAN 2.4GHz	**1.16**	DTS	1.6
WLAN 5GHz	**0.85**	NII	

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

For body worn operation, this device has been tested and meets FCC RF exposure guidelines when used with any accessory that contains no metal and which provides a minimum separation distance from 0mm/7mm/12mm/13mm between this device and the body of the user. Use of other accessories may not ensure compliance with FCC RF exposure guidelines.

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 values are**: 1.16 W/kg (1g).**

3 Client Information

3.1 Applicant Information

Company Name:	Samsung Electronics Co., Ltd
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Contact Person:	Jenni Chun
E-mail:	j1.chun@samsung.com
Telephone:	+1-201-937-4203
Fax:	/

3.2 Manufacturer Information

Company Name:	Samsung Electronics Co., Ltd.
Address /Post:	Samsung R5, Maetan dong 129, Samsung ro Youngtong gu, Suwon city 443 742, Korea
Contact Person:	조성훈 (Sunghoon Cho)
E-mail:	ggobi.cho@samsung.com
Telephone:	+82-10-2722-4159
Fax:	/

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

4.1 About EUT

Description:	Tablet PC
Model name:	SM-T220
Operating mode(s):	BT, Wi-Fi(2.4G&5G)
Tested Tx Frequency:	2412 – 2462 MHz (Wi-Fi 2.4G)
	2402 – 2480 MHz (Bluetooth)
	5180-5240 MHz (U-NII-1)
	5260-5320 MHz (U-NII-2A)
	5500-5720 MHz (U-NII-2C)
	5745-5825 MHz (U-NII-3)
GPRS/EGPRS Multislot Class:	/
Device type:	Tablet
Antenna type:	Embedded
Hotspot mode:	/
Product dimension	Long 212.53mm ;Wide 124.7mm ; Diagonal 246.41mm

4.2 Internal Identification of EUT used during the test

EUT ID*	IMEI/SN	HW Version	SW Version
EUT1	R9PR106B48J	REV1.0	T220.001
EUT2	42006963ca2ca745	REV1.0	T220.001
EUT3	42006963ca2ca7b9	REV1.0	T220.001

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

Note: It is performed to test SAR with the EUT1 and conducted power with the EUT2&3.

4.3 Internal Identification of AE used during the test

AE ID*	Description	Model	SN	Manufacturer
AE1	/	/	/	/

*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: Measurement Techniques.

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

KDB616217 D04 SAR for laptop and tablets v01r02 SAR Evaluation Considerations for Laptop, Notebook, Notebook and Tablet Computers.

KDB648474 D04 Handset SAR v01r03: SAR Evaluation Considerations for Wireless Handsets.

KDB248227 D01 802.11 Wi-Fi SAR v02r02: SAR GUIDANCE FOR IEEE 802.11 (Wi-Fi) TRANSMITTERS

KDB865664 D01SAR measurement 100 MHz to 6 GHz v01r04: SAR Measurement Requirements for 100 MHz to 6 GHz.

KDB865664 D02 RF Exposure Reporting v01r02: RF Exposure Compliance Reporting and Documentation Considerations

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:

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

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

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

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

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

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

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

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

7 Tissue Simulating Liquids

7.1 Targets for tissue simulating liquid

Table 7.1: Targets for tissue simulating liquid

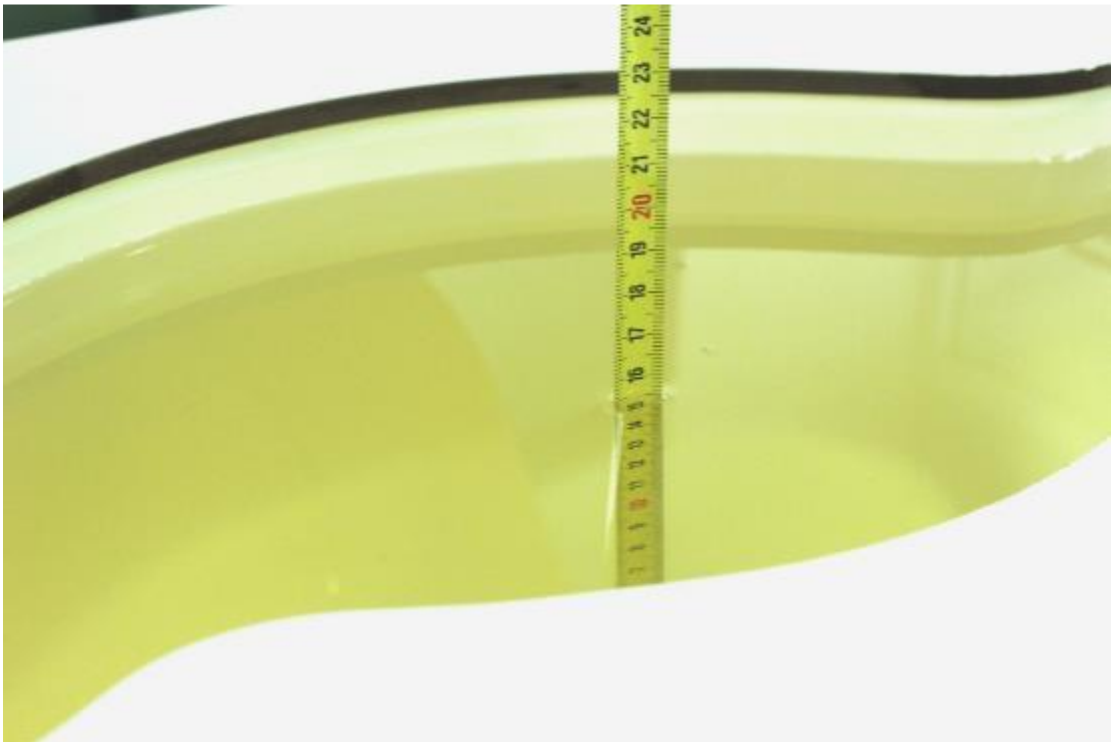
Frequency(MHz)	Liquid Type	Conductivity(σ)	± 5% Range	Permittivity(ε)	± 5% Range
2450	Head	1.80	1.71～1.89	39.2	37.2～41.2
5250	Head	4.71	4.47～4.95	35.93	34.13～37.73
5600	Head	5.07	4.82～5.32	35.53	33.8～37.3
5750	Head	5.22	4.96～5.48	35.36	33.59～37.13

7.2 Dielectric Performance

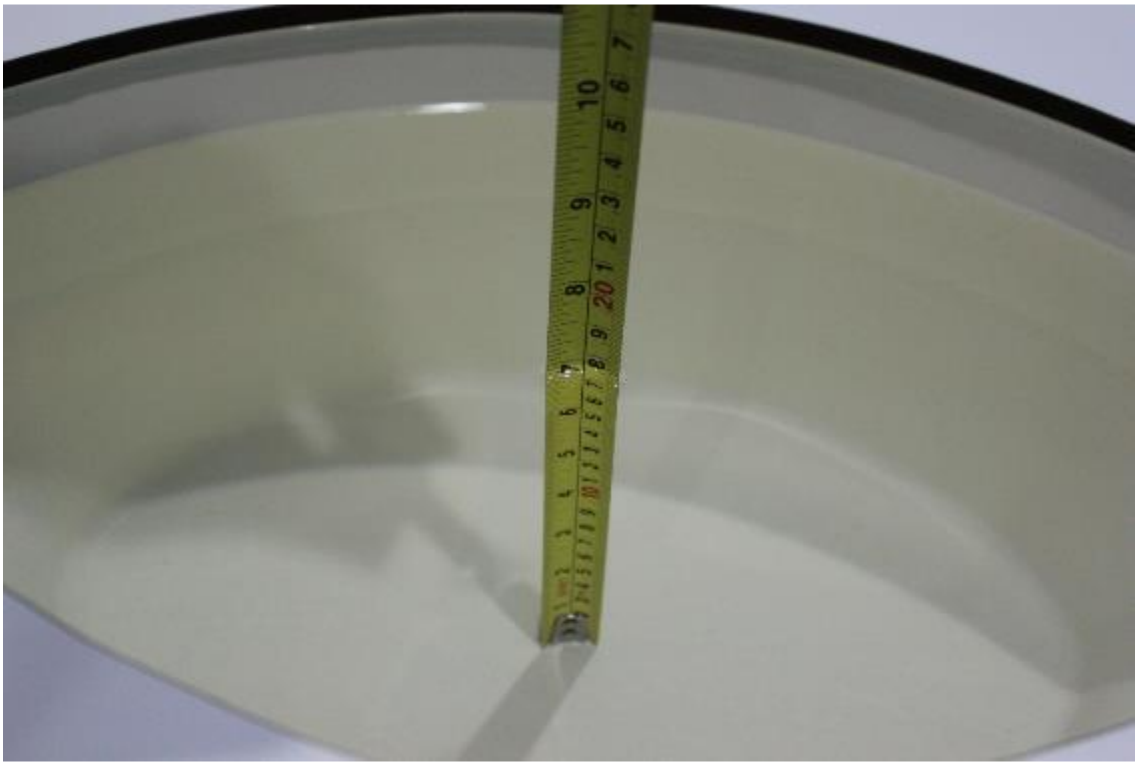
Table 7.2: Dielectric Performance of Tissue Simulating Liquid

Measurement Date yyyy/mm/dd	Frequency	Type	Permittivity ε	Drift (%)	Conductivity σ (S/m)	Drift (%)
2021/2/22	2450MHz	Head	38.98	-0.56	1.817	0.94
2021/2/23	5250MHz	Head	36.01	0.22	4.713	0.06
2021/2/24	5600MHz	Head	36.06	1.49	5.105	0.69
2021/2/25	5750MHz	Head	34.96	-1.13	5.183	-0.71

Note: The liquid temperature is 22.0℃



Picture 7-1 Liquid depth in the Flat Phantom (2450MHz)

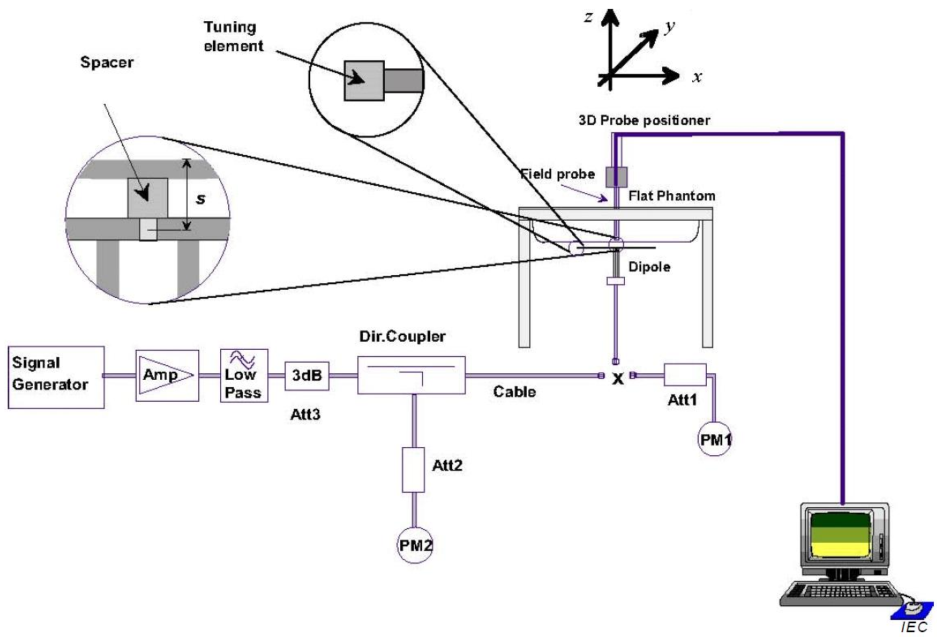


Picture 7-2 Liquid depth in the Flat Phantom (5GHz)

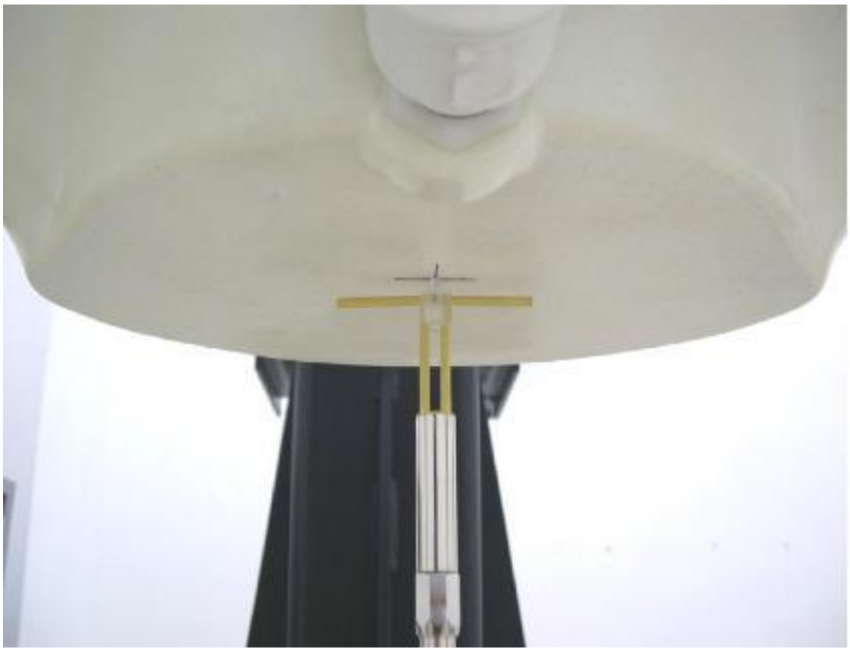
8 System verification

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.

The system verification results are required that the area scan estimated 1-g SAR is within 3% of the zoom scan 1-g SAR. The details are presented in annex B.

