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： Rugged Tablet

Trademark： N/A

Model Name： TRT-5180-12

Serial Model： N/A

Report No.： SER171031003001E

FCC ID： 2AL2M- TRT-5180-12

Prepared for

Teguar Corporation

4235 South Stream Blvd, Suite L-130, Charlotte, NC 28217

Prepared by

Shenzhen NTEK Testing Technology Co., Ltd.

1/F, Building E, Fenda Science Park, Sanwei Community, Xixiang Street,

Bao'an District, Shenzhen 518126 P.R. China.

Tel.: +86-755-6115 6588 Fax.: +86-755-6115 6599

Website: http://www.ntek.org.cn

TEST RESULT CERTIFICATION

Applicant's name..................: Teguar Corporation

Address ....: 4235 South Stream Blvd, Suite L-130, Charlotte, NC 28217

Manufacturer's Name...........: Shenzhen Emdoor Information Co.,Ltd

Address ....: 3A 1/F Jinfulai Tower, No.49-1, Dabao Road, Baoan 28 District, Shenzhen 518101 P.R China

Product description

Product name..........................: Rugged Tablet

Trademark ....: N/A

Model and/or type reference : TRT-5180-12

Serial 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 ....: Nov. 10, 2017 ~ Nov. 15, 2017

Date of Issue ....: Dec. 08, 2017

Test Result ....: **Pass**

Prepared By (Test Engineer) : Cheng Jiawen

(Cheng Jiawen)

Approved By (Lab Manager) : Sam. Chen

(Sam Chen)

※ ※ Revision History ※ ※

REV.	DESCRIPTION	ISSUED DATE	REMARK
Rev.1.0	Initial Test Report Release	Dec. 08, 2017	Cheng Jiawen

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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 TRT-5180-12 are as follows.

Band	Max. Reported SAR (W/kg)
	1-g Body (Separation distance of 0mm)
WLAN 2.4G	1.342
WLAN 5.2G	1.364
WLAN 5.8G	1.017

Note: This device 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	Rugged Tablet		
Trademark	N/A		
Model Name	TRT-5180-12		
Serial Model	N/A		
FCC ID	2AL2M- TRT-5180-12		
Device Phase	Identical Prototype		
Exposure Category	General population / Uncontrolled environment		
Antenna Type	FPCB Antenna		
Battery Information	DC 7.4V, 6300mAh		
Device Operating Configurations			
Supporting Mode(s)	WLAN 2.4G/5G, Bluetooth		
Test Modulation	WLAN(DSSS/OFDM), Bluetooth(GFSK, π/4-DQPSK, 8DPSK)		
Operating Frequency Range(s)	Band	Tx (MHz)	Rx (MHz)
	WLAN 2.4G	2412-2462	
	WLAN 5.2G	5180-5240	
	WLAN 5.8G	5745-5825	
	Bluetooth	2402-2480	
Test Channels (low-mid-high)	1-3-6-9-11(WLAN 2.4G) 36-38-40-42-46-48(WLAN 5.2G) 149-151-155-157-159-165(WLAN 5.8G)		

1.4. Test specification(s)

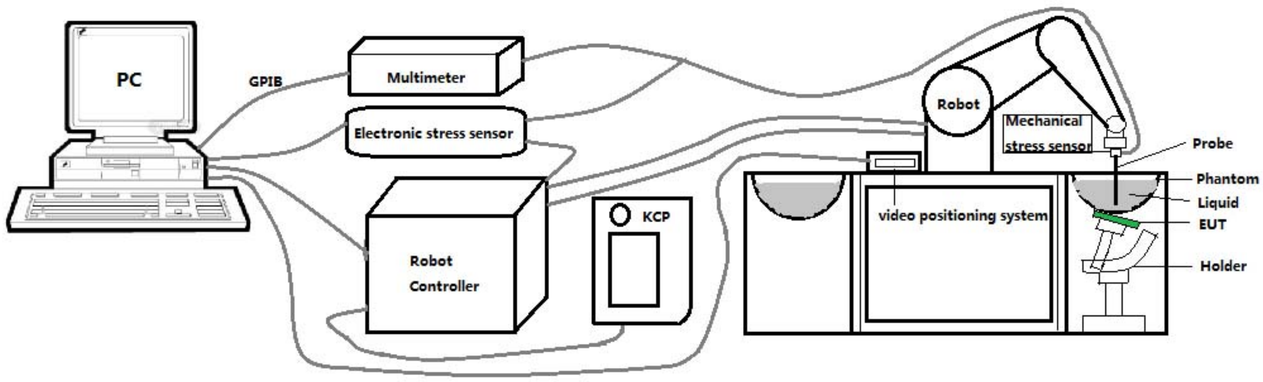
FCC 47 CFR Part 2(2.1093)
ANSI/IEEE C95.1-1992
IEEE Std 1528-2013
KDB 865664 D01 SAR measurement 100 MHz to 6 GHz
KDB 865664 D02 RF Exposure Reporting
KDB 447498 D01 General RF Exposure Guidance
KDB 248227 D01 802.11 Wi-Fi SAR
KDB 616217 D04 SAR for laptop and tablets

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 08/16 EPGO287 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: ±0.08 dB
- Axial isotropy: <0.25 dB
- Hemispherical Isotropy: <0.50 dB
- Calibration range: 650MHz to 5900MHz for head & body simulating liquid.
- Lower detection limit: 7mW/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.

