CETECOM™

SAR Test Report

FOR:

Manufacturer:
I.D. Systems Inc.
Model Number: MVAC3.0
FCC ID: N5VMVAC30
IC Certification Number: 3802A-MVAC30

Test Report #: SAR-IDSY1_002_17001

Date of Report: 2018-1-18

ilac-MRA

A2LA ACCREDITED
TESTING LABORATORY
Certificate #2135.01

***CETECOM* Inc.**
411 Dixon Landing Road ◆ Milpitas, CA 95035 ◆ U.S.A.
Phone: + 1 (408) 586 6200 ◆ Fax: + 1 (408) 586 6299 ◆ E-mail: info@cetecom.com ◆ http://www.cetecom.com
CETECOM Inc. is a Delaware Corporation with Corporation number: 2905571

TABLE OF CONTENTS

1 Assessment

The following device was evaluated against the limits for general population uncontrolled exposure specified in FCC 2.1093 and RSS 102, Issue 5 according to measurement procedures specified in FCC regulation as listed in chapter 5, IEEE 1528:2013 and IEC 62209-2:2010 and no deviations were ascertained during the course of the tests performed.

Manufacturer	Description	Model #
I.D. Systems Inc.	OBDII Tracking Device	MVAC3.0

Responsible for Testing Laboratory:

Date	Section	Name	Signature
2018-1-25	RC&E	James Donnellan (EMC Lab manager)	James Donnellan

Responsible for the Report:

Date	Section	Name	Signature
2018-1-25	RC&E	Joseph Pacheco (SAR Technician)	Joseph Pacheco Digitally signed by Joseph Pacheco DN: cn=Joseph Pacheco, o=CETECOM, email=joseph.pacheco@cetecom.com, c=US Date: 2018.01.25 12:04:35 -08'00'

The test results of this test report relate exclusively to the test item specified in Section 3.
CETECOM Inc. USA does not assume responsibility for any conclusions and generalizations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item. The test report may only be reproduced or published in full. Reproduction or publication of extracts from the report requires the prior written approval of CETECOM Inc. USA.

2 Administrative Data

2.1 Identification of the Testing Laboratory Issuing the SAR Test Report

Company Name	CETECOM Inc.
Department	Compliance
Address	411 Dixon Landing Road Milpitas, CA 95035 U.S.A.
Telephone	+1 (408) 586 6200
Fax	+1 (408) 586 6299
Industry Canada Company Number	3462B
Test Lab Manager	James Donnellan
Responsible Project Manager	Laith Saman

2.2 Identification of the Client and Manufacturer

	Client	Manufacturer
Company	I.D. Systems Inc.	Creation Technologies
Street Address	123 Tice Blvd, Suite 101	1001 Klein Suite 100
City/Zip Code	Woodcliff Lake, NJ 07677	Plano, TX 75074
Country	USA	USA

3 Equipment under Test (EUT)

3.1 General Specification of the Equipment under Test

Model No	MVAC3.0
FCC ID	N5VMVAC30
IC Certification Number	3802A-MVAC30
Product Marketing Name (PMN)	MVAC3.0
Hardware Version Identification Number (HVIN)	900-00000466
Firmware Version Identification Number (FVIN)	M1.25
Host Marketing Name (HMN)	MVAC3.0
Product Type	OBD device
Prototype/Production	Production
RF Exposure Environment	General / Uncontrolled
Dimensions	7.7 x 5.1 x 8.9 [cm]
Exposure Conditions	Vehicular
Supported Radios	• LTE • WCDMA • ISM (Beacons on 315 and 433 MHz with -22 dBm with -5 dBi gain) • Bluetooth (1.5 dBm with 0.5 dBi gain)
Additional Radios[1]	• GPS • A-GPS (UE-assisted)
Power Back-Off Modes	N/A
Simultaneous Transmission Configurations	• Cellular + ISM + Bluetooth
Date of Testing	November 20, 2017 through January 16, 2018

NOTES:
1. Additional radios are supported by the EUT, but are not addressed in this test report.
2. GPS is a Receive only Radio.

3.2 Antenna Information

Antenna	Type	Internal / External	Frequency (MHz)	Manufacturer Stated Max Peak Gain (dBi)
Taoglas	Custom PCB Antenna	Internal	[700-900),(1700-1900]	2-LTE 1.9
				4-LTE 2.3
				5-LTE 2.8
				12-LTE 1.9

3.3 Identification of the Equipment Under Test (EUT)

EUT #	Serial Number	HW Version	SW Version
1	17-MV320570-CTD	900-00000466	M1.25
2	17-MV250002-CRT	900-00000466	M1.25

3.4 Identification of Accessory equipment

AE #	Type	Manufacturer	Model	Serial Number
1	Standard Laptop	N/A	N/A	N/A
2	DC Power Supply	Protek	3003B	H012703

3.5 Maximum SAR values

Equipment Class	Exposure Condition	Maximum Reported 1g SAR[1] (W/kg)
Licensed	Near the body	1.538
With Calculated Simultaneous Transmission	Near the body	1.568

4 Test Result summary

4.1 Test Positions and Configurations

Exposure Condition	Distance	Position	Positioning Photo (Section 10 Appendix B)
Near the body	11 mm	Top/Bottom	Photo 2
		Side with Antenna adjoined	Photo 3

NOTES:

1. For hottest positions, 11 mm was shortest distance. Otherwise, positions had shorter distance. Photos shown are setup examples.

