Head office & Test Lab: 28(175-20,Annyeong-dong)
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FCC SAR TEST REPORT

Report No: KST-FCS-140003

Applicant	:	Bluebird Inc.
Manufacturer	:	Bluebird Inc.
Equipment	:	Countertop Payment Terminal
Brand Name	:	-
Model Name	:	P3500
Standard	:	FCC 47 CFR Parts 1 & 2 FCC KDB 865664 Published RF Exposure KDB Procedures, and TCB workshop updates
Test Date(s)	:	2014.12.12 ~ 2014.12.16
Issue Date	:	2014.12.18
Test Result	:	Compliance
Note	:	-

Supplementary Information

The measurements shown in this test report were found to be in accordance with the requirements given in each KDB Guidance Publications and Rule References and in accordance with the procedure given in standard FCC KDB 865664.

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

Tested by	Mi Young, Lee / Engineer	Approved by	Gyeong Hyeon, Park / Manager
Signature		Signature	

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1. Statement of Compliance

The maximum results of Specific Absorption Rate (SAR) found during testing for DUT are as follows.

Body Worn Configuration

Mode	Position	1g SAR [W/㎏]
GSM850	Rear	0.955
GSM1900	Rear	0.938
WLAN(802.11b)	Front	0.043

*Max SAR value

This device is in compliance with Specific Absorption Rate (SAR) for general population/uncontrolled exposure limits (1.6 W/㎏) specified in ANSI C95.1 – 1999 Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Field, 3 ㎑ to 300 ㎓[2], ANSI C95.3 – 2002 Recommended Practice for the measurement of Potentially Hazardous Electromagnetic Field [3], 47 C.F.R. § 2.1093, FCC KDB 865664.

1-1 Test Method List

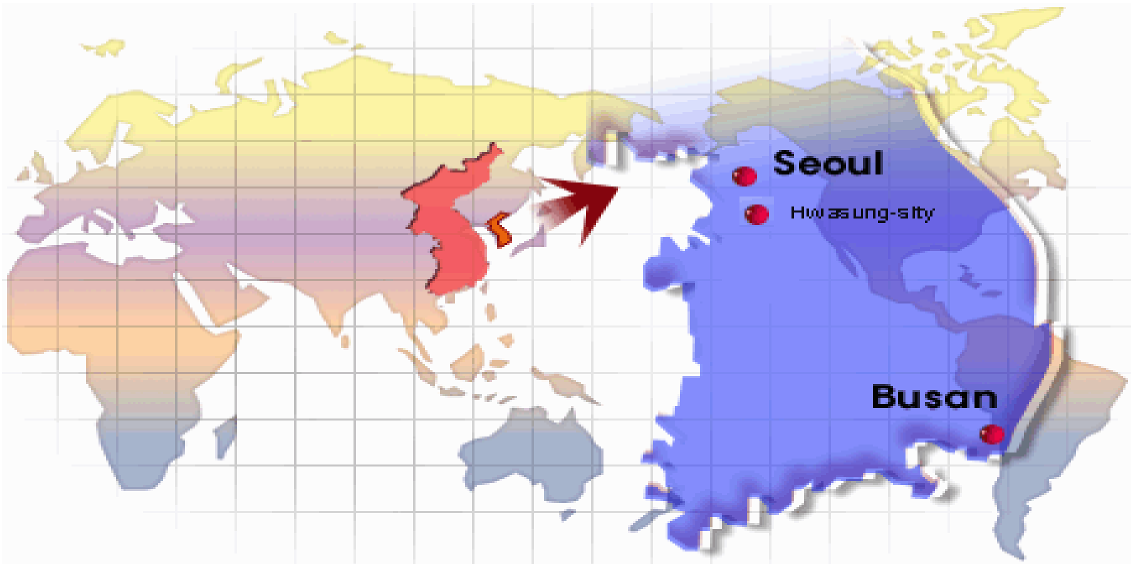
447498 D01 General RF Exposure Guidance v05r02
941225 D01 SAR test for 3G devices v02
941225 D03 SAR Test Reduction GSM GPRS EDGE v01
248227 D01 SAR Meas for 802 11abg v01r02
865664 D01 SAR Measurement 100 MHz to 6 GHz v01r03
865664 D02 SAR Reporting v01r01
690783 D01 SAR Listings on Grants v01r03

2. Administration Data

2.1 Test Laboratory

KOSTEC Co., Ltd.
28(175-20,Annyeong-dong)406-gil sejaro, Hwaseong-si Gyeonggi-do, Korea

2.2 Location



2.3 Applicant

Bluebird Inc.
(Dogok-dong, SEI Tower 13~14), 39, Eonju-ro30-gil, Gangnam-gu, Seoul, Korea

2.4 Manufacturer

Bluebird Inc.
(Dogok-dong, SEI Tower 13~14), 39, Eonju-ro30-gil, Gangnam-gu, Seoul, Korea

2.5 Application Details

Date of Receipt of application : 2014.11.25
Date of Start during the test : 2014.12.12
Date of End during the test : 2014.12.16

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3. GENERAL INFORMATION

3.1 Description of DUT

DUT Type	Portable devices
Device Category	General population/Uncontrolled exposure
Brand Name	-
Model Name	P3500
Accessory	Not supported
Battery Options	Standard only supplied : Li-on battery, Rating 7.4 Vdc
Modulation Type	GPRS: GMSK 802.11b: DSSS (DBPSK / DQPSK / CCK) 802.11g/n(HT20): OFDM (BPSK / QPSK / 16QAM / 64QAM) NFC: ASK
Frequency Range	GSM 850: 824.2 MHz - 848.8 MHz GSM1900: 1 850.2 MHz – 1 909.8 MHz 802.11b/g: 2 412 MHz – 2 462 MHz 802.11n(HT20): 2 412 MHz – 2 462 MHz NFC: 13.561 MHz
Device Class	B
Duty Cycle	GPRS for GSM850 : 1:4.3 GPRS for GSM1 900 : 1:4.3 WLAN: 1:1
GPRS Multi slot Class	Class10(Max number of timeslots in uplink:2 downlink: 4, Max total timeslots: 5
Power Class	GSM 850: Class 4 GSM1 900: Class 1
Operating Mode	For GSM SAR testing, Maximum continuous output using GSM call equipment. For WLAN SAR testing, WLAN Hyper terminal software using test command can provide continuous transmitting RF signal.
Antenna Specification	GSM850 : Internal FPCB Antenna, Max.gain: -2.2 dBi GSM1 900: Internal FPCB Antenna, Max.gain: 1.5 dBi 2 GHz: Internal Metal Press Antenna, Max.gain: -3.2 dBi
Max. Output power(conducted)	GSM 850: 31.34 dBm GSM1 900: 27.98 dBm 802.11b: 14.56 dBm
Max.SAR(1g)	0.955 W/kg
Remark	- The data rates used when evaluating the WLAN transmitter were the lowest data rates for each mode. The device was operating at its maximum output power at the lowest data rate for all measurements. - The GPRS mode does not simultaneously transmit with the WLAN transmitter. - This device is not supported for DTM(Dual Transfer Mode) - The above DUT's information was declared by manufacturer. Please refer to the specifications or user manual for more detailed description.

