FCC SAR EVALUATION REPORT

In accordance with the requirements of
FCC 47 CFR Part 2(2.1093), ANSI/IEEE C95.1-1992 and
IEEE Std 1528-2013

Product Name :	Tractive GPS DOG LTE
Trademark :	N/A
Model Name :	TRNJA4
Family Model :	N/A
Report No. :	S22062306605003
FCC ID :	2AVE6NJ44A

Prepared for

Tractive GmbH

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Prepared by

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TEST RESULT CERTIFICATION

Applicant's name ....: Tractive GmbH
Address.................................: Poststrasse 4, 4061 Pasching, Austria
Manufacturer's Name...........: Tractive GmbH
Address.................................: Poststrasse 4, 4061 Pasching, Austria

Product description

Product name.........................: Tractive GPS DOG LTE
Trademark ....: N/A
Model Name ....: TRNJA4
Family Model..........................: N/A

Standards ....: FCC 47 CFR Part 2(2.1093)
ANSI/IEEE C95.1-1992
IEEE Std 1528-2013
Published RF exposure KDB procedures

This device described above has been tested by Shenzhen NTEK. In accordance with the measurement methods and procedures specified in IEEE Std 1528-2013 and KDB 865664 D01. Testing has shown that this device is capable of compliance with localized specific absorption rate (SAR) specified in FCC 47 CFR Part 2(2.1093) and ANSI/IEEE C95.1-1992. The test results in this report apply only to the tested sample of the stated device/equipment. Other similar device/equipment will not necessarily produce the same results due to production tolerance and measurement uncertainties.

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Date of Test

Date (s) of performance of tests ....: Jan. 05, 2020 ~ Jan. 08, 2020
Additional Antenna Testing:
Jun. 27, 2022 ~ Jul. 01, 2022

Date of Issue ....: Aug. 05, 2022

Test Result..: **Pass**

Note: Customer use two different WWAN antennas in product design. The first antenna(Model: AP900) test during Jan. 05, 2020 ~ Jan. 08, 2020, the other antenna (Model: 9001956) test during Jun. 27, 2022 ~ Jul. 01, 2022.

Prepared By
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(Jacob Chen)

Approved By
(Lab Manager) : Alex
(Alex Li)

※ ※ Revision History ※ ※

REV.	DESCRIPTION	ISSUED DATE	REMARK
Rev.1.0	Initial Test Report Release (WWAN Antenna Model: AP900)	Jan. 14, 2022	Cheng Jiawen
Rev.2.0	Additional Antenna Testing: (WWAN Antenna Model: 9001956)	Aug. 05, 2022	Jacob Chen

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1. General Information

1.1. RF exposure limits

(A).Limits for Occupational/Controlled Exposure (W/kg)

Whole-Body	Partial-Body	Hands, Wrists, Feet and Ankles
0.4	8.0	20.0

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

Whole-Body	Partial-Body	Hands, Wrists, Feet and Ankles
0.08	1.6	4.0

NOTE: ***Whole-Body SAR*** is averaged over the entire body, ***partial-body SAR*** is averaged over any 1 gram of tissue defined as a tissue volume in the shape of a cube. ***SAR for hands, wrists, feet and ankles*** is averaged over any 10 grams of tissue defined as a tissue volume in the shape of a cube.

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:
Are defined as locations where there is the exposure of individuals who have no knowledge or control of their exposure.

NOTE HEAD AND TRUNK LIMIT 1.6 W/kg APPLIED TO THIS EUT

1.2. Statement of Compliance

The maximum results of Specific Absorption Rate (SAR) found during testing for TRNJA4 are as follows.

Band	Max Reported SAR Value(W/kg)	
	1-g Body-Worn (Separation distance of 0mm)	Max Simultaneous Tx
GSM 850	0.541	0.871
GSM 1900	0.430	
LTE Band 2	0.265	
LTE Band 4	0.613	
LTE Band 5	0.202	
LTE Band 12	0.291	
LTE Band 13	0.410	
WLAN 2.4G	0.257	

Note: Test results of TRNJA4 with AP900 ANT.

RF Exposure Conditions		Equipment Class -Highest Reported SAR (W/kg)			
		PCE	DTS	NII	DSS
1-g Body-Worn (Separation distance of 0mm)		0.840	0.257	N/A	N/A
Max Simultaneous Tx	Body-Worn	1.097	1.097	N/A	0.861

Note: Test results of TRNJA4 with 9001956 ANT.

Note: 1. Customer use two different WWAN antennas (Antenna Model : AP900/9001956) and the same WLAN antenna in product design, So retain two SAR results.

2.The Max Simultaneous Tx is calculated based on the same configuration and test position.

3.This device (both designing schemes) is in compliance with Specific Absorption Rate (SAR) for general population/uncontrolled exposure limits (1.6 W/kg) specified in FCC 47 CFR Part 2(2.1093) and ANSI/IEEE C95.1-1992, and had been tested in accordance with the measurement methods and procedures specified in IEEE Std 1528-2013 & KDB 865664 D01.

1.3. EUT Description

Device Information	
Product Name	Tractive GPS DOG LTE
Trade Name	N/A
Model Name	TRNJA4

Family Model	N/A		
FCC ID	2AVE6NJ44A		
Device Phase	Identical Prototype		
Exposure Category	General population / Uncontrolled environment		
Antenna	GSM/LTE: FPC Antenna; Bluetooth/WIFI: SMD Chip; GPS：PATCH		
Battery Information	DC 3.8V, 810mAh, 3.078Wh		
Hardware version:	NJ4-4		
Firmware version：	NJ4-119R		
Software version:	004.016-TRV4-005-0bf3c0		
Device Operating Configurations			
Supporting Mode(s)	GSM 850/1900, LTE-CAT M1 Band 2/4/5/12/13, WLAN 2.4G, Bluetooth		
Test Modulation	GSM(GMSK/8PSK), LTE(QPSK/16QAM), WLAN(DSSS/OFDM), Bluetooth(GFSK)		
Device Class	B, CAT M1		
Operating Frequency Range(s)	Band	Tx (MHz)	Rx (MHz)
	GSM 850	824-849	869-894
	GSM 1900	1850-1910	1930-1990
	LTE Band 2	1850-1910	1930-1990
	LTE Band 4	1710-1755	2110-2155
	LTE Band 5	824-849	869-894
	LTE Band 12	699-716	729-746
	LTE Band 13	777-787	746-756
	WLAN 2.4G	2412-2462	
	Bluetooth	2402-2480	
GPRS Multislot Class(12)	Max Number of Timeslots in Uplink	4	
	Max Number of Timeslots in Downlink	4	
	Max Total Timeslot	5	
EDGE Multislot Class(12)	Max Number of Timeslots in Uplink	4	
	Max Number of Timeslots in Downlink	4	
	Max Total Timeslot	5	
Power Class	4, tested with power level 5(GSM 850)		
	1, tested with power level 0(GSM 1900)		
	3, tested with power control all Max.(LTE Band 2)		
	3, tested with power control all Max.(LTE Band 4)		
	3, tested with power control all Max.(LTE Band 5)		
	3, tested with power control all Max.(LTE Band 12)		
	3, tested with power control all Max.(LTE Band 13)		
Test Channels (low-mid-high)	128-189-251(GSM 850)		

	512-661-810(GSM 1900)
	18607-18900-19193(LTE Band 2 BW=1.4MHz)
	19957-20175-20393(LTE Band 4 BW=1.4MHz)
	20407-20525-20643(LTE Band 5 BW=1.4MHz)
	23017-23095-23173(LTE Band 12 BW=1.4MHz)
	23205-23230-23255(LTE Band 13 BW=1.4MHz)
	1-6-11(WLAN 2.4G)

1.4. Test specification(s)

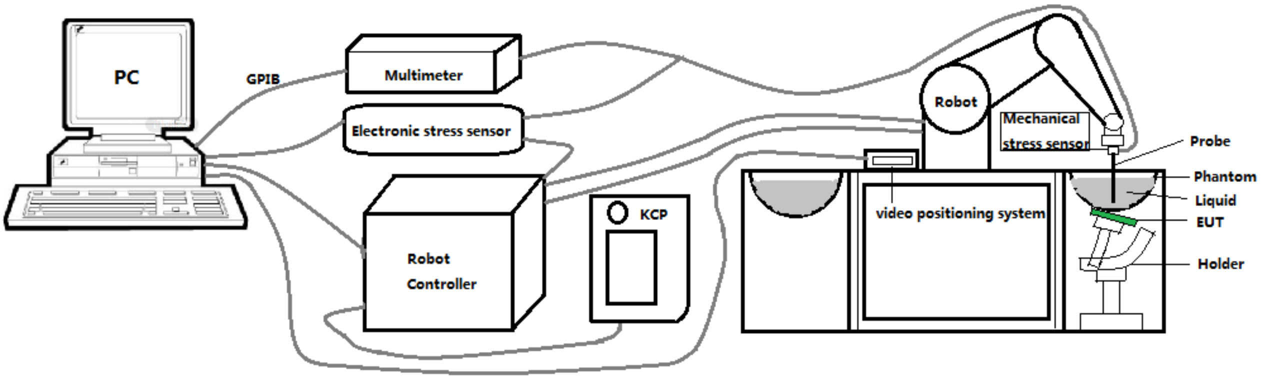
FCC 47 CFR Part 2(2.1093)
ANSI/IEEE C95.1-1992
IEEE Std 1528-2013
KDB 865664 D01 SAR measurement 100 MHz to 6 GHz
KDB 865664 D02 RF Exposure Reporting
KDB 447498 D01 General RF Exposure Guidance
KDB 248227 D01 802.11 Wi-Fi SAR
KDB 941225 D01 3G SAR Procedures
KDB 941225 D05 SAR for LTE Devices

1.5. Ambient Condition

Ambient temperature	20°C – 24°C
Relative Humidity	30% – 70%

2. SAR Measurement System

2.1. SATIMO SAR Measurement Set-up Diagram



These measurements were performed with the automated near-field scanning system OPENSAR from SATIMO. The system is based on a high precision robot (working range: 901 mm), which positions the probes with a positional repeatability of better than ±0.03 mm. The SAR measurements were conducted with dosimetric probe (manufactured by SATIMO), designed in the classical triangular configuration and optimized for dosimetric evaluation.

The first step of the field measurement is the evaluation of the voltages induced on the probe by the device under test. Probe diode detectors are nonlinear. Below the diode compression point, the output voltage is proportional to the square of the applied E-field; above the diode compression point, it is linear to the applied E-field. The compression point depends on the diode, and a calibration procedure is necessary for each sensor of the probe.

The Keithley multimeter reads the voltage of each sensor and send these three values to the PC. The corresponding E field value is calculated using the probe calibration factors, which are stored in the working directory. This evaluation includes linearization of the diode characteristics. The field calculation is done separately for each sensor. Each component of the E field is displayed on the "Dipole Area Scan Interface" and the total E field is displayed on the "3D Interface"

2.2. Robot

The SATIMO SAR system uses the high precision robots from KUKA. For the 6-axis controller system, the robot controller version (KUKA) from KUKA is used. The KUKA robot series have many features that are important for our application:

- High precision (repeatability ±0.03 mm)
- High reliability (industrial design)
- Jerk-free straight movements
- Low ELF interference (the closed metallic construction shields against motor control fields)

2.3. E-Field Probe

This E-field detection probe is composed of three orthogonal dipoles linked to special Schottky diodes with low detection thresholds. The probe allows the measurement of electric fields in liquids such as the one defined in the IEEE and CENELEC standards.

For the measurements the Specific Dosimetric E-Field Probe SN 41/18 EPGO330 with following specifications is used

- Dynamic range: 0.01-100 W/kg
- Tip Diameter: 2.5 mm
- Distance between probe tip and sensor center: 1 mm
- Distance between sensor center and the inner phantom surface: 2 mm (repeatability better than ±1 mm).
- Probe linearity: ±0.10 dB
- Axial isotropy: 0.06 dB
- Hemispherical Isotropy: 0.09 dB
- Calibration range: 650MHz to 5900MHz for head & body simulating liquid.
- Lower detection limit: 9mW/kg

Angle between probe axis (evaluation axis) and surface normal line: less than 30°.

2.3.1. E-Field Probe Calibration

Each probe needs to be calibrated according to a dosimetric assessment procedure with accuracy better than ±10%. The spherical isotropy shall be evaluated and within ±0.25dB. The sensitivity parameters (Norm X, Norm Y, and Norm Z), the diode compression parameter (DCP) and the conversion factor (Conv F) of the probe are tested. The calibration data can be referred to appendix D of this report.

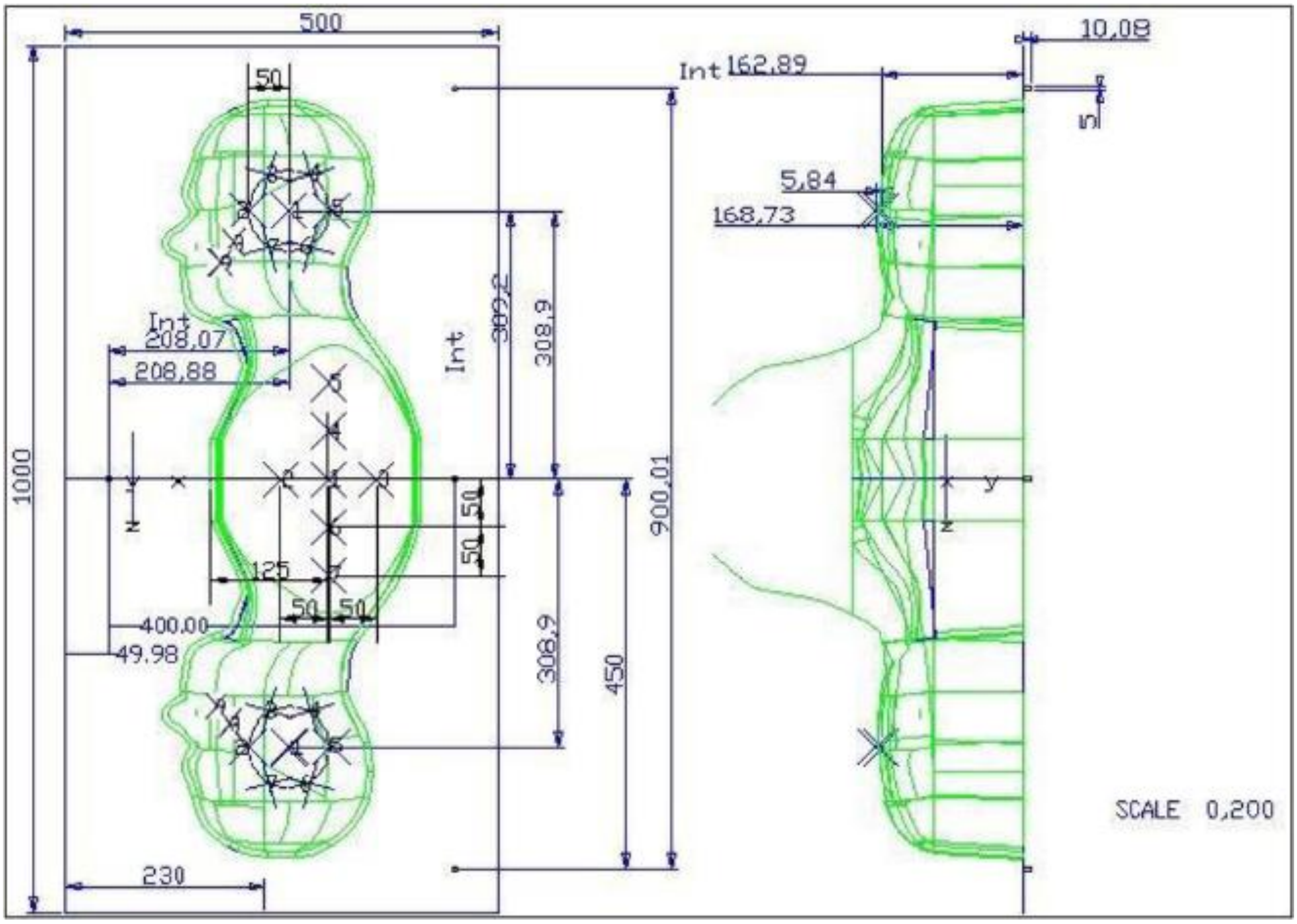
2.4. SAM phantoms

Photo of SAM phantom SN 16/15 SAM119

The SAM phantom is used to measure the SAR relative to people exposed to electro-magnetic field radiated by mobile phones.

2.4.1. Technical Data

Serial Number	Shell thickness	Filling volume	Dimensions	Positionner Material	Permittivity	Loss Tangent
SN 16/15 SAM119	2 mm ±0.2 mm	27 liters	Length:1000 mm Width:500 mm Height:200 mm	Gelcoat with fiberglass	3.4	0.02

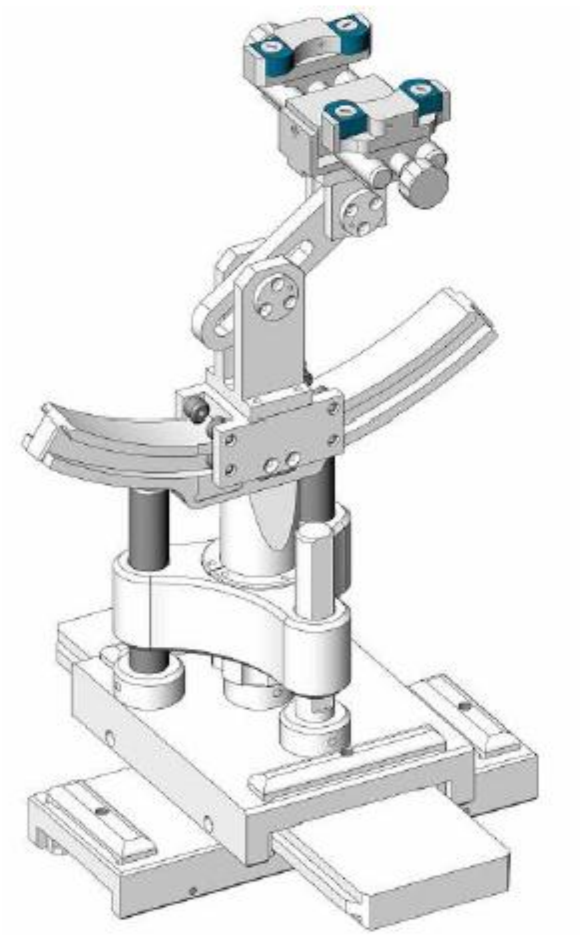


Serial Number	Left Head(mm)		Right Head(mm)		Flat Part(mm)	
SN 16/15 SAM119	2	2.02	2	2.08	1	2.09
	3	2.05	3	2.06	2	2.06
	4	2.07	4	2.07	3	2.08
	5	2.08	5	2.08	4	2.10
	6	2.05	6	2.07	5	2.10
	7	2.05	7	2.05	6	2.07
	8	2.07	8	2.06	7	2.07
	9	2.08	9	2.06	-	-

The test, based on ultrasonic system, allows measuring the thickness with an accuracy of 10 μm.

2.5. Device Holder

The positioning system allows obtaining cheek and tilting position with a very good accuracy. In compliance with CENELEC, the tilt angle uncertainty is lower than 1 degree.



Serial Number	Holder Material	Permittivity	Loss Tangent
SN 16/15 MSH100	Delrin	3.7	0.005

2.6. Test Equipment List

This table gives a complete overview of the SAR measurement equipment.

Devices used during the test described are marked ☒

	Manufacturer	Name of Equipment	Type/Model	Serial Number	Calibration	
					Last Cal.	Due Date
☒	MVG	E FIELD PROBE	SSE2	SN 41/18 EPGO330	May 21, 2019	May 20, 2020
☒	MVG	750 MHz Dipole	SID750	SN 03/15 DIP 0G750-355	Apr. 19, 2018	Apr. 18, 2021
☒	MVG	835 MHz Dipole	SID835	SN 03/15 DIP 0G835-347	Apr. 19, 2018	Apr. 18, 2021
☐	MVG	900 MHz Dipole	SID900	SN 03/15 DIP 0G900-348	Apr. 19, 2018	Apr. 18, 2021
☒	MVG	1800 MHz Dipole	SID1800	SN 03/15 DIP 1G800-349	Apr. 19, 2018	Apr. 18, 2021
☒	MVG	1900 MHz Dipole	SID1900	SN 03/15 DIP 1G900-350	Apr. 19, 2018	Apr. 18, 2021
☐	MVG	2000 MHz Dipole	SID2000	SN 03/15 DIP 2G000-351	Apr. 19, 2018	Apr. 18, 2021
☒	MVG	2450 MHz Dipole	SID2450	SN 03/15 DIP 2G450-352	Apr. 19, 2018	Apr. 18, 2021
☐	MVG	2600 MHz Dipole	SID2600	SN 03/15 DIP 2G600-356	Apr. 19, 2018	Apr. 18, 2021
☐	MVG	5000 MHz Dipole	SWG5500	SN 13/14 WGA 33	Apr. 19, 2018	Apr. 18, 2021
☒	MVG	Liquid measurement Kit	SCLMP	SN 21/15 OCPG 72	NCR	NCR
☒	MVG	Power Amplifier	N.A	AMPLISAR_28/14_003	NCR	NCR
☒	KEITHLEY	Millivoltmeter	2000	4072790	NCR	NCR
☒	R&S	Universal radio communication tester	CMU200	117858	Aug. 06, 2019	Aug. 05, 2020
☒	R&S	Wideband radio communication tester	CMW500	103917	Aug. 28, 2019	Aug. 27, 2020
☒	HP	Network Analyzer	8753D	3410J01136	Aug. 06, 2019	Aug. 05, 2020
☒	Agilent	PSG Analog Signal Generator	E8257D	MY51110112	Aug. 06, 2019	Aug. 05, 2020

☒	Agilent	Power meter	E4419B	MY45102538	Aug. 06, 2019	Aug. 05, 2020
☒	Agilent	Power sensor	E9301A	MY41495644	Aug. 06, 2019	Aug. 05, 2020
☒	Agilent	Power sensor	E9301A	US39212148	Aug. 06, 2019	Aug. 05, 2020
☒	MCLI/USA	Directional Coupler	CB11-20	0D2L51502	Aug. 06, 2019	Aug. 05, 2020

Additional Testing:

	Manufacturer	Name of Equipment	Type/Model	Serial Number	Calibration	
					Last Cal.	Due Date
☒	MVG	E FIELD PROBE	SSE2	SN 08/16 EPGO287	Feb. 01, 2022	Jan. 31, 2023
☒	MVG	750 MHz Dipole	SID750	SN 03/15 DIP 0G750-355	Mar. 01, 2021	Feb. 28, 2024
☒	MVG	835 MHz Dipole	SID835	SN 03/15 DIP 0G835-347	Mar. 01, 2021	Feb. 28, 2024
☐	MVG	900 MHz Dipole	SID900	SN 03/15 DIP 0G900-348	Mar. 01, 2021	Feb. 28, 2024
☒	MVG	1800 MHz Dipole	SID1800	SN 03/15 DIP 1G800-349	Mar. 01, 2021	Feb. 28, 2024
☒	MVG	1900 MHz Dipole	SID1900	SN 03/15 DIP 1G900-350	Mar. 01, 2021	Feb. 28, 2024
☐	MVG	2000 MHz Dipole	SID2000	SN 03/15 DIP 2G000-351	Mar. 01, 2021	Feb. 28, 2024
☐	MVG	2300 MHz Dipole	SID2300	SN 03/16 DIP 2G300-358	Mar. 01, 2021	Feb. 28, 2024
☐	MVG	2450 MHz Dipole	SID2450	SN 03/15 DIP 2G450-352	Mar. 01, 2021	Feb. 28, 2024
☐	MVG	2600 MHz Dipole	SID2600	SN 03/15 DIP 2G600-356	Mar. 01, 2021	Feb. 28, 2024
☐	MVG	5000 MHz Dipole	SWG5500	SN 13/14 WGA 33	Mar. 01, 2021	Feb. 28, 2024
☒	MVG	Liquid measurement Kit	SCLMP	SN 21/15 OCPG 72	NCR	NCR
☒	MVG	Power Amplifier	N.A	AMPLISAR_28/14_003	NCR	NCR
☒	KEITHLEY	Millivoltmeter	2000	4072790	NCR	NCR
☒	R&S	Universal radio communication tester	CMU200	117858	Jun. 17, 2022	Jun. 16, 2023

☒	R&S	Wideband radio communication tester	CMW500	103917	Jun. 17, 2022	Jun. 16, 2023
☒	HP	Network Analyzer	8753D	3410J01136	Jun. 17, 2022	Jun. 16, 2023
☒	Agilent	MXG Vector Signal Generator	N5182A	MY47070317	Jun. 16, 2022	Jun. 15, 2023
☒	Agilent	Power meter	E4419B	MY45102538	Jun. 17, 2022	Jun. 16, 2023
☒	Agilent	Power sensor	E9301A	MY41495644	Jun. 17, 2022	Jun. 16, 2023
☒	Agilent	Power sensor	E9301A	US39212148	Jun. 17, 2022	Jun. 16, 2023
☒	MCLI/USA	Directional Coupler	CB11-20	0D2L51502	Jul. 17, 2020	Jul. 16, 2023

3. SAR Measurement Procedures

The measurement procedures are as follows:

<Conducted power measurement>

(a) For WWAN power measurement, use base station simulator to configure EUT WWAN transmission in conducted connection with RF cable, at maximum power in each supported wireless interface and frequency band.

(b) Read the WWAN RF power level from the base station simulator.

(c) For WLAN/Bluetooth power measurement, use engineering software to configure EUT WLAN/Bluetooth continuously transmission, at maximum RF power in each supported wireless interface and frequency band.

(d) Connect EUT RF port through RF cable to the power meter, and measure WLAN/Bluetooth output power.

<SAR measurement>

(a) Use base station simulator to configure EUT WWAN transmission in radiated connection, and engineering software to configure EUT WLAN/Bluetooth continuously transmission, at maximum RF power, in the highest power channel.

(b) Place the EUT in the positions as Appendix A demonstrates.

(c) Set scan area, grid size and other setting on the OPENSAR software.

(d) Measure SAR results for the highest power channel on each testing position.

(e) Find out the largest SAR result on these testing positions of each band.

(f) Measure SAR results for other channels in worst SAR testing position if the reported SAR of highest power channel is larger than 0.8 W/kg.

According to the test standard, the recommended procedure for assessing the peak spatial-average SAR value consists of the following steps:

(a) Power reference measurement

(b) Area scan

(c) Zoom scan

(d) Power drift measurement

3.1. Power Reference

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

3.2. Area scan & Zoom scan

The area scan is a 2D scan to find the hot spot location on the DUT. The zoom scan is a 3D scan above the hot spot to calculate the 1g and 10g SAR value.

Measurement of the SAR distribution with a grid of 8 to 16 mm * 8 to 16 mm and a constant distance to the inner surface of the phantom. Since the sensors cannot directly measure at the inner phantom surface, the values between the sensors and the inner phantom surface are extrapolated. With these values the area of the maximum SAR is calculated by an interpolation scheme. Around this point, a cube of 30 * 30 *30 mm or 32 * 32 * 32 mm is assessed by measuring 5 or 8 * 5 or 8 * 4 or 5 mm. With these data, the peak spatial-average SAR value can be calculated.

From the scanned SAR distribution, identify the position of the maximum SAR value, in addition identify the positions of any local maxima with SAR values within 2 dB of the maximum value that will not be within the zoom scan of other peaks; additional peaks shall be measured only when the primary peak is within 2 dB of the SAR compliance limit (e.g., 1 W/kg for 1,6 W/kg 1 g limit, or 1,26 W/kg for 2 W/kg, 10 g limit).

Area scan & Zoom scan scan parameters extracted from FCC KDB 865664 D01 SAR measurement 100 MHz to 6 GHz.

<table>
<tr><th colspan="3"></th><th>≤ 3 GHz</th><th>> 3 GHz</th></tr>
<tr><td colspan="3">Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface</td><td>5 ± 1 mm</td><td>½·δ·ln(2) ± 0.5 mm</td></tr>
<tr><td colspan="3">Maximum probe angle from probe axis to phantom surface normal at the measurement location</td><td>30° ± 1°</td><td>20° ± 1°</td></tr>
<tr><td colspan="3" rowspan="2">Maximum area scan spatial resolution: Δx_{Area}, Δy_{Area}</td><td>≤ 2 GHz: ≤ 15 mm
2 – 3 GHz: ≤ 12 mm</td><td>3 – 4 GHz: ≤ 12 mm
4 – 6 GHz: ≤ 10 mm</td></tr>
<tr><td colspan="2">When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be ≤ the corresponding x or y dimension of the test device with at least one measurement point on the test device.</td></tr>
<tr><td colspan="3">Maximum zoom scan spatial resolution: Δx_{Zoom}, Δy_{Zoom}</td><td>≤ 2 GHz: ≤ 8 mm
2 – 3 GHz: ≤ 5 mm*</td><td>3 – 4 GHz: ≤ 5 mm*
4 – 6 GHz: ≤ 4 mm*</td></tr>
<tr><td rowspan="3">Maximum zoom scan spatial resolution, normal to phantom surface</td><td colspan="2">uniform grid: $\Delta z_{Zoom}(n)$</td><td>≤ 5 mm</td><td>3 – 4 GHz: ≤ 4 mm
4 – 5 GHz: ≤ 3 mm
5 – 6 GHz: ≤ 2 mm</td></tr>
<tr><td rowspan="2">graded grid</td><td>$\Delta z_{Zoom}(1)$: between 1st two points closest to phantom surface</td><td>≤ 4 mm</td><td>3 – 4 GHz: ≤ 3 mm
4 – 5 GHz: ≤ 2.5 mm
5 – 6 GHz: ≤ 2 mm</td></tr>
<tr><td>$\Delta z_{Zoom}(n>1)$: between subsequent points</td><td colspan="2">$\leq 1.5 \cdot \Delta z_{Zoom}(n-1)$</td></tr>
<tr><td>Minimum zoom scan volume</td><td colspan="2">x, y, z</td><td>≥ 30 mm</td><td>3 – 4 GHz: ≥ 28 mm
4 – 5 GHz: ≥ 25 mm
5 – 6 GHz: ≥ 22 mm</td></tr>
<tr><td colspan="5">Note: δ is the penetration depth of a plane-wave at normal incidence to the tissue medium; see draft standard IEEE P1528-2011 for details.
* When zoom scan is required and the <u>reported</u> SAR from the area scan based 1-g SAR estimation procedures of KDB 447498 is ≤ 1.4 W/kg, ≤ 8 mm, ≤ 7 mm and ≤ 5 mm zoom scan resolution may be applied, respectively, for 2 GHz to 3 GHz, 3 GHz to 4 GHz and 4 GHz to 6 GHz.</td></tr>
</table>

3.3. Description of interpolation/extrapolation scheme

The local SAR inside the phantom is measured using small dipole sensing elements inside a probe body. The probe tip must not be in contact with the phantom surface in order to minimise measurements errors, but the highest local SAR will occur at the surface of the phantom.
An extrapolation is using to determinate this highest local SAR values. The extrapolation is based on a fourth-order least-square polynomial fit of measured data. The local SAR value is then extrapolated from the liquid surface with a 1 mm step.
The measurements have to be performed over a limited time (due to the duration of the battery) so the step of measurement is high. It could vary between 5 and 8 mm. To obtain an accurate assessment of the maximum SAR averaged over 10 grams and 1 gram requires a very fine resolution in the three dimensional scanned data array.