- High and low channels are evaluated for the worst case positions at least once for each exposure condition regardless of the SAR value on the middle channel, according to guidance in Industry Canada Notice 2012-DRS1203. FCC only requires high and low channels to be evaluated when the SAR value on the middle channel is less than 3 dB below the limit.
- For GSM bands, the uplink timeslot configuration with the highest source-based time-averaged output power is used for full SAR evaluation for body exposure positions.
- SAR evaluation for LTE is performed with the bandwidth and RB configuration with the highest output power.
-Measured SAR values are scaled up to the manufacturer's stated output power. These SAR values are the reported SAR values as described in FCC KDB 447498.
- Configurations with multiple SAR values have at least one peak SAR within 2 dB of the primary peak. 5mm.

4.2 Conducted Measurements

Signal Type	Worst Case For Time Averaged Power Timeslots / Duty Cycle	Type(s) of Uplink Modulation	Band	Uplink Transmit Frequency Range (MHz)	Measured Maximum Conducted Output Power (dBm)	Declared Maximum Output Power (dBm)	Tune up factor linear
WCDMA	100%	QPSK	II	1850 - 1910	23.57	23.5+1	1.24
			V	824 – 849	24.26	23.5+1	1.06
LTE	100%	QPSK	Band 2	1850 - 1910	22.95	23+1	1.27
			Band 4	1710 - 1755	22.95	23+1	1.27
			Band 5	824 – 849	23.42	23+1	1.14
			Band 12	699 - 716	22.23	23+1	1.5

NOTES:

2. EGPRS values are 2dB lower than GPRS, so only GPRS is tested.
3. UMTS with QPSK delivers 1dB higher levels than with 16QAM so only QPSK was tested

4.3 Highest SAR values (details in Annex A)

Band	Signal Type	Exposure Condition	Position	distance	Max measured 1g SAR (W/kg)	Repeat 1g SAR (W/kg)	Ratio initial / repeat measurement	Maximum Scaled 1g SAR[1] (W/kg)	Tune Up Power Scaling Factor
WCDMA II	QPSK	Near the body	Top	5mm	0.97	-	-	1.20	1.24
WCDMA II	QPSK	Near the body	Bottom	7mm	1.04	1.20	1.154	1.486	
WCDMA II	QPSK	Near the body	Side with Antenna	**11mm**	1.22	1.24	1.016	**1.538**	
WCDMA V	QPSK	Near the body	Top	touch	0.581	-	-	0.613	1.056
WCDMA V	QPSK	Near the body	Bottom	touch	0.601	-	-	0.635	
WCDMA V	QPSK	Near the body	Side with Antenna	touch	0.853	-	-	0.901	
2 – LTE	QPSK	Near the body	Top	touch	0.892	0.887	1.006	1.135	1.273
2 – LTE	QPSK	Near the body	Bottom	5mm	0.722	-	-	0.919	
2 – LTE	QPSK	Near the body	Side with Antenna	**11mm**	1.10	1.07	1.028	1.400	
4 – LTE	QPSK	Near the body	Top	touch	0.443	-	-	0.564	1.273
4 – LTE	QPSK	Near the body	Bottom	touch	0.965	1.04	1.078	1.324	
4 – LTE	QPSK	Near the body	Side with Antenna	touch	1.06	1.09	1.028	1.387	

5 – LTE	QPSK	Near the body	Top	touch	0.064	-	-	0.0731	1.143
5 – LTE	QPSK	Near the body	Bottom	touch	0.629	-	-	0.719	
5 – LTE	QPSK	Near the body	Side with Antenna	touch	0.848	-	-	0.969	
12 - LTE	QPSK	Near the body	Top	touch	0.544	-	-	0.818	1.503
12 - LTE	QPSK	Near the body	Bottom	touch	0.652	-	-	0.980	
12 - LTE	QPSK	Near the body	Side with Antenna	touch	0.682	-	-	1.025	

NOTES:

1. Measured 1g SAR scaled to manufacturer stated output power upper tolerance limit.
2. All results above 0.8W/kg have been repeated at least once. Detailed results are included in Annex A. Only the highest results are shown in this table.
3. Measured power drifts specifically for WCDMA V Top 0mm and LTE-2 Top 0mm, were -0.83 dB at 17 V/m and -0.39 dB at 14 V/m respectably, are accepted. Reason being, the sensitivity of the probe is $1uV/(V/m)^2$, a 196uV signal at the sensor with the 14V/m, and the dynamic range of the probe extends to 30uV. In these cases, when the power drift still below 1 dB, the position of the probe is slightly removed from the hot spot.

4.4 SAR Measurement Variability

SAR measurement variability is assessed when the initial measured 1g SAR is ≥ 0.80 W/kg. If the measured SAR value of the initial repeated measurement is < 1.45 W/kg with ≤ 20% variation, only one repeated measurement is required to affirm that the results are not expected to have substation variations. A second repeated measurement is required only if the measured results for the initial repeated measurement is within 10% of the SAR limit and vary by more than 20%.

See table in 4.4 for results of repeated measurements and variation.