Table 8.1: System Verification of Body

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
2021/2/22	2450MHz	24.5	52.5	24.24	52.48	-1.06%	-0.04%
2021/2/23	5250MHz	22.9	80.5	22.9	81.4	0.09%	1.12%
2021/2/24	5600MHz	23.6	83.3	23.7	82.0	0.51%	-1.56%
2021/2/25	5750MHz	22.7	80.4	22.5	81.6	-0.97%	1.49%

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.

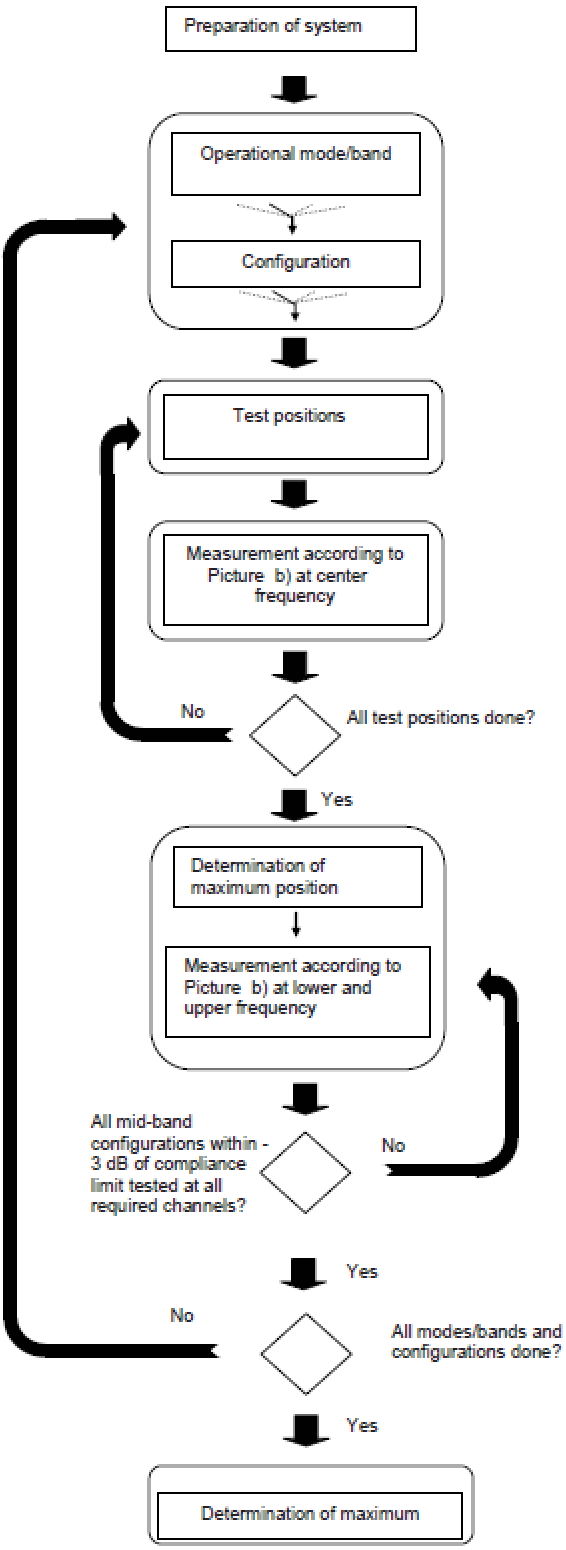
Step 1: The tests described in 9.2 shall be performed at the channel that is closest to the center of the transmit frequency band (f_c) for:

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.

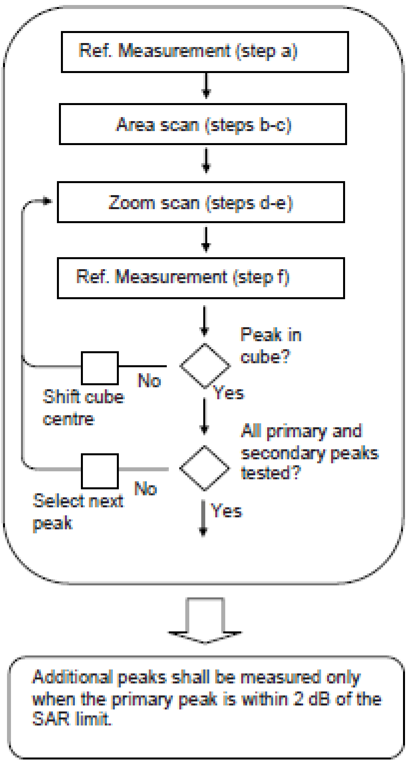
If more than three frequencies need to be tested according to 11.1 (i.e., N_c > 3), then all frequencies, configurations and modes shall be tested for all of the above test conditions.

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 a – Tests to be performed



Picture b – General procedure

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.

<table>
<tr><td colspan="3"></td><td>≤ 3 GHz</td><td>> 3 GHz</td></tr>
<tr><td colspan="3">Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface</td><td>5 ± 1 mm</td><td>½·δ·ln(2) ± 0.5 mm</td></tr>
<tr><td colspan="3">Maximum probe angle from probe axis to phantom surface normal at the measurement location</td><td>30° ± 1°</td><td>20° ± 1°</td></tr>
<tr><td colspan="3" rowspan="2">Maximum area scan spatial resolution: Δx_{Area}, Δy_{Area}</td><td>≤ 2 GHz: ≤ 15 mm
2 – 3 GHz: ≤ 12 mm</td><td>3 – 4 GHz: ≤ 12 mm
4 – 6 GHz: ≤ 10 mm</td></tr>
<tr><td colspan="2">When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be ≤ the corresponding x or y dimension of the test device with at least one measurement point on the test device.</td></tr>
<tr><td colspan="3">Maximum zoom scan spatial resolution: Δx_{Zoom}, Δy_{Zoom}</td><td>≤ 2 GHz: ≤ 8 mm
2 – 3 GHz: ≤ 5 mm*</td><td>3 – 4 GHz: ≤ 5 mm*
4 – 6 GHz: ≤ 4 mm*</td></tr>
<tr><td rowspan="3">Maximum zoom scan spatial resolution, normal to phantom surface</td><td colspan="2">uniform grid: $\Delta z_{Zoom}(n)$</td><td>≤ 5 mm</td><td>3 – 4 GHz: ≤ 4 mm
4 – 5 GHz: ≤ 3 mm
5 – 6 GHz: ≤ 2 mm</td></tr>
<tr><td rowspan="2">graded grid</td><td>$\Delta z_{Zoom}(1)$: between 1st two points closest to phantom surface</td><td>≤ 4 mm</td><td>3 – 4 GHz: ≤ 3 mm
4 – 5 GHz: ≤ 2.5 mm
5 – 6 GHz: ≤ 2 mm</td></tr>
<tr><td>$\Delta z_{Zoom}(n>1)$: between subsequent points</td><td colspan="2">≤ $1.5 \cdot \Delta z_{Zoom}(n-1)$</td></tr>
<tr><td>Minimum zoom scan volume</td><td colspan="2">x, y, z</td><td>≥ 30 mm</td><td>3 – 4 GHz: ≥ 28 mm
4 – 5 GHz: ≥ 25 mm
5 – 6 GHz: ≥ 22 mm</td></tr>
<tr><td colspan="5">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 <u>reported</u> SAR from the area scan based 1-g SAR estimation procedures of KDB 447498 is ≤ 1.4 W/kg, ≤ 8 mm, ≤ 7 mm and ≤ 5 mm zoom scan resolution may be applied, respectively, for 2 GHz to 3 GHz, 3 GHz to 4 GHz and 4 GHz to 6 GHz.</td></tr>
</table>

9.3 WCDMA Measurement Procedures for SAR

The following procedures are applicable to WCDMA handsets operating under 3GPP Release99, Release 5 and Release 6. The default test configuration is to measure SAR with an established radio link between the DUT and a communication test set using a 12.2kbps RMC (reference measurement channel) configured in Test Loop Mode 1. SAR is selectively confirmed for other physical channel configurations (DPCCH & $DPDCH_n$), HSDPA and HSPA (HSUPA/HSDPA) modes according to output power, exposure conditions and device operating capabilities. Both uplink and downlink should be configured with the same RMC or AMR, when required. SAR for Release 5 HSDPA and Release 6 HSPA are measured using the applicable FRC (fixed reference channel) and E-DCH reference channel configurations. Maximum output power is verified according to applicable versions of 3GPP TS 34.121 and SAR must be measured according to these maximum output conditions. When Maximum Power Reduction (MPR) is not implemented according to Cubic Metric (CM) requirements for Release 6 HSPA, the following procedures do not apply.

For Release 5 HSDPA Data Devices:

Sub-test	β_c	β_d	β_d (SF)	β_c/β_d	β_{hs}	CM/dB
1	2/15	15/15	64	2/15	4/15	0.0
2	12/15	15/15	64	12/15	24/25	1.0
3	15/15	8/15	64	15/8	30/15	1.5
4	15/15	4/15	64	15/4	30/15	1.5

For Release 6 HSPA Data Devices

Sub-test	β_c	β_d	β_d (SF)	β_c/β_d	β_{hs}	β_{ec}	β_{ed}	β_{ed} (SF)	β_{ed} (codes)	CM (dB)	MPR (dB)	AG Index	E-TFCI
1	11/15	15/15	64	11/15	22/15	209/225	1039/225	4	1	1.5	1.5	20	75
2	6/15	15/15	64	6/15	12/15	12/15	12/15	4	1	1.5	1.5	12	67
3	15/15	9/15	64	15/9	30/15	30/15	β_{ed1}:47/15 β_{ed2}:47/15	4	2	1.5	1.5	15	92
4	2/15	15/15	64	2/15	4/15	4/15	56/75	4	1	1.5	1.5	17	71
5	15/15	15/15	64	15/15	24/15	30/15	134/15	4	1	1.5	1.5	21	81

Rel.8 DC-HSDPA (Cat 24)

SAR test exclusion for Rel.8 DC-HSDPA must satisfy the SAR test exclusion requirements of Rel.5 HSDPA. SAR test exclusion for DC-HSDPA devices is determined by power measurements according to the H-Set 12, Fixed Reference Channel (FRC) configuration in Table C.8.1.12 of 3GPP TS 34.121-1. A primary and a secondary serving HS-DSCH Cell are required to perform the power measurement and for the results to qualify for SAR test exclusion.

9.4 SAR Measurement for LTE

SAR tests for LTE are performed with a base station simulator, Rohde & Rchwarz CMW500. Closed loop power control was used so the UE transmits with maximum output power during SAR testing. All powers were measured with the CMW 500.

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.

9.5 Bluetooth & Wi-Fi Measurement Procedures for SAR

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

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

9.6 Power Drift

To control the output power stability during the SAR test, DASY4 system calculates the power drift by measuring the E-field at the same location at the beginning and at the end of the measurement for each test position. These drift values can be found in section 14 labeled as: (Power Drift [dB]). This ensures that the power drift during one measurement is within 5%.

10 Area Scan Based 1-g SAR

10.1 Requirement of KDB

According to the KDB447498 D01 v05, when the implementation is based the specific polynomial fit
algorithm as presented at the 29th Bioelectromagnetics Society meeting (2007) and the estimated 1-g SAR is ≤ 1.2 W/kg, a zoom scan measurement is not required provided it is also not needed for any other purpose; for example, if the peak SAR location required for simultaneous transmission SAR test exclusion can be determined accurately by the SAR system or manually to discriminate between distinctive peaks and scattered noisy SAR distributions from area scans.

There must not be any warning or alert messages due to various measurement concerns identified by the SAR system; for example, noise in measurements, peaks too close to scan boundary, peaks are too sharp, spatial resolution and uncertainty issues etc. The SAR system verification must also demonstrate that the area scan estimated 1-g SAR is within 3% of the zoom scan 1-g SAR (See Annex B). When all the SAR results for each exposure condition in a frequency band and wireless mode are based on estimated 1-g SAR, the 1-g SAR for the highest SAR configuration must be determined by a zoom scan.

10.2 Fast SAR Algorithms

The approach is based on the area scan measurement applying a frequency dependent attenuation parameter. This attenuation parameter was empirically determined by analyzing a large number of phones. The MOTOROLA FAST SAR was developed and validated by the MOTOROLA Research Group in Ft. Lauderdale.

In the initial study, an approximation algorithm based on Linear fit was developed. The accuracy of the algorithm has been demonstrated across a broad frequency range (136-2450 MHz) and for both 1- and 10-g averaged SAR using a sample of 264 SAR measurements from 55 wireless handsets. For the sample size studied, the root-mean-squared errors of the algorithm are 1.2% and 5.8% for 1- and 10-g averaged SAR, respectively. The paper describing the algorithm in detail is expected to be published in August 2004 within the Special Issue of Transactions on MTT.

In the second step, the same research group optimized the fitting algorithm to an Polynomial fit whereby the frequency validity was extended to cover the range 30-6000MHz. Details of this study can be found in the BEMS 2007 Proceedings.
Both algorithms are implemented in DASY software.

11 Conducted Output Power

There are two sets of tune-up power, Normal power and Low power, for Wi-Fi2.4G and Wi-Fi5G by proximity sensor. The detail of proximity sensor is presented in annex I.

11.1 Wi-Fi and BT Measurement result

The maximum output power of BT is 7.59dBm.
The maximum tune up of BT is 9 dBm.

