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

SAR EVALUATION REPORT
(WiMax PORTION)

For

3G/4G Module Consists of Cellular CDMA, PCS CDMA, EVDO Rel 0, Rev. A and WiMax
(Tested inside of Lenovo Notebook PC Lenovo Ideapad S205s, model: 2090 and 20127)

MODEL: M600A

FCC ID: XHG-M600A

REPORT NUMBER: 11U13741-3

ISSUE DATE: September 26, 2011

Prepared for
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NVLAP LAB CODE 200065-0

Revision History

Rev.	Issue Date	Revisions	Revised By
--	September 26, 2011	Initial Issue	--

Tablet of Contents

1. Attestation of Test Results

<table>
<tr><td>Company name:</td><td colspan="3">FRANKLIN TECHNOLOGY INC.</td></tr>
<tr><td>EUT Description:</td><td colspan="3">3G/4G Module Consists of Cellular CDMA, PCS CDMA, EVDO Rel 0, Rev. A and WiMax.
Tested inside of Lenovo Notebook PC Lenovo Ideapad S205s, model: 2090 and 20127</td></tr>
<tr><td>Model number:</td><td colspan="3">M600A</td></tr>
<tr><td>Device Category:</td><td colspan="3">Portable</td></tr>
<tr><td>Exposure category:</td><td colspan="3">General Population/Uncontrolled Exposure</td></tr>
<tr><td>Date of tested:</td><td colspan="3">August 14, 2011</td></tr>
<tr><td>FCC rule part</td><td>Freq. range (MHz)</td><td>Highest 1-g SAR (W/kg)</td><td>Limit (W/kg)</td></tr>
<tr><td>27</td><td>2498.5 – 2687.5</td><td>0.009 W/kg (5 MHz_QPSK)
0.011 W/kg (10 MHz_16QAM)</td><td>1.6</td></tr>
<tr><td colspan="3">Applicable Standards</td><td>Test Results</td></tr>
<tr><td colspan="3">FCC OET Bulletin 65 Supplement C 01-01
IEEE STD 1528:2003</td><td>Pass</td></tr>
</table>

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:	Tested By:
Sunny Shih	
Sunny Shih Engineering Team Leader Compliance Certification Services (UL CCS)	Chakrit Thammanavarat EMC 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 01-01 and the following KDB SAR procedures:

- 615223 D01 802.16e WiMax SAR Guidance v01
- 616217 D03 SAR Supp Note and Netbook Laptop v01

Note(s):

PBA is not required based on the KDB 388624 D02 Permit But Ask List v09r04 date 7/19/2011.
b) SAR Evaluation
iii. 802.16e / WiMax (KDB Publication 615223) – when one or more of the following is applicable:
(1) Highest reported (scaled) SAR > 1.2 W/kg
(2) Maximum DL:UL symbol ratio is other than 29:18
(3) AMC zone is used
(4) Maximum burst average output power in any configuration is > 24 dBm

3. Facilities and Accreditation

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

UL 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
Robot - Six Axes	Stäubli	RX90BL	N/A	N/A		
Robot Remote Control	Stäubli	CS7MB	S-0396	N/A		
DASY4 Measurement Server	SPEAG	SEUMS001BA	1246	N/A		
Probe Alignment Unit	SPEAG	LB5/ 80	SE UKS 030 AA	N/A		
SAM Twin Phantom	SPEAG	QDOOOP40CD	1629	N/A		
Oval Flat Phantom (ELI 5.0) A	SPEAG	QDOVA001BB	1120	N/A		
Oval Flat Phantom (ELI 5.0) B	SPEAG	QDOVA001BB	1118	N/A		
Dielectric Probe kit	HP	85070C	N/A	N/A		
ESA Series Network Analyzer	Agilent	E5071B	MY42100131	8	2	2012
Synthesized Signal Generator	HP	83732B	US34490599	7	14	2012
E-Field Probe	SPEAG	EX3DV4	3686	1	24	2012
Thermometer	ERTCO	639-1S	1718	8	19	2012
Data Acquisition Electronics	SPEAG	DAE4	1239	11	17	2012
System Validation Dipole	SPEAG	D2600V2	1036	4	15	2012
Power Meter	Giga-tronics	8651A	8651404	3	13	2012
Power Sensor	Giga-tronics	80701A	1834588	3	13	2012
Amplifier	Mini-Circuits	ZVE-8G	90606	N/A		
Amplifier	Mini-Circuits	ZHL-42W	D072701-5	N/A		

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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	1.53	Normal	1	0.64	0.98
Liquid Permittivity - deviation from target	5.00	Rectangular	1.732	0.6	1.73
Liquid Permittivity - measurement uncertainty	-0.04	Normal	1	0.6	-0.02
Combined Standard Uncertainty Uc(y) =					9.49
Expanded Uncertainty U, Coverage Factor = 2, > 95 % Confidence =				18.98	%
Expanded Uncertainty U, Coverage Factor = 2, > 95 % Confidence =				1.51	dB

5. Equipment under Test

3G/4G Module Consists of Cellular CDMA, PCS CDMA, EVDO Rel 0, Rev. A and WiMax (Tested inside of Lenovo Notebook PC Lenovo Idea pad S205s, model: 2090 and 20127)	
Normal operation:	The top of the screen touching the phantom
Antenna tested:	Manufacturer: ACON Part number: Tx1 (Main): APP6P-700520 Tx2 (Aux): APP6P-700521
Antenna-to-antenna/user separation distances:	See Section 16 for details of antenna locations and separation distances
Assessment for SAR evaluation for Simultaneous transmission:	**WiMAX – WLAN** The 802.16e WiMAX and 802.11a/b/g/n WiFi radio will not transmit simultaneously. **WiMAX – Bluetooth** Simultaneous Bluetooth SAR evaluation is not necessary due to the BT power < 60/f (GHz) mW. **WiMax – WWAN** The 802.16e WiMAX and WWAN radio will not transmit simultaneously.

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5.1. 802.116e/WiMax Device & System Operating Parameters

Description	Parameter	Comment/notes
FCC ID	XHG-M600A	CDMA/WiMax Combo radio card
Radio Service	Part 27 subpart M	Rule parts
Transmit Freq. Range (MHz)	2496 - 2690	System parameter
System/Ch. Bandwidth (MHz)	5 / 10M	System parameter
System Profile	Revision 1.7.0	Defined by WiMax Forum
Modulation Schemes	QPSK, 16QAM	Identify all applicable UL modulations
Sampling Factor	28/25	System parameter
Sampling Frequency (MHz)	5 MHZ BW: 5.6 MHz 10 MHz BW: 11.2 MHz	(Fs)
Sample Time (ns)	5 MHz BW: 178.581 ns 10 MHz BW:89.3 ns	(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
Number of DL OFDMA Symbols per Frame	29	Identify the allowed & maximum symbols, including both traffic & control symbols
Number of UL OFDMA Symbols per Frame	18	
DL:UL Symbol Ratio	29:18	For determining UL duty factor
Power Class (dBm)	Power Class 2, 23±1dBm	
Wave1 / Wave2	Wave 2, 2 antennas with receive MRC DL MIMO matrix A and B.	
UL Zone Types (e.g. FUSC, PUSC, OFUSC, OPUSC, AMC, TUSC1, TUSC2)	Segmented PUSC Unsegmented PUSC	
Maximum Number of UL Sub-Carriers	841 (for 10 MHz BW); 409 (for 5 MHz BW)	
Measured UL Burst Maximum Average Conducted Power	See section 10	See Section 10
UL Control System Configuration	3 PUSC symbols (used for ranging, CQICH and ACK/NACK)	
UL Burst Peak-to-Average (Conducted) Power Ratio (PAPR)		See Section 11
Frame Averaged UL Transmission Duty Factor (%)		See Section 5.6

5.2. WiMax Device Specification

This device is a 2.6 GHz WiMax transceiver using the “Beceem” chipset. It has two built-in antennas, one for transmitting and one for receiving. The system transmits on 5 ms frames using 5 MHz and 10 MHz channels.