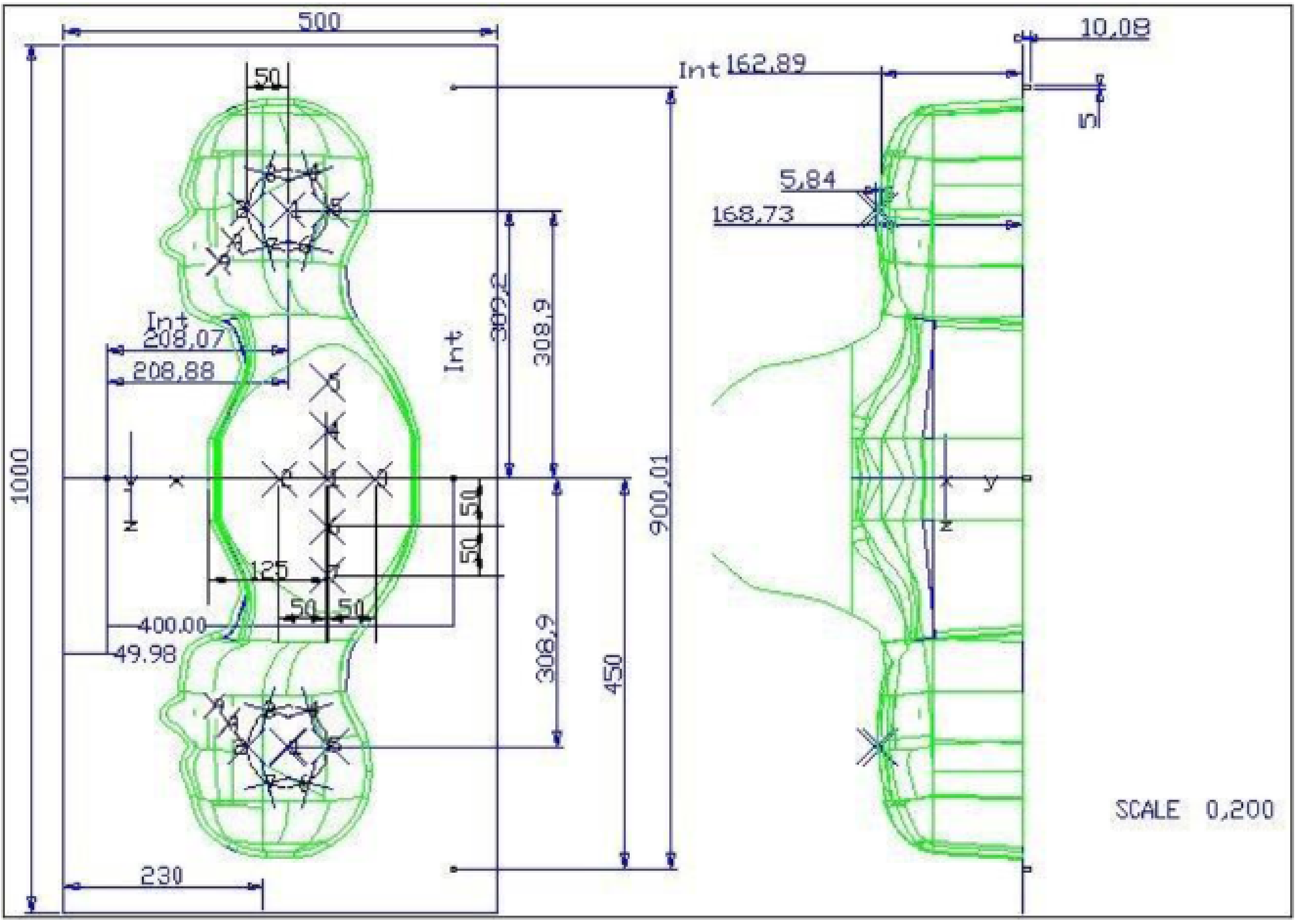
2.4. SAM phantoms

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

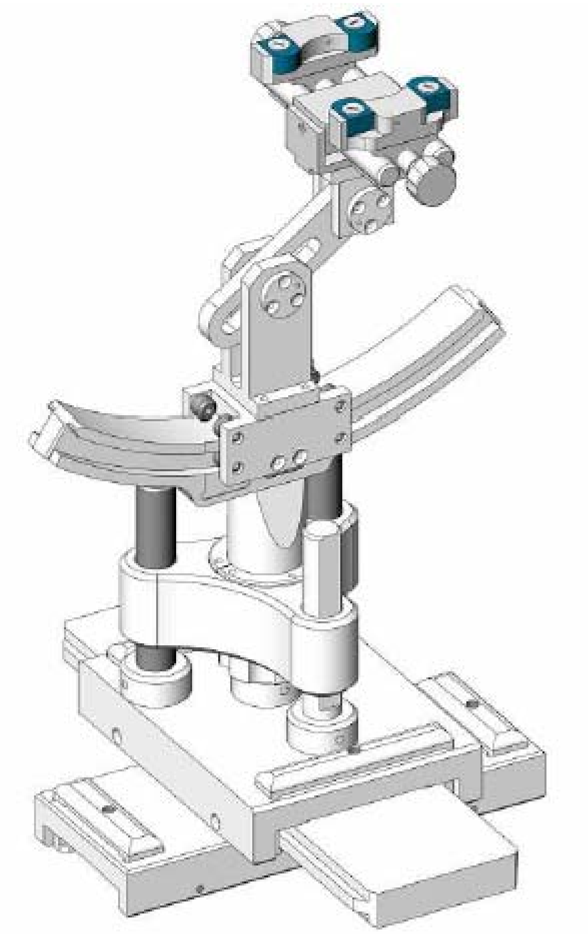


Serial Number	Left Head		Right Head		Flat Part	
SN 16/15 SAM119	2	2.02	2	2.08	1	2.09
	3	2.05	3	2.06	2	2.06
	4	2.07	4	2.07	3	2.08
	5	2.08	5	2.08	4	2.10
	6	2.05	6	2.07	5	2.10
	7	2.05	7	2.05	6	2.07
	8	2.07	8	2.06	7	2.07
	9	2.08	9	2.06	-	-

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 08/16 EPGO287	Sep. 18, 2017	Sep. 17, 2018
☐	MVG	450 MHz Dipole	SID450	SN 03/15 DIP 0G450-345	Apr. 06, 2015	Apr. 05, 2018
☐	MVG	750 MHz Dipole	SID750	SN 03/15 DIP 0G750-355	Apr. 06, 2015	Apr. 05, 2018
☐	MVG	835 MHz Dipole	SID835	SN 03/15 DIP 0G835-347	Apr. 06, 2015	Apr. 05, 2018
☐	MVG	900 MHz Dipole	SID900	SN 03/15 DIP 0G900-348	Apr. 06, 2015	Apr. 05, 2018
☐	MVG	1800 MHz Dipole	SID1800	SN 03/15 DIP 1G800-349	Apr. 06, 2015	Apr. 05, 2018
☐	MVG	1900 MHz Dipole	SID1900	SN 03/15 DIP 1G900-350	Apr. 06, 2015	Apr. 05, 2018
☐	MVG	2000 MHz Dipole	SID2000	SN 03/15 DIP 2G000-351	Apr. 06, 2015	Apr. 05, 2018
☒	MVG	2450 MHz Dipole	SID2450	SN 03/15 DIP 2G450-352	Apr. 06, 2015	Apr. 05, 2018
☐	MVG	2600 MHz Dipole	SID2600	SN 03/15 DIP 2G600-356	Apr. 06, 2015	Apr. 05, 2018
☒	MVG	5000 MHz Dipole	SWG5500	SN 13/14 WGA 33	Apr. 06, 2015	Apr. 05, 2018
☒	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. 07, 2017	Aug. 06, 2018
☐	R&S	Wideband radio communication tester	CMW500	103917	Oct. 26, 2017	Oct. 25, 2018
☒	HP	Network Analyzer	8753D	3410J01136	Aug. 07, 2017	Aug. 06, 2018

☒	Agilent	PSG Analog Signal Generator	E8257D	MY51110112	Aug. 07, 2017	Aug. 06, 2018
☒	Agilent	Power meter	E4419B	MY45102538	Aug. 07, 2017	Aug. 06, 2018
☒	Agilent	Power sensor	E9301A	MY41495644	Aug. 07, 2017	Aug. 06, 2018
☒	Agilent	Power sensor	E9301A	US39212148	Aug. 07, 2017	Aug. 06, 2018
☒	MCLI/USA	Directional Coupler	CB11-20	0D2L51502	Aug. 07, 2017	Aug. 06, 2018

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.

			$\leq$ 3 GHz	> 3 GHz
Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface			5 ± 1 mm	$\frac{1}{2} \cdot \delta \cdot \ln(2) \pm 0.5$ mm
Maximum probe angle from probe axis to phantom surface normal at the measurement location			30° ± 1°	20° ± 1°
Maximum area scan spatial resolution: Δx_{Area}, Δy_{Area}			$\leq$ 2 GHz: $\leq$ 15 mm 2 – 3 GHz: $\leq$ 12 mm	3 – 4 GHz: $\leq$ 12 mm 4 – 6 GHz: $\leq$ 10 mm
			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 $\leq$ the corresponding x or y dimension of the test device with at least one measurement point on the test device.	
Maximum zoom scan spatial resolution: Δx_{Zoom}, Δy_{Zoom}			$\leq$ 2 GHz: $\leq$ 8 mm 2 – 3 GHz: $\leq$ 5 mm*	3 – 4 GHz: $\leq$ 5 mm* 4 – 6 GHz: $\leq$ 4 mm*
Maximum zoom scan spatial resolution, normal to phantom surface	uniform grid: $\Delta z_{Zoom}(n)$		$\leq$ 5 mm	3 – 4 GHz: $\leq$ 4 mm 4 – 5 GHz: $\leq$ 3 mm 5 – 6 GHz: $\leq$ 2 mm
	graded grid	$\Delta z_{Zoom}(1)$: between 1st two points closest to phantom surface	$\leq$ 4 mm	3 – 4 GHz: $\leq$ 3 mm 4 – 5 GHz: $\leq$ 2.5 mm 5 – 6 GHz: $\leq$ 2 mm
		$\Delta z_{Zoom}(n>1)$: between subsequent points	$\leq 1.5 \cdot \Delta z_{Zoom}(n-1)$	
Minimum zoom scan volume	x, y, z		$\geq$ 30 mm	3 – 4 GHz: $\geq$ 28 mm 4 – 5 GHz: $\geq$ 25 mm 5 – 6 GHz: $\geq$ 22 mm

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 *reported* SAR from the *area scan based 1-g SAR estimation* procedures of KDB 447498 is $\leq$ 1.4 W/kg, $\leq$ 8 mm, $\leq$ 7 mm and $\leq$ 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.

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

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.

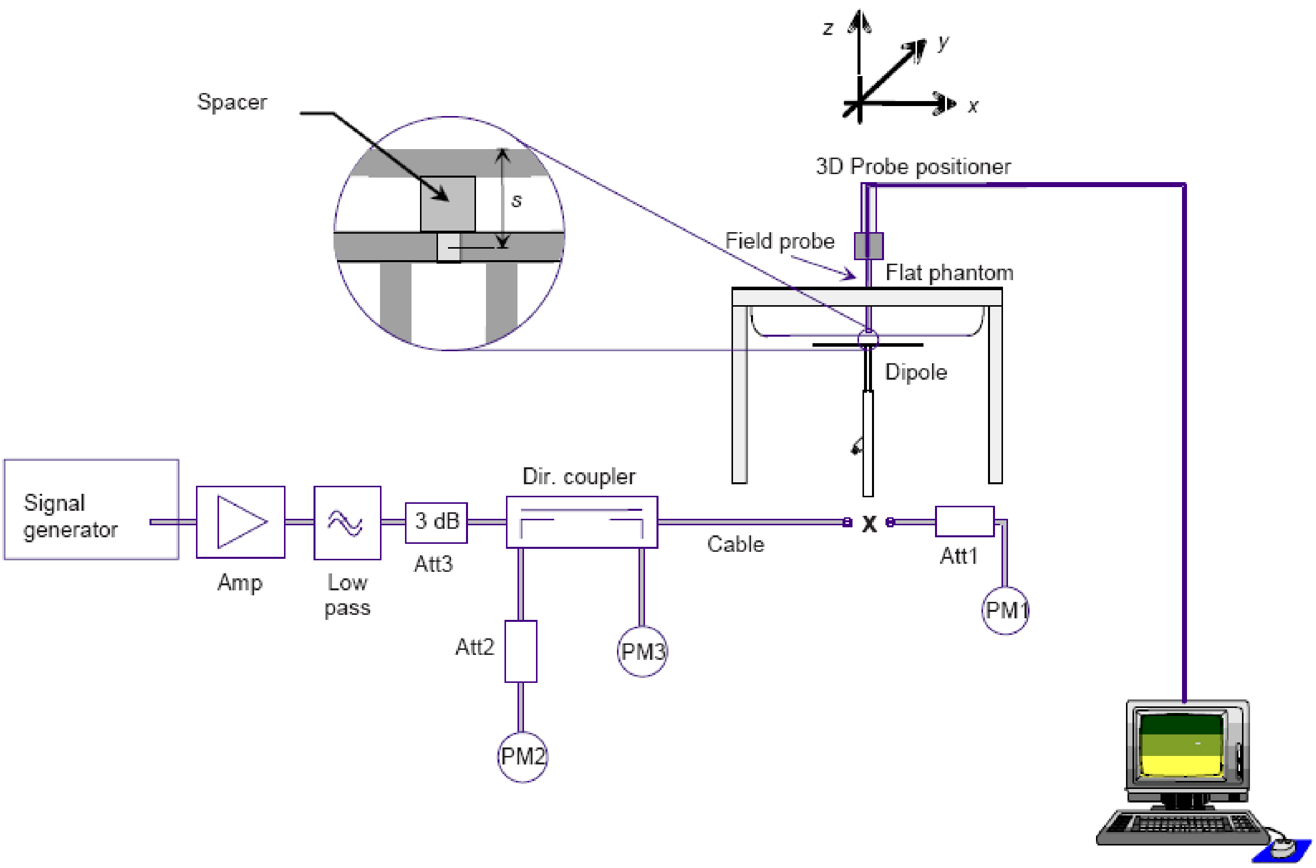
Tissue Type	Measured Frequency (MHz)	Target Tissue		Measured Tissue		Liquid Temp.	Test Date
		εr (±5%)	σ (S/m) (±5%)	εr	σ (S/m)		
Body 2450	2450	52.70 (50.07~55.33)	1.95 (1.85~2.04)	52.28	1.96	21.5 °C	Nov. 10, 2017
Body 5000	5200	49.00 (44.10~53.90)	5.30 (4.77~5.83)	49.62	5.29	21.2 °C	Nov. 14, 2017
Body 5000	5800	48.20 (43.38~53.02)	6.00 (5.40~6.60)	48.41	6.05	21.3 °C	Nov. 15, 2017