4.5 Simultaneous SAR Evaluation

Antenna	Operation Mode	SAR percentage of limit 1.6W/kg used up at 11mm				
Cellular	WCDMA II	1.538 W/kg	/	1.6 W/kg	=	96%
ISM	ISM (Beacons on 315 and 433 MHz with -22 dBm with -5 dBi gain)	0.01 mW 0.01 mW	/ /	55 mW 45 mW	= =	0.02% 0.02%
Bluetooth	Bluetooth (1.5 dBm with 0.5 dBi gain)	1.6 mW x 0.2	/	19 mW	=	2%
Total		98.04%				

1. Worst case duty cycle for BT is 20% duty cycle.

4.6 Dipole verification (details in Annex A)

Prior to formal testing at each frequency band, system verification was performed in accordance with IEEE 1528. The 1 Watt reference SAR value is taken from the SPEAG dipole calibration report. All of the testing described in this report was performed within 24 hours of the system verification. The following results were obtained:

Prior to formal testing at each frequency band, system verification was performed in accordance with IEEE 1528 and IEC 62209-1/2. The 1 Watt reference SAR value is taken from the SPEAG dipole calibration report. All of the testing described in this report was performed within 24 hours of the system verification. The following results were obtained:

Date	Liquid Type	Frequency (MHz)	CW input at dipole feed (Watts)	1g SAR (W/kg) measured	1g SAR (W/kg) from dipole calibration	Difference reference SAR value to normalized SAR
11/22/2017	MSL	750	0.25	2.13	2.2	0.07
11/17/2017	MSL	900	0.25	2.23	2.73	0.5
11/21/2017	MSL	1750	0.25	10.4	9.19	-1.21
11/22/2017	MSL	1900	0.25	9.45	9.6	0.15

5 Subject of Investigation

The objective of the measurements done by CETECOM Inc. was the dosimetry assessment of the EUT described in section 3. The tests were performed in configurations for devices operated next to a person's body. The examinations were carried out with the dosimetry assessment system DASY52 described in Section 6.

5.1 The IEEE Standard C95.1 , FCC Exposure Criteria, and IC Exposure Criteria

The FCC limits are set by CFR 47 FCC rule parts 1.1307 and 2.1093. The IC limits are set by RSS 102, Issue 5 and Safety Code 6 (2015). The limits are derived from the recommendations in IEEE C95.1-1999 (ANSI/IEEE C95.1-1999), "IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz."

5.2 SAR Limit

In this report the comparison between the exposure limits and the SAR data is made using the spatial peak SAR.

Having in mind a worst case consideration, the SAR limit is valid for uncontrolled environment and portable transmitters. The SAR values have to be averaged over a mass of 1g (SAR_{1g}) and/or 10g (SAR_{10g}) with the shape of a cube.

Standard	Exposure Condition	Average SAR (W/kg)	Mass Average (g)
FCC CFR 47 Part 2.1093 (d)(2)	Partial-Body	1.6	1
FCC CFR 47 Part 2.1093 (d)(2)	Hands, Wrists, Feet and Ankles	4.0	10
RSS 102, Issue 5 Safety Code 6 (2015)	Localized Head and Trunk	1.6	1
RSS 102, Issue 5 Safety Code 6 (2015)	Localized Limbs	4.0	10

6 Measurement Procedure

The Federal Communications Commission (FCC) requires routine dosimetry assessment of mobile telecom-communications devices, either by laboratory measurement techniques or by computational modeling, prior to equipment authorization or use. The measurement procedure shall be performed according to IEEE 1528:2013. The following KDB publications have additionally been applied:

447498 D01 V06 – General RF Exposure Guidance
865664 D01 V01R04 – SAR measurement 100 MHz to 6 GHz
941225 D01 V03R01 – SAR Measurement Procedures for 3G Devices
941225 D05 V02R04 – SAR for LTE Devices

Industry Canada (IC) requirements and measurement techniques regarding RF exposure are described in RSS-102, Issue 5, which refers to the latest version of IEEE 1528 and IEC 62209. IC follows many of the same procedures as applied for compliance with FCC requirements regarding EUT specific technologies and form factors. IC allows the use of the above listed KDBs in most aspects as described in IC Notice 2012-DRS1203 regarding Applicability of Latest FCC RF Exposure KDB Procedures (Publication Date: October 24, 2012) and Other Procedures. Additionally the following guideline is used:

RSS-102 Supplementary Procedures (SPR)-001, January 2011 – SAR Testing Requirements with Regard to Bystanders for Laptop Type Computers with Antennas Built-in on display Screen (Laptop Mode/Tablet Mode)

6.1 General Requirements

SAR evaluation was performed in a laboratory with an environment which avoids influence on SAR measurements by ambient EM sources and any reflection from the environment itself. The ambient temperature was in the range of 18°C to 25°C and 30-70% humidity. Simulating liquid temperature did not deviate more than 2°C throughout SAR evaluation.

6.2 Body-worn and Other Configurations

Test Position
The body-worn configurations shall be tested with the supplied accessories (belt-clips, holsters, etc.) attached to the device in normal use configuration. Devices with a headset output shall be tested with a connected headset.

Test to be Performed
For purpose of determining test requirements, accessories may be divided into two categories: those that do not contain metallic components and those that do. For multiple accessories that do not contain metallic components, the device may be tested only with that accessory which provides the closest spacing to the body. For multiple accessories that contain metallic components, the device must be tested with each accessory that contains a unique metallic component. If multiple accessories share an identical metallic component, only the accessory that provides the closest spacing to the body must be tested. If the manufacturer provides none body-worn accessories a separation distance of 1.5 cm between the back of the device and the flat phantom is recommended. Other separation distances may be used, but they shall not exceed 2.5 cm. In these cases, the device may use body-worn accessories that provide a separation distance greater than that tested for the device provided however that the accessory contains no metallic components.

