SAR EVALUATION REPORT

For

SZ DJI TECHNOLOGY CO., LTD

14th floor, West Wing, Skyworth Semiconductor Design Building NO.18 Gaoxin South 4th Ave, Nanshan, Shenzhen, Guangdong, China

FCC ID: SS3-GL300E1609

Report Type:	**Product Type:**
Original Report	C1

Report Number: RDG160820008-20A

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<tr><td>Model Number</td><td colspan="2">GL300E</td></tr>
<tr><td>Test Date</td><td colspan="2">2016-08-29 to 2016-08-30</td></tr>
<tr><td>Mode</td><td colspan="2">Max. SAR Level(s) Reported</td><td>Limit(W/Kg)</td></tr>
<tr><td>LB 5.8G</td><td>10g Extremity SAR</td><td>0.138W/kg 10g SAR</td><td rowspan="3">4.0</td></tr>
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<tr><td>Simultaneous</td><td>10g Extremity SAR</td><td>0.504 W/kg 10g SAR</td></tr>
<tr><td rowspan="5">Applicable Standards</td><td colspan="3">ANSI / IEEE C95.1 : 2005
IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fileds,3 kHz to 300 GHz.</td></tr>
<tr><td colspan="3">ANSI / IEEE C95.3 : 2002
IEEE Recommended Practice for Measurements and Computations of Radio Frequency Electromagnetic Fields With Respect to Human Exposure to SuchFields,100 kHz—300 GHz.</td></tr>
<tr><td colspan="3">IEC 62209-2:2010
Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices-Human models, instrumentation, and procedures-Part 2: Procedure to determine the specific absorption rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)</td></tr>
<tr><td colspan="3">IEEE1528:2003
IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques</td></tr>
<tr><td colspan="3">KDB procedures
KDB 447498 D01 General RF Exposure Guidance v06.
KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz v01r04
KDB 865664 D02 RF Exposure Reporting v01r02
KDB 248227 D01 802.11 Wi-Fi SAR v02r02</td></tr>
<tr><td colspan="4">Note: This wireless device has been shown to be capable of compliance for localized specific absorption rate (SAR) for General Population/Uncontrolled Exposure limits specified in ANSI/IEEE Standards and has been tested in accordance with the measurement procedures specified in IEEE 1528-2013 and RF exposure KDB procedures.
The results and statements contained in this report pertain only to the device(s) evaluated.</td></tr>
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DOCUMENT REVISION HISTORY

Revision Number	Report Number	Description of Revision	Date of Revision
0	RDG160820008-20A	Original Report	2016-09-01

For the LB 2.4GHz SAR data, please refer to report: RDG160820008-20C

EUT DESCRIPTION

This report has been prepared on behalf of SZ DJI TECHNOLOGY CO., LTD and their product, FCC ID: SS3-GL300E1609; Model: GL300E or the EUT (Equipment under Test) as referred to in the rest of this report.

Technical Specification

Product Type	Portable
Exposure Category:	Population / Uncontrolled
Antenna Type(s):	External/Internal Antenna
Face-Head Accessories:	None
Operation Mode :	LB 2.4G, LB 5.8G, WLAN 2.4G and WLAN 5G
Frequency Band:	LB 2.4G: 2404~2478.8 MHz LB 5.8G: 5727~5821.3 MHz WLAN 2.4G: 2412~2462 MHz WLAN 5G: 5180 ~ 5240 MHz;5745 ~ 5825 MHz
Conducted RF Power:	LB 2.4G: 23.16 dBm LB 5.8G: 24.46 dBm WLAN 2.4G: 10.36 dBm WLAN 5G: 11.06 dBm
Dimensions (L*W*H):	18.2 cm (L) x 17.14 cm (W) x 10.52 cm (H)
Power Source:	7.4V DC lithium Rechargeable Battery
Normal Operation:	Hand-held

REFERENCE, STANDARDS, AND GUILDELINES

FCC:

The Report and 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 mW/g as recommended by the ANSI/IEEE standard C95.1-1992 [6] for an uncontrolled environment (Paragraph 65). According to the Supplement C of OET Bulletin 65 “Evaluating Compliance with FCC Guide-lines for Human Exposure to Radio frequency Electromagnetic Fields", released on Jun 29, 2001 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.

This report describes the methodology and results of experiments performed on wireless data terminal. The objective was to determine if there is RF radiation and if radiation is found, what is the extent of radiation with respect to safety limits. SAR (Specific Absorption Rate) is the measure of RF exposure determined by the amount of RF energy absorbed by human body (or its parts) – to determine how the RF energy couples to the body or head which is a primary health concern for body worn devices. The limit below which the exposure to RF is considered safe by regulatory bodies in North America is 1.6 mW/g average over 1 gram of tissue mass.

CE:

The order requires routine SAR evaluation prior to equipment authorization of portable transmitter devices, including portable telephones. For consumer products, the applicable limit is 2 mW/g as recommended by EN62209-1 for an uncontrolled environment. According to the Standard, 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.

This report describes the methodology and results of experiments performed on wireless data terminal. The objective was to determine if there is RF radiation and if radiation is found, what is the extent of radiation with respect to safety limits. SAR (Specific Absorption Rate) is the measure of RF exposure determined by the amount of RF energy absorbed by human body (or its parts) – to determine how the RF energy couples to the body or head which is a primary health concern for body worn devices. The limit below which the exposure to RF is considered safe by regulatory bodies in Europe is 2 mW/g average over 10 gram of tissue mass.

The test configurations were laid out on a specially designed test fixture to ensure the reproducibility of measurements. Each configuration was scanned for SAR. Analysis of each scan was carried out to characterize the above effects in the device.

SAR Limits

FCC Limit

EXPOSURE LIMITS	SAR (W/kg)	
	(General Population / Uncontrolled Exposure Environment)	(Occupational / Controlled Exposure Environment)
Spatial Average (averaged over the whole body)	0.08	0.4
Spatial Peak (averaged over any 1 g of tissue)	1.60	8.0
Spatial Peak (hands/wrists/feet/ankles averaged over 10 g)	4.0	20.0

CE Limit

EXPOSURE LIMITS	SAR (W/kg)	
	(General Population / Uncontrolled Exposure Environment)	(Occupational / Controlled Exposure Environment)
Spatial Average (averaged over the whole body)	0.08	0.4
Spatial Peak (averaged over any 10 g of tissue)	2.0	10
Spatial Peak (hands/wrists/feet/ankles averaged over 10 g)	4.0	20.0

Population/Uncontrolled Environments are defined as locations where there is the exposure of individual who have no knowledge or control of their exposure.

Occupational/Controlled Environments are defined as locations where there is exposure that may be incurred by people who are aware of the potential for exposure (i.e. as a result of employment or occupation).

General Population/Uncontrolled environments Spatial Peak limit 4.0W/kg applied to the EUT.

FACILITIES

The test site used by Bay Area Compliance Laboratories Corp. (Shenzhen) to collect data is located at 6/F, the 3rd Phase of WanLi Industrial Building, Shi Hua Road, Fu Tian Free Trade Zone, Shenzhen, Guangdong, P.R. of China

DESCRIPTION OF TEST SYSTEM

These measurements were performed with ALSAS 10 Universal Integrated SAR Measurement system from APREL Laboratories.

ALSAS-10U System Description

ALSAS-10-U is fully compliant with the technical and scientific requirements of IEEE 1528, IEC 62209, CENELEC, ARIB, ACA, and the Federal Communications Commission. The system comprises of a six axes articulated robot which utilizes a dedicated controller.
ALSAS-10U uses the latest methodologies. And FDTD modeling to provide a platform which is repeatable with minimum uncertainty.

Applications

Predefined measurement procedures compliant with the guidelines of CENELEC, IEEE, IEC, FCC, etc are utilized during the assessment for the device. Automatic detection for all SAR maxima are embedded within the core architecture for the system, ensuring that peak locations used for centering the zoom scan are within a 1mm resolution and a 0.05mm repeatable position. System operation range currently available up-to 6 GHz in simulated tissue.

Area Scans

Area scans are defined prior to the measurement process being executed with a user defined variable spacing between each measurement point (integral) allowing low uncertainty measurements to be conducted. Scans defined for FCC applications utilize a 10mm2 step integral, with 1mm interpolation used to locate the peak SAR area used for zoom scan assessments.

Where the system identifies multiple SAR peaks (which are within 25% of peak value) the system will provide the user with the option of assessing each peak location individually for zoom scan averaging.

Zoom Scan (Cube Scan Averaging)

The averaging zoom scan volume utilized in the ALSAS-10U software is in the shape of a cube and the side dimension of a 1 g or 10 g mass is dependent on the density of the liquid representing the simulated tissue. A density of 1000 kg/m3 is used to represent the head and body tissue density and not the phantom liquid density, in order to be consistent with the definition of the liquid dielectric properties, i.e. the side length of the 1 g cube is 10mm,with the side length of the 10 g cube 21,5mm.

When the cube intersects with the surface of the phantom, it is oriented so that 3 vertices touch the surface of the shell or the center of a face is tangent to the surface. The face of the cube closest to the surface is modified in order to conform to the tangent surface.

The zoom scan integer steps can be user defined so as to reduce uncertainty, but normal practice for typical test applications (including FCC) utilize a physical step of 5x5x8 (8mmx8mmx5mm) providing a volume of 32mm in the X & Y axis, and 35mm in the Z axis.

ALSAS-10U Interpolation and Extrapolation Uncertainty

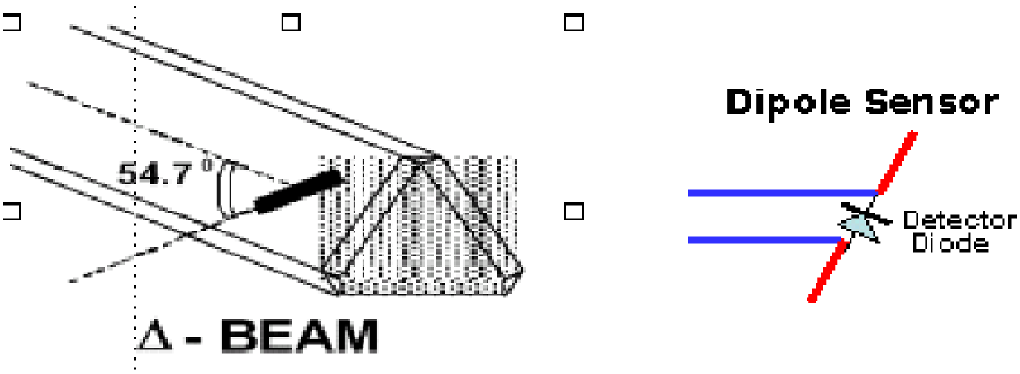
The overall uncertainty for the methodology and algorithms the used during the SAR calculation was evaluated using the data from IEEE 1528 based on the example f3 algorithm:

$$f_3(x, y, z) = A \frac{a^2}{\frac{a^2}{4} + x'^2 + y'^2} \cdot \left(e^{-\frac{2z}{a}} + \frac{a^2}{2(a + 2z)^2} \right)$$

Isotropic E-Field Probe

The isotropic E-Field probe has been fully calibrated and assessed for isotropicity, and boundary effect within a controlled environment. Depending on the frequency for which the probe is calibrated the method utilized for calibration will change.

