FCC OET BULLETIN 65 SUPPLEMENT C 01-01
IEEE 1528:2003

SAR EVALUATION REPORT
(WiMAX Portion)

For
CDMA+WIMAX+WIFI+LTE MOBILE HOT SPOT

MODEL: AC803S

FCC ID: N7NAC803S

REPORT NUMBER: 11U14068-7

ISSUE DATE: March 8, 2012

Prepared for
SIERRA WIRELESS INC.
2200 FARADAY AVENUE, SUITE 150
CARLSBAD, CA 92008

Prepared by
COMPLIANCE CERTIFICATION SERVICES (UL CCS)
47173 BENICIA STREET
FREMONT, CA 94538, U.S.A.
TEL: (510) 771-1000
FAX: (510) 661-0888

NVLAP LAB CODE 200065-0

Revision History

Rev.	Issue Date	Revisions	Revised By
--	March 8, 2012	Initial Issue	--

Table of Contents

1. Attestation of Test Results

Applicant	SIERRA WIRELESS INC.		
DUT description	CDMA+WIMAX+WIFI+LTE MOBILE HOT SPOT		
Model number	AC803S		
Test device is	An identical prototype		
Device category	Portable		
Exposure category	General Population/Uncontrolled Exposure		
Date tested	December 20 - 22, 2011		
FCC Rule Parts	Freq. Range [MHz]	Highest 1-g SAR	Limit (W/kg)
27	2498.5 - 2687.5	0.425 W/kg (Edge 4 w/ 10 mm distance)	1.6
	2501 - 2685	0.412 W/kg (Edge 4 w/ 10 mm distance)	

Applicable Standards	Test Results
FCC OET Bulletin 65 Supplement C 01-01, IEEE 1528:2003	Pass

Compliance Certification Services, Inc. (UL CCS) tested the above equipment in accordance with the requirements set forth in the above standards. All indications of Pass/Fail in this report are opinions expressed by UL CCS based on interpretations and/or observations of test results. Measurement Uncertainties were not taken into account and are published for informational purposes only. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

Note: The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. This document may not be altered or revised in any way unless done so by UL CCS and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL CCS will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, any agency of the Federal Government, or any agency of any government (NIST Handbook 150, Annex A). This report is written to support regulatory compliance of the applicable standards stated above.

Approved & Released For UL CCS By:

Sunny Shih
Engineering Team Leader
Compliance Certification Services (UL CCS)

Tested By:

Devin Chang
SAR Engineer
Compliance Certification Services (UL CCS)

2. Test Methodology

The tests documented in this report were performed in accordance with FCC OET Bulletin 65 Supplement C Edition 01-01, IEEE STD 1528-2003 and the following KDB Procedures.

- 941225 D06 Hot Spot SAR v01
- 615223 802 16e WiMax SAR Guidance

3. Facilities and Accreditation

The test sites and measurement facilities used to collect data are located at 47173 Benicia Street, Fremont, California, USA.

CCS is accredited by NVLAP, Laboratory Code 200065-0. The full scope of accreditation can be viewed at http://www.ccsemc.com.

4. Calibration and Uncertainty

4.1. Measuring Instrument Calibration

The measuring equipment utilized to perform the tests documented in this report has been calibrated in accordance with the manufacturer's recommendations, and is traceable to recognized national standards.

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due date		
				MM	DD	Year
Dielectronic Probe kit	HP	85070C	N/A	N/A		
Synthesized Signal Generator	HP	83732B	US34490599	7	14	2012
E-Field Probe	SPEAG	EX3DV4	3686	1	24	2012
Thermometer	ERTCO	639-1S	1718	7	19	2012
Data Acquisition Electronics	SPEAG	DAE4	1239	10	18	2012
System Validation Dipole	SPEAG	D2600V2	1006	4	7	2012
Power Meter	HP	437B	3125U16345	5	13	2012
Power Sensor	HP	8481A	2702A60780	5	13	2012
Amplifier	MITEQ	4D00400600-50-30P	1620606	N/A		
Directional coupler	Werlatone	C8060-102	2141	N/A		

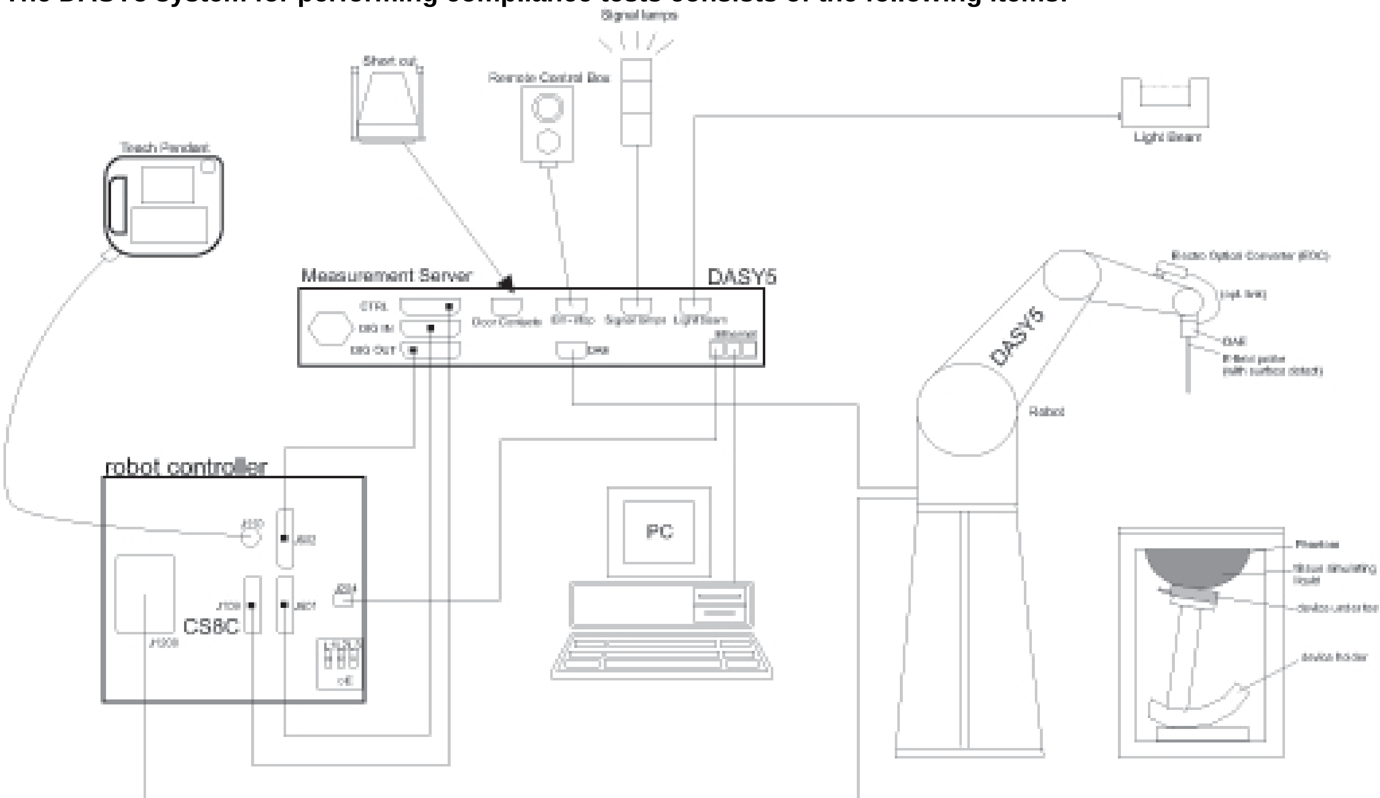
COMPLIANCE CERTIFICATION SERVICES (UL CCS) FORM NO: CCSUP4031B
47173 BENICIA STREET, FREMONT, CA 94538, USA TEL: (510) 771-1000 FAX: (510) 661-0888

