SAR TEST REPORT

REPORT NO.: SA990526E01

MODEL NO.: CDP-PCK2005

FCC ID: UXX-PCK2005

RECEIVED: May 26, 2010

TESTED: Jul. 16 ~ Jul. 20, 2010

ISSUED: Jul. 29, 2010

APPLICANT: Cradlepoint, Inc.

ADDRESS: 1199 shoreline Ln. Suite 301, Boise Idaho, USA

ISSUED BY: Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch

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Testing Laboratory
2021

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1. CERTIFICATION

PRODUCT:	Portable WiFi WiMAX Router
MODEL NO.:	CDP-PCK2005
BRAND:	Cradlepoint
APPLICANT:	Cradlepoint, Inc.
TESTED:	Jul. 16 ~ Jul. 20, 2010
TEST SAMPLE:	Engineering Sample
STANDARDS:	**FCC Part 2 (Section 2.1093)** **FCC OET Bulletin 65, Supplement C (01-01)** **RSS-102**

The above equipment (model: CDP-PCK2005) has been tested by **Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch**, and found compliance with the requirement of the above standards. The test record, data evaluation & Equipment Under Test (EUT) configurations represented herein are true and accurate accounts of the measurements of the sample's EMC characteristics under the conditions specified in this report.

PREPARED BY : Andrea Hsia / Specialist , **DATE :** Jul. 29, 2010

TECHNICAL ACCEPTANCE Responsible for RF : Mason Chang / Engineer , **DATE :** Jul. 29, 2010

APPROVED BY : Gary Chang / Assistant Manager , **DATE :** Jul. 29, 2010

2. GENERAL INFORMATION

2.1 GENERAL DESCRIPTION OF EUT

FOR WiMAX function

EUT	Portable WiFi WiMAX Router	
MODEL NO.	CDP-PCK2005	
FCC ID	UXX-PCK2005	
POWER SUPPLY	DC 5V from adapter and car charger or DC 3.7V from battery	
CODED TYPE/MODULATION/ CODING RATE	**UL**	QPSK: 1/2, 3/4
		16QAM: 1/2, 3/4
	DL	QPSK: 1/2, 3/4
		16QAM: 1/2, 3/4
		64QAM: 1/2, 2/3, 3/4, 5/6
MULTIPLE ACCESS METHOD	TDMA	
MODULATION TECHNOLOGY	OFDMA	
DUPLEX METHOD	TDD	
TX / RX FUNCTION	1TX / 2RX , supports TX diversity	
OPERATING FREQUENCY	5MHz: 2498.5MHz ~ 2687.5MHz 10MHz: 2501MHz ~ 2685MHz	
CHANNEL BANDWIDTH	5MHz, 10MHz	
AVERAGE SAR (1g)	0.467W/kg	
ANTENNA TYPE	Please see note 2	
DATA CABLE	Micro USB cable (Shielded, 1.0m) Micro USB cable (Unshielded, 1.0m)	
I/O PORTS	Refer to user's manual	
ACCESSORY DEVICES	Adapter x 1, Battery x 1. Micro USB cable x 1, Car charger x 1	
MAX DL :UL ratio	29:18	

FOR WLAN function

EUT	Portable WiFi WiMAX Router
MODEL NO.	CDP-PCK2005
FCC ID	UXX-PCK2005
POWER SUPPLY	DC 5V from adapter and car charger or DC 3.7V from battery
MODULATION TYPE	CCK, DQPSK, DBPSK for DSSS 64QAM, 16QAM, QPSK, BPSK for OFDM
MODULATION TECHNOLOGY	DSSS, OFDM
TRANSFER RATE	802.11b: 11 / 5.5 / 2 / 1Mbps 802.11g: 54 / 48 / 36 / 24 / 18 / 12 / 9 / 6Mbps 802.11n (20MHz, 800ns GI):130 / 117 / 104 / 78 / 65 / 58.5 / 52 / 39 / 26 / 19.5 / 13 / 6.5Mbps 802.11n (40MHz, 800ns GI): 270 / 243 / 216 / 162 /135 / 121.5 / 108 / 81 / 54 / 40.5 / 27 / 13.5Mbps
OPERATING FREQUENCY	2412MHz ~ 2462MHz
NUMBER OF CHANNEL	11 for 802.11b, 802.11g, 802.11n (20MHz) 7 for 802.11n (40MHz)
CHANNEL FREQUENCIES UNDER TEST AND ITS CONDUCTED OUTPUT POWER	(see tables below)

