



**FCC OET BULLETIN 65 SUPPLEMENT C
SAR EVALUATION REPORT**

FOR

**NOTEBOOK PC - INTEL WIMAX-WLAN
MODEL NUMBER: NP-NC10**

FCC ID: A3LNC10-512ANXM

REPORT NUMBER: 09U12437-3, Rev. A

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Prepared for

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NVLAP LAB CODE 200065-0

Revision History

<u>Rev.</u>	<u>Issue Date</u>	<u>Revisions</u>	<u>Revised By</u>
--	April 6, 2009	Initial Issue	--
A	May 28, 2009	Revised Duty-factor Scaling Formula	Sunny Shih

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1. ATTESTATION OF TEST RESULTS

COMPANY NAME: SAMSUNG ELECTRONICS CO., LTD.
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EUT DESCRIPTION: NOTEBOOK PC - INTEL WIMAX-WLAN

MODEL: NP-NC10 - SYSTEM APPROVAL

DEVICE CATEGORY: Portable

EXPOSURE CATEGORY: General Population/Uncontrolled Exposure

DATE TESTED: March 13 – 14, 2009

HIGHEST SAR VALUES: See table below

FCC / IC Rule Parts	Frequency Range [MHz]	The Highest SAR Values (1g_mW/g)	Limit (mW/g)
27	2498.5 – 2687.5	0.022	1.6

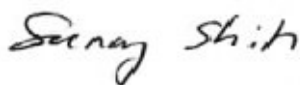
APPLICABLE STANDARDS:

STANDARD	TEST RESULTS
FCC OET BULLETIN 65 SUPPLEMENT C	Pass

Compliance Certification Services, Inc. (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 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 CCS and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by 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.

Approved & Released For CCS By:



SUNNY SHIH
EMC SUPERVISOR
COMPLIANCE CERTIFICATION SERVICES

2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with FCC OET Bulletin 65 Supplement C, Specific FCC Procedure KDB 248227 SAR Measurement Procedure for 802.11abg Transmitters and KDB 447498_RF Exposure Requirements and Procedures for mobile and portable devices and 802.16e/WiMAX Permit-But-Ask and 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://ts.nist.gov/Standards/scopes/2000650.htm>.

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 Number	Cal. Due date		
				MM	DD	Year
Robot - Six Axes	Stäubli	RX90BL	N/A			N/A
Robot Remote Control	Stäubli	CS7MB	3403-91535			N/A
DASY4 Measurement Server	SPEAG	SEUMS001BA	1041			N/A
Probe Alignment Unit	SPEAG	LB (V2)	261			N/A
SAM Phantom (SAM1)	SPEAG	QD000P40CA	1185			N/A
SAM Phantom (SAM2)	SPEAG	QD000P40CA	1050			N/A
Oval Flat Phantom (ELI 4.0)	SPEAG	QD OVA001 B	1003			N/A
Electronic Probe kit	HP	85070C	N/A			N/A
S-Parameter Network Analyzer	Agilent	8753ES-6	MY40001647	11	14	2009
Signal Generator	Agilent	8753ES-6	MY40001647	11	14	2009
E-Field Probe	SPEAG	EX3DV3	3531	4	23	2009
Thermometer	ERTCO	639-1S	1718	5	28	2009
Data Acquisition Electronics	SPEAG	DAE3 V1	427	10	20	2009
System Validation Dipole	SPEAG	D2450V2	748	4	14	2009
System Validation Dipole	SPEAG	D5GHzV2	1003	11	21	2009
MXA Signal Analyzer	Agilent	N9020A	US48350984	10	23	2009
ESG Vector Signal Generator	Agilent	E4438C	US44271090	9	17	2010
Power Meter	Giga-tronics	8651A	8651404	1	11	2010
Power Sensor	Giga-tronics	80701A	1834588	1	11	2010
Amplifier	Mini-Circuits	ZVE-8G	90606			N/A
Amplifier	Mini-Circuits	ZHL-42W	D072701-5			N/A
Simulating Liquid	CCS	M2600	N/A	Within 24 hrs of first test		

4.2. MEASUREMENT UNCERTAINTY

Measurement uncertainty for 300 MHz – 3000 MHz

Uncertainty component	Tol. (±%)	Probe Dist.	Div.	Ci (1g)	Ci (10g)	Std. Unc.(±%)	
						Ui (1g)	Ui(10g)
Measurement System							
Probe Calibration	4.80	N	1	1	1	4.80	4.80
Axial Isotropy	4.70	R	1.732	0.707	0.707	1.92	1.92
Hemispherical Isotropy	9.60	R	1.732	0.707	0.707	3.92	3.92
Boundary Effects	1.00	R	1.732	1	1	0.58	0.58
Linearity	4.70	R	1.732	1	1	2.71	2.71
System Detection Limits	1.00	R	1.732	1	1	0.58	0.58
Readout Electronics	1.00	N	1	1	1	1.00	1.00
Response Time	0.80	R	1.732	1	1	0.46	0.46
Integration Time	2.60	R	1.732	1	1	1.50	1.50
RF Ambient Conditions - Noise	1.59	R	1.732	1	1	0.92	0.92
RF Ambient Conditions - Reflections	0.00	R	1.732	1	1	0.00	0.00
Probe Positioner Mechanical Tolerance	0.40	R	1.732	1	1	0.23	0.23
Probe Positioning With Respect to Phantom Shell	2.90	R	1.732	1	1	1.67	1.67
algorithms for max. SAR evaluation	3.90	R	1.732	1	1	2.25	2.25
Test sample Related							
Test Sample Positioning	1.10	N	1	1	1	1.10	1.10
Device Holder Uncertainty	3.60	N	1	1	1	3.60	3.60
Power and SAR Drift Measurement	5.00	R	1.732	1	1	2.89	2.89
Phantom and Tissue Parameters							
Phantom Uncertainty	4.00	R	1.732	1	1	2.31	2.31
Liquid Conductivity - Target	5.00	R	1.732	0.64	0.43	1.85	1.24
Liquid Conductivity - Meas.	8.60	N	1	0.64	0.43	5.50	3.70
Liquid Permittivity - Target	5.00	R	1.732	0.6	0.49	1.73	1.41
Liquid Permittivity - Meas.	3.30	N	1	0.6	0.49	1.98	1.62
Combined Standard Uncertainty	RSS					11.44	10.49
Expanded Uncertainty (95% Confidence Interval)	K=2					22.87	20.98
Notesfor table							
1. Tol. - tolerance in influence quaitity							
2. N - Nomal							
3. R - Rectangular							
4. Div. - Divisor used to obtain standard uncertainty							
5. Ci - is te sensitivity coefficent							

5. EQUIPMENT UNDER TEST

The EUT is a Notebook PC contains BT module (FCC#: QDS-BRCM1018) and 512ANXMMW WiFi/WiMax Link 5150 are installed. The WiFi/WiMax Link 5150 is manufactured by Intel.								
Normal operation:	Laptop Mode							
Antenna tested:	<table><tr><td><u>Vendor</u></td><td><u>Antenna</u></td><td><u>Part Number</u></td></tr><tr><td>Foxconn</td><td>Main</td><td>WDAN-M1WC1006-DF</td></tr></table>		<u>Vendor</u>	<u>Antenna</u>	<u>Part Number</u>	Foxconn	Main	WDAN-M1WC1006-DF
<u>Vendor</u>	<u>Antenna</u>	<u>Part Number</u>						
Foxconn	Main	WDAN-M1WC1006-DF						
Power supply:	Power supplied through laptop computer (host device)							

The Intel WiFi/WiMax Link 5150 is an embedded IEEE 802.16e and 802.11a/b/g/n wireless network adapter that operates in the 2.4 GHz and 5 GHz spectra for WiFi and 2.6 GHz for WiMAX. The adapter is installed inside the Samsung host. This adapter is capable of delivering up to 300 Mbps Tx/Rx over WiFi and up to 4 Mbps UL/10 Mbps DL over WiMAX.

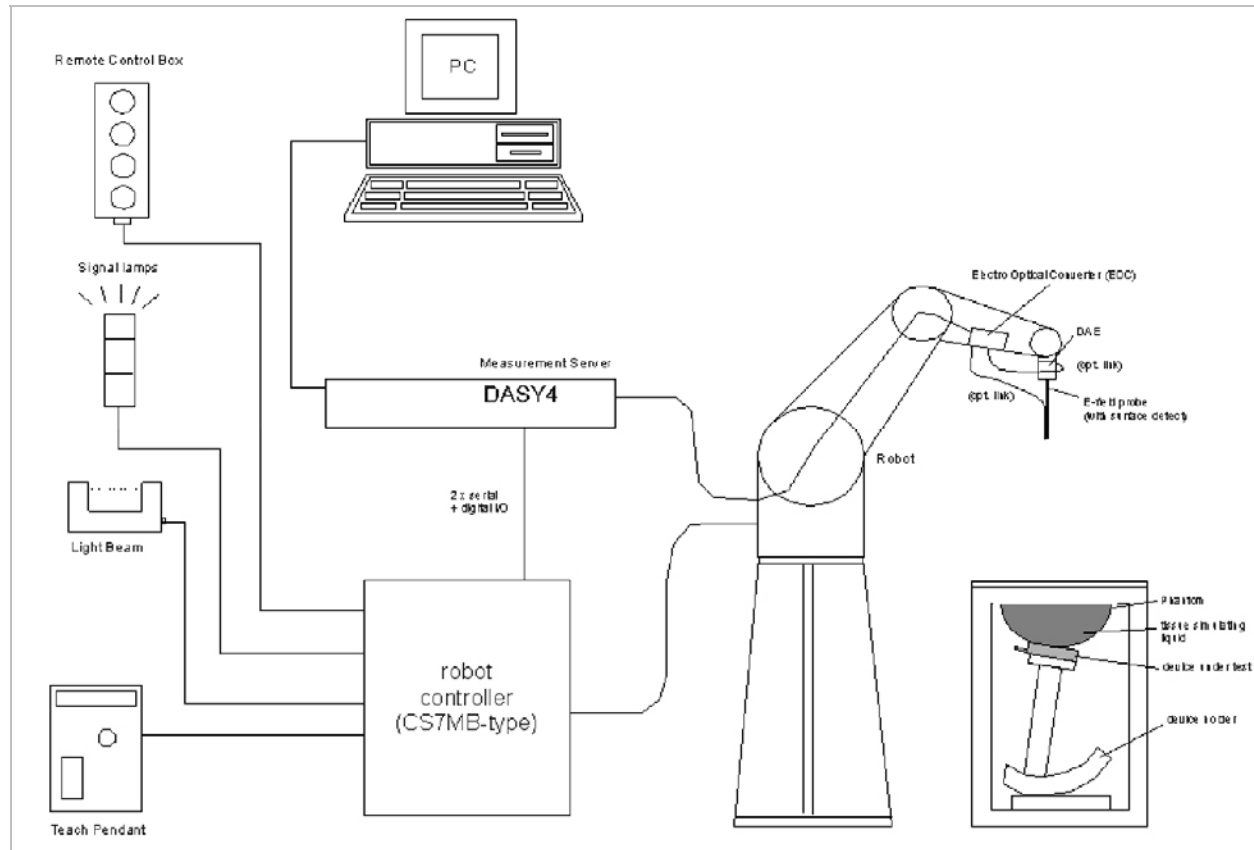
Link 5150 transmits on 5 ms frames using 5 MHz and 10 MHz channels. The 10 MHz channel bandwidth uses 1024 sub-carriers and 35 sub-channels, with 184 null sub-carriers and 840 available for transmission, consisting of 560 data sub-carriers and 280 pilot sub-carriers. The 5 MHz channel bandwidth uses 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.