3.1.1 Simultaneous Transmission Condition

RF Exposure configuration	Capable Transmit Configurations
Head	N/A
Body-worn	N/A
Wireless Router(Hotspot) & WLAN Direct	N/A

Note:
1. Wi-Fi 2.4GHz and GPRS are not supported Hotspot.
2. Wi-Fi 2.4 GHz cannot transmit simultaneously with GPRS

3.1.2 The DUT conducted power measurements

▣ GPRS

GSM 850		Burst-Averaged output power(dB m)			Scale factor (Division factor)	Frame-Averaged output power(dB m)		
		128CH (824.2 ㎒)	190CH (836.6 ㎒)	251CH (848.8 ㎒)		128CH (824.2 ㎒)	190CH (836.6 ㎒)	251CH (848.8 ㎒)
GPRS (GMSK)	1 TX slot	31.34	31.29	31.28	-9.03	22.31	22.26	22.25
	2 TX slot	31.31	31.26	31.25	-6.02	**25.29**	**25.24**	**25.23**

Tune-up limit power	Scaling Factor		
	128CH (824.2MHz)	190CH (836.6MHz)	251CH (848.8MHz)
32.00	1.16	1.18	1.18
32.00	1.17	1.19	1.19

GSM 1900		Burst-Averaged output power(dB m)			Scale factor (Division factor)	Frame-Averaged output power(dB m)		
		512CH (1850.2 ㎒)	661CH (1880 ㎒)	810CH (1909.8 ㎒)		512CH (1850.2 ㎒)	661CH (1880 ㎒)	810CH (1909.8 ㎒)
GPRS (GMSK)	1 TX slot	27.98	27.74	27.68	-9.03	18.95	18.71	18.65
	2 TX slot	27.94	27.72	27.66	-6.02	**21.92**	**21.70**	**21.64**

Tune-up limit power	Scaling Factor		
	128CH (824.2MHz)	190CH (836.6MHz)	251CH (848.8MHz)
29.00	1.26	1.34	1.36
29.00	1.28	1.34	1.36

Note:

1. The frame-averaged power is linearly scaled the maximum burst-averaged power based on time slots. The calculated methods are shown as below:
   1 up link time slot ratio = 1:8 = 10*log(1/8) = -9.03 (Crest factor 8.3)
   2 up link time slot ratio = 2:8 = 10*log(2/8) = -6.02 (Crest factor 4)

2. According to frame-averaged output, Body SAR was performed at GPRS 2 TX slot.
   The maximum powers are marks in bold.

3. For Body -worn SAR testing, the EUT was set in GPRS 2 Tx slots for GSM850 and GPRS 2 Tx GSM1 900 due to its highest frame-average power.

4. The above DUT information is declared by manufacturer and for more detailed features description please refer to the manufacturer's specification or user manual.

▣ WLAN

802.11b	Conducted average power(㏈m)			Tune-up limit power	Scaling Factor		
Channel	1	6	11				
Freq (㎒)	2412	2437	2462				
1Mbps	13.97	14.50	14.15	15.00	1.27	1.12	1.22
2Mbps	14.05	**14.56**	14.13	15.00	1.24	1.11	1.22
5.5Mbps	14.14	14.45	14.21	15.00	1.22	1.14	1.20
11Mbps	13.91	14.20	13.92	15.00	1.29	1.20	1.28

802.11g	Conducted average power(㏈m)			Tune-up limit power	Scaling Factor		
Channel	1	6	11				
Freq (㎒)	2412	2437	2462				
6Mbps	10.84	11.20	11.17	12.00	1.31	1.20	1.21
9Mbps	10.74	10.95	10.94	12.00	1.34	1.27	1.28
12Mbps	10.52	10.93	10.84	12.00	1.41	1.28	1.31
18Mbps	10.37	10.74	10.70	12.00	1.46	1.34	1.35
24Mbps	10.20	10.61	10.53	12.00	1.51	1.38	1.40
36Mbps	9.91	10.35	10.17	12.00	1.62	1.46	1.52
48Mbps	9.60	9.96	9.93	12.00	1.74	1.60	1.61
54Mbps	9.47	9.97	9.82	12.00	1.79	1.60	1.65

802.11n(HT20)	Conducted average power(㏈m)			Tune-up limit power	Scaling Factor		
Channel	1	6	11				
Freq (㎒)	2412	2437	2462				
MCS0	10.55	11.06	10.87	12.00	1.40	1.24	1.30
MCS1	10.33	10.85	10.53	12.00	1.47	1.30	1.40
MCS2	10.12	10.70	10.37	12.00	1.54	1.35	1.46
MCS3	10.11	10.53	10.24	12.00	1.55	1.40	1.50
MCS4	9.89	10.12	10.05	12.00	1.63	1.54	1.57
MCS5	9.60	9.87	9.70	12.00	1.74	1.63	1.70
MCS6	9.34	9.80	9.62	12.00	1.85	1.66	1.73
MCS7	9.30	9.69	9.54	12.00	1.86	1.70	1.76

Note:
1) Conducted output power: The maximum powers are marks in bold.
2) Per WLAN, measured maximum average power using power meter.
3) Per KDB 248227 D01 V01r02, choose the highest output power channel to test SAR and determine further SAR exclusion.
4) Per KDB 248227 D01 v01r02, 11g, 11n(HT20) output power is less than 1/4 ㏈ higher than 11b mode, thus the SAR can be excluded.

