

# **SAR Test Report**

#### FOR:

Manufacturer: iRhythm Technologies Model Number: K102A5001 FCC ID: 2AFBP-SR15G

Test Report #: SAR\_IRHYT-003-15001\_FCC

Date of Report: Oct 9, 2015



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#### CETECOM Inc.

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# **Appendices:**

Appendix A – Plots

Appendix B – Antenna Location , Test Setup Photos Appendix C – Tissue liquid parameters, Equipment list

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#### 1. Assessment

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

Manufacturer	Description	Model #
iRhythm Technologies	ZIO SR ECG Gateway	K102A5001

#### **Responsible for Testing Laboratory:**

		Josie Sabado	
Oct 9, 2015	Compliance	(Lab Manager)	
D-4-	C4!	None	G* <b>4</b>
Date	Section	Name	Signature

#### **Responsible for the Report:**

Oct 9, 2015 Compliance (Sr. EMC Test Engineer)	
Oct 9, 2013 - (St. EMC Test Eligilieer)	
Date Section Name Signature	

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
Test Lab Manager	Josie Sabado
Responsible Project Manager	James Devasia

# 2.2. <u>Identification of the Client</u>

Applicant's Name	iRhythm Technologies
Street Address	650 Townsend St., Ste 380
City/Zip Code	San Francisco, CA 94103
Country	USA
Contact Person:	Matt Ho
Phone No.	415-632-5714
Fax:	415-632-5701
e-mail:	mho@irhythmtech.com

# 2.3. Identification of the Manufacturer

Same as client

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#### **Equipment under Test (EUT)** 3.

## 3.1. General Specification of the Equipment under Test

Model No:	K102A5001	
FCC ID:	2AFBP-SR15G	
<b>Product Type:</b>	Portable	
<b>Prototype/Production:</b>	Pre-Production	
<b>RF Exposure Environment:</b>	General / Uncontrolled	
Dimensions:	Width: 85mm Height: 155mm Depth: 21mm	
<b>Exposure Conditions:</b>	Used near the body (less than 20 cm)	
Supported Radios:	CDMA 850: 824 – 849 MHz CDMA 1900: 1850 – 1910 MHz Bluetooth v4.0: 2400 – 2483.5 MHz	
Battery Pack Operating Voltage Range:	Low: 3.7 Nom: 3.9 High: 4.2	
Operating Temperature Range:	0°C to 45°C	
Power Back-Off Modes:	None	
Simultaneous Transmission Configurations:	Cellular + Bluetooth	
Date of Testing: September 24 - 25, 2015		

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# 3.2. Antenna Information

Antenna	Туре	Internal / External	Frequency (MHz)	Manufacturer Stated Max Peak Gain (dBi)
Cellular	Monopole-PIFA	Internal	824 – 849	1.5
Centulai	Monopole 1 II 71	memai	1850 - 1910	2.3
Bluetooth	PCB Trace	Internal	2400 – 2483.5	-4.2

## 3.3. Technical Specification of Supported Radios

Signal Type	Duty Cycle	Type(s) of Modulation	Band	Uplink Transmit Frequency Range (MHz)	Measured Maximum Conducted Output Power (dBm)
CDMA	100 %	QPSK, HPSK	BC0	824 – 849	24.09
CDMA	100%	QPSK, HPSK	BC1	1850 - 1910	24.05
Bluetooth v4.0 <sup>1</sup>	61%	GFSK	N/A	2400 – 2483.5	0

NOTES:

#### **Identification of the Equipment Under Test (EUT) 3.4.**

EUT # Serial Number		HW Version	SW Version
1	J152001511	2	CC2541_SmartRF_Host

#### **3.5. Identification of Accessory equipment**

No accessory equipment

<sup>1.</sup> Maximum output power for Bluetooth is declared by the manufacturer.

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#### 3.6. Maximum SAR values

Per a KDB inquiry to the FCC relating to SAR test procedures on this device, SAR values are scaled to 33% due to low transmission duty cycle. The 33% duty cycle is derived from the EUT's firmware which limits the transmission time to 20 minutes in any 60 minute period.

Equipment Class	Exposure Condition	Measured 1g SAR (W/kg)	Maximum Reported 1g SAR <sup>1</sup> (W/kg)	With 33% Duty Cycle Scaling Per FCC Inquiry 1g SAR W/Kg
PCT	Near the body	2.93	3.74	1.23
DTS <sup>2</sup>	Near the body	N/A	0.042	N/A

#### NOTES:

- 1. Measured 1g SAR scaled to manufacturer stated output power upper tolerance limit.
- 2. SAR value for DTS is calculated. SAR evaluation was excluded.

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#### 4. Subject of Investigation

The objective of the measurements done by CETECOM Inc. was the dosimetric 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 dosimetric assessment system DASY52 described in Section 6.

