FCC SAR Test Report

APPLICANT : **HMD Global Oy**
EQUIPMENT : **Smart Phone**
BRAND NAME : **NOKIA**
MODEL NAME : **TA-1053**
FCC ID : **2AJOTTA-1053**
STANDARD : **FCC 47 CFR Part 2 (2.1093)**
ANSI/IEEE C95.1-1992
IEEE 1528-2013

We, SPORTON INTERNATIONAL INC., would like to declare that the tested sample has been evaluated in accordance with the procedures and had been in compliance with the applicable technical standards.

The test results in this report apply exclusively to the tested model / sample. Without written approval of SPORTON INTERNATIONAL INC., the test report shall not be reproduced except in full.

Eric Huang

Reviewed by: Eric Huang / Manager

JonesTsai

Approved by: Jones Tsai / Manager

Testing Laboratory
1190

SPORTON INTERNATIONAL INC.
No.52, Hwa Ya 1st Rd., Hwa Ya Technology Park, Kwei-Shan District, Taoyuan City, Taiwan (R.O.C.)

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Revision History

REPORT NO.	VERSION	DESCRIPTION	ISSUED DATE
FA712016-02	Rev. 01	Initial issue of report	Mar. 31, 2017
FA712016-02	Rev. 02	Revised typo in section 4.2	Apr. 11, 2017

1. Statement of Compliance

The maximum results of Specific Absorption Rate (SAR) found during testing for HMD Global Oy, Smart Phone, TA-1053, are as follows.

Equipment Class	Frequency Band	Highest SAR Summary				Highest Simultaneous Transmission 1g SAR (W/kg)
		Head (Separation 0mm)	Body-worn (Separation 15mm)	Hotspot (Separation 10mm)	Product Specific (Separation 0mm)	
		1g SAR (W/kg)			10g SAR (W/kg)	
Licensed	GSM850	0.19	0.24	0.36		1.37
	GSM1900	0.18	0.34	1.19		
	WCDMA II	0.29	0.52	0.93		
	WCDMA V	0.21	0.26	0.40		
	LTE Band 5	0.18	0.27	0.35		
	LTE Band 7	0.17	0.25	0.46		
	LTE Band 38	0.08	0.11	0.22		
DTS	2.4GHz WLAN	0.80	0.06	0.18		
NII	5GHz WLAN	0.42	0.03	0.08	0.18	
Date of Testing:		2017/2/27				

This device is in compliance with Specific Absorption Rate (SAR) for general population/uncontrolled exposure limits (1.6 W/kg for Partial-Body, 4.0 W/kg for Product Specific) specified in FCC 47 CFR part 2 (2.1093) and ANSI/IEEE C95.1-1992, and had been tested in accordance with the measurement methods and procedures specified in IEEE 1528-2013 and FCC KDB publications

2. Administration Data

Testing Laboratory	
Test Site	SPORTON INTERNATIONAL INC.
Test Site Location	No.52, Hwa Ya 1st Rd., Hwa Ya Technology Park, Kwei-Shan District, Taoyuan City, Taiwan (R.O.C.) TEL: +886-3-327-3456 FAX: +886-3-328-4978

Applicant	
Company Name	HMD Global Oy
Address	Karaportti 2, 02610 Espoo, Finland

Manufacturer	
Company Name	HMD Global Oy
Address	Karaportti 2, 02610 Espoo, Finland

3. Guidance Applied

The Specific Absorption Rate (SAR) testing specification, method, and procedure for this device is in accordance with the following standards:

- FCC 47 CFR Part 2 (2.1093)
- ANSI/IEEE C95.1-1992
- IEEE 1528-2013
- FCC KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz v01r04
- FCC KDB 865664 D02 SAR Reporting v01r02
- FCC KDB 447498 D01 General RF Exposure Guidance v06
- FCC KDB 648474 D04 SAR Evaluation Considerations for Wireless Handsets v01r03
- FCC KDB 248227 D01 802.11 Wi-Fi SAR v02r02
- FCC KDB 941225 D01 3G SAR Procedures v03r01
- FCC KDB 941225 D05 SAR for LTE Devices v02r05
- FCC KDB 941225 D06 Hotspot Mode SAR v02r01

4. Equipment Under Test (EUT) Information

4.1 General Information

Product Feature & Specification	
Equipment Name	Smart Phone
Brand Name	NOKIA
Model Name	TA-1053
FCC ID	2AJOTTA-1053
IMEI Code	SIM 1: 356024080014418 SIM 2: 356024080014426
Wireless Technology and Frequency Range	GSM850: 824.2 MHz ~ 848.8 MHz GSM1900: 1850.2 MHz ~ 1909.8 MHz WCDMA Band II: 1852.4 MHz ~ 1907.6 MHz WCDMA Band V: 826.4 MHz ~ 846.6 MHz LTE Band 5: 824.7 MHz ~ 848.3 MHz LTE Band 7: 2502.5 MHz ~ 2567.5 MHz LTE Band 38: 2572.5 MHz ~ 2617.5 MHz WLAN 2.4GHz Band: 2412 MHz ~ 2462 MHz WLAN 5.2GHz Band: 5180 MHz ~ 5240 MHz WLAN 5.3GHz Band: 5260 MHz ~ 5320 MHz WLAN 5.5GHz Band: 5500 MHz ~ 5720 MHz WLAN 5.8GHz Band: 5745 MHz ~ 5825 MHz Bluetooth: 2402 MHz ~ 2480 MHz NFC : 13.56 MHz
Mode	GSM/GPRS/EGPRS/DTM RMC/AMR 12.2Kbps HSDPA HSUPA DC-HSDPA HSPA+ (16QAM uplink) LTE: QPSK, 16QAM 802.11a/b/g/n HT20/HT40 Bluetooth BR/EDR/LE NFC:ASK
GSM / (E)GPRS Dual Transfer mode	Class A – EUT can support Packet Switched and Circuit Switched Network simultaneously.
EUT Stage	Identical Prototype

Remark:

1. The device has two SIM slots and supports Dual SIM Dual Standby. The WWAN radio transmission will be enabled by either one SIM at a time (Single active).
2. This device 2.4GHz / 5.2GHz / 5.8GHz WLAN support Hotspot operation.
   Power reduction for RF exposure consideration :
   (a) Hotspot mode exposure conditions of WWAN transmitter:
   Once hotspot feature is activated, and will notify the WWAN modem side to enter the reduced power for WCDMA B2.
   (b) Head exposure conditions of WLAN transmitter:
   Once the voice call or VoIP call (either through WWAN bearer, or WLAN bearer) is established, upper layer will determine whether the audio is actively routed through the earpiece receiver. If yes, and will notify the WLAN side to enter the reduced power for 2.4GHz WLAN.
3. This report only has LTE Band 5 test record, the other frequency test records please refer to Sporton FCC SAR Test Report, Report No.: FA712016 as Appendix D and the all testing results are used for simultaneous transmission analysis.

4.2 Spot Check Evaluation

1. Introduction Section

This report referenced from the FCC ID: 2AJOTTA-1044
(GSM 850 / 1900, WCDMA Band 2 / 5, LTE Band 7 / 38, DTS, NII and DSS)

The applicant takes full responsibility that the test data as referenced in this report represent compliance for this FCC ID (FCC ID: 2AJOTTA-1053).

2. Difference Section

(FCC ID: 2AJOTTA-1053, model: TA-1053) is a variant model of (FCC ID: 2AJOTTA-1044, model: TA-1044) with removed WCDMA Band 4, LTE Band 2 / 4 / 12 / 17 and added LTE Band 5,for all the divergent bands have been properly tested to ensure compliance. The detailed comparison of (FCC ID: 2AJOTTA-1053, model: TA-1053) and (FCC ID: 2AJOTTA-1044, model: TA-1044) is included in the Operating Description.

The product specification is outlined in the following table:

FCC ID			**2AJOTTA-1044**	**2AJOTTA-1053**
Wireless Tech	**Mode**		**Frequency (MHz)**	
GSM	GSM Voice GPRS (GMSK) EDGE (8PSK) DTM	Multi-Slot Class 12 DTM: Yes	850/1900	850/1900
UMTS	AMR/RCM12.2Kbps HSDPA/HSUPA/DC-HSDPA HSPA+ (16QAM uplink)		B2/B4/B5	B2/5
LTE (FDD/TDD)	QPSK 16QAM		B2/B4/B7/B12/B17/B38	B5/B7/38
Wi-Fi	11b/11g/11n(HT20)		2412-2462 MHz	
	11a/11n(HT20)/11n(HT40)		5180-5240 MHz 5260-5320 MHz 5500-5720 MHz 5745-5825 MHz	
Bluetooth	BR/EDR/LE		2402-2480 MHz	
NFC	ASK		13.56 MHz	

3. Spot Check Verification Data Section

<Head SAR>

Band	Mode	Test Position	Gap (mm)	Ch.	Freq. (MHz)	Original Model(FCC ID: 2AJOTTA-1044)					Spot Check Model(FCC ID: 2AJOTTA-1053)					Deviation
						Average Power (dBm)	Tune-Up Limit (dBm)	Duty Cycle %	Measured 1g SAR (W/kg)	Reported 1g SAR (W/kg)	Average Power (dBm)	Tune-Up Limit (dBm)	Duty Cycle %	Measured 1g SAR (W/kg)	Reported 1g SAR (W/kg)	
GSM850	GPRS (1 Tx slot)	Right Cheek	0mm	189	836.4	32.74	33.00		0.177	0.188	32.69	33.00		0.157	0.169	-10.3%
GSM1900	GPRS (4 Tx slots)	Left Cheek	0mm	810	1909.8	25.82	26.00		0.175	0.182	25.30	26.00		0.172	0.202	10.8%
WCDMA II	RMC 12.2Kbps	Left Cheek	0mm	9538	1907.6	23.97	24.00		0.283	0.285	23.81	24.00		0.303	0.317	11%
WCDMA V	RMC 12.2Kbps	Right Cheek	0mm	4182	836.4	23.75	24.00		0.197	0.209	23.73	24.00		0.178	0.189	-9.2%
LTE Band 7	20M_QPSK_1_0	Right Cheek	0mm	20850	2510	23.36	24.00		0.148	0.171	23.10	24.00		0.128	0.157	-8.2%
LTE Band 38	20M_QPSK_1_0	Right Cheek	0mm	38000	2595	23.50	24.00	62.90	0.071	0.080	22.78	24.00	62.9	0.053	0.071	-11.9%
WLAN2.4GHz	802.11b 1Mbps	Right Cheek	0mm	11	2462	13.99	14.00	97.16	0.770	0.795	13.99	14.00	97.16	0.722	0.745	-6.2%
WLAN5GHz	802.11n-HT40 MCS0	Right Cheek	0mm	62	5310	14.21	14.50	86.49	0.337	0.416	14.21	14.50	86.49	0.289	0.357	-14.2%
WLAN5GHz	802.11n-HT40 MCS0	Right Cheek	0mm	102	5510	14.17	14.50	86.49	0.086	0.107	14.17	14.50	86.49	0.083	0.104	-3.5%
WLAN5GHz	802.11n-HT40 MCS0	Right Cheek	0mm	151	5755	14.34	14.50	86.49	0.060	0.072	14.34	14.50	86.49	0.058	0.070	-3.3%

<Hotspot SAR>

Band	Mode	Test Position	Gap (mm)	Ch.	Freq. (MHz)	Original Model(FCC ID: 2AJOTTA-1044)					Spot Check Model(FCC ID: 2AJOTTA-1053)					Deviation
						Average Power (dBm)	Tune-Up Limit (dBm)	Duty Cycle %	Measured 1g SAR (W/kg)	Reported 1g SAR (W/kg)	Average Power (dBm)	Tune-Up Limit (dBm)	Duty Cycle %	Measured 1g SAR (W/kg)	Reported 1g SAR (W/kg)	
GSM850	GPRS (1 Tx slot)	Front	10mm	189	836.4	32.74	33.00		0.343	0.364	32.69	33.00		0.328	0.352	-3.3%
GSM1900	GPRS (4 Tx slots)	Front	10mm	512	1850.2	25.33	26.00		1.020	1.190	25.14	26.00		0.924	1.126	-5%
WCDMA II	RMC 12.2Kbps	Front	10mm	9262	1852.4	22.55	23.00		0.841	0.933	22.58	23.00		0.746	0.822	-11.9%
WCDMA V	RMC 12.2Kbps	Front	10mm	4182	836.4	23.75	24.00		0.374	0.396	23.73	24.00		0.322	0.343	-13.5%
LTE Band 7	20M_QPSK_1_0	Front	10mm	20850	2510	23.36	24.00		0.400	0.464	23.10	24.00		0.353	0.434	-6.3%
LTE Band 38	20M_QPSK_1_0	Front	10mm	38000	2595	23.50	24.00	62.90	0.193	0.218	22.78	24.00	62.9	0.178	0.237	8.9%
WLAN2.4GHz	802.11b 1Mbps	Front	10mm	1	2412	18.37	18.50	97.16	0.173	0.184	18.37	18.50	97.16	0.170	0.180	-1.7%
WLAN5GHz	802.11n-HT40 MCS0	Front	10mm	38	5190	14.23	14.50	86.49	0.063	0.077	14.23	14.50	86.49	0.059	0.073	-6.3%
WLAN5GHz	802.11n-HT40 MCS0	Front	10mm	151	5755	14.34	14.50	86.49	0.015	0.018	14.34	14.50	86.49	0.014	0.017	-6.7%

