FCC SAR Test Report

Report No.	:	**SA190423W001-1**
Applicant	:	**PUNDI X LABS PTE. LTD.**
Address	:	**6 RAFFLES BOULEVARD, #03-308 MARINA SQUARE SINGAPORE, 039594**
Product	:	**XPOS**
FCC ID	:	**2ASTH-X2**
Brand	:	**Pundi X**
Model No.	:	**X2**
Standards	:	**FCC 47 CFR Part 2 (2.1093) / IEEE C95.1:1992 / IEEE 1528:2013** **KDB 865664 D01 v01r04 / KDB 865664 D02 v01r02** **KDB 248227 D01 v02r02 / KDB 447498 D01 v06** **/ KDB 941225 D01 v03r01 / KDB 941225 D05 v02r05**
Sample Received Date	:	**Dec. 17, 2018**
Date of Testing	:	**Dec. 18, 2018 ~ Jan. 25, 2019**

CERTIFICATION: The above equipment have been tested by **BV 7LAYERS COMMUNICATIONS TECHNOLOGY (SHENZHEN) CO. LTD.**, and found compliance with the requirement of the above standards. The test record, data evaluation & Equipment Under Test (EUT) configurations represented herein are true and accurate accounts of the measurements of the sample's SAR characteristics under the conditions specified in this report. It should not be reproduced except in full, without the written approval of our laboratory. The client should not use it to claim product certification, approval, or endorsement by A2LA or any government agencies.

Prepared By : Wiky Zhang / Engineer

Approved By : Luke Lu / Manager

ACCREDITED
Certificate # 3939.01

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Release Control Record

Report No.	Reason for Change	Date Issued
SA181217W003-1	Initial release	Mar. 11, 2019
SA190423W001-1	Based on the original report SA181217W003-1 changing applicant & manufacturer information.	Apr. 25, 2019

1. Summary of Maximum SAR Value

Equipment Class	Mode	Highest Reported Body SAR_{1g} (0 cm Gap) (W/kg)
PCB	GSM850	1.03
	GSM1900	0.57
	WCDMA II	0.78
	WCDMA V	1.19
	LTE 2	1.02
	LTE 5	0.77
	LTE 7	1.03
	LTE 38	0.63
	LTE 40	0.92
	LTE 41	0.72
DTS	2.4G WLAN	0.52
NII	5.3G WLAN	0.44
	5.6G WLAN	0.54
	5.8G WLAN	0.51
DSS	Bluetooth	N/A
Highest Simultaneous Transmission SAR		Body (W/kg)
PCB + DTS		1.54
PCB + NII		1.56
PCB + DSS		1.34

Note:

1. The SAR limit **(Head & Body: SAR_{1g} 1.6 W/kg)** for general population / uncontrolled exposure is specified in FCC 47 CFR part 2 (2.1093) and ANSI/IEEE C95.1-1992

2. Description of Equipment Under Test

EUT Type	XPOS
FCC ID	2ASTH-X2
Brand Name	Pundi X
Model Name	X2
IMEI Code	351576069000754
HW Version	JP800_MB_V1.2
SW Version	JP800_V1_CF.08_20190110
Tx Frequency Bands (Unit: MHz)	GSM850 : 824.2 ~ 848.8 GSM1900 : 1850.2 ~ 1909.8 WCDMA Band II : 1852.4 ~ 1907.6 WCDMA Band V : 826.4 ~ 846.6 LTE Band 2 : 1850.7 ~ 1909.3 (1.4M), 1851.5 ~ 1908.5 (3M), 1852.5 ~ 1907.5 (5M), 1855 ~ 1905 (10M), 1857.5 ~ 1902.5 (15M), 1860 ~ 1900 (20M) LTE Band 5 : 824.7 ~ 848.3 (1.4M), 825.5 ~ 847.5 (3M), 826.5 ~ 846.5 (5M), 829 ~ 844 (10M) LTE Band 7 : 2502.5 ~ 2567.5 (5M), 2505 ~ 2565 (10M), 2507.5 ~ 2562.5 (15M), 2510 ~ 2560 (20M) LTE Band 38 : 2572.5 ~ 2617.5 (5M), 2575 ~ 2615 (10M), 2577.5 ~ 2612.5(15M), 2580 ~ 2610 (20M) LTE Band 40 : 2307.5 ~ 2312.5 (5M), 2310 (10M) LTE Band 41 : 2557.5 ~ 2562.5 (5M), 2560 ~ 2650 (10M), 2562.5 ~ 2647.5 (15M), 2565 ~ 2645 (20M) WLAN : 2412 ~ 2462, 5180 ~ 5240, 5260 ~ 5320, 5500 ~ 5700, 5745 ~ 5825 Bluetooth : 2402 ~ 2480
Uplink Modulations	GSM & GPRS : GMSK EDGE : 8PSK WCDMA : QPSK LTE : QPSK, 16QAM, 64QAM 802.11b : DSSS 802.11a/g/n : OFDM Bluetooth : GFSK, π/4-DQPSK, 8-DPSK, LE
Maximum Tune-up Conducted Power (Unit: dBm)	Please refer to section 4.6.1 of this report.
Antenna Type	FPC Antenna
EUT Stage	Production Unit

Note:

1. The above EUT information is declared by manufacturer and for more detailed features description please refers to the manufacturer's specifications or User's Manual.

List of Accessory:

Battery	**Brand Name**	XPOS
	Model Name	X2
	Power Rating	3.8Vdc, 4000mAh,15.2Wh
	Type	Li-polymer

3. SAR Measurement System

3.1 Definition of Specific Absorption Rate (SAR)

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

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

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

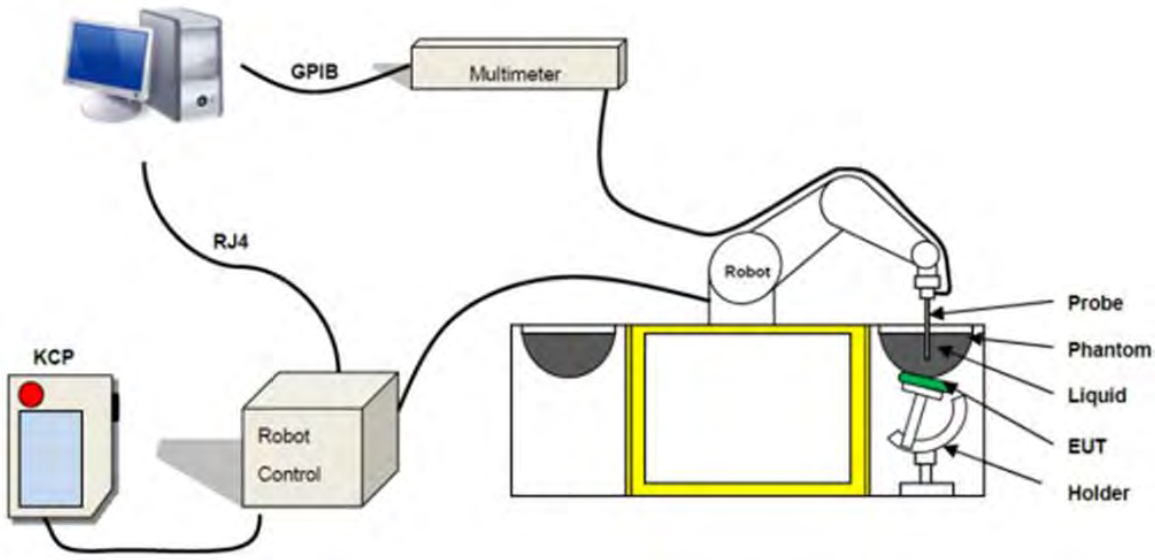
SAR is expressed in units of Watts per kilogram (W/kg)
SAR measurement can be related to the electrical field in the tissue by

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

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

3.2 COMOSAR System

3.2.1 Measurement System Diagram



These measurements were performed with the automated near-field scanning system COMOSAR from SATIMO. The system is based on a high precision robot (working range: 850 mm), which positions the probes with a positional repeatability of better than ± 0.02 mm. Special E- and H-field probes have been developed for measurements close to material discontinuity, the sensors of which are directly loaded with a Schottky diode and connected via highly resistive lines to the data acquisition unit.

The SAR measurements were conducted with dosimetric probe (manufactured by SATIMO), designed in the classical triangular configuration and optimized for dosimetric evaluation. The probe has been calibrated according to the procedure described in SAR standard with accuracy of better than ±10%.The spherical isotropy was evaluated with the procedure described in SAR standard and found to be better than ±0.25 dB. The phantom used was the SAM Phantom as described in FCC supplement C, IEEE P1528.

3.2.2 Robot

The COMOSAR system uses the high precision robots from KUKA. For the 6-axis controller system, the robot controller version (KUKA-KRC2sr) from KUKA is used. The KUKA robot series have many features that are important for our application:

- High precision (repeatability ±0.02 mm)
- High reliability (industrial design)
- Jerk-free straight movements
- Low ELF interference (the closed metallic construction shields against motor control fields)

Fig-3.2 KUKA KR5

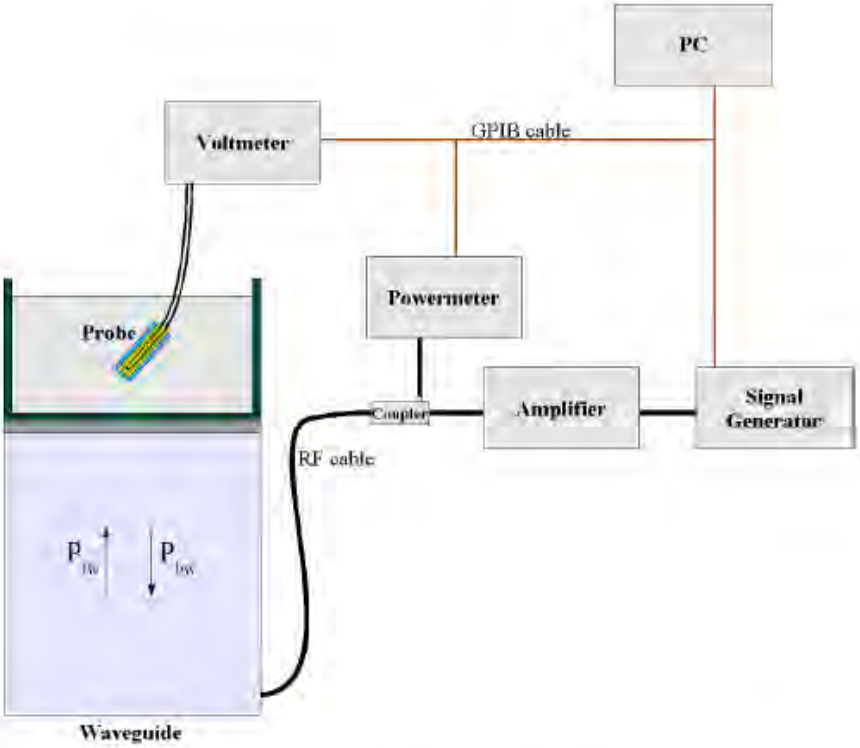
3.2.3 E-Field Probes

The SAR measurement is conducted with the dosimetric probe. The probe is specially designed and calibrated for use in liquid with high permittivity. The dosimetric probe has special calibration in liquid at different frequency.

Device Type	COMOSAR DOSIMETRIC E FIELD PROBE
Model	SSE2
Frequency	100 MHz to 6 GHz
Directivity	±0.25 dB in brain tissue (rotation around probe axis) ±0.5 dB in brain tissue (rotation normal probe axis)
Dynamic Range	0.001W/kg to > 100W/kg
Probe Linearity	± 0.25 dB
Dimensions	Overall length: 330 mm Tip diameter: 2.5 mm Distance from probe tip to dipole centers: <1.5 mm

E-Field Probe Calibration Process

Probe calibration is realized, in compliance with EN/IEC 62209-1/-2 and IEEE 1528 std, with CALISAR, SATIMO proprietary calibration system. The calibration is performed with the technique using reference waveguide.



$$SAR = \frac{4(P_{fw} - P_{bw})}{ab\sigma} \cos^2\left(\pi \frac{y}{a}\right) c^{(2\pi/\sigma)}$$

Where :

Pfw	=	Forward Power
Pbw	=	Backward Power
a and b	=	Waveguide Dimensions
ı	=	Skin Depth

Keithley configuration

Rate=Medium; Filter=ON; RDGS=10; FILTER TYPE=MOVING AVERAGE; RANGE AUTO

After each calibration, a SAR measurement performed on a validation dipole and compared with a NPL calibrated probe, to verify it.

The Calibration factors, CF(N), for the 3 sensors corresponding to dipole 1, dipole 2 and dipole 3 are:

CF(N)=SAR(N)/Vlin(N) (N=1,2,3)

The linearized output voltage Vlin(N) is obtained from the displayed output voltage V(N) using

Vlin(N)=V(N)*(1+V(N)/DCP(N)) N=1,2,3

Where the DCP is the dipole compression point in mV

3.2.4 Phantoms

The phantom developed by SATIMO is produced in accordance with the specified in the standards. It has been designed to fit the COMOSAR phantom tables and is delivered with a plastic cover to prevent liquid evaporation.

Model	SAM Phantom	
Construction	The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (SAM) phantom defined in IEEE 1528 and IEC 62209-1. It enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region. A cover prevents evaporation of the liquid. Reference markings on the phantom allow the complete setup of all predefined phantom positions and measurement grids by teaching reference points with the robot.	
Material	The material is resistant to Glycol and offers high rigidity composite material based on fiberglass).	
Shell Thickness	2 ± 0.2 mm (6 ± 0.2 mm at ear point)	
Dimensions	Length: 1000 mm Width: 500 mm Height: 200 mm	
Filling Volume	approx. 27 liters	

Model	Elliptic Phantom	
Construction	Elliptic Phantom for compliance testing of handheld and body-mounted wireless devices. Elliptic Phantom is fully compatible with the IEC/EN 62209-2 standard and all known tissue simulating liquids. Elliptic Phantom has been optimized regarding its performance and can be integrated into our standard phantom tables. A cover prevents evaporation of the liquid. Reference markings on the phantom allow installation of the complete setup, including all predefined phantom positions and measurement grids, by teaching reference points.	
Material	The material is resistant to Glycol and offers high rigidity composite material based on fiberglass).	
Shell Thickness	2.0 ± 0.2 mm (bottom plate)	
Dimensions	Length: 600 mm Width: 400 mm Height: 200 mm	
Filling Volume	approx. 25 liters	

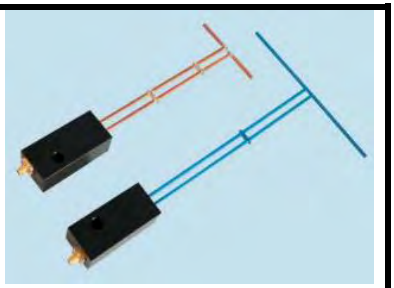
3.2.5 Device Holder

The positioning system is made of an extremely stable material, which ensures easy handling and reproducible positioning. It also allows correct positioning of the dipoles referenced by the IEEE, ANSI and IEC.

Model	Handset Positioning System	
Material properties	The positioning system is made of PETP. This material offers a low permittivity of 3.2 and low loss, with a loss tangent of 0.005 to minimize the influence of the DUT on measurement results.	
Mechanical properties	The positioning system developed by SATIMO allows a positioning resolution better than 1 mm. The system is fixed on a bottom rail “x axis” so that the positioning system can be quickly moved from the right to the left part of the phantom. In addition, it can be moved on a perpendicular “y axis” and the height can be adapted. The system is also composed of three rotation points for accurate positioning of the device’s acoustical output.	
Accuracy and precision	A curved rail on the top part allows the fast switch from the cheek to the tilt position. The required 15° angle for the tilt position can be easily checked thanks to a printed scale on the curved rail with a tolerance of ± 1°	

Model	Device Positioning System	
Material properties	The positioning system is made of PETP. This material offers a low permittivity of 3.2 and low loss, with a loss tangent of 0.005 to minimize the influence of the DUT on measurement results.	
Mechanical properties	2 rows of rail to cover easily the surface of the phantom. The fixing plate is perfectly adapted to larger devices, such as a PC which can be positioned in all configurations.	
Accuracy and precision	Graduated scale available on each axis. The DUT is fixed with a specific adaptable grip.	

3.2.6 System Validation Dipoles

Model	D-Serial	
Construction	Symmetrical dipole with λ0/4 ablaun. Enables measurement of feed point impedance with NWA. Matched for use near flat phantoms filled with tissue simulating solutions.	
Frequency	300 MHz to 6000 MHz	
Return Loss	> 20 dB	
Adaptation	S11 < -20 dB in specified validation Position	

3.2.7 Tissue Simulating Liquids

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 height from the ear reference point (ERP) of the phantom to the liquid top surface is larger than 15 cm. For body SAR testing, the liquid height from the center of the flat phantom to the liquid top surface is larger than 15 cm. The nominal dielectric values of the tissue simulating liquids in the phantom and the tolerance of 5% are listed in Table-3.1.

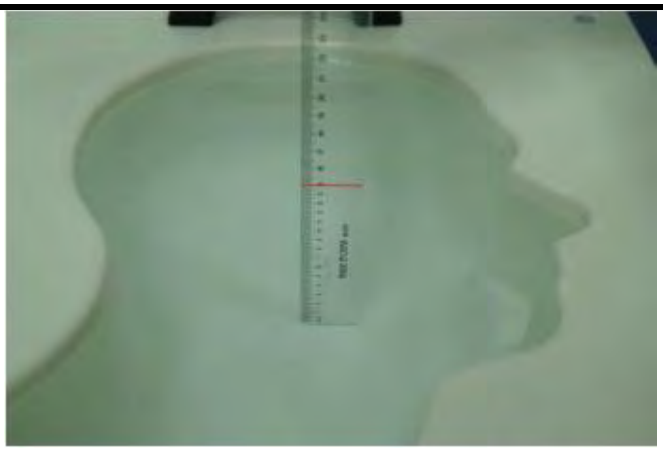
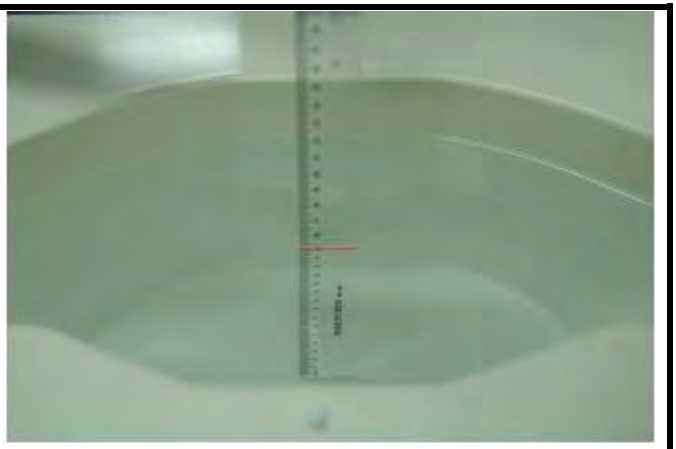
	

Photo of Liquid Height for Head Position	**Photo of Liquid Height for Body Position**

The dielectric properties of the head tissue simulating liquids are defined in IEEE 1528, and KDB 865664 D01 Appendix A. For the body tissue simulating liquids, the dielectric properties are defined in KDB 865664 D01 Appendix A. The dielectric properties of the tissue simulating liquids were verified prior to the SAR evaluation using a dielectric assessment kit and a network analyzer.

Table-3.1 Targets of Tissue Simulating Liquid

Frequency (MHz)	Target Permittivity	Range of ±5%	Target Conductivity	Range of ±5%
For Head				
750	41.9	39.8 ~ 44.0	0.89	0.85 ~ 0.93
835	41.5	39.4 ~ 43.6	0.90	0.86 ~ 0.95
900	41.5	39.4 ~ 43.6	0.97	0.92 ~ 1.02
1450	40.5	38.5 ~ 42.5	1.20	1.14 ~ 1.26
1640	40.3	38.3 ~ 42.3	1.29	1.23 ~ 1.35
1750	40.1	38.1 ~ 42.1	1.37	1.30 ~ 1.44
1800	40.0	38.0 ~ 42.0	1.40	1.33 ~ 1.47
1900	40.0	38.0 ~ 42.0	1.40	1.33 ~ 1.47
2000	40.0	38.0 ~ 42.0	1.40	1.33 ~ 1.47
2300	39.5	37.5 ~ 41.5	1.67	1.59 ~ 1.75
2450	39.2	37.2 ~ 41.2	1.80	1.71 ~ 1.89
2600	39.0	37.1 ~ 41.0	1.96	1.86 ~ 2.06
3500	37.9	36.0 ~ 39.8	2.91	2.76 ~ 3.06
5200	36.0	34.2 ~ 37.8	4.66	4.43 ~ 4.89
5300	35.9	34.1 ~ 37.7	4.76	4.52 ~ 5.00
5500	35.6	33.8 ~ 37.4	4.96	4.71 ~ 5.21
5600	35.5	33.7 ~ 37.3	5.07	4.82 ~ 5.32
5800	35.3	33.5 ~ 37.1	5.27	5.01 ~ 5.53
For Body				
750	55.5	52.7 ~ 58.3	0.96	0.91 ~ 1.01
835	55.2	52.4 ~ 58.0	0.97	0.92 ~ 1.02
900	55.0	52.3 ~ 57.8	1.05	1.00 ~ 1.10
1450	54.0	51.3 ~ 56.7	1.30	1.24 ~ 1.37
1640	53.8	51.1 ~ 56.5	1.40	1.33 ~ 1.47
1750	53.4	50.7 ~ 56.1	1.49	1.42 ~ 1.56
1800	53.3	50.6 ~ 56.0	1.52	1.44 ~ 1.60
1900	53.3	50.6 ~ 56.0	1.52	1.44 ~ 1.60
2000	53.3	50.6 ~ 56.0	1.52	1.44 ~ 1.60
2300	52.9	50.3 ~ 55.5	1.81	1.72 ~ 1.90
2450	52.7	50.1 ~ 55.3	1.95	1.85 ~ 2.05
2600	52.5	49.9 ~ 55.1	2.16	2.05 ~ 2.27
3500	51.3	48.7 ~ 53.9	3.31	3.14 ~ 3.48
5200	49.0	46.6 ~ 51.5	5.30	5.04 ~ 5.57
5300	48.9	46.5 ~ 51.3	5.42	5.15 ~ 5.69
5500	48.6	46.2 ~ 51.0	5.65	5.37 ~ 5.93
5600	48.5	46.1 ~ 50.9	5.77	5.48 ~ 6.06
5800	48.2	45.8 ~ 50.6	6.00	5.70 ~ 6.30

The following table gives the recipes for tissue simulating liquids.

Table-3.2 Recipes of Tissue Simulating Liquid

Tissue Type	Bactericide	DGBE	HEC	NaCl	Sucrose	Triton X-100	Water	Diethylene Glycol Mono-hexylether
H750	0.2	-	0.2	1.5	56.0	-	42.1	-
H835	0.2	-	0.2	1.5	57.0	-	41.1	-
H900	0.2	-	0.2	1.4	58.0	-	40.2	-
H1450	-	43.3	-	0.6	-	-	56.1	-
H1640	-	45.8	-	0.5	-	-	53.7	-
H1750	-	47.0	-	0.4	-	-	52.6	-
H1800	-	44.5	-	0.3	-	-	55.2	-
H1900	-	44.5	-	0.2	-	-	55.3	-
H2000	-	44.5	-	0.1	-	-	55.4	-
H2300	-	44.9	-	0.1	-	-	55.0	-
H2450	-	45.0	-	0.1	-	-	54.9	-
H2600	-	45.1	-	0.1	-	-	54.8	-
H3500	-	8.0	-	0.2	-	20.0	71.8	-
H5G	-	-	-	-	-	17.2	65.5	17.3
B750	0.2	-	0.2	0.8	48.8	-	50.0	-
B835	0.2	-	0.2	0.9	48.5	-	50.2	-
B900	0.2	-	0.2	0.9	48.2	-	50.5	-
B1450	-	34.0	-	0.3	-	-	65.7	-
B1640	-	32.5	-	0.3	-	-	67.2	-
B1750	-	31.0	-	0.2	-	-	68.8	-
B1800	-	29.5	-	0.4	-	-	70.1	-
B1900	-	29.5	-	0.3	-	-	70.2	-
B2000	-	30.0	-	0.2	-	-	69.8	-
B2300	-	31.0	-	0.1	-	-	68.9	-
B2450	-	31.4	-	0.1	-	-	68.5	-
B2600	-	31.8	-	0.1	-	-	68.1	-
B3500	-	28.8	-	0.1	-	-	71.1	-
B5G	-	-	-	-	-	10.7	78.6	10.7

3.3 SAR System Verification

The system check verifies that the system operates within its specifications. It is performed daily or before every SAR measurement. The system check uses normal SAR measurements in the flat section of the phantom with a matched dipole at a specified distance. The system verification setup is shown as below.

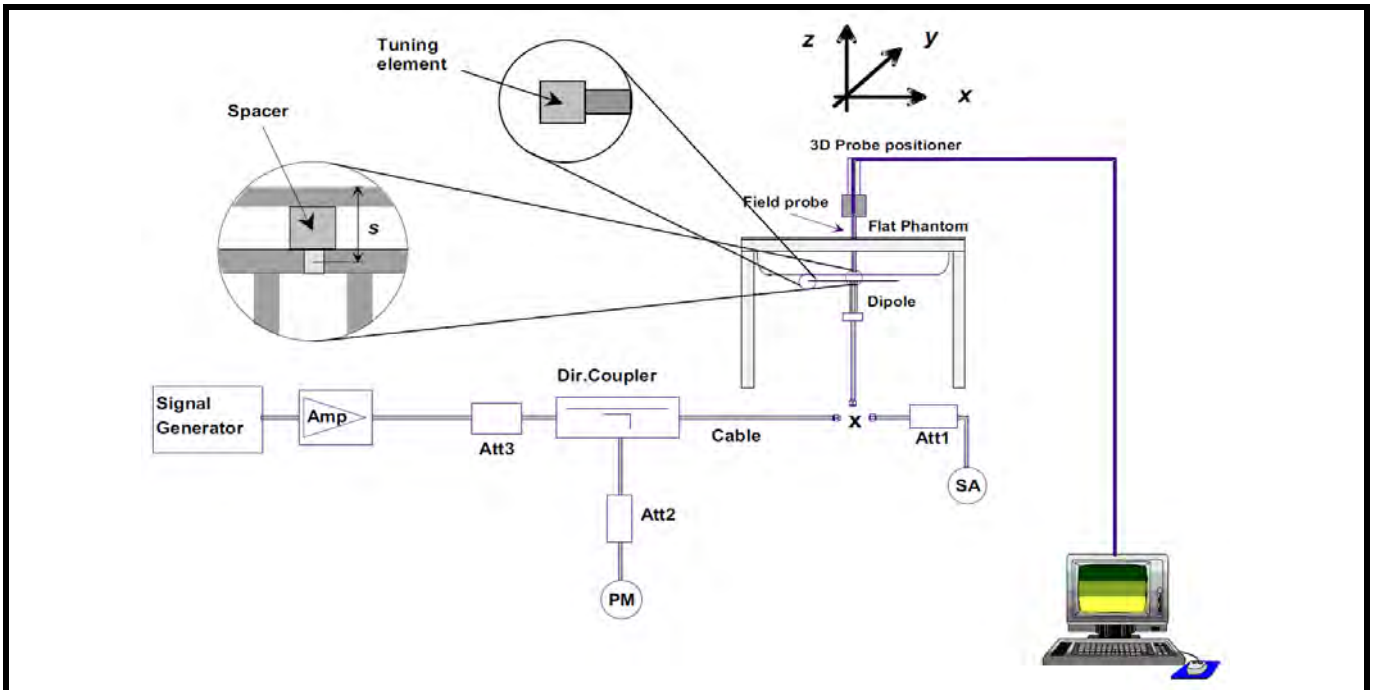


Fig-3.3 System Verification Setup

The validation dipole is placed beneath the flat phantom with the specific spacer in place. The distance spacer is touch the phantom surface with a light pressure at the reference marking and be oriented parallel to the long side of the phantom. The spectrum analyzer measures the forward power at the location of the system check dipole connector. The signal generator is adjusted for the desired forward power at the dipole connector and the power meter is read at that level. After connecting the cable to the dipole, the signal generator is readjusted for the same reading at power meter.