Control signals are transmitted in the first 3 symbols of each uplink burst. The rest of the uplink sub-frame contains normal traffiv data bursts. The first 3 symbols are also used for ranging, which is shared with other users. During normal operation, the control symbols are transmitted at reduced power and the traffic symbols may transmit at maximum power. For SAR testing purposes, the configuration of control symbols is dependent on the test software and test equipment setup.

5.3. WiMax Zone Types

The device transmits using PUSC zone type only. Multiple users can transmit simultaneously within the system. FUSC and other zone types are not used by this device for uplink transmissions. The maximum DL:UL (downlink-to-uplink) symbol ratio is determined according to the PUSC requirements. The system transmits an odd number of symbols using DL-PUSC, consisting of even multiples of traffic and control symbols, plus one symbol for the preamble. The device transmits in multiples of three symbols using UL-PUSC. The OFDMA symbol time allows up to 48 downlink and uplink symbols to be transmitted 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 allowed for this device and determined according to these PUSC parameters is 29:18. However, due to test vector configuration limitations, a DL:UL ratio of 31:15 is used for the SAR measurements. In addition, restrictions from the proprietary test software require special test vectors to be configured for the vector signal generator to work with the test device. The measured results are scaled to the maximum DL:UL ratio of 29:18.to determine SAR compliance.

5.4. 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]
		T5D29U184Q34S85	29:18	[(Max. Rated pwr*5/17*3)+Max. Rated pwr*15]/[Actual pwr*15]
	16QAM	T5D29U1816Q12S85	29:18	[(Max. Rated pwr*5/17*3)+Max. Rated pwr*15]/[Actual pwr*15]
		T5D29U1816Q34S85	29:18	[(Max. Rated pwr*5/17*3)+Max. Rated pwr*15]/[Actual pwr*15]
10 MHz	QPSK	T10D29U184Q12S175	29:18	[(Max. Rated pwr*5/35*3)+Max. Rated pwr*15]/[Actual pwr*12]
		T10D29U184Q34S175	29:18	[(Max. Rated pwr*5/35*3)+Max. Rated pwr*15]/[Actual pwr*12]
	16QAM	T10D29U1816Q12S175	29:18	[(Max. Rated pwr*5/35*3)+Max. Rated pwr*15]/[Actual pwr*12]
		T10D29U1816Q34S175	29:18	[(Max. Rated pwr*5/35*3)+Max. Rated pwr*15]/[Actual pwr*12]

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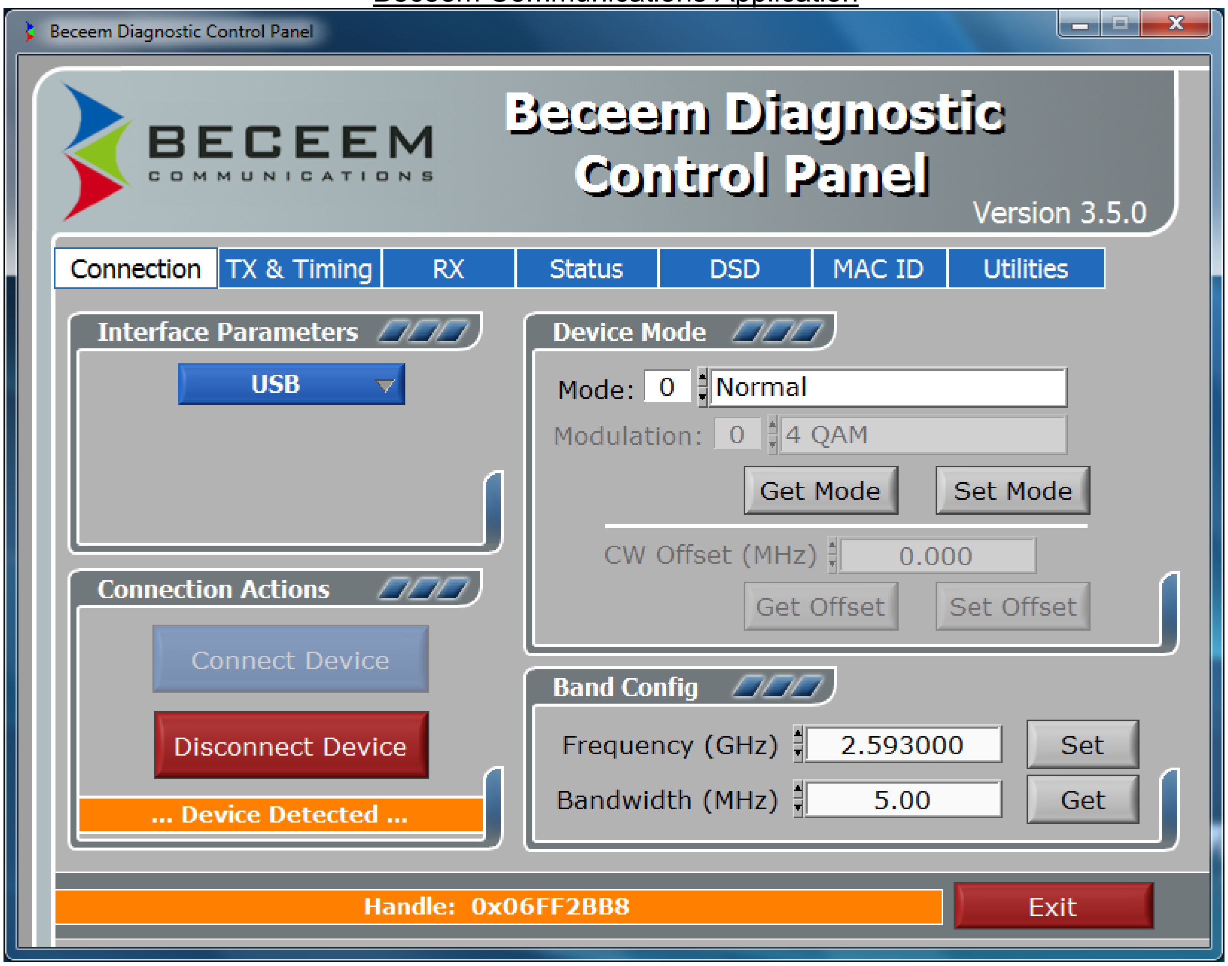
5.5. Test Software Details

The test software tool (Beceem Communications Application) is installed on the host device, to transmit at max. output power. During normal operation, the output power of WiMAX client module is controlled by a WiMAX base station, which also determines the characteristics of the transmission. For testing purposes, the device output power is kept at this max. using Beceem Communications Application loaded in the host device. The uplink transmission is maintained at a stable condition by the radio profile loaded in Vector signal generator. This enables the WiMAX module to transmit at max. power with a constant duty factor according to the specific radio profile. The test software serves only one purpose, to configure the WiMAX module to transmit at the max. power during SAR measurement.