<Product Specific SAR>

Band	Mode	Test Position	Gap (mm)	Ch.	Freq. (MHz)	Original Model(FCC ID: 2AJOTTA-1044)					Spot Check Model(FCC ID: 2AJOTTA-1053)					Deviation
						Average Power (dBm)	Tune-Up Limit (dBm)	Duty Cycle %	Measured 10g SAR (W/kg)	Reported 10g SAR (W/kg)	Average Power (dBm)	Tune-Up Limit (dBm)	Duty Cycle %	Measured 10g SAR (W/kg)	Reported 10g SAR (W/kg)	
WLAN5GHz	802.11n-HT40 MCS0	Front	0mm	62	5310	14.21	14.50	86.49	0.149	0.184	14.21	14.50	86.49	0.130	0.161	-12.8%
WLAN5GHz	802.11n-HT40 MCS0	Front	0mm	102	5510	14.17	14.50	86.49	0.073	0.091	14.17	14.50	86.49	0.069	0.086	-5.5%

<Body-Worn SAR>

Band	Mode	Test Position	Gap (mm)	Ch.	Freq. (MHz)	Original Model(FCC ID: 2AJOTTA-1044)					Spot Check Model(FCC ID: 2AJOTTA-1053)					Deviation
						Average Power (dBm)	Tune-Up Limit (dBm)	Duty Cycle %	Measured 1g SAR (W/kg)	Reported 1g SAR (W/kg)	Average Power (dBm)	Tune-Up Limit (dBm)	Duty Cycle %	Measured 1g SAR (W/kg)	Reported 1g SAR (W/kg)	
GSM850	GPRS (1 Tx slot)	Front	15mm	189	836.4	32.74	33.00		0.222	0.236	32.69	33.00		0.230	0.247	4.8%
GSM1900	GPRS (4 Tx slots)	Front	15mm	810	1909.8	25.82	26.00		0.321	0.335	25.30	26.00		0.302	0.355	6.0%
WCDMA II	RMC 12.2Kbps	Front	15mm	9538	1907.6	23.97	24.00		0.514	0.518	23.81	24.00		0.556	0.581	12.2%
WCDMA V	RMC 12.2Kbps	Front	15mm	4182	836.4	23.75	24.00		0.245	0.260	23.73	24.00		0.216	0.230	-11.4%
LTE Band 7	20M_QPSK_1_0	Front	15mm	20850	2510	23.36	24.00		0.212	0.246	23.10	24.00		0.206	0.253	3.2%
LTE Band 38	20M_QPSK_1_0	Front	15mm	38000	2595	23.50	24.00	62.90	0.098	0.111	22.78	24.00	62.9	0.088	0.117	6.0%
WLAN2.4GHz	802.11b 1Mbps	Front	15mm	1	2412	18.37	18.50	97.16	0.058	0.062	18.37	18.50	97.16	0.056	0.059	-3.4%
WLAN5GHz	802.11n-HT40 MCS0	Front	15mm	62	5310	14.21	14.50	86.49	0.021	0.026	14.21	14.50	86.49	0.019	0.023	-9.5%
WLAN5GHz	802.11n-HT40 MCS0	Front	15mm	102	5510	14.17	14.50	86.49	0.005	0.006	14.17	14.50	86.49	0.005	0.006	-1.6%
WLAN5GHz	802.11n-HT40 MCS0	Front	15mm	151	5755	14.34	14.50	86.49	0.001	0.001	14.34	14.50	86.49	0.001	0.001	0.0%

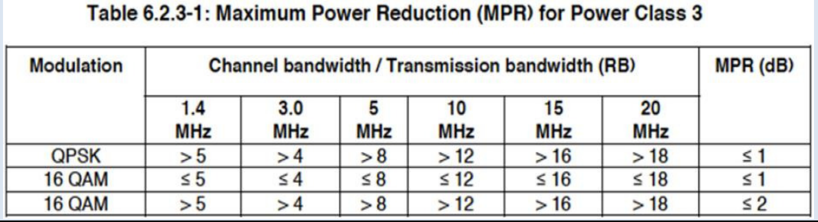
Note:

1. The spot check verification shows SAR performance of 2AJOTTA-1044 represents the performance of 2AJOTTA-1053.

4. Reference detail Section

Rule Part	Frequency Band (MHz)	Wireless Technology	Reference FCC ID	Reference Report Title	Reference Report No.	Reference Report Sections
22	824.2 ~ 848.8	GSM 850	2AJOTTA-1044	FCC SAR Test Report	FA712016	Sections related to GSM 850 test data
24	1850.2 ~ 1909.8	GSM 1900	2AJOTTA-1044	FCC SAR Test Report	FA712016	Sections related to GSM 1900 test data
24	1852.4 ~ 1907.6	WCDMA B2	2AJOTTA-1044	FCC SAR Test Report	FA712016	Sections related to WCDMA B2 test data
22	826.4 ~ 846.6	WCDMA B5	2AJOTTA-1044	FCC SAR Test Report	FA712016	Sections related to WCDMA B5 test data
27	2502.5 ~ 2567.5	LTE B7	2AJOTTA-1044	FCC SAR Test Report	FA712016	Sections related to LTE B7 test data
27	5272.5 ~ 2617.5	LTE B38	2AJOTTA-1044	FCC SAR Test Report	FA712016	Sections related to LTE B38 test data
15C	2402~2480	Bluetooth	2AJOTTA-1044	FCC SAR Test Report	FA712016	Sections related to Bluetooth test data
15C	2412~2462	Wi-Fi	2AJOTTA-1044	FCC SAR Test Report	FA712016	Sections related to WiFi test data
15E	5180~5240 5260~5320 5500~5720 5745~5825	Wi-Fi	2AJOTTA-1044	FCC SAR Test Report	FA712016	Sections related to WiFi test data

4.3 General LTE SAR Test and Reporting Considerations

<table>
<tr><th colspan="2">Summarized necessary items addressed in KDB 941225 D05 v02r05</th></tr>
<tr><td>FCC ID</td><td>2AJOTTA-1053</td></tr>
<tr><td>Equipment Name</td><td>Smart Phone</td></tr>
<tr><td>Operating Frequency Range of each LTE transmission band</td><td>LTE Band 5: 824.7 MHz ~ 848.3 MHz
LTE Band 7: 2502.5 MHz ~ 2567.5 MHz
LTE Band 38: 2572.5 MHz ~ 2617.5 MHz</td></tr>
<tr><td>Channel Bandwidth</td><td>LTE Band 5:1.4MHz, 3MHz, 5MHz, 10MHz
LTE Band 7: 5MHz, 10MHz, 15MHz, 20MHz
LTE Band 38: 5MHz, 10MHz, 15MHz, 20MHz</td></tr>
<tr><td>uplink modulations used</td><td>QPSK, and 16QAM</td></tr>
<tr><td>LTE Voice / Data requirements</td><td>1. VoLTE is supported.</td></tr>
<tr><td>LTE MPR permanently built-in by design</td><td>
Table 6.2.3-1: Maximum Power Reduction (MPR) for Power Class 3
<table>
<tr><th rowspan="2">Modulation</th><th colspan="6">Channel bandwidth / Transmission bandwidth (RB)</th><th rowspan="2">MPR (dB)</th></tr>
<tr><th>1.4 MHz</th><th>3.0 MHz</th><th>5 MHz</th><th>10 MHz</th><th>15 MHz</th><th>20 MHz</th></tr>
<tr><td>QPSK</td><td>> 5</td><td>> 4</td><td>> 8</td><td>> 12</td><td>> 16</td><td>> 18</td><td>≤ 1</td></tr>
<tr><td>16 QAM</td><td>≤ 5</td><td>≤ 4</td><td>≤ 8</td><td>≤ 12</td><td>≤ 16</td><td>≤ 18</td><td>≤ 1</td></tr>
<tr><td>16 QAM</td><td>> 5</td><td>> 4</td><td>> 8</td><td>> 12</td><td>> 16</td><td>> 18</td><td>≤ 2</td></tr>
</table></td></tr>
<tr><td>LTE A-MPR</td><td>In the base station simulator configuration, Network Setting value is set to NS_01 to disable A-MPR during SAR testing and the LTE SAR tests was transmitting on all TTI frames (Maximum TTI)</td></tr>
<tr><td>Spectrum plots for RB configuration</td><td>A properly configured base station simulator was used for the SAR and power measurement; therefore, spectrum plots for each RB allocation and offset configuration are not included in the SAR report.</td></tr>
</table>

Transmission (H, M, L) channel numbers and frequencies in each LTE band

LTE Band 5

	Bandwidth 1.4 MHz		Bandwidth 3 MHz		Bandwidth 5 MHz		Bandwidth 10 MHz	
	Ch. #	Freq. (MHz)	Ch. #	Freq. (MHz)	Ch. #	Freq. (MHz)	Ch. #	Freq. (MHz)
L	20407	824.7	20415	825.5	20425	826.5	20450	829
M	20525	836.5	20525	836.5	20525	836.5	20525	836.5
H	20643	848.3	20635	847.5	20625	846.5	20600	844

LTE Band 7

	Bandwidth 5 MHz		Bandwidth 10 MHz		Bandwidth 15 MHz		Bandwidth 20 MHz	
	Ch. #	Freq. (MHz)	Ch. #	Freq. (MHz)	Ch. #	Freq. (MHz)	Ch. #	Freq. (MHz)
L	20775	2502.5	20800	2505	20825	2507.5	20850	2510
M	21100	2535	21100	2535	21100	2535	21100	2535
H	21425	2567.5	21400	2565	21375	2562.5	21350	2560

LTE Band 38

	Bandwidth 5 MHz		Bandwidth 10 MHz		Bandwidth 15 MHz		Bandwidth 20 MHz	
	Ch. #	Freq. (MHz)	Ch. #	Freq. (MHz)	Ch. #	Freq. (MHz)	Ch. #	Freq. (MHz)
L	37775	2572.5	37800	2575	37825	2577.5	37850	2580
M	38000	2595	38000	2595	38000	2595	38000	2595
H	38225	2617.5	38200	2615	38175	2612.5	38150	2610

5. RF Exposure Limits

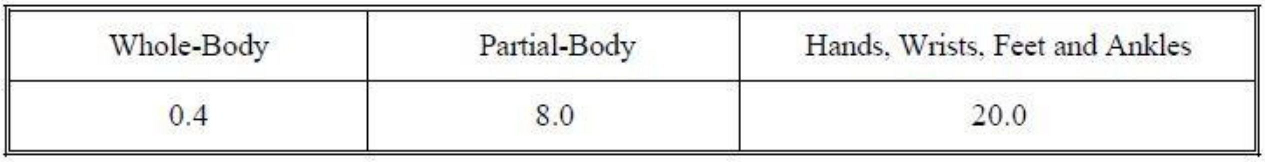
5.1 Uncontrolled Environment

Uncontrolled Environments are defined as locations where there is the exposure of individuals who have no knowledge or control of their exposure. The general population/uncontrolled exposure limits are applicable to situations in which the general public may be exposed or in which persons who are exposed as a consequence of their employment may not be made fully aware of the potential for exposure or cannot exercise control over their exposure. Members of the general public would come under this category when exposure is not employment-related; for example, in the case of a wireless transmitter that exposes persons in its vicinity.

5.2 Controlled Environment

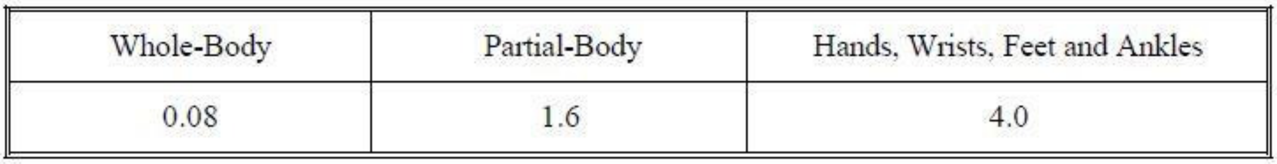
Controlled Environments are defined as locations where there is exposure that may be incurred by persons who are aware of the potential for exposure, (i.e. as a result of employment or occupation). In general, occupational/controlled exposure limits are applicable to situations in which persons are exposed as a consequence of their employment, who have been made fully aware of the potential for exposure and can exercise control over their exposure. The exposure category is also applicable when the exposure is of a transient nature due to incidental passage through a location where the exposure levels may be higher than the general population/uncontrolled limits, but the exposed person is fully aware of the potential for exposure and can exercise control over his or her exposure by leaving the area or by some other appropriate means.

Limits for Occupational/Controlled Exposure (W/kg)



Whole-Body	Partial-Body	Hands, Wrists, Feet and Ankles
0.4	8.0	20.0

Limits for General Population/Uncontrolled Exposure (W/kg)



Whole-Body	Partial-Body	Hands, Wrists, Feet and Ankles
0.08	1.6	4.0

1. Whole-Body SAR is averaged over the entire body, partial-body SAR is averaged over any 1gram of tissue defined as a tissue volume in the shape of a cube. SAR for hands, wrists, feet and ankles is averaged over any 10 grams of tissue defined as a tissue volume in the shape of a cube.