WiFi 2.4G-Normal power

802.11b								
Channel\data rate	1Mbps	2Mbps	5.5Mbps	11Mbps				
11(2462MHz)	15.87	/	/	/				
6(2437(MHz)	16.14	15.07	15.38	14.80				
1(2412MHz)	15.44	/	/	/				
Tune up	17.00	16.50	16.50	16.00				
802.11g								
Channel\data rate	6Mbps	9Mbps	12Mbps	18Mbps	24Mbps	36Mbps	48Mbps	54Mbps
11(2462MHz)	14.67	14.92	/	/	/	/	/	/
6(2437(MHz)	14.97	15.15	14.96	14.20	14.19	14.11	13.82	13.86
1(2412MHz)	14.90	14.91	/	/	/	/	/	/
Tune up	16.50	16.50	16.50	16.00	16.00	16.00	15.50	15.50
802.11n-20MHz								
Channel\data rate	MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
11(2462MHz)	14.92	/	/	/	/	/	/	/
6(2437(MHz)	15.09	14.74	14.53	14.07	14.01	14.25	13.71	13.69
1(2412MHz)	14.53	/	/	/	/	/	/	/
Tune up	16.50	16.50	16.50	16.00	16.00	16.00	15.50	15.50
802.11n-40MHz								
Channel\data rate	MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
9(2452MHz)	14.30		/	/	/	14.33	/	/
6(2437MHz)	14.42	14.47	14.34	14.33	14.28	14.52	13.67	13.64
3(2422MHz)	13.60		/	/	/	13.71	/	/
Tune up	15.00	15.00	15.00	15.00	15.00	15.00	14.00	14.00

WiFi 2.4G-Low power

802.11b								
Channel\data rate	1Mbps	2Mbps	5.5Mbps	11Mbps				
11(2462MHz)	12.61	12.60	12.70	12.44				
6(2437(MHz)	12.59	/	12.38	/				
1(2412MHz)	12.46	/	12.12	/				
Tune up	14.00	14.00	14.00	14.00				
802.11g								
Channel\data rate	6Mbps	9Mbps	12Mbps	18Mbps	24Mbps	36Mbps	48Mbps	54Mbps
11(2462MHz)	12.35	12.27	12.23	12.26	12.05	12.00	12.34	12.32
6(2437(MHz)	12.21	/	/	/	/	/	/	/
1(2412MHz)	12.13	/	/	/	/	/	/	/
Tune up	14.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00
802.11n-20MHz								
Channel\data rate	MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
11(2462MHz)	12.18	12.14	12.10	12.12	12.01	12.25	12.24	12.22
6(2437(MHz)	12.07	/	/	/	/	12.20	/	/
1(2412MHz)	12.02	/	/	/	/	12.08	/	/
Tune up	14.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00
802.11n-40MHz								
Channel\data rate	MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
9(2452MHz)	12.55	/	/	/	/	12.58	/	/
6(2437MHz)	12.59	12.35	12.34	12.40	12.33	12.71	12.46	12.65
3(2422MHz)	12.22	/	/	/	/	12.25	/	/
Tune up	14.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00

WiFi 5G- Normal power

802.11n(dBm)-40MHz								
Channel\data rate	MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
38(5190 MHz)	13.26	/	/	/	/	/	/	/
46(5230 MHz)	13.28	13.11	13.10	13.13	13.12	13.05	12.18	12.17
54(5270 MHz)	13.43	/	/	/	/	/	/	/
62(5310 MHz)	13.49	13.41	13.11	13.06	13.10	13.03	12.07	12.04
102(5510 MHz)	13.15	/	/	/	/	/	/	/
110(5550 MHz)	13.07	/	/	/	/	/	/	/
118(5590 MHz)	13.75	/	/	/	/	/	/	/
126(5630 MHz)	13.94	/	/	/	/	/	/	/
134(5670 MHz)	14.14	13.86	13.89	13.79	13.73	13.56	12.59	12.58
142(5710 MHz)	14.08	/	/	/	/	/	/	/
151(5755 MHz)	13.73	/	/	/	/	/	/	/
159(5795 MHz)	13.94	13.69	13.77	13.68	13.67	13.66	12.73	12.65
Tune up	15.00	15.00	15.00	15.00	15.00	15.00	14.00	14.00

WiFi 5G- Low power

802.11ac(dBm)-80MHz										
Channel\data rate	MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7	MCS8	MCS9
42(5210 MHz)	5.34	5.24	5.23	5.19	5.23	5.22	5.20	5.20	5.22	5.17
58(5290 MHz)	5.74	5.70	5.73	5.70	5.70	5.71	5.69	5.65	5.66	5.65
106(5530 MHz)	5.46	/	/	/	/	/	/	/	/	/
122(5610 MHz)	6.22	/	/	/	/	/	/	/	/	/
138(5690 MHz)	6.58	6.56	6.45	6.46	6.40	6.39	6.46	6.43	6.50	6.43
155(5775 MHz)	6.51	6.48	5.84	5.90	6.53	6.50	5.64	6.52	5.90	5.71
Tune up	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00

12 Simultaneous TX SAR Considerations

12.1 Introduction

N/A

12.2 Transmit Antenna Separation Distances

Please refer to the picture of antenna locations in the document: “The Photos of SAR test - I21Z70040”.

12.3 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 12.1: 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	9.60	8	6.31	YES
2.4GHz WLAN	2.45	Body	9.58	17	50.12	NO
5GHz WLAN	5.2	Body	6.58	15	31.62	NO
	5.3	Body	6.52	15	31.62	NO
	5.6	Body	6.34	15	31.62	NO
	5.8	Body	6.23	15	31.62	NO

13 SAR Test Result

It is determined by user manual for the distance between the EUT and the phantom bottom.
The distance are 0mm, 6mm and 10mm, and just applied to the condition of body worn accessory.
It is performed for all SAR measurements with area scan based 1-g SAR estimation (Fast SAR). A zoom scan measurement is added when the estimated 1-g SAR is the highest measured SAR in each exposure configuration, wireless mode and frequency band combination or more than 1.2W/kg.
The calculated SAR is obtained by the following formula:

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

Where P_{Target} is the power of manufacturing upper limit;
$P_{Measured}$ is the measured power in chapter 11.

13.1 WLAN Evaluation for 2.4G

Table 13.1-1: SAR Values (WLAN - Body)– 802.11b

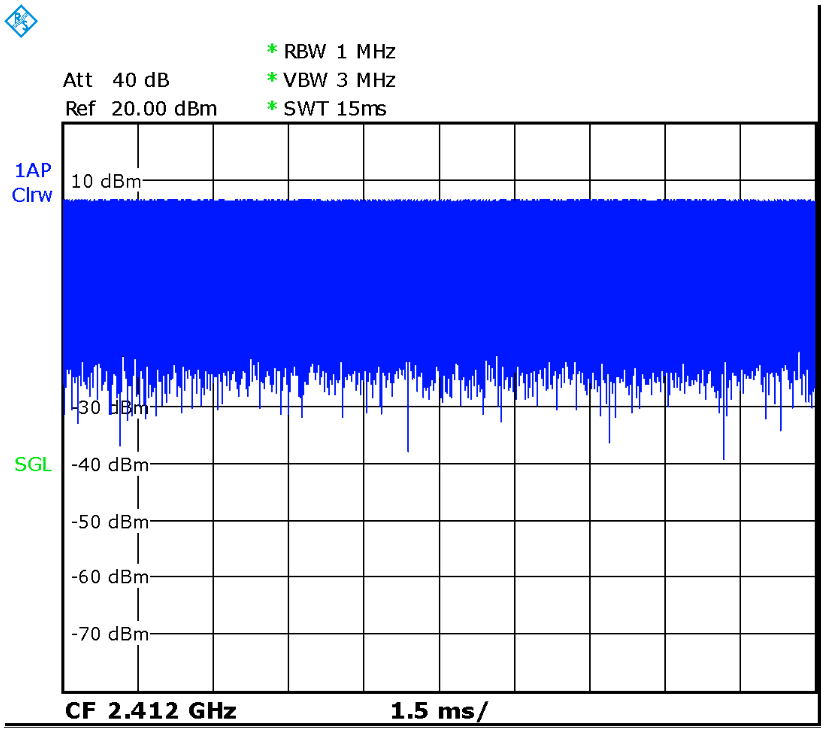
Ambient Temperature: 22.9 °C Liquid Temperature: 22.5°C										
Frequency		Test Position	Figure No./ Note	Conducted Power (dBm)	Max. tune-up Power (dBm)	Measured SAR(10g) (W/kg)	Reported SAR(10g)(W/kg)	Measured SAR(1g) (W/kg)	Reported SAR(1g) (W/kg)	Power Drift (dB)
Ch.	MHz									
6	2437	Front	Note1	16.14	17	0.071	**0.09**	0.141	**0.17**	0.06
6	2437	Rear	Note2	16.14	17	0.113	**0.14**	0.226	**0.28**	0.00
6	2437	Right	Note4	16.14	17	0.025	**0.03**	0.053	**0.06**	-0.05
6	2437	Top	Note3	16.14	17	0.069	**0.08**	0.138	**0.17**	-0.13
11	2462	Front	Note4	12.7	14	0.153	**0.21**	0.415	**0.56**	0.06
11	2462	Rear	Note4	12.7	14	0.274	**0.37**	0.688	**0.93**	-0.09
6	2437	Rear	Note4	12.38	14	0.283	**0.41**	0.598	**0.87**	0.03
1	2412	Rear	Note4/Fig.1	12.12	14	0.3	**0.46**	0.754	**1.16**	0.12
11	2462	Top	Note4	12.7	14	0.137	**0.18**	0.384	**0.52**	-0.17

Note1: The distance between the EUT and the phantom bottom is 13mm by sensor (See detail in annex I).
Note2: The distance between the EUT and the phantom bottom is 7mm by sensor (See detail in annex I).
Note3: The distance between the EUT and the phantom bottom is 12mm. (See detail in annex I).
Note4: The distance between the EUT and the phantom bottom is 0mm.

Table 13.1-2: SAR Values (WLAN - Body) – 802.11b (Scaled Reported SAR)

Ambient Temperature: 22.9 ℃ Liquid Temperature: 22.5℃						
Frequency		Test Position	Actual duty factor	maximum duty factor	Reported SAR (1g)(W/kg)	Scaled reported SAR (1g)(W/kg)
Ch.	MHz					
1	2412	Rear	100%	100%	**1.16**	**1.16**

Additional SAR is required for OFDM because the 802.11b adjusted SAR > 1.2 W/kg.



Picture 13.1 Duty factor plot

13.2 WLAN Evaluation For 5G

Table 13.2-1: OFDM mode specified maximum output power of WLAN antenna

802.11 mode	a	g	n		ac			
Ch. BW(MHz)	20	20	20	40	20	40	80	160
U-NII-1	X		X	X	X	X	X	
U-NII-2A	X		X	X	X	X	X	
U-NII-2C	X		X	X	X	X	X	
U-NII-3	X		X	X	X	X	X	
§ 15.247 (5.8 GHz)								
X: maximum(conducted) output power(mW), including tolerance, specified for production units								

Table 13.2-2: Maximum output power specified of WLAN antenna – Body-Normal power

802.11 mode	a	g	n		ac			
Ch. BW(MHz)	20	20	20	40	20	40	80	160
U-NII-1	32		28	32	28	32	28	
U-NII-2A	32		28	32	28	32	28	
U-NII-2C	32		28	32	28	32	28	
U-NII-3	32		28	32	28	32	28	
§ 15.247 (5.8 GHz)								

- The maximum output power specified for production units is the same for all channels, modulations and data rates in each channel bandwidth configuration of the 802.11a/g/n/ac modes.
- The blue highlighted cells represent highest output configurations in each standalone or aggregated frequency band, with tune-up tolerance included.

Table 13.2-3: Maximum output power specified of WLAN antenna – Body-Low power

802.11 mode	a	g	n		ac			
Ch. BW(MHz)	20	20	20	40	20	40	80	160
U-NII-1	5		5	5	5	5	5	
U-NII-2A	5		5	5	5	5	5	
U-NII-2C	5		5	5	5	5	5	
U-NII-3	5		5	5	5	5	5	
§ 15.247 (5.8 GHz)								

- The maximum output power specified for production units is the same for all channels, modulations and data rates in each channel bandwidth configuration of the 802.11a/g/n/ac modes.
- The blue highlighted cells represent highest output configurations in each standalone or aggregated frequency band, with tune-up tolerance included.

Table 13.2-4: Maximum output power measured of WLAN antenna, for the applicable OFDM configurations according to the default power measurement procedures for selection initial test configurations – Body-Normal power

802.11 mode	a	n		ac		
BW(MHz)	20	20	40	20	40	80
U-NII-1	36/40/44/48 Lower power	36/40/44/48 Lower power	38/46 21/21	36/40/44/48 Lower power	38/46 Lower power	42 Lower power
U-NII-2A	52/56/60/64 Lower power	52/56/60/64 Lower power	54/62 22/22	52/56/60/64 Lower power	54/62 Lower power	58 Lower power
U-NII-2C	100/104/108/112/116/120/124/128/132/136/140/144/ Lower power	100/104/108/112/116/120/124/128/132/136/140/144 Lower power	102/110/118/126/134/142 21/20/24/25/26/26	100/104/108/112/116/120/124/128/132/136/140/144 Lower power	102/110/118/126/134/142 Lower power	106/122/138 Lower power
U-NII-3	149/153/157/161/165 Lower power	149/153/157/161/165 Lower power	151/159 24/25	149/153/157/161/165 Lower power	151/159 Lower power	155 Lower power

- The **bold numbers** is the maximum output measured power (mW).
- Channels with measured maximum power within 0.25dB are considered to have the same measured output.
- Channels selected for initial test configuration are highlighted in yellow.