The E-Field probe utilizes a triangular sensor arrangement as detailed in the diagram below:



SAR is assessed with a calibrated probe which moves at a default height of 5mm from the center of the diode, which is mounted to the sensor, to the phantom surface (in the Z Axis). The 5mm offset height has been selected so as to minimize any resultant boundary effect due to the probe being in close proximity to the phantom surface.

The following algorithm is an example of the function used by the system for linearization of the output from the probe when measuring complex modulation schemes.

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

Isotropic E-Field Probe Specification

Calibration Method	Frequency Dependent Below 1 GHz Calibration in air performed in a TEM Cell Above 1 GHz Calibration in air performed in waveguide
Sensitivity	0.70 $\mu V/(V/m)^2$ to 0.85 $\mu V/(V/m)^2$
Dynamic Range	0.0005 W/kg to 100 W/kg
Isotropic Response	Better than 0.1 dB
Diode Compression Point (DCP)	Calibration for Specific Frequency
Probe Tip Diameter	< 2.9 mm
Sensor Offset	1.56 (+/- 0.02 mm)
Probe Length	289 mm
Video Bandwidth	@ 500 Hz: 1 dB @ 1.02 kHz: 3 dB
Boundary Effect	Less than 2.1% for distance greater than 0.58 mm
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

Boundary Detection Unit and Probe Mounting Device

ALSAS-10U incorporates a boundary detection unit with a sensitivity of 0.05mm for detecting all types of surfaces. The robust design allows for detection during probe tilt (probe normalize) exercises, and utilizes a second stage emergency stop. The signal electronics are fed directly into the robot controller for high accuracy surface detection in lateral and axial detection modes (X, Y, & Z).

The probe is mounted directly onto the Boundary Detection unit for accurate tooling and displacement calculations controlled by the robot kinematics. The probe is connect to an isolated probe interconnect where the output stage of the probe is fed directly into the amplifier stage of the Daq-Paq.

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, sent via a 2 stage auto-set amplifier module. The input signal is amplified accordingly so as to offer a dynamic range from 5μV to 800mV. Integration of the fields measured is carried out at board level utilizing a Co-Processor which then sends the measured fields down into the main computational module in digitized form via an RS232 communications port. Probe linearity and duty cycle compensation is carried out within the main Daq-Paq module.

ADC	12 Bit
Amplifier Range	20 mV to 200 mV and 150 mV to 800 mV
Field Integration	Local Co-Processor utilizing proprietary integration algorithms
Number of Input Channels	4 in total 3 dedicated and 1 spare
Communication	Packet data via RS232

Axis Articulated Robot

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. Utilization of joint 6 allows for full probe rotation with a tolerance better than 0.05mm around the central axis.

Robot/Controller Manufacturer	Thermo CRS
Number of Axis	Six independently controlled axis
Positioning Repeatability	0.05 mm
Controller Type	Single phase Pentium based C500C
Robot Reach	710 mm
Communication	RS232 and LAN compatible

ALSAS Universal Workstation

ALSAS Universal workstation allows for repeatability and fast adaptability. It allows users to do calibration, testing and measurements using different types of phantoms with one set up, which significantly speeds up the measurement process.

Universal Device Positioner

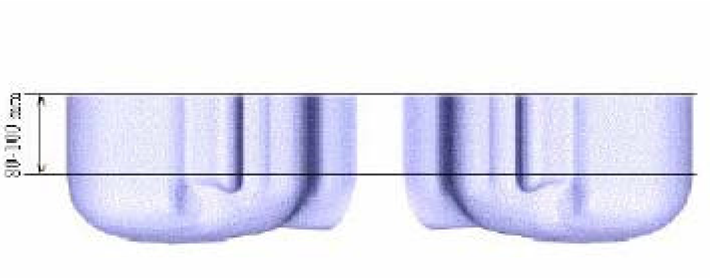
The universal device positioner allows complete freedom of movement of the EUT. Developed to hold a EUT in a free-space scenario any additional loading attributable to the material used in the construction of the positioner has been eliminated. Repeatability has been enhanced through the linear scales which form the design used to indicate positioning for any given test scenario in all major axes. A 15° tilt indicator is included for the of aid cheek to tilt movements for head SAR analysis. Overall uncertainty for measurements have been reduced due to the design of the Universal device positioner, which allows positioning of a device in as near to a free-space scenario as possible, and by providing the means for complete repeatability.

Phantom Types

The ALSAS-10U allows the integration of multiple phantom types. SAM Phantoms fully compliant with IEEE 1528, Universal Phantom, and Universal Flat.

APREL SAM Phantoms

The SAM phantoms developed using the IEEE SAM CAD file. They are fully compliant with the requirements for both IEEE 1528 and FCC Supplement C. Both the left and right SAM phantoms are interchangeable, transparent and include the IEEE 1528 grid with visible NF and MB lines.



APREL Laboratories Universal Phantom

The Universal Phantom is used on the ALSAS-10U as a system validation phantom. The Universal Phantom has been fully validated both experimentally from 800MHz to 6GHz and numerically using XFDTD numerical software.

The shell thickness is 2mm overall, with a 4mm spacer located at the NF/MB intersection providing an overall thickness of 6mm in line with the requirements of IEEE-1528.

The design allows for fast and accurate measurements, of handsets, by allowing the conservative SAR to be evaluated at on frequency for both left and right head experiments in one measurement.

Tissue Dielectric Parameters for Head and Body Phantoms

The head tissue dielectric parameters recommended by the IEEE SCC-34/SC-2 in P1528 have been incorporated in the following table. These head parameters are derived from planar layer models simulating the highest expected SAR for the dielectric properties and tissue thickness variations in a human head. Other head and body tissue parameters that have not been specified in P1528 are derived from the tissue dielectric parameters computed from the 4-Cole-Cole equations described in Reference [12] and extrapolated according to the head parameters specified in P1528.

Ingredients (% by weight)	Frequency (MHz)									
	450		835		915		1900		2450	
Tissue Type	Head	Body	Head	Body	Head	Body	Head	Body	Head	Body
Water	38.56	51.16	41.45	52.4	41.05	56.0	54.9	40.4	62.7	73.2
Salt (Nacl)	3.95	1.49	1.45	1.4	1.35	0.76	0.18	0.5	0.5	0.04
Sugar	56.32	46.78	56.0	45.0	56.5	41.76	0.0	58.0	0.0	0.0
HEC	0.98	0.52	1.0	1.0	1.0	1.21	0.0	1.0	0.0	0.0
Bactericide	0.19	0.05	0.1	0.1	0.1	0.27	0.0	0.1	0.0	0.0
Triton x-100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	36.8	0.0
DGBE	0.0	0.0	0.0	0.0	0.0	0.0	44.92	0.0	0.0	26.7
Dielectric Constant	43.42	58.0	42.54	56.1	42.0	56.8	39.9	54.0	39.8	52.5
Conductivity (s/m)	0.85	0.83	0.91	0.95	1.0	1.07	1.42	1.45	1.88	1.78

Recommended Tissue Dielectric Parameters for Head and Body

Frequency (MHz)	Head Tissue		Body Tissue	
	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

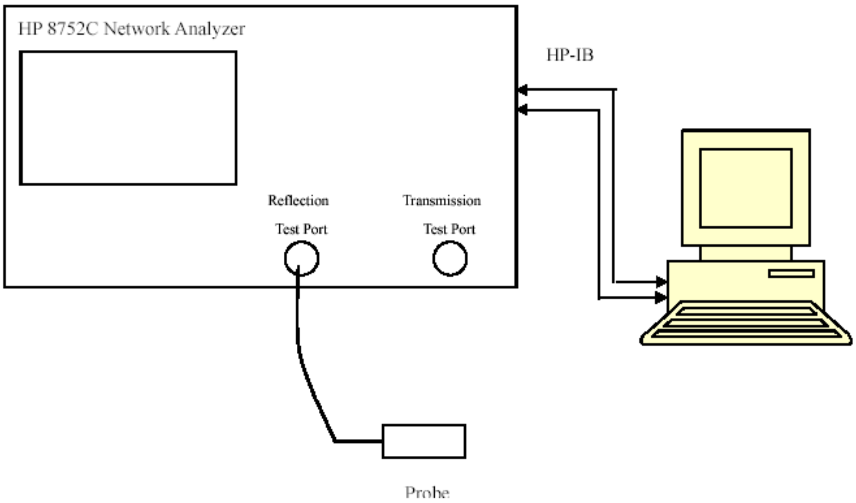
EQUIPMENT LIST AND CALIBRATION

Equipments List & Calibration Information

Equipment	Model	Calibration Date	Calibration Due Date	S/N
CRS F3 robot	ALS-F3	N/A	N/A	RAF0805352
CRS F3 Software	ALS-F3-SW	N/A	N/A	N/A
CRS C500C controller	ALS-C500	N/A	N/A	RCF0805379
Probe mounting device & Boundary Detection Sensor System	ALS-PMDPS-3	N/A	N/A	120-00270
Universal Work Station	ALS-UWS	N/A	N/A	100-00157
Data Acquisition Package	ALS-DAQ-PAQ-3	2015-12-14	2016-12-14	110-00212
Miniature E-Field Probe	ALS-E-020	2015-12-14	2016-12-14	500-00283
Dipole,5800MHz	ALS-D-5800-S-2	2013-10-08	2016-10-08	240-00855
Dipole Spacer	ALS-DS-U	N/A	N/A	250-00907
Device holder/Positioner	ALS-H-E-SET-2	N/A	N/A	170-00510
Left ear SAM phantom	ALS-P-SAM-L	N/A	N/A	130-00311
Right ear SAM phantom	ALS-P-SAM-R	N/A	N/A	140-00359
UniPhantom	ALS-P-UP-1	N/A	N/A	150-00413
Simulated Tissue 5800 MHz Body	ALS-TS-5800-B	Each Time	/	580-00718
Directional couple	DC6180A	N/A	N/A	0325849
Power Amplifier	5S1G4	N/A	N/A	71377
Attenuator	3dB	N/A	N/A	5402
Dielectric probe kit	HP85070B	2016-06-13	2017-06-13	US33020324
Network analyzer	8752C	2016-06-03	2017-06-03	3410A02356
Synthesized Sweeper	HP 8341B	2016-06-03	2017-06-03	2624A00116
EMI Test Receiver	ESCI	2016-06-13	2017-06-13	101746

SAR MEASUREMENT SYSTEM VERIFICATION

Liquid Verification



Liquid Verification Setup Block Diagram

Liquid Verification Results

Frequency	Liquid Type	Liquid Parameter		Target Value		Delta (%)		Tolerance (%)
		ε_r	Ơ (S/m)	ε_r	Ơ (S/m)	$\Delta\varepsilon_r$	ΔƠ (S/m)	
5727	Body	49.38	5.87	48.30	5.91	2.236	-0.677	±5
5745	Body	48.85	5.91	48.27	5.94	1.202	-0.505	±5
5775.3	Body	49.10	5.89	48.23	5.97	1.804	-1.340	±5
5785	Body	48.66	5.94	48.22	5.98	0.912	-0.669	±5
5821.3	Body	48.55	5.90	48.17	6.02	0.789	-1.993	±5
5825	Body	47.92	5.94	48.17	6.03	-0.519	-1.493	±5