#### 4.1. The IEEE Standard C95.1 and the FCC Exposure Criteria

The limits are set by CFR 47 FCC rule parts 1.1307 and 2.1093, following 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."

#### 4.2. 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<sub>1g</sub>) 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

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#### 5. **Measurement Procedure**

The Federal Communications Commission (FCC) requires routine dosimetric assessment of mobile telecomcommunications 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 V05 – General RF Exposure Guidance 865664 D01V01 – SAR measurement 100 MHz to 6 GHz 941225 D01 V02 – SAR Measurement Procedures for 3G Devices

#### **5.1.** 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 20°C to 26°C and 30-70% humidity. Simulating liquid temperature did not deviate more than +/- 2°C throughout SAR evaluation.

#### **5.2.** 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.



#### 5.3. 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  $\pm$  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).

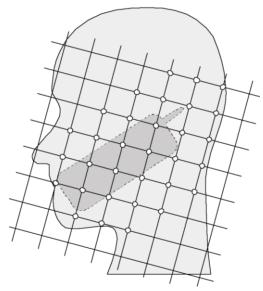


Figure 4 – Example of an area scan including the position of the handset. The scanned area (white dots) should be larger than the area projected by the handset and antenna.

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 is 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.

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#### 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  $\pm 30^{\circ}$  (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 (<30°).

#### **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  $\pm$  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.

#### 5.4. 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.

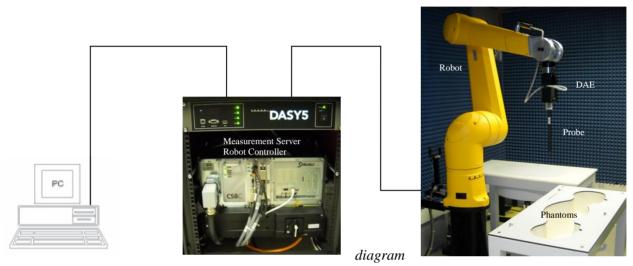


#### 6. The Measurement System

#### **6.1.** 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 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.

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#### **6.2.** Isotropic E-Field Probe for Dosimetric 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.

#### **6.3.** 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.

#### **6.4.** Phantoms

The Twin SAM V4.0 Phantom is designed to specifications defined in IEEE 1528 and IEC/EN 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. 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 permativity is 3.5 +/- 0.5 and the loss tangent is  $\leq$  0.05 for frequencies  $\leq$  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 dosimetric evaluation of body mounted usage. The material thickness is 2 mm + /- 0.2 mm. For frequencies  $\leq 6$ GHz, the relative permativity is 4 + /- 1 and the loss tangent is  $\le 0.05$ . The bottom plate is  $600 \times 400$  mm elliptical shape with a depth of 190 mm.

#### **6.5.** 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.



#### 7. **Test Results Summary**

## 7.1. Measured Conducted Average Output Power

Measurement uncertainty for conducted measurements is  $\pm 0.5$ dB. Tolerance Limits are from Telit Power Tune up procedure for CE910-Dual Product Family. Reference Document: CE910-Dual\_Tune Up Procedure\_2014.02.03.pdf

#### **CDMA Bands**

Average power measured using a Rhode and Schwarz CMU 200.

#### CDMA

			RC1/1, SO55	,		SO32, SCH0 Enabled	
Band	Channel	Frequency [MHz]	Average Power [dBm]	Average Power [dBm]	Average Power [dBm]	Average Power [dBm]	Upper Power Tolerance Limit
	1013	824.7	24.08	24.09	24.05	24.08	
	384	836.6	23.93	23.96	23.91	23.93	25
BC0	777	848.31	23.87	23.87	23.93	23.8	
	25	1851.25	23.54	23.76	23.75	23.72	
	600	1880	23.68	23.94	23.94	23.99	25
BC1	1175	1908.75	23.72	24.05	23.86	23.96	

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# 7.2. Stand-Alone SAR Evaluation Exclusion

Antenna	<b>Operation Mode</b>	SAR Evaluation Exclusion Reason
Bluetooth	GFSK	According to KDB 447498, SAR evaluation can be excluded if the following equation is satisfied:  [(max. power of channel, including tune-up tolerance,
		$mW$ )/(min. test separation distance, mm)] $\cdot [\sqrt{f(GHz)}] \le 3.0$
		The maximum average output power is 1 mW. A minimum test separation distance of 5 mm is used for the calculation. SAR evaluation is excluded.

# 7.3. Test Positions and Configurations

<b>Exposure Condition</b>	Distance	Position	Positioning Photo ( Appendix B)
Body SAR (Elliptical Phantom)	Touch	Back	Photo 1
Body SAR (SAM Phantom)	Touch	Front	Photo 2

All CDMA SAR measurements were performed with service option 32 and SCH0 disabled.