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:

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

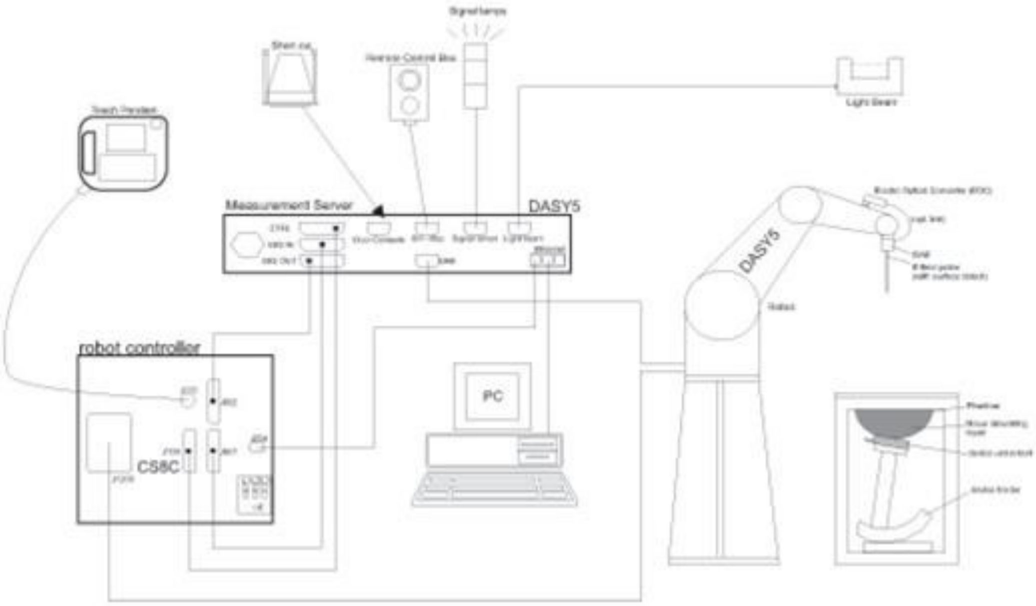
SAR is expressed in units of Watts per kilogram (W/kg)

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

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

7. System Description and Setup

The DASY system used for performing compliance tests consists of the following items:



- A standard high precision 6-axis robot 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 or Win7 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.

7.1 E-Field Probe

The SAR measurement is conducted with the dosimetric probe (manufactured by SPEAG).The probe is specially designed and calibrated for use in liquid with high permittivity. The dosimetric probe has special calibration in liquid at different frequency. This probe has a built in optical surface detection system to prevent from collision with phantom.

<ES3DV3 Probe>

Construction	Symmetric design with triangular core Interleaved sensors Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)	
Frequency	10 MHz – 4 GHz; Linearity: ±0.2 dB (30 MHz – 4 GHz)	
Directivity	±0.2 dB in TSL (rotation around probe axis) ±0.3 dB in TSL (rotation normal to probe axis)	
Dynamic Range	5 µW/g – >100 mW/g; Linearity: ±0.2 dB	
Dimensions	Overall length: 337 mm (tip: 20 mm) Tip diameter: 3.9 mm (body: 12 mm) Distance from probe tip to dipole centers: 3.0 mm	

<EX3DV4 Probe>

Construction	Symmetric design with triangular core Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)	
Frequency	10 MHz – >6 GHz Linearity: ±0.2 dB (30 MHz – 6 GHz)	
Directivity	±0.3 dB in TSL (rotation around probe axis) ±0.5 dB in TSL (rotation normal to probe axis)	
Dynamic Range	10 µW/g – >100 mW/g Linearity: ±0.2 dB (noise: typically <1 µW/g)	
Dimensions	Overall length: 337 mm (tip: 20 mm) Tip diameter: 2.5 mm (body: 12 mm) Typical distance from probe tip to dipole centers: 1 mm	

7.2 Data Acquisition Electronics (DAE)

The data acquisition electronics (DAE) consists 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 and 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 input impedance of the DAE is 200 MOhm; the inputs are symmetrical and floating. Common mode rejection is above 80 dB.

Fig 5.1 Photo of DAE

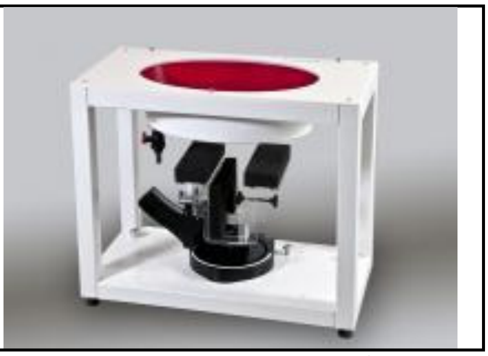
7.3 Phantom

<SAM Twin Phantom>

Shell Thickness	2 ± 0.2 mm; Center ear point: 6 ± 0.2 mm	
Filling Volume	Approx. 25 liters	
Dimensions	Length: 1000 mm; Width: 500 mm; Height: adjustable feet	
Measurement Areas	Left Hand, Right Hand, Flat Phantom	

The bottom plate contains three pair of bolts for locking the device holder. The device holder positions are adjusted to the standard measurement positions in the three sections. A white cover is provided to tap the phantom during off-periods to prevent water evaporation and changes in the liquid parameters. On the phantom top, three reference markers are provided to identify the phantom position with respect to the robot.

<ELI Phantom>

Shell Thickness	2 ± 0.2 mm (sagging: <1%)	
Filling Volume	Approx. 30 liters	
Dimensions	Major ellipse axis: 600 mm Minor axis: 400 mm	

The ELI phantom is intended for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30 MHz to 6 GHz. ELI4 is fully compatible with standard and all known tissue simulating liquids.

7.4 Device Holder

<Mounting Device for Hand-Held Transmitter>

In combination with the Twin SAM V5.0/V5.0c or ELI phantoms, the Mounting Device for Hand-Held Transmitters enables rotation of the mounted transmitter device to specified spherical coordinates. At the heads, the rotation axis is at the ear opening. Transmitter devices can be easily and accurately positioned according to IEC 62209-1, IEEE 1528, FCC, or other specifications. The device holder can be locked for positioning at different phantom sections (left head, right head, flat). And upgrade kit to Mounting Device to enable easy mounting of wider devices like big smart-phones, e-books, small tablets, etc. It holds devices with width up to 140 mm.

Mounting Device for Hand-Held Transmitters

Mounting Device Adaptor for Wide-Phones

<Mounting Device for Laptops and other Body-Worn Transmitters>

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 positioned. The extension is fully compatible with the SAM Twin and ELI phantoms.

Mounting Device for Laptops

8. Measurement Procedures

The measurement procedures are as follows:

<Conducted power measurement>

(a) For WWAN power measurement, use base station simulator to configure EUT WWAN transmission in conducted connection with RF cable, at maximum power in each supported wireless interface and frequency band.
(b) Read the WWAN RF power level from the base station simulator.
(c) For WLAN/BT power measurement, use engineering software to configure EUT WLAN/BT continuously transmission, at maximum RF power in each supported wireless interface and frequency band
(d) Connect EUT RF port through RF cable to the power meter, and measure WLAN/BT output power

<SAR measurement>

(a) Use base station simulator to configure EUT WWAN transmission in radiated connection, and engineering software to configure EUT WLAN/BT continuously transmission, at maximum RF power, in the highest power channel.
(b) Place the EUT in the positions as Appendix D demonstrates.
(c) Set scan area, grid size and other setting on the DASY software.
(d) Measure SAR results for the highest power channel on each testing position.
(e) Find out the largest SAR result on these testing positions of each band
(f) Measure SAR results for other channels in worst SAR testing position if the reported SAR of highest power channel is larger than 0.8 W/kg

According to the test standard, the recommended procedure for assessing the peak spatial-average SAR value consists of the following steps:

(a) Power reference measurement
(b) Area scan
(c) Zoom scan
(d) Power drift measurement

8.1 Spatial Peak SAR Evaluation

The procedure for spatial peak SAR evaluation has been implemented according to the test standard. It can be conducted for 1g and 10g, as well as for user-specific masses. The DASY software includes all numerical procedures necessary to evaluate the spatial peak SAR value.

The base for the evaluation is a "cube" measurement. The measured volume must include the 1g and 10g cubes with the highest averaged SAR values. For that purpose, the center of the measured volume is aligned to the interpolated peak SAR value of a previously performed area scan.

The entire evaluation of the spatial peak values is performed within the post-processing engine (SEMCAD). The system always gives the maximum values for the 1g and 10g cubes. The algorithm to find the cube with highest averaged SAR is divided into the following stages:

(a) Extraction of the measured data (grid and values) from the Zoom Scan
(b) Calculation of the SAR value at every measurement point based on all stored data (A/D values and measurement parameters)
(c) Generation of a high-resolution mesh within the measured volume
(d) Interpolation of all measured values form the measurement grid to the high-resolution grid
(e) Extrapolation of the entire 3-D field distribution to the phantom surface over the distance from sensor to surface
(f) Calculation of the averaged SAR within masses of 1g and 10g

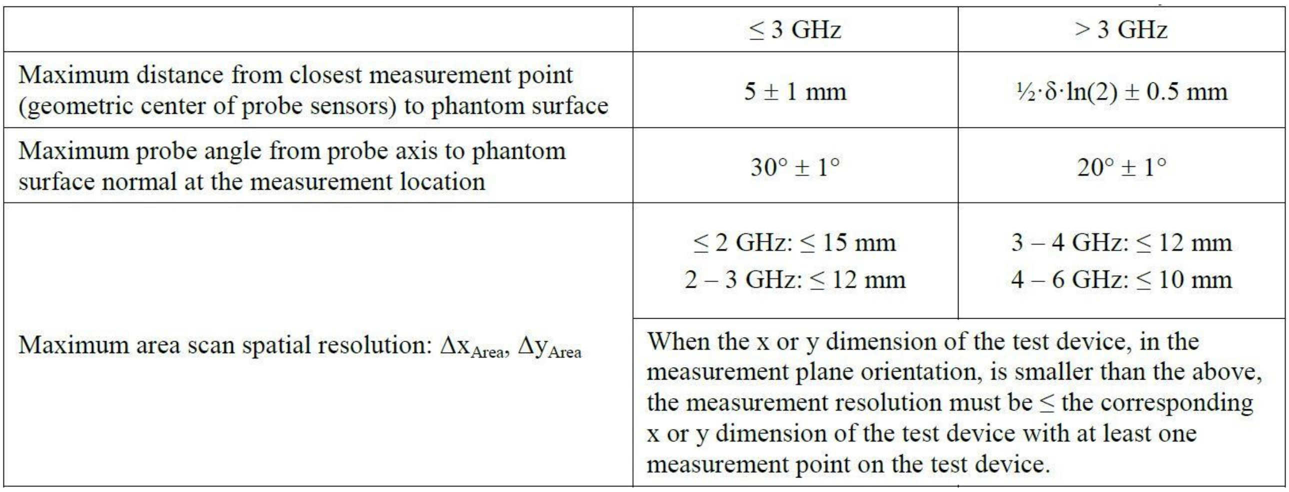
8.2 Power Reference Measurement

The Power Reference Measurement and Power Drift Measurements are for monitoring the power drift of the device under test in the batch process. The minimum distance of probe sensors to surface determines the closest measurement point to phantom surface. This distance cannot be smaller than the distance of sensor calibration points to probe tip as defined in the probe properties.

8.3 Area Scan

The area scan is used as a fast scan in two dimensions to find the area of high field values, before doing a fine measurement around the hot spot. The sophisticated interpolation routines implemented in DASY software can find the maximum found in the scanned area, within a range of the global maximum. The range (in dB0 is specified in the standards for compliance testing. For example, a 2 dB range is required in IEEE standard 1528 and IEC 62209 standards, whereby 3 dB is a requirement when compliance is assessed in accordance with the ARIB standard (Japan), if only one zoom scan follows the area scan, then only the absolute maximum will be taken as reference. For cases where multiple maximums are detected, the number of zoom scans has to be increased accordingly.

Area scan parameters extracted from FCC KDB 865664 D01v01r04 SAR measurement 100 MHz to 6 GHz.