After system check testing, the SAR result will be normalized to 1W forward input power and compared with the reference SAR value derived from validation dipole certificate report. The deviation of system check should be within 10 %.

3.4 SAR Measurement Procedure

According to the SAR 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

The SAR measurement procedures for each of test conditions are as follows:

(a) Make EUT to transmit maximum output power
(b) Measure conducted output power through RF cable
(c) Place the EUT in the specific position of phantom
(d) Perform SAR testing steps on the COMOSAR system
(e) Record the SAR value

3.4.1 Area & Zoom Scan Procedure

First Area Scan is used to locate the approximate location(s) of the local peak SAR value(s). The measurement grid within an Area Scan is defined by the grid extent, grid step size and grid offset. Next, in order to determine the EM field distribution in a three-dimensional spatial extension, Zoom Scan is required. The Zoom Scan is performed around the highest E-field value to determine the averaged SAR-distribution over 10 g. According to KDB 865664 D01, the resolution for Area and Zoom scan is specified in the table below.

Items	<= 2 GHz	2-3 GHz	3-4 GHz	4-5 GHz	5-6 GHz
Area Scan (Δx, Δy)	<= 15 mm	<= 12 mm	<= 12 mm	<= 10 mm	<= 10 mm
Zoom Scan (Δx, Δy)	<= 8 mm	<= 5 mm	<= 5 mm	<= 4 mm	<= 4 mm
Zoom Scan (Δz)	<= 5 mm	<= 5 mm	<= 4 mm	<= 3 mm	<= 2 mm
Zoom Scan Volume	>= 30 mm	>= 30 mm	>= 28 mm	>= 25 mm	>= 22 mm

Note:

When zoom scan is required and report SAR is <= 1.4 W/kg, the zoom scan resolution of Δx / Δy (2-3GHz: <= 8 mm, 3-4GHz: <= 7 mm, 4-6GHz: <= 5 mm) may be applied.

3.4.2 Volume Scan Procedure

The volume scan is used for assess overlapping SAR distributions for antennas transmitting in different frequency bands. It is equivalent to an oversized zoom scan used in standalone measurements. The measurement volume will be used to enclose all the simultaneous transmitting antennas. For antennas transmitting simultaneously in different frequency bands, the volume scan is measured separately in each frequency band. In order to sum correctly to compute the 1g aggregate SAR, the EUT remain in the same test position for all measurements and all volume scan use the same spatial resolution and grid spacing. When all volume scan were completed, the software can combine and subsequently superpose these measurement data to calculating the multiband SAR.

3.4.3 Power Drift Monitoring

All SAR testing is under the EUT install full charged battery and transmit maximum output power. In COMOSAR 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. If the power drift more than 5%, the SAR will be retested.

3.4.4 Spatial Peak SAR Evaluation

The procedure for spatial peak SAR evaluation has been implemented according to the test standard. It can be conducted for 1g and 10g, as well as for user-specific masses. The OPENSAR software includes all numerical procedures necessary to evaluate the spatial peak SAR value.

The base for the evaluation is a "cube" measurement. The measured volume must include the 1g and 10g cubes with the highest averaged SAR values. For that purpose, the center of the measured volume is aligned to the interpolated peak SAR value of a previously performed area scan.

The entire evaluation of the spatial peak values is performed within the post-processing engine. The system always gives the maximum values for the 1g and 10g cubes. The algorithm to find the cube with highest averaged SAR is divided into the following stages:

(a) Extraction of the measured data (grid and values) from the Zoom Scan
(b) Calculation of the SAR value at every measurement point based on all stored data (A/D values and measurement parameters)
(c) Generation of a high-resolution mesh within the measured volume
(d) Interpolation of all measured values form the measurement grid to the high-resolution grid
(e) Extrapolation of the entire 3-D field distribution to the phantom surface over the distance from sensor to surface
(f) Calculation of the averaged SAR within masses of 1g and 10g

3.4.5 SAR Averaged Methods

In COMOSAR System, the interpolation and extrapolation are both based on the modified Quadratic Shepard's method. The interpolation scheme combines a least-square fitted function method and a weighted average method which are the two basic types of computational interpolation and approximation.

4. SAR Measurement Evaluation

4.1 EUT Configuration and Setting

<Connections between EUT and System Simulator>

For WWAN SAR testing, the EUT was linked and controlled by base station emulator (Agilent E5515C is used for GSM/WCDMA, and Anritsu MT8820C is used for LTE). Communication between the EUT and the emulator was established by air link. The distance between the EUT and the communicating antenna of the emulator is larger than 50 cm and the output power radiated from the emulator antenna is at least 30 dB smaller than the output power of EUT. The EUT was set from the emulator to radiate maximum output power during SAR testing.

<Considerations Related to GSM / GPRS / EDGE for Setup and Testing>

The maximum multi-slot capability supported by this device is as below.

1. This EUT is class B device
2. This EUT supports GPRS multi-slot class 12 (max. uplink: 4, max. downlink: 4, total timeslots: 5)
3. This EUT supports EDGE multi-slot class 12 (max. uplink: 4, max. downlink: 4, total timeslots: 5)

For GSM850 frequency band, the power control level is set to 5 for GSM mode and GPRS (GMSK: CS1), and set to 8 for EDGE (GMSK: MCS1, 8PSK: MCS9). For GSM1900 frequency band, the power control level is set to 0 for GSM mode and GPRS (GMSK: CS1), and set to 2 for EDGE (GMSK: MCS1, 8PSK: MCS9).

SAR test reduction for GPRS and EDGE modes is determined by the source-based time-averaged output power specified for production units, including tune-up tolerance. The data mode with highest specified time-averaged output power should be tested for SAR compliance in the applicable exposure conditions. For modes with the same specified maximum output power and tolerance, the higher number time-slot configuration should be tested.

<Considerations Related to WCDMA for Setup and Testing>

WCDMA Handsets Head SAR

SAR for next to the ear head exposure is measured using a 12.2 kbps RMC with TPC bits configured to all “1’s”. The 3G SAR test reduction procedure is applied to AMR configurations with 12.2 kbps RMC as the primary mode.

WCDMA Handsets Body-worn SAR

SAR for body-worn configurations is measured using a 12.2 kbps RMC with TPC bits configured to all “1’s”. The 3G SAR test reduction procedure is applied to other spreading codes and multiple $DPDCH_n$ configurations supported by the handset with 12.2 kbps RMC as the primary mode.

Handsets with Release 5 HSDPA

The 3G SAR test reduction procedure is applied to HSDPA body-worn configurations with 12.2 kbps RMC as the primary mode. Otherwise, SAR is measured for HSDPA using the HSDPA body SAR procedures in the “Release 5 HSDPA Data Devices”, for the highest reported SAR body-worn exposure configuration in 12.2 kbps RMC. Handsets with both HSDPA and HSUPA are tested according to Release 6 HSPA test procedures.

Handsets with Release 6 HSUPA

The 3G SAR test reduction procedure is applied to HSPA (HSUPA/HSDPA with RMC) body-worn configurations with 12.2 kbps RMC as the primary mode. Otherwise, SAR is measured for HSPA using the HSPA body SAR procedures in the "Release 6 HSPA Data Devices", for the highest reported body-worn exposure SAR configuration in 12.2 kbps RMC. When VOIP is applicable for next to the ear head exposure in HSPA, the 3G SAR test reduction procedure is applied to HSPA with 12.2 kbps RMC as the primary mode; otherwise, the same HSPA configuration used for body-worn measurements is tested for next to the ear head exposure.

Release 5 HSDPA Data Devices

The 3G SAR test reduction procedure is applied to body SAR with 12.2 kbps RMC as the primary mode. Otherwise, body SAR for HSDPA is measured using an FRC with H-Set 1 in Sub-test 1 and a 12.2 kbps RMC configured in Test Loop Mode 1, for the highest reported SAR configuration in 12.2 kbps RMC without HSDPA. HSDPA is configured according to the applicable UE category of a test device. The number of HS-DSCH / HS-PDSCHs, HARQ processes, minimum inter-TTI interval, transport block sizes and RV coding sequence are defined by the H-set. To maintain a consistent test configuration and stable transmission conditions, QPSK is used in the H-set for SAR testing. HS-DPCCH should be configured with a CQI feedback cycle of 4 ms and a CQI repetition factor of 2 to maintain a constant rate of active CQI slots. DPCCH and DPDCH gain factors (β_c, β_d), and HS-DPCCH power offset parameters (Δ_{ACK}, Δ_{NACK}, Δ_{CQI}) are set according to values indicated in below. The CQI value is determined by the UE category, transport block size, number of HS-PDSCHs and modulation used in the H-set.

Sub-test	β_c	β_d	β_d (SF)	β_c / β_d	β_{hs} (1)	CM (dB)(2)	MPR
1	2 / 15	15 / 15	64	2 / 15	4 / 15	0.0	0
2	12 / 15 (3)	15 / 15 (3)	64	12 / 15 (3)	24 / 15	1.0	0
3	15 / 15	8 / 15	64	15 / 8	30 / 15	1.5	0.5
4	15 / 15	4 / 15	64	15 / 4	30 / 15	1.5	0.5

Note 1: Δ_{ACK}, Δ_{NACK} and Δ_{CQI} = 8 ⇔ $A_{hs} = \beta_{hs} / \beta_c = 30 / 15 \Leftrightarrow \beta_{hs} = 30 / 15 * \beta_c$.
Note 2: CM = 1 for $\beta_c / \beta_d = 12 / 15$, $\beta_{hs} / \beta_c = 24 / 15$.
Note 3: For subtest 2 the β_c / β_d ratio of 12 / 15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signaled gain factors for the reference TFC (TF1, TF1) to $\beta_c = 11 / 15$ and $\beta_d = 15 / 15$.

Release 6 HSUPA Data Devices

The 3G SAR test reduction procedure is applied to body SAR with 12.2 kbps RMC as the primary mode. Otherwise, body SAR for HSPA is measured with E-DCH Sub-test 5, using H-Set 1 and QPSK for FRC and a 12.2 kbps RMC configured in Test Loop Mode 1 and power control algorithm 2, according to the highest reported body SAR configuration in 12.2 kbps RMC without HSPA. When VOIP applies to head exposure, the 3G SAR test reduction procedure is applied with 12.2 kbps RMC as the primary mode. Otherwise, the same HSPA configuration used for body SAR measurements are applied to head exposure testing. Due to inner loop power control requirements in HSPA, a communication test set is required for output power and SAR tests. The 12.2 kbps RMC, FRC H-set 1 and E-DCH configurations for HSPA are configured according to the β values indicated in below.

Sub-test	β_c	β_d	β_d (SF)	β_c / β_d	β_{hs} (1)	β_{ec}	β_{ed}	β_{ed} (SF)	β_{ed} (codes)	CM (2) (dB)	MPR (dB)	AG (4) Index	E-TFCI
1	11 / 15 (3)	15 / 15 (3)	64	11 / 15 (3)	22 / 15	209 / 225	1039 / 225	4	1	1.0	0.0	20	75
2	6 / 15	15 / 15	64	6 / 15	12 / 15	12 / 15	94 / 75	4	1	3.0	2.0	12	67
3	15 / 15	9 / 15	64	15 / 9	30 / 15	30 / 15	β_{ed1}: 47/15 β_{ed2}: 47/15	4	2	2.0	1.0	15	92
4	2 / 15	15 / 15	64	2 / 15	4 / 15	2 / 15	56 / 75	4	1	3.0	2.0	17	71
5	15 / 15 (4)	15 / 15 (4)	64	15 / 15 (4)	30 / 15	24 / 15	134 / 15	4	1	1.0	0.0	21	81

Note 1: Δ_{ACK}, Δ_{NACK} and Δ_{CQI} = 8 ⇔ A_{hs} = β_{hs} / β_c = 30 / 15 ⇔ β_{hs} = 30 / 15 * β_c.
Note 2: CM = 1 for β_c / β_d = 12 / 15, β_{hs} / β_c = 24 / 15. For all other combinations of DPDCH, DPCCH, HS-DPCCH, E-DPDCH and E-DPCCH the MPR is based on the relative CM difference.
Note 3: For subtest 1 the β_c / β_d ratio of 11 / 15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signaled gain factors for the reference TFC (TF1, TF1) to β_c = 10 / 15 and β_d = 15 / 15.
Note 4: For subtest 5 the β_c / β_d ratio of 15 / 15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signaled gain factors for the reference TFC (TF1, TF1) to β_c = 14 / 15 and β_d = 15 / 15.
Note 5: Testing UE using E-DPDCH Physical Layer category 1 Sub-test 3 is not required according to TS 25.306 Table 5.1g.
Note 6: β_{ed} cannot be set directly; it is set by Absolute Grant Value.

<Considerations Related to LTE for Setup and Testing>

This device contains LTE transmitter which follows 3GPP standards, is category 3, supports both QPSK and 16QAM modulations, and supported LTE band and channel bandwidth is listed in below. The output power was tested per 3GPP TS 36.521-1 maximum transmit procedures for both QPSK and 16QAM modulation. The results please refer to section 4.6 of this report.

EUT Supported LTE Band and Channel Bandwidth						
LTE Band	**BW 1.4 MHz**	**BW 3 MHz**	**BW 5 MHz**	**BW 10 MHz**	**BW 15 MHz**	**BW 20 MHz**
2	**V**	**V**	**V**	**V**	**V**	**V**
5	**V**	**V**	**V**	**V**		
7			**V**	**V**	**V**	**V**
38			**V**	**V**	**V**	**V**
40			**V**	**V**		
41			**V**	**V**	**V**	**V**

The LTE maximum power reduction (MPR) in accordance with 3GPP TS 36.101 is active all times during LTE operation. The allowed MPR for the maximum output power is specified in below.

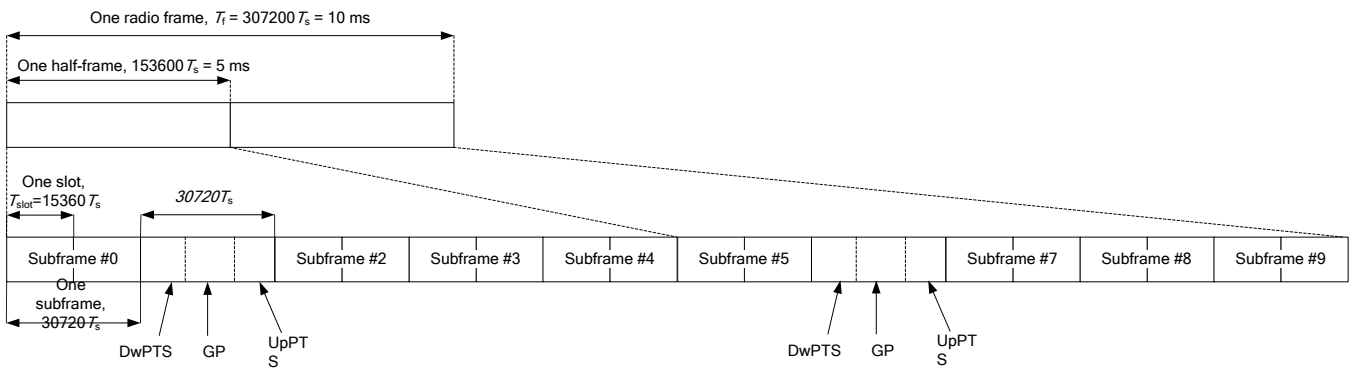
Modulation	**Channel Bandwidth / RB Configurations**						**LTE MPR Setting (dB)**
	BW 1.4 MHz	**BW 3 MHz**	**BW 5 MHz**	**BW 10 MHz**	**BW 15 MHz**	**BW 20 MHz**	
QPSK	**> 5**	**> 4**	**> 8**	**> 12**	**> 16**	**> 18**	**1**
16QAM	**<= 5**	**<= 4**	**<= 8**	**<= 12**	**<= 16**	**<= 18**	**1**
16QAM	**> 5**	**> 4**	**> 8**	**> 12**	**> 16**	**> 18**	**2**

Note: MPR is according to the standard and implemented in the circuit (mandatory).

In addition, the device is compliant with additional maximum power reduction (A-MPR) requirements defined in 3GPP TS 36.101 section 6.2.4 that was disabled for all FCC compliance testing.

During LTE SAR testing, the related parameters of operating band, channel bandwidth, uplink channel number, modulation type, and RB was set in base station simulator. When the EUT has registered and communicated to base station simulator, the simulator set to make EUT transmitting the maximum radiated power.

According to KDB 941225 D05, SAR testing for TDD-LTE device must be tested using a fixed periodic duty factor according to the highest transmission duty factor implemented for the device and supported by the defined 3GPP TDD-LTE configurations. The TDD-LTE of this device supports frame structure type 2 defined in 3GPP TS 36.211 section 4.2, and the frame structure configuration can be referred to below.



3GPP TS 36.211 Figure 4.2-1: Frame Structure Type 2

Special Subframe Configuration	Normal Cyclic Prefix in Downlink			Extended Cyclic Prefix in Downlink		
	DwPTS	UpPTS		DwPTS	UpPTS	
		Normal Cyclic Prefix in Uplink	Extended Cyclic Prefix in Uplink		Normal Cyclic Prefix in Uplink	Extended Cyclic Prefix in Uplink
0	6592 • Ts	2192 • Ts	2560 • Ts	7680 • Ts	2192 • Ts	2560 • Ts
1	19760 • Ts			20480 • Ts		
2	21952 • Ts			23040 • Ts		
3	24144 • Ts			25600 • Ts		
4	26336 • Ts			7680 • Ts	4384 • Ts	5120 • Ts
5	6592 • Ts	4384 • Ts	5120 • Ts	20480 • Ts		
6	19760 • Ts			23040 • Ts		
7	21952 • Ts			12800 • Ts		
8	24144 • Ts			-	-	-
9	13168 • Ts			-	-	-

3GPP TS 36.211 Table 4.2-1: Configuration of Special Subframe

Uplink-Downlink Configuration	Downlink-to-Uplink Switch-Point Periodicity	Subframe Number									
		0	1	2	3	4	5	6	7	8	9
0	5 ms	D	S	U	U	U	D	S	U	U	U
1	5 ms	D	S	U	U	D	D	S	U	U	D
2	5 ms	D	S	U	D	D	D	S	U	D	D
3	10 ms	D	S	U	U	U	D	D	D	D	D
4	10 ms	D	S	U	U	D	D	D	D	D	D
5	10 ms	D	S	U	D	D	D	D	D	D	D
6	5 ms	D	S	U	U	U	D	S	U	U	D

3GPP TS 36.211 Table 4.2-2: Uplink-Downlink Configurations

The variety of different TD-LTE uplink-downlink configurations allows a network operator to allocate the network's capacity between uplink and downlink traffic to meet the needs of the network. The uplink duty cycle of these seven configurations can readily be computed and shown in below.

UL-DL Configuration	0	1	2	3	4	5	6
Highest Duty-Cycle	63.33%	43.33%	23.33%	31.67%	21.67%	11.67%	53.33%

<Considerations Related to WLAN for Setup and Testing>

In general, various vendor specific external test software and chipset based internal test modes are typically used for SAR measurement. These chipset based test mode utilities are generally hardware and manufacturer dependent, and often include substantial flexibility to reconfigure or reprogram a device. A Wi-Fi device must be configured to transmit continuously at the required data rate, channel bandwidth and signal modulation, using the highest transmission duty factor supported by the test mode tools for SAR measurement. The test frequencies established using test mode must correspond to the actual channel frequencies. When 802.11 frame gaps are accounted for in the transmission, a maximum transmission duty factor of 92 - 96% is typically achievable in most test mode configurations. A minimum transmission duty factor of 85% is required to avoid certain hardware and device implementation issues related to wide range SAR scaling. In addition, a periodic transmission duty factor is required for current generation SAR systems to measure SAR correctly. The reported SAR must be scaled to 100% transmission duty factor to determine compliance at the maximum tune-up tolerance limit.

According to KDB 248227 D01, this device has installed WLAN engineering testing software which can provide continuous transmitting RF signal. During WLAN SAR testing, this device was operated to transmit continuously at the maximum transmission duty with specified transmission mode, operating frequency, lowest data rate, and maximum output power.

Initial Test Configuration

An initial test configuration is determined for OFDM transmission modes in 2.4 GHz and 5 GHz bands according to the channel bandwidth, modulation and data rate combination(s) with the highest maximum output power specified for production units in each standalone and aggregated frequency band. When the same maximum power is specified for multiple transmission modes in a frequency band, the largest channel bandwidth, lowest order modulation, lowest data rate and lowest order 802.11a/g/n/ac mode is used for SAR measurement, on the highest measured output power channel in the initial test configuration, for each frequency band.

Subsequent Test Configuration

SAR measurement requirements for the remaining 802.11 transmission mode configurations that have not been tested in the initial test configuration are determined separately for each standalone and aggregated frequency band, in each exposure condition, according to the maximum output power specified for production units. Additional power measurements may be required to determine if SAR measurements are required for subsequent highest output power channels in a subsequent test configuration. When the highest reported SAR for the initial test configuration according to the initial test position or fixed exposure position requirements, is adjusted by the ratio of the subsequent test configuration to initial test configuration specified maximum output power and the adjusted SAR is ≤ 1.2 W/kg, SAR is not required for that subsequent test configuration.

SAR Test Configuration and Channel Selection

When multiple channel bandwidth configurations in a frequency band have the same specified maximum output power, the initial test configuration is using largest channel bandwidth, lowest order modulation, lowest data rate, and lowest order 802.11 mode (i.e., 802.11a is chosen over 802.11n then 802.11ac or 802.11g is chosen over 802.11n). After an initial test configuration is determined, if multiple test channels have the same measured maximum output power, the channel chosen for SAR measurement is determined according to the following.

1) The channel closest to mid-band frequency is selected for SAR measurement.
2) For channels with equal separation from mid-band frequency; for example, high and low channels or two mid-band channels, the higher frequency (number) channel is selected for SAR measurement.

Test Reduction for U-NII-1 (5.2 GHz) and U-NII-2A (5.3 GHz) Bands
For devices that operate in both U-NII bands using the same transmitter and antenna(s), SAR test reduction is determined according to the following.
1) When the same maximum output power is specified for both bands, begin SAR measurement in U-NII-2A band by applying the OFDM SAR requirements. If the highest reported SAR for a test configuration is ≤ 1.2 W/kg, SAR is not required for U-NII-1 band for that configuration (802.11 mode and exposure condition).
2) When different maximum output power is specified for the bands, begin SAR measurement in the band with higher specified maximum output power. The highest reported SAR for the tested configuration is adjusted by the ratio of lower to higher specified maximum output power for the two bands. When the adjusted SAR is ≤ 1.2 W/kg, SAR is not required for the band with lower maximum output power in that test configuration.

4.2 EUT Testing Position

4.2.1 Body Exposure Conditions

This EUT was tested for intend use condition of the EUT as Front Face and Rear Face. The separation distance between this EUT and phantom is 0 cm.

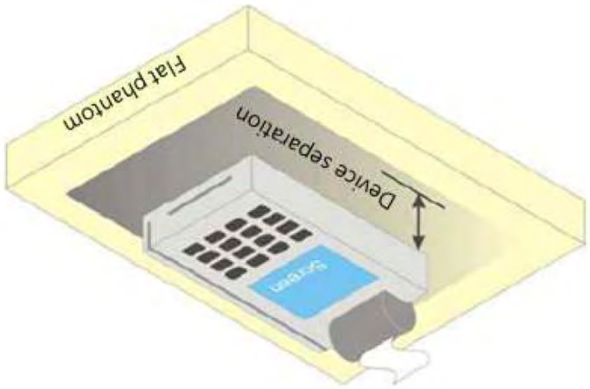


Fig-4.1 Illustration for Body Worn Position

4.2.2 SAR Test Exclusion Evaluations

According to KDB 447498 D01, the SAR test exclusion condition is based on source-based time-averaged maximum conducted output power, adjusted for tune-up tolerance, and the minimum test separation distance required for the exposure conditions. The SAR exclusion threshold is determined by the following formula.

1. For the test separation distance <= 50 mm

$$\frac{\textbf{Max. Tune up Power}_{(mW)}}{\textbf{Min. Test Separation Distance}_{(mm)}} \times \sqrt{f_{(GHz)}} \leq 3.0 \text{ for SAR-1g, } \leq 7.5 \text{ for SAR-10g}$$

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

2. For the test separation distance > 50 mm, and the frequency at 100 MHz to 1500 MHz

$$\left[(\text{Threshold at 50 mm in Step 1}) + (\text{Test Separation Distance} - 50\text{ mm}) \times \left(\frac{f_{(MHz)}}{150}\right)\right]_{(mW)}$$

3. For the test separation distance > 50 mm, and the frequency at > 1500 MHz to 6 GHz

$$[(\text{Threshold at 50 mm in Step 1}) + (\text{Test Separation Distance} - 50\text{ mm}) \times 10]_{(mW)}$$

Mode	Max. Tune-up Power (dBm)	Max. Tune-up Power (mW)	Body-Worn		
			Ant. to Surface (mm)	Calculated Result	Require SAR Testing?
BT (2.48 GHz)	5.5	3.55	5	1.1	No

Note:

1. When separation distance <= 50 mm and the calculated result shown in above table is <= 3.0 for SAR-1g exposure condition, or <= 7.5 for SAR-10g exposure condition, the SAR testing exclusion is applied.
2. When separation distance > 50 mm and the device output power is less than the calculated result (power threshold, mW) shown in above table, the SAR testing exclusion is applied.

4.2.3 Simultaneous Transmission Possibilities

The simultaneous transmission possibilities for this device are listed as below.

Simultaneous TX Combination	Capable Transmit Configurations	Body Exposure Condition
1	GSM850 (Voice / Data) + WLAN (Data)	Yes
2	GSM1900 (Voice / Data) + WLAN (Data)	Yes
3	WCDMA II (Voice / Data) + WLAN (Data)	Yes
4	WCDMA V (Voice / Data) + WLAN (Data)	Yes
5	LTE 2 (Data) + WLAN (Data)	Yes
6	LTE 5 (Data) + WLAN (Data)	Yes
7	LTE 7 (Data) + WLAN (Data)	Yes
8	LTE 38 (Data) + WLAN (Data)	Yes
9	LTE 40 (Data) + WLAN (Data)	Yes
10	LTE 41 (Data) + WLAN (Data)	Yes
11	GSM850 (Voice / Data) + BT (Data)	Yes
12	GSM1900 (Voice / Data) + BT (Data)	Yes
13	WCDMA II (Voice / Data) + BT (Data)	Yes
14	WCDMA V (Voice / Data) + BT (Data)	Yes
15	LTE 2 (Data) + BT (Data)	Yes
16	LTE 5 (Data) + BT (Data)	Yes
17	LTE 7 (Data) + BT (Data)	Yes
18	LTE 38 (Data) + BT (Data)	Yes
19	LTE 40 (Data) + BT (Data)	Yes
20	LTE 41 (Data) + BT (Data)	Yes

Note :

1. The 2.4G WLAN and 5G WLAN cannot transmit simultaneously.
2. The WLAN and Bluetooth cannot transmit simultaneously, so there is no co-location test requirement for WLAN and Bluetooth.
3. This device does not support voice transmission capability.