For devices with retractable antenna the SAR test shall be performed with the antenna fully extended and fully retracted. Other factors that may affect the exposure shall also be tested. For example, optional antennas or optional battery packs which may significantly change the volume, lengths, flip open/closed, etc. of the device, or any other accessories which might have the potential to considerably increase the peak spatial-average SAR value.

6.3 System Check

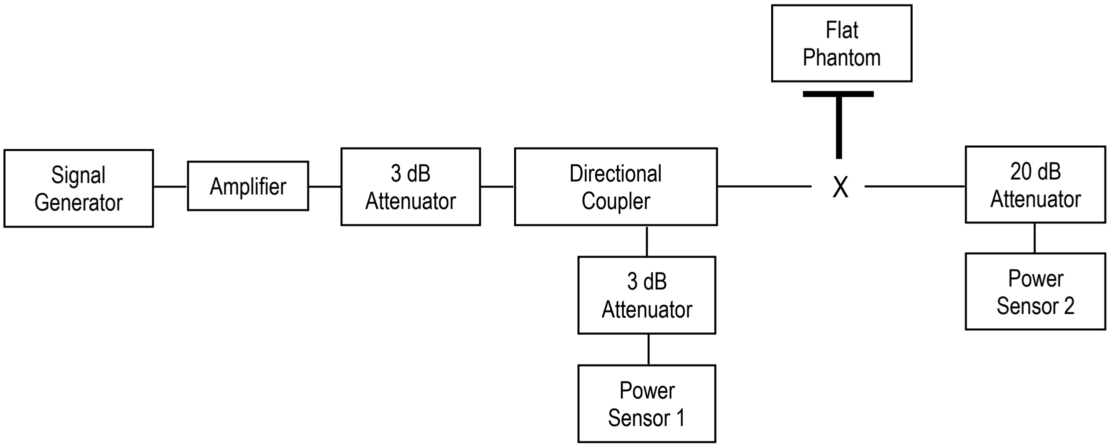
The purpose of the system check is to verify that the system operates within its specifications. System check is performed within 24 hours prior to compliance testing for each liquid type and frequency band. The system check result is verified to be within ±10% of the reference dipole source as measured during calibration of the dipole.

Phantom Set-Up
A flat phantom is used with the same tissue-equivalent liquid that will be used during compliance testing. The dipole feed point is placed at center of the flat phantom and the dipole arms are aligned with the major axis.

Standard Source
A reference dipole source is used to irradiate the phantom. The dipole is placed under the bottom of the phantom and centred with its axis parallel to the longest dimension of the phantom. A low loss spacer is used to establish the correct distance between the top surface of the dipole and the bottom surface of the phantom. For frequencies below 1 GHz, a spacing of 15 mm is used. For frequencies above 1 GHz, a spacing of 10 mm is used. The dipole has a return loss of less than -20 dB at the resonant frequency.

System Check Procedure

The test set-up is as follows:



1. The cable at the output of the directional coupler is connected to the 20 dB attenuator.
2. The signal generator is adjusted until the desired input power to the dipole is measured at power sensor 2. The forward power of the directional coupler is measured with power sensor 1 and noted for step 4.
3. The cable at the output of the directional coupler is connected to the dipole source.
4. The signal generator is adjusted until power sensor 1 measures the same power as in step 2.
5. A SAR measurement is performed with the dipole source radiating.
6. During the system check test, the power measured by power sensor 1 is monitored to ensure the power does not drift.
7. At the conclusion of the SAR measurement, the SAR result is normalized to a dipole input power of 1 W and compared to the 1 [W] reference SAR value in the dipole calibration report. The difference between the measured SAR and the reference SAR is verified to be within ±10%.

6.4 Procedure for assessing the peak spatial-average SAR

Step 1: Power reference measurement:

Prior to the SAR test, a local SAR measurement should be taken at a user-selected spatial reference point to monitor power variations during testing.

Step 2: Area scan

The measurement procedures for evaluating SAR associated with wireless handsets typically start with a coarse measurement grid in order to determine the approximate location of the local peak SAR values. This is referred to as the "area scan" procedure. The SAR distribution is scanned along the inside surface of typically half of the head of the phantom but at least larger than the areas projected (normal to the phantom's surface) by the handset and antenna. An example grid is given in Figure 4. The distance between the measured points and phantom surface should be less than 8 mm, and should remain constant (variation less than ± 1 mm) during the entire scan in order to determine the locations of the local peak SAR with sufficient precision. The distance between the measurement points should enable the detection of the location of local maximum with an accuracy of better than half the linear dimension of the tissue cube after interpolation. The approximate locations of the peak SARs should be determined from area scan. Since a given amplitude local peak with steep gradients may produce lower spatial-average SAR than slightly lower amplitude peaks with less steep gradients, it is necessary to evaluate the other peaks as well. However, since the spatial gradients of local SAR peaks are a function of wavelength inside the tissue simulating liquid and incident magnetic field strength, it is not necessary to evaluate peaks that are less than –2dB of the local maximum. Two-dimensional spline algorithms [Press, et al, 1996], [Brishoual, 2001] are typically used to determine the peaks and gradients within the scanned area. If the peak is closer than one-half of the linear dimension of the 1 g or 10 g tissue cube to the scan border, the measurement area should be enlarged if possible, e.g., by tilting the probe or the phantom (see Figure 5).

