SAR TEST REPORT

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MODEL NO.: DWA-160
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ISSUED: Jan. 23, 2008

APPLICANT : D-Link Co.

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ISSUED BY: Advance Data Technology Corporation

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ACCREDITED
No.: 2177-01

Testing Laboratory
0528

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1. CERTIFICATION

PRODUCT:	Xtreme N Dual Band USB Adapter
MODEL:	DWA-160
BRAND:	D-Link
APPLICANT:	D-Link Co.
TESTED :	Jan. 17 ~ Jan. 20, 2008
TEST SAMPLE:	ENGINEERING SAMPLE
STANDARDS:	**FCC Part 2 (Section 2.1093)** **FCC OET Bulletin 65, Supplement C (01-01)** **RSS-102** **IEEE 1528-2003**

The above equipment (model: DWA-160) have been tested by **Advance Data Technology Corporation**, and found compliance with the requirement of the above standards. The test record, data evaluation & Equipment Under Test (EUT) configurations represented herein are true and accurate accounts of the measurements of the sample's EMC characteristics under the conditions specified in this report.

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Responsible for RF

APPROVED BY : Gary Chang / Assistant Manager , **DATE:** Jan. 23, 2008

2. GENERAL INFORMATION

2.1 GENERAL DESCRIPTION OF EUT

PRODUCT	Xtreme N Dual Band USB Adapter	
MODEL NO.	DWA-160	
FCC ID	KA2WA160A1	
POWER SUPPLY	5Vdc from host equipment	
CLASSIFICATION	Portable device, production unit	
MODULATION TYPE	CCK, DQPSK, DBPSK for DSSS, 64QAM, 16QAM, QPSK, BPSK for OFDM	
RADIO TECHNOLOGY	DSSS, OFDM	
TRANSFER RATE	802.11b: 11 / 5.5 / 2 / 1Mbps 802.11g: 54 / 48 / 36 / 24 / 18 / 12 / 9 / 6Mbps 802.11a: 54 / 48 / 36 / 24 / 18 / 12 / 9 / 6Mbps Draft 802.11n (20MHz): 130 / 117 / 104 / 78 / 65 / 58.5 / 52 / 39 / 26 / 19.5 /13 / 6.5Mbps Draft 802.11n (40MHz): 270 / 243 / 216 / 162 / 135 / 121.5 / 108 / 81 /54 / 40.5 / 27 / 13.5Mbps	
FREQUENCY RANGE	**2.4GHz:**	2400 ~ 2483.5MHz
	5.0GHz:	5150 ~ 5350MHz, 5470 ~ 5725MHz, 5725 ~ 5825MHz
NUMBER OF CHANNEL	**2.4GHz:**	11 for 802.11b, 802.11g, draft 802.11n (20MHz) 7 for draft 802.11n (40MHz)
	5.0GHz:	5150 ~ 5350MHz, 5470 ~ 5725MHz: 19 for 802.11a, draft 802.11n (20MHz) ; 9 for draft 802.11n (40MHz) 5725 ~ 5825MHz: 4 for 802.11a, draft 802.11n (20MHz) ; 3 for draft 802.11n (40MHz)
CHANNEL FREQUENCIES UNDER TEST AND ITS CONDUCTED OUTPUT POWER FOR 2.4GHz	**802.11b:**	**802.11g:**
	118.850mW / Ch1: 2412MHz 187.499mW / Ch6: 2437MHz 115.878mW / Ch11: 2462MHz	105.196mW / Ch1: 2412MHz 239.332mW / Ch6: 2437MHz 83.753mW / Ch11: 2462MHz
	DRAFT 802.11n (20MHz):	**DRAFT 802.11n (40MHz):**
	63.699mW / Ch1: 2412MHz 273.569mW / Ch6: 2437MHz 48.664mW / Ch11: 2462MHz	82.175mW / Ch1: 2422MHz 198.316mW / Ch4: 2437MHz 85.204mW / Ch7: 2452MHz

CHANNEL FREQUENCIES UNDER TEST AND ITS CONDUCTED OUTPUT POWER FOR 5GHz	**802.11a:**	
	28.314mW / Ch36: 5180MHz	31.261mW / Ch120: 5600MHz
	25.882mW / Ch48: 5240MHz	33.343mW / Ch124: 5620MHz
	37.931mW / Ch52: 5260MHz	36.392mW / Ch136: 5680MHz
	39.084mW / Ch64: 5320MHz	37.325mW / Ch140: 5700MHz
	41.783mW / Ch100: 5500MHz	31.261mW / Ch149: 5745MHz
	35.810mW / Ch104: 5520MHz	33.651mW / Ch157: 5785MHz
	38.282mW / Ch116: 5580MHz	28.379mW / Ch164: 5805MHz
	DRAFT 802.11n (20MHz):	
	26.668mW / Ch36: 5180MHz	52.555mW / Ch120: 5600MHz
	26.307mW / Ch48: 5240MHz	52.385mW / Ch124: 5620MHz
	54.285mW / Ch52: 5260MHz	52.127mW / Ch136: 5680MHz
	54.100mW / Ch64: 5320MHz	55.856mW / Ch140: 5700MHz
	52.608mW / Ch100: 5500MHz	55.972mW / Ch149: 5745MHz
	52.061mW / Ch104: 5520MHz	56.013mW / Ch157: 5785MHz
	52.232mW / Ch116: 5580MHz	61.626mW / Ch164: 5805MHz
	DRAFT 802.11n (40MHz):	
	40.932mW / Ch38: 5190MHz	42.443mW / Ch118: 5590MHz
	48.262mW / Ch46: 5230MHz	49.106mW / Ch134: 5670MHz
	46.324mW / Ch54: 5270MHz	43.404mW / Ch151: 5755MHz
	45.665mW / Ch62: 5310MHz	47.206mW / Ch159: 5795MHz
	48.219mW / Ch102: 5510MHz	
AVERAGE SAR (1g)	1.360W/kg for 2.4GHz 1.250W/kg for 5.0GHz	
ANTENNA TYPE	Refer to NOTE 1	
DATA CABLE	NA	
I/O PORTS	USB	
ACCESSORY DEVICES	NA	

NOTE:

1. There are two antennas provided to this EUT, please refer to the following table:

No.	Antenna Type	For 2.4GHz Gain (dBi)	For 5GHz Gain (dBi)	Antenna Connector
1	PCB Printed	0.7	0.5	NA
2	PCB Printed	0.7	0.5	NA

2. The EUT incorporates a MIMO function with 802.11a, 802.11b, 802.11g, draft 802.11n. Physically, the card provides two completed transmit and two completed receivers.
3. The EUT is 2 * 2 spatial MIMO (2Tx & 2Rx) without beam forming function. The antenna configurations are two transmitter antennas and two receiver antennas, as there are 2 PCB Print antennas. Spatial multiplexing modes for simultaneous transmission using 2 antennas, and for simultaneous receiver using 2 antennas.

4. When the EUT operating in draft 802.11n, the software operation, which is defined by manufacturer, MCS (Modulation and Coding Schemes) from 0 to 15.
5. The EUT complies with draft 802.11n standards and backwards compatible with 802. 11a, 802.11b, 802.11g products.
6. The above EUT information was declared by manufacturer and for more detailed features description, please refer to the manufacturer's specifications or user's manual.

2.2 GENERAL DESCRIPTION OF APPLIED STANDARDS

According to the specifications of the manufacturer, this product must comply with the requirements of the following standards:

FCC Part 2 (2.1093)

FCC OET Bulletin 65, Supplement C (01- 01)

RSS-102

IEEE 1528-2003

All test items have been performed and recorded as per the above standards.

2.3 GENERAL INOFRMATION OF THE SAR SYSTEM

DASY4 (software 4.7 Build 53) 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 DASY4 software defined. The DASY4 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 form the optical into digital electric signal of the DAE and transfers data to the PC.

ET3DV6 ISOTROPIC E-FIELD PROBE (FREQUENCY BAND < 3GHz)

CONSTRUCTION	Symmetrical design with triangular core. Built-in optical fiber for surface detection system. Built-in shielding against static charges. PEEK enclosure material (resistant to organic solvents, e.g., glycolether).
FREQUENCY	10 MHz to 3 GHz; Linearity: ± 0.2 dB (30 MHz to 3 GHz)
DYNAMIC RANGE	5 µW/g to > 100 mW/g; Linearity: ± 0.2 dB
OPTICAL SURFACE DETECTION	± 0.2 mm repeatability in air and clear liquids over diffuse reflecting surfaces
DIMENSIONS	Overall length: 330 mm (Tip Length: 16 mm) Tip diameter: 6.8 mm (Body diameter: 12 mm) Distance from probe tip to dipole centers: 2.7 mm
APPLICATION	General dosimetric measurements up to 3 GHz Compliance tests of mobile phones Fast automatic scanning in arbitrary phantoms (ET3DV6)

EX3DV3 ISOTROPIC E-FIELD PROBE (FREQUENCY BAND 5 ~ 6GHz)

DIMENSIONS	Overall length: 330 mm (Tip Length: 20 mm) Tip diameter: 2.5 mm (Body diameter: 12 mm) Distance from probe tip to dipole centers: 1.0 mm
APPLICATION	General dosimetric measurements range 5 ~ 6 GHz. Fast automatic scanning in arbitrary phantoms (EX3DV3)

NOTE

1. The Probe parameters have been calibrated by the SPEAG. Please reference "APPENDIX D" for the Calibration Certification Report.
2. For frequencies above 800 MHz, calibration in a rectangular wave-guide is used, because wave-guide size is manageable.
3. For frequencies below 800 MHz, temperature transfer calibration is used because the wave-guide size becomes relatively large.

TWIN SAM V4.0

CONSTRUCTION	The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (SAM) phantom defined in IEEE 1528-2003, CENELEC 50361 and IEC 62209. 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 manually teaching three points with the robot.
SHELL THICKNESS	2 ± 0.2mm
FILLING VOLUME	Approx. 25liters
DIMENSIONS	Height: 810mm; Length: 1000mm; Width: 500mm

SYSTEM VALIDATION KITS:

CONSTRUCTION	Symmetrical dipole with l/4 balun enables measurement of feedpoint impedance with NWA matched for use near flat phantoms filled with brain simulating solutions. Includes distance holder and tripod adaptor
CALIBRATION	Calibrated SAR value for specified position and input power at the flat phantom in brain simulating solutions
FREQUENCY	2450 , 5200, 5500, 5800 MHz

RETURN LOSS	> 20dB at specified validation position
POWER CAPABILITY	> 100W (f < 1GHz); > 40W (f > 1GHz)
OPTIONS	Dipoles for other frequencies or solutions and other calibration conditions upon request

DEVICE HOLDER FOR SAM TWIN PHANTOM

CONSTRUCTION

The device holder for the mobile phone device is designed to cope with different positions given in the standard. It has two scales for the device rotation (with respect to the body axis) and the device inclination (with respect to the line between the ear reference points). The rotation centers for both scales is the ear reference point (ERP). Thus the device needs no repositioning when changing the angles. The holder has been made out of low-loss POM material having the following dielectric parameters: relative permittivity ε =3 and loss tangent δ =0.02. The amount of dielectric material has been reduced in the closest vicinity of the device, since measurements have suggested that the influence of the clamp on the test results could thus be lowered. The device holder for the portable device makes up of the polyethylene foam. The dielectric parameters of material close to the dielectric parameters of the air.