4.2. Measurement Uncertainty

Measurement uncertainty for 300 MHz to 3 GHz averaged over 1 gram					
Component	error, %	Probe Distribution	Divisor	Sensitivity	U (Xi), %
Measurement System					
Probe Calibration (k=1)	5.50	Normal	1	1	5.50
Axial Isotropy	1.15	Rectangular	1.732	0.7071	0.47
Hemispherical Isotropy	2.30	Rectangular	1.732	0.7071	0.94
Boundary Effect	0.90	Rectangular	1.732	1	0.52
Probe Linearity	3.45	Rectangular	1.732	1	1.99
System Detection Limits	1.00	Rectangular	1.732	1	0.58
Readout Electronics	0.30	Normal	1	1	0.30
Response Time	0.80	Rectangular	1.732	1	0.46
Integration Time	2.60	Rectangular	1.732	1	1.50
RF Ambient Conditions - Noise	3.00	Rectangular	1.732	1	1.73
RF Ambient Conditions - Reflections	3.00	Rectangular	1.732	1	1.73
Probe Positioner Mechanical Tolerance	0.40	Rectangular	1.732	1	0.23
Probe Positioning with respect to Phantom	2.90	Rectangular	1.732	1	1.67
Extrapolation, Interpolation and Integration	1.00	Rectangular	1.732	1	0.58
Test Sample Related					
Test Sample Positioning	2.90	Normal	1	1	2.90
Device Holder Uncertainty	3.60	Normal	1	1	3.60
Output Power Variation - SAR Drift	5.00	Rectangular	1.732	1	2.89
Phantom and Tissue Parameters					
Phantom Uncertainty (shape and thickness)	4.00	Rectangular	1.732	1	2.31
Liquid Conductivity - deviation from target	5.00	Rectangular	1.732	0.64	1.85
Liquid Conductivity - measurement	3.26	Normal	1	0.64	2.09
Liquid Permittivity - deviation from target	5.00	Rectangular	1.732	0.6	1.73
Liquid Permittivity - measurement uncertainty	-3.19	Normal	1	0.6	-1.91
Combined Standard Uncertainty Uc(y) =					9.86
Expanded Uncertainty U, Coverage Factor = 2, > 95 % Confidence =				19.71	%
Expanded Uncertainty U, Coverage Factor = 2, > 95 % Confidence =				1.56	dB

5. Measurement System Description and Setup

The DASY5 system for performing compliance tests consists of the following items:



- A standard high precision 6-axis robot with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- An isotropic Field probe optimized and calibrated for the targeted measurement.
- A data acquisition electronics (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
- The Electro-optical converter (EOC) performs the conversion from optical to electrical signals for the digital communication to the DAE. To use optical surface detection, a special version of the EOC is required. The EOC signal is transmitted to the measurement server.
- The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- The Light Beam used is for probe alignment. This improves the (absolute) accuracy of the probe positioning.
- A computer running WinXP or Win7 and the DASY5 software.
- Remote control and teach pendant as well as additional circuitry for robot safety such as warning lamps, etc.
- The phantom, the device holder and other accessories according to the targeted measurement.

6. SAR Measurement Procedures

6.1. Normal SAR Measurement Procedure

Step 1: Power Reference Measurement
The Power Reference Measurement and Power Drift Measurements are for monitoring the power drift of the device under test in the batch process. The Minimum distance of probe sensors to surface determines the closest measurement point to phantom surface. The minimum distance of probe sensors to surface is 2.1 mm. This distance cannot be smaller than the Distance of sensor calibration points to probe tip as defined in the probe properties.

Step 2: Area Scan
The Area Scan is used as a fast scan in two dimensions to find the area of high field values, before doing a fine measurement around the hot spot. The sophisticated interpolation routines implemented in DASY software can find the maximum locations even in relatively coarse grids. When an Area Scan has measured all reachable points, it computes the field maximal found in the scanned area, within a range of the global maximum. The range (in dB) is specified in the standards for compliance testing. For example, a 2 dB range is required in IEEE Standard 1528 and IEC 62209 standards, whereby 3 dB is a requirement when compliance is assessed in accordance with the ARIB standard (Japan). If only one Zoom Scan follows the Area Scan, then only the absolute maximum will be taken as reference. For cases where multiple maximums are detected, the number of Zoom Scans has to be increased accordingly.

Step 3: Zoom Scan
Zoom Scans are used to assess the peak spatial SAR values within a cubic averaging volume containing 1 g and 10 g of simulated tissue. The Zoom Scan measures ≥ 7x7x9 (above 4.5 GHz) or 5x5x7 (below 3 GHz) points within a cube whose base faces are centered on the maxima found in a preceding area scan job within the same procedure. When the measurement is done, the Zoom Scan evaluates the averaged SAR for 1 g and 10 g and displays these values next to the job's label.

Step 4: Power drift measurement
The Power Drift Measurement measures the field at the same location as the most recent power reference measurement within the same procedure, and with the same settings. The Power Drift Measurement gives the field difference in dB from the reading conducted within the last Power Reference Measurement. This allows a user to monitor the power drift of the device under test within a batch process. The measurement procedure is the same as Step 1.

Step 5: Z-Scan
The Z Scan measures points along a vertical straight line. The line runs along the Z-axis of a one-dimensional grid. In order to get a reasonable extrapolation, the extrapolated distance should not be larger than the step size in Z-direction.

6.2. Volume Scan Procedures

Step 1: Power Reference Measurement
The Power Reference Measurement and Power Drift Measurements are for monitoring the power drift of the device under test in the batch process. The Minimum distance of probe sensors to surface determines the closest measurement point to phantom surface. The minimum distance of probe sensors to surface is 2.1 mm. This distance cannot be smaller than the Distance of sensor calibration points to probe tip as defined in the probe properties.

Step 2: Area Scan
The Area Scan is used as a fast scan in two dimensions to find the area of high field values, before doing a fine measurement around the hot spot. The sophisticated interpolation routines implemented in DASY software can find the maximum locations even in relatively coarse grids. When an Area Scan has measured all reachable points, it computes the field maximal found in the scanned area, within a range of the global maximum. The range (in dB) is specified in the standards for compliance testing. For example, a 2 dB range is required in IEEE Standard 1528 and IEC 62209 standards, whereby 3 dB is a requirement when compliance is assessed in accordance with the ARIB standard (Japan). If only one Zoom Scan follows the Area Scan, then only the absolute maximum will be taken as reference. For cases where multiple maximums are detected, the number of Zoom Scans has to be increased accordingly.

Step 3: Zoom Scan
Zoom Scans are used to assess the peak spatial SAR values within a cubic averaging volume containing 1 g and 10 g of simulated tissue. The Zoom Scan measures ≥ 7x7x9 (above 4.5 GHz) or 5x5x7 (below 3 GHz) points within a cube whose base faces are centered on the maxima found in a preceding area scan job within the same procedure. When the measurement is done, the Zoom Scan evaluates the averaged SAR for 1 g and 10 g and displays these values next to the job's label.

Step 4: Volume Scan
Volume Scans are used to assess peak SAR and averaged SAR measurements in largely extended 3-dimensional volumes within any phantom. This measurement does not need any previous area scan. The grid can be anchored to a user specific point or to the current probe location.

Step 5: Power drift measurement
The Power Drift Measurement measures the field at the same location as the most recent power reference measurement within the same procedure, and with the same settings. The Power Drift Measurement gives the field difference in dB from the reading conducted within the last Power Reference Measurement. This allows a user to monitor the power drift of the device under test within a batch process. The measurement procedure is the same as Step 1.

COMPLIANCE CERTIFICATION SERVICES (UL CCS) FORM NO: CCSUP4031B
47173 BENICIA STREET, FREMONT, CA 94538, USA TEL: (510) 771-1000 FAX: (510) 661-0888

7. Device Under Test

CDMA+WIMAX+WIFI+LTE MOBILE HOT SPOT Model: AC803S	
Normal operation:	Body and Wireless Router (Hotspot) Front, Rear and Edges (Edge 1, 2, 3, and 4): Multiple display orientations supporting both portrait and landscape configurations

7.1. Band and air interlaces

Air Interfaces:	CDMA BC 1: 1850 - 1910 MHz LTE Band 25: 1850 - 1915 MHz WiFi: 802.11bgn: 2.4 GHz WiMAX: 5 MHz BW: 2498.5 - 2687.5 MHz 10 MHz BW:2501 – 2685 MHz

7.2. Personal Hotspot Mode

The device is capable of personal hotspot mode with a form factor > 9 cm x 5 cm (~3.5" x 2"). The hotspot mode can be enabled by the users.

