

FCC 2.1093 SAR Report

for

LG Electronics Inc.

**222, LG-ro Jinwi-myeon, Pyeongtaek-Si, Gyeonggi-Do,
451-713, Korea**

Product Name : Notebook Computer
Model Name : 15Z980
Brand : LG
FCC ID : BEJNT-15Z980
IC : 2703H-15Z980

**Prepared by: : AUDIX Technology Corporation,
EMC Department**



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TEST REPORT CERTIFICATION

Applicant : LG Electronics Inc.
Factory : LG Electronics Nanjing New Technology Co., Ltd.
EUT Description
(1) Product : Notebook Computer
(2) Model : 15Z980
(3) Brand : LG
(4) Power Rating : DC 19V, 2.53A

Applicable Standards:

47 CFR FCC Part 2 (§2.1093)
IEEE 1528-2013

KDB 248227 D01 802.11 Wi-Fi SAR v02r02
KDB 447498 D01 General RF Exposure Guidance v06
KDB 865664 D01 SAR Measurement 100MHz to 6GHz v01r04

Audix Technology Corp. tested the equipment mentioned in accordance with the requirements set forth in the above standards. Test results indicate that the equipment tested is capable of demonstrating compliance with the requirements as documented within this report.

Audix Technology Corp. does not assume responsibility for any conclusions and generalizations drawn from the test results with regard to other specimens and samples.

Date of Report: 2017. 11. 29

Reviewed by: Annie Yu (Annie Yu/Administrator)

Approved by: Ben Cheng (Ben Cheng/Manager)

1. REVISION RECORD OF TEST REPORT

Edition No	Issued Data	Revision Summary	Report Number
0	2017. 11. 29	Original Report	EM-SR170022

2. SUMMARY OF TEST RESULTS

Mode	Highest Reported Body SAR _{1g}	Scale SAR
WLAN 2.4G	0.228 (W/kg)	0.25 (W/kg)
WLAN 5G	1.27 (W/kg)	1.31 (W/kg)
BT	0.036 (W/kg)	0.04 (W/kg)

Note: The SAR limit (SAR_{1g} 1.6 W/kg) for general population / uncontrolled exposure is specified in FCC 47 CFR part 2 (2.1093).

Highest Simultaneous Transmission SAR	Scale SAR
WLAN 2.4G+BT	0.29 (W/kg)
WLAN 5G UNII Band II-2A+BT	1.35 (W/kg)

Note: 1. The SAR limit (SAR_{1g} 1.6 W/kg) for general population / uncontrolled exposure is specified in FCC 47 CFR part 2 (2.1093).
2. It is calculated from scale SAR.
3. Pursuant to section 2.8 of KDB 865664 when measured SAR larger than 0.8W/Kg not scale SAR, thus repeat SAR is not needed.
4. The Simultaneous Transmission SAR Value=
The max Scale SAR in WLAN 2.4G + The max Scale SAR in BT, or
The max Scale SAR in WLAN 5G UNII Band II-2A + The max Scale SAR in BT

3. GENERAL INFORMATION

3.1. Description of Application

Applicant	LG Electronics Inc. 222, LG-ro, Jinwi-myeon, Pyeongtaek-si, Gyeonggi-do 451-713 Korea.
Factory	LG Electronics Nanjing New Technology Co., Ltd. No.346, Yaoxin Road, Economic & Technical Development Zone, Nanjing, China.
Product	Notebook Computer
Model	15Z980
Brand	LG

3.2. Description of EUT

Test Model	15Z980																						
Serial Number	N/A																						
Power Rating	DC 19V, 2.53A																						
RF Features	WLAN: 802.11a/b/g/n/ac Bluetooth: BT and BLE																						
Transmit Type	<table border="1"><thead><tr><th colspan="2">2.4 GHz</th></tr></thead><tbody><tr><td>802.11b</td><td>1T1R</td></tr><tr><td>802.11g</td><td>1T1R</td></tr><tr><td>802.11n-HT20</td><td>2T2R</td></tr><tr><td>802.11n-HT40</td><td>2T2R</td></tr><tr><td>BT/BLE</td><td>1T1R</td></tr></tbody></table> <table border="1"><thead><tr><th colspan="2">UNII Bands</th></tr></thead><tbody><tr><td>802.11a</td><td>1T1R</td></tr><tr><td>802.11n-HT20/ 802.11ac-VHT20</td><td>2T2R</td></tr><tr><td>802.11n-HT40/ 802.11ac-VHT40</td><td>2T2R</td></tr><tr><td>802.11ac-VHT80</td><td>2T2R</td></tr></tbody></table>	2.4 GHz		802.11b	1T1R	802.11g	1T1R	802.11n-HT20	2T2R	802.11n-HT40	2T2R	BT/BLE	1T1R	UNII Bands		802.11a	1T1R	802.11n-HT20/ 802.11ac-VHT20	2T2R	802.11n-HT40/ 802.11ac-VHT40	2T2R	802.11ac-VHT80	2T2R
2.4 GHz																							
802.11b	1T1R																						
802.11g	1T1R																						
802.11n-HT20	2T2R																						
802.11n-HT40	2T2R																						
BT/BLE	1T1R																						
UNII Bands																							
802.11a	1T1R																						
802.11n-HT20/ 802.11ac-VHT20	2T2R																						
802.11n-HT40/ 802.11ac-VHT40	2T2R																						
802.11ac-VHT80	2T2R																						
I/O Ports List	<ul style="list-style-type: none">• One SD Card Slot• One Earphone Port• Three USB 3.0 Ports• One USB Type C Port• One HDMI Port• One DC Input Port																						
Accessories	<ul style="list-style-type: none">• AC Adapter																						
Date of Receipt	2017. 11. 21																						
Date of Test	2017. 11. 23 ~ 27																						

3.4. Antenna Information

2.4G Antenna					
No.	Antenna Part Number	Manufacture	Antenna Type	Frequency (MHz)	Max Gain (dBi)
1	WA-F-LBLB-04-056 (Main)	INPAQ	FPCB	2400	1.39
2				2450	1.54
3				2500	2.06
4	WA-F-LBLB-04-056 (AUX)		FPCB	2400	1.41
5				2450	1.40
6				2500	1.83

5G Antenna					
No.	Antenna Part Number	Manufacture	Antenna Type	Frequency (MHz)	Max Gain (dBi)
1	WA-F-LBLB-04-056 (Main)	INPAQ	FPCB	5100	2.49
2				5400	2.93
3				5800	1.59
4	WA-F-LBLB-04-056 (AUX)		FPCB	5100	2.57
5				5400	2.97
6				5800	2.84

3.5. EUT Specifications Assessed in Current Report

2.4GHz		
Mode	Fundamental Range (MHz)	Channel Number
802.11b	2412-2472	13
802.11g		13
802.11n-HT20		13
802.11n-HT40	2422-2462	9
Bluetooth	2402-2480	79
BLE	2402-2480	40

5GHz			
Mode	UNII Band	Fundamental Range (MHz)	Channel Number
802.11a	I	5180-5240	4
	II-2A	5260-5320	4
	II-2C	5500-5720	12
	III	5745-5825	5
802.11n-HT20/ 802.11ac-VHT20	I	5180-5240	4
	II-2A	5260-5320	4
	II-2C	5500-5720	12
	III	5745-5825	5
802.11n-HT40/ 802.11ac-VHT40	I	5190-5230	2
	II-2A	5270-5310	2
	II-2C	5510-5710	6
	III	5755-5795	2
802.11ac-VHT80	I	5210	1
	II-2A	5290	1
	II-2C	5530-5690	3
	III	5775	1
Remark: UNII Band II (DFS Function, Slave/no In service monitor, no Ad-Hoc mode)			

Mode	Modulation	Data Rate (Mbps)
802.11b	DSSS (DBPSK/DQPSK/CCK)	Up to 11
802.11g	OFDM (BPSK/QPSK/16QAM/64QAM)	Up to 54
802.11a	OFDM (BPSK/QPSK/16QAM/64QAM)	Up to 54
802.11n-HT20	OFDM (BPSK/QPSK/16QAM/64QAM)	Up to 144.4
802.11n-HT40		Up to 300
802.11ac-VHT20	OFDM (BPSK/QPSK/16QAM/64QAM/256QAM)	Up to 173.3
802.11ac-VHT40		Up to 400
802.11ac-VHT80		Up to 866.7
Bluetooth	FHSS (GFSK, $\pi/4$ DQPSK, 8-DPSK)	1/2/3
BLE	GFSK	1

3.6. Description of Key Components

3.6.1. For the All Component Lists

Item	Vendor	Model name	Description
System	Microsoft	Windows 10 Home	---
Main Board	LG	14/15Z980 Main B/D PCB	(with Thunderbolt) Manufacturer: (1) Elec & Eltek Company (MCO) Limited (2) Hannstar Board Tech(Jiang Yin) Corp.,Ltd. (3) LG Innotek Co., Ltd.
	LG	14/15Z980 Main B/D PCB	(without Thunderbolt) Manufacturer: (1) Elec & Eltek Company (MCO) Limited (2) Hannstar Board Tech(Jiang Yin) Corp.,Ltd. (3) LG Innotek Co., Ltd.
SUB Board	LG	15Z980 WLAN SUB B/D	(with Finger Printer) Manufacturer: (1) Hannstar Board Tech(Jiang Yin) Corp.,Ltd. (2) HYUNWOO
	LG	15Z980 WLAN SUB B/D	(without Finger Printer) Manufacturer: (1) Hannstar Board Tech(Jiang Yin) Corp.,Ltd. (2) HYUNWOO
CPU (Socket: BGA1356)	Intel	i7-8550U	1.80GHz, up to 4.0GHz
	Intel	i5-8250U	1.60GHz, up to 3.4GHz
15.6" LCD Panel	LG Display	LP156WFA(SP)(G1)	Resolution: 1920 x 1080, 60Hz FHD IPSW/ Touch (AIT Including touch)
	LG Display	LP156WF9(SP)(N1)	Resolution: 1920 x 1080, 60Hz FHD IPS (Normal Non touch)
Storage (SSD)	SK hynix	HFS512G39TND-N210A BB	512GB (SATA)
	SK hynix	HFS256G39TND-N210A BB	256GB (SATA)
Memory (RAM) (On Board)	SK hynix	H5ANAG6NAMR-UHC	16GB DDR4 2400MHz * 4ea
	Samsung	K4A8G165WB-BCRC	8GB DDR4 2400MHz * 4ea
Memory (RAM)	SK hynix	HMA81GS6AFR8N-UHN0	8GB DDR4 2400MHz
	Samsung	M471A5244CB0-CRC	4GB DDR4 2400MHz