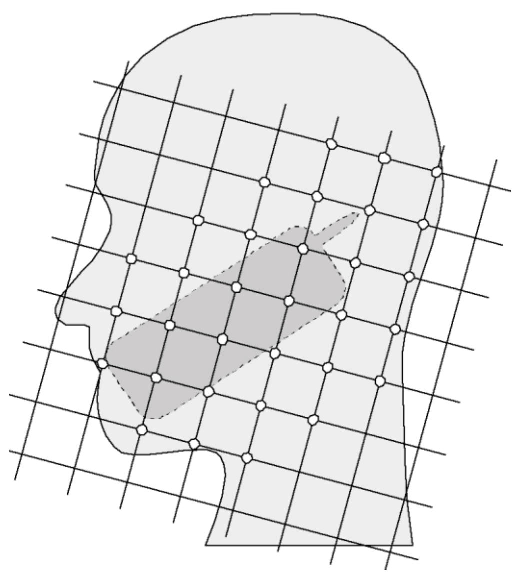


Figure 4 – Example of an area scan including the position of the handset. The scanned area (white dots) should be larger than the area projected by the handset and antenna.

The SPEAG DASY SAR system uses a mechanical sensor detection to find the phantom surface. To decrease test time, the DASY software allows the operator to choose an option where the SAR probe will reuse measurement locations from a previous identical area scan. With this option enabled, the DASY system will not use mechanical sensor detection to find the phantom surface. Locations of each measurement point of the area scan are taken at the same locations as an identical area scan if one is available. Area scans that reused location of measurement points is noted in the result plots under DASY Configuration > Sensor-Surface.

Step 3: Zoom scan

In order to assess the peak spatial SAR values averaged over a 1 g and 10 g cube, fine resolution volume scans, called "zoom scans", are performed at the peak SAR locations determined during the "area scan." The zoom scan volume should have at least 1.5 times the linear dimension of either a 1 g or a 10 g tissue cube for whichever peak spatial-average SAR is being evaluated. The peak local SAR locations that were determined in the area scan (interpolated value) should be on the centerline of the zoom scans. The centerline is the line that is normal to the surface and in the center of the volume scan. If this is not possible, the zoom scan can be shifted but not by more than half the dimension of the 1 g or a 10 g tissue cube.

The maximum spatial-average SAR is determined by a numerical analysis of the SAR values obtained in the volume of the zoom scan, whereby interpolation (between measured points) and extrapolation (between surface and closest measured points) routines should be applied. A 3-D-spline algorithm [Press, et al, 1996], [Kreyszig, 1983], [Brishoual, 2001] can be used for interpolation and a trapezoidal algorithm for the integration (averaging). Scan resolutions of larger than 2 mm can be used provided the uncertainty is evaluated according to E (see E.5).

In some areas of the phantom, such as the jaw and upper head region, the angle of the probe with respect to the line normal to the surface might become large, e.g., at angles larger than ± 30º (see Figure 5), which may increase the boundary effect to an unacceptable level. In these cases, a change in the orientation of the probe and/or the phantom is recommended during the zoom scan so that the angle between the probe housing tube and the line normal to the surface is significantly reduced (<30º).

Step 4: Power reference measurement
The local SAR should be measured at exactly the same location as in Step 1. The absolute value of the measurement drift (the difference between the SAR measured in Step 4 and Step 1) should be recorded in the uncertainty budget. It is recommended that the drift be kept within ± 5%. If this is not possible, even with repeat testing, additional information may be used to demonstrate the power stability during the test. Power reference measurements can be taken after each zoom scan, if more than one zoom scan is needed. However, the drift should always be referred to the initial state with fully charged battery.

6.5 Determination of the largest peak spatial-average SAR

In order to determine the largest value of the peak spatial-average SAR of a handset, all device positions, configurations and operational modes should be tested for each frequency band according to steps 1 to 3 below.

Step 1: The tests of 6.4 should be conducted at the channel that is closest to the center of the transmit frequency band (*fc*) for:

a) All device positions (cheek and tilt, for both left and right sides of the SAM phantom,

b) All configurations for each device position in (a), e.g. antenna extended and retracted, and

c) All operational modes for each device position in (a) and configuration in (b) in each frequency band, e.g. analog and digital.

If more than three frequencies need to be tested, (i.e., Nc > 3), then all frequencies, configurations and modes must be tested for all of the above positions.

Step 2: For the condition providing highest spatial peak SAR determined in Step 1 conduct all tests of 6.4 at all other test frequencies, e.g. lowest and highest frequencies. In addition, for all other conditions (device position, configuration and operational mode) where the spatial peak SAR value determined in Step 1 is within 3dB of the applicable SAR limit, it is recommended that all other test frequencies should be tested as well.

Step 3: Examine all data to determine the largest value of the peak spatial-average SAR found in Steps 1 to 2.

6.6 SAR Scaling Using the Tune-Up Scaling Factor

Conducted output power is tested to check if the EUT is transmitting at the maximum power allowed according to the declared maximum power including tune-up power tolerances. When the conducted output power is less than the maximum output power including tolerance, the measured SAR values are scaled up to the maximum output power including tolerance to ensure all production units are within SAR limits.