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3.1.3 RF Output Power Tolerance

RF Transmitters	Mode	RF Output Power (dBm)		Tolerance (dB)
		Target	Max. tune-up tolerance limit	
GSM850 (GPRS)	1 TX slot	31	32	± 1
	2 TX slot	31	32	± 1
GSM 1900 (GPRS)	1 TX slot	28	29	± 1
	2 TX slot	28	29	± 1
WiFi 2.4 GHz	802.11b	13	15	± 2
	802.11g	10	12	± 2
	802.11n(HT20)	10	12	± 2

3.2 Photographs of EUT

Front

Rear

Top

Bottom

Left

Right

3.3 Exposure Positions Consideration

- Product view

Antenna Type : FPCB with carrier

GSM 850/1900

- Product view

Antenna Type : Metal press antenna

WLAN

Note:

1. This device only use body-worn configuration. Thus tested exposure positions are front and rear.

3.4 Test Condition

3.4.1 Ambient Condition

• Ambient temperature : (20 - 21) ℃ • Relative Humidity : (38 - 42) % R.H.

3.4.2 Test Configuration

-GSM: The device was controlled by using a base station emulator. Communication between the device and the emulator was established by air link. The distance between the DUT and the antenna of the emulator is larger than 50 ㎝ and output power radiated from the emulator antenna is at least 30 ㏈ smaller than the output power of DUT. The DUT was set from the emulator to radiate maximum output power during all tests.

Consider the SAR test reduction per FCC KDB guide line. For GSM/GPRS, set EUT into highest output power channel with test mode which has the maximum source-based time-averaged burst power listed in power table.

The GPRS class is 10 for this EUT, it has at most 2 timeslots in uplink and at most 4 timeslots in downlink, the maximum total timeslot is 5.

-WLAN : For WLAN SAR testing, hyper terminal software using test command can provide continuous transmitting RF signal.

3.5 Requirements for compliance testing defined by FCC

The US Federal Communications Commission has released the report and order “Guidelines for Evaluating the Environmental Effects of RF Radiation", ET Docket No. 93-62 in August 1996 [1]. The order requires routine SAR evaluation prior to equipment authorization of portable transmitter devices, including portable telephones.
For consumer products, the applicable limit is 1.6 ㎽/g for an uncontrolled environment and 8.0 ㎽/g for an occupational/controlled environment as recommended by the ANSI/IEEE standard C95.1-1992 [6].

According to the KDB publications by the FCC, the device should be evaluated at maximum output power (radiated from the antenna) under “worst-case” conditions for normal or intended use, incorporating normal antenna operating positions, device peak performance frequencies and positions for maximum RF energy coupling.

4. Specific Absorption Rate (SAR)

4.1 Introduction

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

4.2 SAR Definition

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

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

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

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

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

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

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

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

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

4.3 SAR Measurement Procedure

The DUT is set to transmit at the required power in line with product specification, at each frequency relating to the LOW, MID, and HIGH channel settings.

Pre-scans are made on the device to establish the location for the transmitting antenna, using a large area scan in either air or tissue simulation fluid.

The DUT is placed against the Universal Phantom where the maximum area scan dimensions are larger than the physical size of the resonating antenna. When the scan size is not large enough to cover the peak SAR distribution, it is modified by either extending the area scan size in both the X and Y directions, or the device is shifted within the predefined area.

The area scan is then run to establish the peak SAR location (interpolated resolution set at $1mm^2$) which is then used to orient the center of the zoom scan. The zoom scan is then executed and the 1g and 10g averages are derived from the zoom scan volume (interpolated resolution set at $1mm^3$)

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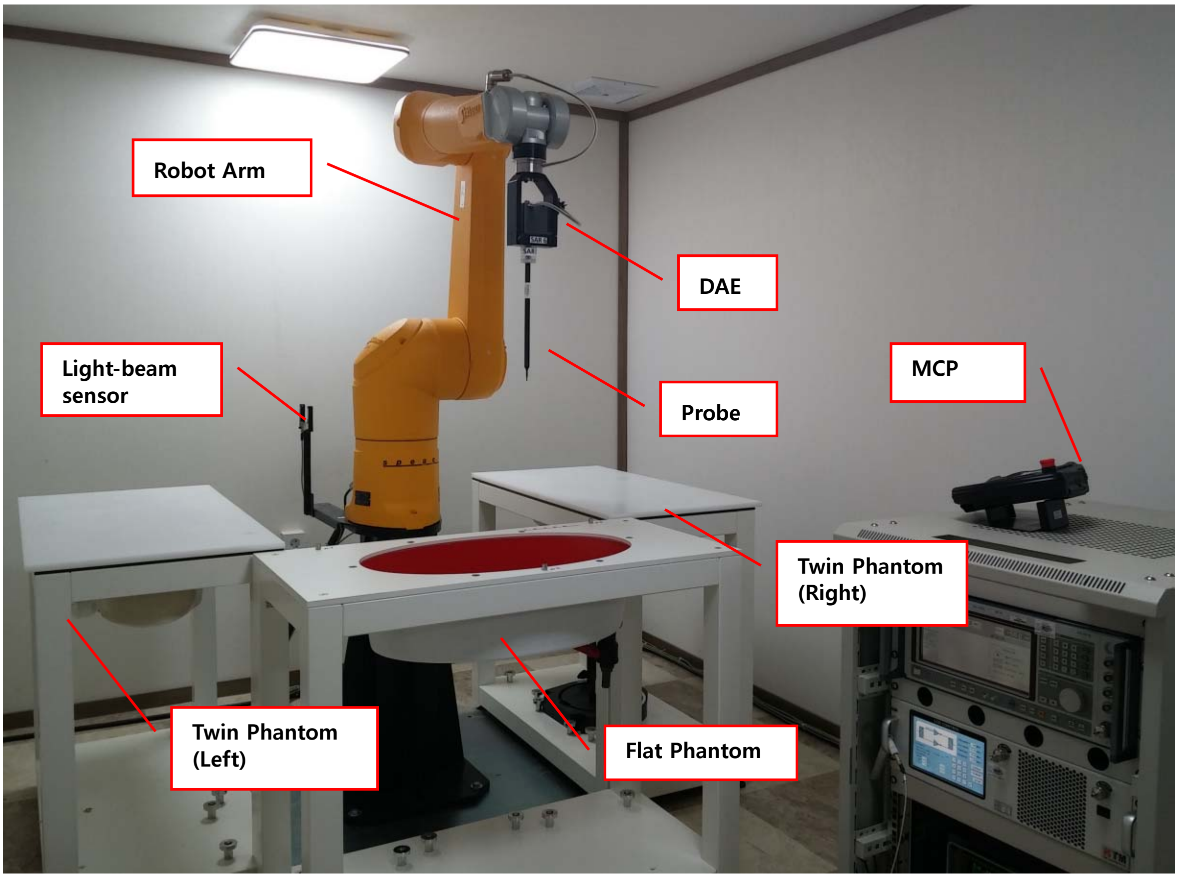
5. SAR Measurement System



[DASY52 SAR System Description]

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DASY52 SAR is a cost-effective package for demonstration of compliance of mobile phones with specific absorption rate (SAR) limits. The fastest and most accurate scanner on the market, it is fully compatible with all worldwide standards for transmitters operating at the ear or near the body (<200 mm from the skin).