DATA ACQUISITION ELECTRONICS

CONSTRUCTION

The data acquisition electronics (DAE3) consists of a highly sensitive electrometer grade preamplifier with auto-zeroing, a channel and gain-switching multiplex, 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 mechanical probe is mounting device includes two different sensor systems for frontal and sideways probe contacts. They are used for mechanical surface detection and probe collision detection. The input impedance of the DAE3 box is 200MOhm; the inputs are symmetrical and floating. Common mode rejection is above 80 dB.

2.4 GENERAL DESCRIPTION OF THE SPATIAL PEAK SAR EVALUATION

The DASY4 post-processing software (SEMCAD) automatically executes the following procedures to calculate the field units from the micro-volt readings at the probe connector. The parameters used in the evaluation are stored in the configuration modules of the software:

Probe parameters:	- Sensitivity	$Norm_i$, a_{i0}, a_{i1}, a_{i2}
	- Conversion factor	$ConvF_i$
	- Diode compression point	dcp_i
Device parameters:	- Frequency	F
	- Crest factor	Cf
Media parameters:	- Conductivity	σ
	- Density	ρ

The first step of the evaluation is a linearization of the filtered input signal to account for the compression characteristics of the detector diode. The compensation depends on the input signal, the diode type and the DC-transmission factor from the diode to the evaluation electronics. If the exciting field is pulsed, the crest factor of the signal must be known to correctly compensate for peak power. The formula for each channel can be given as:

$$V_i = U_i + U_i^2 \bullet \frac{cf}{dcp_i}$$

V_i	=compensated signal of channel i	(i = x, y, z)
U_i	=input signal of channel I	(i = x, y, z)
Cf	=crest factor of exciting field	(DASY parameter)
dcp_i	=diode compression point	(DASY parameter)

From the compensated input signals the primary field data for each channel can be evaluated:

$$\text{E-fieldprobes: } E_i = \sqrt{\frac{V_1}{Norm_i \cdot ConvF}}$$

$$\text{H-fieldprobes: } H_i = \sqrt{V_i} \cdot \frac{a_{i0} + a_{i1} f + a_{i2} f^2}{f}$$

V_i	=compensated signal of channel I	(i = x, y, z)
$Norm_i$	=sensor sensitivity of channel i μV/(V/m)2 for E-field Probes	(i = x, y, z)
ConvF	= sensitivity enhancement in solution	
a_{ij}	= sensor sensitivity factors for H-field probes	
F	= carrier frequency [GHz]	
E_i	= electric field strength of channel i in V/m	
H_i	= magnetic field strength of channel i in A/m	

The RSS value of the field components gives the total field strength (Hermitian magnitude):

$$E_{tot} = \sqrt{E_x^2 + E_y^2 + E_z^2}$$

The primary field data are used to calculate the derived field units.

$$SAR = E_{tot}^2 \cdot \frac{\sigma}{\rho \cdot 1'000}$$

SAR	= local specific absorption rate in mW/g
E_{tot}	= total field strength in V/m
σ	= conductivity in [mho/m] or [Siemens/m]
ρ	= equivalent tissue density in g/cm3

Note that the density is set to 1, to account for actual head tissue density rather than the density of the tissue simulating liquid. 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:

1. The extraction of the measured data (grid and values) from the Zoom Scan
2. The calculation of the SAR value at every measurement point based on all stored data (A/D values and measurement parameters)
3. The generation of a high-resolution mesh within the measured volume
4. The interpolation of all measured values from the measurement grid to the high-resolution grid
5. The extrapolation of the entire 3-D field distribution to the phantom surface over the distance from sensor to surface
6. The calculation of the averaged SAR within masses of 1g and 10g.

The probe is calibrated at the center of the dipole sensors that is located 1 to 2.7mm away from the probe tip. During measurements, the probe stops shortly above the phantom surface, depending on the probe and the surface detecting system. Both distances are included as parameters in the probe configuration file. The software always knows exactly how far away the measured point is from the surface. As the probe cannot directly measure at the surface, the values between the deepest measured point and the surface must be extrapolated. The angle between the probe axis and the surface normal line is less than 30 degree.

In the Area Scan, the gradient of the interpolation function is evaluated to find all the extreme of the SAR distribution. The uncertainty on the locations of the extreme is less than 1/20 of the grid size. Only local maximum within -2dB of the global maximum are searched and passed for the Cube Scan measurement. In the Cube Scan, the interpolation function is used to extrapolate the Peak SAR from the lowest measurement points to the inner phantom surface (the extrapolation distance). The uncertainty increases with the extrapolation distance. To keep the uncertainty within 1% for the 1g and 10g cubes, the extrapolation distance should not be larger than 5mm.

The maximum search is automatically performed after each area scan measurement. It is based on splines in two or three dimensions. The procedure can find the maximum for most SAR distributions even with relatively large grid spacing. After the area scanning measurement, the probe is automatically moved to a position at the interpolated maximum. The following scan can directly use this position for reference, e.g., for a finer resolution grid or the cube evaluations. The 1g and 10g peak evaluations are only available for the predefined cube 7 x 7 x 7 scans. The routines are verified and optimized for the grid dimensions used in these cube measurements. The measured volume of 30 x 30 x 30mm contains about 30g of tissue. The first procedure is an extrapolation (incl. boundary correction) to get the points between the lowest measured plane and the surface. The next step uses 3D interpolation to get all points within the measured volume in a 1mm grid (42875 points). In the last step, a 1g cube is placed numerically into the volume and its averaged SAR is calculated. This cube is the moved around until the highest averaged SAR is found. If the highest SAR is found at the edge of the measured volume, the system will issue a warning: higher SAR values might be found outside of the measured volume. In that case the cube measurement can be repeated, using the new interpolated maximum as the center.

3. DESCRIPTION OF SUPPORT UNITS

The EUT has been tested as an independent unit together with other necessary accessories or support units. The following support units or accessories were used to form a representative test configuration during the tests.

NO.	PRODUCT	BRAND	MODEL NO.	SERIAL NO.	FCC ID
1	NOTEBOOK	HP	n6000	CNU3480WP2	FCC DoC Approved
2	NOTEBOOK	DELL	D820	21498926752	FCC DoC Approved
3	NOTEBOOK	Compaq	N800C	470048-515	FCC DoC Approved
4	NOTEBOOK	Dell	PP01L	TW-09C748-12800-16M-5064	FCC DoC Approved

NO.	SIGNAL CABLE DESCRIPTION OF THE ABOVE SUPPORT UNITS
1	NA
2	NA
3	NA
4	NA

NOTE: All power cords of the above support units are non shielded (1.8m).

4. DESCRIPTION OF TEST MODES AND CONFIGURATIONS

4.1. DESCRIPTION OF ANTENNA LOCATION

4.2. DESCRIPTION OF ASSESSMENT POSITION

The following test configurations have been applied in this test report:

A: NOTEBOOK MODEL: n6000

The bottom of the EUT face to the phantom with 6mm-separation distance.

B: NOTEBOOK MODEL: D820

The bottom of the EUT face to the phantom with 7mm-separation distance.

C: NOTEBOOK MODEL: N800C

The bottom of the EUT face to the phantom with 8mm-separation distance.

D: NOTEBOOK MODEL: PP01L

The edge of the EUT face to the phantom with 5mm-separation distance.

NOTE: The bottom of the notebook contacts to the bottom of the flat phantom with 0mm-separation distance.

4.3. DESCRIPTION OF TEST MODE

ITEM	TEST MODE	MODULATION	ASSESSMENT POSTITION	TESTED CHANNEL
FOR 2.4GHz				
1	802.11b	DBPSK	A	L, M, H
2	802.11g	BPSK	A	L, M, H
3	Draft 802.11n (20MHz)	BPSK	A	L, M, H
4	Draft 802.11n (40MHz)	BPSK	A	L, M, H
5	802.11b	DBPSK	B	M
6	802.11g	BPSK	B	M
7	Draft 802.11n (20MHz)	BPSK	B	M
8	Draft 802.11n (40MHz)	BPSK	B	M
9	802.11b	DBPSK	C	M
10	802.11g	BPSK	C	M
11	Draft 802.11n (20MHz)	BPSK	C	M
12	Draft 802.11n (40MHz)	BPSK	C	M
13	802.11b	DBPSK	D	L, M, H
14	802.11g	BPSK	D	L, M, H
15	Draft 802.11n (20MHz)	BPSK	D	L, M, H
16	Draft 802.11n (40MHz)	BPSK	D	L, M, H

ITEM	TEST MODE	MODULATION	ASSESSMENT POSTITION	TESTED CHANNEL
FOR 5GHz				
17	802.11a	BPSK	A	36, 48, 52, 64, 100, 104, 116, 120, 124, 136, 140, 149, 157, 164
18	Draft 802.11n (20MHz)	BPSK	A	36, 48, 52, 64, 100, 104, 116, 120, 124, 136, 140, 149, 157, 164
19	Draft 802.11n (40MHz)	BPSK	A	38, 46, 54, 62, 102, 118, 134, 151, 159
20	802.11a	BPSK	B	48, 52, 140, 149
21	Draft 802.11n (20MHz)	BPSK	B	48, 52, 120, 157
22	Draft 802.11n (40MHz)	BPSK	B	46, 54, 118, 151
23	802.11a	BPSK	C	48, 52, 140, 149
24	Draft 802.11n (20MHz)	BPSK	C	48, 52, 120, 157
25	Draft 802.11n (40MHz)	BPSK	C	46, 54, 118, 151
26	802.11a	BPSK	D	36, 48, 52, 64, 100, 104, 116, 120, 124, 136, 140, 149, 157, 164
27	Draft 802.11n (20MHz)	BPSK	D	36, 48, 52, 64, 100, 104, 116, 120, 124, 136, 140, 149, 157, 164
28	Draft 802.11n (40MHz)	BPSK	D	38, 46, 54, 62, 102, 118, 134, 151, 159

4.4. SUMMARY OF TEST RESULTS

COMMUNICATION MODE	802.11b	802.11g	Draft 802.11n (20MHz)	Draft 802.11n (40MHz)
TEST MODE	1	2	3	4
MEASURED VALUE OF 1g SAR (W/kg)				
CHANNEL	ASSESSMENT POSITION (A)			
LOW	0.710	0.728	0.148	0.111
MIDDLE	1.320	**1.360**	0.681	0.271
HIGH	0.639	0.599	0.101	0.117

COMMUNICATION MODE	802.11b	802.11g	Draft 802.11n (20MHz)	Draft 802.11n (40MHz)
TEST MODE	5	6	7	8
MEASURED VALUE OF 1g SAR (W/kg)				
CHANNEL	ASSESSMENT POSITION (B)			
LOW	-	-	-	-
MIDDLE	1.010	1.040	0.490	0.162
HIGH	-	-	-	-

COMMUNICATION MODE	802.11b	802.11g	Draft 802.11n (20MHz)	Draft 802.11n (40MHz)
TEST MODE	9	10	11	12
MEASURED VALUE OF 1g SAR (W/kg)				
CHANNEL	ASSESSMENT POSITION (C)			
LOW	-	-	-	-
MIDDLE	0.504	0.538	0.228	0.103
HIGH	-	-	-	-

COMMUNICATION MODE	802.11b	802.11g	Draft 802.11n (20MHz)	Draft 802.11n (40MHz)
TEST MODE	13	14	15	16
MEASURED VALUE OF 1g SAR (W/kg)				
CHANNEL	ASSESSMENT POSITION (D)			
LOW	0.254	0.228	0.038	0.045
MIDDLE	0.499	0.527	0.270	0.110
HIGH	0.315	0.245	0.044	0.051

NOTE: The worst value has been marked by boldface.