Table 13.2-5: Maximum output power measured of WLAN antenna, for the applicable OFDM configurations according to the default power measurement procedures for selection initial test configurations – Body-Low power

802.11 mode	a	n		ac		
BW(MHz)	20	20	40	20	40	80
U-NII-1	36/40/44/48 Lower power	36/40/44/48 Lower power	38/46 Lower power	36/40/44/48 Lower power	38/46 Lower power	42 3
U-NII-2A	52/56/60/64 Lower power	52/56/60/64 Lower power	54/62 Lower power	52/56/60/64 Lower power	54/62 Lower power	58 4
U-NII-2C	100/104/108/112/116/120/124/128/132/136/140/144/ Lower power	100/104/108/112/116/120/124/128/132/136/140/144 Lower power	102/110/118/126/134/142 Lower power	100/104/108/112/116/120/124/128/132/136/140/144 Lower power	102/110/118/126/134/142 Lower power	106/122/138 4/4/5
U-NII-3	149/153/157/16 Lower power	149/153/157/161/165 Lower power	151/159 Lower power	149/153/157/161/165 Lower power	151/159 Lower power	155 4

- The **bold numbers** is the maximum output measured power (mW).
- Channels with measured maximum power within 0.25dB are considered to have the same measured output.
- Channels selected for initial test configuration are highlighted in yellow.

Table 13.2-6: Reported SAR of initial test configuration for Body-Normal power

802.11 mode	a	n		ac		
BW(MHz)	20	20	40	20	40	80
U-NII-1	36/40/44/48	36/40/44/48	38/46 UNII-2A exclusion applied	36/40/44/48	38/46	42
U-NII-2A	52/56/60/64	52/56/60/64	54/62 **0.67**	52/56/60/64	54/62	58
U-NII-2C	100/104/108/112/116/120/124/128/132/136/140/144	100/104/108/112/116/120/124/128/132/136/140/144	102/110/118/126/134/142 **0.45**	100/104/108/112/116/120/124/128/132/136/140/144	102/110/118/126/134/142	106/122/138
U-NII-3	149/153/157/161/165	149/153/157/161/165	151/159 **0.37**	149/153/157/161/165	151/159	155
Highest measured output power channel tested initially are in yellow highlight.						

Table 13.2-7: Reported SAR of initial test configuration for Body-Low power 0mm

802.11 mode	a	n		ac		
BW(MHz)	20	20	40	20	40	80
U-NII-1	36/40/44/48	36/40/44/48	38/46	36/40/44/48	38/46	42 UNII-2A exclusion applied
U-NII-2A	52/56/60/64	52/56/60/64	54/62	52/56/60/64	54/62	58 **0.85**
U-NII-2C	100/104/108/112/116/120/124/128/132/136/140/144	100/104/108/112/116/120/124/128/132/136/140/144	102/110/118/126/134/142	100/104/108/112/116/120/124/128/132/136/140/144	102/110/118/126/134/142	106/122/138 **0.50**
U-NII-3	149/153/157/161/165	149/153/157/161/165	151/159	149/153/157/161/165	151/159	155 **0.60**
The green highlighted channels are next highest measured output channel in the initial test configuration. Highest measured output power channel tested initially are in yellow highlight.						

Table 13.2-8: SAR Values (WLAN 5G - Body)

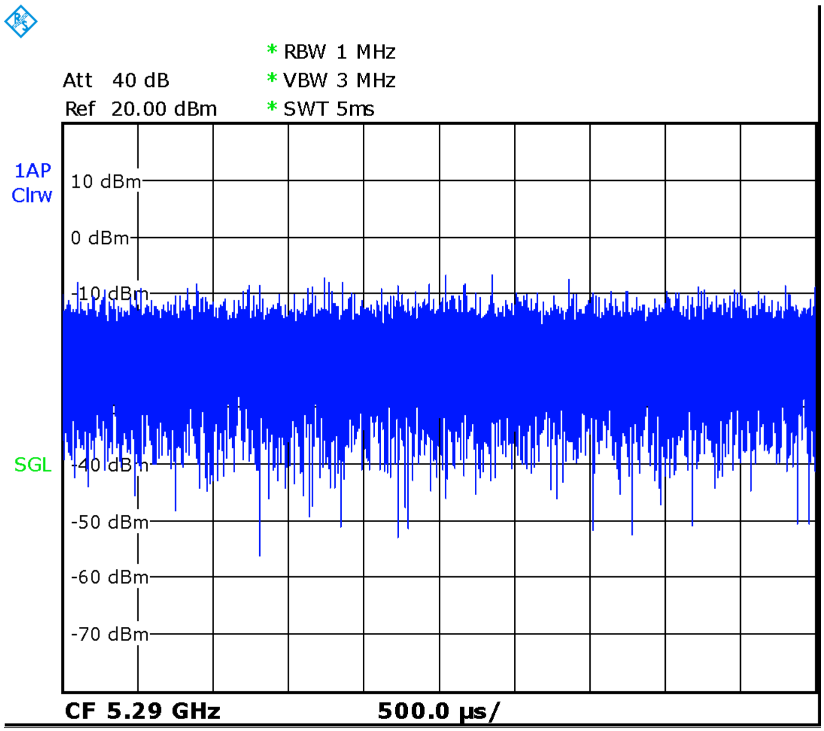
Frequency Ch.	Frequency MHz	Test Position	Figure No.	Conducted Power (dBm)	Max. tune-up Power (dBm)	Measured SAR(10g) (W/kg)	Reported SAR(10g) (W/kg)	Measured SAR(1g) (W/kg)	Reported SAR(1g) (W/kg)	Power Drift (dB)
62	5310	Front	Note1	13.49	15	0.147	**0.21**	0.425	**0.60**	0.16
62	5310	Rear	Note2	13.49	15	0.078	**0.11**	0.214	**0.30**	-0.06
62	5310	Right	Note4	13.49	15	0.029	**0.04**	0.101	**0.14**	0.00
62	5310	Top	Note3	13.49	15	0.178	**0.25**	0.472	**0.67**	0.01
134	5670	Front	Note1	14.14	15	0.104	**0.13**	0.285	**0.35**	-0.09
134	5670	Rear	Note2	14.14	15	0.073	**0.09**	0.206	**0.25**	0.05
134	5670	Right	Note4	14.14	15	0.023	**0.03**	0.075	**0.09**	-0.16
134	5670	Top	Note3	14.14	15	0.14	**0.17**	0.367	**0.45**	0.16
159	5795	Front	Note1	13.94	15	0.096	**0.12**	0.26	**0.33**	-0.04
159	5795	Rear	Note2	13.94	15	0.072	**0.09**	0.197	**0.25**	0.06
159	5795	Right	Note4	13.94	15	0.019	**0.02**	0.065	**0.08**	0.16
159	5795	Top	Note4	13.94	15	0.115	**0.15**	0.293	**0.37**	0.10
58	5290	Front	Note4/Fig.2	5.74	7	0.138	**0.18**	0.634	**0.85**	0.00
58	5290	Rear	Note4	5.74	7	0.048	**0.06**	0.189	**0.25**	0.04
58	5290	Top	Note4	5.74	7	0.101	**0.13**	0.5	**0.67**	0.12
138	5690	Front	Note4	6.58	7	0.11	**0.12**	0.451	**0.50**	-0.11
138	5690	Rear	Note4	6.58	7	0.041	**0.05**	0.172	**0.19**	-0.19
138	5690	Top	Note4	6.58	7	0.087	**0.10**	0.384	**0.42**	-0.07
155	5775	Front	Note4	6.51	7	0.122	**0.14**	0.538	**0.60**	-0.06
155	5775	Rear	Note4	6.51	7	0.051	**0.06**	0.117	**0.13**	-0.18
155	5775	Top	Note4	6.51	7	0.089	**0.10**	0.436	**0.49**	-0.15

Note1: The distance between the EUT and the phantom bottom is 13mm by sensor(See detail in annex I).
Note2: The distance between the EUT and the phantom bottom is 7mm by sensor(See detail in annex I).
Note3: The distance between the EUT and the phantom bottom is 12mm by sensor(See detail in annex I).
Note4:The distance between the EUT and the phantom bottom is 0mm.

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 13.2-9 SAR Values (WLAN 5G - Body) (Scaled Reported SAR)

Frequency Ch.	Frequency MHz	Test Position	D (mm)	Actual duty factor	maximum duty factor	Reported SAR (1g) (W/kg)	Scaled reported SAR (1g) (W/kg)
58	5290	Rear	0	100%	100%	**0.85**	**0.85**



Picture 13.2 The plot of duty factor

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	6.0	N	1	1	1	6.0	6.0	∞
2	Isotropy	B	4.7	R	$\sqrt{3}$	0.7	0.7	1.9	1.9	∞
3	Boundary effect	B	1.0	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	N	1	1	1	0.6	0.6	∞
6	Readout electronics	B	0.3	R	$\sqrt{3}$	1	1	0.3	0.3	∞
7	Response time	B	0.8	R	$\sqrt{3}$	1	1	0.5	0.5	∞
8	Integration time	B	2.6	R	$\sqrt{3}$	1	1	1.5	1.5	∞
9	RF ambient conditions-noise	B	0	R	$\sqrt{3}$	1	1	0	0	∞
10	RFambient conditions-reflection	B	0	R	$\sqrt{3}$	1	1	0	0	∞
11	Probe positioned mech. restrictions	B	0.4	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	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	∞
Phantom and set-up										
17	Phantom uncertainty	B	4.0	R	$\sqrt{3}$	1	1	2.3	2.3	∞
18	Liquid conductivity (target)	B	5.0	R	$\sqrt{3}$	0.64	0.43	1.8	1.2	∞
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	∞
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	

15.2 Measurement Uncertainty for Normal SAR Tests (3~6GHz)

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	6.55	N	1	1	1	6.55	6.55	∞
2	Isotropy	B	4.7	R	$\sqrt{3}$	0.7	0.7	1.9	1.9	∞
3	Boundary effect	B	2.0	R	$\sqrt{3}$	1	1	1.2	1.2	∞
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	0.3	R	$\sqrt{3}$	1	1	0.3	0.3	∞
7	Response time	B	0.8	R	$\sqrt{3}$	1	1	0.5	0.5	∞
8	Integration time	B	2.6	R	$\sqrt{3}$	1	1	1.5	1.5	∞
9	RF ambient conditions-noise	B	0	R	$\sqrt{3}$	1	1	0	0	∞
10	RF ambient conditions-reflection	B	0	R	$\sqrt{3}$	1	1	0	0	∞
11	Probe positioned mech. restrictions	B	0.8	R	$\sqrt{3}$	1	1	0.5	0.5	∞
12	Probe positioning with respect to phantom shell	B	6.7	R	$\sqrt{3}$	1	1	3.9	3.9	∞
13	Post-processing	B	4.0	R	$\sqrt{3}$	1	1	2.3	2.3	∞
Test sample related										
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	∞
Phantom and set-up										
17	Phantom uncertainty	B	4.0	R	$\sqrt{3}$	1	1	2.3	2.3	∞
18	Liquid conductivity (target)	B	5.0	R	$\sqrt{3}$	0.64	0.43	1.8	1.2	∞
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	√3	0.6	0.49	1.7	1.4	∞
21	Liquid permittivity (meas.)	A	1.6	N	1	0.6	0.49	1.0	0.8	521
Combined standard uncertainty		$u_c^{'} = \sqrt{\sum_{i=1}^{21} c_i^2 u_i^2}$						10.7	10.6	257
Expanded uncertainty (confidence interval of 95 %)		$u_e = 2u_c$						21.4	21.1	

15.3 Measurement Uncertainty for Fast 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	6.0	N	1	1	1	6.0	6.0	∞
2	Isotropy	B	4.7	R	√3	0.7	0.7	1.9	1.9	∞
3	Boundary effect	B	1.0	R	√3	1	1	0.6	0.6	∞
4	Linearity	B	4.7	R	√3	1	1	2.7	2.7	∞
5	Detection limit	B	1.0	R	√3	1	1	0.6	0.6	∞
6	Readout electronics	B	0.3	R	√3	1	1	0.3	0.3	∞
7	Response time	B	0.8	R	√3	1	1	0.5	0.5	∞
8	Integration time	B	2.6	R	√3	1	1	1.5	1.5	∞
9	RF ambient conditions-noise	B	0	R	√3	1	1	0	0	∞
10	RF ambient conditions-reflection	B	0	R	√3	1	1	0	0	∞
11	Probe positioned mech. Restrictions	B	0.4	R	√3	1	1	0.2	0.2	∞
12	Probe positioning with respect to phantom shell	B	2.9	R	√3	1	1	1.7	1.7	∞
13	Post-processing	B	1.0	R	√3	1	1	0.6	0.6	∞
14	Fast SAR z-Approximation	B	7.0	R	√3	1	1	4.0	4.0	∞
Test sample related										
15	Test sample positioning	A	3.3	N	1	1	1	3.3	3.3	71
16	Device holder uncertainty	A	3.4	N	1	1	1	3.4	3.4	5
17	Drift of output power	B	5.0	R	√3	1	1	2.9	2.9	∞

Phantom and set-up										
18	Phantom uncertainty	B	4.0	R	$\sqrt{3}$	1	1	2.3	2.3	∞
19	Liquid conductivity (target)	B	5.0	R	$\sqrt{3}$	0.64	0.43	1.8	1.2	∞
20	Liquid conductivity (meas.)	A	2.06	N	1	0.64	0.43	1.32	0.89	43
21	Liquid permittivity (target)	B	5.0	R	$\sqrt{3}$	0.6	0.49	1.7	1.4	∞
22	Liquid permittivity (meas.)	A	1.6	N	1	0.6	0.49	1.0	0.8	521
Combined standard uncertainty		$u_c^{'} = \sqrt{\sum_{i=1}^{22} c_i^2 u_i^2}$						10.4	10.3	257
Expanded uncertainty (confidence interval of 95 %)		$u_e = 2u_c$						20.8	20.6	