4.3 Tissue Verification

The measuring results for tissue simulating liquid are shown as below.

Test Date	Tissue Type	Frequency (MHz)	Liquid Temp. (℃)	Measured Conductivity (σ)	Measured Permittivity (ε_r)	Target Conductivity (σ)	Target Permittivity (ε_r)	Conductivity Deviation (%)	Permittivity Deviation (%)
Jan. 14, 2019	BL850	835	21.3	0.98	56.30	0.97	55.20	1.03	1.99
Jan. 15, 2019	BL1900	1900	21.1	1.54	55.12	1.52	53.30	1.32	3.41
Jan. 16, 2019	BL2450	2450	21.2	1.92	54.22	1.95	52.70	-1.54	2.88
Jan. 17, 2019	BL2600	2600	21.0	2.11	54.13	2.16	52.50	-2.31	3.10
Jan. 21, 2019	BL5G	5200	21.6	5.61	48.61	5.51	48.64	1.81	-0.06
Jan. 22, 2019	BL5G	5600	21.4	5.66	46.93	5.77	46.79	-1.91	0.30
Jan. 23, 2019	BL5G	5800	21.2	6.17	47.64	6.10	47.04	1.15	1.28

Note:

1. The dielectric properties of the tissue simulating liquid must be measured within 24 hours before the SAR testing and within ±5% of the target values. Liquid temperature during the SAR testing must be within ±2 ℃.
2. Since the maximum deviation of dielectric properties of the tissue simulating liquid is within 5%, SAR correction is evaluated in the measurement uncertainty shown on section 6 of this report.

4.4 System Validation

The SAR measurement system was validated according to procedures in KDB 865664 D01. The validation status in tabulated summary is as below.

Test Date	Probe S/N	Calibration Point		Measured Conductivity (σ)	Measured Permittivity (ε_r)	Validation for CW			Validation for Modulation		
						Sensitivity Range	Probe Linearity	Probe Isotropy	Modulation Type	Duty Factor	PAR
Jan. 14, 2019	SN 27/15 EPGO262	Body	835	0.98	56.30	Pass	Pass	Pass	GMSK	Pass	N/A
Jan. 15, 2019	SN 27/15 EPGO262	Body	1900	1.54	55.12	Pass	Pass	Pass	GMSK	Pass	N/A
Jan. 16, 2019	SN 27/15 EPGO262	Body	2450	1.92	54.22	Pass	Pass	Pass	OFDM	N/A	Pass
Jan. 17, 2019	SN 27/15 EPGO262	Body	2600	2.11	54.13	Pass	Pass	Pass	N/A	N/A	N/A
Jan. 21, 2019	SN 27/15 EPGO262	Body	5200	5.61	48.61	Pass	Pass	Pass	OFDM	N/A	Pass
Jan. 22, 2019	SN 27/15 EPGO262	Body	5600	5.66	46.93	Pass	Pass	Pass	OFDM	N/A	Pass
Jan. 23, 2019	SN 27/15 EPGO262	Body	5800	6.17	47.64	Pass	Pass	Pass	OFDM	N/A	Pass

4.5 System Verification

The measuring result for system verification is tabulated as below.

Test Date	Mode	Frequency (MHz)	1W Target SAR-1g (W/kg)	Measured SAR-1g (W/kg)	Normalized to 1W SAR-1g (W/kg)	Deviation (%)	Dipole S/N	Probe S/N
Jan. 14, 2019	Body	835	9.96	0.97	9.71	-2.51	SN 18/11 DIPC150	SN 27/15 EPGO262
Jan. 15, 2019	Body	1900	40.38	4.13	41.33	2.35	SN 18/11 DIPG153	SN 27/15 EPGO262
Jan. 16, 2019	Body	2450	52.73	5.12	51.24	-2.83	SN 18/11 DIPJ155	SN 27/15 EPGO262
Jan. 17, 2019	Body	2600	54.23	5.62	56.21	3.65	SN 26/14 DIP2G600-326	SN 27/15 EPGO262
Jan. 21, 2019	Body	5200	152.11	14.53	145.27	-4.50	SN 24/11/ WGA16	SN 27/15 EPGO262
Jan. 22, 2019	Body	5600	169.48	17.17	171.67	1.29	SN 24/11/ WGA16	SN 27/15 EPGO262
Jan. 23, 2019	Body	5800	175.88	17.34	173.41	-1.40	SN 24/11/ WGA16	SN 27/15 EPGO262

Note:

Comparing to the reference SAR value provided by MVG, the validation data should be within its specification of 10 %. The result indicates the system check can meet the variation criterion and the plots can be referred to Appendix A of this report.

4.6 Maximum Output Power

4.6.1 Maximum Conducted Power

The maximum conducted average power (Unit: dBm) including tune-up tolerance is shown as below.

Mode	GSM850	GSM1900
GPRS (GMSK, 1Tx-slot)	33.0	30.0
GPRS (GMSK, 2Tx-slot)	31.0	29.5
GPRS (GMSK, 3Tx-slot)	29.0	27.5
GPRS (GMSK, 4Tx-slot)	28.0	26.5
EDGE (8PSK, 1Tx-slot)	27.5	26.5
EDGE (8PSK, 2Tx-slot)	27.0	25.5
EDGE (8PSK, 3Tx-slot)	25.5	23.5
EDGE (8PSK, 4Tx-slot)	24.0	22.5

Mode	WCDMA Band II	WCDMA Band V
RMC 12.2K	21.5	23.5
HSDPA	21.5	23.5
HSUPA	21.5	23.5

Mode	LTE 2	LTE 5	LTE 7
QPSK / 16QAM / 64QAM	22.0 / 21.0 / 21.0	24.0 / 23.0 / 23.0	24.5 / 23.5 / 23.5

Mode	LTE 38	LTE 40	LTE 41
QPSK / 16QAM / 64QAM	24.5 / 23.5 / 23.5	24.0 / 23.0 / 23.0	24.5 / 23.5 / 23.5

Mode	2.4G WLAN	5.2G WLAN	5.3G WLAN	5.6G WLAN	5.8G WLAN
802.11b	17.0	N/A	N/A	N/A	N/A
802.11g	14.0	N/A	N/A	N/A	N/A
802.11a	N/A	14.0	14.0	15.0	15.5
802.11n HT20	16.0	14.0	14.0	14.0	15.5
802.11n HT40	14.0	13.5	13.5	14.0	15.5

Mode	2.4G Bluetooth
GFSK	5.5
8-DPSK	4.0
LE	5.5

4.6.2 Measured Conducted Power Result

The measuring conducted average power (Unit: dBm) is shown as below.

Band	GSM850			GSM1900		
Channel	128	189	251	512	661	810
Frequency (MHz)	824.2	836.4	848.8	1850.2	1880.0	1909.8
Maximum Burst-Averaged Output Power						
GPRS (GMSK, 1Tx-slot)	32.54	**32.59**	32.55	29.53	**29.56**	29.55
GPRS (GMSK, 2Tx-slot)	30.20	30.25	30.21	28.78	28.81	28.80
GPRS (GMSK, 3Tx-slot)	28.37	28.42	28.38	27.08	27.11	27.10
GPRS (GMSK, 4Tx-slot)	27.82	27.87	27.83	26.00	26.03	26.02
EDGE (8PSK, 1Tx-slot)	27.20	27.25	27.21	25.83	25.86	25.85
EDGE (8PSK, 2Tx-slot)	26.40	26.45	26.41	24.91	24.94	24.93
EDGE (8PSK, 3Tx-slot)	24.71	24.76	24.72	23.01	23.04	23.03
EDGE (8PSK, 4Tx-slot)	23.72	23.77	23.73	21.88	21.91	21.90
Maximum Frame-Averaged Output Power						
GPRS (GMSK, 1Tx-slot)	23.54	23.59	23.55	20.53	20.55	20.56
GPRS (GMSK, 2Tx-slot)	23.54	23.59	23.55	20.53	20.56	20.55
GPRS (GMSK, 3Tx-slot)	24.20	24.25	24.21	22.78	22.81	22.80
GPRS (GMSK, 4Tx-slot)	24.11	24.16	24.12	22.82	22.85	22.84
EDGE (8PSK, 1Tx-slot)	24.82	**24.87**	24.83	23.00	**23.03**	23.02
EDGE (8PSK, 2Tx-slot)	18.20	18.25	18.21	16.83	16.86	16.85
EDGE (8PSK, 3Tx-slot)	20.40	20.45	20.41	18.91	18.94	18.93
EDGE (8PSK, 4Tx-slot)	20.45	20.50	20.46	18.75	18.78	18.77

Note:

1. SAR testing was performed on the maximum frame-averaged power mode.
2. The frame-averaged power is linearly proportion to the slot number configured and it is linearly scaled the maximum burst-averaged power based on time slots. The calculated method is shown as below:
   Frame-averaged power = 10 x log (Burst-averaged power mW x Slot used / 8)

Band	WCDMA Band II			WCDMA Band V			3GPP MPR (dB)
Channel	9262	9400	9538	4132	4182	4233	
Frequency (MHz)	1852.4	1880.0	1907.6	826.4	836.4	846.6	
RMC 12.2K	21.09	**21.23**	21.06	22.94	**23.12**	22.96	-
HSDPA Subtest-1	21.03	21.17	21.00	22.88	23.06	22.90	0
HSDPA Subtest-2	21.01	21.15	20.98	22.86	23.04	22.88	0
HSDPA Subtest-3	20.89	21.03	20.86	22.74	22.92	22.76	0.5
HSDPA Subtest-4	20.27	20.41	20.24	22.12	22.30	22.14	0.5
HSUPA Subtest-1	20.57	20.71	20.54	22.42	22.60	22.44	0
HSUPA Subtest-2	20.35	20.49	20.32	22.20	22.38	22.22	2
HSUPA Subtest-3	21.02	21.16	20.99	22.87	23.05	22.89	1
HSUPA Subtest-4	20.34	20.48	20.31	22.19	22.37	22.21	2
HSUPA Subtest-5	20.82	20.96	20.79	22.67	22.85	22.69	0

LTE Band / BW	RB Size	RB Offset	QPSK			3GPP MPR (dB)	16QAM			3GPP MPR (dB)	64QAM			3GPP MPR (dB)
			Low CH 18607 1850.7 MHz	Mid CH 18900 1880.0 MHz	High CH 19193 1909.3 MHz		Low CH 18607 1850.7 MHz	Mid CH 18900 1880.0 MHz	High CH 19193 1909.3 MHz		Low CH 18607 1850.7 MHz	Mid CH 18900 1880.0 MHz	High CH 19193 1909.3 MHz	
2 / 1.4M	1	0	21.51	21.52	21.40	0	20.40	20.41	20.29	1	20.66	20.67	20.55	1
	1	2	21.34	21.35	21.23	0	20.51	20.52	20.40	1	20.50	20.51	20.39	1
	1	5	20.74	20.75	20.63	0	19.99	20.00	19.88	1	20.21	20.22	20.10	1
	3	0	20.43	20.44	20.32	1	19.43	19.44	19.32	2	20.64	20.65	20.53	2
	3	1	20.39	20.40	20.28	1	19.41	19.42	19.30	2	20.48	20.49	20.37	2
	3	3	20.32	20.33	20.21	1	19.32	19.33	19.21	2	20.19	20.20	20.08	2
	6	0	20.36	20.37	20.25	1	19.35	19.36	19.24	2	19.34	19.35	19.23	2

LTE Band / BW	RB Size	RB Offset	QPSK			3GPP MPR (dB)	16QAM			3GPP MPR (dB)	64QAM			3GPP MPR (dB)
			Low CH 18615 1851.5 MHz	Mid CH 18900 1880.0 MHz	High CH 19185 1908.5 MHz		Low CH 18615 1851.5 MHz	Mid CH 18900 1880.0 MHz	High CH 19185 1908.5 MHz		Low CH 18615 1851.5 MHz	Mid CH 18900 1880.0 MHz	High CH 19185 1908.5 MHz	
2 / 3M	1	0	21.54	21.55	21.43	0	20.43	20.44	20.32	1	20.69	20.70	20.58	1
	1	7	21.37	21.38	21.26	0	20.54	20.55	20.43	1	20.53	20.54	20.42	1
	1	14	20.77	20.78	20.66	0	20.02	20.03	19.91	1	20.24	20.25	20.13	1
	8	0	20.44	20.45	20.33	1	19.45	19.46	19.34	2	19.44	19.45	19.33	2
	8	3	20.40	20.41	20.29	1	19.43	19.44	19.32	2	19.33	19.34	19.22	2
	8	7	20.33	20.34	20.22	1	19.34	19.35	19.23	2	19.36	19.37	19.25	2
	15	0	20.37	20.38	20.26	1	19.37	19.38	19.26	2	19.37	19.38	19.26	2

LTE Band / BW	RB Size	RB Offset	QPSK			3GPP MPR (dB)	16QAM			3GPP MPR (dB)	64QAM			3GPP MPR (dB)
			Low CH 18625 1852.5 MHz	Mid CH 18900 1880.0 MHz	High CH 19175 1907.5 MHz		Low CH 18625 1852.5 MHz	Mid CH 18900 1880.0 MHz	High CH 19175 1907.5 MHz		Low CH 18625 1852.5 MHz	Mid CH 18900 1880.0 MHz	High CH 19175 1907.5 MHz	
2 / 5M	1	0	21.57	21.58	21.46	0	20.46	20.47	20.35	1	20.72	20.73	20.61	1
	1	12	21.40	21.41	21.29	0	20.57	20.58	20.46	1	20.56	20.57	20.45	1
	1	24	20.80	20.81	20.69	0	20.05	20.06	19.94	1	20.27	20.28	20.16	1
	12	0	20.47	20.48	20.36	1	19.48	19.49	19.37	2	19.47	19.48	19.36	2
	12	6	20.43	20.44	20.32	1	19.46	19.47	19.35	2	19.36	19.37	19.25	2
	12	13	20.36	20.37	20.25	1	19.37	19.38	19.26	2	19.39	19.40	19.28	2
	25	0	20.40	20.41	20.29	1	19.40	19.41	19.29	2	19.40	19.41	19.29	2

LTE Band / BW	RB Size	RB Offset	QPSK			3GPP MPR (dB)	16QAM			3GPP MPR (dB)	64QAM			3GPP MPR (dB)
			Low CH 18650 1855.0 MHz	Mid CH 18900 1880.0 MHz	High CH 19150 1905.0 MHz		Low CH 18650 1855.0 MHz	Mid CH 18900 1880.0 MHz	High CH 19150 1905.0 MHz		Low CH 18650 1855.0 MHz	Mid CH 18900 1880.0 MHz	High CH 19150 1905.0 MHz	
2 / 10M	1	0	21.59	21.60	21.48	0	20.48	20.49	20.37	1	20.74	20.75	20.63	1
	1	24	21.42	21.43	21.31	0	20.59	20.60	20.48	1	20.58	20.59	20.47	1
	1	49	20.82	20.83	20.71	0	20.07	20.08	19.96	1	20.29	20.30	20.18	1
	25	0	20.49	20.50	20.38	1	19.50	19.51	19.39	2	19.49	19.50	19.38	2
	25	12	20.45	20.46	20.34	1	19.48	19.49	19.37	2	19.38	19.39	19.27	2
	25	25	20.38	20.39	20.27	1	19.39	19.40	19.28	2	19.41	19.42	19.30	2
	50	0	20.42	20.43	20.31	1	19.42	19.43	19.31	2	19.42	19.43	19.31	2

LTE Band / BW	RB Size	RB Offset	QPSK			3GPP MPR (dB)	16QAM			3GPP MPR (dB)	64QAM			3GPP MPR (dB)
			Low CH 18675 1857.5 MHz	Mid CH 18900 1880.0 MHz	High CH 19125 1902.5 MHz		Low CH 18675 1857.5 MHz	Mid CH 18900 1880.0 MHz	High CH 19125 1902.5 MHz		Low CH 18675 1857.5 MHz	Mid CH 18900 1880.0 MHz	High CH 19125 1902.5 MHz	
2 / 15M	1	0	21.62	21.63	21.51	0	20.51	20.52	20.40	1	20.77	20.78	20.66	1
	1	37	21.45	21.46	21.34	0	20.62	20.63	20.51	1	20.61	20.62	20.50	1
	1	74	20.85	20.86	20.74	0	20.10	20.11	19.99	1	20.32	20.33	20.21	1
	36	0	20.52	20.53	20.41	1	19.53	19.54	19.42	2	19.52	19.53	19.41	2
	36	19	20.48	20.49	20.37	1	19.51	19.52	19.40	2	19.41	19.42	19.30	2
	36	39	20.41	20.42	20.30	1	19.42	19.43	19.31	2	19.44	19.45	19.33	2
	75	0	20.45	20.46	20.34	1	19.45	19.46	19.34	2	19.45	19.46	19.34	2

LTE Band / BW	RB Size	RB Offset	QPSK			3GPP MPR (dB)	16QAM			3GPP MPR (dB)	64QAM			3GPP MPR (dB)
			Low CH 18700 1860.0 MHz	Mid CH 18900 1880.0 MHz	High CH 19100 1900.0 MHz		Low CH 18700 1860.0 MHz	Mid CH 18900 1880.0 MHz	High CH 19100 1900.0 MHz		Low CH 18700 1860.0 MHz	Mid CH 18900 1880.0 MHz	High CH 19100 1900.0 MHz	
2 / 20M	1	0	21.67	**21.68**	21.56	0	20.56	20.57	20.45	1	20.82	20.83	20.71	1
	1	50	21.50	21.51	21.39	0	20.67	20.68	20.56	1	20.66	20.67	20.55	1
	1	99	20.90	20.91	20.79	0	20.15	20.16	20.04	1	20.37	20.38	20.26	1
	50	0	20.57	20.58	20.46	1	19.58	19.59	19.47	2	19.57	19.58	19.46	2
	50	25	20.53	20.54	20.42	1	19.56	19.57	19.45	2	19.46	19.47	19.35	2
	50	50	20.46	20.47	20.35	1	19.47	19.48	19.36	2	19.49	19.50	19.38	2
	100	0	20.50	20.51	20.39	1	19.50	19.51	19.39	2	19.50	19.51	19.39	2

LTE Band / BW	RB Size	RB Offset	QPSK			3GPP MPR (dB)	16QAM			3GPP MPR (dB)	64QAM			3GPP MPR (dB)
			Low CH 20407 824.7 MHz	Mid CH 20525 836.5 MHz	High CH 20643 848.3 MHz		Low CH 20407 824.7 MHz	Mid CH 20525 836.5 MHz	High CH 20643 848.3 MHz		Low CH 20407 824.7 MHz	Mid CH 20525 836.5 MHz	High CH 20643 848.3 MHz	
5 / 1.4M	1	0	23.48	23.52	23.51	0	22.59	22.63	22.62	1	22.55	22.59	22.58	1
	1	2	23.42	23.46	23.45	0	22.66	22.70	22.69	1	22.60	22.64	22.63	1
	1	5	22.90	22.94	22.93	0	22.26	22.30	22.29	1	22.18	22.22	22.21	1
	3	0	22.60	22.64	22.63	1	21.52	21.56	21.55	2	21.50	21.54	21.53	2
	3	1	22.58	22.62	22.61	1	21.60	21.64	21.63	2	21.59	21.63	21.62	2
	3	3	22.41	22.45	22.44	1	21.50	21.54	21.53	2	21.50	21.54	21.53	2
	6	0	22.43	22.47	22.46	1	21.54	21.58	21.57	2	21.63	21.67	21.66	2

LTE Band / BW	RB Size	RB Offset	QPSK			3GPP MPR (dB)	16QAM			3GPP MPR (dB)	64QAM			3GPP MPR (dB)
			Low CH 20415 825.5 MHz	Mid CH 20525 836.5 MHz	High CH 20635 847.5 MHz		Low CH 20415 825.5 MHz	Mid CH 20525 836.5 MHz	High CH 20635 847.5 MHz		Low CH 20415 825.5 MHz	Mid CH 20525 836.5 MHz	High CH 20635 847.5 MHz	
5 / 3M	1	0	23.52	23.56	23.55	0	22.63	22.67	22.66	1	22.59	22.63	22.62	1
	1	7	23.46	23.50	23.49	0	22.70	22.74	22.73	1	22.64	22.68	22.67	1
	1	14	22.94	22.98	22.97	0	22.30	22.34	22.33	1	22.22	22.26	22.25	1
	8	0	22.62	22.66	22.65	1	21.53	21.57	21.56	2	21.51	21.55	21.54	2
	8	3	22.60	22.64	22.63	1	21.61	21.65	21.64	2	21.60	21.64	21.63	2
	8	7	22.43	22.47	22.46	1	21.51	21.55	21.54	2	21.51	21.55	21.54	2
	15	0	22.45	22.49	22.48	1	21.55	21.59	21.58	2	21.64	21.68	21.67	2

LTE Band / BW	RB Size	RB Offset	QPSK			3GPP MPR (dB)	16QAM			3GPP MPR (dB)	64QAM			3GPP MPR (dB)
			Low CH 20425 826.5 MHz	Mid CH 20525 836.5 MHz	High CH 20625 846.5 MHz		Low CH 20425 826.5 MHz	Mid CH 20525 836.5 MHz	High CH 20625 846.5 MHz		Low CH 20425 826.5 MHz	Mid CH 20525 836.5 MHz	High CH 20625 846.5 MHz	
5 / 5M	1	0	23.58	23.62	23.61	0	22.69	22.73	22.72	1	22.65	22.69	22.68	1
	1	12	23.52	23.56	23.55	0	22.76	22.80	22.79	1	22.70	22.74	22.73	1
	1	24	23.00	23.04	23.03	0	22.36	22.40	22.39	1	22.28	22.32	22.31	1
	12	0	22.68	22.72	22.71	1	21.59	21.63	21.62	2	21.57	21.61	21.60	2
	12	6	22.66	22.70	22.69	1	21.67	21.71	21.70	2	21.66	21.70	21.69	2
	12	13	22.49	22.53	22.52	1	21.57	21.61	21.60	2	21.57	21.61	21.60	2
	25	0	22.51	22.55	22.54	1	21.61	21.65	21.64	2	21.70	21.74	21.73	2

LTE Band / BW	RB Size	RB Offset	QPSK			3GPP MPR (dB)	16QAM			3GPP MPR (dB)	64QAM			3GPP MPR (dB)
			Low CH 20450 829.0 MHz	Mid CH 20525 836.5 MHz	High CH 20600 844.0 MHz		Low CH 20450 829.0 MHz	Mid CH 20525 836.5 MHz	High CH 20600 844.0 MHz		Low CH 20450 829.0 MHz	Mid CH 20525 836.5 MHz	High CH 20600 844.0 MHz	
5 / 10M	1	0	23.61	**23.65**	23.64	0	22.72	22.76	22.75	1	22.68	22.72	22.71	1
	1	24	23.55	23.59	23.58	0	22.79	22.83	22.82	1	22.73	22.77	22.76	1
	1	49	23.03	23.07	23.06	0	22.39	22.43	22.42	1	22.31	22.35	22.34	1
	25	0	22.71	22.75	22.74	1	21.62	21.66	21.65	2	21.60	21.64	21.63	2
	25	12	22.69	22.73	22.72	1	21.70	21.74	21.73	2	21.69	21.73	21.72	2
	25	25	22.52	22.56	22.55	1	21.60	21.64	21.63	2	21.60	21.64	21.63	2
	50	0	22.54	22.58	22.57	1	21.64	21.68	21.67	2	21.73	21.77	21.76	2

LTE Band / BW	RB Size	RB Offset	QPSK			3GPP MPR (dB)	16QAM			3GPP MPR (dB)	64QAM			3GPP MPR (dB)
			Low CH 20775 2502.5 MHz	Mid CH 21100 2535.0 MHz	High CH 21425 2567.5 MHz		Low CH 20775 2502.5 MHz	Mid CH 21100 2535.0 MHz	High CH 21425 2567.5 MHz		Low CH 20775 2502.5 MHz	Mid CH 21100 2535.0 MHz	High CH 21425 2567.5 MHz	
7 / 5M	1	0	23.58	24.09	23.54	0	22.43	22.94	22.39	1	22.48	22.99	22.44	1
	1	12	23.40	23.91	23.36	0	22.40	22.91	22.36	1	22.43	22.94	22.39	1
	1	24	22.93	23.44	22.89	0	22.37	22.88	22.33	1	22.23	22.74	22.19	1
	12	0	22.63	23.14	22.59	1	21.64	22.15	21.60	2	21.53	22.04	21.49	2
	12	6	22.48	22.99	22.44	1	21.50	22.01	21.46	2	21.48	21.99	21.44	2
	12	13	22.40	22.91	22.36	1	21.38	21.89	21.34	2	21.41	21.92	21.37	2
	25	0	22.47	22.98	22.43	1	21.54	22.05	21.50	2	21.45	21.96	21.41	2

LTE Band / BW	RB Size	RB Offset	QPSK			3GPP MPR (dB)	16QAM			3GPP MPR (dB)	64QAM			3GPP MPR (dB)
			Low CH 20800 2505.0 MHz	Mid CH 21100 2535.0 MHz	High CH 21400 2565.0 MHz		Low CH 20800 2505.0 MHz	Mid CH 21100 2535.0 MHz	High CH 21400 2565.0 MHz		Low CH 20800 2505.0 MHz	Mid CH 21100 2535.0 MHz	High CH 21400 2565.0 MHz	
7 / 10M	1	0	23.62	24.13	23.58	0	22.47	22.98	22.43	1	22.52	23.03	22.48	1
	1	24	23.44	23.95	23.40	0	22.44	22.95	22.40	1	22.47	22.98	22.43	1
	1	49	22.97	23.48	22.93	0	22.41	22.92	22.37	1	22.27	22.78	22.23	1
	25	0	22.67	23.18	22.63	1	21.68	22.19	21.64	2	21.57	22.08	21.53	2
	25	12	22.52	23.03	22.48	1	21.54	22.05	21.50	2	21.52	22.03	21.48	2
	25	25	22.44	22.95	22.40	1	21.42	21.93	21.38	2	21.45	21.96	21.41	2
	50	0	22.51	23.02	22.47	1	21.58	22.09	21.54	2	21.49	22.00	21.45	2

LTE Band / BW	RB Size	RB Offset	QPSK			3GPP MPR (dB)	16QAM			3GPP MPR (dB)	64QAM			3GPP MPR (dB)
			Low CH 20825 2507.5 MHz	Mid CH 21100 2535.0 MHz	High CH 21375 2562.5 MHz		Low CH 20825 2507.5 MHz	Mid CH 21100 2535.0 MHz	High CH 21375 2562.5 MHz		Low CH 20825 2507.5 MHz	Mid CH 21100 2535.0 MHz	High CH 21375 2562.5 MHz	
7 / 15M	1	0	23.68	24.19	23.64	0	22.53	23.04	22.49	1	22.58	23.09	22.54	1
	1	37	23.50	24.01	23.46	0	22.50	23.01	22.46	1	22.53	23.04	22.49	1
	1	74	23.03	23.54	22.99	0	22.47	22.98	22.43	1	22.33	22.84	22.29	1
	36	0	22.73	23.24	22.69	1	21.74	22.25	21.70	2	21.63	22.14	21.59	2
	36	19	22.58	23.09	22.54	1	21.60	22.11	21.56	2	21.58	22.09	21.54	2
	36	39	22.50	23.01	22.46	1	21.48	21.99	21.44	2	21.51	22.02	21.47	2
	75	0	22.57	23.08	22.53	1	21.64	22.15	21.60	2	21.55	22.06	21.51	2