COMMUNICATION MODE	802.11a	Draft 802.11n (20MHz)
TEST MODE	17	18
MEASURED VALUE OF 1g SAR (W/kg)		
CHANNEL	ASSESSMENT POSITION (A)	
36	1.040	0.765
48	1.130	0.761
52	0.967	**1.250**
64	0.869	0.972
100	0.560	0.561
104	0.481	0.474
116	0.599	0.694
120	0.640	0.780
124	0.612	0.592
136	0.633	0.423
140	0.648	0.397
149	0.787	0.384
157	0.685	0.392
164	0.643	0.332

COMMUNICATION MODE	Draft 802.11n (40MHz)
TEST MODE	19
MEASURED VALUE OF 1g SAR (W/kg)	
CHANNEL	ASSESSMENT POSITION (A)
38	0.950
46	1.150
54	1.080
62	0.975
102	0.628
118	0.895
134	0.488
151	0.396
159	0.328

NOTE: The worst value has been marked by boldface.

COMMUNICATION MODE	802.11a	
TEST MODE	20	23
MEASURED VALUE OF 1g SAR (W/kg)		
CHANNEL	ASSESSMENT POSITION (B)	ASSESSMENT POSITION (C)
48	0.813	0.627
52	0.706	0.520
140	0.418	0.224
149	0.427	0.235

COMMUNICATION MODE	Draft 802.11n (20MHz)	
TEST MODE	21	24
MEASURED VALUE OF 1g SAR (W/kg)		
CHANNEL	ASSESSMENT POSITION (B)	ASSESSMENT POSITION (C)
48	0.498	0.393
52	0.910	0.867
120	0.573	0.436
157	0.234	0.191

COMMUNICATION MODE	Draft 802.11n (40MHz)	
TEST MODE	22	25
MEASURED VALUE OF 1g SAR (W/kg)		
CHANNEL	ASSESSMENT POSITION (B)	ASSESSMENT POSITION (C)
46	0.820	0.703
54	0.725	0.639
118	0.604	0.405
151	0.254	0.200

COMMUNICATION MODE	802.11a	Draft 802.11n (20MHz)
TEST MODE	26	27
MEASURED VALUE OF 1g SAR (W/kg)		
CHANNEL	ASSESSMENT POSITION (D)	
36	0.786	0.394
48	0.693	0.315
52	0.877	0.960
64	0.805	0.617
100	0.474	0.595
104	0.409	0.529
116	0.329	0.522
120	0.455	0.483
124	0.268	0.433
136	0.274	0.361
140	0.298	0.364
149	0.309	0.368
157	0.293	0.367
164	0.274	0.378

COMMUNICATION MODE	Draft 802.11n (40MHz)
TEST MODE	28
MEASURED VALUE OF 1g SAR (W/kg)	
CHANNEL	ASSESSMENT POSITION (D)
38	0.387
46	0.838
54	0.345
62	0.414
102	0.667
118	0.380
134	0.292
151	0.309
159	0.274

5. TEST RESULTS

5.1 TEST PROCEDURES

The EUT plugged into the notebook. Use the software to control the EUT channel and transmission power. Then record the conducted power before the testing. Place the EUT to the specific test location. After the testing, must writing down the conducted power of the EUT into the report. The SAR value was calculated via the 3D spline interpolation algorithm that has been implemented in the software of DASY4 SAR measurement system manufactured and calibrated by SPEAG. According to the IEEE 1528 standards, the recommended procedure for assessing the peak spatial-average SAR value consists of the following steps:

- Power reference measurement
- Verification of the power reference measurement
- Area scan
- Zoom scan
- Power reference measurement

The area scan was performed for the highest spatial SAR location. The zoom scan with 30mm x 30mm x 30mm volume was performed for SAR value averaged over 1g and 10g spatial volumes.

In the zoom scan, the distance between the measurement point at the probe sensor location (geometric center behind the probe tip) and the phantom surface is 4.0mm and maintained at a constant distance of ±1.0mm during a zoom scan to determine peak SAR locations. The distance is 4mm between the first measurement point and the bottom surface of the phantom. The secondary measurement point to the bottom surface of the phantom is with 9mm separation distance. The cube size is 7 x 7 x 7 points consist of 343 points and the grid space is 5mm.

The measurement time is 0.5s at each point of the zoom scan. The probe boundary effect compensation shall be applied during the SAR test. Because of the tip of the probe to the Phantom surface separated distances are longer than half a tip probe diameter.

In the area scan, the separation distance is 4mm between the each measurement point and the phantom surface. The scan size shall be included the transmission portion of the EUT. The measurement time is the same as the zoom scan. At last the reference power drift shall be less than ±5%.

5.2 MEASURED SAR RESULTS

ENVIRONMENTAL CONDITION	Air Temperature：22.4°C, Liquid Temperature：21.3°C Humidity：58%RH		
TESTED BY	Sam Onn	DATE	Jan. 17, 2008

CHAN.	FREQ. (MHz)	TEST MODE	CONDUCTED POWER (mW)		POWER DRIFT (%)	DEVICE TEST POSITION MODE	MEASURED 1g SAR (W/kg)
			BEGIN TEST	AFTER TEST			
1	2412 (Low)	802.11b	118.850	117.471	-1.16	1	0.710
6	2437 (Mid.)	802.11b	187.499	185.099	-1.28	1	1.320
11	2462 (High)	802.11b	115.878	114.325	-1.34	1	0.639
1	2412 (Low)	802.11g	105.196	103.692	-1.43	2	0.728
6	2437 (Mid.)	802.11g	239.332	235.694	-1.52	2	**1.360**
11	2462 (High)	802.11g	83.753	82.354	-1.67	2	0.599
1	2412 (Low)	DRAFT 802.11n (20MHz)	63.699	62.540	-1.82	3	0.148
6	2437 (Mid.)	DRAFT 802.11n (20MHz)	273.569	268.344	-1.91	3	0.681
11	2462 (High)	DRAFT 802.11n (20MHz)	48.664	47.681	-2.02	3	0.101
1	2422 (Low)	DRAFT 802.11n (40MHz)	82.175	80.40	-2.16	4	0.111
4	2437 (Mid.)	DRAFT 802.11n (40MHz)	198.316	193.933	-2.21	4	0.271
7	2452 (High)	DRAFT 802.11n (40MHz)	85.204	83.253	-2.29	4	0.117

NOTE:

1. Test configuration of each mode is described in section 3.
2. In this testing, the limit for General Population Spatial Peak averaged over 1g, **1.6 W/kg**, is applied.
3. Please see the Appendix A for the data.
4. The variation of the EUT conducted power measured before and after SAR testing should not over 5%.

ENVIRONMENTAL CONDITION	Air Temperature : 22.4°C, Liquid Temperature : 21.3°C Humidity : 58%RH		
TESTED BY	Sam Onn	DATE	Jan. 17, 2008

CHAN.	FREQ. (MHz)	TEST MODE	CONDUCTED POWER (mW)		POWER DRIFT (%)	DEVICE TEST POSITION MODE	MEASURED 1g SAR (W/kg)
			BEGIN TEST	AFTER TEST			
6	2437 (Mid.)	802.11b	187.499	184.968	-1.35	5	1.010
6	2437 (Mid.)	802.11g	239.332	235.981	-1.40	6	1.040
6	2437 (Mid.)	DRAFT 802.11n (20MHz)	273.569	271.517	-0.75	7	0.490
4	2437 (Mid.)	DRAFT 802.11n (40MHz)	198.316	196.670	-0.83	8	0.162
6	2437 (Mid.)	802.11b	187.499	185.793	-0.91	9	0.504
6	2437 (Mid.)	802.11g	239.332	236.795	-1.06	10	0.538
6	2437 (Mid.)	DRAFT 802.11n (20MHz)	273.569	270.505	-1.12	11	0.228
4	2437 (Mid.)	DRAFT 802.11n (40MHz)	198.316	195.877	-1.23	12	0.103

NOTE:

1. Test configuration of each mode is described in section 3.
2. In this testing, the limit for General Population Spatial Peak averaged over 1g, **1.6 W/kg**, is applied.
3. Please see the Appendix A for the data.
4. The variation of the EUT conducted power measured before and after SAR testing should not over 5%.

ENVIRONMENTAL CONDITION	Air Temperature：22.4°C, Liquid Temperature：21.3°C Humidity：58%RH		
TESTED BY	Sam Onn	DATE	Jan. 17, 2008

CHAN.	FREQ. (MHz)	TEST MODE	CONDUCTED POWER (mW)		POWER DRIFT (%)	DEVICE TEST POSITION MODE	MEASURED 1g SAR (W/kg)
			BEGIN TEST	AFTER TEST			
1	**2412 (Low)**	**802.11b**	118.850	117.590	-1.06	13	0.254
6	**2437 (Mid.)**	**802.11b**	187.499	185.362	-1.14	13	0.499
11	**2462 (High)**	**802.11b**	115.878	114.476	-1.21	13	0.315
1	**2412 (Low)**	**802.11g**	105.196	104.112	-1.03	14	0.228
6	**2437 (Mid.)**	**802.11g**	239.332	236.651	-1.12	14	0.527
11	**2462 (High)**	**802.11g**	83.753	82.723	-1.23	14	0.245
1	**2412 (Low)**	**DRAFT 802.11n (20MHz)**	63.699	62.903	-1.25	15	0.038
6	**2437 (Mid.)**	**DRAFT 802.11n (20MHz)**	273.569	269.985	-1.31	15	0.270
11	**2462 (High)**	**DRAFT 802.11n (20MHz)**	48.664	47.988	-1.39	15	0.044
1	**2422 (Low)**	**DRAFT 802.11n (40MHz)**	82.175	81.016	-1.41	16	0.045
4	**2437 (Mid.)**	**DRAFT 802.11n (40MHz)**	198.316	195.361	-1.49	16	0.110
7	**2452 (High)**	**DRAFT 802.11n (40MHz)**	85.204	83.909	-1.52	16	0.051

NOTE:

1. Test configuration of each mode is described in section 3.
2. In this testing, the limit for General Population Spatial Peak averaged over 1g, **1.6 W/kg**, is applied.
3. Please see the Appendix A for the data.
4. The variation of the EUT conducted power measured before and after SAR testing should not over 5%.

