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FCC SAR TEST REPORT

Report No: KST-FCS-140002

Applicant	:	Bluebird Inc.
Manufacturer	:	Bluebird Inc.
Equipment	:	Handheld Mobile Computer
Brand Name	:	-
Model Name	:	BM180
Standard	:	FCC 47 CFR Parts 1 & 2 FCC KDB 865664 Published RF Exposure KDB Procedures, and TCB workshop updates
Test Date(s)	:	2014.06.03 ~ 2014.06.18
Issue Date	:	2014.06.20
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	0.084
GSM1900	FRONT	0.012
WCDMA Band V	FRONT	0.251
WCDMA Band II	FRONT	0.738
WLAN(802.11b)	LEFT	0.488

Head Configuration

Mode	Position	1g SAR [W/㎏]
GSM850	Right Cheek	0.253
GSM1900	Right Cheek	0.027
WCDMA Band V	Right Cheek	0.271
***WCDMA Band II**	**Right Cheek**	**0.776**

*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
648474 D04 Handset SAR v01r02
941225 D01 SAR test for 3G devices v02
941225 D02 HSPA and 1x Advanced v02r02
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

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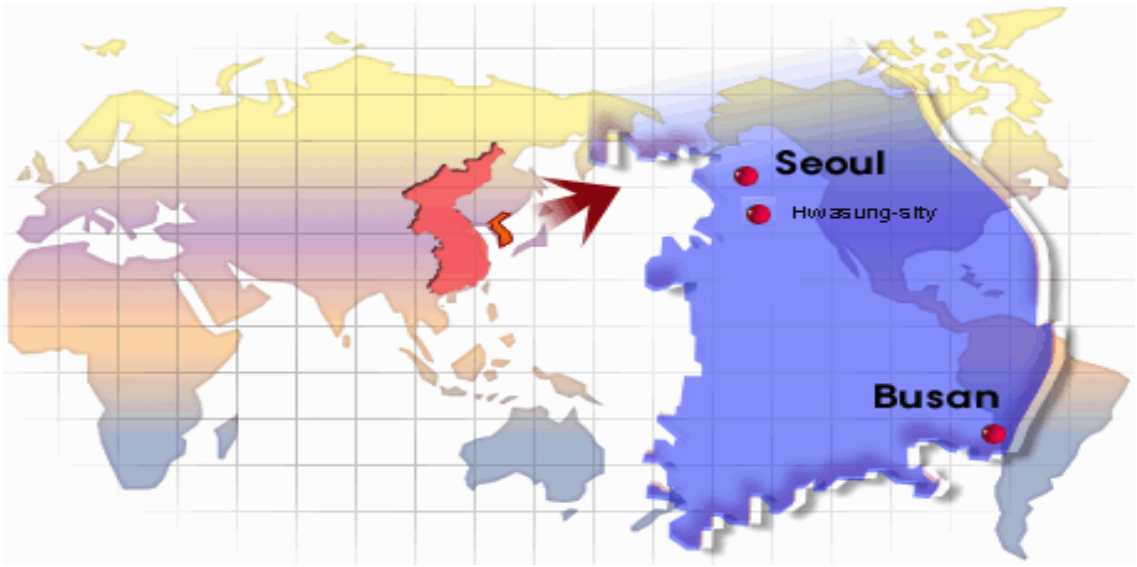
2. Administration Data

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 : 2014.06.03
Date of Start during the test : 2014.06.18
Date of End during the test : 2014.06.20

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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	BM180
Accessory	Not supported
Battery Options	Standard only supplied : Li-on battery, Rating 3.7 Vdc
Modulation Type	GSM: GMSK, 8PSK WCDMA: QPSK 802.11b: DSSS (DBPSK / DQPSK / CCK) 802.11a/g/n: OFDM (BPSK / QPSK / 16QAM / 64QAM) Bluetooth 2.1 BDR (1Mbps) : GFSK Bluetooth 2.1 EDR (2Mbps) : π/4-DQPSK Bluetooth 2.1 EDR (3Mbps) : 8-DPSK Bluetooth 4.0 LE: GFSK NFC: ASK
Frequency Range	GSM 850: 824.2 MHz - 848.8 MHz GSM1900: 1850.2 MHz – 1909.8 MHz WCDMA Band II: 1 852.4 MHz – 1 907.6 MHz WCDMA Band V: 826.4 MHz - 846.6 MHz 802.11b/g: 2 412 MHz – 2 462 MHz 802.11a: 5 180 MHz – 5 240 MHz (UNII Band I) 5 745 MHz – 5 825 MHz (UNII Band IV) 802.11n(HT20): 2 412 MHz – 2 462 MHz 5 180 MHz – 5 240 MHz (UNII Band I) 5 745 MHz – 5 825 MHz (UNII Band IV) 802.11n(HT40): 2 422 MHz – 2 452 MHz 5 190 MHz – 5 230 MHz (UNII Band I) 5 755 MHz – 5 795 MHz (UNII Band IV) Bluetooth: 2 402 MHz – 2 480 MHz NFC: 13.561 MHz
Device Class	B
Duty Cycle	GSM voice : 1:8.3 GPRS&EGPRS for GSM850 : 1:8.3 GPRS&EGPRS for GSM1900 : 1:2 WCDMA: 1:1 WLAN: 1:1
GPRS/EGPRS Multislot Class	Class12(Max number of timeslots in uplink & downlink: 4, Max total timeslots: 5
Power Class	GSM 850: Class 4 GSM1900: Class 1 WCDMA Band II: Class 3 WCDMA Band V: Class 3

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Operating Mode	For GSM and WCDMA SAR testing, Maximum continuous output using GSM&WCDMA call equipment. For WLAN SAR testing, WLAN engineering testing software installed on the EUT can provide continuous transmitting RF signal.
Antenna Specification	GSM 900: Internal PCB Antenna, Max.gain: 0.52 dBi GSM1800: Internal PCB Antenna, Max.gain: 1.15 dBi WCDMA Band I: Internal PCB Antenna, Max.gain: 1.15 dBi WCDMA Band VIII: Internal PCB Antenna, Max.gain: 0.52 dBi 2 GHz: Internal PCB Antenna, Max.gain: 1.56 dBi 5 GHz: Internal PCB Antenna, Max.gain: 3.51 dBi
Max. Output power(conducted)	GSM 850: 28.96 dBm GSM1900: 28.50 dBm WCDMA Band II: 22.0 dBm WCDMA Band V: 22.6 dBm 802.11b: 18.90 dBm
Max.SAR(10 g)	0.776 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 test utility for WLAN is GRCT. - The Bluetooth transmitter does not simultaneously transmit with the WLAN transmitter. -This device is supported for VoIP(GPRS) - This device is not supported for hotspot. - This device is not supported for DTM(Dual Transfer Mode) - The power class for GSM/WCDMA module is each Class4, class1 and class 3 but conducted target power is reduced by applicant. - 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 configration	Capable Transmit Configurations
Head	N/A
Body-worn	N/A
Wireless Router(Hotspot) & WLAN Direct	N/A

Note:
1. VoIP is support in GPRS and WCDMA
2. Wi-Fi 2.4GHz and GPRS, WCDMA are not supported Hotspot.
3. Wi-Fi 2.4 GHz cannot transmit simultaneously with Bluetooth.

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3.1.2 The DUT conducted power measurements

▣ GSM

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 ㎒)
GSM(GMSK)	Voice	28.96	28.76	28.61	-9.03	**19.93**	**19.73**	**19.58**
GPRS EGPRS (GMSK)	1 TX slot	28.95	28.85	28.60	-9.03	19.92	19.82	19.57
	2 TX slot	27.80	27.60	27.58	-6.02	**21.78**	**21.58**	**21.56**
	3 TX slot	25.79	25.83	25.84	-4.26	21.53	21.57	21.58
	4 TX slot	24.75	24.76	24.65	-3.01	21.74	21.75	21.64
EGPRS (8PSK)	1 TX slot	25.62	25.64	25.63	-9.03	16.59	16.61	16.60
	2 TX slot	24.63	24.64	24.63	-6.02	18.61	18.62	18.61
	3 TX slot	22.60	22.62	22.62	-4.26	18.34	18.36	18.36
	4 TX slot	21.86	21.85	21.86	-3.01	18.85	18.84	18.85

Tune-up limit power	Scaling Factor		
	128CH (824.2MHz)	190CH (836.6MHz)	251CH (848.8MHz)
29.50	1.13	**1.19**	1.23
29.50	1.14	1.16	1.23
28.50	1.17	**1.23**	1.24
26.50	1.18	1.17	1.16
25.50	1.19	1.19	1.22
26.50	1.22	1.22	1.22
25.50	1.22	1.22	1.22
23.50	1.23	1.22	1.22
22.50	1.16	1.16	1.16

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 ㎒)
GSM(GMSK)	Voice	28.50	28.50	28.40	-9.03	**19.47**	**19.47**	**19.37**
GPRS EGPRS (GMSK)	1 TX slot	28.47	28.48	28.47	-9.03	19.44	19.45	19.44
	2 TX slot	27.65	27.64	27.63	-6.02	**21.63**	**21.62**	**21.61**
	3 TX slot	25.03	25.02	25.03	-4.26	20.77	20.76	20.77
	4 TX slot	24.53	24.48	24.50	-3.01	21.52	21.47	21.49
EGPRS (8PSK)	1 TX slot	23.30	23.30	23.27	-9.03	14.27	14.27	14.24
	2 TX slot	22.00	22.27	22.26	-6.02	15.98	16.25	16.24
	3 TX slot	21.53	21.53	21.52	-4.26	17.27	17.27	17.26
	4 TX slot	20.13	20.13	20.10	-3.01	17.12	17.12	17.09

Tune-up limit power	Scaling Factor		
	512CH (1850.2MHz)	661CH (1880MHz)	810CH (1909.8MHz)
29.50	1.26	**1.26**	1.29
29.50	1.27	1.26	1.27
28.50	1.22	**1.22**	1.22
26.50	1.40	1.41	1.40
25.50	1.25	1.26	1.26
24.50	1.32	1.32	1.33
23.50	1.41	1.33	1.33
22.50	1.25	1.25	1.25
21.50	1.37	1.37	1.38

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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)
   3 up link time slot ratio = 3:8 = 10*log(3/8) = -4.26 (Crest factor 2.66)
   4 up link time slot ratio = 4:8 = 10*log(4/8) = -3.01 (Crest factor 2)
2. According to frame-averaged output, Body SAR was performed at GPRS 2 TX slot.
   The maximum powers are marks in bold.
3. For head SAR testing, the EUT was set in GSM Voice for GSM850 and GSM1900 due to its highest frame-average power.
4. For Body VoIP SAR testing, the EUT was set in GPRS 2 Tx slots for GSM850 and GPRS 2 Tx GSM1900 due to its highest frame-average power.
5. For body worn SAR testing, the EUT was set in GSM Voice for GSM850 and GSM1900 due to its highest frame-average power.
6. The above DUT information is declared by manufacturer and for more detailed features description please refer to the manufacturer's specification or user manual.
7. The SAR test for EGPRS(8PSK) mode can be excluded, because max conducted power of EGPRS is not 1/4 dB higher than that measured using GPRS(GMSK)

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▣ WCDMA

UMTS Band 5 (850 ㎒)		Averaged max conducted power(dBm)			Tune-up limit power	Scaling Factor		
US	CH	4132	4182	4233		4132	4182	4233
	FREQ [㎒]	826.4	836.4	846.6		826.4	836.4	846.6
WCDMA	12.2kbps RMC	22.5	22.5	22.5	22.5	1.00	**1.00**	1.00
	64kbps RMC	22.5	22.5	22.5	22.5	1.00	1.00	1.00
	144kbps RMC	22.5	22.5	22.5	22.5	1.00	1.00	1.00
	384kbps RMC	22.5	22.5	22.5	22.5	1.00	1.00	1.00
HSDPA	Subtest1	22.1	22.1	22.0	22.5	1.10	1.10	1.12
	Subtest2	22.2	22.1	22.1	22.5	1.07	1.10	1.10
	Subtest3	22.4	22.5	22.4	22.5	1.02	1.00	1.02
	Subtest4	22.1	22.0	22.0	22.5	1.10	1.12	1.12
HSUPA	Subtest1	22.0	22.0	21.9	22.5	1.12	1.12	1.15
	Subtest2	22.2	22.1	22.1	22.5	1.07	1.10	1.10
	Subtest3	22.4	22.5	22.4	22.5	1.02	1.00	1.02
	Subtest4	22.0	21.9	22.0	22.5	1.12	1.15	1.12
	Subtest5	22.2	22.2	22.2	22.5	1.07	1.07	1.07

UMTS Band 2 (1900 ㎒)		Averaged max conducted power(dBm)			Tune-up limit power	Scaling Factor		
US	CH	9262	9400	9538		9262	9400	9538
	FREQ [㎒]	1852.4	1880	1907.6		1852.4	1880	1907.6
WCDMA	12.2kbps RMC	21.7	22.0	21.9	22.0	1.07	**1.00**	1.02
	64kbps RMC	21.7	22.0	21.8	22.0	1.07	1.00	1.05
	144kbps RMC	21.8	22.0	21.8	22.0	1.05	1.00	1.05
	384kbps RMC	21.9	22.0	21.9	22.0	1.02	1.00	1.02
HSDPA	Subtest1	21.4	21.1	21.3	22.0	1.15	1.23	1.17
	Subtest2	21.5	21.5	21.3	22.0	1.12	1.12	1.17
	Subtest3	21.8	21.6	21.2	22.0	1.05	1.10	1.20
	Subtest4	21.4	21.2	21.3	22.0	1.15	1.20	1.17
HSUPA	Subtest1	21.4	21.2	21.6	22.0	1.15	1.20	1.10
	Subtest2	21.6	21.3	21.3	22.0	1.10	1.17	1.17
	Subtest3	21.9	21.6	21.6	22.0	1.02	1.10	1.10
	Subtest4	21.5	21.3	21.3	22.0	1.12	1.17	1.17
	Subtest5	21.6	21.3	21.3	22.0	1.10	1.17	1.17

Note:
1. Conducted output power;
   The maximum powers are marks in bold.

2. Per KDB941225 D01v02, when maximum output of each RF channel with HSDPA/HSUPA active is ≤0.25 dB higher than without HSDPA/HSUPA using 12.2 kbps RMC and maximum SAR for 12.2 kbps RMC is ≤ 75% of SAR limit, SAR evaluation for HSDPA/HSUPA can be excluded.

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802.11b	Conducted power(dBm)			Tune-up limit power	Scaling Factor		
Channel	1	6	11				
Freq	2 412	2 437	2 462				
1Mbps	**18.83**	**18.90**	**18.63**	**19.5**	**1.17**	***1.15**	**1.22**
2Mbps	18.56	18.61	18.45	-	-	-	-
5.5Mbps	17.56	17.35	17.22	-	-	-	-
11Mbps	17.47	17.56	17.43	-	-	-	-

*Tested channel and mode.

802.11g	Conducted power(dBm)		
Channel	1	6	11
Freq	2 412	2 437	2 462
6Mbps	6.25	6.13	4.53
9Mbps	6.21	6.21	4.42
12Mbps	6.13	6.10	4.45
18Mbps	6.05	6.07	4.30
24Mbps	6.07	6.01	4.21
36Mbps	6.14	6.07	4.18
48Mbps	6.10	6.12	4.21
54Mbps	6.07	6.03	4.20

802.11n(HT20)	Conducted power(dBm)		
Channel	1	6	11
Freq	2 412	2 437	2 462
MCS0	5.86	5.68	4.63
MCS1	5.76	5.64	4.59
MCS2	5.83	5.86	4.53
MCS3	5.76	5.79	4.46
MCS4	5.75	5.80	4.42
MCS5	5.76	5.79	4.46
MCS6	5.79	5.80	4.42
MCS7	5.80	5.82	4.40

802.11n(HT40)	Conducted power(dBm)		
Channel	3	6	9
Freq	2 422	2 437	2 452
MCS0	6.02	5.95	4.56
MCS1	6.00	5.91	4.51
MCS2	6.00	5.86	4.49
MCS3	5.99	5.85	4.48
MCS4	5.97	5.67	4.48
MCS5	5.98	5.90	4.46
MCS6	5.97	5.85	4.41
MCS7	5.96	5.62	4.42

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802.11a (UNII band I)	Conducted power(dBm)		
Channel	36	44	48
Freq	5 180	5 220	5 240
6Mbps	**6.00**	**5.99**	**6.03**
9Mbps	5.99	5.97	5.79
12Mbps	5.70	5.51	5.40
18Mbps	5.31	5.10	5.02
24Mbps	4.95	4.72	4.64
36Mbps	4.53	4.33	4.25
48Mbps	4.64	4.91	4.87
54Mbps	4.69	4.53	4.48

802.11n(HT20) (UNII band I)	Conducted power(dBm)		
Channel	36	44	48
Freq	5 180	5 220	5 240
MCS0	**6.03**	**5.83**	**6.10**
MCS1	6.02	5.79	5.65
MCS2	5.62	5.37	5.22
MCS3	5.25	5.86	5.85
MCS4	5.83	5.62	5.45
MCS5	5.41	5.26	5.09
MCS6	5.06	4.81	4.59
MCS7	4.61	4.42	4.27

802.11n(HT40) (UNII band I)	Conducted power(dBm)		
Channel	38	46	
Freq	5 190	5 230	
MCS0	**5.86**	**6.02**	
MCS1	5.84	5.86	
MCS2	5.72	5.54	
MCS3	5.43	5.26	
MCS4	5.68	5.45	
MCS5	5.76	5.59	
MCS6	4.39	4.23	
MCS7	4.36	4.25	

802.11a (UNII band IV)	Conducted power(dBm)		
Channel	149	157	165
Freq	5 745	5 785	5 825
6Mbps	**6.00**	**5.99**	**6.03**
9Mbps	5.65	5.87	5.25
12Mbps	5.26	5.74	5.86
18Mbps	5.87	5.37	5.48
24Mbps	5.48	5.32	5.21
36Mbps	5.09	5.63	4.71
48Mbps	4.70	5.25	4.67
54Mbps	4.31	4.88	4.38

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802.11n(HT20) (UNII band IV)	Conducted power(dBm)		
Channel	149	157	165
Freq	5 745	5 785	5 825
MCS0	**6.02**	**6.05**	**6.10**
MCS1	5.68	5.44	5.57
MCS2	5.29	5.35	5.21
MCS3	4.91	4.66	4.84
MCS4	4.53	4.23	4.47
MCS5	4.15	4.87	4.41
MCS6	4.76	4.48	4.74
MCS7	4.38	4.09	4.37

802.11n(HT40) (UNII band IV)	Conducted power(dBm)		
Channel	151	159	
Freq	5 755	5 795	
MCS0	**5.93**	**5.95**	
MCS1	5.56	5.47	
MCS2	5.23	5.82	
MCS3	5.63	5.65	
MCS4	5.57	5.33	
MCS5	5.24	5.09	
MCS6	4.91	4.72	
MCS7	4.58	4.41	

Note:
1) Conducted output power;
The maximum powers are marks in bold.
2) Per WLAN, measured maximum average power using power meter. Per BT, measured peak conducted power and converted maximum average power using duty cycle.
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 dB higher than 11b mode, thus the SAR can be excluded.
5) For each frequency band, testing at higher data rates and higher order modulations is not required when the maximum average output power for each of these configurations is less than 1/4 dB higher than those measured at the lowest data rate.
6) UNII band I and IV were not evaluated as the power levels were less than the exclusion level per KDB 447498 Appendix A.

Tune-up maximum power(dBm) : 6.60 dBm
Tune-up maximum power(mW) : 4.57 mW
Antenna to user (mm) : 5
SAR exclusion threshold: 7 mW at 5 mm in 5200 MHz and 6 mW at 5 mm in 5400 ~ 5800 MHz

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▣ **BT**

Frequency [MHz]	Test Results [dBm]			
	BDR	EDR		LE
2 402	3.03	2.62	2.97	1.83
2 440	-	-	-	2.17
2 441	3.15	2.79	3.11	-
2 480	2.99	2.66	2.95	1.97

Note:
1) Bluetooth operation was not evaluated as the power level of the BT transmitter was less than 10 ㎽ per KDB 447498 Appendix A.

Tune-up maximum power(dBm) : 3.65 dBm
Tune-up maximum power(mW) : 2.32 mW
Antenna to user (mm) : 5
SAR exclusion threshold: 10 mW at 5 mm in 2 450 MHz

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3.1.3 RF Output Power Tolerance

Upper limit(dB): 0.5 ~ -1.5		RF Output Power (dBm)	
RF Transmitters	Mode	Target	Max. tune-up tolerance limit
GSM 850	Voice	29	29.5
	1 TX slot	29	29.5
	2 TX slot	28	28.5
	3 TX slot	26	26.5
	4 TX slot	25	25.5
GSM 1900	Voice	29	29.5
	1 TX slot	29	29.5
	2 TX slot	28	28.5
	3 TX slot	26	26.5
	4 TX slot	25	25.5
W-CDMA Band V	RMC	22	22.5
	HSDPA	22	22.5
	HSUPA	22	22.5
W-CDMA Band II	RMC	21.5	22.0
	HSDPA	21.5	22.0
	HSUPA	21.5	22.0
Upper limit(dB): 0.5 ~ -2.0		RF Output Power (dBm)	
WiFi 2.4 GHz	802.11b	19	19.5
	802.11g	6	6.5
	802.11n(HT20)	6	6.5
	802.11n(HT40)	6	6.5
WiFi 5.7 GHz	802.11a	6	6.5
	802.11n(HT20)	6	6.5
	802.11n(HT40)	6	6.5
WiFi 5.1 GHz	802.11a	6	6.5
	802.11n(HT20)	6	6.5
	802.11n(HT40)	6	6.5
Bluetooth		3	3.5
Bluetooth LE		2	2.5

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3.2 Photographs of EUT

Front

Rear

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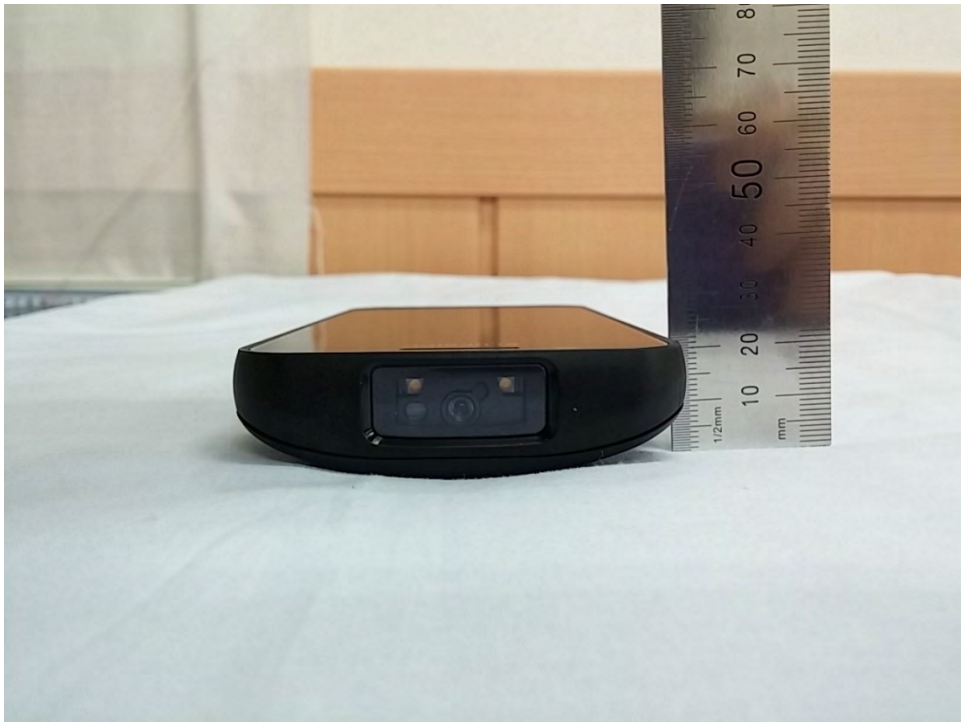
Top



Bottom

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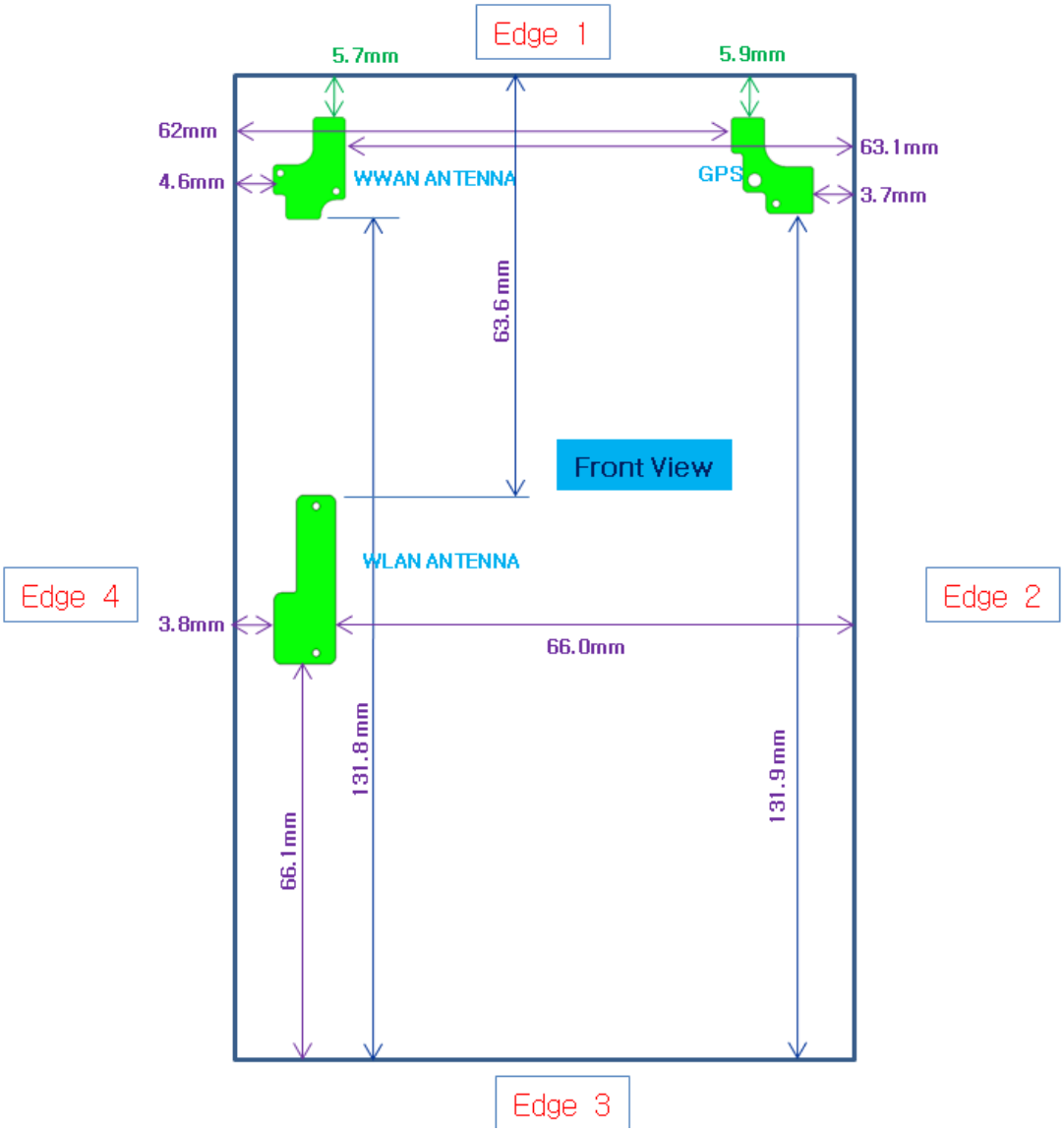
Left

Right

3.3 Exposure Positions Consideration



Note:

1. Per KDB 447498 D01v05r02, the 1-g and 10-g SAR test exclusion thresholds for 100 ㎒ to 6 ㎓ at test separation distances ≤ 50 ㎜ are determined by:

   [(max. power of channel, including tune-up tolerance, ㎽)/(min. test separation distance, ㎜)] ·[√f(㎓)] ≤ 3.0 for 1-g SAR and ≤ 7.5 for 10-g extremity SAR

   - f(㎓) is the RF channel transmit frequency in ㎓
   - Power and distance are rounded to the nearest ㎽ and ㎜ before calculation
   - The result is rounded to one decimal place for comparison

2. Per KDB 447498 D01v05r02, at 100 ㎒ to 6 ㎓ and for test separation distances > 50 ㎜, the SAR test exclusion threshold is determined according to the following

   a) [Threshold at 50 ㎜ in step 1) + (test separation distance - 50 ㎜)·(f(MHz)/150)] ㎽, at 100 ㎒ to 1500 ㎒
   b) [Threshold at 50 ㎜ in step 1) + (test separation distance - 50 ㎜)·10] ㎽ at > 1500 ㎒ and ≤ 6 ㎓

Thus, Edge 2 and 3 are not tested.(In case of body-supported)

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3.4 Test Condition

3.4.1 Ambient Condition

• Ambient temperature : (21 - 22) ℃ • Relative Humidity : (42 - 49) % 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/EGPRS, set EUT into highest output power channel with test mode which has the maximum source-based time-averaged burst power listed in power table. If the source-based time-average output power for each data mode of EGPRS is lower than that in normal GPRS mode, then testing under EGPRS mode is not necessary. When SAR tests for EGPRS mode is necessary, GMSK modulation should be used to minimize SAR measurement error due to higher peak-to-average power (PAR) ratios inherent in 8-PSK.

The GPRS class is 12 for this EUT, it has at most 4 timeslots in uplink and at most 4 timeslots in downlink, the maximum total timeslot is 5. EGPRS class is same with above.

-WCDMA :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.

SAR is measured for HSDPA when the maximum average output of each RF channel with HSDPA active is at least 1/4 dB higher than that measured without HSDPA using 12.2kbps RMC or the maximum SAR 12.2kbps RMC is above 75% of the SAR limit. SAR for HSDPA is measured using an FRC with H-Set 1 in Sub-test 1 and a 12.2kbps RMC configured in Test Loop Mode 1, using the highest SAR configuration in 12.2 kbps RMC without HSDPA.

SAR is also measured for HSPA when the maximum average output of each RF channel with HSPA active is at least ¼ dB higher than that measured without HSPA using 12.2 kbps RMC or the maximum SAR for 12.2 kbps RMC is above 75% of the SAR limit. Body SAR for HSPA is measured with E-DCH Sub-test 5, using H-Set 1 and QPSK for FRC and a 12.2 kbps RMC configured in Test Loop Mode 1 with power control algorithm 2, according to the highest SAR configuration in 12.2 kbps RMC without HSPA.

-WLAN : For WLAN SAR testing, WLAN engineering testing software installed on the EUT 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.

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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:

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

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

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

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

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

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

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

[ALSAS-10U System Description]

The CRS F3 robot is a 6 axis articulated robot with a reach of 710 mm and a maximum speed of 1016 mm/s.

The PMDPS is a probe mounting and proximity sensing device mounted on joint 6 of the F3 Robot. The PMDPS purpose is to hold the probe, house the data acquisition hardware and detect the phantom surface. It can detect a flat-phantom surface to a tolerance of +/- .05 mm. The PMDPS is also equipped with an E-Stop feature that is designed to protect probes and the user from harm. If the probe collides with an object the E-Stop will be triggered and the robot will stop immediately.

The phantoms sit on top of the workstation and are positioned such that the robot has optimal reach into all areas of each phantom. The system contains a SAM-Left, SAM-Right and a Uni-Phantom TM that can be used as a flat phantom for system validations.

The Device positioner is a plastic positioning device for the DUT. It has 8 degrees of freedom that can be locked individually and a 15 degree touch to tilt feature for fast and accurate repositioning.

The shelves in the ALSAS-10U system can be adjusted to accommodate larger devices. The workstation rests on levellers that can be adjusted to ensure that the system is level.

The system consists of the following components;

1) CRS F3 Robot
2) PMDPS
3) Phantoms
4) Device Positioner
5) Adjustable Shelves
6) Work Station
7) Probes
8) Dipoles (not in picture)

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

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5.1 E-field Probe

The APREL Laboratories E-Field probe utilizes an orthogonally triangular sensor arrangement.

E-Field Probes have been characterized from 30MHz to 6GHz with the probe diameter scientifically verified for use at frequencies above 3GHz eliminating the need for separate probe types.

The isotropic E-Field probe used by APREL Laboratories, has been fully calibrated and assessed for isotropicity and sensitivity in both air and tissue, including boundary effect within a controlled ISO-IEC 17025 accredited laboratory.

SAR is assessed with the calibrated probe which can be positioned at a user defined or default height(s) of 2.4 or 4mm from phantom surfaces so as to minimize any resultant boundary effect due to the probe being in close proximity to the phantom surface and provides improved measurement uncertainty at higher frequencies.

A new 2.8mm probe is now available for use at higher frequencies allowing for smaller scan resolutions and greater measurement point density.

Compliant Standards	IEEE 1528, IEC 62209 Part 1 & 2
Frequency Range	30 MHz ~ 6 GHz
Sensitivity	0.60 μV/(V/m)^2 to1.25 μV/(V/m)^2
Dynamic Range SAR	0.001 W/kg to 100 W/kg
Isotropic Response Axial	Better than 0.2dB in air Better than 0.05dB in tissue
Hemispherical isotropy	±0.3 dB or better
Diode Compression Point (DCP)	Calibrated for Specific Frequency typically 95mV +/- 10%
Linearity	±0.2 dB or better
Probe Tip Radius	<2.9mm
Sensor Offset	1.56 (± 0.02 mm)
Probe Length	290 mm
Video Bandwidth	@ 500 Hz: 1 dB @ 1K Hz: 3 dB
Boundary Effect	Less than 2% for distances greater than 1.4mm
Material	Ertalyte™
Connector	6 Pin Bayonet
Probe Diameter	Less than 2.8mm

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5.2 Device Positioner

The APREL Laboratories Universal Device Positioner has been developed so as to allow complete freedom of movement of a DUT. Developed to hold the DUT in the equivalent of free space to avoid additional loading attributable to the material used in the construction of the positioner so as to reduce measurement uncertainty.

Positioner has a built-in 15 degree feature used for fast and accurate touch to tilt movement.

The APREL device positioner can hold in-place devices such as handsets, smart phones, Clam shell phones, PDA's and small size tablet PC's.

When used with the Universal Work Station and its adjustable shelves, the positioned provides 8 degrees of motion, and does not require the user to crouch or sit on the floor (a stool or chair can be used) when positioning the DUT against a phantom.