The system consists of the following components;

1) TX90XL Stäubli Robot and Controller CS8c incl. Cabinet
2) EOCx Electro Optical Converter (mounted on robot arm)
3) Robot Stand for TX90XL
4) Robot Arm Extension and Adaptors
5) Robot Remote Control
6) LB5 Light Beam Switch for Probe Tooling (incl. LB Adaptor)
7) Light Beam Mounting Plate
8) DASY5 Measurement Server
9) Desktop PC / 3.4 GHz (or higher) incl. Color-Monitor 23"
10) SAM Twin Phantom V5.0 incl. Support DASY5
11) MD4HHTV5 Mounting Device for Hand-Held Transmitters
12) DAEx Data Acquisition Electronics
13) ES3DVx SAR Probe (incl. Conv.F for HSL at 900 and 1750 MHz)
14) DP5 Dummy Probe for Training Purposes
15) Dipoles (not in picture)

Some of the components are described in details in the following sub-sections.

5.1 E-field Probe

	Symmetrical design with triangular core Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)
Calibration	ISO/IEC 17025 calibration service available.
Frequency	10 MHz to > 6 GHz Linearity: ± 0.2 dB (30 MHz to 6 GHz)
Directivity	± 0.3 dB in TSL (rotation around probe axis) ± 0.5 dB in TSL (rotation normal to probe axis)
Dynamic Range	10 μW/g to > 100 mW/g Linearity: ± 0.2 dB (noise: typically < 1 μW/g)
Dimensions	Overall length: 337 mm (Tip: 20 mm) Tip diameter: 2.5 mm (Body: 12 mm) Typical distance from probe tip to dipole centers: 1 mm
Application	High precision dosimetric measurements in any exposure scenario (e.g., very strong gradient fields); the only probe that enables compliance testing for frequencies up to 6 GHz with precision of better 30%.
Compatibility	DASY3, DASY4, DASY52 SAR and higher, EASY4/MRI

5.2 Device Positioner

 Mounting Device for Hand-Held Transmitters	**MD4HHTV5 - Mounting Device for Hand-Held Transmitters** In combination with the Twin SAM V5.0/V5.0c or ELI Phantoms, the Mounting Device for Hand-Held Transmitters enables rotation of the mounted transmitter device to specified spherical coordinates. At the heads, the rotation axis is at the ear opening. Transmitter devices can be easily and accurately positioned according to IEC 62209-1, IEEE 1528, FCC, or other specifications. The device holder can be locked for positioning at different phantom sections (left head, right head, flat). **Material:** Polyoxymethylene (POM)
 Mounting Device Adaptor for Wide-Phones	**MDA4WTV5 - Mounting Device Adaptor for Ultra Wide Transmitters** An upgrade kit to Mounting Device to enable easy mounting of wider devices like big smart-phones, e-books, small tablets, etc. It holds devices with width up to 140mm. **Material:** Polyoxymethylene (POM)

5.3 DASY5 Robot: TX90XL

Specifications	TX90XL
Number of Axes	6
Nominal Load	5 kg
Maximum Load	12 kg
Reach	1450 mm
Repeatability	± 0.035 mm
Control Unit	CS8c
Programming Language	VAL3
Weight	116 kg

5.4 Twin SAM Phantoms

	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. Twin SAM V5.0 has the same shell geometry and is manufactured from the same material as Twin SAM V4.0, but has reinforced top structure.
Material	Vinylester, glass fiber reinforced (VE-GF)
Liquid Compatibility	Compatible with all SPEAG tissue simulating liquids (incl. DGBE type)
Shell Thickness	2 ± 0.2 mm (6 ± 0.2 mm at ear point)
Dimensions (incl. Wooden Support)	Length: 1000 mm Width: 500 mm Height: adjustable feet
Filling Volume	approx. 25 liters
Wooden Support	SPEAG standard phantom table

5.5 ELI Flat Phantoms

	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. ELI V5.0 has the same shell geometry and is manufactured from the same material as ELI4, but has reinforced top structure. ELI V6.0, released in August 2014, has the same shell geometry as ELI4 but offers increased longterm stability.
Material	Vinylester, glass fiber reinforced (VE-GF)
Liquid Compatibility	Compatible with all SPEAG tissue simulating liquids (incl. DGBE type)
Shell Thickness	2.0 ± 0.2 mm (bottom plate)
Dimensions	Major axis: 600 mm Minor axis: 400 mm
Filling Volume	approx. 30 liters
Wooden Support	SPEAG standard phantom table
Accessories	Mounting Device and Adaptors

5.6 DAE4 - Data Acquisition Electronics

	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 μV (with auto zero)
Input Resistance	200 M Ohm
Input Bias Current	< 50 fA
Battery Power	> 10 hours of operation (with two 9.6 V NiMH accus)
Dimensions (L x W x H)	60 x 60 x 68 mm
Calibration	ISO/IEC 17025 calibration service available.

5.7 Validation Dipoles

	Symmetrical dipole with l/4 balun Enables measurement of feed point impedance with NWA Matched for use near flat phantoms filled with tissue simulating solutions
Calibration	ISO/IEC 17025 calibration service available.
Frequency	300, 400, 450, 600, 733, 750, 835, 850, 900, 1300, 1450, 1500, 1640, 1750, 1800, 1900, 1950, 2000, 2100, 2300, 2450, 2550, 2600, 3000, 3300, 3500, 3700 MHz and D5GHz (5100-5800 MHz)
Return Loss	> 20 dB at specified validation position
Power Capability	> 100 W (f < 1GHz); > 40 W (f > 1GHz)
Options	Dipoles for other frequencies or solutions as well as other calibration conditions available upon request (contact info@speag.com)
Accessories	Distance holder, tripod adaptor, tripod, fitting SAM phantom