3.4. Volumetric Scan

The volumetric scan consists to a full 3D scan over a specific area. This 3D scan is useful form multi Tx SAR measurement. Indeed, it is possible with OpenSAR to add, point by point, several volumetric scan to calculate the SAR value of the combined measurement as it is define in the standard IEEE1528 and IEC62209.

3.5. Power Drift

All SAR testing is under the EUT install full charged battery and transmit maximum output power. In OpenSAR measurement software, the power reference measurement and power drift measurement procedures are used for monitoring the power drift of EUT during SAR test. Both these procedures measure the field at a specified reference position before and after the SAR testing. The software will calculate the field difference in V/m. If the power drifts more than ±5%, the SAR will be retested.

4. System Verification Procedure

4.1. Tissue Verification

The following tissue formulations are provided for reference only as some of the parameters have not been thoroughly verified. The composition of ingredients may be modified accordingly to achieve the desired target tissue parameters required for routine SAR evaluation.

Ingredients (% of weight)	Head Tissue									
Frequency Band (MHz)	750	835	900	1800	1900	2000	2450	2600	5200	5800
Water	34.40	34.40	34.40	55.36	55.36	57.87	57.87	57.87	65.53	65.53
NaCl	0.79	0.79	0.79	0.35	0.35	0.16	0.16	0.16	0.00	0.00
1,2-Propanediol	64.81	64.81	64.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Triton X-100	0.00	0.00	0.00	30.45	30.45	19.97	19.97	19.97	24.24	24.24
DGBE	0.00	0.00	0.00	13.84	13.84	22.00	22.00	22.00	10.23	10.23
Ingredients (% of weight)	Body Tissue									
Frequency Band (MHz)	750	835	900	1800	1900	2000	2450	2600	5200	5800
Water	50.30	50.30	50.30	69.91	69.91	71.88	71.88	71.88	79.54	79.54
NaCl	0.60	0.60	0.60	0.13	0.13	0.16	0.16	0.16	0.00	0.00
1,2-Propanediol	49.10	49.10	49.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Triton X-100	0.00	0.00	0.00	9.99	9.99	19.97	19.97	19.97	11.24	11.24
DGBE	0.00	0.00	0.00	19.97	19.97	7.99	7.99	7.99	9.22	9.22

For SAR measurement of the field distribution inside the phantom, the phantom must be filled with homogeneous tissue simulating liquid to a depth of at least 15 cm. For head SAR testing, the liquid depth from the ear reference point (ERP) of the phantom to the liquid top surface is larger than 15 cm.

Photo of Liquid depth for Head Position	Photo of Liquid depth for Body Position
	

4.1.1. Tissue Dielectric Parameter Check Results

The simulating liquids should be checked at the beginning of a series of SAR measurements to determine of the dielectric parameter are within the tolerances of the specified target values. The measured conductivity and relative permittivity should be within ±5% of the target values.

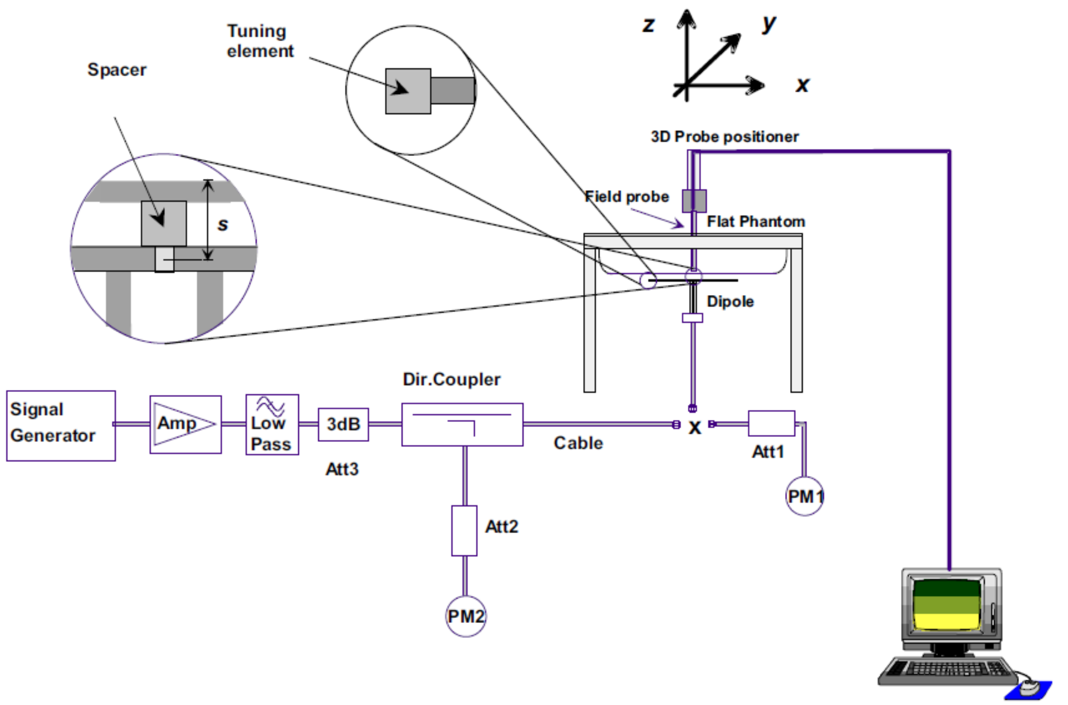
Tissue Type	Measured Frequency (MHz)	Target Tissue		Measured Tissue		Liquid Temp.	Test Date
		εr (±5%)	σ (S/m) (±5%)	εr	σ (S/m)		
Body 750	750	55.55 (52.77~58.33)	0.96 (0.91~1.01)	55.23	0.97	21.2 °C	Jan. 05, 2020
Body 850	835	55.20 (52.44~57.96)	0.97 (0.92~1.02)	54.32	1.01	21.3 °C	Jan. 06, 2020
Body 1800	1800	53.30 (50.64~55.97)	1.52 (1.44~1.60)	53.17	1.54	21.2 °C	Jan. 07, 2020
Body 1900	1900	53.30 (50.64~55.97)	1.52 (1.44~1.60)	52.50	1.57	21.4 °C	Jan. 08, 2020
Body 2450	2450	52.70 (50.07~55.34)	1.95 (1.85~2.05)	52.02	2.03	21.2 °C	Jan. 07, 2020
Head 750	750	41.96 (39.86~44.06)	0.89 (0.85~0.93)	40.48	0.89	21.8 °C	Jun. 28, 2022
Head 850	835	41.50 (39.43~43.58)	0.90 (0.86~0.95)	41.75	0.91	21.4 °C	Jul. 01, 2022
Head 1800	1800	40.00 (38.00~42.00)	1.40 (1.33~1.47)	38.56	1.37	21.3 °C	Jun. 27, 2022
Head 1900	1900	40.00 (38.00~42.00)	1.40 (1.33~1.47)	38.35	1.45	21.2 °C	Jun. 30, 2022

NOTE: The dielectric parameters of the tissue-equivalent liquid should be measured under similar ambient conditions and within 2 °C of the conditions expected during the SAR evaluation to satisfy protocol requirements.

4.2. System Verification Procedure

The system verification is performed for verifying the accuracy of the complete measurement system and performance of the software. The dipole is connected to the signal source consisting of signal generator and amplifier via a directional coupler, N-connector cable and adaption to SMA. It is fed with a power of 100mW (below 5GHz) or 100mW (above 5GHz). To adjust this power a power meter is used. The power sensor is connected to the cable before the system verification to measure the power at this point and do adjustments at the signal generator. At the outputs of the directional coupler both return loss as well as forward power are controlled during the system verification to make sure that emitted power at the dipole is kept constant. This can also be checked by the power drift measurement after the test (result on plot).

The system verification is shown as below picture:



4.2.1. System Verification Results

Comparing to the original SAR value provided by SATIMO, the verification data should be within its specification of ±10%. Below table shows the target SAR and measured SAR after normalized to 1W input power. The table below indicates the system performance verification can meet the variation criterion and the plots can be referred to Appendix B of this report.

System Verification	Target SAR (1W) (±10%)		Measured SAR (Normalized to 1W)		Liquid Temp.	Test Date
	1-g (W/Kg)	10-g (W/Kg)	1-g (W/Kg)	10-g (W/Kg)		
750MHz	8.85 (7.97~9.74)	5.91 (5.32~6.50)	8.28	6.04	21.2 °C	Jan. 05, 2020
835MHz	9.83 (8.85~10.81)	6.45 (5.81~7.10)	9.50	6.72	21.3 °C	Jan. 06, 2020
1800MHz	38.13 (34.32~41.94)	20.65 (18.59~22.72)	38.19	21.77	21.2 °C	Jan. 07, 2020
1900MHz	39.02 (35.12~42.92)	20.57 (18.51~22.63)	39.22	21.89	21.4 °C	Jan. 08, 2020
2450MHz	52.90 (47.61~58.19)	24.09 (21.68~26.50)	52.67	25.41	21.2 °C	Jan. 07, 2020
750MHz	8.53 (7.68~9.38)	5.56 (5.01~6.11)	8.91	5.93	21.8 °C	Jun. 28, 2022
835MHz	9.84 (8.86~10.82)	6.22 (5.60~6.84)	10.07	6.69	21.4 °C	Jul. 01, 2022
1800MHz	37.96 (34.17~41.75)	19.81 (17.83~21.79)	41.25	19.76	21.3 °C	Jun. 27, 2022
1900MHz	40.37 (36.34~44.40)	20.48 (18.44~22.52)	36.71	18.76	21.2 °C	Jun. 30, 2022

5. SAR Measurement variability and uncertainty

5.1. SAR measurement variability

Per KDB865664 D01 SAR measurement 100 MHz to 6 GHz, SAR measurement variability must be assessed for each frequency band, which is determined by the SAR probe calibration point and tissue-equivalent medium used for the device measurements. The additional measurements are repeated after the completion of all measurements requiring the same head or body tissue-equivalent medium in a frequency band. The test device should be returned to ambient conditions (normal room temperature) with the battery fully charged before it is re-mounted on the device holder for the repeated measurement(s) to minimize any unexpected variations in the repeated results.

1) Repeated measurement is not required when the original highest measured SAR is < 0.80 W/kg; steps 2) through 4) do not apply.
2) When the original highest measured SAR is ≥ 0.80 W/kg, repeat that measurement once.
3) Perform a second repeated measurement only if the ratio of largest to smallest SAR for the original and first repeated measurements is > 1.20 or when the original or repeated measurement is ≥ 1.45 W/kg (~ 10% from the 1-g SAR limit).
4) Perform a third repeated measurement only if the original, first or second repeated measurement is ≥1.5 W/kg and the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 1.20.

5.2. SAR measurement uncertainty

Per KDB865664 D01 SAR Measurement 100 MHz to 6 GHz, when the highest measured 1-g SAR within a frequency band is < 1.5 W/kg, the extensive SAR measurement uncertainty analysis described in IEEE Std 1528-2013 is not required in SAR reports submitted for equipment approval. The equivalent ratio (1.5/1.6) is applied to extremity and occupational exposure conditions.

6. RF Exposure Positions

6.1. Body Worn Accessory

1. Body-worn operating configurations are tested with the belt-clips and holsters attached to the device and positioned against a flat phantom in a normal use configuration (see Figure 6.1). Per KDB 648474 D04, body-worn accessory exposure is typically related to voice mode operations when handsets are carried in body-worn accessories. The body-worn accessory procedures in FCC KDB 447498 D01 should be used to test for body-worn accessory SAR compliance, without a headset connected to it. This enables the test results for such configuration to be compatible with that required for hotspot mode when the body-worn accessory test separation distance is greater than or equal to that required for hotspot mode, when applicable. 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 handset attached to the handset.
2. Accessories for body-worn operation configurations are divided into two categories: those that do not contain metallic components and those that do contain metallic components and those that do contain metallic components. When multiple accessories that do not contain metallic components are supplied with the device, the device is tested with only the accessory that dictates the closest spacing to the body. Then multiple accessories that contain metallic components are test with the device with each accessory. If multiple accessories share an identical metallic component (i.e. the same metallic belt-chip used with different holsters with no other metallic components) only the accessory that dictates the closest spacing to the body is tested.

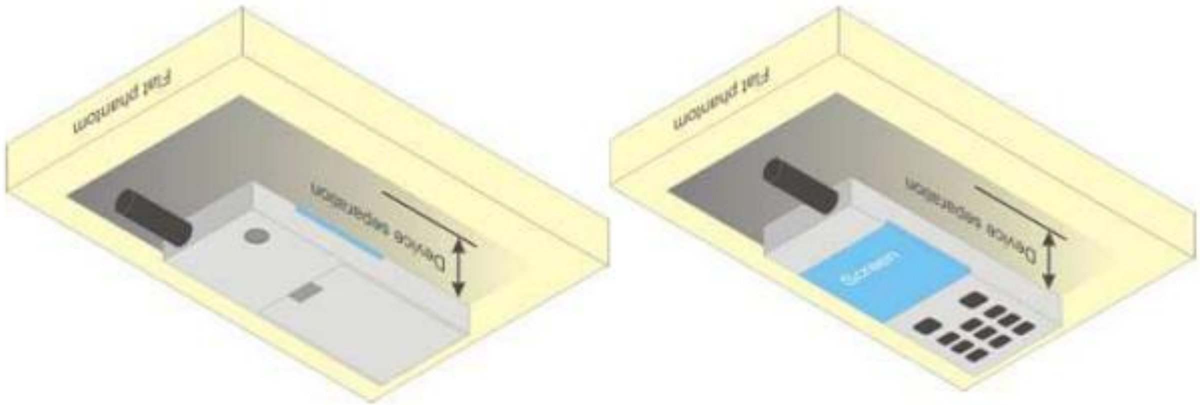


Figure 6.1 – Test positions for body-worn devices

This device is used for pet positioning, when used, the back side of tracker is fixed on the collar and then worn on the pet's neck. In the second test, we use 0mm Separation distance to test the Back Side (worse case) of tracker.

7. RF Output Power

7.1. GSM Conducted Power

Band GSM850	Burst-Averaged output Power (dBm)				Frame-Averaged output Power (dBm)			
Tx Channel	Tune-up	128	189	251	Tune-up	128	189	251
Frequency (MHz)	(dBm)	824.2	836.4	848.8	(dBm)	824.2	836.4	848.8
GPRS(GMSK, 1 TS)	33.00	32.73	32.69	32.62	23.97	23.70	23.66	23.59
GPRS(GMSK, 2 TS)	32.00	31.13	31.10	30.81	25.98	25.11	25.08	24.79
GPRS(GMSK, 3 TS)	30.00	29.83	29.80	29.66	25.74	25.57	25.54	25.40
GPRS(GMSK, 4 TS)	29.00	28.57	28.46	28.40	25.99	25.56	25.45	25.39
EDGE(8PSK, 1 TS)	28.00	27.07	26.74	26.74	18.97	18.04	17.71	17.71
EDGE(8PSK, 2 TS)	26.00	25.32	25.59	25.56	19.98	19.30	19.57	19.54
EDGE(8PSK, 3 TS)	25.00	24.32	24.22	24.12	20.74	20.06	19.96	19.86
EDGE(8PSK, 4 TS)	24.00	23.13	23.00	23.05	20.99	20.12	19.99	20.04
Band GSM1900	Burst-Averaged output Power (dBm)				Frame-Averaged output Power (dBm)			
Tx Channel	Tune-up	512	661	810	Tune-up	512	661	810
Frequency (MHz)	(dBm)	1850.2	1880.0	1909.8	(dBm)	1850.2	1880.0	1909.8
GPRS(GMSK, 1 TS)	30.00	29.24	29.29	29.20	20.97	20.21	20.26	20.17
GPRS(GMSK, 2 TS)	30.00	29.15	29.10	28.99	23.98	23.13	23.08	22.97
GPRS(GMSK, 3 TS)	29.00	28.94	28.91	28.69	24.74	24.68	24.65	24.43
GPRS(GMSK, 4 TS)	29.00	28.75	28.71	28.54	25.99	25.74	25.70	25.53
EDGE(8PSK, 1 TS)	26.00	25.46	25.52	25.11	16.97	16.43	16.49	16.08
EDGE(8PSK, 2 TS)	26.00	25.24	25.07	25.18	19.98	19.22	19.05	19.16
EDGE(8PSK, 3 TS)	26.00	25.02	25.03	24.90	21.74	20.76	20.77	20.64
EDGE(8PSK, 4 TS)	25.00	24.88	24.91	24.71	21.99	21.87	21.90	21.70

Note: The frame-averaged power is linearly scaled the maximum burst averaged power over 8 time slots.
The calculated method are shown as below:
Frame-averaged power = Maximum burst averaged power (1 TS) - 9.03 dB
Frame-averaged power = Maximum burst averaged power (2 TS) - 6.02 dB
Frame-averaged power = Maximum burst averaged power (3 TS) - 4.26 dB
Frame-averaged power = Maximum burst averaged power (4 TS) - 3.01 dB

7.2. LTE Conducted Power

Band	Band Width	Modulation	RB Configuration		Tune-up	Channel/Frequency(MHz)		
			RB Size	RB Offset		18607/1850.7	18900/1880	19193/1909.3
LTE Band 2	1.4MHz	QPSK	1	0	21.00	20.38	20.43	20.52
			1	2	21.00	20.35	20.45	20.53
			1	5	21.00	20.36	20.44	20.60
			3	0	21.00	20.56	20.65	20.65
			3	1	21.00	20.55	20.66	20.66
			3	2	21.00	20.62	20.51	20.68
			6	0	20.00	19.62	19.50	19.91
		16QAM	1	0	21.00	20.56	20.98	20.95
			1	2	21.00	20.56	20.88	20.96
			1	5	21.00	20.62	20.98	20.94
			3	0	20.00	19.75	19.57	19.59
			3	1	20.00	19.72	19.55	19.68
			3	2	20.00	19.68	19.76	19.82
			6	0	20.00	19.86	19.83	19.95

Band	Band Width	Modulation	RB Configuration		Tune-up	Channel/Frequency(MHz)		
			RB Size	RB Offset		19957/1710.7	20175/1732.5	20393/1754.3
LTE Band 4	1.4MHz	QPSK	1	0	22.00	21.02	21.23	21.31
			1	2	22.00	21.05	21.25	21.35
			1	5	22.00	21.05	21.31	21.32
			3	0	21.00	20.84	20.64	20.78
			3	1	21.00	20.83	20.68	20.75
			3	2	21.00	20.74	20.71	20.76
			6	0	20.00	19.83	19.65	19.82
		16QAM	1	0	22.00	21.35	21.32	21.43
			1	2	22.00	21.46	21.43	21.45
			1	5	22.00	21.47	21.56	21.42
			3	0	20.00	19.91	19.73	19.92
			3	1	20.00	19.89	19.75	19.98
			3	2	20.00	19.95	19.68	19.91
			6	0	21.00	20.07	19.94	20.21

Band	Band Width	Modulation	RB Configuration		Tune-up	Channel/Frequency(MHz)		
			RB Size	RB Offset		20407/824.7	20525/836.5	20643/848.3
LTE Band 5	1.4MHz	QPSK	1	0	21.00	20.71	20.97	20.89
			1	2	21.00	20.73	20.96	20.88
			1	5	21.00	20.75	20.97	20.79
			3	0	21.00	20.96	20.97	20.89
			3	1	21.00	20.95	20.95	20.95
			3	2	21.00	20.97	20.98	20.93
			6	0	20.00	19.86	19.97	19.89
		16QAM	1	0	21.00	20.02	20.80	20.88
			1	2	21.00	20.13	20.80	20.85
			1	5	21.00	20.11	20.78	20.76
			3	0	21.00	20.22	20.20	20.25
			3	1	21.00	20.21	20.31	20.22
			3	2	21.00	20.15	20.25	20.19
			6	0	21.00	20.13	20.15	20.22

Band	Band Width	Modulation	RB Configuration		Tune-up	Channel/Frequency(MHz)		
			RB Size	RB Offset		23017/699.7	23095/707.5	23173/715.3
LTE Band 12	1.4MHz	QPSK	1	0	22.00	20.71	21.11	20.94
			1	2	22.00	20.74	21.09	20.93
			1	5	22.00	20.76	21.08	20.91
			3	0	21.00	19.80	20.02	20.06
			3	1	21.00	19.82	20.03	20.05
			3	2	21.00	19.82	20.05	20.05
			6	0	21.00	20.51	20.54	20.53
		16QAM	1	0	22.00	20.11	21.23	21.21
			1	2	22.00	20.09	21.22	21.33
			1	5	22.00	20.08	21.25	21.28
			3	0	21.00	20.69	20.74	20.76
			3	1	21.00	20.86	20.75	20.78
			3	2	21.00	20.92	20.71	20.80
			6	0	21.00	20.79	20.78	20.87

Band	Band Width	Modulation	RB Configuration		Tune-up	Channel/Frequency(MHz)		
			RB	RB		23205/779.5	23230/782	23255/784.5

			Size	Offset				
LTE Band 13	1.4MHz	QPSK	1	0	22.00	21.03	20.96	21.03
			1	2	22.00	21.13	20.95	21.05
			1	5	22.00	21.04	20.98	21.02
			3	0	21.00	20.02	19.99	20.03
			3	1	21.00	20.05	19.98	20.03
			3	2	21.00	20.03	19.96	20.01
			6	0	21.00	20.01	19.98	20.19
		16QAM	1	0	21.00	20.96	20.95	20.93
			1	2	21.00	20.95	20.96	20.95
			1	5	21.00	20.94	20.95	20.92
			3	0	21.00	20.43	20.36	20.43
			3	1	21.00	20.42	20.35	20.45
			3	2	21.00	20.45	20.43	20.44
			6	0	21.00	20.90	20.81	20.83

7.3. WLAN & Bluetooth Output Power

7.3.1. Output Power Results Of WLAN

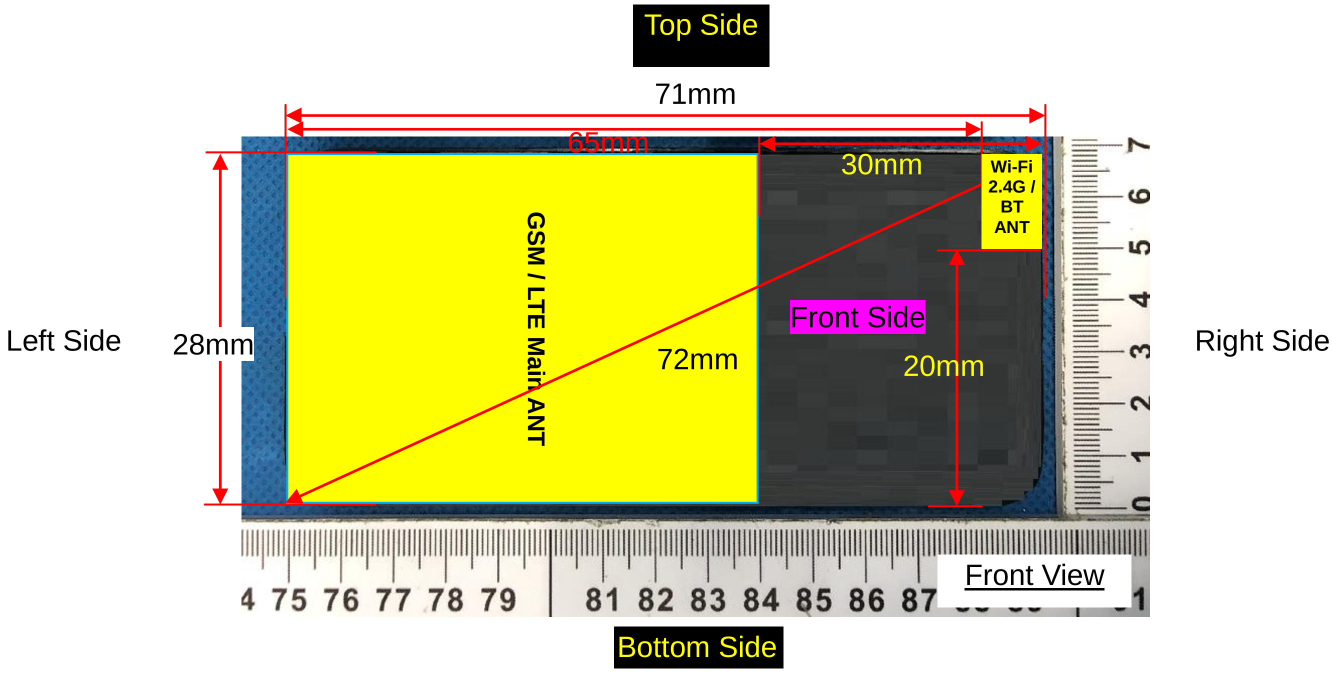
Mode	Channel	Frequency (MHz)	Tune-up	Output Power (dBm)
802.11b	1	2412	10.00	8.59
	6	2437	10.00	9.01
	11	2462	10.00	9.70

NOTE: Power measurement results of WLAN 2.4G.

7.3.2. Output Power Results Of Bluetooth

	Channel	Tune-up	Output Power (dBm)
BLE	0CH	-3.000	-4.013
	19CH	-3.000	-4.108
	39CH	-3.000	-4.310

8. Antenna Location



Note: The WWAN ANT AP900 and 9001956 have the same size.

9. Stand-alone SAR test exclusion

Refer to FCC KDB 447498D01, the 1-g SAR 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)]·[$\sqrt{f_{(GHZ)}}$] ≤ 3.0 for 1-g SAR and ≤ 7.5 for 10-g extremity SAR, where:

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

When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion.

Mode	P_{max} (dBm)	P_{max} (mW)	Distance (mm)	f (GHz)	Calculation Result	SAR Exclusion threshold	SAR test exclusion
Bluetooth	-3.00	0.50	5	2.48	0.2	3.0	Yes

NOTE: Standalone SAR test exclusion for Bluetooth

When standalone SAR test exclusion applies to an antenna that transmits simultaneously with other antennas, the standalone SAR must be estimated according to following to determine simultaneous transmission SAR test exclusion:

[(max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)] * [$\sqrt{f_{(GHZ)}}$/x] W/kg for test separation distances ≤ 50mm, where x = 7.5 for 1-g SAR and x = 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.