LTE Band / BW	RB Size	RB Offset	QPSK			3GPP MPR (dB)	16QAM			3GPP MPR (dB)	64QAM			3GPP MPR (dB)
			Low CH 20850 2510.0 MHz	Mid CH 21100 2535.0 MHz	High CH 21350 2560.0 MHz		Low CH 20850 2510.0 MHz	Mid CH 21100 2535.0 MHz	High CH 21350 2560.0 MHz		Low CH 20850 2510.0 MHz	Mid CH 21100 2535.0 MHz	High CH 21350 2560.0 MHz	
7 / 20M	1	0	23.71	**24.22**	23.67	0	22.56	23.07	22.52	1	22.61	23.12	22.57	1
	1	50	23.53	24.04	23.49	0	22.53	23.04	22.49	1	22.56	23.07	22.52	1
	1	99	23.06	23.57	23.02	0	22.50	23.01	22.46	1	22.36	22.87	22.32	1
	50	0	22.76	23.27	22.72	1	21.77	22.28	21.73	2	21.66	22.17	21.62	2
	50	25	22.61	23.12	22.57	1	21.63	22.14	21.59	2	21.61	22.12	21.57	2
	50	50	22.53	23.04	22.49	1	21.51	22.02	21.47	2	21.54	22.05	21.50	2
	100	0	22.60	23.11	22.56	1	21.67	22.18	21.63	2	21.58	22.09	21.54	2

LTE Band / BW	RB Size	RB Offset	QPSK			3GPP MPR (dB)	16QAM			3GPP MPR (dB)	64QAM			3GPP MPR (dB)
			Low CH 37775 2572.5 MHz	Mid CH 38000 2595.0 MHz	High CH 38225 2617.5 MHz		Low CH 37775 2572.5 MHz	Mid CH 38000 2595.0 MHz	High CH 38225 2617.5 MHz		Low CH 37775 2572.5 MHz	Mid CH 38000 2595.0 MHz	High CH 38225 2617.5 MHz	
38 / 5M	1	0	24.11	24.18	24.14	0	22.94	23.01	22.97	1	22.76	22.83	22.79	2
	1	12	23.80	23.87	23.83	0	22.77	22.84	22.80	1	22.60	22.67	22.63	2
	1	24	23.72	23.79	23.75	0	22.71	22.78	22.74	1	22.51	22.58	22.54	2
	12	0	22.91	22.98	22.94	0	22.00	22.07	22.03	1	21.93	22.00	21.96	3
	12	6	22.86	22.93	22.89	0	21.91	21.98	21.94	1	21.87	21.94	21.90	3
	12	13	22.83	22.90	22.86	0	21.85	21.92	21.88	1	21.82	21.89	21.85	3
	25	0	22.90	22.97	22.93	1	21.90	21.97	21.93	2	21.96	22.03	21.99	3

LTE Band / BW	RB Size	RB Offset	QPSK			3GPP MPR (dB)	16QAM			3GPP MPR (dB)	64QAM			3GPP MPR (dB)
			Low CH 37800 2575.0 MHz	Mid CH 38000 2595.0 MHz	High CH 38200 2615.0 MHz		Low CH 37800 2575.0 MHz	Mid CH 38000 2595.0 MHz	High CH 38200 2615.0 MHz		Low CH 37800 2575.0 MHz	Mid CH 38000 2595.0 MHz	High CH 38200 2615.0 MHz	
38 / 10M	1	0	24.15	24.22	24.18	0	22.98	23.05	23.01	1	22.80	22.87	22.83	2
	1	24	23.84	23.91	23.87	0	22.81	22.88	22.84	1	22.64	22.71	22.67	2
	1	49	23.76	23.83	23.79	0	22.75	22.82	22.78	1	22.55	22.62	22.58	2
	25	0	22.95	23.02	22.98	0	22.04	22.11	22.07	1	21.97	22.04	22.00	3
	25	12	22.90	22.97	22.93	0	21.95	22.02	21.98	1	21.91	21.98	21.94	3
	25	25	22.87	22.94	22.90	0	21.89	21.96	21.92	1	21.86	21.93	21.89	3
	50	0	22.94	23.01	22.97	1	21.94	22.01	21.97	2	22.00	22.07	22.03	3

LTE Band / BW	RB Size	RB Offset	QPSK			3GPP MPR (dB)	16QAM			3GPP MPR (dB)	64QAM			3GPP MPR (dB)
			Low CH 37825 2577.5 MHz	Mid CH 38000 2595.0 MHz	High CH 38175 2612.5 MHz		Low CH 37825 2577.5 MHz	Mid CH 38000 2595.0 MHz	High CH 38175 2612.5 MHz		Low CH 37825 2577.5 MHz	Mid CH 38000 2595.0 MHz	High CH 38175 2612.5 MHz	
38 / 15M	1	0	24.18	24.25	24.21	0	23.01	23.08	23.04	1	22.83	22.90	22.86	2
	1	37	23.87	23.94	23.90	0	22.84	22.91	22.87	1	22.67	22.74	22.70	2
	1	74	23.79	23.86	23.82	0	22.78	22.85	22.81	1	22.58	22.65	22.61	2
	36	0	22.98	23.05	23.01	0	22.07	22.14	22.10	1	22.00	22.07	22.03	3
	36	19	22.93	23.00	22.96	0	21.98	22.05	22.01	1	21.94	22.01	21.97	3
	36	39	22.90	22.97	22.93	0	21.92	21.99	21.95	1	21.89	21.96	21.92	3
	75	0	22.97	23.04	23.00	1	21.97	22.04	22.00	2	22.03	22.10	22.06	3

LTE Band / BW	RB Size	RB Offset	QPSK			3GPP MPR (dB)	16QAM			3GPP MPR (dB)	64QAM			3GPP MPR (dB)
			Low CH 37850 2580.0 MHz	Mid CH 38000 2595.0 MHz	High CH 38150 2610.0 MHz		Low CH 37850 2580.0 MHz	Mid CH 38000 2595.0 MHz	High CH 38150 2610.0 MHz		Low CH 37850 2580.0 MHz	Mid CH 38000 2595.0 MHz	High CH 38150 2610.0 MHz	
38 / 20M	1	0	24.25	**24.32**	24.28	0	23.08	23.15	23.11	1	22.90	22.97	22.93	2
	1	50	23.94	24.01	23.97	0	22.91	22.98	22.94	1	22.74	22.81	22.77	2
	1	99	23.86	23.93	23.89	0	22.85	22.92	22.88	1	22.65	22.72	22.68	2
	50	0	23.05	23.12	23.08	0	22.14	22.21	22.17	1	22.07	22.14	22.10	3
	50	25	23.00	23.07	23.03	0	22.05	22.12	22.08	1	22.01	22.08	22.04	3
	50	50	22.97	23.04	23.00	0	21.99	22.06	22.02	1	21.96	22.03	21.99	3
	100	0	23.04	23.11	23.07	1	22.04	22.11	22.07	2	22.10	22.17	22.13	3

LTE Band / BW	RB Size	RB Offset	QPSK			3GPP MPR (dB)	16QAM			3GPP MPR (dB)	64QAM			3GPP MPR (dB)
			Low CH 38725 2307.5 MHz	Mid CH 38750 2310.0 MHz	High CH 38775 2312.5 MHz		Low CH 38725 2307.5 MHz	Mid CH 38750 2310.0 MHz	High CH 38775 2312.5 MHz		Low CH 38725 2307.5 MHz	Mid CH 38750 2310.0 MHz	High CH 38775 2312.5 MHz	
40 / 5M	1	0	23.59	23.65	23.60	0	22.60	22.66	22.61	1	22.53	22.59	22.54	
	1	12	23.39	23.45	23.40	0	22.40	22.46	22.41	1	22.23	22.29	22.24	
	1	24	23.36	23.42	23.37	0	22.36	22.42	22.37	1	22.19	22.25	22.20	
	12	0	22.62	22.68	22.63	0	21.64	21.70	21.65	1	21.64	21.70	21.65	
	12	6	22.53	22.59	22.54	0	21.51	21.57	21.52	1	21.53	21.59	21.54	
	12	13	22.49	22.55	22.50	0	21.47	21.53	21.48	1	21.57	21.63	21.58	
	25	0	22.51	22.57	22.52	1	21.62	21.68	21.63	2	21.56	21.62	21.57	

LTE Band / BW	RB Size	RB Offset	QPSK	3GPP MPR (dB)	16QAM	3GPP MPR (dB)	64QAM	3GPP MPR (dB)
			Mid CH 38750 2310.0 MHz		Mid CH 38750 2310.0 MHz		Mid CH 38750 2310.0 MHz	
40 / 10M	1	0	**23.71**	0	22.72	1	22.65	
	1	24	23.51	0	22.52	1	22.35	
	1	49	23.48	0	22.48	1	22.31	
	25	0	22.74	0	21.76	1	21.76	
	25	12	22.65	0	21.63	1	21.65	
	25	25	22.61	0	21.59	1	21.69	
	50	0	22.63	1	21.74	2	21.68	

LTE Band / BW	RB Size	RB Offset	QPSK				3GPP MPR (dB)	16QAM				3GPP MPR (dB)
			L-CH 40265 2557.5 MHz	M-CH 40585 2589.5 MHz	M-CH 40905 2621.5 MHz	H-CH 41215 2652.5 MHz		L-CH 39675 2498.5 MHz	M-CH 40148 2545.8 MHz	M-CH 40620 2593.0 MHz	M-CH 41093 2640.3 MHz	
41 / 5M	1	0	23.93	23.99	23.96	23.83	0	22.94	23.00	22.97	22.84	1
	1	12	23.80	23.86	23.83	23.70	0	22.77	22.83	22.80	22.67	1
	1	24	23.72	23.78	23.75	23.62	0	22.71	22.77	22.74	22.61	1
	12	0	22.91	22.97	22.94	22.81	1	22.00	22.06	22.03	21.90	2
	12	6	22.86	22.92	22.89	22.76	1	21.91	21.97	21.94	21.81	2
	12	13	22.83	22.89	22.86	22.73	1	21.85	21.91	21.88	21.75	2
	25	0	22.90	22.96	22.93	22.80	1	21.90	21.96	21.93	21.80	2

LTE Band / BW	RB Size	RB Offset	64QAM				3GPP MPR (dB)
			L-CH 40265 2557.5 MHz	M-CH 40585 2589.5 MHz	M-CH 40905 2621.5 MHz	H-CH 41215 2652.5 MHz	
41 / 5M	1	0	22.76	22.82	22.79	22.66	0
	1	12	22.60	22.66	22.63	22.50	0
	1	24	22.51	22.57	22.54	22.41	0
	12	0	21.93	21.99	21.96	21.83	1
	12	6	21.87	21.93	21.90	21.77	1
	12	13	21.82	21.88	21.85	21.72	1
	25	0	21.96	22.02	21.99	21.86	1

LTE Band / BW	RB Size	RB Offset	QPSK				3GPP MPR (dB)	16QAM				3GPP MPR (dB)
			L-CH 40290 2560 MHz	M-CH 40590 2590 MHz	M-CH 40890 2620 MHz	H-CH 41190 2650 MHz		L-CH 40290 2560 MHz	M-CH 40590 2590 MHz	M-CH 40890 2620 MHz	H-CH 41190 2650 MHz	
41 / 10M	1	0	23.98	24.04	24.01	23.88	0	22.99	23.05	23.02	22.89	1
	1	24	23.85	23.91	23.88	23.75	0	22.82	22.88	22.85	22.72	1
	1	49	23.77	23.83	23.80	23.67	0	22.76	22.82	22.79	22.66	1
	25	0	22.96	23.02	22.99	22.86	1	22.05	22.11	22.08	21.95	2
	25	12	22.91	22.97	22.94	22.81	1	21.96	22.02	21.99	21.86	2
	25	25	22.88	22.94	22.91	22.78	1	21.90	21.96	21.93	21.80	2
	50	0	22.95	23.01	22.98	22.85	1	21.95	22.01	21.98	21.85	2

LTE Band / BW	RB Size	RB Offset	64QAM				3GPP MPR (dB)
			L-CH 40290 2560 MHz	M-CH 40590 2590 MHz	M-CH 40890 2620 MHz	H-CH 41190 2650 MHz	
41 / 10M	1	0	22.81	22.87	22.84	22.71	1
	1	24	22.65	22.71	22.68	22.55	1
	1	49	22.56	22.62	22.59	22.46	1
	25	0	21.98	22.04	22.01	21.88	2
	25	12	21.92	21.98	21.95	21.82	2
	25	25	21.87	21.93	21.90	21.77	2
	50	0	22.01	22.07	22.04	21.91	2

LTE Band / BW	RB Size	RB Offset	QPSK				3GPP MPR (dB)	16QAM				3GPP MPR (dB)
			L-CH 40315 2562.5 MHz	M-CH 40595 2590.5 MHz	M-CH 40885 2619.5 MHz	H-CH 41165 2647.5 MHz		L-CH 40315 2562.5 MHz	M-CH 40595 2590.5 MHz	M-CH 40885 2619.5 MHz	H-CH 41165 2647.5 MHz	
41 / 15M	1	0	24.02	24.08	24.05	23.92	0	23.03	23.09	23.06	22.93	1
	1	37	23.89	23.95	23.92	23.79	0	22.86	22.92	22.89	22.76	1
	1	74	23.81	23.87	23.84	23.71	0	22.80	22.86	22.83	22.70	1
	36	0	23.00	23.06	23.03	22.90	1	22.09	22.15	22.12	21.99	2
	36	19	22.95	23.01	22.98	22.85	1	22.00	22.06	22.03	21.90	2
	36	39	22.92	22.98	22.95	22.82	1	21.94	22.00	21.97	21.84	2
	75	0	22.99	23.05	23.02	22.89	1	21.99	22.05	22.02	21.89	2

LTE Band / BW	RB Size	RB Offset	64QAM				3GPP MPR (dB)
			L-CH 40315 2562.5 MHz	M-CH 40595 2590.5 MHz	M-CH 40885 2619.5 MHz	H-CH 41165 2647.5 MHz	
41 / 15M	1	0	22.85	22.91	22.88	22.75	1
	1	37	22.69	22.75	22.72	22.59	1
	1	74	22.60	22.66	22.63	22.50	1
	36	0	22.02	22.08	22.05	21.92	2
	36	19	21.96	22.02	21.99	21.86	2
	36	39	21.91	21.97	21.94	21.81	2
	75	0	22.05	22.11	22.08	21.95	2

LTE Band / BW	RB Size	RB Offset	QPSK				3GPP MPR (dB)	16QAM				3GPP MPR (dB)
			L-CH 40340 2565 MHz	M-CH 40600 2591 MHz	M-CH 40870 2618 MHz	H-CH 41140 2645 MHz		L-CH 40340 2565 MHz	M-CH 40600 2591 MHz	M-CH 40870 2618 MHz	H-CH 41140 2645 MHz	
41 / 20M	1	0	24.08	**24.14**	24.11	23.98	0	23.09	23.15	23.12	22.99	1
	1	50	23.95	24.01	23.98	23.85	0	22.92	22.98	22.95	22.82	1
	1	99	23.87	23.93	23.90	23.77	0	22.86	22.92	22.89	22.76	1
	50	0	23.06	23.12	23.09	22.96	1	22.15	22.21	22.18	22.05	2
	50	25	23.01	23.07	23.04	22.91	1	22.06	22.12	22.09	21.96	2
	50	50	22.98	23.04	23.01	22.88	1	22.00	22.06	22.03	21.90	2
	100	0	23.05	23.11	23.08	22.95	1	22.05	22.11	22.08	21.95	2

LTE Band / BW	RB Size	RB Offset	64QAM				3GPP MPR (dB)
			L-CH 40340 2565 MHz	M-CH 40600 2591 MHz	M-CH 40870 2618 MHz	H-CH 41140 2645 MHz	
41 / 20M	1	0	22.91	22.97	22.94	22.81	1
	1	50	22.75	22.81	22.78	22.65	1
	1	99	22.66	22.72	22.69	22.56	1
	50	0	22.08	22.14	22.11	21.98	2
	50	25	22.02	22.08	22.05	21.92	2
	50	50	21.97	22.03	22.00	21.87	2
	100	0	22.11	22.17	22.14	22.01	2

<WLAN 2.4G>

Mode	802.11b		
Channel / Frequency (MHz)	1 (2412)	6 (2437)	11 (2462)
Average Power	15.42	15.99	**16.78**
Mode	802.11g		
Channel / Frequency (MHz)	1 (2412)	6 (2437)	11 (2462)
Average Power	**13.65**	12.42	13.21
Mode	802.11n (HT20)		
Channel / Frequency (MHz)	1 (2412)	6 (2437)	11 (2462)
Average Power	**15.41**	13.71	12.86
Mode	802.11n (HT40)		
Channel / Frequency (MHz)	3 (2422)	6 (2437)	9 (2452)
Average Power	13.08	**13.48**	11.19

<WLAN 5.2G>

Mode	802.11a			
Channel / Frequency (MHz)	36 (5180)	40 (5200)	44 (5220)	48 (5240)
Average Power	**13.81**	13.53	13.51	13.74
Mode	802.11n (HT20)			
Channel / Frequency (MHz)	36 (5180)	40 (5200)	44 (5220)	48 (5240)
Average Power	13.53	13.68	13.71	**13.91**
Mode	802.11n (HT40)			
Channel / Frequency (MHz)	38 (5190)		46 (5230)	
Average Power	12.52		**13.22**	

<WLAN 5.3G>

Mode	802.11a			
Channel / Frequency (MHz)	52 (5260)	56 (5280)	60 (5300)	64 (5320)
Average Power	**13.56**	13.48	13.51	13.45
Mode	802.11n (HT20)			
Channel / Frequency (MHz)	52 (5260)	56 (5280)	60 (5300)	64 (5320)
Average Power	**13.68**	13.58	13.52	13.48
Mode	802.11n (HT40)			
Channel / Frequency (MHz)	54 (5270)		62 (5310)	
Average Power	**13.13**		12.65	

<WLAN 5.6G>

Mode	802.11a							
Channel / Frequency (MHz)	100 (5500)	104 (5520)	108 (5540)	112 (5560)	116 (5580)	132 (5660)	136 (5680)	140 (5700)
Average Power	13.78	13.56	13.54	13.61	14.16	14.26	14.55	**14.67**
Mode	802.11n (HT20)							
Channel / Frequency (MHz)	100 (5500)	104 (5520)	108 (5540)	112 (5560)	116 (5580)	132 (5660)	136 (5680)	140 (5700)
Average Power	12.31	13.05	13.16	13.13	**13.56**	13.44	13.42	13.42
Mode	802.11n (HT40)							
Channel / Frequency (MHz)	102 (5510)				134 (5670)			
Average Power	13.45				**13.87**			

<WLAN 5.8G>

Mode	802.11a				
Channel / Frequency (MHz)	149 (5745)	153 (5765)	157 (5785)	161 (5805)	165 (5825)
Average Power	15.17	15.19	**15.25**	15.22	15.02
Mode	802.11n (HT20)				
Channel / Frequency (MHz)	149 (5745)	153 (5765)	157 (5785)	161 (5805)	165 (5825)
Average Power	14.89	14.93	15.17	15.12	**15.23**
Mode	802.11n (HT40)				
Channel / Frequency (MHz)	151 (5755)			159 (5795)	
Average Power	**14.92**			14.81	

<Bluetooth>

Mode	Bluetooth GFSK		
Channel / Frequency (MHz)	0 (2402)	39 (2441)	78 (2480)
Average Power	4.12	4.49	**5.23**
Mode	Bluetooth 8-DPSK		
Channel / Frequency (MHz)	0 (2402)	39 (2441)	78 (2480)
Average Power	2.81	3.07	**3.58**
Mode	Bluetooth LE		
Channel / Frequency (MHz)	0 (2402)	19 (2440)	39 (2480)
Average Power	4.35	4.37	**5.27**

4.7 SAR Testing Results

4.7.1 SAR Test Reduction Considerations

<KDB 447498 D01, General RF Exposure Guidance>

Testing of other required channels within the operating mode of a frequency band is not required when the reported SAR for the mid-band or highest output power channel is:

(1) ≤ 0.8 W/kg or 2.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≤ 100 MHz

(2) ≤ 0.6 W/kg or 1.5 W/kg, for 1-g or 10-g respectively, when the transmission band is between 100 MHz and 200 MHz

(3) ≤ 0.4 W/kg or 1.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≥ 200 MHz

<KDB 941225 D01, 3G SAR Measurement Procedures>

The mode tested for SAR is referred to as the primary mode. The equivalent modes considered for SAR test reduction are denoted as secondary modes. Both primary and secondary modes must be in the same frequency band. When the maximum output power and tune-up tolerance specified for production units in a secondary mode is ≤ 1/4 dB higher than the primary mode or when the highest reported SAR of the primary mode is scaled by the ratio of specified maximum output power and tune-up tolerance of secondary to primary mode and the adjusted SAR is ≤ 1.2 W/kg, SAR measurement is not required for the secondary mode.

<KDB 941225 D05, SAR Evaluation Considerations for LTE Devices>

(1) QPSK with 1 RB and 50% RB allocation

Start with the largest channel bandwidth and measure SAR, using the RB offset and required test channel combination with the highest maximum output power among RB offsets at the upper edge, middle and lower edge of each required test channel. When the reported SAR is ≤ 0.8 W/kg, testing of the remaining RB offset configurations and required test channels is not required; otherwise, SAR is required for the remaining required test channels and only for the RB offset configuration with the highest output power for that channel. When the reported SAR of a required test channel is > 1.45 W/kg, SAR is required for all three RB offset configurations for that required test channel.

(2) QPSK with 100% RB allocation

SAR is not required when the highest maximum output power for 100% RB allocation is less than the highest maximum output power in 50% and 1 RB allocations and the highest reported SAR for 1 RB and 50% RB allocation are ≤ 0.8 W/kg. Otherwise, SAR is measured for the highest output power channel; and if the reported SAR is > 1.45 W/kg, the remaining required test channels must also be tested.

(3) Higher order modulations

SAR is required only when the highest maximum output power for the configuration in the higher order modulation is > 1/2 dB higher than the same configuration in QPSK or when the reported SAR for the QPSK configuration is > 1.45 W/kg.

(4) Other channel bandwidth

SAR is required when the highest maximum output power of the smaller channel bandwidth is > 1/2 dB higher than the equivalent channel configurations in the largest channel bandwidth configuration or the reported SAR of a configuration for the largest channel bandwidth is > 1.45 W/kg.

<KDB 248227 D01, SAR Guidance for Wi-Fi Transmitters>

(1) For handsets operating next to ear, hotspot mode or mini-tablet configurations, the initial test position procedures were applied. The test position with the highest extrapolated peak SAR will be used as the initial test position. When the reported SAR of initial test position is <= 0.4 W/kg, SAR testing for remaining test positions is not required. Otherwise, SAR is evaluated at the subsequent highest peak SAR positions until the reported SAR result is <= 0.8 W/kg or all test positions are measured.

(2) For WLAN 2.4 GHz, the highest measured maximum output power channel for DSSS was selected for SAR measurement. When the reported SAR is <= 0.8 W/kg, no further SAR testing is required. Otherwise, SAR is evaluated at the next highest measured output power channel. When any reported SAR is > 1.2 W/kg, SAR is required for the third channel. For OFDM modes (802.11g/n), SAR is not required when the highest reported SAR for DSSS is adjusted by the ratio of OFDM to DSSS specified maximum output power and it is <= 1.2 W/kg.

(3) For WLAN 5 GHz, the initial test configuration was selected according to the transmission mode with the highest maximum output power. When the reported SAR of initial test configuration is > 0.8 W/kg, SAR is required for the subsequent highest measured output power channel until the reported SAR result is <= 1.2 W/kg or all required channels are measured. For other transmission modes, SAR is not required when the highest reported SAR for initial test configuration is adjusted by the ratio of subsequent test configuration to initial test configuration specified maximum output power and it is <= 1.2 W/kg.

4.7.2 SAR Results for Body Exposure Condition (Separation Distance is 0 cm Gap)

Plot No.	Band	Mode	Test Position	Ch.	Max. Tune-up Power (dBm)	Measured Conducted Power (dBm)	Power Drift (%)	Measured SAR-1g (W/kg)	Scaling Factor	Scaled SAR-1g (W/kg)
	GSM850	GPRS12	Front Face	189	28.0	27.87	-1.05	0.564	1.03	0.58
	GSM850	GPRS12	Rear Face	189	28.0	27.87	-1.93	0.951	1.03	0.98
	GSM850	GPRS12	Rear Face	128	28.0	27.82	-3.33	0.839	1.04	0.87
1#	GSM850	GPRS12	Rear Face	251	28.0	27.83	-3.38	0.988	1.04	**1.03**
	GSM850	GPRS12	Rear Face	251	28.0	27.83	-0.52	0.974	1.04	1.01
2#	GSM1900	GPRS12	Front Face	661	26.5	26.03	-0.49	0.511	1.11	**0.57**
	GSM1900	GPRS12	Rear Face	661	26.5	26.03	-0.59	0.453	1.11	0.50
3#	WCDMA II	RMC12.2K	Front Face	9400	21.5	21.23	-4.16	0.735	1.06	**0.78**
	WCDMA II	RMC12.2K	Rear Face	9400	21.5	21.23	-1.82	0.594	1.06	0.63
	WCDMA V	RMC12.2K	Front Face	4182	23.5	23.12	-0.75	0.112	1.09	0.12
	WCDMA V	RMC12.2K	Rear Face	4182	23.5	23.12	-0.64	0.871	1.09	0.95
	WCDMA V	RMC12.2K	Rear Face	4132	23.5	22.94	-0.24	0.804	1.14	0.91
4#	WCDMA V	RMC12.2K	Rear Face	4233	23.5	22.96	-0.55	1.047	1.13	**1.19**
	WCDMA V	RMC12.2K	Rear Face	4233	23.5	22.96	-0.55	1.012	1.13	1.15

Plot No.	Band	Mode	Test Position	Ch.	RB#	RB Offset	Max. Tune-up Power (dBm)	Measured Conducted Power (dBm)	Power Drift (%)	Measured SAR-1g (W/kg)	Scaling Factor	Scaled SAR-1g (W/kg)
5#	LTE 2	QPSK20M	Front Face	18900	1	0	22.0	21.68	-0.9	0.951	1.08	**1.02**
	LTE 2	QPSK20M	Rear Face	18900	1	0	22.0	21.68	-1.39	0.731	1.08	0.79
	LTE 2	QPSK20M	Front Face	18900	50	0	21.0	20.58	0.25	0.721	1.10	0.79
	LTE 2	QPSK20M	Rear Face	18900	50	0	21.0	20.58	0.52	0.568	1.10	0.63
	LTE 2	QPSK20M	Front Face	18700	1	0	22.0	21.67	-0.79	0.886	1.08	0.96
	LTE 2	QPSK20M	Front Face	19100	1	0	22.0	21.56	0.14	0.912	1.11	1.01
	LTE 2	QPSK20M	Front Face	18900	100	0	21.0	20.51	0.46	0.651	1.12	0.73
	LTE 2	QPSK20M	Front Face	18900	1	0	22.0	21.68	0.67	0.935	1.08	1.01
	LTE 5	QPSK10M	Front Face	20525	1	0	24.0	23.65	-1.05	0.389	1.08	0.42
6#	LTE 5	QPSK10M	Rear Face	20525	1	0	24.0	23.65	-1.49	0.713	1.08	**0.77**
	LTE 5	QPSK10M	Front Face	20525	25	0	23.0	22.75	-0.69	0.375	1.06	0.40
	LTE 5	QPSK10M	Rear Face	20525	25	0	23.0	22.75	-0.1	0.685	1.06	0.73
	LTE 7	QPSK20M	Front Face	21100	1	0	24.5	24.22	-0.24	0.6	1.07	0.64
7#	LTE 7	QPSK20M	Rear Face	21100	1	0	24.5	24.22	0.98	0.968	1.07	**1.03**
	LTE 7	QPSK20M	Front Face	21100	50	0	23.5	23.27	0.06	0.55	1.05	0.58
	LTE 7	QPSK20M	Rear Face	21100	50	0	23.5	23.27	-2.31	0.823	1.05	0.87
	LTE 7	QPSK20M	Rear Face	20850	1	0	24.5	23.71	-2.58	0.799	1.20	0.96
	LTE 7	QPSK20M	Rear Face	21350	1	0	24.5	23.67	-1.01	0.774	1.21	0.94
	LTE 7	QPSK20M	Rear Face	20850	50	0	23.5	22.76	-1.36	0.609	1.19	0.72
	LTE 7	QPSK20M	Rear Face	21350	50	0	23.5	22.72	-0.23	0.663	1.20	0.79
	LTE 7	QPSK20M	Rear Face	21100	100	0	23.5	23.11	0.37	0.768	1.09	0.84
	LTE 7	QPSK20M	Rear Face	21100	1	0	24.5	24.22	0.24	0.953	1.07	1.02
	LTE 38	QPSK20M	Front Face	38000	1	0	24.5	24.32	0.37	0.455	1.04	0.47
8#	LTE 38	QPSK20M	Rear Face	38000	1	0	24.5	24.32	1.38	0.601	1.04	**0.63**
	LTE 38	QPSK20M	Front Face	38000	50	0	23.5	23.12	0.34	0.365	1.09	0.40
	LTE 38	QPSK20M	Rear Face	38000	50	0	23.5	23.12	1.03	0.547	1.09	0.60