5.8 Test Equipment List

No.	Instrument	Manufacturer	Model	S/N	Due to cal date	used
1	Staubli robot	SPEAG	TX90XL	F10/5E6EA1/A/01, F10/5E6EA1/C/01	N/A	☒
2	DAE	SPEAG	DAE4	1240	2015.09.18	☒
3	Twin SAM Phantom	SPEAG	QD 000 P40 CC	1600	N/A	☒
4	Twin SAM Phantom	SPEAG	QD 000 P40 CC	1601	N/A	☒
5	ELI Flat Phantom	SPEAG	ELI V6.0	2002	N/A	☒
6	Mounting Device for Hand-Held Devices	SPEAG	MD4HHTV5	SD 000H01 MA	N/A	☒
7	85070E.Dielectric Probe kit	Agilent	85070 E	None	N/A	☒
8	SAR Probe	SPEAG	EX3 DV4	3664	2015.09.22	☒
9	Dipole	SPEAG	D835V2	4d172	2015.07.10	☒
10	Dipole	SPEAG	D1900V2	5d160	2015.04.23	☒
11	Dipole	SPEAG	D2450V2	895	2015.07.24	☒
12	3.5 ㎜ Cal. Kit	Agilent Technologies	85033D	3423A07123	N/A	☒
13	3 ㏈ Attenuator	Agilent Technology	8491B	MY39263672	2015.02.07	☒
14	Attenuator	HP	8498A	3318A09485	2015.02.07	☒
15	EPM Series Power meter	Agilent Technology	E4418B	MY41293610	2015.02.07	☒
16	Power sensor	Agilent Technology	E9300A	MY41496666	2015.02.07	☒
17	EPM Series Power meter	Agilent Technology	E4418B	GB39512547	2015.02.07	☒
18	Power Sensor	Agilent Technology	E9300A	MY41496631	2015.02.07	☒
19	RF Amplifier	Sungsan Electronics	SSA024	SSEC0001	2015.02.07	☒
20	Signal Generator	ROHDE&SCHWARZ	SMT-06	100552	2015.02.07	☒
21	Network Analyzer	Agilent	8753ES	US39170869	2015.09.18	☒
22	Radio Communication Analyzer	ANRITSU	MT8815A	6200429622	2015.02.07	☐
23	CDMA Mobile Station Test Set	AGILENT	E8285A	US40081298	2015.02.07	☐
24	Wideband Radio Communication Tester	ROHDE&SCHWARZ	CMW500	127302	2015.04.10	☒
25	Low pass filter	WAINWRIGMCS INSTRUMNENTS GMBH	WLJS1000-6EF	1	2015.02.07	☒
26	Low pass filter	WAINWRIGMCS INSTRUMNENTS GMBH	WLJS2500-6EF	1	2015.02.07	☒
27	High pass Filter	WAINWRIGMCS INSTRUMNENTS GMBH	WHJS3000-10EF	1	2015.02.07	☐
28	Dual directional coupler	HEWLETT PACKARD	778D	17693	2015.02.07	☒
29	Dual directional coupler	HEWLETT PACKARD	772D	2839A00924	2015.02.07	☒

6. Measurement Results

6.1 Tissue Simulating Liquids

The simulating liquids should be checked at the beginning of a series of SAR measurements to determine of the dielectric parameters are within the tolerances of the specified target values. The uncertainty due to the liquid conductivity and permittivity arises from two different sources. The first source of error is the deviation of the liquid conductivity from its target value (max± 5 %) For head SAR testing, the liquid height from the ear reference point 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.

6.1.1 Recipes for tissue simulating liquid.

Ingredients (% by weight)	Freq. (MHz)					
	835		1900		2450	
Tissue Type	Head	Body	Head	Body	Head	Body
Water	41.45	52.4	54.9	40.4	62.7	73.2
Salt (NaCl)	1.45	1.4	0.18	0.5	0.5	0.04
Sugar	56	45	0	58	0	0
HEC	1	1	0	1	0	0
Bactericide	0.1	0.1	0	0.1	0	0
Triton X-100	0	0	0	0	36.8	0
DGBE	0	0	44.92	0	0	26.7
Dielectric Constant	42.54	56.1	39.9	54	39.8	52.5
Conductivity (S/m)	0.91	0.95	1.42	1.45	1.88	1.78

6.1.2 Simulated tissue liquid parameter confirmation

The head and Body tissue dielectric parameters recommended by the KDB865664 D01 have been incorporated in the following table.

Target Frequency (MHz)	Head		Body	
	εr	σ (S/m)	εr	σ (S/m)
150	52.3	0.76	61.9	0.80
300	45.3	0.87	58.2	0.92
450	43.5	0.87	56.7	0.94
835	41.5	0.90	55.2	0.97
900	41.5	0.97	55.0	1.05
915	41.5	0.98	55.0	1.06
1450	40.5	1.20	54.0	1.30
1610	40.3	1.29	53.8	1.40
1800 - 2000	40.0	1.40	53.3	1.52
2450	39.2	1.80	52.7	1.95
3000	38.5	2.40	52.0	2.73
5800	35.3	5.27	48.2	6.00
(εr = relative permittivity, σ = conductivity and ρ = 1000 kg/m3)				

6.1.3 Measuring result for simulating liquid

Liquid		Parameters	Target	Measured	Deviation	Limit	Date
Freq. (MHz)	Temp. (°C)						
2 450 Body	20	Permitivity	52.7	51.57	2.15	±5	2014.12.12
		Conductivity	1.95	1.89	2.91	±5	
835 Body	20	Permitivity	55.2	54.33	1.57	±5	2014.12.15
		Conductivity	0.97	0.96	0.69	±5	
1 900 Body	20	Permitivity	53.3	52.81	0.91	±5	2014.12.16
		Conductivity	1.52	1.50	1.10	±5	

Note: Please see appendix for the plot of measured tissue.