Compliant Standards	IEEE 1528, IEC 62209 Part 1 & 2
Dielectric constant	Less than 5.0
Loss Tangent	Less than 0.05
Number of Axis	6 axis freedom of movement (8 when utilized with ALSAS-10U Workstation
Translation Along MB Line	± 76.2 mm
Translation Along NF Line	± 38.1 mm
Translation Along Z Axis	± 25.4 mm (expandable up to 500 mm)
Rotation Around MB Line (yaw)	±10°
Rotation Around NF (pitch)	± 30°
Line Rotation (roll)	360° full circle
Maximum Grip Range	0 mm to 150 mm
Material	Resistant to DGBE and all other tissue stimulant materials
Tilt Movement	Full movement with built-in 15° gauge

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5.3 6 Axis Articulated Robot ALS-F3

ALSAS-10U utilizes a six axis articulated robot, which is controlled using a Pentium based real-time movement controller. The movement kinematics engine utilizes proprietary (Thermo CRS) interpolation and extrapolation algorithms, which allow full freedom of movement for each of the six joints within the working envelope.

The accuracy of the probe tip positioning over the measurement area is better than 0.05 mm.

The robot is capable of moving the probe to angles greater than 30°.

Robot positioning repeatability should only be used as a reference when a process has been developed for repeated point to point detection. This value is not relevant to SAR measurements as it is not expected that a user would measure the exact same condition** more than 100 times (as per the robotic manufacturers standard for determining the positional repeatability).

**Condition specified above with respect to SAR measurements would reflect a process executed on a DUT which has been defined, characterized, setup and measured repeatedly without any changes to the setup condition for more than 100 times.

Compliant Standards	IEEE 1528, IEC 62209 Part 1 & 2
Dielectric constant	Less than 5.0
Loss Tangent	Less than 0.05
Number of Axis	6 axis freedom of movement (8 when utilized with ALSAS-10U Workstation
Translation Along MB Line	± 76.2 mm
Translation Along NF Line	± 38.1 mm
Translation Along Z Axis	± 25.4 mm (expandable up to 500 mm)
Rotation Around MB Line (yaw)	±10°
Rotation Around NF (pitch)	± 30°
Line Rotation (roll)	360° full circle
Maximum Grip Range	0 mm to 150 mm
Material	Resistant to DGBE and all other tissue stimulant materials
Tilt Movement	Full movement with built-in 15° gauge

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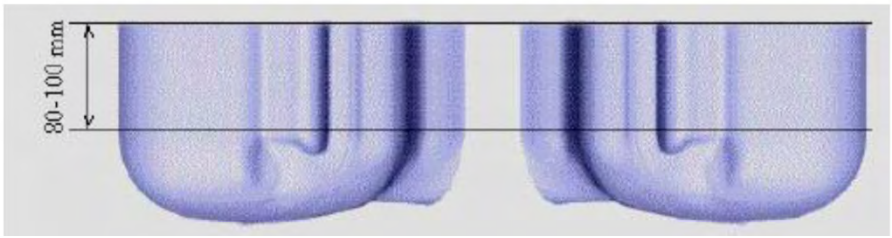
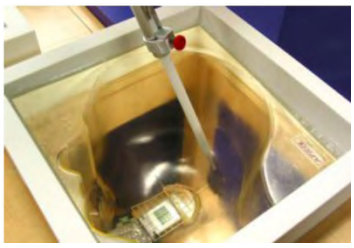
5.4 SAM Phantoms

The APREL Laboratories SAM phantoms have been designed so as to aid repeatability and positioning for any DUT. Developed using the IEEE SAM CAD file they are fully compliant with the requirements for IEEE 1528, IEC 62209 Part 1 and 2 (draft) and FCC Supplement C. Both the left and right SAM phantoms are sagitally cut and can be interchangeable on the Universal Workstation. The phantoms are transparent and include the IEEE 1528 grid with visible NF and MB lines. The phantom is surrounded by an Acrylic Polymer Blend frame, which adds additional support and load bearing characteristics.





Compliant Standards	IEEE 1528, IEC 62209 Part 1 & 2
SAM	In accordance with the IEEE 1528 standard & IEC 62209 Part 1
Material	Composite urethane which allows for the device to be viewed through the phantom, resistant to DGBE
Phantom Shell Shape Tolerance	Fully calibrated to be better than ±0.2 mm
Frame Material	Corian®
Tissue Simulation Volume	7 liter with 15.0 ±0.5 cm tissue
Thickness	2 mm ±0.2 mm 6 mm ±0.2 mm at NF/MB intersection
Loss Tangent	<0.05
Relative Permittivity	<5
Resistant to Solvents	Resistant to all solvents used for tissue manufacturing detailed in IEEE 1528 & IEC 62209
Load Deflection	<1mm with sugar water compositions
Manufacturing Process	Injection Molded
Phantom Weight	Less than 10kg when filled with 15cm of simulation tissue

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5.5 Flat Phantoms

The APREL Flat Phantom has been developed as an engineering tool for SAR compliance and development testing of handheld and body-mounted wireless devices in the frequency range of 30 MHz to 6 GHz. The enhanced design allows repeatable measurements for a wide range of devices, including handsets, PDA units, laptops, tablets, computers, and validation dipoles.

The APREL Flat Phantom is IEEE 1528; IEC 62209-1/IEC 62209-2 (Elliptic flat phantoms); FCC OET Bulletin 65 /Ed. 97-01 (custom flat phantoms) compliant and compatible with tissue-equivalent liquid chemicals.

Compliant Standards	IEEE-1528, IEC 62209, CENELEC, and others
Manufacturing Process	Compression molded
Material	S-Glass and Vinyl Ester Resin
Phantom Shell Shape Tolerance	Less than ±0.2 mm
Operating Frequency Range	30 MHz – 6 GHz
Tissue Simulation Volume	12.8 liter with a liquid depth of 150 mm
Shell Thickness	2 mm ±0.2 mm
Loss Tangent	<0.05
Relative Permittivity	<4
Resistant to Solvents	Resistant to all solvents specified in IEEE 1528, IEC 62209 (Part 1 and 2)
Load Deflection	<1.8 mm
Dimensions without frame	340 mm x 270 mm x 225 mm

Additional Phantom Specification Details

- Clear Phantoms for improved positioning of DUT and measurement repeatability provides overall improvement to uncertainty of the SAR measurement.

- Overall phantom shell thickness uncertainty is +/- 0.2mm

-Lower volume phantoms need less than 7l of tissue for SAR measurements.

-Corian™ frames with built-in spout for easier tissue evacuation.

-Permanent IEEE 1528 and IEC 62209 positioning reference markings included on phantom for better positioning accuracy, repeatability and improvement to uncertainty of the SAR measurement (see images on next page).

-Additional markings are included on phantoms to improve DUT positioning and accuracy.

-Universal Phantom ™ for use in validation, body, and head SAR evaluations. The Universal Phantom ™ speeds up the measurement process by allowing for left and right measurements to be made in one measurement step (less than 10 minutes for complete process).

-Weight of SAM and Universal Phantom ™ when filled is less than 10 kg.

-After test completion phantoms and tissue can be placed in storage box until next use.

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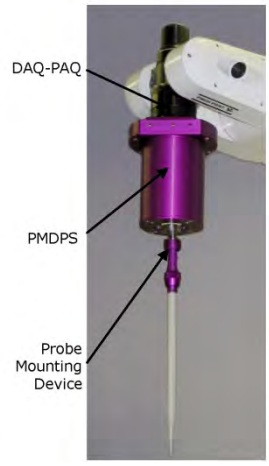
5.6 DAQ-PAQ (Analog to Digital Electronics)



ALSAS 10U incorporates a fully calibrated DAQ-PAQ (analog to digital conversion system) which has a 4 channel input stage, combined with the integrated amplifier module. The input signal is amplified accordingly so as to offer a dynamic range from 4 µV to 330 mV. Integration of the fields measured is carried out at board level utilizing a Co-Processor utilizing proprietary algorithms. Improvements to measurement speed are improved by sending processed data down to the main computational module.

PMDPS is used to hold a probe and to detect complex boundary locations (curved and flat surfaces) during a SAR or HAC assessment process. It utilizes relative movements of internal components to trigger integrated micro-sensor mechanisms in order to detect boundary(s) and consequently position the probe at the specified distance relative to a boundary in order to achieve accurate and repeatable measurements.

All surface detection methods are controlled by a proprietary algorithm which dynamically compensates for every detection point, and allows for a 20-30% improvement to surface detection speeds. By eliminating optical detection sensors uncertainty is further reduced by integrating micro detection sensors which can determine movements of less than 1µm.

Amplifier Range	4 μV to 330 mV
ADC	16 Bit optically isolated
Built-in E-Stop Feature	Emergency Stop feature to prevent damage of equipment and for user safety purposes
Field Integration	Local Co-Processor utilizing proprietary integration algorithms
SAR Dynamic Range	0.001 W/kg -100 W/kg.
Ambient Noise	Below 0.001 W/kg measured with probe in tissue
LED Indication	Boundary detection and DAQ-PAQ State
Number of Input Channels	4 in total 3 dedicated and 1 spare for future upgrades
Communication	Optically isolated packet data via RS232
Robot Arm Integration	DAQ-PAQ and Boundary Detection Unit are mounted directly onto joint 6 of the F3 arm utilizing joint 6 tool (ISO Standard M8 Mounting Plate) to allow easy integration and removal (no angular interface)
Supply	DC supply powered by an isolated external supply unit
LED Indicators	Probe status (amplifier on) and boundary detection

Additional PMDPS Specification Details:

- Accuracy of Positioning: Better than 10µm at 6GHz.
- SAR Uncertainty: Better than 0.01 W/kg SAR at 6Gz.
- Detection Mechanism: 2 x 360° Stage Axial and Lateral Detection at 6GHz.
- Emergency Stop: 4 Stage 360° Axial and Lateral Detection at 6GHz.
- Probe Mounting: 6 Pin Bayonet for Fast Probe Change.
- Calibration: Every PMDPS is Calibrated to 0.01 W/kg SAR at 6GHz.

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5.7 Validation Dipoles

APREL have developed a range of dipoles for use in dosimetric (SAR) and near/far field applications.

Validation dipoles have been designed using the data presented in IEEE-1528, IEC-62209 1&2.

All tuned dipoles have a return loss grater than -20 dBm, for dosimetric applications.

Compliant Standards	EEE 1528, IEC 62209 Part 1 & 2,EN50361
Electrical	Symmetrical Dipole with variable λ/divisor
Frequency range	30 MHz – 6 GHz
Application	Tuned for Dosimetric System Validation
Material	Rigid Coated Brass
Dipole Diameter	1.805 mm From Center (3.6mm)
Calibration	Return Loss, Standing Wave Ratio, Impedance & 1 & 10 g Averages
Length	Dependent on Specification
Return Loss	> -20 dBm
Max Power Input	100 Watt

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5.8 Test Equipment List

No.	Instrument	Manufacturer	Model	S/N	Due to cal date	used
1	The Teach Pedant	Thermo ELECTRON CORPORATION	STP 500	STP0502506	N/A	☒
2	Universal Phantom	APREL Laboratories	ALS-P-UP-1	None	N/A	☐
3	Left Ear SAM Phantom	APREL Laboratories	ALS-P-SAM-L	130-00316	N/A	☒
4	Right Ear SAM Phantom	APREL Laboratories	ALS-P-SAM-R	140-00367	N/A	☒
5	6 Axis Articulated Robot	Thermo CRS	ALS-F3	RAF0504263	N/A	☒
6	ROBOTS CONTROLLER	Thermo CRS	UMI-R3-310	RCF0503290	N/A	☒
7	Data Acquisition Package	APREL Laboratories	ALS-DAQ-PAQ-3	110-00204	N/A	☒
8	Probe Mounting Device and Boundary Detection Sensor System	APREL Laboratories	ALS-PMDPS-3	120-00269	N/A	☒
9	Device Holder	APREL Laboratories	ALS-H-E-SET-2	170-00507	N/A	☒
10	Reference Dipole	APREL Laboratories	ALS-D-450-S-2	175-00504	2015.02.27	☐
11	Reference Dipole	APREL Laboratories	ALS-D-835-S-2	180-00555	2015.02.14	☒
12	Reference Dipole	APREL Laboratories	ALS-D-1800-S-2	200-00656	2015.02.14	☐
13	Reference Dipole	APREL Laboratories	ALS-D-1900-S-2	210-00717	2015.02.27	☒
14	Reference Dipole	APREL Laboratories	ALS-D-2000-S-2	212-00830	2015.02.14	☐
15	Reference Dipole	APREL Laboratories	ALS-D-2450-S-2	220-00764	2015.02.27	☒
16	Reference Dipole	APREL Laboratories	ALS-D-BB-S-2	235-00807	2015.02.27	☐
17	Miniature E-Field Probe	APREL Laboratories	ALS-E-020	271	2014.07.02	☒
18	Miniature E-Field Probe	APREL Laboratories	ALS-DR	028	N/A	☐
19	Di-Electric Probe	APREL Laboratories	ALS-PR-DIEL	260-00961	N/A	☒
20	Lowpass filter	WAINWRIGHT INSTRUMNENTS GMBH	WLJS1000-6EF	1	2015.02.07	☒
21	Lowpass filter	WAINWRIGHT INSTRUMNENTS GMBH	WLJS2500-6EF	1	2015.02.07	☒
22	Dual directional coupler	HEWLETT PACKARD	778D	17693	2015.02.07	☒
23	Dual directional coupler	HEWLETT PACKARD	772D	2839A00924	2015.02.07	☒
24	3.5 ㎜ Cal. Kit	Agilent Technologies	85033D	3423A07123	N/A	☒
25	3 dB Attenuator	Agilent Technology	8491B	MY39263672	2015.02.07	☒
26	EPM Series Power meter	Agilent Technology	E4418B	MY41293610	2015.02.07	☒
27	Power sensor	Agilent Technology	E9300A	MY41496666	2015.02.07	☒
28	RF Amplifier	Sungsan Electronics Communications	SSA024	SSEC0001	2015.02.07	☒
29	Hot plate & Magnetic stirrer	Misung Elec.	HS33	None	N/A	☐
30	Stirrer	Misung Elec.	BL1003D	None	N/A	☐
31	Electric balance	CAS	SW-30H	CLA1675	2015.02.07	☐
32	Electric balance	SHENZHEN ACCT	KB-500	KB031419	2015.02.07	☐
33	Di-water machine	HYSC	HWS-FA12	XM0015576	N/A	☐
34	Digital Hygrometer	ACUBA	CS-102	1211	2015.02.10	☒
35	Flat Phantom	APREL Laboratories	ALS-UM-FLAT	153-00102	N/A	☒
36	Digital thermo-hgrometer	SATO	PC-5000TRH-II	1	2014.08.08	☒
37	Digital thermo-hgrometer	SATO	PC-5000TRH-II	2	2014.08.08	☒
38	EPM Series Power meter	Agilent Technology	E4418B	GB39512547	2015.02.07	☒
39	Power Sensor	Agilent Technology	E9300A	MY41496631	2015.02.07	☒

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No.	Instrument	Manufacturer	Model	S/N	Due to cal date	used
40	Radio Communication Alalyzer	ANRITSU	MT8815A	6200429622	2015.02.07	☒
41	CDMA Mobile Station Test Set	AGILENT	E8285A	US40081298	2015.02.07	☐
42	Wideband Radio Communication Tester	ROHDE&SCHWARZ	CMW500	102276	2015.04.10	☐
43	Attenuator	HP	8498A	3318A09485	2015.02.07	☒
44	Signal Generator	ROHDE&SCHWARZ	SMT-06	100552	2015.02.07	☒
45	Highpass Filter	WAINWRIGHT INSTRUMNENTS GMBH	WHJS3000-10EF	1	2015.02.07	☐
46	Network Analyzer	Agilent	8753ES	US39170869	2014.10.05	☒
47	Vernier Calipers	Mitutoyo	None	8280373	2014.10.05	☒

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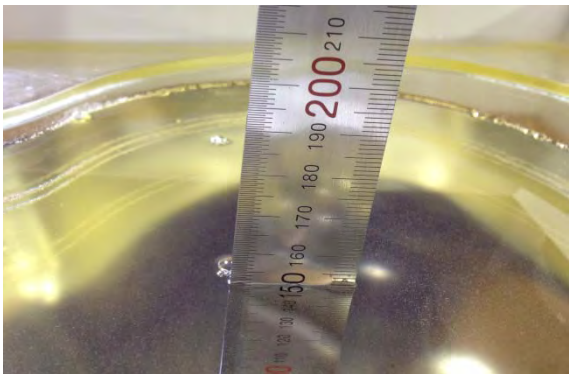
6. Measurement Results

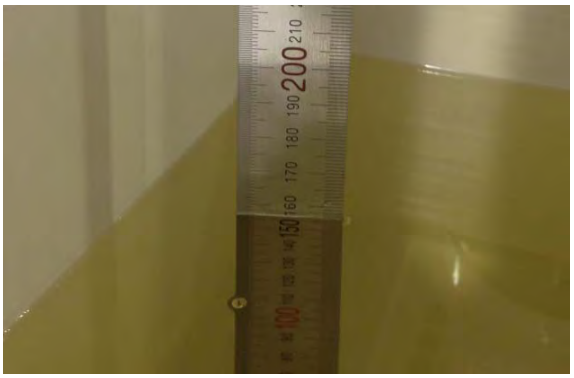
6.1 Tissue Simulating Liquids

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 %)

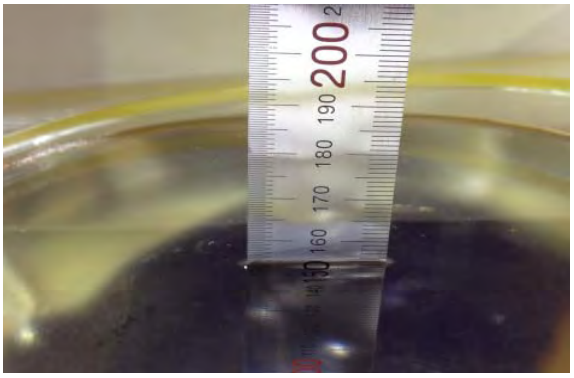
For head SAR testing, the liquid height from the ear reference point of the phantom to the liquid top surface is larger than 15 cm. for body SAR testing, the liquid height from the center of the flat phantom to the liquid top surface is larger than 15 cm.



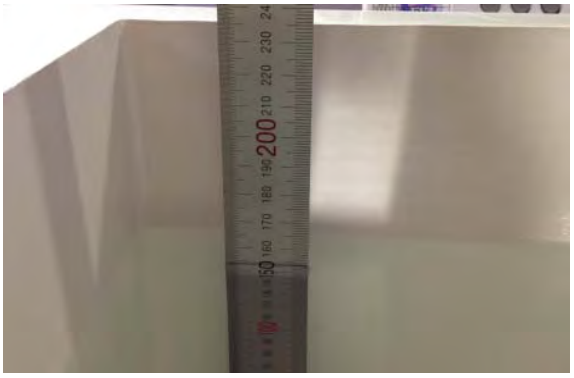
835 ㎒ Head



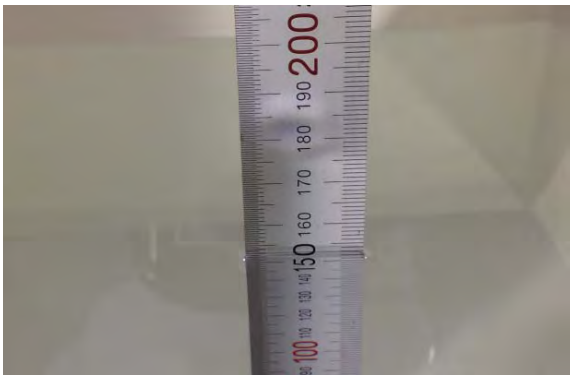
835 ㎒ Body



1 800 ㎒, 1 900 ㎒ Head



1 800 ㎒, 1 900 ㎒ Body



2 450 ㎒ Body

[Photo of liquid height for SAR testing]

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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	21	Permitivity	52.7	52.77	0.11	±5	2014.06.03
		Conductivity	1.95	2.01	2.99	±5	
1 900 Head	21	Permitivity	39.9	38.43	3.69	±5	2014.06.06
		Conductivity	1.42	1.35	4.79	±5	
1 900 Head	21	Permitivity	39.9	38.97	2.32	±5	2014.06.07
		Conductivity	1.42	1.36	4.23	±5	
1 900 Body	21	Permitivity	53.3	54.54	2.33	±5	2014.06.11
		Conductivity	1.52	1.44	4.93	±5	
835 Head	21	Permitivity	41.5	40.39	2.68	±5	2014.06.13
		Conductivity	0.90	0.87	3.17	±5	
835 Body	21	Permitivity	55.2	55.29	0.16	±5	2014.06.18
		Conductivity	0.97	0.97	0.16	±5	

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

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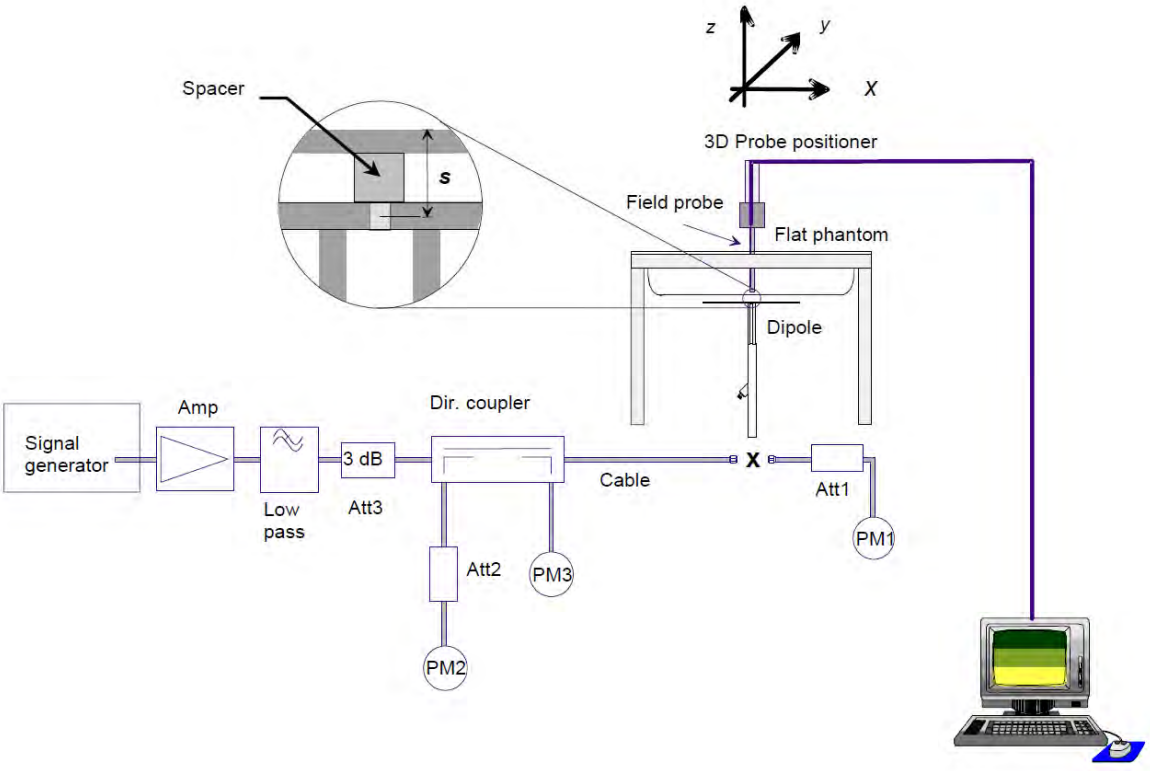
6.2 System Verification

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]

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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 (%)
2014.06.03	2 450 Body	5.134	51.340	52.4	-2.02
2014.06.06	1 900 Head	3.940	39.400	39.7	-0.76
2014.06.07	1 900 Head	3.999	39.990	39.7	0.73
2014.06.11	1 900 Body	3.905	39.050	39.7	-1.64
2014.06.13	835 Head	0.932	9.320	9.5	-2.51
2014.06.18	835 Body	0.996	9.960	9.5	4.18

Note:

1. Comparing to the original SAR value provided by APREL, 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.

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6.3 DUT Testing Position

Please see appendix for the DUT setup photos

6.4 SAR measurement procedure

The ALSAS-10U calculates SAR using the following equation,

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

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

The measurement procedures are as follows:

1) For DUT, using engineering software and (or) radio communication tester to transmit RF power continuously in the middle channel.
2) Mesure output power through RF cable and power meter.
3) Place the DUT in the positions described in the appendix for the DUT setup photos.
4) set area scan, grid size and other setting on the ALSAS-10U software.
5) Taking data for the middle channel on each testing position.
6) Find out the largest SAR result on these testing positions of each band
7) measure SAR results for the lowest and highest channels in worst SAR testing position.

The area scan is then run to establish the peak SAR location (interpolated resolution set at 1 ㎟) which is then used to orient the center of the zoom scan. The zoom scan is then executed and the 1 g and 10 g averages are derived from the zoom scan volume (interpolated resolution set at 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

HEAD GSM850 / GSM1900

No	Mode	Freq.	CH	Test Position	Antenna	Power Drift(%)	Measured 1 g SAR (W/Kg)	Scaled 1 g SAR (W/Kg)	Scaling factor	LIMIT 1.6 W/kg	NOTE
1	GSM Voice	836.6	190	Left Cheek	Internal	-0.352	0.055	0.065	1.19	PASS	GSM850 Head
2		836.6	190	Left Tilt	Internal	-3.667	0.055	0.065	1.19	PASS	
3		836.6	190	Right Cheek	Internal	-1.985	0.208	0.248	1.19	PASS	
4		836.6	190	Right Tilt	Internal	-3.276	0.086	0.102	1.19	PASS	
5	GPRS 2 slots	836.6	190	Left Cheek	Internal	3.776	0.120	0.148	1.23	PASS	GSM850 Head VoIP
6		836.6	190	Left Tilt	Internal	1.062	0.050	0.062	1.23	PASS	
7		836.6	190	Right Cheek	Internal	-0.688	**0.253**	**0.311**	1.23	PASS	
8		836.6	190	Right Tilt	Internal	1.579	0.105	0.129	1.23	PASS	
9	GSM Voice	1880	661	Left Cheek	Internal	-4.588	0.017	0.021	1.26	PASS	GSM1900 Head
10		1880	661	Left Tilt	Internal	2.732	0.009	0.011	1.26	PASS	
11		1880	661	Right Cheek	Internal	-1.709	0.023	0.029	1.26	PASS	
12		1880	661	Right Tilt	Internal	-4.298	0.017	0.021	1.26	PASS	
13	GPRS 2 slots	1880	661	Left Cheek	Internal	-3.652	0.012	0.015	1.22	PASS	GSM1900 Head VoIP
14		1880	661	Left Tilt	Internal	2.962	0.006	0.007	1.22	PASS	
15		1880	661	Right Cheek	Internal	-4.319	**0.027**	**0.033**	1.22	PASS	
16		1880	661	Right Tilt	Internal	3.443	0.013	0.016	1.22	PASS	

BODY GSM850/ GSM1900

No	Mode	Freq.	CH	Test Position	Antenna	Power Drift(%)	Measured 1 g SAR (W/Kg)	Scaled 1 g SAR (W/Kg)	Scaling factor	LIMIT 1.6 W/kg	NOTE
1	GSM Voice	836.6	190	FRONT	Internal	-2.199	0.107	0.127	1.19	PASS	GSM850 Body-worn
2		836.6	190	REAR	Internal	-3.459	**0.084**	**0.100**	1.19	PASS	
3	GPRS 2 slots	836.6	190	Front	Internal	-3.571	0.081	0.100	1.23	PASS	GSM850 Body-worn(VoIP)
4		836.6	190	Rear	Internal	-2.318	0.063	0.077	1.23	PASS	
5	GSM Voice	1880	661	FRONT	Internal	3.731	**0.012**	**0.015**	1.26	PASS	GSM1900 Body-worn
6		1880	661	REAR	Internal	2.828	0.010	0.013	1.26	PASS	
7	GPRS 2 slots	1880	661	Front	Internal	-3.648	0.010	0.012	1.22	PASS	GSM850 Body-worn(VoIP)
8		1880	661	Rear	Internal	3.915	0.012	0.015	1.22	PASS	

* Test separation distance : 5 mm

HEAD WCDMA Band V / Band II

No	Mode	Freq.	CH	Test Position	Antenna	Power Drift(%)	Measured 1 g SAR (W/Kg)	Scaled 1 g SAR (W/Kg)	Scaling factor	LIMIT 1.6 W/kg	NOTE
1	WCDMA RMC 12.2K	836.4	4182	Left Cheek	Internal	0.565	0.208	0.208	1.00	PASS	WCDMA Band V
2		836.4	4182	Left Tilt	Internal	-1.116	0.139	0.139	1.00	PASS	
3		836.4	4182	Right Cheek	Internal	1.074	0.271	0.271	1.00	PASS	
4		836.4	4182	Right Tilt	Internal	-0.471	0.127	0.127	1.00	PASS	
5	WCDMA RMC 12.2K	1880	9400	Left Cheek	Internal	-3.616	0.419	0.419	1.00	PASS	WCDMA Band II
6		1880	9400	Left Tilt	Internal	2.005	0.174	0.174	1.00	PASS	
7		1880	9400	Right Cheek	Internal	-0.304	0.776	0.776	1.00	PASS	
8		1880	9400	Right Tilt	Internal	-4.504	0.333	0.333	1.00	PASS	

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BODY WCDMA Band V / Band II

No	Mode	Freq.	CH	Test Position	Antenna	Power Drift(%)	Measured 1 g SAR (W/Kg)	Scaled 1 g SAR (W/Kg)	Scaling factor	LIMIT 1.6 W/kg	NOTE
1	WCDMA RMC 12.2K	836.4	4182	FRONT	Internal	-1.828	0.251	0.251	1.00	PASS	WCDMA Band V Body-worn
2		836.4	4182	REAR	Internal	-2.296	0.248	0.248	1.00	PASS	
3	WCDMA RMC 12.2K	1880	9400	FRONT	Internal	3.372	0.738	0.738	1.00	PASS	WCDMA Band II Body-worn
4		1880	9400	REAR	Internal	3.421	0.685	0.685	1.00	PASS	

* Test separation distance : 5 mm

BODY WLAN

No	Mode	Freq.	CH	Test Position	Antenna	Power Drift(%)	Measured 1 g SAR (W/Kg)	Scaled 1 g SAR (W/Kg)	Scaling factor	LIMIT 1.6 W/kg	NOTE
1	802.11b	2437	CH6	FRONT	Internal	-3.658	0.248	0.251	1.15	PASS	2.4 GHz band (Body-supported)
2		2437	CH6	REAR	Internal	-4.451	0.267	0.270	1.15	PASS	
3		2437	CH6	TOP	Internal	-3.099	0.042	0.042	1.15	PASS	
4		2437	CH6	LEFT	Internal	-4.027	**0.488**	**0.494**	1.15	PASS	

* Test separation distance : 5 mm

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 D01v01,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 648474 D04 Handset SAR, With headset attached, when the reported SAR for body-worn accessory, measured without a headset connected to the handset, is > 1.2 W/kg, the highest reported SAR configuration for that wireless mode and frequency band should be repeated for that body-worn accessory with a headset attached to the handset.

Please see appendix for the SAR test plots.

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7. Uncertainty Assessment

Source of Uncertainty	Tolerance Value	Probability Distribution	Divisor	c_i^1 (1-g)	c_i^1 (10-g)	Standard Uncertainty (1-g) %	Standard Uncertainty (10-g) %
Measurement System							
Probe Calibration	3.5	normal	1	1	1	3.5	3.5
Axial Isotropy	3.7	rectangular	√3	$(1-cp)^{1/2}$	$(1-cp)^{1/2}$	1.5	1.5
Hemispherical Isotropy	10.9	rectangular	√3	√cp	√cp	4.4	4.4
Boundary Effect	1.0	rectangular	√3	1	1	0.6	0.6
Linearity	4.7	rectangular	√3	1	1	2.7	2.7
Detection Limit	1.0	rectangular	√3	1	1	0.6	0.6
Readout Electronics	1.0	normal	1	1	1	1.0	1.0
Response Time	0.8	rectangular	√3	1	1	0.5	0.5
Integration Time	1.7	rectangular	√3	1	1	1.0	1.0
RF Ambient Condition	3.0	rectangular	√3	1	1	1.7	1.7
Probe Positioner Mech.	0.4	rectangular	√3	1	1	0.2	0.2
Restriction							
Probe Positioning with respect to Phantom Shell	2.9	rectangular	√3	1	1	1.7	1.7
Extrapolation and Integration	3.7	rectangular	√3	1	1	2.1	2.1
Test Sample Positioning	4.0	normal	1	1	1	4.0	4.0
Device Holder Uncertainty	2.0	normal	1	1	1	2.0	2.0
Drift of Output Power	0.3	rectangular	√3	1	1	0.2	0.2
Phantom and Setup							
Phantom Uncertainty(shape & thickness tolerance)	3.4	rectangular	√3	1	1	2.0	2.0
Liquid Conductivity(target)	5.0	rectangular	√3	0.7	0.5	2.0	1.4
Liquid Conductivity(meas.)	3.4	normal	1	0.7	0.5	2.4	1.7
Liquid Permittivity(target)	5.0	rectangular	√3	0.6	0.5	1.7	1.4
Liquid Permittivity(meas.)	4.1	normal	1	0.6	0.5	2.5	2.1
Combined Uncertainty		RSS				8.7	8.4
Combined Uncertainty (coverage factor=2)		Normal(k=2)				17.4	16.8

[Exposure Assessment Measurement Uncertainty]

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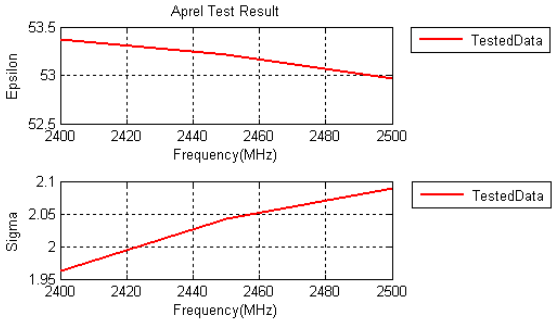
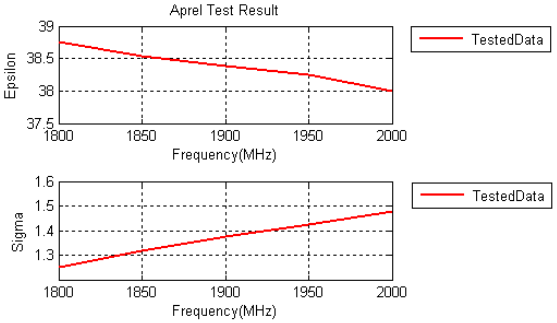
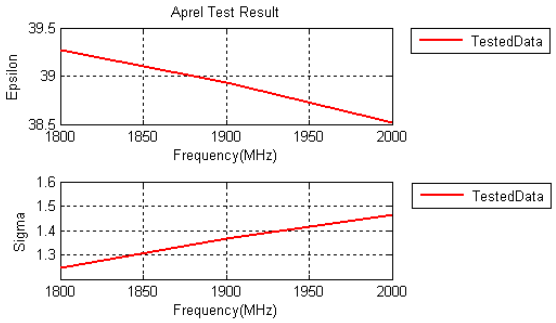
Appendix A : Plot of measured tissue.