CHANNEL FREQUENCIES UNDER TEST AND ITS CONDUCTED OUTPUT POWER

ANT 1

	802.11b		802.11g	
CH	**Peak (dBm)**	**Avg (dBm)**	**Peak (dBm)**	**Avg (dBm)**
2412	14.0	11.5	17.4	7.2
2437	14.3	12.0	17.4	7.3
2462	14.0	11.7	16.8	7.6

802.11n (20MHz)			802.11n (40MHz)		
CH	**Peak (dBm)**	**Avg (dBm)**	**CH**	**Peak (dBm)**	**Avg (dBm)**
2412	16.7	7.5	**2422**	16.3	7.3
2437	16.4	7.3	**2437**	16.3	7.1
2462	16.0	7.6	**2452**	16.1	7.2

ANT 2

	802.11b		802.11g	
CH	**Peak (dBm)**	**Avg (dBm)**	**Peak (dBm)**	**Avg (dBm)**
2412	13.24	10.7	16.58	6.4
2437	13.51	11.3	16.64	6.5
2462	13.32	11.0	16.03	6.8

802.11n (20MHz)			802.11n (40MHz)		
CH	**Peak (dBm)**	**Avg (dBm)**	**CH**	**Peak (dBm)**	**Avg (dBm)**
2412	15.88	6.7	**2422**	15.45	6.5
2437	15.61	6.5	**2437**	15.52	6.4
2462	15.2	6.8	**2452**	15.26	6.4

AVERAGE SAR (1g)	0.070W/kg
ANTENNA TYPE	Please see note 2
DATA CABLE	Micro USB cable (Shielded, 1.0m) Micro USB cable (Unshielded, 1.0m)
I/O PORTS	Refer to user's manual
ACCESSORY DEVICES	Adapter x 1, Battery x 1. Micro USB cable x 1, Car charger x 1

NOTE:

1. There are two sets of antennas provided to this EUT, please refer to the following table:

Set 1 for WiMAX antenna						
Antenna	**Antenna Type**	**Antenna Connector**	**Gain (dBi)**	**Cable Length(cm)**	**Frequency range (MHz)**	**Diversity Function**
1	PCB	I-PEX	4.5	3	2500~2700	YES
2	PCB	I-PEX	5	9	2500~2700	YES
Set 2 for WIFI antenna						
Antenna	**Antenna Type**	**Antenna Connector**	**Gain (dBi)**	**Cable Length(cm)**	**Frequency range (MHz)**	**Diversity Function**
1	Printed PCB	NA	2.7	-	2412~2472	YES
2	Printed PCB	NA	1.7	-	2412~2472	YES

2. The EUT could be supplied with 3.7V battery, car charger or the following power adapter which will be sold together with the EUT :

Item	**Brand**	**Model No.**	**Spec.**
Adapter 1	TenPao	S005SU0500070	AC I/P: 100-240V, 50/60Hz, 150mA DC O/P: 5V, 700mA
Adapter 2	Maxtela	MUC-5EJ1	AC I/P: 100-240V, 50/60Hz, 0.15A DC O/P: 5V, 1A
Battery	ETI CA	0340-1371080001 (BP08-000720)	DC 3.7V, 1900mAh
Car charger 1	Atech	CC615-0510A21	AC I/P: 12-24V, 1A MAX DC O/P: 5V, 1A
Car charger 2	Maxtela	MCC-5K	AC I/P: 12-24V, 600mA DC O/P: 5V, 1A

3. The EUT must be supplied with a USB cable and following two different USB cable could be chosen:

Cable	**Description**
Cable 1	Micro USB cable (Shielded, 1.0m)
Cable 2	Micro USB cable (Unshielded, 1.0m)

4. The EUT incorporates a SIMO function with 802.11b, 802.11g, 802.11n. Physically, the EUT provides one completed transmitter and two receivers.
5. The EUT is 1 * 2 spatial SIMO without beam forming function. The antenna configuration is one transmitter antenna and two receiver antennas, as there are 2 Printed PCB antennas.