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)		
2450MHz Body	49.32 (44.39~54.25)	22.89 (20.60~25.17)	49.40	23.21	21.5 °C	Nov. 10, 2017
5200MHz Body	150.06 (135.05~165.07)	53.20 (47.88~58.52)	155.97	54.09	21.2 °C	Nov. 14, 2017
5800MHz Body	173.64 (156.28~191.00)	59.29 (53.36~65.22)	179.85	61.63	21.3 °C	Nov. 15, 2017

5. SAR Measurement variability and uncertainty

5.1. SAR measurement variability

Refer to 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

Refer to 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 Conditions

6.1. Tablet host platform exposure conditions

Refer to KDB616217 D04, When the modular approach is used, transmitters and modules must be initially tested for standalone operations in generic host conditions according to the following minimum test separation distance and antenna installation requirements for incorporation in the tablet platform. The separation distance required for incorporation in qualified hosts is described in KDB 447498; item 5) of section 4.1 and item 1) of section 5.2.2 etc.

- ≤ 5 mm between the antenna and user for both back surface and edge exposure conditions
- the antennas used by the host must have been tested for equipment approval or qualify for SAR test exclusion
- the antenna polarization, physical orientation, rotation and installation configurations used by the host must have been tested for compliance or qualify for test exclusion
- when the *SAR Test Exclusion Threshold* in KDB 447498 applies, a *test separation distance* of 5 mm is required to determine test exclusion for the tablet platform

The antennas embedded in tablets are typically ≤ 5mm from the outer housing. The required antenna to user test separation distance is a "not to exceed test" distance required to apply the modular approach. Instead of the typical zero gap tablet edge test requirement between the edge of a tablet and the user, when an antenna has been tested at ≤ 5 mm according to the modular approach it can be incorporated into tablets with at least twice the tested distance from the outer housing of the tablet edge; otherwise, the tablet edge zero gap test requirement applies. When the dedicated host approach is applied, the back surface and edges of the tablet should be tested for SAR compliance with the tablet touching the phantom.

7. RF Output Power

7.1. Maximum Tune-up Limit

Band	Mode		The Tune-up Maximum Power (Customer Declared)(dBm)	Range	Measured Output Maximum Power(dBm)
WLAN 2.4G	802.11b		13±1	12~14	13.9
	802.11g		9±1	8~10	9.3
	802.11n-HT20		9±1	8~10	9.4
	802.11n-HT40		9±1	8~10	9.2
WLAN 5.2G	802.11a		13±1	12~14	13.7
	802.11n (20M)		12±1	11~13	12.5
	802.11n (40M)		12±1	11~13	11.9
	802.11ac (20M)		12±1	11~13	12.3
	802.11ac (40M)		12±1	11~13	11.6
	802.11ac (80M)		12±1	11~13	11.2
WLAN 5.8G	802.11a		13±1	12~14	13.4
	802.11n (20M)		12±1	11~13	12.6
	802.11n (40M)		11±1	10~12	11.4
	802.11ac (20M)		11±1	10~12	11.6
	802.11ac (40M)		11±1	10~12	10.9
	802.11ac (80M)		11±1	10~12	11.2
Bluetooth	3.0	1M	2±1	1~3	2.85
		2M	-2±1	-3~-1	-1.50
		3M	-2±1	-3~-1	-1.30
	4.0		1±1	0~2	1.29

7.2. WLAN Output Power

Mode	Channel	Frequency (MHz)	Tune-up	Output Power (dBm)
802.11b	1	2412	14	13.9
	6	2437	14	13.6
	11	2462	14	13.2
802.11g	1	2412	10	9.1
	6	2437	10	9.3
	11	2462	10	9.1
802.11n (HT20)	1	2412	10	9.4
	6	2437	10	9.3
	11	2462	10	9.4

802.11n (HT40)	3	2422	10	9.2
	6	2437	10	9.0
	9	2452	10	9.2
802.11a	36	5180	14	13.7
	40	5200	14	13.5
	48	5240	14	13.4
802.11n (20M)	36	5180	13	12.4
	40	5200	13	12.5
	48	5240	13	12.3
802.11n (40M)	38	5190	13	11.8
	46	5230	13	11.9
802.11ac (20M)	36	5180	13	12.1
	40	5200	13	12.3
	48	5240	13	12.2
802.11ac (40M)	38	5190	13	11.3
	46	5230	13	11.6
802.11ac (80M)	42	5210	13	11.2
802.11a	149	5745	14	13.3
	157	5785	14	13.2
	165	5825	14	13.4
802.11n (20M)	149	5745	13	12.4
	157	5785	13	12.6
	165	5825	13	12.2
802.11n (40M)	151	5755	12	11.2
	159	5795	12	11.4
802.11ac (20M)	149	5745	12	11.5
	157	5785	12	11.3
	165	5825	12	11.6
802.11ac (40M)	151	5755	12	10.9
	159	5795	12	10.5
802.11ac (80M)	155	5775	12	11.2

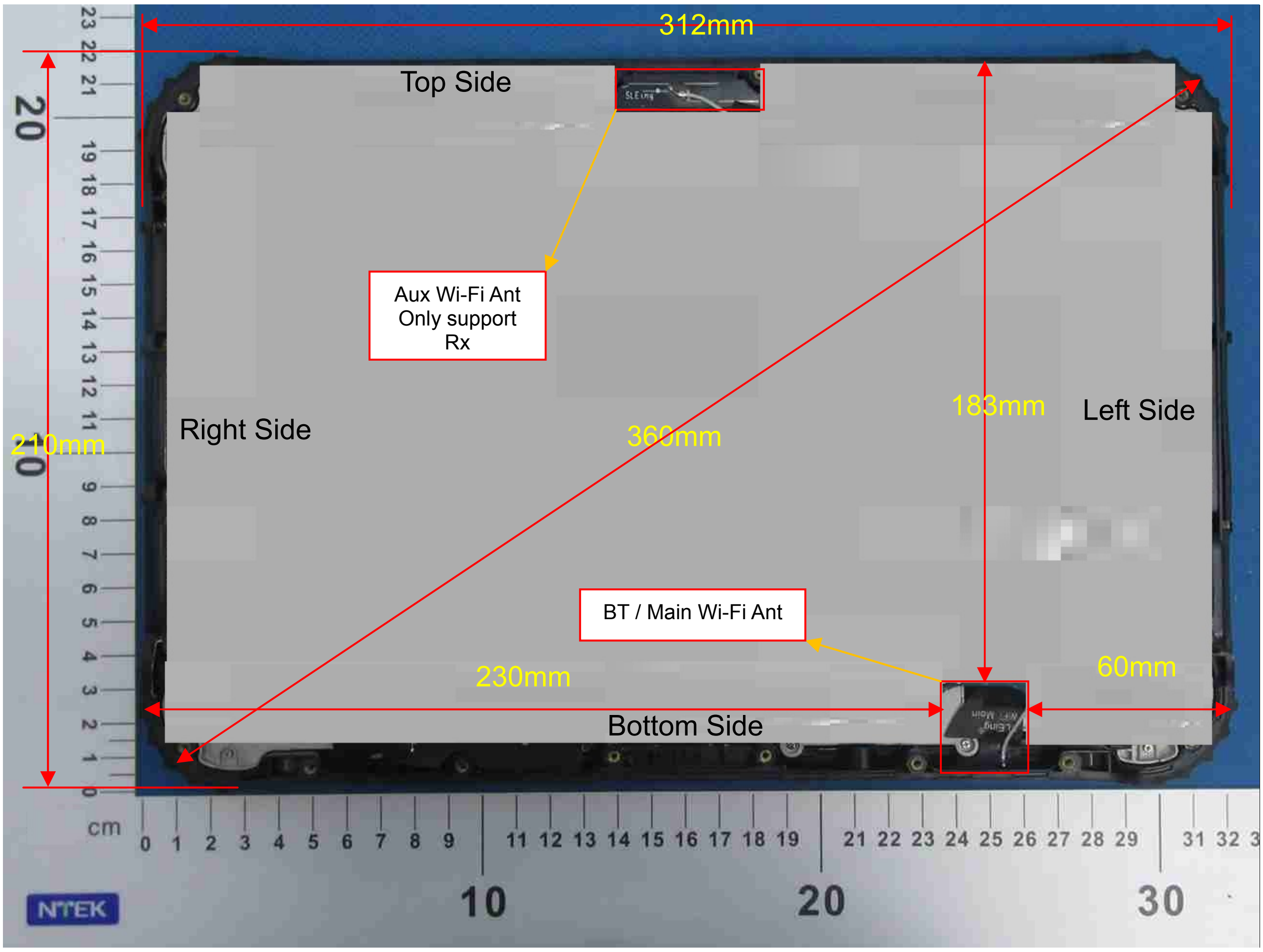
7.3. Bluetooth Output Power

The output power of Bluetooth is as following:

Bluetooth(3.0)	Output Power (dBm)			
	Tune-up	0CH	39CH	78CH
1M	3.00	2.44	2.85	2.52
2M	-1.00	-2.00	-1.50	-1.60
3M	-1.00	-1.82	-1.30	-1.40

	Channel	Tune-up	Output Power (dBm)
Bluetooth(4.0)	0CH	2.00	0.80
	19CH	2.00	1.29
	39CH	2.00	1.04

8. Antenna Location



Distance of the Antenna to the EUT surface/edge						
Antennas	Front Side	Back Side	Left Side	Right Side	Top Side	Bottom Side
WLAN & Bluetooth	≤5mm	≤5mm	60mm	210mm	183mm	≤5mm

Positions for SAR tests		
Test separation distances ≤ 50 mm		
Exposure Positions	Tune-up Maximum power of 802.11b	
	14dBm	
Front Side	Antenna to user(mm)	5
	SAR exclusion threshold	8
	SAR testing required?	**YES**
Back Side	Antenna to user(mm)	5
	SAR exclusion threshold	8
	SAR testing required?	**YES**
Bottom Side	Antenna to user(mm)	5
	SAR exclusion threshold	8
	SAR testing required?	**YES**
Exposure Positions	Tune-up Maximum power of 802.11a(5.2G)	
	14dBm	
Front Side	Antenna to user(mm)	5
	SAR exclusion threshold	11
	SAR testing required?	**YES**
Back Side	Antenna to user(mm)	5
	SAR exclusion threshold	11
	SAR testing required?	**YES**
Bottom Side	Antenna to user(mm)	5
	SAR exclusion threshold	11
	SAR testing required?	**YES**
Exposure Positions	Tune-up Maximum power of 802.11a(5.8G)	
	14dBm	
Front Side	Antenna to user(mm)	5
	SAR exclusion threshold	12
	SAR testing required?	**YES**
Back Side	Antenna to user(mm)	5
	SAR exclusion threshold	12
	SAR testing required?	**YES**
Bottom Side	Antenna to user(mm)	5
	SAR exclusion threshold	12
	SAR testing required?	**YES**

NOTE: Refer to section 4.3.1 of KDB 447498 D01.

Positions for SAR tests		
Test separation distances > 50 mm		
Exposure Positions	Tune-up Maximum power of 802.11b	
	14dBm	25mW
Left Side	Antenna to user(mm)	60
	SAR exclusion threshold(mW)	196
	SAR testing required?	**NO**
Right Side	Antenna to user(mm)	210
	SAR exclusion threshold(mW)	1696
	SAR testing required?	**NO**
Top Side	Antenna to user(mm)	183
	SAR exclusion threshold(mW)	1426
	SAR testing required?	**NO**
Exposure Positions	Tune-up Maximum power of 802.11a(5.2G)	
	14dBm	25mW
Left Side	Antenna to user(mm)	60
	SAR exclusion threshold(mW)	166
	SAR testing required?	**NO**
Right Side	Antenna to user(mm)	210
	SAR exclusion threshold(mW)	1666
	SAR testing required?	**NO**
Top Side	Antenna to user(mm)	183
	SAR exclusion threshold(mW)	1396
	SAR testing required?	**NO**
Exposure Positions	Tune-up Maximum power of 802.11a(5.8G)	
	14dBm	25mW
Left Side	Antenna to user(mm)	60
	SAR exclusion threshold(mW)	162
	SAR testing required?	**NO**
Right Side	Antenna to user(mm)	210
	SAR exclusion threshold(mW)	1662
	SAR testing required?	**NO**
Top Side	Antenna to user(mm)	183
	SAR exclusion threshold(mW)	1392
	SAR testing required?	**NO**

NOTE: Refer to section 4.3.1 of KDB 447498 D01.

9. Stand-alone SAR test exclusion

Refer to KDB 447498 D01, 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	2	5	2.48	0.63	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	2	5	2.48	7.5	0.084

NOTE: Estimated SAR calculation for Bluetooth

10. SAR Results

10.1. SAR measurement results

General Notes:

1) Refer to KDB447498 D01, all measurement SAR results are scaled to the maximum tune-up tolerance limit to demonstrate compliant.

2) Refer to KDB447498 D01, testing of other required channels within the operating mode of a frequency band is not required when the reported 1-g or 10-g SAR for the mid-band or highest output power channel is: ≤ 0.8 W/kg or 2.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≤ 100MHz. When the maximum output power variation across the required test channels is > ½ dB, instead of the middle channel, the highest output power channel must be used.

3) Refer to KDB865664 D01, for each frequency band, repeated SAR measurement is required only when the measured SAR is ≥0.8W/Kg; if the deviation among the repeated measurement is ≤20%,and the measured SAR <1.45W/Kg, only one repeated measurement is required.

4) Refer to KDB865664 D02, SAR plot is only required for the highest measured SAR in each exposure configuration, wireless mode and frequency band combination; Plots are also required when the measured SAR is > 1.5 W/kg, or > 7.0 W/kg for occupational exposure. The published RF exposure KDB procedures may require additional plots; for example, to support SAR to peak location separation ratio test exclusion and/or volume scan post-processing(Refer to appendix C for details).

10.1.1. SAR measurement Result of WLAN

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)
			1g	10g				
Front Side	1/2412	802.11b	0.569	0.268	1.19	13.90	14.00	0.582
Back Side	1/2412	802.11b	1.180	0.604	0.76	13.90	14.00	1.207
Bottom Side	1/2412	802.11b	0.494	0.220	0.75	13.90	14.00	0.506
Back Side	6/2437	802.11b	1.224	0.604	-1.43	13.60	14.00	1.342
Back Side - Repeated	6/2437	802.11b	1.195	0.602	-1.14	13.60	14.00	1.310
Back Side	11/2462	802.11b	1.029	0.433	-2.69	13.20	14.00	1.237

NOTE: Body SAR test results 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)
			1g	10g				
Front Side	36/5180	802.11a	0.611	0.384	2.11	13.70	14.00	0.655
Back Side	36/5180	802.11a	1.142	0.534	1.89	13.70	14.00	1.224
Bottom Side	36/5180	802.11a	0.502	0.337	-1.75	13.70	14.00	0.538
Back Side	40/5200	802.11a	0.898	0.316	-1.31	13.50	14.00	1.008
Back Side	48/5240	802.11a	1.188	0.726	2.03	13.40	14.00	1.364
Back Side - Repeated	48/5240	802.11a	1.098	0.705	2.11	13.40	14.00	1.261

NOTE: Body SAR test results of WLAN 5.2G

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)
			1g	10g				
Front Side	165/5825	802.11a	0.523	0.208	1.15	13.40	14.00	0.600
Back Side	165/5825	802.11a	0.886	0.316	-4.22	13.40	14.00	1.017
Back Side - Repeated	165/5825	802.11a	0.856	0.312	-2.52	13.40	14.00	0.983
Bottom Side	165/5825	802.11a	0.205	0.100	-4.13	13.40	14.00	0.235
Back Side	149/5745	802.11a	0.562	0.227	-2.17	13.30	14.00	0.660
Back Side	157/4785	802.11a	0.682	0.308	1.15	13.20	14.00	0.820

NOTE: Body SAR test results of WLAN 5.8G

10.2. Simultaneous Transmission Possibilities Analysis

WLAN 2.4/5GHz and Bluetooth share the same antenna, and cannot transmit simultaneously.