**Liquid Verification was performed on 2016-08-29.*

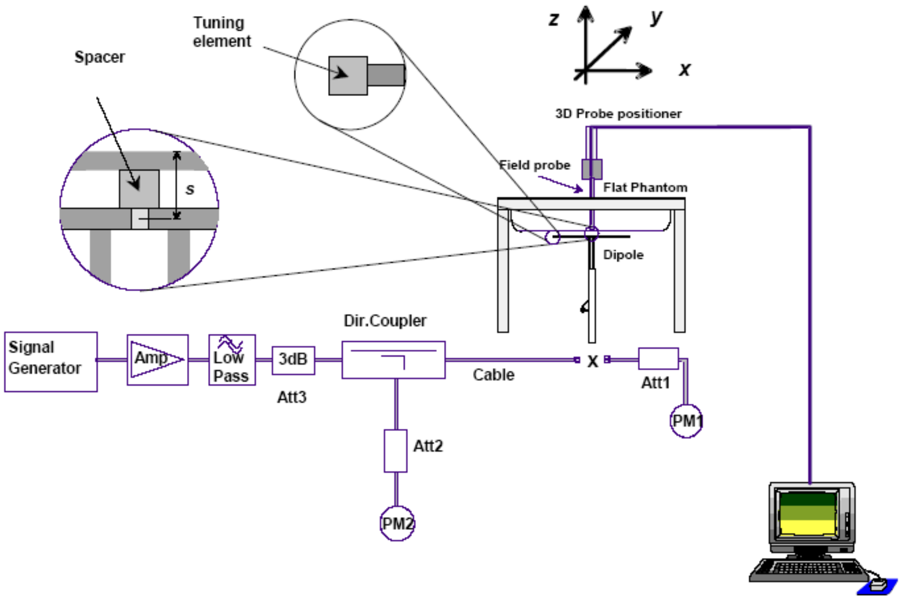
Frequency	Liquid Type	Liquid Parameter		Target Value		Delta (%)		Tolerance (%)
		ε_r	Ơ (S/m)	ε_r	Ơ (S/m)	$\Delta\varepsilon_r$	ΔƠ (S/m)	
5180	Body	50.27	5.29	49.04	5.28	2.508	0.189	±5
5200	Body	49.65	5.33	49.01	5.30	1.306	0.566	±5
5240	Body	50.52	5.32	48.96	5.35	3.186	-0.561	±5

**Liquid Verification was performed on 2016-08-30.*

System Accuracy Verification

Prior to the assessment, the system validation kit was used to test whether the system was operating within its specifications of ±10%. The validation results are tabulated below. And also the corresponding SAR plot is attached as well in the SAR plots files.

System Verification Setup Block Diagram



System Accuracy Check Results

Date	Frequency Band	Liquid Type	Measured SAR (W/Kg)		Target Value (W/Kg)	Delta (%)	Tolerance (%)
2016-08-29	5800	Body	10g	4.956*4	19.31	2.662	±10
2016-08-30	5250	Body	10g	5.127*4	20.00	2.540	±10

*All SAR values are normalized to 1 Watt forward power.

SAR SYSTEM VALIDATION DATA

Test Laboratory: Bay Area Compliance Lab Corp. (Shenzhen)

System Performance Check 5800 MHz Body Liquid

Dipole 5800 MHz; Type: ALS-D-5800-S-2; S/N: 240-00855

Product Data	
Device Name	: Dipole 5800MHz
Serial No.	: 240-00855
Type	: Dipole
Model	: ALS-D-5800-S-2
Frequency	: 5800 MHz
Max. Transmit Pwr	: 0.25 W
Drift Time	: 3 min(s)
Power Drift-Start	: 6.315 W/kg
Power Drift-Finish	: 6.396 W/kg
Power Drift (%)	: 1.273

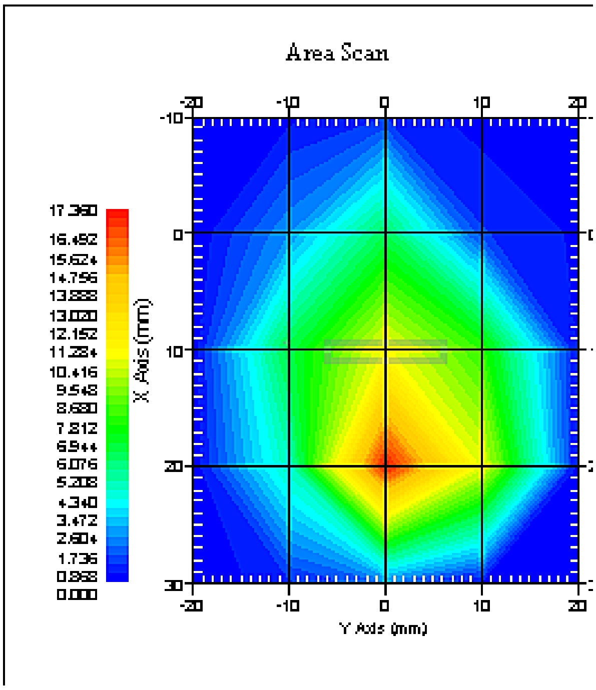
Phantom Data	
Name	: APREL-Uni
Type	: Uni-Phantom
Size (mm)	: 280 x 280 x 200
Serial No.	: System Default
Location	: Center
Description	: Default

Tissue Data	
Type	: BODY
Serial No.	: 580-00718
Frequency	: 5800 MHz
Last Calib. Date	: 29-Aug-2016
Temperature	: 20.00 °C
Ambient Temp.	: 21.00 °C
Humidity	: 50.00 RH%
Epsilon	: 48.27 F/m
Sigma	: 5.92 S/m
Density	: 1000.00 kg/cu. M

Probe Data	
Name	: E-Field
Model	: E-020
Type	: E-Field Triangle
Serial No.	: 500-00283
Last Calib. Date	: 14-Dec-2015
Frequency	: 5800 MHz
Duty Cycle Factor	: 1
Conversion Factor	: 2.6
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.	: 20.00 °C
Ambient Temp.	: 20.00 °C
Area Scan	: 7x7x1 : Measurement x=10mm, y=10mm, z=4mm
Zoom Scan	: 7x7x12 : Measurement x=4mm, y=4mm, z=2mm

1 gram SAR value	: 14.582 W/kg
10 gram SAR value	: 4.956 W/kg
Area Scan Peak SAR	: 17.311 W/kg
Zoom Scan Peak SAR	: 38.227 W/kg



5800 MHz System Validation

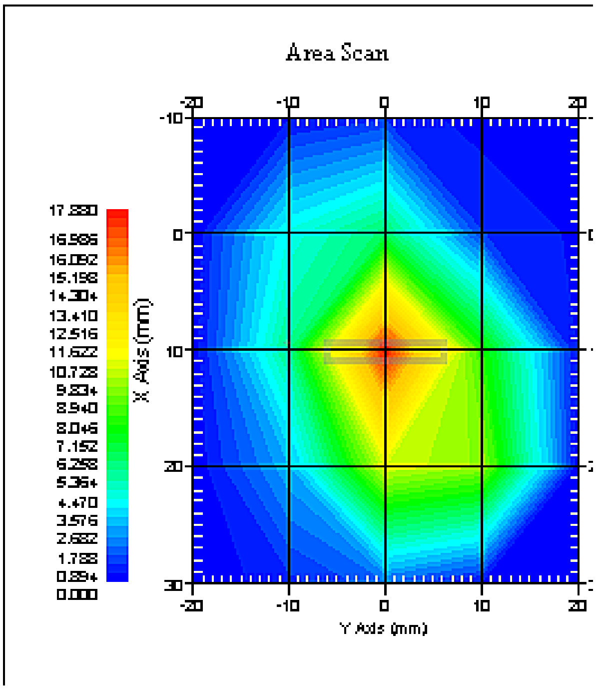
Test Laboratory: Bay Area Compliance Lab Corp. (Shenzhen)

System Performance Check 5250 MHz Body Liquid

Dipole 5250 MHz; Type: ALS-D-5250-S-2; S/N: 230-00805

Product Data	
Device Name	: Dipole 5250MHz
Serial No.	: 230-00805
Type	: Dipole
Model	: ALS-D-5250-S-2
Frequency	: 5250 MHz
Max. Transmit Pwr	: 0.25 W
Drift Time	: 3 min(s)
Power Drift-Start	: 9.261 W/kg
Power Drift-Finish	: 9.373 W/kg
Power Drift (%)	: 1.223
Phantom Data	
Name	: APREL-Uni
Type	: Uni-Phantom
Size (mm)	: 280 x 280 x 200
Serial No.	: System Default
Location	: Center
Description	: Default
Tissue Data	
Type	: BODY
Serial No.	: 520-00705
Frequency	: 5250 MHz
Last Calib. Date	: 30-Aug-2016
Temperature	: 20.00 °C
Ambient Temp.	: 21.00 °C
Humidity	: 50.00 RH%
Epsilon	: 48.98 F/m
Sigma	: 5.38 S/m
Density	: 1000.00 kg/cu. M
Probe Data	
Name	: E-Field
Model	: E-020
Type	: E-Field Triangle
Serial No.	: 500-00283
Last Calib. Date	: 14-Dec-2015
Frequency	: 5250 MHz
Duty Cycle Factor	: 1
Conversion Factor	: 2.9
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.	: 20.00 °C
Ambient Temp.	: 20.00 °C
Area Scan	: 7x7x1 : Measurement x=10mm, y=10mm, z=4mm
Zoom Scan	: 7x7x12 : Measurement x=4mm, y=4mm, z=2mm

1 gram SAR value	: 14.829 W/kg
10 gram SAR value	: 5.127 W/kg
Area Scan Peak SAR	: 17.815 W/kg
Zoom Scan Peak SAR	: 39.720 W/kg



5250 MHz System Validation

EUT TEST STRATEGY AND METHODOLOGY

Test positions for Hand-held device

Hand-held device means a portable device which is located in a user's hand during its intended use Hand-held usage of the device, not at the head or torso. The device shall be placed directly against the flat phantom as shown in Figure J.1, for those sides of the device that are in contact with the hand during intended use.

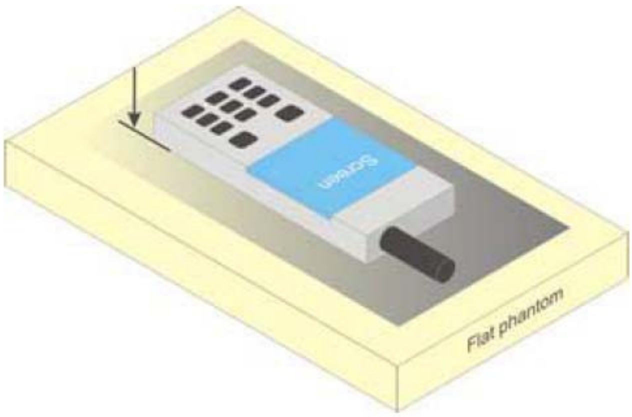


Figure J.1 – Test position for hand-held devices, not used at the head or torso

SAR Evaluation Procedure

The evaluation was performed with the following procedure:

Step 1: Measurement of the SAR value at a fixed location above the ear point or central position was used as a reference value for assessing the power drop. The SAR at this point is measured at the start of the test and then again at the end of the testing.