The EUT driver software installed in the host support equipment during testing was Beceem Communications Version 3.5.0

Beceem Communications Application



5.6. Signal Generator Details

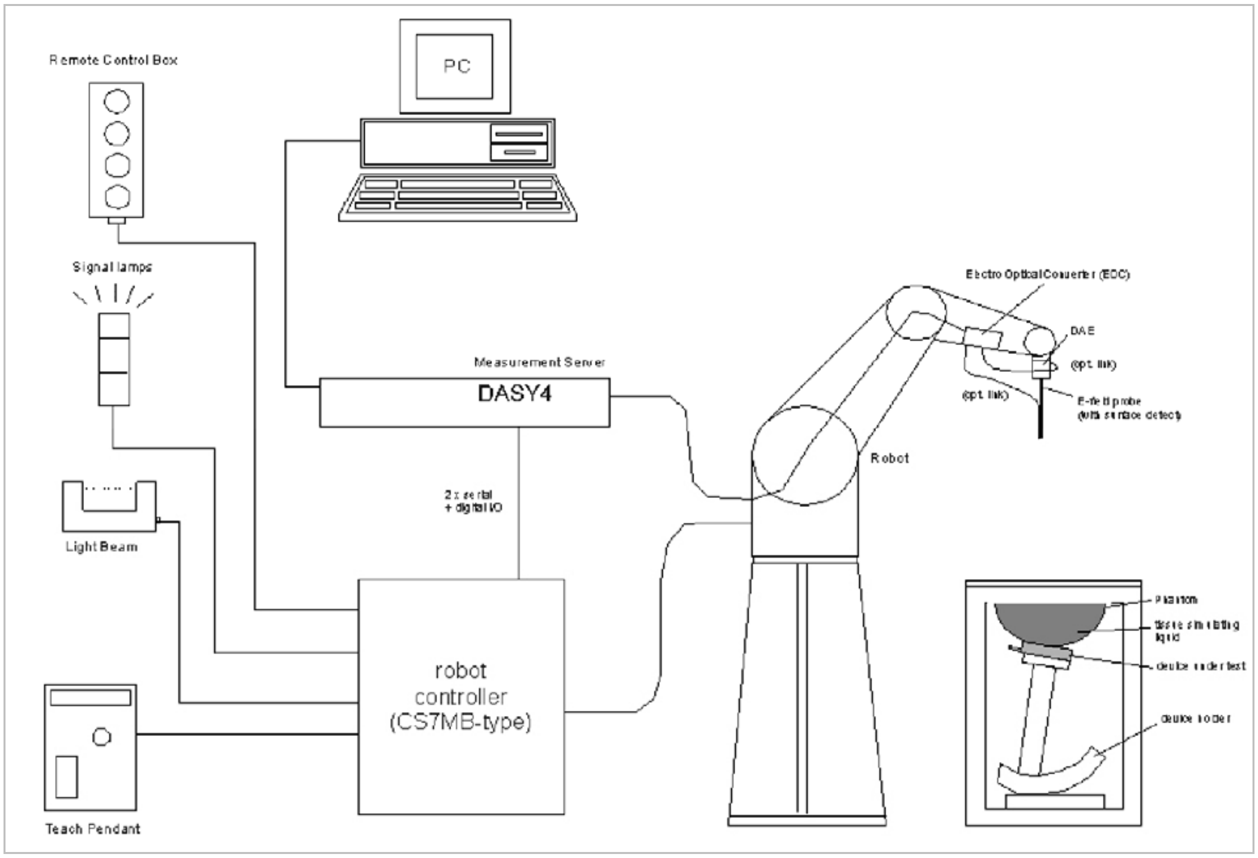
Frame Profile loaded in Vector Signal Generator:

Ch. BW	Modulation	Vector Waveform File	DL:UL Ratio	Calculated Duty Factor [((18-3)*102.857)/5000]
5 MHz	QPSK	T5D29U184Q12S85	29 :18	30.86%
		T5D29U184Q34S85	29 :18	30.86%
	16QAM	T5D29U1816Q12S85	29 :18	30.86%
		T5D29U1816Q34S85	29 :18	30.86%
10 MHz	QPSK	T10D29U184Q12S175	29 :18	30.86%
		T10D29U184Q34S175	29 :18	30.86%
	16QAM	T10D29U1816Q12S175	29 :18	30.86%
		T10D29U1816Q34S175	29 :18	30.86%

Agilent ESG Vector Signal Generator / Model: E4438C is used in conjunction with Intel supplied radio profile to configure the WiMAX module for the SAR evaluation. ESG Vector Signal Generator is loaded with the downlink signal, containing the respective FCH, DL-MAP and UL-MAP required by the test device to configure the uplink transmission. The test device can synchronize itself to the signal received from VSG, both in frequency and time. It then modulates the DL-MAP and UL-MAP transmitted in the downlink sub-frame and determines the DL: UL symbol ratio. The downlink burst is repeated in each frame, every 5 ms, to simulate the normal transmission from a WiMAX base station. The UL-MAP received by the device is used to configure the uplink burst with all data symbols and sub-channels active. Since this is a one-way communication configuration, control channel transmission is neither requested nor transmitted.

For TDD systems, both uplink and downlink transmissions are at the same frequency. The output power of the VSG is kept at least 80 dB lower than the test device to avoid interfering with the SAR measurements. In addition, a horn antenna is used for the VSG and it is kept more than 1 meter away from the test device to further minimize unnecessary pickup by the SAR probe.

6. System Description



The DASY4 system for performing compliance tests consists of the following items:

- A standard high precision 6-axis robot (Stäubli RX family) with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- A dosimetric probe, i.e., an isotropic E-field probe optimized and calibrated for usage in tissue simulating liquid. The probe is equipped with an optical surface detector system.
- 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 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.
- A probe alignment unit which improves the (absolute) accuracy of the probe positioning.
- A computer operating Windows 2000 or Windows XP.
- DASY software.
- Remote controls with teach pendant and additional circuitry for robot safety such as warning lamps, etc.
- The SAM twin phantom enabling testing left-hand and right-hand usage.
- The device holder for handheld mobile phones.
- Tissue simulating liquid mixed according to the given recipes.
- Validation dipole kits allowing validating the proper functioning of the system.

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7. Composition of Ingredients for Tissue Simulating Liquids

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		2600
Tissue Type	Head	Body	Head	Body	Head	Body	Head	Body	Head	Body	Body
Water	38.56	51.16	41.45	52.4	41.05	56.0	54.9	40.4	62.7	73.2	73.2
Salt (NaCl)	3.95	1.49	1.45	1.4	1.35	0.76	0.18	0.5	0.5	0.04	0.05
Sugar	56.32	46.78	56.0	45.0	56.5	41.76	0.0	58.0	0.0	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	0.0
Bactericide	0.19	0.05	0.1	0.1	0.1	0.27	0.0	0.1	0.0	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	0.0
DGBE	0.0	0.0	0.0	0.0	0.0	0.0	44.92	0.0	0.0	26.7	27.2
Dielectric Constant	43.42	58.0	42.54	56.1	42.0	56.8	39.9	54.0	39.8	52.5	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	2.16

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

8. Simulating Liquid Parameters

The simulating liquids should be checked at the beginning of a series of SAR measurements to determine of the dielectric parameters are within the tolerances of the specified target values. For frequencies in 300 MHz to 2 GHz, the measured conductivity and relative permittivity should be within ± 5% of the target values. For frequencies in the range of 2–3 GHz and above the measured conductivity should be within ± 5% of the target values. The measured relative permittivity tolerance can be relaxed to no more than ± 10%.