11. Appendix A. Photo documentation

Table of contents

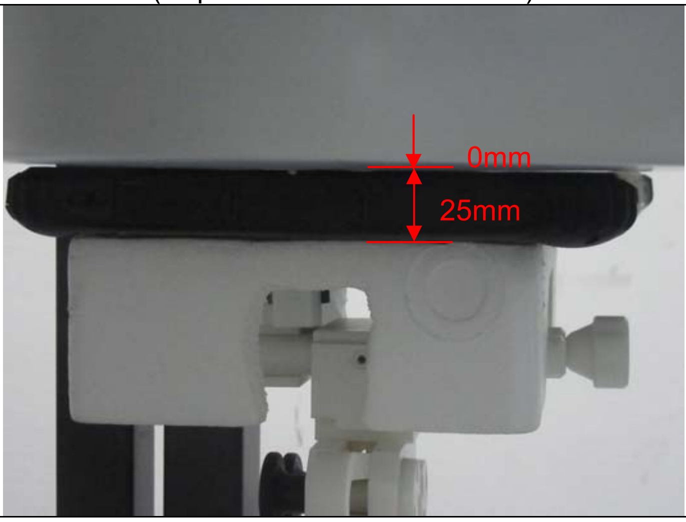
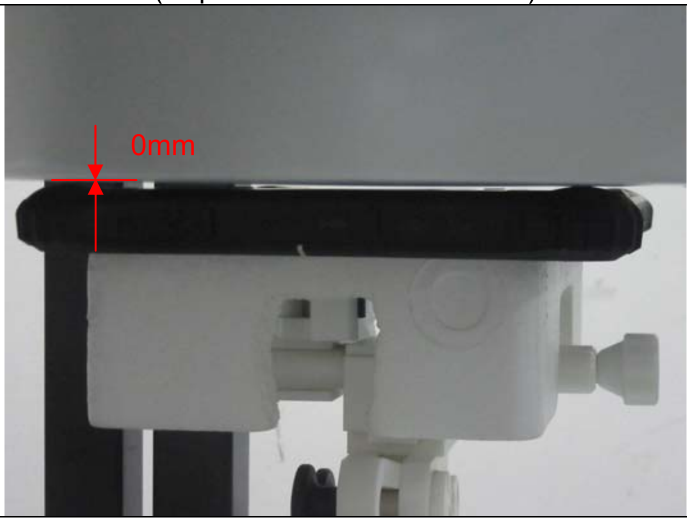
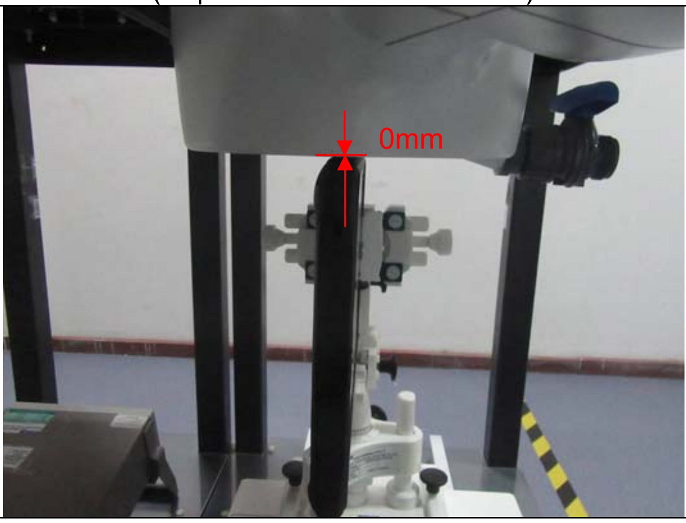
Test Facility

Measurement System SATIMO

Product Photo

Front View	Back View
	
Reference Line	N/A
	N/A

Test Positions

<table>
<tr><td>Front Side
(Separation distance of 0mm)</td><td>Back Side
(Separation distance of 0mm)</td></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td>Bottom Side
(Separation distance of 0mm)</td><td>N/A</td></tr>
<tr><td>
</td><td>N/A</td></tr>
</table>

Liquid depth

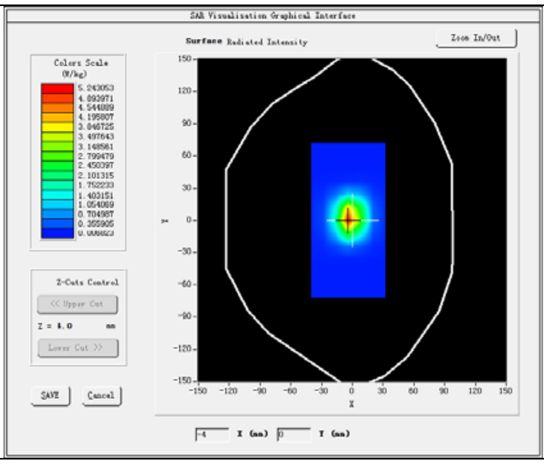
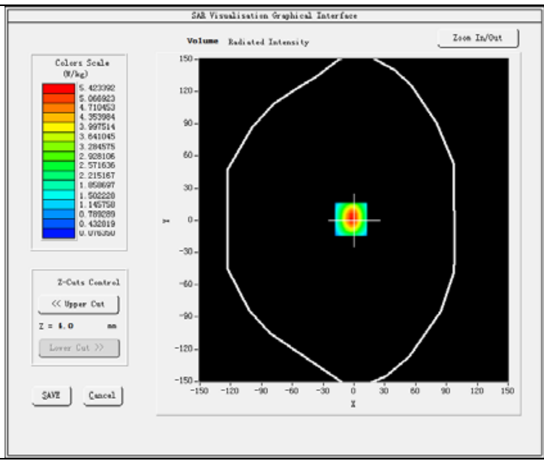
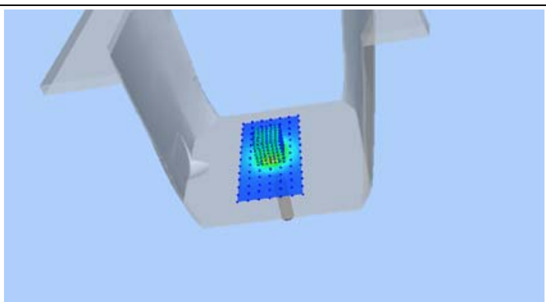
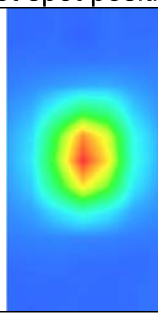
<table>
<tr><td>Body Position with 2450MHz liquid depth (15.2cm)</td><td>Body Position with 5000MHz liquid depth (15.4cm)</td></tr>
<tr><td></td><td></td></tr>
</table>

12. Appendix B. System Check Plots

Table of contents
System Performance Check - 2450MHz
System Performance Check - 5200MHz
System Performance Check - 5800MHz

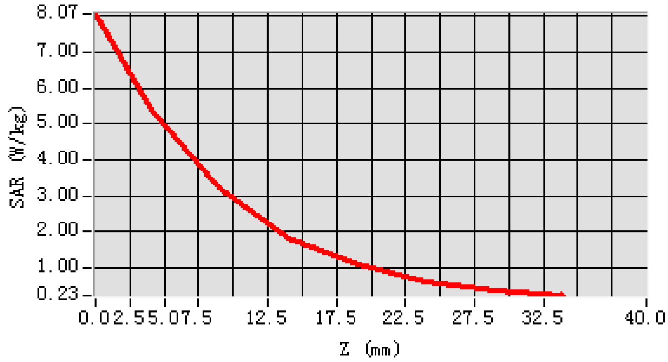
System Performance Check - SID2450-Body

Date of measurement:	Nov. 10, 2017
Signal:	Communication System: CW; Frequency: 2450.00MHz; Duty Cycle: 1:1.00
ConvF:	2.27
Liquid Parameters:	Relative permittivity (real part): 52.28; Conductivity (S/m): 1.96;
Device Position:	Dipole
Area Scan:	dx=12mm dy=12mm, h=5.00mm
Zoom Scan:	7x7x7, dx=5mm dy=5mm dz=5mm, h=5.00mm

Surface SAR	Volume SAR
	
3D screen shot	**Hot spot position**
	

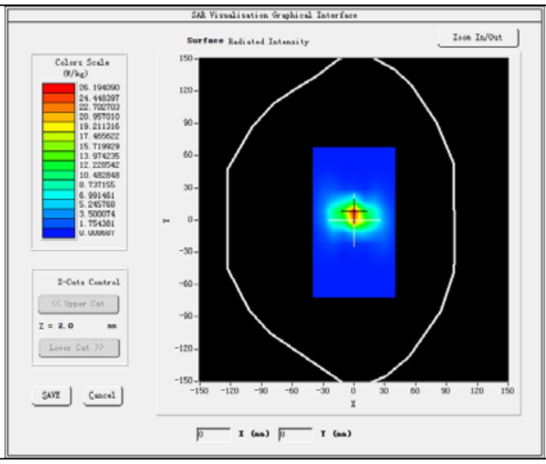
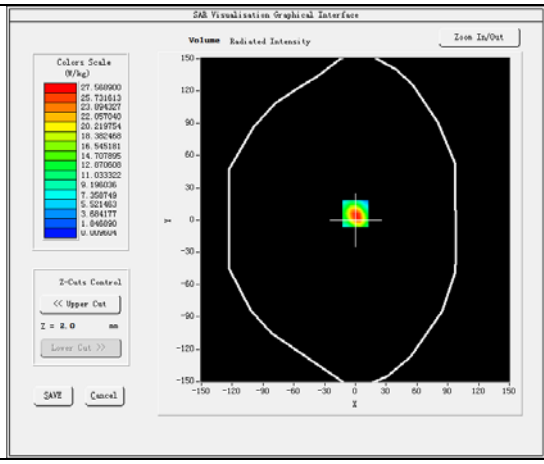
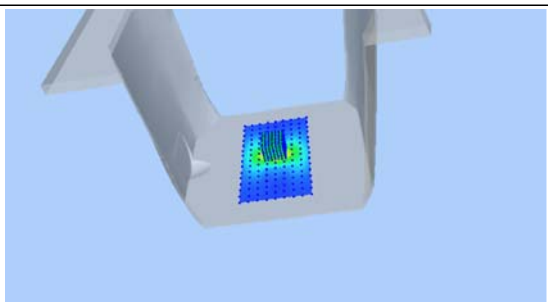
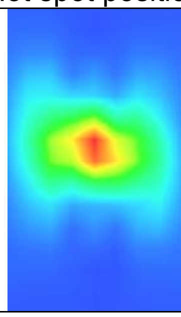
Maximum location: X=-3.00, Y=1.00
SAR Peak: 8.16 W/kg