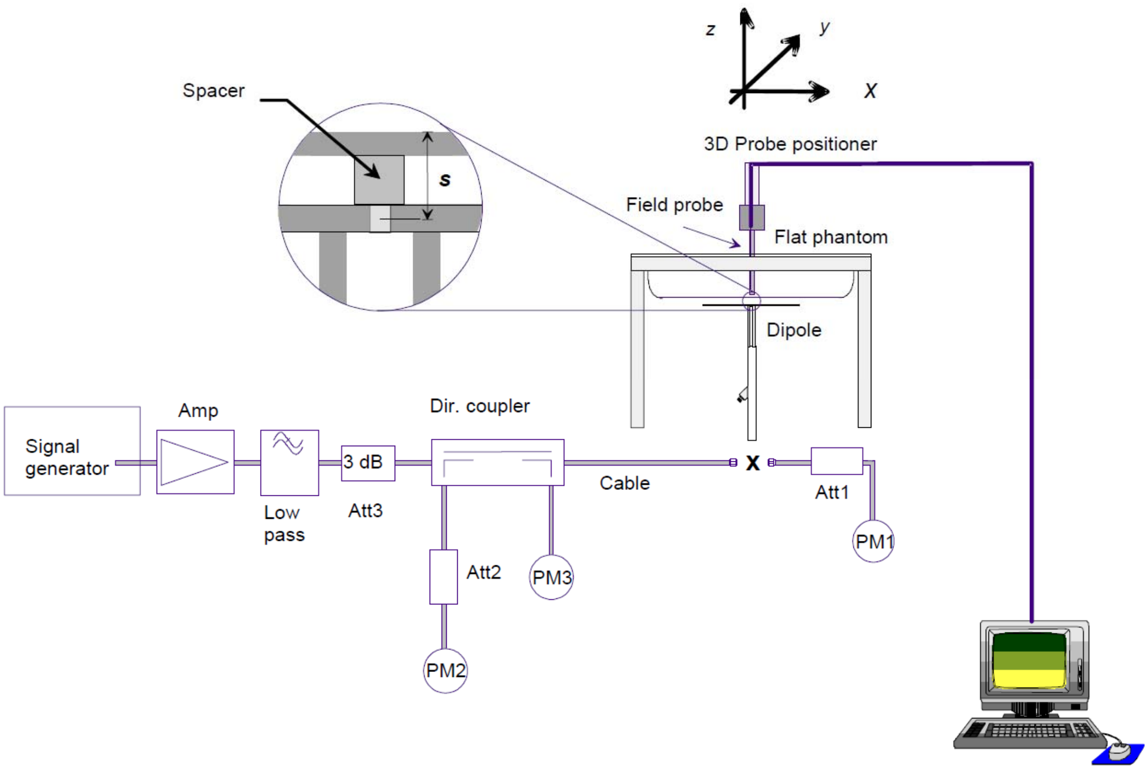
6.2 System Verification

6.2.1 Purpose of system performance check

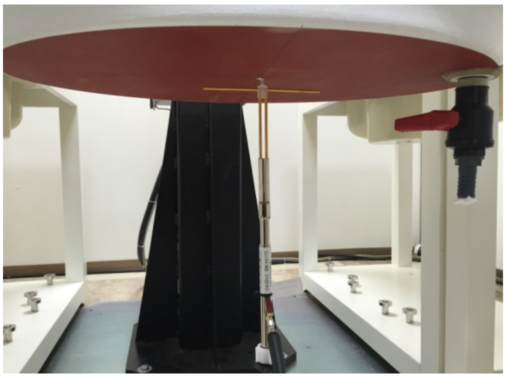
The system performance check is performed prior to any usage of the system in order to guarantee reproducible results. The system performance check verifies that the system operates within its specifications of ±5 %. Since the SAR value is calculated from the measured electric field, dielectric constant 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, 100 ㎽ RF dipole input power was used. The 1g and 10 g spatial average SAR values normalized to 1 W dipole input power give reference data for comparisons and it's equal to 10x(dipole forward power)

6.2.2 System setup

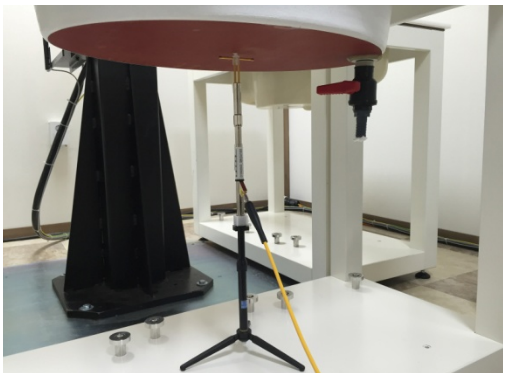
In the simplified setup for system evaluation, the DUT is replaced by a calibrated dipole and power source is replaced by a continuous wave that comes from a signal generator. The calibrated dipole must be placed beneath the flat phantom with the correct distance spacer. The distance holder should touch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



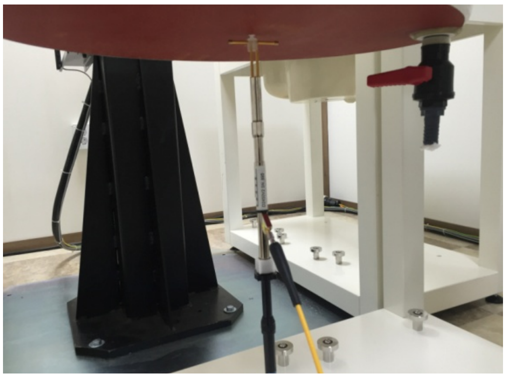
[System set-up for system validation]



835 ㎒



1 900 ㎒



2 450 ㎒

[Photo of dipole setup]

6.2.3 Verification Results

Date	Frequency (㎒)	Measured 1-g SAR (W/kg)	Normalized SAR (W/kg)	Target SAR (W/kg)	Devation (%)
2014.12.12	2 450 Body	5.29	52.9	50.9	3.93
2014.12.15	835 Body	0.96	9.6	9.58	0.21
2014.12.16	1 900 Body	3.91	39.1	40.2	-2.74

Note:

1. Comparing to the original SAR value provided by SPEAG, the validation data should be within its specification of 10 %. Above table shows the target SAR and measured SAR after normalized to 1W input power.

2. Please see appendix for the plot of system verification test.

6.3 DUT Testing Position

Please see appendix for the DUT setup photos

6.4 SAR measurement procedure

Step 1: Power Reference Measurement

The Power Reference Measurement and Power Drift Measurements are for monitoring the power drift of the device under test in the batch process. The minimum distance of probe sensors to surface determines the closest measurement point to phantom surface. The minimum distance of probe sensors to surface is 2.1 mm. This distance cannot be smaller than the distance of sensor calibration points to probe tip as defined in the probe properties.