Intel WiFi/WiMax Link 5150 received single module approval on 09/16/2008.

WiMAX and 802.11 a/b/g/n co-location conditions:

The 802.16e WiMAX and 802.11 a/b/g/n WiFi radio will not transmit simultaneously. When the 512ANXMMW is installed in the typical laptop computer, once the network is chosen by the end user during WiMAX/WiFi network, only the WiMAX radio or WiFi radio will transmit.

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.
- DASY4 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 to validate the proper functioning of the system.

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	
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

8. SIMULATING LIQUID CHECK

The simulating liquids should be checked at the beginning of a series of SAR measurements to determine if the dielectric parameters are within the tolerances of the specified target values. The relative permittivity and conductivity of the tissue material should be within $\pm 5\%$ of the values given in the table below.

Reference Values of Tissue Dielectric Parameters for Body Phantom

The head tissue dielectric parameters recommended by the IEEE SCC-34/SC-2 in IEEE Standard 1528 have been incorporated in the following table. These head parameters are derived from planar layer models simulating the highest expected SAR for the dielectric properties and tissue thickness variations in a human head. Other head and 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 $\rho = 1000 \text{ kg/m}^3$)

8.1. SIMULATING LIQUID CHECK RESULTS

Simulating Liquid Dielectric Parameter Check Result @ Muscle 2600 MHz

Room Ambient Temperature = 24°C; Relative humidity = 35%

Measured by: CHAOYEN LIN

Simulating Liquid		Parameters			Measured	Target	Deviation (%)	Limit (%)
f (MHz)	Depth (cm)							
2500	15	e'	53.352	Relative Permittivity (ϵ_r):	53.3519	52.6	1.43	± 5
		e"	15.097	Conductivity (σ):	2.09971	2.02	3.95	± 5
2590	15	e'	52.907	Relative Permittivity (ϵ_r):	52.9067	52.5	0.77	± 5
		e"	15.565	Conductivity (σ):	2.24271	2.15	4.31	± 5
2600	15	e'	52.931	Relative Permittivity (ϵ_r):	52.9308	52.5	0.80	± 5
		e"	15.604	Conductivity (σ):	2.25701	2.16	4.45	± 5
2690	15	e'	52.321	Relative Permittivity (ϵ_r):	52.3214	52.4	-0.15	± 5
		e"	15.900	Conductivity (σ):	2.37936	2.29	3.90	± 5

Liquid Check

Ambient temperature: 24 deg. C; Liquid Temperature: 23 deg. C

March 13, 2009 09:19 AM

Frequency	e'	e"
2460000000.	53.3642	15.0374
2470000000.	53.4004	15.1108
2480000000.	53.3994	15.1874
2490000000.	53.3835	15.1691
2500000000.	53.3519	15.0973
2510000000.	53.3055	15.0783
2520000000.	53.2412	15.0688
2530000000.	53.1351	15.0860
2540000000.	53.0352	15.1556
2550000000.	52.9210	15.2426
2560000000.	52.8659	15.3364
2570000000.	52.8549	15.4262
2580000000.	52.8530	15.5124
2590000000.	52.9067	15.5652
2600000000.	52.9308	15.6042
2610000000.	52.9638	15.6225
2620000000.	52.9100	15.5991
2630000000.	52.8343	15.5880
2640000000.	52.7166	15.5612
2650000000.	52.6098	15.5692
2660000000.	52.5123	15.6219
2670000000.	52.4159	15.7108
2680000000.	52.3466	15.8144
2690000000.	52.3214	15.8997
2700000000.	52.3285	15.9918

The conductivity (σ) can be given as:

$$\sigma = \omega \epsilon_0 e'' = 2 \pi f \epsilon_0 e''$$

where $f = \text{target } f * 10^6$

$$\epsilon_0 = 8.854 * 10^{-12}$$

Simulating Liquid Dielectric Parameter Check Result @ Muscle 2600 MHz

Room Ambient Temperature = 23°C; Relative humidity = 40%

Measured by: Sunny Shih

Simulating Liquid		Parameters			Measured	Target	Deviation (%)	Limit (%)
f (MHz)	Depth (cm)							
2500	15	e'	53.9174	Relative Permittivity (ϵ_r):	53.9174	52.6	2.50	± 5
		e"	14.9459	Conductivity (σ):	2.07865	2.02	2.90	± 5
2590	15	e'	53.5353	Relative Permittivity (ϵ_r):	53.5353	52.5	1.97	± 5
		e"	15.3192	Conductivity (σ):	2.20727	2.15	2.66	± 5
2600	15	e'	53.5646	Relative Permittivity (ϵ_r):	53.5646	52.5	2.01	± 5
		e"	15.4090	Conductivity (σ):	2.22878	2.16	3.15	± 5
2690	15	e'	53.5646	Relative Permittivity (ϵ_r):	53.5646	52.4	2.22	± 5
		e"	15.6986	Conductivity (σ):	2.34927	2.29	2.59	± 5

Liquid Check

Ambient temperature: 24 deg. C; Liquid Temperature: 23 deg. C

March 14, 2009 10:10 AM

Frequency	e'	e"
2460000000.	53.9387	14.8622
2470000000.	53.9481	14.8973
2480000000.	53.9657	14.9134
2490000000.	53.9526	14.9323
2500000000.	53.9174	14.9459
2510000000.	53.8523	14.9658
2520000000.	53.7550	14.9792
2530000000.	53.6791	15.0326
2540000000.	53.5738	15.1044
2550000000.	53.4909	15.1620
2560000000.	53.4395	15.2007
2570000000.	53.4386	15.2337
2580000000.	53.4816	15.2820
2590000000.	53.5353	15.3192
2600000000.	53.5646	15.4090
2610000000.	53.5566	15.4463
2620000000.	53.4883	15.4780
2630000000.	53.3786	15.4890
2640000000.	53.2545	15.4978
2650000000.	53.1593	15.5027
2660000000.	53.0681	15.5237
2670000000.	52.9990	15.5669
2680000000.	52.9724	15.6349
2690000000.	52.9660	15.6986
2700000000.	52.9811	15.7976

The conductivity (σ) can be given as:

$$\sigma = \omega \epsilon_0 e'' = 2 \pi f \epsilon_0 e''$$

where $f = \text{target } f * 10^6$

$$\epsilon_0 = 8.854 * 10^{-12}$$

9. SYSTEM PERFORMAMCE CHECK

The system performance check is performed prior to any usage of the system in order to guarantee reproducible results. The system performance check verifies that the system operates within its specifications of $\pm 10\%$.

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 DASY4 system with an Isotropic E-Field Probe EX3DV3-SN: 3531 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 (2.4 GHz) fine cube was chosen for cube integration.
- Distance between probe sensors and phantom surface was set to 3 mm.
- The dipole input power (forward power) was 250 mW $\pm 3\%$.
- The results are normalized to 1 W input power.

Reference SAR Values for body-tissue

The reference SAR values based on SPEAG's Calibration Certificate, Certificate No: D2600V2-1006_Jun07.

SAR result with Body TSL

SAR averaged over 1 cm ³ (1 g) of Body TSL	condition	
SAR measured	250 mW input power	14.4 mW / g
SAR normalized	normalized to 1W	57.6 mW / g
SAR for nominal Body TSL parameters ¹	normalized to 1W	58.5 mW / g $\pm 17.0\%$ (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	6.46 mW / g
SAR normalized	normalized to 1W	25.8 mW / g
SAR for nominal Body TSL parameters ¹	normalized to 1W	26.2 mW / g $\pm 16.5\%$ (k=2)

Please see Attachment named "4_Certificate of System Validation Dipole - D2600V2 SN 1006" for details.

9.1. SYSTEM PERFORMANCE CHECK RESULTS

System Validation Dipole: D2600V2 SN 1006

Results

Date: March 13, 2009

Ambient Temperature = 24°C; Relative humidity = 35%

Measured by: CHAOYEN LIN

Body Simulating Liquid			Normalized to 1 W		Target	Deviation (%)	Lim it (%)
f (MHz)	Temp. (°C)	Depth (cm)					
2600	23	15	1g	55.4	57.6	-3.82	± 10
			10g	24.4	25.8	-5.43	± 10

Date: March 14, 2009

Ambient Temperature = 24°C; Relative humidity = 30%

Measured by: Sunny Shih

Body Simulating Liquid			Normalized to 1 W		Target	Deviation (%)	Lim it (%)
f (MHz)	Temp. (°C)	Depth (cm)					
2600	23	15	1g	54.2	57.6	-5.90	± 10
			10g	23.9	25.8	-7.36	± 10

10. WiMAX / 802.16e DEVICE SPECIFICATION

10.1. 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 Link 5150 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-PUSC 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

10.2. Duty Factor Considerations

- Although the chipset can supply higher downlink-to-uplink (DL/UL) symbol ratios, Link 5150 is only supplied to BRS/EBS WiMAX operators with agreements to transmit at a maximum DL/UL symbol ratio of 29:18. Link 5150 is limited by firmware and the corresponding WiMAX system to operate at or below this maximum duty factor. 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.
- SAR evaluations were performed by using test vector waveform file loaded in the Vector Signal Generator. For 10 MHz bandwidth, test vector waveform file with 12 UL symbol and control symbols not allocated nor active, each burst contains 12 traffic symbols. For an in-network / end-user DL:UL symbol ratio of 29:18, the duty factor scaling formula is :

$$\{ (\text{ctrl_symb_power} \times 3 + \text{traffic_symb_max_power} \times 15) / (\text{actual_power} \times 12) \}$$

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.

The max. measured output power is 23.11 dBm/ 205mW for 10 MHz BW/QPSK @2593 MHz. Control Symbol power is calculated as : $205 \times 5/35 = 29.29$ mW. 23.11 dBm is the max. output power for 10 MHz BW/QPSK modulation.