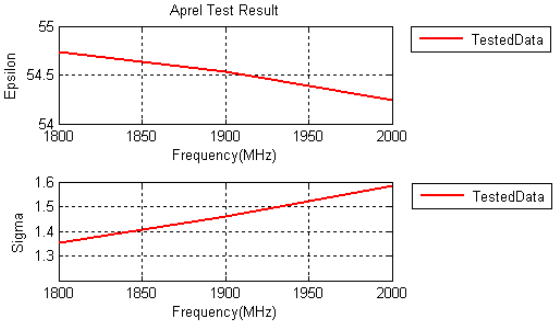
2 450 ㎒ Body, 2014.06.03



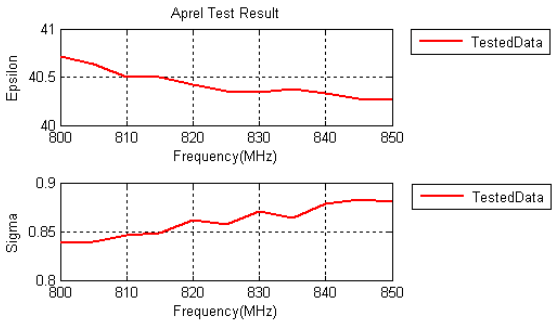
1 900 ㎒ Head, 2014.06.06



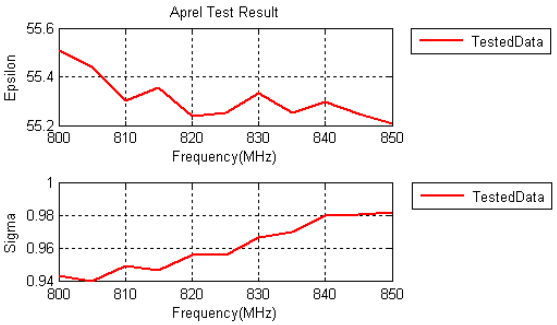
1 900 ㎒ Head, 2014.06.07



1 900 ㎒ Body, 2014.06.11



835 ㎒ Head, 2014.06.13



835 ㎒ Body, 2014.06.18

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Measuring result table for simulating liquid

2 450 ㎒ Body

1st

****
Aprel Laboratory
Test Result for UIM Dielectric Parameter
Thu 03/Jun/2014 12:32:52
Freq Frequency(GHz)
Test_e Epsilon of UIM
Test_s Sigma of UIM
****

Freq	Test_e	Test_s
2.4000	53.38	1.96
2.4120	53.34	1.98*
2.4370	53.24	2.03*
2.4500	53.21	2.04
2.4620	53.10	2.06*
2.5000	52.97	2.09

*value interpolated

2nd

****
Aprel Laboratory
Test Result for UIM Dielectric Parameter
Thu 03/Jun/2014 12:34:21
Freq Frequency(GHz)
Test_e Epsilon of UIM
Test_s Sigma of UIM
****

Freq	Test_e	Test_s
2.4000	52.83	1.95
2.4120	52.79	1.96*
2.4370	52.70	2.00*
2.4500	52.68	2.01
2.4620	52.57	2.04*
2.5000	52.43	2.08

*value interpolated

3rd

****
Aprel Laboratory
Test Result for UIM Dielectric Parameter
Thu 03/Jun/2014 12:35:29
Freq Frequency(GHz)
Test_e Epsilon of UIM
Test_s Sigma of UIM
****

Freq	Test_e	Test_s
2.4000	52.46	1.93
2.4120	52.43	1.95*
2.4370	52.36	1.99*
2.4500	52.34	2.00
2.4620	52.21	2.03*
2.5000	52.04	2.06

*value interpolated

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1 900 ㎒ Head, 2014.06.06

1st

****
Aprel Laboratory
Test Result for UIM Dielectric Parameter
Sat 06/Jun/2014 09:35:57
Freq Frequency(GHz)
Test_e Epsilon of UIM
Test_s Sigma of UIM
****

Freq	Test_e	Test_s
1.8000	38.76	1.25
1.8500	38.53	1.32
1.8502	38.53	1.32*
1.8800	38.45	1.35*
1.9000	38.39	1.37
1.9098	38.36	1.38*
1.9224	38.32	1.40*
1.9500	38.24	1.43
1.9776	38.10	1.46*
2.0000	37.99	1.48

*value interpolated

2nd

****
Aprel Laboratory
Test Result for UIM Dielectric Parameter
Sat 06/Jun/2014 09:37:08
Freq Frequency(GHz)
Test_e Epsilon of UIM
Test_s Sigma of UIM
****

Freq	Test_e	Test_s
1.8000	38.64	1.26
1.8500	38.49	1.31
1.8502	38.49	1.31*
1.8800	38.41	1.35*
1.9000	38.35	1.37
1.9098	38.32	1.38*
1.9224	38.29	1.40*
1.9500	38.21	1.44
1.9776	38.07	1.46*
2.0000	37.96	1.48

*value interpolated

3rd

Aprel Laboratory
Test Result for UIM Dielectric Parameter
Sat 06/Jun/2014 09:38:25
Freq Frequency(GHz)
Test_e Epsilon of UIM
Test_s Sigma of UIM
****

Freq	Test_e	Test_s
1.8000	38.68	1.25
1.8500	38.50	1.32
1.8502	38.50	1.32*
1.8800	38.42	1.35*
1.9000	38.36	1.37
1.9098	38.34	1.38*
1.9224	38.31	1.40*
1.9500	38.24	1.44
1.9776	38.08	1.46*
2.0000	37.95	1.48

*value interpolated

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1 900 ㎒ Head, 2014.06.07

1st

****
Aprel Laboratory
Test Result for UIM Dielectric Parameter
Sun 07/Jun/2014 08:57:08
Freq Frequency(GHz)
Test_e Epsilon of UIM
Test_s Sigma of UIM
****

Freq	Test_e	Test_s
1.8000	39.27	1.35
1.8502	39.10	1.36*
1.8800	39.00	1.36*
1.9000	38.93	1.36
1.9098	38.89	1.37*
1.9224	38.84	1.38*
1.9500	38.73	1.41*
1.9776	38.61	1.44*
2.0000	38.52	1.46

*value interpolated

2nd

****
Aprel Laboratory
Test Result for UIM Dielectric Parameter
Sun 07/Jun/2014 08:57:58
Freq Frequency(GHz)
Test_e Epsilon of UIM
Test_s Sigma of UIM
****

Freq	Test_e	Test_s
1.8000	39.30	1.35
1.8502	39.08	1.36*
1.8800	38.96	1.36*
1.9000	38.87	1.36
1.9098	38.84	1.37*
1.9224	38.79	1.38*
1.9500	38.70	1.41*
1.9776	38.61	1.44*
2.0000	38.53	1.46

*value interpolated

3rd

****
Aprel Laboratory
Test Result for UIM Dielectric Parameter
Sun 07/Jun/2014 08:58:46
Freq Frequency(GHz)
Test_e Epsilon of UIM
Test_s Sigma of UIM
****

Freq	Test_e	Test_s
1.8000	39.25	1.35
1.8502	39.07	1.36*
1.8800	38.96	1.36*
1.9000	38.89	1.36
1.9098	38.85	1.37*
1.9224	38.80	1.38*
1.9500	38.70	1.41*
1.9776	38.59	1.44*
2.0000	38.50	1.46

*value interpolated

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1 900 ㎒ Body, 2014.06.11

1st

****
Aprel Laboratory
Test Result for UIM Dielectric Parameter
Sun 11/Jun/2014 08:41:30
Freq Frequency(GHz)
Test_e Epsilon of UIM
Test_s Sigma of UIM
****

Freq	Test_e	Test_s
1.8000	54.74	1.35
1.8502	54.63	1.41*
1.8800	54.57	1.44*
1.9000	54.53	1.46
1.9098	54.50	1.47*
1.9224	54.47	1.49*
1.9500	54.39	1.52*
1.9776	54.31	1.55*
2.0000	54.25	1.58

*value interpolated

2nd

****
Aprel Laboratory
Test Result for UIM Dielectric Parameter
Sun 11/Jun/2014 08:42:48
Freq Frequency(GHz)
Test_e Epsilon of UIM
Test_s Sigma of UIM
****

Freq	Test_e	Test_s
1.8000	54.70	1.34
1.8502	54.59	1.40*
1.8800	54.52	1.44*
1.9000	54.48	1.45
1.9098	54.46	1.46*
1.9224	54.43	1.48*
1.9500	54.38	1.52*
1.9776	54.32	1.55*
2.0000	54.27	1.58

*value interpolated

3rd

****
Aprel Laboratory
Test Result for UIM Dielectric Parameter
Sun 11/Jun/2014 08:43:43
Freq Frequency(GHz)
Test_e Epsilon of UIM
Test_s Sigma of UIM
****

Freq	Test_e	Test_s
1.8000	54.73	1.34
1.8502	54.61	1.40*
1.8800	54.54	1.44*
1.9000	54.49	1.46
1.9098	54.47	1.47*
1.9224	54.43	1.49*
1.9500	54.37	1.53*
1.9776	54.30	1.56*
2.0000	54.24	1.59

*value interpolated

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835 ㎒ Head, 2014.06.13

1st

****
Aprel Laboratory
Test Result for UIM Dielectric Parameter
Thu 13/Jun/2014 09:24:54
Freq Frequency(GHz)
Test_e Epsilon of UIM
Test_s Sigma of UIM
****

Freq	Test_e	Test_s	0.8350	40.38	0.86
0.8000	40.72	0.84	0.8364	40.37	0.87*
0.8050	40.64	0.84	0.8366	40.36	0.87*
0.8100	40.50	0.85	0.8400	40.33	0.88
0.8150	40.50	0.85	0.8450	40.27	0.88
0.8200	40.42	0.86	0.8466	40.27	0.88*
0.8242	40.37	0.86*	0.8488	40.26	0.88*
0.8250	40.36	0.86	0.8500	40.26	0.88
0.8264	40.35	0.86*			
0.8300	40.34	0.87	*value interpolated		

2nd

****
Aprel Laboratory
Test Result for UIM Dielectric Parameter
Thu 13/Jun/2014 09:26:35
Freq Frequency(GHz)
Test_e Epsilon of UIM
Test_s Sigma of UIM
****

Freq	Test_e	Test_s	0.8350	40.39	0.87
0.8000	40.74	0.84	0.8364	40.37	0.87*
0.8050	40.61	0.84	0.8366	40.37	0.87*
0.8100	40.55	0.84	0.8400	40.32	0.88
0.8150	40.62	0.85	0.8450	40.34	0.88
0.8200	40.48	0.86	0.8466	40.31	0.88*
0.8242	40.41	0.86*	0.8488	40.27	0.88*
0.8250	40.40	0.86	0.8500	40.25	0.88
0.8264	40.40	0.86*			
0.8300	40.40	0.86	*value interpolated		

3rd

****
Aprel Laboratory
Test Result for UIM Dielectric Parameter
Thu 13/Jun/2014 09:28:00
Freq Frequency(GHz)
Test_e Epsilon of UIM
Test_s Sigma of UIM
****

Freq	Test_e	Test_s	0.8350	40.42	0.87
0.8000	40.71	0.84	0.8364	40.42	0.87*
0.8050	40.71	0.84	0.8366	40.42	0.87*
0.8100	40.57	0.85	0.8400	40.42	0.88
0.8150	40.59	0.85	0.8450	40.36	0.88
0.8200	40.50	0.86	0.8466	40.36	0.88*
0.8242	40.37	0.86*	0.8488	40.36	0.88*
0.8250	40.35	0.86	0.8500	40.36	0.88
0.8264	40.36	0.86*			
0.8300	40.39	0.87	*value interpolated		

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835 MHz Body, 2014.06.18

1st

****
Aprel Laboratory
Test Result for UIM Dielectric Parameter
Thu 18/Jun/2014 09:06:29
Freq Frequency(GHz)
Test_e Epsilon of UIM
Test_s Sigma of UIM
****

Freq	Test_e	Test_s	0.8350	55.30	0.97
0.8000	55.38	0.94	0.8364	55.27	0.97*
0.8050	55.44	0.95	0.8366	55.27	0.97*
0.8100	55.35	0.95	0.8400	55.20	0.98
0.8150	55.39	0.94	0.8450	55.27	0.98
0.8200	55.21	0.95	0.8466	55.26	0.98*
0.8242	55.31	0.96*	0.8488	55.24	0.99*
0.8250	55.33	0.96	0.8500	55.23	0.99
0.8264	55.31	0.97*			
0.8300	55.26	0.98	*value interpolated		

2nd

****
Aprel Laboratory
Test Result for UIM Dielectric Parameter
Thu 18/Jun/2014 09:07:54
Freq Frequency(GHz)
Test_e Epsilon of UIM
Test_s Sigma of UIM
****

Freq	Test_e	Test_s	0.8350	55.35	0.97
0.8000	55.40	0.94	0.8364	55.33	0.97*
0.8050	55.38	0.94	0.8366	55.33	0.97*
0.8100	55.31	0.95	0.8400	55.28	0.98
0.8150	55.27	0.95	0.8450	55.17	0.98
0.8200	55.30	0.96	0.8466	55.18	0.98*
0.8242	55.25	0.96*	0.8488	55.19	0.98*
0.8250	55.24	0.96	0.8500	55.20	0.98
0.8264	55.24	0.96*			
0.8300	55.24	0.97	*value interpolated		

3rd

****
Aprel Laboratory
Test Result for UIM Dielectric Parameter
Thu 18/Jun/2014 09:09:17
Freq Frequency(GHz)
Test_e Epsilon of UIM
Test_s Sigma of UIM
****

Freq	Test_e	Test_s	0.8350	55.25	0.97
0.8000	55.51	0.94	0.8364	55.26	0.97*
0.8050	55.44	0.94	0.8366	55.27	0.97*
0.8100	55.30	0.95	0.8400	55.30	0.98
0.8150	55.36	0.95	0.8450	55.25	0.98
0.8200	55.24	0.96	0.8466	55.24	0.98*
0.8242	55.25	0.96*	0.8488	55.22	0.98*
0.8250	55.25	0.96	0.8500	55.21	0.98
0.8264	55.27	0.96*			
0.8300	55.33	0.97	*value interpolated		

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Appendix B : Plot of system verification test.

▣ 2450B

SAR Test Report

```
Report Date      : 03-Jun-2014
By Operator      : Miyoung.Lee
Measurement Date  : 03-Jun-2014
Starting Time    : 03-Jun-2014  01:05:57 PM
End Time        : 03-Jun-2014  01:30:00 PM
Scanning Time    : 1443 secs

Product Data
Device Name      : 2450 MHz Dipole
Serial No.       : 220-00764
Type            : Dipole
Model           : ALS-D-2450-S-2
Frequency        : 2450.00 MHz
Max. Transmit Pwr : 0.1 W
Drift Time       : 10 min(s)
Length          : 52.5 mm
Width           : 3.6 mm
Depth           : 17 mm
Antenna Type     : Internal
Orientation      : Touch
Power Drift-Start : 5.651 W/kg
Power Drift-Finish: 5.706 W/kg
Power Drift (%)   : 0.972
Picture          :

Phantom Data
Name            : APREL-Uni
Type            : Uni-Phantom
Size (mm)        : 280 x 280 x 200
Serial No.       : User Define
Location        : Center
Description      : User Defined

Tissue Data
Type            : BODY
Serial No.       : 2450B
Frequency        : 2450.00 MHz
Last Calib. Date : 03-Jun-2014
Temperature      : 21.00 °C
Ambient Temp.    : 21.00 °C
Humidity         : 45.00 RH%
Epsilon          : 52.74 F/m
Sigma           : 2.02 S/m
Density          : 1000.00 kg/cu. m
```

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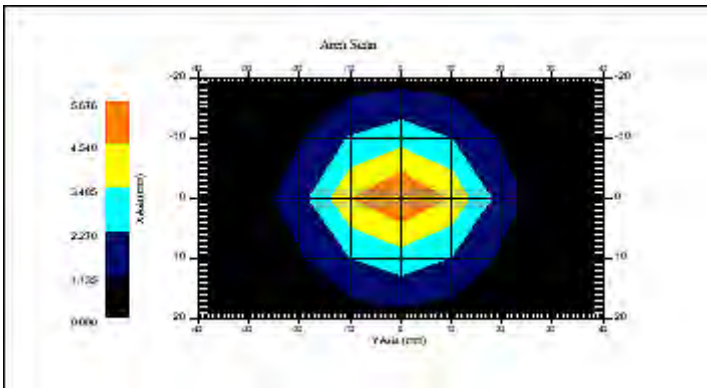
```
Probe Data
Name           : E-Field
Model          : E-020
Type           : E-Field Triangle
Serial No.      : 271_CW
Last Calib. Date : 02-Jul-2013
Frequency       : 2450.00 MHz
Duty Cycle Factor: 1
Conversion Factor: 4.3
Probe Sensitivity: 1.20  1.20  1.20   μV/(V/m)²
Compression Point: 95.00 mV
Offset          : 1.56 mm

Measurement Data
Crest Factor    : 1
Scan Type       : Complete
Tissue Temp.    : 21.00 °C
Ambient Temp.   : 21.00 °C
Set-up Date     : 03-Jun-2014
Set-up Time     : 1:02:14 PM
Area Scan       : 5x9x1 : Measurement x=10mm, y=10mm, z=4mm
Zoom Scan       : 7x7x7 : Measurement x=5mm, y=5mm, z=5mm

Other Data
DUT Position    : Touch
Separation      : 10
```



```
1 gram SAR value   : 5.134 W/kg
10 gram SAR value  : 2.381 W/kg
Area Scan Peak SAR : 5.676 W/kg
Zoom Scan Peak SAR : 9.608 W/kg
```

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▣ 1900H

SAR Test Report

```
Report Date      : 06-Jun-2014
By Operator      : Miyoung.Lee
Measurement Date  : 06-Jun-2014
Starting Time     : 06-Jun-2014  09:48:04 AM
End Time         : 06-Jun-2014  10:12:39 AM
Scanning Time     : 1475 secs

Product Data
Device Name      : 1900 MHz Dipole
Serial No.       : 210-00717
Type            : Dipole
Model           : ALS-D-1900-S-S
Frequency        : 1900.00 MHz
Max. Transmit Pwr : 0.25 W
Drift Time       : 10 min(s)
Length          : 68 mm
Width           : 3.7 mm
Depth           : 41.8 mm
Antenna Type     : Internal
Orientation      : Touch
Power Drift-Start : 4.243 W/kg
Power Drift-Finish: 4.247 W/kg
Power Drift (%)   : 0.113
Picture          :

Phantom Data
Name            : APREL-Uni
Type            : Uni-Phantom
Size (mm)        : 280 x 280 x 200
Serial No.       : User Define
Location        : Center
Description      : User Defined

Tissue Data
Type            : HEAD
Serial No.       : 1900H
Frequency        : 1900.00 MHz
Last Calib. Date : 06-Jun-2014
Temperature      : 21.00 °C
Ambient Temp.    : 21.00 °C
Humidity         : 49.00 RH%
Epsilon          : 38.37 F/m
Sigma           : 1.37 S/m
Density          : 1000.00 kg/cu. m
```

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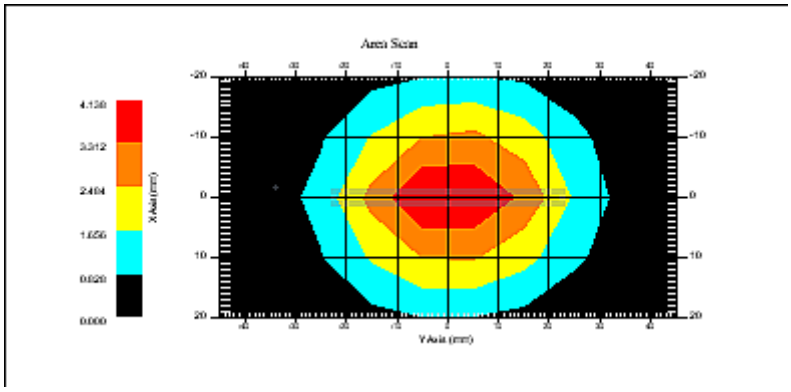
```
Probe Data
Name           : E-Field
Model          : E-020
Type           : E-Field Triangle
Serial No.      : 271_CW
Last Calib. Date : 02-Jul-2013
Frequency       : 1900.00 MHz
Duty Cycle Factor: 1
Conversion Factor: 5.6
Probe Sensitivity: 1.20  1.20  1.20   μV/(V/m)²
Compression Point: 95.00 mV
Offset          : 1.56 mm

Measurement Data
Crest Factor    : 1
Scan Type       : Complete
Tissue Temp.    : 21.00 °C
Ambient Temp.   : 21.00 °C
Set-up Date     : 06-Jun-2014
Set-up Time     : 9:34:35 AM
Area Scan       : 5x10x1 : Measurement x=10mm, y=10mm, z=4mm
Zoom Scan       : 7x7x7 : Measurement x=5mm, y=5mm, z=5mm

Other Data
DUT Position    : Touch
Separation      : 10
```




```
1 gram SAR value   : 3.940 W/kg
10 gram SAR value  : 2.056 W/kg
Area Scan Peak SAR : 4.138 W/kg
Zoom Scan Peak SAR : 6.685 W/kg
```

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▣ 1900H

SAR Test Report

Report Date : 07-Jun-2014
By Operator : Miyoung.Lee
Measurement Date : 07-Jun-2014
Starting Time : 07-Jun-2014 09:14:04 AM
End Time : 07-Jun-2014 09:39:26 AM
Scanning Time : 1522 secs

Product Data
Device Name : 1900 MHz Dipole
Serial No. : 210-00717
Type : Dipole
Model : ALS-D-1900-S-S
Frequency : 1900.00 MHz
Max. Transmit Pwr : 0.25 W
Drift Time : 10 min(s)
Length : 68 mm
Width : 3.7 mm
Depth : 41.8 mm
Antenna Type : Internal
Orientation : Touch
Power Drift-Start : 4.313 W/kg
Power Drift-Finish: 4.323 W/kg
Power Drift (%) : 0.221
Picture :

Phantom Data
Name : APREL-Uni
Type : Uni-Phantom
Size (mm) : 280 x 280 x 200
Serial No. : User Define
Location : Center
Description : User Defined

Tissue Data
Type : HEAD
Serial No. : 1900H
Frequency : 1900.00 MHz
Last Calib. Date : 07-Jun-2014
Temperature : 21.00 °C
Ambient Temp. : 21.00 °C
Humidity : 45.00 RH%
Epsilon : 38.90 F/m
Sigma : 1.36 S/m
Density : 1000.00 kg/cu. m

Head office & Test Lab: 28(175-20,Annyeong-dong)
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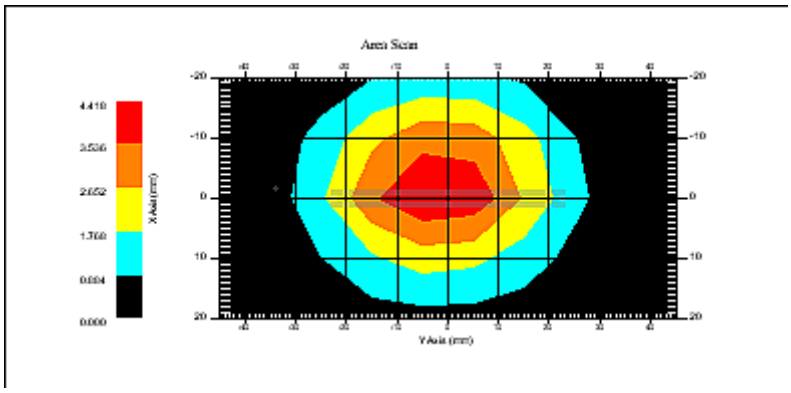
```
Probe Data
Name           : E-Field
Model          : E-020
Type           : E-Field Triangle
Serial No.      : 271_CW
Last Calib. Date : 02-Jul-2013
Frequency       : 1900.00 MHz
Duty Cycle Factor: 1
Conversion Factor: 5.6
Probe Sensitivity: 1.20  1.20  1.20   μV/(V/m)²
Compression Point: 95.00 mV
Offset          : 1.56 mm

Measurement Data
Crest Factor    : 1
Scan Type       : Complete
Tissue Temp.    : 21.00 °C
Ambient Temp.   : 21.00 °C
Set-up Date     : 07-Jun-2014
Set-up Time     : 9:08:35 AM
Area Scan       : 5x10x1 : Measurement x=10mm, y=10mm, z=4mm
Zoom Scan       : 7x7x7 : Measurement x=5mm, y=5mm, z=5mm

Other Data
DUT Position    : Touch
Separation      : 10
```




```
1 gram SAR value   : 3.999 W/kg
10 gram SAR value  : 2.085 W/kg
Area Scan Peak SAR : 4.418 W/kg
Zoom Scan Peak SAR : 6.986 W/kg
```

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▣ 1900B

SAR Test Report

```
Report Date      : 11-Jun-2014
By Operator      : Miyoung.Lee
Measurement Date  : 11-Jun-2014
Starting Time     : 11-Jun-2014  09:36:07 AM
End Time         : 11-Jun-2014  10:01:26 AM
Scanning Time     : 1519 secs

Product Data
Device Name       : 1900 MHz Dipole
Serial No.        : 210-00717
Type             : Dipole
Model            : ALS-D-1900-S-S
Frequency         : 1900.00 MHz
Max. Transmit Pwr : 0.25 W
Drift Time        : 10 min(s)
Length           : 68 mm
Width            : 3.7 mm
Depth            : 41.8 mm
Antenna Type      : Internal
Orientation       : Touch
Power Drift-Start : 4.229 W/kg
Power Drift-Finish: 4.251 W/kg
Power Drift (%)   : 0.500
Picture          :

Phantom Data
Name            : APREL-Uni
Type            : Uni-Phantom
Size (mm)        : 280 x 280 x 200
Serial No.       : User Define
Location         : Center
Description      : User Defined

Tissue Data
Type            : BODY
Serial No.       : 1900B
Frequency        : 1900.00 MHz
Last Calib. Date : 11-Jun-2014
Temperature      : 21.00 °C
Ambient Temp.    : 21.00 °C
Humidity         : 52.00 RH%
Epsilon          : 54.50 F/m
Sigma            : 1.47 S/m
Density          : 1000.00 kg/cu. m
```

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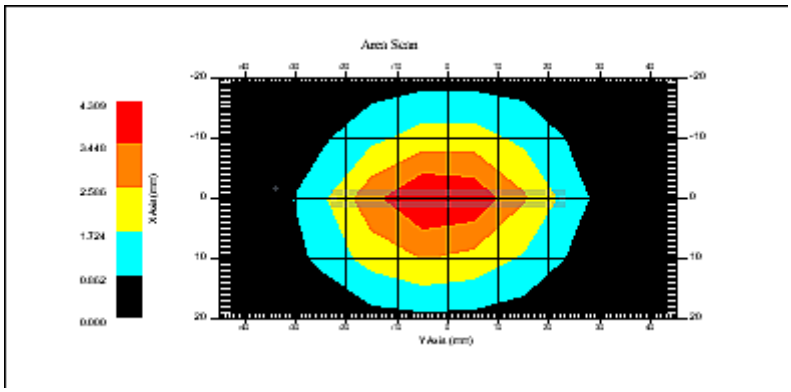
Probe Data
Name : E-Field
Model : E-020
Type : E-Field Triangle
Serial No. : 271_CW
Last Calib. Date : 02-Jul-2013
Frequency : 1900.00 MHz
Duty Cycle Factor: 1
Conversion Factor: 5.4
Probe Sensitivity: 1.20 1.20 1.20 $\mu V/(V/m)^2$
Compression Point: 95.00 mV
Offset : 1.56 mm

Measurement Data
Crest Factor : 1
Scan Type : Complete
Tissue Temp. : 21.00 °C
Ambient Temp. : 21.00 °C
Set-up Date : 11-Jun-2014
Set-up Time : 9:30:16 AM
Area Scan : 5x10x1 : Measurement x=10mm, y=10mm, z=4mm
Zoom Scan : 7x7x7 : Measurement x=5mm, y=5mm, z=5mm

Other Data
DUT Position : Touch
Separation : 10



1 gram SAR value : 3.905 W/kg
10 gram SAR value : 2.047 W/kg
Area Scan Peak SAR : 4.309 W/kg
Zoom Scan Peak SAR : 6.706 W/kg

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▣ 835H

SAR Test Report

```
Report Date      : 13-Jun-2014
By Operator      : Miyoung.Lee
Measurement Date  : 13-Jun-2014
Starting Time    : 13-Jun-2014  09:18:40 AM
End Time         : 13-Jun-2014  09:47:54 AM
Scanning Time    : 1754 secs

Product Data
Device Name      : 835 MHz Dipole
Serial No.       : 180-00555
Type            : Dipole
Model           : ALS-D-835-s-2
Frequency        : 835.00 MHz
Max. Transmit Pwr : 0.1 W
Drift Time       : 10 min(s)
Length          : 161 mm
Width           : 3.6 mm
Depth           : 3.6 mm
Antenna Type     : Internal
Orientation      : Touch
Power Drift-Start : 0.983 W/kg
Power Drift-Finish: 0.976 W/kg
Power Drift (%)   : -0.674
Picture          :

Phantom Data
Name           : APREL-Uni
Type           : Uni-Phantom
Size (mm)       : 280 x 280 x 200
Serial No.      : User Define
Location        : Center
Description     : User Defined

Tissue Data
Type           : HEAD
Serial No.      : 835H
Frequency       : 835.00 MHz
Last Calib. Date : 13-Jun-2014
Temperature     : 21.00 °C
Ambient Temp.    : 21.00 °C
Humidity        : 45.00 RH%
Epsilon         : 40.40 F/m
Sigma           : 0.87 S/m
Density         : 1000.00 kg/cu. m
```

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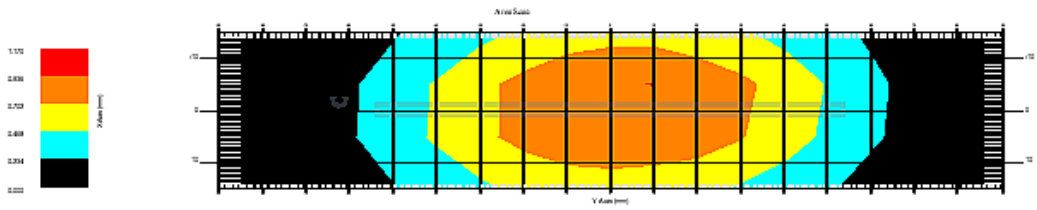
```
Probe Data
Name           : E-Field
Model          : E-020
Type           : E-Field Triangle
Serial No.      : 271_CW
Last Calib. Date : 02-Jul-2013
Frequency       : 835.00 MHz
Duty Cycle Factor: 1
Conversion Factor: 6.5
Probe Sensitivity: 1.20  1.20  1.20   μV/(V/m)²
Compression Point: 95.00 mV
Offset          : 1.56 mm

Measurement Data
Crest Factor    : 1
Scan Type       : Complete
Tissue Temp.    : 21.00 °C
Ambient Temp.   : 21.00 °C
Set-up Date     : 13-Jun-2014
Set-up Time     : 9:17:36 AM
Area Scan       : 4x19x1 : Measurement x=10mm, y=10mm, z=4mm
Zoom Scan       : 7x7x7 : Measurement x=5mm, y=5mm, z=5mm

Other Data
DUT Position    : Touch
Separation      : 15
```



```
1 gram SAR value   : 0.932 W/kg
10 gram SAR value  : 0.593 W/kg
Area Scan Peak SAR : 0.937 W/kg
Zoom Scan Peak SAR : 1.381 W/kg
```

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▣ 835B

SAR Test Report

```
Report Date      : 18-Jun-2014
By Operator      : Miyoung.Lee
Measurement Date  : 18-Jun-2014
Starting Time    : 18-Jun-2014  09:16:56 AM
End Time         : 18-Jun-2014  09:46:03 AM
Scanning Time    : 1747 secs

Product Data
Device Name      : 835 MHz Dipole
Serial No.       : 180-00555
Type            : Dipole
Model           : ALS-D-835-s-2
Frequency        : 835.00 MHz
Max. Transmit Pwr : 0.1 W
Drift Time       : 10 min(s)
Length          : 161 mm
Width           : 3.6 mm
Depth           : 3.6 mm
Antenna Type     : Internal
Orientation      : Touch
Power Drift-Start : 0.993 W/kg
Power Drift-Finish: 1.026 W/kg
Power Drift (%)   : 3.393
Picture          :

Phantom Data
Name            : APREL-Uni
Type            : Uni-Phantom
Size (mm)        : 280 x 280 x 200
Serial No.       : User Define
Location        : Center
Description      : User Defined

Tissue Data
Type            : BODY
Serial No.       : 835B
Frequency        : 835.00 MHz
Last Calib. Date : 18-Jun-2014
Temperature      : 21.00 °C
Ambient Temp.    : 21.00 °C
Humidity        : 46.00 RH%
Epsilon         : 55.30 F/m
Sigma           : 0.97 S/m
Density         : 1000.00 kg/cu. m
```

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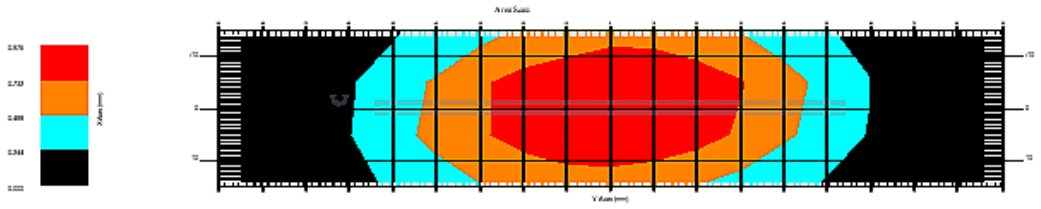
```
Probe Data
Name           : E-Field
Model          : E-020
Type           : E-Field Triangle
Serial No.      : 271_CW
Last Calib. Date : 02-Jul-2013
Frequency       : 835.00 MHz
Duty Cycle Factor: 1
Conversion Factor: 6.5
Probe Sensitivity: 1.20  1.20  1.20   μV/(V/m)²
Compression Point: 95.00 mV
Offset          : 1.56 mm

Measurement Data
Crest Factor    : 1
Scan Type       : Complete
Tissue Temp.    : 21.00 °C
Ambient Temp.   : 21.00 °C
Set-up Date     : 18-Jun-2014
Set-up Time     : 9:16:30 AM
Area Scan       : 4x19x1 : Measurement x=10mm, y=10mm, z=4mm
Zoom Scan       : 7x7x7 : Measurement x=5mm, y=5mm, z=5mm

Other Data
DUT Position    : Touch
Separation      : 15
```



```
1 gram SAR value   : 0.996 W/kg
10 gram SAR value  : 0.636 W/kg
Area Scan Peak SAR : 0.975 W/kg
Zoom Scan Peak SAR : 1.481 W/kg
```

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Appendix C : Plot of SAR test.