Step 2: Area Scan

The Area Scan is used as a fast scan in two dimensions to find the area of high field values, before doing a fine measurement around the hot spot. The sophisticated interpolation routines implemented in DASY software can find the maximum locations even in relatively coarse grids. When an Area Scan has measured all reachable points, it computes the field maximal found in the scanned area, within a range of the global maximum. The range (in dB) is specified in the standards for compliance testing. For example, a 2 dB range is required in IEEE Standard 1528 and IEC 62209 standards, whereby 3 dB is a requirement when compliance is assessed in accordance with the ARIB standard (Japan). If only one Zoom Scan follows the Area Scan, then only the absolute maximum will be taken as reference. For cases where multiple maximums are detected, the number of Zoom Scans has to be increased accordingly.

Step 3: Zoom Scan

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

Step 4: Power drift measurement

The Power Drift Measurement measures the field at the same location as the most recent power reference measurement within the same procedure, and with the same settings. The Power Drift Measurement gives the field difference in dB from the reading conducted within the last Power Reference Measurement. This allows a user to monitor the power drift of the device under test within a batch process. The measurement procedure is the same as Step 1.

6.5 SAR Exposure Limits

Type of Exposure	SAR Limit(W/kg)
Whole body	0.08
Head/Body	1.6
Hands, Wrists, Feet and Ankles	4.0

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6.6 SAR test result

No	MODE	FREQ	CH	LOCATION	ANTENNA	Drift (dB)	Measured 1 g SAR (W/Kg)	Scaled 1 g SAR (W/Kg)	Scaling factor	Plot No.	NOTE
1	GPRS 2 slots	836.6	190	Front	Internal	0.11	0.051	0.061	1.19		GSM850 Body-worn
2		**836.6**	**190**	**Rear**	**Internal**	**-0.07**	**0.955**	**1.136**	1.19	Plot 1	
3		824.2	128	Front	Internal	-0.10	0.044	0.051	1.17		
4		824.2	128	Rear	Internal	-0.12	0.707	0.827	1.17		
5		848.8	251	Front	Internal	-0.19	0.070	0.083	1.19		
6		848.8	251	Rear	Internal	-0.07	0.908	1.081	1.19		
						MAX	0.955	1.136			
7	GPRS 2 slots	1880	661	Front	Internal	-0.11	0.214	0.287	1.34		GSM1900 Body-worn
8		1880	661	Rear	Internal	-0.10	0.887	1.189	1.34		
9		1850.2	512	Front	Internal	-0.17	0.180	0.230	1.28		
10		1850.2	512	Rear	Internal	0.01	0.894	1.144	1.28		
11		1909.8	810	Front	Internal	-0.02	0.225	0.306	1.36		
12		**1909.8**	**810**	**Rear**	**Internal**	**-0.17**	**0.938**	**1.276**	1.36	Plot 2	
						MAX	0.938	1.276			
13	802.11b	**2437**	**CH6**	**Front**	**Internal**	**0.19**	**0.043**	**0.048**	1.11	Plot 3	2.4 GHz Body-worn
14	802.11b	2437	CH6	Rear	Internal	0.18	0.041	0.046	1.11		
						MAX	0.043	0.048			

Repeated SAR test Result

No	Mode	Freq.	CH	Test Position	Measured 1 g SAR (W/Kg)			Ratio	NOTE
					Original	1st Repeat	2nd Repeat		
-	-	-	-	-	-	-	-	-	-
Note: Not Applicable.									

Note:

1. Per KDB 447498 D01v05r02, the SAR test shall be performed at the high, middle and low frequency channels of each operating mode. If the SAR measured at mid-band channel for each test configuration is lower than the 0.8 W/kg, other channels SAR testing is not necessary.

2. Per KDB 865664 D01v01r03,for each frequency band,repeated SAR measurement is required only when the measured SAR is ≥0.8W/Kg; if the deviation among the repeated measurement is ≤20%,and the measured SAR <1.45W/Kg,only one repeated measurement is required.

3. Per KDB 447498 D01v05r02, the reported SAR is the measured SAR value adjusted for maximum tune-up tolerance.

Scaling Factor = tune-up limit power (㎽) / EUT RF power (㎽), where tune-up limit is the maximum rated power among all production units.

Reported SAR(W/㎏)= Measured SAR(W/㎏)* Scaling Factor
The above DUT's power and tune-up tolerance were declared by manufacturer.

4. Per KDB865664 D02v01r01, SAR plot is only required for the highest measured SAR in each exposure configuration, wireless mode and frequency band combination; Plots are also required when the measured SAR is > 1.5 W/kg

5. Per KDB 447498 D01 v05r02 General RF Exposure Guidance: Testing of other required channels within the operating mode of a frequency band is not required when the reported 1-g or 10-g SAR for the mid-band or highest output power channel is:

≤ 0.8 W/kg or 2.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≤ 100 MHz
≤ 0.6 W/kg or 1.5 W/kg, for 1-g or 10-g respectively, when the transmission band is between 100 MHz and 200 MHz
≤ 0.4 W/kg or 1.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≥ 200 MHz

Please see appendix for the SAR test plots.

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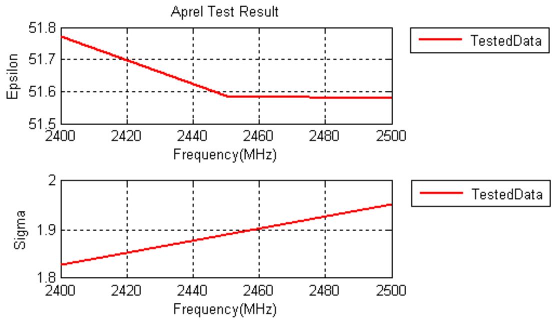
7. Uncertainty Assessment