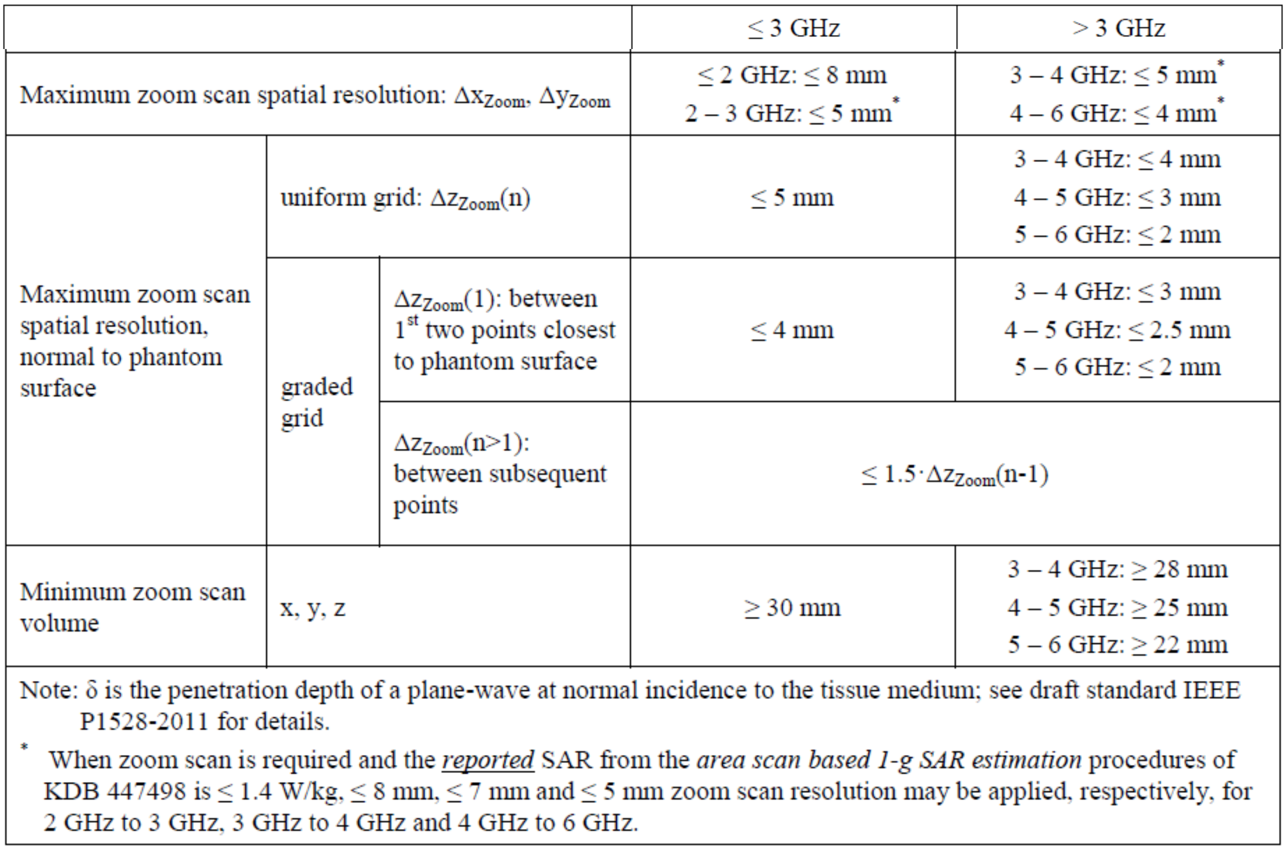


	≤ 3 GHz	> 3 GHz
Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface	5 ± 1 mm	½·δ·ln(2) ± 0.5 mm
Maximum probe angle from probe axis to phantom surface normal at the measurement location	30° ± 1°	20° ± 1°
Maximum area scan spatial resolution: Δx_{Area}, Δy_{Area}	≤ 2 GHz: ≤ 15 mm 2 – 3 GHz: ≤ 12 mm	3 – 4 GHz: ≤ 12 mm 4 – 6 GHz: ≤ 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 ≤ the corresponding x or y dimension of the test device with at least one measurement point on the test device.	

8.4 Zoom Scan

Zoom scans are used assess the peak spatial SAR values within a cubic averaging volume containing 1 gram and 10 gram of simulated tissue. The zoom scan measures points (refer to table below) within a cube shoes base faces are centered on the maxima found in a preceding area scan job within the same procedure. When the measurement is done, the zoom scan evaluates the averaged SAR for 1 gram and 10 gram and displays these values next to the job's label.

Zoom scan parameters extracted from FCC KDB 865664 D01v01r04 SAR measurement 100 MHz to 6 GHz.



			≤ 3 GHz	> 3 GHz
Maximum zoom scan spatial resolution: Δx_{Zoom}, Δy_{Zoom}			≤ 2 GHz: ≤ 8 mm $2 - 3$ GHz: ≤ 5 mm*	$3 - 4$ GHz: ≤ 5 mm* $4 - 6$ GHz: ≤ 4 mm*
Maximum zoom scan spatial resolution, normal to phantom surface	uniform grid: $\Delta z_{Zoom}(n)$		≤ 5 mm	$3 - 4$ GHz: ≤ 4 mm $4 - 5$ GHz: ≤ 3 mm $5 - 6$ GHz: ≤ 2 mm
	graded grid	$\Delta z_{Zoom}(1)$: between 1st two points closest to phantom surface	≤ 4 mm	$3 - 4$ GHz: ≤ 3 mm $4 - 5$ GHz: ≤ 2.5 mm $5 - 6$ GHz: ≤ 2 mm
		$\Delta z_{Zoom}(n>1)$: between subsequent points	$\leq 1.5 \cdot \Delta z_{Zoom}(n-1)$	
Minimum zoom scan volume	x, y, z		≥ 30 mm	$3 - 4$ GHz: ≥ 28 mm $4 - 5$ GHz: ≥ 25 mm $5 - 6$ GHz: ≥ 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 ≤ 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.

8.5 Volume Scan Procedures

The volume scan is used for assess overlapping SAR distributions for antennas transmitting in different frequency bands. It is equivalent to an oversized zoom scan used in standalone measurements. The measurement volume will be used to enclose all the simultaneous transmitting antennas. For antennas transmitting simultaneously in different frequency bands, the volume scan is measured separately in each frequency band. In order to sum correctly to compute the 1g aggregate SAR, the EUT remain in the same test position for all measurements and all volume scan use the same spatial resolution and grid spacing. When all volume scan were completed, the software, SEMCAD postprocessor can combine and subsequently superpose these measurement data to calculating the multiband SAR.

8.6 Power Drift Monitoring

All SAR testing is under the EUT install full charged battery and transmit maximum output power. In DASY measurement software, the power reference measurement and power drift measurement procedures are used for monitoring the power drift of EUT during SAR test. Both these procedures measure the field at a specified reference position before and after the SAR testing. The software will calculate the field difference in dB. If the power drifts more than 5%, the SAR will be retested.

9. Test Equipment List

Manufacturer	Name of Equipment	Type/Model	Serial Number	Calibration	
				Last Cal.	Due Date
SPEAG	835MHz System Validation Kit	D835V2	499	Mar. 21, 2016	Mar. 20, 2017
SPEAG	Data Acquisition Electronics	DAE3	577	Sep. 28, 2016	Sep. 27, 2017
SPEAG	Dosimetric E-Field Probe	EX3DV4	3931	Oct. 03, 2016	Oct. 02, 2017
Wisewind	Thermometer	HTC-1	TM560	Oct. 12, 2016	Oct. 11, 2017
Anritsu	Radio Communication Analyzer	MT8820C	6201381760	May. 10, 2016	May. 09, 2017
SPEAG	Device Holder	N/A	N/A	N/A	N/A
Anritsu	Signal Generator	MG3710A	6201502524	Dec. 09, 2016	Dec. 08, 2017
Agilent	ENA Network Analyzer	E5071C	MY46316648	Jan. 04, 2017	Jan. 03, 2018
SPEAG	Dielectric Probe Kit	DAK-3.5	1126	Jul. 19, 2016	Jul. 18, 2017
LINE SEIKI	Digital Thermometer	LKMelectronic	DTM3000SPEZIAL	Sep. 05, 2016	Sep. 04, 2017
Anritsu	Power Meter	ML2495A	1419002	May. 10, 2016	May. 09, 2017
Anritsu	Power Sensor	MA2411B	1339124	May. 10, 2016	May. 09, 2017
Anritsu	Spectrum Analyzer	MS2830A	6201396378	Jun. 21, 2016	Jun. 20, 2017
Mini-Circuits	Power Amplifier	ZVE-8G+	D120604	Mar. 16, 2016	Mar. 15, 2017
Mini-Circuits	Power Amplifier	ZHL-42W+	QA1344002	Mar. 16, 2016	Mar. 15, 2017
ATM	Dual Directional Coupler	C122H-10	P610410z-02	Note 1	
Woken	Attenuator 1	WK0602-XX	N/A	Note 1	
PE	Attenuator 2	PE7005-10	N/A	Note 1	
PE	Attenuator 3	PE7005- 3	N/A	Note 1	

General Note:

1. Prior to system verification and validation, the path loss from the signal generator to the system check source and the power meter, which includes the amplifier, cable, attenuator and directional coupler, was measured by the network analyzer. The reading of the power meter was offset by the path loss difference between the path to the power meter and the path to the system check source to monitor the actual power level fed to the system check source.

10. System Verification

10.1 Tissue Simulating Liquids

For the measurement of the field distribution inside the SAM phantom with DASY, the phantom must be filled with around 25 liters of homogeneous body tissue simulating liquid. For head SAR testing, the liquid height from the ear reference point (ERP) of the phantom to the liquid top surface is larger than 15 cm, which is shown in Fig. 10.1. For body SAR testing, the liquid height from the center of the flat phantom to the liquid top surface is larger than 15 cm, which is shown in Fig. 10.2.

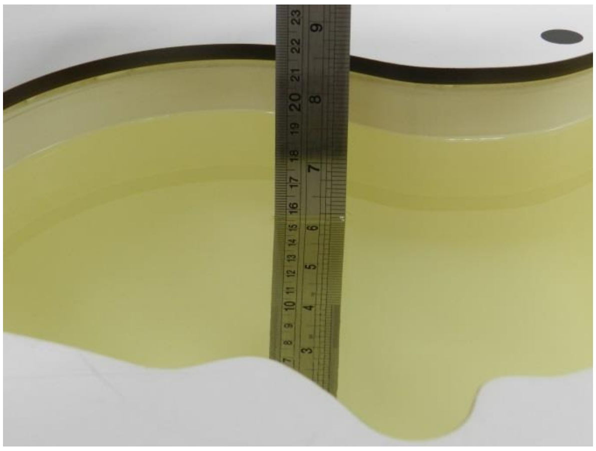


Fig 10.1Photo of Liquid Height for Head SAR

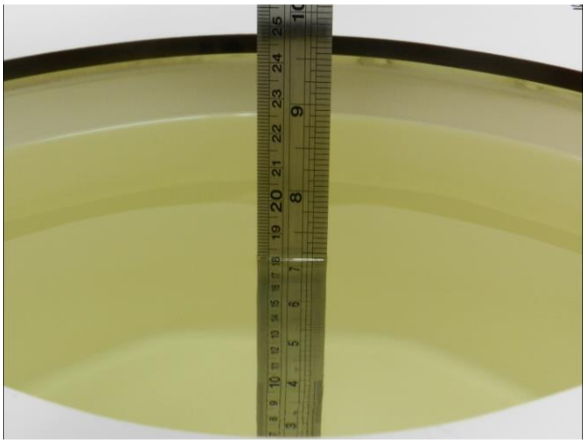


Fig 10.2 Photo of Liquid Height for Body SAR

10.2 Tissue Verification

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

Frequency (MHz)	Water (%)	Sugar (%)	Cellulose (%)	Salt (%)	Preventol (%)	DGBE (%)	Conductivity (σ)	Permittivity (εr)
For Head								
750	41.1	57.0	0.2	1.4	0.2	0	0.89	41.9
835	40.3	57.9	0.2	1.4	0.2	0	0.90	41.5
900	40.3	57.9	0.2	1.4	0.2	0	0.97	41.5
1800, 1900, 2000	55.2	0	0	0.3	0	44.5	1.40	40.0
2450	55.0	0	0	0	0	45.0	1.80	39.2
2600	54.8	0	0	0.1	0	45.1	1.96	39.0
For Body								
750	51.7	47.2	0	0.9	0.1	0	0.96	55.5
835	50.8	48.2	0	0.9	0.1	0	0.97	55.2
900	50.8	48.2	0	0.9	0.1	0	1.05	55.0
1800, 1900, 2000	70.2	0	0	0.4	0	29.4	1.52	53.3
2450	68.6	0	0	0	0	31.4	1.95	52.7
2600	68.1	0	0	0.1	0	31.8	2.16	52.5

Simulating Liquid for 5GHz, Manufactured by SPEAG

Ingredients	(% by weight)
Water	64~78%
Mineral oil	11~18%
Emulsifiers	9~15%
Additives and Salt	2~3%

<Tissue Dielectric Parameter Check Results>

Frequency (MHz)	**Tissue Type**	**Liquid Temp. (℃)**	**Conductivity (σ)**	**Permittivity (ε_r)**	**Conductivity Target (σ)**	**Permittivity Target (ε_r)**	**Delta (σ) (%)**	**Delta (ε_r) (%)**	**Limit (%)**	**Date**
835	HSL	22.4	0.907	43.142	0.90	41.50	0.78	3.96	±5	2017/2/27
835	MSL	22.4	0.991	57.462	0.97	55.20	2.16	4.10	±5	2017/2/27

10.3 System Performance Check Results

Comparing to the original SAR value provided by SPEAG, the verification data should be within its specification of 10 %. Below table shows the target SAR and measured SAR after normalized to 1W input power. The table below indicates the system performance check can meet the variation criterion and the plots can be referred to Appendix A of this report.