SAR 1g (W/Kg)				4.940			
SAR 10g (W/Kg)				2.321			
Power Drift (±5%):				0.17			
Z (mm)	0.00	4.00	9.00	14.00	19.00	24.00	29.00
SAR (W/Kg)	8.0691	5.4234	3.2143	1.8346	1.0816	0.6344	0.3803



System Performance Check - SID5200-Body

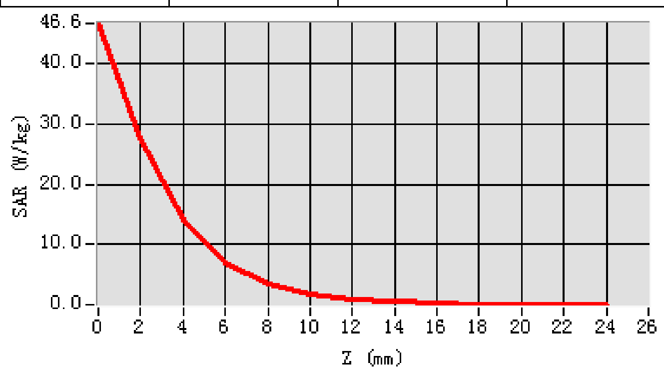
Date of measurement:	Nov. 14, 2017
Signal:	Communication System: CW; Frequency: 5200.00MHz; Duty Cycle: 1:1.00
ConvF:	2.46
Liquid Parameters:	Relative permittivity (real part): 49.62; Conductivity (S/m):5.29;
Device Position:	Dipole
Area Scan:	dx=10mm dy=10mm, h=5.00mm
Zoom Scan:	7x7x12, dx=4mm dy=4mm dz=2mm, h=5.00mm

Surface SAR	Volume SAR
	
3D screen shot	Hot spot position
	

Maximum location: X=0.00, Y=6.00
SAR Peak: 49.61 W/kg

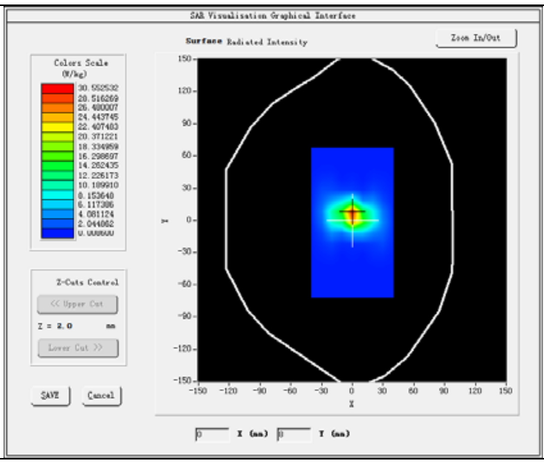
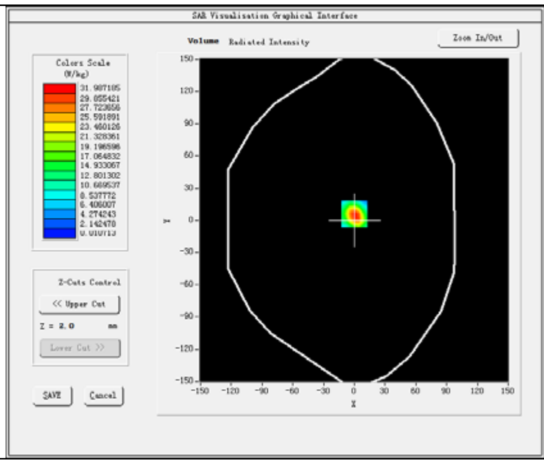
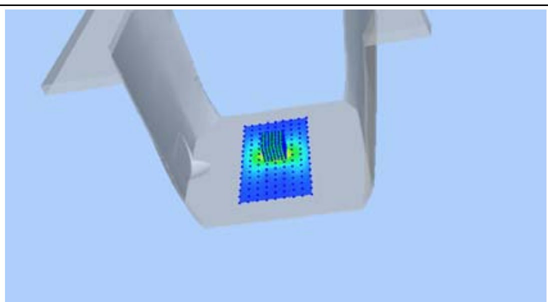
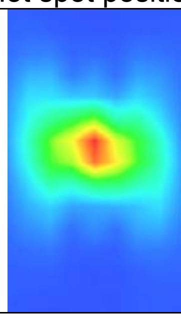
SAR 1g (W/Kg)	15.597
SAR 10g (W/Kg)	5.409
Power Drift (±5%):	-0.59

Z (mm)	0.00	4.00	8.00	12.00	16.00	20.00	22.00
SAR (W/Kg)	46.6126	14.0604	3.5943	0.8986	0.2436	0.0618	0.0470



System Performance Check - SID5800-Body

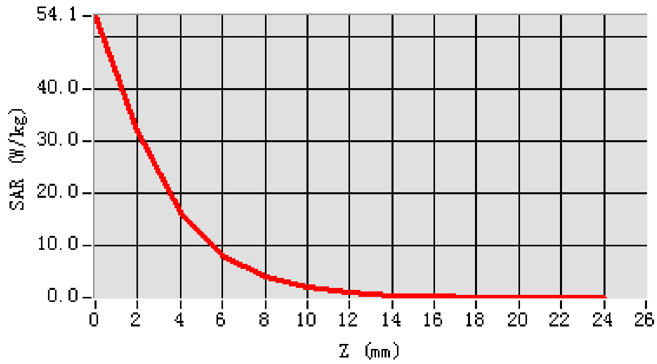
Date of measurement:	Nov. 15, 2017
Signal:	Communication System: CW; Frequency: 5800.00MHz; Duty Cycle: 1:1.00
ConvF:	2.57
Liquid Parameters:	Relative permittivity (real part): 48.41; Conductivity (S/m): 6.05;
Device Position:	Dipole
Area Scan:	dx=10mm dy=10mm, h=5.00mm
Zoom Scan:	7x7x12, dx=4mm dy=4mm dz=2mm, h=5.00mm

Surface SAR	Volume SAR
	
3D screen shot	Hot spot position
	

Maximum location: X=0.00, Y=6.00
SAR Peak: 57.20 W/kg

SAR 1g (W/Kg)	17.985
SAR 10g (W/Kg)	6.163
Power Drift (±5%):	-0.32

Z (mm)	0.00	4.00	8.00	12.00	16.00	20.00	22.00
SAR (W/Kg)	54.1397	16.3513	4.0829	1.0345	0.2729	0.0755	0.0502



13. Appendix C. Plots of High SAR Measurement

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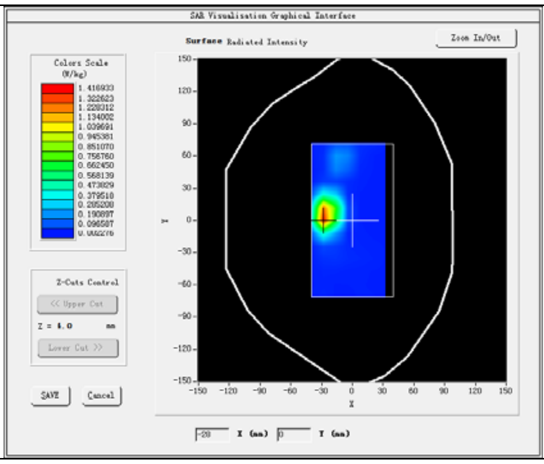
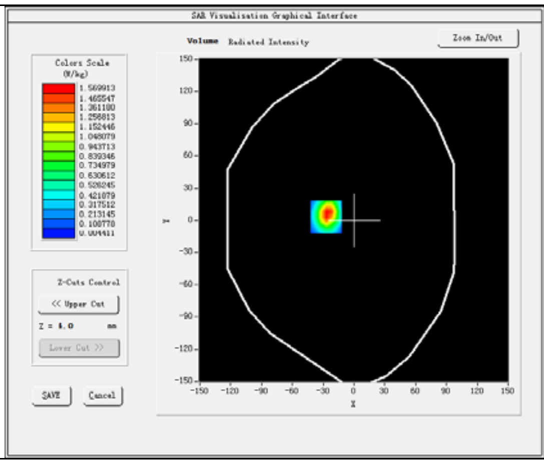
WLAN 2.4G_802.11b_Ch6_Back Side_0mm

Date of measurement:	Nov. 10, 2017
Signal:	Communication System: WLAN 802.11a/b/g/n/ac; Frequency: 2437.00MHz; Duty Cycle: 1:1.00
ConvF:	2.27
Liquid Parameters:	Relative permittivity (real part): 52.35; Conductivity (S/m): 1.94;
Device Position:	Body
Area Scan:	dx=12mm dy=12mm, h=5.00mm
Zoom Scan:	7x7x7, dx=5mm dy=5mm dz=5mm, h=5.00mm