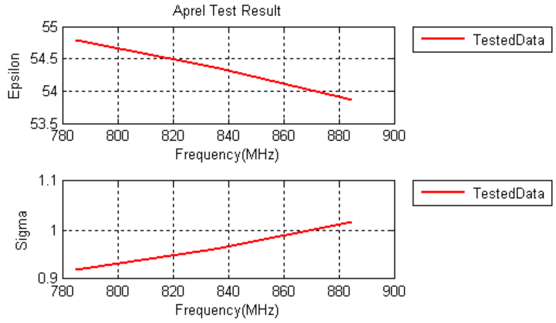
Error Description	Uncert. Value	Prob. Dist.	Div.	(c_i) 1g	(c_i) 10g	Std. Unc. (1g)	Std. Unc. (10g)	(*vi*)
Measurement System								
Probe Calibration	6.55	N	1	1	1	6.55	6.55	∞
Axial Isotropy	4.7	R	√3	0.7	0.7	1.9	1.9	∞
Hemispherical Isotropy	9.6	R	√3	0.7	0.7	3.9	3.9	∞
Linearity	4.7	R	√3	1	1	2.7	2.7	∞
Modulation Response	2.4	R	√3	1	1	1.4	1.4	∞
System Detection Limits	1.0	R	√3	1	1	0.6	0.6	∞
Boundary Effects	2.0	R	√3	1	1	1.2	1.2	∞
Readout Electronics	0.3	N	1	1	1	0.3	0.3	∞
Response Time	0.8	R	√3	1	1	0.5	0.5	∞
Integration Time	2.6	R	√3	1	1	1.5	1.5	∞
RF Ambient Noise	3.0	R	√3	1	1	1.7	1.7	∞
RF Ambient Reflections	3.0	R	√3	1	1	1.7	1.7	∞
Probe Positioner	0.8	R	√3	1	1	0.5	0.5	∞
Probe Positioing	6.7	R	√3	1	1	3.9	3.9	∞
Post-processing	4.0	R	√3	1	1	2.3	2.3	∞
Test Sample Related								
Device Holder	3.6	N	1	1	1	3.6	3.6	5.0
Test sample Positioning	2.9	N	1	1	1	2.9	2.9	145.0
Power Drift	5.0	R	√3	1	1	2.9	2.9	∞
Phantom and Setup								
Phantom Uncertainty	7.6	R	√3	1	1	4.4	4.4	∞
SAR correction	1.9	R	√3	1	0.84	1.1	0.9	∞
Liquid Conductivity (mea.)	5.0	R	√3	0.78	0.71	2.3	2.0	∞
Liquid Permittivity (mea.)	5.0	R	√3	0.26	0.26	0.8	0.8	∞
Temp. unc. - Conductivity	3.4	R	√3	0.78	0.71	1.5	1.4	∞
Temp. unc. - Permittivity	0.4	R	√3	0.23	0.26	0.1	0.1	∞
Combined Std. Uncertainty						12.1	12.0	
Expanded STD Uncertainty						24.3	24.1	

[Exposure Assessment Measurement Uncertainty]

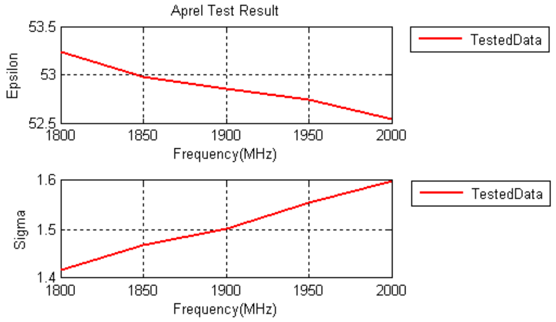
Appendix A : Plot of measured tissue.



2 450 ㎒ Body, 2014.12.12



835 ㎒ Body, 2014.12.15



1 900 ㎒ Body, 2014.12.16

Measuring result table for simulating liquid

2 450 ㎒ Body

1st

****
Aprel Laboratory
Test Result for UIM Dielectric Parameter
Fri 12/Dec/2014 11:45:39
Freq Frequency(GHz)
Test_e Epsilon of UIM
Test_s Sigma of UIM
****

Freq	Test_e	Test_s
2.4000	51.65	1.84
2.4500	51.49	1.90
2.5000	51.49	1.96

2nd

****
Aprel Laboratory
Test Result for UIM Dielectric Parameter
Fri 12/Dec/2014 11:47:26
Freq Frequency(GHz)
Test_e Epsilon of UIM
Test_s Sigma of UIM
****

Freq	Test_e	Test_s
2.4000	51.80	1.83
2.4500	51.62	1.89
2.5000	51.62	1.94

3rd

****
Aprel Laboratory
Test Result for UIM Dielectric Parameter
Fri 12/Dec/2014 11:48:26
Freq Frequency(GHz)
Test_e Epsilon of UIM
Test_s Sigma of UIM
****

Freq	Test_e	Test_s
2.4000	51.77	1.83
2.4500	51.59	1.89
2.5000	51.58	1.95

835 ㎒ Body, 2014.06.18

1st

****

Aprel Laboratory
Test Result for UIM Dielectric Parameter
Mon 15/Dec/2014 09:00:32
Freq Frequency(GHz)
Test_e Epsilon of UIM
Test_s Sigma of UIM

****

Freq	Test_e	Test_s
0.7850	55.01	0.91
0.8350	54.50	0.98
0.8850	54.12	1.02

2nd

****

Aprel Laboratory
Test Result for UIM Dielectric Parameter
Mon 15/Dec/2014 09:02:12
Freq Frequency(GHz)
Test_e Epsilon of UIM
Test_s Sigma of UIM

****

Freq	Test_e	Test_s
0.7850	54.80	0.92
0.8350	54.36	0.96
0.8850	53.86	1.02

3rd

****

Aprel Laboratory
Test Result for UIM Dielectric Parameter
Mon 15/Dec/2014 09:03:23
Freq Frequency(GHz)
Test_e Epsilon of UIM
Test_s Sigma of UIM

****

Freq	Test_e	Test_s
0.7850	54.63	0.92
0.8350	54.14	0.96
0.8850	53.53	1.01

1 900 ㎒ Body

1st

****

Aprel Laboratory
Test Result for UIM Dielectric Parameter
Tue 16/Dec/2014 12:35:16
Freq Frequency(GHz)
Test_e Epsilon of UIM
Test_s Sigma of UIM

****

Freq	Test_e	Test_s
1.8000	53.06	1.42
1.8500	52.96	1.46
1.9000	52.77	1.51
1.9500	52.74	1.56
2.0000	52.50	1.60

2nd

****

Aprel Laboratory
Test Result for UIM Dielectric Parameter
Tue 16/Dec/2014 12:36:35
Freq Frequency(GHz)
Test_e Epsilon of UIM
Test_s Sigma of UIM

****

Freq	Test_e	Test_s
1.8000	53.12	1.43
1.8500	52.99	1.46
1.9000	52.81	1.50
1.9500	52.77	1.54
2.0000	52.52	1.59

3rd

****

Aprel Laboratory
Test Result for UIM Dielectric Parameter
Tue 16/Dec/2014 12:38:22
Freq Frequency(GHz)
Test_e Epsilon of UIM
Test_s Sigma of UIM

****

Freq	Test_e	Test_s
1.8000	53.23	1.42
1.8500	52.98	1.47
1.9000	52.86	1.50
1.9500	52.74	1.55
2.0000	52.54	1.60