Step 2: The SAR distribution at the exposed side of the head was measured at a distance of 4 mm from the inner surface of the shell. The area covered the entire dimension of the head or EUT and the horizontal grid spacing was 10 mm x 10 mm. Based on these data, the area of the maximum absorption was determined by spline interpolation. The first Area Scan covers the entire dimension of the EUT to ensure that the hotspot was correctly identified.

Step 3: Around this point, a volume of 30 mm x 30 mm x 30 mm was assessed by measuring 7x 7 x 7 points. On the basis of this data set, the spatial peak SAR value was evaluated under the following procedure:

1) The data at the surface were extrapolated, since the center of the dipoles is 1.2 mm away from the tip of the probe and the distance between the surface and the lowest measuring point is 1.3 mm. The extrapolation was based on a least square algorithm. A polynomial of the fourth order was calculated through the points in z-axes. This polynomial was then used to evaluate the points between the surface and the probe tip.

2) The maximum interpolated value was searched with a straightforward algorithm. Around this maximum the SAR values averaged over the spatial volumes (1 g or 10 g) were computed by the 3D-Spline interpolation algorithm. The 3D-Spline is composed of three one dimensional splines with the "Not a knot"-condition (in x, y and z-directions). The volume was integrated with the trapezoidal-algorithm. One thousand points (10 x 10 x 10) were interpolated to calculate the averages.

All neighboring volumes were evaluated until no neighboring volume with a higher average value was found.

Step 4: Re-measurement of the SAR value at the same location as in Step 1. If the value changed by more than 5%, the evaluation was repeated.

Test methodology

KDB 447498 D01 General RF Exposure Guidance v06.
KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz v01r04
KDB 865664 D02 RF Exposure Reporting v01r02
KDB 248227 D01 802.11 Wi-Fi SAR v02r02

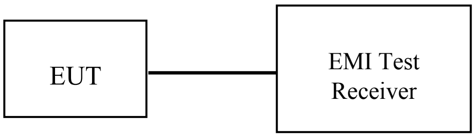
CONDUCTED OUTPUT POWER MEASUREMENT

Provision Applicable

The measured peak output power should be greater and within 5% than EMI measurement.

Test Procedure

The RF output of the transmitter was connected to the input of the EMI Test Receiver through sufficient attenuation.



LB 5.8G/WLAN 5.8G/WLAN 5.2G

Maximum Output Power among production units

Max Target Power for Production Unit (dBm)					
Mode/Band			Channel		
			Low	Middle	High
WLAN 5.8GHz	802.11a	Chain 0	11.50	11.50	11.50
		Chain 1	11.50	11.50	11.50
	802.11n20	Chain 0	11.50	11.50	11.50
		Chain 1	11.50	11.50	11.50
LB 5.8G		Chain 0	22.50	24.50	23.00
WLAN 5.2G	802.11a	Chain 0	10.50	10.50	9.00
		Chain 1	10.50	10.50	10.50
	802.11n20	Chain 0	10.50	10.50	10.50
		Chain 1	10.50	10.50	10.50

Test Results:

Band	Mode	Channel	Frequency (MHz)	Maximum Conducted Output Power(dBm)		Total (dBm)
				Chain 0	Chain 1	
WLAN 5.8G	802.11a	149	5745	**11.06**	10.91	14.00
		157	5785	10.27	10.73	13.52
		165	5825	9.75	9.8	12.79
	802.11n20	149	5745	**11.05**	10.77	13.92
		157	5785	10.37	10.57	13.48
		165	5825	9.81	9.69	12.76
LB 5.8G		1	5727	22.18	/	/
		22	5775.3	**24.46**	/	/
		42	5821.3	22.92	/	/
WLAN 5.2GHz	802.11a	36	5180	9.12	9.13	12.14
		40	5200	8.95	**10.08**	12.56
		48	5240	8.89	9.74	12.35
	802.11n20	36	5180	8.97	**10.04**	12.55
		40	5200	8.81	10.02	12.47
		48	5240	8.77	9.66	12.25

Note:
1. For 802.11a/n mode, the device employed Cyclic Delay Diversity (CDD) for MIMO transmitting,

Standalone SAR test exclusion considerations

Mode	Frequency (MHz)	Pavg (dBm)	Pavg (mW)	Distance (mm)	Calculated value	Threshold (10-g)	SAR Test Exclusion
WLAN 5.2G	5240	10.50	11.22	0	5.1	7.5	YES
WLAN 5.8G	5825	11.50	14.13	0	6.8	7.5	YES
LB 5.8G	5821.3	24.50	281.84	0	135.5	7.5	NO

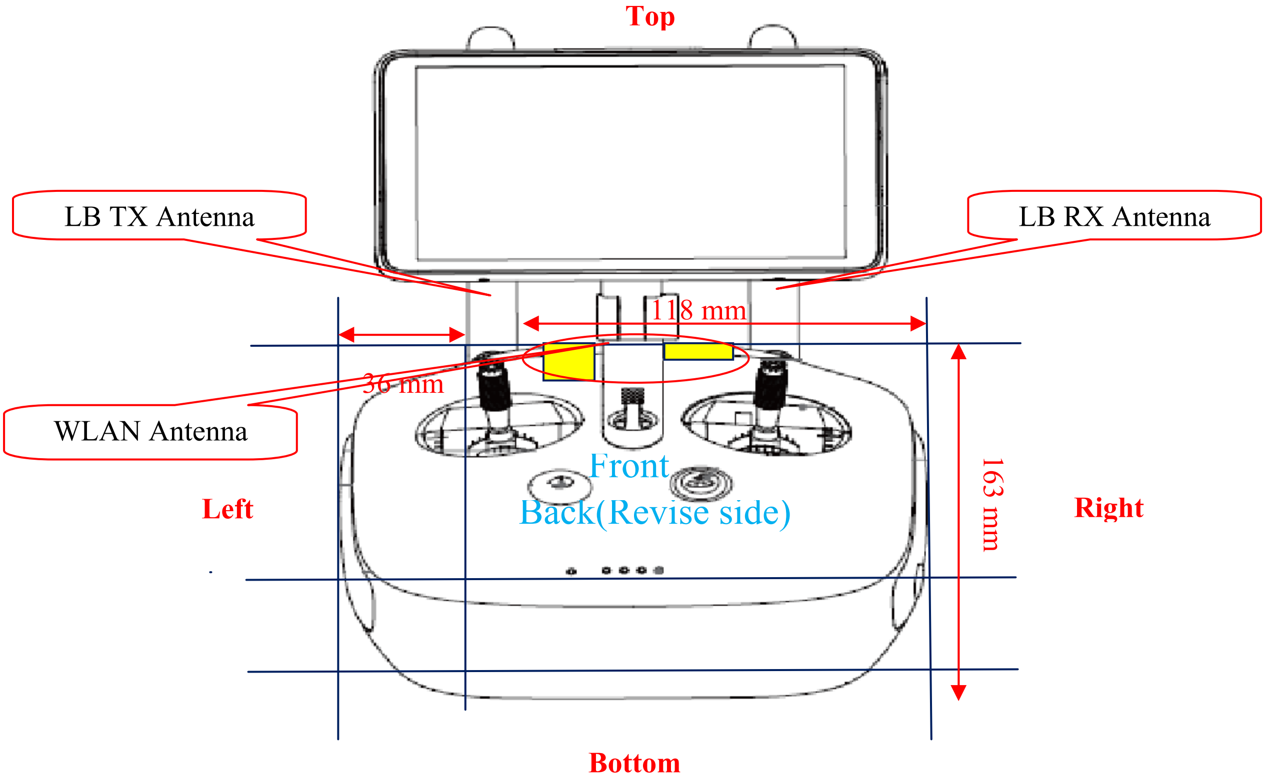
NOTE:
The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:
[(max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)]
[√f(GHz)] ≤ 3.0 for 1-g SAR and ≤7.5 for 10-g extremity SAR, where
1. f(GHz) is the RF channel transmit frequency in GHz.
2. Power and distance are rounded to the nearest mW and mm before calculation.
3. The result is rounded to one decimal place for comparison.
4. When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test Exclusion.

Standalone SAR estimation:

Mode	Frequency (MHz)	Pavg (dBm)	Pavg (mW)	Distance (mm)	Estimated 10-g (W/kg)
WLAN 5.2G Chain 0	5240	10.50	11.22	0	0.273
WLAN 5.2G Chain 1	5240	10.50	11.22	0	0.273
WLAN 5.8G Chain 0	5825	11.50	14.13	0	0.361
WLAN 5.8G Chain 1	5825	11.50	14.13	0	0.361

When standalone SAR test exclusion applies to an antenna that transmits simultaneously with otherantennas, the standalone SAR must be estimated according to following to determine simultaneoustransmission SAR test exclusion:
[(max. power of channel, including tune-up tolerance , mW)/(min. test separation distance, mm)] ·
[√f(GHz)/x]
W/kg for test separation distances ≤50 mm;
where x = 7.5 for 1-g SAR and 18.75 for 10-g SAR.
When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test Exclusion

Antenna Location:



Antenna Distance To Edge

Antenna Distance To Edge(mm)					
Mode	**Left**	**Right**	**Back**	**Top**	**Bottom**
LB 5.8G	36	118	14	0	163

SAR test exclusion for the EUT edge considerations Result

SAR Test Exclusion for the EUT Edges Considerations					
Mode	**Left**	**Right**	**Back**	**Top**	**Bottom**
LB 2.4G	Judge	Judge	Judge	Exclusion	Judge

Note:
Required: The distance is less than 5mm, the SAR test is required as Standalone SAR test exclusion considerations table.
Exclusion: In normal operation mode, the Edge(s) will not be touched by the users directly.
Judge: Please refer the below tables for detail.

SAR test exclusion for the EUT edge considerations detail:

Distance< 50mm

Mode	Edge	Frequency (MHz)	Pavg (dBm)	Pavg (mW)	Distance (mm)	Calculated value	Threshold (10-g)	SAR Test required
LB 5.8G	Left	5821.3	24.50	281.84	36	18.8	7.5	Yes
LB 5.8G	Back	5821.3	24.50	281.84	14	48.4	7.5	Yes

The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:
[(max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)] · [√f(GHz)] ≤ 3.0 for 1-g SAR and ≤7.5 for 10-g extremity SAR, where
1. f(GHz) is the RF channel transmit frequency in GHz.
2. Power and distance are rounded to the nearest mW and mm before calculation.
3. The result is rounded to one decimal place for comparison.
4. When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test Exclusion.

Distance> 50mm

Mode	Edge	Frequency (MHz)	Pavg (dBm)	Pavg (mW)	Distance (mm)	Test exclusion Threshold (mW)	SAR Test required
LB 5.8G	Right	5821.3	24.50	281.84	118	835	No
LB 5.8G	Bottom	5821.3	24.50	281.84	163	1285	No

At 100 MHz to 6 GHz and for *test separation distances* > 50 mm, the SAR test exclusion threshold is determined according to the following:

a) [Power allowed at numeric threshold for 50 mm in step 1) + (test separation distance - 50 mm)·(f(MHz)/150)] mW, at 100 MHz to 1500 MHz

b) [Power allowed at numeric threshold for 50 mm in step 1) + (test separation distance - 50 mm)·10] mW at > 1500 MHz and ≤ 6 GHz

SAR MEASUREMENT RESULTS

This page summarizes the results of the performed dosimetric evaluation.