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## 7.4. SAR Results for Body

Band	Channel	Frequency (MHz)	Position / Distance	Measured SAR 1g (W/kg)	Reported SAR 1g and 33% DC (W/kg)	Results (Appendix A)
BC 0	384	836.6	Front / 0mm	0.463	0.194	Plot 1
BC 0	384	836.6	Back / 0mm	0.856	0.359	Plot 2
BC 0	1013	824.7	Back / 0mm	0.968	0.406	Plot 3
BC 0	777	848.31	Back / 0mm	0.757	0.317	Plot 4
BC 0	384	836.6	Back / 0mm	0.899	0.377	Plot 5
BC 1	600	1880	Front / 0mm	2.47	1.04	Plot 6
BC 1	600	1880	Back / 0mm	2.93	1.23	Plot 7
BC 1	25	1851.3	Back / 0mm	2.72	1.19	Plot 8
BC 1	1175	1908.8	Back / 0mm	2.89	1.19	Plot 9
BC 1	600	1880	Back / 0mm	2.86	1.21	Plot 10

#### NOTES:

<sup>1.</sup> Measured SAR values are scaled up to the manufacturer's stated output power and corrected to reflect a 33% Duty Cycle



#### 7.5. SAR Measurement Variability

SAR measurement variability is assessed when the initial measured 1g SAR is  $\geq 0.80$  W/kg. If the reported and scaled SAR value of the initial repeated measurement is < 1.45 W/kg with  $\le 20\%$  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 reported and scaled results for the initial repeated measurement is within 10% of the SAR limit and vary by more than 20%.

Band	Operation Mode	Frequency (MHz)	Position	Initial 1g SAR (W/kg)	Repeated 1g SAR (W/kg)	Ratio of largest to smallest 1g SAR
BC0	S032, SCH0 Disabled	836.6	Back	0.359	0.377	1.05
BC1	S032, SCH0 Disabled	1880	Back	1.23	1.21	1.02

#### 7.6. Simultaneous Transmission SAR Evaluation Consideration

According to KDB 447498, SAR evaluation for simultaneous transmission can be excluded when specific requirements are satisfied.

When standalone SAR evaluation is excluded, the estimated SAR value is calculated as:  $(max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)] \cdot [\sqrt{f(GHz)/x}] W/kg$ where x=7.5. Bluetooth for body positions is calculated as 0.042 W/kg

	Highest Reported 1g SAR (W/kg)				
Position	Bluetooth	Cellular			
Front	0.042	1.04			
Back	0.042	1.23			

Position	Simultaneous Transmission Antenna Combinations	Sum of 1g SAR (W/kg)	SAR to Peak Location Separation Ratio <sup>1</sup>	Simultaneous Transmission Evaluation Exclusion Reason
Front	Cellular + Bluetooth	1.08	N/A	Sum of 1g SAR is less than 1.6 W/kg
Back	Cellular + Bluetooth	1.27	N/A	Sum of 1g SAR is less than 1.6 W/kg

SAR to Peak Location Separation Ratio is only calculated if the sum of 1g SAR (W/kg) is equal to or greater than 1.6 W/kg

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#### 7.7. Dipole verification

Prior to formal testing at each frequency a system verification was performed in accordance with IEEE 1528. The 1 Watt reference SAR value is taken from the SPEAG dipole calibration report as required by FCC KDB 450824 D01. 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) <sup>1</sup>	1 Watt reference SAR value (W/kg)	Difference reference SAR value to normalized SAR	Results (Appendix A)
9/24/2015	MSL	1900	1	36.6	40.2	- 8.9%	Plot 11
9/25/2015	MSL	850	1	9.08	9.30	- 2.3%	Plot 12

#### Note:

1. Verification was done with 100 mW input to the dipole. 1g SAR values are normalized to 1W.

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#### 8. References

- 1. [IEEE 1999] IEEE Std C95.1-1999: IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz, Inst. of Electrical and Electronics Engineers, Inc., December 1998.
- 2. [IEEE 2013] IEEE Std 1528-2013: IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head From Wireless Communications Devices: Measurement Techniques. Inst. of Electrical and Electronics Engineers, Inc., June 2013.
- 3. [NIST 1994] NIST: Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results, Technical Note 1297 (TN1297), United States Department of Commerce Technology Administration, National Institute of Standards and Technology, September 1994.
- 4. [FCC 20XX] Various FCC KDB Publications, < <a href="http://transition.fcc.gov/oet/ea/eameasurements.html#sar">http://transition.fcc.gov/oet/ea/eameasurements.html#sar</a>

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#### **Report History** 9.

Date	Report Name - Changes to Report	Report prepared by
OCT 9, 2015	SAR_IRHYT-003-15001_FCC	J. Donnellan