Reference Values of Tissue Dielectric Parameters for Body Phantom

The body tissue parameters that have not been specified in P1528 are derived from the tissue dielectric parameters computed from the 4-Cole-Cole equations and extrapolated according to the head parameters specified in IEEE Standard 1528.

Target Frequency (MHz)	Body	
	ε_r	σ (S/m)
2450	52.7	1.95
2500	52.6	2.02
2600	52.5	2.16
2690	52.4	2.29

(ε_r = relative permittivity, σ = conductivity and ρ = 1000 kg/m^3)

8.1. Liquid Check Results

Date	Freq. (MHz)	Liquid Parameters			Measured	Target	Delta (%)	Limit ±(%)
8/14/2011	Body 2600	e'	52.4924	Relative Permittivity (ϵ_r):	52.49	52.51	-0.04	5
		e"	15.1752	Conductivity (σ):	2.19	2.16	1.53	5

Liquid Check
Ambient temperature: 25 deg. C; Liquid temperature: 24 deg. C; Relative humidity = 40%
August 14, 2011 04:50 PM

Frequency	e'	e"
2510000000.	52.8068	14.8096
2515000000.	52.7927	14.8320
2520000000.	52.7784	14.8542
2525000000.	52.7621	14.8759
2530000000.	52.7465	14.8966
2535000000.	52.7290	14.9164
2540000000.	52.7122	14.9378
2545000000.	52.6913	14.9574
2550000000.	52.6741	14.9761
2555000000.	52.6529	14.9961
2560000000.	52.6313	15.0149
2565000000.	52.6112	15.0324
2570000000.	52.5935	15.0535
2575000000.	52.5749	15.0746
2580000000.	52.5556	15.0919
2585000000.	52.5398	15.1149
2590000000.	52.5231	15.1334
2595000000.	52.5073	15.1532
2600000000.	**52.4924**	**15.1752**
2605000000.	52.4784	15.1958
2610000000.	52.4634	15.2180
2615000000.	52.4476	15.2412
2620000000.	52.4336	15.2599
2625000000.	52.4164	15.2761
2630000000.	52.4006	15.2952
2635000000.	52.3777	15.3112
2640000000.	52.3561	15.3281
2645000000.	52.3322	15.3452
2650000000.	52.3076	15.3647
2655000000.	52.2814	15.3827
2660000000.	52.2560	15.3994
2665000000.	52.2346	15.4196
2670000000.	52.2130	15.4358

The conductivity (σ) can be given as:

$$\sigma = \omega\varepsilon_0 e'' = 2\pi f \varepsilon_0 e''$$

where f = target $f * 10^6$

$\varepsilon_0 = 8.854 * 10^{-12}$

9. System Verification

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

System Performance Check Measurement Conditions

- The measurements were performed in the flat section of the SAM twin phantom filled with Body simulating liquid of the following parameters.
- The DASY system with an Isotropic E-Field Probe EX3DV4-SN: 3686 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.

Reference SAR Values for HEAD & BODY-tissue from calibration certificate of SPEAG.

System validation dipole	Cal. certificate #	Cal. date	SAR Avg (mW/g)		
			Tissue:	Head	Body
D2600V2	D2600V2-1036_Apr 11	4/15/11	1g SAR:	59.6	59.2
			10g SAR:	26.4	26.0

9.1. System Check Results

System validation dipole	Date Tested	Measured (Normalized to 1 W)		Target	Delta (%)	Tolerance (%)
D2600V2 Body	08/14/11	1g SAR:	56.7	59.2	-4.22	±10
		10g SAR:	24.8	26.0	-4.62	

10. Output Power Measurement

The max 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.

Output power measurement results

Ch BW	Mode	Test Vector file name	Freq.	Original output Pwr (From original EMC report)		Actual autput Pwr	
			(MHz)	(dBm)	(mW)	(dBm)	(mW)
5 MHz	QPSK	T5D29U184Q12S85	2498.5	**23.42**	219.79	22.16	164.44
			2593.0	23.11	204.64	**22.92**	195.88
			2687.5	23.10	204.17	22.71	186.64
		T5D29U184Q34S85	2498.5	23.07	202.77	22.51	178.24
			2593.0	23.00	199.53	22.54	179.47
			2687.5	23.13	205.59	22.11	162.55
	16QAM	T5D29U1816Q12S85	2498.5	23.18	207.97	22.45	175.79
			2593.0	22.97	198.15	**22.85**	192.75
			2687.5	23.06	202.30	22.37	172.58
		T5D29U1816Q34S85	2498.5	**23.18**	207.97	22.00	158.49
			2593.0	23.09	203.70	22.51	178.24
			2687.5	22.93	196.34	22.48	177.01
10MHz	QPSK	T10D29U184Q12S175	2501.0	22.76	188.80	22.31	170.22
			2593.0	22.62	182.81	**22.45**	175.79
			2685.0	22.61	182.39	22.05	160.32
		T10D29U184Q34S175	2501.0	**22.84**	192.31	22.38	172.98
			2593.0	22.63	183.23	22.16	164.44
			2685.0	22.56	180.30	22.07	161.06
	16QAM	T10D29U1816Q12S175	2501.0	22.85	192.75	22.12	162.93
			2593.0	22.71	186.64	**22.32**	170.61
			2685.0	22.62	182.81	22.12	162.93
		T10D29U1816Q34S175	2501.0	**22.90**	194.98	22.18	165.20
			2593.0	22.72	187.07	22.20	165.96
			2685.0	22.54	179.47	22.13	163.31

11. Peak to Average 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	2593	33.17	22.92	10.25
		T5D29U184Q34S85	2593	33.29	22.54	10.75
	16QAM	T5D29U1816Q12S85	2593	32.05	22.85	9.20
		T5D29U1816Q34S85	2593	33.30	22.51	10.79
10 MHz	QPSK	T10D29U184Q12S175	2593	33.70	22.45	11.25
		T10D29U184Q34S175	2593	33.89	22.07	11.82
	16QAM	T10D29U1816Q12S175	2593	33.64	22.32	11.32
		T10D29U1816Q34S175	2593	33.88	22.20	11.68

12. SAR Test Results

Main Antenna

5 MHz BW

29:18 UL:DL Ratio = [(Max. Rated pwr*5/17*3) + (Max. Rated pwr*15)] / Actual pwr*15)]

Mode	Test vector file name	Calculated		Freq. (MHz)	Output power				Scale Factors	1 g SAR (W/kg)	
		Duty Cycle (%)	Crest Factor		Actual		Max. Rated			Measured	Scaled
					dBm	mW	dBm	mW			
QPSK	T5D29U184Q12S85	30.86	3.24	2498.5	22.16	164.4	23.42	219.79			
				2593.0	22.92	195.9	23.42	219.79	1.19	0.00605	0.007
				2687.5	22.71	186.6	23.42	219.79			
16QAM	T5D29U1816Q12S85	30.86	3.24	2506.0	22.45	175.8	23.18	207.97			
				2593.0	22.85	192.8	23.18	207.97	1.14	0.00780	**0.009**
				2685.0	22.37	172.6	23.18	207.97			

Note(s):

1. "*cf*" = 1/(15/48) = 3.2 for 5 MHz
2. SAR test was performed in the middle channel only as the measured level was < 50% of the SAR limit (1.6W/kg).