7.3. Simultaneous Transmission Conditions

No	Simultaneous Transmission	Head	Body	Hot-spot
1	CDMA + WiFi 2.4 GHz	☐	☐	☒
2	LTE + WiFi 2.4 GHz	☐	☐	☒
3	WiMAX + WiFi 2.4 GHz	☐	☐	☒

7.4. 802.116e/WiMax Device & System Operating Parameters

Description	Parameter	Comment/notes
FCC ID	N7NAC803	CDMA+WIMAX+WIFI+LTE MOBILE HOT SPOT
Radio Service	Part 27 subpart M	Rule parts
Transmit Freq. Range (MHz)	5 MHz BW: 2498.5 – 2687.5 10MHz BW:2501 - 2685	System parameter
System/Ch. Bandwidth (MHz)	5 / 10M	System parameter
Modulation Schemes	QPSK, 16QAM	Identify all applicable UL modulations
Sample Time (ns)	5MHz BW:178usec 10MHz BW:89.3usec	(1/Fs)
FFT Size (NFFT)	5 MHz BW: 512 10 MHz BW: 1024	(NFFT)
Sub-Carrier Spacing (kHz)	10.9375	(If)
Useful Symbol time (µs)	91.43	(Tb=1/Δf)
Guard Time (µs)	11.43	(Tag=Tb/cp); cp = cyclic prefix
OFDMA Symbol Time (µs)	102.85714	(Ts=Tibet)
Frame Size (ms)	5	System parameter
TTG + RTG (µs or number of symbols)	165.7143us	Idle time, system parameter
DL:UL Symbol Ratio	29:18,	For determining UL duty factor
Power Class (dBm)	Power Class 2 16QAM: 21 <= PTx,max < 25 QPSK: 23 <= PTx,max < 27	
Wave1 / Wave2	Wave 2: two antennas. Antenna1 (main) is TX/RX diversity antenna, Antenna 2(aux) is TX/RX diversity antenna. Antenna 1 and Antenna 2 cannot transmit simultaneously.	
UL Zone Types (e.g. FUSC, PUSC, OFUSC, OPUSC, AMC, TUSC1, TUSC2)	PUSC only	
Maximum Number of UL Sub-Carriers	**10 MHz BW**	**5 MHz BW**
	Null Sub-Carriers=184 Pilot Sub-Carriers=280 Data Sub-Carriers=560	Null Sub-Carriers=104 Pilot Sub-Carriers=136 Data Sub-Carrier=272
Measured UL Burst Maximum Average Conducted Power		See Section 6
UL Control System Configuration	3 (Ranging, CQICH, HARQ ACK/NACK) HARQ ACKCH is used for transmission of ACK/NACK for downlink HARQ burst. HARQ allows BS to employ aggressive link adaptation to improve system throughput. CQICH is used for transmission of CQI information from MS to BS. BS may utilize this information for link adaptation and handover decision. MS is configured by BS to transmit CQI every Nth frame, which implies that CQI feedback delay is determined by BS configuration. BS determines CQI period N as a result of trade-off between CQI overhead and CQI accuracy.	
UL Burst Peak-to-Average (Conducted) Power Ratio (PAPR)		See Section 7
Frame Averaged UL Transmission Duty Factor (%)		See Section 5.6

7.5. DUT Description

a. The Sierra Wireless WiMAX Router + WiFi Router, model no: AC803 is equipped with WiFi and 2.6 GHz WiMAX radio capabilities.
b. AC803 transmits on 5 ms frames using 5 MHz and 10 MHz channels. The 10 MHz channel bandwidth uses 1024 sub-carriers and 35 sub-channels, with 184 null sub-carriers and 840 available for transmission, consisting of 560 data sub-carriers and 280 pilot sub-carriers. The 5 MHz channel bandwidth uses 512 sub-carriers and 17 sub-channels, with 104 null sub-carriers and 408 available for transmission, consisting 272 data sub-carriers and 136 pilot sub-carriers.
c. The 802.16e WiMAX and WiFi radio can transmit simultaneously.

7.6. WiMax Zone Types

The device and its system are both transmitting using only PUSC zone type. This enables multiple users to transmit simultaneously within the system. FUSC, AMC and other zone types are not used by AC803 for uplink transmission. The maximum DL:UL symbol ratio can be determined according to the PUSC requirements. The system transmit an odd number of symbols using DL-PUSL consisting of even multiples of traffics and control symbols plus one symbol for the preamble. Multiples of three symbols are transmitted by the device using UL-PUSC. The OFDMA symbol time allows up to 48 downlink and uplink symbols in each 5 ms frame. TTG and RTG are also included in each frame as DL/UL transmission gaps; therefore, the system can only allow 47 or less symbols per frame. The maximum DL:UL symbol ratio is determined according to these PUSC parameters for evaluating SAR compliance.

WiMAX chipset is capable of supporting the following Downlink / Uplink based upon 802.16e.

Description	Down Link	Up Link
Number of OFDM Symbols in Down Link and Up Link for 5 MHz and 10 MHz Bandwidth	35	12
	34	13
	32	15
	31	16
	30	17
	29	18
	28	19
	27	20
	26	21

7.7. Duty Factor Considerations

a. All Test Vector are performing with all UL symbols at maximum power.

b. Although the chipset can supply higher downlink-to-uplink (DL/UL) symbol ratios, SAR values are scaled up or down based upon BRS/EBS WiMAX operators with agreements to transmit at a maximum DL/UL symbol ratio of 29:18 Vs actual UL traffic symbols were used during SAR measurement. Therefore, the maximum transmission duty factor supported by the chipset is not applicable for this device. The system can transmit up to 48 OFDMA symbols in each 5 ms frame, including 1.6 symbols for TTG and RTG.

c. UL Burst Max. Average Power was measured using spectrum analyzer gated to measure the power only during Tx “On” stage.

d. The control channels may occupy up to 5 slots during normal operation. A slot is a sub-channel with the duration of 3 symbols. There are a total of 35 slots in the 10 MHz channel configuration

e. The control channels may occupy up to 5 slots during normal operation. A slot is a sub-channel with the duration of 3 symbols. There are a total of 17 slots in the 5 MHz channel configuration.

f. When the device is transmitting at max rated power, the output power for the control symbol and the target output power for UL:DL ratio of 29:18 is calculated as the following:

Ch. BW	Mode	Waveform file	DL:UL Ratio	DL:UL Ration SAR Scaling Factor
5 MHz	QPSK	T5D29U184Q12S85	29:18	[(Max. Rated pwr*5/17*3)+Max. Rated pwr*15]/[Actual pwr*15]
	16 QAM	T5D29U1816Q12S85	29:18	[Max. Rated pwr*5/17*3)+Max. Rated pwr*15]/[Actual pwr*15]
10 MHz	QPSK	T10D29U184Q34S175	29:18	[(Max. Rated pwr*5/35*3)+Max. Rated pwr*15]/[Actual pwr*12]
	16 QAM	T10D29U1816Q12S175	29:18	[(Max. Rated pwr*5/35*3)+Max. Rated pwr*15]/[Actual pwr*12]

7.8. Signal Generator Details

Frame Profile loaded in Vector Signal Generator:

Ch. BW	Mode	Test Vector file name	DL:UL Ratio	Calculated Duty Factor [((UL-3)*102.857)/5000]
5 MHz	QPSK	T5D29U184Q12S85	29 : 18	30.86 %
	16QAM	T5D29U1816Q12S85	29 : 18	30.86 %
10 MHz	QPSK	T10D29U184Q34S175	29 : 18	30.86 %
	16QAM	T10D29U1816Q12S175	29 : 18	30.86 %

Crest Factor: The SAR of this device is measured using a DL: UL symbol ratio of 29:18, consisting of 15 traffic symbols and 3 control symbols are not activated. A duty factor of (15 x 102.857μs)/5000μs = 30.86% is applied by the SAR system to calculate the measured SAR. The cf factor, a conversion factor related to 1/(duty factor), used by SAR measurement systems for periodic pulse signal compensation is set to 1/0.3086 = 3.24.

Note: On the spectrum analyzer plots, very small power level corresponding to the noise floor of the TX in these first three control symbols. The remaining 15 symbols are fully occupied with a TX burst which uses all slots and therefore all sub channels.

8. RF Output Power Measurement

The maximum conducted output power is measured for the uplink burst in the difference modulation and channel bandwidth. The output power is measured for the uplink bursts through triggering and gating.