Since the control symbols are not allocated nor active, the measured burst power is equal to traffic symbol power = 205 mW

$(29.29\text{mW} \times 3 + 205 \times 15) / (205 \text{ mW} \times 12) = \mathbf{1.29}$ (duty –factor scaling factor for 10 MHZ BW/QPSK@2593 MHz).

The actual measured output power is 22.78 dBm/ 190mW for 10 MHz BW/16QAM @2593 MHz. The max. output power for 10 MHz BW/16QAM is 22.98 dBm / 198.61 mW which will be used as traffic symbol max. power. Control Symbol power is calculated as : $198.61 \times 5/35 = 28.37 \text{ mW}.$

Since the control symbols are not allocated nor active, the measured burst power is equal to Max. traffic symbol power = 198.61 mW

$(28.37\text{mW} \times 3 + 198.61\text{mW} \times 15) / (190 \text{ mW} \times 12) = \mathbf{1.34}$ (duty –factor scaling factor for 10 MHZ BW/16QAM@2593 MHz).

- c. For 5 MHz bandwidth, test vector waveform file with 18 UL symbol and control symbols not allocated nor active, each burst contains 18 traffic symbols. For an in-network / end-user DL:UL symbol ratio of 29:18, the duty factor scaling formula is :

$\{ (\text{ctrl_symb_power} \times 3 + \text{traffic_symb_max_power} \times 15) / (\text{actual_power} \times 18) \}$

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.

The actual measured output power is 23.31 dBm/ 214mW for 5 MHz BW/QPSK@2593MHz. The Max. measured output power for 5 MHz BW/QPSK is 23.44 dBm/220.80mW which is used as traffic symbol max. power. Control Symbol power is calculated as : $220.80 \times 5/17 = 64.94 \text{ mW}.$

Since the control symbols are not allocated nor active, the measured Max burst power is equal to traffic symbol power = 220.8 mW

$(64.94\text{mW} \times 3 + 220.8\text{mW} \times 15) / (214 \text{ mW} \times 18) = \mathbf{0.91}$ (duty –factor scaling factor for 5 MHZ BW/QPSK@2593MHz).

The actual measured output power is 23.51 dBm/ 224.39mW for 5 MHz BW/16QAM@2593MHz. The Max. measured output power for 5 MHz/16QAM is 23.76 dBm/237.68mW which is used as traffic symbol max. power. Control Symbol power is calculated as : $237.68 \times 5/17 = 69.9 \text{ mW}.$

Since the control symbols are not allocated nor active, the measured Max. burst power is equal to traffic symbol power = 237.68 mW

$(69.9\text{mW} \times 3 + 237.68\text{mW} \times 15) / (224.39 \text{ mW} \times 18) = \mathbf{0.94}$ (duty –factor scaling factor for 5 MHZ BW/16QAM@2593MHz).

- d. The measured SAR must be scaled to the 29:18 in-network / end-user DL:UL ratio.

- e. Duty Factor and Crest Factor: Since control symbols not allocated nor active in the SAR measurement. All UL symbols are counted. A duty factor = (number of uplink symbols x 102.857us)/5000us. Crest Factor = 1/(duty factor) for this periodic pulse signal device

Test Vector File Name	BW	Test Vector UL Symbols (no control symbol)	UL duty Cycle	Crest Factor	DL Modulation	UL Modulation
RDQ64_56_UQ4_12_10M	10 MHz	12 (traffic symbols)	24.4%	4.09	QAM64 R5/6	QPSK R1/2
RDQ4_12_UQ16_34_10M	10 MHz	12 (traffic symbols)	24.7%	4.05	QPSK R1/2	QAM16 R3/4
RDQ64_56_UQ4_12_5M	5 MHz	18 (traffic symbols)	37%	2.7	QAM64 R5/6	QPSK R1/2
RDQ4_12_UQ16_34_5M	5 MHz	18 (traffic symbols)	37%	2.7	QPSK R1/2	QAM16 R3/4

- f. Duty-factor scaling:.

Test Vector File Name	BW	Test Vector UL Symbol (no control symbols)	UL duty Cycle (%)	Duty-factor scaling factor
RDQ64_56_UQ4_12_10M	10 MHz	12 (traffic symbols)	24.40%	1.29
RDQ4_12_UQ16_34_10M	10 MHz	12 (traffic symbols)	24.70%	1.34
RDQ64_56_UQ4_12_5M	5 MHz	18 (traffic symbols)	37%	0.91
RDQ4_12_UQ16_34_5M	5 MHz	18 (traffic symbols)	37%	0.94

11. TEST SOFTWARE

The Test tool is a diagnostic software tool that works in conjunction with the WiMAX simulated base station waveforms loaded in the ESG (Vector Signal Generator) to operate the client card at full power (originally tested and approved) in the various modes:

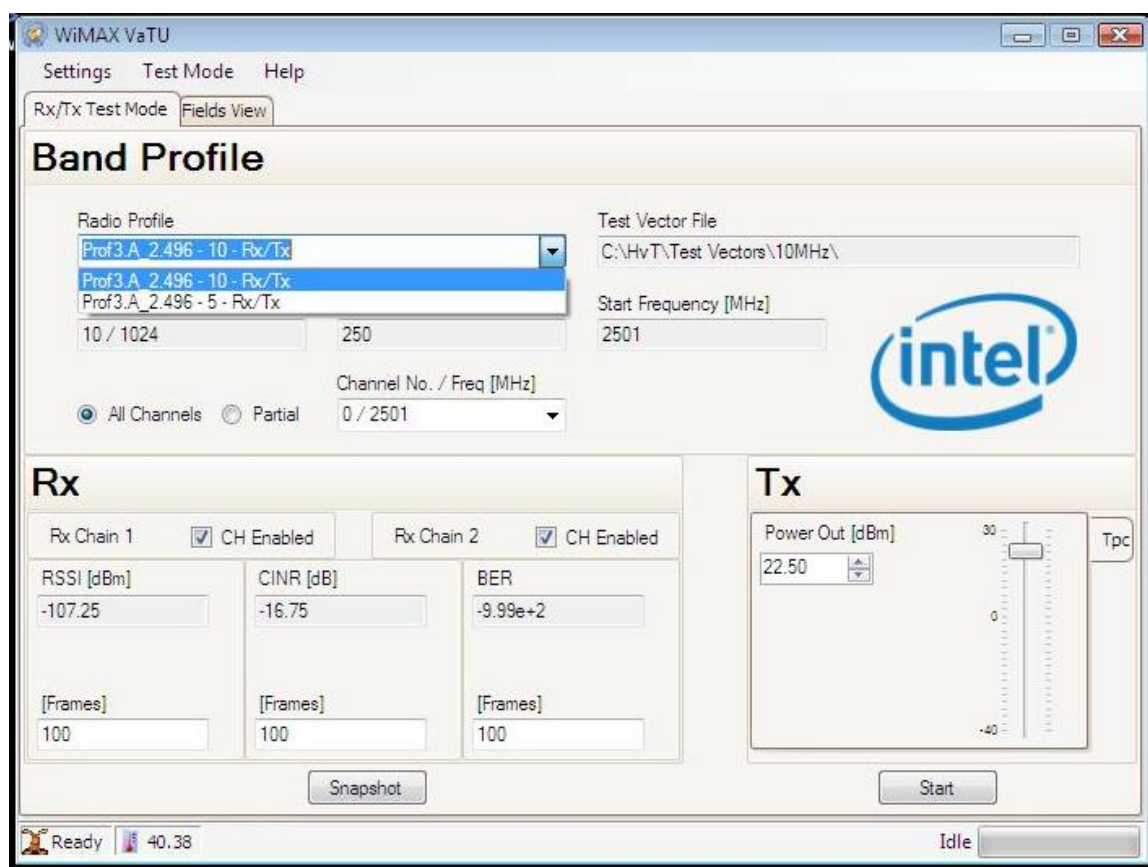
10MHz Channel BW 16QAM

10MHz Channel BW QPSK

5MHz Channel BW 16QAM

5MHz Channel BW QPSK

The test software tool (WiMAX VaTU SW application) is installed on the Samsung Netbook computer to configure the test device, Intel WiFi/WiMAX Link 5150, to transmit at max. output power. During normal operation, the output power of WiFi/WiMAX client module is controlled by a WiMAX basestation, which also determines the characteristics of the transmission. For testing purposes, the device output power is kept at this max. using WiMAX VATU SW application loaded in the Samsung Netbook. The uplink transmission is maintained at a stable condition by the radio profile loaded in Vector signal generator. This enables the WiFi/WiMAX module to transmit at max. power with a constant duty factor according to the specific radio profile as documented in the section 3. The test software serves only one purpose, to configure the WiFi/WiMAX module to transmit at the max. power during SAR measurement.

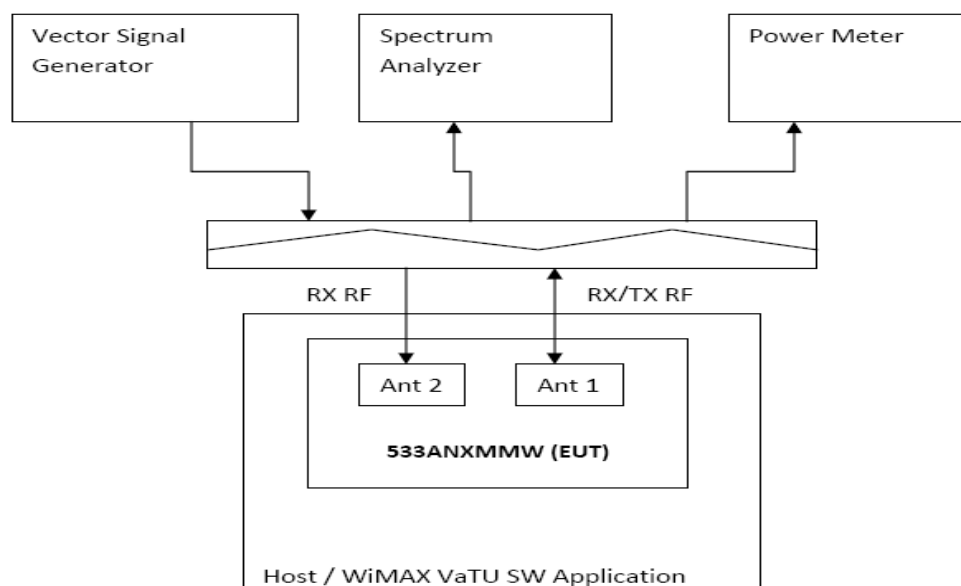


12. SIGNAL GENERATEOR DETAILS

a. Frame Profile loaded in Vector Signal Generator:

Test Vector File Name	BW	Test Vector UL Symbols (no control symbol)	UL duty Cycle	DL Modulation	UL Modulation
RDQ64_56_UQ4_12_10M	10 MHz	12 (traffic symbols)	24.4%	QAM64 R5/6	QPSK R1/2
RDQ4_12_UQ16_34_10M	10 MHz	12 (traffic symbols)	24.7%	QPSK R1/2	QAM16 R3/4
RDQ64_56_UQ4_12_5M	5 MHz	18 (traffic symbols)	37%	QAM64 R5/6	QPSK R1/2
RDQ4_12_UQ16_34_5M	5 MHz	18 (traffic symbols)	37%	QPSK R1/2	QAM16 R3/4

b. Connection Diagram



Agilent ESG Vector Signal Generator / Model :E4438C is used in conjunction with Intel supplied radio profile to configure the WiFi/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 waveform is configured for a test vector with UL symbol of 12 traffic symbols for 10 MHz and 18 UL traffic symbol for 5 MHz using Intel Signal Waveform Software for 802.16 WiMAX, on the PC and downloaded to the VSG. 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 determine 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.