ENVIRONMENTAL CONDITION	Air Temperature：22.3°C, Liquid Temperature：21.3°C Humidity：57%RH		
TESTED BY	Sam Onn	DATE	Jan. 18, 2008

CHAN.	FREQ. (MHz)	TEST MODE	CONDUCTED POWER (mW)		POWER DRIFT (%)	DEVICE TEST POSITION MODE	MEASURED 1g SAR (W/kg)
			BEGIN TEST	AFTER TEST			
36	5180.000	802.11a	28.314	28.102	-0.75	17	1.040
48	5240.000	802.11a	25.882	25.667	-0.83	17	1.130
52	5260.000	802.11a	37.931	37.586	-0.91	17	0.967
64	5320.000	802.11a	39.084	38.670	-1.06	17	0.869
100	5500.000	802.11a	41.783	41.315	-1.12	17	0.560
104	5520.000	802.11a	35.810	35.370	-1.23	17	0.481
116	5580.000	802.11a	38.282	37.800	-1.26	17	0.599
120	5600.000	802.11a	31.261	30.845	-1.33	17	0.640
124	5620.000	802.11a	33.343	32.886	-1.37	17	0.612
136	5680.000	802.11a	36.392	35.872	-1.43	17	0.633
140	5700.000	802.11a	37.325	36.769	-1.49	17	0.648
149	5745.000	802.11a	31.261	30.783	-1.53	17	0.787
157	5785.000	802.11a	33.651	33.119	-1.58	17	0.685
164	5805.000	802.11a	28.379	27.919	-1.62	17	0.643

NOTE:

1. Test configuration of each mode is described in section 3.
2. In this testing, the limit for General Population Spatial Peak averaged over 1g, 1.6 W/kg, is applied.
3. Please see the Appendix A for the data.
4. The variation of the EUT conducted power measured before and after SAR testing should not over 5%.

ENVIRONMENTAL CONDITION	Air Temperature：22.3°C, Liquid Temperature：21.3°C Humidity：57%RH						
TESTED BY	Sam Onn			DATE	Jan. 18, 2008		

CHAN.	FREQ. (MHz)	TEST MODE	CONDUCTED POWER (mW)		POWER DRIFT (%)	DEVICE TEST POSITION MODE	MEASURED 1g SAR (W/kg)
			BEGIN TEST	AFTER TEST			
36	**5180.000**	**DRAFT 802.11n (20MHz)**	26.668	26.500	-0.63	18	0.765
48	**5240.000**	**DRAFT 802.11n (20MHz)**	26.307	26.120	-0.71	18	0.761
52	**5260.000**	**DRAFT 802.11n (20MHz)**	54.285	53.829	-0.84	18	**1.250**
64	**5320.000**	**DRAFT 802.11n (20MHz)**	54.100	53.602	-0.92	18	0.972
100	**5500.000**	**DRAFT 802.11n (20MHz)**	52.608	52.071	-1.02	18	0.561
104	**5520.000**	**DRAFT 802.11n (20MHz)**	52.061	51.494	-1.09	18	0.474
116	**5580.000**	**DRAFT 802.11n (20MHz)**	52.232	51.642	-1.13	18	0.694
120	**5600.000**	**DRAFT 802.11n (20MHz)**	52.555	51.924	-1.20	18	0.780
124	**5620.000**	**DRAFT 802.11n (20MHz)**	52.385	51.709	-1.29	18	0.592
136	**5680.000**	**DRAFT 802.11n (20MHz)**	52.127	51.418	-1.36	18	0.423
140	**5700.000**	**DRAFT 802.11n (20MHz)**	55.856	55.063	-1.42	18	0.397
149	**5745.000**	**DRAFT 802.11n (20MHz)**	55.972	55.110	-1.54	18	0.384
157	**5785.000**	**DRAFT 802.11n (20MHz)**	56.013	55.106	-1.62	18	0.392
164	**5805.000**	**DRAFT 802.11n (20MHz)**	61.626	60.572	-1.71	18	0.332

NOTE:

1. Test configuration of each mode is described in section 3.
2. In this testing, the limit for General Population Spatial Peak averaged over 1g, 1.6 W/kg, is applied.
3. Please see the Appendix A for the data.
4. The variation of the EUT conducted power measured before and after SAR testing should not over 5%.

ENVIRONMENTAL CONDITION	Air Temperature：22.3°C, Liquid Temperature：21.3°C Humidity：57%RH		
TESTED BY	Sam Onn	DATE	Jan. 18, 2008

CHAN.	FREQ. (MHz)	TEST MODE	CONDUCTED POWER (mW)		POWER DRIFT (%)	DEVICE TEST POSITION MODE	MEASURED 1g SAR (W/kg)
			BEGIN TEST	AFTER TEST			
38	5190.000	DRAFT 802.11n (40MHz)	40.932	40.490	-1.08	19	0.950
46	5230.000	DRAFT 802.11n (40MHz)	48.262	47.702	-1.16	19	1.150
54	5270.000	DRAFT 802.11n (40MHz)	46.324	45.754	-1.23	19	1.080
62	5310.000	DRAFT 802.11n (40MHz)	45.665	45.039	-1.37	19	0.975
102	5510.000	DRAFT 802.11n (40MHz)	48.219	47.529	-1.43	19	0.628
118	5590.000	DRAFT 802.11n (40MHz)	42.443	41.798	-1.52	19	0.895
134	5670.000	DRAFT 802.11n (40MHz)	49.106	48.325	-1.59	19	0.488
151	5755.000	DRAFT 802.11n (40MHz)	43.404	42.697	-1.63	19	0.396
159	5795.000	DRAFT 802.11n (40MHz)	47.206	46.413	-1.68	19	0.328

NOTE:

1. Test configuration of each mode is described in section 3.
2. In this testing, the limit for General Population Spatial Peak averaged over 1g, 1.6 W/kg, is applied.
3. Please see the Appendix A for the data.
4. The variation of the EUT conducted power measured before and after SAR testing should not over 5%.

ENVIRONMENTAL CONDITION	Air Temperature：22.4°C, Liquid Temperature：21.5°C Humidity：60%RH		
TESTED BY	Sam Onn	DATE	Jan. 19, 2008

CHAN.	FREQ. (MHz)	TEST MODE	CONDUCTED POWER (mW)		POWER DRIFT (%)	DEVICE TEST POSITION MODE	MEASURED 1g SAR (W/kg)
			BEGIN TEST	AFTER TEST			
48	5240.000	802.11a	25.882	25.617	-1.03	20	0.813
52	5260.000	802.11a	37.931	37.506	-1.12	20	0.706
140	5700.000	802.11a	37.325	36.866	-1.23	20	0.418
149	5745.000	802.11a	31.261	30.870	-1.25	20	0.427
48	5240.000	DRAFT 802.11n (20MHz)	26.307	25.962	-1.31	21	0.498
52	5260.000	DRAFT 802.11n (20MHz)	54.285	53.530	-1.39	21	0.910
120	5600.000	DRAFT 802.11n (20MHz)	52.555	51.814	-1.41	21	0.573
157	5785.000	DRAFT 802.11n (20MHz)	56.013	55.178	-1.49	21	0.234
46	5230.000	DRAFT 802.11n (40MHz)	48.262	47.750	-1.06	22	0.820
54	5270.000	DRAFT 802.11n (40MHz)	46.324	45.796	-1.14	22	0.725
118	5590.000	DRAFT 802.11n (40MHz)	42.443	41.929	-1.21	22	0.604
151	5755.000	DRAFT 802.11n (40MHz)	43.404	42.857	-1.26	22	0.254

NOTE:

1. Test configuration of each mode is described in section 3.
2. In this testing, the limit for General Population Spatial Peak averaged over 1g, 1.6 W/kg, is applied.
3. Please see the Appendix A for the data.
4. The variation of the EUT conducted power measured before and after SAR testing should not over 5%.

ENVIRONMENTAL CONDITION	Air Temperature：22.4°C, Liquid Temperature：21.5°C Humidity：60%RH		
TESTED BY	Sam Onn	DATE	Jan. 19, 2008

CHAN.	FREQ. (MHz)	TEST MODE	CONDUCTED POWER (mW)		POWER DRIFT (%)	DEVICE TEST POSITION MODE	MEASURED 1g SAR (W/kg)
			BEGIN TEST	AFTER TEST			
48	5240.000	802.11a	25.882	25.719	-0.63	23	0.627
52	5260.000	802.11a	37.931	37.662	-0.71	23	0.520
140	5700.000	802.11a	37.325	37.011	-0.84	23	0.224
149	5745.000	802.11a	31.261	30.973	-0.92	23	0.235
48	5240.000	DRAFT 802.11n (20MHz)	26.307	26.039	-1.02	24	0.393
52	5260.000	DRAFT 802.11n (20MHz)	54.285	53.693	-1.09	24	0.867
120	5600.000	DRAFT 802.11n (20MHz)	52.555	51.961	-1.13	24	0.436
157	5785.000	DRAFT 802.11n (20MHz)	56.013	55.340	-1.20	24	0.191
46	5230.000	DRAFT 802.11n (40MHz)	48.262	47.610	-1.35	25	0.703
54	5270.000	DRAFT 802.11n (40MHz)	46.324	45.671	-1.41	25	0.639
118	5590.000	DRAFT 802.11n (40MHz)	42.443	41.811	-1.49	25	0.405
151	5755.000	DRAFT 802.11n (40MHz)	43.404	42.744	-1.52	25	0.200

NOTE:

1. Test configuration of each mode is described in section 3.
2. In this testing, the limit for General Population Spatial Peak averaged over 1g, 1.6 W/kg, is applied.
3. Please see the Appendix A for the data.
4. The variation of the EUT conducted power measured before and after SAR testing should not over 5%.