6. The EUT complies with 802.11n standards and backwards compatible with 802.11b, 802.11g products.
7. The EUT, operates in the 2.4GHz frequency range, lets you connect IEEE 802.11g or IEEE 802.11b and 802.11n technique devices to the network.
8. The EUT embedded a firmware for testing that needs to control from Notebook computer to let EUT with different DL/UL ration.
9. The device has different DL/UL ration in normal operation. It was tested with (DL:UL= 29:18) duty cycle mode for 5MHz and 10MHz, which is the worse mode, and controlled by software. (The detail duty cycle refer to appendix A).
10. The above EUT information was declared by the manufacturer and for more detailed features description, please refer to the manufacturer's specifications or User's Manual.

2.2 GENERAL DESCRIPTION OF APPLIED STANDARDS

According to the specifications of the manufacturer, this product must comply with the requirements of the following standards:

FCC Part 2 (2.1093)

FCC OET Bulletin 65, Supplement C (01- 01)

RSS-102

IEEE 1528-2003

All test items have been performed and recorded as per the above standards.

2.3 GENERAL INOFRMATION OF THE SAR SYSTEM

DASY5 (software 5.2 Build 162) consists of high precision robot, probe alignment sensor, phantom, robot controller, controlled measurement server and near-field probe. The robot includes six axes that can move to the precision position of the DASY5 software defined. The DASY5 software can define the area that is detected by the probe. The robot is connected to controlled box. Controlled measurement server is connected to the controlled robot box. The DAE includes amplifier, signal multiplexing, AD converter, offset measurement and surface detection. It is connected to the Electro-optical coupler (ECO). The ECO performs the conversion form the optical into digital electric signal of the DAE and transfers data to the PC.

EX3DV4 ISOTROPIC E-FIELD PROBE

CONSTRUCTION	Symmetrical design with triangular core Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)
FREQUENCY	10 MHz to > 6 GHz Linearity: ± 0.2 dB (30 MHz to 6 GHz)
DIRECTIVITY	± 0.3 dB in HSL (rotation around probe axis) ± 0.5 dB in tissue material (rotation normal to probe axis)
DYNAMIC RANGE	10 μW/g to > 100 mW/g Linearity: ± 0.2 dB (noise: typically < 1 μW/g)
DIMENSIONS	Overall length: 330 mm (Tip: 20 mm) Tip diameter: 2.5 mm (Body: 12 mm) Typical distance from probe tip to dipole centers: 1 mm
APPLICATION	High precision dosimetric measurements in any exposure scenario (e.g., very strong gradient fields). Only probe which enables compliance testing for frequencies up to 6 GHz with precision of better 30%.

NOTE

1. The Probe parameters have been calibrated by the SPEAG. Please reference “APPENDIX D” for the Calibration Certification Report.
2. For frequencies above 800MHz, calibration in a rectangular wave-guide is used, because wave-guide size is manageable.
3. For frequencies below 800MHz, temperature transfer calibration is used because the wave-guide size becomes relatively large.

TWIN SAM V4.0

CONSTRUCTION	The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (SAM) phantom defined in IEEE 1528-2003, EN 62209-1 and IEC 62209. It enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region. A cover prevents evaporation of the liquid. Reference markings on the phantom allow the complete setup of all predefined phantom positions and measurement grids by manually teaching three points with the robot.
SHELL THICKNESS	2 ± 0.2mm
FILLING VOLUME	Approx. 25liters
DIMENSIONS	Height: 810mm; Length: 1000mm; Width: 500mm

SYSTEM VALIDATION KITS:

CONSTRUCTION	Symmetrical dipole with l/4 balun enables measurement of feedpoint impedance with NWA matched for use near flat phantoms filled with brain simulating solutions. Includes distance holder and tripod adaptor
CALIBRATION	Calibrated SAR value for specified position and input power at the flat phantom in brain simulating solutions
FREQUENCY	2450, 2600MHz
RETURN LOSS	> 20dB at specified validation position
POWER CAPABILITY	> 100W (f < 1GHz); > 40W (f > 1GHz)
OPTIONS	Dipoles for other frequencies or solutions and other calibration conditions upon request

DEVICE HOLDER FOR SAM TWIN PHANTOM

CONSTRUCTION	The device holder for the mobile phone device is designed to cope with different positions given in the standard. It has two scales for the device rotation (with respect to the body axis) and the device inclination (with respect to the line between the ear reference points). The rotation centers for both scales is the ear reference point (ERP). Thus the device needs no repositioning when changing the angles. The holder has been made out of low-loss POM material having the following dielectric parameters: relative permittivity ε =3 and loss tangent δ =0.02. The amount of dielectric material has been reduced in the closest vicinity of the device, since measurements have suggested that the influence of the clamp on the test results could thus be lowered. The device holder for the portable device makes up of the polyethylene foam. The dielectric parameters of material close to the dielectric parameters of the air.