The tune-up power scaling factor is a multiplicative factor. The tune-up power scaling factor is calculated as:

10 ^ [(Maximum Output Power Including Tolerance – Measured Conducted Output Power) / 10]

Where

Maximum Output Power Including Tolerance: dBm

Measured Conducted Output Power: dBm

Example SAR scaling calculation:

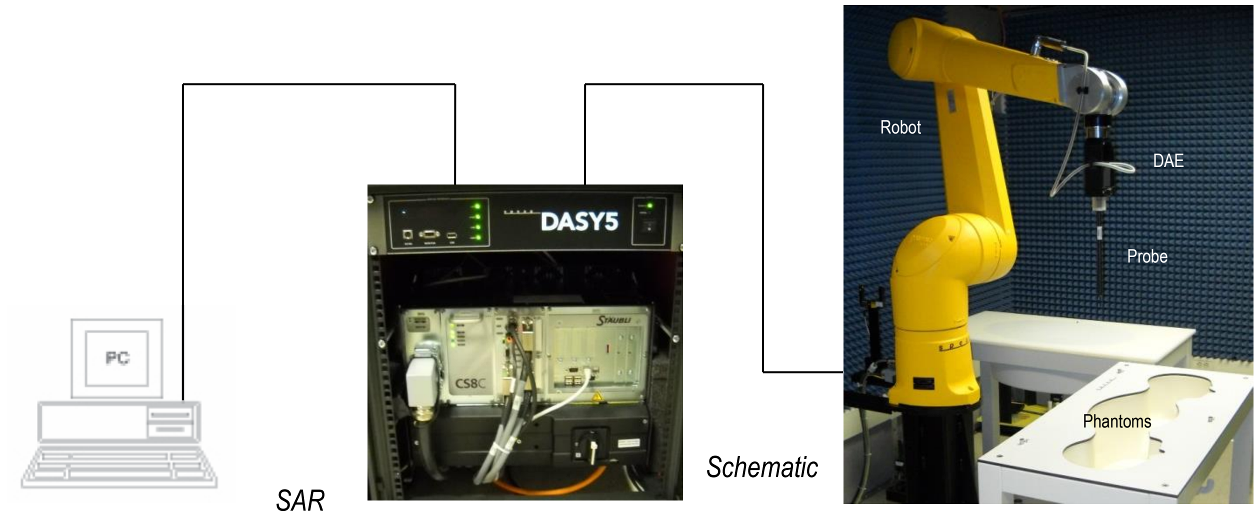
Measured Conducted Output Power (dBm)	Maximum Output Power Including Tolerance (dBm)	Tune-Up Power Scaling Factor	Measured 1g SAR (W/kg)	Scaled/Reported SAR value (W/kg)
32.0	32.5	1.12	1.0	1.12

7 The Measurement System

7.1 Robot system specification

The SAR measurement system being used is the SPEAG DASY52 system, which consists of a Stäubli TX90XL 6-axis robot arm and CS8c controller, SPEAG SAR Probe, Data Acquisition Electronics, and SAM Twin Phantom. The robot is used to articulate the probe to programmed positions inside the phantom to obtain the SAR readings from the EUT.

The system is controlled remotely from a PC, which contains the software to control the robot and data acquisition equipment. The software also displays the data obtained from test scans.



Schematic diagram of the SAR measurement system

In operation, the system first does an area (2D) scan at a fixed depth within the liquid from the inside wall of the phantom. When the maximum SAR point has been found, the system will then carry out a 3D scan centered at that point to determine volume averaged SAR level.

7.2 Isotropic E-Field Probe for Dosimetry Measurements

The probes are constructed using three orthogonal dipole sensors arranged on an interlocking, triangular prism core. The probes have built-in shielding against static charges and are contained within a PEEK cylindrical enclosure material at the tip. Probe calibration is described in the probe's calibration certificate.

7.3 Data Acquisition Electronics

The DAE contains a signal amplifier, multiplexer, 16bit A/D converter and control logic. It uses an optical link for communication with the DASY5 system. The DAE has a dynamic range of -100 to 300 mV. It also contains a two step probe touch detector for mechanical surface detection and emergency robot stop.

7.4 Phantoms

The Twin SAM V4.0 Phantom is designed to specifications defined in IEEE 1528, and IEC/EN 62209-1. It enables the dissymmetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region. The material shell thickness is 2mm +/- 0.2 mm at the flat section and 6mm +/- 0.2 mm at the ear reference point. The relative permittivity is 3.5 +/- 0.5 and the loss tangent is ≤ 0.05 for frequencies ≤ 6 GHz.

Additionally, the Oval Flat ELI V4.0 Phantom is designed to specification defined in IEEE 1528, and IEC/EN 62209-2. It enables the dissymmetric evaluation of body mounted usage. The material thickness is 2mm +/- 0.2 mm. For frequencies ≤ 6 GHz, the relative permittivity is 4 +/- 1 and the loss tangent is ≤ 0.05. The bottom plate is 600 x 400 mm elliptical shape with a depth of 190 mm.

7.5 Interpolation and Extrapolation schemes

The interpolation, extrapolation and maximum search routines are all 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. The routines construct a once-continuously differentiable function that interpolates the measurement values.

8 Uncertainty Assessment

The uncertainty budget is included as required by Industry Canada RSS-102. and as applicable for the FCC when The highest measured SAR in a band is ≥ 1.5W/kg per KDB 865664 section 2.8.2.