ENVIRONMENTAL CONDITION	Air Temperature：22.6°C, Liquid Temperature：21.4°C Humidity：58%RH		
TESTED BY	Sam Onn	DATE	Jan. 20, 2008

CHAN.	FREQ. (MHz)	TEST MODE	CONDUCTED POWER (mW)		POWER DRIFT (%)	DEVICE TEST POSITION MODE	MEASURED 1g SAR (W/kg)
			BEGIN TEST	AFTER TEST			
36	**5180.000**	**802.11a**	28.314	28.024	-1.03	26	0.786
48	**5240.000**	**802.11a**	25.882	25.592	-1.12	26	0.693
52	**5260.000**	**802.11a**	37.931	37.464	-1.23	26	0.877
64	**5320.000**	**802.11a**	39.084	38.595	-1.25	26	0.805
100	**5500.000**	**802.11a**	41.783	41.236	-1.31	26	0.474
104	**5520.000**	**802.11a**	35.810	35.312	-1.39	26	0.409
116	**5580.000**	**802.11a**	38.282	37.742	-1.41	26	0.329
120	**5600.000**	**802.11a**	31.261	30.795	-1.49	26	0.455
124	**5620.000**	**802.11a**	33.343	32.836	-1.52	26	0.268
136	**5680.000**	**802.11a**	36.392	35.802	-1.62	26	0.274
140	**5700.000**	**802.11a**	37.325	36.687	-1.71	26	0.298
149	**5745.000**	**802.11a**	31.261	30.695	-1.81	26	0.309
157	**5785.000**	**802.11a**	33.651	33.012	-1.90	26	0.293
164	**5805.000**	**802.11a**	28.379	27.797	-2.05	26	0.274

NOTE:

1. Test configuration of each mode is described in section 3.
2. In this testing, the limit for General Population Spatial Peak averaged over 1g, 1.6 W/kg, is applied.
3. Please see the Appendix A for the data.
4. The variation of the EUT conducted power measured before and after SAR testing should not over 5%.

ENVIRONMENTAL CONDITION	Air Temperature：22.6°C, Liquid Temperature：21.4°C Humidity：58%RH						
TESTED BY	Sam Onn			DATE	Jan. 20, 2008		
CHAN.	FREQ. (MHz)	TEST MODE	CONDUCTED POWER (mW)		POWER DRIFT (%)	DEVICE TEST POSITION MODE	MEASURED 1g SAR (W/kg)
			BEGIN TEST	AFTER TEST			
36	5180.000	DRAFT 802.11n (20MHz)	26.668	26.183	-1.82	27	0.394
48	5240.000	DRAFT 802.11n (20MHz)	26.307	25.805	-1.91	27	0.315
52	5260.000	DRAFT 802.11n (20MHz)	54.285	53.188	-2.02	27	0.960
64	5320.000	DRAFT 802.11n (20MHz)	54.100	52.931	-2.16	27	0.617
100	5500.000	DRAFT 802.11n (20MHz)	52.608	51.445	-2.21	27	0.595
104	5520.000	DRAFT 802.11n (20MHz)	52.061	50.869	-2.29	27	0.529
116	5580.000	DRAFT 802.11n (20MHz)	52.232	50.994	-2.37	27	0.522
120	5600.000	DRAFT 802.11n (20MHz)	52.555	51.772	-1.49	27	0.483
124	5620.000	DRAFT 802.11n (20MHz)	52.385	51.589	-1.52	27	0.433
136	5680.000	DRAFT 802.11n (20MHz)	52.127	51.314	-1.56	27	0.361
140	5700.000	DRAFT 802.11n (20MHz)	55.856	54.940	-1.64	27	0.364
149	5745.000	DRAFT 802.11n (20MHz)	55.972	55.026	-1.69	27	0.368
157	5785.000	DRAFT 802.11n (20MHz)	56.013	55.050	-1.72	27	0.367
164	5805.000	DRAFT 802.11n (20MHz)	61.626	60.529	-1.78	27	0.378

NOTE:

1. Test configuration of each mode is described in section 3.
2. In this testing, the limit for General Population Spatial Peak averaged over 1g, 1.6 W/kg, is applied.
3. Please see the Appendix A for the data.
4. The variation of the EUT conducted power measured before and after SAR testing should not over 5%.

ENVIRONMENTAL CONDITION	Air Temperature：22.6°C, Liquid Temperature：21.4°C Humidity：58%RH		
TESTED BY	Sam Onn	DATE	Jan. 20, 2008

CHAN.	FREQ. (MHz)	TEST MODE	CONDUCTED POWER (mW)		POWER DRIFT (%)	DEVICE TEST POSITION MODE	MEASURED 1g SAR (W/kg)
			BEGIN TEST	AFTER TEST			
38	5190.000	DRAFT 802.11n (40MHz)	40.932	40.490	-1.08	28	0.387
46	5230.000	DRAFT 802.11n (40MHz)	48.262	47.702	-1.16	28	0.838
54	5270.000	DRAFT 802.11n (40MHz)	46.324	45.754	-1.23	28	0.345
62	5310.000	DRAFT 802.11n (40MHz)	45.665	45.039	-1.37	28	0.414
102	5510.000	DRAFT 802.11n (40MHz)	48.219	47.529	-1.43	28	0.667
118	5590.000	DRAFT 802.11n (40MHz)	42.443	41.798	-1.52	28	0.380
134	5670.000	DRAFT 802.11n (40MHz)	49.106	48.325	-1.59	28	0.292
151	5755.000	DRAFT 802.11n (40MHz)	43.404	42.697	-1.63	28	0.309
159	5795.000	DRAFT 802.11n (40MHz)	47.206	46.413	-1.68	28	0.274

NOTE:

1. Test configuration of each mode is described in section 3.
2. In this testing, the limit for General Population Spatial Peak averaged over 1g, 1.6 W/kg, is applied.
3. Please see the Appendix A for the data.
4. The variation of the EUT conducted power measured before and after SAR testing should not over 5%.

5.3 SAR LIMITS

HUMAN EXPOSURE	SAR (W/kg)	
	(GENERAL POPULATION / UNCONTROLLED EXPOSURE ENVIRONMENT)	(OCCUPATIONAL / CONTROLLED EXPOSURE ENVIRONMENT)
Spatial Average (whole body)	0.08	0.4
Spatial Peak (averaged over 1 g)	**1.6**	8.0
Spatial Peak (hands / wrists / feet / ankles averaged over 10 g)	4.0	20.0

NOTE:

1. This limits accord to 47 CFR 2.1093 – Safety Limit.
2. The EUT property been complied with the partial body exposure limit under the general population environment.

5.4 RECIPES FOR TISSUE SIMULATING LIQUIDS

For the measurement of the field distribution inside the SAM phantom, the phantom must be filled with 25 litters of tissue simulation liquid.

The following ingredients are used：

- **WATER-** Deionized water (pure H20), resistivity _16 M - as basis for the liquid
- **SUGAR-** Refined sugar in crystals, as available in food shops - to reduce relative permittivity
- **SALT-** Pure NaCl - to increase conductivity
- **CELLULOSE-** Hydroxyethyl-cellulose, medium viscosity (75-125mPa.s, 2% in water, 20_C),
  CAS # 54290 - to increase viscosity and to keep sugar in solution
- **PRESERVATIVE-** Preventol D-7 Bayer AG, D-51368 Leverkusen, CAS # 55965-84-9 - to prevent the spread of bacteria and molds
- **DGMBE-** Diethylenglycol-monobuthyl ether (DGMBE), Fluka Chemie GmbH, CAS # 112-34-5 - to reduce relative permittivity

THE RECIPES FOR 2450MHz SIMULATING LIQUID TABLE

INGREDIENT	HEAD SIMULATING LIQUID 2450MHz (HSL-2450)	MUSCLE SIMULATING LIQUID 2450MHz (MSL-2450)
Water	45%	69.83%
DGMBE	55%	30.17%
Salt	NA	NA
Dielectric Parameters at 22℃	f= 2450MHz ε= 39.2 ± 5% σ= 1.80 ± 5% S/m	f= 2450MHz ε= 52.7 ± 5% σ= 1.95 ± 5% S/m

THE INFORMATION FOR 5GHz SIMULATING LIQUID

The 5GHz liquids were purchased from SPEAG.

Body liquid model: HSL 5800, P/N: SL AAH 5800 AA

Head liquid model: M 5800, P/N: SL AAM 580 AD

5GHz liquids contain the following ingredients:

Water 64 - 78%

Mineral Oil 11 - 18%

Emulsifiers 9 - 15%

Additives and Salt 2 - 3%

Testing the liquids using the Agilent Network Analyzer E8358A and Agilent Dielectric Probe Kit 85070D.The testing procedure is following as

1. Turn Network Analyzer on and allow at least 30min. warm up.
2. Mount dielectric probe kit so that interconnecting cable to Network Analyzer will not be moved during measurements or calibration.
3. Pour de-ionized water and measure water temperature (±1°).
4. Set water temperature in Agilent-Software (Calibration Setup).
5. Perform calibration.
6. Validate calibration with dielectric material of known properties (e.g. polished ceramic slab with >8mm thickness ε'=10.0, ε''=0.0). If measured parameters do not fit within tolerance, repeat calibration (±0.2 for ε': ±0.1 for ε'').
7. Conductivity can be calculated from ε'' by $\sigma = \omega \varepsilon_0 \varepsilon'' = \varepsilon'' f [GHz] / 18$.
8. Measure liquid shortly after calibration. Repeat calibration every hour.
9. Stir the liquid to be measured. Take a sample (~ 50ml) with a syringe from the center of the liquid container.
10. Pour the liquid into a small glass flask. Hold the syringe at the bottom of the flask to avoid air bubbles.
11. Put the dielectric probe in the glass flask. Check that there are no air bubbles in front of the opening in the dielectric probe kit.
12. Perform measurements.
13. Adjust medium parameters in DASY4 for the frequencies necessary for the measurements (‘Setup Config’, select medium (e.g. Brain 900MHz) and press ‘Option’-button.
14. Select the current medium for the frequency of the validation (e.g. Setup Medium Brain 900MHz).