15.4 Measurement Uncertainty for Fast SAR Tests (3~6GHz)

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	6.55	N	1	1	1	6.55	6.55	∞
2	Isotropy	B	4.7	R	$\sqrt{3}$	0.7	0.7	1.9	1.9	∞
3	Boundary effect	B	2.0	R	$\sqrt{3}$	1	1	1.2	1.2	∞
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	0.3	R	$\sqrt{3}$	1	1	0.3	0.3	∞
7	Response time	B	0.8	R	$\sqrt{3}$	1	1	0.5	0.5	∞
8	Integration time	B	2.6	R	$\sqrt{3}$	1	1	1.5	1.5	∞
9	RF ambient conditions-noise	B	0	R	$\sqrt{3}$	1	1	0	0	∞
10	RF ambient conditions-reflection	B	0	R	$\sqrt{3}$	1	1	0	0	∞
11	Probe positioned mech. Restrictions	B	0.8	R	$\sqrt{3}$	1	1	0.5	0.5	∞
12	Probe positioning with respect to phantom shell	B	6.7	R	$\sqrt{3}$	1	1	3.9	3.9	∞
13	Post-processing	B	1.0	R	$\sqrt{3}$	1	1	0.6	0.6	∞
14	Fast SAR z-Approximation	B	14.0	R	$\sqrt{3}$	1	1	8.1	8.1	∞

Test sample related										
15	Test sample positioning	A	3.3	N	1	1	1	3.3	3.3	71
16	Device holder uncertainty	A	3.4	N	1	1	1	3.4	3.4	5
17	Drift of output power	B	5.0	R	$\sqrt{3}$	1	1	2.9	2.9	∞
Phantom and set-up										
18	Phantom uncertainty	B	4.0	R	$\sqrt{3}$	1	1	2.3	2.3	∞
19	Liquid conductivity (target)	B	5.0	R	$\sqrt{3}$	0.64	0.43	1.8	1.2	∞
20	Liquid conductivity (meas.)	A	2.06	N	1	0.64	0.43	1.32	0.89	43
21	Liquid permittivity (target)	B	5.0	R	$\sqrt{3}$	0.6	0.49	1.7	1.4	∞
22	Liquid permittivity (meas.)	A	1.6	N	1	0.6	0.49	1.0	0.8	521
Combined standard uncertainty		$u_c^{'} = \sqrt{\sum_{i=1}^{22} c_i^2 u_i^2}$						13.5	13.4	257
Expanded uncertainty (confidence interval of 95 %)		$u_e = 2u_c$						27.0	26.8	

16 MAIN TEST INSTRUMENTS

No.	Name	Type	Serial Number	Calibration Date	Valid Period
01	Network analyzer	E5071C	MY46110673	January 14, 2021	One year
02	Dielectric Probe Kit	85070E	Agilent	No Calibration Requested	
03	Power meter	NRP2	101919	May 12, 2020	One year
04	Power sensor	NRP-Z91	101547		
05	Signal Generator	E4438C	MY49071430	February 1, 2021	One Year
05	Amplifier	60S1G4	0331848	No Calibration Requested	
06	Directional Coupler	778D	MY48220584	No Calibration Requested	
07	BTS	CMW500	159889	January 13, 2021	One year
08	E-field Probe	SPEAG EX3DV4	7307	May 29, 2020	One year
09	DAE	SPEAG DAE4	536	November 6, 2020	One year
10	Dipole Validation Kit	SPEAG D2450V2	853	July 21,2020	One year
11	Dipole Validation Kit	SPEAG D5GHzV2	1060	July 27,2020	One year

END OF REPORT BODY

ANNEX A Graph Results

WLAN2450_CH1 Rear 0mm

Date: 2/22/2021

Electronics: DAE4 Sn536

Medium: head 2450 MHz

Medium parameters used: f = 2412 MHz; σ = 1.781 mho/m; εr = 39.03; ρ = 1000 kg/m^3

Ambient Temperature: 22.5°C, Liquid Temperature: 22.3°C

Communication System: WLAN2450 2412MHz Duty Cycle: 1:1

Probe: EX3DV4 – SN7307 ConvF(7.77,7.77,7.77)

Area Scan (71x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 1.18 W/kg

Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 1.664 V/m; Power Drift = 0.12 dB
Peak SAR (extrapolated) = 1.95 W/kg
SAR(1 g) = 0.754 W/kg; SAR(10 g) = 0.3 W/kg
Maximum value of SAR (measured) = 1.46 W/kg

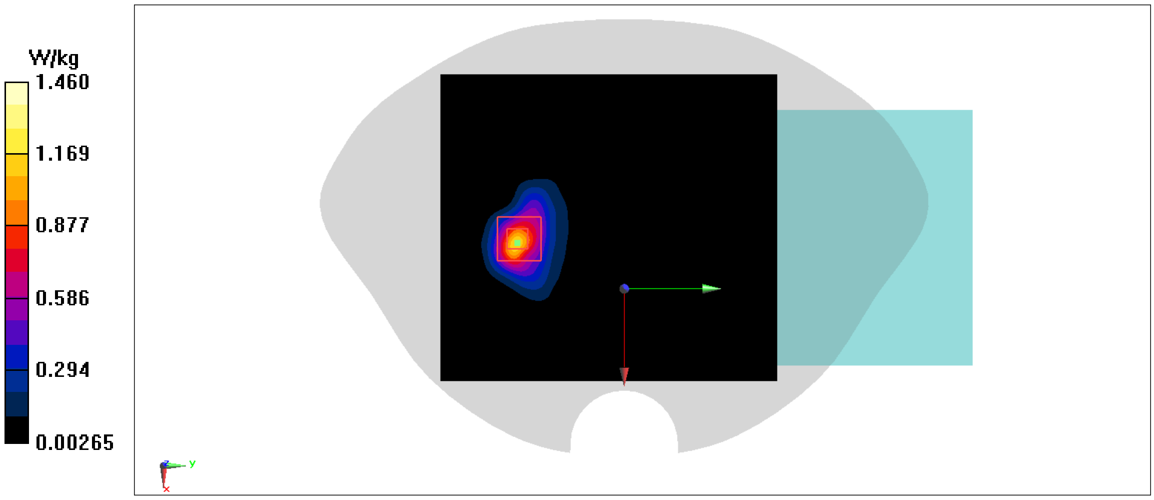


Fig A.1

WLAN5G_CH58 Front 0mm
Date: 2/23/2021
Electronics: DAE4 Sn536
Medium: head 5 GHz
Medium parameters used: f = 5290 MHz; σ =4.918 mho/m; εr =35.92 ; ρ = 1000 kg/m^3
Ambient Temperature: 22.5ºC, Liquid Temperature: 22.3ºC
Communication System: WLAN5G 5290MHz Duty Cycle: 1:1
Probe: EX3DV4 – SN7307 ConvF(5.51,5.51,5.51)

Area Scan (71x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 1.31 W/kg

Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 0 V/m; Power Drift = 0 dB
Peak SAR (extrapolated) = 3.61 W/kg
SAR(1 g) = 0.634 W/kg; SAR(10 g) = 0.138 W/kg
Maximum value of SAR (measured) = 2.01 W/kg

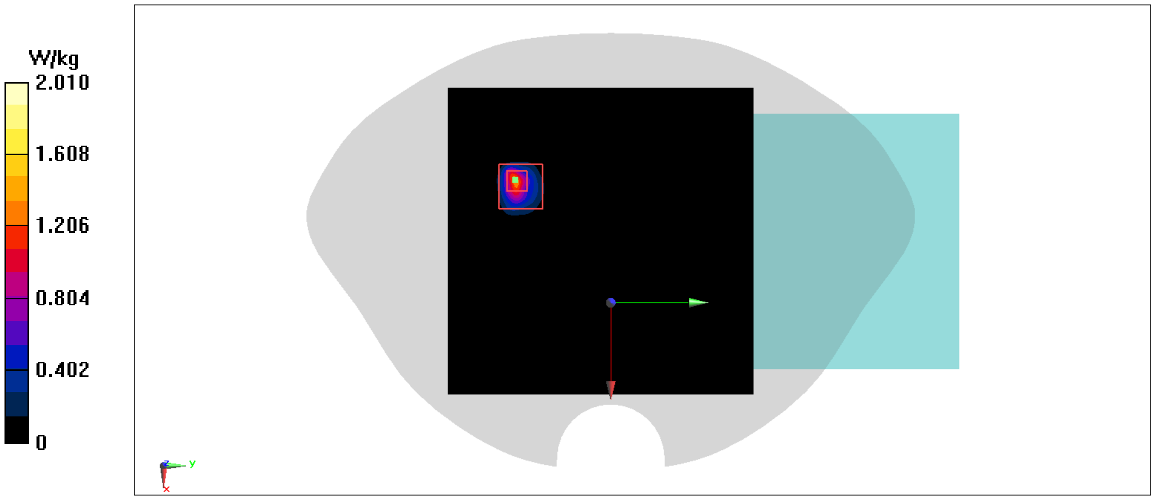
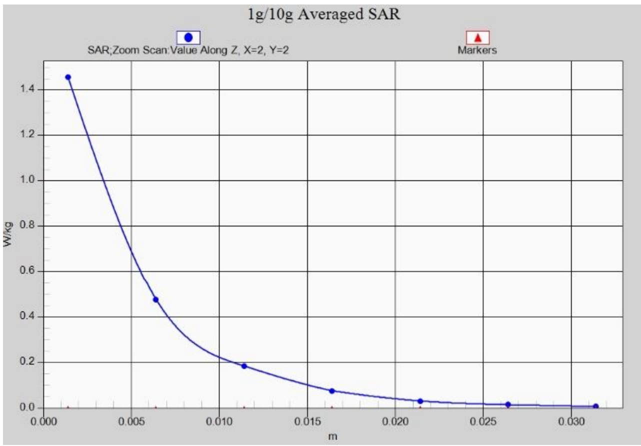
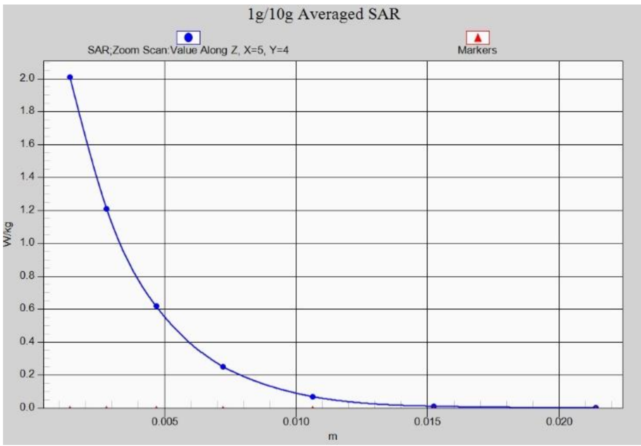


Fig A.2



Z-Scan at power reference point (WIFI2.4G 802.11b)



Z-Scan at power reference point (WIFI5G 802.11ac)

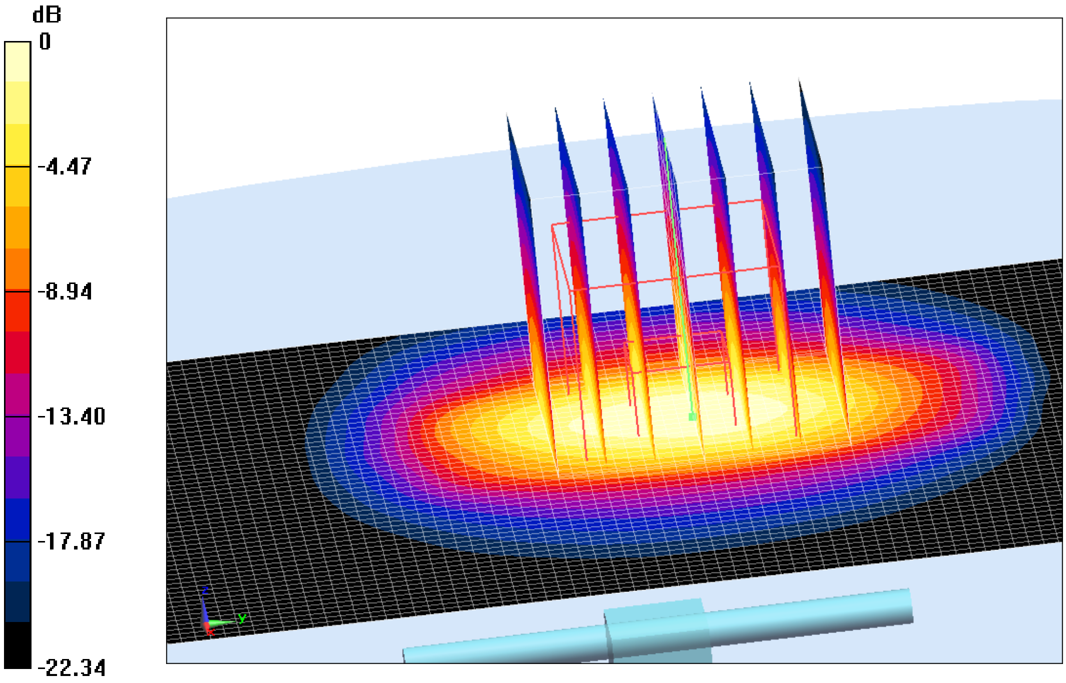
ANNEX B System Verification Results

2450 MHz

Date: 2/22/2021
Electronics: DAE4 Sn536
Medium: Head 2450 MHz
Medium parameters used: f = 2450 MHz; σ =1.817 mho/m; ε_r = 38.98; ρ = 1000 kg/m^3
Ambient Temperature: 22.5ºC Liquid Temperature: 22.3ºC
Communication System: CW Frequency: 2450 MHz Duty Cycle: 1:1
Probe: EX3DV4 – SN7307 ConvF(7.77,7.77,7.77)