Ch BW	Mode	Test Vector file name	Freq.	Output Power (dBm)			
				Antenna 1		Antenna 2	
			(MHz)	(dBm)	(mW)	(dBm)	(mW)
5 MHz	QPSK	T5D29U184Q12S85	2498.5	**22.7**	**187.9**	**22.7**	**187.5**
			2593.0	22.2	167.1	22.3	169.8
			2687.5	22.6	182.4	22.7	187.5
		T5D29U184Q34S85	2498.5	22.7	186.2	22.7	186.2
			2593.0	22.2	167.1	22.2	166.7
			2687.5	22.6	183.7	22.7	186.2
	16QAM	T5D29U1816Q12S85	2498.5	**22.8**	**189.2**	**22.7**	**187.1**
			2593.0	22.3	168.3	22.4	171.8
			2687.5	22.6	182.4	22.6	181.6
		T5D29U1816Q34S85	2498.5	22.7	187.5	22.7	186.2
			2593.0	22.2	166.3	22.2	166.7
			2687.5	22.6	181.1	22.6	183.7
10 MHz	QPSK	T10D29U184Q12S175	2501.0	**22.9**	**194.5**	**22.9**	**195.0**
			2596.0	22.3	169.4	22.4	172.6
			2685.0	22.8	191.9	22.9	195.4
		T10D29U184Q34S175	2501.0	22.9	194.5	23.0	197.7
			2596.0	22.3	169.4	22.3	171.0
			2685.0	22.8	191.9	22.9	195.4
	16QAM	T10D29U1816Q12S175	2501.0	**22.9**	**196.3**	**22.8**	**191.0**
			2596.0	22.3	169.8	22.2	167.1
			2685.0	22.8	189.2	22.8	189.2
		T10D29U1816Q34S175	2501.0	22.8	191.4	22.8	190.5
			2596.0	22.2	166.7	22.2	164.1
			2685.0	22.7	187.9	22.8	190.1

9. Peak-to-Average Power Ratio

Peak and Average Output power measurements were made with Power Meter.

Ch. BW	Mode	Test Vector file name	Freq. (MHz)	Conducted Power (dBm)		Peak-to-average ratio (PAR)
				Peak	Average	
5 MHz	QPSK	T5D29U184Q12S85	2498.5	30.9	22.7	8.2
	16QAM	T5D29U1816Q12S85	2498.5	30.9	22.8	8.1
10 MHz	QPSK	T10D29U184Q12S175	2501	31.1	22.9	8.2
	16QAM	T10D29U1816Q12S175	2501	31.1	22.9	8.2

10. Tissue Dielectric Properties

IEEE Std 1528-2003 Table 2

Target Frequency (MHz)	Head	
	ε_r	σ (S/m)
300	45.3	0.87
450	43.5	0.87
835	41.5	0.90
900	41.5	0.97
1450	40.5	1.20
1800 – 2000	40.0	1.40
2450	39.2	1.80
2600	39.0	1.96
3000	38.5	2.40

FCC OET Bulletin 65 Supplement C 01-01 & IC RSS-102

Target Frequency (MHz)	Head		Body	
	ε_r	σ (S/m)	ε_r	σ (S/m)
150	52.3	0.76	61.9	0.8
300	45.3	0.87	58.2	0.92
450	43.5	0.87	56.7	0.94
835	41.5	0.9	55.2	0.97
900	41.5	0.97	55	1.05
915	41.5	0.98	55	1.06
1450	40.5	1.2	54	1.3
1610	40.3	1.29	53.8	1.4
1800 – 2000	40	1.4	53.3	1.52
2450	39.2	1.8	52.7	1.95
3000	38.5	2.4	52	2.73
5000	36.2	4.45	49.3	5.07
5100	36.1	4.55	49.1	5.18
5200	36.0	4.66	49.0	5.30
5300	35.9	4.76	48.9	5.42
5400	35.8	4.86	48.7	5.53
5500	35.6	4.96	48.6	5.65
5600	35.5	5.07	48.5	5.77
5700	35.4	5.17	48.3	5.88
5800	35.3	5.27	48.2	6.00

10.1. Composition of Ingredients for the Tissue Material Used in the SAR Tests

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

Ingredients (% by weight)	Frequency (MHz)									
	450		835		915		1900		2450	
Tissue Type	Head	Body	Head	Body	Head	Body	Head	Body	Head	Body
Water	38.56	51.16	41.45	52.4	41.05	56.0	54.9	40.4	62.7	73.2
Salt (NaCl)	3.95	1.49	1.45	1.4	1.35	0.76	0.18	0.5	0.5	0.04
Sugar	56.32	46.78	56.0	45.0	56.5	41.76	0.0	58.0	0.0	0.0
HEC	0.98	0.52	1.0	1.0	1.0	1.21	0.0	1.0	0.0	0.0
Bactericide	0.19	0.05	0.1	0.1	0.1	0.27	0.0	0.1	0.0	0.0
Triton X-100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	36.8	0.0
DGBE	0.0	0.0	0.0	0.0	0.0	0.0	44.92	0.0	0.0	26.7
Dielectric Constant	43.42	58.0	42.54	56.1	42.0	56.8	39.9	54.0	39.8	52.5
Conductivity (S/m)	0.85	0.83	0.91	0.95	1.0	1.07	1.42	1.45	1.88	1.78

Salt: 99+% Pure Sodium Chloride Sugar: 98+% Pure Sucrose
Water: De-ionized, 16 MΩ+ resistivity HEC: Hydroxyethyl Cellulose
DGBE: 99+% Di(ethylene glycol) butyl ether, [2-(2-butoxyethoxy)ethanol]
Triton X-100 (ultra pure): Polyethylene glycol mono [4-(1,1, 3, 3-tetramethylbutyl)phenyl]ether

10.2. Tissue Dielectric Parameters Check Results

Date	Freq. (MHz)	Liquid Parameters			Measured	Target	Delta (%)	Limit ±(%)
12/20/2011	Body 2500	e'	51.3436	Relative Permittivity (ϵ_r):	51.34	52.64	-2.46	5
		e"	15.0073	Conductivity (σ):	2.09	2.02	3.26	5
	Body 2600	e'	51.0204	Relative Permittivity (ϵ_r):	51.02	52.51	-2.84	5
		e"	15.3893	Conductivity (σ):	2.22	2.16	2.96	5
	Body 2690	e'	50.7276	Relative Permittivity (ϵ_r):	50.73	52.40	-3.19	5
		e"	15.7271	Conductivity (σ):	2.35	2.29	2.84	5
12/22/2011	Body 2500	e'	52.4481	Relative Permittivity (ϵ_r):	52.45	52.64	-0.36	5
		e"	14.3526	Conductivity (σ):	2.00	2.02	-1.24	5
	Body 2600	e'	52.1222	Relative Permittivity (ϵ_r):	52.12	52.51	-0.74	5
		e"	14.7083	Conductivity (σ):	2.13	2.16	-1.59	5
	Body 2690	e'	51.8391	Relative Permittivity (ϵ_r):	51.84	52.40	-1.07	5
		e"	15.0056	Conductivity (σ):	2.24	2.29	-1.87	5

11. System Performance Check

The system performance check is performed prior to any usage of the system in order to verify SAR system measurement accuracy. The system performance check verifies that the system operates within its specifications of ±10%.

11.1. System Performance Check Measurement Conditions

- The measurements were performed in the flat section of the TWIN SAM or ELI phantom, shell thickness: 2.0 ±0.2 mm (bottom plate) filled with Body or Head simulating liquid of the following parameters.
- The DASY system with an E-Field Probe was used for the measurements.
- The dipole was mounted on the small tripod so that the dipole feed point was positioned below the center marking of the flat phantom section and the dipole was oriented parallel to the body axis (the long side of the phantom). The standard measuring distance was 10 mm (above 1 GHz) and 15 mm (below 1 GHz) from dipole center to the simulating liquid surface.
- The coarse grid with a grid spacing of 15 mm was aligned with the dipole.
  For 5 GHz band - The coarse grid with a grid spacing of 10 mm was aligned with the dipole.
- Special 7x7x7 fine cube was chosen for cube.
- Distance between probe sensors and phantom surface was set to 3 mm.
  For 5 GHz band - Distance between probe sensors and phantom surface was set to 2.5 mm
- The dipole input power (forward power) was 100 mW.
- The results are normalized to 1 W input power.