Plot No.	Band	Mode	Test Position	Ch.	RB#	RB Offset	Max. Tune-up Power (dBm)	Measured Conducted Power (dBm)	Power Drift (%)	Measured SAR-1g (W/kg)	Scaling Factor	Scaled SAR-1g (W/kg)
9#	LTE 40	QPSK20M	Front Face	38750	1	0	24.0	23.71	0.37	0.858	1.07	**0.92**
	LTE 40	QPSK20M	Rear Face	38750	1	0	24.0	23.71	-1.04	0.715	1.07	0.76
	LTE 40	QPSK20M	Front Face	38750	50	0	23.0	22.74	0.34	0.723	1.06	0.77
	LTE 40	QPSK20M	Rear Face	38750	50	0	23.0	22.74	1.03	0.634	1.06	0.67
	LTE 40	QPSK20M	Front Face	38750	1	0	24.0	23.71	-0.67	0.849	1.07	0.91
	LTE 41	QPSK20M	Front Face	40600	1	0	24.5	24.14	0.64	0.458	1.09	0.50
10#	LTE 41	QPSK20M	Rear Face	40600	1	0	24.5	24.14	1.05	0.66	1.09	**0.72**
	LTE 41	QPSK20M	Front Face	40600	50	0	23.5	23.12	1.12	0.387	1.09	0.42
	LTE 41	QPSK20M	Rear Face	40600	50	0	23.5	23.12	1.34	0.536	1.09	0.59
	LTE 41	QPSK20M	Rear Face	40340	1	0	24.5	24.08	-1.23	0.613	1.10	0.68
	LTE 41	QPSK20M	Rear Face	40870	1	0	24.5	24.11	1.06	0.631	1.09	0.69
	LTE 41	QPSK20M	Rear Face	41140	1	0	24.5	23.98	0.15	0.587	1.13	0.66

Plot No.	Band	Mode	Test Position	Ch.	Max. Tune-up Power (dBm)	Measured Conducted Power (dBm)	Power Drift (%)	Measured SAR-1g (W/kg)	Scaling Factor	Scaled SAR-1g (W/kg)
11#	802.11b	-	Front Face	11	17.0	16.78	2.5	0.493	1.05	**0.52**
	802.11b	-	Rear Face	11	17.0	16.78	1.78	0.03	1.05	0.03
12#	802.11a	-	Front Face	52	14.0	13.56	0.16	0.395	1.11	**0.44**
	802.11a	-	Rear Face	52	14.0	13.56	0.55	0.066	1.11	0.07
13#	802.11a	-	Front Face	140	15.0	14.67	2.57	0.502	1.08	**0.54**
	802.11a	-	Rear Face	140	15.0	14.67	-0.81	0.057	1.08	0.06
14#	802.11a	-	Front Face	157	15.5	15.25	1.37	0.478	1.06	**0.51**
	802.11a	-	Rear Face	157	15.5	15.25	1.25	0.063	1.06	0.07

4.7.3 SAR Measurement Variability

According to KDB 865664 D01, SAR measurement variability was assessed for each frequency band, which is determined by the SAR probe calibration point and tissue-equivalent medium used for the device measurements. When both head and body tissue-equivalent media are required for SAR measurements in a frequency band, the variability measurement procedures should be applied to the tissue medium with the highest measured SAR, using the highest measured SAR configuration for that tissue-equivalent medium. Alternatively, if the highest measured SAR for both head and body tissue-equivalent media are ≤ 1.45 W/kg and the ratio of these highest SAR values, i.e., largest divided by smallest value, is ≤ 1.10, the highest SAR configuration for either head or body tissue-equivalent medium may be used to perform the repeated measurement. These 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.

SAR repeated measurement procedure:

1. When the highest measured SAR is < 0.80 W/kg, repeated measurement is not required.
2. When the highest measured SAR is >= 0.80 W/kg, repeat that measurement once.
3. 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, perform a second repeated measurement.
4. If the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 1.20, and the original, first or second repeated measurement is >= 1.5 W/kg, perform a third repeated measurement.

Band	Mode	Test Position	Ch.	Original Measured SAR-1g (W/kg)	1st Repeated SAR-1g (W/kg)	L/S Ratio	2nd Repeated SAR-1g (W/kg)	L/S Ratio	3rd Repeated SAR-1g (W/kg)	L/S Ratio
GSM850	GPRS12	Rear Face	251	0.988	0.974	1.01	N/A	N/A	N/A	N/A
WCDMA V	RMC12.2K	Rear Face	4233	1.047	1.012	1.03	N/A	N/A	N/A	N/A
LTE 2	QPSK20M	Front Face	18900	0.951	0.935	1.02	N/A	N/A	N/A	N/A
LTE 7	QPSK20M	Rear Face	21100	0.968	0.953	1.02	N/A	N/A	N/A	N/A
LTE 40	QPSK20M	Front Face	38750	0.858	0.849	1.01	N/A	N/A	N/A	N/A

4.7.4 Simultaneous Multi-band Transmission Evaluation

<Estimated SAR Calculation>

According to KDB 447498 D01, when standalone SAR test exclusion applies to an antenna that transmits simultaneously with other antennas, the standalone SAR was estimated according to following formula to result in substantially conservative SAR values of <= 0.4 W/kg to determine simultaneous transmission SAR test exclusion.

$$\text{Estimated SAR} = \frac{\text{Max. Tune up Power}_{(\text{mW})}}{\text{Min. Test Separation Distance}_{(\text{mm})}} \times \frac{\sqrt{f_{(\text{GHz})}}}{7.5}$$

If the minimum test separation distance is < 5 mm, a distance of 5 mm is used for estimated SAR calculation. When the test separation distance is > 50 mm, the 0.4 W/kg is used for SAR-1g.

Mode / Band	Frequency (GHz)	Max. Tune-up Power (dBm)	Test Position	Separation Distance (mm)	Estimated SAR (W/kg)
BT (DSS)	2.48	5.5	Body	5	0.15

Note:

1. The separation distance is determined from the outer housing of the tablet to the user.
2. When standalone SAR testing is not required, an estimated SAR can be applied to determine simultaneous transmission SAR test exclusion.

<SAR Summation Analysis>

Simultaneous transmission SAR test exclusion is determined for each operating configuration and exposure condition according to the reported standalone SAR of each applicable simultaneous transmitting antenna. When the sum of SAR_{1g} of all simultaneously transmitting antennas in an operating mode and exposure condition combination is within the SAR limit (SAR_{1g} 1.6 W/kg), the simultaneous transmission SAR is not required. When the sum of SAR_{1g} is greater than the SAR limit (SAR_{1g} 1.6 W/kg), SAR test exclusion is determined by the SPLSR.

No.	Conditions (SAR1 + SAR2)	Exposure Condition	Test Position	Max. SAR1	Max. SAR2	SAR Summation	SPLSR Analysis
1	GSM 850 + WLAN (DTS)	Body	Front Face	0.58	0.52	**1.10**	∑SAR < 1.6, Not required
			Rear Face	1.03	0.03	**1.06**	∑SAR < 1.6, Not required
2	GSM 850 + WLAN (NII)	Body	Front Face	0.58	0.54	**1.12**	∑SAR < 1.6, Not required
			Rear Face	1.03	0.07	**1.10**	∑SAR < 1.6, Not required
3	GSM 850 + BT (DSS)	Body	Front Face	0.58	0.15	**0.73**	∑SAR < 1.6, Not required
			Rear Face	1.03	0.15	**1.18**	∑SAR < 1.6, Not required

No.	Conditions (SAR1 + SAR2)	Exposure Condition	Test Position	Max. SAR1	Max. SAR2	SAR Summation	SPLSR Analysis
4	GSM 1900 + WLAN (DTS)	Body	Front Face	0.57	0.52	**1.09**	∑SAR < 1.6, Not required
			Rear Face	0.50	0.03	**0.53**	∑SAR < 1.6, Not required
5	GSM 1900 + WLAN (NII)	Body	Front Face	0.57	0.54	**1.11**	∑SAR < 1.6, Not required
			Rear Face	0.50	0.07	**0.57**	∑SAR < 1.6, Not required
6	GSM 1900 + BT (DSS)	Body	Front Face	0.57	0.15	**0.72**	∑SAR < 1.6, Not required
			Rear Face	0.50	0.15	**0.65**	∑SAR < 1.6, Not required

No.	Conditions (SAR1 + SAR2)	Exposure Condition	Test Position	Max. SAR1	Max. SAR2	SAR Summation	SPLSR Analysis
7	WCDMA II + WLAN (DTS)	Body	Front Face	0.78	0.52	**1.30**	∑SAR < 1.6, Not required
			Rear Face	0.63	0.03	**0.66**	∑SAR < 1.6, Not required
8	WCDMA II + WLAN (NII)	Body	Front Face	0.78	0.54	**1.32**	∑SAR < 1.6, Not required
			Rear Face	0.63	0.07	**0.70**	∑SAR < 1.6, Not required
9	WCDMA II + BT (DSS)	Body	Front Face	0.78	0.15	**0.93**	∑SAR < 1.6, Not required
			Rear Face	0.63	0.15	**0.78**	∑SAR < 1.6, Not required

No.	Conditions (SAR1 + SAR2)	Exposure Condition	Test Position	Max. SAR1	Max. SAR2	SAR Summation	SPLSR Analysis
10	WCDMA V + WLAN (DTS)	Body	Front Face	0.12	0.52	**0.64**	∑SAR < 1.6, Not required
			Rear Face	1.19	0.03	**1.22**	∑SAR < 1.6, Not required
11	WCDMA V + WLAN (NII)	Body	Front Face	0.12	0.54	**0.66**	∑SAR < 1.6, Not required
			Rear Face	1.19	0.07	**1.26**	∑SAR < 1.6, Not required
12	WCDMA V + BT (DSS)	Body	Front Face	0.12	0.15	**0.27**	∑SAR < 1.6, Not required
			Rear Face	1.19	0.15	**1.34**	∑SAR < 1.6, Not required

No.	Conditions (SAR1 + SAR2)	Exposure Condition	Test Position	Max. SAR1	Max. SAR2	SAR Summation	SPLSR Analysis
13	LTE Band 2 + WLAN (DTS)	Body	Front Face	1.02	0.52	**1.54**	∑SAR < 1.6, Not required
			Rear Face	0.19	0.03	**0.22**	∑SAR < 1.6, Not required
14	LTE Band 2 + WLAN (NII)	Body	Front Face	1.02	0.54	**1.56**	∑SAR < 1.6, Not required
			Rear Face	0.19	0.07	**0.26**	∑SAR < 1.6, Not required
15	LTE Band 2 + BT (DSS)	Body	Front Face	1.02	0.15	**1.17**	∑SAR < 1.6, Not required
			Rear Face	0.19	0.15	**0.34**	∑SAR < 1.6, Not required

No.	Conditions (SAR1 + SAR2)	Exposure Condition	Test Position	Max. SAR1	Max. SAR2	SAR Summation	SPLSR Analysis
16	LTE Band 5 + WLAN (DTS)	Body	Front Face	0.42	0.52	**0.94**	∑SAR < 1.6, Not required
			Rear Face	0.77	0.03	**0.80**	∑SAR < 1.6, Not required
17	LTE Band 5 + WLAN (NII)	Body	Front Face	0.42	0.54	**0.96**	∑SAR < 1.6, Not required
			Rear Face	0.77	0.07	**0.84**	∑SAR < 1.6, Not required
18	LTE Band 5 + BT (DSS)	Body	Front Face	0.42	0.15	**0.57**	∑SAR < 1.6, Not required
			Rear Face	0.77	0.15	**0.92**	∑SAR < 1.6, Not required

No.	Conditions (SAR1 + SAR2)	Exposure Condition	Test Position	Max. SAR1	Max. SAR2	SAR Summation	SPLSR Analysis
19	LTE Band 7 + WLAN (DTS)	Body	Front Face	0.64	0.52	**1.16**	∑SAR < 1.6, Not required
			Rear Face	1.03	0.03	**1.06**	∑SAR < 1.6, Not required
20	LTE Band 7 + WLAN (NII)	Body	Front Face	0.64	0.54	**1.18**	∑SAR < 1.6, Not required
			Rear Face	1.03	0.07	**1.10**	∑SAR < 1.6, Not required
21	LTE Band 7 + BT (DSS)	Body	Front Face	0.64	0.15	**0.79**	∑SAR < 1.6, Not required
			Rear Face	1.03	0.15	**1.18**	∑SAR < 1.6, Not required

No.	Conditions (SAR1 + SAR2)	Exposure Condition	Test Position	Max. SAR1	Max. SAR2	SAR Summation	SPLSR Analysis
22	LTE Band 38 + WLAN (DTS)	Body	Front Face	0.47	0.52	**0.99**	∑SAR < 1.6, Not required
			Rear Face	0.63	0.03	**0.66**	∑SAR < 1.6, Not required
23	LTE Band 38 + WLAN (NII)	Body	Front Face	0.47	0.54	**1.01**	∑SAR < 1.6, Not required
			Rear Face	0.63	0.07	**0.70**	∑SAR < 1.6, Not required
24	LTE Band 38 + BT (DSS)	Body	Front Face	0.47	0.15	**0.62**	∑SAR < 1.6, Not required
			Rear Face	0.63	0.15	**0.78**	∑SAR < 1.6, Not required

No.	Conditions (SAR1 + SAR2)	Exposure Condition	Test Position	Max. SAR1	Max. SAR2	SAR Summation	SPLSR Analysis
25	LTE Band 40 + WLAN (DTS)	Body	Front Face	0.92	0.52	**1.44**	∑SAR < 1.6, Not required
			Rear Face	0.76	0.03	**0.79**	∑SAR < 1.6, Not required
26	LTE Band 40 + WLAN (NII)	Body	Front Face	0.92	0.54	**1.46**	∑SAR < 1.6, Not required
			Rear Face	0.76	0.07	**1.46**	∑SAR < 1.6, Not required
27	LTE Band 40 + BT (DSS)	Body	Front Face	0.92	0.15	**1.07**	∑SAR < 1.6, Not required
			Rear Face	0.76	0.15	**0.91**	∑SAR < 1.6, Not required

No.	Conditions (SAR1 + SAR2)	Exposure Condition	Test Position	Max. SAR1	Max. SAR2	SAR Summation	SPLSR Analysis
28	LTE Band 41 + WLAN (DTS)	Body	Front Face	0.50	0.52	**1.02**	∑SAR < 1.6, Not required
			Rear Face	0.72	0.03	**0.75**	∑SAR < 1.6, Not required
29	LTE Band 41 + WLAN (NII)	Body	Front Face	0.50	0.54	**1.04**	∑SAR < 1.6, Not required
			Rear Face	0.72	0.07	**0.79**	∑SAR < 1.6, Not required
30	LTE Band 41 + BT (DSS)	Body	Front Face	0.50	0.15	**0.65**	∑SAR < 1.6, Not required
			Rear Face	0.72	0.15	**0.87**	∑SAR < 1.6, Not required

Test Engineer : Wiky Zhang

5. Calibration of Test Equipment

Equipment	Manufacturer	Model	SN	Cal. Date	Cal. Interval
System Validation Dipole	SATIMO	SID835	SN 18/11 DIPC 150	Jun. 08, 2017	2 Years
System Validation Dipole	SATIMO	SID1900	SN 18/11 DIPG 153	Jun. 08, 2017	2 Years
System Validation Dipole	SATIMO	SID2450	SN 18/11 DIPJ155	Jun. 08, 2017	2 Years
System Validation Dipole	SATIMO	SID2600	SN 26/14 DIP2G600-326	Jun. 08, 2017	2 Years
System Validation Dipole	SATIMO	SWG5500	SN 24/11/ WGA16	Jun. 08, 2017	2 Years
E-Field Probe	MVG	SSE2	SN 27/15 EPGO262	Jun. 07, 2018	1 Year
MultiMeter	Keithley	Multimate 2000	1331865	Jun. 21, 2018	1 Year
Radio Communication Analyzer	ANRITSU	MT8820C	6201300717	Jul. 24, 2018	1 Year
Wireless Communication Test Set	Agilent	E5515C	MY50260600	Jun. 28, 2018	1 Year
ENA Series Network Analyzer	Agilent	E5071C	MY46214638	Jul. 24, 2018	1 Year
Spectrum Analyzer	KEYSIGHT	N9010A	MY54510355	Jun. 27, 2018	1Year
MXG Analog Signal Generator	KEYSIGHT	N5183A	MY50143024	Mar. 01, 2018	1 Year
Power Meter	Agilent	N1914A	MY52180044	Aug. 12, 2018	1 Year
Power Sensor	Agilent	E9304A H18	MY52050011	Jan. 04, 2019	1 Year
Power Meter	Agilent	ML2495A	1506002	Mar. 01, 2018	1 Year
Power Sensor	Agilent	MA2411B	1339353	Mar. 01, 2018	1 Year
Temp. & Humi. Recorder	CLOCK	HTC-1	157248	Jul. 26, 2018	1 Year
Electronic Thermometer	YONGFA	YF-160A	120100323	Sep. 22, 2018	1 Year
Coupler	Woken	0110A056020-10	COM27RW1A 3	Sep. 20, 2018	1 Year

6. Measurement Uncertainty

Source of Uncertainty	Tolerance (± %)	Probability Distribution	Divisor	Ci (1g)	Ci (10g)	Standard Uncertainty (1g)	Standard Uncertainty (10g)	Vi Veff
Measurement System								
Probe Calibration	6.0	N	1	1	1	6.0	6.0	∞
Axial Isotropy	5.9	R	1.732	0.7	0.7	2.4	2.4	∞
Hemispherical Isotropy	12.2	R	1.732	0.7	0.7	4.9	4.9	∞
Boundary Effects	1.0	R	1.732	1	1	0.6	0.6	∞
Linearity	5.9	R	1.732	1	1	3.4	3.4	∞
System Detection Limits	1.0	R	1.732	1	1	0.6	0.6	∞
Readout Electronics	1.0	N	1	1	1	1.0	1.0	∞
Response Time	0.0	R	1.732	1	1	0.0	0.0	∞
Integration Time	2.6	R	1.732	1	1	1.5	1.5	∞
RF Ambient Noise	3.0	R	1.732	1	1	1.7	1.7	∞
RF Ambient Reflections	3.0	R	1.732	1	1	1.7	1.7	∞
Probe Positioner	1.4	R	1.732	1	1	0.8	0.8	∞
Probe Positioning	1.4	R	1.732	1	1	0.8	0.8	∞
Max. SAR Eval.	2.3	R	1.732	1	1	1.3	1.3	∞
Test Sample Related								
Device Positioning	2.3	N	1	1	1	2.3	2.3	35
Device Holder	2.7	N	1	1	1	2.7	2.7	12
Power Drift	5.0	R	1.732	1	1	2.9	2.9	∞
Power Scaling	0.0	R	1.732	1	1	0.0	0.0	∞
Phantom and Setup								
Phantom Uncertainty	4.0	R	1.732	1	1	2.3	2.3	∞
SAR correction	1.2	R	1.732	1	0.84	0.7	0.6	∞
Liquid Conductivity (target)	5.0	R	1.732	0.78	0.71	2.3	2.0	∞
Liquid Conductivity (mea.)	4.1	R	1.732	0.78	0.71	1.8	1.7	∞
Temp. unc. - Conductivity	3.4	R	1.732	0.78	0.71	1.5	1.4	∞
Liquid Permittivity (target)	5.0	R	1.732	0.23	0.26	0.7	0.8	∞
Liquid Permittivity (mea.)	5.0	R	1.732	0.23	0.26	0.7	0.8	∞
Temp. unc. - Permittivity	0.83	R	1.732	0.23	0.26	0.1	0.1	∞
Combined Standard Uncertainty (K = 1)						± 11.4 %	± 11.3 %	2923
Expanded Uncertainty (K = 2)						**± 22.7 %**	**± 22.6 %**	

7. Information on the Testing Laboratories

We, BV 7LAYERS COMMUNICATIONS TECHNOLOGY (SHENZHEN) CO. LTD., were founded in 2015 to provide our best service in EMC, Radio, Telecom and Safety consultation. Our laboratories are accredited and approved according to ISO/IEC 17025.

If you have any comments, please feel free to contact us at the following:

Add: No. B102, Dazu Chuangxin Mansion, North of Beihuan Avenue, North Area, Hi-Tech Industry Park, Nanshan District, Shenzhen, Guangdong, China
Tel: 86-755-8869-6566
Fax: 86-755-8869-6577

Email: customerservice.dg@cn.bureauveritas.com
Web Site: www.bureauveritas.com

The road map of all our labs can be found in our web site also.

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Appendix A. SAR Plots of System Verification

The plots for system verification with largest deviation for each SAR system combination are shown as follows.

System Verification Plots

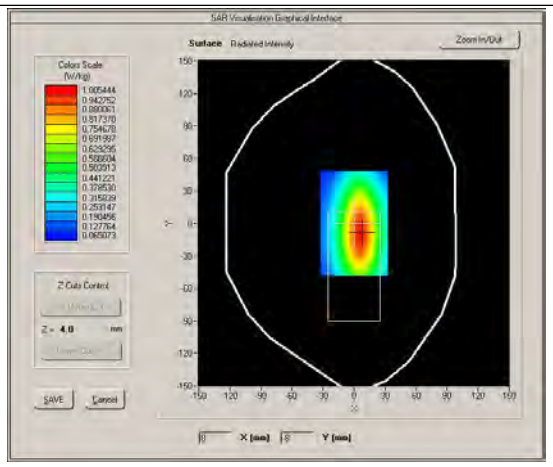
Product Description: Dipole

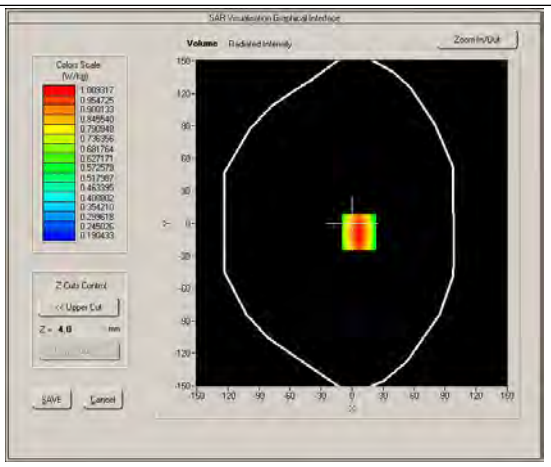
Model: SID835

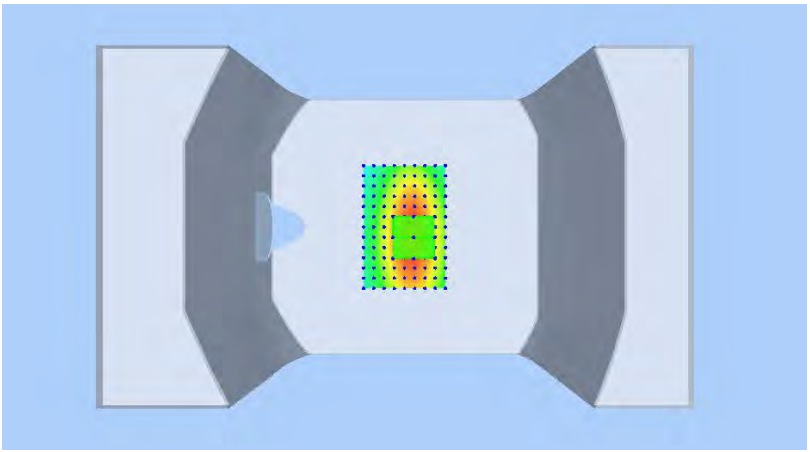
Test Date: Jan 14, 2019

Ambient Temperature：22.4℃; Liquid Temperature：21.3℃

Medium(liquid type)	BL835
Frequency (MHz)	835.000000
Relative permittivity (real part)	56.30
Conductivity (S/m)	0.98
Input power	100mW
E-Field Probe	SN 27/15 EPGO262
Crest factor	1.0
Conversion Factor	1.86
Sensor-surface	4mm
Area Scan	dx=8mm dy=8mm
Zoom Scan	5x5x7,dx=8mm dy=8mm dz=5mm
Variation (%)	-1.200000
SAR 10g (W/Kg)	0.641343
SAR 1g (W/Kg)	0.971214







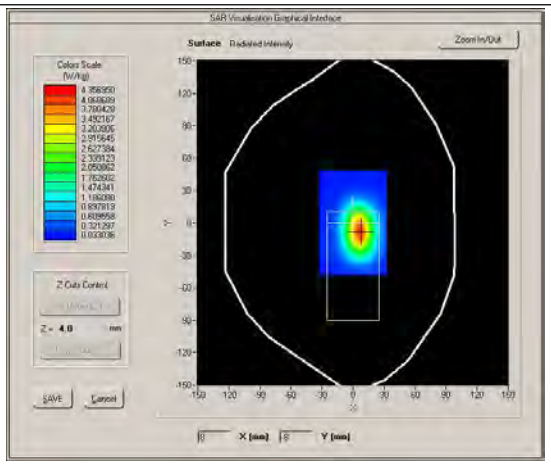
Product Description: Dipole

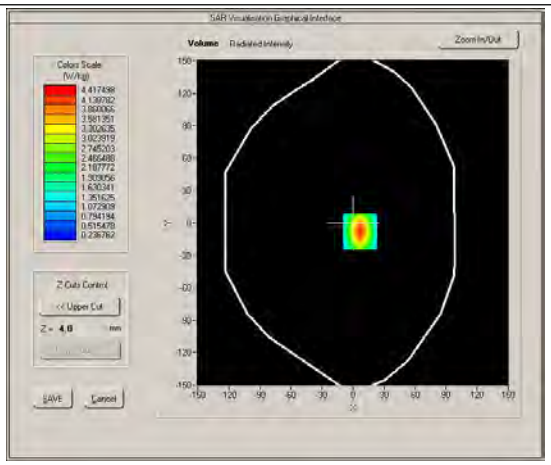
Model: SID1900

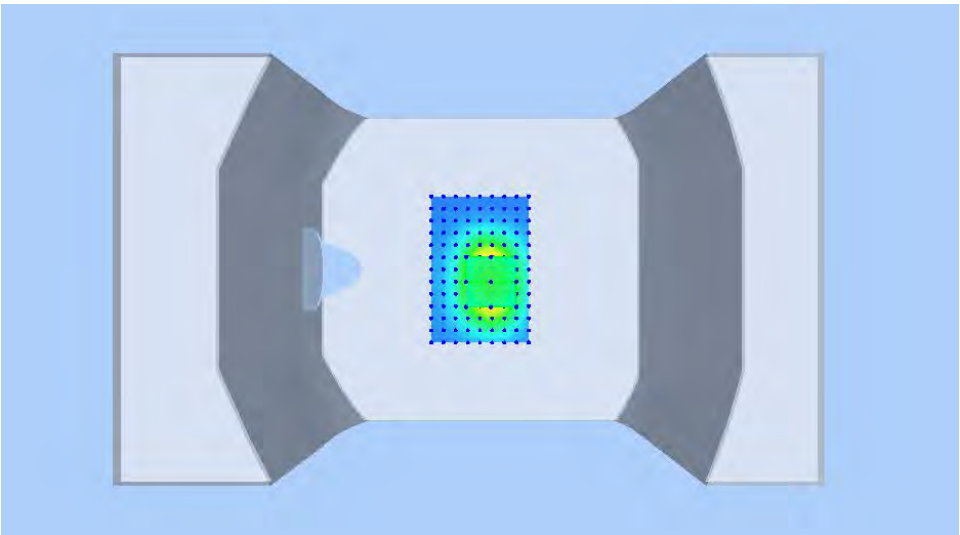
Test Date: Jan 15, 2019

Ambient Temperature：22.2℃; Liquid Temperature：21.1℃

Medium(liquid type)	BL1900
Frequency (MHz)	1900.000
Relative permittivity (real part)	55.12
Conductivity (S/m)	1.54
Input power	100mW
E-Field Probe	SN 27/15 EPGO262
Crest factor	1.0
Conversion Factor	2.20
Sensor-Surface	4mm
Area Scan	dx=8mm dy=8mm
Zoom Scan	5x5x7,dx=8mm dy=8mm dz=5mm
Variation (%)	-1.340000
SAR 10g (W/Kg)	2.143671
SAR 1g (W/Kg)	4.133416