FOR 2.4GHz BAND SIMULATING LIQUID

LIQUID TYPE		HSL-2450		MSL-2450	
SIMULATING LIQUID TEMP.		NA		21.3	
TEST DATE		NA		Jan. 17, 2008	
TESTED BY		NA		Sam Onn	
FREQ. (MHz)	LIQUID PARAMETER	STANDARD VALUE	MEASUREMENT VALUE	STANDARD VALUE	MEASUREMENT VALUE
2412.0	Permitivity (ε)	NA	NA	52.80	54.50
2422.0		NA	NA	52.70	54.50
2437.0		NA	NA	52.70	54.40
2450.0		NA	NA	52.70	54.30
2452.0		NA	NA	52.70	54.30
2462.0		NA	NA	52.70	54.30
2412.0	Conductivity (σ) S/m	NA	NA	1.91	1.94
2422.0		NA	NA	1.92	1.95
2437.0		NA	NA	1.94	1.96
2450.0		NA	NA	1.95	1.98
2452.0		NA	NA	1.95	1.98
2462.0		NA	NA	1.96	1.99
Dielectric Parameters Required at 22℃		**f= 2450MHz ε= 39.2 ± 5% σ= 1.80 ± 5% S/m**		**f= 2450MHz ε= 52.7 ± 5% σ= 1.95 ± 5% S/m**	

FOR 5.0GHz BAND SIMULATING LIQUID

LIQUID TYPE		HSL-5800		MSL-5800	
SIMULATING LIQUID TEMP.		NA		21.3	
TEST DATE		NA		Jan. 18, 2008	
TESTED BY		NA		Sam Onn	
FREQ. (MHz)	LIQUID PARAMETER	STANDARD VALUE	MEASUREMENT VALUE	STANDARD VALUE	MEASUREMENT VALUE
5180	Permitivity (ε)	NA	NA	49.00	50.90
5190		NA	NA	49.00	50.80
5200		NA	NA	49.00	50.80
5230		NA	NA	49.00	50.70
5240		NA	NA	49.00	50.70
5260		NA	NA	48.90	50.70
5270		NA	NA	48.90	50.60
5310		NA	NA	48.90	50.60
5320		NA	NA	48.90	50.60
5500		NA	NA	48.60	50.20
5510		NA	NA	48.60	50.20
5520		NA	NA	48.60	50.20
5580		NA	NA	48.50	50.00
5590		NA	NA	48.50	50.00
5600		NA	NA	48.50	50.00
5620		NA	NA	48.40	50.00
5670		NA	NA	48.40	49.80
5680		NA	NA	48.40	49.90
5700		NA	NA	48.30	49.80
5745		NA	NA	48.30	49.70
5755		NA	NA	48.30	49.60
5785		NA	NA	48.20	49.70
5795		NA	NA	48.20	49.60
5800		NA	NA	48.20	49.60
5805		NA	NA	48.20	49.60
Dielectric Parameters Required at 21℃					

LIQUID TYPE		HSL-5800		MSL-5800	
SIMULATING LIQUID TEMP.		NA		21.3	
TEST DATE		NA		Jan. 18, 2008	
TESTED BY		NA		Sam Onn	
FREQ. (MHz)	LIQUID PARAMETER	STANDARD VALUE	MEASUREMENT VALUE	STANDARD VALUE	MEASUREMENT VALUE
5180	Conductivity (σ) S/m	NA	NA	5.28	5.24
5190		NA	NA	5.29	5.25
5200		NA	NA	5.30	5.27
5230		NA	NA	5.33	5.31
5240		NA	NA	5.35	5.33
5260		NA	NA	5.37	5.36
5270		NA	NA	5.38	5.37
5310		NA	NA	5.43	5.43
5320		NA	NA	5.44	5.45
5500		NA	NA	5.65	5.71
5510		NA	NA	5.66	5.72
5520		NA	NA	5.67	5.74
5580		NA	NA	5.74	5.82
5590		NA	NA	5.75	5.83
5600		NA	NA	5.77	5.85
5620		NA	NA	5.79	5.88
5670		NA	NA	5.85	5.95
5680		NA	NA	5.86	5.97
5700		NA	NA	5.88	6.00
5745		NA	NA	5.94	6.07
5755		NA	NA	5.95	6.08
5785		NA	NA	5.98	6.13
5795		NA	NA	5.99	6.14
5800		NA	NA	6.00	6.15
5805		NA	NA	6.01	6.17
Dielectric Parameters Required at 21℃					

LIQUID TYPE		HSL-5800		MSL-5800	
SIMULATING LIQUID TEMP.		NA		21.5	
TEST DATE		NA		Jan. 19, 2008	
TESTED BY		NA		Sam Onn	
FREQ. (MHz)	LIQUID PARAMETER	STANDARD VALUE	MEASUREMENT VALUE	STANDARD VALUE	MEASUREMENT VALUE
5180	Permitivity (ε)	NA	NA	49.00	50.50
5190		NA	NA	49.00	50.40
5200		NA	NA	49.00	50.40
5230		NA	NA	49.00	50.30
5240		NA	NA	49.00	50.30
5260		NA	NA	48.90	50.30
5270		NA	NA	48.90	50.20
5310		NA	NA	48.90	50.20
5320		NA	NA	48.90	50.20
5500		NA	NA	48.60	49.80
5510		NA	NA	48.60	49.80
5520		NA	NA	48.60	49.80
5580		NA	NA	48.50	49.60
5590		NA	NA	48.50	49.50
5600		NA	NA	48.50	49.60
5620		NA	NA	48.40	49.50
5670		NA	NA	48.40	49.40
5680		NA	NA	48.40	49.40
5700		NA	NA	48.30	49.40
5745		NA	NA	48.30	49.30
5755		NA	NA	48.30	49.20
5785		NA	NA	48.20	49.20
5795		NA	NA	48.20	49.20
5800		NA	NA	48.20	49.20
5805		NA	NA	48.20	49.20
Dielectric Parameters Required at 21℃					

LIQUID TYPE		HSL-5800		MSL-5800	
SIMULATING LIQUID TEMP.		NA		21.5	
TEST DATE		NA		Jan. 19, 2008	
TESTED BY		NA		Sam Onn	
FREQ. (MHz)	LIQUID PARAMETER	STANDARD VALUE	MEASUREMENT VALUE	STANDARD VALUE	MEASUREMENT VALUE
5180	Conductivity (σ) S/m	NA	NA	5.28	5.27
5190		NA	NA	5.29	5.28
5200		NA	NA	5.30	5.30
5230		NA	NA	5.33	5.34
5240		NA	NA	5.35	5.36
5260		NA	NA	5.37	5.39
5270		NA	NA	5.38	5.40
5310		NA	NA	5.43	5.46
5320		NA	NA	5.44	5.48
5500		NA	NA	5.65	5.74
5510		NA	NA	5.66	5.75
5520		NA	NA	5.67	5.77
5580		NA	NA	5.74	5.85
5590		NA	NA	5.75	5.86
5600		NA	NA	5.77	5.88
5620		NA	NA	5.79	5.92
5670		NA	NA	5.85	5.98
5680		NA	NA	5.86	6.00
5700		NA	NA	5.88	6.03
5745		NA	NA	5.94	6.10
5755		NA	NA	5.95	6.11
5785		NA	NA	5.98	6.16
5795		NA	NA	5.99	6.18
5800		NA	NA	6.00	6.19
5805		NA	NA	6.01	6.21
Dielectric Parameters Required at 21℃					

LIQUID TYPE		HSL-5800		MSL-5800	
SIMULATING LIQUID TEMP.		NA		21.4	
TEST DATE		NA		Jan. 20, 2008	
TESTED BY		NA		Sam Onn	
FREQ. (MHz)	LIQUID PARAMETER	STANDARD VALUE	MEASUREMENT VALUE	STANDARD VALUE	MEASUREMENT VALUE
5180	Permitivity (ε)	NA	NA	49.00	50.10
5190		NA	NA	49.00	50.00
5200		NA	NA	49.00	50.00
5230		NA	NA	49.00	49.90
5240		NA	NA	49.00	49.90
5260		NA	NA	48.90	49.90
5270		NA	NA	48.90	49.90
5310		NA	NA	48.90	49.80
5320		NA	NA	48.90	49.80
5500		NA	NA	48.60	49.40
5510		NA	NA	48.60	49.40
5520		NA	NA	48.60	49.40
5580		NA	NA	48.50	49.20
5590		NA	NA	48.50	49.20
5600		NA	NA	48.50	49.20
5620		NA	NA	48.40	49.20
5670		NA	NA	48.40	49.00
5680		NA	NA	48.40	49.00
5700		NA	NA	48.30	49.00
5745		NA	NA	48.30	48.90
5755		NA	NA	48.30	48.90
5785		NA	NA	48.20	48.90
5795		NA	NA	48.20	48.80
5800		NA	NA	48.20	48.80
5805		NA	NA	48.20	48.80
Dielectric Parameters Required at 21℃					

LIQUID TYPE		HSL-5800		MSL-5800	
SIMULATING LIQUID TEMP.		NA		21.4	
TEST DATE		NA		Jan. 20, 2008	
TESTED BY		NA		Sam Onn	
FREQ. (MHz)	LIQUID PARAMETER	STANDARD VALUE	MEASUREMENT VALUE	STANDARD VALUE	MEASUREMENT VALUE
5180	Conductivity (σ) S/m	NA	NA	5.28	5.24
5190		NA	NA	5.29	5.25
5200		NA	NA	5.30	5.27
5230		NA	NA	5.33	5.31
5240		NA	NA	5.35	5.33
5260		NA	NA	5.37	5.36
5270		NA	NA	5.38	5.37
5310		NA	NA	5.43	5.43
5320		NA	NA	5.44	5.45
5500		NA	NA	5.65	5.71
5510		NA	NA	5.66	5.72
5520		NA	NA	5.67	5.74
5580		NA	NA	5.74	5.82
5590		NA	NA	5.75	5.83
5600		NA	NA	5.77	5.85
5620		NA	NA	5.79	5.88
5670		NA	NA	5.85	5.95
5680		NA	NA	5.86	5.97
5700		NA	NA	5.88	6.00
5745		NA	NA	5.94	6.07
5755		NA	NA	5.95	6.08
5785		NA	NA	5.98	6.13
5795		NA	NA	5.99	6.14
5800		NA	NA	6.00	6.15
5805		NA	NA	6.01	6.17
Dielectric Parameters Required at 21℃					

5.5 TEST EQUIPMENT FOR TISSUE PROPERTY

ITEM	NAME	BAND	TYPE	SERIES NO.	CALIBRATED UNTIL
1	Network Analyzer	Agilent	E8358A	US41480538	Nov. 11, 2008
2	Dielectric Probe	Agilent	85070D	US01440176	NA

NOTE:

1. Before starting, all test equipment shall be warmed up for 30min.
2. The tolerance (k=1) specified by Agilent for general dielectric measurements, deriving from inaccuracies in the calibration data, analyzer drift, and random errors, are usually ±2.5% and ±5% for measured permittivity and conductivity, respectively. However, the tolerances for the conductivity is smaller for material with large loss tangents, i.e., less than ±2.5% (k=1). It can be substantially smaller if more accurate methods are applied.

6. SYSTEM VALIDATION

The system validation was performed in the flat phantom with equipment listed in the following table. Since the SAR value is calculated from the measured electric field, dielectric constant and conductivity of the body tissue, and the SAR is proportional to the square of the electric field. So, the SAR value will be also proportional to the RF power input to the system validation dipole under the same test environment. In our system validation test, 250mW RF input power was used.

6.1 TEST EQUIPMENT

ITEM	NAME	BAND	TYPE	SERIES NO.	CALIBRATED UNTIL
1	SAM Phantom	S & P	QD000 P40 CA	PT-1150	NA
2	Signal Generator	Anritsu	68247B	984703	May 18, 2008
3	E-Field Probe	Speaq	EX3DV3	3506	Mar. 19, 2008
4	DAE	Speaq	DAE	579	Mar. 22, 2008
5	Robot Positioner	Staubli Unimation	NA	NA	NA
6	Validation Dipole	Speaq	D2450V2	737	Apr. 23, 2008
7	Validation Dipole	Speaq	D5GHzV2	1018	Apr. 18, 2008

NOTE: Before starting the measurement, all test equipment shall be warmed up for 30min.