Mode	Position	P_{max} (dBm)	P_{max} (mW)	Distance (mm)	f (GHz)	x	Estimated SAR (W/Kg)
Bluetooth	Body	-3.00	0.50	5	2.48	7.5	0.021

NOTE: Estimated SAR calculation for Bluetooth

10. SAR Results

10.1. SAR measurement results

10.1.1. SAR measurement Result of GSM 850

Test Position of Body with 0mm	Test channel /Freq.	Test Mode	SAR Value (W/kg)		Power Drift (±5%)	Conducted power (dBm)	Tune-up power (dBm)	Scaled SAR 1g (W/Kg)	Date
			1g	10g					
Front Side	189/836.4	GPRS(GMSK 4TS)	0.365	0.274	4.29	28.46	29.00	0.413	2020/1/6
Back Side	189/836.4	GPRS(GMSK 4TS)	0.478	0.356	0.02	28.46	29.00	0.541	2020/1/6

NOTE: Antenna AP900 Body SAR test results of GSM 850

Test Position of Body with 0mm	Test channel /Freq.	Test Mode	SAR Value (W/kg)		Power Drift (±5%)	Conducted power (dBm)	Tune-up power (dBm)	Scaled SAR 1g (W/Kg)	Date
			1g	10g					
Back Side	189/836.4	GPRS(GMSK 4TS)	0.742	0.509	-3.43	28.46	29.00	0.840	2022/7/01
Back Side	128/824.2	GPRS(GMSK 4TS)	0.632	0.421	-2.57	28.57	29.00	0.698	2022/7/01
Back Side	251/848.8	GPRS(GMSK 4TS)	0.638	0.429	3.11	28.40	29.00	0.733	2022/7/01

NOTE: Antenna 9001956 Body SAR test results of GSM 850

10.1.2. SAR measurement Result of GSM 1900

Test Position of Body with 0mm	Test channel /Freq.	Test Mode	SAR Value (W/kg)		Power Drift (±5%)	Conducted power (dBm)	Tune-up power (dBm)	Scaled SAR 1g (W/Kg)	Date
			1g	10g					
Front Side	661/1880	GPRS(GMSK 4TS)	0.331	0.188	-2.07	28.71	29.00	0.354	2020/1/8
Back Side	661/1880	GPRS(GMSK 4TS)	0.402	0.226	1.15	28.71	29.00	0.430	2020/1/8

NOTE: Antenna AP900 Body SAR test results of GSM 1900

Test Position of Body with	Test channel /Freq.	Test Mode	SAR Value (W/kg)		Power Drift (±5%)	Conducted power (dBm)	Tune-up power (dBm)	Scaled SAR 1g	Date
			1g	10g					

0mm								(W/Kg)	
Back Side	661/1880	GPRS(GMSK 4TS)	0.362	0.200	-1.63	28.71	29.00	0.387	2022/6/30

NOTE: Antenna 9001956 Body SAR test results of GSM 1900

10.1.3. SAR measurement Result of LTE Band 2

Test Position of Body with 0mm	Test channel /Freq.	Test Mode	SAR Value (W/kg)		Power Drift (±5%)	Conducted power (dBm)	Tune-up power (dBm)	Scaled SAR 1g (W/Kg)	Date
			1g	10g					
1RB									
Front Side	18900/1880	1.4M QPSK(1,5)	0.178	0.102	-3.70	20.44	21.00	0.202	2020/1/8
Back Side	18900/1880	1.4M QPSK(1,5)	0.233	0.130	-0.87	20.44	21.00	0.265	2020/1/8
50%RB									
Front Side	18900/1880	1.4M QPSK(3,2)	0.163	0.095	0.03	20.51	21.00	0.182	2020/1/8
Back Side	18900/1880	1.4M QPSK(3,2)	0.211	0.124	0.07	20.51	21.00	0.236	2020/1/8

NOTE: Antenna AP900 Body SAR test results of LTE Band 2

Test Position of Body with 0mm	Test channel /Freq.	Test Mode	SAR Value (W/kg)		Power Drift (±5%)	Conducted power (dBm)	Tune-up power (dBm)	Scaled SAR 1g (W/Kg)	Date
			1g	10g					
1RB									
Back Side	18900/1880	1.4M QPSK(1,5)	0.030	0.019	-4.51	20.44	21.00	0.034	2022/6/30
50%RB									
Back Side	18900/1880	1.4M QPSK(3,2)	0.026	0.016	1.24	20.51	21.00	0.029	2022/6/30

NOTE: Antenna 9001956 Body SAR test results of LTE Band 2

10.1.4. SAR measurement Result of LTE Band 4

Test Position of Body with	Test channel /Freq.	Test Mode	SAR Value (W/kg)		Power Drift (±5%)	Conducted power (dBm)	Tune-up power (dBm)	Scaled SAR 1g (W/Kg)	Date
			1g	10g					

0mm									
1RB									
Front Side	20175/1732.5	1.4M QPSK(1,2)	0.431	0.219	3.93	21.25	22.00	0.512	2020/1/7
Back Side	20175/1732.5	1.4M QPSK(1,2)	0.516	0.266	-0.90	21.25	22.00	0.613	2020/1/7
50%RB									
Front Side	20175/1732.5	1.4M QPSK(3,0)	0.403	0.197	0.33	20.64	21.00	0.438	2020/1/7
Back Side	20175/1732.5	1.4M QPSK(3,0)	0.491	0.247	-0.09	20.64	21.00	0.533	2020/1/7

NOTE: Antenna AP900 Body SAR test results of LTE Band 4

Test Position of Body with 0mm	Test channel /Freq.	Test Mode	SAR Value (W/kg)		Power Drift (±5%)	Conducted power (dBm)	Tune-up power (dBm)	Scaled SAR 1g (W/Kg)	Date
			1g	10g					
1RB									
Back Side	20175/1732.5	1.4M QPSK(1,2)	0.118	0.066	1.46	21.25	22.00	0.140	2022/6/27
50%RB									
Back Side	20175/1732.5	1.4M QPSK(3,0)	0.106	0.058	2.37	20.64	21.00	0.115	2022/6/27

NOTE: Antenna 9001956 Body SAR test results of LTE Band 4

10.1.5. SAR measurement Result of LTE Band 5

Test Position of Body with 0mm	Test channel /Freq.	Test Mode	SAR Value (W/kg)		Power Drift (±5%)	Conducted power (dBm)	Tune-up power (dBm)	Scaled SAR 1g (W/Kg)	Date
			1g	10g					
1RB									
Front Side	20525/836.5	1.4M QPSK(1,0)	0.169	0.127	-3.81	20.97	21.00	0.170	2020/1/6
Back Side	20525/836.5	1.4M QPSK(1,0)	0.201	0.155	0.34	20.97	21.00	0.202	2020/1/6
50%RB									
Front Side	20525/836.5	1.4M QPSK(3,2)	0.147	0.103	-0.18	20.98	21.00	0.148	2020/1/6
Back	20525/836.5	1.4M QPSK(3,2)	0.182	0.136	0.11	20.98	21.00	0.183	2020/1/6

Side									

NOTE: Antenna AP900 Body SAR test results of LTE Band 5

Test Position of Body with 0mm	Test channel /Freq.	Test Mode	SAR Value (W/kg)		Power Drift (±5%)	Conducted power (dBm)	Tune-up power (dBm)	Scaled SAR 1g (W/Kg)	Date
			1g	10g					
1RB									
Back Side	20525/836.5	1.4M QPSK(1,0)	0.075	0.045	-2.63	20.97	21.00	0.076	2022/7/01
50%RB									
Back Side	20525/836.5	1.4M QPSK(3,2)	0.067	0.040	1.26	20.98	21.00	0.067	2022/7/01

NOTE: Antenna 9001956 Body SAR test results of LTE Band 5

10.1.6. SAR measurement Result of LTE Band 12

Test Position of Body with 0mm	Test channel /Freq.	Test Mode	SAR Value (W/kg)		Power Drift (±5%)	Conducted power (dBm)	Tune-up power (dBm)	Scaled SAR 1g (W/Kg)	Date
			1g	10g					
1RB									
Front Side	23095/707.5	1.4M QPSK(1,0)	0.201	0.161	-2.00	21.11	22.00	0.247	2020/1/5
Back Side	23095/707.5	1.4M QPSK(1,0)	0.237	0.193	1.92	21.11	22.00	0.291	2020/1/5
50%RB									
Front Side	23095/707.5	1.4M QPSK(3,0)	0.103	0.085	-0.02	20.02	21.00	0.129	2020/1/5
Back Side	23095/707.5	1.4M QPSK(3,0)	0.147	0.103	0.29	20.02	21.00	0.184	2020/1/5

NOTE: Antenna AP900 Body SAR test results of LTE Band 12

Test Position of Body with 0mm	Test channel /Freq.	Test Mode	SAR Value (W/kg)		Power Drift (±5%)	Conducted power (dBm)	Tune-up power (dBm)	Scaled SAR 1g (W/Kg)	Date
			1g	10g					
1RB									
Back Side	23095/707.5	1.4M QPSK(1,0)	0.113	0.067	1.47	21.11	22.00	0.139	2022/6/28

50%RB									
Back Side	23095/707.5	1.4M QPSK(3,0)	0.101	0.059	-2.88	20.02	21.00	0.127	2022/6/28

NOTE: Antenna 9001956 Body SAR test results of LTE Band 12

10.1.7. SAR measurement Result of LTE Band 13

Test Position of Body with 0mm	Test channel /Freq.	Test Mode	SAR Value (W/kg)		Power Drift (±5%)	Conducted power (dBm)	Tune-up power (dBm)	Scaled SAR 1g (W/Kg)	Date
			1g	10g					
1RB									
Front Side	23230/782	1.4M QPSK(1,2)	0.272	0.160	-1.52	20.95	22.00	0.346	2020/1/5
Back Side	23230/782	1.4M QPSK(1,2)	0.322	0.194	-0.64	20.95	22.00	0.410	2020/1/5
50%RB									
Front Side	23230/782	1.4M QPSK(3,1)	0.127	0.106	-0.15	19.98	21.00	0.161	2020/1/5
Back Side	23230/782	1.4M QPSK(3,1)	0.232	0.148	-1.41	19.98	21.00	0.294	2020/1/5

NOTE: Antenna AP900 Body SAR test results of LTE Band 13

Test Position of Body with 0mm	Test channel /Freq.	Test Mode	SAR Value (W/kg)		Power Drift (±5%)	Conducted power (dBm)	Tune-up power (dBm)	Scaled SAR 1g (W/Kg)	Date
			1g	10g					
1RB									
Back Side	23230/782	1.4M QPSK(1,2)	0.054	0.037	2.95	20.95	22.00	0.069	2022/6/28
50%RB									
Back Side	23230/782	1.4M QPSK(3,1)	0.050	0.034	1.11	19.98	21.00	0.063	2022/6/28

NOTE: Antenna 9001956 Body SAR test results of LTE Band 13

10.1.8. SAR measurement Result of WLAN 2.4G

Test Position of Body with 0mm	Test channel /Freq.	Test Mode	SAR Value (W/kg)		Power Drift (±5%)	Conducted power (dBm)	Tune-up power (dBm)	Scaled SAR 1g (W/Kg)	Date
			1g	10g					

Front Side	6/2437	802.11 b	0.129	0.065	-1.41	9.01	10.00	0.162	2020/1/7
Back Side	6/2437	802.11 b	0.205	0.107	-0.53	9.01	10.00	0.257	2020/1/7

NOTE: Body SAR test results of WLAN 2.4G

10.2. SAR Summation Scenario

Per KDB 447498 D01, simultaneous transmission SAR is compliant if,

1) Scalar SAR summation < 1.6W/kg.

2) SPLSR = $(SAR_1 + SAR_2)^{1.5}$ / (min. separation distance, mm), and the peak separation distance is determined from the square root of $[(x_1-x_2)^2 + (y_1-y_2)^2 + (z_1-z_2)^2]$, where (x_1, y_1, z_1) and (x_2, y_2, z_2) are the coordinates of the extrapolated peak SAR locations in the zoom scan. If SPLSR ≤ 0.04, simultaneously transmission SAR measurement is not necessary.

a. Summation Scenario for TRNJA4 with AP900 ANT:

Test Position		Scaled SAR_{MAX}		∑1-g SAR (W/Kg)	SPLSR	Remark
		GSM 850	WLAN 2.4G			
Body	Front Side	0.413	0.162	0.575	N/A	N/A
	Back Side	0.541	0.257	0.799	N/A	N/A

NOTE: 1-g SAR Simultaneous Tx Combination of GSM 850 and WLAN 2.4G.

Test Position		Scaled SAR_{MAX}		∑1-g SAR (W/Kg)	SPLSR	Remark
		GSM 1900	WLAN 2.4G			
Body	Front Side	0.354	0.162	0.516	N/A	N/A
	Back Side	0.430	0.257	0.687	N/A	N/A

NOTE: 1-g SAR Simultaneous Tx Combination of GSM 1900 and WLAN 2.4G.

Test Position		Scaled SAR_{MAX}		∑1-g SAR (W/Kg)	SPLSR	Remark
		LTE Band 2	WLAN 2.4G			
Body	Front Side	0.202	0.162	0.365	N/A	N/A
	Back Side	0.265	0.257	0.523	N/A	N/A

NOTE: 1-g SAR Simultaneous Tx Combination of LTE Band 2 and WLAN 2.4G.

Test Position		Scaled SAR_{MAX}		∑1-g SAR (W/Kg)	SPLSR	Remark
		LTE Band 4	WLAN 2.4G			
Body	Front Side	0.512	0.162	0.674	N/A	N/A
	Back Side	0.613	0.257	0.871	N/A	N/A

NOTE: 1-g SAR Simultaneous Tx Combination of LTE Band 4 and WLAN 2.4G.

Test Position		Scaled SAR_{MAX}		∑1-g SAR (W/Kg)	SPLSR	Remark
		LTE Band 5	WLAN 2.4G			
Body	Front Side	0.170	0.162	0.332	N/A	N/A
	Back Side	0.202	0.257	0.460	N/A	N/A

NOTE: 1-g SAR Simultaneous Tx Combination of LTE Band 5 and WLAN 2.4G.

Test Position		Scaled SAR_{MAX}		∑1-g SAR (W/Kg)	SPLSR	Remark
		LTE Band 12	WLAN 2.4G			
Body	Front Side	0.247	0.162	0.409	N/A	N/A
	Back Side	0.291	0.257	0.548	N/A	N/A

NOTE: 1-g SAR Simultaneous Tx Combination of LTE Band 12 and WLAN 2.4G.

Test Position		Scaled SAR_{MAX}		∑1-g SAR (W/Kg)	SPLSR	Remark
		LTE Band 13	WLAN 2.4G			
Body	Front Side	0.346	0.162	0.508	N/A	N/A
	Back Side	0.410	0.257	0.668	N/A	N/A

NOTE: 1-g SAR Simultaneous Tx Combination of LTE Band 13 and WLAN 2.4G.

Test Position		Scaled SAR_{MAX}		∑1-g SAR (W/Kg)	SPLSR	Remark
		GSM 850	BT			
Body	Front Side	0.413	0.021	0.434	N/A	N/A
	Back Side	0.541	0.021	0.562	N/A	N/A

NOTE: 1-g SAR Simultaneous Tx Combination of GSM 850 and BT.

Test Position		Scaled SAR_{MAX}		∑1-g SAR (W/Kg)	SPLSR	Remark
		GSM 1900	BT			
Body	Front Side	0.354	0.021	0.375	N/A	N/A
	Back Side	0.430	0.021	0.451	N/A	N/A

NOTE: 1-g SAR Simultaneous Tx Combination of GSM 1900 and BT.

Test Position		Scaled SAR_{MAX}		∑1-g SAR (W/Kg)	SPLSR	Remark
		LTE Band 2	BT			
Body	Front Side	0.202	0.021	0.224	N/A	N/A
	Back Side	0.265	0.021	0.286	N/A	N/A

NOTE: 1-g SAR Simultaneous Tx Combination of LTE Band 2 and BT.

Test Position		Scaled SAR_{MAX}		∑1-g SAR (W/Kg)	SPLSR	Remark
		LTE Band 4	BT			
Body	Front Side	0.512	0.021	0.533	N/A	N/A
	Back Side	0.613	0.021	0.634	N/A	N/A

NOTE: 1-g SAR Simultaneous Tx Combination of LTE Band 4 and BT.

Test Position		Scaled SAR_{MAX}		∑1-g SAR (W/Kg)	SPLSR	Remark
		LTE Band 5	BT			

Test Position		Scaled SAR_MAX		∑1-g SAR (W/Kg)	SPLSR	Remark
Body	Front Side	0.170	0.021	0.191	N/A	N/A
	Back Side	0.202	0.021	0.223	N/A	N/A

NOTE: 1-g SAR Simultaneous Tx Combination of LTE Band 5 and BT.

Test Position		Scaled SAR_{MAX}		∑1-g SAR (W/Kg)	SPLSR	Remark
		LTE Band 12	BT			
Body	Front Side	0.247	0.021	0.268	N/A	N/A
	Back Side	0.291	0.021	0.312	N/A	N/A

NOTE: 1-g SAR Simultaneous Tx Combination of LTE Band 12 and BT.

Test Position		Scaled SAR_{MAX}		∑1-g SAR (W/Kg)	SPLSR	Remark
		LTE Band 13	BT			
Body	Front Side	0.346	0.021	0.367	N/A	N/A
	Back Side	0.410	0.021	0.431	N/A	N/A

NOTE: 1-g SAR Simultaneous Tx Combination of LTE Band 13 and BT.

b. Summation Scenario for TRNJA4 with 9001956 ANT:

Test Position		Scaled SAR_{MAX}		∑1-g SAR (W/Kg)	SPLSR	Remark
		WWAN	DTS			
Body-Worn	Back Side	0.840	0.257	1.097	N/A	N/A

Test Position		Scaled SAR_{MAX}		∑1-g SAR (W/Kg)	SPLSR	Remark
		WWAN	DSS			
Body-Worn	Back Side	0.840	0.021	0.861	N/A	N/A

11. Appendix A. Photo documentation

Refer to appendix Test Setup photo---SAR

12. Appendix B. System Check Plots

Table of contents

MEASUREMENT 1

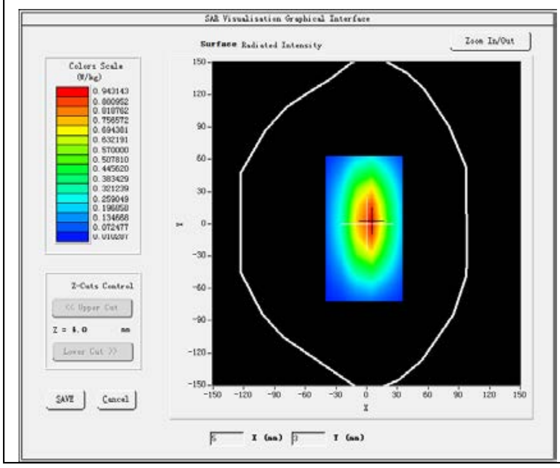
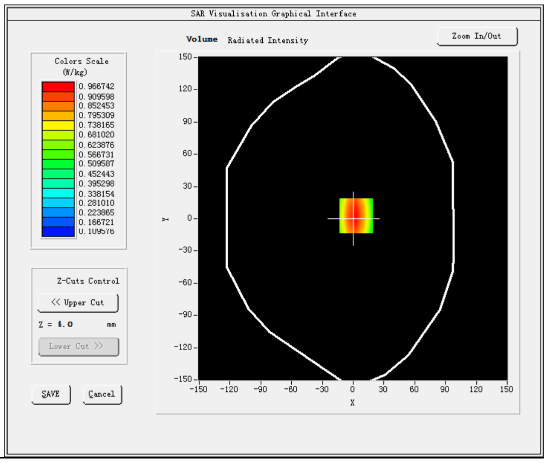
Date of measurement: 5/1/2020

A. Experimental conditions.

Area Scan	dx=15mm dy=15mm, h= 5.00 mm
ZoomScan	5x5x7,dx=8mm dy=8mm dz=5mm
Phantom	Validation plane
Device Position	Dipole
Band	CW750
Channels	Middle
Signal	CW (Crest factor: 1.0)

B. SAR Measurement Results

Frequency (MHz)	750.000000
Relative permittivity (real part)	55.230248
Relative permittivity (imaginary part)	23.363842
Conductivity (S/m)	0.970318
Variation (%)	-1.490000

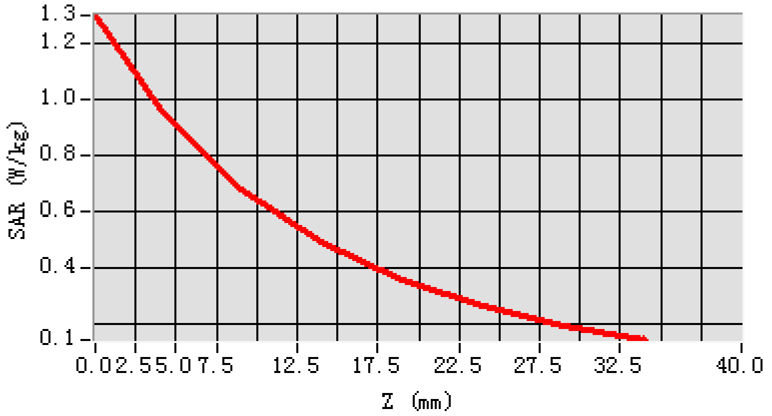
SURFACE SAR	VOLUME SAR
	

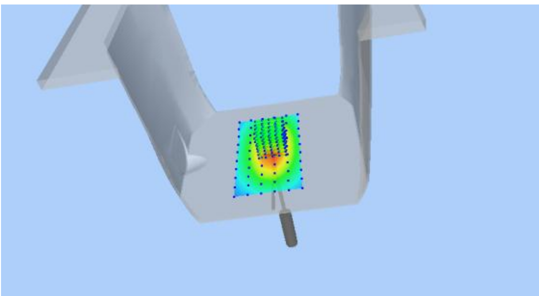
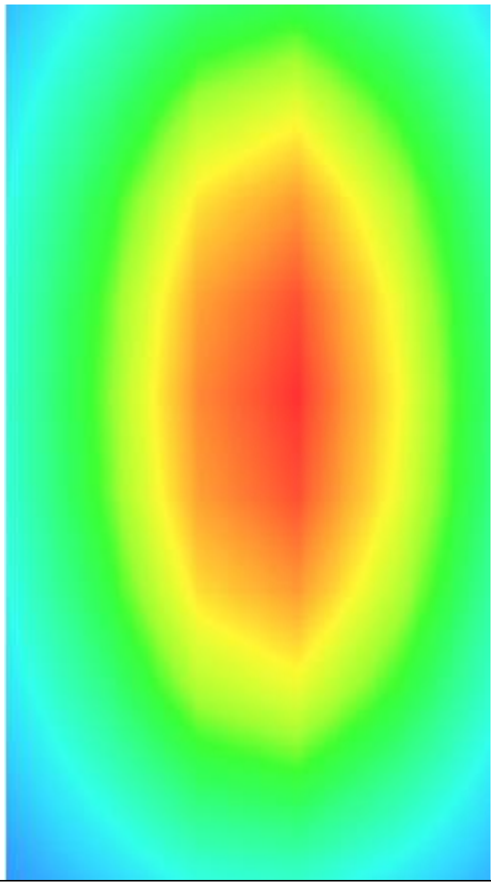
Maximum location: X=3.00, Y=3.00

SAR Peak: 1.30 W/kg

SAR 10g (W/Kg)	0.604281
SAR 1g (W/Kg)	0.828263

Z (mm)	0.00	4.00	9.00	14.00	19.00	24.00	29.00
SAR (W/Kg)	1.2957	0.9688	0.6736	0.4819	0.3573	0.2623	0.1930



3D screen shot	Hot spot position
	

MEASUREMENT 2

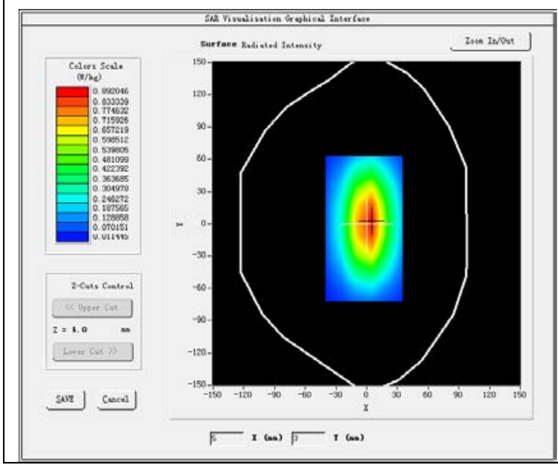
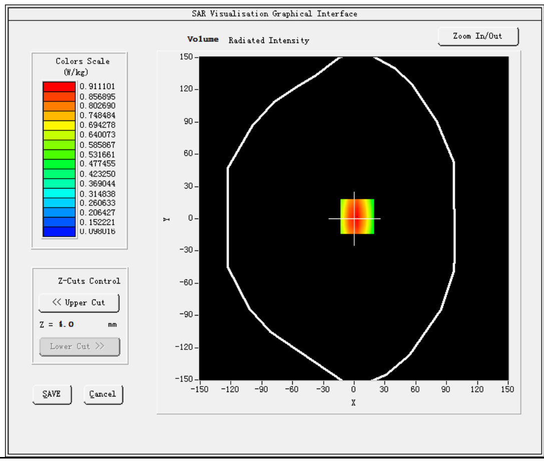
Date of measurement: 6/1/2020

A. Experimental conditions.

Area Scan	dx=15mm dy=15mm, h= 5.00 mm
ZoomScan	5x5x7,dx=8mm dy=8mm dz=5mm
Phantom	Validation plane
Device Position	Dipole
Band	CW835
Channels	Middle
Signal	CW (Crest factor: 1.0)

B. SAR Measurement Results

Frequency (MHz)	835.000000
Relative permittivity (real part)	54.321111
Relative permittivity (imaginary part)	21.793359
Conductivity (S/m)	1.011236
Variation (%)	-1.200000

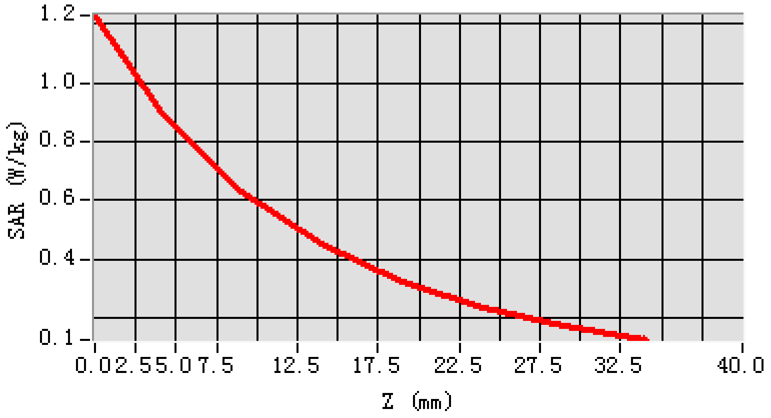
SURFACE SAR	VOLUME SAR
	

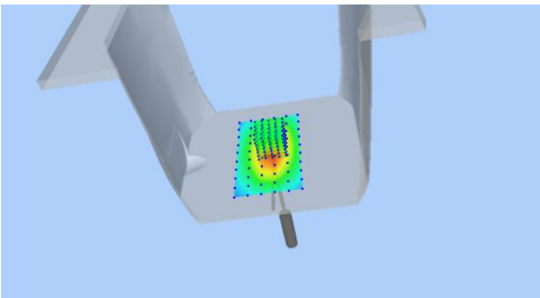
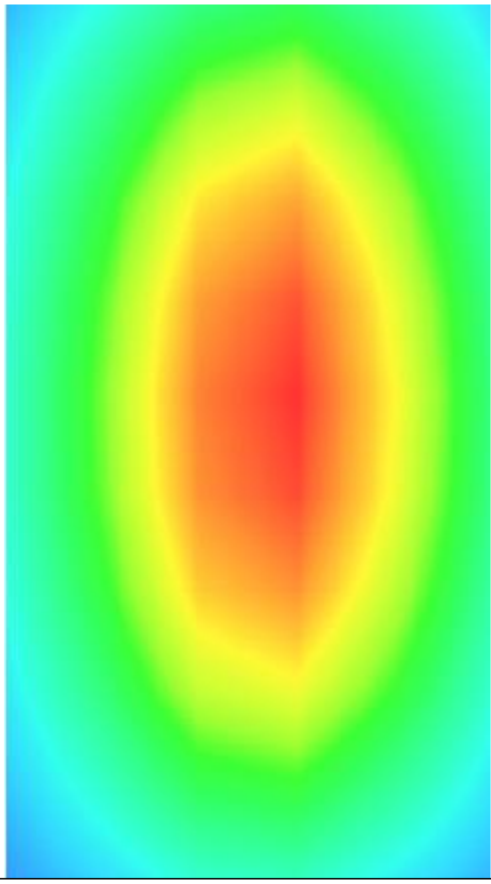
Maximum location: X=3.00, Y=2.00

SAR Peak: 1.23 W/kg

SAR 10g (W/Kg)	0.672123
SAR 1g (W/Kg)	0.950356

Z (mm)	0.00	4.00	9.00	14.00	19.00	24.00	29.00
SAR (W/Kg)	1.2214	0.9178	0.6330	0.4575	0.3252	0.2301	0.1735



3D screen shot	Hot spot position
	

MEASUREMENT 3

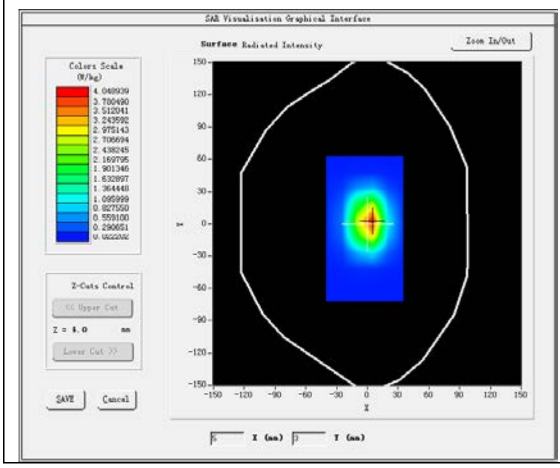
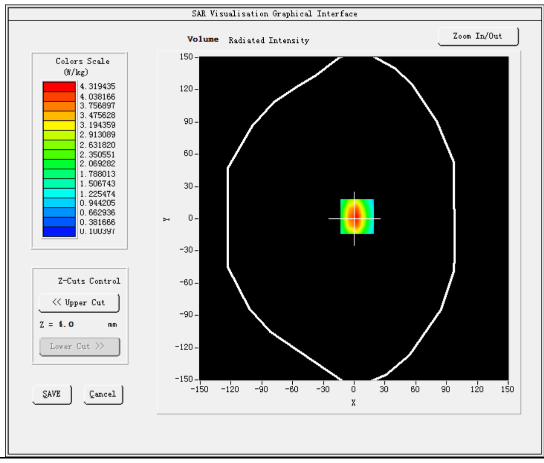
Date of measurement: 7/1/2020

A. Experimental conditions.

Area Scan	dx=15mm dy=15mm, h= 5.00 mm
ZoomScan	5x5x7,dx=8mm dy=8mm dz=5mm
Phantom	Validation plane
Device Position	Dipole
Band	CW1800
Channels	Middle
Signal	CW (Crest factor: 1.0)

B. SAR Measurement Results

Frequency (MHz)	1800.000000
Relative permittivity (real part)	53.173510
Relative permittivity (imaginary part)	15.434016
Conductivity (S/m)	1.543096
Variation (%)	2.020000

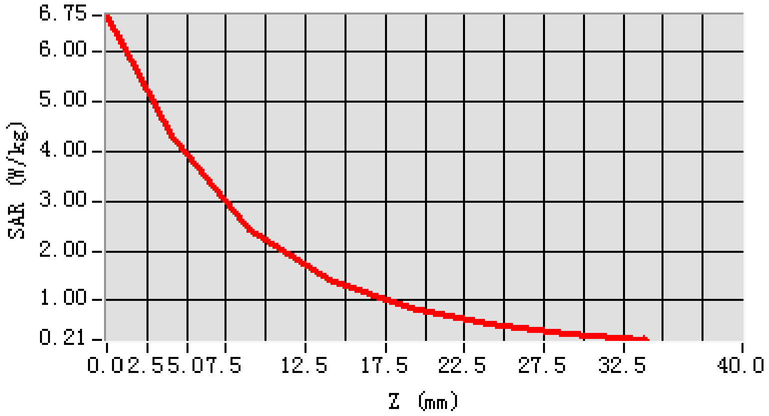
SURFACE SAR	VOLUME SAR
	

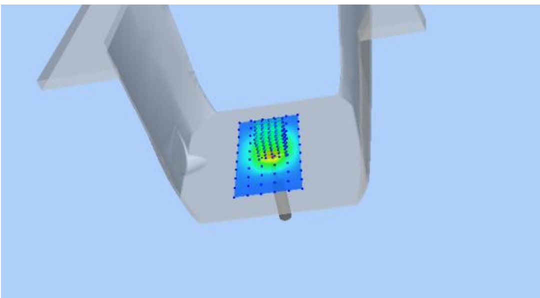
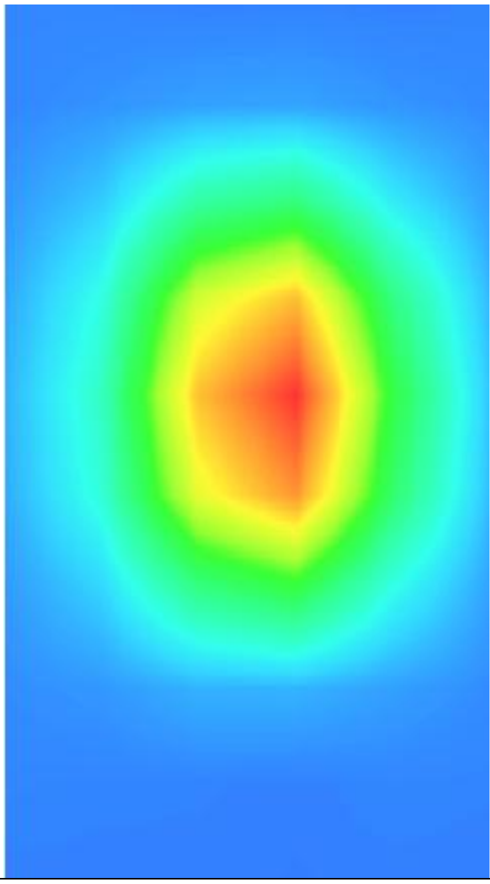
Maximum location: X=3.00, Y=2.00

SAR Peak: 6.82 W/kg

SAR 10g (W/Kg)	2.177379
SAR 1g (W/Kg)	3.819268

Z (mm)	0.00	4.00	9.00	14.00	19.00	24.00	29.00
SAR (W/Kg)	6.7434	4.3133	2.4332	1.4247	0.8577	0.5244	0.3266