Date	Frequency (MHz)	Tissue Type	Input Power (mW)	Dipole S/N	Probe S/N	DAE S/N	Measured 1g SAR (W/kg)	Targeted 1g SAR (W/kg)	Normalized 1g SAR (W/kg)	Deviation (%)
2017/2/27	835	HSL	250	D835V2-499	EX3DV4 - SN3931	DAE3 Sn577	2.32	9.14	9.28	1.53
2017/2/27	835	MSL	250	D835V2-499	EX3DV4 - SN3931	DAE3 Sn577	2.56	9.52	10.24	7.56

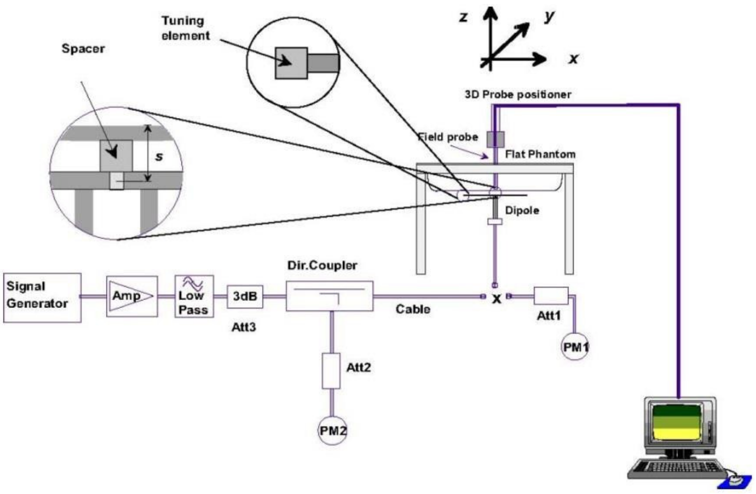


Fig 8.3.1 System Performance Check Setup

Fig 8.3.2 Setup Photo

11. RF Exposure Positions

11.1 Ear and handset reference point

Figure 9.1.1 shows the front, back, and side views of the SAM phantom. The center-of-mouth reference point is labeled “M,” the left ear reference point (ERP) is marked “LE,” and the right ERP is marked “RE.” Each ERP is 15 mm along the B-M (back-mouth) line behind the entrance-to-ear-canal (EEC) point, as shown in Figure 9.1.2 The Reference Plane is defined as passing through the two ear reference points and point M. The line N-F (neck-front), also called the reference pivoting line, is normal to the Reference Plane and perpendicular to both a line passing through RE and LE and the B-M line (see Figure 9.1.3). Both N-F and B-M lines should be marked on the exterior of the phantom shell to facilitate handset positioning. Posterior to the N-F line the ear shape is a flat surface with 6 mm thickness at each ERP, and forward of the N-F line the ear is truncated, as illustrated in Figure 9.1.2. The ear truncation is introduced to preclude the ear lobe from interfering with handset tilt, which could lead to unstable positioning at the cheek.

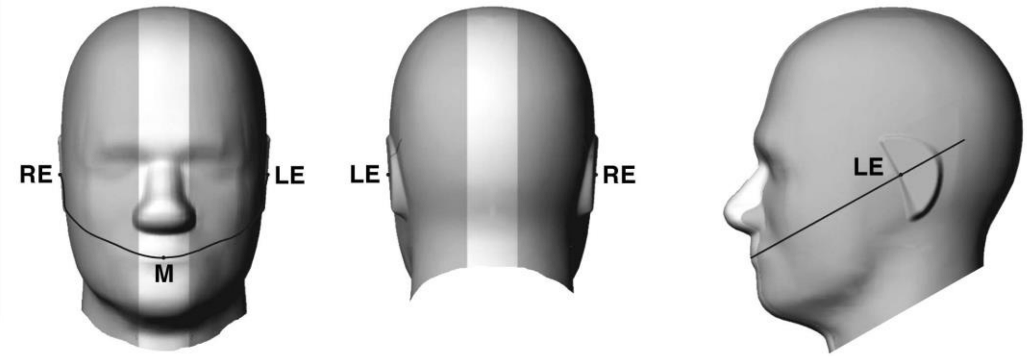


Fig 9.1.1 Front, back, and side views of SAM twin phantom

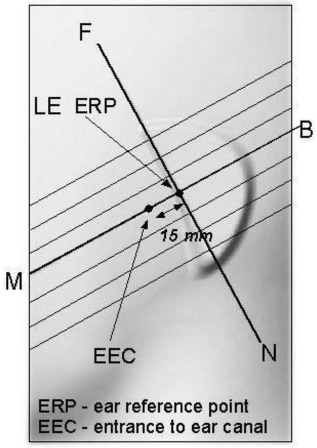


Fig 9.1.2 Close-up side view of phantom showing the ear region.

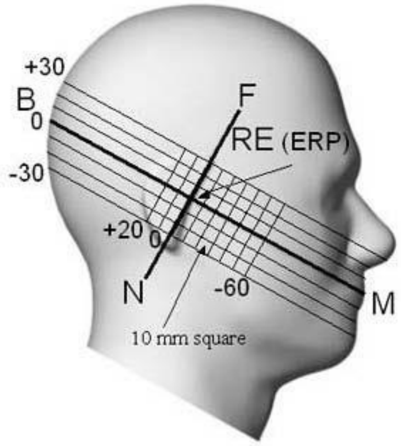


Fig 9.1.3 Side view of the phantom showing relevant markings and seven cross-sectional plane locations

11.2 Definition of the cheek position

1. Ready the handset for talk operation, if necessary. For example, for handsets with a cover piece (flip cover), open the cover. If the handset can transmit with the cover closed, both configurations must be tested.
2. Define two imaginary lines on the handset—the vertical centerline and the horizontal line. The vertical centerline passes through two points on the front side of the handset—the midpoint of the width wt of the handset at the level of the acoustic output (point A in Figure 9.2.1 and Figure 9.2.2), and the midpoint of the width wb of the bottom of the handset (point B). The horizontal line is perpendicular to the vertical centerline and passes through the center of the acoustic output (see Figure 9.2.1). The two lines intersect at point A. Note that for many handsets, point A coincides with the center of the acoustic output; however, the acoustic output may be located elsewhere on the horizontal line. Also note that the vertical centerline is not necessarily parallel to the front face of the handset (see Figure 9.2.2), especially for clamshell handsets, handsets with flip covers, and other irregularly-shaped handsets.
3. Position the handset close to the surface of the phantom such that point A is on the (virtual) extension of the line passing through points RE and LE on the phantom (see Figure 9.2.3), such that the plane defined by the vertical centerline and the horizontal line of the handset is approximately parallel to the sagittal plane of the phantom.
4. Translate the handset towards the phantom along the line passing through RE and LE until handset point A touches the pinna at the ERP.
5. While maintaining the handset in this plane, rotate it around the LE-RE line until the vertical centerline is in the plane normal to the plane containing B-M and N-F lines, i.e., the Reference Plane.
6. Rotate the handset around the vertical centerline until the handset (horizontal line) is parallel to the N-F line.
7. While maintaining the vertical centerline in the Reference Plane, keeping point A on the line passing through RE and LE, and maintaining the handset contact with the pinna, rotate the handset about the N-F line until any point on the handset is in contact with a phantom point below the pinna on the cheek. See Figure 9.2.3. The actual rotation angles should be documented in the test report.

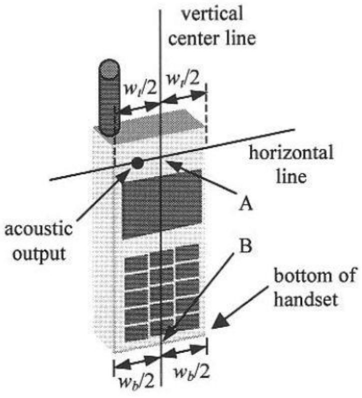


Fig 9.2.1 Handset vertical and horizontal reference lines—"fixed case

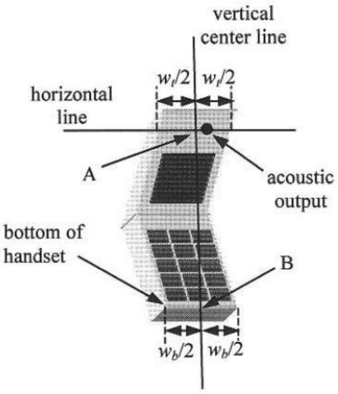


Fig 9.2.2 Handset vertical and horizontal reference lines—"clam-shell case"

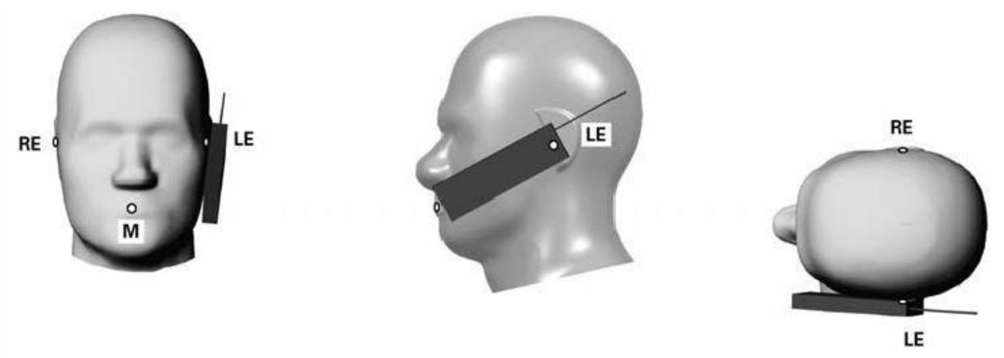


Fig 9.2.3 cheek or touch position. The reference points for the right ear (RE), left ear (LE), and mouth (M), which establish the Reference Plane for handset positioning, are indicated.

11.3 Definition of the tilt position

1. Ready the handset for talk operation, if necessary. For example, for handsets with a cover piece (flip cover), open the cover. If the handset can transmit with the cover closed, both configurations must be tested.
2. While maintaining the orientation of the handset, move the handset away from the pinna along the line passing through RE and LE far enough to allow a rotation of the handset away from the cheek by 15°.
3. Rotate the handset around the horizontal line by 15°.
4. While maintaining the orientation of the handset, move the handset towards the phantom on the line passing through RE and LE until any part of the handset touches the ear. The tilt position is obtained when the contact point is on the pinna. See Figure 9.3.1. If contact occurs at any location other than the pinna, e.g., the antenna at the back of the phantom head, the angle of the handset should be reduced. In this case, the tilt position is obtained if any point on the handset is in contact with the pinna and a second point

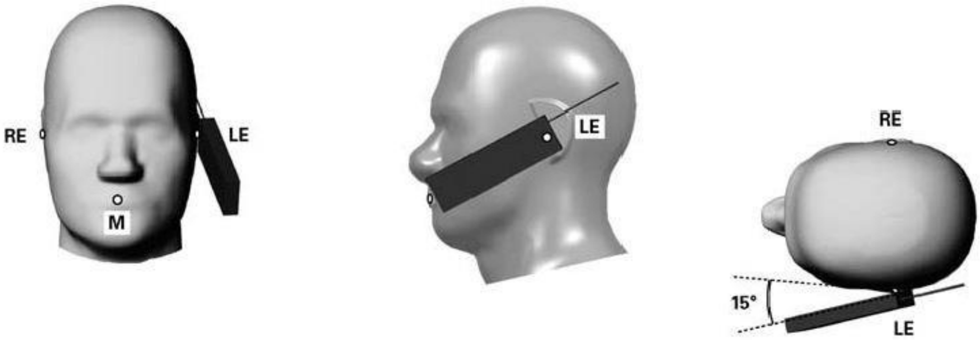


Fig 9.3.1 Tilt position. The reference points for the right ear (RE), left ear (LE), and mouth (M), which define the Reference Plane for handset positioning, are indicated.

11.4 Body Worn Accessory

Body-worn operating configurations are tested with the belt-clips and holsters attached to the device and positioned against a flat phantom in a normal use configuration (see Figure 9.4). Per KDB648474 D04v01r03, body-worn accessory exposure is typically related to voice mode operations when handsets are carried in body-worn accessories. The body-worn accessory procedures in FCC KDB 447498 D01v06 should be used to test for body-worn accessory SAR compliance, without a headset connected to it. This enables the test results for such configuration to be compatible with that required for hotspot mode when the body-worn accessory test separation distance is greater than or equal to that required for hotspot mode, when applicable. When the reported SAR for body-worn accessory, measured without a headset connected to the handset is > 1.2 W/kg, the highest reported SAR configuration for that wireless mode and frequency band should be repeated for that body-worn accessory with a handset attached to the handset.

Accessories for body-worn operation configurations are divided into two categories: those that do not contain metallic components and those that do contain metallic components and those that do contain metallic components. When multiple accessories that do not contain metallic components are supplied with the device, the device is tested with only the accessory that dictates the closest spacing to the body. Then multiple accessories that contain metallic components are test with the device with each accessory. If multiple accessories share an identical metallic component (i.e. the same metallic belt-chip used with different holsters with no other metallic components) only the accessory that dictates the closest spacing to the body is tested.

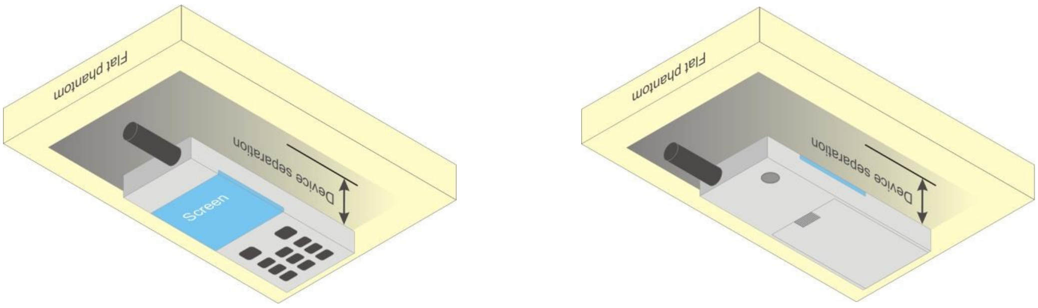


Fig 9.4 Body Worn Position

11.5 Product Specific

For smart phones with a display diagonal dimension > 15.0 cm or an overall diagonal dimension > 16.0 cm that provide similar mobile web access and multimedia support found in mini-tablets or UMPC mini-tablets that support voice calls next to the ear, According to KDB648474 D04v01r03, the following phablet procedures should be applied to evaluate SAR compliance for each applicable wireless modes and frequency band. Devices marketed as phablets, regardless of form factors and operating characteristics must be tested as a phablet to determine SAR compliance

1. The normally required head and body-worn accessory SAR test procedures for handsets, including hotspot mode, must be applied.