13. COMMUNICATION TEST SET DETAILS

Modulation and channel bandwidth selection is loaded to Vector Signal Generator. For example, when evaluating 16QAM with 10 MHz channel Bandwidth, radio profile name "RDQ4_12_UQ16_34_10M " is active on the Vector Signal Generator.

Parameter /Value	Frame definition for 10 MHz RCT		
	Test vector name		Remark
	RDQ4_12_UQ16_34_10M	RDQ64_56_UQ4_12_10M	
Band Width	10MHz	10MHz	
FFT size	1024	1024	
UL Traffic Symbols	12	12	
Down link			
Zone profiles	Zone 1 – PUSC	Zone 1 – PUSC	single zone
Burst profile / MCS	MCS : QPSK R1/2	MCS : QAM64 R5/6	Single DIUC
Up link			
Duty Cycle power compensation factor	6.1dB	6.1dB	
Zone profiles	Zone 1 – PUSC	Zone 1 – PUSC	single zone
Burst profile / MCS	MCS : QAM16 R3/4	MCS : QPSK R1/2	Single DIUC

Parameter /Value	Frame definition for 5MHz RCT		
	Test vector name		Remarks
	RDQ64_56_UQ4_12_5M	RDQ4_12_UQ16_34_5M	
Band Width	5MHz	5MHz	
FFT size	512	512	
UL traffic symbols	18	18	
Down link			
Zone profiles	Zone 1 – PUSC	Zone 1 – PUSC	single zone
Burst profile / MCS	MCS : QAM64 R5/6	MCS : QPSK R1/2	Single DIUC
Up link			
Duty Cycle power compensation factor	4.3dB	4.3dB	
Zone profiles	Zone 1 – PUSC	Zone 1 – PUSC	single zone
Burst profile / MCS	MCS : QPSK R1/2	MCS : QAM16 R3/4	Single DIUC

14. OUTPUT POWER, DUTY CYCLE AND PEAK TO AVERAGE RATIO

The max. average conducted output power is measured for the uplink burst in the difference modulation and channel bandwidth. Conducted average output power were measured with the module connected to the test jig with over-the-air communication link to Vector Signal generator. During SAR evaluation, the module is installed in the computer and the over-the-air communication link is established between the computer and Vector signal generator. The average output power is measured for the uplink bursts through triggering and gating.

The following procedures have been used to prepare the EUT for the SAR test.

The EUT driver software installed in the host support equipment during testing was WiMAX VaTU, version: 3.0.0.0

The modes with highest output power channel were chosen for the conducted output power measurement.

With Spectrum Analyzer with Gate-On, Channel Power. Measured with peak and average detector

PSA setting: RBW=100 kHz; VBW = 300 kHz with Average detection, sweep time = 1 s

14.1. AVERAGE OUTPUT POWER

10 MHz

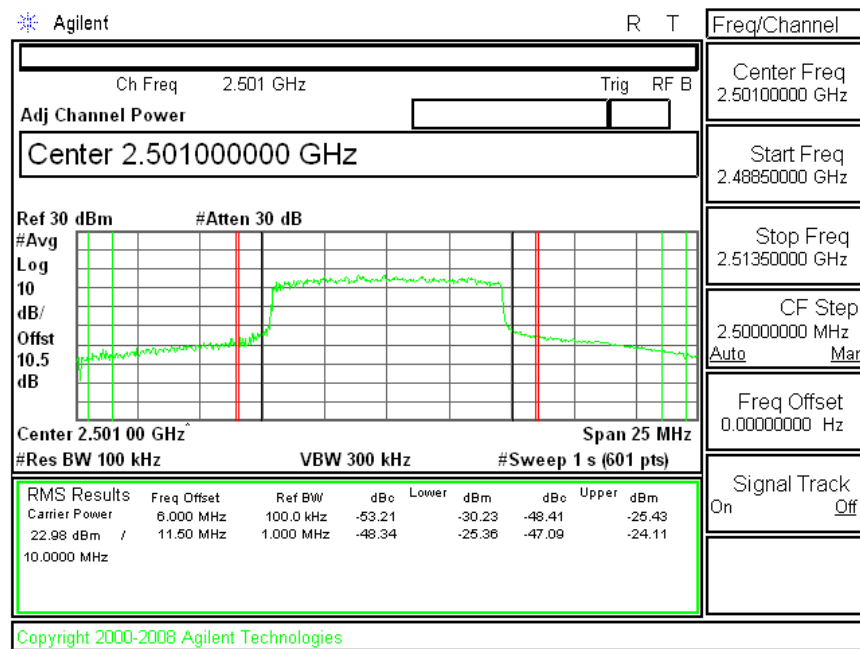
Mode	Test Vector file name	Ch. No	f (MHz)	Average Output power (dBm)	Average Output power (mW)
16QAM	RDQ4_12_UQ16_34_10M	0	2501	22.98	198.61
		368	2593	22.78	189.67
		736	2685	22.77	189.23
QPSK	RDQ64_56_UQ4_12_10M	0	2501	22.86	193.20
		368	2593	23.11	204.64
		736	2685	23.00	199.53

5 MHz

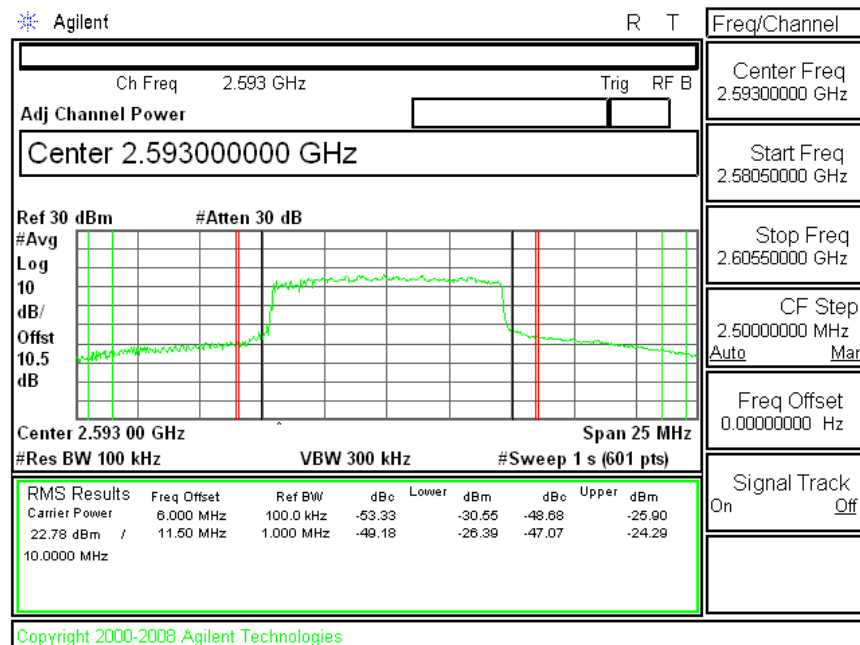
Mode	Test Vector file name	Ch. No	f (MHz)	Average	Average
16QAM	RDQ4_12_UQ16_34_5M	0	2498.5	23.76	237.68
		378	2593	23.51	224.39
		756	2687.5	23.42	219.79
QPSK	RDQ64_56_UQ4_12_5M	0	2498.5	23.44	220.80
		378	2593	23.31	214.29
		756	2687.5	23.27	212.32