8.1 Measurement Uncertainty Budget According to IEEE 1528:2013

The uncertainty values for components specified were evaluated according to the procedures of *IEEE 1528-2013, NIST 1297 1994 edition and ISO Guide to the Expression of Uncertainty in Measurements (GUM)*.

a	*b*	*c*	*d*	*e = f(d,k)*	*f*	*g*	*h = c x f / e*	*i = c x f / e*	*k*
Uncertainty Component	**Sec.**	**TOL. (± %)**	**Prob. Dist.**	**Div.**	**c_i (1-g)**	**c_i (10-g)**	**1-g u_i (±%)**	**10-g u_i (±%)**	**v_i**
Measurement System									
Probe Calibration	E2.1	6.55	N	1	1	1	6.55	6.55	∞
Axial Isotropy	E2.2	4.7	R	√3	0.7	0.7	1.9	1.9	∞
Hemispherical Isotropy	E2.2	9.6	R	√3	0.7	0.7	3.9	3.9	∞
Boundary Effect	E2.3	2	R	√3	1	1	1.2	1.2	∞
Linearity	E2.4	4.7	R	√3	1	1	2.7	2.7	∞
System Detection Limits	E2.4	1	R	√3	1	1	0.6	0.6	∞
Probe Modulation Response	E2.5	2.4	R	√3	1	1	1.4	1.4	∞
Readout Electronics	E2.6	0.3	N	1	1	1	0.3	0.3	∞
Response Time	E2.7	0.8	R	√3	1	1	0.5	0.5	∞
Integration Time	E2.8	2.6	R	√3	1	1	1.5	1.5	∞
RF Ambient Noise	E6.1	3	R	√3	1	1	1.7	1.7	∞
RF Ambient Reflections	E6.1	3	R	√3	1	1	1.7	1.7	∞
Probe Positioner Mechanical Tolerance	E6.2	0.8	R	√3	1	1	0.5	0.5	∞
Probe Positioning with respect to Phantom Shell	E6.3	6.7	R	√3	1	1	3.9	3.9	∞
Extrapolation, interpolation and Integration Algorithms for Max. SAR Evaluation	E5.2	4	R	√3	1	1	2.3	2.3	∞
Test sample Related									
Test Sample Positioning	E4.2	2.9	N	1	1	1	2.9	2.9	*145*
Device Holder Uncertainty	E4.1	3.6	N	1	1	1	3.6	3.6	*5*
Output Power Variation - SAR drift measurement	E2.9	5	R	√3	1	1	2.9	2.9	∞
SAR Power Scaling	E.6.5	0	R	√3	1	1	0.0	0.0	∞
Phantom and Tissue Parameters									
Phantom Uncertainty (shape and thickness tolerances)	E3.1	6.6	R	√3	1	1	3.8	3.8	∞
Uncertainty in SAR Correction	E.3.2	1.9	R	√3	1	0.84	1.9	1.6	∞
Liquid Conductivity Target - tolerance	E3.3	2.5	R	√3	0.78	0.71	2.0	1.8	∞
Liquid Permittivity Target tolerance	E3.3	2.5	R	√3	0.26	0.26	0.7	0.7	∞
Liquid Conductivity - Temp uncertainty	E3.4	3.4	N	√3	0.78	0.71	2.7	2.4	∞
Liquid Permittivity - Temp uncertainty	E3.4	0.4	N	√3	0.23	0.26	0.1	0.1	∞
Combined Standard Uncertainty			RSS				**12.7**	12.6	748
Expanded Uncertainty (95% CONFIDENCE INTERVAL)			*k*= 2.00705				**25.4**	25.2	

8.2 Measurement Uncertainty Budget According to EN 62209-2

A measurement uncertainty assessment has been undertaken following guidance given in IEC/EN-622090-2. Some of the uncertainty contributions are site-specific and, for these, CETECOM, Inc. has assessed the uncertainty contributions arising from local environmental and procedural factors. The resultant uncertainty budget, following the assessment template given IEC/EN-62209-2 is shown below:

Uncertainty Component	Sec.	TOL. (± %)	Prob. Dist.	Div.	c_i (1-g)	c_i (10-g)	1-g u_i (±%)	10-g u_i (±%)	v_i
Measurement System									
Probe Calibration	7.2.2.1	6.55	N	1	1	1	6.55	6.55	∞
Axial Isotropy	7.2.2.2	4.7	R	√3	0.7	0.7	1.9	1.9	∞
Hemispherical Isotropy	7.2.2.2	9.6	R	√3	0.7	0.7	3.9	3.9	∞
Boundary Effect	7.2.2.6	2.0	R	√3	1	1	1.2	1.2	∞
Linearity	7.2.2.3	4.7	R	√3	1	1	2.7	2.7	∞
Probe Modulation Response	7.2.2.4	2.4	R	√3	1	1	1.4	1.4	∞
System Detection Limits	7.2.2.5	1.0	R	√3	1	1	0.6	0.6	∞
Readout Electronics	7.2.2.7	0.3	N	1	1	1	0.3	0.3	∞
Response Time	7.2.2.8	0.8	R	√3	1	1	0.5	0.5	∞
Integration Time	7.2.2.9	2.6	R	√3	1	1	1.5	1.5	∞
RF Ambient Noise	7.2.4.5	3.0	R	√3	1	1	1.7	1.7	∞
RF Ambient Reflections	7.2.4.5	3.0	R	√3	1	1	1.7	1.7	∞
Probe Positioner Mechanical Tolerance	7.2.3.1	0.8	R	√3	1	1	0.5	0.5	∞
Probe Positioning with respect to Phantom Shell	7.2.3.3	6.7	R	√3	1	1	3.9	3.9	∞
Post Processing	7.2.5	4.0	R	√3	1	1	2.3	2.3	∞
Test sample Related									
Test Sample Positioning	7.2.3.4.3	2.9	N	1	1	1	2.9	2.9	145
Device Holder Uncertainty	7.2.3.4.2	3.6	N	1	1	1	3.6	3.6	5
Power Scaling	L.3	0	R	√3	1	1	0.0	0..0	∞
Output Power Variation - SAR drift measurement	7.2.2.10	5.0	R	√3	1	1	2.9	2.9	∞
Phantom and Tissue Parameters									
Phantom Uncertainty (shape and thickness tolerances)	7.2.3.2	7.9	R	√3	1	1	4.6	4.6	∞
Algorithm for correcting SAR for deviations in permittivity and conductivity	7.2.4.3	1.9	R	√3	1	0.84	1.1	0.9	∞
Liquid Conductivity - measurement uncertainty	7.2.4.3	2.5	R	√3	0.78	0.71	1.1	1.0	∞
Liquid Permittivity - measurement uncertainty	7.2.4.3	2.5	R	√3	0.26	0.26	0.3	0.4	∞
Temperature Uncertainty – Conductivity	7.2.4.4	3.4	R	√3	0.78	0.71	1.5	1.4	∞
Temperature Uncertainty – Permittivity	7.2.4.4	0.4	R	√3	0.23	0.26	0.1	0.1	∞
Combined Standard Uncertainty			RSS				**12.5**	12.5	748
Expanded Uncertainty (95% CONFIDENCE INTERVAL)			*k*= 2.00705				**25.1**	25.0	