Test Plot list

No	Configration	Type	Mode	Freq	CH	Test position	1 g SAR (W/Kg)
1	Head	GSM850	GPRS 2 slots	836.6	190	Right Cheek	0.253
2	Head	GSM1900	GPRS 2 slots	1880	661	Right Cheek	0.027
3	Head	WCDMA Band V	WCDMA RMC 12.2K	836.4	4182	Right Cheek	0.271
4	**Head**	**WCDMA Band II**	**WCDMA RMC 12.2K**	**1880**	**9400**	**Right Cheek**	**0.776***
5	Body	GSM850	GSM Voice	836.6	190	REAR	0.084
6	Body	GSM1900	GSM Voice	1880	661	FRONT	0.012
7	Body	WCDMA Band V	WCDMA RMC 12.2K	836.4	4182	FRONT	0.251
8	Body	WCDMA Band II	WCDMA RMC 12.2K	1880	9400	FRONT	0.738
9	Body	WLAN	802.11b	2437	CH6	LEFT	0.488

*Max SAR value

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1	Head	GSM850	GPRS 2 slots	836.6	190	Right Cheek

SAR Test Report

```
Report Date      : 13-Jun-2014
By Operator      : Miyoung.Lee
Measurement Date  : 13-Jun-2014
Starting Time    : 13-Jun-2014  09:55:01 AM
End Time         : 13-Jun-2014  10:29:46 AM
Scanning Time    : 2085 secs

Product Data
Device Name      : Bluebird Inc.
Serial No.       : Proto Type
Type            : PDA
Model           : BM180
Frequency        : 836.60 MHz
Max. Transmit Pwr : 0.1 W
Drift Time       : 10 min(s)
Length          : 150 mm
Width           : 80 mm
Depth           : 22 mm
Antenna Type     : Internal
Orientation      : Touch
Power Drift-Start : 0.074 W/kg
Power Drift-Finish: 0.073 W/kg
Power Drift (%)   : -0.688
Picture          : C:\Alsas\bitmap\Device-19.bmp

Phantom Data
Name           : APREL-SAM Right Ear
Type           : SAM-Right
Size (mm)       : 280 x 280 x 280
Serial No.      : User Define
Location        : Right
Description     : RSAM User Defined

Tissue Data
Type           : HEAD
Serial No.      : 836.6H
Frequency       : 836.60 MHz
Last Calib. Date : 13-Jun-2014
Temperature     : 21.00 °C
Ambient Temp.    : 21.00 °C
Humidity        : 45.00 RH%
Epsilon         : 40.38 F/m
Sigma          : 0.87 S/m
Density         : 1000.00 kg/cu. m
```

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```
Probe Data
Name           : E-Field
Model          : E-020
Type           : E-Field Triangle
Serial No.      : 271_CW
Last Calib. Date : 02-Jul-2013
Frequency       : 835.00 MHz
Duty Cycle Factor: 8.3
Conversion Factor: 7.0
Probe Sensitivity: 1.20  1.20  1.20   μV/(V/m)²
Compression Point: 95.00 mV
Offset          : 1.56 mm

Measurement Data
Crest Factor    : 4
Scan Type       : Complete
Tissue Temp.    : 21.00 °C
Ambient Temp.   : 21.00 °C
Set-up Date     : 13-Jun-2014
Set-up Time     : 9:49:51 AM
Area Scan       : 6x7x1 : Measurement x=15mm, y=15mm, z=4mm
Zoom Scan       : 7x7x7 : Measurement x=5mm, y=5mm, z=5mm

Other Data
DUT Position    : Touch
Separation      : 0
Channel         : Mid
```

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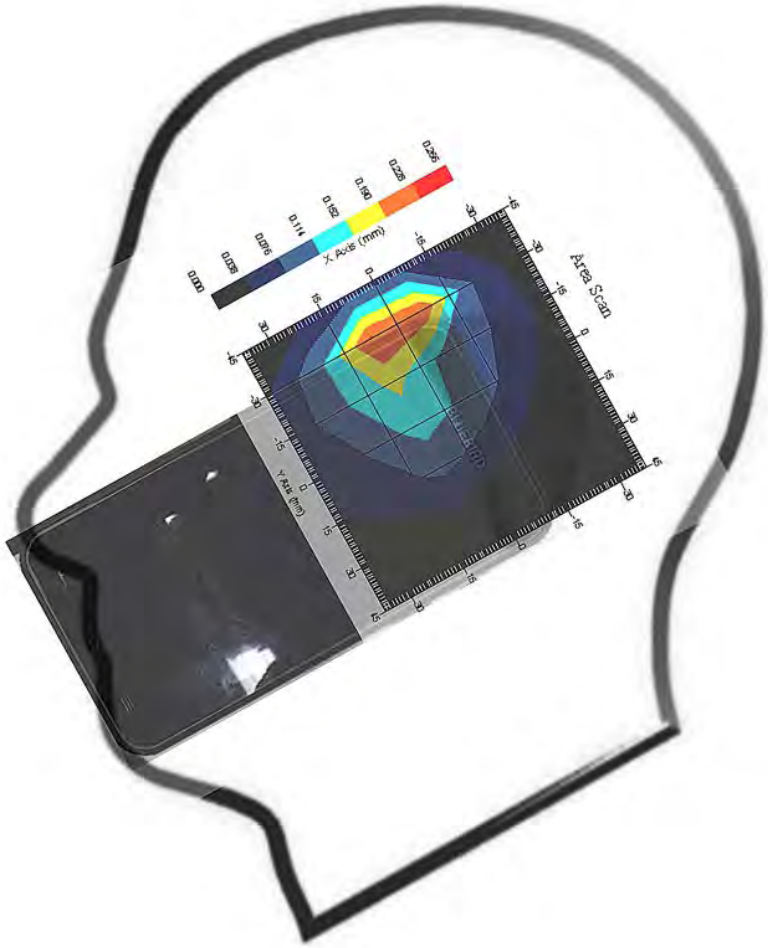

1 gram SAR value : 0.253 W/kg
10 gram SAR value : 0.118 W/kg
Area Scan Peak SAR : 0.229 W/kg
Zoom Scan Peak SAR : 0.480 W/kg

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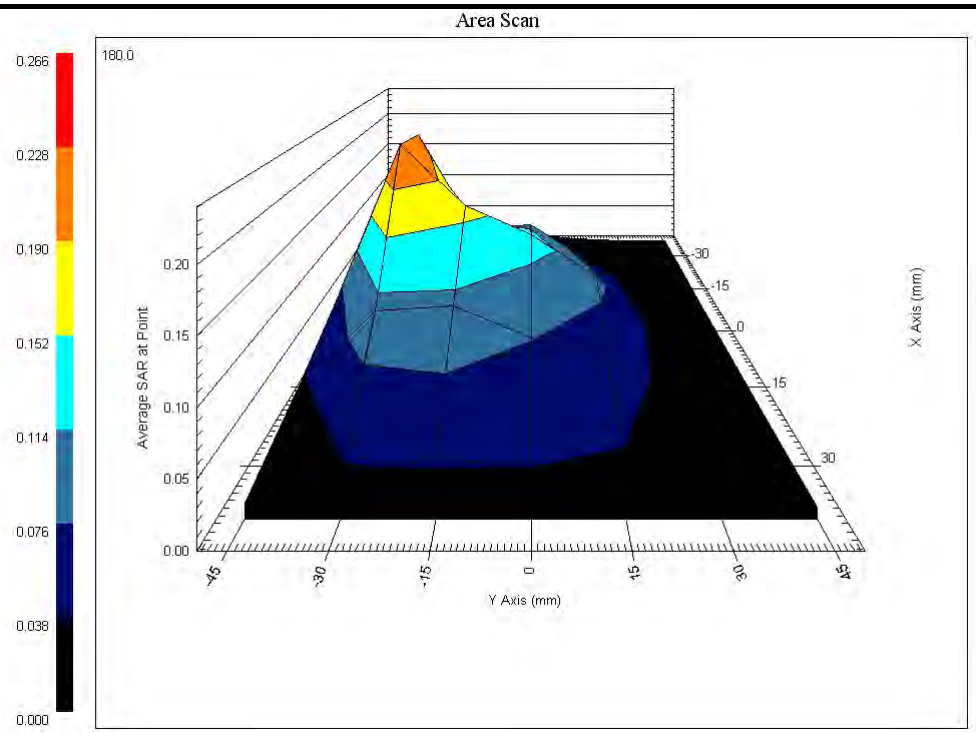
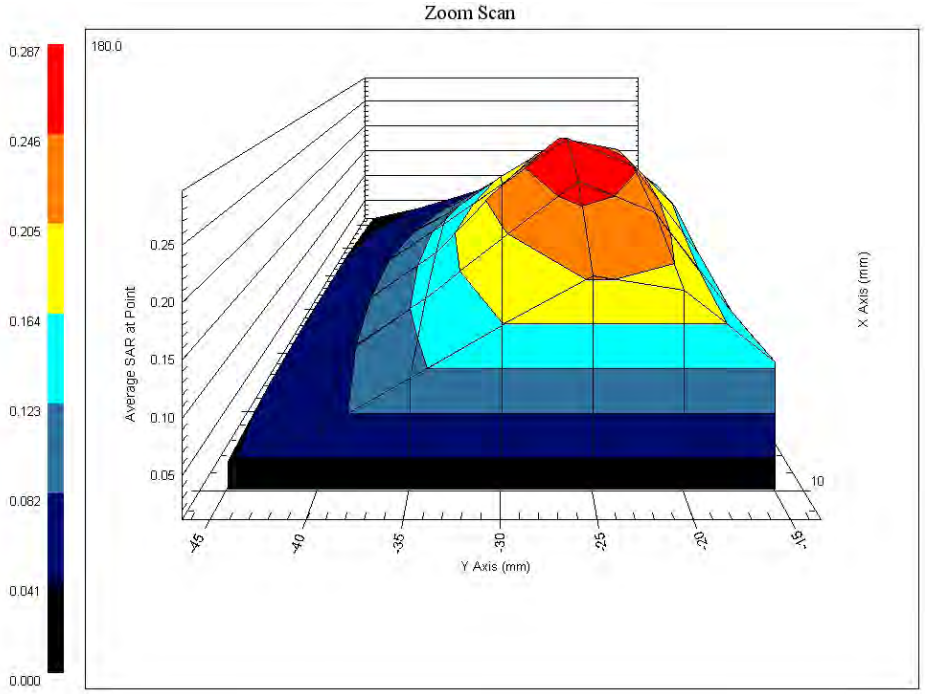


AREA SCAN Graph



ZOOM SCAN Graph

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2	Head	GSM1900	GPRS 2 slots	1880	661	Right Cheek

SAR Test Report

```
Report Date      : 07-Jun-2014
By Operator      : Miyoung.Lee
Measurement Date  : 07-Jun-2014
Starting Time    : 07-Jun-2014  06:29:07 PM
End Time         : 07-Jun-2014  07:05:06 PM
Scanning Time    : 2159 secs

Product Data
Device Name      : Bluebird Inc.
Serial No.       : Proto Type
Type            : PDA
Model           : BM180
Frequency        : 1880.00 MHz
Max. Transmit Pwr : 0.09 W
Drift Time       : 10 min(s)
Length          : 150 mm
Width           : 80 mm
Depth           : 22 mm
Antenna Type     : Internal
Orientation      : Touch
Power Drift-Start : 0.011 W/kg
Power Drift-Finish: 0.011 W/kg
Power Drift (%)   : -4.319
Picture          : C:\Alsas\bitmap\Device-23.bmp

Phantom Data
Name           : APREL-SAM Right Ear
Type           : SAM-Right
Size (mm)       : 280 x 280 x 280
Serial No.      : User Define
Location        : Right
Description     : RSAM User Defined

Tissue Data
Type           : HEAD
Serial No.      : 1880H
Frequency       : 1880.00 MHz
Last Calib. Date : 07-Jun-2014
Temperature     : 21.00 °C
Ambient Temp.    : 21.00 °C
Humidity        : 43.00 RH%
Epsilon         : 38.97 F/m
Sigma          : 1.36 S/m
Density         : 1000.00 kg/cu. m
```

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```
Probe Data
Name           : E-Field
Model          : E-020
Type           : E-Field Triangle
Serial No.      : 271_CW
Last Calib. Date : 02-Jul-2013
Frequency       : 1900.00 MHz
Duty Cycle Factor: 8.3
Conversion Factor: 5.6
Probe Sensitivity: 1.20  1.20  1.20   µV/(V/m)²
Compression Point: 95.00 mV
Offset          : 1.56 mm

Measurement Data
Crest Factor    : 4
Scan Type       : Complete
Tissue Temp.    : 21.00 °C
Ambient Temp.   : 21.00 °C
Set-up Date     : 07-Jun-2014
Set-up Time     : 4:05:44 PM
Area Scan       : 6x7x1 : Measurement x=15mm, y=15mm, z=4mm
Zoom Scan       : 7x7x7 : Measurement x=5mm, y=5mm, z=5mm

Other Data
DUT Position    : Touch
Separation      : 0
Channel         : Mid
```

Head office & Test Lab: 28(175-20,Annyeong-dong)
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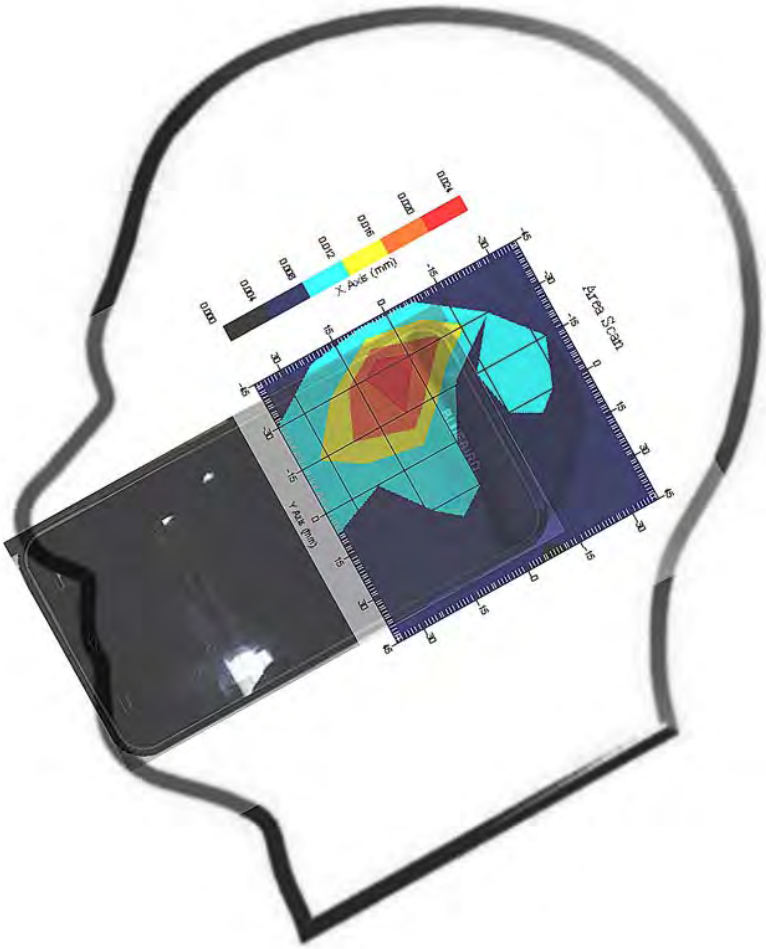

1 gram SAR value : 0.027 W/kg
10 gram SAR value : 0.015 W/kg
Area Scan Peak SAR : 0.024 W/kg
Zoom Scan Peak SAR : 0.050 W/kg

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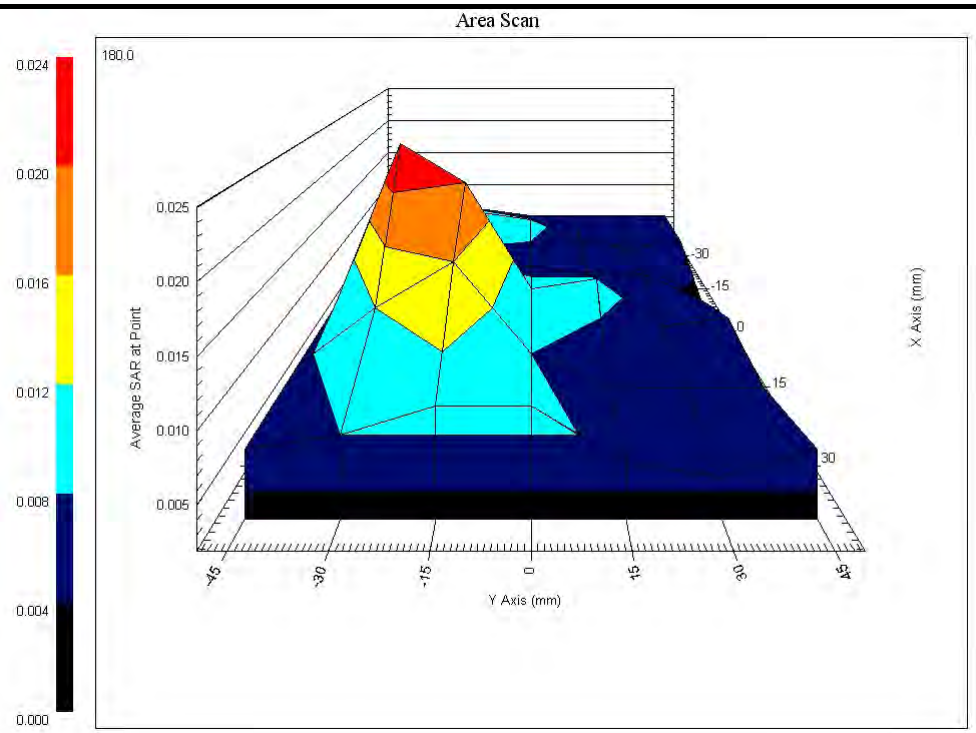
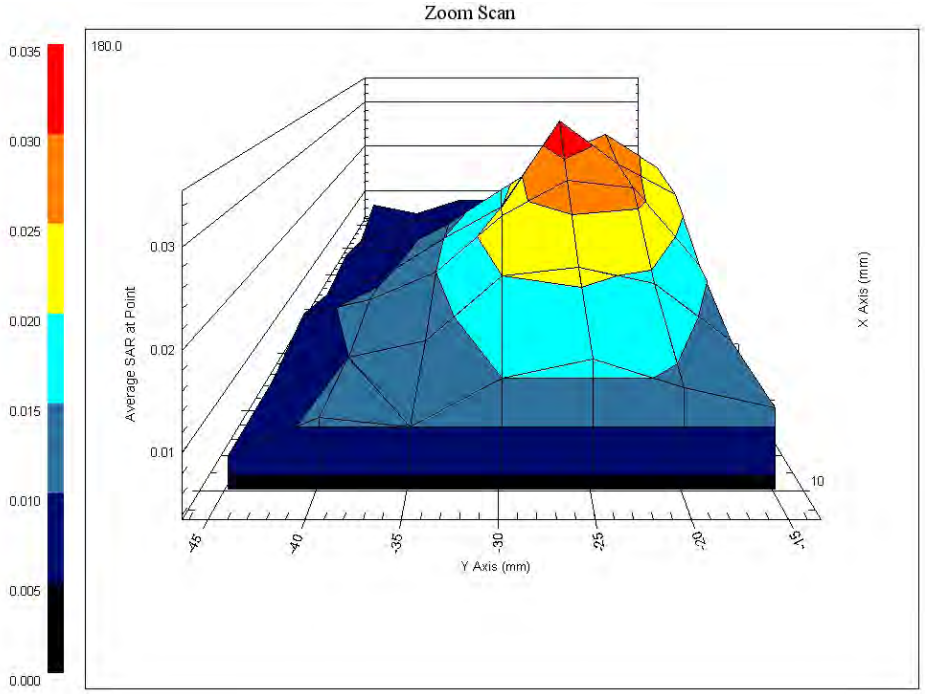


AREA SCAN Graph



ZOOM SCAN Graph

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3	Head	WCDMA Band V	WCDMA RMC 12.2K	836.4	4182	Right Cheek

SAR Test Report

```
Report Date      : 13-Jun-2014
By Operator      : Miyoung.Lee
Measurement Date  : 13-Jun-2014
Starting Time    : 13-Jun-2014  03:01:38 PM
End Time         : 13-Jun-2014  03:27:14 PM
Scanning Time    : 1536 secs

Product Data
Device Name      : Bluebird Inc.
Serial No.       : Proto Type
Type            : PDA
Model           : BM180
Frequency        : 836.40 MHz
Max. Transmit Pwr : 0.19 W
Drift Time       : 10 min(s)
Length          : 150 mm
Width           : 80 mm
Depth           : 22 mm
Antenna Type     : Internal
Orientation      : Touch
Power Drift-Start : 0.133 W/kg
Power Drift-Finish: 0.124 W/kg
Power Drift (%)   : -1.074
Picture          : C:\Alsas\bitmap\Device-19.bmp

Phantom Data
Name           : APREL-SAM Right Ear
Type           : SAM-Right
Size (mm)       : 280 x 280 x 280
Serial No.      : User Define
Location        : Right
Description     : RSAM User Defined

Tissue Data
Type           : HEAD
Serial No.      : 836.4H
Frequency       : 836.40 MHz
Last Calib. Date : 13-Jun-2014
Temperature     : 21.00 °C
Ambient Temp.    : 21.00 °C
Humidity        : 45.00 RH%
Epsilon         : 40.39 F/m
Sigma           : 0.87 S/m
Density         : 1000.00 kg/cu. m
```

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```
Probe Data
Name           : E-Field
Model          : E-020
Type           : E-Field Triangle
Serial No.      : 271_CW
Last Calib. Date : 02-Jul-2013
Frequency       : 835.00 MHz
Duty Cycle Factor: 1
Conversion Factor: 7.0
Probe Sensitivity: 1.20  1.20  1.20   μV/(V/m)²
Compression Point: 95.00 mV
Offset          : 1.56 mm

Measurement Data
Crest Factor    : 1
Scan Type       : Complete
Tissue Temp.    : 21.00 °C
Ambient Temp.   : 21.00 °C
Set-up Date     : 13-Jun-2014
Set-up Time     : 1:56:02 PM
Area Scan       : 6x7x1 : Measurement x=15mm, y=15mm, z=4mm
Zoom Scan       : 7x7x7 : Measurement x=5mm, y=5mm, z=5mm

Other Data
DUT Position    : Touch
Separation      : 0
Channel         : Mid
```

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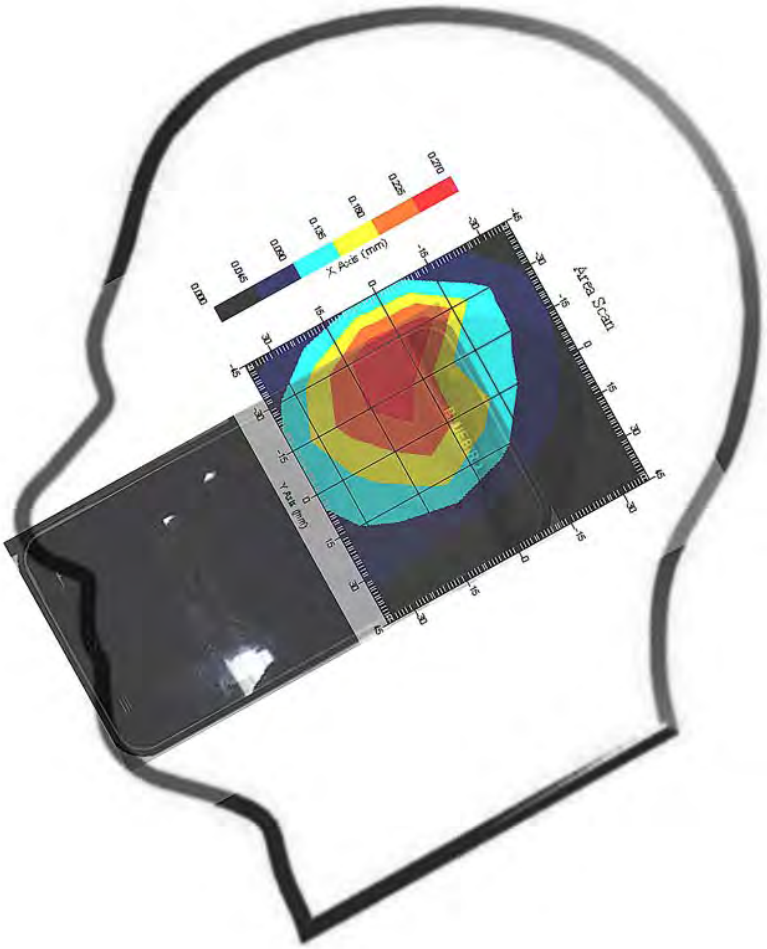
Tel: +82-31-222-4251 / Fax: +82-31-222-4252



1 gram SAR value : 0.271 W/kg
10 gram SAR value : 0.132 W/kg
Area Scan Peak SAR : 0.268 W/kg
Zoom Scan Peak SAR : 0.450 W/kg

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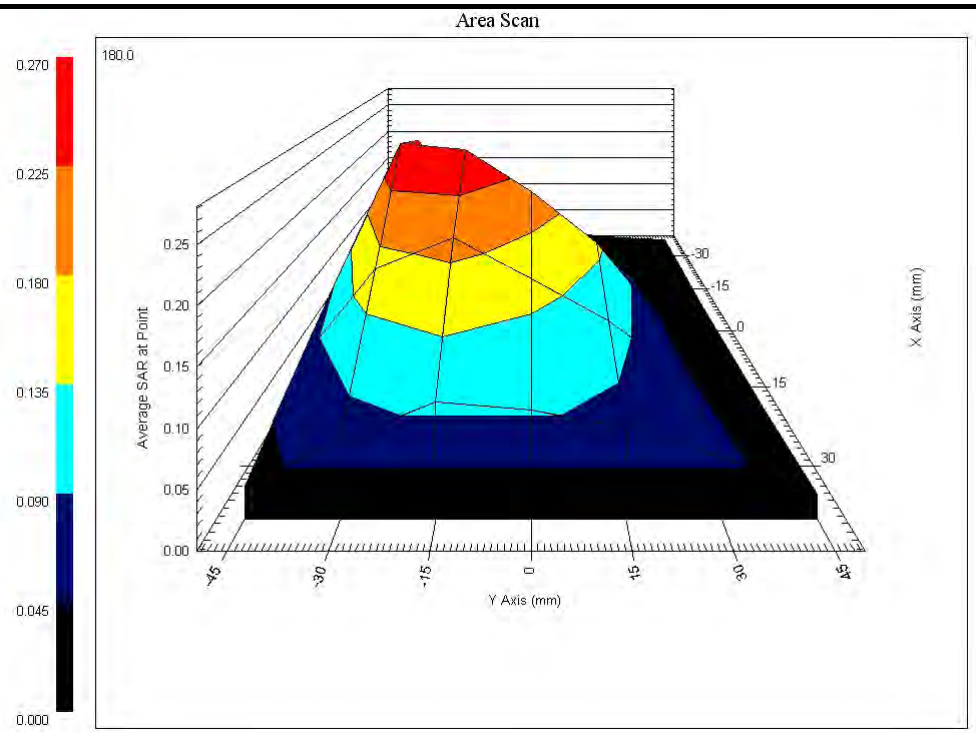
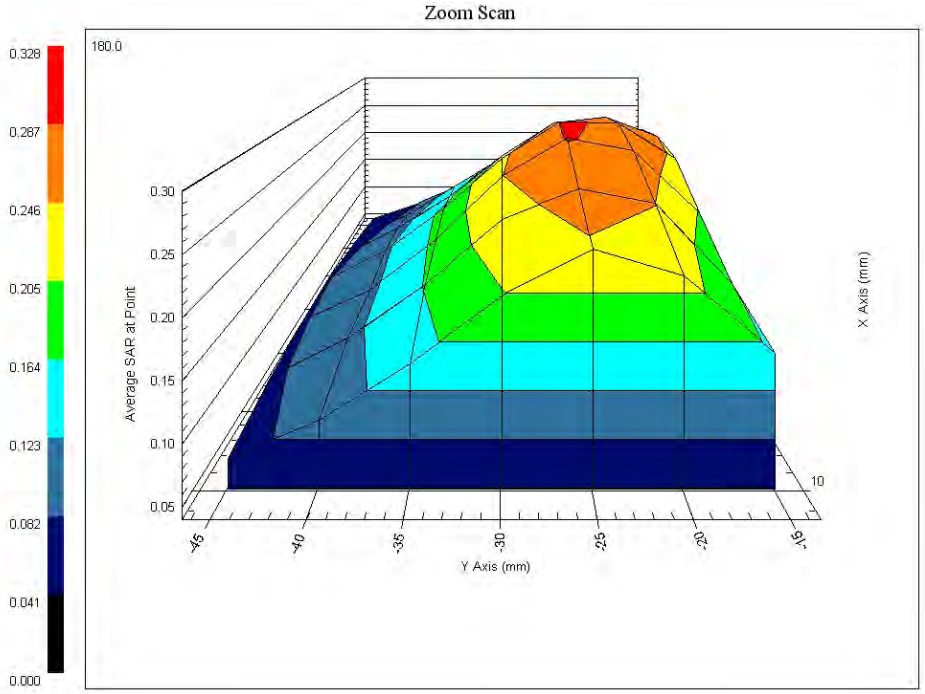


AREA SCAN Graph



ZOOM SCAN Graph

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4	Head	WCDMA Band II	WCDMA RMC 12.2K	1880	9400	Right Cheek

SAR Test Report

```
Report Date      : 06-Jun-2014
By Operator      : Miyoung.Lee
Measurement Date  : 06-Jun-2014
Starting Time    : 06-Jun-2014  05:40:07 PM
End Time         : 06-Jun-2014  06:06:08 PM
Scanning Time    : 1561 secs

Product Data
Device Name      : Bluebird Inc.
Serial No.       : Proto Type
Type            : PDA
Model           : BM180
Frequency        : 1880.00 MHz
Max. Transmit Pwr : 0.16 W
Drift Time       : 10 min(s)
Length          : 150 mm
Width           : 80 mm
Depth           : 22 mm
Antenna Type     : Internal
Orientation      : Touch
Power Drift-Start : 0.215 W/kg
Power Drift-Finish: 0.215 W/kg
Power Drift (%)   : -0.304
Picture          : C:\Alsas\bitmap\Device-23.bmp

Phantom Data
Name           : APREL-SAM Right Ear
Type           : SAM-Right
Size (mm)       : 280 x 280 x 280
Serial No.      : User Define
Location        : Right
Description     : RSAM User Defined

Tissue Data
Type           : HEAD
Serial No.      : 1880H
Frequency       : 1880.00 MHz
Last Calib. Date : 06-Jun-2014
Temperature     : 21.00 °C
Ambient Temp.    : 21.00 °C
Humidity        : 49.00 RH%
Epsilon         : 38.43 F/m
Sigma          : 1.35 S/m
Density         : 1000.00 kg/cu. m
```

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Probe Data
Name : E-Field
Model : E-020
Type : E-Field Triangle
Serial No. : 271_CW
Last Calib. Date : 02-Jul-2013
Frequency : 1900.00 MHz
Duty Cycle Factor: 1
Conversion Factor: 5.6
Probe Sensitivity: 1.20 1.20 1.20 $\mu V/(V/m)^2$
Compression Point: 95.00 mV
Offset : 1.56 mm

Measurement Data
Crest Factor : 1
Scan Type : Complete
Tissue Temp. : 21.00 °C
Ambient Temp. : 21.00 °C
Set-up Date : 06-Jun-2014
Set-up Time : 3:42:12 PM
Area Scan : 6x7x1 : Measurement x=15mm, y=15mm, z=4mm
Zoom Scan : 7x7x7 : Measurement x=5mm, y=5mm, z=5mm

Other Data
DUT Position : Touch
Separation : 0
Channel : Mid

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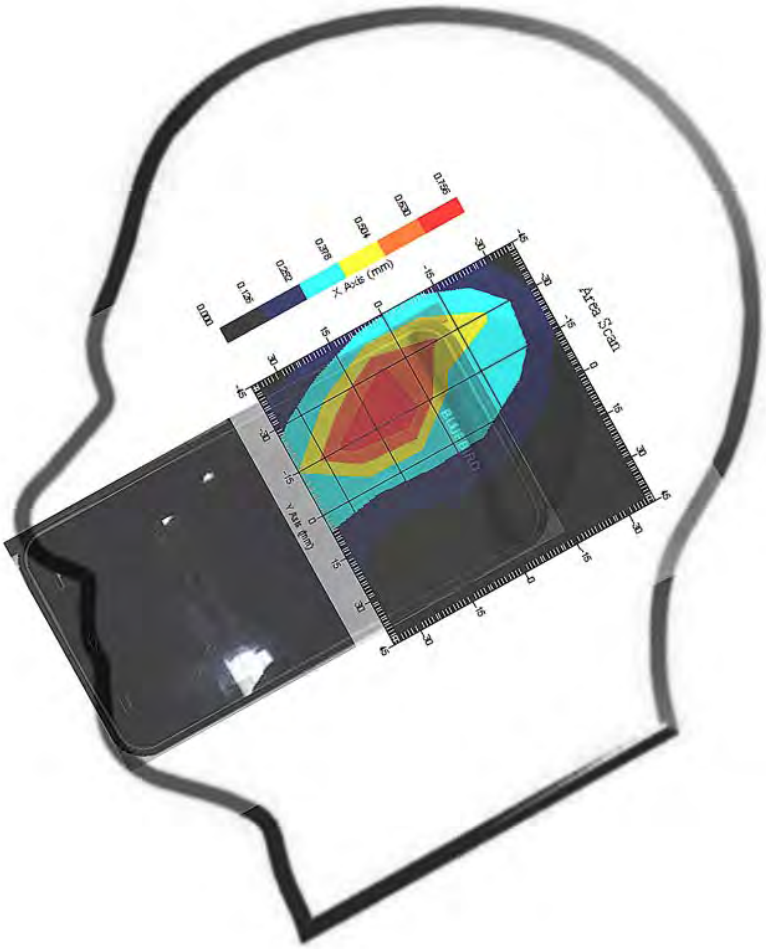

1 gram SAR value : 0.776 W/kg
10 gram SAR value : 0.415 W/kg
Area Scan Peak SAR : 0.753 W/kg
Zoom Scan Peak SAR : 1.321 W/kg

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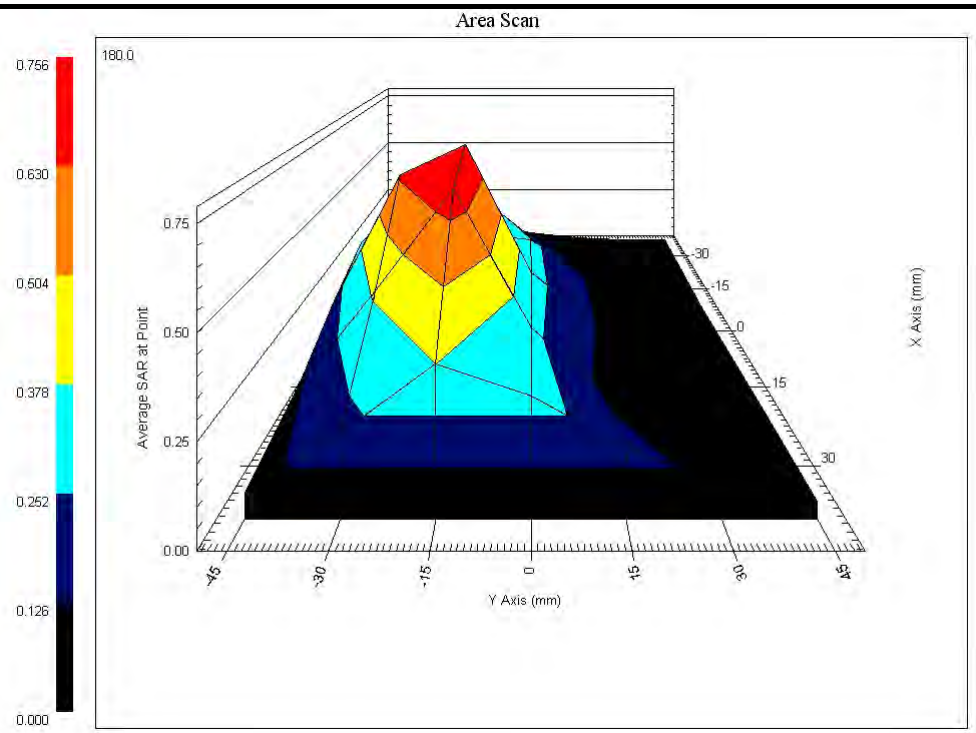
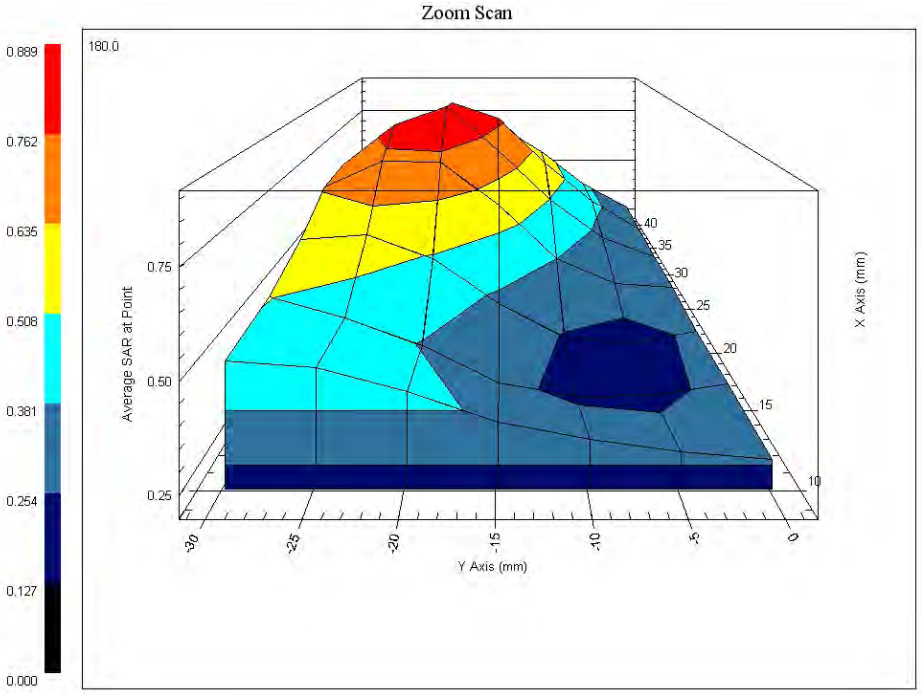


AREA SCAN Graph



ZOOM SCAN Graph

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5	Body	GSM850	GSM Voice	836.6	190	REAR

SAR Test Report