Average Power Plots for 10 MHz

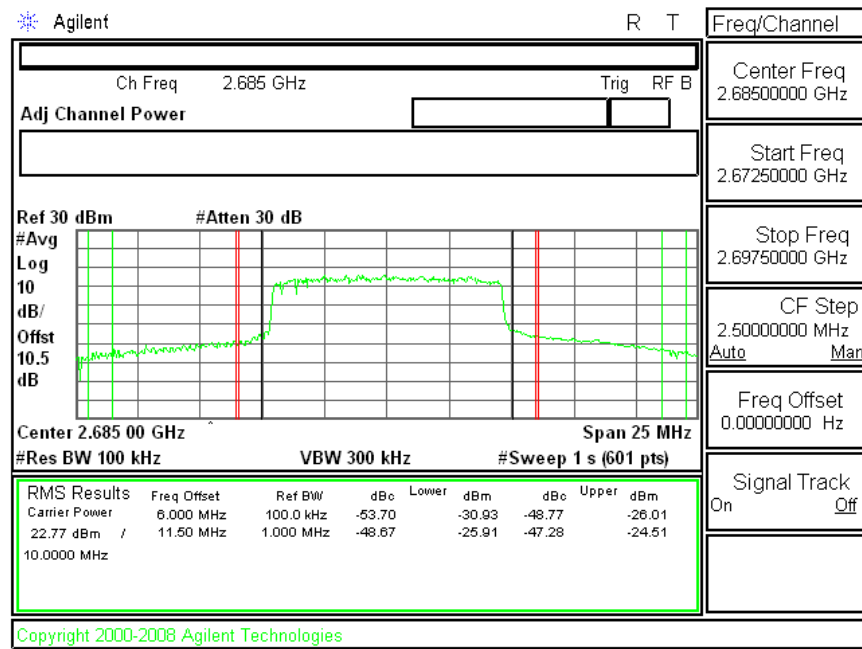
10MHz 16QAM Low CH



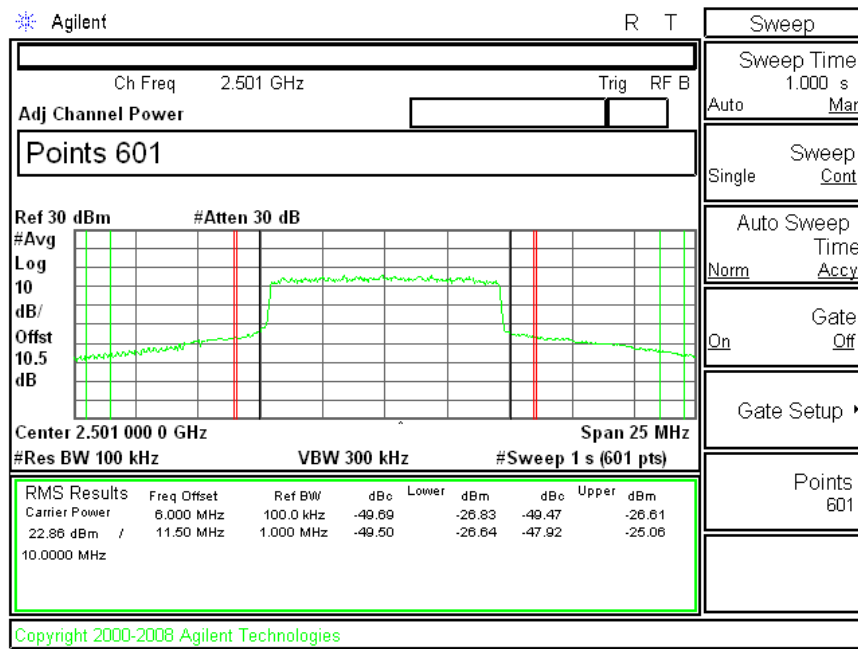
10MHz 16QAM Mid CH



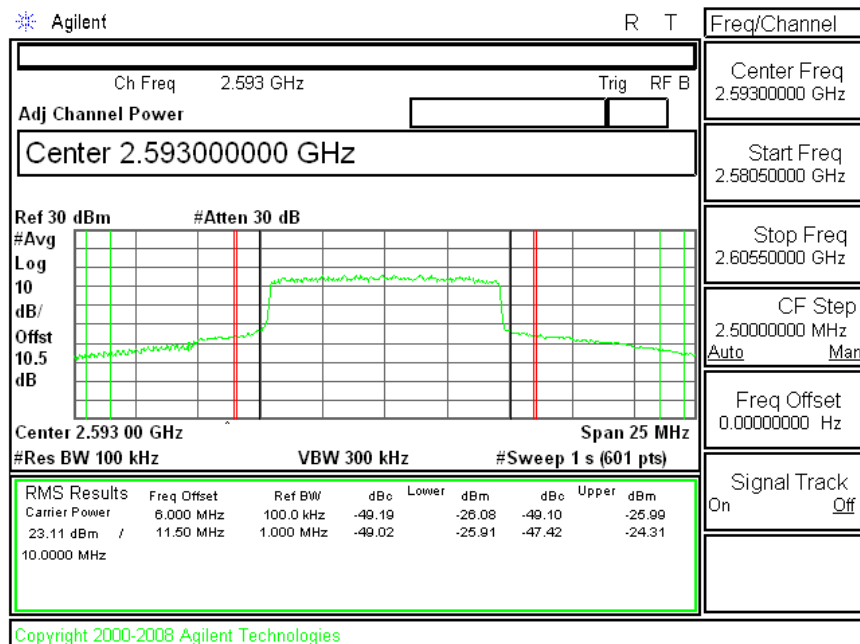
10MHz 16QAM High CH



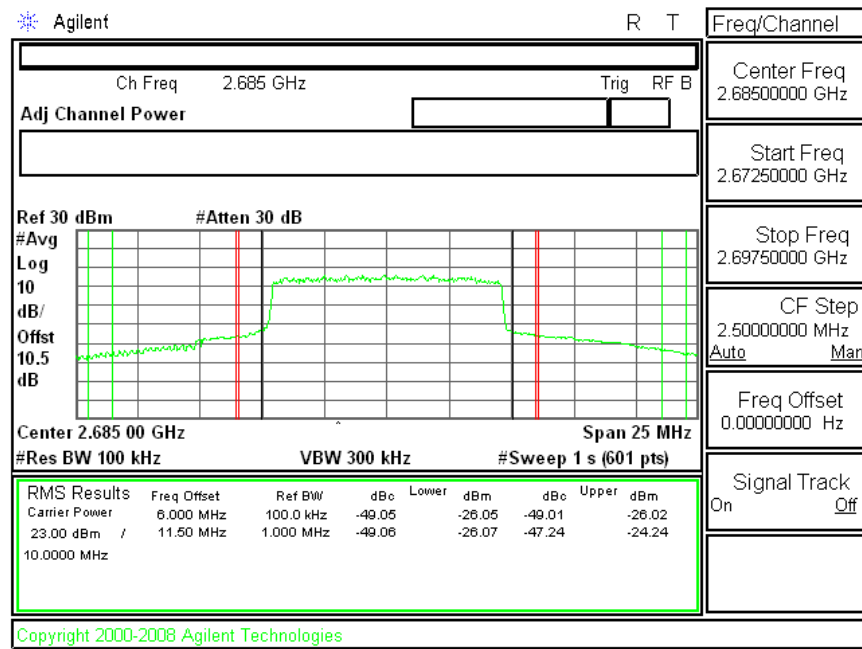
10MHz QPSK Low CH



10MHz QPSK Mid CH

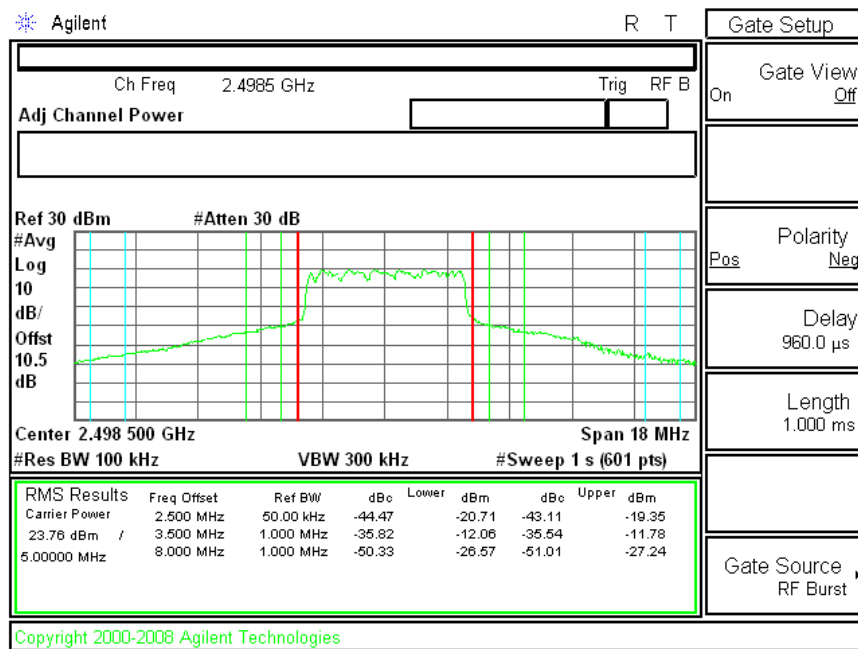


10MHz QPSK High CH

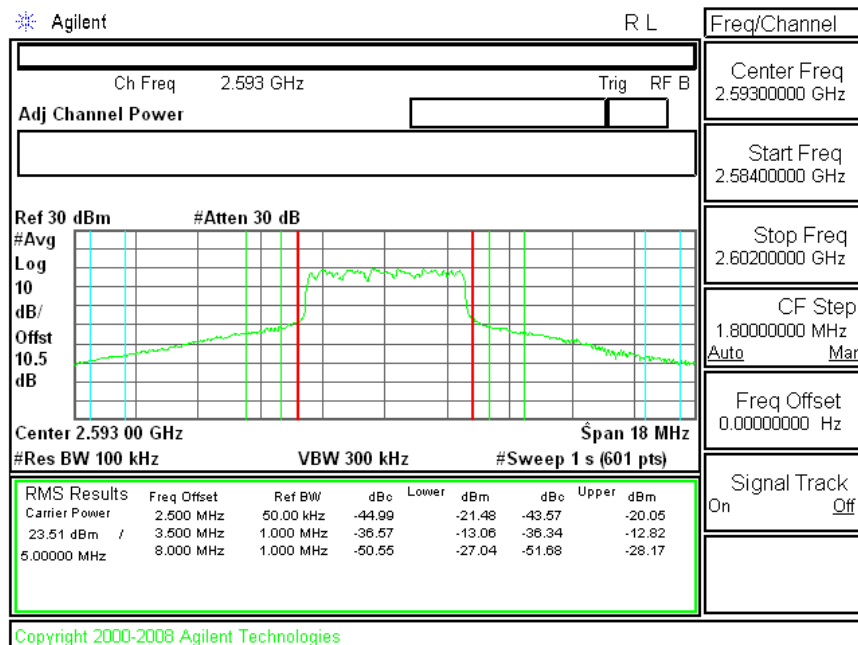


Average Power Plots 5 MHz

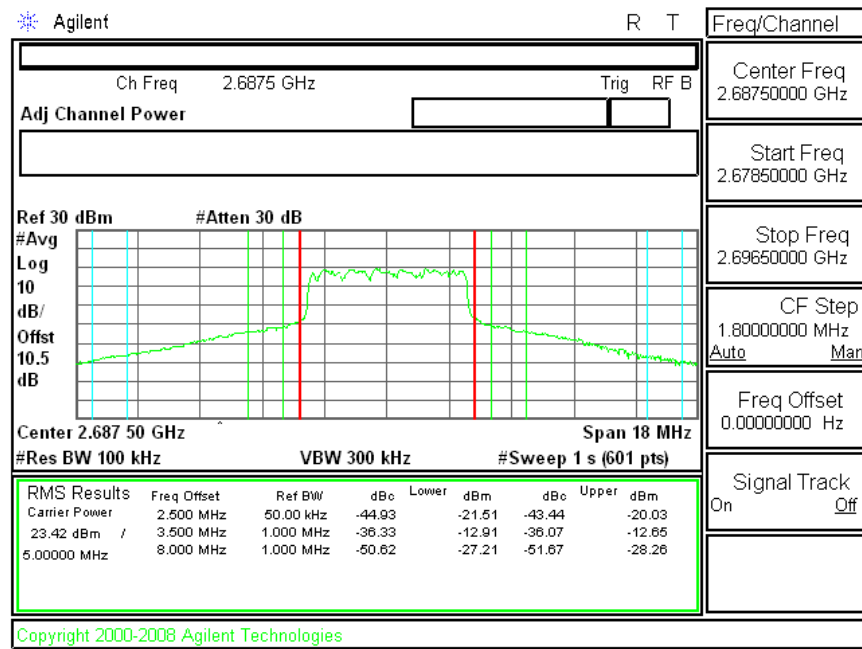
5MHz 16QAM Low CH



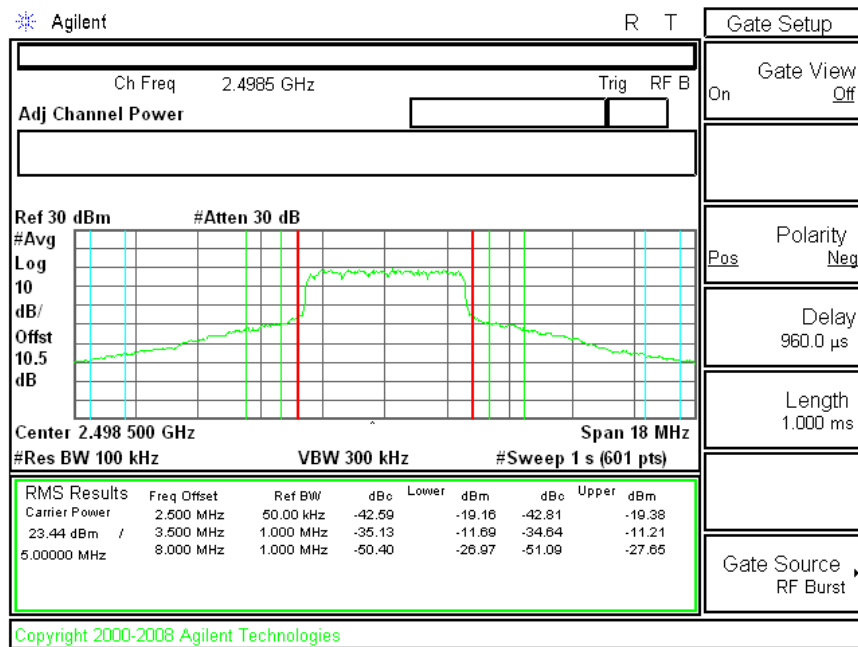
5MHz 16QAM Mid CH