DATA ACQUISITION ELECTRONICS

CONSTRUCTION

The data acquisition electronics (DAE3) consists of a highly sensitive electrometer grade preamplifier with auto-zeroing, a channel and gain-switching multiplex, a fast 16 bit AD converter and a command decoder and control logic unit. Transmission to the measurement server is accomplished through an optical downlink for data and status information as well as an optical uplink for commands and the clock. The mechanical probe is mounting device includes two different sensor systems for frontal and sideways probe contacts. They are used for mechanical surface detection and probe collision detection. The input impedance of the DAE3 box is 200MOhm; the inputs are symmetrical and floating. Common mode rejection is above 80 dB.

2.4 TEST EQUIPMENT

FOR SAR MEASURENENT

ITEM	NAME	BRAND	TYPE	SERIES NO.	DATE OF CALIBRATION	DUE DATE OF CALIBRATION
1	SAM Phantom	S & P	QD000 P40 CA	TP-1485	NA	NA
2	Signal Generator	Agilent	E8257C	MY43320668	Feb. 23, 2010	Feb. 22, 2011
3	E-Field Probe	S & P	EX3DV4	3504	Jan. 26, 2010	Jan. 25, 2011
4	DAE	S & P	DAE 4	510	Dec. 16, 2009	Dec. 15, 2010
5	Robot Positioner	Staubli Unimation	NA	NA	NA	NA
6	Validation Dipole	S & P	D2450V2	737	Feb. 19, 2010	Feb. 18, 2011
7			D2600V2	1020	Jan. 27, 2010	Jan. 26, 2011

NOTE: Before starting the measurement, all test equipment shall be warmed up for 30min.

FOR TISSUE PROPERTY

ITEM	NAME	BRAND	TYPE	SERIES NO.	DATE OF CALIBRATION	DUE DATE OF CALIBRATION
1	Network Analyzer	Agilent	E8358A	US41480538	Dec. 03, 2009	Dec. 02, 2010
2	Dielectric Probe	Agilent	85070D	US01440176	NA	NA

NOTE:

1. Before starting, all test equipment shall be warmed up for 30min.
2. The tolerance (k=1) specified by Agilent for general dielectric measurements, deriving from inaccuracies in the calibration data, analyzer drift, and random errors, are usually ±2.5% and ±5% for measured permittivity and conductivity, respectively. However, the tolerances for the conductivity is smaller for material with large loss tangents, i.e., less than ±2.5% (k=1). It can be substantially smaller if more accurate methods are applied.

2.5 GENERAL DESCRIPTION OF THE SPATIAL PEAK SAR EVALUATION

The DASY5 post-processing software (SEMCAD) automatically executes the following procedures to calculate the field units from the micro-volt readings at the probe connector. The parameters used in the evaluation are stored in the configuration modules of the software:

Probe parameters:	- Sensitivity	$Norm_i$, a_{i0}, a_{i1}, a_{i2}
	- Conversion factor	$ConvF_i$
	- Diode compression point	dcp_i
Device parameters:	- Frequency	F
	- Crest factor	Cf
Media parameters:	- Conductivity	σ
	- Density	ρ

The first step of the evaluation is a linearization of the filtered input signal to account for the compression characteristics of the detector diode. The compensation depends on the input signal, the diode type and the DC-transmission factor from the diode to the evaluation electronics. If the exciting field is pulsed, the crest factor of the signal must be known to correctly compensate for peak power. The formula for each channel can be given as:

$$V_i = U_i + U_i^2 \bullet \frac{cf}{dcp_i}$$

V_i	=compensated signal of channel i	(i = x, y, z)
U_i	=input signal of channel I	(i = x, y, z)
Cf	=crest factor of exciting field	(DASY parameter)
dcp_i	=diode compression point	(DASY parameter)