```
Report Date      : 18-Jun-2014
By Operator      : Miyoung.Lee
Measurement Date  : 18-Jun-2014
Starting Time    : 18-Jun-2014  10:55:51 AM
End Time         : 18-Jun-2014  11:40:17 AM
Scanning Time    : 2666 secs

Product Data
Device Name      : Bluebird Inc.
Serial No.       : Proto Type
Type            : PDA
Model           : BM180
Frequency        : 836.60 MHz
Max. Transmit Pwr : 0.1 W
Drift Time       : 10 min(s)
Length          : 150 mm
Width           : 80 mm
Depth           : 22 mm
Antenna Type     : Internal
Orientation      : Touch
Power Drift-Start : 0.054 W/kg
Power Drift-Finish: 0.052 W/kg
Power Drift (%)   : -3.459
Picture          : C:\Alsas\bitmap\Device-19.bmp

Phantom Data
Name            : APREL-Uni
Type            : Uni-Phantom
Size (mm)        : 280 x 280 x 200
Serial No.       : User Define
Location        : Center
Description      : User Defined

Tissue Data
Type            : BODY
Serial No.       : 836.6B
Frequency        : 836.60 MHz
Last Calib. Date : 18-Jun-2014
Temperature      : 21.00 °C
Ambient Temp.    : 21.00 °C
Humidity         : 46.00 RH%
Epsilon          : 55.29 F/m
Sigma           : 0.97 S/m
Density          : 1000.00 kg/cu. m
```

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Probe Data
Name : E-Field
Model : E-020
Type : E-Field Triangle
Serial No. : 271_CW
Last Calib. Date : 02-Jul-2013
Frequency : 835.00 MHz
Duty Cycle Factor: 8.3
Conversion Factor: 6.5
Probe Sensitivity: 1.20 1.20 1.20 $\mu V/(V/m)^2$
Compression Point: 95.00 mV
Offset : 1.56 mm

Measurement Data
Crest Factor : 8.3
Scan Type : Complete
Tissue Temp. : 21.00 °C
Ambient Temp. : 21.00 °C
Set-up Date : 12-Jun-2014
Set-up Time : 1:31:54 PM
Area Scan : 13x8x1 : Measurement x=15mm, y=15mm, z=4mm
Zoom Scan : 7x7x7 : Measurement x=5mm, y=5mm, z=5mm

Other Data
DUT Position : Touch
Separation : 5
Channel : Mid

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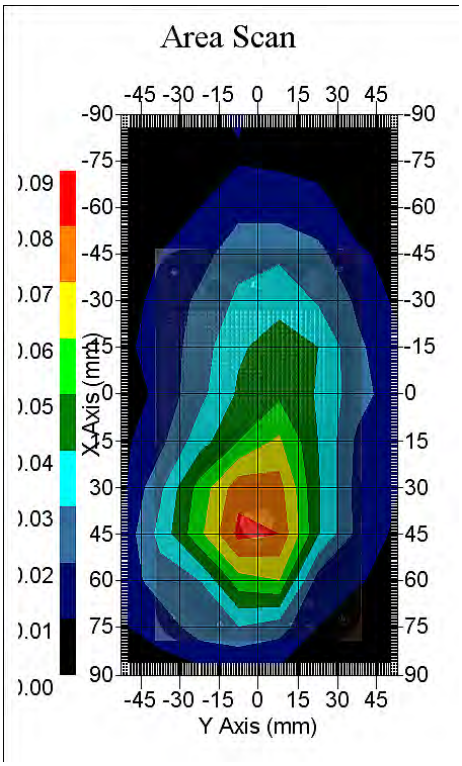

1 gram SAR value : 0.084 W/kg
10 gram SAR value : 0.056 W/kg
Area Scan Peak SAR : 0.083 W/kg
Zoom Scan Peak SAR : 0.120 W/kg

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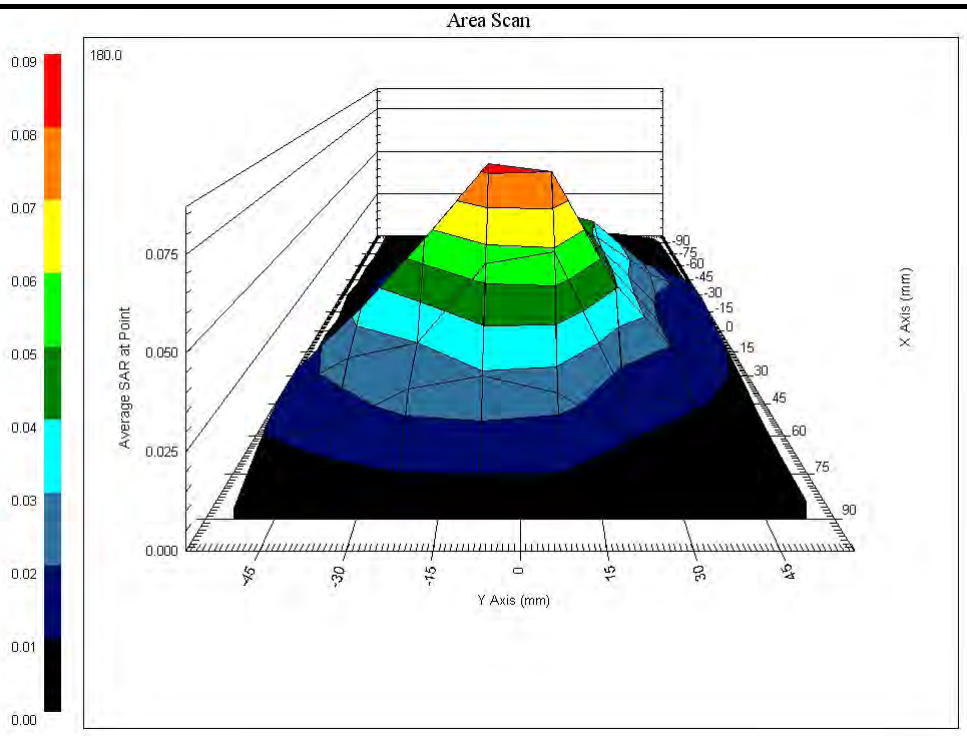
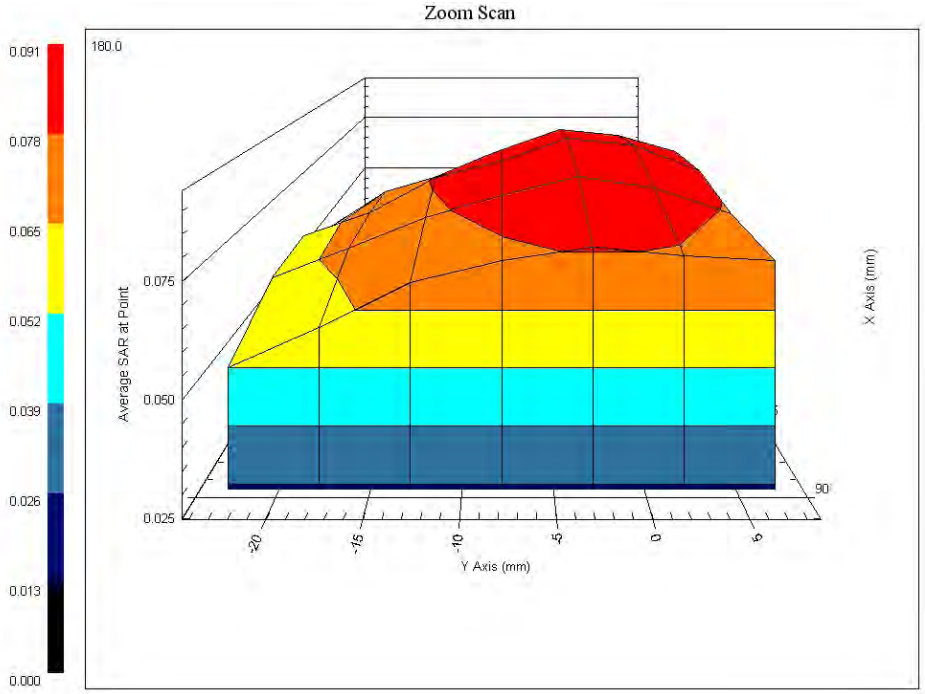


AREA SCAN Graph



ZOOM SCAN Graph

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6	Body	GSM1900	GSM Voice	1880	661	FRONT

SAR Test Report

```
Report Date      : 11-Jun-2014
By Operator      : Miyoung.Lee
Measurement Date  : 11-Jun-2014
Starting Time    : 11-Jun-2014  11:06:17 AM
End Time         : 11-Jun-2014  11:40:00 AM
Scanning Time    : 2023 secs

Product Data
Device Name      : Bluebird Inc.
Serial No.       : Proto Type
Type            : PDA
Model           : BM180
Frequency        : 1880.00 MHz
Max. Transmit Pwr : 0.09 W
Drift Time       : 10 min(s)
Length          : 150 mm
Width           : 80 mm
Depth           : 22 mm
Antenna Type     : Internal
Orientation      : Touch
Power Drift-Start : 0.007 W/kg
Power Drift-Finish: 0.007 W/kg
Power Drift (%)   : 3.731
Picture          : C:\Alsas\bitmap\Device-23.bmp

Phantom Data
Name           : APREL-Uni
Type           : Uni-Phantom
Size (mm)       : 280 x 280 x 200
Serial No.      : User Define
Location        : Center
Description     : User Defined

Tissue Data
Type           : BODY
Serial No.      : 1880B
Frequency       : 1880.00 MHz
Last Calib. Date : 11-Jun-2014
Temperature     : 21.00 °C
Ambient Temp.    : 21.00 °C
Humidity        : 52.00 RH%
Epsilon         : 54.54 F/m
Sigma          : 1.44 S/m
Density         : 1000.00 kg/cu. m
```

Head office & Test Lab: 28(175-20,Annyeong-dong)
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Tel: +82-31-222-4251 / Fax: +82-31-222-4252

Probe Data
Name : E-Field
Model : E-020
Type : E-Field Triangle
Serial No. : 271_CW
Last Calib. Date : 02-Jul-2013
Frequency : 1900.00 MHz
Duty Cycle Factor: 1
Conversion Factor: 5.4
Probe Sensitivity: 1.20 1.20 1.20 $\mu V/(V/m)^2$
Compression Point: 95.00 mV
Offset : 1.56 mm

Measurement Data
Crest Factor : 8.3
Scan Type : Complete
Tissue Temp. : 21.00 °C
Ambient Temp. : 21.00 °C
Set-up Date : 11-Jun-2014
Set-up Time : 10:28:30 AM
Area Scan : 13x8x1 : Measurement x=15mm, y=15mm, z=4mm
Zoom Scan : 7x7x7 : Measurement x=5mm, y=5mm, z=5mm

Other Data
DUT Position : Touch
Separation : 5
Channel : Mid

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406-gil sejaro, Hwaseong-si Gyeonggi-do, Korea
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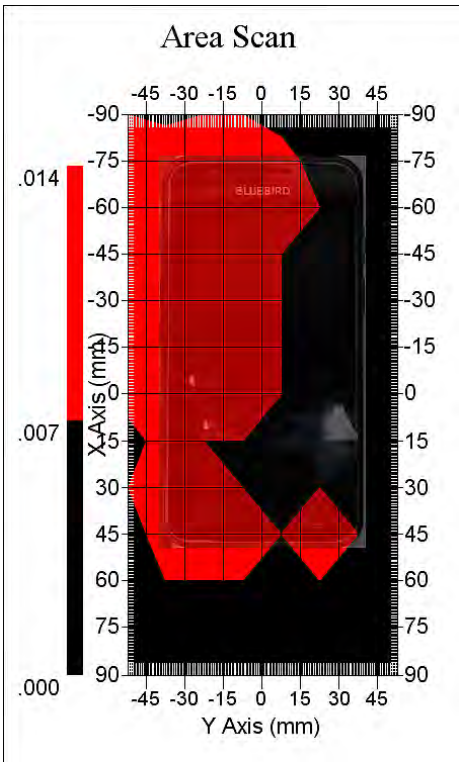


```
1 gram SAR value   : 0.012 W/kg
10 gram SAR value  : 0.010 W/kg
Area Scan Peak SAR : 0.013 W/kg
Zoom Scan Peak SAR : 0.010 W/kg
```

Head office & Test Lab: 28(175-20,Annyeong-dong)
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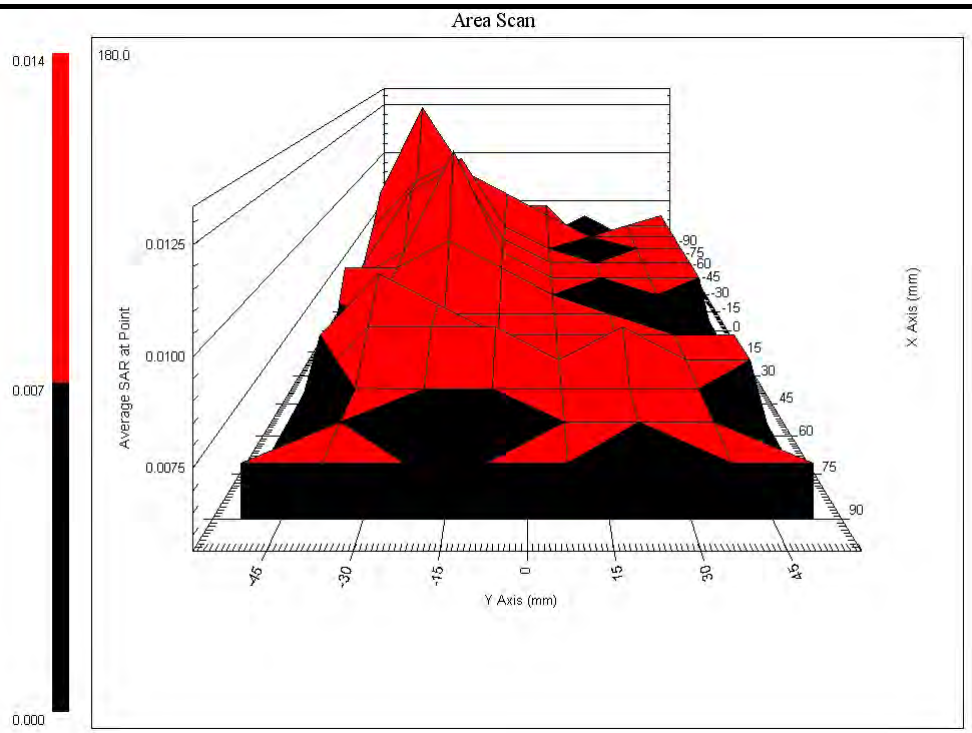
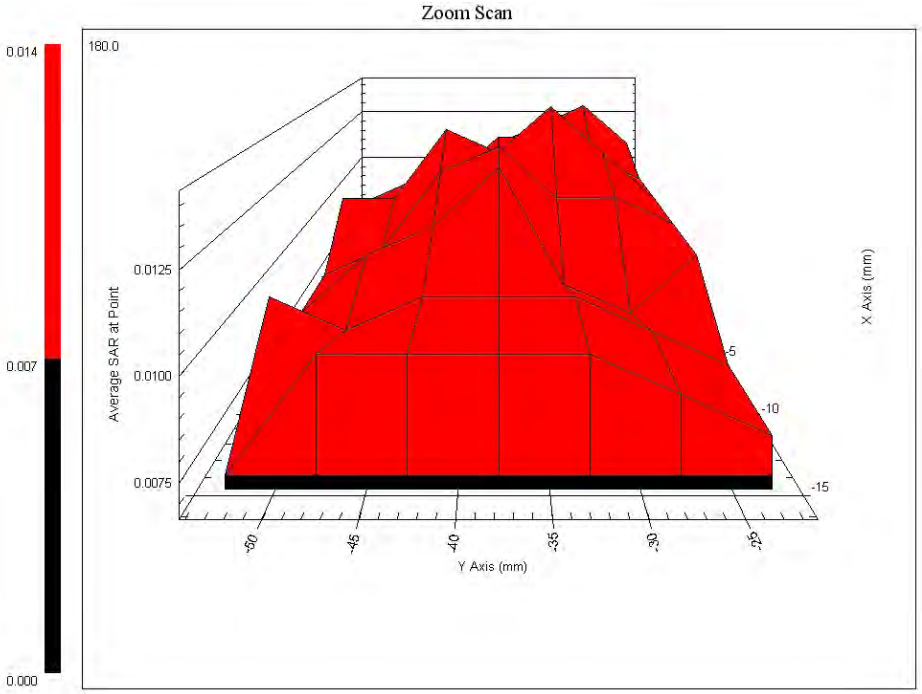


AREA SCAN Graph



ZOOM SCAN Graph

Head office & Test Lab: 28(175-20,Annyeong-dong)
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7	Body	WCDMA Band V	WCDMA RMC 12.2K	836.4	4182	FRONT

SAR Test Report

```
Report Date      : 18-Jun-2014
By Operator      : Miyoung.Lee
Measurement Date  : 18-Jun-2014
Starting Time    : 18-Jun-2014  02:51:24 PM
End Time         : 18-Jun-2014  03:25:35 PM
Scanning Time    : 2051 secs

Product Data
Device Name      : Bluebird Inc.
Serial No.       : Proto Type
Type            : PDA
Model           : BM180
Frequency        : 836.40 MHz
Max. Transmit Pwr : 0.19 W
Drift Time       : 10 min(s)
Length          : 150 mm
Width           : 80 mm
Depth           : 22 mm
Antenna Type     : Internal
Orientation      : Touch
Power Drift-Start : 0.047 W/kg
Power Drift-Finish: 0.046 W/kg
Power Drift (%)   : -1.828
Picture          : C:\Alsas\bitmap\Device-19.bmp

Phantom Data
Name           : APREL-Uni
Type           : Uni-Phantom
Size (mm)       : 280 x 280 x 200
Serial No.      : User Define
Location        : Center
Description     : User Defined

Tissue Data
Type           : BODY
Serial No.      : 836.4B
Frequency       : 836.40 MHz
Last Calib. Date : 18-Jun-2014
Temperature     : 21.00 °C
Ambient Temp.    : 21.00 °C
Humidity        : 46.00 RH%
Epsilon         : 55.29 F/m
Sigma           : 0.97 S/m
Density         : 1000.00 kg/cu. m
```

Head office & Test Lab: 28(175-20,Annyeong-dong)
406-gil sejaro, Hwaseong-si Gyeonggi-do, Korea
Tel: +82-31-222-4251 / Fax: +82-31-222-4252

Probe Data
Name : E-Field
Model : E-020
Type : E-Field Triangle
Serial No. : 271_CW
Last Calib. Date : 02-Jul-2013
Frequency : 835.00 MHz
Duty Cycle Factor: 1
Conversion Factor: 6.5
Probe Sensitivity: 1.20 1.20 1.20 $\mu V/(V/m)^2$
Compression Point: 95.00 mV
Offset : 1.56 mm

Measurement Data
Crest Factor : 1
Scan Type : Complete
Tissue Temp. : 21.00 °C
Ambient Temp. : 21.00 °C
Set-up Date : 18-Jun-2014
Set-up Time : 1:36:47 PM
Area Scan : 13x8x1 : Measurement x=15mm, y=15mm, z=4mm
Zoom Scan : 7x7x7 : Measurement x=5mm, y=5mm, z=5mm

Other Data
DUT Position : Touch
Separation : 5
Channel : Mid

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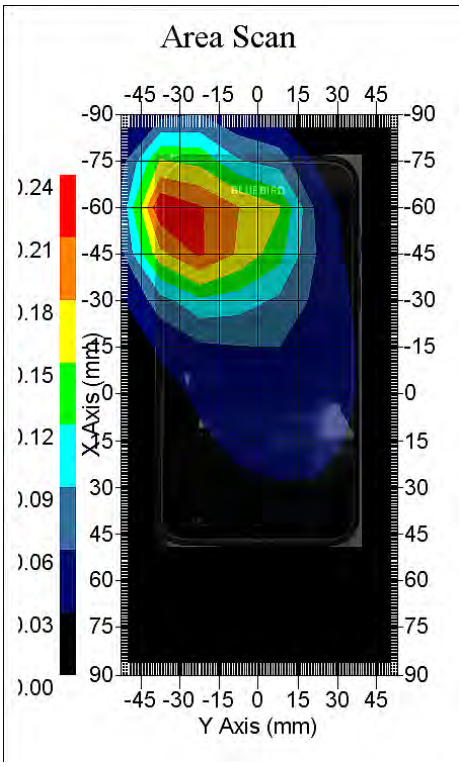


```
1 gram SAR value   : 0.251 W/kg
10 gram SAR value  : 0.122 W/kg
Area Scan Peak SAR : 0.236 W/kg
Zoom Scan Peak SAR : 0.420 W/kg
```

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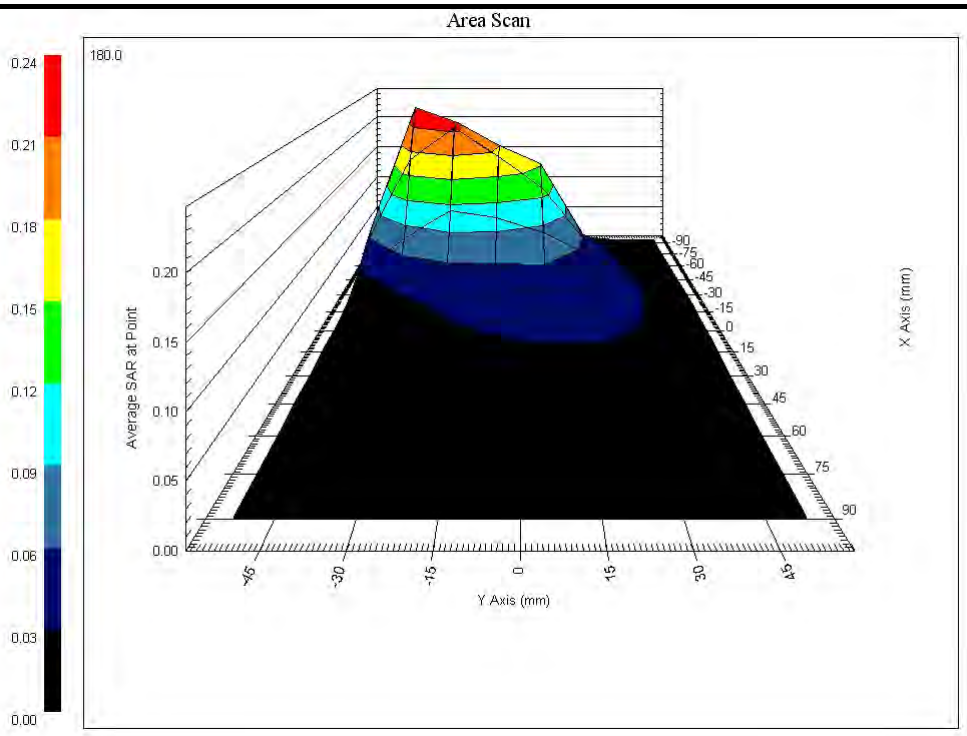
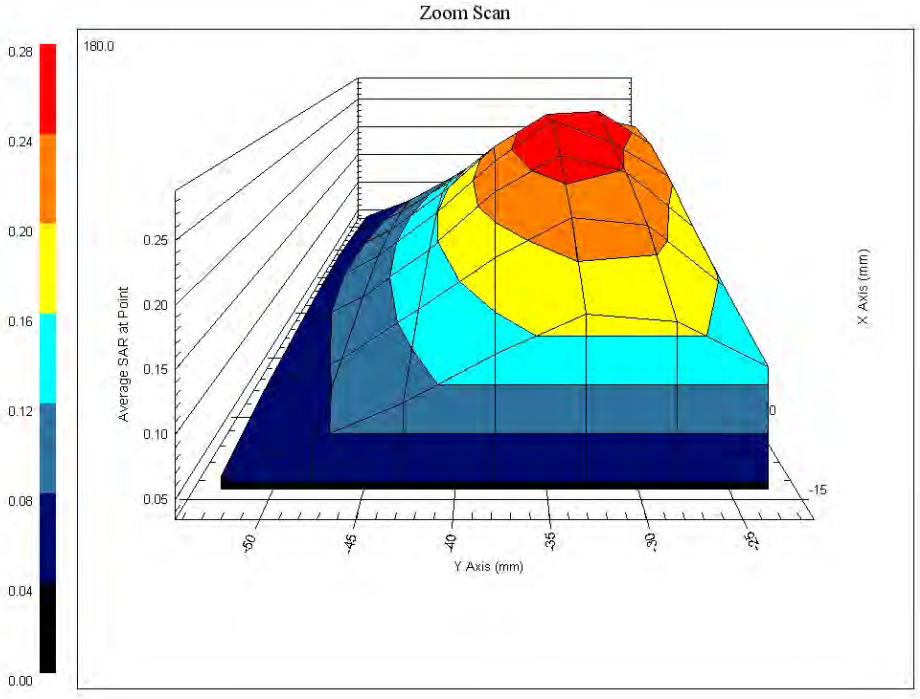


AREA SCAN Graph



ZOOM SCAN Graph

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8	Body	WCDMA Band II	WCDMA RMC 12.2K	1880	9400	FRONT

SAR Test Report

Report Date : 11-Jun-2014
By Operator : Miyoung.Lee
Measurement Date : 11-Jun-2014
Starting Time : 11-Jun-2014 03:37:21 PM
End Time : 11-Jun-2014 04:10:33 PM
Scanning Time : 1992 secs

Product Data
Device Name : Bluebird Inc.
Serial No. : Proto Type
Type : PDA
Model : BM180
Frequency : 1880.00 MHz
Max. Transmit Pwr : 0.16 W
Drift Time : 10 min(s)
Length : 150 mm
Width : 80 mm
Depth : 22 mm
Antenna Type : Internal
Orientation : Touch
Power Drift-Start : 0.127 W/kg
Power Drift-Finish: 0.132 W/kg
Power Drift (%) : 3.372
Picture : C:\Alsas\bitmap\Device-23.bmp

Phantom Data
Name : APREL-Uni
Type : Uni-Phantom
Size (mm) : 280 x 280 x 200
Serial No. : User Define
Location : Center
Description : User Defined

Tissue Data
Type : BODY
Serial No. : 1880B
Frequency : 1880.00 MHz
Last Calib. Date : 11-Jun-2014
Temperature : 21.00 °C
Ambient Temp. : 21.00 °C
Humidity : 52.00 RH%
Epsilon : 54.54 F/m
Sigma : 1.44 S/m
Density : 1000.00 kg/cu. m

Head office & Test Lab: 28(175-20,Annyeong-dong)
406-gil sejaro, Hwaseong-si Gyeonggi-do, Korea
Tel: +82-31-222-4251 / Fax: +82-31-222-4252

Probe Data
Name : E-Field
Model : E-020
Type : E-Field Triangle
Serial No. : 271_CW
Last Calib. Date : 02-Jul-2013
Frequency : 1900.00 MHz
Duty Cycle Factor: 1
Conversion Factor: 5.4
Probe Sensitivity: 1.20 1.20 1.20 $\mu V/(V/m)^2$
Compression Point: 95.00 mV
Offset : 1.56 mm

Measurement Data
Crest Factor : 1
Scan Type : Complete
Tissue Temp. : 21.00 °C
Ambient Temp. : 21.00 °C
Set-up Date : 11-Jun-2014
Set-up Time : 10:28:30 AM
Area Scan : 13x8x1 : Measurement x=15mm, y=15mm, z=4mm
Zoom Scan : 7x7x7 : Measurement x=5mm, y=5mm, z=5mm

Other Data
DUT Position : Touch
Separation : 5
Channel : Mid

Head office & Test Lab: 28(175-20,Annyeong-dong)
406-gil sejaro, Hwaseong-si Gyeonggi-do, Korea
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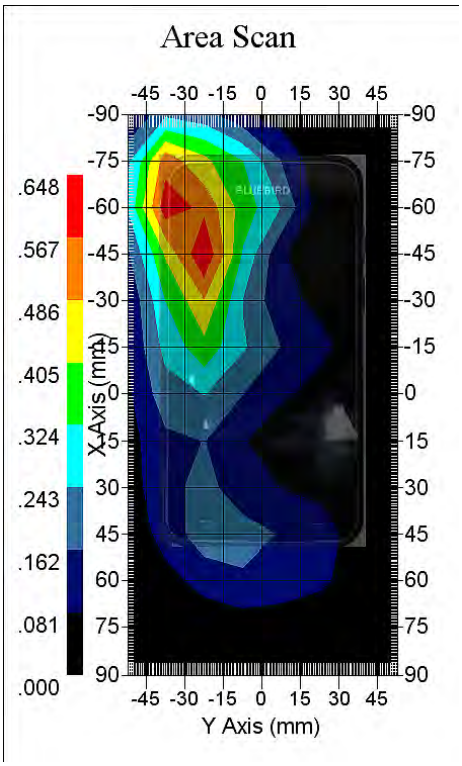