Item	Vendor	Model name	Description
Battery Pack	LG	LBS1224E	DC 7.7V, 72Wh, Typ 9450mAh
WLAN Combo Card	Intel	8265D2W	802.11a/b/g/n/ac 2.4GHz/5GHz + BT 4.2 BLE
WLAN Combo Antenna	LG (INPAQ)	WA-F-LBLB-04-056	FPCB Type Main: Black, Aux: Gray
Keyboard	LG	SN3870	Black: BL, White: BL 1
Web Camera	Lite-On	7BF109N2	With two MIC
Finger Print	SUNTEL	SFPC-L0016A(White)	---
	SUNTEL	SFPC-L0016B(Black)	---
LAN Gender (Type C to LAN)	LG	80-5946-111 (White)	10/100 Megabit Ethernet Manufacturer: SUZHOU MEC ELECTRONICS
		80-5946-101 (Black)	
	LG	GD-08MF-36-WH-LP05 (White)	10/100 Megabit Ethernet Manufacturer: ARIN TECH CO. LTD
		GD-08MF-36-BK-LP06 (Black)	
Type C to LAN: Shielded, Undetached, 0.12m			
AC Adapter	LG (Lite-on)	PA-1650-43	I/P: AC 100-240V, 50/60Hz, 1.6A, O/P: DC 19V, 3.42A
	DC Power Cord: Non-Shielded, Undetached, 1.8m, Bonded a ferrite core AC Power Cord: Non-Shielded, Detached, 1.0m (3C)		

Remark: For more detailed features description, please refer to the manufacturer's specifications or the user.

3.6.2. The EUT collocates with following worst components, which are used to establish a basic configuration of system during test:

SKU #1	
Main Board	LG, 14/15Z980 Main B/D PCB(with Thunderbolt)
SUB Board	LG, 15Z980 WLAN SUB B/D/(with Finger Printer)
CPU	Intel, i7-8550U
15.6" LCD Panel	LG Display, LP156WFA(SP)(G1)/(AIT Including touch)
Storage (SSD)	SK hynix, 512GB*2
Memory (RAM) (On Board)	SK hynix, 16GB
Memory (RAM)	SK hynix, 8G
Battery Pack	LG, LBS1224E
WLAN Combo Card	Intel, 8265D2W
WLAN Combo Antenna	LG (INPAQ), WA-F-LBLB-04-056
Keyboard	LG, SN3870
Web Camera	Lite-On, 7BF109N2
Finger Print	SUNTEL, SFPC-L0016B(Black)
LAN Gender (Type C to LAN)	LG, 80-5946-111 (White)
AC Adapter	LG (Lite-on), PA-1650-43

3.7. Test Environment

Ambient conditions in the laboratory:

Item	Require	Actual
Temperature (°C)	18-25	22 ± 2
Humidity (%RH)	30-70	48 ± 2

3.8. Description of Test Facility

Name of Test Firm	Audix Technology Corporation / EMC Department No. 53-11, Dingfu, Linkou Dist., New Taipei City 244, Taiwan Tel: +886-2-26092133 Fax: +886-2-26099303 Website : www.audixtech.com Contact e-mail: sales@audixtech.com
Accreditations	The laboratory is accredited by following organizations under ISO/IEC 17025:2005 (1) NVLAP(USA) NVLAP Lab Code 200077-0 (2) TAF(Taiwan) No. 1724 (3) FCC OET Designation No. TW1004 & TW1090
Test Facilities	(1) SAR Room

3.9. Measurement Uncertainty

DASY5 Uncertainty								
Measurement uncertainty for 300 MHz to 3 GHz averaged over 1 gram / 10 gram.								
Error Description	Uncert. value	Prob. Dist.	Div.	(ci) 1g	(ci) 10g	Std. Unc. (1g)	Std. Unc. (10g)	(vi) v _{eff}
Measurement System								
Probe Calibration	±6.0%	N	1	1	1	±6.0%	±6.0%	∞
Axial Isotropy	±4.7%	R	$\sqrt{3}$	0.7	0.7	±1.9%	±1.9%	∞
Hemispherical Isotropy	±9.6%	R	$\sqrt{3}$	0.7	0.7	±3.9%	±3.9%	∞
Boundary Effects	±1.0%	R	$\sqrt{3}$	1	1	±0.6%	±0.6%	∞
Linearity	±4.7%	R	$\sqrt{3}$	1	1	±2.7%	±2.7%	∞
System Detection Limits	±1.0%	R	$\sqrt{3}$	1	1	±0.6%	±0.6%	∞
Readout Electronics	±0.3%	N	1	1	1	±0.3%	±0.3%	∞
Response Time	±0.8%	R	$\sqrt{3}$	1	1	±0.5%	±0.5%	∞
Integration Time	±2.6%	R	$\sqrt{3}$	1	1	±1.5%	±1.5%	∞
RF Ambient Noise	±3.0%	R	$\sqrt{3}$	1	1	±1.7%	±1.7%	∞
RF Ambient Reflections	±3.0%	R	$\sqrt{3}$	1	1	±1.7%	±1.7%	∞
Probe Positioner	±0.4%	R	$\sqrt{3}$	1	1	±0.2%	±0.2%	∞
Probe Positioning	±2.9%	R	$\sqrt{3}$	1	1	±1.7%	±1.7%	∞
Max. SAR Eval.	±1.0%	R	$\sqrt{3}$	1	1	±0.6%	±0.6%	∞
Test Sample Related								
Device Positioning	±2.9%	N	1	1	1	±2.9%	±2.9%	145
Device Holder	±3.6%	N	1	1	1	±3.6%	±3.6%	5
Power Drift	±5.0%	R	$\sqrt{3}$	1	1	±2.9%	±2.9%	∞
Phantom and Setup								
Phantom Uncertainty	±4.0%	R	$\sqrt{3}$	1	1	±2.3%	±2.3%	∞
Liquid Conductivity (target)	±5.0%	R	$\sqrt{3}$	0.64	0.43	±1.8%	±1.2%	∞
Liquid Conductivity (meas.)	±2.5%	N	1	0.64	0.43	±1.6%	±1.1%	∞
Liquid Permittivity (target)	±5.0%	R	$\sqrt{3}$	0.6	0.49	±1.7%	±1.4%	∞
Liquid Permittivity (meas.)	±2.5%	N	1	0.6	0.49	±1.5%	±1.2%	∞
Combined Std. Uncertainty						±11%	±10.8%	387
Expanded STD Uncertainty						±22%	±21.5%	

4. MEASUREMENT EQUIPMENT LIST

Item	Type	Manufacturer	Model No.	Serial No.	Cal. Date	Cal. Interval
1.	Stäubli Robot TX90 XL	Stäubli	TX90	F12/5K9SA1/ A101	N/A	N/A
2.	Controller	SPEAG	CS8c	N/A	N/A	N/A
3.	SAM Twin Phantom	SPEAG	N/A	1706	N/A	N/A
4.	ELI5 Phantom	SPEAG	N/A	1170	N/A	N/A
5.	Device Holder	SPEAG	N/A	N/A	N/A	N/A
6.	Data Acquisition Electronic	SPEAG	DAE4	1337	2017. 09. 25	1 Year
7.	E-Field Probe	SPEAG	EX3DV4	3855	2017. 09. 29	1 Year
8.	SAR Software	SPEAG	DASY52	V.52.8.8.1222	N/A	N/A
9.	ENA Network Analyzer	Agilent	E5071C	Y46214331	2017. 09. 20	1 Year
10.	Signal Generator	Aglient	N5181A	MY50143917	2017. 09. 14	1 Year
11.	Power Meter	Aglient	ML2487A	MY52180007	2017. 09. 14	1 Year
12.	Power Sensor	Aglient	N8481	MY52080006	2017. 09. 14	1 Year
13.	Dipole Antenna	SPEAG	D2450V2	888	2015. 09. 28	3 Years
14.	Dipole Antenna	SPEAG	D5GHzV2	1203	2015. 10. 06	3 Years

5. SAR MEASUREMENT SYSTEM

5.1. Definition of Specific Absorption Rate (SAR)

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.

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:

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

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

SAR measurement can be related to the electrical field in the tissue by

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

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

5.2. SPEAG DASY System

DASY system consists of high precision robot, probe alignment sensor, phantom, robot controller, controlled measurement server and near-field probe. The robot includes six axes that can move to the precision position of the DASY5 software defined. The DASY software can define the area that is detected by the probe. The robot is connected to controlled box. Controlled measurement server is connected to the controlled robot box. The DAE includes amplifier, signal multiplexing, AD converter, offset measurement and surface detection. It is connected to the Electro-optical coupler (ECO). The ECO performs the conversion from the optical into digital electric signal of the DAE and transfers data to the PC.