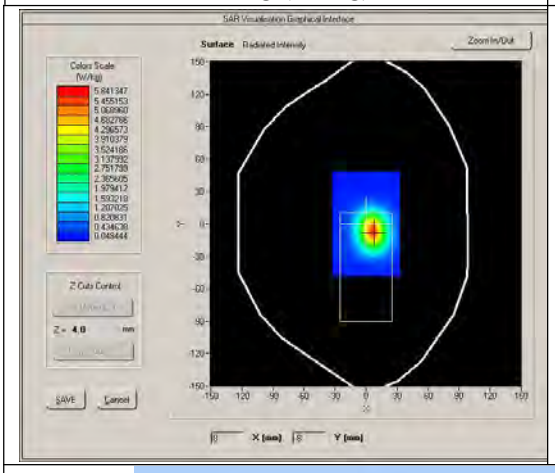
Product Description: Dipole

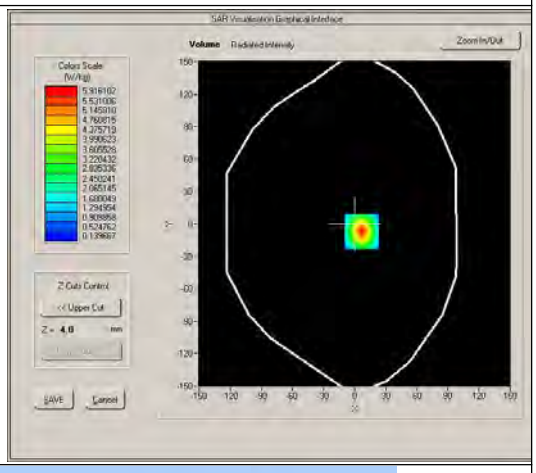
Model: SID2450

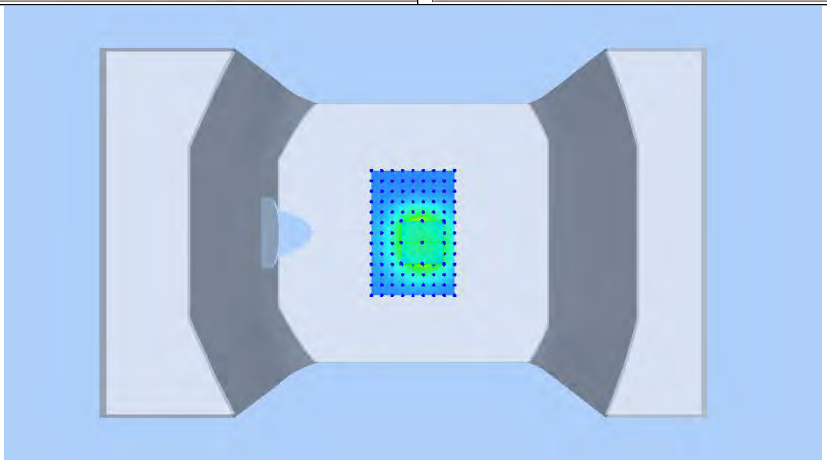
Test Date: Jan 16, 2019

Ambient Temperature：22.4℃; Liquid Temperature：21.2℃

Medium(liquid type)	BL_2450
Frequency (MHz)	2450
Relative permittivity (real part)	54.22
Conductivity (S/m)	1.92
Input power	100mW
Crest factor	1.0
E-Field Probe	SN 27/15 EPGO262
Conversion Factor	2.31
Area Scan	dx=8mm dy=8mm
Zoom Scan	5x5x7,dx=5mm dy=5mm dz=5mm
Variation (%)	-1.330000
SAR 10g (W/Kg)	2.402541
SAR 1g (W/Kg)	5.124504







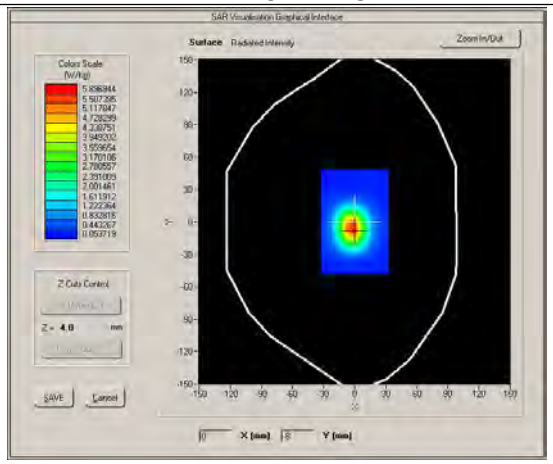
Product Description: Dipole

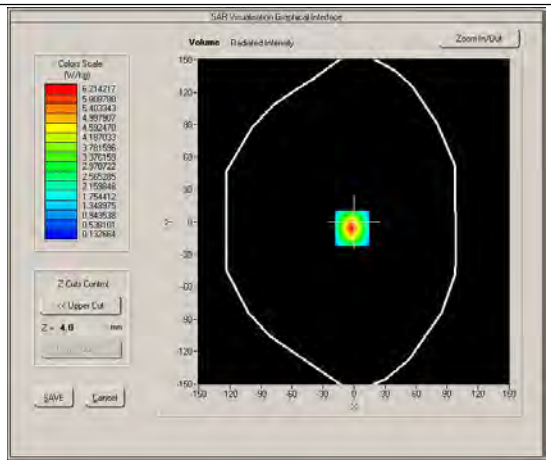
Model: SID2600

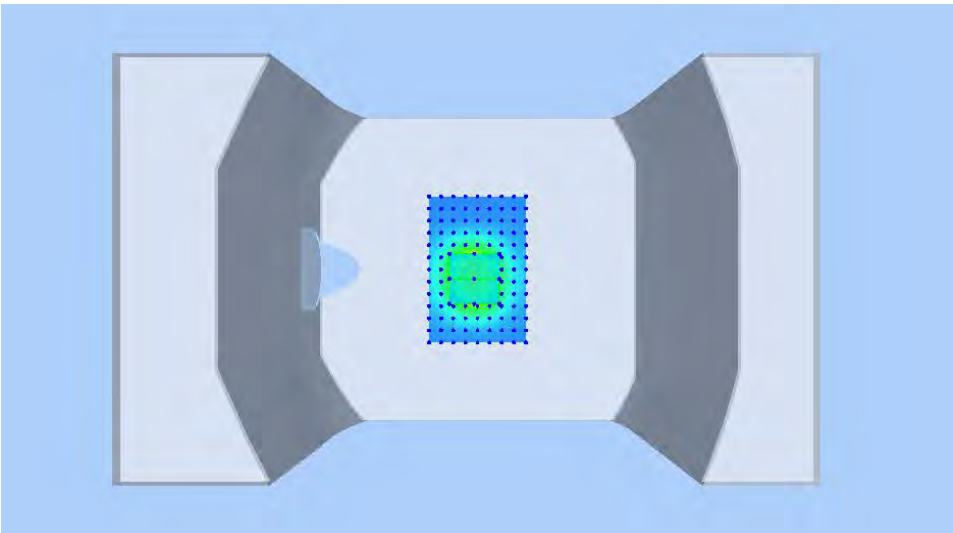
Test Date: Jan 17, 2019

Ambient Temperature：22.3℃; Liquid Temperature：21.0℃

Medium(liquid type)	BL_2600
Frequency (MHz)	2600.000
Relative permittivity (real part)	54.13
Conductivity (S/m)	2.11
Input power	100mW
E-Field Probe	SN 27/15 EPGO262
Crest factor	1.0
Conversion Factor	2.21
Sensor-Surface	4mm
Area Scan	dx=8mm dy=8mm
Zoom Scan	7x7x7,dx=5mm dy=5mm dz=5mm
Variation (%)	-1.320000
SAR 10g (W/Kg)	2.525772
SAR 1g (W/Kg)	5.621318







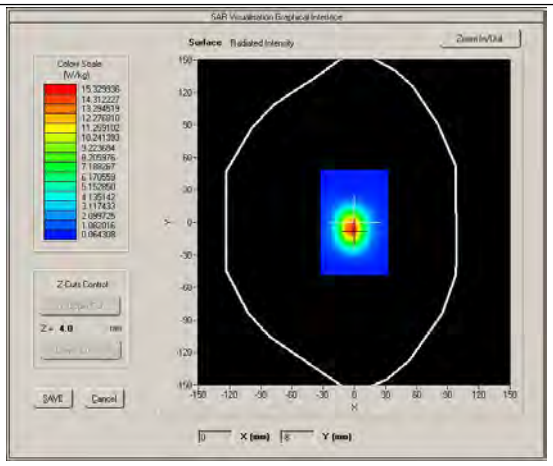
Product Description: Dipole

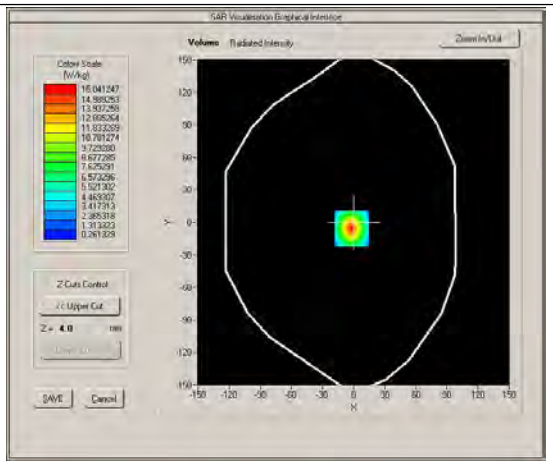
Model: SWG5500

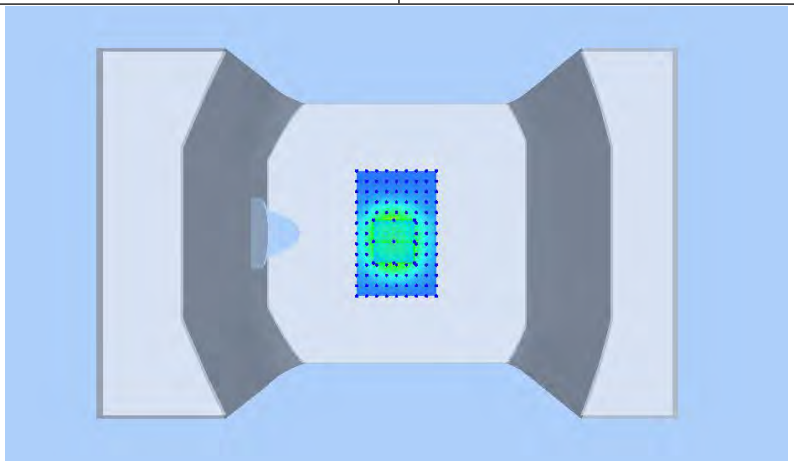
Test Date: Jan 21, 2019

Ambient Temperature：22.6℃; Liquid Temperature：21.6℃

Medium(liquid type)	BL5200
Frequency (MHz)	5200.000
Relative permittivity (real part)	48.61
Conductivity (S/m)	5.61
Input power	100mW
Crest factor	1.0
E-Field Probe	SN 27/15 EPGO262
Conversion Factor	1.76
Area Scan	dx=8mm dy=8mm
Zoom Scan	5x5x11,dx=4mm dy=4mm dz=2mm
Variation (%)	1.340000
SAR 10g (W/Kg)	5.587633
SAR 1g (W/Kg)	14.527114







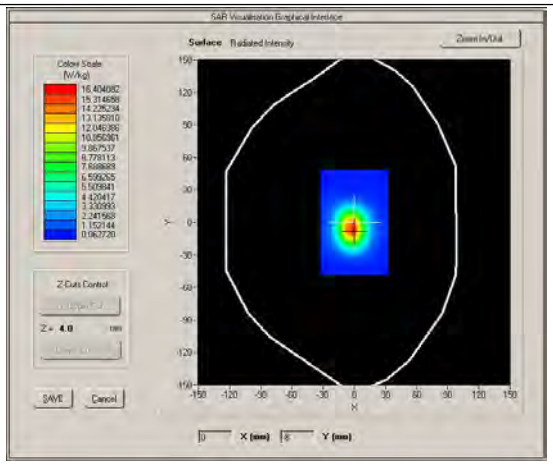
Product Description: Dipole

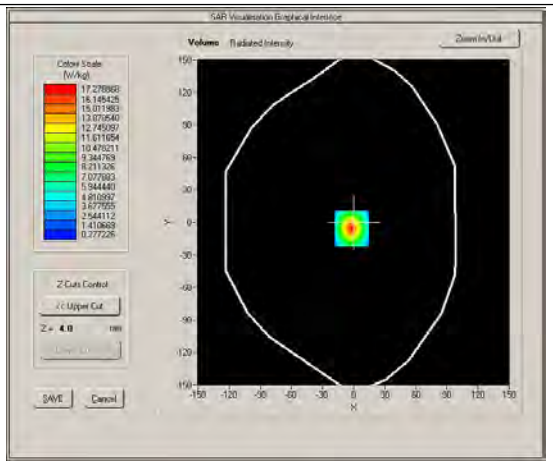
Model: SWG5500

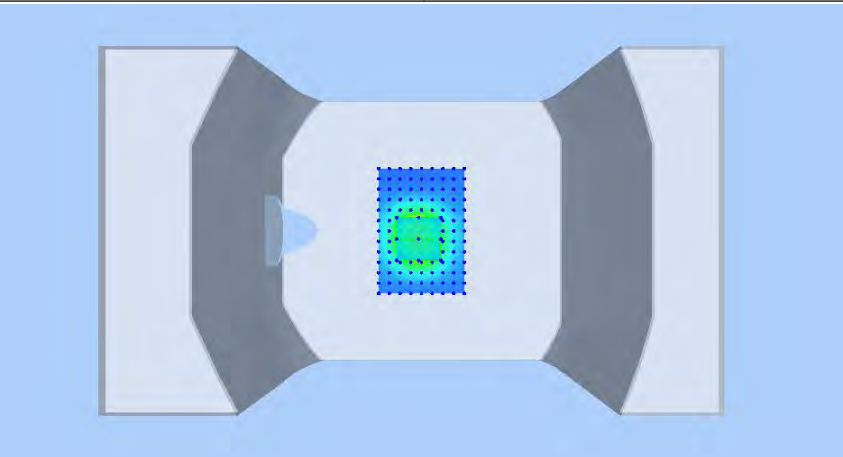
Test Date: Jan 22, 2019

Ambient Temperature：22.4℃; Liquid Temperature：21.4℃

Medium(liquid type)	BL5600
Frequency (MHz)	5600.000
Relative permittivity (real part)	46.93
Conductivity (S/m)	5.66
Input power	100mW
Crest factor	1.0
E-Field Probe	SN 27/15 EPGO262
Conversion Factor	1.75
Area Scan	dx=8mm dy=8mm
Zoom Scan	5x5x11,dx=4mm dy=4mm dz=2mm
Variation (%)	1.270000
SAR 10g (W/Kg)	8.143672
SAR 1g (W/Kg)	17.167216







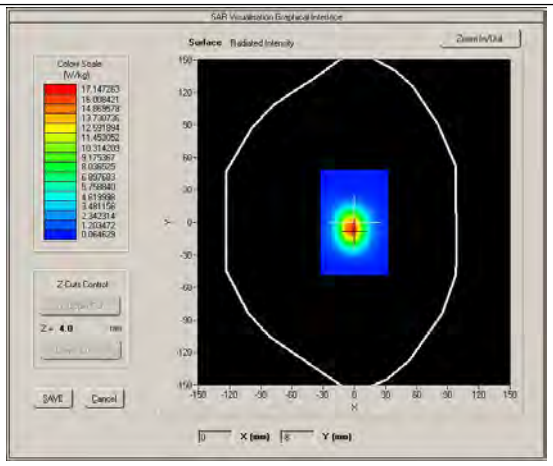
Product Description: Dipole

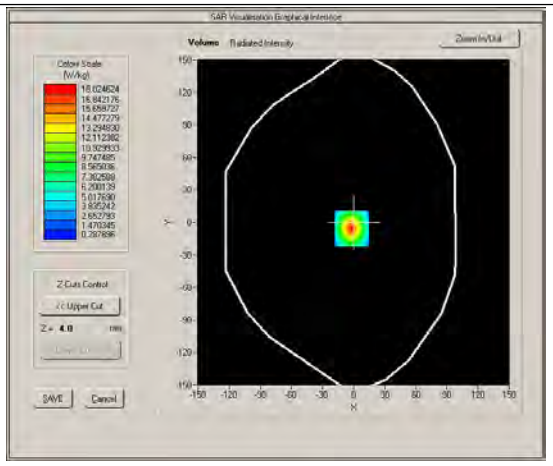
Model: SWG5500

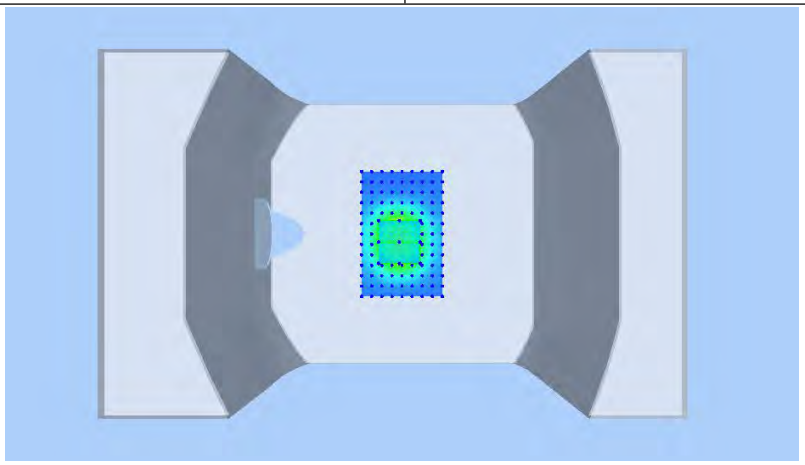
Test Date: Jan 23, 2019

Ambient Temperature：22.7℃; Liquid Temperature：21.2℃

Medium(liquid type)	BL5800
Frequency (MHz)	5800.000
Relative permittivity (real part)	47.64
Conductivity (S/m)	6.17
Input power	100mW
Crest factor	1.0
E-Field Probe	SN 27/15 EPGO262
Conversion Factor	1.74
Area Scan	dx=8mm dy=8mm
Zoom Scan	5x5x11,dx=4mm dy=4mm dz=2mm
Variation (%)	1.060000
SAR 10g (W/Kg)	7.415654
SAR 1g (W/Kg)	17.341164







Appendix B. SAR Plots of SAR Measurement

The SAR plots for highest measured SAR in each exposure configuration, wireless mode and frequency band combination, and measured SAR > 1.5 W/kg are shown as follows.

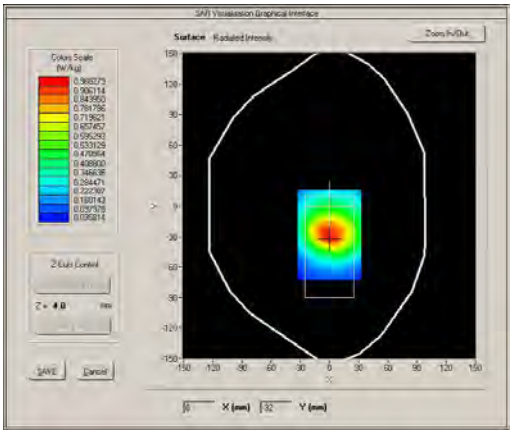
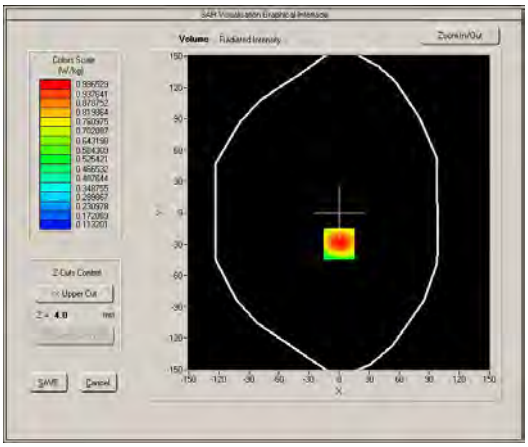
Maximum SAR measurement Plots

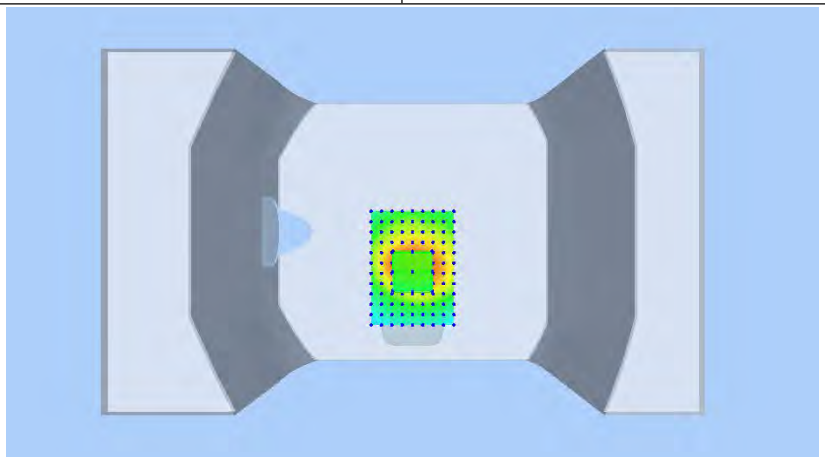
1# GSM850_GPRS12_Rear Face_0cm_Ch251

DUT:181217W003

Test Date: Jan 14, 2019

Ambient Temperature：22.4℃; Liquid Temperature：21.3℃

Medium(liquid type)	BL835
Frequency (MHz)	848.8
Relative permittivity (real part)	56.30
Conductivity (S/m)	0.98
E-Field Probe	SN 27/15 EPGO262
Crest factor	2.0
Conversion Factor	1.86
Sensor-Surface	4mm
Area Scan	dx=8mm dy=8mm
Zoom Scan	5x5x7,dx=8mm dy=8mm dz=5mm
Variation (%)	-3.380000
SAR 10g (W/Kg)	0.601425
SAR 1g (W/Kg)	0.988044
SURFACE SAR	**VOLUME SAR**
	

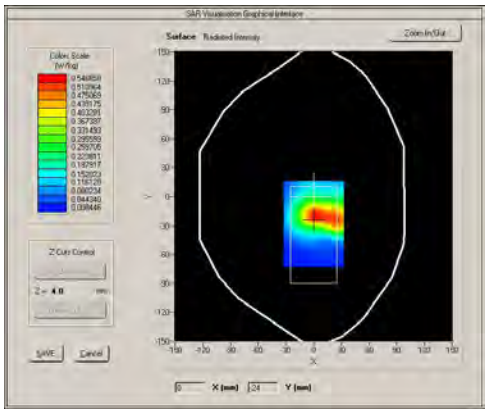
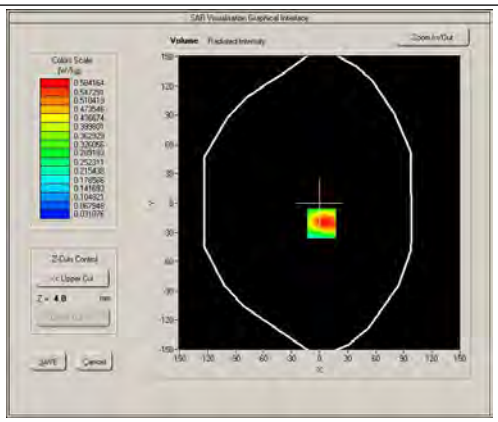
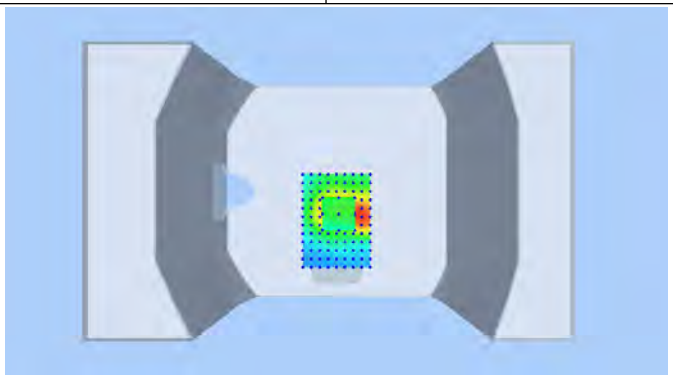