System Validation /Area Scan (81x191x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Reference Value = 120.3 V/m; Power Drift = 0.03
Fast SAR: SAR(1 g) = 12.9 W/kg; SAR(10 g) = 6.24 W/kg
Maximum value of SAR (interpolated) = 21.71 W/kg

System Validation /Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value =120.3 V/m; Power Drift = 0.03 dB
Peak SAR (extrapolated) = 25.79 W/kg
SAR(1 g) = 13.12 W/kg; SAR(10 g) = 6.06 W/kg
Maximum value of SAR (measured) = 21.71 W/kg



0 dB = 21.71 W/kg = 13.37 dB W/kg

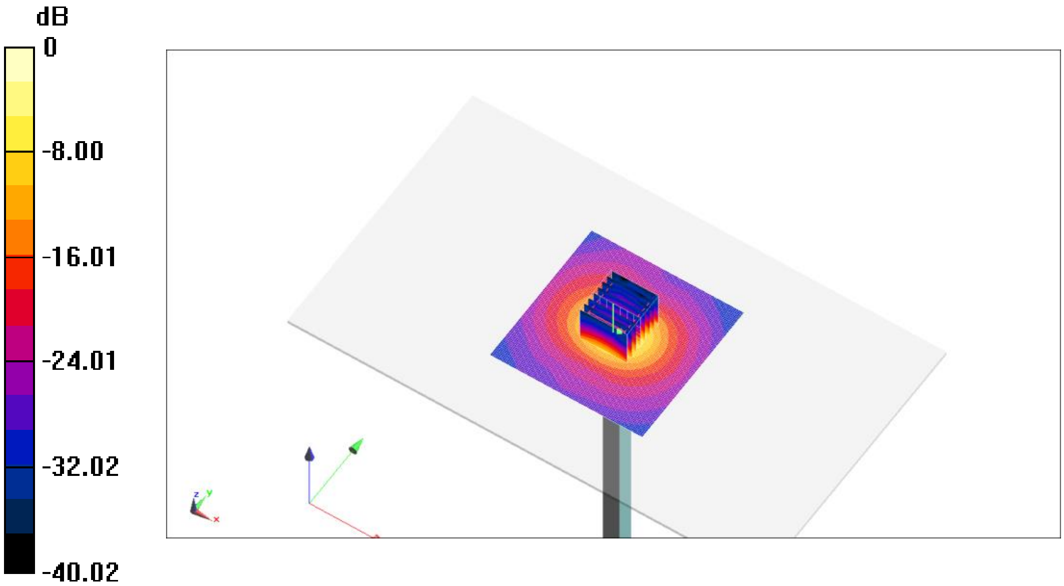
Fig.B.1 validation 2450 MHz 250mW

5250 MHz

Date: 2/23/2021
Electronics: DAE4 Sn536
Medium: Head 5250 MHz
Medium parameters used: f = 5250 MHz; σ =4.713 mho/m; ε_r = 36.01; ρ = 1000 kg/m^3
Ambient Temperature: 22.5°C Liquid Temperature: 22.3°C
Communication System: CW Frequency: 5250 MHz Duty Cycle: 1:1
Probe: EX3DV4 – SN7307 ConvF(5.61,5.61,5.61)

System Validation /Area Scan (81x191x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Reference Value = 79.57 V/m; Power Drift = 0.04
Fast SAR: SAR(1 g) = 20.12 W/kg; SAR(10 g) = 5.66 W/kg
Maximum value of SAR (interpolated) = 18.62 W/kg

System Validation /Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value =79.57 V/m; Power Drift = 0.04 dB
Peak SAR (extrapolated) = 28.49 W/kg
SAR(1 g) = 20.35 W/kg; SAR(10 g) = 5.73 W/kg
Maximum value of SAR (measured) = 18.62 W/kg



0 dB = 18.62 W/kg = 12.7 dB W/kg

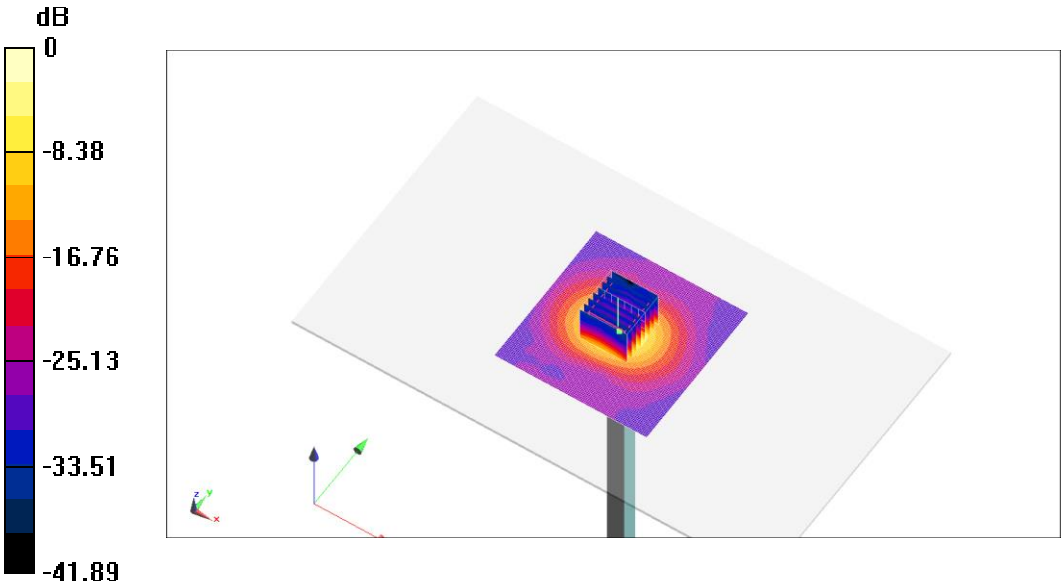
Fig.B.2 validation 5250 MHz 250mW

5600 MHz

Date: 2/24/2021
Electronics: DAE4 Sn536
Medium: Head 5600 MHz
Medium parameters used: f = 5600 MHz; σ =5.105 mho/m; ε_r = 36.06; ρ = 1000 kg/m^3
Ambient Temperature: 22.5°C Liquid Temperature: 22.3°C
Communication System: CW Frequency: 5600 MHz Duty Cycle: 1:1
Probe: EX3DV4 – SN7307 ConvF(5.1,5.1,5.1)

System Validation /Area Scan (81x191x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Reference Value = 77.7 V/m; Power Drift = 0.06
Fast SAR: SAR(1 g) = 20.55 W/kg; SAR(10 g) = 5.9 W/kg
Maximum value of SAR (interpolated) = 20.3 W/kg

System Validation /Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value =77.7 V/m; Power Drift = 0.06 dB
Peak SAR (extrapolated) = 31.48 W/kg
SAR(1 g) = 20.5 W/kg; SAR(10 g) = 5.93 W/kg
Maximum value of SAR (measured) = 20.2 W/kg



0 dB = 20.2 W/kg = 13.05 dB W/kg

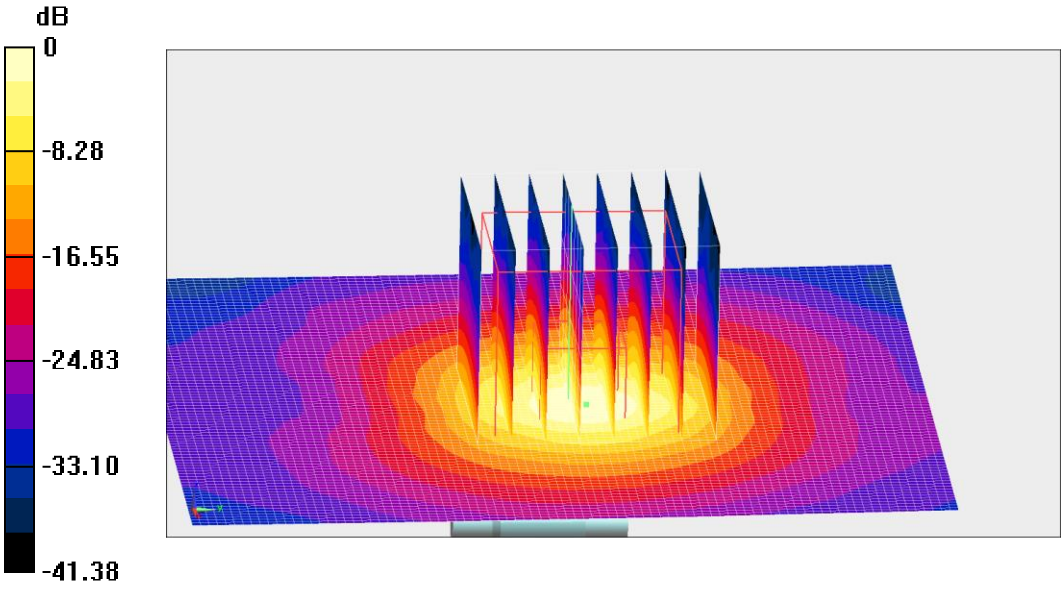
Fig.B.3 validation 5600 MHz 250mW

5750 MHz

Date: 2/25/2021
Electronics: DAE4 Sn536
Medium: Head 5750 MHz
Medium parameters used: f = 5750 MHz; σ =5.183 mho/m; ε_r = 34.96; ρ = 1000 kg/m^3
Ambient Temperature: 22.5°C Liquid Temperature: 22.3°C
Communication System: CW Frequency: 5750 MHz Duty Cycle: 1:1
Probe: EX3DV4 – SN7307 ConvF(5.05,5.05,5.05)

System Validation /Area Scan (81x191x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Reference Value = 74.89 V/m; Power Drift = 0.02
Fast SAR: SAR(1 g) = 20.17 W/kg; SAR(10 g) = 5.68 W/kg
Maximum value of SAR (interpolated) = 20.01 W/kg

System Validation /Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value =74.89 V/m; Power Drift = 0.02 dB
Peak SAR (extrapolated) = 31.96 W/kg
SAR(1 g) = 20.4 W/kg; SAR(10 g) = 5.62 W/kg
Maximum value of SAR (measured) = 19.78 W/kg



0 dB = 19.78 W/kg = 12.96 dB W/kg

Fig.B.4 validation 5750 MHz 250mW

The SAR system verification must be required that the area scan estimated 10-g SAR is within 3% of the zoom scan 10-g SAR.

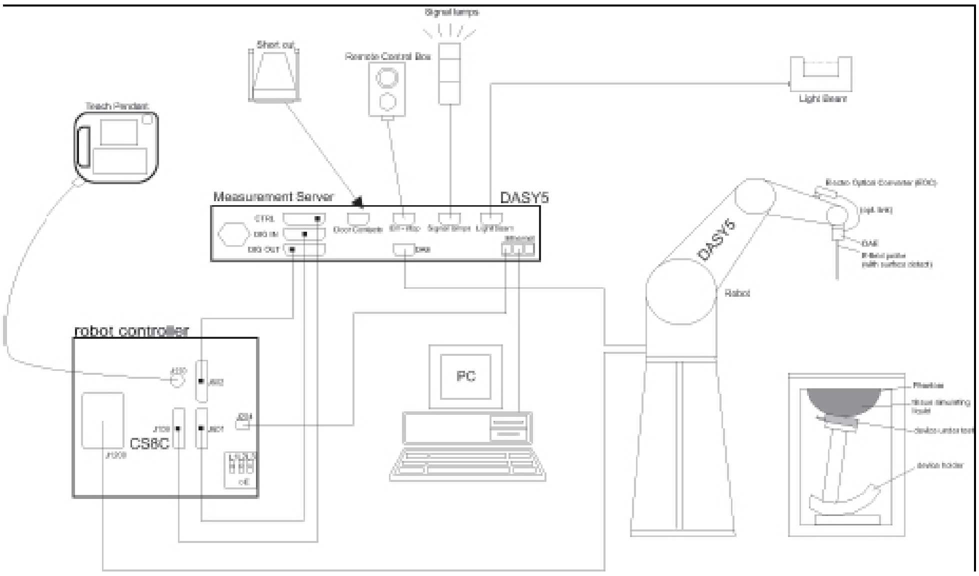
Table B.1 Comparison between area scan and zoom scan for system verification

Date	Band	Position	Area scan (1g)	Zoom scan (1g)	Drift (%)
2021/2/22	2450MHz	Head	12.9	13.12	-1.68

ANNEX C SAR Measurement Setup

C.1 Measurement Set-up

The Dasy4 or 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 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 durning a software approach and looks for the maximum using 2nd 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 (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 broad with CPU (dasy4: 166 MHz, Intel Pentium; DASY5: 400 MHz, Intel Celeron), chipdisk (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 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.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 ±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.

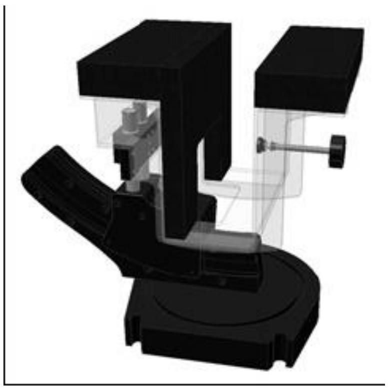
The DASY device holder is designed to cope with the different positions given in the standard. It has two scales for device rotation (with respect to the body axis) and device inclination (with respect to the line between the ear reference points). The rotation centers for both scales is the ear reference 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.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 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).