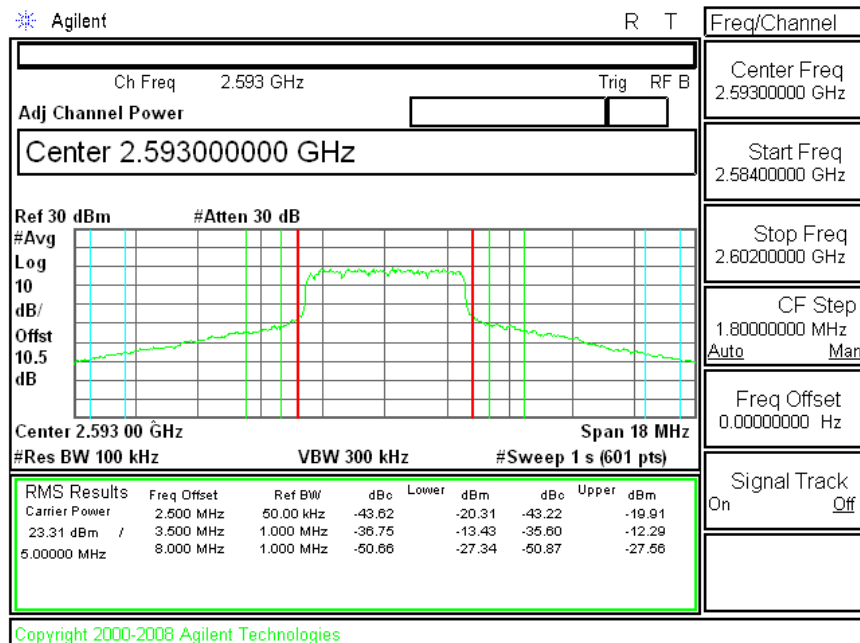
5MHz 16QAM High CH



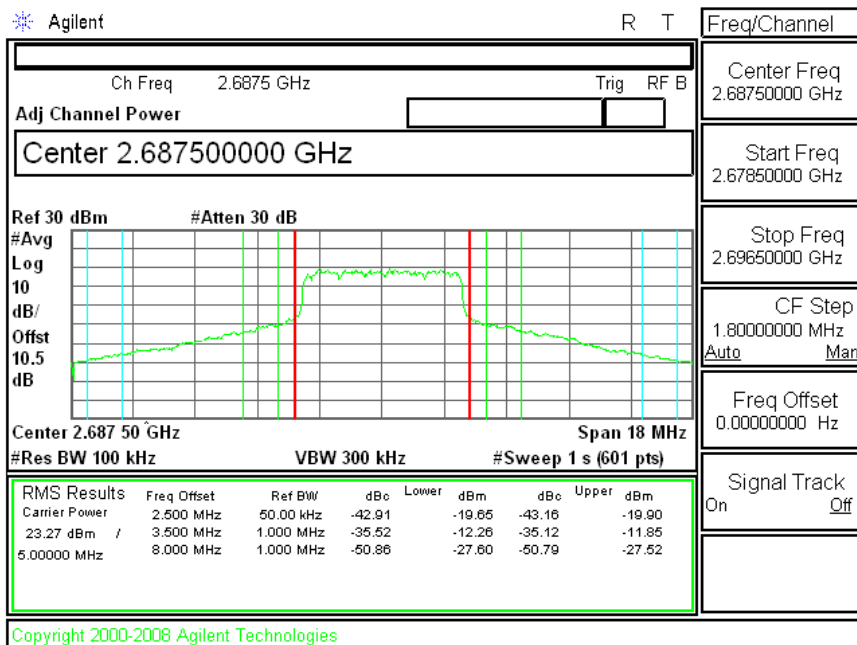
5MHz_QPSK Low CH



5MHz_QPSK Mid CH



5MHz_QPSK High CH



14.2. DUTY CYCLE

10 MHz

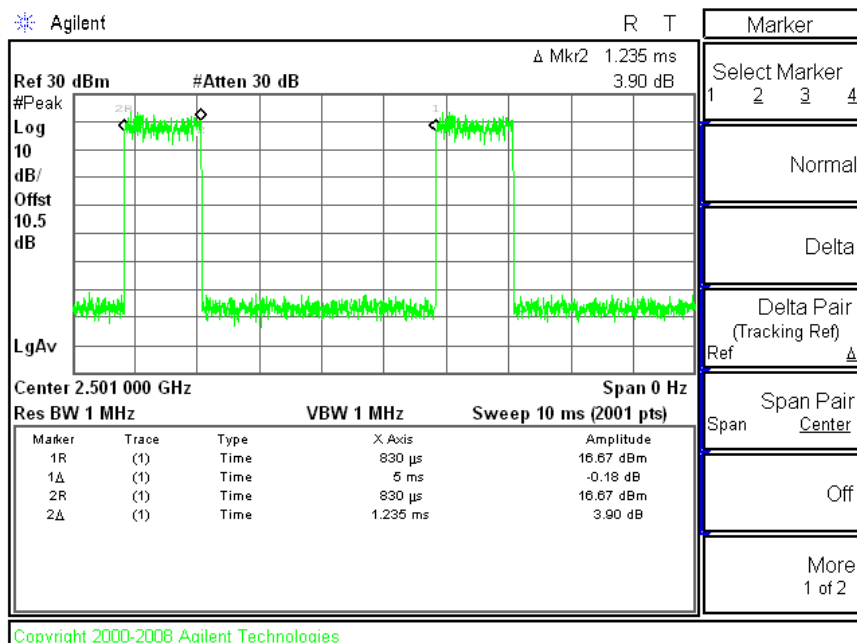
Mode	Test Vector file name	TX on (msec)	TX on + TX off (msec)	Duty cycle (%)
16QAM	RDQ4_12_UQ16_34_10M	1.235	5	24.7
QPSK	RDQ64_56_UQ4_12_10M	1.22	5.00	24.4

5 MHz

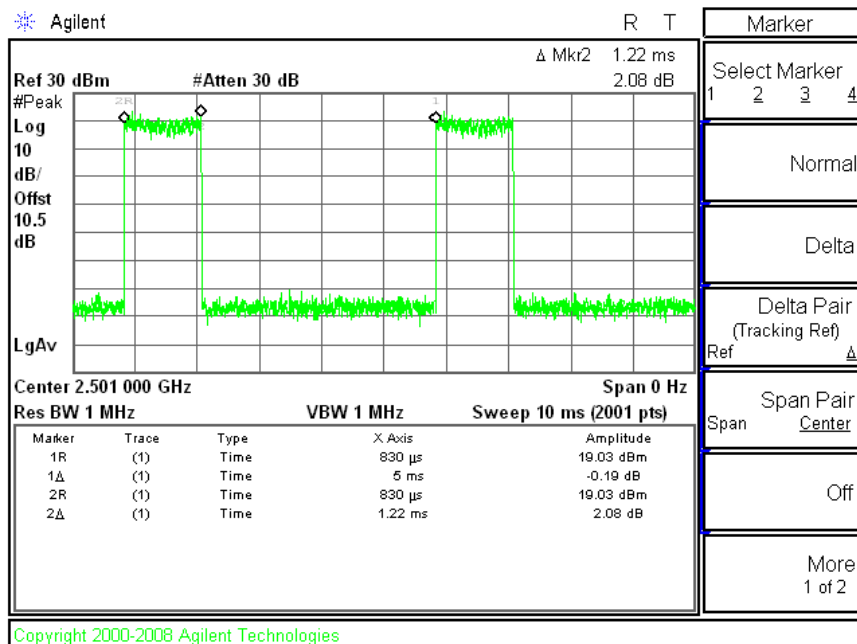
Mode	Test Vector file name	TX on (msec)	TX on + TX off (msec)	Duty cycle (%)
16QAM	RDQ4_12_UQ16_34_5M	1.85	5	37
QPSK	RDQ64_56_UQ4_12_5M	1.85	5	37