10 MHz Bandwidth

29:18 UL:DL Ratio = [(Max. Rated pwr*5/35*3) + (Max. Rated pwr*15)] / Actual pwr*12)]

Mode	Test vector file name	Calculated		Freq. (MHz)	Output power				Scale Factors	1 g SAR (W/kg)	
		Duty Cycle (%)	Crest Factor		Actual		Max. Rated			Measured	Scaled
					dBm	mW	dBm	mW			
QPSK	T10D29U184Q12S175	30.86	4.0	2501.0	22.31	170.2	22.84	192.31			
				2593.0	22.45	175.8	22.84	192.31	1.41	0.00630	0.009
				2685.0	22.05	160.3	22.84	192.31			
16QAM	T10D29U1816Q12S175	30.86	4.0	2501.0	22.12	162.9	22.90	194.98			
				2593.0	22.32	170.6	22.90	194.98	1.47	0.00672	**0.010**
				2685.0	22.12	162.9	22.90	194.98			

Note(s):

1. "*cf*" = 1/(12/48) = 4.0 for 10 MHz
2. SAR test was performed in the middle channel only as the measured level was < 50% of the SAR limit (1.6W/kg).

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Aux Antenna

5 MHz Bandwidth

29:18 UL:DL Ratio = [(Max. Rated pwr*5/17*3) + (Max. Rated pwr*15)] / Actual pwr*15)]

Mode	Test vector file name	Calculated		Freq. (MHz)	Output power				Scale Factors	1 g SAR (W/kg)	
		Duty Cycle (%)	Crest Factor		Actual		Max. Rated			Measured	Scaled
					dBm	mW	dBm	mW			
QPSK	T5D29U184Q12S85	30.86	3.24	2498.5	22.16	164.4	23.42	219.79			
				2593.0	22.92	195.9	23.42	219.79	1.19	0.00782	**0.009**
				2687.5	22.71	186.6	23.42	219.79			
16QAM	T5D29U1816Q12S85	30.86	3.24	2506.0	22.45	175.8	23.18	207.97			
				2593.0	22.85	192.8	23.18	207.97	1.14	0.00670	0.008
				2685.0	22.37	172.6	23.18	207.97			

Note(s):

1. "*cf*" = 1/(15/48) = 3.2 for 5 MHz
2. SAR test was performed in the middle channel only as the measured level was < 50% of the SAR limit (1.6W/kg).

10 MHz Bandwidth

29:18 UL:DL Ratio = [(Max. Rated pwr*5/35*3) + (Max. Rated pwr*15)] / Actual pwr*12)]

Mode	Test vector file name	Calculated		Freq. (MHz)	Output power				Scale Factors	1 g SAR (W/kg)	
		Duty Cycle (%)	Crest Factor		Actual		Max. Rated			Measured	Scaled
					dBm	mW	dBm	mW			
QPSK	T10D29U184Q12S175	30.86	4.0	2501.0	22.31	170.2	22.84	192.31			
				2593.0	22.45	175.8	22.84	192.31	1.41	0.00723	0.010
				2685.0	22.05	160.3	22.84	192.31			
16QAM	T10D29U1816Q12S175	30.86	4.0	2501.0	22.12	162.9	22.90	194.98			
				2593.0	22.32	170.6	22.90	194.98	1.47	0.00767	**0.011**
				2685.0	22.12	162.9	22.90	194.98			

Note(s):

1. "*cf*" = 1/(12/48) = 4.0 for 10 MHz
2. SAR test was performed in the middle channel only as the measured level was < 50% of the SAR limit (1.6W/kg).

13. Worst-case SAR Plots

Worst-case SAR Test Plot - 5MHz_QPSK

Date: 8/14/2011

Test Laboratory: UL CCS SAR Lab A

Lap held

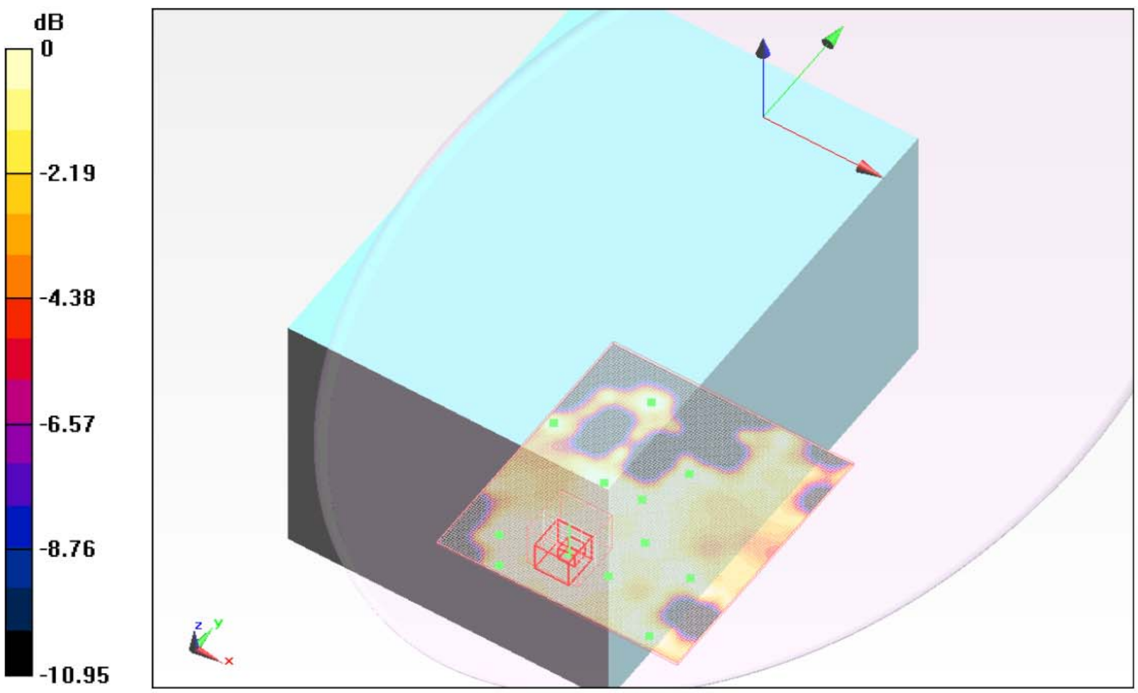
Communication System: IEEE 802.16e WiMAX, 5MHz; Frequency: 2593 MHz;Duty Cycle: 1:3.20037
Medium parameters used (interpolated): f = 2593 MHz; σ = 2.185 mho/m; ε_r = 52.514; ρ = 1000 kg/m^3
Phantom section: Flat Section

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)
- Electronics: DAE4 Sn1239; Calibrated: 11/17/2010
- Phantom: ELI v4.0(A); Type: QDOVA001BB; Serial: 1119
- Measurement SW: DASY52, Version 52.6 (2);SEMCAD X Version 14.4.5 (3634)

5MHz_Ant Aux/QPSK_Mid ch/Area Scan (101x111x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 0.015 mW/g

5MHz_Ant Aux/QPSK_Mid ch/Zoom Scan 2 (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 1.933 V/m; Power Drift = -0.08 dB
Peak SAR (extrapolated) = 0.015 W/kg
SAR(1 g) = 0.00782 mW/g; SAR(10 g) = 0.00508 mW/g
Maximum value of SAR (measured) = 0.011 mW/g