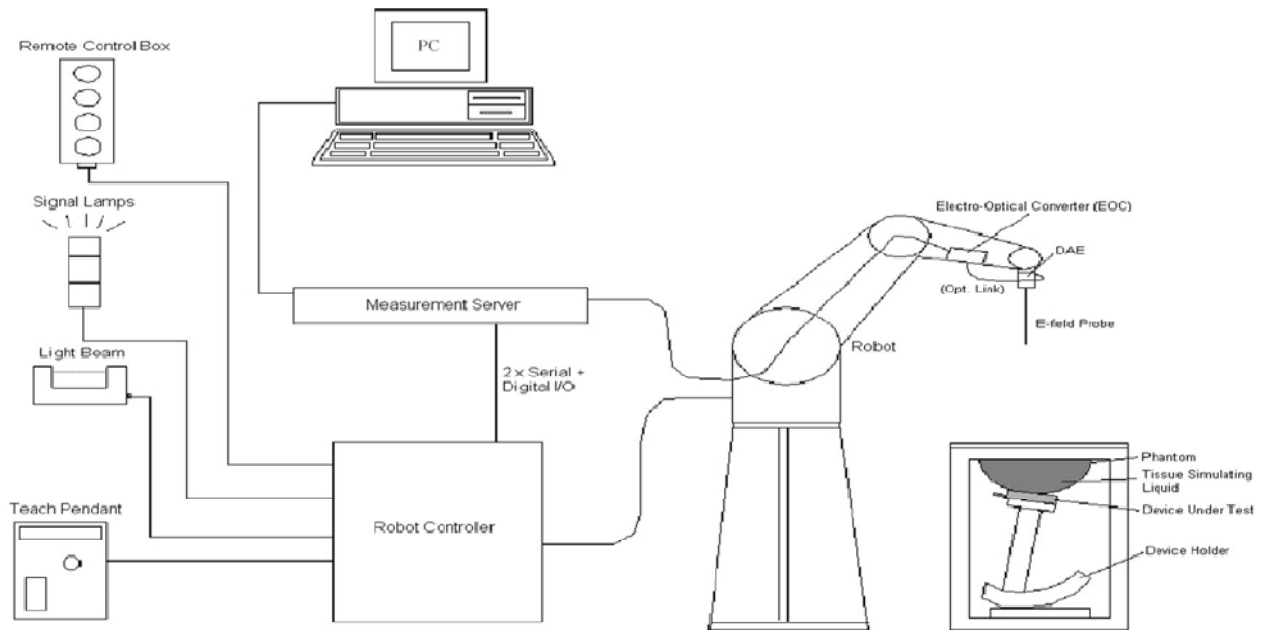
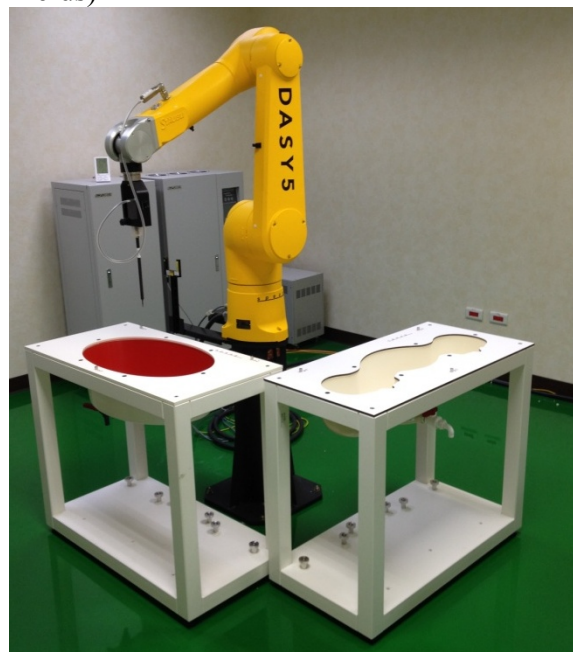


Fig-3.1 DASY System Setup


5.2.1. Robot

The DASY system uses the high precision robots from Stäubli SA (France). For the 6-axis controller system, the robot controller version (DASY5: CS8c) from Stäubli is used. The Stäubli robot series have many features that are important for our application:


- High precision (repeatability ± 0.035 mm)
- High reliability (industrial design)
- Jerk-free straight movements
- Low ELF interference (the closed metallic construction shields against motor control fields)




5.2.2. Probes


Model	Ex3DV4	
Construction	Symmetrical design with triangular core Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)	
Frequency	10 MHz to 6 GHz Linearity: ± 0.2 dB	
Directivity	± 0.3 dB in HSL (rotation around probe axis) ± 0.5 dB in tissue material (rotation normal to probe axis)	
Dynamic Range	10 μ W/g to 100 mW/g Linearity: ± 0.2 dB (noise: typically < 1 μ W/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	

5.2.3. Data Acquisition Electronics (DAE)


Model	DAE4	
Construction	Signal amplifier, multiplexer, A/D converter and control logic. Serial optical link for communication with DASY4/5 embedded system (fully remote controlled). Two step probe touch detector for mechanical surface detection and emergency robot stop.	
Measurement Range	-100 to +300 mV (16 bit resolution and two range settings: 4mV, 400mV)	
Input Offset Voltage	$< 5\mu$ V (with auto zero)	
Input Bias Current	< 50 fA	
Dimensions	60 x 60 x 68 mm	


5.2.4. Phantom

Model	Twin SAM	
Construction	The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (SAM) phantom defined in IEEE 1528 and IEC 62209-1. It enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region. A cover prevents evaporation of the liquid. Reference markings on the phantom allow the complete setup of all predefined phantom positions and measurement grids by teaching three points with the robot.	
Material	Vinylester, glass fiber reinforced (VE-GF)	
Shell Thickness	2 ± 0.2 mm (6 ± 0.2 mm at ear point)	
Dimensions	Length: 1000 mm Width: 500 mm Height: adjustable feet	
Filling Volume	approx. 25 liters	


Model	ELI	
Construction	Phantom for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30 MHz to 6 GHz. ELI is fully compatible with the IEC 62209-2 standard and all known tissue simulating liquids. ELI has been optimized regarding its performance and can be integrated into our standard phantom tables. A cover prevents evaporation of the liquid. Reference markings on the phantom allow installation of the complete setup, including all predefined phantom positions and measurement grids, by teaching three points. The phantom is compatible with all SPEAG dosimetric probes and dipoles.	
Material	Vinylester, glass fiber reinforced (VE-GF)	
Shell Thickness	2.0 ± 0.2 mm (bottom plate)	
Dimensions	Major axis: 600 mm Minor axis: 400 mm	
Filling Volume	approx. 30 liters	

5.2.5. Device Holder

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

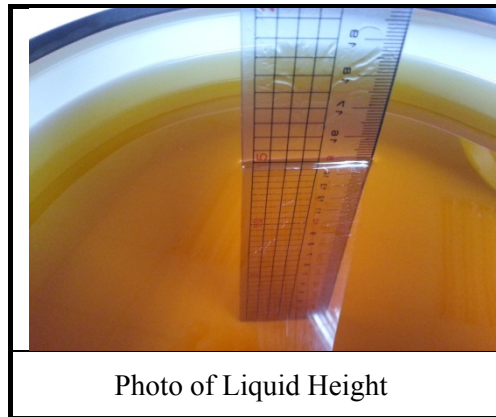
Model	Laptop Extensions Kit	
Construction	Simple but effective and easy-to-use extension for Mounting Device that facilitates the testing of larger devices according to IEC 62209-2 (e.g., laptops, cameras, etc.). It is lightweight and fits easily on the upper part of the Mounting Device in place of the phone positioner.	
Material	POM, Acrylic glass, Foam	

5.2.6. Reference Dipole

Model	System Validation Dipoles	
Construction	Symmetrical dipole with 1/4 balun. Enables measurement of feed point impedance with NWA. Matched for use near flat phantoms filled with tissue simulating solutions.	
Frequency	750 MHz to 5800 MHz	
Return Loss	> 20 dB	
Power Capability	> 100 W (f < 1GHz), > 40 W (f > 1GHz)	

5.2.7. Tissue Simulating Liquids

For SAR measurement of the field distribution inside the phantom, the phantom must be filled with homogeneous tissue simulating liquid to a depth of at least 15 cm. 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. For body SAR testing, the liquid height from the center of the flat phantom to the liquid top surface is larger than 15 cm. The nominal dielectric values of the tissue simulating liquids in the phantom and the tolerance of 5% are listed in Table-5.1.



The dielectric properties of the head tissue simulating liquids are defined in IEEE 1528 and FCC OET 65 Supplement C Appendix C. For the body tissue simulating liquids, the dielectric properties are defined in FCC OET 65 Supplement C Appendix C. The dielectric properties of the tissue simulating liquids were verified prior to the SAR evaluation using an Agilent 85070D Dielectric Probe Kit and an Agilent Network Analyzer.