2. The UMPC mini-tablet procedures must also be applied to test the SAR of all surfaces and edges with an antenna located at ≤ 25 mm from that surface or edge, in direct contact with a flat phantom, for 10-g extremity SAR according to the body-equivalent tissue dielectric parameters in KDB 865664 to address interactive hand use exposure conditions.6 The UMPC mini-tablet 1-g SAR at 5 mm is not required. When hotspot mode applies, 10-g extremity SAR is required only for the surfaces and edges with hotspot mode 1-g reported SAR > 1.2 W/kg.

11.6 Wireless Router

Some battery-operated handsets have the capability to transmit and receive user through simultaneous transmission of WIFI simultaneously with a separate licensed transmitter. The FCC has provided guidance in FCC KDB Publication 941225 D06 v02r01 where SAR test considerations for handsets (L x W ≥ 9 cm x 5 cm) are based on a composite test separation distance of 10mm from the front, back and edges of the device containing transmitting antennas within 2.5cm of their edges, determined form general mixed use conditions for this type of devices. Since the hotspot SAR results may overlap with the body-worn accessory SAR requirements, the more conservative configurations can be considered, thus excluding some body-worn accessory SAR tests.

When the user enables the personal wireless router functions for the handset, actual operations include simultaneous transmission of both the WIFI transmitter and another licensed transmitter. Both transmitters often do not transmit at the same transmitting frequency and thus cannot be evaluated for SAR under actual use conditions due to the limitations of the SAR assessment probes. Therefore, SAR must be evaluated for each frequency transmission and mode separately and spatially summed with the WIFI transmitter according to FCC KDB Publication 447498 D01v06 publication procedures. The “Portable Hotspot” feature on the handset was NOT activated during SAR assessments, to ensure the SAR measurements were evaluated for a single transmission frequency RF signal at a time.

12. Conducted RF Output Power (Unit: dBm)

<LTE Conducted Power>

General Note:

1. Anritsu MT8820C base station simulator was used to setup the connection with EUT; the frequency band, channel bandwidth, RB allocation configuration, modulation type are set in the base station simulator to configure EUT transmitting at maximum power and at different configurations which are requested to be reported to FCC, for conducted power measurement and SAR testing.
2. Per KDB 941225 D05v02r05, when a properly configured base station simulator is used for the SAR and power measurements, spectrum plots for each RB allocation and offset configuration is not required.
3. Per KDB 941225 D05v02r05, 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 for RB offsets at the upper edge, middle and lower edge of each required test channel.
4. Per KDB 941225 D05v02r05, 50% RB allocation for QPSK SAR testing follows 1RB QPSK allocation procedure.
5. Per KDB 941225 D05v02r05, 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 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.
6. Per KDB 941225 D05v02r05, 16QAM output power for each RB allocation configuration is > not ½ dB higher than the same configuration in QPSK and the reported SAR for the QPSK configuration is ≤ 1.45 W/kg; Per KDB 941225 D05v02r05, 16QAM SAR testing is not required.
7. Per KDB 941225 D05v02r05, Smaller bandwidth output power for each RB allocation configuration is > not ½ dB higher than the same configuration in the largest supported bandwidth, and the reported SAR for the largest supported bandwidth is ≤ 1.45 W/kg; Per KDB 941225 D05v02r05, smaller bandwidth SAR testing is not required.
8. For LTE B5 the maximum bandwidth does not support three non-overlapping channels, per KDB 941225 D05v02r05, when a device supports overlapping channel assignment in a channel bandwidth configuration, the middle channel of the group of overlapping channels should be selected for testing.

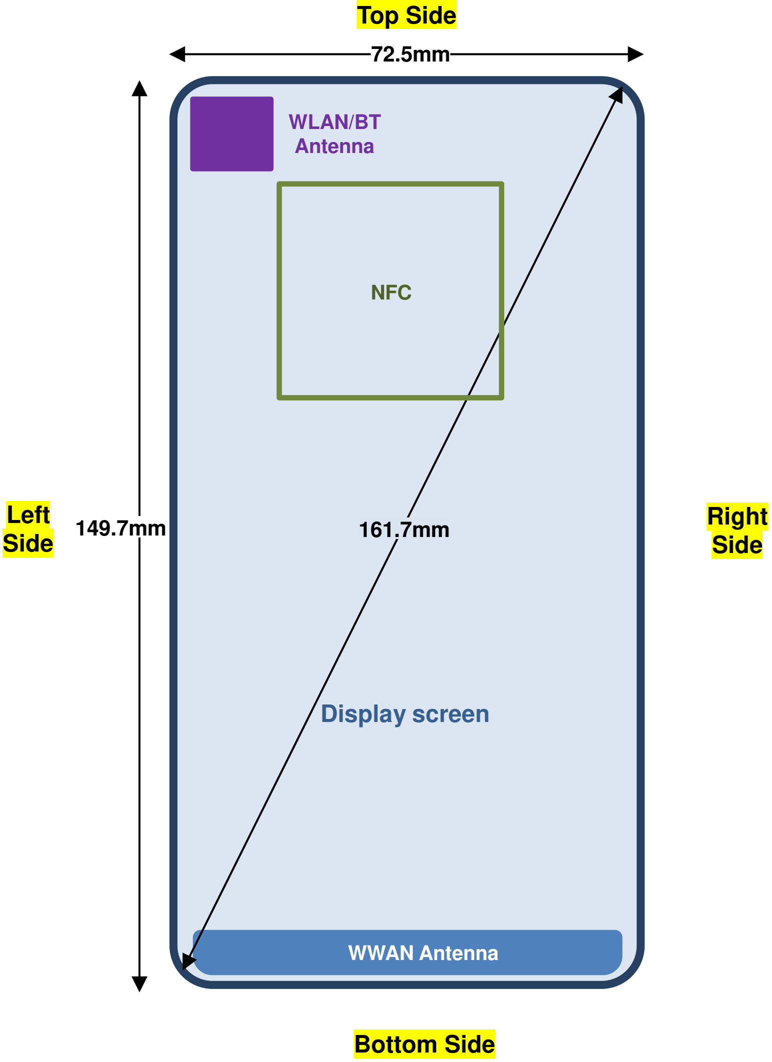
<LTE Band 5>

BW [MHz]	Modulation	RB Size	RB Offset	Power Low Ch. / Freq.	Power Middle Ch. / Freq.	Power High Ch. / Freq.	Tune-up limit (dBm)	MPR (dB)
Channel				20450	20525	20600		
Frequency (MHz)				829	836.5	844		
10	QPSK	1	0	22.97	23.04	22.90	24	0
10	QPSK	1	25	23.60	23.61	23.55		
10	QPSK	1	49	23.02	23.46	23.07		
10	QPSK	25	0	22.40	22.38	22.38	23	1
10	QPSK	25	12	22.38	22.33	22.34		
10	QPSK	25	25	22.32	22.40	22.27		
10	QPSK	50	0	22.46	22.44	22.34		
10	16QAM	1	0	21.65	21.99	21.90	23	1
10	16QAM	1	25	21.79	21.79	21.69		
10	16QAM	1	49	21.74	21.71	21.76		
10	16QAM	25	0	21.33	21.42	21.41	22	2
10	16QAM	25	12	21.51	21.38	21.30		
10	16QAM	25	25	21.39	21.43	21.29		
10	16QAM	50	0	21.48	21.40	21.37		
Channel				20425	20525	20625	Tune-up limit (dBm)	MPR (dB)
Frequency (MHz)				826.5	836.5	846.5		
5	QPSK	1	0	22.99	23.02	23.14	24	0
5	QPSK	1	12	23.56	23.43	23.50		
5	QPSK	1	24	23.17	23.28	22.92		
5	QPSK	12	0	22.37	22.33	22.23	23	1
5	QPSK	12	7	22.47	22.43	22.32		
5	QPSK	12	13	22.38	22.35	22.24		
5	QPSK	25	0	22.31	22.28	22.20		
5	16QAM	1	0	21.87	21.49	22.09	23	1
5	16QAM	1	12	22.08	22.51	21.86		
5	16QAM	1	24	21.50	22.10	21.43		
5	16QAM	12	0	21.21	21.06	21.38	22	2
5	16QAM	12	7	21.29	21.37	21.41		
5	16QAM	12	13	21.31	21.18	21.31		
5	16QAM	25	0	21.23	21.45	21.46		
Channel				20415	20525	20635	Tune-up limit (dBm)	MPR (dB)
Frequency (MHz)				825.5	836.5	847.5		
3	QPSK	1	0	23.10	22.99	23.31	24	0
3	QPSK	1	8	23.25	23.08	23.25		
3	QPSK	1	14	23.11	23.06	22.97		
3	QPSK	8	0	22.37	22.47	22.46	23	1
3	QPSK	8	4	22.37	22.25	22.31		
3	QPSK	8	7	22.35	22.31	22.33		
3	QPSK	15	0	22.29	22.37	22.38		
3	16QAM	1	0	21.71	21.42	21.49	23	1
3	16QAM	1	8	22.33	21.78	21.44		
3	16QAM	1	14	21.88	21.71	21.70		
3	16QAM	8	0	21.25	21.32	21.26	22	2
3	16QAM	8	4	21.43	21.46	21.42		
3	16QAM	8	7	21.40	21.41	21.44		
3	16QAM	15	0	21.20	21.44	21.48		

Channel				20407	20525	20643	Tune-up limit (dBm)	MPR (dB)
Frequency (MHz)				824.7	836.5	848.3		
1.4	QPSK	1	0	23.18	23.23	23.20	24	0
1.4	QPSK	1	3	23.26	23.27	23.31		
1.4	QPSK	1	5	23.21	23.18	23.24		
1.4	QPSK	3	0	23.33	23.24	23.42		
1.4	QPSK	3	1	23.32	23.31	23.59		
1.4	QPSK	3	3	23.25	23.31	23.33		
1.4	QPSK	6	0	22.22	22.31	22.29	23	1
1.4	16QAM	1	0	21.80	21.64	21.65	23	1
1.4	16QAM	1	3	21.61	22.06	22.02		
1.4	16QAM	1	5	21.87	21.96	21.93		
1.4	16QAM	3	0	22.16	22.02	22.15		
1.4	16QAM	3	1	22.17	22.47	22.14		
1.4	16QAM	3	3	22.34	22.17	22.17		
1.4	16QAM	6	0	21.26	21.20	21.16	22	2

13. Antenna Location

<Mobile Phone>



Front View

Distance of the Antenna to the EUT surface/edge						
Antennas	Back	Front	Top Side	Bottom Side	Right Side	Left Side
WWAN Main	≤ 25mm	≤ 25mm	>25mm	≤ 25mm	≤ 25mm	≤ 25mm
BT&WLAN	≤ 25mm	≤ 25mm	≤ 25mm	>25mm	>25mm	≤ 25mm

Positions for SAR tests; Hotspot mode						
Antennas	Back	Front	Top Side	Bottom Side	Right Side	Left Side
WWAN Main	Yes	Yes	No	Yes	Yes	Yes
BT&WLAN	Yes	Yes	Yes	No	No	Yes

General Note:

1. Referring to KDB 941225 D06 v02r01, when the overall device length and width are ≥ 9cm*5cm, the test distance is 10 mm. SAR must be measured for all sides and surfaces with a transmitting antenna located within 25mm from that surface or edge

14. SAR Test Results

General Note:

1. Per KDB 447498 D01v06, the reported SAR is the measured SAR value adjusted for maximum tune-up tolerance.
    a. Tune-up scaling Factor = tune-up limit power (mW) / EUT RF power (mW), where tune-up limit is the maximum rated power among all production units.
    b. For WWAN: Reported SAR(W/kg)= Measured SAR(W/kg)*Tune-up Scaling Factor
2. Per KDB 447498 D01v06, for each exposure position, testing of other required channels within the operating mode of a frequency band is not required when the *reported* 1-g or 10-g SAR for the mid-band or highest output power channel is:
    - ≤ 0.8 W/kg or 2.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≤ 100 MHz
    - ≤ 0.6 W/kg or 1.5 W/kg, for 1-g or 10-g respectively, when the transmission band is between 100 MHz and 200 MHz
    - ≤ 0.4 W/kg or 1.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≥ 200 MHz
3. Per KDB 865664 D01v01r04, for each frequency band, repeated SAR measurement is required only when the measured SAR is ≥0.8W/kg.
4. Per KDB 648474 D04v01r03, when the reported SAR for a body-worn accessory measured without a headset connected to the handset is ≤ 1.2 W/kg, SAR testing with a headset connected to the handset is not required.