From the compensated input signals the primary field data for each channel can be evaluated:

$$\text{E-fieldprobes: } E_i = \sqrt{\frac{V_1}{Norm_i \cdot ConvF}}$$

$$\text{H-fieldprobes: } H_i = \sqrt{V_i} \cdot \frac{a_{i0} + a_{i1} f + a_{i2} f^2}{f}$$

V_i	=compensated signal of channel I	(i = x, y, z)
$Norm_i$	=sensor sensitivity of channel i μV/(V/m)2 for E-field Probes	(i = x, y, z)
ConvF	= sensitivity enhancement in solution	
a_{ij}	= sensor sensitivity factors for H-field probes	
F	= carrier frequency [GHz]	
E_i	= electric field strength of channel i in V/m	
H_i	= magnetic field strength of channel i in A/m	

The RSS value of the field components gives the total field strength (Hermitian magnitude):

$$E_{tot} = \sqrt{E_x^2 + E_y^2 + E_z^2}$$

The primary field data are used to calculate the derived field units.

$$SAR = E_{tot}^2 \cdot \frac{\sigma}{\rho \cdot 1'000}$$

SAR	= local specific absorption rate in mW/g
E_{tot}	= total field strength in V/m
σ	= conductivity in [mho/m] or [Siemens/m]
ρ	= equivalent tissue density in g/cm3

Note that the density is set to 1, to account for actual head tissue density rather than the density of the tissue simulating liquid. The entire evaluation of the spatial peak values is performed within the Post-processing engine (SEMCAD). The system always gives the maximum values for the 1g and 10g cubes. The algorithm to find the cube with highest averaged SAR is divided into the following stages:

1. The extraction of the measured data (grid and values) from the Zoom Scan
2. The calculation of the SAR value at every measurement point based on all stored data (A/D values and measurement parameters)
3. The generation of a high-resolution mesh within the measured volume
4. The interpolation of all measured values from the measurement grid to the high-resolution grid
5. The extrapolation of the entire 3-D field distribution to the phantom surface over the distance from sensor to surface
6. The calculation of the averaged SAR within masses of 1g and 10g.

The probe is calibrated at the center of the dipole sensors that is located 1 to 2.7mm away from the probe tip. During measurements, the probe stops shortly above the phantom surface, depending on the probe and the surface detecting system. Both distances are included as parameters in the probe configuration file. The software always knows exactly how far away the measured point is from the surface. As the probe cannot directly measure at the surface, the values between the deepest measured point and the surface must be extrapolated. The angle between the probe axis and the surface normal line is less than 30 degree.

The maximum search is automatically performed after each area scan measurement. It is based on splines in two or three dimensions. The procedure can find the maximum for most SAR distributions even with relatively large grid spacing. After the area scanning measurement, the probe is automatically moved to a position at the interpolated maximum. The following scan can directly use this position for reference, e.g., for a finer resolution grid or the cube evaluations. The 1g and 10g peak evaluations are only available for the predefined cube 7 x 7 x 7 scans. The routines are verified and optimized for the grid dimensions used in these cube measurements. The measured volume of 30 x 30 x 30mm contains about 30g of tissue. The first procedure is an extrapolation (incl. boundary correction) to get the points between the lowest measured plane and the surface. The next step uses 3D interpolation to get all points within the measured volume in a 1mm grid (42875 points). In the last step, a 1g cube is placed numerically into the volume and its averaged SAR is calculated. This cube is the moved around until the highest averaged SAR is found. If the highest SAR is found at the edge of the measured volume, the system will issue a warning: higher SAR values might be found outside of the measured volume. In that case the cube measurement can be repeated, using the new interpolated maximum as the center.

3. DESCRIPTION OF SUPPORT UNITS

The EUT has been tested as an independent unit.

4. RECIPES FOR TISSUE SIMULATING LIQUIDS

For the measurement of the field distribution inside the SAM phantom, the phantom must be filled with 25 litters of tissue simulation liquid.