11.2. Reference SAR Values for System Performance Check

The reference SAR values can be obtained from the calibration certificate of system validation dipoles

System validation dipole	Serial No.	Cal. date	Cal. Freq. (GHz)	SAR Avg (mW/g)		
				Tissue:	Head	Body
D2600V2	1006	4/7/11	2.6	1g SAR:	59.2	58.0
				10g SAR:	26.2	25.4

11.3. System Check Results

Date Tested	System validation dipole		Measured (Normalized to 1 W)		Target	Delta (%)	Tolerance (%)
12/20/11	Body	2600	1g SAR:	56.1	58.0	-3.28	±10
			10g SAR:	24.6	25.4	-3.15	
12./22	Body	2600	1g SAR:	54.3	58.0	-6.38	±10
			10g SAR:	23.7	25.4	-6.69	

12. Summary of Test Configurations

The following test configurations are based on 941225 D06 Hot Spot SAR v01

Test Configuration	Antenna-to-edge/surface	SAR Required	note
Front	5.01 mm	Yes	
Rear	15.35 mm	Yes	
Edge 1	36.53 mm	No	SAR is not required due to antenna-to-edge's distance is greater than 25 mm.
Edge 2	4.31 mm	Yes	Antenna 2
Edge 3	3.97 mm	Yes	
Edge 4	4.31 mm	Yes	Antenna 1

13. SAR Test Results

Test mode reduction considerations

The 16QAM SAR is not required, due to the 16QAM maximum output power is ≤ 1/4 dB higher than QPSK and QPSK SAR is < 0.8 mW/g.

Test position	dist. (mm)	BW (MHz)	Mode	Test vector file name	Antenna	Calculated		Freq. (MHz)	Output power		Scale Factors	1 g SAR (W/kg)		Note
						Duty Cycle (%)	Crest Factor		Actual dBm	Max. Rated dBm		Measured	Scaled	
Front	10	5	QPSK	T5D29U184Q12S85	1	30.86	3.24	2498.5	22.7	23.0	1.35	0.281	0.379	
								2593.0	22.2	23.0	1.51			1
								2687.5	22.6	23.0	1.38			1
					2	30.86	3.24	2498.5	22.7	23.0	1.35	0.186	0.251	
								2593.0	22.3	23.0	1.48			1
								2687.5	22.7	23.0	1.35			1
		10	QPSK	T10D29U184Q12S175	1	30.86	3.24	2501.0	22.9	23.0	1.32	0.283	0.372	
								2596.0	22.3	23.0	1.51			1
								2685.0	22.8	23.0	1.35			1
					2	30.86	3.24	2501.0	22.9	23.0	1.32	0.189	0.249	
								2596.0	22.4	23.0	1.48			1
								2685.0	22.9	23.0	1.32			1
Rear	10	5	QPSK	T5D29U184Q12S85	1	30.86	3.24	2498.5	22.7	23.0	1.35	0.216	0.291	
								2593.0	22.2	23.0	1.51			1
								2687.5	22.6	23.0	1.38			1
					2	30.86	3.24	2498.5	22.7	23.0	1.35	0.187	0.252	
								2593.0	22.3	23.0	1.48			1
								2687.5	22.7	23.0	1.35			1
		10	QPSK	T10D29U184Q12S175	1	30.86	3.24	2501.0	22.9	23.0	1.32	0.214	0.282	
								2596.0	22.3	23.0	1.51			1
								2685.0	22.8	23.0	1.35			1
					2	30.86	3.24	2501.0	22.9	23.0	1.32	0.180	0.237	
								2596.0	22.4	23.0	1.48			1
								2685.0	22.9	23.0	1.32			1
Edge 2	10	5	QPSK	T5D29U184Q12S85	2	30.86	3.24	2498.5	22.7	23.0	1.35	0.221	0.298	
								2593.0	22.2	23.0	1.51			1
								2687.5	22.6	23.0	1.38			1
		10	QPSK	T10D29U184Q12S175	2	30.86	3.24	2501.0	22.9	23.0	1.32	0.220	0.289	
								2596.0	22.3	23.0	1.51			1
								2685.0	22.8	23.0	1.35			1
Edge 4	10	5	QPSK	T5D29U184Q12S85	1	30.86	3.24	2498.5	22.7	23.0	1.35	0.315	**0.425**	
								2593.0	22.2	23.0	1.51			1
								2687.5	22.6	23.0	1.38			1
		10	QPSK	T10D29U184Q12S175	1	30.86	3.24	2501.0	22.9	23.0	1.32	0.313	**0.412**	
								2596.0	22.3	23.0	1.51			1
								2685.0	22.8	23.0	1.35			1

Note(s):

1. SAR test was performed in the middle channel only as the measured level was < 50% of the SAR limit (1.6W/kg).
2. "*cf*": 1/(15/48) = 3.2 for 5 MHz and 1/(12/48) = 4.0 for 10 MHz
3. Scale factors for 5MHz, 29:18 UL:DL Ratio = [(Max. Rated pwr*5/17*3) + (Max. Rated pwr*15)] / Actual pwr*15)]
4. Scale factors for 10MHz, 29:18 UL:DL Ratio = [(Max. Rated pwr*5/35*3) + (Max. Rated pwr*15)] / Actual pwr*12)]

SAR Test Results (Continued)

Test position	dist. (mm)	BW (MHz)	Mode	Test vector file name	Antenna	Calculated		Freq. (MHz)	Output power		Scale Factors	1 g SAR (W/kg)		Note
						Duty Cycle (%)	Crest Factor		Actual	Max. Rated		Measured	Scaled	
									dBm	dBm				
Edge 3	10	5	QPSK	T5D29U184Q12S85	1	30.86	3.24	2498.5	22.7	23.0	1.35	0.271	0.366	
								2593.0	22.2	23.0	1.51			1
								2687.5	22.6	23.0	1.38			1
					2	30.86	3.24	2498.5	22.7	23.0	1.35	0.273	0.368	
								2593.0	22.3	23.0	1.48			1
								2687.5	22.7	23.0	1.35			1
		10	QPSK	T10D29U184Q12S175	1	30.86	3.24	2501.0	22.9	23.0	1.32	0.260	0.342	
								2596.0	22.3	23.0	1.51			1
								2685.0	22.8	23.0	1.35			1
					2	30.86	3.24	2501.0	22.9	23.0	1.32	0.265	0.349	
								2596.0	22.4	23.0	1.48			1
								2685.0	22.9	23.0	1.32			1

Note(s):

1. SAR test was performed in the middle channel only as the measured level was < 50% of the SAR limit (1.6W/kg).
2. "*cf*": 1/(15/48) = 3.2 for 5 MHz and 1/(12/48) = 4.0 for 10 MHz
3. Scale factors for 5MHz, 29:18 UL:DL Ratio = [(Max. Rated pwr*5/17*3) + (Max. Rated pwr*15)] / Actual pwr*15)]
4. Scale factors for 10MHz, 29:18 UL:DL Ratio = [(Max. Rated pwr*5/35*3) + (Max. Rated pwr*15)] / Actual pwr*12)]

14. Summary of Highest SAR Values

Technology/Band	Test configuration	Mode	Separation distance (mm)	Highest 1g SAR (W/kg)
WiMAX	Edge 4	5MHz QPSK	10	0.425
WiMAX	Edge 4	10MHz QPSK	10	0.412