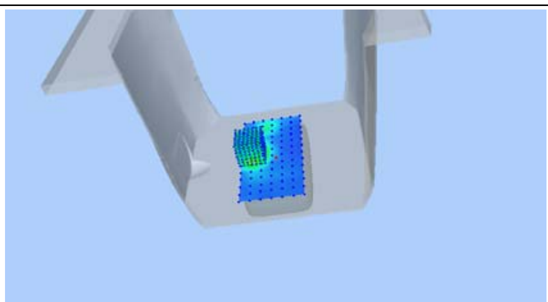
Surface SAR



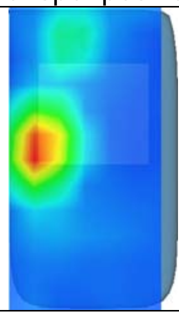
Volume SAR



3D screen shot

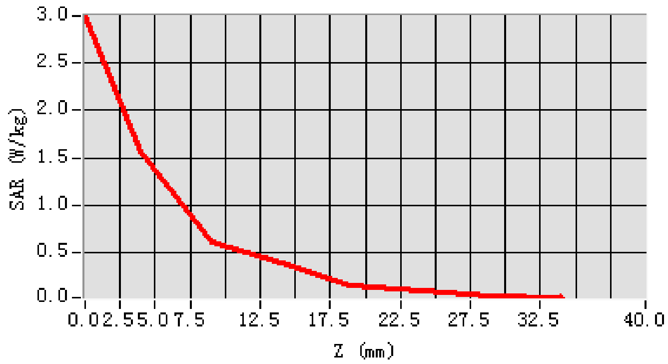


Hot spot position



Maximum location: X=-27.00, Y=3.00
SAR Peak: 2.73 W/kg

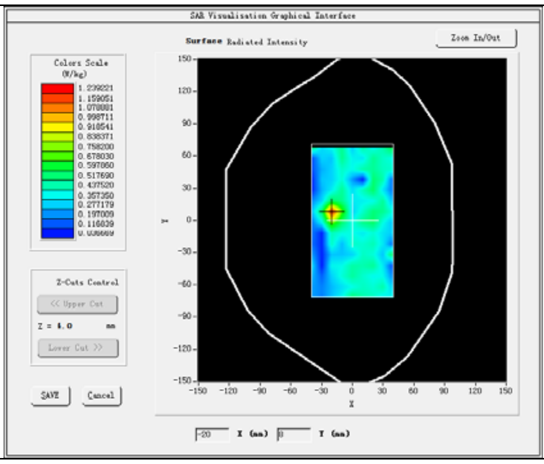
SAR 1g (W/Kg)				1.224			
SAR 10g (W/Kg)				0.604			
Power Drift (±5%):				-1.43			
Z (mm)	0.00	4.00	9.00	14.00	19.00	24.00	29.00
SAR (W/Kg)	2.9992	1.5699	0.6104	0.3925	0.1453	0.1000	0.0358



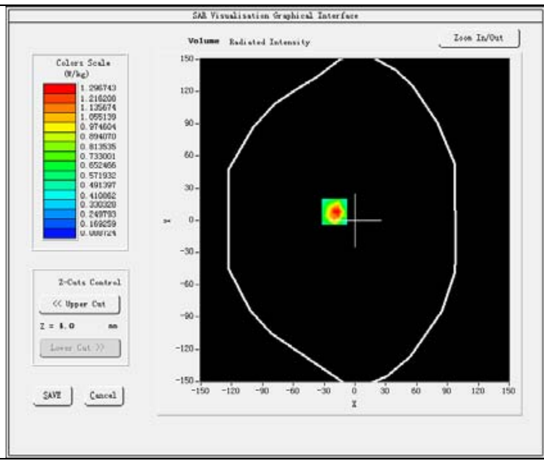
WLAN 5.2G_802.11a_Ch48_Back Side_0mm

Date of measurement:	Nov. 14, 2017
Signal:	Communication System: WLAN 802.11a/b/g/n/ac; Frequency: 5240.00MHz; Duty Cycle: 1:1.00
ConvF:	2.46
Liquid Parameters:	Relative permittivity (real part): 49.46; Conductivity (S/m): 5.33;
Device Position:	Body
Area Scan:	dx=10mm dy=10mm, h=5.00mm
Zoom Scan:	7x7x12, dx=4mm dy=4mm dz=2mm, h=5.00mm

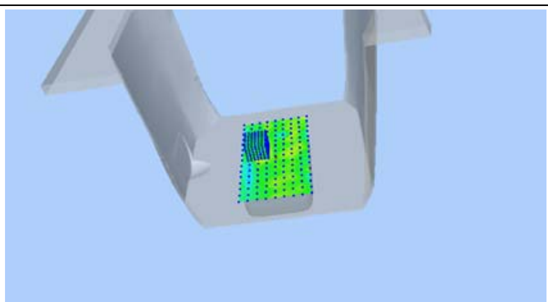
Surface SAR



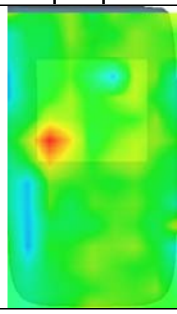
Volume SAR



3D screen shot

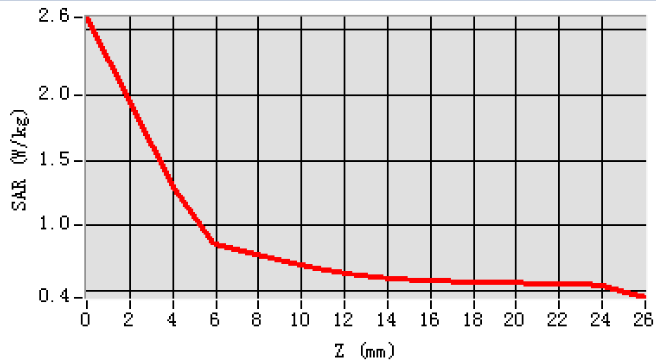


Hot spot position



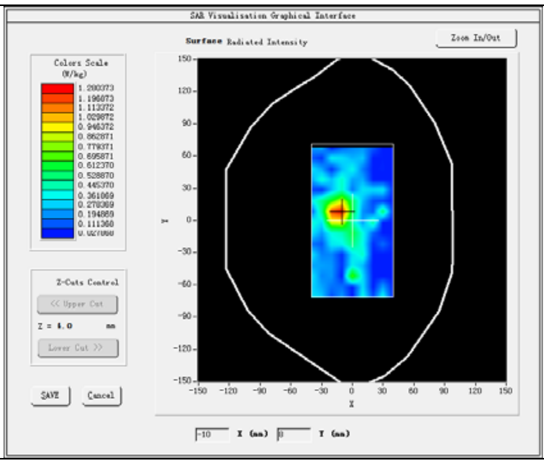
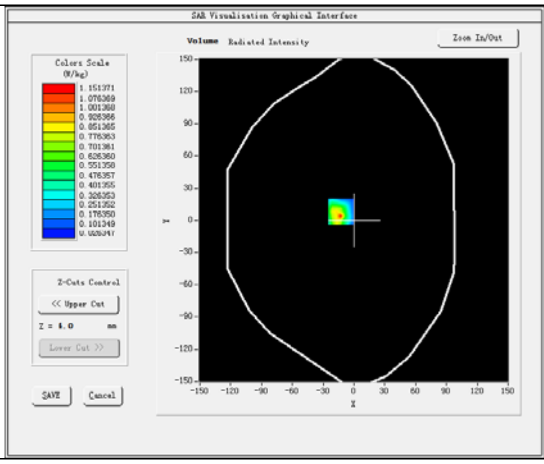
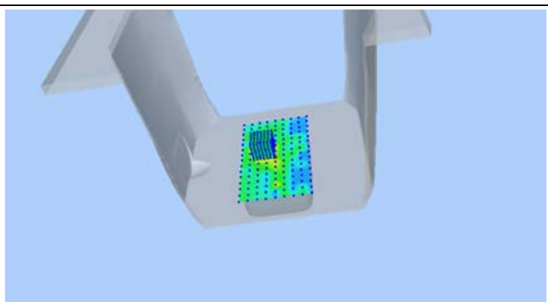
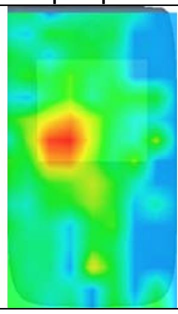
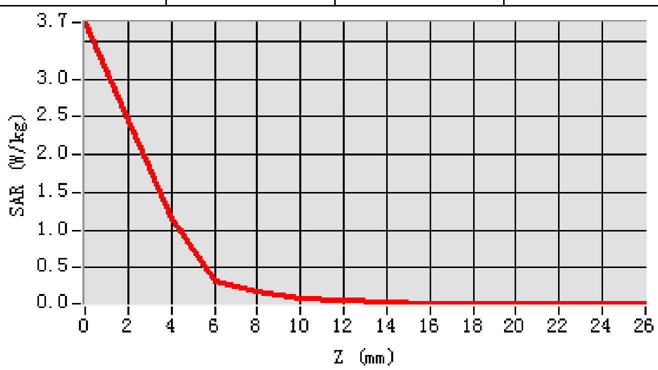
Maximum location: X=-20.00, Y=8.00
SAR Peak: 2.85 W/kg