```
1 gram SAR value   : 0.738 W/kg
10 gram SAR value  : 0.408 W/kg
Area Scan Peak SAR : 0.645 W/kg
Zoom Scan Peak SAR : 1.201 W/kg
```

Head office & Test Lab: 28(175-20,Annyeong-dong)
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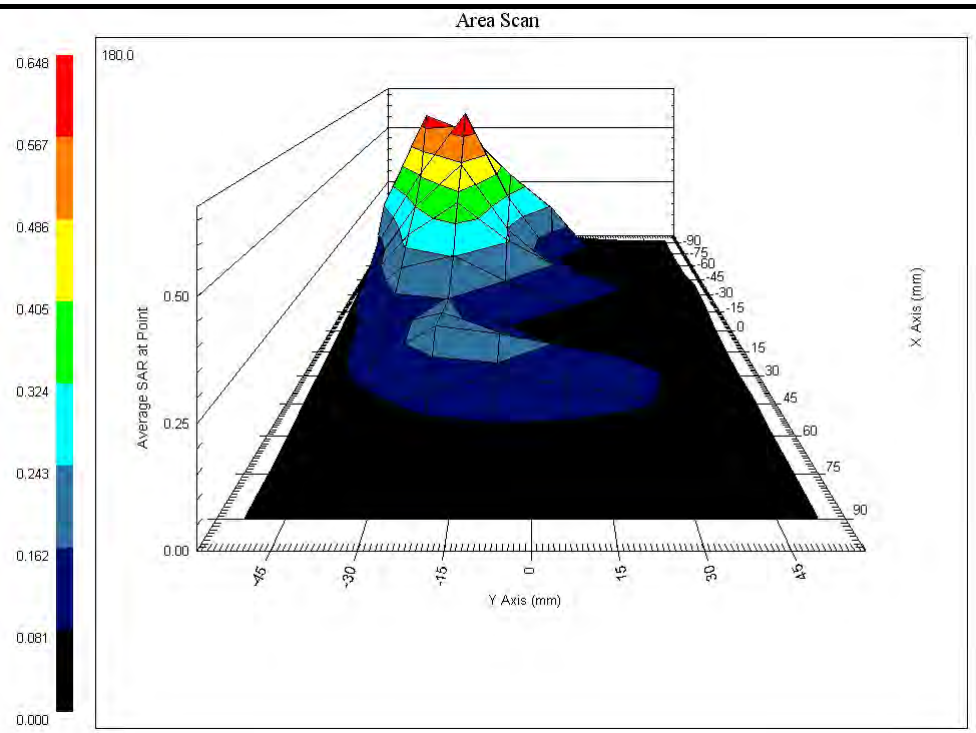
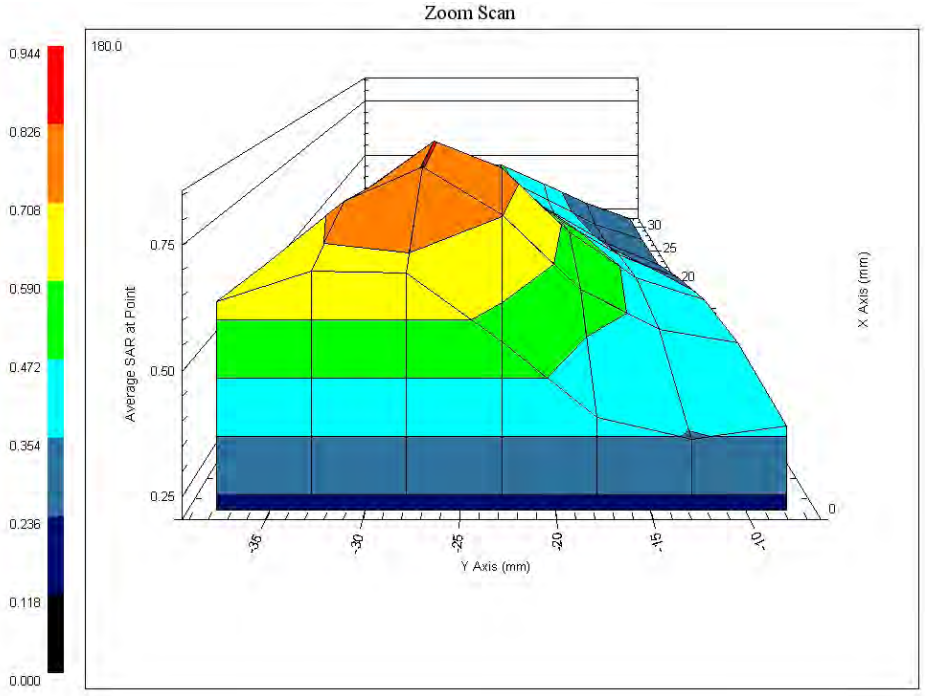


AREA SCAN Graph



ZOOM SCAN Graph

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9	Body	WLAN	802.11b	2437	CH6	LEFT

SAR Test Report

```
Report Date      : 03-Jun-2014
By Operator      : Miyoung.Lee
Measurement Date  : 03-Jun-2014
Starting Time    : 03-Jun-2014  05:35:57 PM
End Time         : 03-Jun-2014  06:07:24 PM
Scanning Time    : 1887 secs

Product Data
Device Name      : Bluebird Inc.
Serial No.       : Proto Type
Type            : PDA
Model           : BM-180
Frequency        : 2437.00 MHz
Max. Transmit Pwr : 0.04 W
Drift Time       : 10 min(s)
Length          : 150 mm
Width           : 22 mm
Depth           : 80 mm
Antenna Type     : Internal
Orientation      : Touch
Power Drift-Start : 0.357 W/kg
Power Drift-Finish: 0.343 W/kg
Power Drift (%)   : -4.027
Picture          : C:\Alsas\bitmap\Device-23.bmp

Phantom Data
Name           : APREL-Uni
Type           : Uni-Phantom
Size (mm)       : 280 x 280 x 200
Serial No.      : User Define
Location        : Center
Description     : User Defined