Table-5.1 Targets of Tissue Simulating Liquid

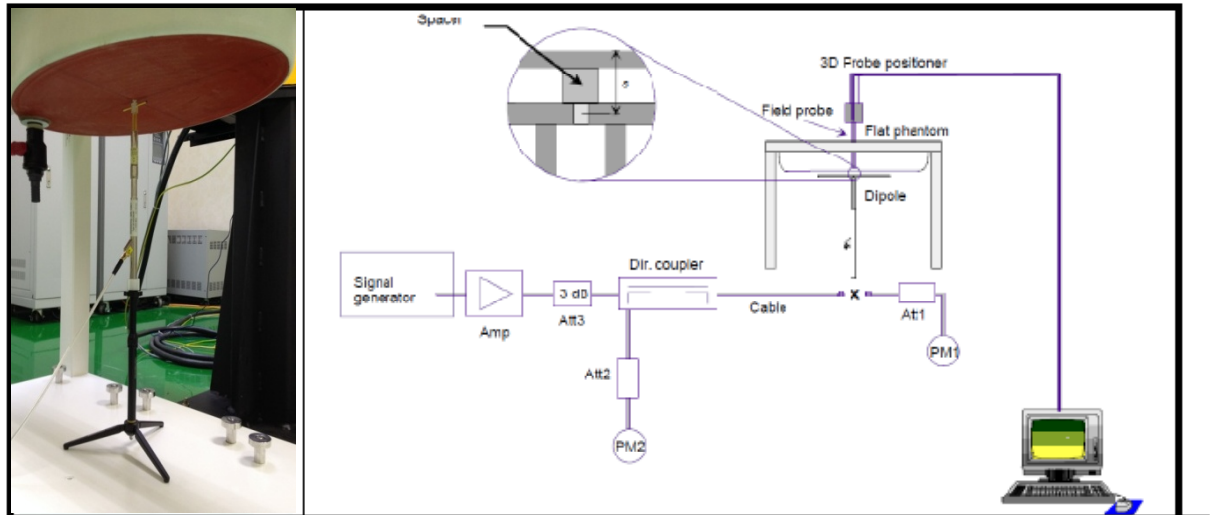
Target Frequency [MHz]	Target Permittivity (ϵ_r)	Range of $\pm 5\%$	Target Conductivity σ [s/m]	Range of $\pm 5\%$
For Head				
750	41.9	39.8 ~ 44.0	0.89	0.85 ~ 0.93
835	41.5	39.4 ~ 43.6	0.90	0.86 ~ 0.95
900	41.5	39.4 ~ 43.6	0.97	0.92 ~ 1.02
1450	40.5	38.5 ~ 42.5	1.20	1.14 ~ 1.26
1640	40.3	38.3 ~ 42.3	1.29	1.23 ~ 1.35
1750	40.1	38.1 ~ 42.1	1.37	1.30 ~ 1.44
1800	40.0	38.0 ~ 42.0	1.40	1.33 ~ 1.47
1900	40.0	38.0 ~ 42.0	1.40	1.33 ~ 1.47
2000	40.0	38.0 ~ 42.0	1.40	1.33 ~ 1.47
2300	39.5	37.5 ~ 41.5	1.67	1.59 ~ 1.75
2450	39.2	37.2 ~ 41.2	1.80	1.71 ~ 1.89
2600	39.0	37.1 ~ 41.0	1.96	1.86 ~ 2.06
3500	37.9	36.0 ~ 39.8	2.91	2.76 ~ 3.06
5200	36.0	34.2 ~ 37.8	4.66	4.43 ~ 4.89
5300	35.9	34.1 ~ 37.7	4.76	4.52 ~ 5.00
5500	35.6	33.8 ~ 37.4	4.96	4.71 ~ 5.21
5600	35.5	33.7 ~ 37.3	5.07	4.82 ~ 5.32
5800	35.3	33.5 ~ 37.1	5.27	5.01 ~ 5.53
For Body				
750	55.5	52.7 ~ 58.3	0.96	0.91 ~ 1.01
835	55.2	52.4 ~ 58.0	0.97	0.92 ~ 1.02
900	55.0	52.3 ~ 57.8	1.05	1.00 ~ 1.10
1450	54.0	51.3 ~ 56.7	1.30	1.24 ~ 1.37
1640	53.8	51.1 ~ 56.5	1.40	1.33 ~ 1.47
1750	53.4	50.7 ~ 56.1	1.49	1.42 ~ 1.56
1800	53.3	50.6 ~ 56.0	1.52	1.44 ~ 1.60
1900	53.3	50.6 ~ 56.0	1.52	1.44 ~ 1.60
2000	53.3	50.6 ~ 56.0	1.52	1.44 ~ 1.60
2300	52.9	50.3 ~ 55.5	1.81	1.72 ~ 1.90
2450	52.7	50.1 ~ 55.3	1.95	1.85 ~ 2.05
2600	52.5	49.9 ~ 55.1	2.16	2.05 ~ 2.27
3500	51.3	48.7 ~ 53.9	3.31	3.14 ~ 3.48
5200	49.0	46.6 ~ 51.5	5.30	5.04 ~ 5.57
5300	48.9	46.5 ~ 51.3	5.42	5.15 ~ 5.69
5500	48.6	46.2 ~ 51.0	5.65	5.37 ~ 5.93
5600	48.5	46.1 ~ 50.9	5.77	5.48 ~ 6.06
5800	48.2	45.8 ~ 50.6	6.00	5.70 ~ 6.30

Table-5.2 Recipes of Tissue Simulating Liquid

Tissue Type	Bactericide	DGBE	HEC	NaCl	Sucrose	Triton X-100	Water	Diethylene Glycol Mono-hexylether
For Head								
H750	0.2	-	0.2	1.5	56.0	-	42.1	-
H835	0.2	-	0.2	1.5	57.0	-	41.1	-
H900	0.2	-	0.2	1.4	58.0	-	40.2	-
H1450	-	43.3	-	0.6	-	-	56.1	-
H1640	-	45.8	-	0.5	-	-	53.7	-
H1750	-	47.0	-	0.4	-	-	52.6	-
H1800	-	44.5	-	0.3	-	-	55.2	-
H1900	-	44.5	-	0.2	-	-	55.3	-
H2000	-	44.5	-	0.1	-	-	55.4	-
H2300	-	44.9	-	0.1	-	-	55.0	-
H2450	-	45.0	-	0.1	-	-	54.9	-
H2600	-	45.1	-	0.1	-	-	54.8	-
H3500	-	8.0	-	0.2	-	20.0	71.8	-
H5G	-	-	-	-	-	17.2	65.5	17.3
For Body								
B750	0.2	-	0.2	0.8	48.8	-	50.0	-
B835	0.2	-	0.2	0.9	48.5	-	50.2	-
B900	0.2	-	0.2	0.9	48.2	-	50.5	-
B1450	-	34.0	-	0.3	-	-	65.7	-
B1640	-	32.5	-	0.3	-	-	67.2	-
B1750	-	31.0	-	0.2	-	-	68.8	-
B1800	-	29.5	-	0.4	-	-	70.1	-
B1900	-	29.5	-	0.3	-	-	70.2	-
B2000	-	30.0	-	0.2	-	-	69.8	-
B2300	-	31.0	-	0.1	-	-	68.9	-
B2450	-	31.4	-	0.1	-	-	68.5	-
B2600	-	31.8	-	0.1	-	-	68.1	-
B3500	-	28.8	-	0.1	-	-	71.1	-
B5G	-	-	-	-	-	10.7	78.6	10.7

5.3. SAR System Verification

The system check verifies that the system operates within its specifications. It is performed daily or before every SAR measurement. The system check uses normal SAR measurements in the flat section of the phantom with a matched dipole at a specified distance. The system verification setup is shown as below.



The validation dipole is placed beneath the flat phantom with the specific spacer in place. The distance spacer is touch the phantom surface with a light pressure at the reference marking and be oriented parallel to the long side of the phantom. The power meter PM1 measures the forward power at the location of the system check dipole connector. The signal generator is adjusted for the desired forward power (250 mW is used for 700 MHz to 3 GHz, 100 mW is used for 3.5 GHz to 6 GHz) at the dipole connector and the power meter PM2 is read at that level. After connecting the cable to the dipole, the signal generator is readjusted for the same reading at power meter PM2.

After system check testing, the SAR result will be normalized to 1W forward input power and compared with the reference SAR value derived from validation dipole certificate report. The deviation of system check should be within 10 %.

5.3.1. SAR System Verification Result

System Performance Check at WLAN				
Dipole Kit: D2450V2 (Body)				
Frequency [MHz]	Description	SAR [w/kg] 1g	SAR [w/kg] 10g	Tissue Temp. [°C]
2450MHz	Reference result	12.90	6.00	N/A
	± 10% window	11.610 to 14.190	5.400 to 6.600	
	2017. 11. 27	12.70	5.72	22.1
Note: All SAR values are normalized to 250mW forward power.				

System Performance Check at WLAN				
Dipole Kit: D5GHzV2 (Body)				
Frequency [MHz]	Description	SAR [w/kg] 1g	SAR [w/kg] 10g	Tissue Temp. [°C]
5200MHz	Reference result	7.69	2.14	N/A
	± 10% window	6.921 to 8.459	1.926 to 2.354	
	2017. 11. 23	8.15	2.28	22.2
Note: All SAR values are normalized to 100mW forward power.				

System Performance Check at WLAN				
Dipole Kit: D5GHzV2 (Body)				
Frequency [MHz]	Description	SAR [w/kg] 1g	SAR [w/kg] 10g	Tissue Temp. [°C]
5500MHz	Reference result	8.26	2.28	N/A
	± 10% window	7.434 to 9.086	2.052 to 2.508	
	2017. 11. 24	8.42	2.37	22.1
Note: All SAR values are normalized to 100mW forward power.				

System Performance Check at WLAN				
Dipole Kit: D5GHzV2 (Body)				
Frequency [MHz]	Description	SAR [w/kg] 1g	SAR [w/kg] 10g	Tissue Temp. [°C]
5800MHz	Reference result	7.88	2.16	N/A
	± 10% window	7.092 to 8.668	1.944 to 2.376	
	2017. 11. 25	8.32	2.25	22.3
Note: All SAR values are normalized to 100mW forward power.				

5.3.2. SAR System Check Data

Date: 11/27/2017

Test Laboratory: Audix_SAR Lab

System Check_B2450

DUT: Dipole 2450 MHz D2450V2; Type: D2450V2; Serial: D2450V2 - SN:888

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

Medium parameters used: $f = 2450$ MHz; $\sigma = 1.97$ S/m; $\epsilon_r = 51.396$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

DASY Configuration:

- Probe: EX3DV4 - SN3855; ConvF(7.65, 7.65, 7.65); Calibrated: 9/29/2017;
- Sensor-Surface: 2mm (Mechanical Surface Detection), $z = 1.0, 31.0$
- Electronics: DAE4 Sn1337; Calibrated: 9/25/2017
- Phantom: ELI v5.0; Type: QDOVA002AA; Serial: TP:1170
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

Area Scan (8x8x1): Measurement grid: $dx=10$ mm, $dy=10$ mm

Maximum value of SAR (measured) = 17.0 W/kg

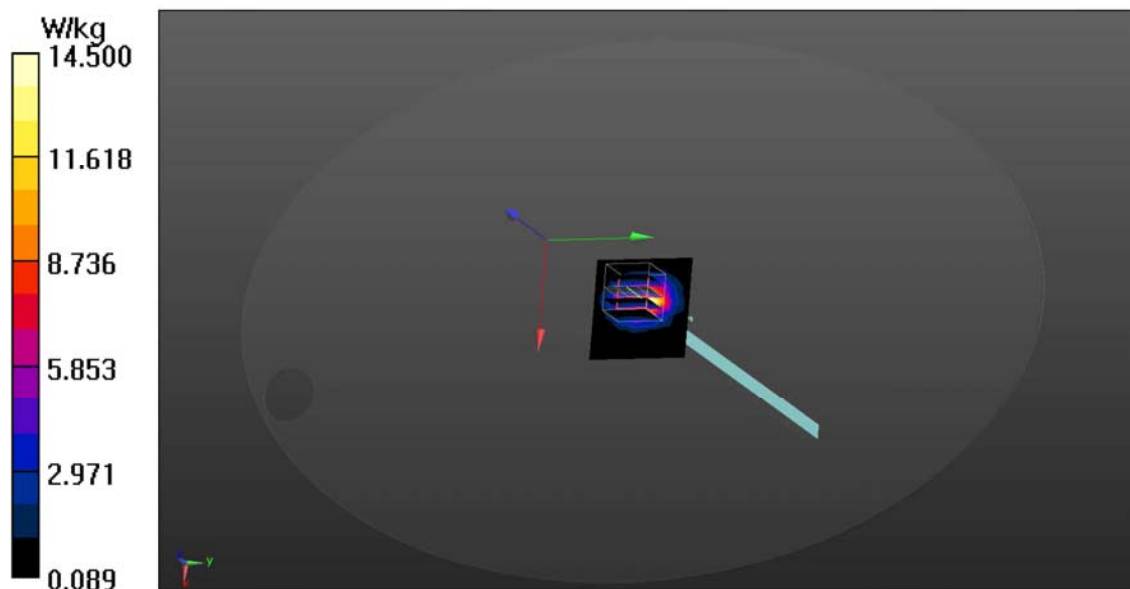
Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=8$ mm, $dy=8$ mm, $dz=5$ mm