3D screen shot	Hot spot position
	

MEASUREMENT 4

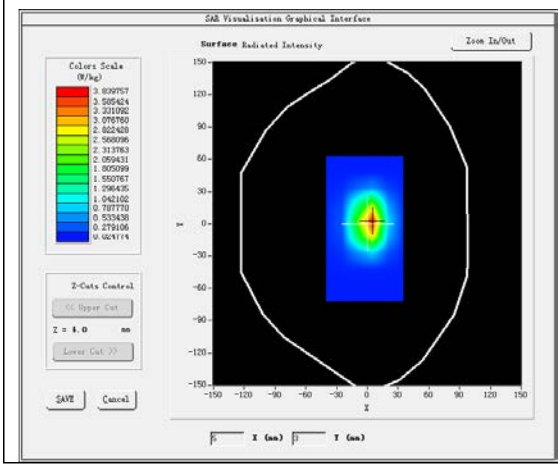
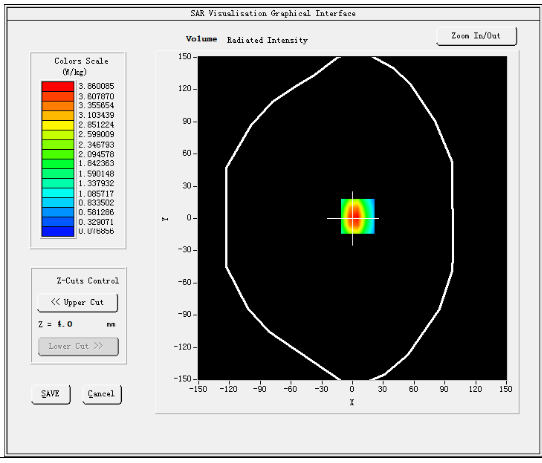
Date of measurement: 8/1/2020

A. Experimental conditions.

Area Scan	dx=15mm dy=15mm, h= 5.00 mm
ZoomScan	5x5x7,dx=8mm dy=8mm dz=5mm
Phantom	Validation plane
Device Position	Dipole
Band	CW1900
Channels	Middle
Signal	CW (Crest factor: 1.0)

B. SAR Measurement Results

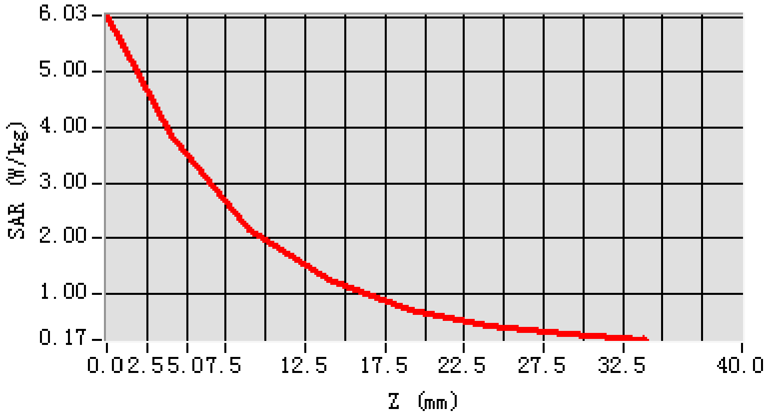
Frequency (MHz)	1900.000000
Relative permittivity (real part)	52.503335
Relative permittivity (imaginary part)	14.853503
Conductivity (S/m)	1.569566
Variation (%)	3.460000

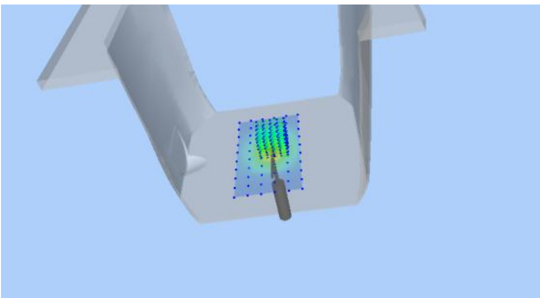
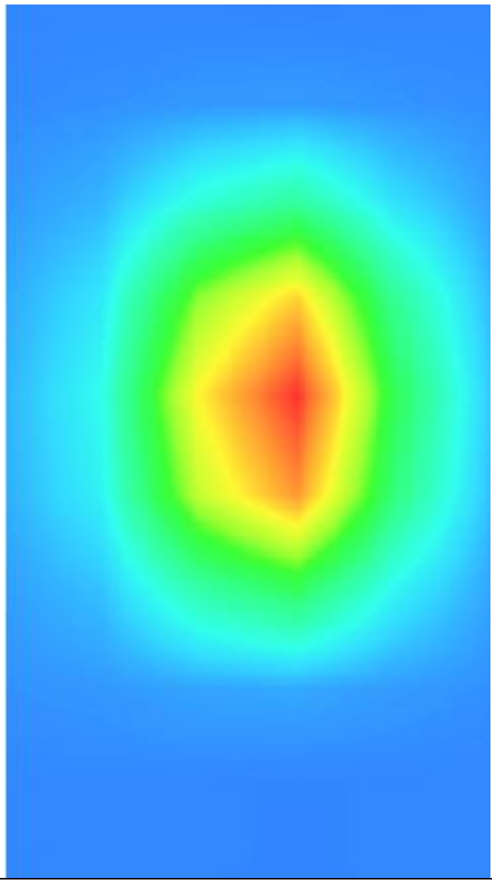
SURFACE SAR	VOLUME SAR
	

Maximum location: X=5.00, Y=2.00
SAR Peak: 6.39 W/kg

SAR 10g (W/Kg)	2.189329
SAR 1g (W/Kg)	3.922402

Z (mm)	0.00	4.00	9.00	14.00	19.00	24.00	29.00
SAR (W/Kg)	6.0345	3.8665	2.1619	1.2445	0.7255	0.4326	0.2634



3D screen shot	Hot spot position
	

MEASUREMENT 5

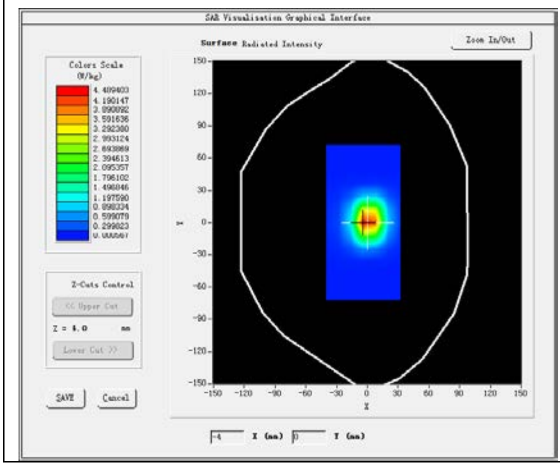
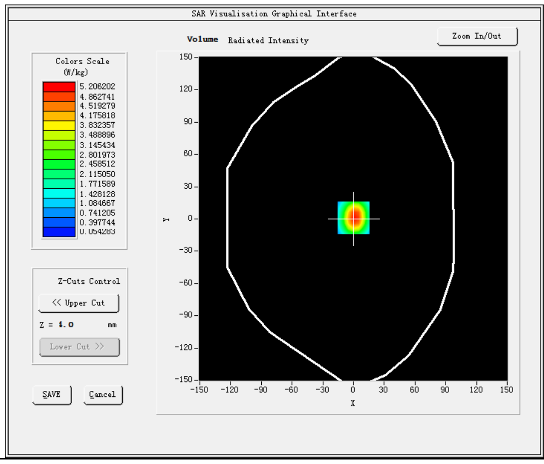
Date of measurement: 7/1/2020

A. Experimental conditions.

Area Scan	dx=12mm dy=12mm, h= 5.00 mm
ZoomScan	7x7x7,dx=5mm dy=5mm dz=5mm
Phantom	Validation plane
Device Position	Dipole
Band	CW2450
Channels	Middle
Signal	CW (Crest factor: 1.0)

B. SAR Measurement Results

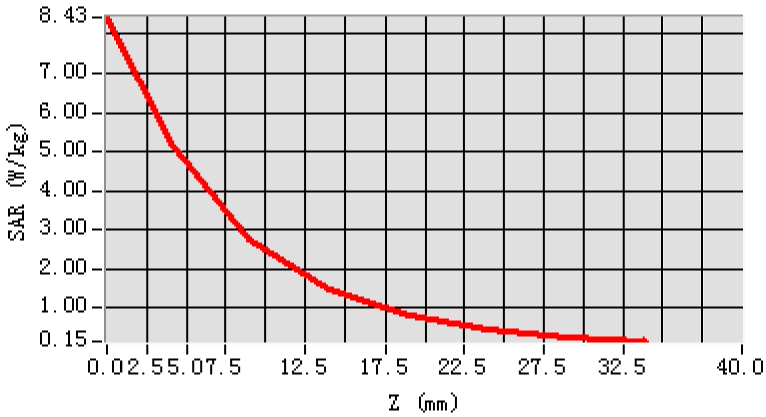
Frequency (MHz)	2450.000000
Relative permittivity (real part)	52.021497
Relative permittivity (imaginary part)	14.933566
Conductivity (S/m)	2.032816
Variation (%)	1.420000

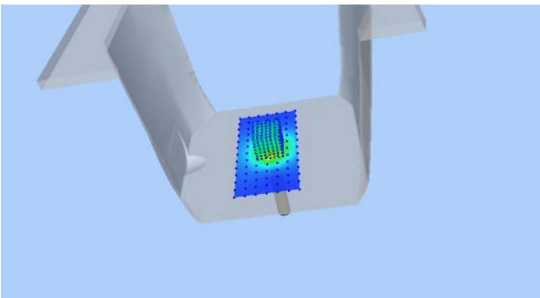
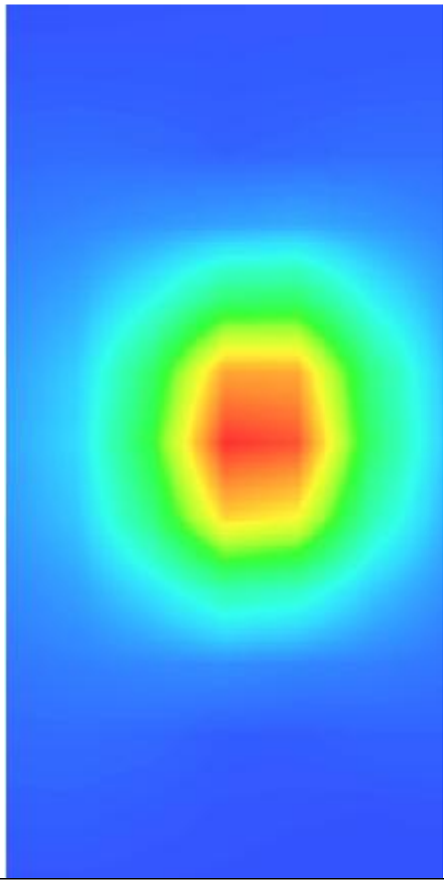
SURFACE SAR	VOLUME SAR
	

Maximum location: X=0.00, Y=1.00
SAR Peak: 8.46 W/kg

SAR 10g (W/Kg)	2.541285
SAR 1g (W/Kg)	5.267270

Z (mm)	0.00	4.00	9.00	14.00	19.00	24.00	29.00
SAR (W/Kg)	8.4312	5.2217	2.7528	1.4235	0.8268	0.4398	0.2567



3D screen shot	Hot spot position
	

MEASUREMENT 6

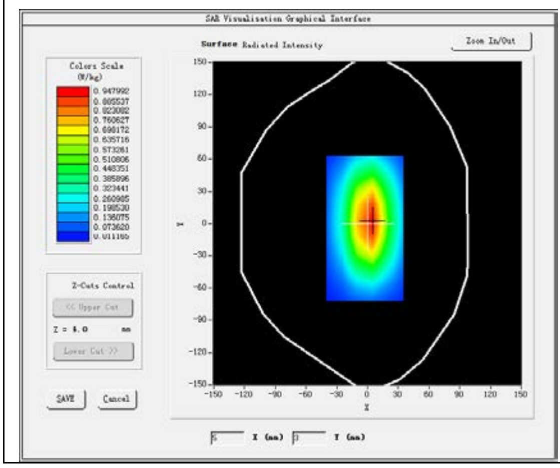
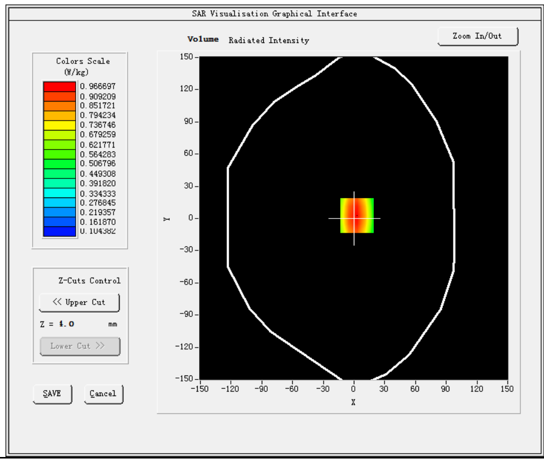
Date of measurement: 28/6/2022

A. Experimental conditions.

Area Scan	dx=15mm dy=15mm, h= 5.00 mm
ZoomScan	5x5x7,dx=8mm dy=8mm dz=5mm
Phantom	Validation plane
Device Position	Dipole
Band	CW750
Channels	Middle
Signal	CW (Crest factor: 1.0)

B. SAR Measurement Results

Frequency (MHz)	750.000000
Relative permittivity (real part)	40.482655
Relative permittivity (imaginary part)	21.251162
Conductivity (S/m)	0.885465
Variation (%)	1.970000

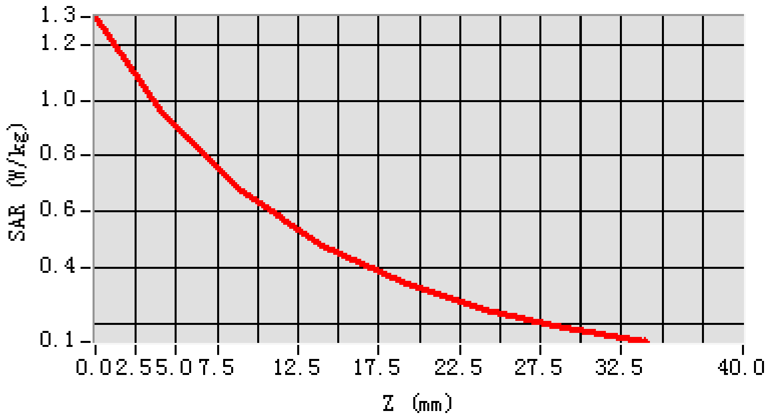
SURFACE SAR	VOLUME SAR
	

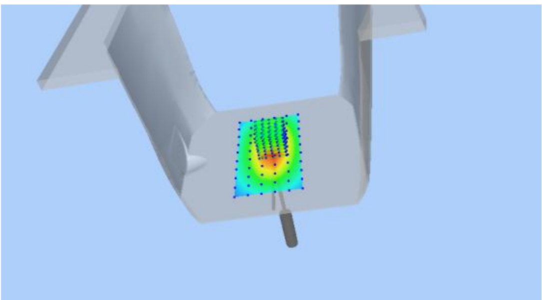
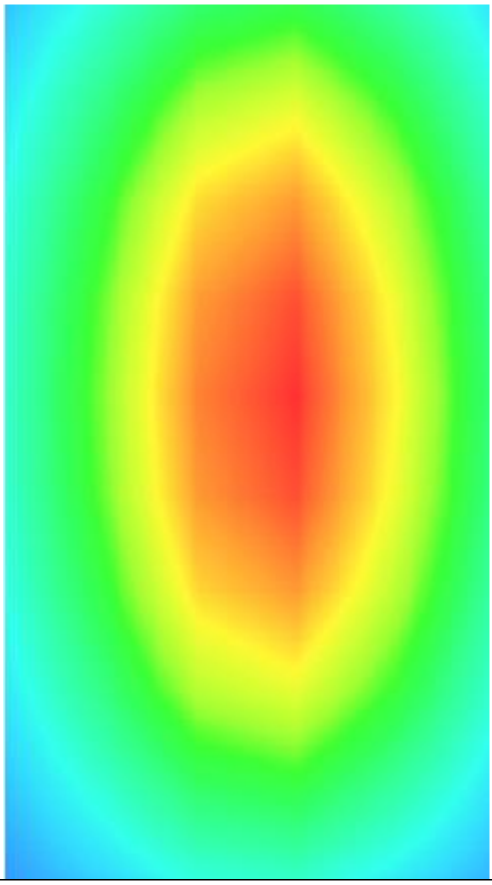
Maximum location: X=3.00, Y=3.00

SAR Peak: 1.30 W/kg

SAR 10g (W/Kg)	0.593191
SAR 1g (W/Kg)	0.891231

Z (mm)	0.00	4.00	9.00	14.00	19.00	24.00	29.00
SAR (W/Kg)	1.2906	0.9670	0.6744	0.4829	0.3486	0.2547	0.1823



3D screen shot	Hot spot position
	

MEASUREMENT 7

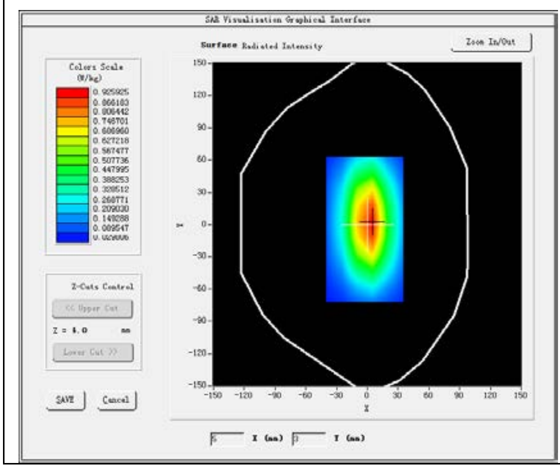
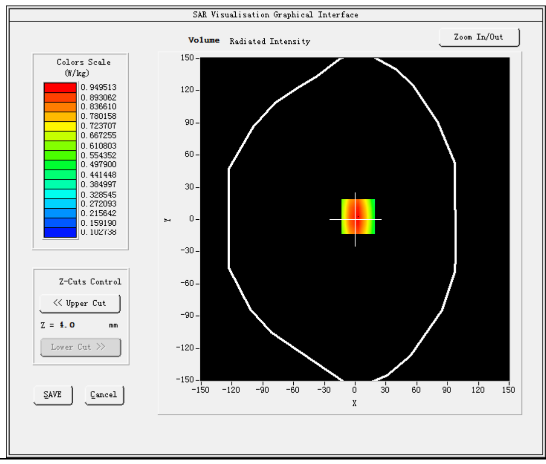
Date of measurement: 1/7/2022

A. Experimental conditions.

Area Scan	dx=15mm dy=15mm, h= 5.00 mm
ZoomScan	5x5x7,dx=8mm dy=8mm dz=5mm
Phantom	Validation plane
Device Position	Dipole
Band	CW835
Channels	Middle
Signal	CW (Crest factor: 1.0)

B. SAR Measurement Results

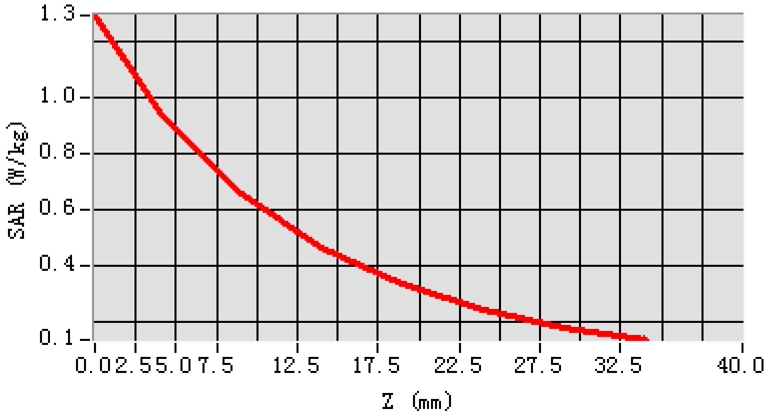
Frequency (MHz)	835.000000
Relative permittivity (real part)	41.748057
Relative permittivity (imaginary part)	19.704465
Conductivity (S/m)	0.914068
Variation (%)	-2.520000

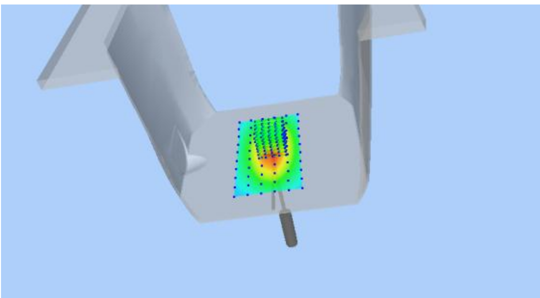
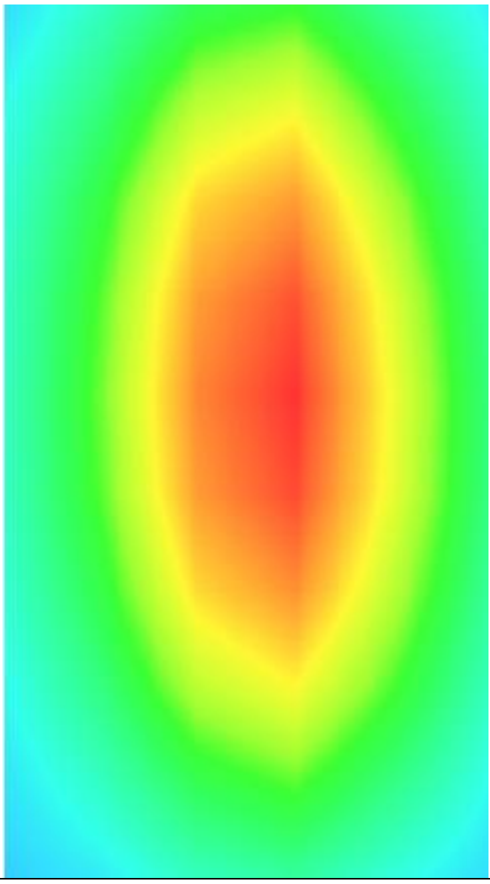
SURFACE SAR	VOLUME SAR
	

Maximum location: X=3.00, Y=3.00
SAR Peak: 1.30 W/kg

SAR 10g (W/Kg)	0.669296
SAR 1g (W/Kg)	1.007160

Z (mm)	0.00	4.00	9.00	14.00	19.00	24.00	29.00
SAR (W/Kg)	1.2904	0.9495	0.6549	0.4623	0.3232	0.2451	0.1759



3D screen shot	Hot spot position
	

MEASUREMENT 8

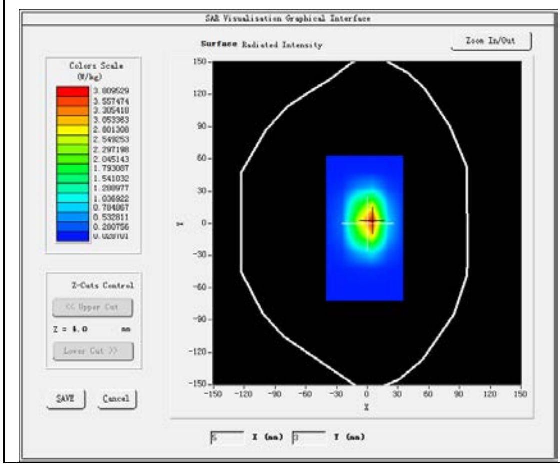
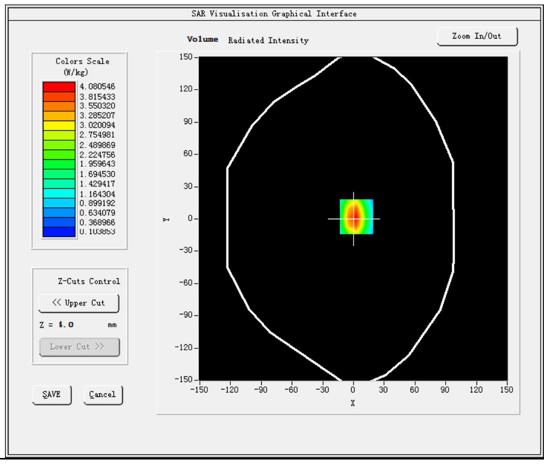
Date of measurement: 27/6/2022

A. Experimental conditions.

Area Scan	dx=15mm dy=15mm, h= 5.00 mm
ZoomScan	5x5x7,dx=8mm dy=8mm dz=5mm
Phantom	Validation plane
Device Position	Dipole
Band	CW1800
Channels	Middle
Signal	CW (Crest factor: 1.0)

B. SAR Measurement Results

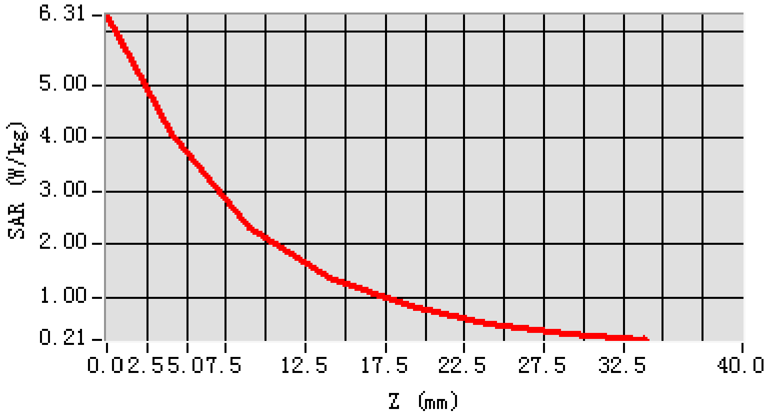
Frequency (MHz)	1800.000000
Relative permittivity (real part)	38.564261
Relative permittivity (imaginary part)	13.710583
Conductivity (S/m)	1.371058
Variation (%)	2.050000

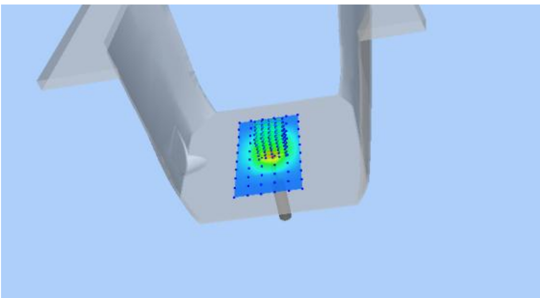
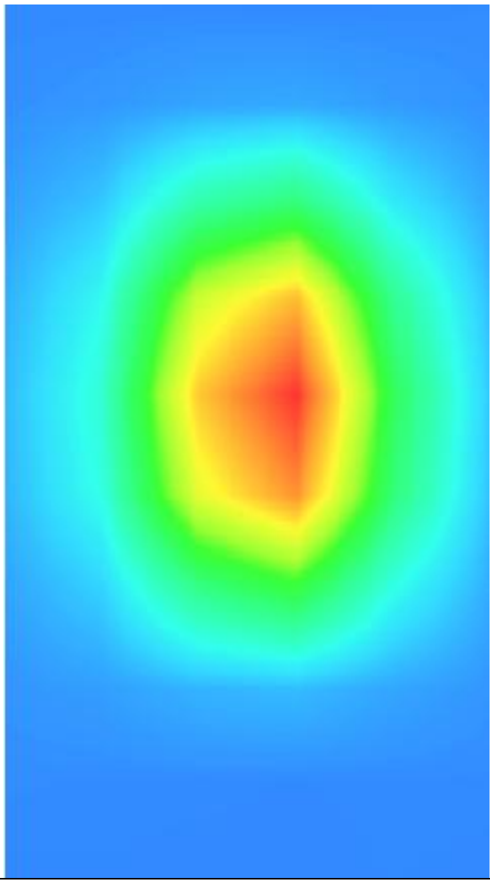
SURFACE SAR	VOLUME SAR
	

Maximum location: X=3.00, Y=2.00
SAR Peak: 6.39 W/kg

SAR 10g (W/Kg)	1.976384
SAR 1g (W/Kg)	4.125097

Z (mm)	0.00	4.00	9.00	14.00	19.00	24.00	29.00
SAR (W/Kg)	6.3174	4.0812	2.3337	1.3805	0.8378	0.5139	0.3286



3D screen shot	Hot spot position
	

MEASUREMENT 9

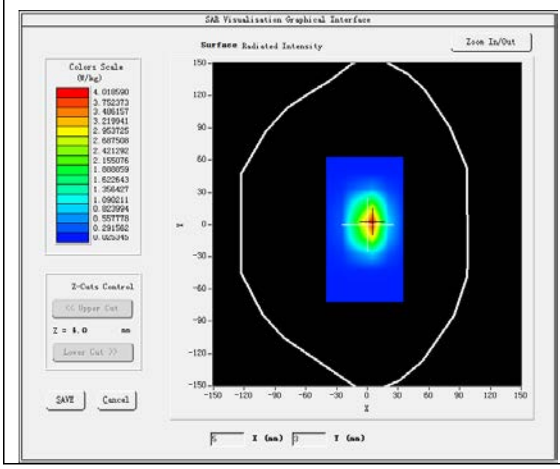
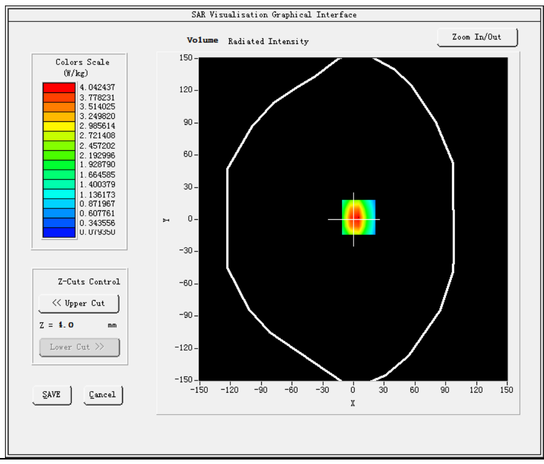
Date of measurement: 30/6/2022

A. Experimental conditions.

Area Scan	dx=15mm dy=15mm, h= 5.00 mm
ZoomScan	5x5x7,dx=8mm dy=8mm dz=5mm
Phantom	Validation plane
Device Position	Dipole
Band	CW1900
Channels	Middle
Signal	CW (Crest factor: 1.0)

B. SAR Measurement Results

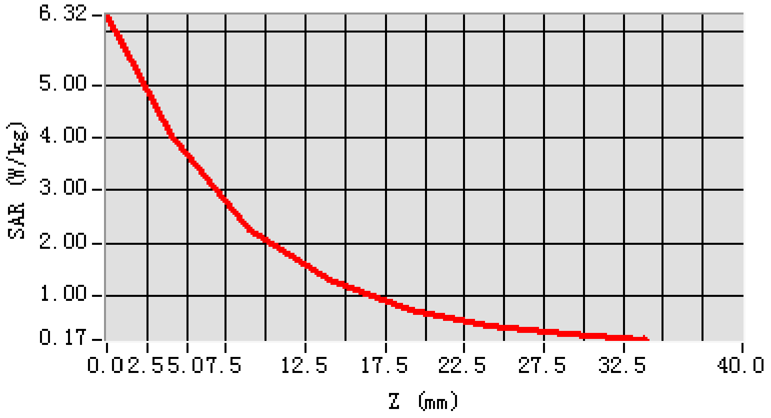
Frequency (MHz)	1900.000000
Relative permittivity (real part)	38.348211
Relative permittivity (imaginary part)	13.723397
Conductivity (S/m)	1.448581
Variation (%)	1.570000