Tissue Data
Type           : BODY
Serial No.      : 2437B
Frequency       : 2437.00 MHz
Last Calib. Date : 03-Jun-2014
Temperature     : 21.00 °C
Ambient Temp.    : 21.00 °C
Humidity        : 45.00 RH%
Epsilon         : 52.77 F/m
Sigma           : 2.01 S/m
Density         : 1000.00 kg/cu. m
```

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406-gil sejaro, Hwaseong-si Gyeonggi-do, Korea
Tel: +82-31-222-4251 / Fax: +82-31-222-4252

Probe Data
Name : E-Field
Model : E-020
Type : E-Field Triangle
Serial No. : 271_CW
Last Calib. Date : 02-Jul-2013
Frequency : 2450.00 MHz
Duty Cycle Factor: 1
Conversion Factor: 4.3
Probe Sensitivity: 1.20 1.20 1.20 $\mu V/(V/m)^2$
Compression Point: 95.00 mV
Offset : 1.56 mm

Measurement Data
Crest Factor : 1
Scan Type : Complete
Tissue Temp. : 20.00 °C
Ambient Temp. : 21.00 °C
Set-up Date : 03-Jun-2014
Set-up Time : 1:38:56 PM
Area Scan : 18x5x1 : Measurement x=10mm, y=10mm, z=4mm
Zoom Scan : 7x7x7 : Measurement x=5mm, y=5mm, z=5mm

Other Data
DUT Position : Touch
Separation : 5
Channel : Mid

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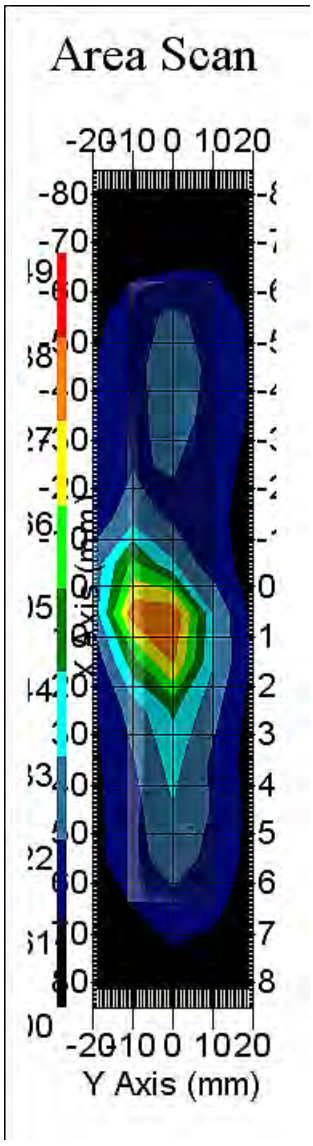

1 gram SAR value : 0.488 W/kg
10 gram SAR value : 0.214 W/kg
Area Scan Peak SAR : 0.490 W/kg
Zoom Scan Peak SAR : 0.950 W/kg

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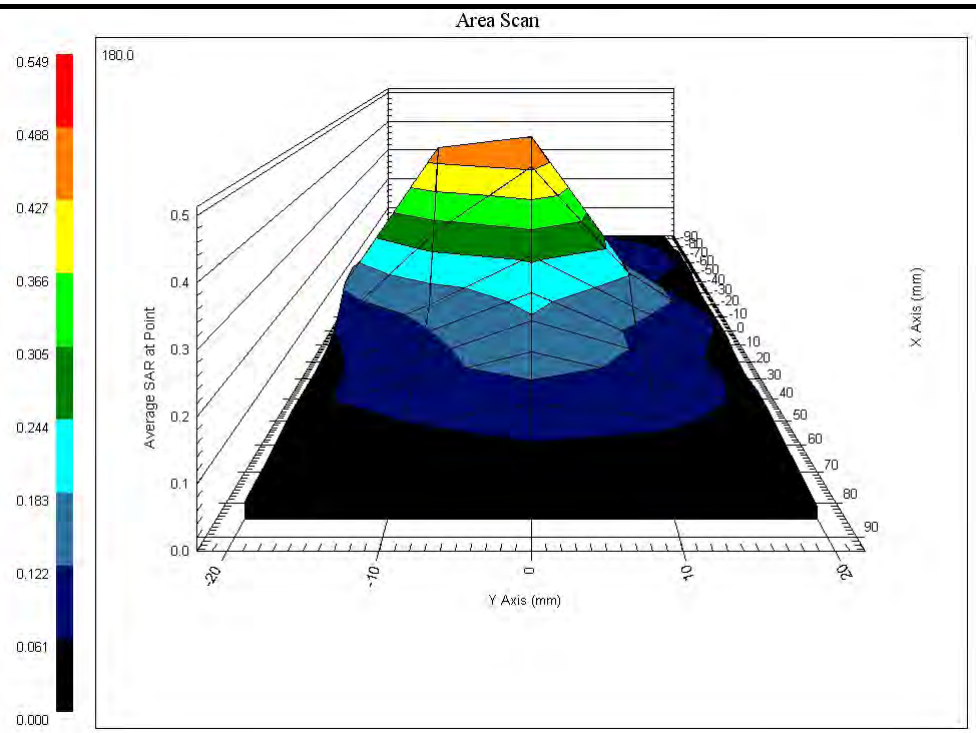
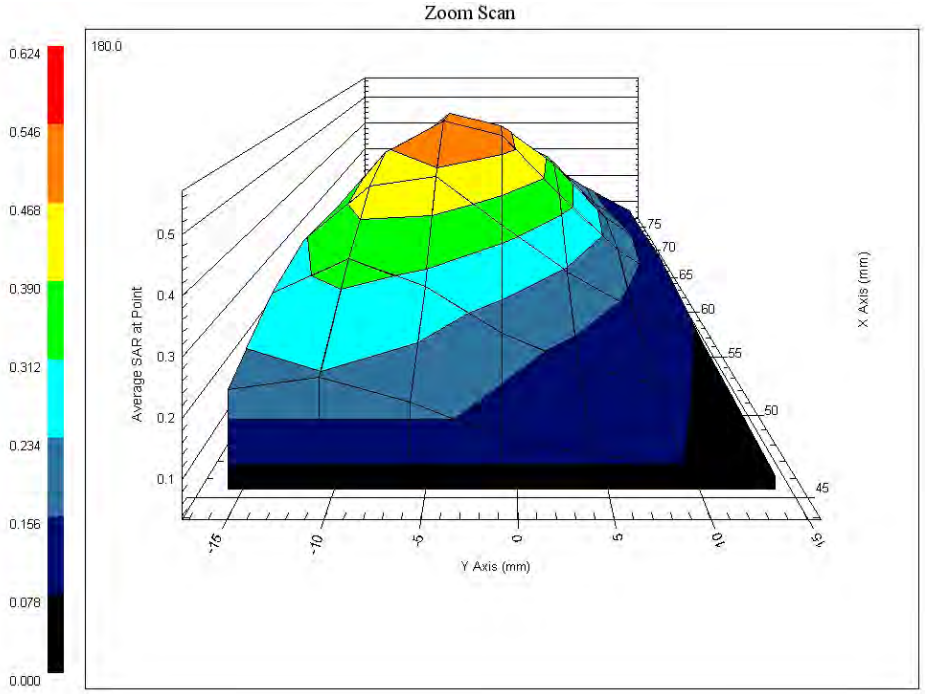


AREA SCAN Graph



ZOOM SCAN Graph

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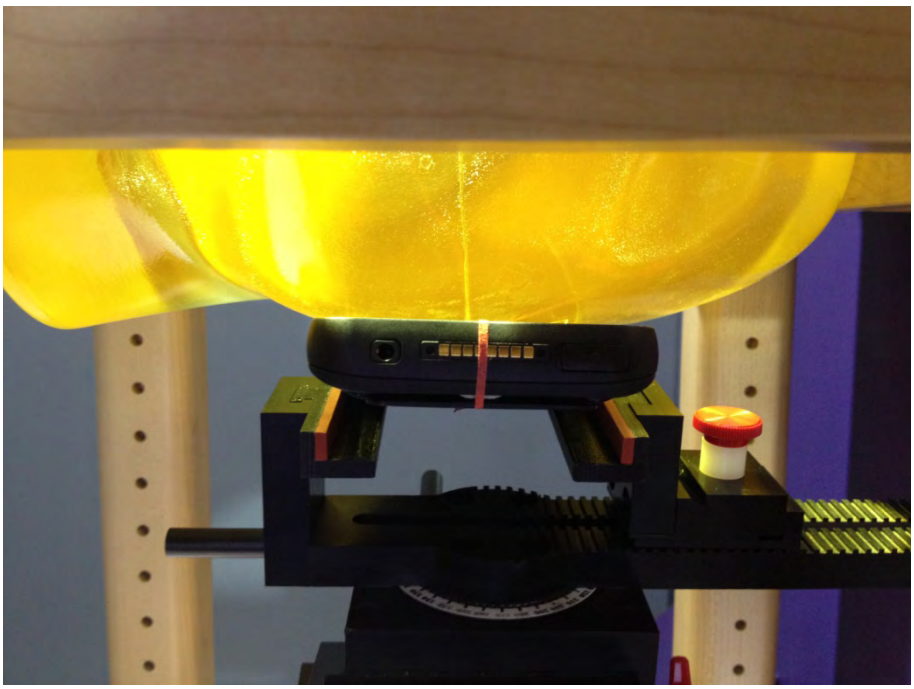
Appendix D: DUT setup photos

Head configration



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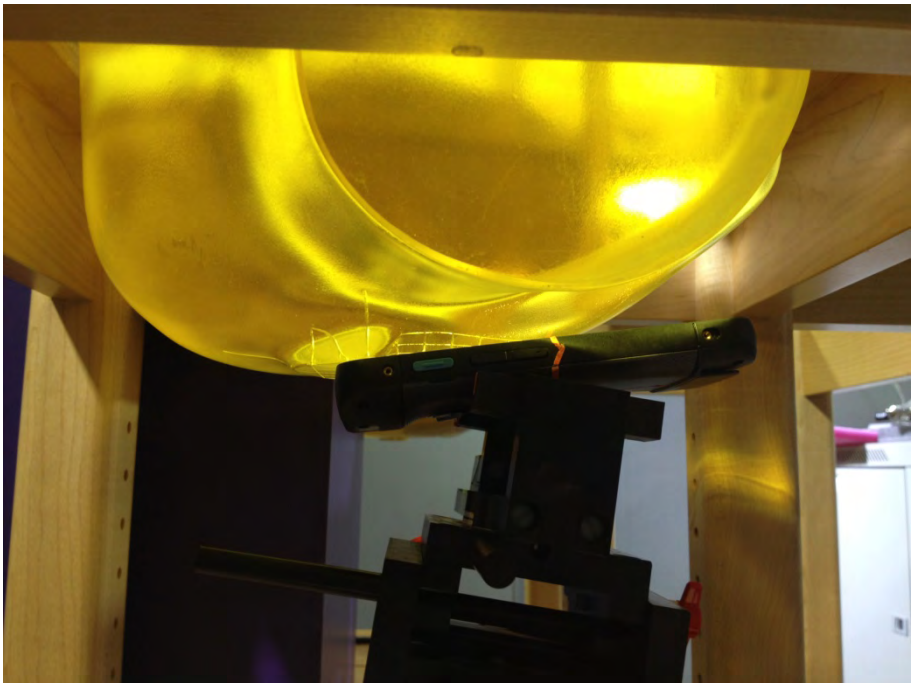

[LEFT_CHEEK_SIDE]

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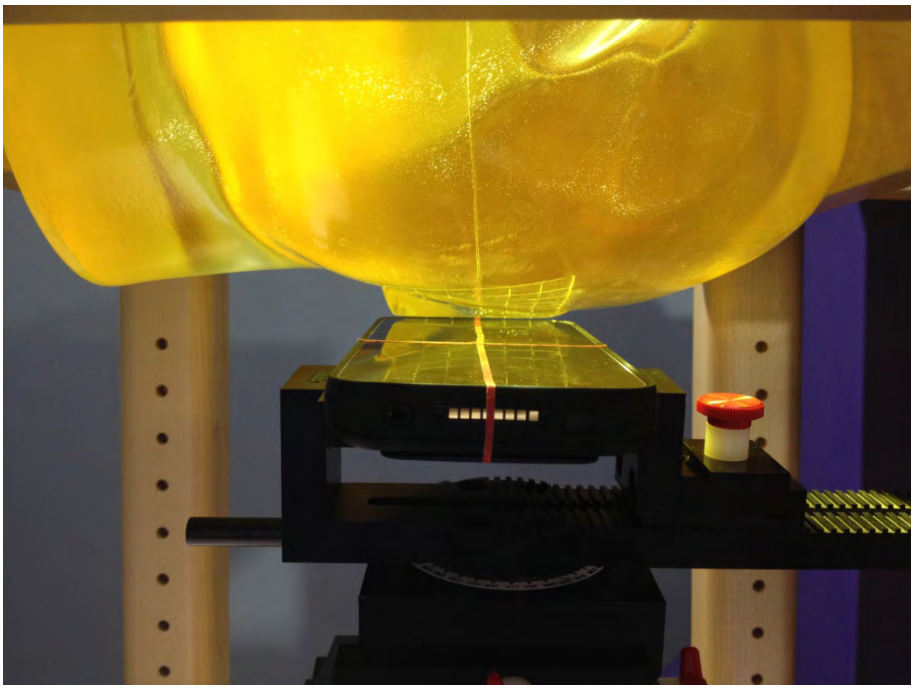

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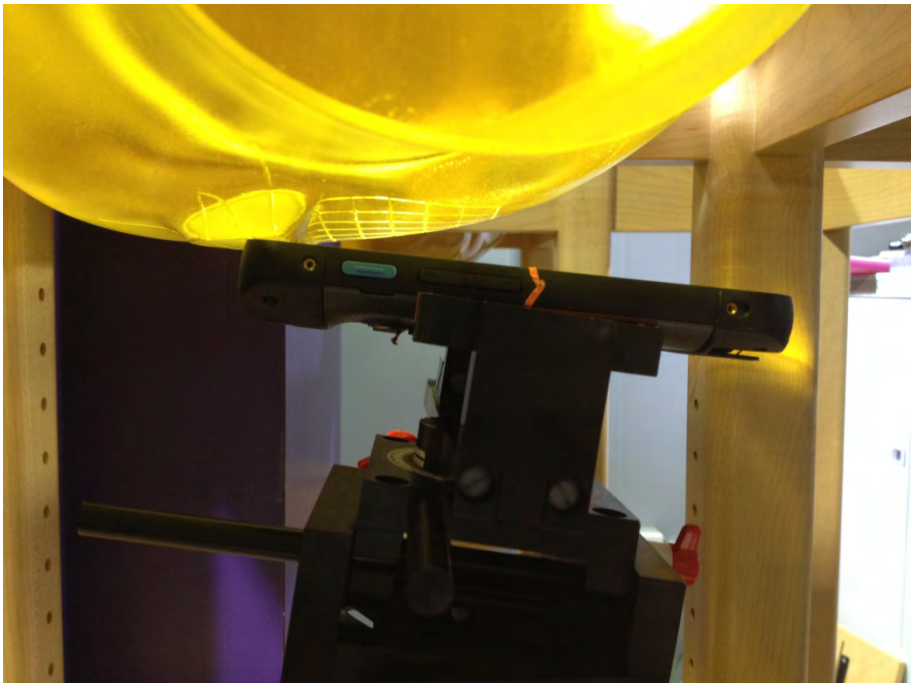

[LEFT_TILT_SIDE]

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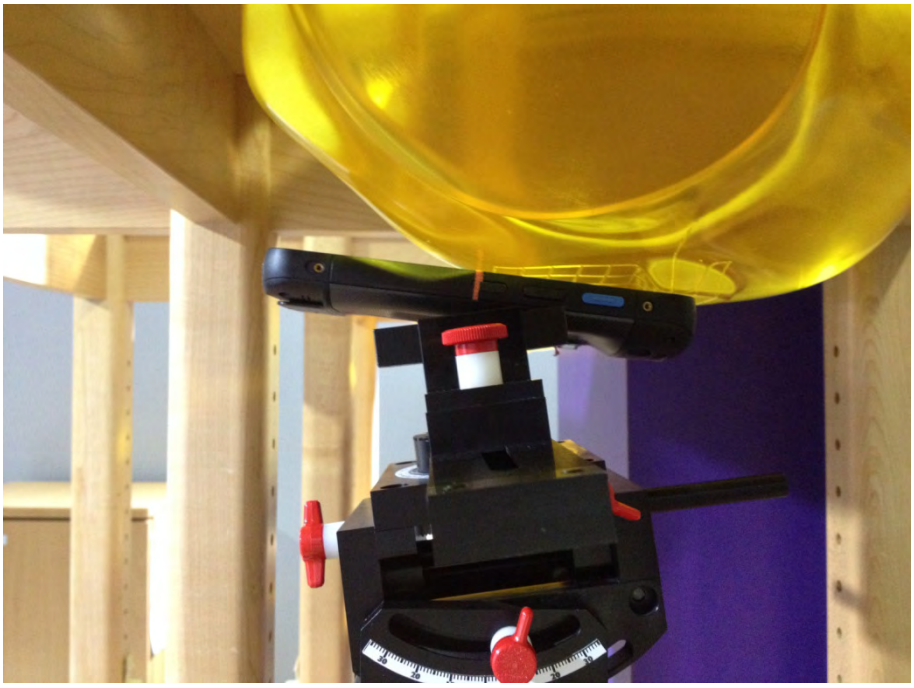
[Right_CHEEK_FRONT]



[Right_CHEEK_SIDE]

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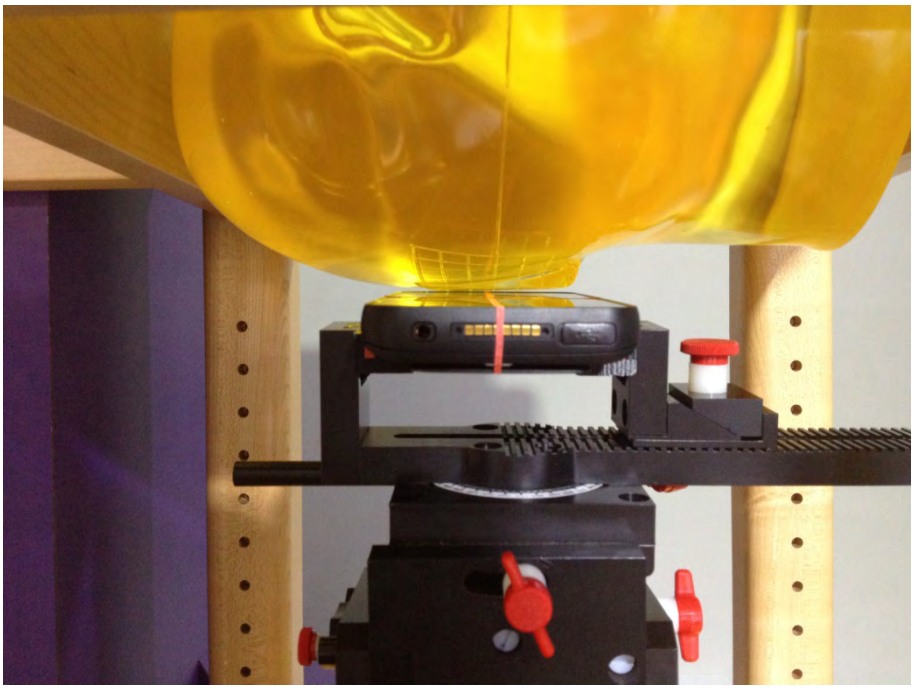

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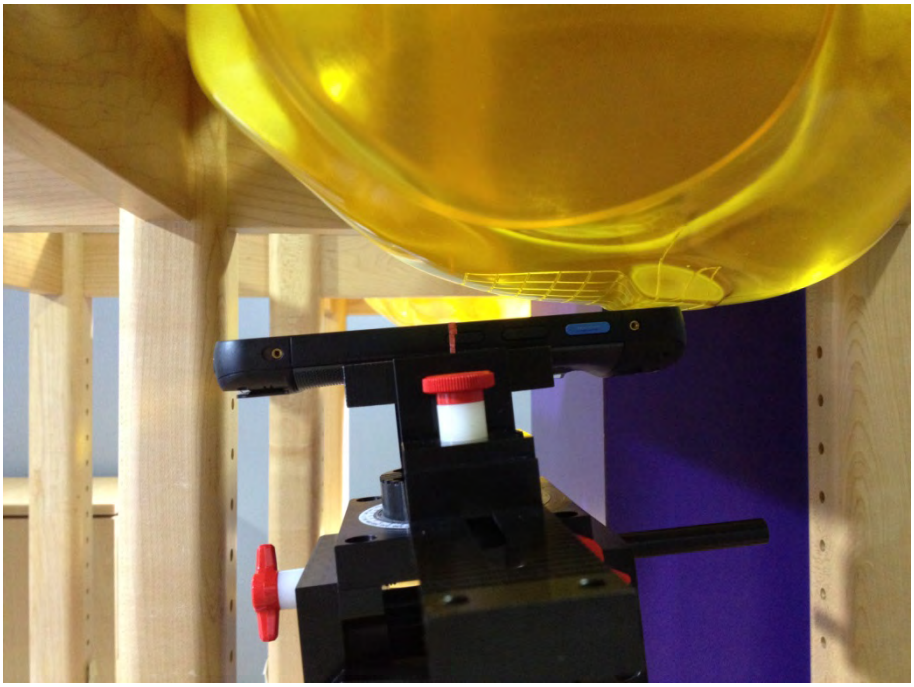

[Right_TILT_SIDE]

Head office & Test Lab: 28(175-20,Annyeong-dong)
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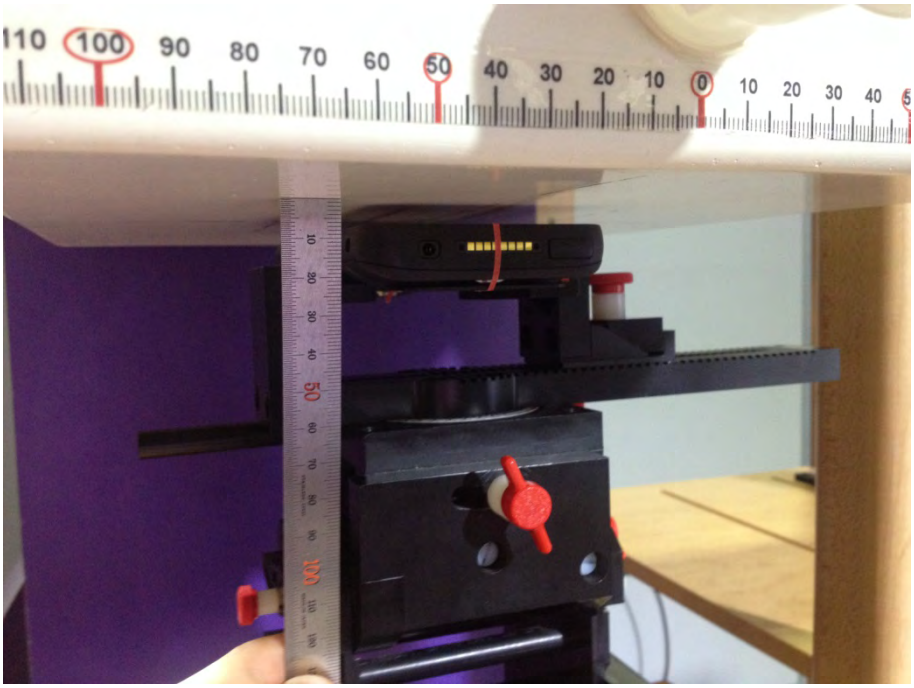
Body worn & Body support configration



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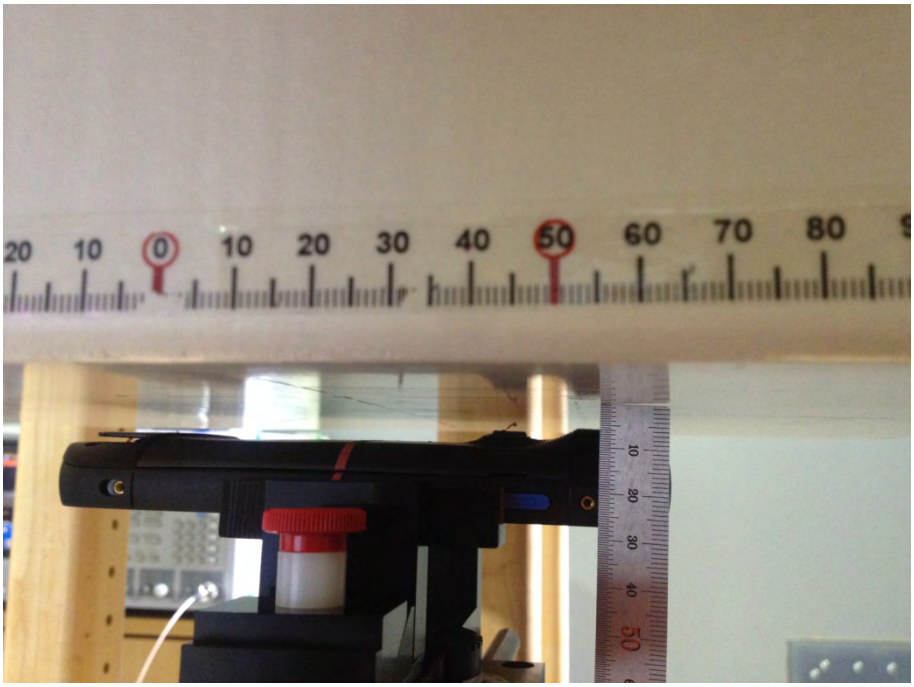

[REAR]

Head office & Test Lab: 28(175-20,Annyeong-dong)
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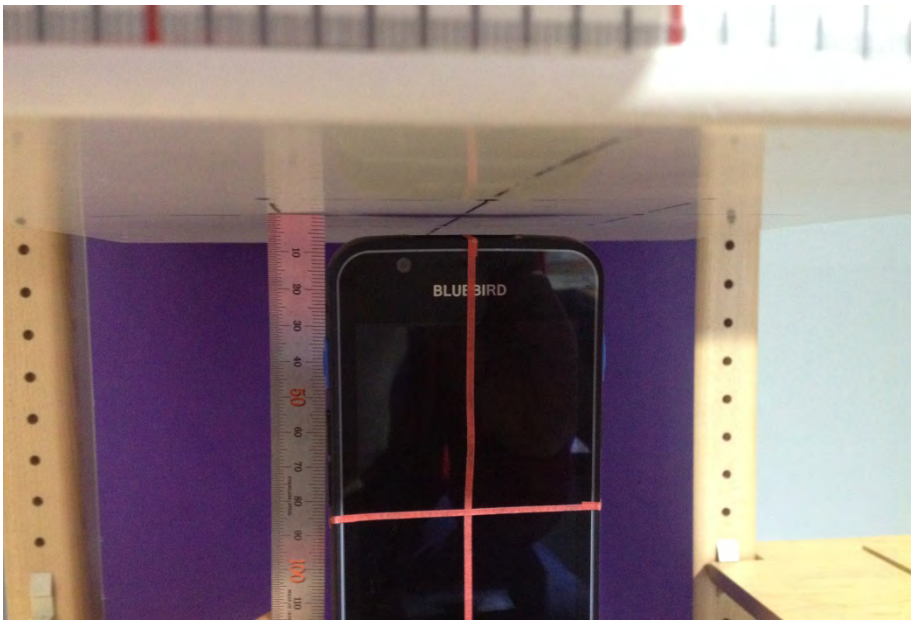
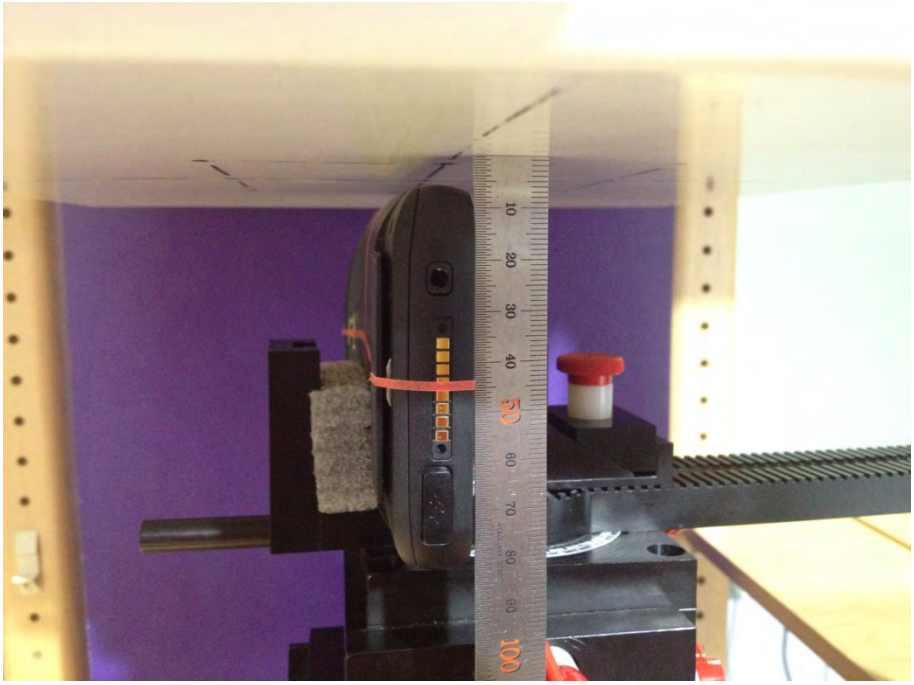


[TOP]



[LEFT]

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Appendix E: System Certificate & calibration

E-1: Probe Calibration

NCL CALIBRATION LABORATORIES

Calibration File No.: 1218

Customer: Kostec
28(175-20, Annyeong-dong)406-gil sejaro, Hwaseong-si Gyeong-do, Korea

CERTIFICATE OF CALIBRATION

It is certified that the equipment identified below has been calibrated in the **NCL CALIBRATION LABORATORIES** by qualified personnel following recognized procedures and using transfer standards traceable to NRC/NIST.

Equipment: Miniature Isotropic RF Probe
Record of Calibration

Manufacturer: APREL Laboratories
Model No.: ALS-E020
Serial No.: 500-00271
Frequency.: Various

Calibration Procedure: D01-032-E020-V2, D22-012-Tissue, D28-002-Dipole
Project No: KOST-PC-5719

Calibrated: 2th July 2013
Released on: 2th July 2013

This Calibration Certificate is Incomplete Unless Accompanied with the Calibration Results Summary

Released By: _____

Art Brennan, Quality Manager

NCL CALIBRATION LABORATORIES

303 Terry Fox Drive, Suite 102
Kanata, Ontario
CANADA K2K 3J1

Division of APREL
TEL: (613) 435-8300
FAX: (613) 435-8306

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NCL Calibration Laboratories
Division of APREL Inc.

Introduction

This Calibration Report reproduces the results of the calibration performed in line with the references listed below. Calibration is performed using accepted methodologies as per the references listed below. Probes are calibrated for air, and tissue and the values reported are the results from the physical quantification of the probe through meteorgical practices.

Calibration Method

Probes are calibrated using the following methods.

<1000MHz
TEM Cell for sensitivity in air
Standard phantom using temperature transfer method for sensitivity in tissue

>1000MHz
Waveguide* method to determine sensitivity in air and tissue
*Waveguide is numerically (simulation) assessed to determine the field distribution and power

The boundary effect for the probe is assessed using a standard flat phantom where the probe output is compared against a numerically simulated series of data points

References

- IEEE Standard 1528 (2003) including Amendment 1
  IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques
- EN 62209-1 (2006)
  Human Exposure to RF Fields from hand-held and body-mounted wireless communication devices - Human models, instrumentation, and procedures-Part 1: Procedure to measure the Specific Absorption Rate (SAR) for hand-held mobile wireless devices
- IEC 62209-2 Ed. 1.0 (2010-03)
  Human exposure to RF fields from hand-held and body-mounted wireless devices - Human models, instrumentation, and procedures - Part 2: specific absorption rate (SAR) for wireless communication devices (30 MHz - 6 GHz)
- TP-D01-032-E020-V2 E-Field probe calibration procedure
- D22-012-Tissue dielectric tissue calibration procedure
- D28-002-Dipole procedure for validation of SAR system using a dipole
- IEEE 1309 Draft Standard for Calibration of Electromagnetic Field Sensors and Probes, Excluding Antennas, from 9kHz to 40GHz

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Conditions

Probe 500-00271 was a re-calibration.

Ambient Temperature of the Laboratory: 22 °C +/- 1.5°C
Temperature of the Tissue: 21 °C +/- 1.5°C
Relative Humidity: < 54%

Primary Measurement Standards

Instrument	Serial Number	Cal due date
Attenuator HP 8495A (70dB)	2748A07325	March, 2014
Network Analyzer Anritsu 37347C	002106	Feb.. 2015
Secondary Measurement Standards		
Signal Generator HP 83640B	3844A00689	February 12, 2015
Power meter Agilent E4416A	MY45101929	October, 2013
Power Sensor Agilent E9323A	MY4421557	November, 2013

Attestation

The below named signatories have conducted the calibration and review of the data which is presented in this calibration report.

We the undersigned attest that to the best of our knowledge the calibration of this subject has been accurately conducted and that all information contained within the results pages have been reviewed for accuracy.

Art Brennan, Quality Manager

Dan Brooks, Test Engineer

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Probe Summary

Probe Type:	E-Field Probe E020
Sensor Offset:	1.56
Sensor Length:	2.5
Tip Enclosure:	Composite*
Tip Diameter:	< 2.9 mm
Tip Length:	55 mm
Total Length:	289 mm

*Resistive to recommended tissue recipes per IEEE-1528

Sensitivity in Air

Channel X:	1.2 $\mu V/(V/m)^2$
Channel Y:	1.2 $\mu V/(V/m)^2$
Channel Z:	1.2 $\mu V/(V/m)^2$
Diode Compression Point:	95 mV

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Calibration for Tissue (Head H, Body B)

Frequency	Tissue Type	Measured Epsilon	Measured Sigma	Calibration Uncertainty	Tolerance Uncertainty for 5%*	Conversion Factor
450 H	**Head**	**45.58**	**0.88**	**3.5**	**2.4**	**6.6**
450 B	Body	X	X	X	X	X
600 H	Head	X	X	X	X	X
750 H	Head	X	X	X	X	X
750 B	Body	X	X	X	X	X
835 H	**Head**	**41.85**	**0.88**	**3.5**	**3.4**	**7.0**
835 B	**Body**	**56.65**	**1.02**	**3.5**	**2.5**	**6.5**
900 H	Head	X	X	X	X	X
900 B	Body	X	X	X	X	X
1450 H	Head	X	X	X	X	X
1450 B	Body	X	X	X	X	X
1500 H	Head	X	X	X	X	X
1500 B	Body	X	X	X	X	X
1640 H	Head	X	X	X	X	X
1640 B	Body	X	X	X	X	X
1750 H	Head	X	X	X	X	X
1750 B	Body	X	X	X	X	X
1800 H	**Head**	**40.55**	**1.38**	**3.5**	**2.4**	**5.1**
1800 B	Body	X	X	X	X	X
1900 H	**Head**	**38.55**	**1.33**	**3.5**	**2.5**	**5.6**
1900 B	**Body**	**51.69**	**1.59**	**3.5**	**2.5**	**5.4**
2000 H	**Head**	**39.15**	**1.35**	**3.5**	**2.5**	**5.6**
2000 B	Body	X	X	X	X	X
2100 H	Head	X	X	X	X	X
2100 B	Body	X	X	X	X	X
2300 H	Head	X	X	X	X	X
2300 B	Body	X	X	X	X	X
2450 H	**Head**	**38.68**	**1.87**	**3.5**	**2.5**	**4.5**
2450 B	**Body**	**50.87**	**2.99**	**3.5**	**2.5**	**4.3**
2600 H	Head	X	X	X	X	X
2600 B	Body	X	X	X	X	X
3600 H	Head	X	X	X	X	X
3600 B	Body	X	X	X	X	X
5200 H	**Head**	**36.30**	**4.55**	**3.5**	**2.5**	**3.1**
5200 B	**Body**	**47.41**	**5.08**	**3.5**	**2.5**	**2.8**
5400 H	**Head**	**35.71**	**4.75**	**3.5**	**2.5**	**2.8**
5400 B	**Body**	**46.72**	**5.27**	**3.5**	**2.5**	**2.7**
5600 H	**Head**	**35.14**	**4.94**	**3.5**	**2.5**	**2.7**
5600 B	**Body**	**46.50**	**5.67**	**3.5**	**2.5**	**2.6**
5800 H	**Head**	**34.71**	**5.19**	**3.5**	**2.5**	**3.1**
5800 B	**Body**	**45.61**	**5.95**	**3.5**	**2.5**	**2.8**

This page has been reviewed for content and attested to on Page 2 of this document.

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Boundary Effect:

Uncertainty resulting from the boundary effect is less than 2.1% for the distance between the tip of the probe and the tissue boundary, when less than 0.58mm.

Spatial Resolution:

The spatial resolution uncertainty is less than 1.5% for 4.9mm diameter probe.
The spatial resolution uncertainty is less than 1.0% for 2.5mm diameter probe.

DAQ-PAQ Contribution

To minimize the uncertainty calculation all tissue sensitivity values were calculated using a load impedance of 5 MΩ.

Boundary Effect:

For a distance of 0.58mm the worst case evaluated uncertainty (increase in the probe sensitivity) is less than 2.1%.

NOTES:

*The maximum deviation from the centre frequency when comparing the lower to upper range is listed.

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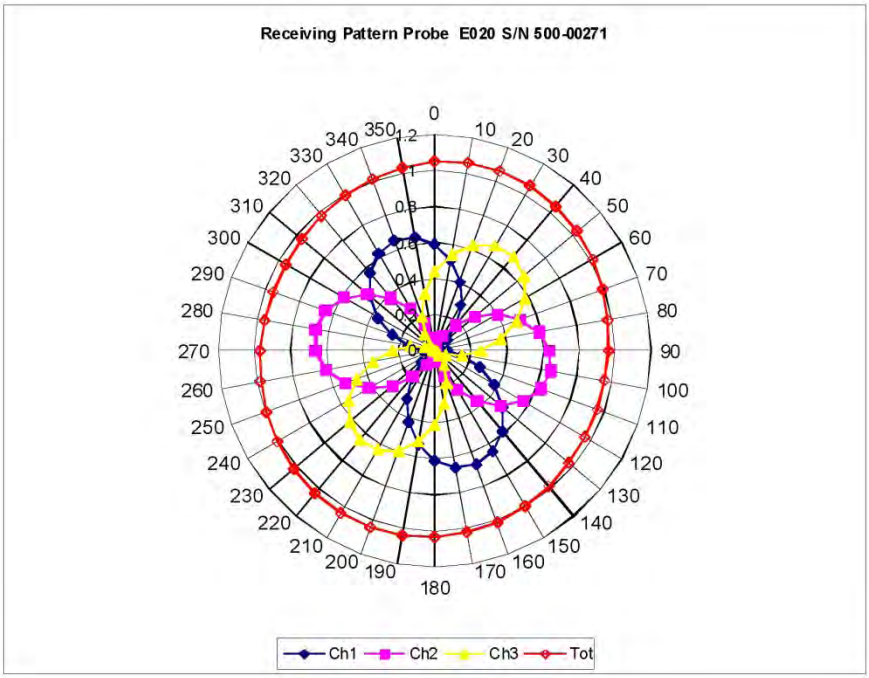
Division of APREL Inc.

Receiving Pattern Air



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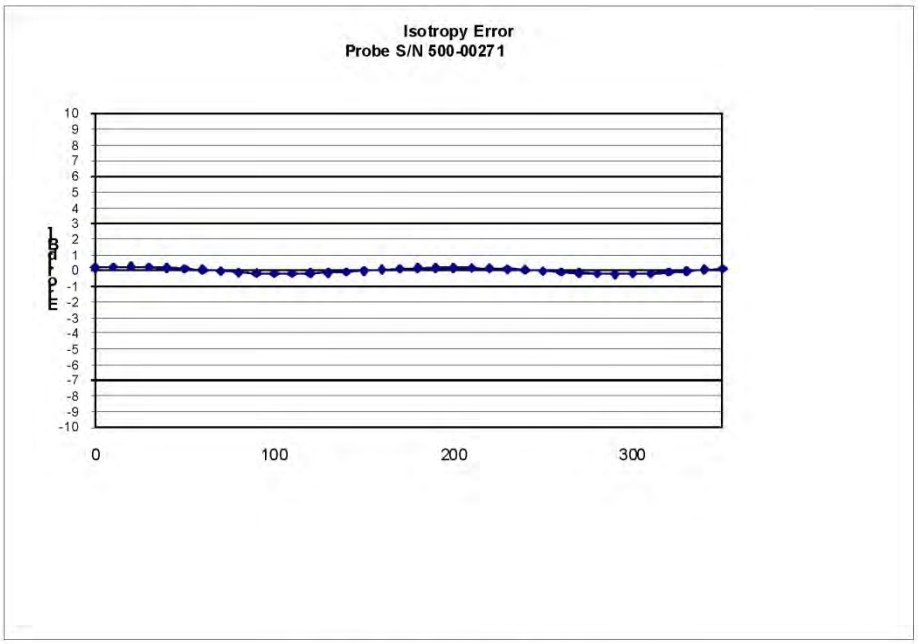
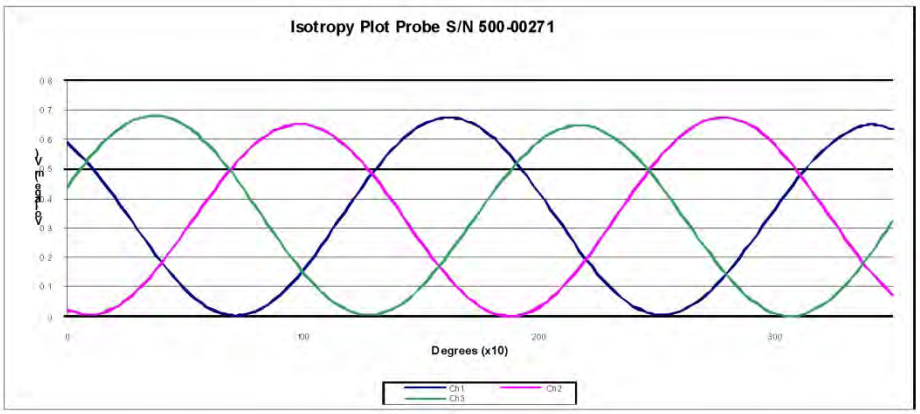
Isotropy Error (Air)





Isotropicity Tissue: 0.189 dB

Page 8 of 11
This page has been reviewed for content and attested to on Page 2 of this document.

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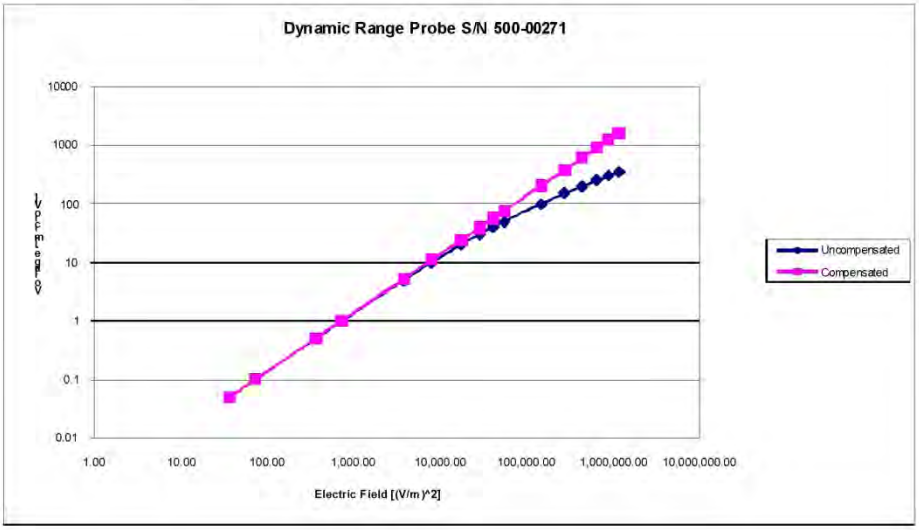
Dynamic Range



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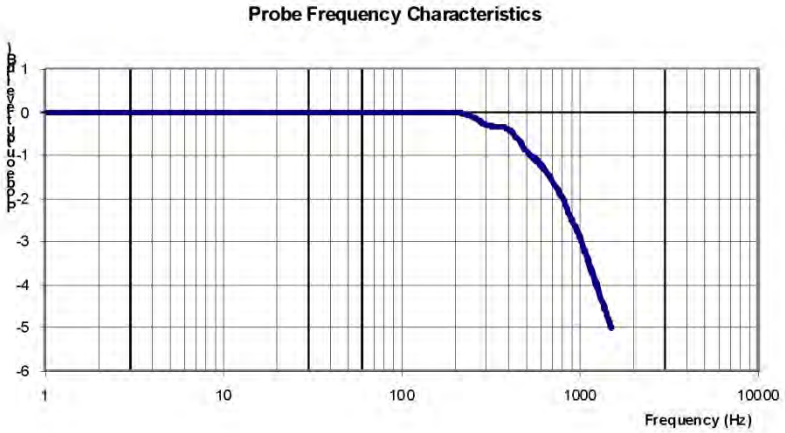
Video Bandwidth



Video Bandwidth at 500 Hz 1 dB
Video Bandwidth at 1.02 KHz: 3 dB

Test Equipment

The te st eq uipment used du ring Probe Calibration, man ufacturer, mod el number and, cu rrent calibration status are li sted a nd l ocated on the main A PREL server R:\NCL\Calibration Equipment\Instrument List May 2012.

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NCL Calibration Laboratories
Division of APREL Inc.

ANNEX

PROBE ALS-E020 S/N 500-00272 CALIBRATION

Conditions

Ambient Temperature of the Laboratory: 22 °C +/- 1.5°C
Temperature of the Tissue: 21 °C +/- 1.5°C
Relative Humidity: < 54%

Sensitivity in Head Tissue

Frequency: 600 MHz

Epsilon: 43.8 **Sigma:** 0.83 S/m

The relative permittivity and conductivity values for frequency 600 MHz are not specified in IEEE 1528 and IEC 62209 standards. The target values were linearly interpolated utilizing the data from Table 2 IEEE 1528 (2003).

Dipole Mechanical Dimensions*

Length: 312 mm
Height: 166.56 mm

*450 MHz Dipole and Uni-Fhantom were used for these calibration procedures. For the system validation with APREL Flat Phantom the dipole should be aligned against the sort side of the phantom.

ConvF

Channel 1: 2.8

Channel 2: 2.8

Channel 3: 2.8

Conversion factors were determined in respect to the numerical simulation values (see Dipole ALS-D-450-S-2 Serial Number 175-00504 600 MHz Non-Standard Addendum).

E-2: Dipole antenna Calibration (835 ㎒)

NCL CALIBRATION LABORATORIES

Calibration File No: DC-1231
Project Number: KOST-DC-5575-76

CERTIFICATE OF CALIBRATION

It is certified that the equipment identified below has been calibrated in the **NCL CALIBRATION LABORATORIES** by qualified personnel following recognized procedures and using transfer standards traceable to NRC/NIST.

Validation Dipole
835MHz Head

Manufacturer: APREL Laboratories
Part number: ALS-D-835-S-2
Frequency: 835MHz
Serial No: 180-00555

Customer: Kostec
28(175-20, Annyeong-dong)406-gil sejaro, Hwaseong-si Gyeong-do, Korea

Calibrated: 14th February 2013
Released on: 14th February 2013

This Calibration Certificate is Incomplete Unless Accompanied with the Calibration Results Summary

Released By: _____

NCL CALIBRATION LABORATORIES

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Kanata, Ontario
CANADA K2K 3J1

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Head office & Test Lab: 28(175-20,Annyeong-dong)
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NCL Calibration Laboratories
Division of APREL Inc.

Conditions

Dipole 180-00555 was a re-calibration.

Ambient Temperature of the Laboratory:	22 °C +/- 0.5°C
Temperature of the Tissue:	21 °C +/- 0.5°C

We the undersigned attest that to the best of our knowledge the calibration of this device has been accurately conducted and that all information contained within this report has been reviewed for accuracy.

Stuart Nicol

C. Teodorian

This page has been reviewed for content and attested to by signature within this document.

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Tel: +82-31-222-4251 / Fax: +82-31-222-4252

NCL Calibration Laboratories
Division of APREL Inc.

Calibration Results Summary

The following results relate the Calibrated Dipole and should be used as a quick reference for the user.

Mechanical Dimensions

Length: 161.0 mm
Height: 89.8 mm

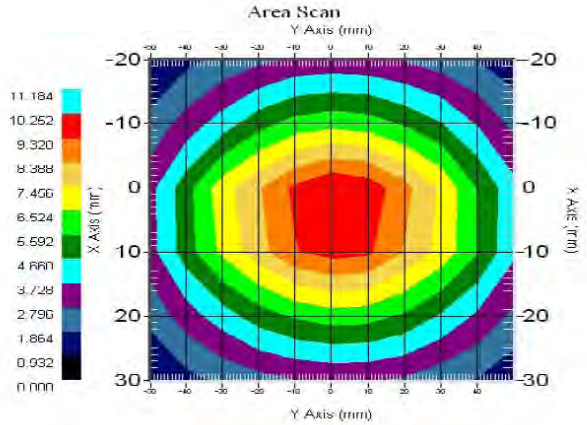
Electrical Specification 835MHz

Tissue Type	Return Loss:	Impedance:	SWR:
Head	-44.818	50.328	1.012U
Body	X	X	X

System Validation Results

Tissue	Frequency	1 Gram	10 Gram	Peak
Head	835 MHz	9.590	6.003	15.013
Body	835 MHz	X	X	X

835MHz



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NCL Calibration Laboratories
Division of APREL Inc.

Introduction

This Calibration Report has been produced in line with the SSI Dipole Calibration Procedure SSI-TP-018-ALSAS. The results contained within this report are for Validation Dipole 180-00555. The calibration routine consisted of a three-step process. Step 1 was a mechanical verification of the dipole to ensure that it meets the mechanical specifications. Step 2 was an Electrical Calibration for the Validation Dipole, where the SWR, Impedance, and the Return loss were assessed. Step 3 involved a System Validation using the ALSAS-10U, along with APREL E-030 130 MHz to 26 GHz E-Field Probe Serial Number 215.

References

- IEEE Standard 1528 (2003) including Amendment 1
  IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques
- EN 62209-1 (2006)
  Human Exposure to RF Fields from hand-held and body-mounted wireless communication devices - Human models. instrumentation, and procedures-Part 1: Procedure to measure the Specific Absorption Rate (SAR) for hand-held mobile wireless devices
- IEC 62209-2 Ed. 1.0 (2010-03)
  Human exposure to RF fields from hand-held and body-mounted wireless devices - Human models, instrumentation, and procedures - Part 2: specific absorption rate (SAR) for wireless communication devices (30 MHz - 6 GHz)
- TP-D01-032-E020-V2 E-Field probe calibration procedure
- D22-012-Tissue dielectric tissue calibration procedure
- D28-002-Dipole procedure for validation of SAR system using a dipole
- IEEE 1309 Draft Standard for Calibration of Electromagnetic Field Sensors and Probes, Excluding Antennas, from 9kHz to 40GHz

Conditions

Dipole 180-00555 was a re-calibration.

Ambient Temperature of the Laboratory:	22 °C +/- 0.5°C
Temperature of the Tissue:	20 °C +/- 0.5°C

Dipole Calibration uncertainty

The calibration uncertainty for the dipole is made up of various parameters presented below.

Mechanical	1%
Positioning Error	1.22%
Electrical	1.7%
Tissue	2.2%
Dipole Validation	2.2%
TOTAL	**8.32% (16.64% K=2)**

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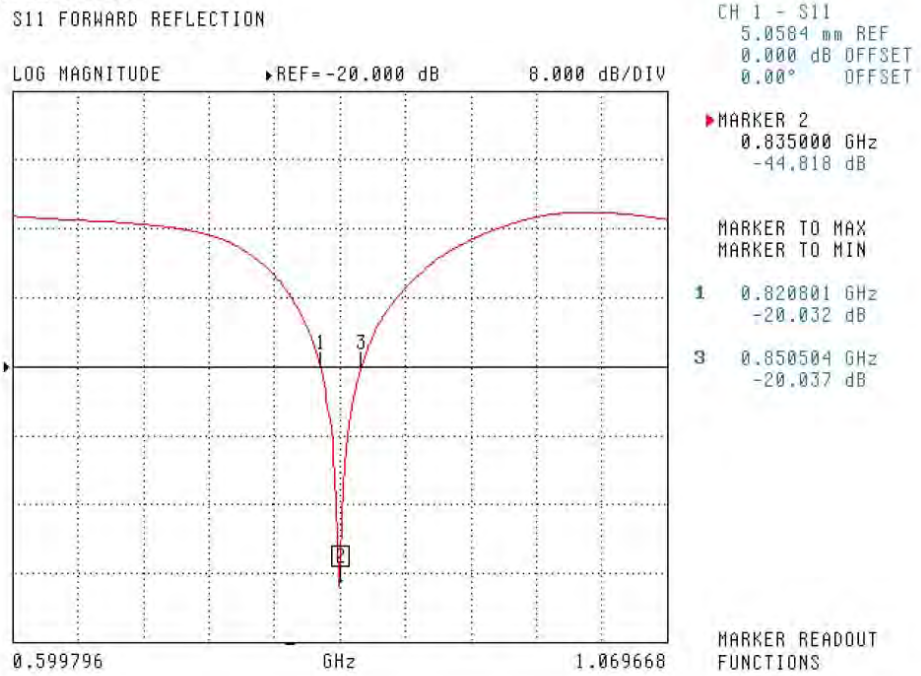
NCL Calibration Laboratories
Division of APREL Inc.

Electrical Calibration

Electrical Specification 835MHz

Tissue Type	Measured Epsilon	Measured Sigma
Head	41.09	0.89
Body	X	X

Head Tissue



Body Tissue

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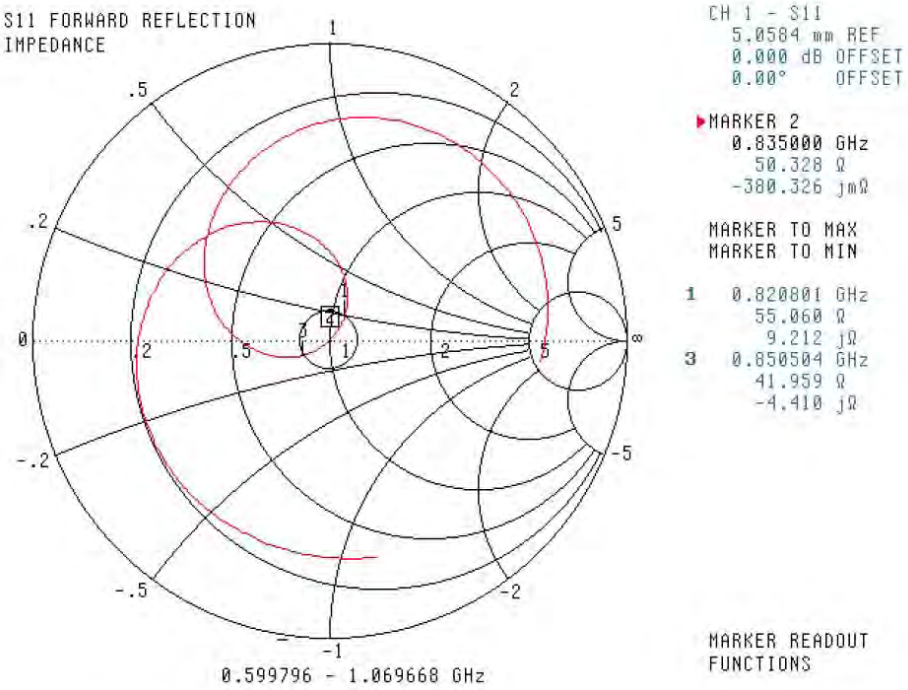
NCL Calibration Laboratories
Division of APREL Inc.

Electrical Specification 835MHz
Impedance

Tissue Type	Measured Epsilon	Measured Sigma
Head	41.09	0.89
Body	X	X

Head Tissue



Body Tissue

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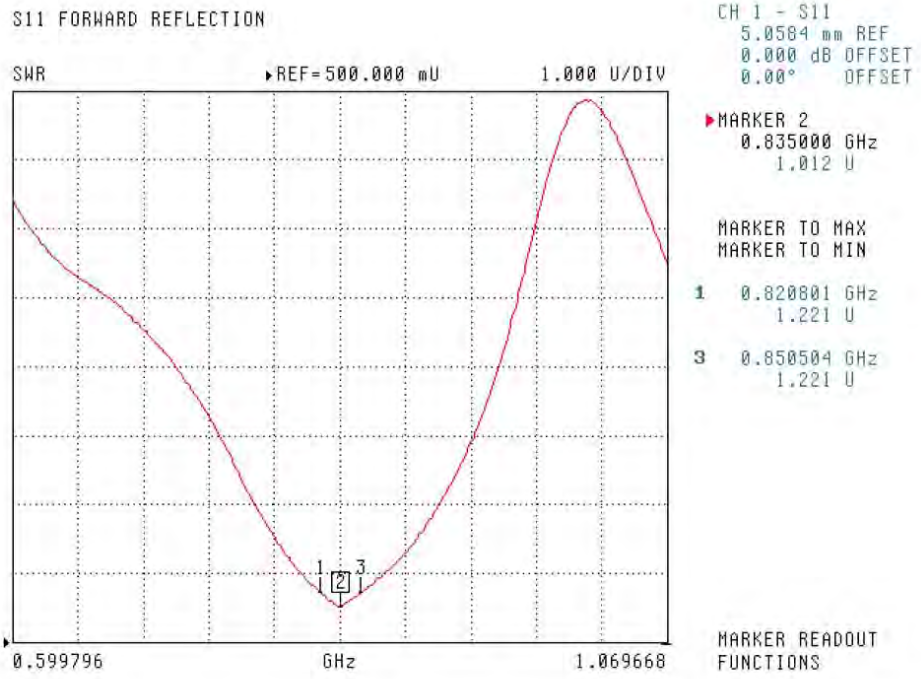
NCL Calibration Laboratories
Division of APREL Inc.

Electrical Specification 835MHz
Standing Wave Ratio

Tissue Type	Measured Epsilon	Measured Sigma
Head	41.09	0.89
Body	X	X

Head Tissue



Body Tissue

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NCL Calibration Laboratories
Division of APREL Inc.

Test Equipment

The test equipment used during Probe Calibration, manufacturer, model number and, current calibration status are listed and located on the main APREL server R:\NCL\Calibration Equipment\Instrument List May 2012.

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NCL CALIBRATION LABORATORIES

Calibration File No: DC-1485