SAR Test Data

Environmental Conditions

Temperature:	22-24 ℃
Relative Humidity:	50-53 %
ATM Pressure:	1001-1002 mbar

Testing was performed by Terry Xiahou on 2016-08-29 to 2016-08-30

LB 5.8G mode :

EUT Position	Frequency (MHz)	Antenna Config.	Power Drift (%)	Meas. Avg. Power (dBm)	Max. Rated Avg. Power (dBm)	10 g SAR Value (W/Kg)			
						Scaled Factor	Meas. SAR	Scaled SAR	Plot
Handheld-Back (0mm)	5727	Unfold	/	/	/	/	/	/	/
	5775.3		-2.286	24.46	24.50	1.009	0.137	**0.138**	**1#**
	5821.3		/	/	/	/	/	/	/
	5727	Fold (perpendicular to the phantom)	/	/	/	/	/	/	/
	5775.3		-4.279	24.46	24.50	1.009	0.093	0.094	/
	5821.3		/	/	/	/	/	/	/
Handheld-Left (0mm)	5727	Unfold	/	/	/	/	/	/	/
	5775.3		2.372	24.46	24.50	1.009	0.079	0.079	/
	5821.3		/	/	/	/	/	/	/
	5727	Fold (perpendicular to the phantom)	/	/	/	/	/	/	/
	5775.3		-1.144	24.46	24.50	1.009	0.071	0.071	/
	5821.3		/	/	/	/	/	/	/

Note:

1. When the 10-g SAR is ≤ 2.0W/Kg, testing for other channel is optional.
2. According to IEEE 1528-2013, the middle channel is required to be tested first.
3. KDB 447498D01- When the maximum output power variation across the required test channels is > ½ dB, instead of the middle channel, the highest output power channel must be used.

Simultaneous SAR test exclusion considerations:

Mode(SAR1+SAR2+SAR3)	Position	Reported SAR(W/kg)			ΣSAR < 4.0 W/kg
		SAR1	SAR2	SAR3	
LB 2.4G + WLAN 5.2G Chain 0+ WLAN 5.2G Chain 1	Hand-held -Back Unfold	0.295	0.273	0.273	0.841
	Hand-held -Back fold	0.049	0.273	0.273	0.595
	Hand-held -Left Unfold	0.021	0.273	0.273	0.567
	Hand-held -Left Fold	0.02	0.273	0.273	0.566
LB 2.4G + WLAN 5.8G Chain 0+ WLAN 5.8G Chain 1	Hand-held -Back Unfold	0.295	0.361	0.361	**1.017**
	Hand-held -Back fold	0.049	0.361	0.361	0.771
	Hand-held -Left Unfold	0.021	0.361	0.361	0.743
	Hand-held -Left Fold	0.02	0.361	0.361	0.742
LB 5G + WLAN 2.4G Chain 0+ WLAN 2.4G Chain 1	Hand-held -Back Unfold	0.138	0.183	0.183	0.504
	Hand-held -Back fold	0.094	0.183	0.183	0.46
	Hand-held -Left Unfold	0.079	0.183	0.183	0.445
	Hand-held -Left Fold	0.071	0.183	0.183	0.437

Note: 2.4GHz LB can`t transmit simultaneously with 2.4G WLAN, and 5.8GHz LB can`t transmit simultaneously with 5G WLAN.

Conclusion:

Sum of SAR: **ΣSAR < 4.0 W/kg** therefore simultaneous transmission SAR with Volume Scans is **not required**.

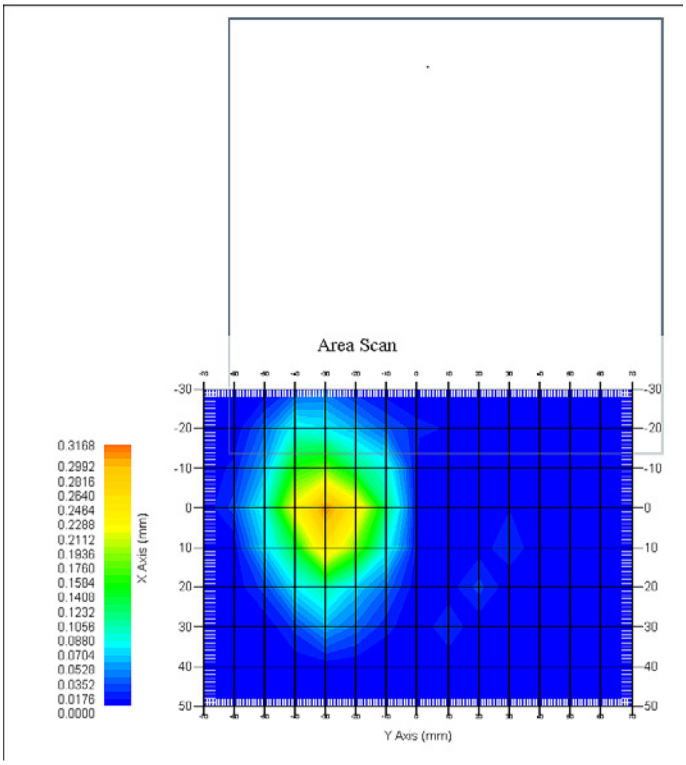
SAR Plots (Summary of the Highest SAR Values)

Test Laboratory: Bay Area Compliance Lab Corp. (Shenzhen)

LB 5.8G mode; Handheld-Back-Unfold (5775.3 MHz)

Measurement Data	
Crest Factor	: 1
Scan Type	: Complete
Area Scan	: 8x11x1 : Measurement x=10mm, y=10mm, z=2mm
Zoom Scan	: 7x7x12 : Measurement x=4mm, y=4mm, z=2mm
Power Drift-Start	: 0.087 W/kg
Power Drift-Finish	: 0.085 W/kg
Power Drift (%)	: -2.286
Tissue Data	
Type	: Body
Frequency	: 5775.3 MHz
Epsilon	: 49.10 F/m
Sigma	: 5.89 S/m
Density	: 1000.00 kg/cu. m
Probe Data	
Serial No.	: 500-00283
Frequency Band	: 5800 MHz
Duty Cycle Factor	: 1
Conversion Factor	: 2.6
Probe Sensitivity	: 1.20 1.20 1.20 µV/(V/m)2
Compression Point	: 95.00 mV
Offset	: 1.56 mm
1 gram SAR value	: 0.243 W/kg
10 gram SAR value	: 0.137 W/kg
Area Scan Peak SAR	: 0.316 W/kg
Zoom Scan Peak SAR	: 0.677 W/kg

Plot 1#



APPENDIX A MEASUREMENT UNCERTAINTY

According to **IEEE1528:2013**, the uncertainty budget has been determined for the Head SAR measurement system and is given in the following Table.

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	$\sqrt{3}$	$(1\text{-cp})^{1/2}$	$(1\text{-cp})^{1/2}$	1.5	1.5
Hemispherical Isotropy	10.9	rectangular	$\sqrt{3}$	√cp	√cp	4.4	4.4
Boundary Effect	1.0	rectangular	$\sqrt{3}$	1	1	0.6	0.6
Linearity	4.7	rectangular	$\sqrt{3}$	1	1	2.7	2.7
Detection Limit	1.0	rectangular	$\sqrt{3}$	1	1	0.6	0.6
Readout Electronics	1.0	normal	1	1	1	1.0	1.0
Response Time	0.8	rectangular	$\sqrt{3}$	1	1	0.5	0.5
Integration Time	1.7	rectangular	$\sqrt{3}$	1	1	1.0	1.0
RF Ambient Condition -Noise	0.6	rectangular	$\sqrt{3}$	1	1	0.3	0.3
RF Ambient Condition - Reflections	3.0	rectangular	$\sqrt{3}$	1	1	1.7	1.7
Probe Positioner Mech. Restrictions	0.4	rectangular	$\sqrt{3}$	1	1	0.2	0.2
Probe Positioning with respect to Phantom Shell	2.9	rectangular	$\sqrt{3}$	1	1	1.7	1.7
Extrapolation and Integration	3.7	rectangular	$\sqrt{3}$	1	1	2.1	2.1
Test sample related							
Test sample positioning	2.0	normal	1	1	1	2.0	2.0
Device Holder Uncertainty	4.0	normal	1	1	1	6.215	6.215
Drift of Output Power	5.0	rectangular	$\sqrt{3}$	1	1	2.67	2.67
Phantom and Setup							
Phantom Uncertainty	3.4	rectangular	$\sqrt{3}$	1	1	2.0	2.0
SAR correction in permittivity and conductivity	1.2	normal	1	1	0.85	1.2	1.0
Liquid conductivity measurement	5.0	normal	1	0.78	0.71	3.9	3.6
Liquid permittivity measurement	5.0	normal	1	0.25	0.29	1.3	1.5
conductivity—temperature	1.1	rectangular	$\sqrt{3}$	0.78	0.71	0.5	0.5
permittivity—temperature	1.3	rectangular	$\sqrt{3}$	0.23	0.23	0.2	0.2
Combined Uncertainty		RSS				10.78	10.55
Expanded uncertainty (coverage factor=2)		Normal(k=2)				21.56	21.10

According to **IEC62209-2:2010**, the uncertainty budget has been determined for the Body SAR measurement system and is given in the following Table.

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	$\sqrt{3}$	1	1	1.5	1.5
Boundary Effect	1.0	rectangular	$\sqrt{3}$	1	1	0.6	0.6
Linearity	4.7	rectangular	$\sqrt{3}$	1	1	2.7	2.7
Detection Limit	1.0	rectangular	$\sqrt{3}$	1	1	0.6	0.6
Readout Electronics	1.0	normal	1	1	1	1.0	1.0
Response Time	0.8	rectangular	$\sqrt{3}$	1	1	0.5	0.5
Integration Time	1.7	rectangular	$\sqrt{3}$	1	1	1.0	1.0
RF Ambient Condition -Noise	0.6	rectangular	$\sqrt{3}$	1	1	0.3	0.3
RF Ambient Condition - Reflections	3.0	rectangular	$\sqrt{3}$	1	1	1.7	1.7
Probe Positioner Mech. Restrictions	0.4	rectangular	$\sqrt{3}$	1	1	0.2	0.2
Probe Positioning with respect to Phantom Shell	2.9	rectangular	$\sqrt{3}$	1	1	1.7	1.7
Extrapolation and Integration	3.7	rectangular	$\sqrt{3}$	1	1	2.1	2.1
Test sample related							
Test sample positioning	2.0	normal	1	1	1	2.0	2.0
Device Holder Uncertainty	4.0	normal	1	1	1	6.215	6.215
Drift of Output Power	5.0	rectangular	$\sqrt{3}$	1	1	2.67	2.67
Phantom and Setup							
Phantom Uncertainty	3.4	rectangular	$\sqrt{3}$	1	1	2.0	2.0
SAR correction in permittivity and conductivity	1.2	normal	1	1	0.84	1.2	1.0
Liquid conductivity measurement	5.0	normal	1	0.78	0.71	3.9	3.6
Liquid permittivity measurement	5.0	normal	1	0.23	0.26	1.3	1.5
conductivity—temperature	1.1	rectangular	$\sqrt{3}$	0.78	0.71	0.5	0.5
permittivity—temperature	1.3	rectangular	$\sqrt{3}$	0.23	0.26	0.2	0.2
Combined Uncertainty		RSS				9.58	9.49
Expanded uncertainty (coverage factor=2)		Normal(k=2)				19.16	18.98

APPENDIX B – PROBE CALIBRATION CERTIFICATES

NCL CALIBRATION LABORATORIES

Calibration File No.: PC-1654

Task No: BACL-5805

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
Head and Body
Manufacturer: APREL Inc.
Model No.: ALS-E020
Serial No.: 500-00283

Calibration Procedure: D01-032-E020-V2, D22-012-Tissue, D28-002-Dipole
Project No: BACL-5805

Calibrated: 12th December 2015
Released on: 14th December 2015

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

Released By: ______________________

Art Brennan, Quality Manager

NCL CALIBRATION LABORATORIES
Suite 102, 303 Terry Fox Dr,
OTTAWA, ONTARIO
CANADA K2K 3J1
Division of APREL Lab.
TEL: (613) 435-8300
FAX: (613) 435-8306

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.