8.3 Measurement Uncertainty Budget According to IEC/EN 62209-1 and IEC/EN 62209-2

A measurement uncertainty assessment has been undertaken following guidance given in IEC/EN-62209-1 and IEC/EN-62209-2. Some of the uncertainty contributions are site-specific and, for these, CETECOM, Inc. has assessed the uncertainty contributions arising from local environmental and procedural factors. The resultant uncertainty budget, following the assessment template given IEC/EN-62209-1 and IEC/EN-62209-2 is shown below:

Uncertainty Component	Sec.	TOL. (± %)	Prob. Dist.	Div.	c_i (1-g)	c_i (10-g)	1-g u_i (±%)	10-g u_i (±%)	v_i
Measurement System									
Probe Calibration	7.2.2.1	6.55	N	1	1	1	6.55	6.55	∞
Axial Isotropy	7.2.2.2	4.7	R	√3	0.7	0.7	1.9	1.9	∞
Hemispherical Isotropy	7.2.2.2	9.6	R	√3	0.7	0.7	3.9	3.9	∞
Boundary Effect	7.2.2.6	2.0	R	√3	1	1	1.2	1.2	∞
Linearity	7.2.2.3	4.7	R	√3	1	1	2.7	2.7	∞
Modulation Response	7.2.2.4	2.4	R	√3	1	1	1.4	1.4	∞
System Detection Limits	7.2.2.5	1.0	R	√3	1	1	0.6	0.6	∞
Readout Electronics	7.2.2.7	0.3	N	1	1	1	0.3	0.3	∞
Response Time	7.2.2.8	0.8	R	√3	1	1	0.5	0.5	∞
Integration Time	7.2.2.9	2.6	R	√3	1	1	1.5	1.5	∞
RF Ambient Noise	7.2.4.5	3.0	R	√3	1	1	1.7	1.7	∞
RF Ambient Reflections	7.2.4.5	3.0	R	√3	1	1	1.7	1.7	∞
Probe Positioner Mechanical Tolerance	7.2.3.1	0.8	R	√3	1	1	0.5	0.5	∞
Probe Positioning with respect to Phantom Shell	7.2.3.3	6.7	R	√3	1	1	3.9	3.9	∞
Post Processing	7.2.5	4.0	R	√3	1	1	2.3	2.3	∞
Test sample Related									
Test Sample Positioning	7.2.3.4.3	2.9	N	1	1	1	2.9	2.9	145
Device Holder Uncertainty	7.2.3.4.2	3.6	N	1	1	1	3.6	3.6	5
Power Scaling	L.3	0	R	√3	1	1	0.0	0..0	∞
Output Power Variation - SAR drift measurement	7.2.2.10	5.0	R	√3	1	1	2.9	2.9	∞
Phantom and Tissue Parameters									
Phantom Uncertainty (shape and thickness tolerances)	7.2.3.2	7.9	R	√3	1	1	4.6	4.6	∞
SAR Correction	7.2.4.3	1.9	R	√3	1	0.84	1.1	0.9	∞
Liquid Conductivity - measurement uncertainty	7.2.4.3	2.5	R	√3	0.78	0.71	1.1	1.0	∞
Liquid Permittivity - measurement uncertainty	7.2.4.3	2.5	R	√3	0.26	0.26	0.3	0.4	∞
Temperature Uncertainty – Conductivity	7.2.4.4	3.4	R	√3	0.78	0.71	1.5	1.4	∞
Temperature Uncertainty – Permittivity	7.2.4.4	0.4	R	√3	0.23	0.26	0.1	0.1	∞
Combined Standard Uncertainty			RSS				**12.5**	12.5	748
Expanded Uncertainty (95% CONFIDENCE INTERVAL)			k= 2.00705				**25.1**	25.0	

9 References

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   < http://transition.fcc.gov/oet/ea/eameasurements.html#sar>

5. [IC 2015] Safety Code 6: Limits of Human Exposure to Radiofrequency Electromagnetic Energy in the Frequency Range from 3 kHz to 300 GHz

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8. EN 62209-2:2010, Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices - Human models, instrumentation, and procedures - Part 2: Procedure to determine the specific absorption rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)

10 Report History

Date	Report Name	Changes to Report	Report prepared by
2018-01-25	SAR-IDSY1_002_17001	Initial version	Joseph Pacheco