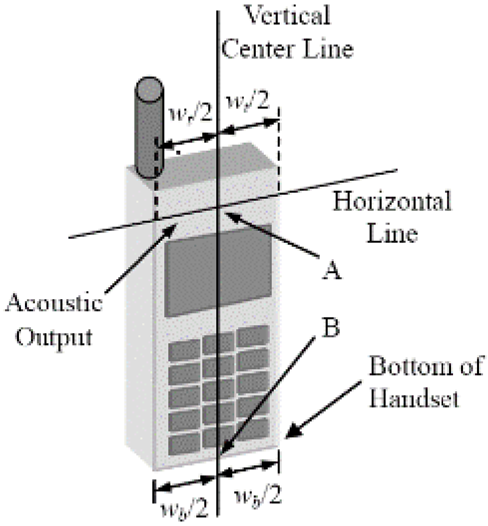
Shell Thickness: 2 ± 0. 2 mm
Filling Volume: Approx. 25 liters
Dimensions: 810 x l000 x 500 mm (H x L x W)
Available: Special

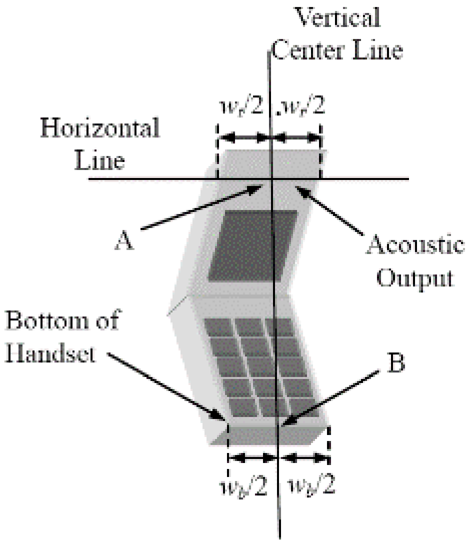
Picture C.10: SAM Twin Phantom

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

D.1 General considerations

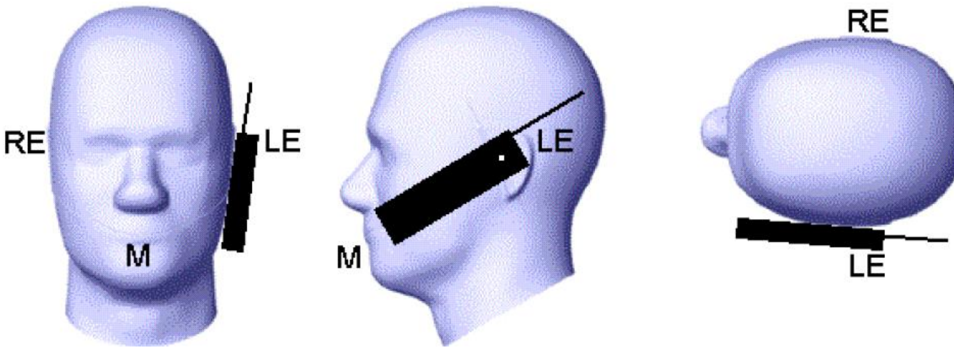
This standard specifies two handset test positions against the head phantom – the “cheek” position and the “tilt” position.



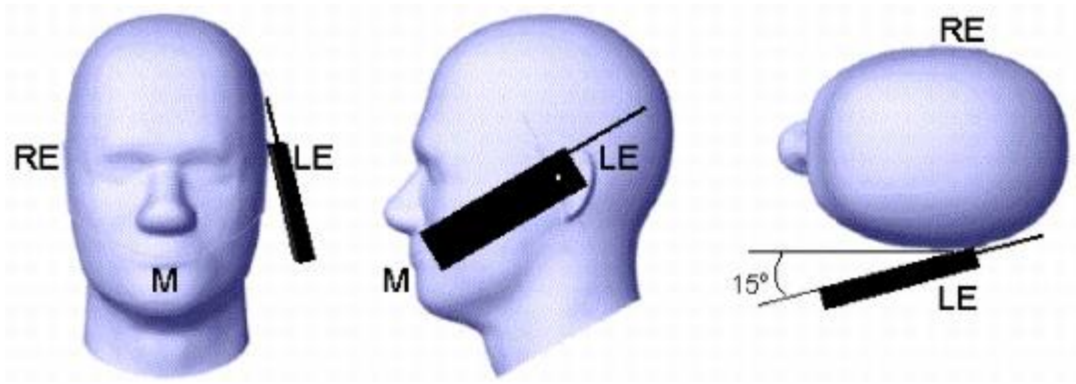


w_t	Width of the handset at the level of the acoustic
w_b	Width of the bottom of the handset
A	Midpoint of the width w_t of the handset at the level of the acoustic output
B	Midpoint of the width w_b of the bottom of the handset

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



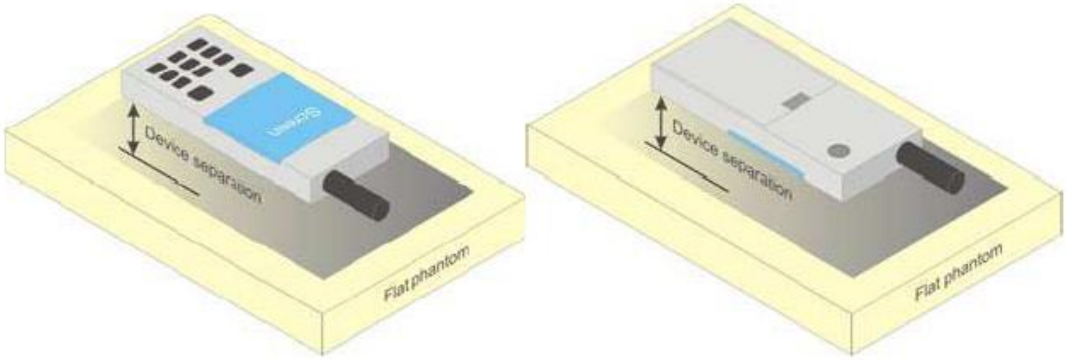
Picture D.2 Cheek position of the wireless device on the left side of SAM



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.

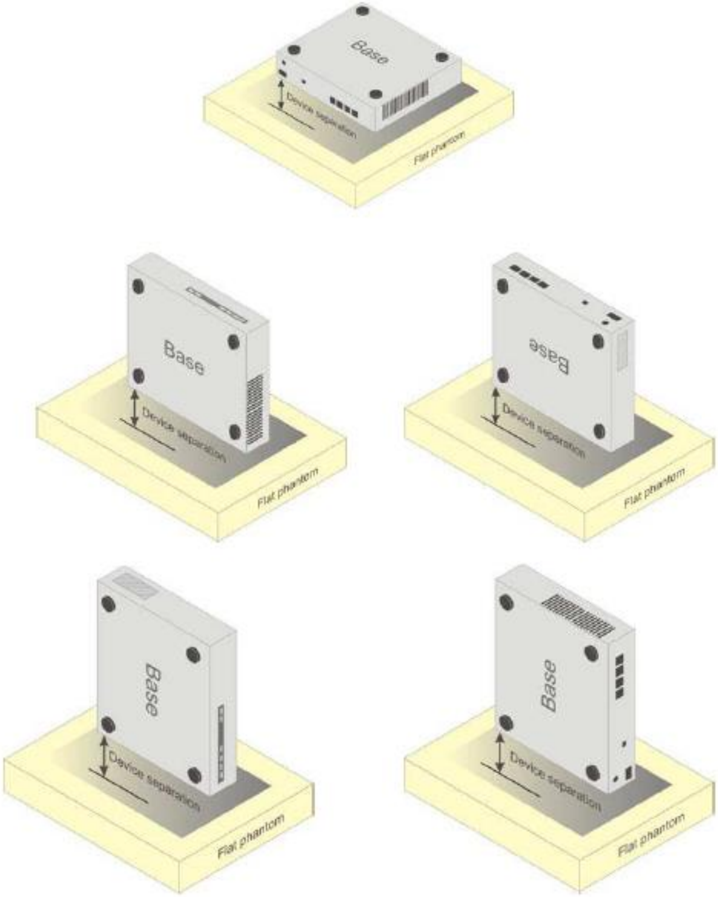


Picture D.4 Test positions for body-worn devices

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

Table E.1: Composition of the Tissue Equivalent Matter

Frequency (MHz)	835 Head	835 Body	1900 Head	1900 Body	2450 Head	2450 Body	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 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 7307

Probe SN.	Liquid name	Validation date	Frequency point	Status (OK or Not)
7307	Head 750MHz	June.15,2020	750 MHz	OK
7307	Head 850MHz	June.15,2020	835 MHz	OK
7307	Head 900MHz	June.15,2020	900 MHz	OK
7307	Head 1750MHz	June.15,2020	1750 MHz	OK
7307	Head 1810MHz	June.15,2020	1810 MHz	OK
7307	Head 1900MHz	June.16,2020	1900 MHz	OK
7307	Head 2000MHz	June.16,2020	2000 MHz	OK
7307	Head 2100MHz	June.16,2020	2100 MHz	OK
7307	Head 2300MHz	June.16,2020	2300 MHz	OK
7307	Head 2450MHz	June.16,2020	2450 MHz	OK
7307	Head 2600MHz	June.17,2020	2600 MHz	OK
7307	Head 3500MHz	June.17,2020	3500 MHz	OK
7307	Head 3700MHz	June.17,2020	3700 MHz	OK
7307	Head 5200MHz	June.17,2020	5250 MHz	OK
7307	Head 5500MHz	June.17,2020	5600 MHz	OK
7307	Head 5800MHz	June.17,2020	5800 MHz	OK
7307	Body 750MHz	June.17,2020	750 MHz	OK
7307	Body 850MHz	June.18,2020	835 MHz	OK
7307	Body 900MHz	June.18,2020	900 MHz	OK
7307	Body 1750MHz	June.18,2020	1750 MHz	OK
7307	Body 1810MHz	June.18,2020	1810 MHz	OK
7307	Body 1900MHz	June.18,2020	1900 MHz	OK
7307	Body 2000MHz	June.19,2020	2000 MHz	OK
7307	Body 2100MHz	June.19,2020	2100 MHz	OK
7307	Body 2300MHz	June.19,2020	2300 MHz	OK
7307	Body 2450MHz	June.19,2020	2450 MHz	OK
7307	Body 2600MHz	June.19,2020	2600 MHz	OK
7307	Body 3500MHz	June.20,2020	3500 MHz	OK
7307	Body 3700MHz	June.20,2020	3700 MHz	OK
7307	Body 5200MHz	June.20,2020	5250 MHz	OK
7307	Body 5500MHz	June.20,2020	5600 MHz	OK
7307	Body 5800MHz	June.20,2020	5800 MHz	OK

ANNEX G Probe Calibration Certificate

Probe 7307 Calibration Certificate

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

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

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

Accreditation No.: **SCS 0108**

Client **CTTL (Auden)** Certificate No: **EX3-7307_May20**

CALIBRATION CERTIFICATE

Object	EX3DV4 - SN:7307
Calibration procedure(s)	QA CAL-01.v9, QA CAL-12.v9, QA CAL-14.v5, QA CAL-23.v5, QA CAL-25.v7 Calibration procedure for dosimetric E-field probes
Calibration date:	May 29, 2020

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	01-Apr-20 (No. 217-03100/03101)	Apr-21
Power sensor NRP-Z91	SN: 103244	01-Apr-20 (No. 217-03100)	Apr-21
Power sensor NRP-Z91	SN: 103245	01-Apr-20 (No. 217-03101)	Apr-21
Reference 20 dB Attenuator	SN: CC2552 (20x)	31-Mar-20 (No. 217-03106)	Apr-21
DAE4	SN: 660	27-Dec-19 (No. DAE4-660_Dec19)	Dec-20
Reference Probe ES3DV2	SN: 3013	31-Dec-19 (No. ES3-3013_Dec19)	Dec-20
Secondary Standards	ID	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB41293874	06-Apr-16 (in house check Jun-18)	In house check: Jun-20
Power sensor E4412A	SN: MY41498087	06-Apr-16 (in house check Jun-18)	In house check: Jun-20
Power sensor E4412A	SN: 000110210	06-Apr-16 (in house check Jun-18)	In house check: Jun-20
RF generator HP 8648C	SN: US3642U01700	04-Aug-99 (in house check Jun-18)	In house check: Jun-20
Network Analyzer E8358A	SN: US41080477	31-Mar-14 (in house check Oct-19)	In house check: Oct-20

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

Issued: June 2, 2020

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

Certificate No: EX3-7307_May20 Page 1 of 22

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

S Schweizerischer Kalibrierdienst
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S Servizio svizzero di taratura
Swiss Calibration Service

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

Accreditation No.: SCS 0108

Glossary:

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

Calibration is Performed According to the Following Standards:

a) IEEE Std 1528-2013, “IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques”, June 2013
b) IEC 62209-1, ", “Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)”, July 2016
c) IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
d) KDB 865664, “SAR Measurement Requirements for 100 MHz to 6 GHz”

Methods Applied and Interpretation of Parameters:

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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:7307

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm (μV/(V/m)^2)[A]	0.43	0.56	0.62	± 10.1 %
DCP (mV)[B]	100.0	98.2	100.3	