0 dB = 0.010mW/g

Worst-case SAR Test Plot - 10 MHz_16QAM

Date: 8/14/2011, Date: 8/15/2011

Test Laboratory: UL CCS SAR Lab A

Lap held

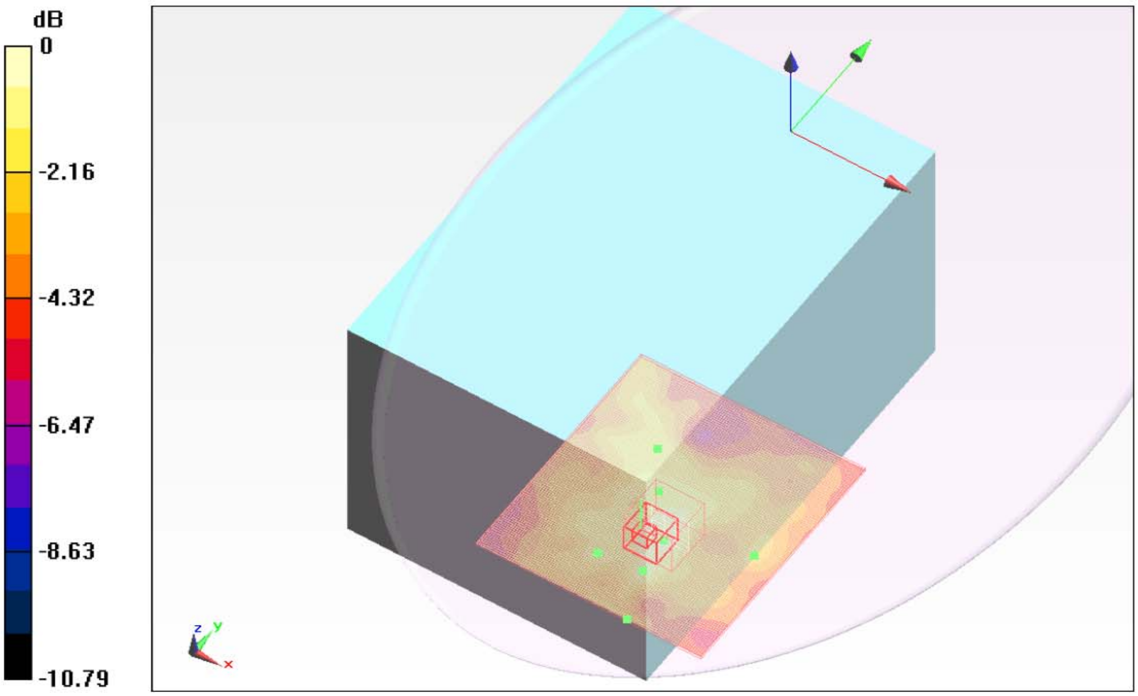
Communication System: IEEE 802.16e WiMAX, 10MHz; Frequency: 2593 MHz; Duty Cycle: 1:4.00037
Medium parameters used (interpolated): f = 2593 MHz; σ = 2.185 mho/m; ε_r = 52.514; ρ = 1000 kg/m^3
Phantom section: Flat Section

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: 11/17/2010
- Phantom: ELI v4.0(A); Type: QDOVA001BB; Serial: 1119
- Measurement SW: DASY52, Version 52.6 (2);SEMCAD X Version 14.4.5 (3634)

10MHz_Ant Aux/16QAM_Mid ch/Area Scan (101x111x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 0.00876 mW/g

10MHz_Ant Aux/16QAM_Mid ch/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 1.949 V/m; Power Drift = -0.02 dB
Peak SAR (extrapolated) = 0.018 W/kg
SAR(1 g) = 0.00767 mW/g; SAR(10 g) = 0.00531 mW/g
Maximum value of SAR (measured) = 0.011 mW/g



0 dB = 0.010mW/g

14. 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 2 mm separation distance. **(w/ 2.0 mm distance from WiMax main antenna-to-phantom)**

   Note: *Refer to Section 20 for SAR linearity test setup photo and separation distance from antenna-to-phantom. (For the purpose of evaluation but not consider as normal SAR test configuration)*
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.

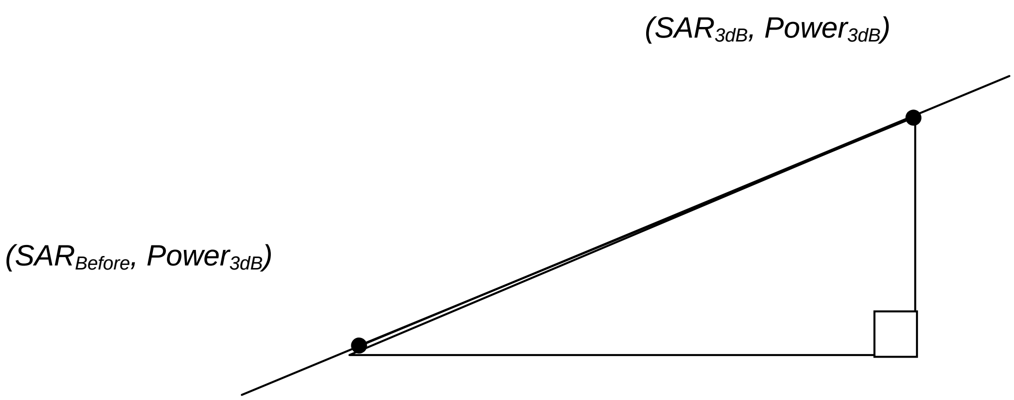
Assumption:

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:

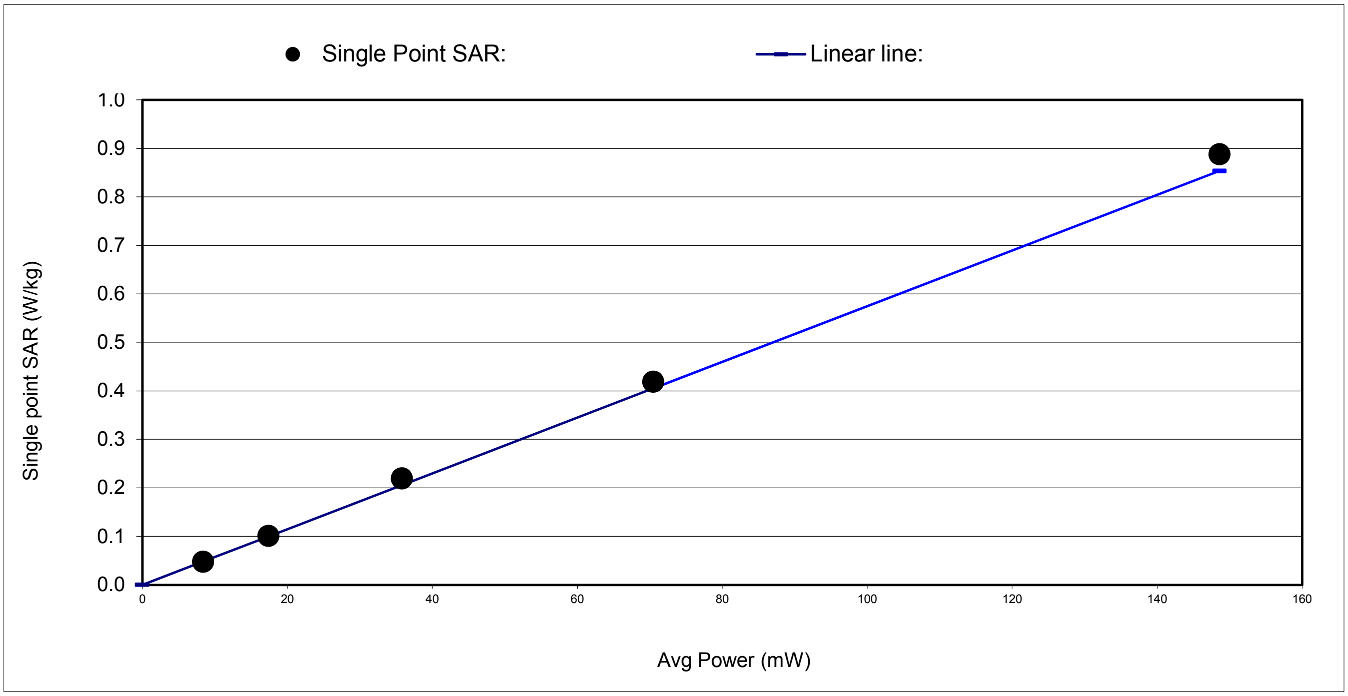
The actual measure output power has an tolerance due to the accuracy of the power sensors, RF cable and attenuator therefore the measure power will exhibited a +/- 0.05 % error. When power is set to 10 mW and SAR value "*x*" is known the next value on the Linear Line at approximately 3 dB up can be calculated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