Duty Cycle Plots

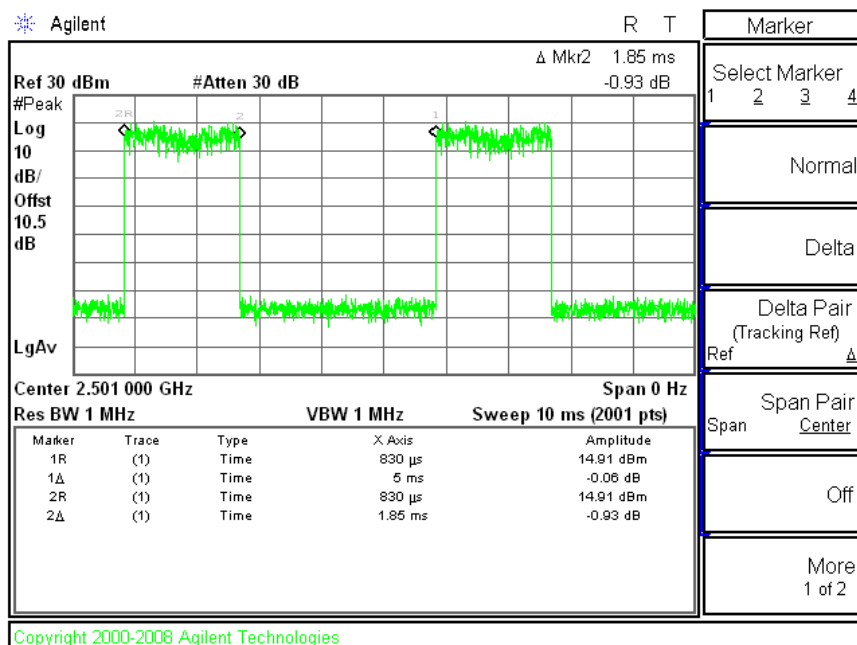
10MHz_16QAM



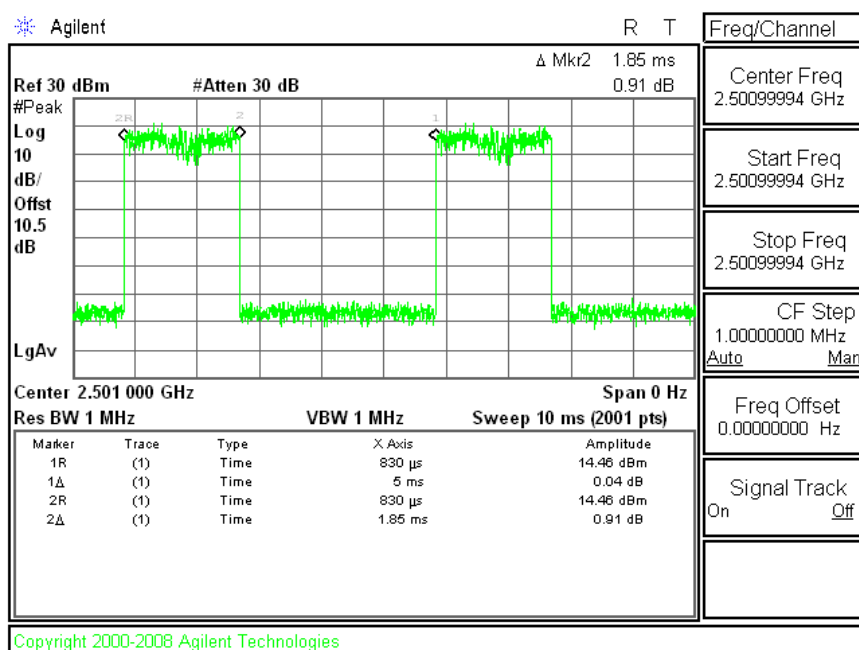
10MHz_QPSK



5MHz 16QAM



5MHz QPSK



14.3. PEAK TO AVERAGE RATIO

Peak and Average Output power measurements were made with Power Meter

10 MHz

Mode	Test Vector file name	Ch. No	f (MHz)	Peak	Average	Peak-to-average ratio
16QAM	RDQ4_12_UQ16_34_10M	368	2593	30.081	22.543	7.538
QPSK	RDQ64_56_UQ4_12_10M	368	2593	30.494	23.102	7.392

5 MHz

Mode	Test Vector file name	Ch. No	f (MHz)	Peak	Average	Peak-to-average ratio
16QAM	RDQ4_12_UQ16_34_5M	378	2593	30.113	24.081	6.032
QPSK	RDQ64_56_UQ4_12_5M	378	2593	30.421	23.857	6.564

Peak to Average Ratio Plots

10MHz_16QAM



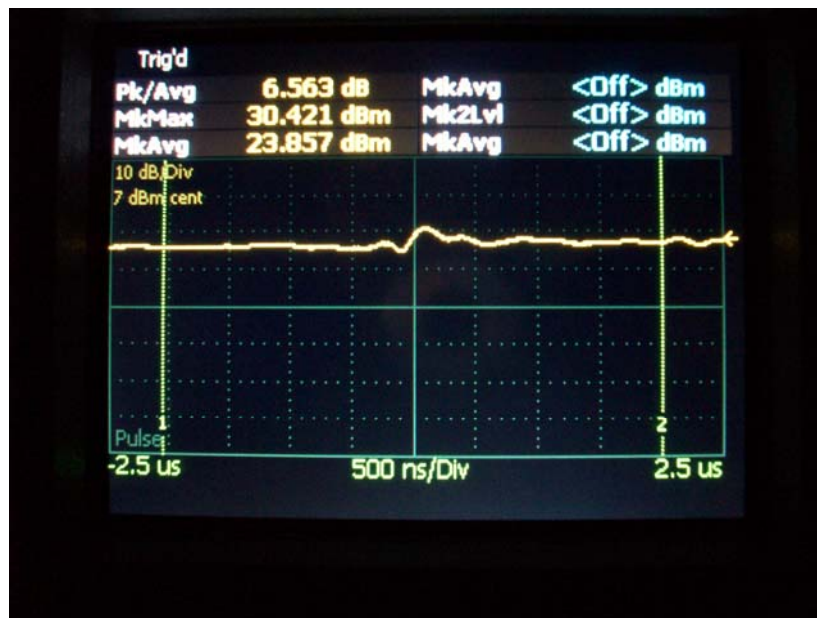
10MHz_QPSK



5MHz_16QAM



5MHz_QPSK



15. SUMMARY OF TEST RESULTS

The SAR measured at the middle channel for this configuration is at least 3 dB lower (0.8 mW/g) than SAR limit (1.6 mW/g), thus testing at low & high channel is optional.

15.1. 10 MHz CHANNEL BANDWIDTH

Mode	Test vector file name	f (MHz)	1g_SAR (mW/g)	Duty Cycle Scale Up Factor	Corrected 1g_SAR (mW/g)	Limit (mW/g)
QPSK	RDQ64_56_UQ4_12_10M	2593	0.017	1.29	0.022	1.6
16QAM	RDQ4_12_UQ16_34_10M	2593	0.012	1.34	0.016	1.6

15.2. 5 MHz CHANNEL BANDWIDTH

Mode	Test vector file name	f (MHz)	1g_SAR (mW/g)	Duty Cycle Scale Up Factor	Corrected 1g_SAR (mW/g)	Limit (mW/g)
QPSK	RDQ64_56_UQ4_12_5M	2593	0.016	0.91	0.015	1.6
16QAM	RDQ4_12_UQ16_34_5M	2593	0.013	0.94	0.012	1.6

QPSK 10 MHz Ch. BW SAR Plot & Data

Date/Time: 3/13/2009 4:49:43 PM

Test Laboratory: Compliance Certification Services

Laptop mode 10M

DUT: Samsung; Type: NP-NC10; Serial: EY1793AS200118P

Communication System: WIMAX 2.6G 10M; Frequency: 2593 MHz; Duty Cycle: 1:4.09

Medium parameters used (interpolated): $f = 2593$ MHz; $\sigma = 2.25$ mho/m; $\epsilon_r = 52.9$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY4 Configuration:

- Area Scan setting - Find Secondary Maximum Within: 2.0 dB and with a peak SAR value greater than 0.0012W/kg
- Probe: EX3DV3 - SN3531; ConvF(7.58, 7.58, 7.58); Calibrated: 4/23/2008
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn427; Calibrated: 10/20/2008
- Phantom: Flat Phantom ELI4.0; Type: QDOVA001BA; Serial: SN:XXXX
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

QPSK 10M - Mid-ch/Area Scan (17x18x1): Measurement grid: dx=15mm, dy=15mm

[Info: Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (measured) = 0.019 mW/g

QPSK 10M - Mid-ch/Zoom Scan (7x7x9)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=3mm

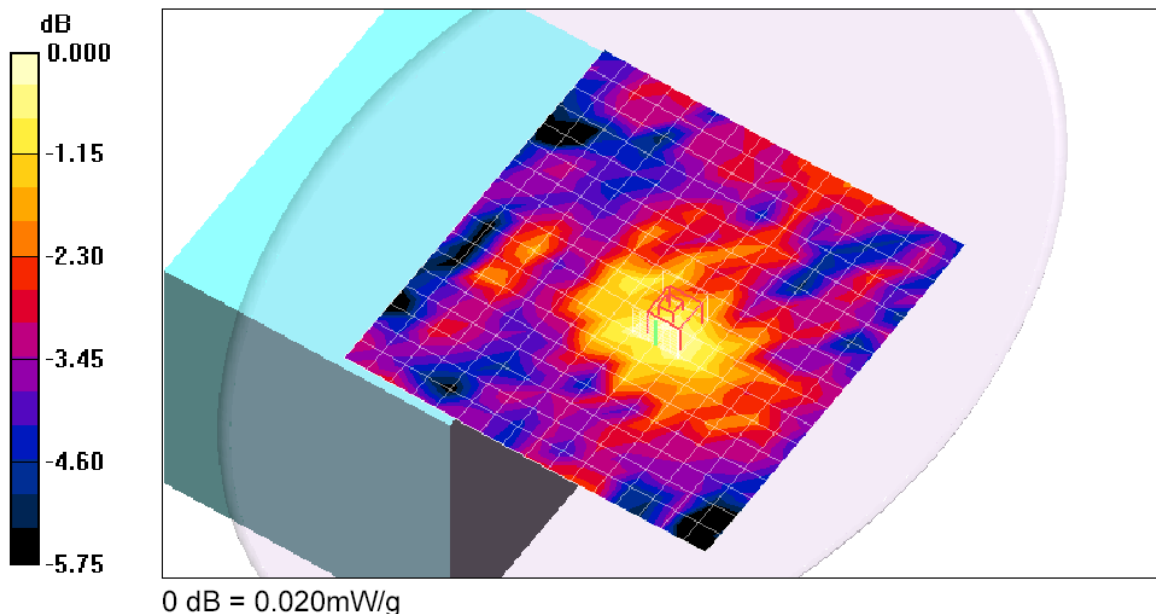
Reference Value = 2.62 V/m; Power Drift = 0.735 dB

Peak SAR (extrapolated) = 0.037 W/kg

SAR(1 g) = 0.017 mW/g; SAR(10 g) = 0.013 mW/g

[Info: Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (measured) = 0.020 mW/g



16QAM 10 MHz Ch. BW SAR Plot & Data

Date/Time: 3/13/2009 6:02:33 PM

Test Laboratory: Compliance Certification Services

Laptop mode 10M

DUT: Samsung; Type: NP-NC10; Serial: EY1793AS200118P

Communication System: WIMAX 2.6G 10M; Frequency: 2593 MHz; Duty Cycle: 1:4.05

Medium parameters used (interpolated): $f = 2593$ MHz; $\sigma = 2.25$ mho/m; $\epsilon_r = 52.9$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY4 Configuration:

- Area Scan setting - Find Secondary Maximum Within: 2.0 dB and with a peak SAR value greater than 0.0012W/kg
- Probe: EX3DV3 - SN3531; ConvF(7.58, 7.58, 7.58); Calibrated: 4/23/2008
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn427; Calibrated: 10/20/2008
- Phantom: Flat Phantom ELI4.0; Type: QDOVA001BA; Serial: SN:XXXX
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