SAR 1g (W/Kg)				1.188			
SAR 10g (W/Kg)				0.726			
Power Drift (±5%):				2.03			
Z (mm)	0.00	6.00	10.00	14.00	18.00	22.00	24.00
SAR (W/Kg)	2.5966	0.8296	0.6526	0.5852	0.5543	0.5389	0.5107



WLAN 5.8G_802.11a_Ch165_Back Side_0mm

Date of measurement:	Nov. 15, 2017
Signal:	Communication System: WLAN 802.11a/b/g/n/ac; Frequency: 5825.00MHz; Duty Cycle: 1:1.00
ConvF:	2.57
Liquid Parameters:	Relative permittivity (real part): 48.34; Conductivity (S/m): 6.07;
Device Position:	Body
Area Scan:	dx=10mm dy=10mm, h=5.00mm
Zoom Scan:	7x7x12, dx=4mm dy=4mm dz=2mm, h=5.00mm

<table>
<tr><td colspan="4">Surface SAR</td><td colspan="4">Volume SAR</td></tr>
<tr><td colspan="4"></td><td colspan="4"></td></tr>
<tr><td colspan="4">3D screen shot</td><td colspan="4">Hot spot position</td></tr>
<tr><td colspan="4"></td><td colspan="4"></td></tr>
<tr><td colspan="8">Maximum location: X=-13.00, Y=8.00
SAR Peak: 3.54 W/kg</td></tr>
<tr><td colspan="4">SAR 1g (W/Kg)</td><td colspan="4">0.886</td></tr>
<tr><td colspan="4">SAR 10g (W/Kg)</td><td colspan="4">0.316</td></tr>
<tr><td colspan="4">Power Drift (±5%):</td><td colspan="4">-4.22</td></tr>
<tr><td>Z (mm)</td><td>0.00</td><td>6.00</td><td>10.00</td><td>14.00</td><td>18.00</td><td>22.00</td><td>24.00</td></tr>
<tr><td>SAR (W/Kg)</td><td>3.7483</td><td>0.3308</td><td>0.0993</td><td>0.0436</td><td>0.0375</td><td>0.0322</td><td>0.0288</td></tr>
<tr><td colspan="8"></td></tr>
</table>

14. Appendix D. Calibration Certificate

Table of contents
E Field Probe - SN 08/16 EPGO287
2450 MHz Dipole - SN 03/15 DIP 2G450-352
5000-6000 MHz Dipole - SN 13/14 WGA 33
Extended Calibration Certificate

COMOSAR E-Field Probe Calibration Report

Ref : ACR.261.2.17.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 DOSIMETRIC E-FIELD PROBE
SERIAL NO.: SN 08/16 EPGO287

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

ACCREDITED
Calibration CERT #2246-02

Calibration Date: 09/18/2017

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	9/18/2017	JS
Checked by :	Jérôme LUC	Product Manager	9/18/2017	JS
Approved by :	Kim RUTKOWSKI	Quality Manager	9/18/2017	Kim Rutkowski

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

Issue	Date	Modifications
A	9/18/2017	Initial release

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1 DEVICE UNDER TEST

Device Under Test	
Device Type	COMOSAR DOSIMETRIC E FIELD PROBE
Manufacturer	MVG
Model	SSE2
Serial Number	SN 08/16 EPGO287
Product Condition (new / used)	Used
Frequency Range of Probe	0.4 GHz-6GHz
Resistance of Three Dipoles at Connector	Dipole 1: R1=0.208 MΩ Dipole 2: R2=0.196 MΩ Dipole 3: R3=0.196 MΩ

A yearly calibration interval is recommended.

2 PRODUCT DESCRIPTION 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.

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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%

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5 CALIBRATION MEASUREMENT RESULTS

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

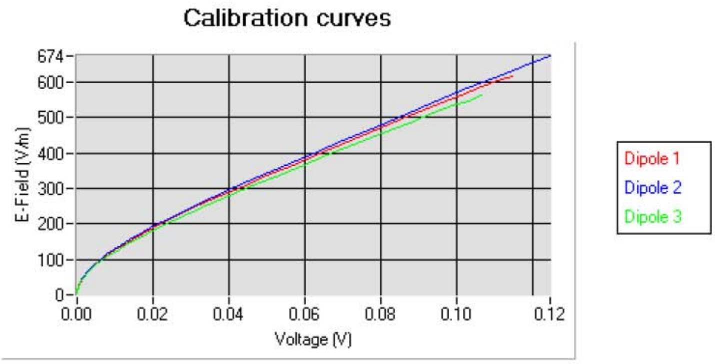
5.1 SENSITIVITY IN AIR

Normx dipole 1 ($\mu V/(V/m)^2$)	Normy dipole 2 ($\mu V/(V/m)^2$)	Normz dipole 3 ($\mu V/(V/m)^2$)
0.69	0.78	0.61

DCP dipole 1 (mV)	DCP dipole 2 (mV)	DCP dipole 3 (mV)
92	90	96

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

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



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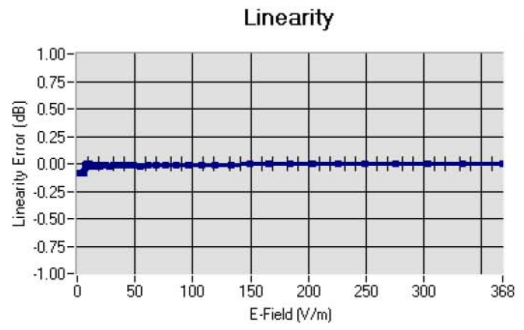
5.2 LINEARITY



Linearity:+/-1.86% (+/-0.08dB)

5.3 SENSITIVITY IN LIQUID

Liquid	Frequency (MHz +/- 100MHz)	Permittivity	Epsilon (S/m)	ConvF
HL750	750	42.09	0.91	1.44
BL750	750	55.69	0.95	1.49
HL850	835	42.71	0.89	1.48
BL850	835	57.52	1.03	1.53
HL900	900	41.94	0.93	1.50
BL900	900	52.87	1.09	1.54
HL1800	1800	40.62	1.39	1.75
BL1800	1800	53.22	1.47	1.79
HL1900	1900	41.22	1.37	2.00
BL1900	1900	50.99	1.52	2.07
HL2000	2000	40.39	1.36	1.93
BL2000	2000	54.39	1.54	1.99
HL2450	2450	40.46	1.87	2.18
BL2450	2450	54.62	1.95	2.27
HL2600	2600	38.46	2.01	2.15
BL2600	2600	51.98	2.16	2.19
HL5200	5200	35.14	4.74	2.37
BL5200	5200	49.01	5.27	2.46
HL5400	5400	34.52	4.77	2.33
BL5400	5400	49.67	5.45	2.41
HL5600	5600	37.08	5.03	2.47
BL5600	5600	47.57	5.69	2.54
HL5800	5800	34.64	5.19	2.51
BL5800	5800	49.82	5.94	2.57

LOWER DETECTION LIMIT: 7mW/kg

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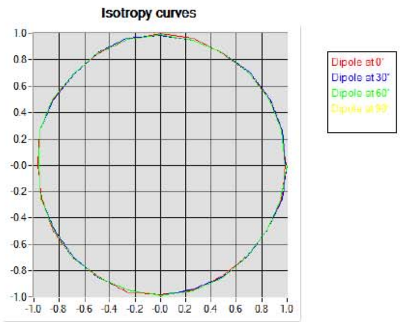
5.4 ISOTROPY

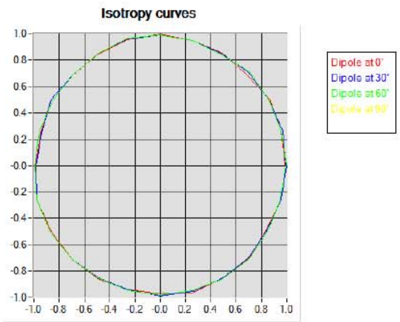
HL900 MHz

- Axial isotropy: 0.05 dB
- Hemispherical isotropy: 0.06 dB



HL1800 MHz

- Axial isotropy: 0.05 dB
- Hemispherical isotropy: 0.08 dB



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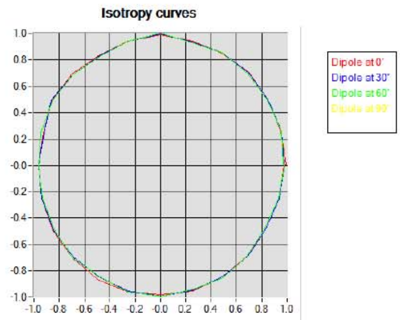
HL5600 MHz

- Axial isotropy: 0.06 dB
- Hemispherical isotropy: 0.08 dB



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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	02/2016	02/2019
Reference Probe	MVG	EP 94 SN 37/08	10/2016	10/2017
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	10/2015	10/2017

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SAR Reference Dipole Calibration Report

Ref : ACR.139.9.15.SATU.A

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: 2450 MHZ
SERIAL NO.: SN 03/15 DIP 2G450-352

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

Calibration CERT #2246-02

04/06/2015

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.139.9.15.SATU.A

	Name	*Function*	*Date*	*Signature*
Prepared by :	Jérôme LUC	Product Manager	5/19/2015	JS
Checked by :	Jérôme LUC	Product Manager	5/19/2015	JS
Approved by :	Kim RUTKOWSKI	Quality Manager	5/19/2015	Kim Rutkowski

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

Issue	*Date*	*Modifications*
A	5/19/2015	Initial release

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