The following ingredients are used：

- **WATER-** Deionized water (pure H20), resistivity _16 M - as basis for the liquid
- **DGMBE-** Diethylenglycol-monobuthyl ether (DGMBE), Fluka Chemie GmbH, CAS # 112-34-5 - to reduce relative permittivity

THE RECIPES FOR 2450MHz SIMULATING LIQUID TABLE

INGREDIENT	BODY SIMULATING LIQUID 2450MHz (MSL-2450)
Water	69.83%
DGMBE	30.17%
Dielectric Parameters at 22℃	f= 2450MHz ε= 52.7 ± 5% σ= 1.95 ± 5% S/m

THE RECIPES FOR 2600MHz SIMULATING LIQUID TABLE

Ingredient	Muscle Simulating Liquid 2600MHz (MSL-2600)
Water	69.83%
DGMBE	30.17%
Salt	NA
Dielectric Parameters at 22℃	f= 2600MHz ε= 52.5 ± 5% σ= 2.16 ± 5% S/m

Testing the liquids using the Agilent Network Analyzer E8358A and Agilent Dielectric Probe Kit 85070D.The testing procedure is following as

1. Turn Network Analyzer on and allow at least 30min. warm up.
2. Mount dielectric probe kit so that interconnecting cable to Network Analyzer will not be moved during measurements or calibration.
3. Pour de-ionized water and measure water temperature (±1°).
4. Set water temperature in Agilent-Software (Calibration Setup).
5. Perform calibration.
6. Validate calibration with dielectric material of known properties (e.g. polished ceramic slab with >8mm thickness ε'=10.0, ε''=0.0). If measured parameters do not fit within tolerance, repeat calibration (±0.2 for ε': ±0.1 for ε'').
7. Conductivity can be calculated from ε'' by $\sigma = \omega\, \varepsilon_0\, \varepsilon'' = \varepsilon''\, f\, [GHz] / 18$.
8. Measure liquid shortly after calibration. Repeat calibration every hour.
9. Stir the liquid to be measured. Take a sample (~ 50ml) with a syringe from the center of the liquid container.
10. Pour the liquid into a small glass flask. Hold the syringe at the bottom of the flask to avoid air bubbles.
11. Put the dielectric probe in the glass flask. Check that there are no air bubbles in front of the opening in the dielectric probe kit.
12. Perform measurements.
13. Adjust medium parameters in DASY5 for the frequencies necessary for the measurements (‘Setup Config’, select medium (e.g. Brain 900MHz) and press ‘Option’-button.
14. Select the current medium for the frequency of the validation (e.g. Setup Medium Brain 900MHz).

FOR SIMULATING LIQUID

LIQUID TYPE		MSL-2450			
SIMULATING LIQUID TEMP.		21.4			
TEST DATE		Jul. 20, 2010			
TESTED BY		Sam Onn			
FREQ. (MHz)	**LIQUID PARAMETER**	**STANDARD VALUE**	**MEASUREMENT VALUE**	**ERROR PERCENTAGE (%)**	**LIMIT(%)**
2437	Permitivity (ε)	52.70	54.80	3.98	±5
2450		52.70	54.60	3.61	
2437	Conductivity (σ) S/m	1.94	1.98	2.06	
2450		1.95	2.00	2.56	

LIQUID TYPE		MSL-2600			
SIMULATING LIQUID TEMP.		21.8			
TEST DATE		Jul. 16, 2010			
TESTED BY		Sam Onn			
FREQ. (MHz)	**LIQUID PARAMETER**	**STANDARD VALUE**	**MEASUREMENT VALUE**	**ERROR PERCENTAGE (%)**	**LIMIT(%)**
2587	Permitivity (ε)	52.50	53.80	2.48	±5
2593		52.50	53.80	2.48	
2600		52.50	53.80	2.48	
2587	Conductivity (σ) S/m	2.14	2.16	0.93	
2593		2.15	2.16	0.47	
2600		2.16	2.17	0.46	

5. SYSTEM VALIDATION

The system validation was performed in the flat phantom with equipment listed in the following table. Since the SAR value is calculated from the measured electric field, dielectric constant and conductivity of the body tissue and the SAR is proportional to the square of the electric field. So, the SAR value will be also proportional to the RF power input to the system validation dipole under the same test environment. In our system validation test, 250mW RF input power was used.

5.1 TEST PROCEDURE

Before the system performance check, we need only to tell the system which components (probe, medium, and device) are used for the system performance check; the system will take care of all parameters. The dipole must be placed beneath the flat section of the SAM Twin Phantom with the correct distance holder in place. The distance holder should touch the phantom surface with a light pressure at the reference marking (little cross) and be oriented parallel to the long side of the phantom. Accurate positioning is not necessary, since the system will search for the peak SAR location, except that the dipole arms should be parallel to the surface. The device holder for mobile phones can be left in place but should be rotated away from the dipole.