Calibration Method

Probes are calibrated using the following methods.

<800 MHz
TEM Cell for sensitivity in air
Standard phantom using temperature transfer method for sensitivity in tissue

>800 MHz
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 1528:2013
  IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques
- IEC 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 62209-2:2010
  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 Standard for Calibration of Electromagnetic Field Sensors and Probes, Excluding Antennas, from 9kHz to 40GHz

NCL Calibration Laboratories

Division of APREL Inc.

Conditions

Probe 500-00283 was a recalibration.

Ambient Temperature of the Laboratory:	20 °C +/- 1.5°C
Temperature of the Tissue:	21 °C +/- 1.5°C
Relative Humidity:	< 60%

Primary Measurement Standards

Instrument	Serial Number	Cal due date
Power Meter Tektronix USB	11C940	Apr 2, 2017
Signal Generator Agilent E4438C	MY45094463	Dec 11, 2017

Secondary Measurement Standards

Network Analyzer Anritsu 37347C	002106	Feb. 4, 2017

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

Page 3 of 10 Probe S/N 500-00283

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

NCL Calibration Laboratories
Division of APREL Inc.

Probe Summary

Probe Type: E-Field Probe E-020

Serial Number: 500-00283

Frequency: As presented on page 5

Sensor Offset: 1.56

Sensor Length: 2.5

Tip Enclosure: Composite*

Tip Diameter: < 2.9 mm

Tip Length: 55 mm

Total Length: 289 mm

Diode Compression Point: 95 mV

Sensitivity in Air

Frequency Range	Channel X, μV/(V/m)^2	Channel Y, μV/(V/m)^2	Channel Z, μV/(V/m)^2	Tolerance, μV/(V/m)^2
450 MHz	1.212	1.205	1.199	±0.004
750 MHz, 835 MHz 900 MHz	1.212	1.21	1.209	±0.004
1 GHz – 4 GHz	1.21	1.21	1.207	±0.004
5 GHz – 6 GHz	1.2	1.192	1.19	±0.005

*Resistive to recommended tissue recipes per IEEE-1528

Page 4 of 10 Probe S/N 500-00283
This page has been reviewed for content and attested to on Page 2 of this document.

NCL Calibration Laboratories
Division of APREL Inc.

Calibration for Tissue (Head H, Body B)

Frequency	Tissue Type	Measured Epsilon	Measured Sigma	Standard Uncertainty (%)	Calibration Frequency Range (MHz)	Conversion Factor
450 H	Head	43.5	0.84	3.5	±50	5.7
450 B	Body	56.77	0.93	3.5	±50	5.8
750 H	Head	42.92	0.92	3.5	±50	6.0
750 B	Body	55.57	0.93	3.5	±50	5.9
835 H	Head	43.44	0.94	3.5	±50	5.9
835 B	Body	54.91	1.00	3.5	±50	5.9
900 H	Head	41.05	1.01	3.5	±50	6.0
900 B	Body	54.86	1.04	3.5	±50	5.9
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	38.58	1.36	3.5	±75	5.4
1750 B	Body	51.5	1.52	3.5	±75	5.3
1800 H	Head	X	X	X	X	X
1800 B	Body	X	X	X	X	X
1900 H	Head	40.72	1.37	3.5	±75	4.8
1900 B	Body	52.29	1.58	3.5	±75	4.8
2000 H	Head	X	X	X	X	X
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	37.35	1.85	3.5	±75	4.8
2450B	Body	53.26	1.96	3.5	±75	4.3
3000 H	Head	X	X	X	X	X
3000 B	Body	X	X	X	X	X
3600 H	Head	37.24	3.14	3.5	±100	4.4
3600 B	Body	50.23	3.81	3.5	±100	4.1
5250 H	Head	35.05	4.65	3.5	±100	3.1
5250 B	Body	46.24	5.11	3.5	±100	2.9
5600 H	Head	34.95	5.06	3.5	±100	3.0
5600 B	Body	45.95	5.73	3.5	±100	2.4
5800 H	Head	34.57	5.27	3.5	±100	3.1
5800 B	Body	46.01	6.10	3.5	±100	2.6

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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

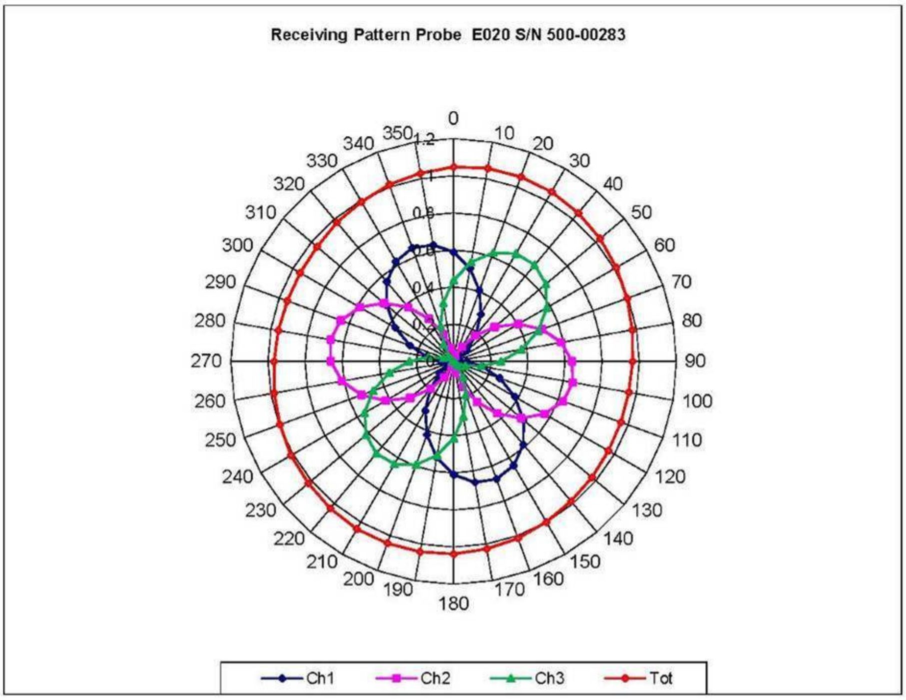
To minimize the uncertainty calculation all tissue sensitivity values were calculated using a load impedance of 5 MΩ.

Probe Calibration Uncertainty

Uncertainty component	Tolerance (± %)	Probability distribution	Divisor	Standard uncertainty (± %)
Incident or forward power	2.5	R	√3	1.44
Reflected power	2	R	√3	1.15
Liquid conductivity measurement	1	R	√3	0.58
Liquid permittivity measurement	1	R	√3	0.58
Liquid conductivity deviation	1.5	R	√3	0.87
Liquid permittivity deviation	1.5	R	√3	0.87
Frequency deviation	2.25	R	√3	1.30
Field homogeneity	2.5	R	√3	1.44
Field-probe positioning	2.5	R	√3	1.44
Field-probe linearity	1.55	R	√3	0.89
Combined standard uncertainty		RSS		**3.50**

NCL Calibration Laboratories
Division of APREL Inc.

Receiving Pattern Air



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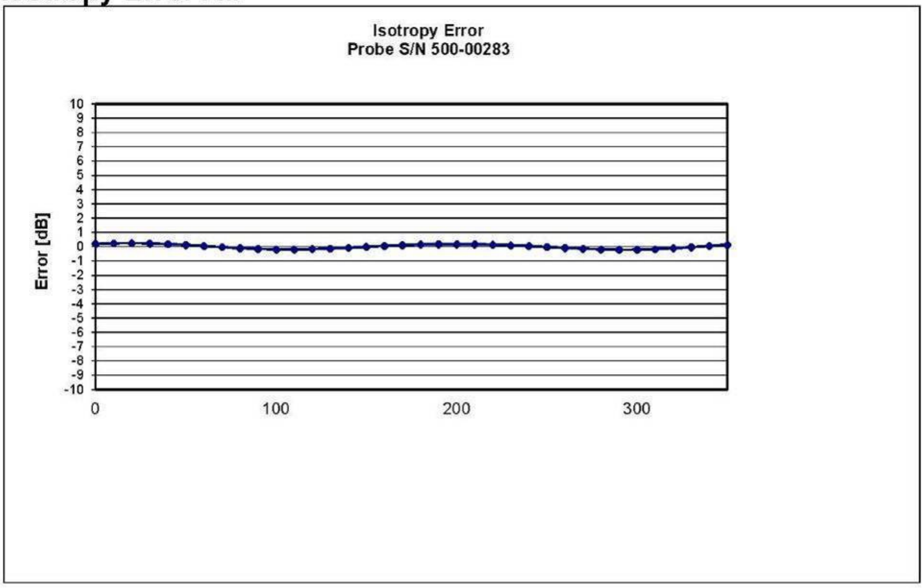
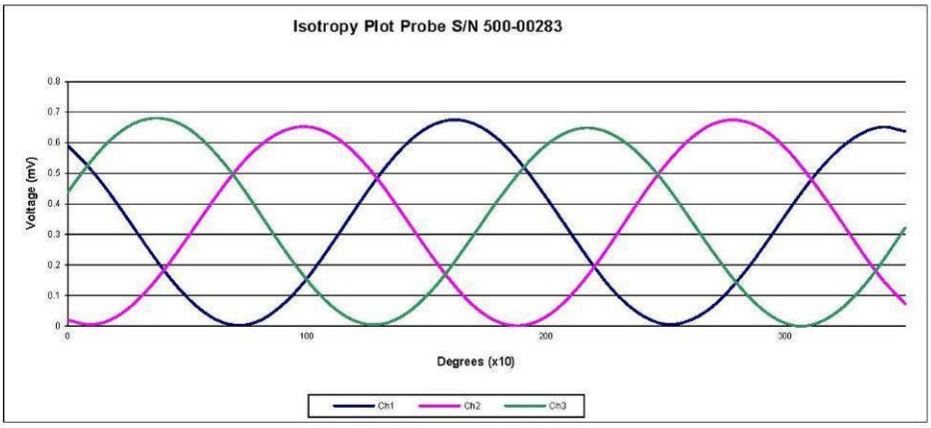
NCL Calibration Laboratories

Division of APREL Inc.