LTE Note:

1. Per KDB 941225 D05v02r05, 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 for RB offsets at the upper edge, middle and lower edge of each required test channel.
2. Per KDB 941225 D05v02r05, 50% RB allocation for QPSK SAR testing follows 1RB QPSK allocation procedure.
3. Per KDB 941225 D05v02r05, 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 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.
4. Per KDB 941225 D05v02r05, 16QAM output power for each RB allocation configuration is > not ½ dB higher than the same configuration in QPSK and the reported SAR for the QPSK configuration is ≤ 1.45 W/kg; Per KDB 941225 D05v02r05, 16QAM SAR testing is not required.
5. Per KDB 941225 D05v02r05, Smaller bandwidth output power for each RB allocation configuration is > not ½ dB higher than the same configuration in the largest supported bandwidth, and the reported SAR for the largest supported bandwidth is ≤ 1.45 W/kg; Per KDB 941225 D05v02r05, smaller bandwidth SAR testing is not required.
6. For LTE B5 the maximum bandwidth does not support three non-overlapping channels, per KDB 941225 D05v02r05, when a device supports overlapping channel assignment in a channel bandwidth configuration, the middle channel of the group of overlapping channels should be selected for testing.

14.1 Head SAR

<LTE SAR>

Plot No.	Band	BW (MHz)	Modulation	RB Size	RB offset	Test Position	Gap (mm)	Ch.	Freq. (MHz)	Average Power (dBm)	Tune-Up Limit (dBm)	Tune-up Scaling Factor	Power Drift (dB)	Measured 1g SAR (W/kg)	Reported 1g SAR (W/kg)
01	LTE Band 5	10M	QPSK	1	25	Right Cheek	0mm	20525	836.5	23.61	24.00	1.094	-0.05	0.167	0.183
	LTE Band 5	10M	QPSK	25	25	Right Cheek	0mm	20525	836.5	22.40	23.00	1.148	-0.07	0.139	0.160
	LTE Band 5	10M	QPSK	1	25	Right Tilted	0mm	20525	836.5	23.61	24.00	1.094	-0.13	0.087	0.095
	LTE Band 5	10M	QPSK	25	25	Right Tilted	0mm	20525	836.5	22.40	23.00	1.148	0.03	0.067	0.077
	LTE Band 5	10M	QPSK	1	25	Left Cheek	0mm	20525	836.5	23.61	24.00	1.094	0.14	0.154	0.168
	LTE Band 5	10M	QPSK	25	25	Left Cheek	0mm	20525	836.5	22.40	23.00	1.148	-0.05	0.115	0.132
	LTE Band 5	10M	QPSK	1	25	Left Tilted	0mm	20525	836.5	23.61	24.00	1.094	-0.12	0.089	0.097
	LTE Band 5	10M	QPSK	25	25	Left Tilted	0mm	20525	836.5	22.40	23.00	1.148	0.09	0.068	0.078

14.2 Hotspot SAR

<LTE SAR>

Plot No.	Band	BW (MHz)	Modulation	RB Size	RB offset	Test Position	Gap (mm)	Ch.	Freq. (MHz)	Average Power (dBm)	Tune-Up Limit (dBm)	Tune-up Scaling Factor	Power Drift (dB)	Measured 1g SAR (W/kg)	Reported 1g SAR (W/kg)
02	LTE Band 5	10M	QPSK	1	25	Front	10mm	20525	836.5	23.61	24.00	1.094	-0.11	0.315	0.345
	LTE Band 5	10M	QPSK	25	25	Front	10mm	20525	836.5	22.40	23.00	1.148	-0.03	0.253	0.290
	LTE Band 5	10M	QPSK	1	25	Back	10mm	20525	836.5	23.61	24.00	1.094	0.06	0.174	0.190
	LTE Band 5	10M	QPSK	25	25	Back	10mm	20525	836.5	22.40	23.00	0.869	0.08	0.137	0.119
	LTE Band 5	10M	QPSK	1	25	Left Side	10mm	20525	836.5	23.61	24.00	1.445	-0.14	0.162	0.234
	LTE Band 5	10M	QPSK	25	25	Left Side	10mm	20525	836.5	22.40	23.00	1.148	-0.11	0.119	0.137
	LTE Band 5	10M	QPSK	1	25	Right Side	10mm	20525	836.5	23.61	24.00	1.094	0.01	0.286	0.313
	LTE Band 5	10M	QPSK	25	25	Right Side	10mm	20525	836.5	22.40	23.00	1.148	-0.09	0.217	0.249
	LTE Band 5	10M	QPSK	1	25	Bottom Side	10mm	20525	836.5	23.61	24.00	1.094	-0.06	0.146	0.160
	LTE Band 5	10M	QPSK	25	25	Bottom Side	10mm	20525	836.5	22.40	23.00	1.148	-0.09	0.115	0.132

14.3 Body Worn Accessory SAR

<LTE SAR>

Plot No.	Band	BW (MHz)	Modulation	RB Size	RB offset	Test Position	Gap (mm)	Ch.	Freq. (MHz)	Average Power (dBm)	Tune-Up Limit (dBm)	Tune-up Scaling Factor	Power Drift (dB)	Measured 1g SAR (W/kg)	Reported 1g SAR (W/kg)
03	LTE Band 5	10M	QPSK	1	25	Front	15mm	20525	836.5	23.61	24.00	1.094	-0.19	0.246	0.269
	LTE Band 5	10M	QPSK	25	25	Front	15mm	20525	836.5	22.40	23.00	1.148	-0.01	0.193	0.222
	LTE Band 5	10M	QPSK	1	25	Back	15mm	20525	836.5	23.61	24.00	1.094	0.18	0.154	0.168
	LTE Band 5	10M	QPSK	25	25	Back	15mm	20525	836.5	22.40	23.00	1.148	-0.1	0.128	0.147

15. Simultaneous Transmission Analysis

NO.	Simultaneous Transmission Configurations	Portable Handset			
		Head	Body-worn	Hotspot	Product Specific
1.	GSM Voice + WLAN2.4GHz	Yes	Yes		Yes
2.	GPRS/EDGE + WLAN2.4GHz	Yes	Yes	Yes	Yes
3.	WCDMA + WLAN2.4GHz	Yes	Yes	Yes	Yes
4.	LTE + WLAN2.4GHz	Yes	Yes	Yes	Yes
5.	GSM Voice + Bluetooth		Yes		Yes
6.	GPRS/EDGE + Bluetooth		Yes		Yes
7.	WCDMA+ Bluetooth		Yes		Yes
8.	LTE + Bluetooth		Yes		Yes
9.	GSM Voice + WLAN5GHz	Yes	Yes		Yes
10.	GPRS/EDGE + WLAN5GHz	Yes	Yes	Yes	Yes
11.	WCDMA + WLAN5GHz	Yes	Yes	Yes	Yes
12.	LTE + WLAN5GHz	Yes	Yes	Yes	Yes

General Note:

1. This report only has LTE Band 5 test record, the other frequency test records please refer to Sporton FCC SAR Test Report, Report No.: FA712016 as Appendix D and the all testing results are used for simultaneous transmission analysis.
2. This device 2.4GHz / 5.2GHz / 5.8GHz WLAN support Hotspot operation.
3. The worst case WLAN reported SAR for each configuration was used for SAR summation. Therefore, the following summations represent the absolute worst cases for simultaneous transmission with WLAN.
4. WLAN and Bluetooth share the same antenna, and cannot transmit simultaneously.
5. EUT will choose either WLAN 2.4GHz or WLAN 5GHz according to the network signal condition; therefore, 2.4GHz WLAN and 5GHz WLAN will not operate simultaneously at any moment.
6. The Scaled SAR summation is calculated based on the same configuration and test position.
7. Per KDB 447498 D01v06, simultaneous transmission SAR is compliant if,
    i) Scalar SAR summation < 1.6W/kg.
    ii) SPLSR = (SAR1 + SAR2)^1.5 / (min. separation distance, mm), and the peak separation distance is determined from the square root of [(x1-x2)2 + (y1-y2)2 + (z1-z2)2], where (x1, y1, z1) and (x2, y2, z2) are the coordinates of the extrapolated peak SAR locations in the zoom scan.
    iii) If SPLSR ≤ 0.04, simultaneously transmission SAR measurement is not necessary.
    iv) Simultaneously transmission SAR measurement, and the reported multi-band SAR < 1.6W/kg.
8. For simultaneous transmission analysis, Bluetooth SAR is estimated per KDB 447498 D01v06 based on the formula below.
    i) (*max. power of channel, including tune-up tolerance, mW*)/(*min. test separation distance, mm*)]·[√f(GHz)/*x*] W/kg for *test separation distances* ≤ 50 mm; where *x* = 7.5 for 1-g SAR, and *x* = 18.75 for 10-g SAR.
    ii) When the minimum separation distance is < 5mm, the distance is used 5mm to determine SAR test exclusion.
    iii) 0.4 W/kg for 1-g SAR and 1.0 W/kg for 10-g SAR, when the *test separation distances* is > 50 mm.

Bluetooth Max Power	Exposure Position	Body worn
	Test separation	15 mm
8dBm	Estimated SAR (W/kg)	0.084 W/kg

15.1 Head Exposure Conditions

WWAN Band		Exposure Position	1 WWAN 1g SAR (W/kg)	2 2.4GHz WLAN 1g SAR (W/kg)	3 5GHz WLAN 1g SAR (W/kg)	1+2 Summed 1g SAR (W/kg)	1+3 Summed 1g SAR (W/kg)
GSM	GSM850	Right Cheek	0.188	0.795	0.416	**0.983**	**0.604**
		Right Tilted	0.091	0.580	0.407	**0.671**	**0.498**
		Left Cheek	0.180	0.235	0.211	**0.415**	**0.391**
		Left Tilted	0.106	0.183	0.225	**0.289**	**0.331**
	GSM1900	Right Cheek	0.085	0.795	0.416	**0.880**	**0.501**
		Right Tilted	0.068	0.580	0.407	**0.648**	**0.475**
		Left Cheek	0.182	0.235	0.211	**0.417**	**0.393**
		Left Tilted	0.052	0.183	0.225	**0.235**	**0.277**
WCDMA	WCDMA II	Right Cheek	0.143	0.795	0.416	**0.938**	**0.559**
		Right Tilted	0.107	0.580	0.407	**0.687**	**0.514**
		Left Cheek	0.285	0.235	0.211	**0.520**	**0.496**
		Left Tilted	0.082	0.183	0.225	**0.265**	**0.307**
	WCDMA V	Right Cheek	0.209	0.795	0.416	**1.004**	**0.625**
		Right Tilted	0.096	0.580	0.407	**0.676**	**0.503**
		Left Cheek	0.194	0.235	0.211	**0.429**	**0.405**
		Left Tilted	0.119	0.183	0.225	**0.302**	**0.344**
LTE	LTE Band 5	Right Cheek	0.183	0.795	0.416	**0.978**	**0.599**
		Right Tilted	0.095	0.580	0.407	**0.675**	**0.502**
		Left Cheek	0.168	0.235	0.211	**0.403**	**0.379**
		Left Tilted	0.097	0.183	0.225	**0.280**	**0.322**
	LTE Band 7	Right Cheek	0.171	0.795	0.416	**0.966**	**0.587**
		Right Tilted	0.038	0.580	0.407	**0.618**	**0.445**
		Left Cheek	0.136	0.235	0.211	**0.371**	**0.347**
		Left Tilted	0.083	0.183	0.225	**0.266**	**0.308**
	LTE Band 38	Right Cheek	0.080	0.795	0.416	**0.875**	**0.496**
		Right Tilted	0.017	0.580	0.407	**0.597**	**0.424**
		Left Cheek	0.053	0.235	0.211	**0.288**	**0.264**
		Left Tilted	0.035	0.183	0.225	**0.218**	**0.260**

15.2 Hotspot Exposure Conditions

WWAN Band		Exposure Position	1 WWAN 1g SAR (W/kg)	2 2.4GHz WLAN 1g SAR (W/kg)	3 5GHz WLAN 1g SAR (W/kg)	1+2 Summed 1g SAR (W/kg)	1+3 Summed 1g SAR (W/kg)
GSM	GSM850	Front	0.364	0.184	0.077	**0.548**	**0.441**
		Back	0.211	0.055	0.008	**0.266**	**0.219**
		Left side	0.138	0.056	0.020	**0.194**	**0.158**
		Right side	0.256			**0.256**	**0.256**
		Top side		0.061	0.046	**0.061**	**0.046**
		Bottom side	0.159			**0.159**	**0.159**
	GSM1900	Front	1.190	0.184	0.077	**1.374**	**1.267**
		Back	0.169	0.055	0.008	**0.224**	**0.177**
		Left side	0.266	0.056	0.020	**0.322**	**0.286**
		Right side	0.010			**0.010**	**0.010**
		Top side		0.061	0.046	**0.061**	**0.046**
		Bottom side	0.712			**0.712**	**0.712**
WCDMA	WCDMA II	Front	0.933	0.184	0.077	**1.117**	**1.010**
		Back	0.183	0.055	0.008	**0.238**	**0.191**
		Left side	0.315	0.056	0.020	**0.371**	**0.335**
		Right side	0.015			**0.015**	**0.015**
		Top side		0.061	0.046	**0.061**	**0.046**
		Bottom side	0.913			**0.913**	**0.913**
	WCDMA V	Front	0.396	0.184	0.077	**0.580**	**0.473**
		Back	0.224	0.055	0.008	**0.279**	**0.232**
		Left side	0.163	0.056	0.020	**0.219**	**0.183**
		Right side	0.292			**0.292**	**0.292**
		Top side		0.061	0.046	**0.061**	**0.046**
		Bottom side	0.187			**0.187**	**0.187**
LTE	LTE Band 5	Front	0.345	0.184	0.077	**0.529**	**0.422**
		Back	0.190	0.055	0.008	**0.245**	**0.198**
		Left side	0.234	0.056	0.020	**0.290**	**0.254**
		Right side	0.313			**0.313**	**0.313**
		Top side		0.061	0.046	**0.061**	**0.046**
		Bottom side	0.160			**0.160**	**0.160**
	LTE Band 7	Front	0.464	0.184	0.077	**0.648**	**0.541**
		Back	0.379	0.055	0.008	**0.434**	**0.387**
		Left side	0.089	0.056	0.020	**0.145**	**0.109**
		Right side	0.417			**0.417**	**0.417**
		Top side		0.061	0.046	**0.061**	**0.046**
		Bottom side	0.445			**0.445**	**0.445**
	LTE Band 38	Front	0.218	0.184	0.077	**0.402**	**0.295**
		Back	0.114	0.055	0.008	**0.169**	**0.122**
		Left side	0.036	0.056	0.020	**0.092**	**0.056**
		Right side	0.146			**0.146**	**0.146**
		Top side		0.061	0.046	**0.061**	**0.046**
		Bottom side	0.154			**0.154**	**0.154**

15.3 Product Specific

1	2	3	1+2 Summed 10g SAR (W/kg)	1+3 Summed 10g SAR (W/kg)
WWAN	2.4GHz WLAN	5GHz WLAN		
10g SAR (W/kg)	10g SAR (W/kg)	10g SAR (W/kg)		
-	-	0.184	**-**	**0.184**

General Note:

1. The worst case 5GHz WLAN results are taking from 5.3GHz (U-NII-2A) and 5.5GHz (U-NII-2C) perform product specific simultaneous transmission analysis.
2. According to KDB 648474 D04v01r03, for WWAN and 2.4GHz WLAN SAR (“-“) was excluded, due to Body SAR was < 1.2W/kg.