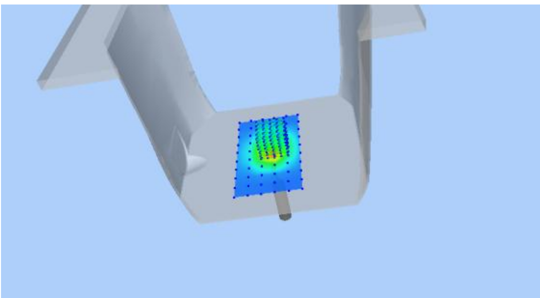
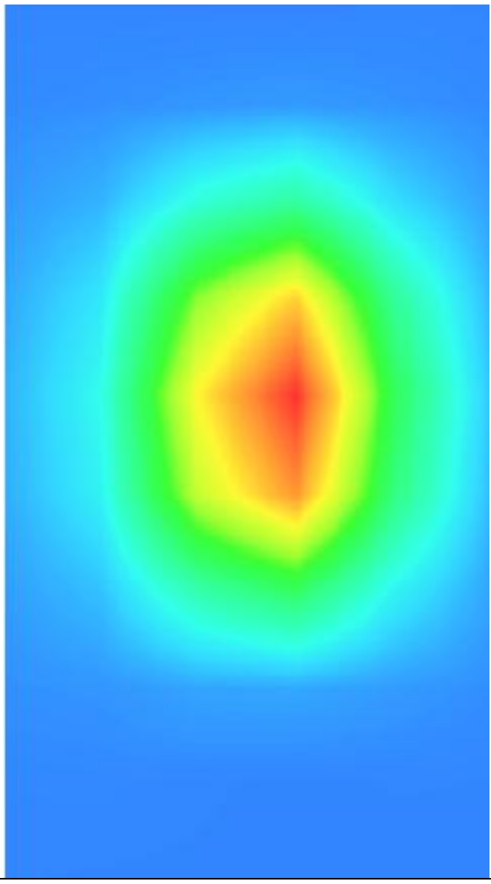
SURFACE SAR	VOLUME SAR
	

Maximum location: X=5.00, Y=2.00
SAR Peak: 6.70 W/kg

SAR 10g (W/Kg)	1.876172
SAR 1g (W/Kg)	3.671128

Z (mm)	0.00	4.00	9.00	14.00	19.00	24.00	29.00
SAR (W/Kg)	6.3140	4.0411	2.2654	1.3012	0.7668	0.4541	0.2783



3D screen shot	Hot spot position
	

13. Appendix C. Plots of High SAR Measurement

Table of contents

MEASUREMENT 1

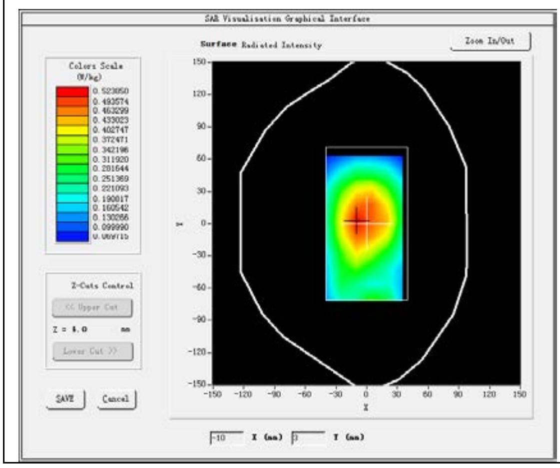
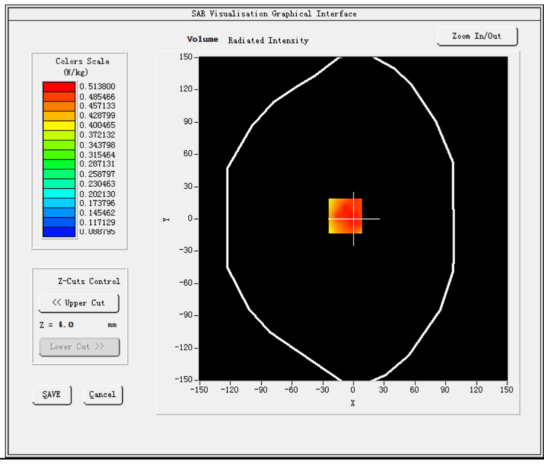
Date of measurement: 6/1/2020

A. Experimental conditions.

Area Scan	dx=15mm dy=15mm, h= 5.00 mm
ZoomScan	5x5x7,dx=8mm dy=8mm dz=5mm
Phantom	Validation plane
Device Position	Body
Band	GSM850
Channels	Middle
Signal	TDMA (Crest factor: 2.0)

B. SAR Measurement Results

Frequency (MHz)	836.400000
Relative permittivity (real part)	54.339581
Relative permittivity (imaginary part)	21.822741
Conductivity (S/m)	1.014030
Variation (%)	0.020000

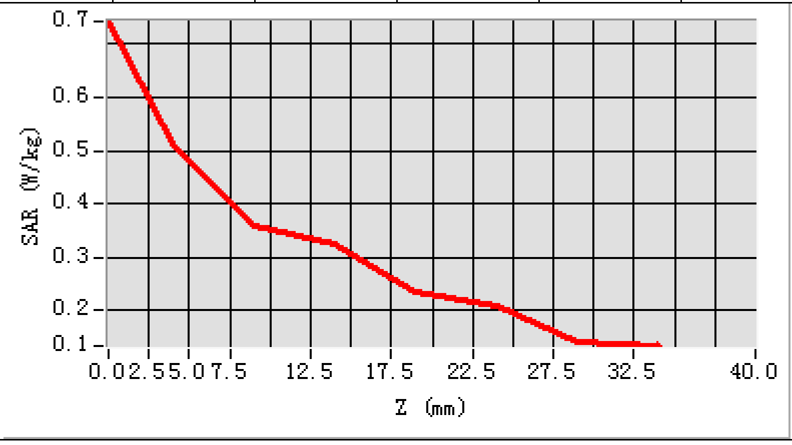
SURFACE SAR	VOLUME SAR
	

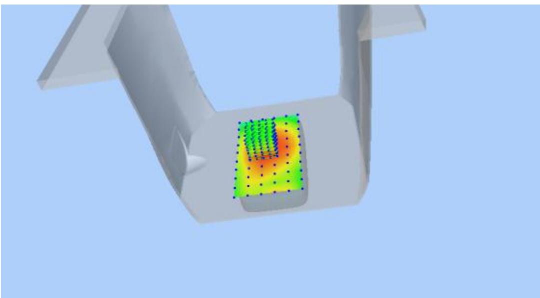
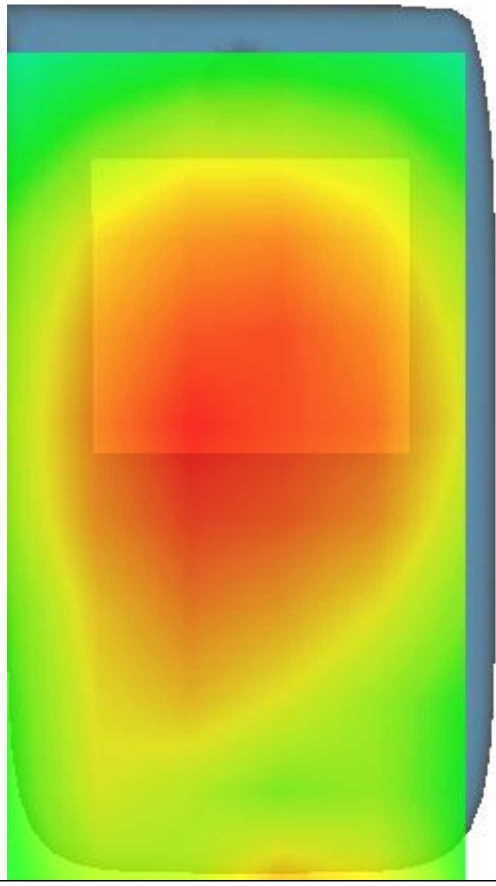
Maximum location: X=-8.00, Y=3.00

SAR Peak: 0.68 W/kg

SAR 10g (W/Kg)	0.355654
SAR 1g (W/Kg)	0.477624

Z (mm)	0.00	4.00	9.00	14.00	19.00	24.00	29.00
SAR (W/Kg)	0.7433	0.5138	0.3601	0.3245	0.2349	0.2074	0.1387



3D screen shot	Hot spot position
	

MEASUREMENT 2

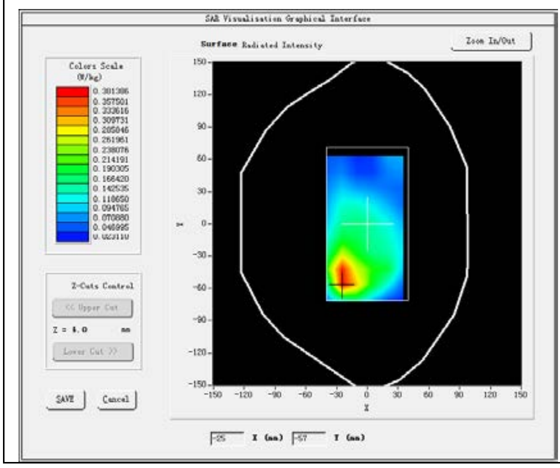
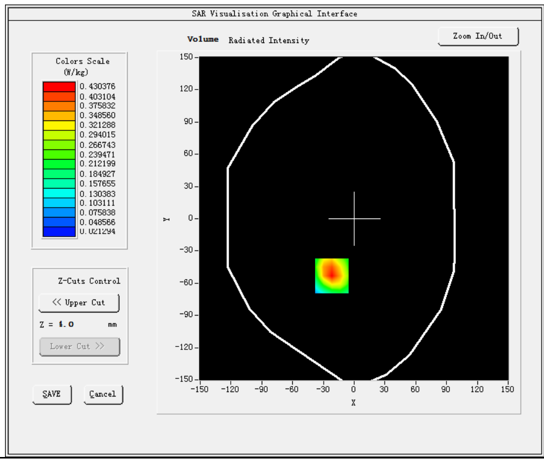
Date of measurement: 8/1/2020

A. Experimental conditions.

Area Scan	dx=15mm dy=15mm, h= 5.00 mm
ZoomScan	5x5x7,dx=8mm dy=8mm dz=5mm
Phantom	Validation plane
Device Position	Body
Band	GSM1900
Channels	Middle
Signal	TDMA (Crest factor: 2.0)

B. SAR Measurement Results

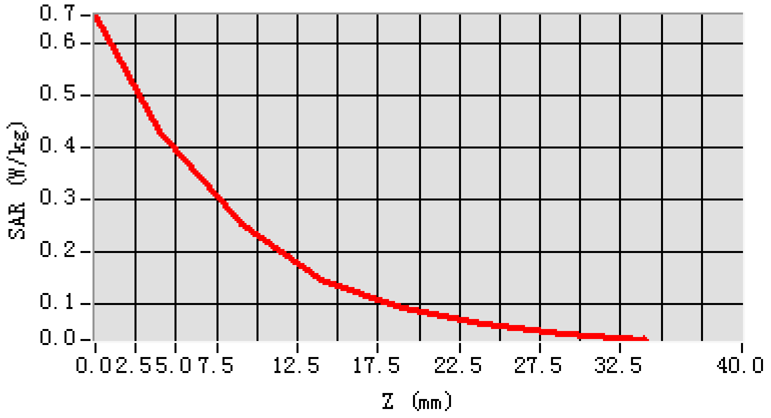
Frequency (MHz)	1880.000000
Relative permittivity (real part)	53.138901
Relative permittivity (imaginary part)	14.807700
Conductivity (S/m)	1.546582
Variation (%)	1.150000

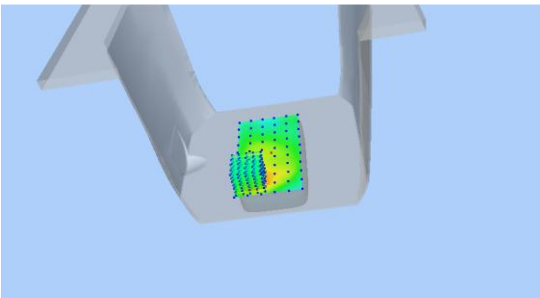
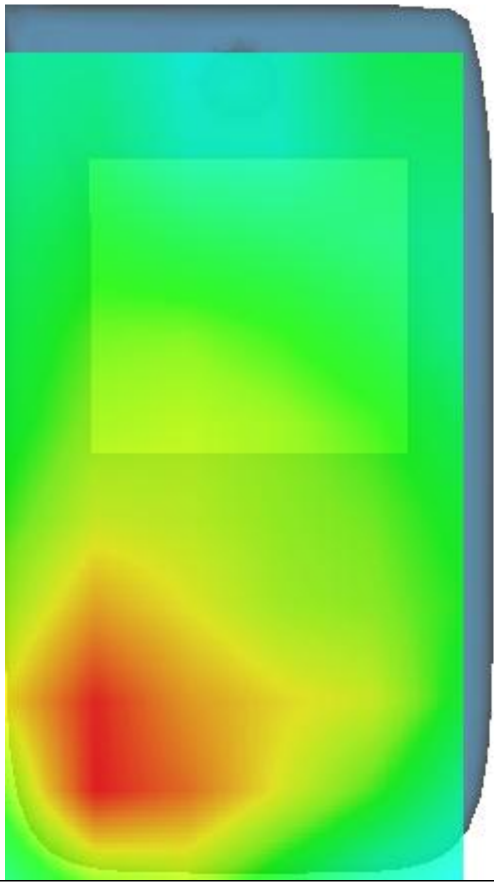
SURFACE SAR	VOLUME SAR
	

Maximum location: X=-22.00, Y=-53.00
SAR Peak: 0.65 W/kg

SAR 10g (W/Kg)	0.226112
SAR 1g (W/Kg)	0.401619

Z (mm)	0.00	4.00	9.00	14.00	19.00	24.00	29.00
SAR (W/Kg)	0.6529	0.4304	0.2521	0.1477	0.0922	0.0618	0.0426



3D screen shot	Hot spot position
	

MEASUREMENT 3

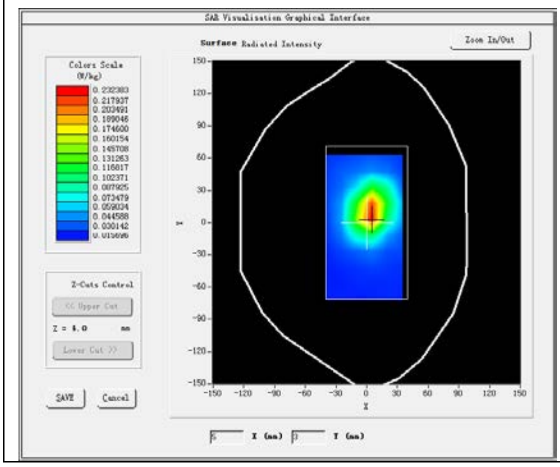
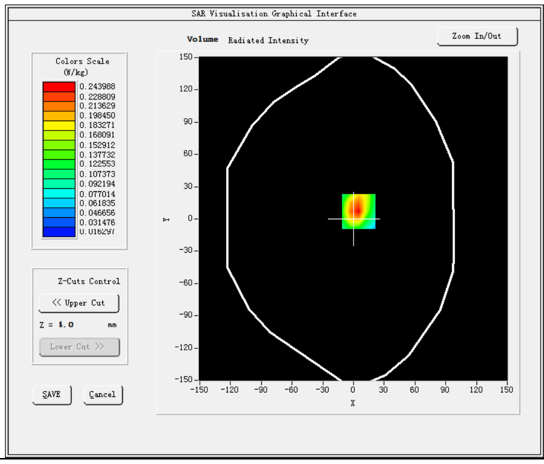
Date of measurement: 8/1/2020

A. Experimental conditions.

Area Scan	dx=15mm dy=15mm, h= 5.00 mm
ZoomScan	5x5x7,dx=8mm dy=8mm dz=5mm
Phantom	Validation plane
Device Position	Body
Band	LTE band 2
Channels	Middle
Signal	LTE (Crest factor: 1.0)

B. SAR Measurement Results

Frequency (MHz)	1880.000000
Relative permittivity (real part)	52.585949
Relative permittivity (imaginary part)	14.946150
Conductivity (S/m)	1.560627
Variation (%)	-0.870000

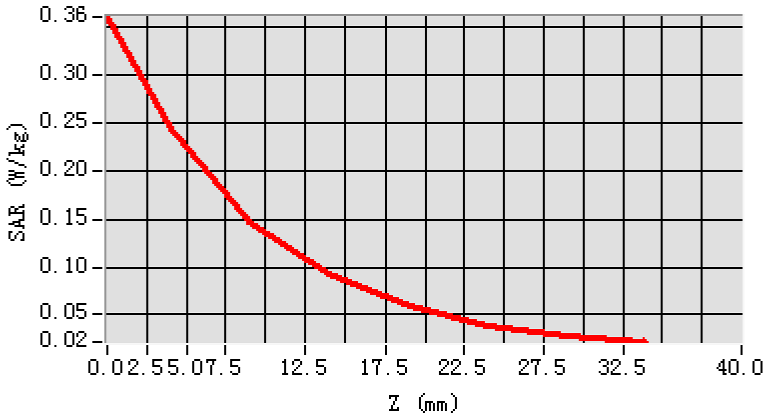
SURFACE SAR	VOLUME SAR
	

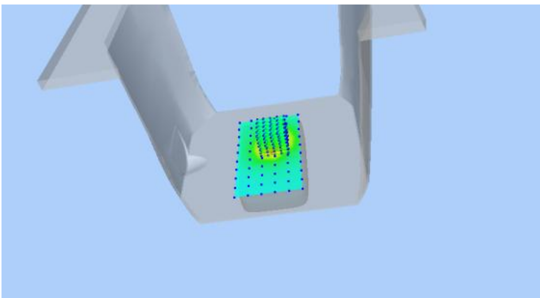
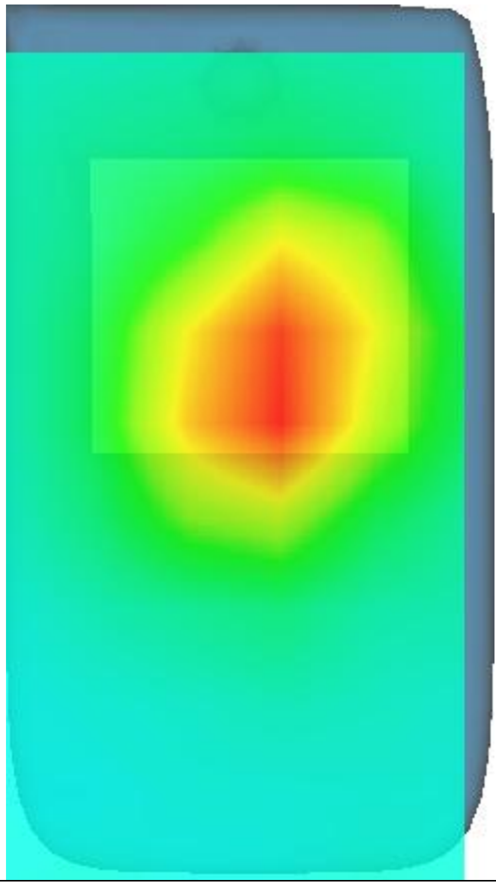
Maximum location: X=5.00, Y=7.00

SAR Peak: 0.36 W/kg

SAR 10g (W/Kg)	0.129528
SAR 1g (W/Kg)	0.232738

Z (mm)	0.00	4.00	9.00	14.00	19.00	24.00	29.00
SAR (W/Kg)	0.3599	0.2440	0.1476	0.0935	0.0589	0.0390	0.0291



3D screen shot	Hot spot position
	

MEASUREMENT 4

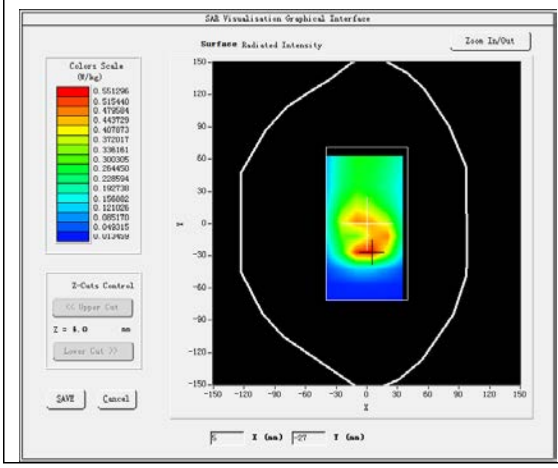
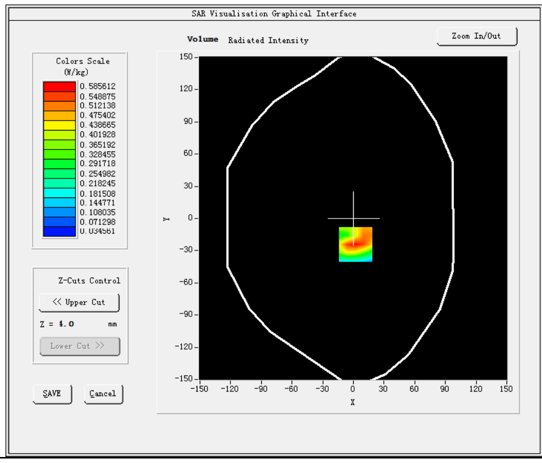
Date of measurement: 7/1/2020

A. Experimental conditions.

Area Scan	dx=15mm dy=15mm, h= 5.00 mm
ZoomScan	5x5x7,dx=8mm dy=8mm dz=5mm
Phantom	Validation plane
Device Position	Body
Band	Band4_WCDMA1700
Channels	Middle
Signal	WCDMA (Crest factor: 1.0)

B. SAR Measurement Results

Frequency (MHz)	1732.600000
Relative permittivity (real part)	54.116165
Relative permittivity (imaginary part)	15.391370
Conductivity (S/m)	1.480992
Variation (%)	-0.900000

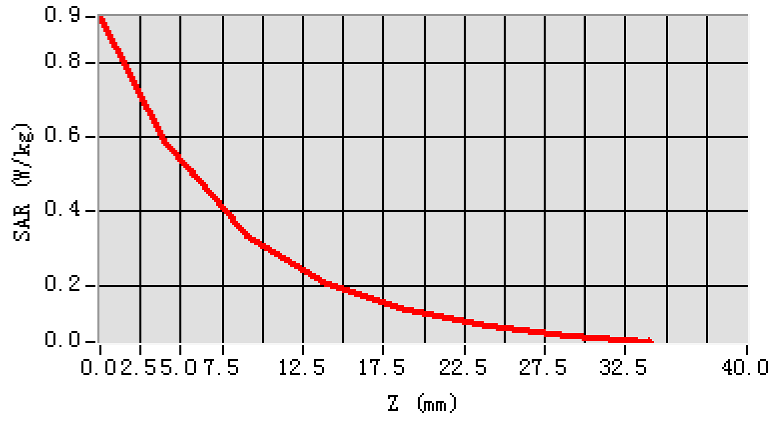
SURFACE SAR	VOLUME SAR
	

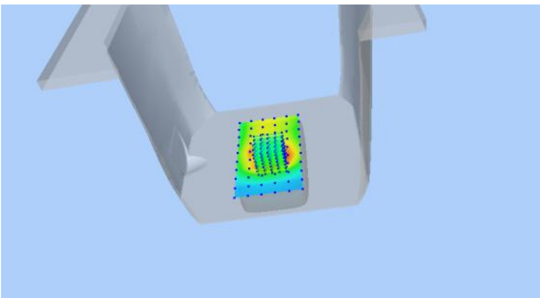
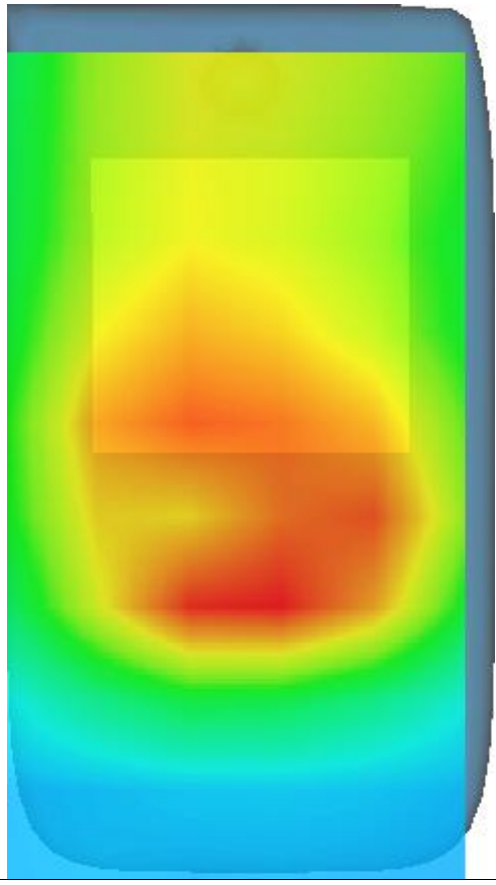
Maximum location: X=2.00, Y=-24.00

SAR Peak: 0.95 W/kg

SAR 10g (W/Kg)	0.266050
SAR 1g (W/Kg)	0.515668

Z (mm)	0.00	4.00	9.00	14.00	19.00	24.00	29.00
SAR (W/Kg)	0.9245	0.5856	0.3311	0.2027	0.1307	0.0882	0.0610



3D screen shot	Hot spot position
	

MEASUREMENT 5

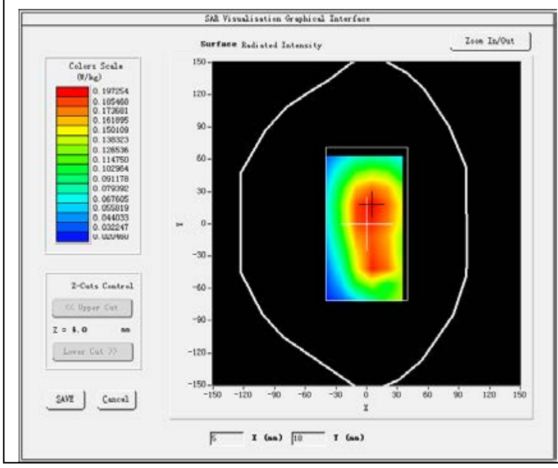
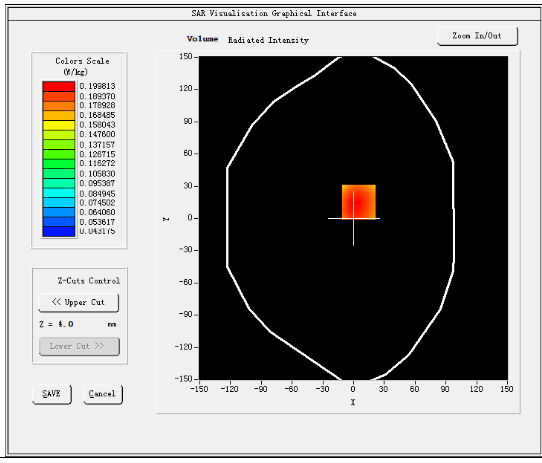
Date of measurement: 6/1/2020

A. Experimental conditions.

Area Scan	dx=15mm dy=15mm, h= 5.00 mm
ZoomScan	5x5x7,dx=8mm dy=8mm dz=5mm
Phantom	Validation plane
Device Position	Body
Band	Band5_WCDMA850
Channels	Middle
Signal	WCDMA (Crest factor: 1.0)

B. SAR Measurement Results

Frequency (MHz)	836.500000
Relative permittivity (real part)	54.779579
Relative permittivity (imaginary part)	21.622740
Conductivity (S/m)	1.004737
Variation (%)	0.340000

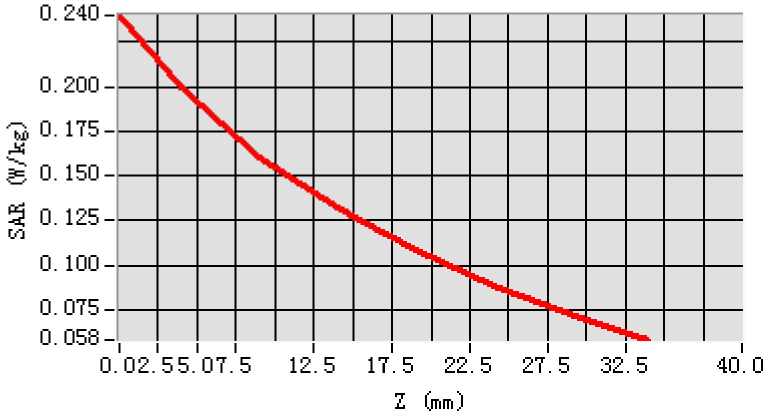
SURFACE SAR	VOLUME SAR
	

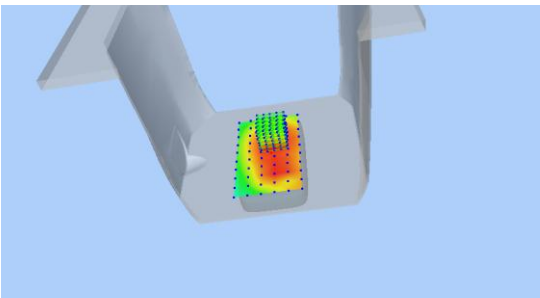
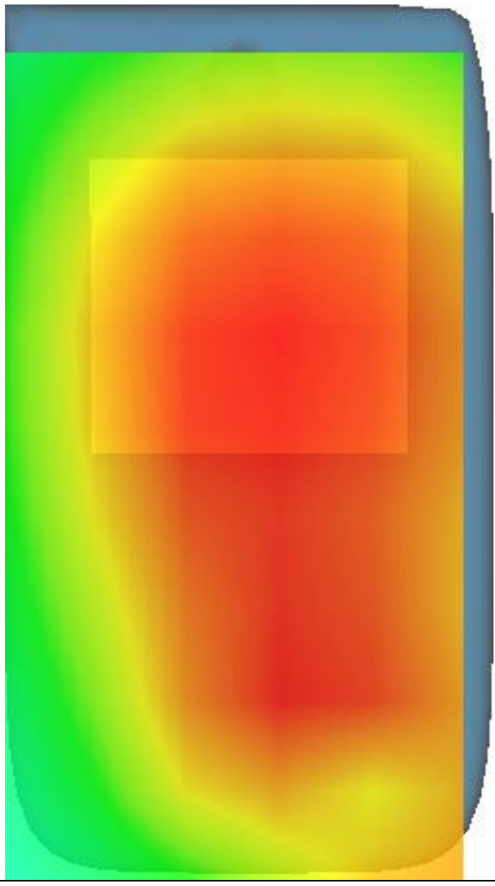
Maximum location: X=5.00, Y=15.00

SAR Peak: 0.24 W/kg

SAR 10g (W/Kg)	0.155004
SAR 1g (W/Kg)	0.201216

Z (mm)	0.00	4.00	9.00	14.00	19.00	24.00	29.00
SAR (W/Kg)	0.2400	0.1998	0.1608	0.1320	0.1086	0.0880	0.0726