6.2 TEST PROCEDURE

Before the system performance check, we need only to tell the system which components (probe, medium, and device) are used for the system performance check; the system will take care of all parameters. The dipole must be placed beneath the flat section of the SAM Twin Phantom with the correct distance holder in place. The distance holder should touch the phantom surface with a light pressure at the reference marking (little cross) and be oriented parallel to the long side of the phantom. Accurate positioning is not necessary, since the system will search for the peak SAR location, except that the dipole arms should be parallel to the surface. The device holder for mobile phones can be left in place but should be rotated away from the dipole.

The ”Power Reference Measurement” and ”Power Drift Measurement” jobs are located at the beginning and end of the batch process. They measure the field drift at one single point in the liquid over the complete procedure. The indicated drift is mainly the variation of the amplifier output power. If it is too high (above ±0.1 dB), the system performance check should be repeated; some amplifiers have very high drift during warm-up. A stable amplifier gives drift results in the DASY system below ±0.02dB.

The ”Surface Check” job tests the optical surface detection system of the DASY system by repeatedly detecting the surface with the optical and mechanical surface detector and comparing the results. The output gives the detecting heights of both systems, the difference between the two systems and the standard deviation of the detection repeatability. Air bubbles or refraction in the liquid due to separation of the sugar-water mixture gives poor repeatability (above ±0.1mm). In that case it is better to abort the system performance check and stir the liquid. The difference between the optical surface detection and the actual surface depends on the probe and is specified with each probe. (It does not depend on the surface reflectivity or the probe angle to the surface within $\pm 30^{O}$.) However, varying breaking indices of different liquid compositions might also influence the distance. If the indicated difference varies from the actual setting, the probe parameter ”optical surface

The ”Area Scan” job measures the SAR above the dipole on a plane parallel to the surface. It is used to locate the approximate location of the peak SAR. The proposed scan uses large grid spacing for faster measurement; due to the symmetric field, the peak detection is reliable. If a finer graphic is desired, the grid spacing can be reduced. Grid spacing and orientation have no influence on the SAR result.

The ”Zoom Scan” job measures the field in a volume around the peak SAR value assessed in the previous ”Area Scan” job (for more information see the application note on SAR evaluation).

About the validation dipole positioning uncertainty, the constant and low loss dielectric spacer is used to establish the correct distance between the top surface of the dipole and the bottom surface of the phantom, the error component introduced by the uncertainty of the distance between the liquid (i.e., phantom shell) and the validation dipole in the DASY4 system is less than ±0.1mm.

$$SAR_{tolerance}[\%] = 100 \times (\frac{(a+d)^2}{a^2} - 1)$$

As the closest distance is 10mm, the resulting tolerance $SAR_{tolerance}[\%]$ is <2%.

6.3 VALIDATION RESULTS

SYSTEM VALIDATION TEST IN THE MUSCLE SIMULATING LIQUID					
TEST FREQUENCY (MHz)	REQUIRED SAR (mW/g)	MEASURED SAR (mW/g)	DEVIATION (%)	SEPARATION DISTANCE	TEST DATE
MSL2450	12.90 (1g)	12.20	-5.43	10mm	Jan. 17, 2008
MSL5200	19.50 (1g)	19.30	-1.03	10mm	Jan. 18, 2008
MSL5200	19.50 (1g)	19.10	-2.05	10mm	Jan. 19, 2008
MSL5200	19.50 (1g)	19.20	-1.54	10mm	Jan. 20, 2008
MSL5500	19.60 (1g)	19.10	-2.55	10mm	Jan. 18, 2008
MSL5500	19.60 (1g)	18.70	-4.59	10mm	Jan. 19, 2008
MSL5500	19.60 (1g)	18.90	-3.57	10mm	Jan. 20, 2008
MSL5800	17.60 (1g)	17.20	-2.27	10mm	Jan. 18, 2008
MSL5800	17.60 (1g)	17.00	-3.41	10mm	Jan. 19, 2008
MSL5800	17.60 (1g)	17.10	-2.84	10mm	Jan. 20, 2008
TESTED BY	Sam Onn				

NOTE: Please see Appendix for the photo of system validation test.

6.4 SYSTEM VALIDATION UNCERTAINTIES

In the table below, the system validation uncertainty with respect to the analytically assessed SAR value of a dipole source as given in the IEEE 1528 standard is given. This uncertainty is smaller than the expected uncertainty for mobile phone measurements due to the simplified setup and the symmetric field distribution.

Error Description	Tolerance (±%)	Probability Distribution	Divisor	(C_i)		Standard Uncertainty (±%)		(v_i)
				(1g)	(10g)	(1g)	(10g)	
Measurement System								
Probe Calibration	4.8	Normal	1	1	1	4.8	4.8	∞
Axial Isotropy	4.7	Rectangular	$\sqrt{3}$	1	1	2.7	2.7	∞
Hemispherical Isotropy	0	Rectangular	$\sqrt{3}$	1	1	0	0	∞
Boundary effect	1.0	Rectangular	$\sqrt{3}$	1	1	0.6	0.6	∞
Linearity	4.7	Rectangular	$\sqrt{3}$	1	1	2.7	2.7	∞
System Detection Limit	1.0	Rectangular	$\sqrt{3}$	1	1	0.6	0.6	∞
Readout Electronics	1.0	Normal	1	1	1	1.0	1.0	∞
Response Time	0	Rectangular	$\sqrt{3}$	1	1	0	0	∞
Integration Time	0	Rectangular	$\sqrt{3}$	1	1	0	0	∞
RF Ambient Conditions	3.0	Rectangular	$\sqrt{3}$	1	1	1.7	1.7	∞
Probe Positioner	0.4	Rectangular	$\sqrt{3}$	1	1	0.2	0.2	∞
Probe positioning	2.9	Rectangular	$\sqrt{3}$	1	1	1.7	1.7	∞
Algorithms for Max. SAR Evaluation	1.0	Rectangular	$\sqrt{3}$	1	1	0.6	0.6	∞
Dipole								
Dipole Axis to Liquid Distance	2.0	Rectangular	$\sqrt{3}$	1	1	1.2	1.2	∞
Input power and SAR drift measurement	4.7	Rectangular	$\sqrt{3}$	1	1	2.7	2.7	∞
Phantom and Tissue Parameters								
Phantom Uncertainty	4.0	Rectangular	$\sqrt{3}$	1	1	2.3	2.3	∞
Liquid Conductivity (target)	5.0	Rectangular	$\sqrt{3}$	0.64	0.43	1.8	1.2	∞
Liquid Conductivity (measurement)	2.5	Normal	1	0.64	0.43	1.6	1.1	∞
Liquid Permittivity (target)	5.0	Rectangular	$\sqrt{3}$	0.6	0.49	1.7	1.4	∞
Liquid Permittivity (measurement)	2.5	Normal	1	0.6	0.49	1.5	1.2	∞
Combined Standard Uncertainty						8.4	8.1	∞
Coverage Factor for 95%						kp=2		
Expanded Uncertainty (K=2)						16.8	16.2	

NOTE: About the system validation uncertainty assessment, please reference the section 7.

7. MEASUREMENT SAR PROCEDURE UNCERTAINTIES

The assessment of spatial peak SAR of the hand handheld devices is according to IEEE 1528. All testing situation shall be met below these requirements.

• The system is used by an experienced engineer who follows the manual and the guidelines taught during the training provided by SPEAG.

• The probe has been calibrated within the requested period and the stated uncertainty for the relevant frequency bands does not exceed 4.8% (k=1).

• The validation dipole has been calibrated within the requested period and the system performance check has been successful.

• The DAE unit has been calibrated within the within the requested period.

• The minimum distance between the probe sensor and inner phantom shell is selected to be between 4 and 5mm.

• The operational mode of the DUT is CW, CDMA, FDMA or TDMA (GSM, DCS, PCS, IS136 and PDC) and the measurement/integration time per point is >500 ms.

• The dielectric parameters of the liquid have been assessed using Agilent 85070D dielectric probe kit or a more accurate method.

• The dielectric parameters are within 5% of the target values.

• The DUT has been positioned as described in section 3.

7.1. PROBE CALIBRATION UNCERTAINTY

SPEAG conducts the probe calibration in compliance with international and national standards (e.g. IEEE 1528, EN 50361, IEC 62209, etc.) under ISO17025. The uncertainties are stated on the calibration certificate. For the most relevant frequency bands, these values do not exceed 4.8% (k=1). If evaluations of other bands are performed for which the uncertainty exceeds these values, the uncertainty tables given in the summary have to be revised accordingly.

7.2. ISOTROPY UNCERTAINTY

The axial isotropy tolerance accounts for probe rotation around its axis while the hemispherical isotropy error includes all probe orientations and field polarizations. These parameters are assessed by SPEAG during initial calibration. In 2001, SPEAG further tightened its quality controls and warrants that the maximal deviation from axial isotropy is ±0.20dB, while the maximum deviation of hemispherical isotropy is ±0.40dB, corresponding to ±4.7% and ±9.6%, respectively. A weighting factor of cp equal to 0.5 can be applied, since the axis of the probe deviates less than 30 degrees from the normal surface orientation.

7.3. BOUNDARY EFFECT UNCERTAINTY

The effect can be estimated according to the following error approximation formula

$$SAR_{tolerance}[\%] = SAR_{be}[\%] \times \frac{(d_{be} + d_{step})^2}{2d_{step}} \frac{e^{-\frac{d_{be}}{\delta/2}}}{\delta/2}$$

$$d_{be} + d_{step} < 10mm$$

The parameter d_{be} is the distance in mm between the surface and the closest measurement point used in the averaging process; d_{step} is the separation distance in mm between the first and second measurement points; δ is the minimum penetration depth in mm within the head tissue equivalent liquids (i.e., δ= 13.95mm at 3GHz); SAR_{be} is the deviation between the measured SAR value at the distance d_{be} from the boundary and the wave-guide analytical value SAR_{ref}.DASY4 applies a boundary effect compensation algorithm according to IEEE 1528, which is possible since the axis of the probe never deviates more than 30 degrees from the normal surface orientation. SAR_{be}[%] is assessed during the calibration process and SPEAG warrants that the uncertainty at distances larger than 4mm is always less than 1%.In summary, the worst case boundary effect SAR tolerance[%] for scanning distances larger than 4mm is < ± 0.8%.

7.4. PROBE LINEARITY UNCERTAINTY

Field probe linearity uncertainty includes errors from the assessment and compensation of the diode compression effects for CW and pulsed signals with known duty cycles. This error is assessed using the procedure described in IEEE 1528. For SPEAG field probes, the measured difference between CW and pulsed signals, with pulse frequencies between 10Hz and 1kHz and duty cycles between 1 and 100, is < ±0.20dB (< ±4.7%).