15.4 Body-Worn Accessory Exposure Conditions

WWAN Band		Exposure Position	1	2	3	4	1+2 Summed 1g SAR (W/kg)	1+3 Summed 1g SAR (W/kg)	1+4 Summed 1g SAR (W/kg)
			WWAN	2.4GHz WLAN	5GHz WLAN	Bluetooth			
			1g SAR (W/kg)	1g SAR (W/kg)	1g SAR (W/kg)	Estimated 1g SAR (W/kg)			
GSM	GSM850	Front	0.236	0.062	0.026	0.084	**0.298**	**0.262**	**0.320**
		Back	0.190	0.030	0.001	0.084	**0.220**	**0.191**	**0.274**
	GSM1900	Front	0.335	0.062	0.026	0.084	**0.397**	**0.361**	**0.419**
		Back	0.103	0.030	0.001	0.084	**0.133**	**0.104**	**0.187**
WCDMA	WCDMA II	Front	0.518	0.062	0.026	0.084	**0.580**	**0.544**	**0.602**
		Back	0.134	0.030	0.001	0.084	**0.164**	**0.135**	**0.218**
	WCDMA V	Front	0.260	0.062	0.026	0.084	**0.322**	**0.286**	**0.344**
		Back	0.204	0.030	0.001	0.084	**0.234**	**0.205**	**0.288**
LTE	LTE Band 5	Front	0.269	0.062	0.026	0.084	**0.331**	**0.295**	**0.353**
		Back	0.168	0.030	0.001	0.084	**0.198**	**0.169**	**0.252**
	LTE Band 7	Front	0.246	0.062	0.026	0.084	**0.308**	**0.272**	**0.330**
		Back	0.202	0.030	0.001	0.084	**0.232**	**0.203**	**0.286**
	LTE Band 38	Front	0.111	0.062	0.026	0.084	**0.173**	**0.137**	**0.195**
		Back	0.059	0.030	0.001	0.084	**0.089**	**0.060**	**0.143**

Test Engineer : Iran Wang and Tommy Chen

16. Uncertainty Assessment

The component of uncertainly may generally be categorized according to the methods used to evaluate them. The evaluation of uncertainly by the statistical analysis of a series of observations is termed a Type An evaluation of uncertainty. The evaluation of uncertainty by means other than the statistical analysis of a series of observation is termed a Type B evaluation of uncertainty. Each component of uncertainty, however evaluated, is represented by an estimated standard deviation, termed standard uncertainty, which is determined by the positive square root of the estimated variance.

A Type A evaluation of standard uncertainty may be based on any valid statistical method for treating data. This includes calculating the standard deviation of the mean of a series of independent observations; using the method of least squares to fit a curve to the data in order to estimate the parameter of the curve and their standard deviations; or carrying out an analysis of variance in order to identify and quantify random effects in certain kinds of measurement.

A type B evaluation of standard uncertainty is typically based on scientific judgment using all of the relevant information available. These may include previous measurement data, experience, and knowledge of the behavior and properties of relevant materials and instruments, manufacture's specification, data provided in calibration reports and uncertainties assigned to reference data taken from handbooks. Broadly speaking, the uncertainty is either obtained from an outdoor source or obtained from an assumed distribution, such as the normal distribution, rectangular or triangular distributions indicated in table below.

Uncertainty Distributions	Normal	Rectangular	Triangular	U-Shape
Multi-plying Factor[(a)]	$1/k^{(b)}$	$1/\sqrt{3}$	$1/\sqrt{6}$	$1/\sqrt{2}$

(a) standard uncertainty is determined as the product of the multiplying factor and the estimated range of variations in the measured quantity

(b) κ is the coverage factor

Table 16.1. Standard Uncertainty for Assumed Distribution

The combined standard uncertainty of the measurement result represents the estimated standard deviation of the result. It is obtained by combining the individual standard uncertainties of both Type A and Type B evaluation using the usual “root-sum-squares” (RSS) methods of combining standard deviations by taking the positive square root of the estimated variances.

Expanded uncertainty is a measure of uncertainty that defines an interval about the measurement result within which the measured value is confidently believed to lie. It is obtained by multiplying the combined standard uncertainty by a coverage factor. Typically, the coverage factor ranges from 2 to 3. Using a coverage factor allows the true value of a measured quantity to be specified with a defined probability within the specified uncertainty range. For purpose of this document, a coverage factor two is used, which corresponds to confidence interval of about 95 %. The DASY uncertainty Budget is shown in the following tables.

Error Description	Uncertainty Value (±%)	Probability	Divisor	(Ci) 1g	(Ci) 10g	Standard Uncertainty (1g) (±%)	Standard Uncertainty (10g) (±%)
Measurement System							
Probe Calibration	6.00	N	1	1	1	6.0	6.0
Axial Isotropy	4.70	R	1.732	0.7	0.7	1.9	1.9
Hemispherical Isotropy	9.60	R	1.732	0.7	0.7	3.9	3.9
Boundary Effects	1.00	R	1.732	1	1	0.6	0.6
Linearity	4.70	R	1.732	1	1	2.7	2.7
System Detection Limits	1.00	R	1.732	1	1	0.6	0.6
Modulation Response	4.68	R	1.732	1	1	2.7	2.7
Readout Electronics	0.30	N	1	1	1	0.3	0.3
Response Time	0.00	R	1.732	1	1	0.0	0.0
Integration Time	2.60	R	1.732	1	1	1.5	1.5
RF Ambient Noise	3.00	R	1.732	1	1	1.7	1.7
RF Ambient Reflections	3.00	R	1.732	1	1	1.7	1.7
Probe Positioner	0.40	R	1.732	1	1	0.2	0.2
Probe Positioning	2.90	R	1.732	1	1	1.7	1.7
Max. SAR Eval.	2.00	R	1.732	1	1	1.2	1.2
Test Sample Related							
Device Positioning	3.03	N	1	1	1	3.0	3.0
Device Holder	3.60	N	1	1	1	3.6	3.6
Power Drift	5.00	R	1.732	1	1	2.9	2.9
Power Scaling	0.00	R	1.732	1	1	0.0	0.0
Phantom and Setup							
Phantom Uncertainty	6.10	R	1.732	1	1	3.5	3.5
SAR correction	0.00	R	1.732	1	0.84	0.0	0.0
Liquid Conductivity Repeatability	0.03	N	1	0.78	0.71	0.0	0.0
Liquid Conductivity (target)	5.00	R	1.732	0.78	0.71	2.3	2.0
Liquid Conductivity (mea.)	2.50	R	1.732	0.78	0.71	1.1	1.0
Temp. unc. - Conductivity	3.68	R	1.732	0.78	0.71	1.7	1.5
Liquid Permittivity Repeatability	0.02	N	1	0.23	0.26	0.0	0.0
Liquid Permittivity (target)	5.00	R	1.732	0.23	0.26	0.7	0.8
Liquid Permittivity (mea.)	2.50	R	1.732	0.23	0.26	0.3	0.4
Temp. unc. - Permittivity	0.84	R	1.732	0.23	0.26	0.1	0.1
Combined Std. Uncertainty						11.6%	11.6%
Coverage Factor for 95 %						K=2	K=2
Expanded STD Uncertainty						23.2%	23.1%

Table 16.2. Uncertainty Budget for frequency range 300 MHz to 3 GHz

Error Description	Uncertainty Value (±%)	Probability	Divisor	(Ci) 1g	(Ci) 10g	Standard Uncertainty (1g) (±%)	Standard Uncertainty (10g) (±%)
Measurement System							
Probe Calibration	7.00	N	1	1	1	7.0	7.0
Axial Isotropy	4.70	R	1.732	0.7	0.7	1.9	1.9
Hemispherical Isotropy	9.60	R	1.732	0.7	0.7	3.9	3.9
Boundary Effects	2.00	R	1.732	1	1	1.2	1.2
Linearity	4.70	R	1.732	1	1	2.7	2.7
System Detection Limits	1.00	R	1.732	1	1	0.6	0.6
Modulation Response	4.68	R	1.732	1	1	2.7	2.7
Readout Electronics	0.30	N	1	1	1	0.3	0.3
Response Time	0.00	R	1.732	1	1	0.0	0.0
Integration Time	2.60	R	1.732	1	1	1.5	1.5
RF Ambient Noise	3.00	R	1.732	1	1	1.7	1.7
RF Ambient Reflections	3.00	R	1.732	1	1	1.7	1.7
Probe Positioner	0.40	R	1.732	1	1	0.2	0.2
Probe Positioning	6.70	R	1.732	1	1	3.9	3.9
Max. SAR Eval.	4.00	R	1.732	1	1	2.3	2.3
Test Sample Related							
Device Positioning	3.03	N	1	1	1	3.0	3.0
Device Holder	3.60	N	1	1	1	3.6	3.6
Power Drift	5.00	R	1.732	1	1	2.9	2.9
Power Scaling	0.00	R	1.732	1	1	0.0	0.0
Phantom and Setup							
Phantom Uncertainty	6.60	R	1.732	1	1	3.8	3.8
SAR correction	0.00	R	1.732	1	0.84	0.0	0.0
Liquid Conductivity Repeatability	0.03	N	1	0.78	0.71	0.0	0.0
Liquid Conductivity (target)	5.00	R	1.732	0.78	0.71	2.3	2.0
Liquid Conductivity (mea.)	2.50	R	1.732	0.78	0.71	1.1	1.0
Temp. unc. - Conductivity	3.68	R	1.732	0.78	0.71	1.7	1.5
Liquid Permittivity Repeatability	0.02	N	1	0.23	0.26	0.0	0.0
Liquid Permittivity (target)	5.00	R	1.732	0.23	0.26	0.7	0.8
Liquid Permittivity (mea.)	2.50	R	1.732	0.23	0.26	0.3	0.4
Temp. unc. - Permittivity	0.84	R	1.732	0.23	0.26	0.1	0.1
Combined Std. Uncertainty						12.9%	12.9%
Coverage Factor for 95 %						K=2	K=2
Expanded STD Uncertainty						25.9%	25.8%

Table 16.3. Uncertainty Budget for frequency range 3 GHz to 6 GHz

17. References

[1] FCC 47 CFR Part 2 “Frequency Allocations and Radio Treaty Matters; General Rules and Regulations”

[2] ANSI/IEEE Std. C95.1-1992, “IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz”, September 1992

[3] IEEE Std. 1528-2013, “IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques”, Sep 2013

[4] SPEAG DASY System Handbook

[5] FCC KDB 248227 D01 v02r02, “SAR Guidance for IEEE 802.11 (WiFi) Transmitters”, Oct 2015.

[6] FCC KDB 447498 D01 v06, “Mobile and Portable Device RF Exposure Procedures and Equipment Authorization Policies”, Oct 2015

[7] FCC KDB 648474 D04 v01r03, “SAR Evaluation Considerations for Wireless Handsets”, Oct 2015.

[8] FCC KDB 941225 D01 v03r01, “3G SAR MEAUREMENT PROCEDURES”, Oct 2015

[9] FCC KDB 941225 D05 v02r05, “SAR Evaluation Considerations for LTE Devices”, Dec 2015

[10] FCC KDB 941225 D06 v02r01, "SAR Evaluation Procedures for Portable Devices with Wireless Router Capabilities", Oct 2015.

[11] FCC KDB 865664 D01 v01r04, "SAR Measurement Requirements for 100 MHz to 6 GHz", Aug 2015.

[12] FCC KDB 865664 D02 v01r02, “RF Exposure Compliance Reporting and Documentation Considerations” Oct 2015.