Calibration Results for Modulation Response

UID	Communication System Name		A dB	B dB√μV	C	D dB	VR mV	Max dev.	Max Unc[E] (k=2)
0	CW	X	0.00	0.00	1.00	0.00	153.0	± 3.0 %	± 4.7 %
		Y	0.00	0.00	1.00		151.6		
		Z	0.00	0.00	1.00		158.4		
10352-AAA	Pulse Waveform (200Hz, 10%)	X	1.84	62.62	7.81	10.00	60.0	± 4.6 %	± 9.6 %
		Y	6.38	76.27	14.75		60.0		
		Z	1.45	61.01	7.00		60.0		
10353-AAA	Pulse Waveform (200Hz, 20%)	X	0.81	60.00	5.70	6.99	80.0	± 3.2 %	± 9.6 %
		Y	20.00	88.66	17.39		80.0		
		Z	0.86	60.00	5.68		80.0		
10354-AAA	Pulse Waveform (200Hz, 40%)	X	0.45	60.00	4.93	3.98	95.0	± 1.7 %	± 9.6 %
		Y	20.00	91.41	17.41		95.0		
		Z	0.51	60.00	5.04		95.0		
10355-AAA	Pulse Waveform (200Hz, 60%)	X	0.29	60.62	5.22	2.22	120.0	± 1.2 %	± 9.6 %
		Y	20.00	96.26	18.63		120.0		
		Z	38.00	82.00	11.00		120.0		
10387-AAA	QPSK Waveform, 1 MHz	X	1.69	67.29	15.38	1.00	150.0	± 1.8 %	± 9.6 %
		Y	1.57	65.07	14.15		150.0		
		Z	1.73	66.94	15.28		150.0		
10388-AAA	QPSK Waveform, 10 MHz	X	2.20	68.11	15.92	0.00	150.0	± 1.1 %	± 9.6 %
		Y	2.08	66.56	14.89		150.0		
		Z	2.29	68.47	15.98		150.0		
10396-AAA	64-QAM Waveform, 100 kHz	X	2.35	68.48	18.03	3.01	150.0	± 0.8 %	± 9.6 %
		Y	2.51	68.48	17.79		150.0		
		Z	2.53	69.19	18.31		150.0		
10399-AAA	64-QAM Waveform, 40 MHz	X	3.38	66.64	15.59	0.00	150.0	± 0.9 %	± 9.6 %
		Y	3.47	66.68	15.44		150.0		
		Z	3.45	66.86	15.65		150.0		
10414-AAA	WLAN CCDF, 64-QAM, 40MHz	X	4.67	65.35	15.39	0.00	150.0	± 1.9 %	± 9.6 %
		Y	4.64	64.85	15.04		150.0		
		Z	4.77	65.48	15.43		150.0		

Note: For details on UID parameters see Appendix

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

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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:7307

Sensor Model Parameters

	C1 fF	C2 fF	α V^{-1}	T1 $ms.V^{-2}$	T2 $ms.V^{-1}$	T3 ms	T4 V^{-2}	T5 V^{-1}	T6
X	35.6	260.75	34.45	5.76	0.00	4.90	1.28	0.00	1.00
Y	41.0	304.44	35.07	7.30	0.00	5.01	1.33	0.09	1.01
Z	40.7	299.93	34.68	9.21	0.00	4.91	0.98	0.11	1.00

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	23.6
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	9 mm
Tip Diameter	2.5 mm
Probe Tip to Sensor X Calibration Point	1 mm
Probe Tip to Sensor Y Calibration Point	1 mm
Probe Tip to Sensor Z Calibration Point	1 mm
Recommended Measurement Distance from Surface	1.4 mm

DASY/EASY - Parameters of Probe: EX3DV4 - SN:7307

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) C	Relative Permittivity F	Conductivity (S/m) F	ConvF X	ConvF Y	ConvF Z	Alpha G	Depth G (mm)	Unc (k=2)
64	54.2	0.75	14.38	14.38	14.38	0.00	1.00	± 13.3 %
150	52.3	0.76	13.49	13.49	13.49	0.00	1.00	± 13.3 %
300	45.3	0.87	11.83	11.83	11.83	0.10	1.20	± 13.3 %
450	43.5	0.87	11.16	11.16	11.16	0.12	1.30	± 13.3 %
750	41.9	0.89	10.41	10.41	10.41	0.55	0.80	± 12.0 %
835	41.5	0.90	10.20	10.20	10.20	0.47	0.80	± 12.0 %
900	41.5	0.97	9.95	9.95	9.95	0.44	0.87	± 12.0 %
1450	40.5	1.20	8.85	8.85	8.85	0.40	0.80	± 12.0 %
1640	40.2	1.31	8.74	8.74	8.74	0.39	0.86	± 12.0 %
1750	40.1	1.37	8.64	8.64	8.64	0.39	0.86	± 12.0 %
1810	40.0	1.40	8.39	8.39	8.39	0.38	0.86	± 12.0 %
1900	40.0	1.40	8.33	8.33	8.33	0.35	0.86	± 12.0 %
2000	40.0	1.40	8.31	8.31	8.31	0.35	0.88	± 12.0 %
2100	39.8	1.49	8.29	8.29	8.29	0.30	0.88	± 12.0 %
2300	39.5	1.67	8.15	8.15	8.15	0.33	0.90	± 12.0 %
2450	39.2	1.80	7.77	7.77	7.77	0.34	0.90	± 12.0 %
2600	39.0	1.96	7.61	7.61	7.61	0.35	0.90	± 12.0 %
3300	38.2	2.71	7.09	7.09	7.09	0.35	1.30	± 13.1 %
3500	37.9	2.91	6.72	6.72	6.72	0.35	1.30	± 13.1 %
3700	37.7	3.12	6.50	6.50	6.50	0.35	1.30	± 13.1 %
3900	37.5	3.32	6.60	6.60	6.60	0.40	1.60	± 13.1 %
4100	37.2	3.53	6.50	6.50	6.50	0.40	1.60	± 13.1 %
4200	37.1	3.63	6.40	6.40	6.40	0.40	1.70	± 13.1 %
4400	36.9	3.84	6.30	6.30	6.30	0.40	1.70	± 13.1 %
4600	36.7	4.04	6.22	6.22	6.22	0.40	1.70	± 13.1 %
4800	36.4	4.25	6.18	6.18	6.18	0.40	1.80	± 13.1 %
4950	36.3	4.40	5.90	5.90	5.90	0.40	1.80	± 13.1 %
5200	36.0	4.66	5.72	5.72	5.72	0.40	1.80	± 13.1 %
5250	35.9	4.71	5.61	5.61	5.61	0.40	1.80	± 13.1 %
5300	35.9	4.76	5.51	5.51	5.51	0.40	1.80	± 13.1 %
5500	35.6	4.96	5.20	5.20	5.20	0.40	1.80	± 13.1 %
5600	35.5	5.07	5.10	5.10	5.10	0.40	1.80	± 13.1 %
5750	35.4	5.22	5.05	5.05	5.05	0.40	1.80	± 13.1 %
5800	35.3	5.27	4.95	4.95	4.95	0.40	1.80	± 13.1 %

C Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Validity of ConvF assessed at 6 MHz is 4-9 MHz, and ConvF assessed at 13 MHz is 9-19 MHz. Above 5 GHz frequency validity can be extended to ± 110 MHz.

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

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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:7307

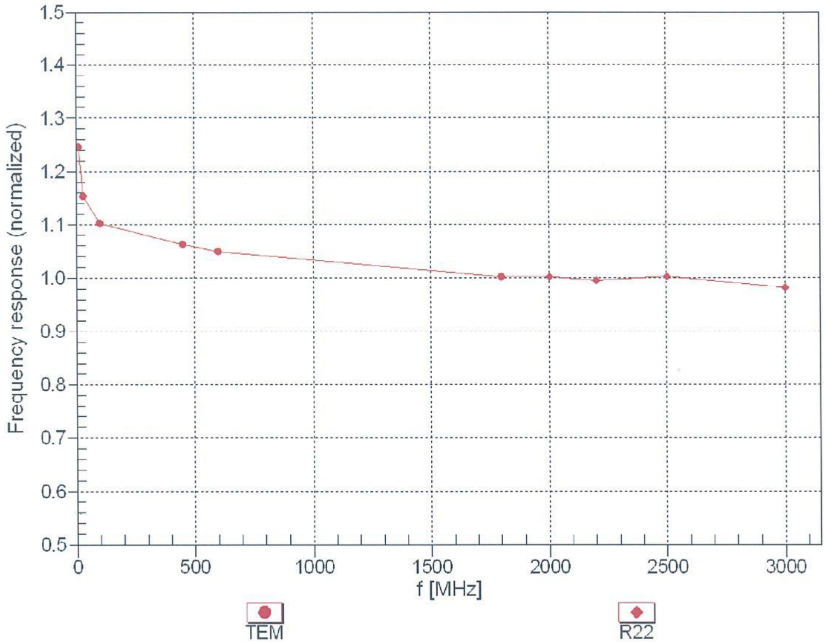
Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unc (k=2)
150	61.9	0.80	13.01	13.01	13.01	0.00	1.00	± 13.3 %
300	58.2	0.92	11.81	11.81	11.81	0.06	1.20	± 13.3 %
450	56.7	0.94	11.33	11.33	11.33	0.07	1.30	± 13.3 %
750	55.5	0.96	10.47	10.47	10.47	0.34	0.95	± 12.0 %
835	55.2	0.97	10.12	10.12	10.12	0.51	0.80	± 12.0 %
900	55.0	1.05	9.88	9.88	9.88	0.43	0.88	± 12.0 %
1450	54.0	1.30	8.90	8.90	8.90	0.34	0.80	± 12.0 %
1640	53.7	1.42	8.70	8.70	8.70	0.39	0.86	± 12.0 %
1750	53.4	1.49	8.41	8.41	8.41	0.45	0.86	± 12.0 %
1810	53.3	1.52	8.34	8.34	8.34	0.45	0.86	± 12.0 %
1900	53.3	1.52	8.30	8.30	8.30	0.32	0.88	± 12.0 %
2000	53.3	1.52	8.27	8.27	8.27	0.32	0.88	± 12.0 %
2100	53.2	1.62	8.24	8.24	8.24	0.42	0.88	± 12.0 %
2300	52.9	1.81	7.91	7.91	7.91	0.40	0.90	± 12.0 %
2450	52.7	1.95	7.79	7.79	7.79	0.34	0.90	± 12.0 %
2600	52.5	2.16	7.63	7.63	7.63	0.27	0.90	± 12.0 %
3300	51.6	3.08	6.66	6.66	6.66	0.40	1.30	± 13.1 %
3500	51.3	3.31	6.36	6.36	6.36	0.40	1.40	± 13.1 %
3700	51.0	3.55	6.27	6.27	6.27	0.40	1.40	± 13.1 %
3900	51.2	3.78	6.24	6.24	6.24	0.40	1.60	± 13.1 %
4100	50.5	4.01	6.20	6.20	6.20	0.40	1.60	± 13.1 %
4200	50.4	4.13	6.10	6.10	6.10	0.40	1.60	± 13.1 %
4400	50.1	4.37	6.02	6.02	6.02	0.40	1.70	± 13.1 %
4600	49.8	4.60	5.81	5.81	5.81	0.40	1.70	± 13.1 %
4800	49.6	4.83	5.50	5.50	5.50	0.50	1.90	± 13.1 %
4950	49.4	5.01	5.30	5.30	5.30	0.50	1.90	± 13.1 %
5200	49.0	5.30	4.85	4.85	4.85	0.50	1.90	± 13.1 %
5250	48.9	5.36	4.81	4.81	4.81	0.50	1.90	± 13.1 %
5300	48.9	5.42	4.80	4.80	4.80	0.50	1.90	± 13.1 %
5500	48.6	5.65	4.47	4.47	4.47	0.50	1.90	± 13.1 %
5600	48.5	5.77	4.37	4.37	4.37	0.50	1.90	± 13.1 %
5750	48.3	5.94	4.45	4.45	4.45	0.50	1.90	± 13.1 %
5800	48.2	6.00	4.31	4.31	4.31	0.50	1.90	± 13.1 %

[C] Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Validity of ConvF assessed at 6 MHz is 4-9 MHz, and ConvF assessed at 13 MHz is 9-19 MHz. Above 5 GHz frequency validity can be extended to ± 110 MHz.
[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.
[G] Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

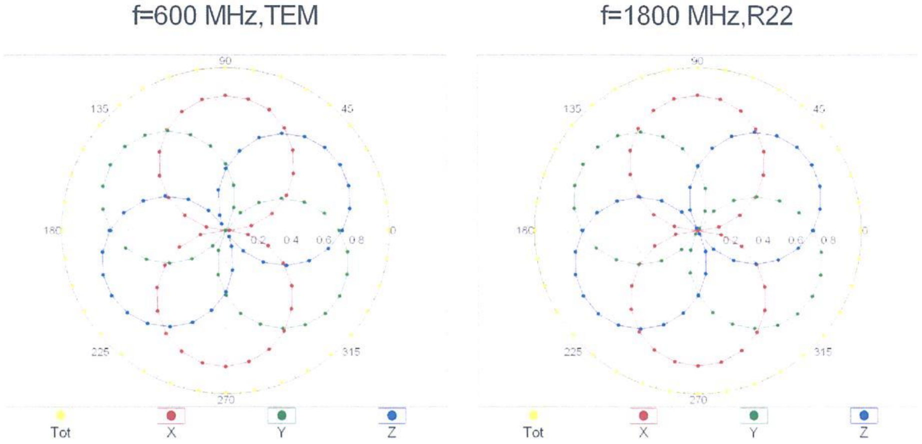
Frequency Response of E-Field

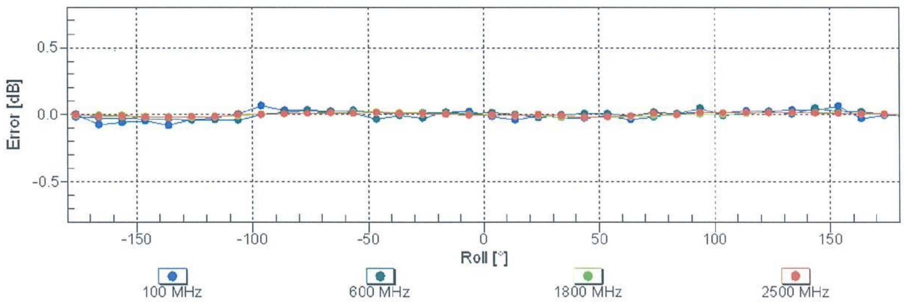
(TEM-Cell:ifi110 EXX, Waveguide: R22)



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

Receiving Pattern (ϕ), ϑ = 0°





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