2# GSM1900_GPRS12_Front Face_0cm_Ch661

DUT:181217W003

Test Date: Jan 15, 2019

Ambient Temperature：22.2℃; Liquid Temperature：21.1℃

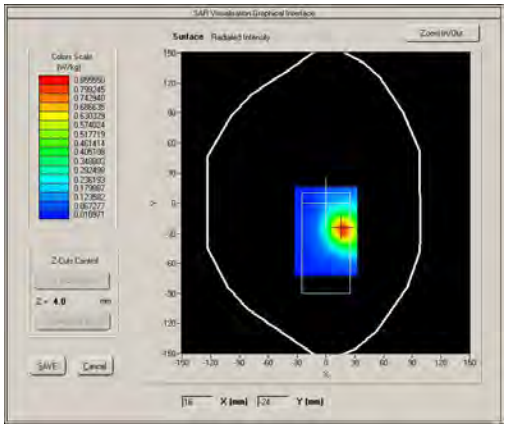
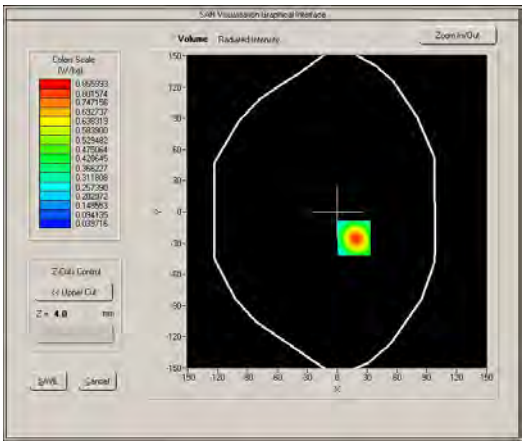
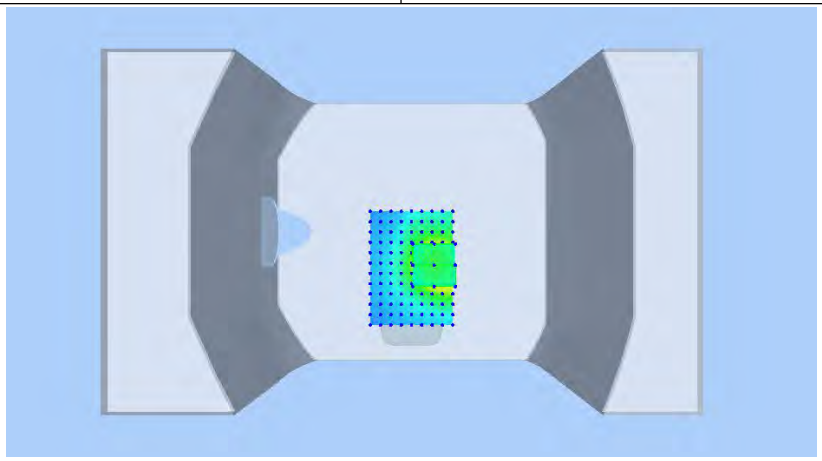
Medium(liquid type)	BL1900
Frequency (MHz)	1880.0
Relative permittivity (real part)	55.12
Conductivity (S/m)	1.54
E-Field Probe	SN 27/15 EPGO262
Crest factor	2.0
Conversion Factor	2.20
Sensor-Surface	4mm
Area Scan	dx=8mm dy=8mm
Zoom Scan	5x5x7,dx=8mm dy=8mm dz=5mm
Variation (%)	-0.4900000
SAR 10g (W/Kg)	0.272123
SAR 1g (W/Kg)	0.511373
SURFACE SAR	**VOLUME SAR**
	
	

3# WCDMA Band Ⅱ_RMC12.2K_Front Face_0cm_Ch9400

DUT:181217W003

Test Date: Jan 15, 2019

Ambient Temperature：22.2℃; Liquid Temperature：21.1℃

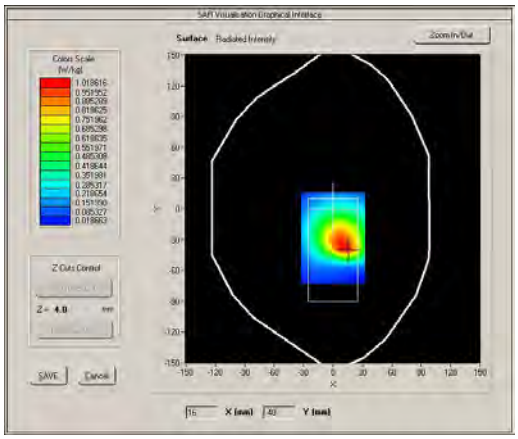
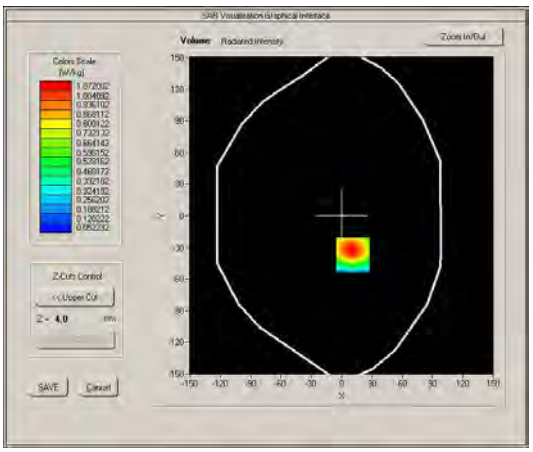
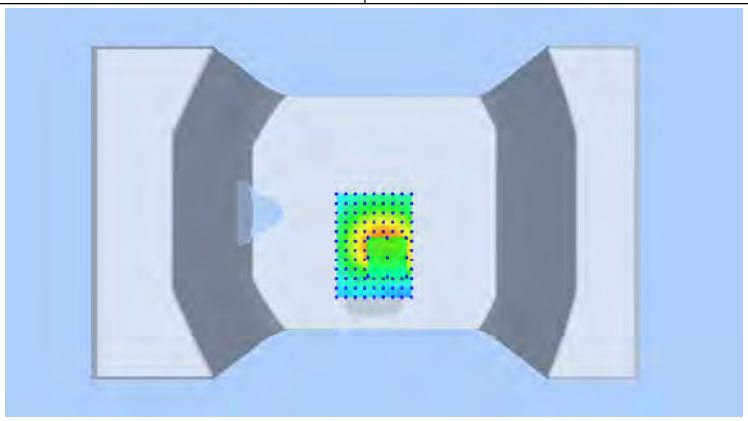
Medium(liquid type)	BL1900
Frequency (MHz)	1880.0
Relative permittivity (real part)	55.12
Conductivity (S/m)	1.54
E-Field Probe	SN 27/15 EPGO262
Crest factor	1.0
Conversion Factor	2.20
Sensor-Surface	4mm
Area Scan	dx=8mm dy=8mm
Zoom Scan	5x5x7,dx=8mm dy=8mm dz=5mm
Variation (%)	-4.160000
SAR 10g (W/Kg)	0.392374
SAR 1g (W/Kg)	0.735357
SURFACE SAR	**VOLUME SAR**
	
	

4# WCDMA Band Ⅴ_RMC12.2K_Rear Face_0cm_Ch4233

DUT:181217W003

Test Date: Jan 14, 2019

Ambient Temperature：22.4℃; Liquid Temperature：21.3℃

Medium(liquid type)	BL835
Frequency (MHz)	846.6
Relative permittivity (real part)	56.30
Conductivity (S/m)	0.98
E-Field Probe	SN 27/15 EPGO262
Crest factor	1.0
Conversion Factor	1.86
Sensor-Surface	4mm
Area Scan	dx=8mm dy=8mm
Zoom Scan	5x5x7,dx=8mm dy=8mm dz=5mm
Variation (%)	-0.550000
SAR 10g (W/Kg)	0.630532
SAR 1g (W/Kg)	1.046670
SURFACE SAR	**VOLUME SAR**
	
	

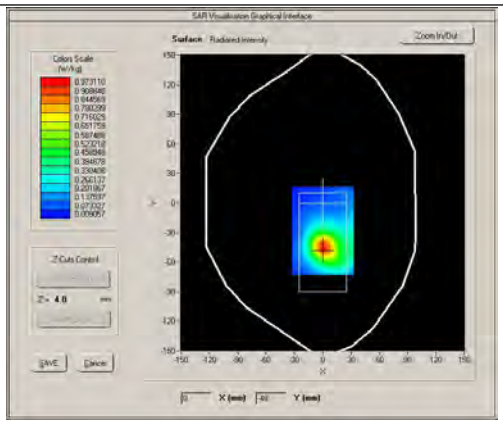
5# LTE BAND 2_QPSK20M_ Front Face_0cm_Ch18900_1RB_OS0

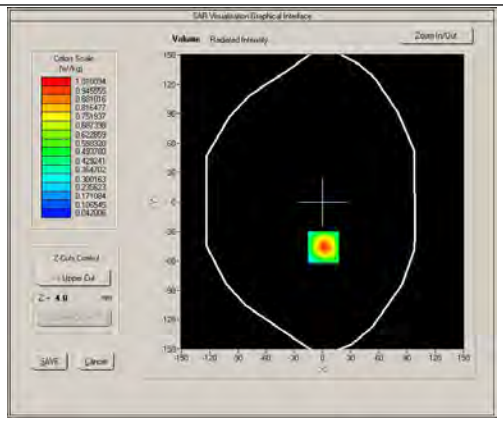
DUT:181217W003

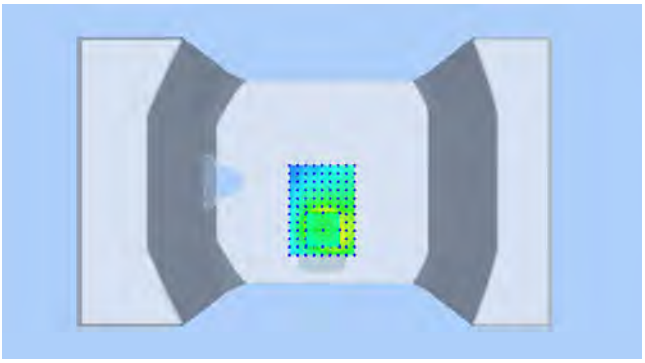
Test Date: Jan 15, 2019

Ambient Temperature：22.2℃; Liquid Temperature：21.1℃

Medium(liquid type)	BL_1900
Frequency (MHz)	1880.0000
Relative permittivity (real part)	55.12
Conductivity (S/m)	1.54
E-Field Probe	SN 27/15 EPGO262
Crest factor	1.0
Conversion Factor	2.2
Sensor-Surface	4mm
Bandwidth(MHz)	20
RB Allocation	1
RB Offset	0
Area Scan	dx=8mm dy=8mm
Zoom Scan	5x5x7,dx=8mm dy=8mm dz=5mm
Variation (%)	-0.900000
SAR 10g (W/Kg)	0.521293
SAR 1g (W/Kg)	0.951308
SURFACE SAR	**VOLUME SAR**





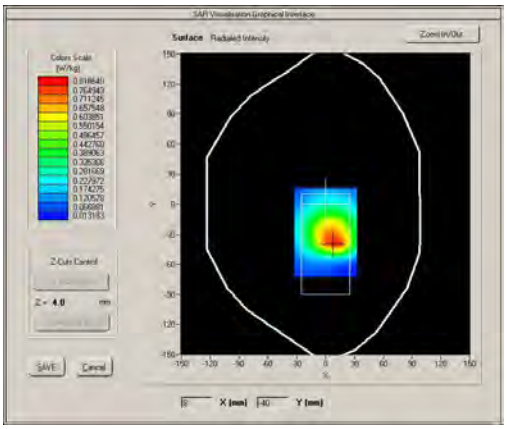
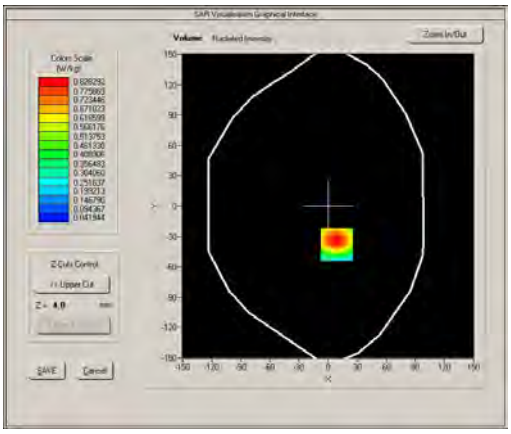
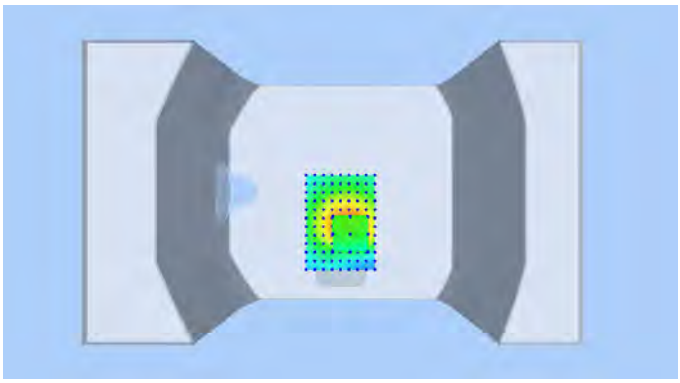


6# LTE BAND 5_QPSK10M_ Rear Face_0cm_Ch20525_1RB_OS0

DUT:181217W003

Test Date: Jan 14, 2019

Ambient Temperature：22.4℃; Liquid Temperature：21.3℃

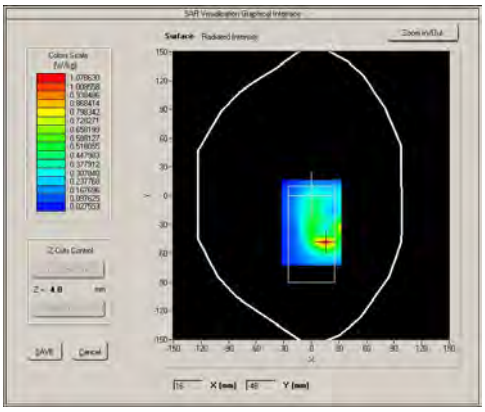
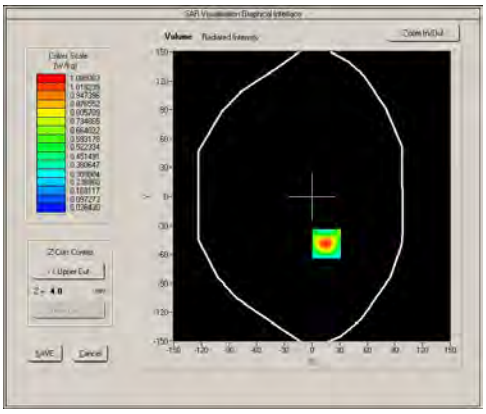
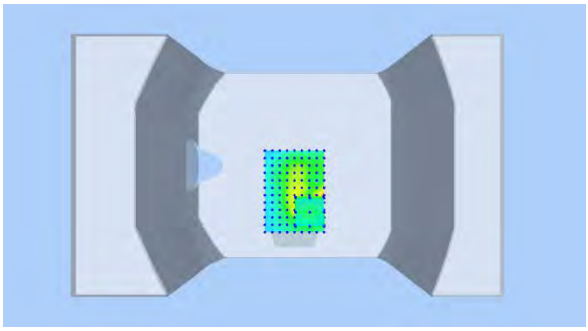
Medium(liquid type)	BL_835
Frequency (MHz)	836.5000
Relative permittivity (real part)	56.30
Conductivity (S/m)	0.98
E-Field Probe	SN 27/15 EPGO262
Crest factor	1.0
Conversion Factor	1.86
Sensor-Surface	4mm
Bandwidth(MHz)	10
RB Allocation	1
RB Offset	0
Area Scan	dx=8mm dy=8mm
Zoom Scan	5x5x7,dx=8mm dy=8mm dz=5mm
Variation (%)	-1.490000
SAR 10g (W/Kg)	0.492503
SAR 1g (W/Kg)	0.713396
SURFACE SAR	**VOLUME SAR**
	
	

7# LTE BAND 7_QPSK20M_ Rear Face_0cm_Ch21100_1RB_OS0

DUT:181217W003

Test Date: Jan 17, 2019

Ambient Temperature：22.3℃; Liquid Temperature：21.0℃

Medium(liquid type)	BL_2600
Frequency (MHz)	2535.0000
Relative permittivity (real part)	54.13
Conductivity (S/m)	2.11
E-Field Probe	SN 27/15 EPGO262
Crest factor	1.0
Conversion Factor	2.21
Sensor-Surface	4mm
Bandwidth(MHz)	20
RB Allocation	1
RB Offset	0
Area Scan	dx=8mm dy=8mm
Zoom Scan	5x5x7,dx=8mm dy=8mm dz=5mm
Variation (%)	0.980000
SAR 10g (W/Kg)	0.464945
SAR 1g (W/Kg)	0.967603
SURFACE SAR	**VOLUME SAR**
	
	

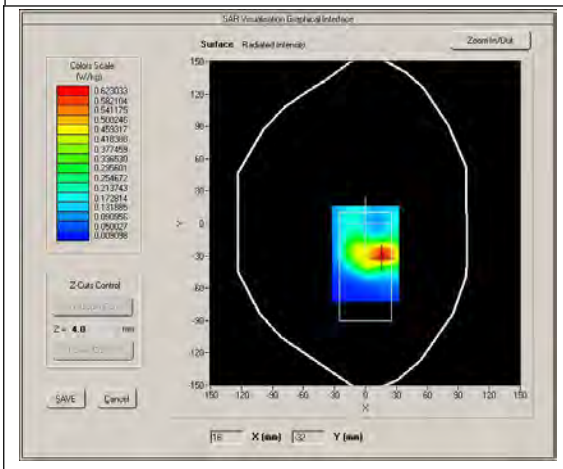
8# LTE BAND 38_QPSK20M_ Rear Face_0cm_Ch38000_1RB_OS0

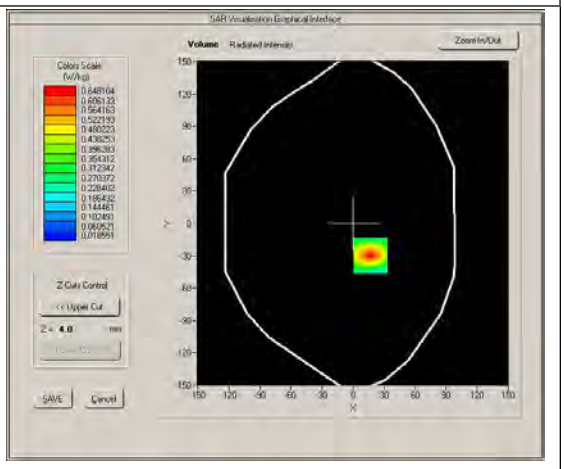
DUT:181217W003

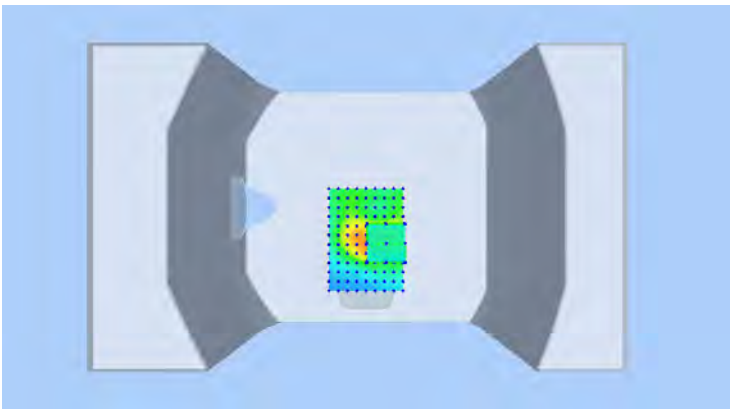
Test Date: Jan 17, 2019

Ambient Temperature：22.3℃; Liquid Temperature：21.0℃

Medium(liquid type)	BL_2600
Frequency (MHz)	2595.0000
Relative permittivity (real part)	54.13
Conductivity (S/m)	2.11
E-Field Probe	SN 27/15 EPGO262
Crest factor	1.0
Conversion Factor	2.21
Sensor-Surface	4mm
Bandwidth(MHz)	20
RB Allocation	1
RB Offset	0
Area Scan	dx=8mm dy=8mm
Zoom Scan	5x5x7,dx=8mm dy=8mm dz=5mm
Variation (%)	1.380000
SAR 10g (W/Kg)	0.295154
SAR 1g (W/Kg)	0.601425
SURFACE SAR	**VOLUME SAR**







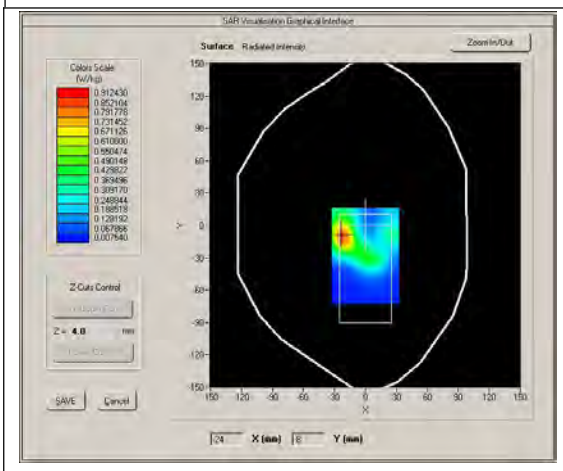
9# LTE BAND 40_QPSK20M_ Front Face_0cm_Ch38750_1RB_OS0

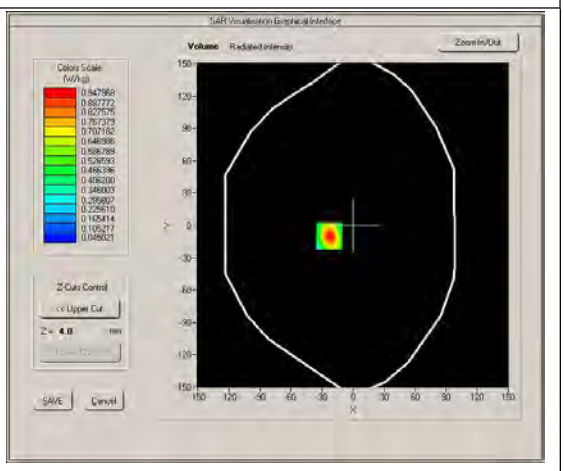
DUT:181217W003

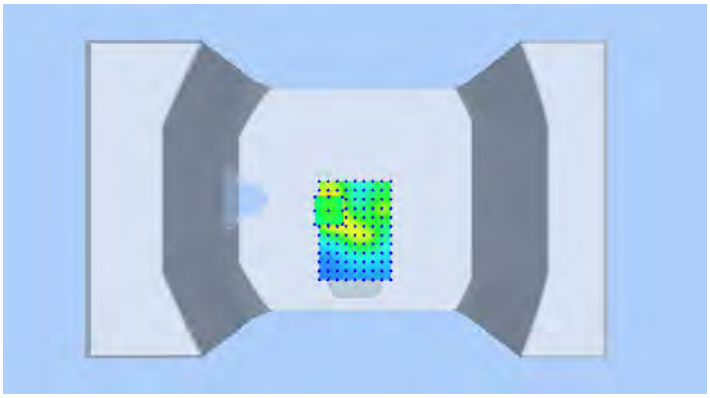
Test Date: Jan 16, 2019

Ambient Temperature：22.4℃; Liquid Temperature：21.2℃

Medium(liquid type)	BL_2450
Frequency (MHz)	2310.0000
Relative permittivity (real part)	54.22
Conductivity (S/m)	1.92
E-Field Probe	SN 27/15 EPGO262
Crest factor	1.0
Conversion Factor	2.31
Sensor-Surface	4mm
Bandwidth(MHz)	20
RB Allocation	1
RB Offset	0
Area Scan	dx=8mm dy=8mm
Zoom Scan	5x5x7,dx=8mm dy=8mm dz=5mm
Variation (%)	0.370000
SAR 10g (W/Kg)	0.433245
SAR 1g (W/Kg)	0.858303
SURFACE SAR	**VOLUME SAR**







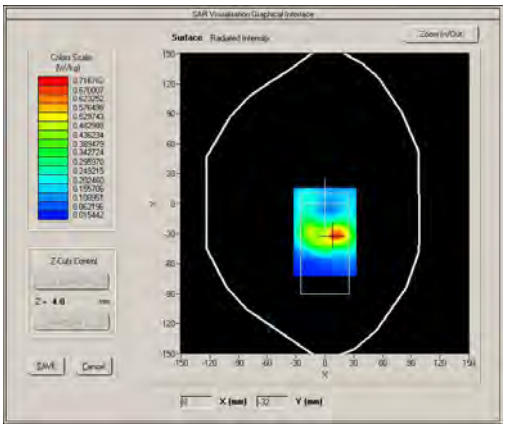
10# LTE BAND 41_QPSK20M_ Rear Face_0cm_Ch40600_1RB_OS0

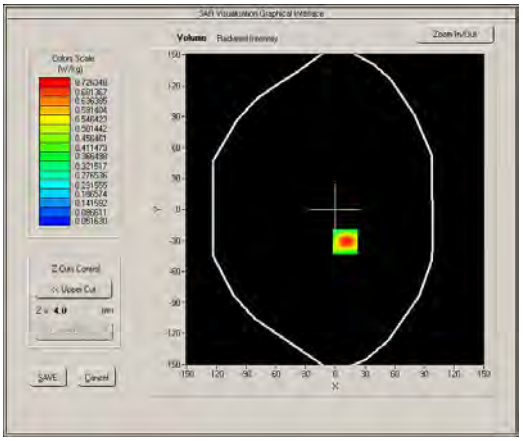
DUT:181217W003

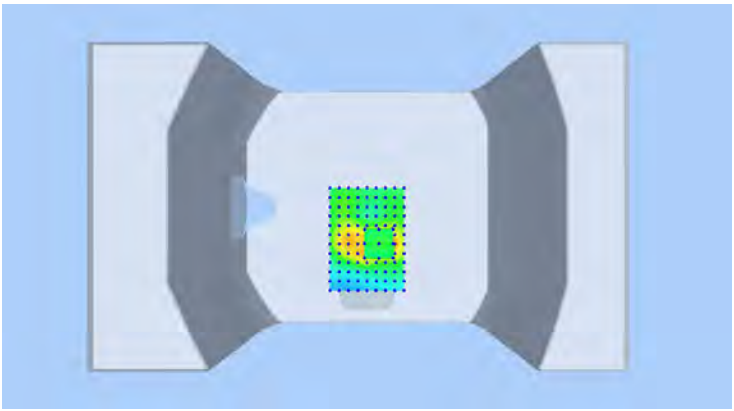
Test Date: Jan 17, 2019

Ambient Temperature：22.3℃; Liquid Temperature：21.0℃

Medium(liquid type)	BL_2600
Frequency (MHz)	2591.0000
Relative permittivity (real part)	54.13
Conductivity (S/m)	2.11
E-Field Probe	SN 27/15 EPGO262
Crest factor	1.0
Conversion Factor	2.21
Sensor-Surface	4mm
Bandwidth(MHz)	20
RB Allocation	1
RB Offset	0
Area Scan	dx=8mm dy=8mm
Zoom Scan	5x5x7,dx=8mm dy=8mm dz=5mm
Variation (%)	1.050000
SAR 10g (W/Kg)	0.323215
SAR 1g (W/Kg)	0.660125
SURFACE SAR	**VOLUME SAR**