Reference Value = 71.54 V/m; Power Drift = 0.10 dB

Peak SAR (extrapolated) = 22.8 W/kg

SAR(1 g) = 12.5 W/kg; SAR(10 g) = 5.92 W/kg

Maximum value of SAR (measured) = 14.5 W/kg



Date: 11/23/2017

Test Laboratory: Audix_SAR Lab

System Check_B5200**DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1203**

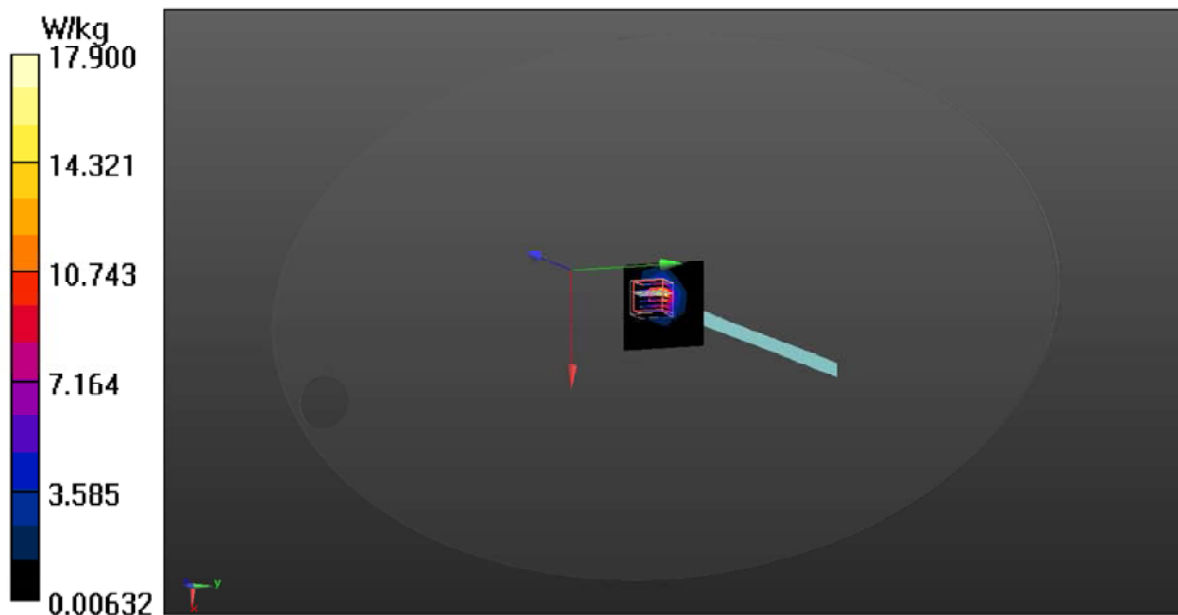
Communication System: UID 0, CW (0); Frequency: 5200 MHz;Duty Cycle:1:1
Medium parameters used: $f = 5200$ MHz; $\sigma = 5.351$ S/m; $\epsilon_r = 47.485$; $\rho = 1000$ kg/m³
Phantom section: Flat Section

DASY Configuration:

- Probe: EX3DV4 - SN3855; ConvF(4.74, 4.74, 4.74); Calibrated: 9/29/2017;
- Sensor-Surface: 2mm (Mechanical Surface Detection), $z = 1.0, 31.0$
- Electronics: DAE4 Sn1337; Calibrated: 9/25/2017
- Phantom: ELI v5.0; Type: QDOVA002AA; Serial: TP:1170
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

Area Scan (7x7x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (measured) = 16.0 W/kg

Zoom Scan (7x7x9)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2.5mm
Reference Value = 32.81 V/m; Power Drift = 0.21 dB
Peak SAR (extrapolated) = 34.2 W/kg
SAR(1 g) = 8.15 W/kg; SAR(10 g) = 2.28 W/kg
Maximum value of SAR (measured) = 17.9 W/kg



Date: 11/24/2017

Test Laboratory: Audix_SAR Lab

System Check_B5500**DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1203**

Communication System: UID 0, CW (0); Frequency: 5500 MHz;Duty Cycle:1:1

Medium parameters used: $f = 5500$ MHz; $\sigma = 5.779$ S/m; $\epsilon_r = 46.963$; $\rho = 1000$ kg/m³

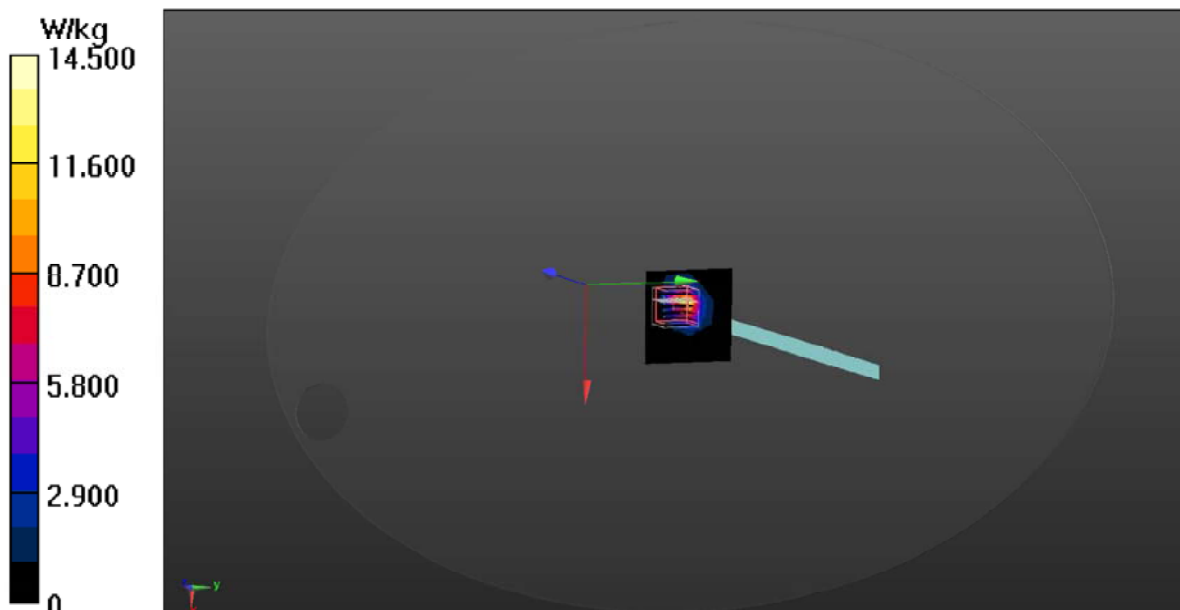
Phantom section: Flat Section

DASY Configuration:

- Probe: EX3DV4 - SN3855; ConvF(4.3, 4.3, 4.3); Calibrated: 9/29/2017;
- Sensor-Surface: 2mm (Mechanical Surface Detection), z = 1.0, 31.0
- Electronics: DAE4 Sn1337; Calibrated: 9/25/2017
- Phantom: ELI v5.0; Type: QDOVA002AA; Serial: TP:1170
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

Area Scan (7x7x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (measured) = 12.7 W/kg

Zoom Scan (7x7x9)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2.5mm
Reference Value = 27.03 V/m; Power Drift = 0.26 dB
Peak SAR (extrapolated) = 32.1 W/kg
SAR(1 g) = 8.42 W/kg; SAR(10 g) = 2.37 W/kg
Maximum value of SAR (measured) = 14.5 W/kg



Date: 11/25/2017

Test Laboratory: Audix_SAR Lab

System Check_B5800**DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1203**

Communication System: UID 0, CW (0); Frequency: 5800 MHz;Duty Cycle:1:1

Medium parameters used: $f = 5800$ MHz; $\sigma = 6.216$ S/m; $\epsilon_r = 46.264$; $\rho = 1000$ kg/m³

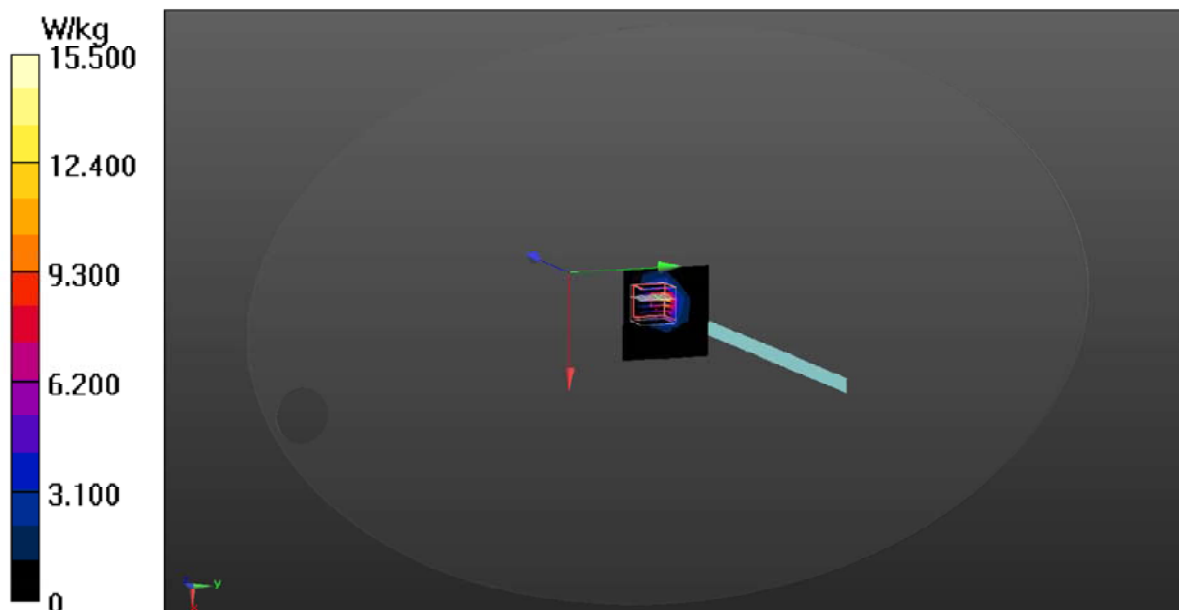
Phantom section: Flat Section

DASY Configuration:

- Probe: EX3DV4 - SN3855; ConvF(4.42, 4.42, 4.42); Calibrated: 9/29/2017;
- Sensor-Surface: 2mm (Mechanical Surface Detection), $z = 1.0, 31.0$
- Electronics: DAE4 Sn1337; Calibrated: 9/25/2017
- Phantom: ELI v5.0; Type: QDOVA002AA; Serial: TP:1170
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

Configuration/CW 2450/Area Scan (7x7x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (measured) = 13.1 W/kg

Configuration/CW 2450/Zoom Scan (7x7x9)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2.5mm
Reference Value = 26.66 V/m; Power Drift = 0.26 dB
Peak SAR (extrapolated) = 32.0 W/kg
SAR(1 g) = 8.32 W/kg; SAR(10 g) = 2.25 W/kg
Maximum value of SAR (measured) = 14.8 W/kg



5.4. SAR Measurement Procedure

According to the SAR 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

The SAR measurement procedures for each of test conditions are as follows:

- (a) Make EUT to transmit maximum output power
- (b) Measure conducted output power through RF cable
- (c) Place the EUT in the specific position of phantom
- (d) Perform SAR testing steps on the DASY system
- (e) Record the SAR value

5.4.1. Area & Zoom Scan Procedure

First Area Scan is used to locate the approximate location(s) of the local peak SAR value(s). The measurement grid within an Area Scan is defined by the grid extent, grid step size and grid offset. Next, in order to determine the EM field distribution in a three-dimensional spatial extension, Zoom Scan is required. The Zoom Scan is performed around the highest E-field value to determine the averaged SAR-distribution over 10 g. According to KDB 865664 D01 v01r03, the resolution for Area and Zoom scan is specified in the table below.

Items	<= 2 GHz	2-3 GHz	3-4 GHz	4-5 GHz	5-6 GHz
Area Scan (Δx , Δy)	<= 15mm	<= 12mm	<= 12mm	<= 10mm	<= 10mm
Zoom Scan (Δx , Δy)	<= 8mm	<= 5mm	<= 5mm	<= 4mm	<= 4mm
Zoom Scan (Δz)	<= 5mm	<= 5mm	<= 4mm	<= 3mm	<= 2mm
Zoom Scan Volume	>= 30mm	>= 30mm	>= 28mm	>= 25mm	>= 22mm

Note:

When zoom scan is required and report SAR is <= 1.4 W/kg, the zoom scan resolution of Δx / Δy (2-3GHz: <= 8 mm, 3-4GHz: <= 7 mm, 4-6GHz: <= 5 mm) may be applied.

5.4.2. Volume Scan Procedure

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.

5.4.3. 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 drift more than 5%, the SAR will be retested.

5.4.4. 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

5.4.5. SAR Averaged Methods

In DASYS, the interpolation and extrapolation are both based on the modified Quadratic Shepard's method. The interpolation scheme combines a least-square fitted function method and a weighted average method which are the two basic types of computational interpolation and approximation.

Extrapolation routines are used to obtain SAR values between the lowest measurement points and the inner phantom surface. The extrapolation distance is determined by the surface detection distance and the probe sensor offset. The uncertainty increases with the extrapolation distance. To keep the uncertainty within 1% for the 1 g and 10 g cubes, the extrapolation distance should not be larger than 5 mm.

6. SAR MEASUREMENT EVALUATION

6.1. EUT Configuration and Setting

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 KDB 447498 D01 are 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 the reported SAR for a 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 headset attached to the handset.

Body-worn accessories that do not contain metallic or conductive components may be tested according to worst-case exposure configurations, typically according to the smallest test separation distance required for the group of body-worn accessories with similar operating and exposure characteristics. All body-worn accessories containing metallic components are tested in conjunction with the host device.

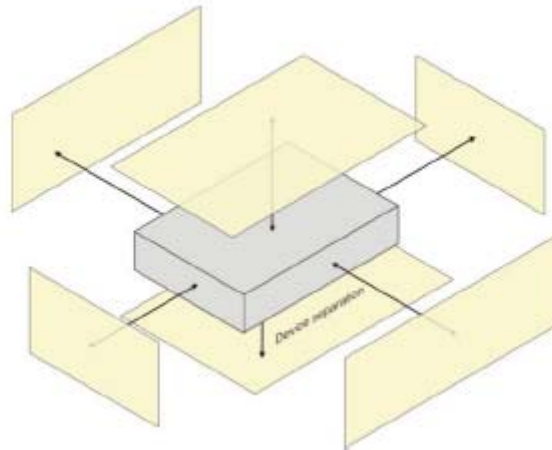
Body-worn accessory SAR compliance is based on a single minimum test separation distance for all wireless and operating modes applicable to each body-worn accessory used by the host, and according to the relevant voice and/or data mode transmissions and operations. If a body-worn accessory supports voice only operations in its normal and expected use conditions, testing of data mode for body-worn compliance is not required.

A conservative minimum test separation distance for supporting off-the-shelf body-worn accessories that may be acquired by users of consumer handsets is used to test for body-worn accessory SAR compliance. This distance is determined by the handset manufacturer, according to the requirements of Supplement C 01-01. Devices that are designed to operate on the body of users using lanyards and straps, or without requiring additional body-worn accessories, will be tested using a conservative minimum test separation distance ≤ 5 mm to support compliance.

6.2. EUT Testing Position

The wireless router device is tested for SAR compliance in body configurations described in the following subsections.

A test separation of 0 mm is required. SAR must be measured for all sides and surfaces with a transmitting antenna located within 25 mm from that surface or edge, for the data modes, wireless technologies and frequency bands supporting hotspot mode. The standalone SAR results in each device test orientation must be analyzed for the applicable hotspot mode simultaneous transmission configurations to determine SAR test exclusion and volume scan requirements. The simultaneous transmission configurations must be clearly described in the SAR report to support the analyses or test results. When the device form factor is smaller than 9 cm x 5 cm, unless a test separation distance of 5 mm or less is used a KDB inquiry is required to determine the acceptable test distance.



The SAR testing required mode is listed as below.

Antenna	Front Face	Rear Face	Top Side	Bottom Side	Left Side	Right Side
WLAN		√				

Note: Per KDB 447498 D01

- a) For 100 MHz to 6 GHz and test separation distances ≤ 50 mm, the 1-g and 10-g SAR test exclusion thresholds are determined by the following:

$$[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}] \leq 3.0$$
 for 1-g SAR, and ≤ 7.5 for 10-g extremity SAR, where
 - $f(\text{GHz})$ is the RF channel transmit frequency in GHz
- b) For 100 MHz to 6 GHz and test separation distances > 50 mm, the 1-g and 10-g SAR test exclusion thresholds are determined by the following (also illustrated in Appendix B):³²
 - 1) $\{[\text{Power allowed at numeric threshold for 50 mm in step a)}] + [(\text{test separation distance} - 50 \text{ mm}) \cdot (f(\text{MHz})/150)]\}$ mW, for 100 MHz to 1500 MHz
 - 2) $\{[\text{Power allowed at numeric threshold for 50 mm in step a)}] + [(\text{test separation distance} - 50 \text{ mm}) \cdot 10]\}$ mW, for > 1500 MHz and ≤ 6 GHz

SAR test exclusion table distance is > 50 mm @ Left Side

Frequency (GHz)	In Step 1 threshold Power (mW)	Distance between antenna and user (mm)	SAR Exclusion Threshold Power @ > 50 mm (mW)	EUT tune-up maximum power (mW)	SAR test
2.437	96.0867	68.8	284.0867	104.713	No
5.230	65.5904	68.8	253.5904	116.681	No
5.270	65.3410	68.8	253.3410	112.720	No
5.690	62.8833	68.8	250.8833	144.877	No
5.795	62.3110	68.8	250.3110	154.882	No

SAR test exclusion table distance is > 50 mm @ Right Side

Frequency (GHz)	In Step 1 threshold Power (mW)	Distance between antenna and user (mm)	SAR Exclusion Threshold Power @ > 50 mm (mW)	EUT tune-up maximum power (mW)	SAR test
2.417	96.4835	198.8	1584.4835	104.713	No
5.230	65.5904	198.8	1553.5904	116.681	No
5.270	65.3410	198.8	1553.3410	112.720	No
5.690	62.8833	198.8	1550.8833	144.877	No
5.795	62.3110	198.8	1550.3110	154.882	No

6.3. Tissue Calibration Result

The dielectric parameters of the liquids were verified prior to the SAR evaluation using Aligent Dielectric Probe Kit and Aligent E5071C Vector Network Analyzer.

Body Tissue Simulate Measurement					
Frequency [MHz]	Description	Dielectric Parameters			Tissue Temp. [°C]
		ϵ_r		σ [s/m]	
2450MHz	Reference result ± 5% window	52.70		1.95	N/A
		50.065	to 55.335	1.853 to 2.048	
	2017. 11. 27	51.396		1.97	22.1

Body Tissue Simulate Measurement					
Frequency [MHz]	Description	Dielectric Parameters			Tissue Temp. [°C]
		ϵ_r		σ [s/m]	
5200MHz	Reference result ± 5% window	49.01		5.299	N/A
		46.560	to 51.461	5.034 to 5.564	
	2017. 11. 23	47.599		5.347	22.2

Body Tissue Simulate Measurement					
Frequency [MHz]	Description	Dielectric Parameters			Tissue Temp. [°C]
		ϵ_r		σ [s/m]	
5500MHz	Reference result ± 5% window	48.61		5.650	N/A
		46.180	to 51.041	5.368 to 5.933	
	2017. 11. 24	46.963		5.779	22.1

Body Tissue Simulate Measurement					
Frequency [MHz]	Description	Dielectric Parameters			Tissue Temp. [°C]
		ϵ_r		σ [s/m]	
5800MHz	Reference result ± 5% window	48.20		6.00	N/A
		45.790	to 50.610	5.700 to 6.300	
	2017. 11. 25	46.415		6.171	22.3

6.4. SAR Exposure Limits

SAR assessments have been made in line with the requirements of IEEE-1528, FCC Supplement C, and comply with ANSI/IEEE C95.1-1992 “Uncontrolled Environments” limits. These limits apply to a location which is deemed as “Uncontrolled Environment” which can be described as a situation where the general public may be exposed to an RF source with no prior knowledge or control over their exposure.