7.5. READOUT ELECTRONICS UNCERTAINTY

All uncertainties related to the probe readout electronics (DAE unit), including the gain and linearity of the instrumentation amplifier, its loading effect on the probe, and accuracy of the signal conversion algorithm, have been assessed accordingly to IEEE 1528.The combination (root-sum-square RSS method) of these components results in an overall maximum error of ±1.0%.

7.6. RESPONSE TIME UNCERTAINTY

The time response of the field probes is assessed by exposing the probe to a well-controlled electric field producing SAR larger than 2.0W/kg at the tissue medium surface. The signal response time is evaluated as the time required by the system to reach 90% of the expected final value after an on/of switch of the power source. Analytically, it can be expressed as:

$$SAR_{tolerance}[\%] = 100 \times (\frac{T_m}{T_m + \tau e^{-T_m/\tau} - \tau} - 1)$$

where Tm is 500 ms, i.e., the time between measurement samples, and τ the time constant. The response time τ of SPEAG's probes is <5ms. In the current implementation, DASY4 waits longer than 100 ms after having reached the grid point before starting a measurement, i.e., the response time uncertainty is negligible.

7.7. INTEGRATION TIME UNCERTAINTY

If the device under test does not emit a CW signal, the integration time applied to measure the electric field at a specific point may introduce additional uncertainties due to the discretization and can be assessed as follows

$$SAR_{tolerance}[\%] = 100 \times \sum_{allsub-frames} \frac{t_{frame}}{t_{integration}} \frac{slot_{idle}}{slot_{total}}$$

The tolerances for the different systems are given in Table 7.1, whereby the worst-case $SAR_{tolerance}$ is 2.6%.

System	$SAR_{tolerance}$ %
CW	0
CDMA*	0
WCDMA*	0
FDMA	0
IS-136	2.6
PDC	2.6
GSM/DCS/PCS	1.7
DECT	1.9
Worst-Case	2.6

TABLE 7.1

7.8. PROBE POSITIONER MECHANICAL TOLERANCE

The mechanical tolerance of the field probe positioner can introduce probe positioning uncertainties. The resulting SAR uncertainty is assessed by comparing the SAR obtained according to the specifications of the probe positioner with respect to the actual position defined by the geometric enter of the probe sensors. The tolerance is determined as:

$$SAR_{tolerance}[\%] = 100 \times \frac{d_{ph}}{\delta/2}$$

The specified repeatability of the RX robot family used in DASY4 systems is ±25μm. The absolute accuracy for short distance movements is better than ±0.1mm, i.e., the $SAR_{tolerance}$[%] is better than 1.5% (rectangular).

7.9. PROBE POSITIONING

The probe positioning procedures affect the tolerance of the separation distance between the probe tip and the phantom surface as:

$$SAR_{tolerance}[\%] = 100 \times \frac{d_{ph}}{\delta/2}$$

where d_{ph} is the maximum deviation of the distance between the probe tip and the phantom surface. The optical surface detection has a precision of better than 0.2mm, resulting in an $SAR_{tolerance}$[%] of <2.9% (rectangular distribution). Since the mechanical detection provides better accuracy, 2.9% is a worst-case figure for DASY4 system.

7.10. PHANTOM UNCERTAINTY

The SAR measurement uncertainty due to SPEAG phantom shell production tolerances has been evaluated using

$$SAR_{tolerance}[\%] \cong 100 \times \frac{2d}{a}, \qquad d << a$$

For a maximum deviation d of the inner and outer shell of the phantom from that specified in the CAD file of ±0.2mm, and a 10mm spacing a between source and tissue liquid, the calculated phantom uncertainty is ±4.0%.

7.11. DASY4 UNCERTAINTY BUDGET (FOR 2.4GHz)

Error Description	Tolerance (±%)	Probability Distribution	Divisor	(C_i) (1g)	(C_i) (10g)	Standard Uncertainty (±%) (1g)	Standard Uncertainty (±%) (10g)	(v_i)
Measurement Equipment								
Probe Calibration	4.8	Normal	1	1	1	4.8	4.8	∞
Axial Isotropy	4.7	Rectangular	$\sqrt{3}$	1	1	1.9	1.9	∞
Hemispherical Isotropy	9.6	Rectangular	$\sqrt{3}$	1	1	3.9	3.9	∞
Boundary effect	1.0	Rectangular	$\sqrt{3}$	1	1	0.6	0.6	∞
Linearity	4.7	Rectangular	$\sqrt{3}$	1	1	2.7	2.7	∞
System Detection Limit	1.0	Rectangular	$\sqrt{3}$	1	1	0.6	0.6	∞
Readout Electronics	1.0	Normal	1	1	1	1.0	1.0	∞
Response Time	0.8	Normal	1	1	1	0.8	0.8	∞
Integration Time	2.6	Normal	1	1	1	2.6	2.6	∞
Noise	0.0	Normal	1	0	0	0	0	∞
Mechanical Constraints								
Scanning System	0.4	Rectangular	$\sqrt{3}$	1	1	0.2	0.2	∞
Phantom Shell	4.0	Rectangular	$\sqrt{3}$	1	1	2.3	2.3	∞
Probe Positioning	2.9	Rectangular	$\sqrt{3}$	1	1	1.7	1.7	∞
Device Positioning	2.9	Normal	1	1	1	2.9	2.9	875
Physical Parameters								
Liquid Conductivity (target)	5.0	Rectangular	$\sqrt{3}$	0.7	0.5	2	1.4	∞
Liquid Conductivity (measurement)	4.3	Rectangular	$\sqrt{3}$	0.7	0.5	1.7	1.2	∞
Liquid Permittivity (target)	5.0	Rectangular	$\sqrt{3}$	0.6	0.5	1.7	1.4	∞
Liquid Permittivity (measurement)	4.3	Rectangular	$\sqrt{3}$	0.6	0.5	1.5	1.2	∞
Power Drift	5	Rectangular	$\sqrt{3}$	1	1	2.9	2.9	∞
RF Ambient Conditions	3.0	Rectangular	$\sqrt{3}$	1	1	1.7	1.7	∞
Post-Processing								
Extrapolation and Integration	1	Rectangular	$\sqrt{3}$	1	1	0.6	0.6	∞
Combined Standard Uncertainty						**9.9**	**9.7**	
Coverage Factor for 95%						**kp=2**		
Expanded Uncertainty (K=2)						**19.9**	**19.3**	

TABLE 7.2

The table 7.2: Worst-Case uncertainty budget for DASY4 assessed according to IEEE 1528. The budget is valid for the frequency range 300MHz ~ 3GHz and represents a worst-case analysis. For specific tests and configurations, the uncertainty could be considerable smaller.

7.12.DASY4 UNCERTAINTY BUDGET (FOR 5 ~ 6GHz)

Error Description	Tolerance (±%)	Probability Distribution	Divisor	(C_i)		Standard Uncertainty (±%)		(v_i)
				(1g)	(10g)	(1g)	(10g)	
Measurement System								
Probe Calibration	6.8	Normal	1	1	1	6.8	6.8	∞
Axial Isotropy	4.7	Rectangular	$\sqrt{3}$	0.7	0.7	1.9	1.9	∞
Hemispherical Isotropy	9.6	Rectangular	$\sqrt{3}$	0.7	0.7	3.9	3.9	∞
Boundary effect	2.0	Rectangular	$\sqrt{3}$	1	1	1.2	1.2	∞
Linearity	4.7	Rectangular	$\sqrt{3}$	1	1	2.7	2.7	∞
System Detection Limit	1.0	Rectangular	$\sqrt{3}$	1	1	0.6	0.6	∞
Readout Electronics	1.0	Normal	1	1	1	1.0	1.0	∞
Response Time	0.8	Rectangular	$\sqrt{3}$	1	1	0.5	0.5	∞
Integration Time	2.6	Rectangular	$\sqrt{3}$	1	1	1.5	1.5	∞
RF Ambient Conditions	3.0	Rectangular	$\sqrt{3}$	1	1	1.7	1.7	∞
Probe Positioner	0.8	Rectangular	$\sqrt{3}$	1	1	0.5	0.5	∞
Probe positioning	5.7	Normal	1	1	1	5.7	5.7	∞
Algorithms for Max. SAR Evaluation	4.0	Rectangular	$\sqrt{3}$	1	1	2.3	2.3	∞
Test EUT Related								
Device Positioning	2.9	Normal	1	1	1	2.9	2.9	145
Device Holder	3.6	Normal	1	1	1	3.6	3.6	5
Power Drift	5.0	Rectangular	$\sqrt{3}$	1	1	2.9	2.9	∞
Phantom and Tissue Parameters								
Phantom Uncertainty	4.0	Rectangular	$\sqrt{3}$	1	1	2.3	2.3	∞
Liquid Conductivity (target)	5.0	Rectangular	$\sqrt{3}$	0.64	0.43	1.8	1.2	∞
Liquid Conductivity (measurement)	2.5	Normal	1	0.64	0.43	1.6	1.1	∞
Liquid Permittivity (target)	5.0	Rectangular	$\sqrt{3}$	0.60	0.49	1.7	1.4	∞
Liquid Permittivity (measurement)	2.5	Normal	1	0.60	0.49	1.5	1.2	∞
Combined Standard Uncertainty						12.8	12.7	330
Expanded STD Uncertainty						**25.7**	**25.3**	

TABLE 7.3

The table 7.3: Worst-Case uncertainty budget for DASY4 valid for the frequency range 5 ~ 6 GHz. Probe calibration error reflects uncertainty of the narrow-bandwidth EX3DV3 probe conversion factor (±50 MHz).

8. INFORMATION ON THE TESTING LABORATORIES

We, ADT Corp., were founded in 1988 to provide our best service in EMC, Radio, Telecom and Safety consultation. Our laboratories are accredited and approved by the following approval agencies according to ISO/IEC 17025.

USA	FCC, UL, A2LA
GERMANY	TUV Rheinland
JAPAN	VCCI
NORWAY	NEMKO
CANADA	INDUSTRY CANADA , CSA
R.O.C.	TAF, BSMI, NCC
NETHERLANDS	Telefication
SINGAPORE	GOST-ASIA (MOU)
RUSSIA	CERTIS (MOU)

Copies of accreditation certificates of our laboratories obtained from approval agencies can be downloaded from our web site: www.adt.com.tw/index.5/phtml. If you have any comments, please feel free to contact us at the following:

Linko EMC/RF Lab:
Tel: 886-2-26052180
Fax: 886-2-26051924

Hsin Chu EMC/RF Lab:
Tel: 886-3-5935343
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Hwa Ya EMC/RF/Safety/Telecom Lab:
Tel: 886-3-3183232
Fax: 886-3-3185050

Web Site: www.adt.com.tw

The address and road map of all our labs can be found in our web site also.