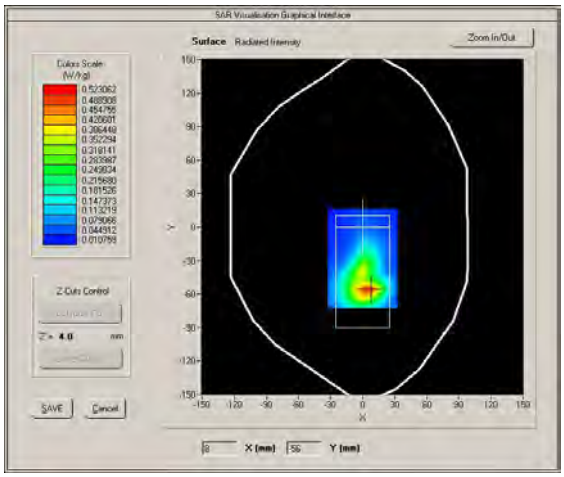
11# 802.11b_Front Face_0cm_Ch 11

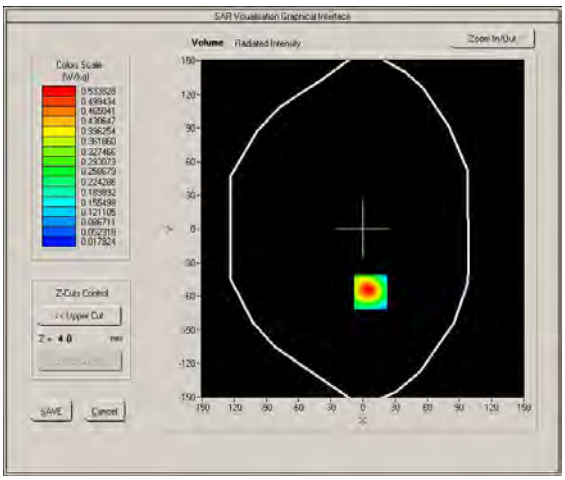
DUT:181217W003

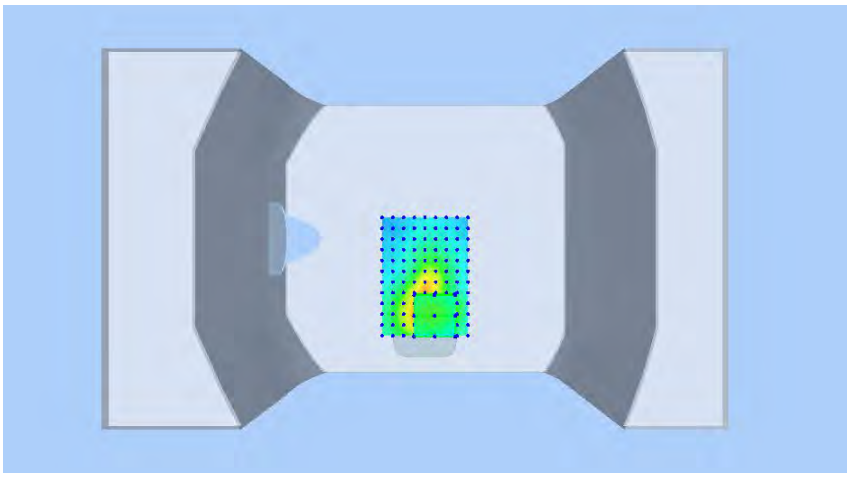
Test Date: Jan 16, 2019

Ambient Temperature：22.4℃; Liquid Temperature：21.2℃

Medium(liquid type)	BL_2450
Frequency (MHz)	2462
Relative permittivity (real part)	54.22
Conductivity (S/m)	1.92
Crest factor	1.0
E-Field Probe	SN 27/15 EPGO262
Conversion Factor	2.31
Area Scan	dx=8mm dy=8mm
Zoom Scan	5x5x7,dx=5mm dy=5mm dz=5mm
Variation (%)	2.500000
SAR 10g (W/Kg)	0.254177
SAR 1g (W/Kg)	0.492785







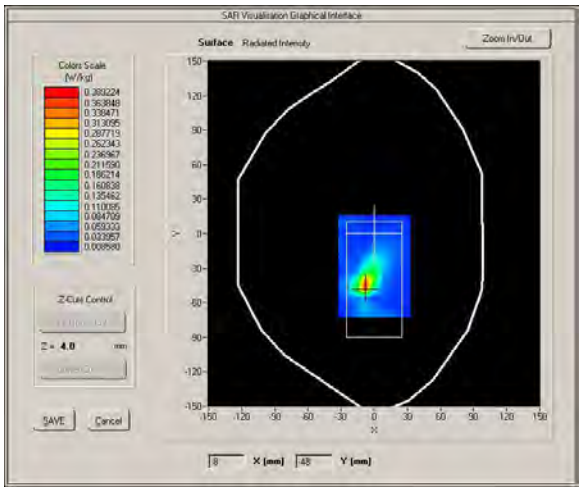
12# 802.11a_Rear Face_0cm_Ch 52

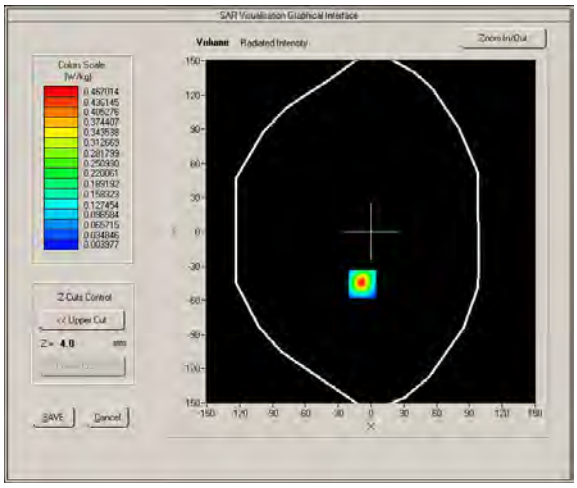
DUT:181217W003

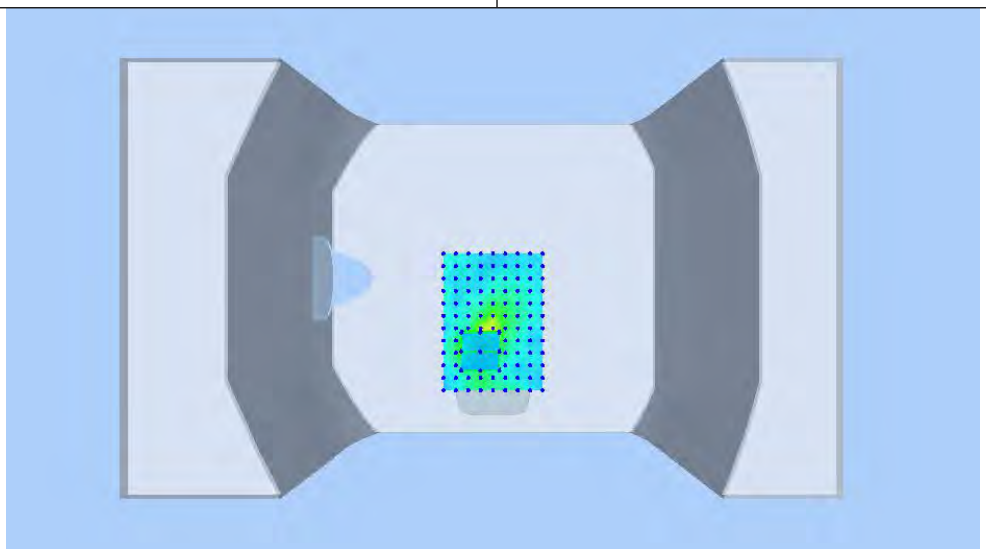
Test Date: Jan 21, 2019

Ambient Temperature：22.6℃; Liquid Temperature：21.6℃

Medium(liquid type)	BL_5200
Frequency (MHz)	5260.000
Relative permittivity (real part)	48.61
Conductivity (S/m)	5.61
Crest factor	1.0
E-Field Probe	SN 27/15 EPGO262
Conversion Factor	1.76
Area Scan	dx=8mm dy=8mm
Zoom Scan	5x5x11,dx=4mm dy=4mm dz=2mm
Variation (%)	0.160000
SAR 10g (W/Kg)	0.130271
SAR 1g (W/Kg)	0.395243







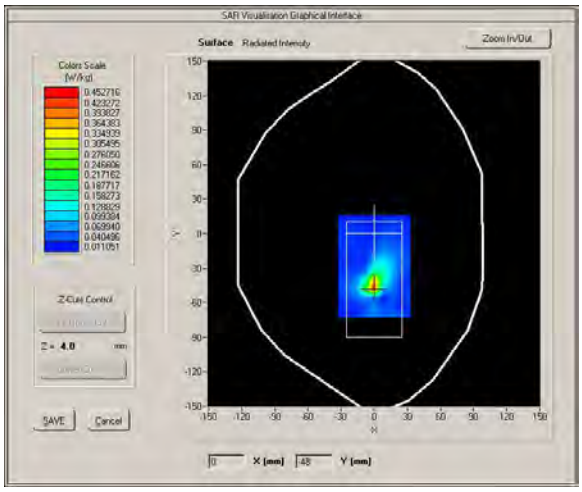
13# 802.11a_Rear Face_Ch 140

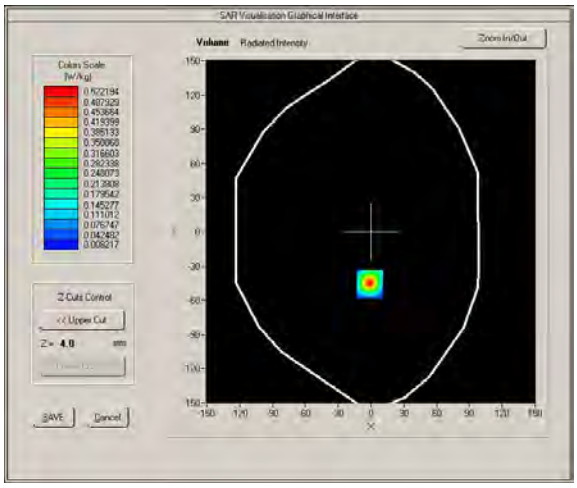
DUT:181217W003

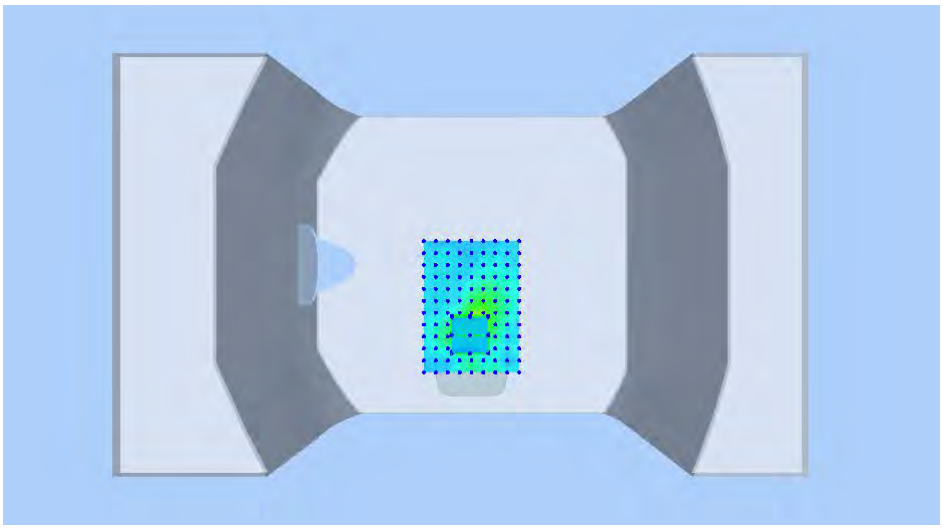
Test Date: Jan 22, 2019

Ambient Temperature：22.4℃; Liquid Temperature：21.4℃

Medium(liquid type)	BL_5600
Frequency (MHz)	5700.000
Relative permittivity (real part)	46.93
Conductivity (S/m)	5.66
Crest factor	1.0
E-Field Probe	SN 27/15 EPGO262
Conversion Factor	1.75
Area Scan	dx=8mm dy=8mm
Zoom Scan	5x5x11,dx=4mm dy=4mm dz=2mm
Variation (%)	2.570000
SAR 10g (W/Kg)	0.163329
SAR 1g (W/Kg)	0.502419







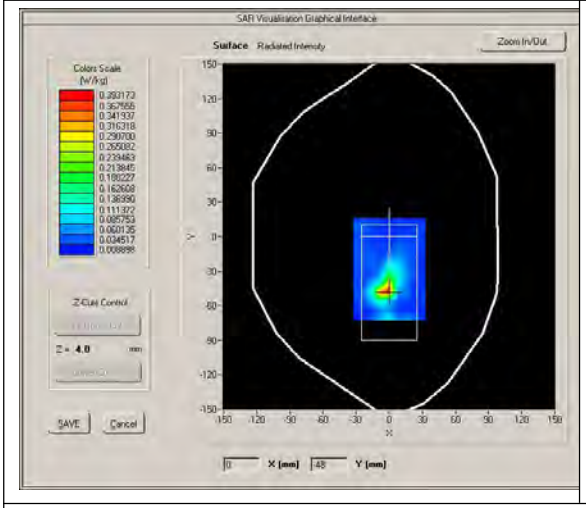
14# 802.11a_Rear Face_0cm_Ch 157

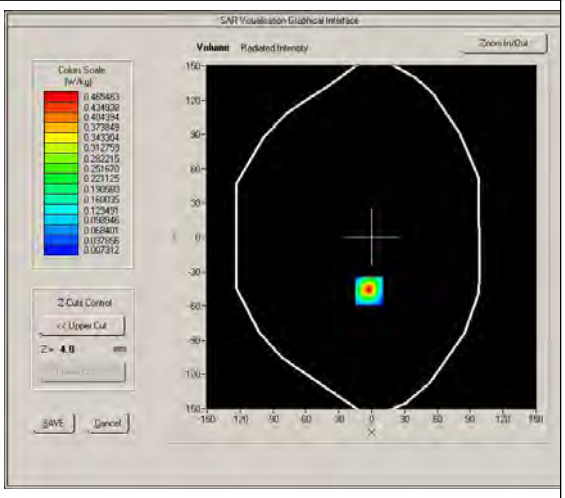
DUT:181217W003

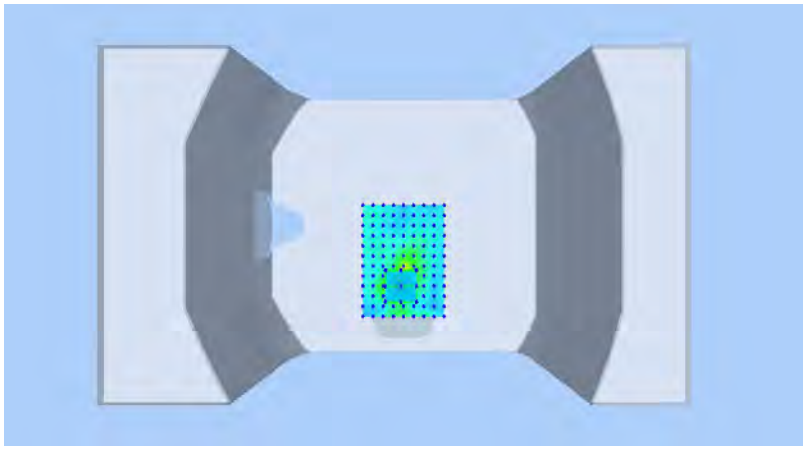
Test Date: Jan 23, 2019

Ambient Temperature：22.7℃; Liquid Temperature：21.2℃

Medium(liquid type)	BL_5800
Frequency (MHz)	5785.000
Relative permittivity (real part)	47.64
Conductivity (S/m)	6.17
Crest factor	1.0
E-Field Probe	SN 27/15 EPGO262
Conversion Factor	1.74
Area Scan	dx=8mm dy=8mm
Zoom Scan	5x5x11,dx=4mm dy=4mm dz=2mm
Variation (%)	1.370000
SAR 10g (W/Kg)	0.142611
SAR 1g (W/Kg)	0.478209







Appendix C. Calibration Certificate for Probe and Dipole

The MVG calibration certificates are shown as follows.

Appendix C CALIBRATION REPORTS

COMOSAR E-Field Probe Calibration Report

Ref : ACR.158.1.18.SATU.A

BV 7LAYERS COMMUNICATIONS TECHNOLOGY (SHENZHEN) CO. LTD

NO.B102, DAZU CHUANGXIN MANSION,NORTH OF BEIHUAN AVENUE,NORTH AREA,

HI-TECH INDUSTRIAL PARK,NANSHAN DISTRICT,SHENZHEN, CHINA

MVG COMOSAR DOSIMETRIC E-FIELD PROBE

SERIAL NO.: SN 27/15 EPGO262

Calibrated at MVG US

2105 Barrett Park Dr. - Kennesaw, GA 30144

Calibration Date: 06/07/2018

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	6/7/2018	JS
Checked by :	Jérôme LUC	Product Manager	6/7/2018	JS
Approved by :	Kim RUTKOWSKI	Quality Manager	6/7/2018	Kim Rutkowski

	Customer Name
Distribution :	BV 7Layers Communications Technology (Shenzhen) Co. Ltd

Issue	*Date*	*Modifications*
A	6/7/2018	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 27/15 EPGO262
Product Condition (new / used)	Used
Frequency Range of Probe	0.7 GHz-6GHz
Resistance of Three Dipoles at Connector	Dipole 1: R1=0.222 MΩ Dipole 2: R2=0.200 MΩ Dipole 3: R3=0.200 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.

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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%

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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 %

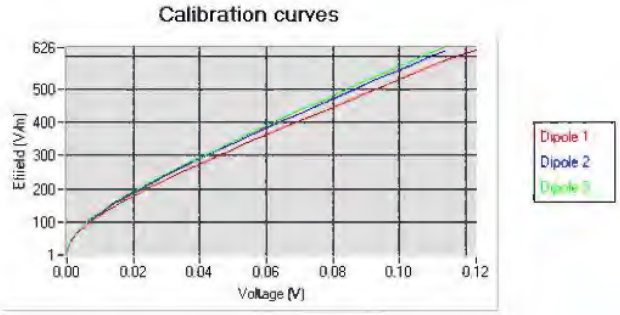
5.1 SENSITIVITY IN AIR

Normx dipole 1 (µV/(V/m)^2)	Normy dipole 2 (µV/(V/m)^2)	Normz dipole 3 (µV/(V/m)^2)
0.76	0.67	0.67

DCP dipole 1 (mV)	DCP dipole 2 (mV)	DCP dipole 3 (mV)
90	93	91

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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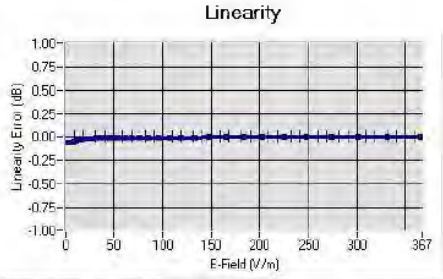
5.2 LINEARITY



Linearity:[]+/-1.39% (+/-0.06dB)

5.3 SENSITIVITY IN LIQUID

Liquid	Frequency (MHz +/- 100MHz)	Permittivity	Epsilon (S/m)	ConvF
HL750	750	40.03	0.93	1.71
BL750	750	56.83	1.00	1.76
HL850	835	42.19	0.90	1.79
BL850	835	54.67	1.01	1.86
HL900	900	42.08	1.01	1.84
HL1450	1450	40.64	1.18	1.87
BL1450	1450	53.01	1.33	1.93
HL1750	1750	41.01	1.45	1.88
BL1750	1750	53.50	1.50	1.95
HL1900	1900	38.45	1.45	2.14
BL1900	1900	53.32	1.56	2.20
HL2000	2000	38.26	1.38	2.02
HL2300	2300	39.44	1.62	2.24
BL2300	2300	54.52	1.77	2.32
HL2450	2450	37.50	1.80	2.25
BL2450	2450	53.22	1.89	2.31
HL2600	2600	39.80	1.99	2.16
BL2600	2600	52.52	2.23	2.21
HL5200	5250	35.85	4.74	1.70
BL5200	5250	48.01	5.40	1.76
HL5600	5600	36.66	5.17	1.69
BL5600	5600	46.79	5.77	1.75
HL5800	5800	35.31	5.31	1.71
BL5800	5800	47.04	6.10	1.74

LOWER DETECTION LIMIT: 9mW/kg

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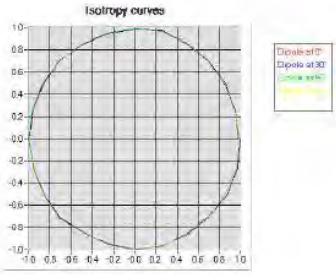
5.4 ISOTROPY

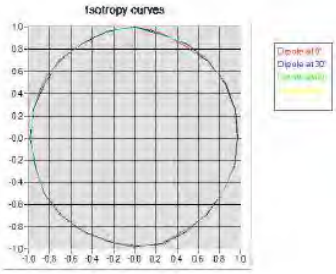
HL900 MHz

- Axial isotropy: 0.04 dB
- Hemispherical isotropy: 0.07 dB



HL1800 MHz

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



HL5600 MHz

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

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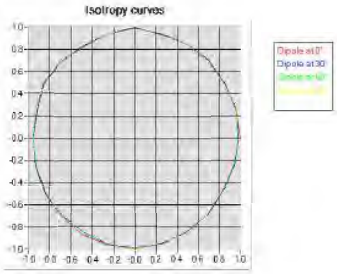

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6 LIST OF EQUIPMENT

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	10/2017	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.
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

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SAR Reference Dipole Calibration Report

Ref : ACR.165.2.17.SATU.A

SIEMIC TESTING AND CERTIFICATION SERVICES

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MVG COMOSAR REFERENCE DIPOLE

FREQUENCY: 835 MHZ

SERIAL NO.: SN 18/11 DIPC150

Calibrated at MVG US

2105 Barrett Park Dr. - Kennesaw, GA 30144

ACCREDITED

Calibration CERT #2246-02

Calibration Date: 06/8/2017

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	6/14/2017	
Checked by :	Jérôme LUC	Product Manager	6/14/2017	
Approved by :	Kim RUTKOWSKI	Quality Manager	6/14/2017	

	Customer Name
Distribution :	SIEMIC Testing and Certification Services

Issue	*Date*	*Modifications*
A	6/14/2017	Initial release

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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 835 MHz REFERENCE DIPOLE
Manufacturer	MVG
Model	SID835
Serial Number	SN 18/11 DIPC150
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*

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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 constucted 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 %

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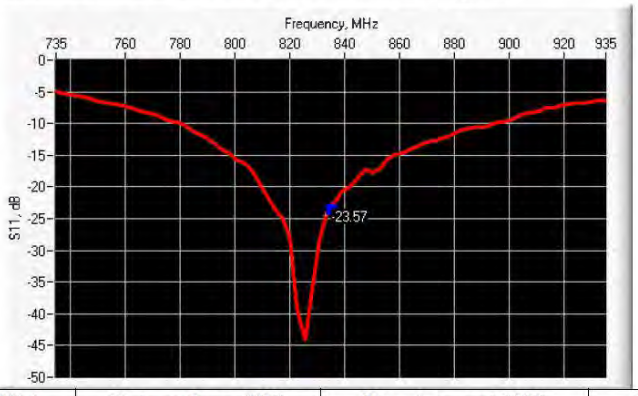
10 g	20.1 %

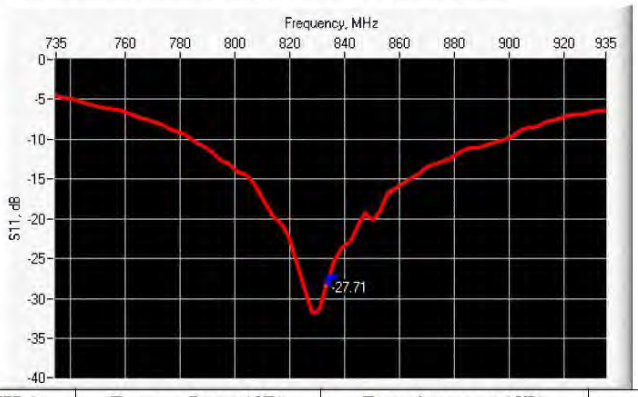
6 CALIBRATION MEASUREMENT RESULTS

6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
835	-23.57	-20	57.0 Ω + 1.2 jΩ

6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
835	-27.71	-20	52.9 Ω + 3.1 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 %.	

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450	290.0 ±1 %.		166.7 ±1 %.		6.35 ±1 %.	
750	176.0 ±1 %.		100.0 ±1 %.		6.35 ±1 %.	
835	161.0 ±1 %.	PASS	89.8 ±1 %.	PASS	3.6 ±1 %.	PASS
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 %		0.89 ±5 %	
835	41.5 ±5 %	PASS	0.90 ±5 %	PASS
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 %	

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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 : 0.90
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	835 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		5.55	
835	9.56	9.64 (0.96)	6.22	6.20 (0.62)
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	

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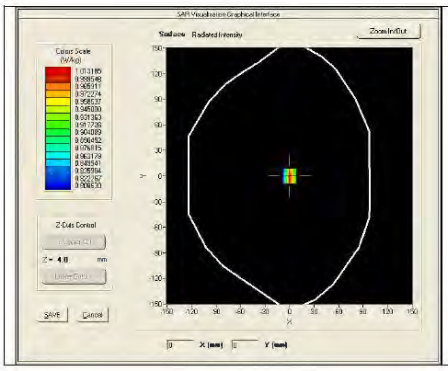
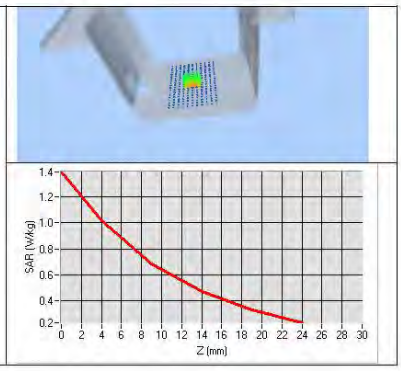
1900	39.7		20.5	
1950	40.5		20.9	
2000	41.1		21.1	
2100	43.6		21.9	
2300	48.7		23.3	
2450	52.4		24	
2600	55.3		24.6	
3000	63.8		25.7	
3500	67.1		25	
3700	67.4		24.2	





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 %		0.96 ±5 %	
835	55.2 ±5 %	PASS	0.97 ±5 %	PASS
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 %	

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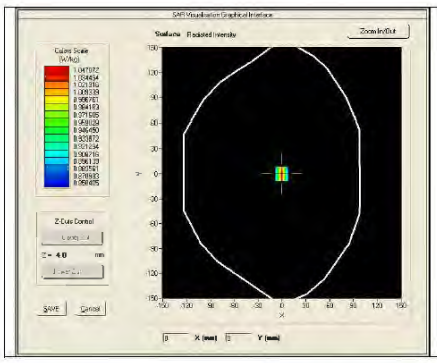
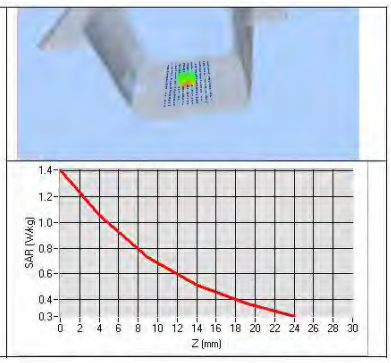
2300	52.9 ±5 %		1.81 ±5 %	
2450	52.7 ±5 %		1.95 ±5 %	
2600	52.5 ±5 %		2.16 ±5 %	
3000	52.0 ±5 %		2.73 ±5 %	
3500	51.3 ±5 %		3.31 ±5 %	
3700	51.0 ±5 %		3.55 ±5 %	
5200	49.0 ±10 %		5.30 ±10 %	
5300	48.9 ±10 %		5.42 ±10 %	
5400	48.7 ±10 %		5.53 ±10 %	
5500	48.6 ±10 %		5.65 ±10 %	
5600	48.5 ±10 %		5.77 ±10 %	
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' : 57.5 sigma : 0.96
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	835 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
835	9.96 (1.00)	6.53 (0.65)





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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	10/2016	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.
Temperature and Humidity Sensor	Control Company	150798832	10/2015	10/2017

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SAR Reference Dipole Calibration Report

Ref : ACR.165.5.17.SATU.A

SIEMIC TESTING AND CERTIFICATION SERVICES

ZONE A,FLOOR 1,BUILDING 2,WAN YE LONG TECHNOLOGY PARK,SOUTH SIDE OF ZHOUSHI ROAD, SHIYAN STREET,BAO'AN DISTRICT, SHENZHEN 518108 , GUANGDONG , P.R.C.

MVG COMOSAR REFERENCE DIPOLE

FREQUENCY: 1900 MHZ

SERIAL NO.: SN 18/11 DIPG153

Calibrated at MVG US

2105 Barrett Park Dr. - Kennesaw, GA 30144

Calibration Date: 06/8/2017

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	6/14/2017	JS
Checked by :	Jérôme LUC	Product Manager	6/14/2017	JS
Approved by :	Kim RUTKOWSKI	Quality Manager	6/14/2017	Kim Rutkowski

	Customer Name
Distribution :	SIEMIC Testing and Certification Services

Issue	*Date*	*Modifications*
A	6/14/2017	Initial release

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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 1900 MHz REFERENCE DIPOLE
Manufacturer	MVG
Model	SID1900
Serial Number	SN 18/11 DIPG153
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*

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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 constucted 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 %

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