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

Type Exposure	Uncontrolled Environment Limit
Spatial Peak SAR (1g cube tissue for brain or body)	1.60 W/kg
Spatial Average SAR (whole body)	0.08 W/kg
Spatial Peak SAR (10g for hands, feet, ankles and wrist)	4.00 W/kg

6.5. Conducted Power Measurement

6.5.1. For WLAN Function

Type of Network	Channel	Frequency (MHz)	Output Power (dBm)		Max Average Output Power (dBm)	Tune-Up Limit	Scale Factor	SAR Test
			Main	AUX				
802.11b	CH 1	2412	18.86	18.84	18.86	19.00	---	No ^{NOTE1}
	CH 2	2417	18.92	18.68	18.92	19.00	---	No ^{NOTE1}
	CH 6	2437	18.98	18.68	18.98	19.00	1.08	Yes
	CH 10	2457	18.53	18.42	18.53	19.00	---	No ^{NOTE1}
	CH 11	2462	18.57	18.53	18.57	19.00	---	No ^{NOTE1}
	CH 12	2467	15.08	15.00	15.08	15.50	---	No ^{NOTE1}
	CH 13	2472	7.49	7.30	7.49	7.50	---	No ^{NOTE1}
802.11g	CH 1	2412	16.89	16.65	16.89	17.00	---	No ^{NOTE1}
	CH 2	2417	18.60	18.55	18.60	19.00	---	No ^{NOTE1}
	CH 6	2437	18.94	18.90	18.94	19.00	---	No ^{NOTE1}
	CH 10	2457	16.42	16.38	16.42	16.50	---	No ^{NOTE1}
	CH 11	2462	15.93	15.80	15.93	16.00	---	No ^{NOTE1}
	CH 12	2467	8.98	8.88	8.98	9.00	---	No ^{NOTE1}
	CH 13	2472	-3.98	-3.99	-3.98	-4.00	---	No ^{NOTE1}

Note: 1. No : Not Required

2. As per FCC OET KDB 248227 D01, conducted output power and SAR testing are not required for 802.11g/n20/n40 channels when the highest reported SAR for DSSS is adjusted by the ratio of OFDM to DSSS specified maximum output power and the adjusted SAR is $\leq 1.2W/kg$
3. Scale factor is applied to calculated scale SAR presented in section 6.7.
4. Scale factor not listed for channels are exempted from SAR testing.

Type of Network	Channel	Frequency (MHz)	Output Power (dBm)		Total Average Output Power (dBm)	Tune-Up Limit	Scale Factor	SAR Test
			Main	AUX				
802.11n-HT20	CH 1	2412	15.99	15.85	19.15	20.00	---	No ^{NOTE1}
	CH 2	2417	16.28	16.82	19.79	20.50	---	No ^{NOTE1}
	CH 6	2437	16.99	16.94	20.20	20.50	---	No ^{NOTE1}
	CH 10	2457	16.98	16.93	20.19	20.50	---	No ^{NOTE1}
	CH 11	2462	15.00	14.98	18.22	18.50	---	No ^{NOTE1}
	CH 12	2467	8.99	8.97	12.21	12.50	---	No ^{NOTE1}
	CH 13	2472	-6.45	-5.62	-2.78	-3.00	---	No ^{NOTE1}
802.11n-HT40	CH 3	2422	14.08	13.74	17.10	17.50	---	No ^{NOTE1}
	CH 4	2427	14.45	14.30	17.56	18.00	---	No ^{NOTE1}
	CH 6	2437	15.94	15.87	19.09	19.50	---	No ^{NOTE1}
	CH 8	2447	14.97	14.90	18.12	18.50	---	No ^{NOTE1}
	CH 9	2452	13.94	13.87	17.09	17.50	---	No ^{NOTE1}
	CH 10	2457	10.49	10.44	13.65	14.00	---	No ^{NOTE1}
	CH 11	2462	0.6	-3.5	2.20	2.50	---	No ^{NOTE1}

Note: 1. No : Not Required

2. As per FCC OET KDB 248227 D01, conducted output power and SAR testing are not required for 802.11g/n20/n40 channels when the highest reported SAR for DSSS is adjusted by the ratio of OFDM to DSSS specified maximum output power and the adjusted SAR is $\leq 1.2W/kg$
3. Scale factor is applied to calculated scale SAR presented in section 6.7.
4. Scale factor not listed for channels are exempted from SAR testing.

Type of Network	Channel	Frequency (MHz)	Output Power (dBm)		Max Average Output Power (dBm)	Tune-Up Limit	Scale Factor	SAR Test	
			Main	AUX					
802.11a	UNII Band I	CH 36	5180	16.87	16.32	16.87	17.00	1.03	Yes
		CH 40	5200	18.54	18.49	18.54	19.00	---	No ^{NOTE2}
		CH 48	5240	18.51	18.41	18.51	19.00	---	No ^{NOTE2}
	UNII Band II-2A	CH 52	5260	18.88	18.77	18.88	19.00	1.05	Yes
		CH 60	5300	18.81	18.77	18.81	19.00	---	No ^{NOTE3,4}
		CH 64	5320	16.55	15.47	16.55	17.00	1.11	Yes
	UNII Band II-2C	CH 100	5500	15.49	16.47	16.47	16.50	---	No ^{NOTE3,4}
		CH 116	5580	19.03	18.80	19.03	19.50	1.11	Yes
		CH 140	5700	14.99	14.88	14.99	15.00	---	No ^{NOTE3,4}
		CH 144	5720	16.26	16.03	16.26	16.50	---	No ^{NOTE3,4}
	UNII Band III	CH 144	5720	8.63	8.13	8.63	9.00	---	No ^{NOTE3,4}
		CH 149	5745	18.75	18.99	18.99	19.00	---	No ^{NOTE3,4}
		CH 157	5785	19.05	18.92	19.05	19.50	1.11	Yes
		CH 165	5825	18.99	18.87	18.99	19.00	---	No ^{NOTE3,4}

Note: 1. No : Not Required

2. When the same maximum output power is specified for both bands, begin SAR measurement in U-NII-2A band by applying the OFDM SAR requirements. If the highest reported SAR for a test configuration is ≤ 1.2 W/kg, SAR is not required for U-NII-1 band (see §B.5.2 in this document).
3. When multiple transmission modes (802.11a/g/n/ac) have the same specified maximum output power, largest channel bandwidth, lowest order modulation and lowest data rate, lowest order 802.11 mode is selected (i.e. a, g, n, then ac)
4. According to FCC OET KDB 248227 D01 v02r02, when the reported SAR of the initial test configuration is < 0.8 W/kg, SAR measurement is not required for subsequent configuration.
5. When band gap channels between UNII-2C and UNII-3 band are supported channels in UNII-2C band below 5.65 GHz are considered as one band and channels above 5.65 GHz, together with channels in 5.8 GHz U-NII-3 or §15.247 band, are considered as a separate band
6. Scale factor is applied to calculated scale SAR presented in section 6.7.
7. Scale factor not listed for channels are exempted from SAR testing.

Type of Network		Channel	Frequency (MHz)	Output Power (dBm)		Total Average Output Power (dBm)	Tune-Up Limit	Scale Factor	SAR Test
				Main	Main				
802.11n- HT20	UNII Band I	CH 36	5180	16.20	16.30	19.27	19.50	---	No ^{NOTE2}
		CH 40	5200	17.45	17.03	20.26	20.50	---	No ^{NOTE2}
		CH 48	5240	17.37	17.00	20.21	20.50	---	No ^{NOTE2}
	UNII Band II-2A	CH 52	5260	17.42	17.01	20.24	20.50	1.06	Yes
		CH 60	5300	17.36	16.99	20.20	20.50	---	No ^{NOTE3,4}
		CH 64	5320	15.77	15.55	18.68	19.00	---	No ^{NOTE3,4}
	UNII Band II-2C	CH 100	5500	15.39	15.11	18.28	18.50	---	No ^{NOTE3,4}
		CH 116	5580	17.10	17.00	20.07	20.50	1.10	Yes
		CH 140	5700	13.74	13.99	16.90	17.00	---	No ^{NOTE3,4}
		CH 144	5720	17.66	17.97	20.83	21.00	---	No ^{NOTE3,4}
	UNII Band III	CH 144	5720	10.49	11.03	13.82	14.00	---	No ^{NOTE3,4}
		CH 149	5745	17.75	18.18	20.99	21.00	1.00	Yes
CH 157		5785	18.85	18.34	21.62	22.00	1.09	Yes	
CH 165		5825	18.74	18.06	21.43	21.50	1.02	Yes	

Note: 1. No : Not Required

2. When the same maximum output power is specified for both bands, begin SAR measurement in U-NII-2A band by applying the OFDM SAR requirements. If the highest reported SAR for a test configuration is ≤ 1.2 W/kg, SAR is not required for U-NII-1 band (see §B.5.2 in this document).
3. When multiple transmission modes (802.11a/g/n/ac) have the same specified maximum output power, largest channel bandwidth, lowest order modulation and lowest data rate, lowest order 802.11 mode is selected (i.e. a, g, n, then ac)
4. According to FCC OET KDB 248227 D01 v02r02, when the reported SAR of the initial test configuration is < 0.8 W/kg, SAR measurement is not required for subsequent configuration.
5. When band gap channels between UNII-2C and UNII-3 band are supported channels in UNII-2C band below 5.65 GHz are considered as one band and channels above 5.65 GHz, together with channels in 5.8 GHz U-NII-3 or §15.247 band, are considered as a separate band
6. Scale factor is applied to calculated scale SAR presented in section 6.7.
7. Scale factor not listed for channels are exempted from SAR testing.