16QAM 10M - Mid-ch/Area Scan (17x18x1): Measurement grid: dx=15mm, dy=15mm

[Info: Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (measured) = 0.016 mW/g

16QAM 10M - Mid-ch/Zoom Scan (7x7x9)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=3mm

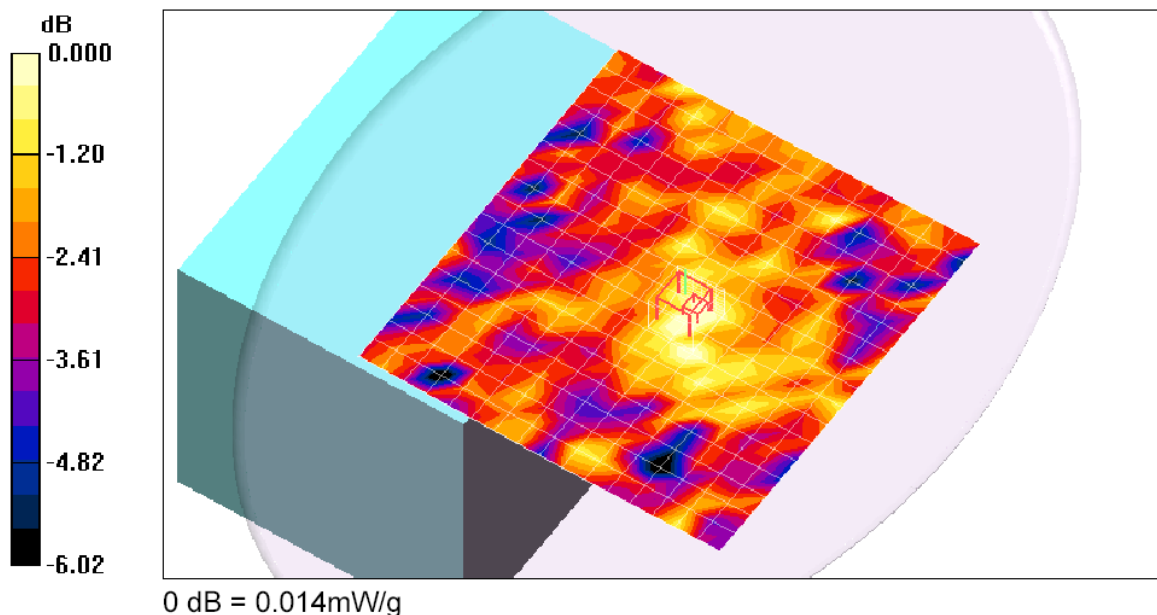
Reference Value = 2.16 V/m; Power Drift = -0.231 dB

Peak SAR (extrapolated) = 0.029 W/kg

SAR(1 g) = 0.012 mW/g; SAR(10 g) = 0.00894 mW/g

[Info: Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (measured) = 0.014 mW/g



QPSK 5 MHz Ch. BW SAR Plot & Data

Date/Time: 3/14/2009 11:38:32 AM

Test Laboratory: Compliance Certification Services

Laptop mode 5M

DUT: Samsung; Type: NP-NC10; Serial: EY1793AS200118P

Communication System: WIMAX 2.6G 5M; Frequency: 2593 MHz; Duty Cycle: 1:2.7

Medium parameters used (interpolated): $f = 2593$ MHz; $\sigma = 2.25$ mho/m; $\epsilon_r = 52.9$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY4 Configuration:

- Area Scan setting - Find Secondary Maximum Within: 2.0 dB and with a peak SAR value greater than 0.0012W/kg
- Probe: EX3DV3 - SN3531; ConvF(7.58, 7.58, 7.58); Calibrated: 4/23/2008
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn427; Calibrated: 10/20/2008
- Phantom: Flat Phantom ELI4.0; Type: QDOVA001BA; Serial: SN:XXXX
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

QPSK 5M - Mid-ch/Area Scan (17x18x1): Measurement grid: dx=15mm, dy=15mm

[Info: Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (measured) = 0.019 mW/g

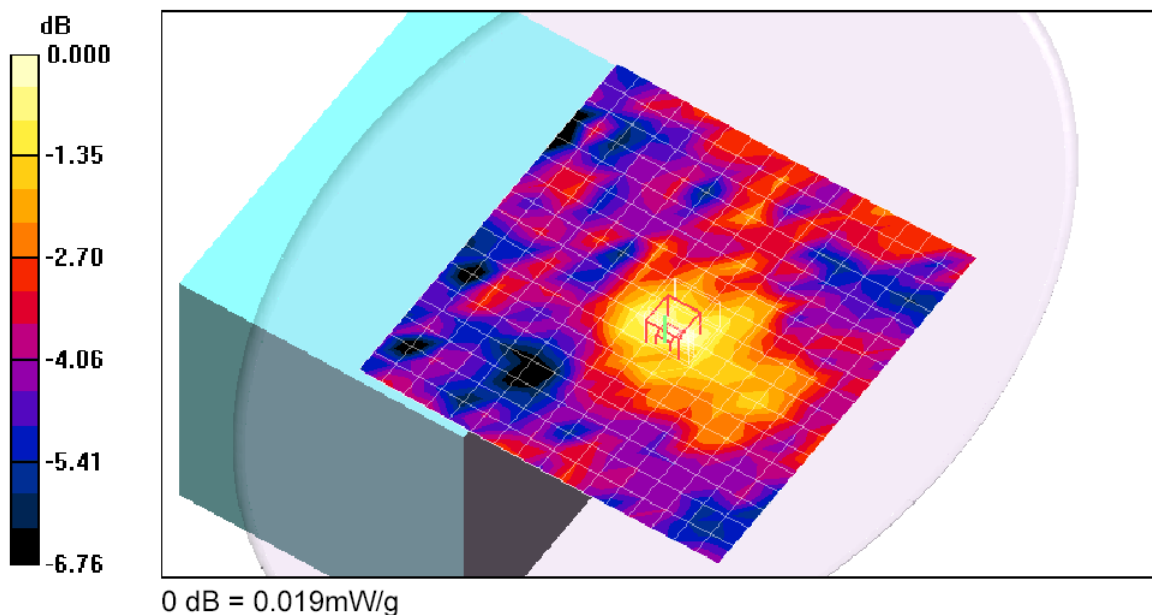
QPSK 5M - Mid-ch/Zoom Scan (7x7x9)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=3mm

Reference Value = 2.36 V/m; Power Drift = 0.287 dB

Peak SAR (extrapolated) = 0.038 W/kg

SAR(1 g) = 0.016 mW/g; SAR(10 g) = 0.011 mW/g

[Info: Interpolated medium parameters used for SAR evaluation.](#)



16QAM 5 MHz Ch. BW SAR Plot & Data

Date/Time: 3/14/2009 10:46:50 AM

Test Laboratory: Compliance Certification Services

Laptop mode 5M

DUT: Samsung; Type: NP-NC10; Serial: EY1793AS200118P

Communication System: WIMAX 2.6G 5M; Frequency: 2593 MHz; Duty Cycle: 1:2.7

Medium parameters used (interpolated): $f = 2593$ MHz; $\sigma = 2.25$ mho/m; $\epsilon_r = 52.9$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY4 Configuration:

- Area Scan setting - Find Secondary Maximum Within: 2.0 dB and with a peak SAR value greater than 0.0012W/kg
- Probe: EX3DV3 - SN3531; ConvF(7.58, 7.58, 7.58); Calibrated: 4/23/2008
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn427; Calibrated: 10/20/2008
- Phantom: Flat Phantom ELI4.0; Type: QDOVA001BA; Serial: SN:XXXX
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

16QAM 5M - Mid-ch/Area Scan (17x18x1): Measurement grid: dx=15mm, dy=15mm

[Info: Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (measured) = 0.016 mW/g

16QAM 5M - Mid-ch/Zoom Scan (7x7x9)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=3mm

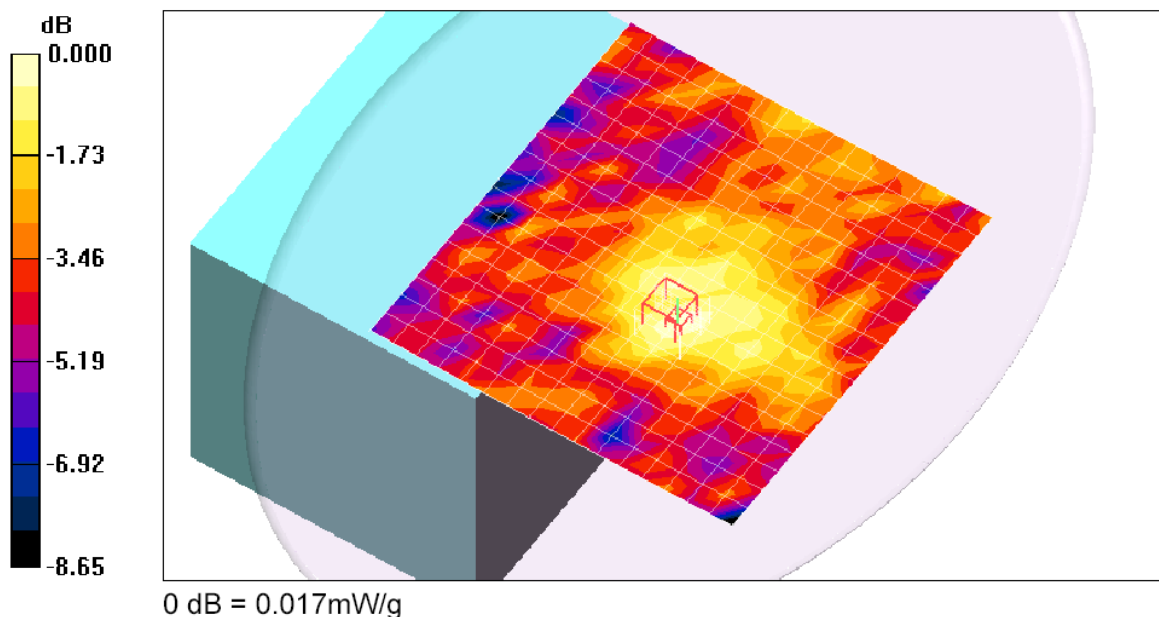
Reference Value = 2.38 V/m; Power Drift = 0.879 dB

Peak SAR (extrapolated) = 0.033 W/kg

SAR(1 g) = 0.013 mW/g; SAR(10 g) = 0.00906 mW/g

[Info: Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (measured) = 0.017 mW/g



16. ATTACHMENTS

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1	System Performance Check Plots	4
2	Certificate of E-Field Probe - EX3DV3SN3531	10
3	Certificate of System Validation Dipole - D2600V2 - SN:1006	6