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



Measurement Result for 5 MHz, QPSK: T5D29U184Q12S85

Average Power (dBm):	9.22	12.40	15.54	18.48	21.72
Average Power (mW):	8.4	17.4	35.8	70.5	148.6
Single Point SAR:	**0.048**	**0.101**	**0.220**	**0.419**	**0.888**
Linear line:	**0.048**	**0.100**	**0.206**	**0.405**	**0.854**
Estimated (%):	0.000	1.177	6.950	3.508	4.033



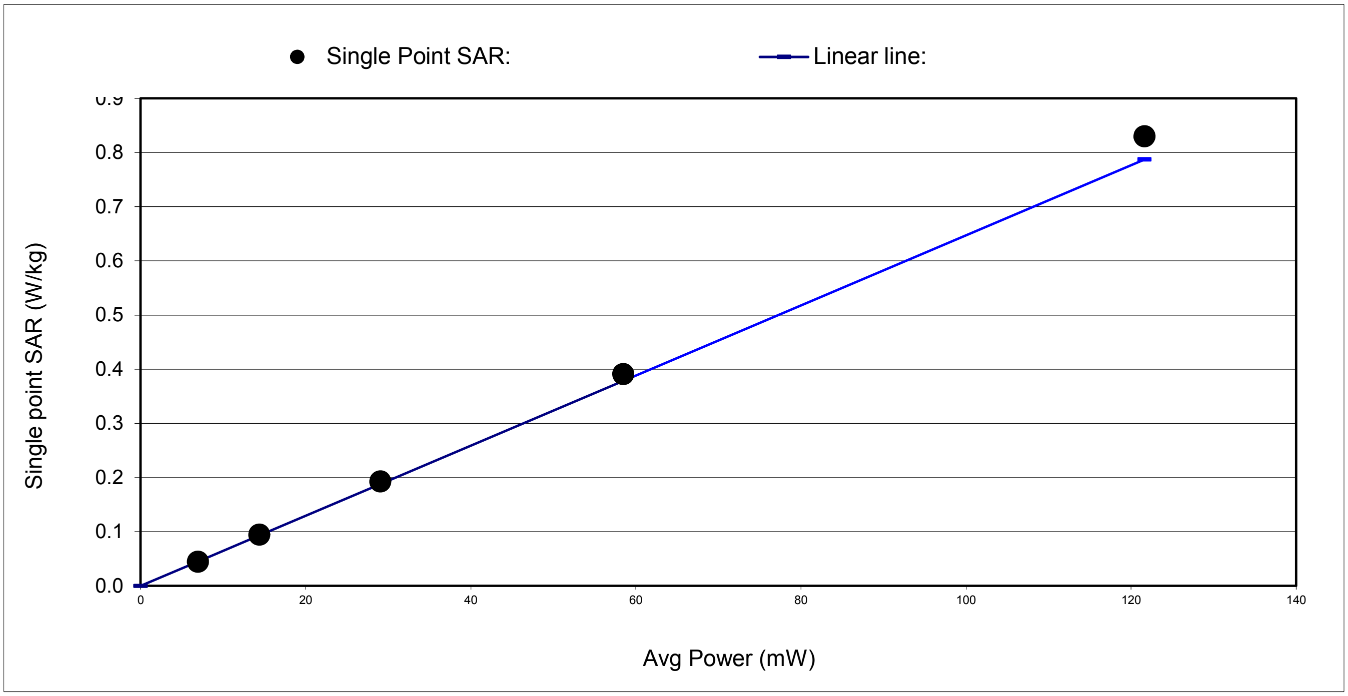
Procedure in establishing linear line (SAR):

- First reference Point = 0 when power = 0
- Second reference Point: 0.048 W/kg @ 8.4 mW
- Third reference point: (0.048*20)/10 = 0.100
- Fourth reference point: (0.10*39.8)/20 = 0.206
- Fifth h reference point: (0.206*79.4)/39.8 = 0.405
- Sixth reference point: (0.405*158.5)/79.4= 0.854

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

Measurement Result for 5 MHz, 16 QAM: T5D29U1816Q12S85

Average Power (dBm):	8.42	11.58	14.63	17.67	20.85
Average Power (mW):	7.0	14.4	29.0	58.5	121.6
Single Point SAR:	**0.045**	**0.095**	**0.193**	**0.391**	**0.830**
Linear line:	**0.045**	**0.093**	**0.188**	**0.379**	**0.787**
Estimated (%):	0.000	1.979	2.647	3.268	5.406