Type of Network	Channel	Frequency (MHz)	Output Power (dBm)		Total Average Output Power (dBm)	Tune-Up Limit	Scale Factor	SAR Test	
			Main	Main					
802.11n-HT40	UNII Band I	CH 38	5190	12.35	12.22	15.43	15.50	---	No ^{NOTE2}
		CH 46	5230	17.62	17.43	20.67	21.00	---	No ^{NOTE2}
	UNII Band II-2A	CH 54	5270	17.48	17.27	20.52	21.00	---	No ^{NOTE3, 4}
		CH 62	5310	11.74	12.00	15.01	15.50	---	No ^{NOTE3, 4}
	UNII Band II-2C	CH 102	5510	11.90	12.05	15.12	15.50	---	No ^{NOTE3, 4}
		CH 110	5550	17.28	17.38	20.47	20.50	---	No ^{NOTE3, 4}
		CH 134	5670	16.28	16.71	19.64	20.00	---	No ^{NOTE3, 4}
		CH 142	5710	16.33	16.19	19.41	19.50	---	No ^{NOTE3, 4}
	UNII Band III	CH 142	5710	11.52	11.29	14.55	15.00	---	No ^{NOTE3, 4}
		CH 151	5755	18.84	18.44	21.79	22.00	---	No ^{NOTE3, 4}
CH 159		5795	18.87	18.65	21.90	22.00	---	No ^{NOTE3, 4}	
802.11ac-VHT80	UNII Band I	CH 52	5210	9.36	9.57	14.22	14.50	---	No ^{NOTE2}
	UNII Band II-2A	CH 58	5290	7.52	7.64	12.33	12.50	---	No ^{NOTE3, 4}
	UNII Band II-2C	CH 106	5530	7.69	7.98	12.59	13.00	---	No ^{NOTE3, 4}
		CH 133	5610	16.29	15.84	20.58	21.00	---	No ^{NOTE3, 4}
		CH 138	5690	17.10	16.61	21.61	22.00	---	No ^{NOTE3, 4}
	UNII Band III	CH 138	5690	0.96	0.29	5.39	5.50	---	No ^{NOTE3, 4}
		CH 155	5775	14.05	14.10	18.82	19.00	---	No ^{NOTE3, 4}

Note: 1. No : Not Required

2. When the same maximum output power is specified for both bands, begin SAR measurement in U-NII-2A band by applying the OFDM SAR requirements. If the highest reported SAR for a test configuration is ≤ 1.2 W/kg, SAR is not required for U-NII-1 band (see §B.5.2 in this document).
3. When multiple transmission modes (802.11a/g/n/ac) have the same specified maximum output power, largest channel bandwidth, lowest order modulation and lowest data rate, lowest order 802.11 mode is selected (i.e. a, g, n, then ac)
4. According to FCC OET KDB 248227 D01 v02r02, when the reported SAR of the initial test configuration is < 0.8 W/kg, SAR measurement is not required for subsequent configuration.
5. When band gap channels between UNII-2C and UNII-3 band are supported channels in UNII-2C band below 5.65 GHz are considered as one band and channels above 5.65 GHz, together with channels in 5.8 GHz U-NII-3 or §15.247 band, are considered as a separate band
6. Scale factor is applied to calculated scale SAR presented in section 6.7.
7. Scale factor not listed for channels are exempted from SAR testing.

6.5.2. For BT Function

Type of Network	Channel	Frequency (MHz)	Max Output Power (dBm)	Tune-Up Limit	Scale Factor	SAR Test
Bluetooth-GFSK	CH 0	2402	7.33	7.50	---	No ^{NOTE}
	CH 39	2441	7.98	8.00	1.00	Yes
	CH 78	2480	6.49	6.50	---	No ^{NOTE}
Bluetooth-8-DPSK	CH 0	2402	4.63	5.00	---	No ^{NOTE}
	CH 39	2441	5.29	5.50	---	No ^{NOTE}
	CH 78	2480	3.75	4.00	---	No ^{NOTE}
BLE	CH 37	2402	2.44	2.50	---	No ^{NOTE}
	CH 17	2440	2.95	3.00	---	No ^{NOTE}
	CH 39	2480	1.60	2.00	---	No ^{NOTE}

Note: No : Not Required

6.6. SAR Test Result

Test Date	2017/11/27	Temp./Hum.	23°C/55%
Test Voltage	AC 120V, 60Hz (with AC Adapter)		

Liquid Temperature : 22.1°C		Depth of Liquid: > 15cm						
Test Mode: 2.4GHz								
Test Position: Body	Antenna Position	Separation Distance (cm)	Frequency	Conducted power (dBm)	SAR 1g (W/kg)	Scale Factor	Scale SAR	Limit (W/kg)
802.11b								
Antenna: Main								
Rear	Fixed	0	2437	18.98	0.221	1.00	0.22	1.6
Antenna: AUX								
Rear	Fixed	0	2437	18.68	0.228	1.08	0.25	1.6

Test Date	2017/11/23 ~ 25	Temp./Hum.	23°C/55%
Test Voltage	AC 120V, 60Hz (with AC Adapter)		

Liquid Temperature : 22.2°C					Depth of Liquid: > 15cm			
Test Mode: 5GHz								
Test Position: Body	Antenna Position	Separation Distance (cm)	Frequency	Conducted power (dBm)	SAR 1g (W/kg)	Scale Factor	Scale SAR	Limit (W/kg)
802.11a (UNII Band I)								
Main Antenna								
Rear	Fixed	0	5180	16.87	0.714	1.03	0.74	1.6
802.11a (UNII Band II-2A)								
Main Antenna								
Rear	Fixed	0	5260	18.88	NOTE 1 1.27	1.03	1.31	1.6
Rear	Fixed	0	5260	18.88	NOTE 2 1.24	1.03	1.31	1.6
Rear	Fixed	0	5320	16.55	0.763	1.11	0.85	1.6
AUX Antenna								
Rear	Fixed	0	5260	18.77	0.380	1.05	0.40	1.6
802.11a (UNII Band II-2C)								
Main Antenna								
Rear	Fixed	0	5580	19.03	0.583	1.11	0.65	1.6
AUX Antenna								
Rear	Fixed	0	5580	18.80	0.255	1.05	0.27	1.6
802.11a (UNII Band III)								
Main Antenna								
Rear	Fixed	0	5785	19.05	0.222	1.11	0.25	1.6
AUX Antenna								
Rear	Fixed	0	5785	18.92	0.143	1.02	0.15	1.6

Note 1: Pursuant section 2.8.1(2) KDB 865664 D01, when the original highest measured SAR is ≥ 0.80 W/kg, repeat that measurement once.

Pursuant section 2.8.1(3) KDB 865664 D01, 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).

Note 2: The original measurement is 1.27W/kg, the first repeated measurement is 1.24W/kg.

1.27 W/kg / 1.24 W/kg = 1.02 < 1.20, thus it is unnecessary to test second repeated measurement.

Test Date	2017/11/23 ~ 25	Temp./Hum.	23°C/55%
Test Voltage	AC 120V, 60Hz (with AC Adapter)		

Liquid Temperature : 22.2°C					Depth of Liquid: > 15cm			
Test Mode: 5GHz								
Test Position: Body	Antenna Position	Separation Distance (cm)	Frequency	Conducted power (dBm)	SAR 1g (W/kg)	Scale Factor	Scale SAR	Limit (W/kg)
802.11n-HT20 (UNII Band II-2A)								
Main Antenna								
Rear	Fixed	0	5260	17.42	0.774	1.06	0.82	1.6
AUX Antenna								
Rear	Fixed	0	5260	17.01	0.287	1.06	0.30	1.6
802.11n-HT20 (UNII Band II-2C)								
Main Antenna								
Rear	Fixed	0	5580	17.10	0.280	1.10	0.31	1.6
AUX Antenna								
Rear	Fixed	0	5580	17.00	0.268	1.10	0.30	1.6
802.11n-HT20 (UNII Band III)								
Main Antenna								
Rear	Fixed	0	5745	17.75	0.745	1.00	0.75	1.6
Rear	Fixed	0	5785	18.85	NOTE 1 0.813	1.09	0.89	1.6
Rear	Fixed	0	5785	18.85	NOTE 2 0.809	1.09	0.88	1.6
Rear	Fixed	0	5825	18.74	0.784	1.02	0.80	1.6
AUX Antenna								
Rear	Fixed	0	5785	18.34	0.078	1.09	0.09	1.6

Note 1: Pursuant section 2.8.1(2) KDB 865664 D01, when the original highest measured SAR is ≥ 0.80 W/kg, repeat that measurement once.

Pursuant section 2.8.1(3) KDB 865664 D01, 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).

Note 2: The original measurement is 0.813W/kg, the first repeated measurement is 0.809W/kg.

0.813 W/kg / 0.809 W/kg = 1.00 < 1.20, thus it is unnecessary to test second repeated measurement.

Test Date	2017/11/27	Temp./Hum.	23°C/55%
Test Voltage	AC 120V, 60Hz (with AC Adapter)		

Liquid Temperature : 22.1°C		Depth of Liquid: > 15cm						
Test Mode: BT-GFSK								
Test Position: Body	Antenna Position	Separation Distance (cm)	Frequency	Conducted power (dBm)	SAR 1g (W/kg)	Scale Factor	Scale SAR	Limit (W/kg)
Antenna: AUX								
Rear	Fixed	0	2441	7.98	0.036	1.00	0.04	1.6



Audix Technology Corp.
No. 53-11, Dingfu, Linkou, Dist.,
New Taipei City 244, Taiwan

Tel: +886 2 26099301
Fax: +886 2 26099303

APPENDIX A

GRAPH RESULT

(Model: 15Z980)



*Audix Technology Corp.
No. 53-11, Dingfu, Linkou, Dist.,
New Taipei City 244, Taiwan*

*Tel: +886 2 26099301
Fax: +886 2 26099303*

APPENDIX B

TEST PHOTOGRAPHS

(Model: 15Z980)



*Audix Technology Corp.
No. 53-11, Dingfu, Linkou, Dist.,
New Taipei City 244, Taiwan*

*Tel: +886 2 26099301
Fax: +886 2 26099303*

APPENDIX C

Test Equipment Calibration Data