3D screen shot	Hot spot position
	

MEASUREMENT 6

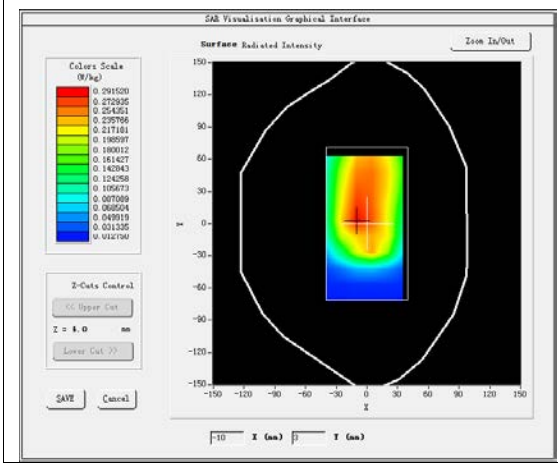
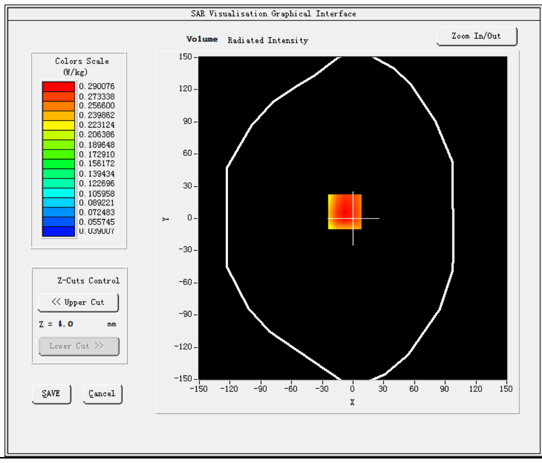
Date of measurement: 5/1/2020

A. Experimental conditions.

Area Scan	dx=15mm dy=15mm, h= 5.00 mm
ZoomScan	5x5x7,dx=8mm dy=8mm dz=5mm
Phantom	Validation plane
Device Position	Body
Band	LTE band 12
Channels	Middle
Signal	LTE (Crest factor: 1.0)

B. SAR Measurement Results

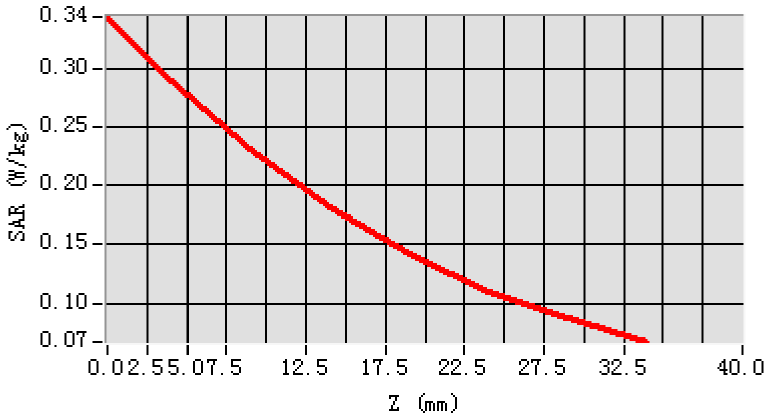
Frequency (MHz)	707.500000
Relative permittivity (real part)	55.715910
Relative permittivity (imaginary part)	23.711100
Conductivity (S/m)	0.931978
Variation (%)	1.920000

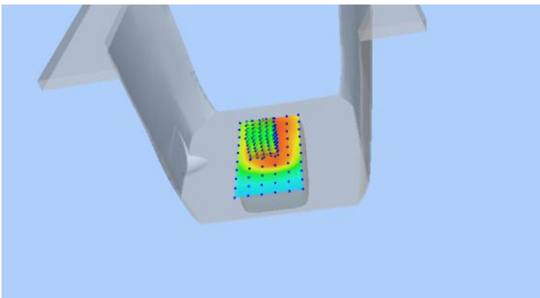
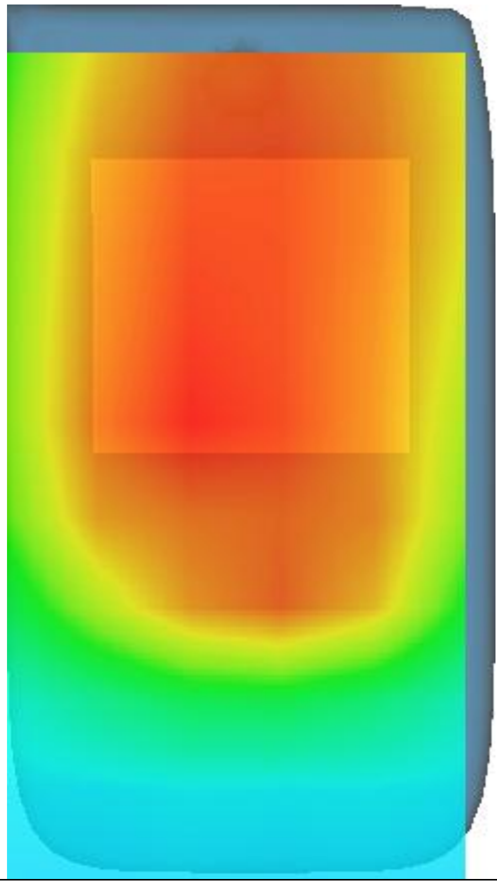
SURFACE SAR	VOLUME SAR
	

Maximum location: X=-8.00, Y=6.00
SAR Peak: 0.36 W/kg

SAR 10g (W/Kg)	0.193128
SAR 1g (W/Kg)	0.236844

Z (mm)	0.00	4.00	9.00	14.00	19.00	24.00	29.00
SAR (W/Kg)	0.3447	0.2901	0.2308	0.1814	0.1429	0.1092	0.0867



3D screen shot	Hot spot position
	

MEASUREMENT 7

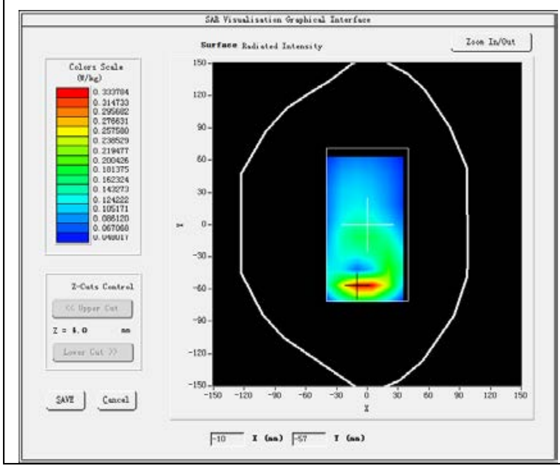
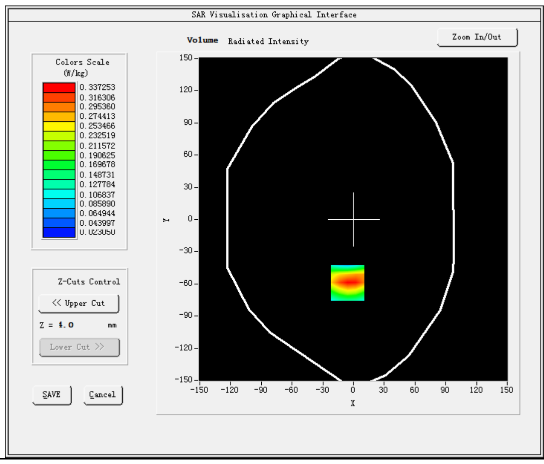
Date of measurement: 5/1/2020

A. Experimental conditions.

Area Scan	dx=15mm dy=15mm, h= 5.00 mm
ZoomScan	5x5x7,dx=8mm dy=8mm dz=5mm
Phantom	Validation plane
Device Position	Body
Band	LTE band 13
Channels	Middle
Signal	LTE (Crest factor: 1.0)

B. SAR Measurement Results

Frequency (MHz)	782.000000
Relative permittivity (real part)	54.779910
Relative permittivity (imaginary part)	23.037000
Conductivity (S/m)	1.000830
Variation (%)	-0.640000

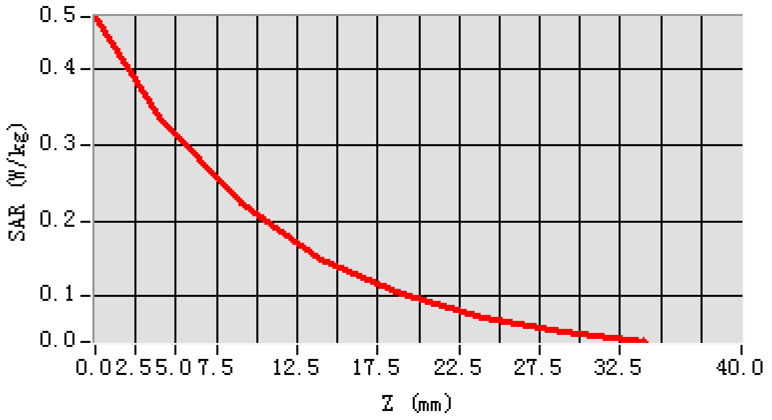
SURFACE SAR	VOLUME SAR
	

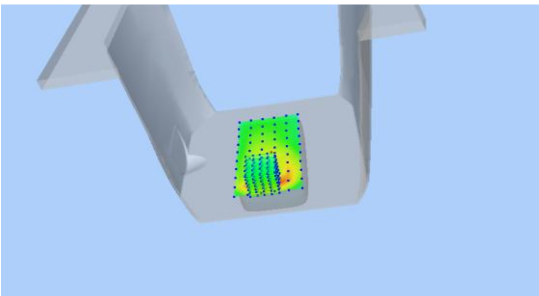
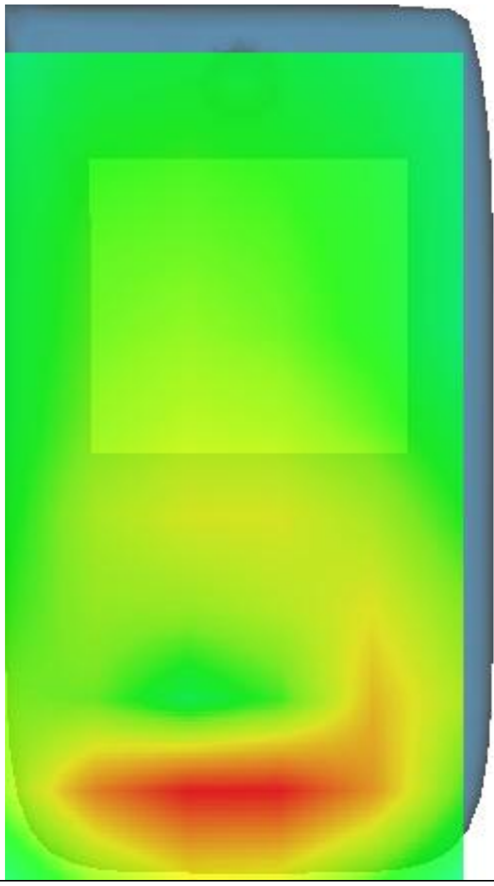
Maximum location: X=-6.00, Y=-59.00

SAR Peak: 0.50 W/kg

SAR 10g (W/Kg)	0.193522
SAR 1g (W/Kg)	0.321695

Z (mm)	0.00	4.00	9.00	14.00	19.00	24.00	29.00
SAR (W/Kg)	0.4702	0.3343	0.2228	0.1481	0.1024	0.0711	0.0534



3D screen shot	Hot spot position
	

MEASUREMENT 8

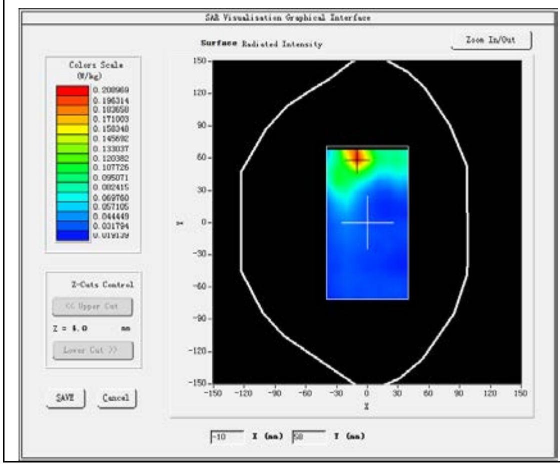
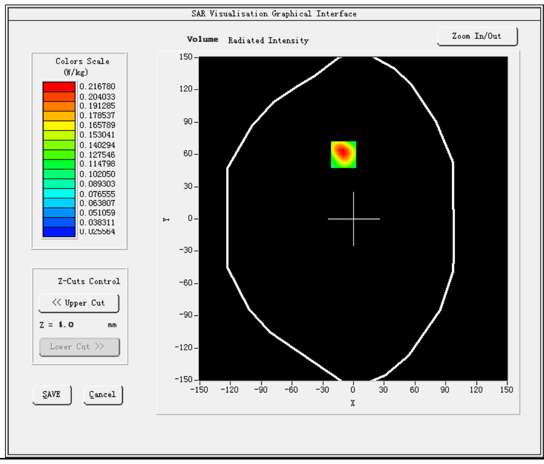
Date of measurement: 7/1/2020

A. Experimental conditions.

Area Scan	dx=12mm dy=12mm, h= 5.00 mm
ZoomScan	7x7x7,dx=5mm dy=5mm dz=5mm
Phantom	Validation plane
Device Position	Body
Band	IEEE 802.11b ISM
Channels	Middle
Signal	IEEE802.11b (Crest factor: 1.0)

B. SAR Measurement Results

Frequency (MHz)	2437.000000
Relative permittivity (real part)	52.241600
Relative permittivity (imaginary part)	14.875620
Conductivity (S/m)	2.013994
Variation (%)	-0.530000

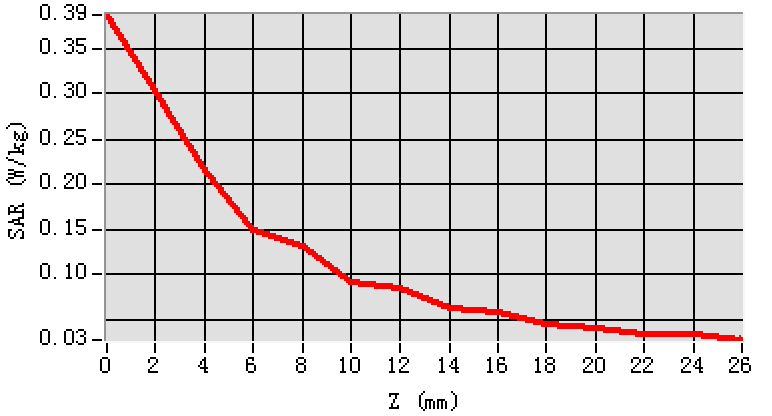
SURFACE SAR	VOLUME SAR
	

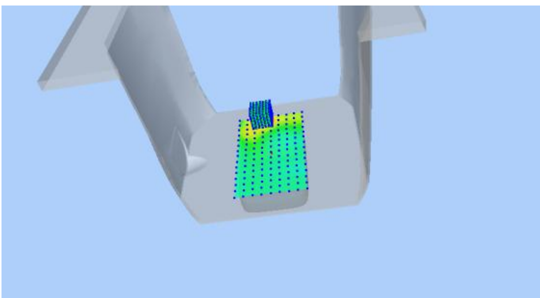
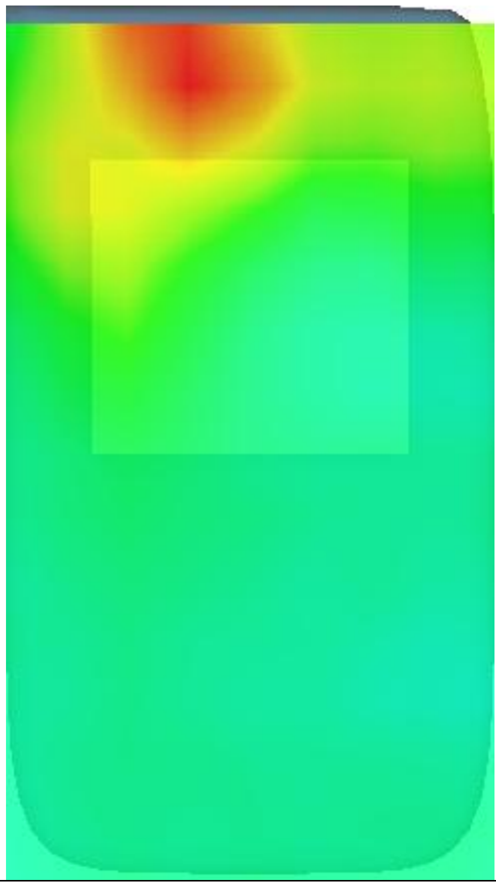
Maximum location: X=-10.00, Y=60.00

SAR Peak: 0.35 W/kg

SAR 10g (W/Kg)	0.106912
SAR 1g (W/Kg)	0.205372

Z (mm)	0.00	4.00	6.00	8.00	10.00	12.00	14.00	16.00	18.00	20.00	22.00	24.00
SAR (W/Kg)	0.3869	0.2152	0.1514	0.1303	0.0955	0.0846	0.0626	0.0588	0.0442	0.0419	0.0318	0.0342



3D screen shot	Hot spot position
	

MEASUREMENT 9

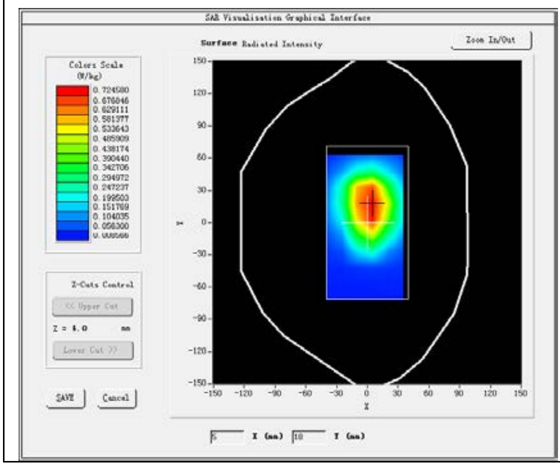
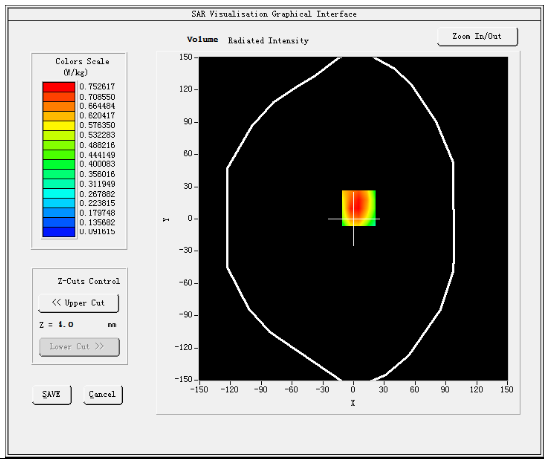
Date of measurement: 1/7/2022

A. Experimental conditions.

Area Scan	dx=15mm dy=15mm, h= 5.00 mm
ZoomScan	5x5x7,dx=8mm dy=8mm dz=5mm
Phantom	Validation plane
Device Position	Body
Band	GSM850
Channels	Middle
Signal	TDMA (Crest factor: 2.0)

B. SAR Measurement Results

Frequency (MHz)	836.400000
Relative permittivity (real part)	41.663715
Relative permittivity (imaginary part)	19.730305
Conductivity (S/m)	0.916802
Variation (%)	-3.430000

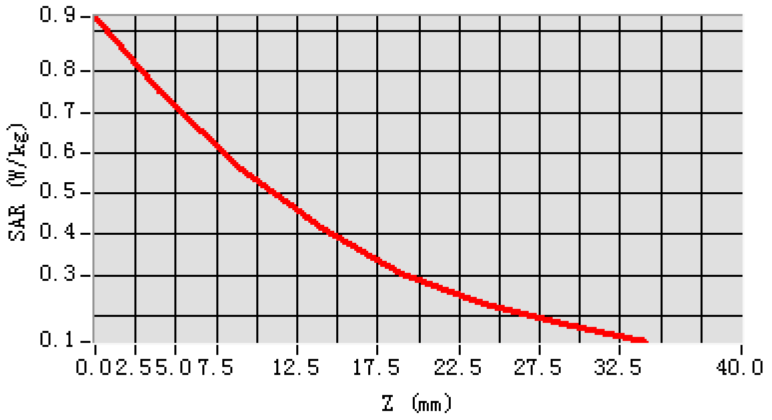
SURFACE SAR	VOLUME SAR
	

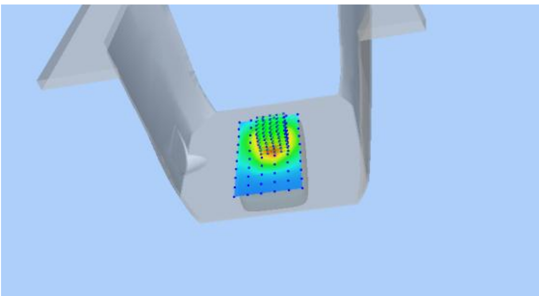
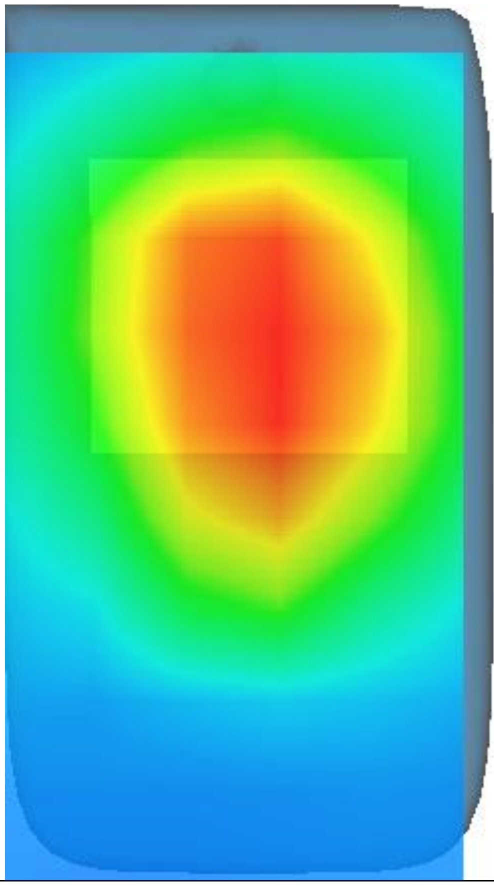
Maximum location: X=5.00, Y=10.00

SAR Peak: 1.00 W/kg

SAR 10g (W/Kg)	0.508824
SAR 1g (W/Kg)	0.741868

Z (mm)	0.00	4.00	9.00	14.00	19.00	24.00	29.00
SAR (W/Kg)	0.9346	0.7526	0.5611	0.4146	0.3048	0.2283	0.1784



3D screen shot	Hot spot position
	

MEASUREMENT 10

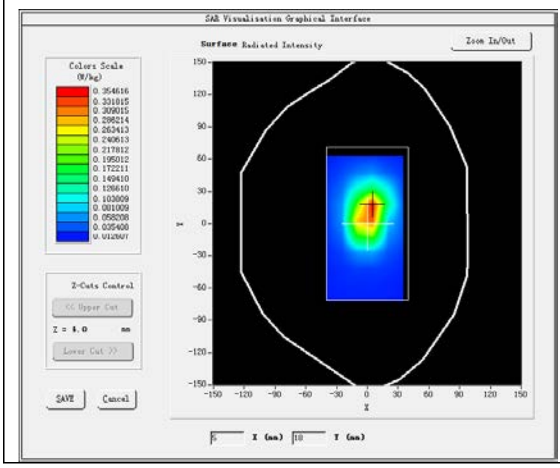
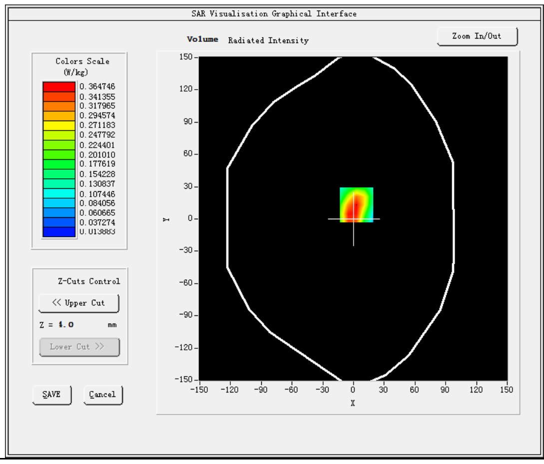
Date of measurement: 30/6/2022

A. Experimental conditions.

Area Scan	dx=15mm dy=15mm, h= 5.00 mm
ZoomScan	5x5x7,dx=8mm dy=8mm dz=5mm
Phantom	Validation plane
Device Position	Body
Band	GSM1900
Channels	Middle
Signal	TDMA (Crest factor: 2.0)

B. SAR Measurement Results

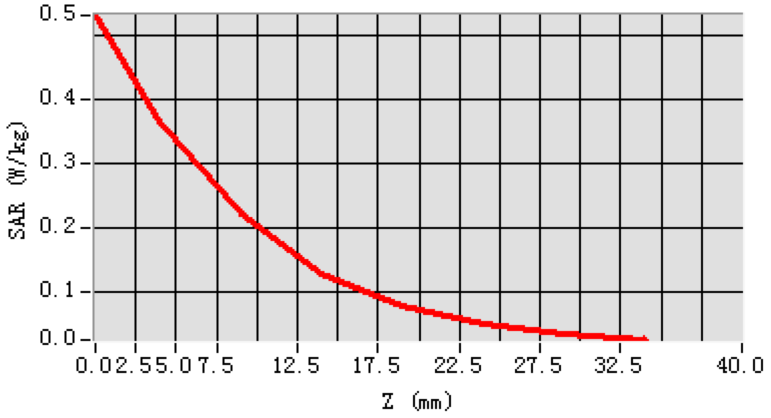
Frequency (MHz)	1880.000000
Relative permittivity (real part)	38.434612
Relative permittivity (imaginary part)	13.741197
Conductivity (S/m)	1.435192
Variation (%)	-1.630000

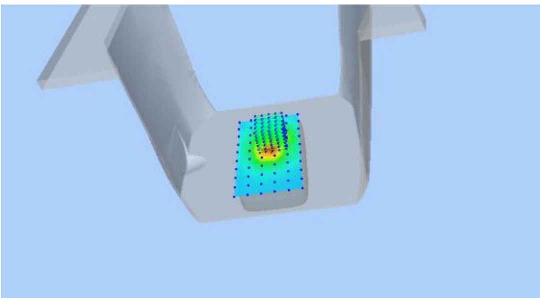
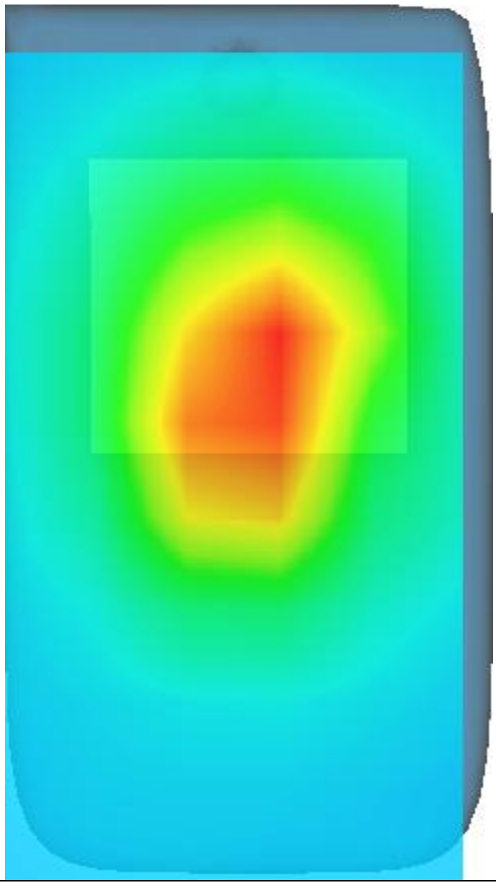
SURFACE SAR	VOLUME SAR
	

Maximum location: X=3.00, Y=13.00
SAR Peak: 0.55 W/kg

SAR 10g (W/Kg)	0.199918
SAR 1g (W/Kg)	0.362288

Z (mm)	0.00	4.00	9.00	14.00	19.00	24.00	29.00
SAR (W/Kg)	0.5308	0.3647	0.2221	0.1267	0.0770	0.0479	0.0320



3D screen shot	Hot spot position
	

MEASUREMENT 11

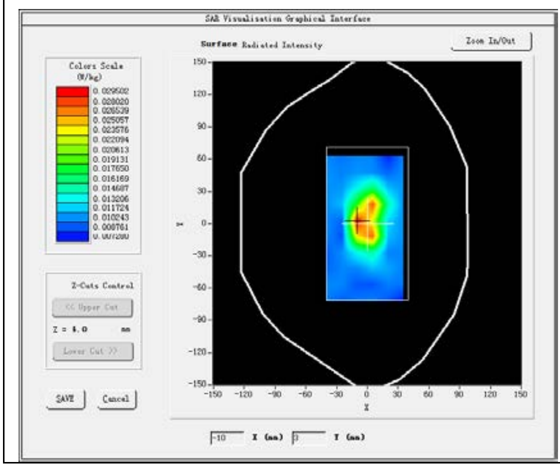
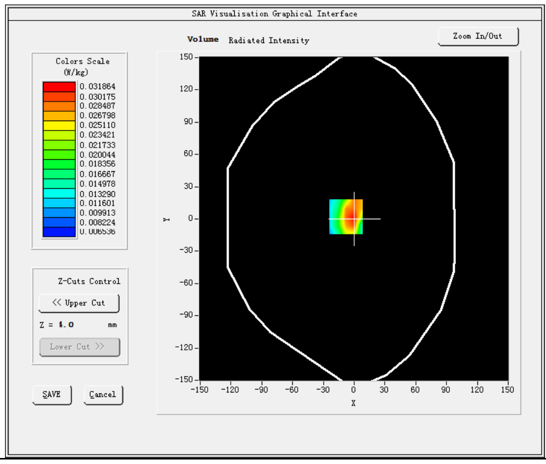
Date of measurement: 30/6/2022

A. Experimental conditions.

Area Scan	dx=15mm dy=15mm, h= 5.00 mm
ZoomScan	5x5x7,dx=8mm dy=8mm dz=5mm
Phantom	Validation plane
Device Position	Body
Band	LTE band 2
Channels	Middle
Signal	(Crest factor: 1.0)

B. SAR Measurement Results

Frequency (MHz)	1880.000000
Relative permittivity (real part)	38.434612
Relative permittivity (imaginary part)	13.741197
Conductivity (S/m)	1.435192
Variation (%)	-4.510000