Project Number: KOST-DC-5715

CERTIFICATE OF CALIBRATION

It is certified that the equipment identified below has been calibrated in the **NCL CALIBRATION LABORATORIES** by qualified personnel following recognized procedures and using transfer standards traceable to NRC/NIST.

Validation Dipole
835MHz Body

Manufacturer: APREL Laboratories
Part number: ALS-D-835-S-2
Frequency: 835MHz
Serial No: 180-00555

Customer: Kostec
28(175-20, Annyeong-dong)406-gil sejaro, Hwaseong-si Gyeong-do, Korea

Calibrated: 27th February 2013
Released on: 27th February 2013

This Calibration Certificate is Incomplete Unless Accompanied with the Calibration Results Summary

Released By: _____

Art Brennan, Quality Manager

NCL CALIBRATION LABORATORIES

303 Terry Fox Drive, Suite 102
Kanata, Ontario
CANADA K2K 3J1

Division of APREL
TEL (613) 435-8300
FAX: (613) 435-8306

Head office & Test Lab: 28(175-20,Annyeong-dong)
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NCL Calibration Laboratories
Division of APREL Inc.

Conditions

Dipole 180-00555 was a re-calibration.

Ambient Temperature of the Laboratory:	22 °C +/- 0.5°C
Temperature of the Tissue:	21 °C +/- 0.5°C

We the undersigned attest that to the best of our knowledge the calibration of this subject has been accurately conducted and that all information contained within the results pages have been reviewed for accuracy.

Art Brennan, Quality Manager

Dan Brooks, Test Engineer

This page has been reviewed for content and attested to by signature within this document.

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NCL Calibration Laboratories
Division of APREL Inc.

Calibration Results Summary

The following results relate the Calibrated Dipole and should be used as a quick reference for the user.

Mechanical Dimensions

Length: 161.0 mm
Height: 89.8 mm

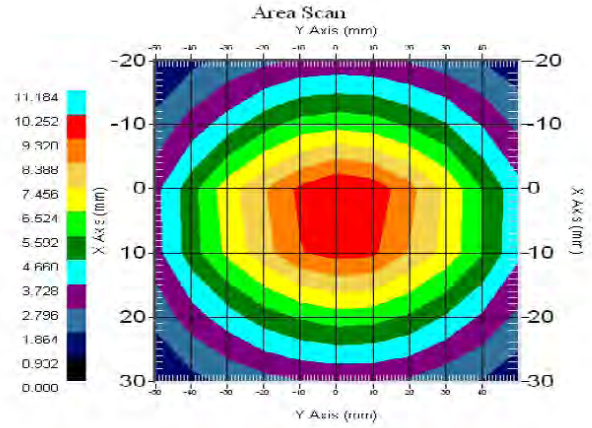
Electrical Calibration

Tissue Type	Return Loss:	Impedance:	SWR:
Body	-28.461 dB	53.266 Ω	1.078 μ

System Validation Results

Tissue	Frequency	1 Gram	10 Gram	Peak
Body	835 MHz	10.047	6.377	15.119

835MHz



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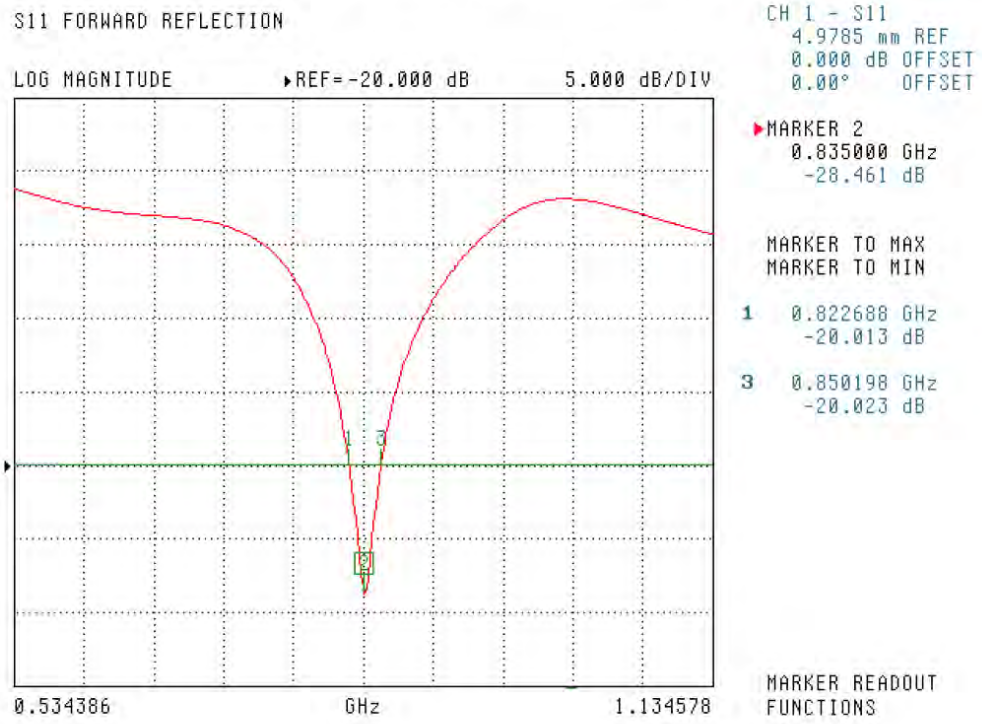
NCL Calibration Laboratories
Division of APREL Inc.

Electrical Calibration

Tissue Type	Return Loss:	Impedance:	SWR:
Body	-28.461 dB	53.266 Ω	1.078 μ



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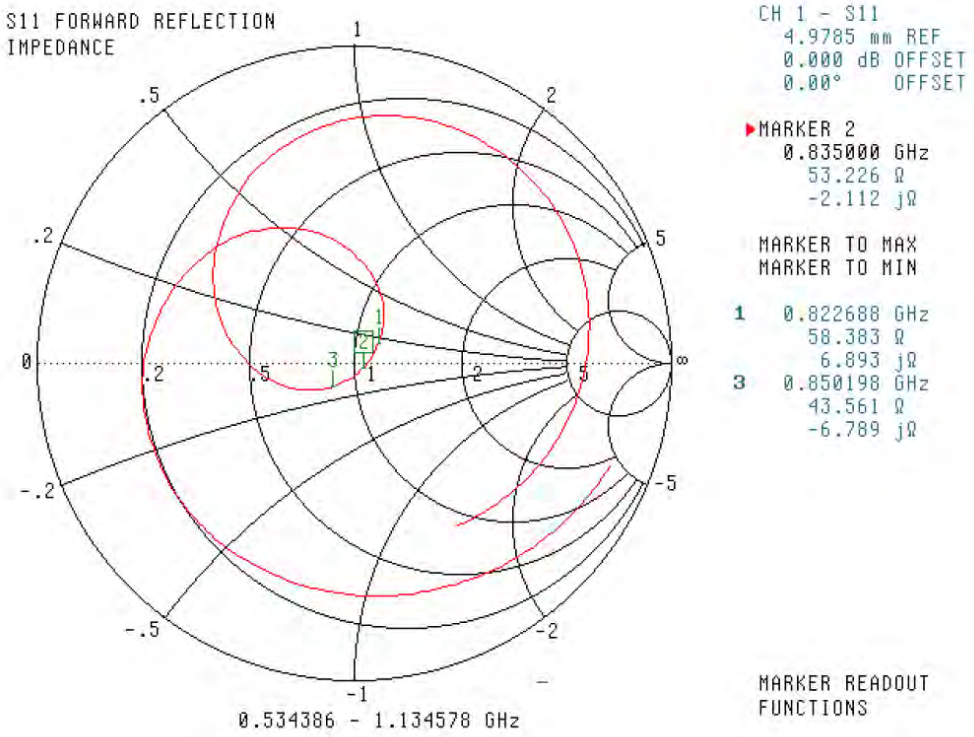
NCL Calibration Laboratories
Division of APREL Inc.



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NCL Calibration Laboratories
Division of APREL Inc.

Test Equipment

The test equipment used during Probe Calibration, manufacturer, model number and, current calibration status are listed and located on the main APREL server R:\NCL\Calibration Equipment\Instrument List May 2012.

8

This page has been reviewed for content and attested to by signature within this document.

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Dipole antenna Calibration (1 900 ㎒)

NCL CALIBRATION LABORATORIES

Calibration File No: DC-1482
Project Number: KOST-DC-5721

CERTIFICATE OF CALIBRATION

It is certified that the equipment identified below has been calibrated in the **NCL CALIBRATION LABORATORIES** by qualified personnel following recognized procedures and using transfer standards traceable to NRC/NIST.

Validation Dipole
1900MHz Head & Body

Manufacturer: APREL Laboratories
Part number: ALS-D-1900-S-2
Frequency: 1900MHz
Serial No: 210-00717

Customer: Kostec
28(175-20, Annyeong-dong)406-gil sejaro, Hwaseong-si Gyeong-do, Korea

Calibrated: 27th February 2013
Released on: 27th February 2013

This Calibration Certificate is Incomplete Unless Accompanied with the Calibration Results Summary

Released By: 

Art Brennan, Quality Manager

NCL CALIBRATION LABORATORIES

303 Terry Fox Drive, Suite 102
Kanata, Ontario
CANADA K2K 3J1

Division of APREL
TEL (613) 435-8300
FAX (613) 435-8306

Head office & Test Lab: 28(175-20,Annyeong-dong)
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Tel: +82-31-222-4251 / Fax: +82-31-222-4252

NCL Calibration Laboratories
Division of APREL Inc.

Conditions

Dipole 210-00717 was an original calibration. New taken from stock

Ambient Temperature of the Laboratory:	22 °C +/- 0.5°C
Temperature of the Tissue:	21 °C +/- 0.5°C

We the undersigned attest that to the best of our knowledge the calibration of this subject has been accurately conducted and that all information contained within the results pages have been reviewed for accuracy.

Art Brennan, Quality Manager

Dan Brooks, Test Engineer

This page has been reviewed for content and attested to by signature within this document.

Head office & Test Lab: 28(175-20,Annyeong-dong)
406-gil sejaro, Hwaseong-si Gyeonggi-do, Korea
Tel: +82-31-222-4251 / Fax: +82-31-222-4252

NCL Calibration Laboratories
Division of APREL Inc.

Calibration Results Summary

The following results relate the Calibrated Dipole and should be used as a quick reference for the user.

Mechanical Dimensions

Length: 68.00 mm
Height: 39.47 mm

Electrical Calibration

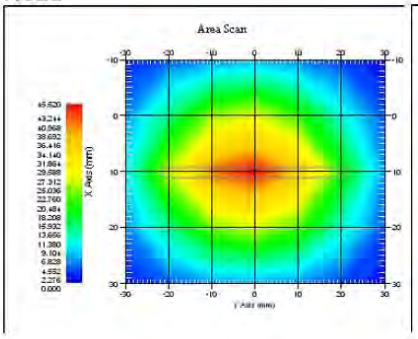
Tissue Type	Return Loss:	Impedance:	SWR:
Head	-37.745 dB	50.887 Ω	1.026 U
Body	-26.428 dB	53.020 Ω	1.100 U

System Validation Results

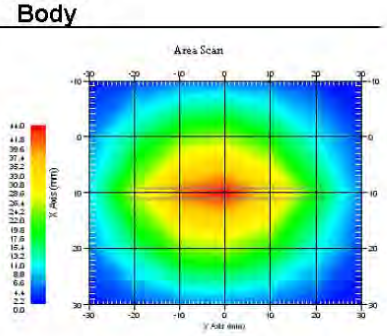
Tissue	Frequency	1 Gram	10 Gram	Peak
Head	1900 MHz	40.387	19.95	76.067
Body	1900 MHz	38.126	19.051	72.464

1900MHz

Head



Body



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NCL Calibration Laboratories
Division of APREL Inc.

Introduction

This Calibration Report has been produced in line with the SSI Dipole Calibration Procedure SSI-TP-018-ALSAS. The results contained within this report are for Validation Dipole 210-00717. The calibration routine consisted of a three-step process. Step 1 was a mechanical verification of the dipole to ensure that it meets the mechanical specifications. Step 2 was an Electrical Calibration for the Validation Dipole, where the SWR, Impedance, and the Return loss were assessed. Step 3 involved a System Validation using the ALSAS-10U, along with APREL E-030 130 MHz to 26 GHz E-Field Probe Serial Number 215.

References

- IEEE Standard 1528 (2003) including Amendment 1
  IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques
- EN 62209-1 (2006)
  Human Exposure to RF Fields from hand-held and body-mounted wireless communication devices - Human models. instrumentation, and procedures-Part 1: Procedure to measure the Specific Absorption Rate (SAR) for hand-held mobile wireless devices
- IEC 62209-2 Ed. 1.0 (2010-03)
  Human exposure to RF fields from hand-held and body-mounted wireless devices - Human models, instrumentation, and procedures - Part 2: specific absorption rate (SAR) for wireless communication devices (30 MHz - 6 GHz)
- TP-D01-032-E020-V2 E-Field probe calibration procedure
- D22-012-Tissue dielectric tissue calibration procedure
- D28-002-Dipole procedure for validation of SAR system using a dipole
- IEEE 1309 Draft Standard for Calibration of Electromagnetic Field Sensors and Probes, Excluding Antennas, from 9kHz to 40GHz

Conditions

Dipole 210-00717 was an original calibration. New taken from stock.

Ambient Temperature of the Laboratory:	22 °C +/- 0.5°C
Temperature of the Tissue:	20 °C +/- 0.5°C

Dipole Calibration uncertainty

The calibration uncertainty for the dipole is made up of various parameters presented below.

Mechanical	1%
Positioning Error	1.22%
Electrical	1.7%
Tissue	2.2%
Dipole Validation	2.2%
TOTAL	**8.32% (16.64% K=2)**

4

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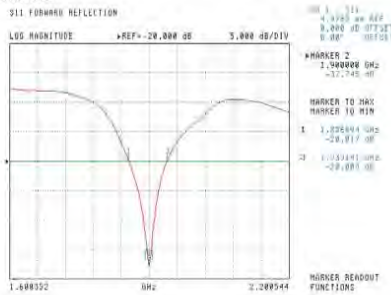
NCL Calibration Laboratories

Division of APREL Inc.

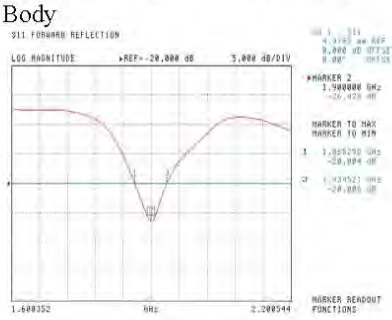
Electrical Calibration

Tissue Type	Return Loss:	Impedance:	SWR:
Head	-37.745 dB	50.887 Ω	1.026 U
Body	-26.428 dB	53.020 Ω	1.100 U

Head



Body



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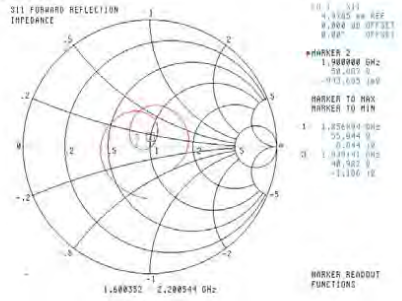
NCL Calibration Laboratories

Division of APREL Inc.

Head



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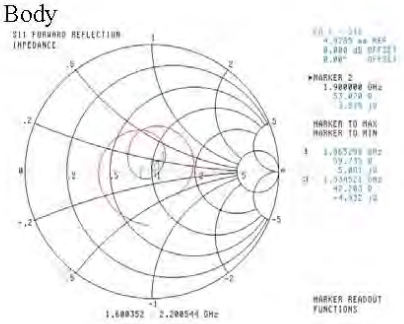

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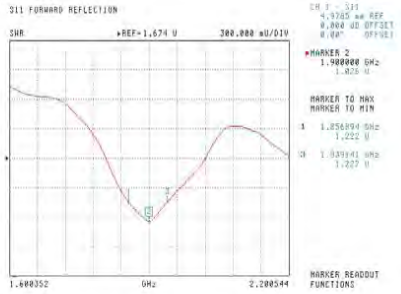
NCL Calibration Laboratories

Division of APREL Inc.

Head



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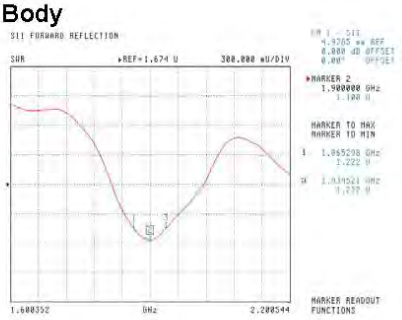

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NCL Calibration Laboratories
Division of APREL Inc.

Test Equipment

The test equipment used during Probe Calibration, manufacturer, model number and, current calibration status are listed and located on the main APREL server R:\NCL\Calibration Equipment\Instrument List May 2012.

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Dipole antenna Calibration (2 450 ㎒)

NCL CALIBRATION LABORATORIES

Calibration File No: DC-1483
Project Number: KOST-DC-5722

CERTIFICATE OF CALIBRATION

It is certified that the equipment identified below has been calibrated in the **NCL CALIBRATION LABORATORIES** by qualified personnel following recognized procedures and using transfer standards traceable to NRC/NIST.

Validation Dipole
2450MHz Head & Body

Manufacturer: APREL Laboratories
Part number: ALS-D-2450-S-2
Frequency: 2450MHz
Serial No: 220-00764

Customer: Kostec
28(175-20, Annyeong-dong)406-gil sejaro, Hwaseong-si Gyeong-do, Korea

Calibrated: 27th February 2013
Released on: 27th February 2013

This Calibration Certificate is Incomplete Unless Accompanied with the Calibration Results Summary

Released By: _____

Art Brennan, Quality Manager

NCL CALIBRATION LABORATORIES

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FAX: (613) 435-8306

Head office & Test Lab: 28(175-20,Annyeong-dong)
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Tel: +82-31-222-4251 / Fax: +82-31-222-4252

NCL Calibration Laboratories
Division of APREL Inc.

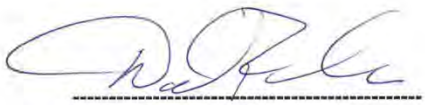
Conditions

Dipole 220-00764 was an original calibration. New taken from stock

Ambient Temperature of the Laboratory: 22 °C +/- 0.5°C
Temperature of the Tissue: 21 °C +/- 0.5°C

We the undersigned attest that to the best of our knowledge the calibration of this subject has been accurately conducted and that all information contained within the results pages have been reviewed for accuracy.

Art Brennan, Quality Manager



Dan Brooks, Test Engineer

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NCL Calibration Laboratories
Division of APREL Inc.

Calibration Results Summary

The following results relate the Calibrated Dipole and should be used as a quick reference for the user.

Mechanical Dimensions

Length: 52.50 mm
Height: 30.59 mm

Electrical Calibration

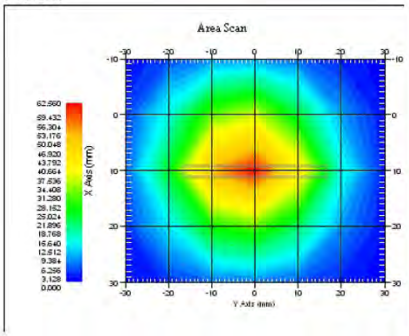
Tissue Type	Return Loss:	Impedance:	SWR:
Head	-41.522 dB	50.117 Ω	1.022U
Body	-31.148 dB	53.332 Ω	1.058 U

System Validation Results

Tissue	Frequency	1 Gram	10 Gram	Peak
Head	2450 MHz	52.926	24.39	106.93
Body	2450 MHz	49.785	22.475	102.89

2450MHz

Head



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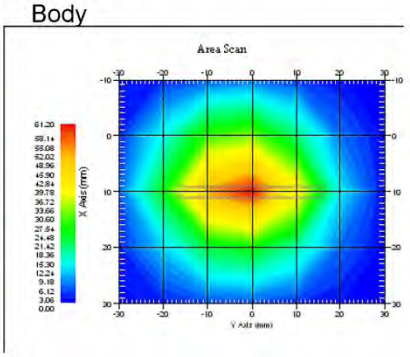

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NCL Calibration Laboratories
Division of APREL Inc.

Introduction

This Calibration Report has been produced in line with the SSI Dipole Calibration Procedure SSI-TP-018-ALSAS. The results contained within this report are for Validation Dipole 220-00764. The calibration routine consisted of a three-step process. Step 1 was a mechanical verification of the dipole to ensure that it meets the mechanical specifications. Step 2 was an Electrical Calibration for the Validation Dipole, where the SWR, Impedance, and the Return loss were assessed. Step 3 involved a System Validation using the ALSAS-10U, along with APREL E-030 130 MHz to 26 GHz E-Field Probe Serial Number 215.

References

- IEEE Standard 1528 (2003) including Amendment 1
  IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques
- EN 62209-1 (2006)
  Human Exposure to RF Fields from hand-held and body-mounted wireless communication devices - Human models, instrumentation, and procedures-Part 1: Procedure to measure the Specific Absorption Rate (SAR) for hand-held mobile wireless devices
- IEC 62209-2 Ed. 1.0 (2010-03)
  Human exposure to RF fields from hand-held and body-mounted wireless devices - Human models, instrumentation, and procedures - Part 2: specific absorption rate (SAR) for wireless communication devices (30 MHz - 6 GHz)
- TP-D01-032-E020-V2 E-Field probe calibration procedure
- D22-012-Tissue dielectric tissue calibration procedure
- D28-002-Dipole procedure for validation of SAR system using a dipole
- IEEE 1309 Draft Standard for Calibration of Electromagnetic Field Sensors and Probes, Excluding Antennas, from 9kHz to 40GHz

Conditions

Dipole 220-00764 was an original calibration. New taken from stock.

Ambient Temperature of the Laboratory: 22 °C +/- 0.5°C
Temperature of the Tissue: 20 °C +/- 0.5°C

Dipole Calibration uncertainty

The calibration uncertainty for the dipole is made up of various parameters presented below.

Mechanical	1%
Positioning Error	1.22%
Electrical	1.7%
Tissue	2.2%
Dipole Validation	2.2%
TOTAL	**8.32% (16.64% K=2)**

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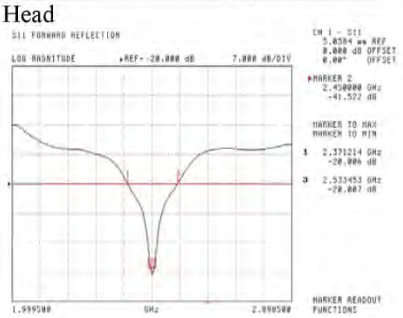
Electrical Calibration

Tissue Type	Return Loss:	Impedance:	SWR:
Head	-41.522 dB	50.117 Ω	1.022U
Body	-31.148 dB	53.332 Ω	1.058 U

Head



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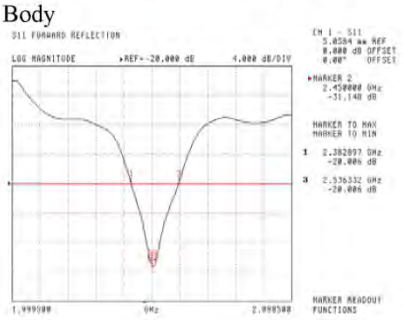

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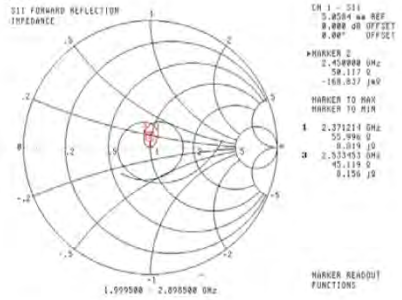
Head



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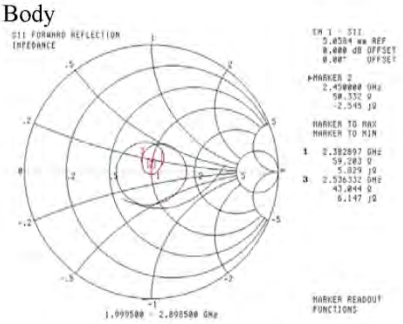

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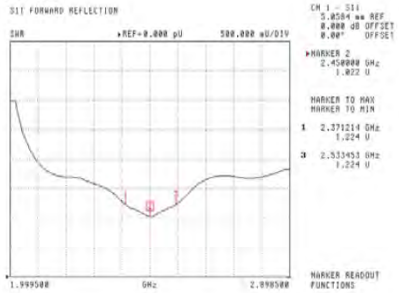
Head



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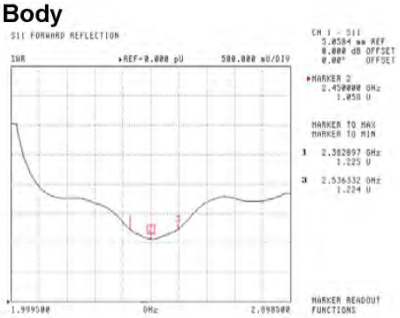

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Test Equipment

The test equipment used during Probe Calibration, manufacturer, model number and, current calibration status are listed and located on the main APREL server R:\NCL\Calibration Equipment\Instrument List May 2012.

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Appendix F: Dipoles extended calibrations

Per KDB 865664, dipoles are verified in return loss(<-20 dB, within 20 % of prior calibration), and in impedance (within 5 ohm of prior calibration), the annual calibration is not necessary and the calibration interval can be extended.

Justification of extended calibration

835 MHz Dipole(MN: ALS-D-835-S-2)						
Head tissue						
Date of Measurement	Return-Loss (dB)	Delta (%)	Impedance (Ω)	Delta (Ω)	SWR (μ)	Delta (μ)
2013. 02. 14	-44.818	-	50.328	-	1.012	-
2014. 02. 14	-43.647	2.613	51.057	0.729	1.013	0.001

835 MHz Dipole(MN: ALS-D-835-S-2)						
Body tissue						
Date of Measurement	Return-Loss (dB)	Delta (%)	Impedance (Ω)	Delta (Ω)	SWR (μ)	Delta (μ)
2013. 02. 27	-28.461	-	53.266	-	1.078	-
2014. 02. 27	-29.554	3.840	52.941	0.325	1.069	0.009

1900 MHz Dipole(MN: ALS-D-1900-S-2)						
Head tissue						
Date of Measurement	Return-Loss (dB)	Delta (%)	Impedance (Ω)	Delta (Ω)	SWR (μ)	Delta (μ)
2013. 02. 27	-37.745	-	50.887	-	1.026	-
2014. 02. 27	-36.220	4.040	50.744	0.143	1.031	0.005

1900 MHz Dipole(MN: ALS-D-1900-S-2)						
Body tissue						
Date of Measurement	Return-Loss (dB)	Delta (%)	Impedance (Ω)	Delta (Ω)	SWR (μ)	Delta (μ)
2013. 02. 27	-26.428	-	53.020	-	1.100	-
2014. 02. 27	-26.879	1.707	51.453	1.567	1.095	0.005

2450MHz Dipole(MN: ALS-D-2450-S-2)						
Head tissue						
Date of Measurement	Return-Loss (dB)	Delta (%)	Impedance (Ω)	Delta (Ω)	SWR (μ)	Delta (μ)
2013. 02. 27	-41.522	-	50.117	-	1.022	-
2014. 02. 27	-41.382	0.337	50.656	0.539	1.017	0.005

2450MHz Dipole(MN: ALS-D-2450-S-2)						
Body tissue						
Date of Measurement	Return-Loss (dB)	Delta (%)	Impedance (Ω)	Delta (Ω)	SWR (μ)	Delta (μ)
2013. 02. 27	-31.148	-	53.332	-	1.058	-
2014. 02. 27	-30.229	2.950	51.688	1.644	1.063	0.005

The return-loss is <20 dB, within 20 % of perior calibarion, the impedance is within 5 Ω of perior calibarion. Therefore the verification result should support extended calibarion.

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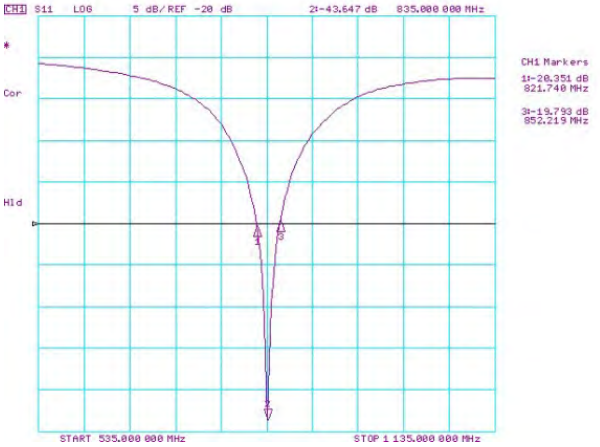
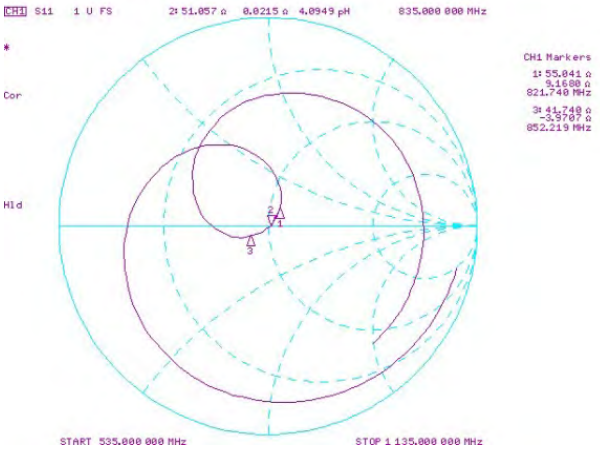
▣ 835 MHz Dipole Head tissue

Return-Loss



Impedance



SWR

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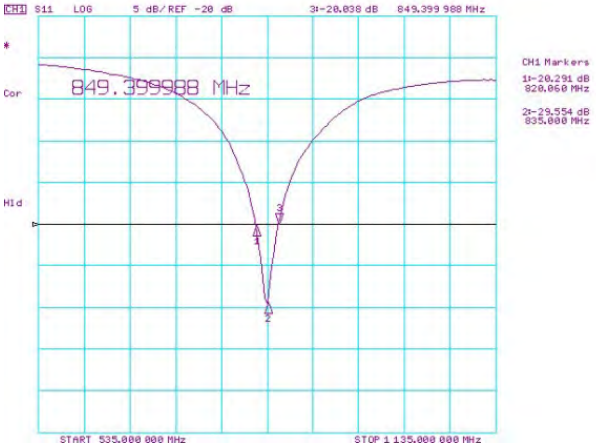
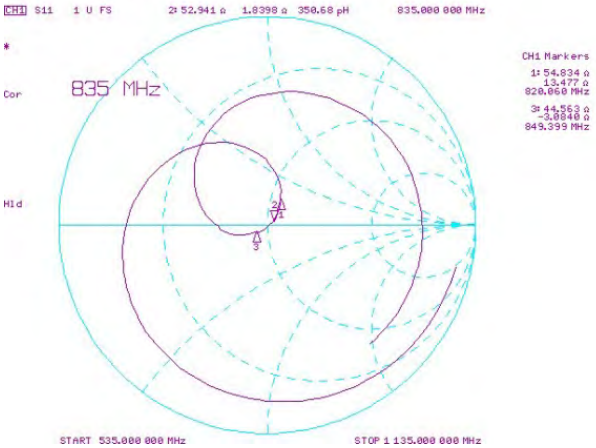
▣ 835 MHz Dipole Body tissue

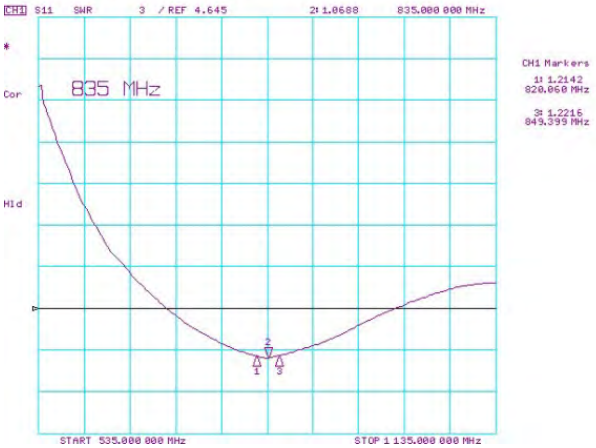
Return-Loss



Impedance



SWR



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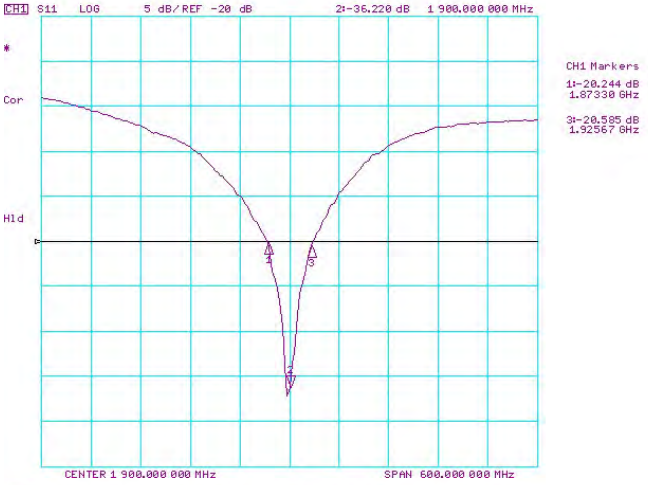
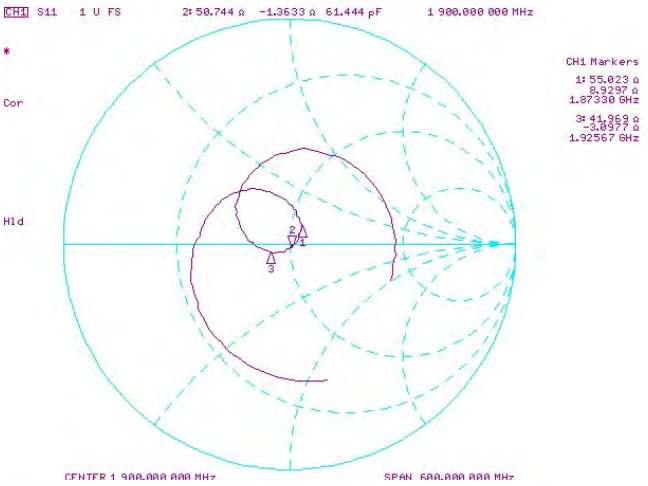
▣ 1900 MHz Dipole Head tissue

Return-Loss



Impedance



SWR

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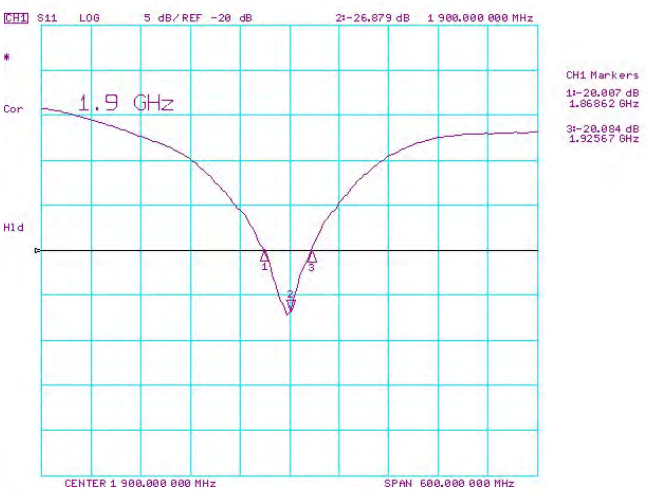
▣ 1900 MHz Dipole Body tissue

Return-Loss



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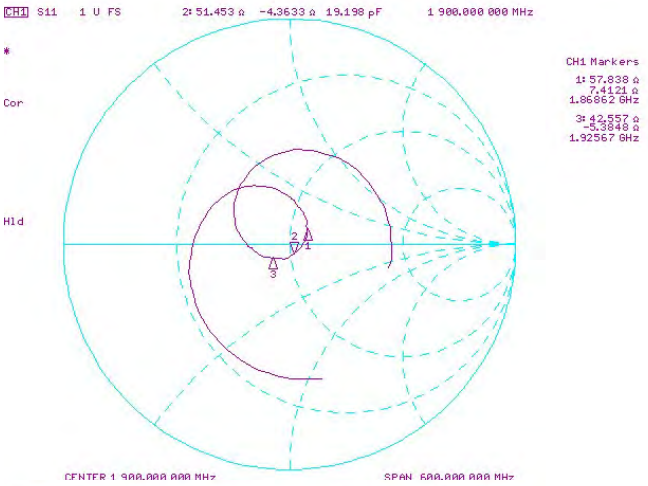

SWR

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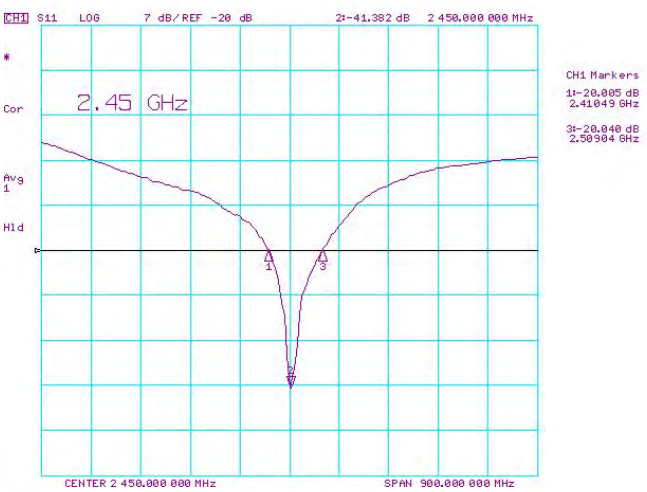
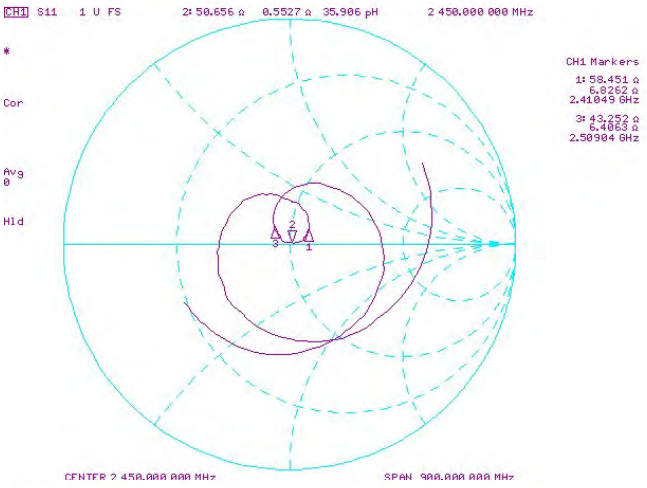
▣ 2450 MHz Dipole Head tissue

Return-Loss



Impedance



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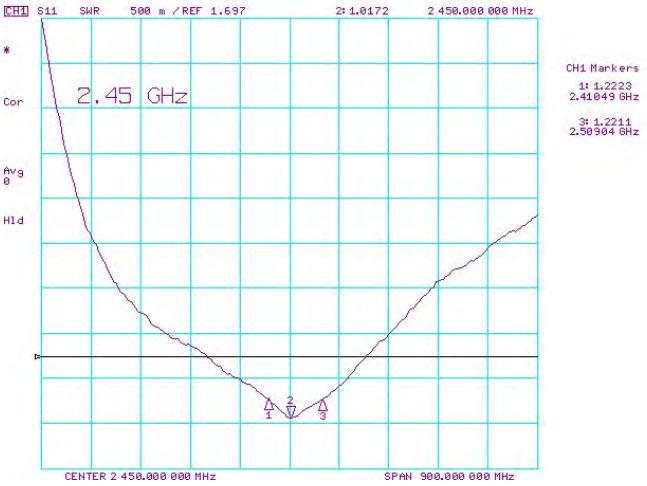

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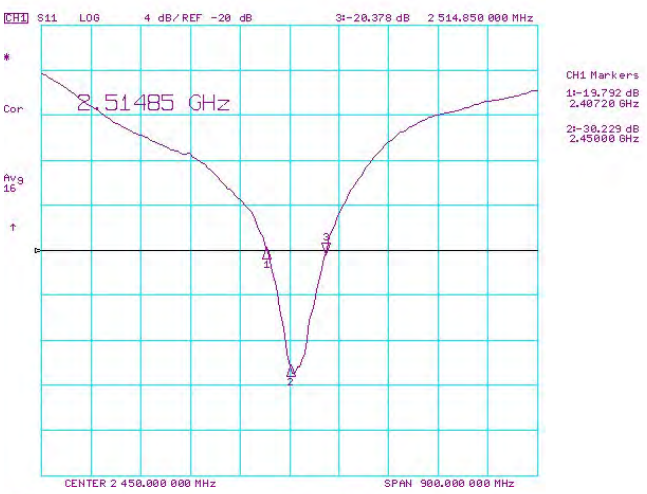
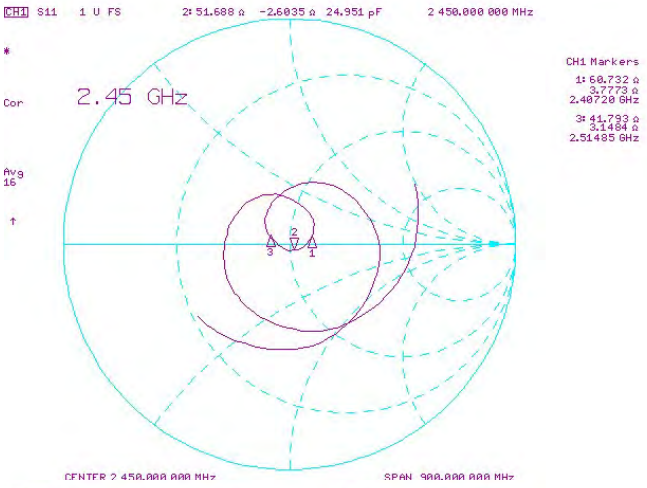
▣ 2450 MHz Dipole Body tissue

Return-Loss



Impedance



SWR