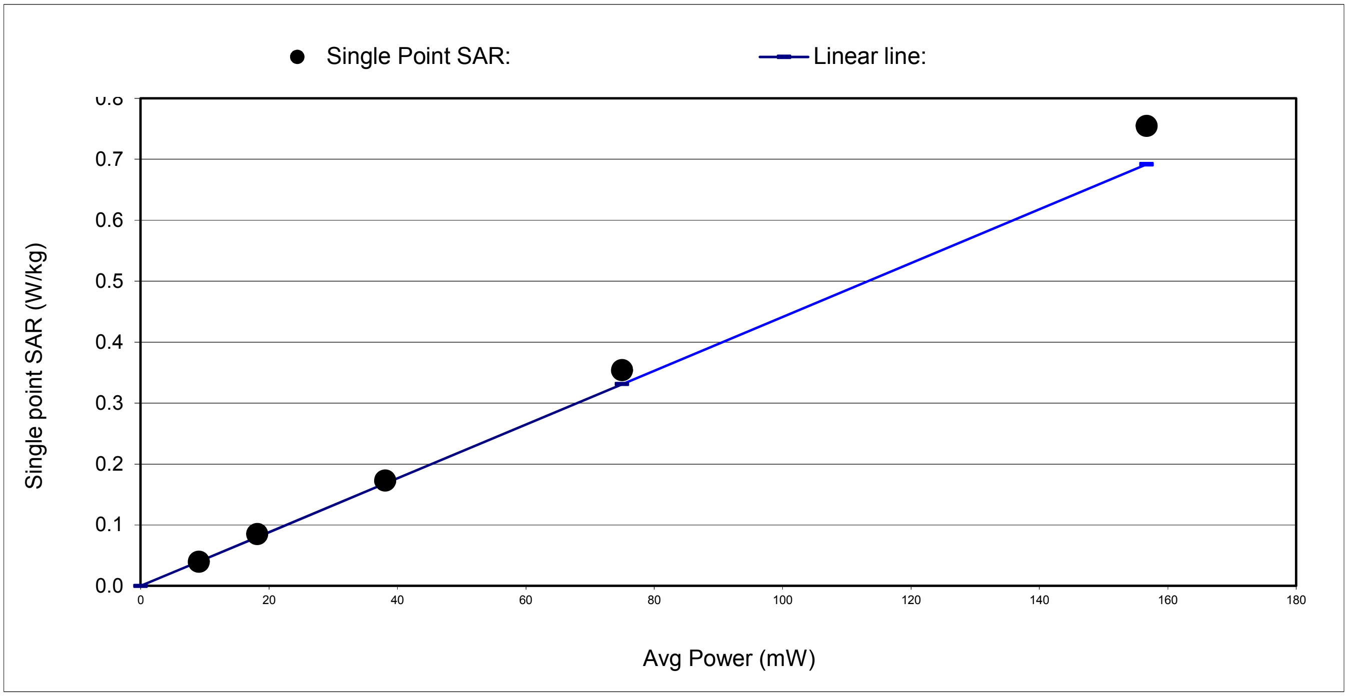
Procedure in establishing linear line (SAR):

- First reference Point = 0 when power = 0
- Second reference Point: 0.045 W/kg @ 7.0 mW
- Third reference point: (0.045*21.4)/10.7 = 0.093
- Fourth reference point: (0.093*42.7)/21.4 = 0.188
- Fifth h reference point: (0.188*85.1)/42.7 = 0.379
- Sixth reference point: (0.379*173.8)/85.1= 0.787

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

Measurement Result for 10 MHz, QPSK T10D29U184Q12S175

Average Power (dBm):	9.57	12.59	15.81	18.75	21.95
Average Power (mW):	9.1	18.2	38.1	75.0	156.7
Single Point SAR:	**0.040**	**0.085**	**0.173**	**0.354**	**0.755**
Linear line:	**0.040**	**0.080**	**0.168**	**0.331**	**0.692**
Estimated (%):	0.000	6.013	2.798	6.892	9.116



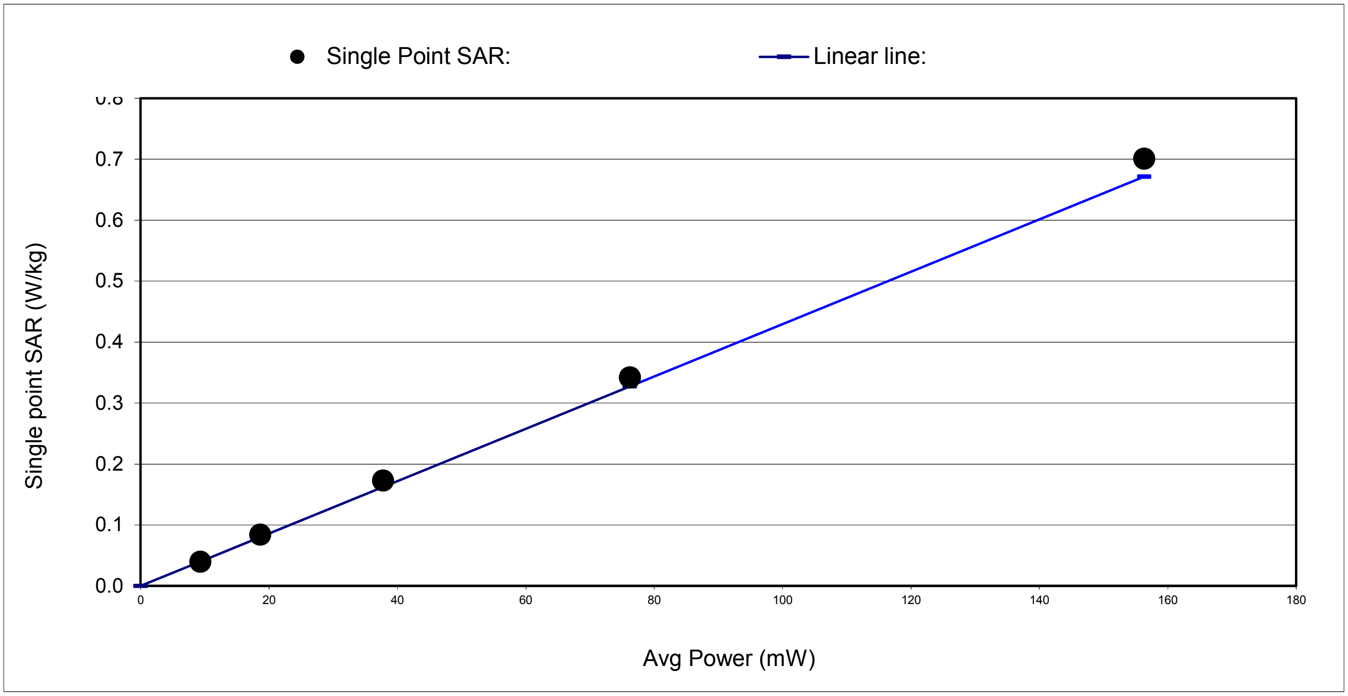
Procedure in establishing linear line (SAR):

- First reference Point = 0 when power = 0
- Second reference Point: 0.040W/kg @ 9.1 mW
- Third reference point: (0.040*21.4)/10.7 = 0.080
- Fourth reference point: (0.080*42.7)/21.4 = 0.168
- Fifth h reference point: (0.168*85.1)/42.7 = 0.331
- Sixth reference point: (0.331*213.8)/85.1 = 0.692

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

Measurement Result for 10 MHz, 16QAM:T10D29U1816Q12S175

Average Power (dBm):	9.69	12.70	15.77	18.82	21.94
Average Power (mW):	9.3	18.6	37.7	76.2	156.3
Single Point SAR:	**0.040**	**0.084**	**0.173**	**0.342**	**0.701**
Linear line:	**0.040**	**0.080**	**0.162**	**0.327**	**0.672**
Estimated (%):	0.000	5.007	6.730	4.464	4.390



Procedure in establishing linear line (SAR):

- First reference Point = 0 when power = 0
- Second reference Point: 0.040W/kg @ 9.3 mW
- Third reference point: (0.040*26.3)/13.2 = 0.080
- Fourth reference point: (0.080*52.5)/26.3 = 0.162
- Fifth h reference point: (0.162*104.7)/52.5 = 0.327
- Sixth reference point: (0.327*208.9)/104.7 = 0.672

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

15. Appendixes

Refer to separated files for the following appendixes.

15.1. Appendix A: System Check Plot

15.2. Appendix B: SAR Test Plots for WiMax

15.3. Appendix C: Certificate of E-Field Probe - EX3DV4 SN 3686

15.4. Appendix D: Calibration Certificate - Validation Dipole D2600V2 - SN 1036

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