15. Highest (Worst-case) SAR Plots

Date: 12/21/2011

Test Laboratory: UL CCS SAR Lab C

WiMAX 2.6GHz

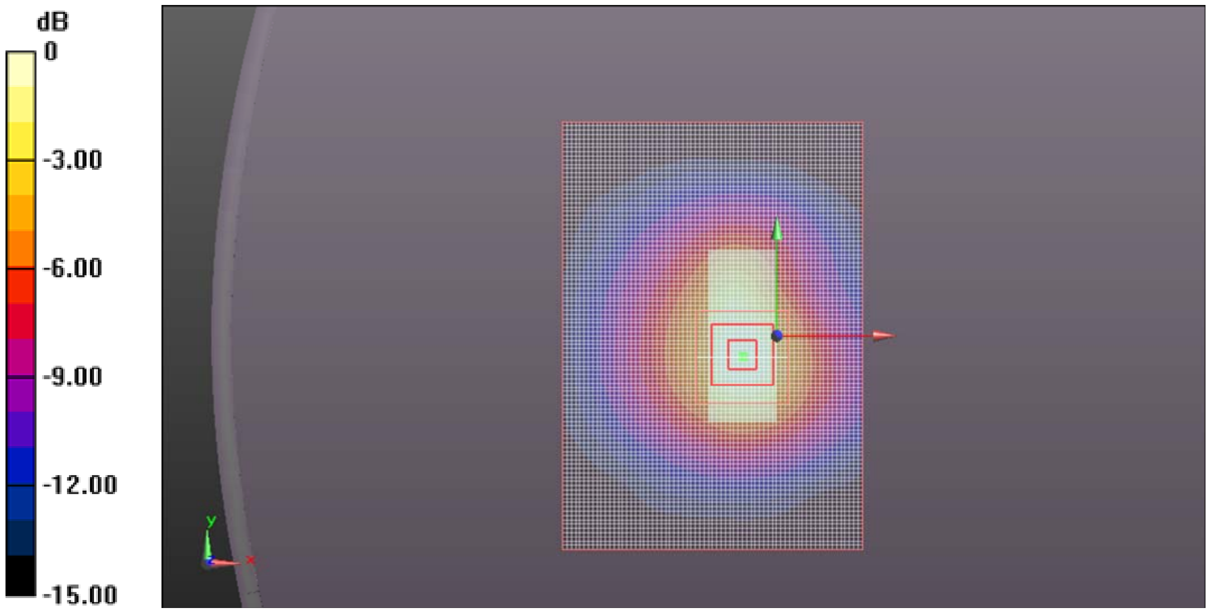
Communication System: IEEE 802.16e WiMAX, 5MHz; Frequency: 2498.5 MHz; Duty Cycle: 1:3.20037
Medium parameters used (interpolated): f = 2498.5 MHz; σ = 2.085 mho/m; ε_r = 51.349; ρ = 1000 kg/m^3
Phantom section: Flat Section

Room Ambient Temperature: 24.0 deg. C; Liquid Temperature: 23.0 deg. C

DASY5 Configuration:
- Area Scan setting - Find Secondary Maximum Within: 2.0 dB and with a peak SAR value greater than 0.0012W/kg
- Probe: EX3DV4 - SN3686; ConvF(6.86, 6.86, 6.86); Calibrated: 1/24/2011
- Sensor-Surface: 2.5mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1239; Calibrated: 10/18/2011
- Phantom: ELI v4.0 (A); Type: QDOVA001BB; Serial: 1117
- Measurement SW: DASY52, Version 52.6 (2);SEMCAD X Version 14.4.5 (3634)

Edge 4/5MHz_QPSK_Ant 1_L ch/Area Scan (71x101x1): Measurement grid: dx=15mm, dy=15mm
Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (interpolated) = 0.421 mW/g

Edge 4/5MHz_QPSK_Ant 1_L ch/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 13.583 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 0.599 W/kg
SAR(1 g) = 0.315 mW/g; SAR(10 g) = 0.166 mW/g
Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 0.424 mW/g



0 dB = 0.420mW/g

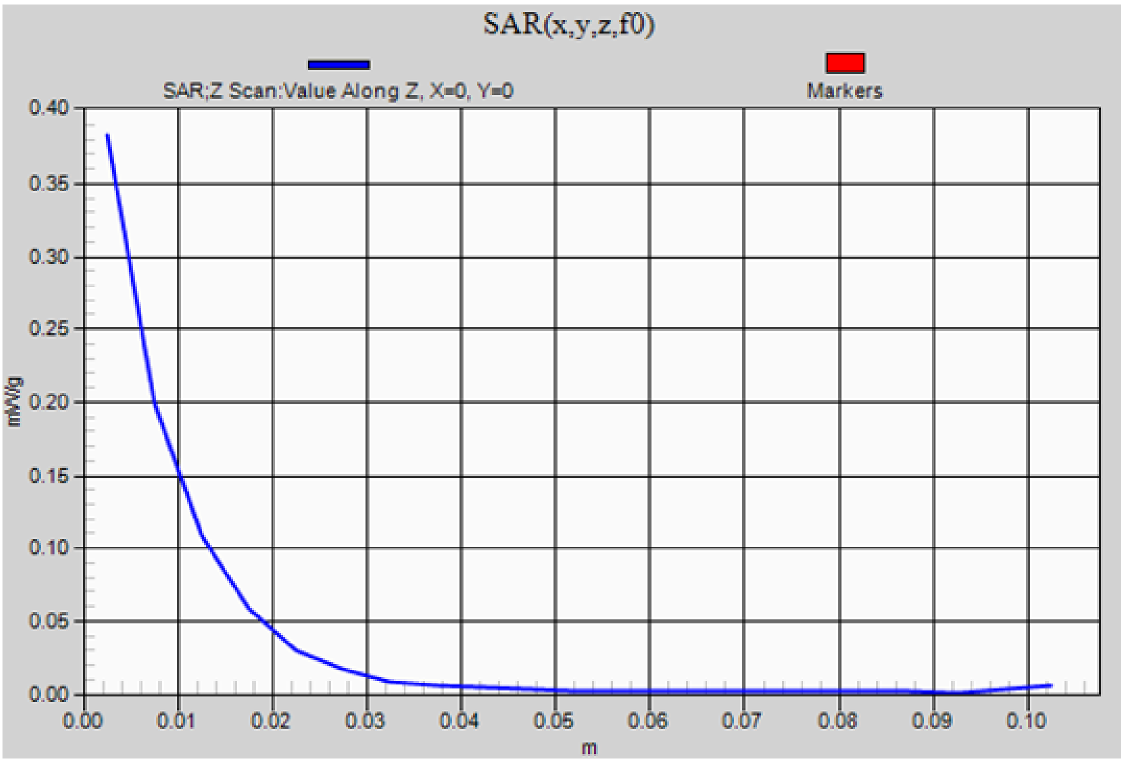
Date: 12/21/2011

Test Laboratory: UL CCS SAR Lab C

WiMAX 2.6GHz

Communication System: IEEE 802.16e WiMAX, 5MHz; Frequency: 2498.5 MHz; Duty Cycle: 1:3.20037

Edge 4/5MHz_QPSK_Ant 1_L ch/Z Scan (1x1x21): Measurement grid: dx=20mm, dy=20mm, dz=5mm
Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 0.383 mW/g



Date: 12/21/2011

Test Laboratory: UL CCS SAR Lab C

WiMAX 2.6GHz

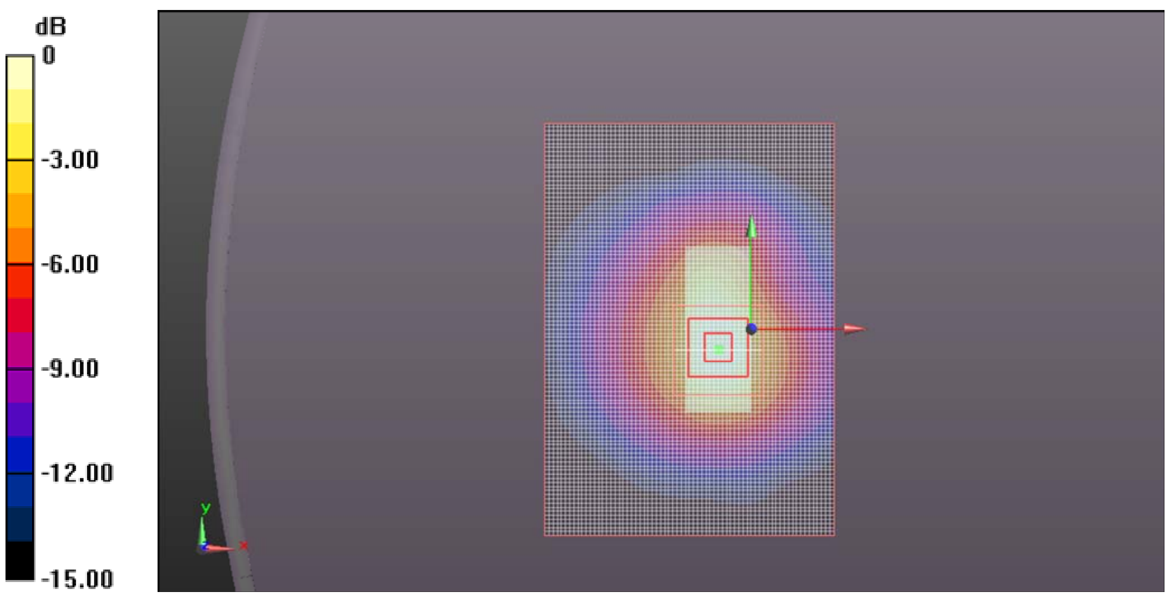
Communication System: IEEE 802.16e WiMAX, 10MHz; Frequency: 2501 MHz; Duty Cycle: 1:4.00037
Medium parameters used (interpolated): f = 2501 MHz; σ = 2.089 mho/m; ε_r = 51.341; ρ = 1000 kg/m^3
Phantom section: Flat Section