Isotropy Error Air





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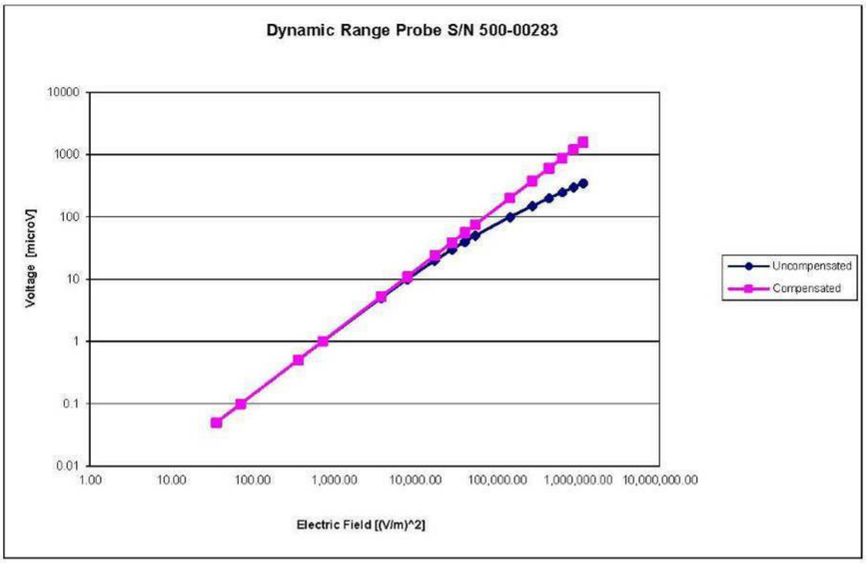
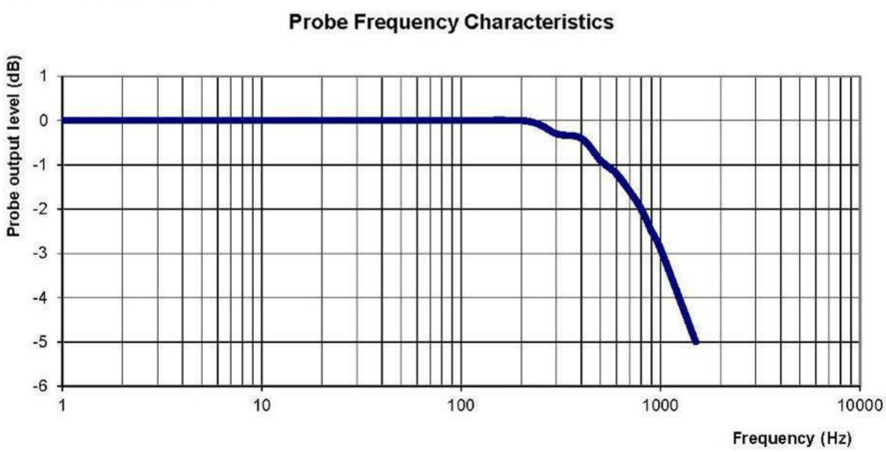
NCL Calibration Laboratories
Division of APREL Inc.

Dynamic Range



Video Bandwidth



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

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APPENDIX C DIPOLE CALIBRATION CERTIFICATES

NCL CALIBRATION LABORATORIES

Calibration File No: DC-1536
Project Number: BACL- 5745

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

Manufacturer: APREL Laboratories
Part number: ALS-D-5800-S-2
Frequency: 5800 MHz
Serial No: 240-00855

Customer: Bay Area Compliance Laboratory

Calibrated: 8th of October 2013
Released on: 8th of October 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

NCL Calibration Laboratories

Division of APREL Laboratories.

Conditions

Dipole 240-00855 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. 2

NCL Calibration Laboratories

Division of APREL Laboratories.

Calibration Results Summary

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

Mechanical Dimensions

Length: 20.8 mm
Height: 21.0 mm

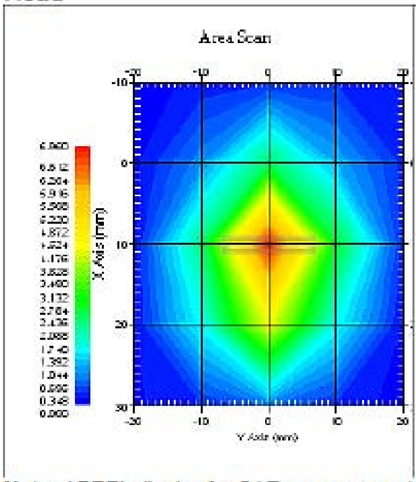
Electrical Calibration

Test	Result Head	Result Body
S11 R/L	-23.009 dB	-22.056 dB
SWR	1.152 U	1.172 U
Impedance	47.800 Ω	47.400 Ω

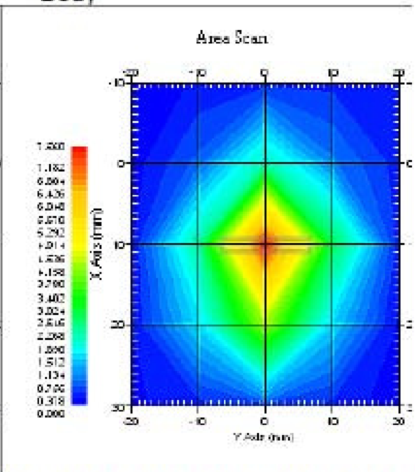
System Validation Results

Frequency 5800 MHz	1 Gram	10 Gram
Head	61.81	18.9
Body	62.84	19.31

Head



Body



Note: APREL dipoles for SAR measurements above 5 GHz are calibrated referring the target 1 g and 10 g SAR numbers as a result of numerical simulation utilizing XFDTD method (Remcom Inc.) for the configuration of APREL dipoles and Uni- and Flat Phantoms.

3

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

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 240-00855. 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-020 130 MHz to 26 GHz E-Field Probe Serial Number 212.

References

- SSI-TP-018-ALSAS Dipole Calibration Procedure
- SSI-TP-016 Tissue Calibration Procedure
- IEEE 1528 "Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communications Devices: Experimental Techniques"
- IEC-62209 "Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices – Human models, instrumentation, and procedures"
- Part 1: "Procedure to determine the Specific Absorption Rate (SAR) for hand-held devices used in close proximity of the ear (frequency range of 300 MHz to 3 GHz)"
- IEC-62209 "Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices – Human models, instrumentation, and procedures"
- Part 2: "Procedure to determine the Specific Absorption Rate (SAR) for hand-held devices used in close proximity of the ear (frequency range of 30 MHz to 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 240-00855 was a re-calibration.

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

NCL Calibration Laboratories
Division of APREL Laboratories.

Dipole Calibration Results

Mechanical Verification

APREL Length	APREL Height	Measured Length	Measured Height
21.0 mm	21.0 mm	20.8 mm	21.0 mm

Tissue Validation

Tissue 5800 MHz	Measured Head	Measured Body
Dielectric constant, ε_r	32.72	44.28
Conductivity, σ [S/m]	5.38	6.04

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%

Combined Standard Uncertainty 3.88% (7.76% K=2)

Primary Measurement Standards

Instrument	Serial Number	Cal due date
Tektronix USB Power Meter	11C940	May 14, 2015
Network Analyzer Anritsu 37347C	002106	Feb. 20, 2015

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NCL Calibration Laboratories
Division of APREL Laboratories.

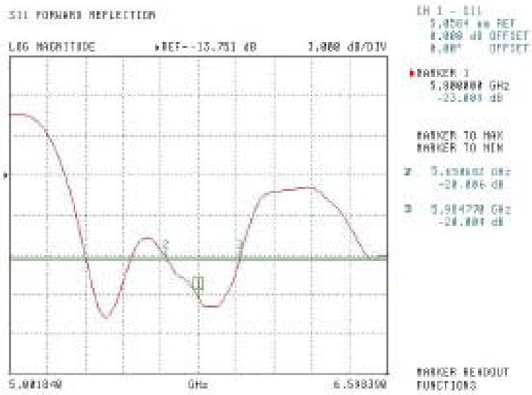
Electrical Calibration

Test	Result Head	Result Body
S11 R/L	-23.009 dB	-22.056 dB
SWR	1.152 U	1.172 U
Impedance	47.800 Ω	47.400 Ω

The Following Graphs are the results as displayed on the Vector Network Analyzer.

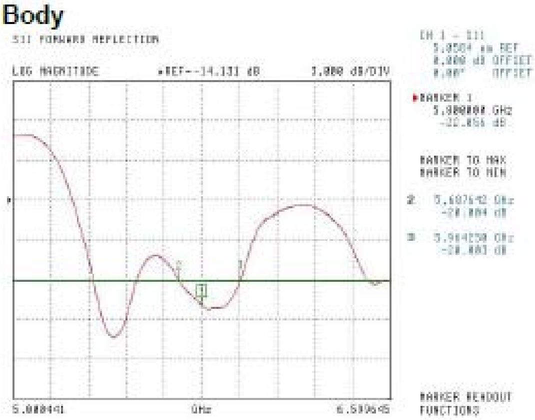
S11 Parameter Return Loss

Head



Frequency Range 5650 MHz to 5984 MHz

Body



Frequency Range 5687 MHz to 5964 MHz

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SWR

Head

Body

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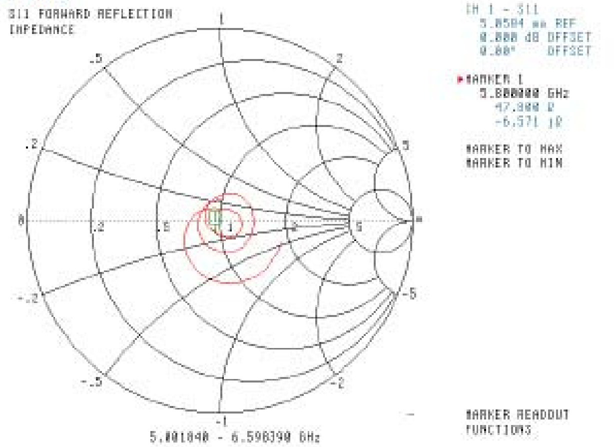
NCL Calibration Laboratories

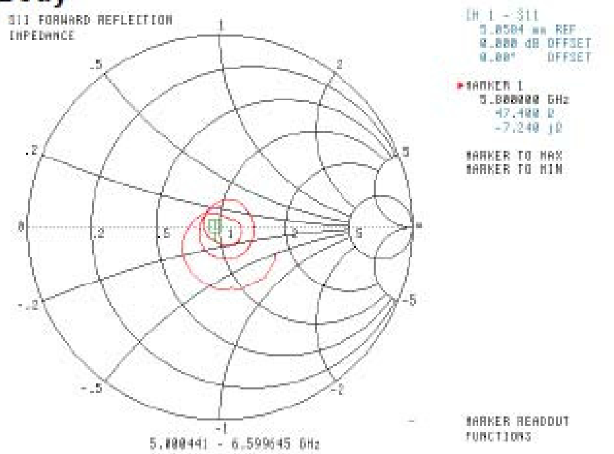
Division of APREL Laboratories.