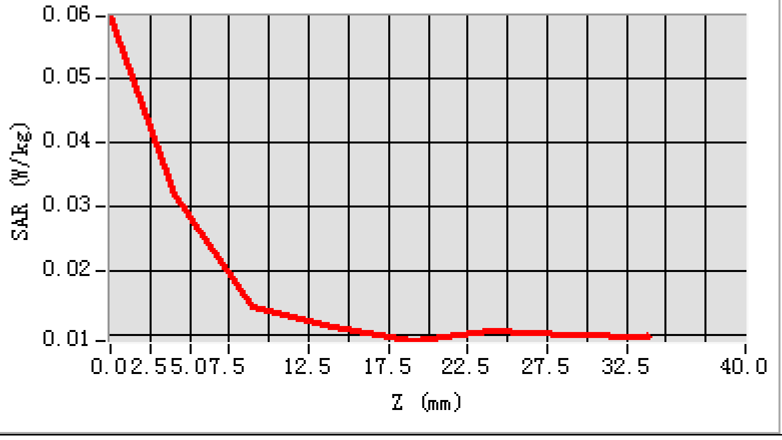
SURFACE SAR	VOLUME SAR
	

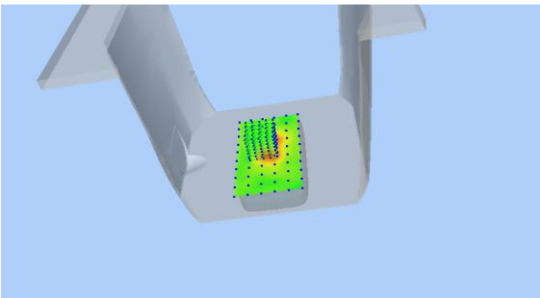
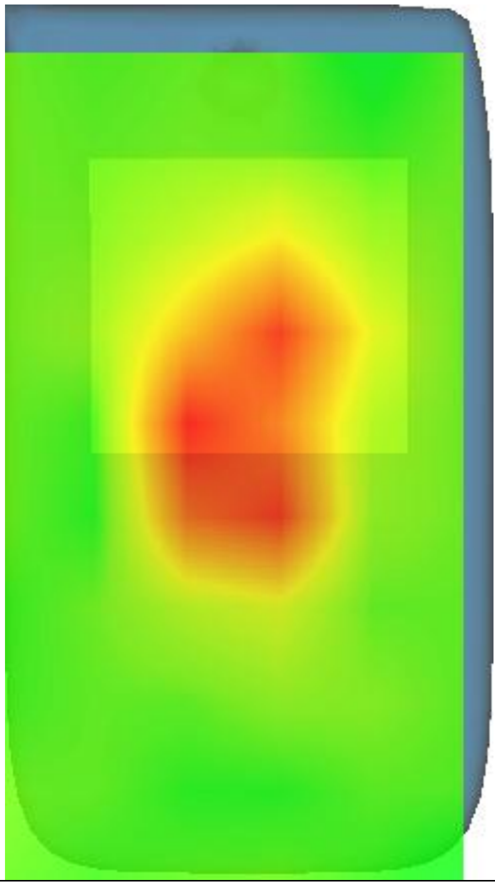
Maximum location: X=-8.00, Y=2.00

SAR Peak: 0.04 W/kg

SAR 10g (W/Kg)	0.019147
SAR 1g (W/Kg)	0.030028

Z (mm)	0.00	4.00	9.00	14.00	19.00	24.00	29.00
SAR (W/Kg)	0.0598	0.0319	0.0143	0.0112	0.0089	0.0104	0.0100



3D screen shot	Hot spot position
	

MEASUREMENT 12

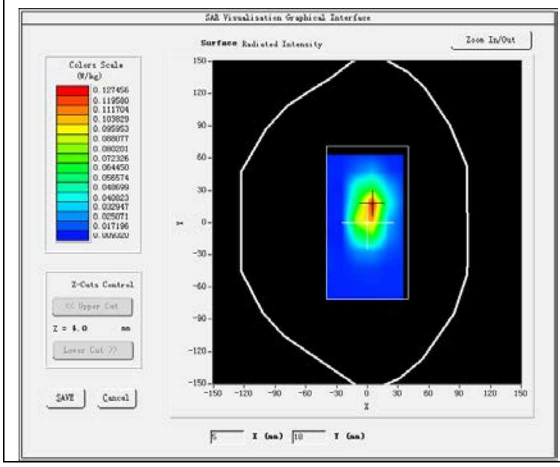
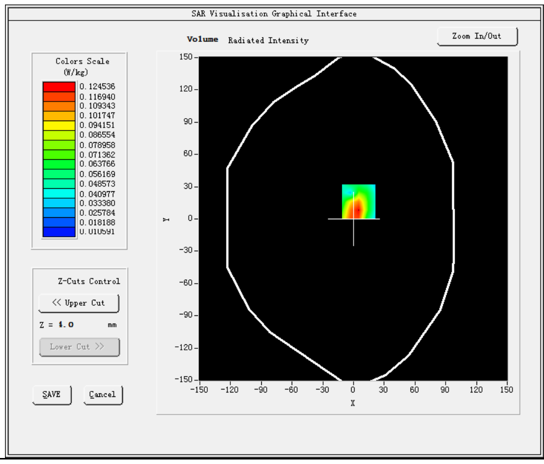
Date of measurement: 27/6/2022

A. Experimental conditions.

Area Scan	dx=15mm dy=15mm, h= 5.00 mm
ZoomScan	5x5x7,dx=8mm dy=8mm dz=5mm
Phantom	Validation plane
Device Position	Body
Band	LTE band 4
Channels	Middle
Signal	(Crest factor: 1.0)

B. SAR Measurement Results

Frequency (MHz)	1732.500000
Relative permittivity (real part)	39.031860
Relative permittivity (imaginary part)	13.647733
Conductivity (S/m)	1.313594
Variation (%)	1.460000

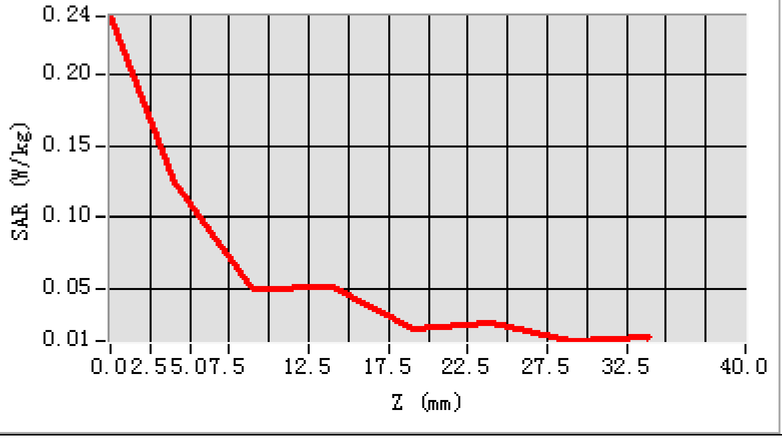
SURFACE SAR	VOLUME SAR
	

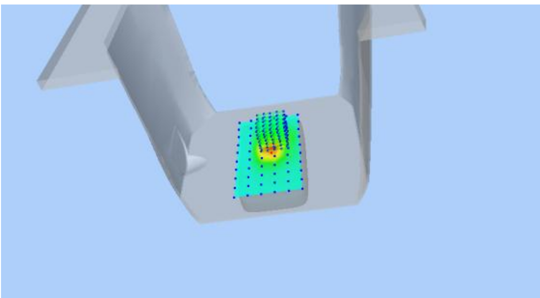
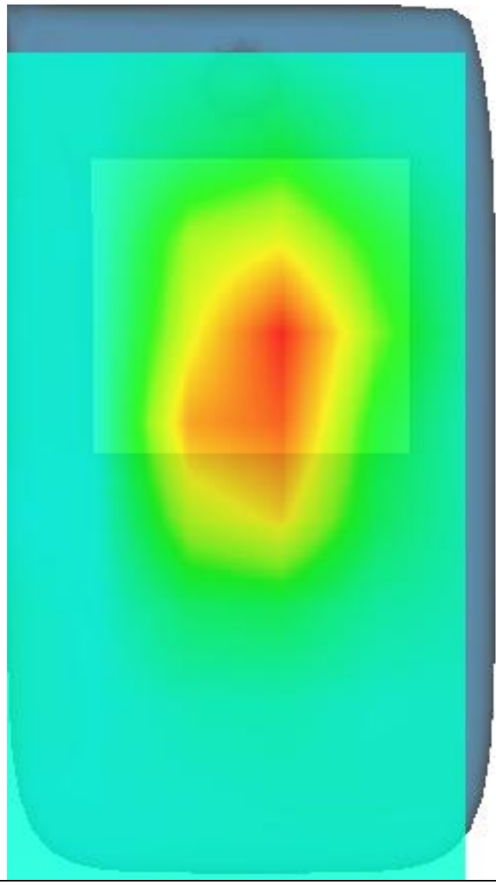
Maximum location: X=5.00, Y=16.00

SAR Peak: 0.19 W/kg

SAR 10g (W/Kg)	0.066399
SAR 1g (W/Kg)	0.118040

Z (mm)	0.00	4.00	9.00	14.00	19.00	24.00	29.00
SAR (W/Kg)	0.2408	0.1245	0.0505	0.0523	0.0225	0.0260	0.0139



3D screen shot	Hot spot position
	

MEASUREMENT 13

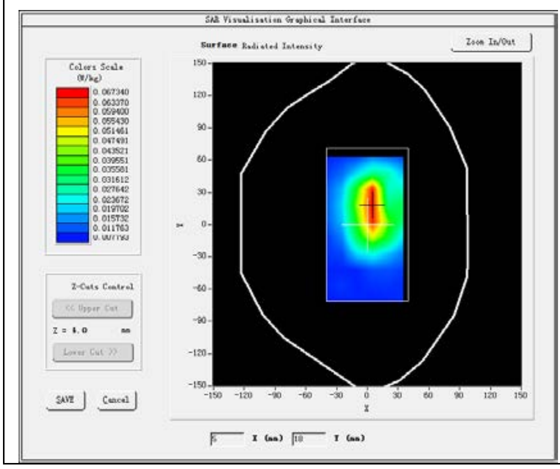
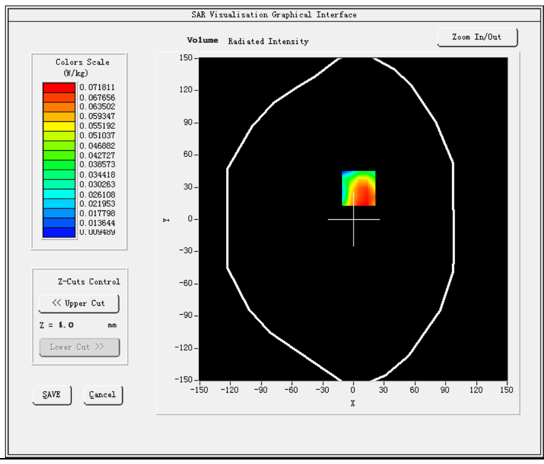
Date of measurement: 1/7/2022

A. Experimental conditions.

Area Scan	dx=15mm dy=15mm, h= 5.00 mm
ZoomScan	5x5x7,dx=8mm dy=8mm dz=5mm
Phantom	Validation plane
Device Position	Body
Band	LTE band 5
Channels	Middle
Signal	(Crest factor: 1.0)

B. SAR Measurement Results

Frequency (MHz)	836.500000
Relative permittivity (real part)	41.563744
Relative permittivity (imaginary part)	19.410902
Conductivity (S/m)	0.902068
Variation (%)	-2.630000

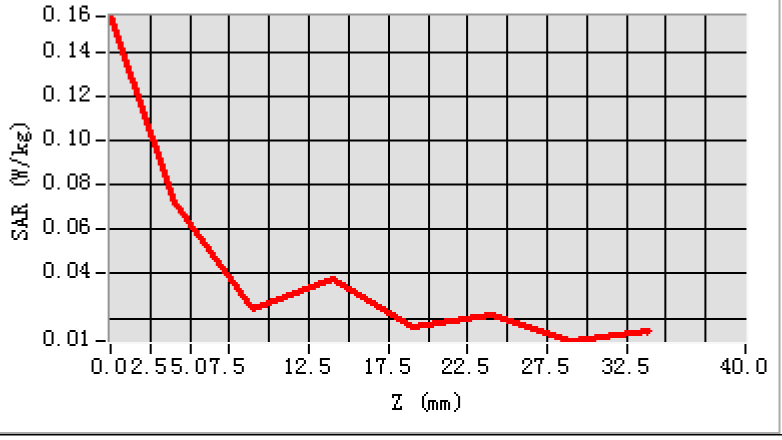
SURFACE SAR	VOLUME SAR
	

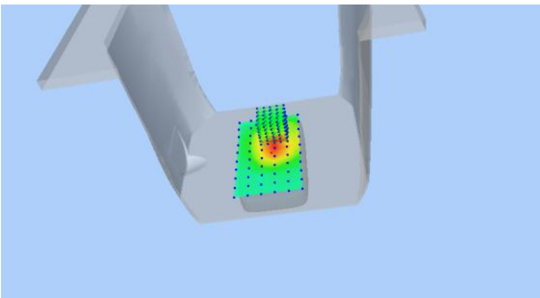
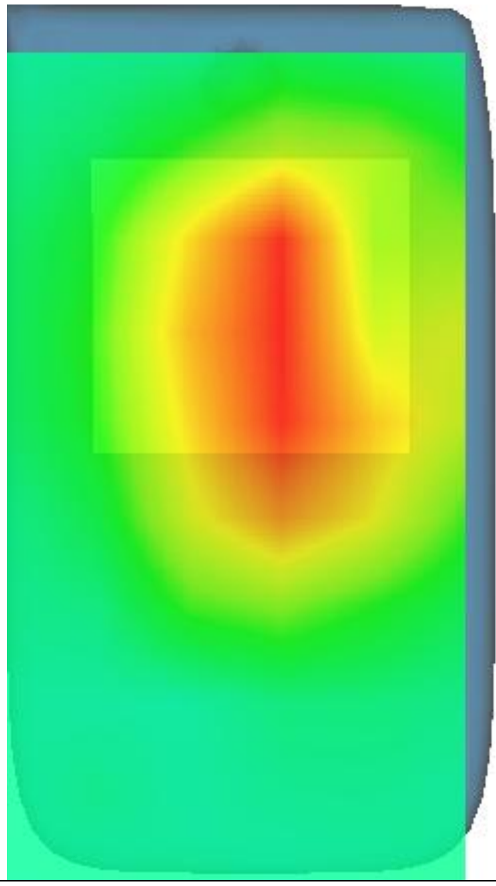
Maximum location: X=5.00, Y=29.00

SAR Peak: 0.14 W/kg

SAR 10g (W/Kg)	0.044955
SAR 1g (W/Kg)	0.074863

Z (mm)	0.00	4.00	9.00	14.00	19.00	24.00	29.00
SAR (W/Kg)	0.1563	0.0718	0.0241	0.0373	0.0158	0.0218	0.0096



3D screen shot	Hot spot position
	

MEASUREMENT 14

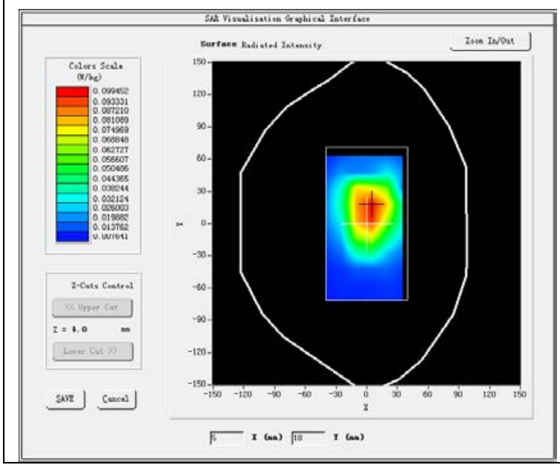
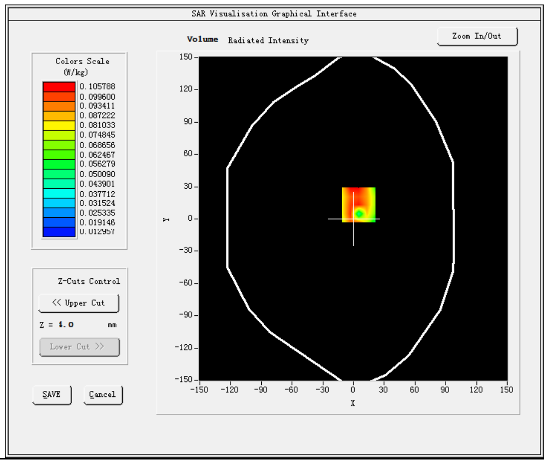
Date of measurement: 28/6/2022

A. Experimental conditions.

Area Scan	dx=15mm dy=15mm, h= 5.00 mm
ZoomScan	5x5x7,dx=8mm dy=8mm dz=5mm
Phantom	Validation plane
Device Position	Body
Band	LTE band 12
Channels	Middle
Signal	(Crest factor: 1.0)

B. SAR Measurement Results

Frequency (MHz)	707.500000
Relative permittivity (real part)	41.025307
Relative permittivity (imaginary part)	21.562912
Conductivity (S/m)	0.847542
Variation (%)	1.470000

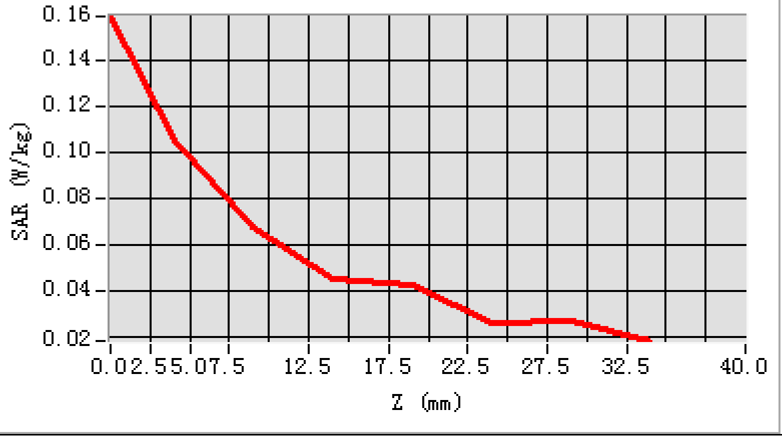
SURFACE SAR	VOLUME SAR
	

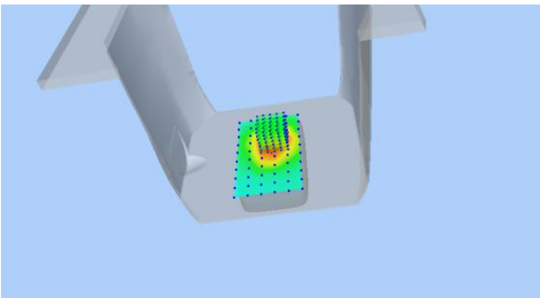
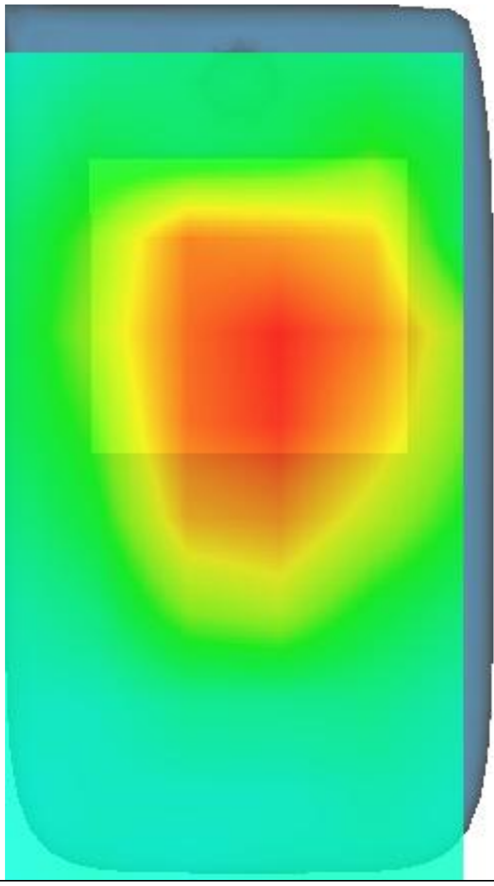
Maximum location: X=5.00, Y=13.00

SAR Peak: 0.25 W/kg

SAR 10g (W/Kg)	0.066609
SAR 1g (W/Kg)	0.112613

Z (mm)	0.00	4.00	9.00	14.00	19.00	24.00	29.00
SAR (W/Kg)	0.1592	0.1058	0.0677	0.0454	0.0427	0.0264	0.0270



3D screen shot	Hot spot position
	

MEASUREMENT 15

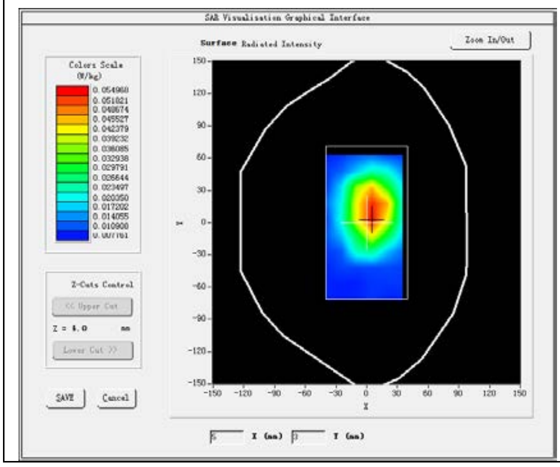
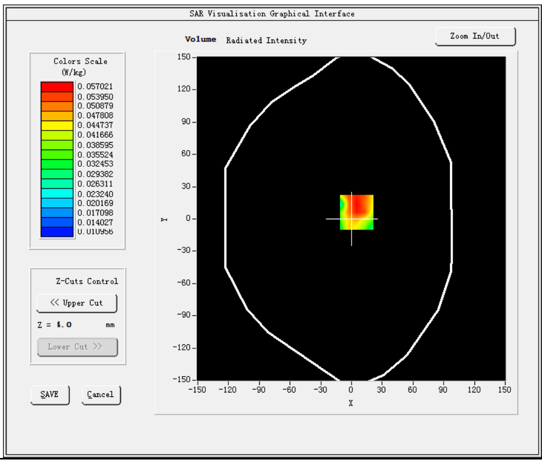
Date of measurement: 28/6/2022

A. Experimental conditions.

Area Scan	dx=15mm dy=15mm, h= 5.00 mm
ZoomScan	5x5x7,dx=8mm dy=8mm dz=5mm
Phantom	Validation plane
Device Position	Body
Band	eMTC band 13
Channels	Middle
Signal	(Crest factor: 1.0)

B. SAR Measurement Results

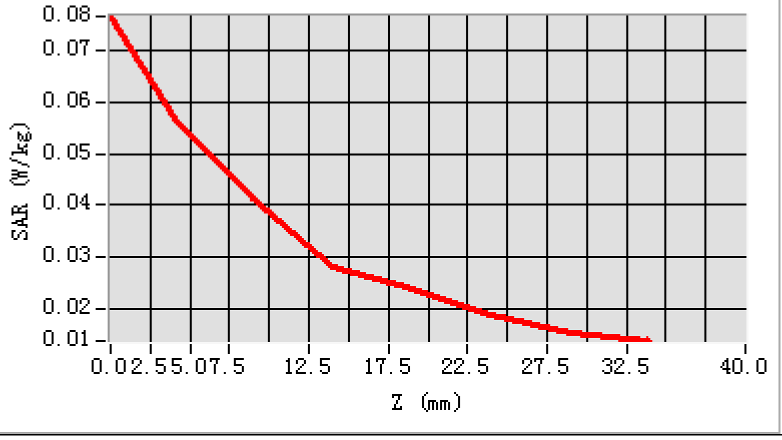
Frequency (MHz)	782.000000
Relative permittivity (real part)	40.137655
Relative permittivity (imaginary part)	20.820462
Conductivity (S/m)	0.904533
Variation (%)	2.950000

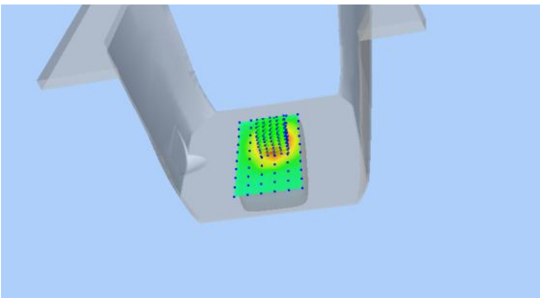
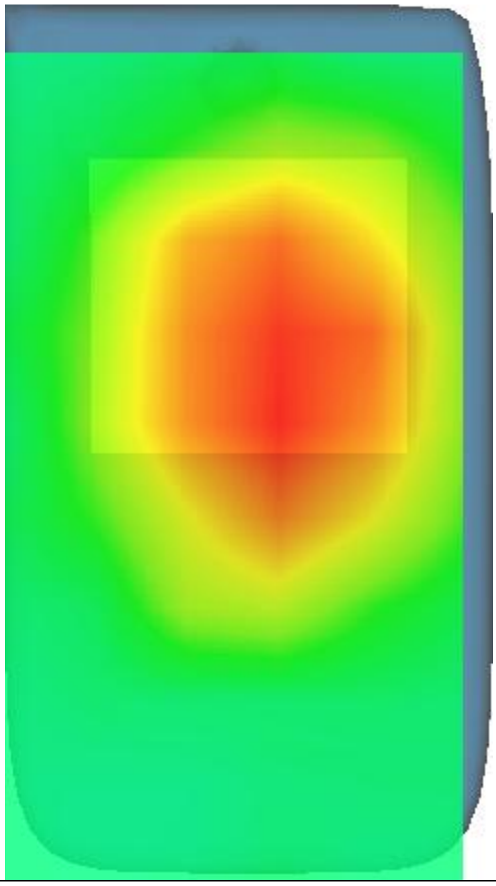
SURFACE SAR	VOLUME SAR
	

Maximum location: X=5.00, Y=6.00
SAR Peak: 0.08 W/kg

SAR 10g (W/Kg)	0.037249
SAR 1g (W/Kg)	0.054011

Z (mm)	0.00	4.00	9.00	14.00	19.00	24.00	29.00
SAR (W/Kg)	0.0768	0.0570	0.0414	0.0280	0.0237	0.0185	0.0151



3D screen shot	Hot spot position
	

14. Appendix D. Calibration Certificate

COMOSAR E-Field Probe Calibration Report

Ref : ACR.142.2.19.SATU.B

SHENZHEN NTEK TESTING TECHNOLOGY CO., LTD.
BUILDING E, FENDA SCIENCE PARK, SANWEI COMMUNITY, XIXIANG STREET,
BAO'AN DISTRICT, SHENZHEN GUANGDONG, CHINA
MVG COMOSAR DOSIMETRIC E-FIELD PROBE
SERIAL NO.: SN 41/18 EPGO330

Calibrated at MVG US
2105 Barrett Park Dr. - Kennesaw, GA 30144

Calibration CERT #2246-02

Calibration Date: 05/21/19

Summary:

This document presents the method and results from an accredited COMOSAR Dosimetric E-Field Probe calibration performed in MVG USA using the CALISAR / CALIBAIR test bench, for use with a COMOSAR system only. All calibration results are traceable to national metrology institutions.

	Name	*Function*	*Date*	*Signature*
Prepared by :	Jérôme LUC	Product Manager	5/22/2019	[signature]
Checked by :	Jérôme LUC	Product Manager	5/22/2019	[signature]
Approved by :	Kim RUTKOWSKI	Quality Manager	5/22/2019	[signature]

	Customer Name
Distribution :	CCIC SOUTHERN TESTING CO., LTD

Issue	*Date*	*Modifications*
A	5/22/2019	Initial release
B	5/27/2019	Change customer name and address

TABLE OF CONTENTS

1 DEVICE UNDER TEST

Device Under Test	
Device Type	COMOSAR DOSIMETRIC E FIELD PROBE
Manufacturer	MVG
Model	SSE2
Serial Number	SN 41/18 EPGO330
Product Condition (new / used)	New
Frequency Range of Probe	0.15 GHz-6GHz
Resistance of Three Dipoles at Connector	Dipole 1: R1=0.186 MΩ Dipole 2: R2=0.191 MΩ Dipole 3: R3=0.201 MΩ

A yearly calibration interval is recommended.

2 PRODUCT DESCRIPTION

2.1 GENERAL INFORMATION

MVG's COMOSAR E field Probes are built in accordance to the IEEE 1528, OET 65 Bulletin C and CEI/IEC 62209 standards.

Figure 1 – *MVG COMOSAR Dosimetric E field Dipole*

Probe Length	330 mm
Length of Individual Dipoles	2 mm
Maximum external diameter	8 mm
Probe Tip External Diameter	2.5 mm
Distance between dipoles / probe extremity	1 mm

3 MEASUREMENT METHOD

The IEEE 1528, OET 65 Bulletin C, CENELEC EN50361 and CEI/IEC 62209 standards provide recommended practices for the probe calibrations, including the performance characteristics of interest and methods by which to assess their affect. All calibrations / measurements performed meet the fore mentioned standards.

3.1 LINEARITY

The evaluation of the linearity was done in free space using the waveguide, performing a power sweep to cover the SAR range 0.01W/kg to 100W/kg.

3.2 SENSITIVITY

The sensitivity factors of the three dipoles were determined using a two step calibration method (air and tissue simulating liquid) using waveguides as outlined in the standards.

3.3 LOWER DETECTION LIMIT

The lower detection limit was assessed using the same measurement set up as used for the linearity measurement. The required lower detection limit is 10 mW/kg.

3.4 ISOTROPY

The axial isotropy was evaluated by exposing the probe to a reference wave from a standard dipole with the dipole mounted under the flat phantom in the test configuration suggested for system validations and checks. The probe was rotated along its main axis from 0 - 360 degrees in 15 degree steps. The hemispherical isotropy is determined by inserting the probe in a thin plastic box filled with tissue-equivalent liquid, with the plastic box illuminated with the fields from a half wave dipole. The dipole is rotated about its axis (0°–180°) in 15° increments. At each step the probe is rotated about its axis (0°–360°).

3.5 BOUNDARY EFFECT

The boundary effect is defined as the deviation between the SAR measured data and the expected exponential decay in the liquid when the probe is oriented normal to the interface. To evaluate this effect, the liquid filled flat phantom is exposed to fields from either a reference dipole or waveguide. With the probe normal to the phantom surface, the peak spatial average SAR is measured and compared to the analytical value at the surface.

4 MEASUREMENT UNCERTAINTY

The guidelines outlined in the IEEE 1528, OET 65 Bulletin C, CENELEC EN50361 and CEI/IEC 62209 standards were followed to generate the measurement uncertainty associated with an E-field probe calibration using the waveguide technique. All uncertainties listed below represent an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2, traceable to the Internationally Accepted Guides to Measurement Uncertainty.