Room Ambient Temperature: 24.0 deg. C; Liquid Temperature: 23.0 deg. C

DASY5 Configuration:
- Area Scan setting - Find Secondary Maximum Within: 2.0 dB and with a peak SAR value greater than 0.0012W/kg
- Probe: EX3DV4 - SN3686; ConvF(6.78, 6.78, 6.78); Calibrated: 1/24/2011
- Sensor-Surface: 2.5mm (Mechanical Surface Detection (Locations From Previous Scan Used)), Sensor-Surface: 2.5mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1239; Calibrated: 10/18/2011
- Phantom: ELI v4.0 (A); Type: QDOVA001BB; Serial: 1117
- Measurement SW: DASY52, Version 52.6 (2);SEMCAD X Version 14.4.5 (3634)

Edge 4/10MHz_QPSK_Ant 1_L ch/Area Scan (71x101x1): Measurement grid: dx=15mm, dy=15mm
Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (interpolated) = 0.420 mW/g

Edge 4/10MHz_QPSK_Ant 1_L ch/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 13.538 V/m; Power Drift = -0.02 dB
Peak SAR (extrapolated) = 0.596 W/kg
SAR(1 g) = 0.313 mW/g; SAR(10 g) = 0.165 mW/g
Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 0.421 mW/g



0 dB = 0.420mW/g

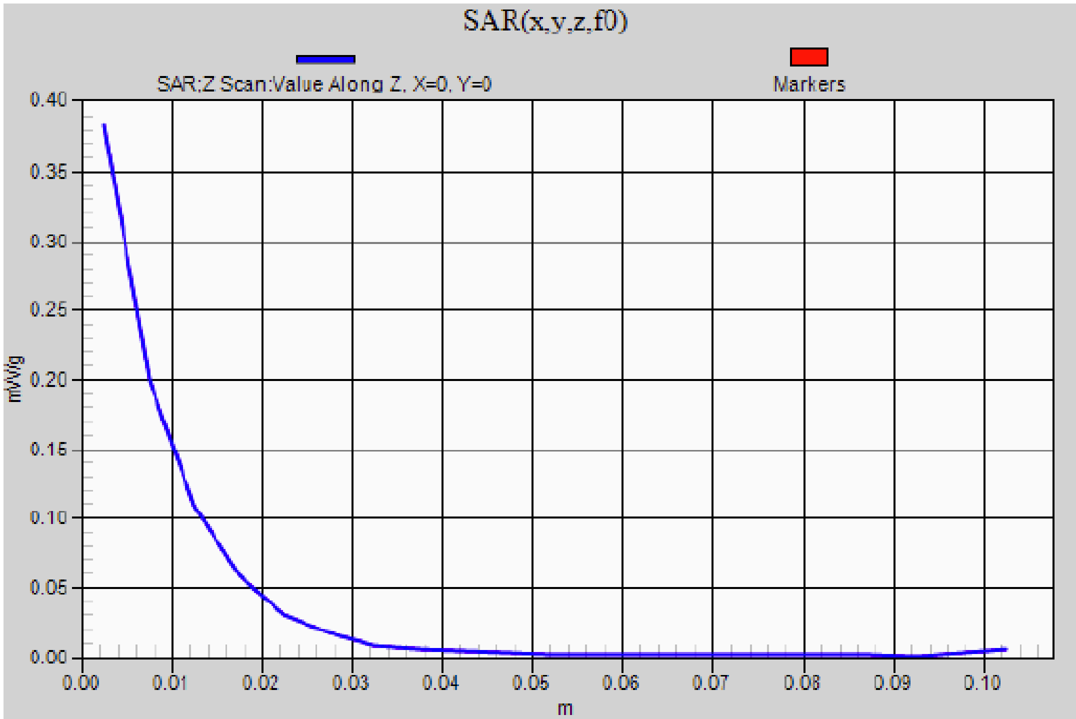
Date: 12/21/2011

Test Laboratory: UL CCS SAR Lab C

WiMAX 2.6GHz

Communication System: IEEE 802.16e WiMAX, 10MHz; Frequency: 2501 MHz; Duty Cycle: 1:4.00037

Edge 4/10MHz_QPSK_Ant 1_L ch/Z Scan (1x1x21): Measurement grid: dx=20mm, dy=20mm, dz=5mm
Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 0.371 mW/g



16. Simultaneous Transmission SAR Analysis

Body exposure condition (WiMAX + WiFi)

Test Position	Data			Sum of 1g SAR (mW/g)
	WiMAX (5MHz)	WiMAX (10MHz)	*WiFi 2.4G	
Front	0.379		0.183	0.562
Rear	0.291		0.027	0.318
Edge 2	0.298		0.013	0.311
Edge 4	0.425		0.011	0.436
Edge 1	0		0.023	0.023
Edge 3	0.368		0	0.368
Front		0.372	0.183	0.555
Rear		0.282	0.027	0.309
Edge 2		0.289	0.013	0.302
Edge 4		0.412	0.011	0.423
Edge 1		0	0.023	0.023
Edge 3		0.349	0	0.349

Note(s)

*: WiFi max. 1g SAR from SAR report 11U14068-6.

Conclusions:

Simultaneous transmission SAR measurement (volume scan) is not required due to the sum of the 1-g SAR is < 1.6 W/kg.

17. PAR and SAR Error Consideration

In order to estimate the measurement error due to PAR issues, the configuration with the highest SAR in each channel bandwidth and frequency band is measured at various power levels, from approximately 12.5 mW at approx. 3 dB steps, until the maximum power is reached.

In order to estimate the measurement error due to PAR issues, the configuration with the highest SAR in each channel bandwidth and frequency band is measured at various power levels, from approximately 10 mW at approx. 3 dB steps, until the maximum power is reached.

Procedure:

1. Position the EUT at flat phantom with the bottom of the PC in direct contact against a flat phantom and the display open to the maximum angle possible
2. Perform single point SAR evaluation with EUT power to be tuned at 10 - 15 mW.
3. Record the highest single point SAR value for each power setting as indicated above.
4. Without changing probe and EUT position increase the EUT power by 3 dB steps.

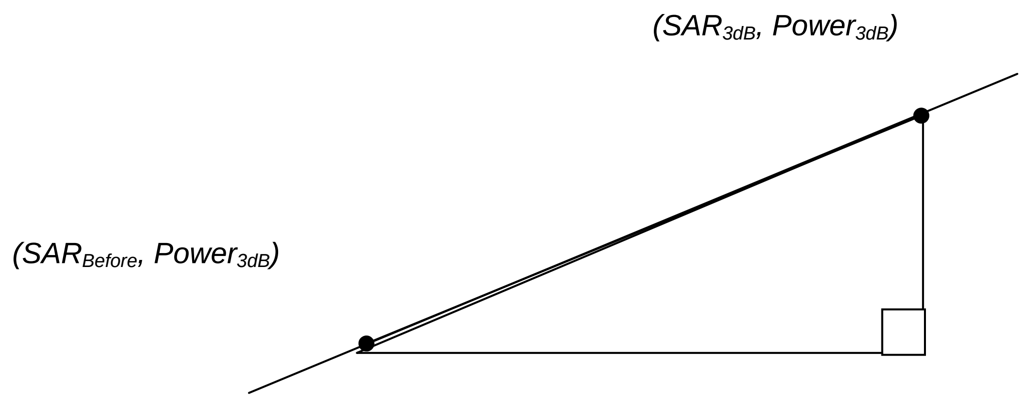
Assumption:

1. First single point SAR at power = 0 mW the SAR = 0 W/kg
2. SAR is linear to power only when the measurement probe sensors are operating within the square-law region.