Smith Chart Dipole Impedance

Head



Body



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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 2013.

NCL CALIBRATION LABORATORIES

Calibration File No: DC-1535
Project Number: BACL-5745

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

Manufacturer: APREL Laboratories
Part number: ALS-D-5200-S-2
Frequency: 5250 MHz
Serial No: 230-00805

Customer: Bay Area Compliance Laboratory

Calibrated: 8th of October, 2013
Released on: 8th of October, 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

NCL Calibration Laboratories

Division of APREL Laboratories.

Conditions

Dipole 230-00805 was new and taken from stock prior to 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

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NCL Calibration Laboratories

Division of APREL Laboratories.

Calibration Results Summary

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

Mechanical Dimensions

Length: 23.4 mm
Height: 21.9 mm

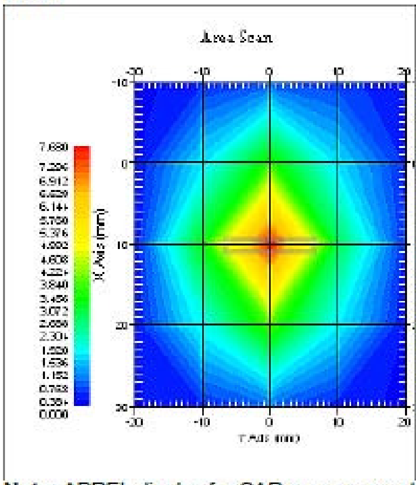
Electrical Calibration

Test	Result Head	Result Body
S11 R/L	-21.071 dB	-20.067 dB
SWR	1.196 U	1.221 U
Impedance	44.119 Ω	44.044 Ω

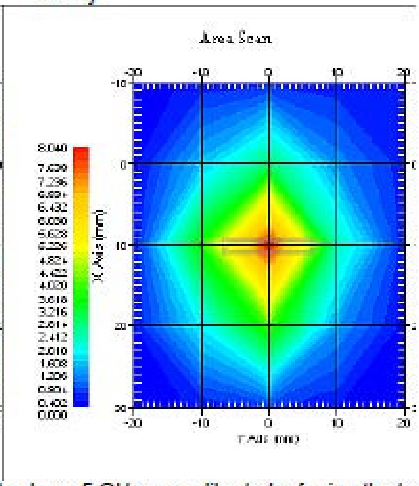
System Validation Results

Frequency 5250 MHz	1 Gram	10 Gram
Head	62.18	20.82
Body	64.00	20.00

Head



Body



Note: APREL dipoles for SAR measurements above 5 GHz are calibrated referring the target 1 g and 10 g SAR numbers as a result of numerical simulation utilizing XFDTD method (Remcom Inc.) for the configuration of APREL dipoles and Uni- and Flat Phantoms.

This page has been reviewed for content and attested to by signature within this document. 3

NCL Calibration Laboratories

Division of APREL Laboratories.

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 230-00805. 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-020 130 MHz to 26 GHz E-Field Probe Serial Number 212.

References

- SSI-TP-018-ALSAS Dipole Calibration Procedure
- SSI-TP-016 Tissue Calibration Procedure
- IEEE 1528 "Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communications Devices: Experimental Techniques"
- IEC-62209 "Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices – Human models, instrumentation, and procedures"
- Part 1: "Procedure to determine the Specific Absorption Rate (SAR) for hand-held devices used in close proximity of the ear (frequency range of 300 MHz to 3 GHz)"
- IEC-62209 "Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices – Human models, instrumentation, and procedures"
- Part 2: "Procedure to determine the Specific Absorption Rate (SAR) for hand-held devices used in close proximity of the ear (frequency range of 30 MHz to 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 230-00805 was a re-calibration.

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

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

NCL Calibration Laboratories
Division of APREL Laboratories.

Dipole Calibration Results

Mechanical Verification

APREL Length	APREL Height	Measured Length	Measured Height
23 mm	21 mm	23.4 mm	21.9 mm

Tissue Validation

Tissue 5250 MHz	Measured Head	Measured Body
Dielectric constant, ε_r	34.65	47.6
Conductivity, σ [S/m]	4.8	5.3

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%
Combined Standard Uncertainty	**3.88% (7.76% K=2)**

Primary Measurement Standards

Instrument	Serial Number	Cal due date
Tektronix USB Power Meter	11C940	May 14, 2015
Network Analyzer Anritsu 37347C	002106	Feb. 20, 2015

5

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

NCL Calibration Laboratories

Division of APREL Laboratories.

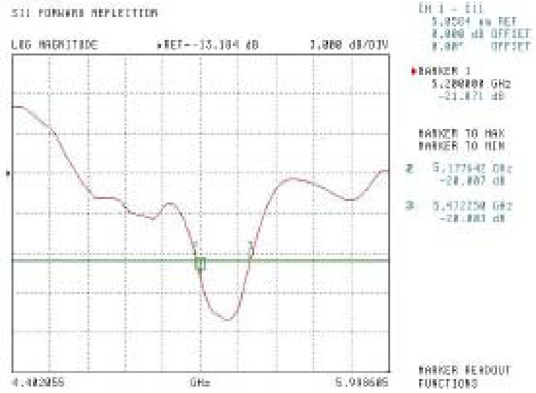
Electrical Calibration

Test	Result Head	Result Body
S11 R/L	-21.071 dB	-20.067 dB
SWR	1.196 U	1.221 U
Impedance	44.119 Ω	44.044 Ω

The Following graphs are the results as displayed on the Vector Network Analyzer.

S11 Parameter Return Loss

Head



Frequency Range 5.177 GHz to 5.472 GHz

Body

Frequency Range 5.200 GHz to 5.417 GHz

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SWR

Head

Body

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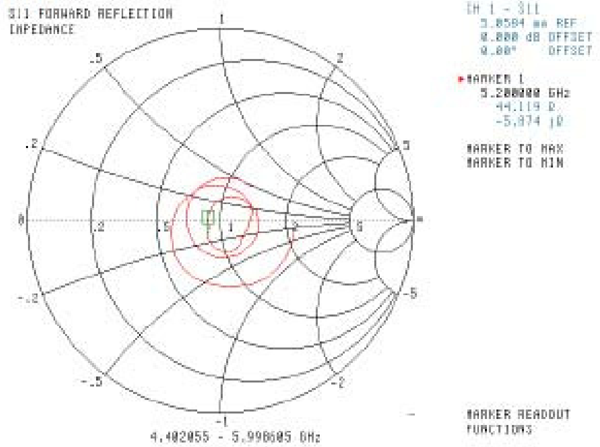
NCL Calibration Laboratories

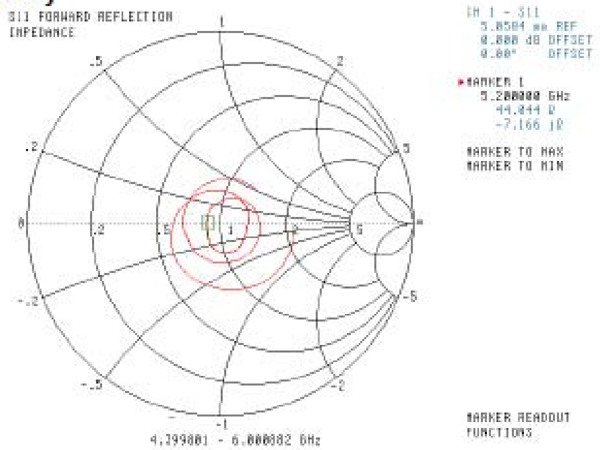
Division of APREL Laboratories.

Smith Chart Dipole Impedance

Head



Body



This page has been reviewed for content and attested to by signature within this document. 8

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 2013.

APPENDIX D EUT TEST POSITION PHOTOS

Please Refer to the Attachment.

APPENDIX F INFORMATIVE REFERENCES

[1] Federal Communications Commission, \Report and order: Guidelines for evaluating the environmental effects of radiofrequency radiation", Tech. Rep. FCC 96-326, FCC, Washington, D.C. 20554, 1996.

[2] David L. Means Kwok Chan, Robert F. Cleveland, \Evaluating compliance with FCC guidelines for human exposure to radiofrequency electromagnetic fields", Tech. Rep., Federal Communication Commission, O_ce of Engineering & Technology, Washington, DC, 1997.

[3] Thomas Schmid, Oliver Egger, and Niels Kuster, \Automated E-_eld scanning system for dosimetricPage 63 of 63
assessments", IEEE Transactions on Microwave Theory and Techniques, vol. 44, pp. 105{113, Jan. 1996.

[4] Niels Kuster, Ralph K.astle, and Thomas Schmid, \Dosimetric evaluation of mobile communications equipment with known precision", IEICE Transactions on Communications, vol. E80-B, no. 5, pp. 645{652, May 1997.

[5] CENELEC, \Considerations for evaluating of human exposure to electromagnetic fields (EMFs) from mobile telecommunication equipment (MTE) in the frequency range 30MHz - 6GHz", Tech. Rep., CENELEC, European Committee for Electrotechnical Standardization, Brussels, 1997.

[6] ANSI, ANSI/IEEE C95.1-1992: IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz, The Institute of Electrical and Electronics Engineers, Inc., New York, NY 10017, 1992.

[7] Katja Pokovic, Thomas Schmid, and Niels Kuster, \Robust setup for precise calibration of E-field probes in tissue simulating liquids at mobile communications frequencies", in ICECOM _ 97, Dubrovnik, October 15{17, 1997, pp. 120-24.

[8] Katja Pokovic, Thomas Schmid, and Niels Kuster, \E-field probe with improved isotropy in brain simulating liquids", in Proceedings of the ELMAR, Zadar, Croatia, 23{25 June, 1996, pp. 172-175.

[9] Volker Hombach, Klaus Meier, Michael Burkhardt, Eberhard K. uhn, and Niels Kuster, \The depen-dence of EM energy absorption upon human head modeling at 900 MHz", IEEE Transactions on Microwave Theory and Techniques, vol. 44, no. 10, pp. 1865-1873, Oct. 1996.

[10] Klaus Meier, Ralf Kastle, Volker Hombach, Roger Tay, and Niels Kuster, \The dependence of EM energy absorption upon human head modeling at 1800 MHz", IEEE Transactions on Microwave Theory and Techniques, Oct. 1997, in press.

[11] W. Gander, Computermathematik, Birkhaeuser, Basel, 1992.

[12] W. H. Press, S. A. Teukolsky,W. T. Vetterling, and B. P. Flannery, Numerical Recepies in C, The Art of Scientific Computing, Second Edition, Cambridge University Press, 1992.Dosimetric Evaluation of Sample device, month 1998 9

[13] NIS81 NAMAS, \The treatment of uncertainity in EMC measurement", Tech. Rep., NAMAS Executive, National Physical Laboratory, Teddington, Middlesex, England, 1994.

[14] Barry N. Taylor and Christ E. Kuyatt, \Guidelines for evaluating and expressing the uncertainty of NIST measurement results", Tech. Rep., National Institute of Standards and Technology, 1994. Dosimetric Evaluation of Sample device, month 1998 10.

******* END OF REPORT *******