Uncertainty analysis of the probe calibration in waveguide					
ERROR SOURCES	Uncertainty value (%)	Probability Distribution	Divisor	ci	Standard Uncertainty (%)
Incident or forward power	3.00%	Rectangular	$\sqrt{3}$	1	1.732%
Reflected power	3.00%	Rectangular	$\sqrt{3}$	1	1.732%
Liquid conductivity	5.00%	Rectangular	$\sqrt{3}$	1	2.887%
Liquid permittivity	4.00%	Rectangular	$\sqrt{3}$	1	2.309%
Field homogeneity	3.00%	Rectangular	$\sqrt{3}$	1	1.732%
Field probe positioning	5.00%	Rectangular	$\sqrt{3}$	1	2.887%

Field probe linearity	3.00%	Rectangular	$\sqrt{3}$	1	1.732%
Combined standard uncertainty					5.831%
Expanded uncertainty 95 % confidence level k = 2					12.0%

5 CALIBRATION MEASUREMENT RESULTS

Calibration Parameters	
Liquid Temperature	21 °C
Lab Temperature	21 °C
Lab Humidity	45 %

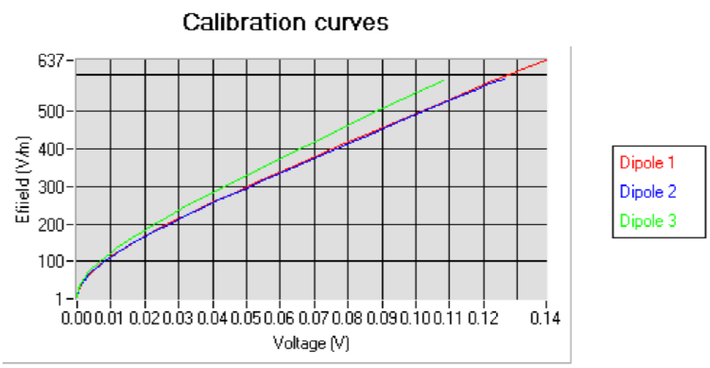
5.1 SENSITIVITY IN AIR

Normx dipole 1 ($\mu V/(V/m)^2$)	Normy dipole 2 ($\mu V/(V/m)^2$)	Normz dipole 3 ($\mu V/(V/m)^2$)
0.92	0.79	0.63

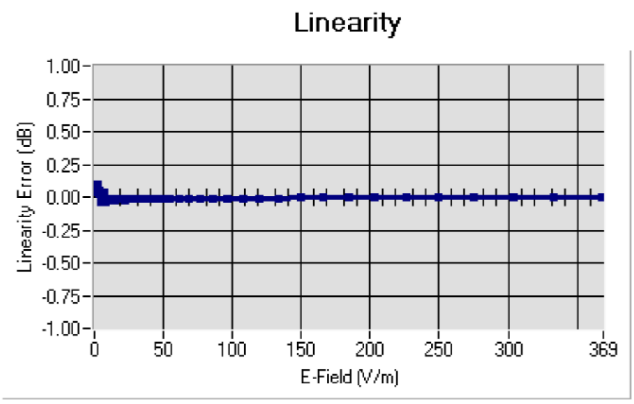
DCP dipole 1 (mV)	DCP dipole 2 (mV)	DCP dipole 3 (mV)
90	97	92

Calibration curves ei=f(V) (i=1,2,3) allow to obtain H-field value using the formula:

$$E = \sqrt{E_1^{\ 2} + E_2^{\ 2} + E_3^{\ 2}}$$



5.2 LINEARITY



Linearity:+/-2.36% (+/-0.10dB)

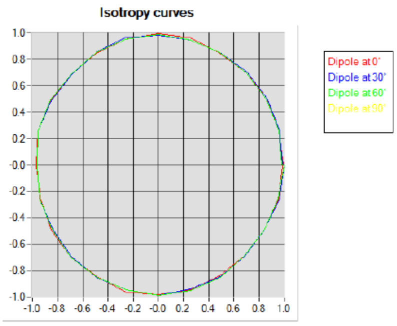
5.3 SENSITIVITY IN LIQUID

Liquid	Frequency (MHz +/- 100MHz)	Permittivity	Epsilon (S/m)	ConvF
HL750	750	40.76	0.93	1.54
BL750	750	56.70	0.98	1.59
HL850	835	40.86	0.92	1.60
BL850	835	56.35	0.99	1.64
HL900	900	42.84	0.95	1.61
BL900	900	53.25	1.05	1.65
HL1800	1800	39.56	1.40	1.74
BL1800	1800	52.84	1.45	1.81
HL1900	1900	39.67	1.38	2.03
BL1900	1900	52.84	1.59	2.08
HL2000	2000	38.71	1.42	1.86
BL2000	2000	52.03	1.52	1.92
HL2450	2450	38.72	1.80	2.05
BL2450	2450	54.91	1.97	2.12
HL2600	2600	39.98	1.89	2.06
BL2600	2600	54.42	2.18	2.11
HL5200	5200	36.68	4.45	1.85
BL5200	5200	49.02	5.46	1.92
HL5400	5400	36.08	4.69	1.75
BL5400	5400	49.55	5.53	1.83
HL5600	5600	35.34	4.95	1.88
BL5600	5600	47.60	5.77	1.95
HL5800	5800	34.81	5.08	1.89
BL5800	5800	47.81	6.12	1.94

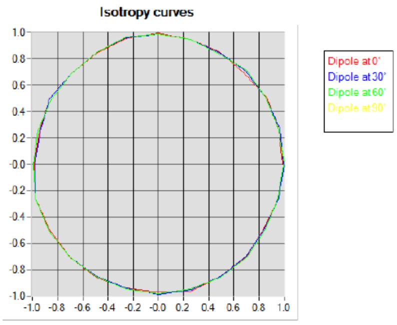
LOWER DETECTION LIMIT: 9mW/kg

5.4 ISOTROPY

HL900 MHz
- Axial isotropy: 0.05 dB
- Hemispherical isotropy: 0.07 dB

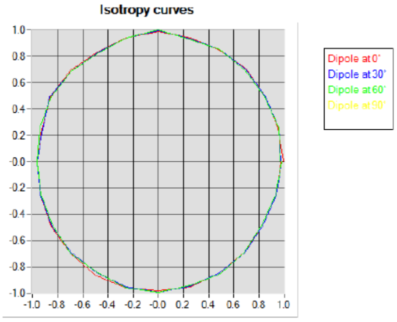


HL1800 MHz
- Axial isotropy: 0.06 dB
- Hemispherical isotropy: 0.07 dB



HL5600 MHz

- Axial isotropy: 0.06 dB
- Hemispherical isotropy: 0.09 dB



6 LIST OF EQUIPMENT

Equipment Summary Sheet				
Equipment Description	**Manufacturer / Model**	**Identification No.**	**Current Calibration Date**	**Next Calibration Date**
Flat Phantom	MVG	SN-20/09-SAM71	Validated. No cal required.	Validated. No cal required.
COMOSAR Test Bench	Version 3	NA	Validated. No cal required.	Validated. No cal required.
Network Analyzer	Rhode & Schwarz ZVA	SN100132	02/2019	02/2022
Reference Probe	MVG	EP 94 SN 37/08	10/2017	10/2019
Multimeter	Keithley 2000	1188656	01/2017	01/2020
Signal Generator	Agilent E4438C	MY49070581	01/2017	01/2020
Amplifier	Aethercomm	SN 046	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Power Meter	HP E4418A	US38261498	01/2017	01/2020
Power Sensor	HP ECP-E26A	US37181460	01/2017	01/2020
Directional Coupler	Narda 4216-20	01386	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Waveguide	Mega Industries	069Y7-158-13-712	Validated. No cal required.	Validated. No cal required.
Waveguide Transition	Mega Industries	069Y7-158-13-701	Validated. No cal required.	Validated. No cal required.
Waveguide Termination	Mega Industries	069Y7-158-13-701	Validated. No cal required.	Validated. No cal required.
Temperature / Humidity Sensor	Control Company	150798832	11/2017	11/2020

SAR Reference Dipole Calibration Report

Ref : ACR.109.1.18.SATU.A

SHENZHEN NTEK TESTING TECHNOLOGY CO., LTD.
BUILDING E, FENDA SCIENCE PARK, SANWEI COMMUNITY, XIXIANG STREET,
BAO'AN DISTRICT, SHENZHEN GUANGDONG, CHINA
MVG COMOSAR REFERENCE DIPOLE
FREQUENCY: 750 MHZ
SERIAL NO.: SN 03/15 DIP 0G750-355

Calibrated at MVG US
2105 Barrett Park Dr. - Kennesaw, GA 30144

Calibration CERT #2246-02

Calibration Date: 04/19/2018

Summary:

This document presents the method and results from an accredited SAR reference dipole calibration performed in MVG USA using the COMOSAR test bench. All calibration results are traceable to national metrology institutions.

SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.109.1.18.SATU.A

	Name	*Function*	*Date*	*Signature*
Prepared by :	Jérôme LUC	Product Manager	4/19/2018	[signature]
Checked by :	Jérôme LUC	Product Manager	4/19/2018	[signature]
Approved by :	Kim RUTKOWSKI	Quality Manager	4/19/2018	Kim Rutkowski

	Customer Name
Distribution :	SHENZHEN NTEK TESTING TECHNOLOGY CO., LTD.

Issue	*Date*	*Modifications*
A	4/19/2018	Initial release

SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.109.1.18.SATU.A

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1 INTRODUCTION

This document contains a summary of the requirements set forth by the IEEE 1528, FCC KDBs and CEI/IEC 62209 standards for reference dipoles used for SAR measurement system validations and the measurements that were performed to verify that the product complies with the fore mentioned standards.

2 DEVICE UNDER TEST

Device Under Test	
Device Type	COMOSAR 750 MHz REFERENCE DIPOLE
Manufacturer	MVG
Model	SID750
Serial Number	SN 03/15 DIP 0G750-355
Product Condition (new / used)	Used

A yearly calibration interval is recommended.

3 PRODUCT DESCRIPTION

3.1 GENERAL INFORMATION

MVG's COMOSAR Validation Dipoles are built in accordance to the IEEE 1528, FCC KDBs and CEI/IEC 62209 standards. The product is designed for use with the COMOSAR test bench only.

Figure 1 – *MVG COMOSAR Validation Dipole*

4 MEASUREMENT METHOD

The IEEE 1528, FCC KDBs and CEI/IEC 62209 standards provide requirements for reference dipoles used for system validation measurements. The following measurements were performed to verify that the product complies with the fore mentioned standards.

4.1 RETURN LOSS REQUIREMENTS

The dipole used for SAR system validation measurements and checks must have a return loss of -20 dB or better. The return loss measurement shall be performed against a liquid filled flat phantom, with the phantom constructed as outlined in the fore mentioned standards.

4.2 MECHANICAL REQUIREMENTS

The IEEE Std. 1528 and CEI/IEC 62209 standards specify the mechanical components and dimensions of the validation dipoles, with the dimensions frequency and phantom shell thickness dependent. The COMOSAR test bench employs a 2 mm phantom shell thickness therefore the dipoles sold for use with the COMOSAR test bench comply with the requirements set forth for a 2 mm phantom shell thickness.

5 MEASUREMENT UNCERTAINTY

All uncertainties listed below represent an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2, traceable to the Internationally Accepted Guides to Measurement Uncertainty.

5.1 RETURN LOSS

The following uncertainties apply to the return loss measurement:

Frequency band	Expanded Uncertainty on Return Loss
400-6000MHz	0.1 dB

5.2 DIMENSION MEASUREMENT

The following uncertainties apply to the dimension measurements:

Length (mm)	Expanded Uncertainty on Length
3 - 300	0.05 mm

5.3 VALIDATION MEASUREMENT

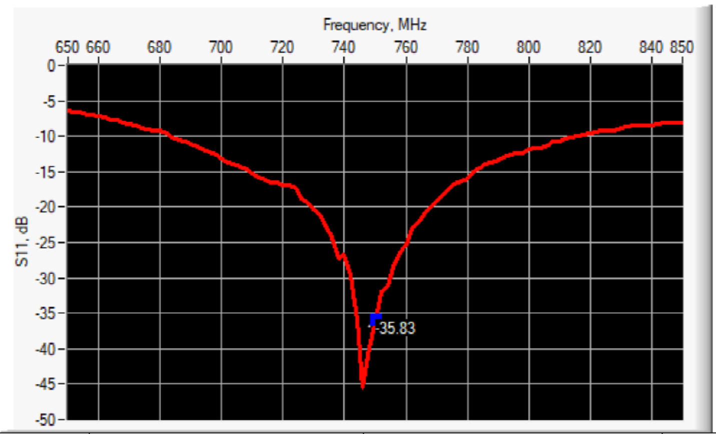
The guidelines outlined in the IEEE 1528, FCC KDBs, CENELEC EN50361 and CEI/IEC 62209 standards were followed to generate the measurement uncertainty for validation measurements.

Scan Volume	Expanded Uncertainty
1 g	20.3 %

10 g	20.1 %

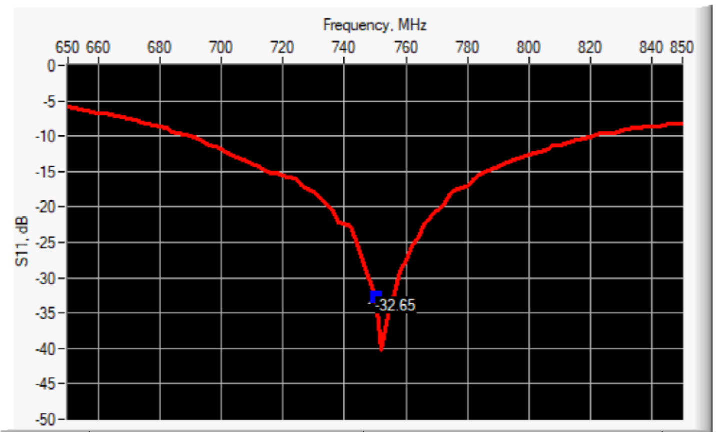
6 CALIBRATION MEASUREMENT RESULTS

6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
750	-35.83	-20	51.3 Ω - 1.2 jΩ

6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
750	-32.65	-20	50.8 Ω + 2.3 jΩ

6.3 MECHANICAL DIMENSIONS

Frequency MHz	L mm		h mm		d mm	
	required	measured	required	measured	required	measured
300	420.0 ±1 %.		250.0 ±1 %.		6.35 ±1 %.	

450	290.0 ±1 %.		166.7 ±1 %.		6.35 ±1 %.	
750	176.0 ±1 %.	PASS	100.0 ±1 %.	PASS	6.35 ±1 %.	PASS
835	161.0 ±1 %.		89.8 ±1 %.		3.6 ±1 %.	
900	149.0 ±1 %.		83.3 ±1 %.		3.6 ±1 %.	
1450	89.1 ±1 %.		51.7 ±1 %.		3.6 ±1 %.	
1500	80.5 ±1 %.		50.0 ±1 %.		3.6 ±1 %.	
1640	79.0 ±1 %.		45.7 ±1 %.		3.6 ±1 %.	
1750	75.2 ±1 %.		42.9 ±1 %.		3.6 ±1 %.	
1800	72.0 ±1 %.		41.7 ±1 %.		3.6 ±1 %.	
1900	68.0 ±1 %.		39.5 ±1 %.		3.6 ±1 %.	
1950	66.3 ±1 %.		38.5 ±1 %.		3.6 ±1 %.	
2000	64.5 ±1 %.		37.5 ±1 %.		3.6 ±1 %.	
2100	61.0 ±1 %.		35.7 ±1 %.		3.6 ±1 %.	
2300	55.5 ±1 %.		32.6 ±1 %.		3.6 ±1 %.	
2450	51.5 ±1 %.		30.4 ±1 %.		3.6 ±1 %.	
2600	48.5 ±1 %.		28.8 ±1 %.		3.6 ±1 %.	
3000	41.5 ±1 %.		25.0 ±1 %.		3.6 ±1 %.	
3500	37.0±1 %.		26.4 ±1 %.		3.6 ±1 %.	
3700	34.7±1 %.		26.4 ±1 %.		3.6 ±1 %.	

7 VALIDATION MEASUREMENT

The IEEE Std. 1528, FCC KDBs and CEI/IEC 62209 standards state that the system validation measurements must be performed using a reference dipole meeting the fore mentioned return loss and mechanical dimension requirements. The validation measurement must be performed against a liquid filled flat phantom, with the phantom constructed as outlined in the fore mentioned standards. Per the standards, the dipole shall be positioned below the bottom of the phantom, with the dipole length centered and parallel to the longest dimension of the flat phantom, with the top surface of the dipole at the described distance from the bottom surface of the phantom.

7.1 HEAD LIQUID MEASUREMENT

Frequency MHz	Relative permittivity (ε_r')		Conductivity (σ) S/m	
	required	measured	required	measured
300	45.3 ±5 %		0.87 ±5 %	
450	43.5 ±5 %		0.87 ±5 %	
750	41.9 ±5 %	PASS	0.89 ±5 %	PASS
835	41.5 ±5 %		0.90 ±5 %	
900	41.5 ±5 %		0.97 ±5 %	
1450	40.5 ±5 %		1.20 ±5 %	
1500	40.4 ±5 %		1.23 ±5 %	
1640	40.2 ±5 %		1.31 ±5 %	
1750	40.1 ±5 %		1.37 ±5 %	

1800	40.0 ±5 %		1.40 ±5 %	
1900	40.0 ±5 %		1.40 ±5 %	
1950	40.0 ±5 %		1.40 ±5 %	
2000	40.0 ±5 %		1.40 ±5 %	
2100	39.8 ±5 %		1.49 ±5 %	
2300	39.5 ±5 %		1.67 ±5 %	
2450	39.2 ±5 %		1.80 ±5 %	
2600	39.0 ±5 %		1.96 ±5 %	
3000	38.5 ±5 %		2.40 ±5 %	
3500	37.9 ±5 %		2.91 ±5 %	

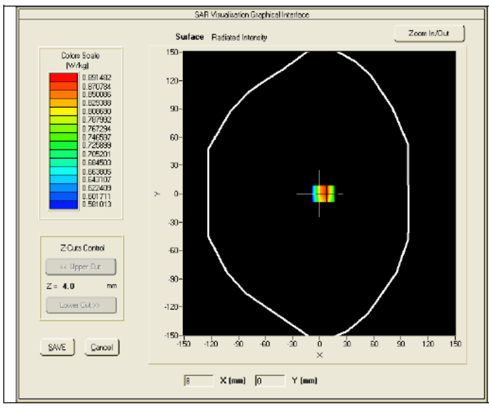
7.2 SAR MEASUREMENT RESULT WITH HEAD LIQUID

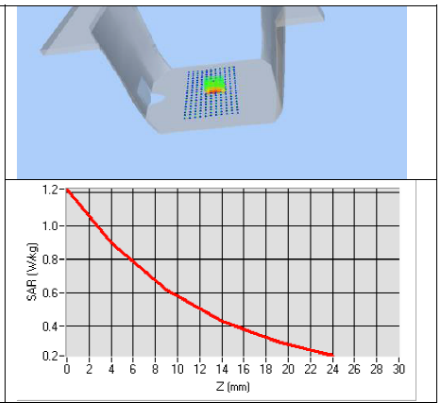
The IEEE Std. 1528 and CEI/IEC 62209 standards state that the system validation measurements should produce the SAR values shown below (for phantom thickness of 2 mm), within the uncertainty for the system validation. All SAR values are normalized to 1 W forward power. In bracket, the measured SAR is given with the used input power.

Software	OPENSAR V4
Phantom	SN 20/09 SAM71
Probe	SN 18/11 EPG122
Liquid	Head Liquid Values: eps' : 40.0 sigma : 0.93
Distance between dipole center and liquid	15.0 mm
Area scan resolution	dx=8mm/dy=8mm
Zoon Scan Resolution	dx=8mm/dy=8mm/dz=5mm
Frequency	750 MHz
Input power	20 dBm
Liquid Temperature	21 °C
Lab Temperature	21 °C
Lab Humidity	45 %

Frequency MHz	1 g SAR (W/kg/W)		10 g SAR (W/kg/W)	
	required	measured	required	measured
300	2.85		1.94	
450	4.58		3.06	
750	8.49	8.56 (0.86)	5.55	5.61 (0.56)
835	9.56		6.22	
900	10.9		6.99	
1450	29		16	
1500	30.5		16.8	
1640	34.2		18.4	
1750	36.4		19.3	
1800	38.4		20.1	

1900	39.7		20.5	
1950	40.5		20.9	
2000	41.1		21.1	
2100	43.6		21.9	
2300	48.7		23.3	
2450	52.4		24	
2600	55.3		24.6	
3000	63.8		25.7	
3500	67.1		25	
3700	67.4		24.2	





7.3 BODY LIQUID MEASUREMENT

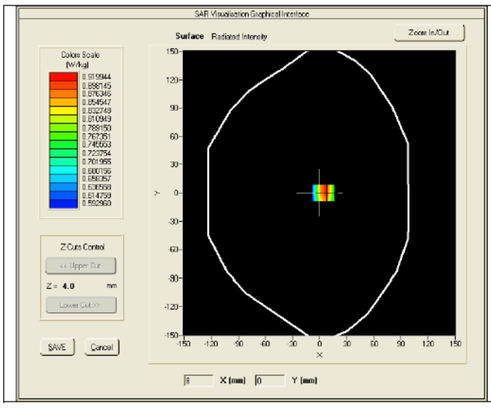
Frequency MHz	Relative permittivity (ε_r')		Conductivity (σ) S/m	
	required	measured	required	measured
150	61.9 ±5 %		0.80 ±5 %	
300	58.2 ±5 %		0.92 ±5 %	
450	56.7 ±5 %		0.94 ±5 %	
750	55.5 ±5 %	PASS	0.96 ±5 %	PASS
835	55.2 ±5 %		0.97 ±5 %	
900	55.0 ±5 %		1.05 ±5 %	
915	55.0 ±5 %		1.06 ±5 %	
1450	54.0 ±5 %		1.30 ±5 %	
1610	53.8 ±5 %		1.40 ±5 %	
1800	53.3 ±5 %		1.52 ±5 %	
1900	53.3 ±5 %		1.52 ±5 %	
2000	53.3 ±5 %		1.52 ±5 %	
2100	53.2 ±5 %		1.62 ±5 %	

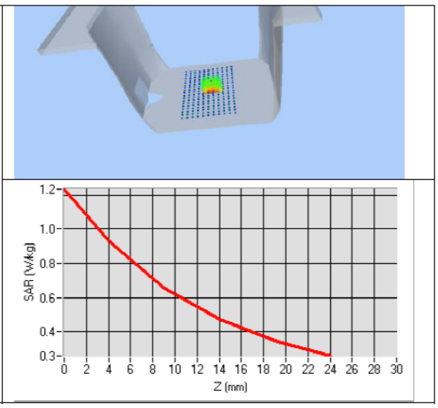
2300	52.9 ±5 %		1.81 ±5 %	
2450	52.7 ±5 %		1.95 ±5 %	
2600	52.5 ±5 %		2.16 ±5 %	
3000	52.0 ±5 %		2.73 ±5 %	
3500	51.3 ±5 %		3.31 ±5 %	
3700	51.0 ±5 %		3.55 ±5 %	
5200	49.0 ±10 %		5.30 ±10 %	
5300	48.9 ±10 %		5.42 ±10 %	
5400	48.7 ±10 %		5.53 ±10 %	
5500	48.6 ±10 %		5.65 ±10 %	
5600	48.5 ±10 %		5.77 ±10 %	
5800	48.2 ±10 %		6.00 ±10 %	

7.4 SAR MEASUREMENT RESULT WITH BODY LIQUID

Software	OPENSAR V4
Phantom	SN 20/09 SAM71
Probe	SN 18/11 EPG122
Liquid	Body Liquid Values: eps' : 56.8 sigma : 1.00
Distance between dipole center and liquid	15.0 mm
Area scan resolution	dx=8mm/dy=8mm
Zoon Scan Resolution	dx=8mm/dy=8mm/dz=5mm
Frequency	750 MHz
Input power	20 dBm
Liquid Temperature	21 °C
Lab Temperature	21 °C
Lab Humidity	45 %

Frequency MHz	1 g SAR (W/kg/W)	10 g SAR (W/kg/W)
	measured	measured
750	8.85 (0.89)	5.91 (0.59)





8 LIST OF EQUIPMENT

Equipment Summary Sheet				
Equipment Description	**Manufacturer / Model**	**Identification No.**	**Current Calibration Date**	**Next Calibration Date**
SAM Phantom	MVG	SN-20/09-SAM71	Validated. No cal required.	Validated. No cal required.
COMOSAR Test Bench	Version 3	NA	Validated. No cal required.	Validated. No cal required.
Network Analyzer	Rhode & Schwarz ZVA	SN100132	02/2016	02/2019
Calipers	Carrera	CALIPER-01	01/2017	01/2020
Reference Probe	MVG	EPG122 SN 18/11	10/2017	10/2018
Multimeter	Keithley 2000	1188656	01/2017	01/2020
Signal Generator	Agilent E4438C	MY49070581	01/2017	01/2020
Amplifier	Aethercomm	SN 046	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Power Meter	HP E4418A	US38261498	01/2017	01/2020
Power Sensor	HP ECP-E26A	US37181460	01/2017	01/2020
Directional Coupler	Narda 4216-20	01386	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Temperature and Humidity Sensor	Control Company	150798832	11/2017	11/2020

SAR Reference Dipole Calibration Report

Ref : ACR.109.2.18.SATU.A

SHENZHEN NTEK TESTING TECHNOLOGY CO., LTD.
BUILDING E, FENDA SCIENCE PARK, SANWEI COMMUNITY, XIXIANG STREET,
BAO'AN DISTRICT, SHENZHEN GUANGDONG, CHINA
MVG COMOSAR REFERENCE DIPOLE
FREQUENCY: 835 MHZ
SERIAL NO.: SN 03/15 DIP 0G835-347

Calibrated at MVG US
2105 Barrett Park Dr. - Kennesaw, GA 30144

Calibration Date: 04/19/2018

Summary:

This document presents the method and results from an accredited SAR reference dipole calibration performed in MVG USA using the COMOSAR test bench. All calibration results are traceable to national metrology institutions.

	Name	*Function*	*Date*	*Signature*
Prepared by :	Jérôme LUC	Product Manager	4/19/2018	[signature]
Checked by :	Jérôme LUC	Product Manager	4/19/2018	[signature]
Approved by :	Kim RUTKOWSKI	Quality Manager	4/19/2018	[signature]

	Customer Name
Distribution :	SHENZHEN NTEK TESTING TECHNOLOGY CO., LTD.

Issue	*Date*	*Modifications*
A	4/19/2018	Initial release

TABLE OF CONTENTS

1 INTRODUCTION

This document contains a summary of the requirements set forth by the IEEE 1528, FCC KDBs and CEI/IEC 62209 standards for reference dipoles used for SAR measurement system validations and the measurements that were performed to verify that the product complies with the fore mentioned standards.

2 DEVICE UNDER TEST

Device Under Test	
Device Type	COMOSAR 835 MHz REFERENCE DIPOLE
Manufacturer	MVG
Model	SID835
Serial Number	SN 03/15 DIP 0G835-347
Product Condition (new / used)	Used

A yearly calibration interval is recommended.

3 PRODUCT DESCRIPTION

3.1 GENERAL INFORMATION

MVG's COMOSAR Validation Dipoles are built in accordance to the IEEE 1528, FCC KDBs and CEI/IEC 62209 standards. The product is designed for use with the COMOSAR test bench only.

Figure 1 – *MVG COMOSAR Validation Dipole*

4 MEASUREMENT METHOD

The IEEE 1528, FCC KDBs and CEI/IEC 62209 standards provide requirements for reference dipoles used for system validation measurements. The following measurements were performed to verify that the product complies with the fore mentioned standards.

4.1 RETURN LOSS REQUIREMENTS

The dipole used for SAR system validation measurements and checks must have a return loss of -20 dB or better. The return loss measurement shall be performed against a liquid filled flat phantom, with the phantom constructed as outlined in the fore mentioned standards.

4.2 MECHANICAL REQUIREMENTS

The IEEE Std. 1528 and CEI/IEC 62209 standards specify the mechanical components and dimensions of the validation dipoles, with the dimensions frequency and phantom shell thickness dependent. The COMOSAR test bench employs a 2 mm phantom shell thickness therefore the dipoles sold for use with the COMOSAR test bench comply with the requirements set forth for a 2 mm phantom shell thickness.

5 MEASUREMENT UNCERTAINTY

All uncertainties listed below represent an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2, traceable to the Internationally Accepted Guides to Measurement Uncertainty.

5.1 RETURN LOSS

The following uncertainties apply to the return loss measurement:

Frequency band	Expanded Uncertainty on Return Loss
400-6000MHz	0.1 dB

5.2 DIMENSION MEASUREMENT

The following uncertainties apply to the dimension measurements:

Length (mm)	Expanded Uncertainty on Length
3 - 300	0.05 mm

5.3 VALIDATION MEASUREMENT

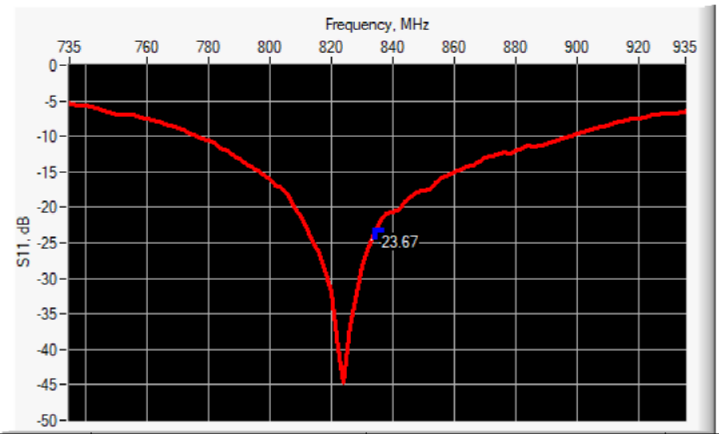
The guidelines outlined in the IEEE 1528, FCC KDBs, CENELEC EN50361 and CEI/IEC 62209 standards were followed to generate the measurement uncertainty for validation measurements.

Scan Volume	Expanded Uncertainty
1 g	20.3 %

10 g	20.1 %

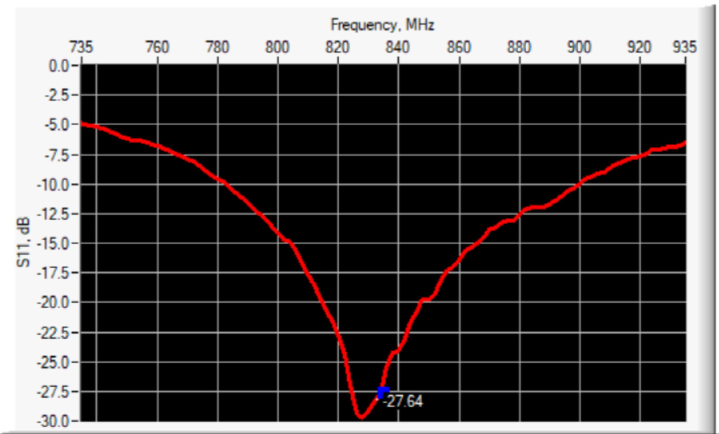
6 CALIBRATION MEASUREMENT RESULTS

6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
835	-23.67	-20	56.8 Ω - 1.5 jΩ

6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
835	-27.64	-20	53.5 Ω + 2.3 jΩ

6.3 MECHANICAL DIMENSIONS

Frequency MHz	L mm		h mm		d mm	
	required	measured	required	measured	required	measured
300	420.0 ±1 %.		250.0 ±1 %.		6.35 ±1 %.	