Linear Line:

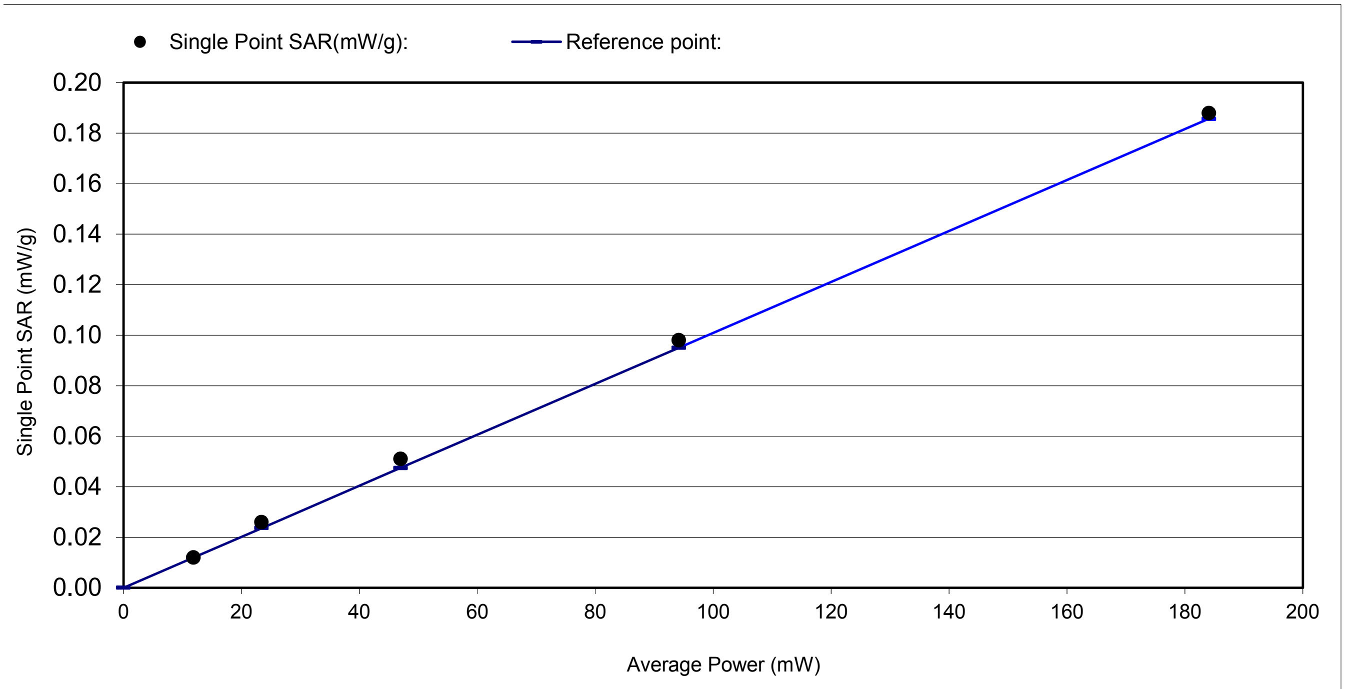
The actual measure output power has an tolerance due to the accuracy of the power sensors, RF cable and attenuator therefore the measure power will exhibited a +/- 0.05 % error. When power is set to 10 mW and SAR value “x” is known the next value on the Linear Line at approximately 3 dB up can be calculated as follow:

$SAR_{3dB} = (SAR_{Before} \times Power_{3dB}) / Power_{Before}$



Measurement Result for 5 MHz, QPSK

3dB Steps:	2nd	3rd	4th	5th	6th
Average Power (dBm):	10.75	13.70	16.72	19.74	22.65
Average Power (mW):	11.90	23.44	46.99	94.19	184.08
Single Point SAR(mW/g):	0.012	0.026	0.051	0.098	0.188
Reference point:	0.012	0.024	0.047	0.095	0.186
Estimated (%):	0.000	9.949	7.594	3.144	1.246



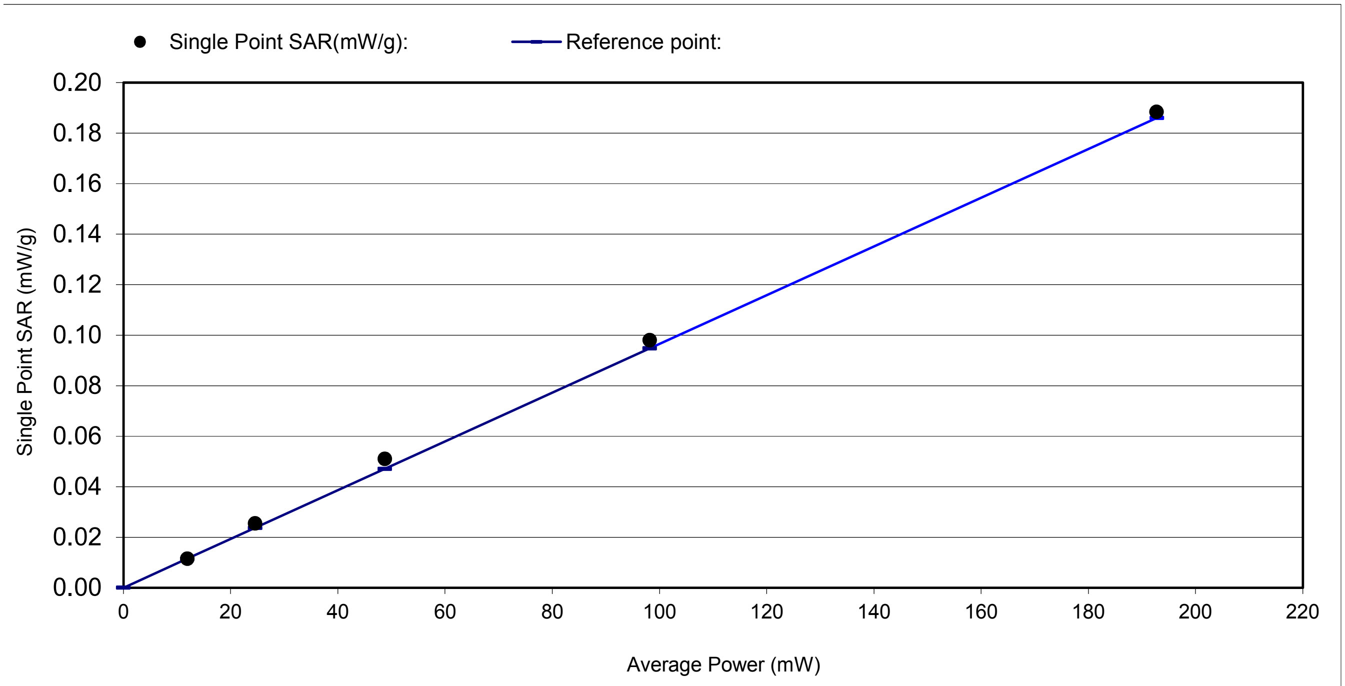
Procedure in establishing linear line (SAR):

1st reference point = 0 mW/g when power = 0 mW
2nd reference point: 0.012 mW/g @ 11.90 mW
3rd reference point: (0.012 * 23.44 mW) / 11.90 mW = 0.024
4th reference point: (0.024 * 46.99 mW) / 23.44 mW = 0.047
5th reference point: (0.047 * 94.19 mW) / 46.99 mW = 0.095
6th reference point: (0.095 * 184.08 mW) / 94.19 mW = 0.186

Draw a reference line from first reference point to sixth reference point.

Measurement Result for 10 MHz, QPSK

3dB Steps:	2nd	3rd	4th	5th	6th
Average Power (dBm):	10.76	13.90	16.88	19.92	22.85
Average Power (mW):	11.91	24.55	48.75	98.17	192.75
Single Point SAR(mW/g):	0.012	0.026	0.051	0.098	0.188
Reference point:	0.012	0.024	0.047	0.095	0.186
Estimated (%):	0.000	7.607	8.361	3.402	1.247



Procedure in establishing linear line (SAR):

1st reference point = 0 mW/g when power = 0 mW
2nd reference point: 0.012 mW/g @ 11.91 mW
3rd reference point: (0.012 * 24.55 mW) / 11.91 mW = 0.024
4th reference point: (0.024 * 48.75 mW) / 24.55 mW = 0.047
5th reference point: (0.047 * 98.17 mW) / 48.75 mW = 0.095
6th reference point: (0.095 * 192.75 mW) / 98.17 mW = 0.186

Draw a reference line from first reference point to sixth reference point.

18. Appendixes

Refer to separated files for the following appendixes.

18.1. System performance check plots

18.2. SAR test plots for WiMAX

18.3. Calibration certificate for E-Field Probe EX3DV4 SN 3686

18.4. Calibration certificate for D2600V2 SN: 1006