1. The ”Power Reference Measurement” and ”Power Drift Measurement” jobs are located at the beginning and end of the batch process. They measure the field drift at one single point in the liquid over the complete procedure. The indicated drift is mainly the variation of the amplifier output power. If it is too high (above ±0.1 dB), the system performance check should be repeated; some amplifiers have very high drift during warm-up. A stable amplifier gives drift results in the DASY system below ±0.02dB.

2. The ”Surface Check” job tests the optical surface detection system of the DASY system by repeatedly detecting the surface with the optical and mechanical surface detector and comparing the results. The output gives the detecting heights of both systems, the difference between the two systems and the standard deviation of the detection repeatability. Air bubbles or refraction in the liquid due to separation of the sugar-water mixture gives poor repeatability (above ±0.1mm). In that case it is better to abort the system performance check and stir the liquid.

3. The ”Area Scan” job measures the SAR above the dipole on a plane parallel to the surface. It is used to locate the approximate location of the peak SAR. The proposed scan uses large grid spacing for faster measurement; due to the symmetric field, the peak detection is reliable. If a finer graphic is desired, the grid spacing can be reduced. Grid spacing and orientation have no influence on the SAR result.

4. The ”Zoom Scan” job measures the field in a volume around the peak SAR value assessed in the previous ”Area Scan” job (for more information see the application note on SAR evaluation).

About the validation dipole positioning uncertainty, the constant and low loss dielectric spacer is used to establish the correct distance between the top surface of the dipole and the bottom surface of the phantom, the error component introduced by the uncertainty of the distance between the liquid (i.e., phantom shell) and the validation dipole in the DASY5 system is less than ±0.1mm.

$$SAR_{tolerance}[\%] = 100 \times (\frac{(a+d)^2}{a^2} - 1)$$

As the closest distance is 10mm, the resulting tolerance $SAR_{tolerance}[\%]$ is <2%.

5.2 VALIDATION RESULTS

SYSTEM VALIDATION TEST OF SIMULATING LIQUID					
FREQUENCY (MHz)	REQUIRED SAR (mW/g)	MEASURED SAR (mW/g)	DEVIATION (%)	SEPARATION DISTANCE	TESTED DATE
MSL 2450	13.1 (1g)	12.8	-2.29	10mm	Jul. 20, 2010
MSL 2600	13.9 (1g)	13.2	-5.04	10mm	Jul. 16, 2010

NOTE: Please see Appendix for the photo of system validation test.

5.3 SYSTEM VALIDATION UNCERTAINTIES

In the table below, the system validation uncertainty with respect to the analytically assessed SAR value of a dipole source as given in the IEEE 1528 standard is given. This uncertainty is smaller than the expected uncertainty for mobile phone measurements due to the simplified setup and the symmetric field distribution.

Error Description	Tolerance (±%)	Probability Distribution	Divisor	(C_i)		Standard Uncertainty (±%)		(v_i)
				(1g)	(10g)	(1g)	(10g)	
Measurement System								
Probe Calibration	5.50	Normal	1	1	1	5.50	5.50	∞
Axial Isotropy	0.25	Rectangular	√3	0.7	0.7	0.10	0.10	∞
Hemispherical Isotropy	1.30	Rectangular	√3	0.7	0.7	0.53	0.53	∞
Boundary effects	1.00	Rectangular	√3	1	1	0.58	0.58	∞
Linearity	0.30	Rectangular	√3	1	1	0.17	0.17	∞
System Detection Limits	1.00	Rectangular	√3	1	1	0.58	0.58	∞
Readout Electronics	0.30	Normal	1	1	1	0.30	0.30	∞
Response Time	0.80	Rectangular	√3	1	1	0.46	0.46	∞
Integration Time	2.60	Rectangular	√3	1	1	1.50	1.50	∞
RF Ambient Noise	3.00	Rectangular	√3	1	1	1.73	1.73	9
RF Ambient Reflections	3.00	Rectangular	√3	1	1	1.73	1.73	9
Probe Positioner	0.40	Rectangular	√3	1	1	0.23	0.23	∞
Probe Positioning	2.90	Rectangular	√3	1	1	1.67	1.67	∞
Max. SAR Eval.	1.00	Rectangular	√3	1	1	0.58	0.58	∞
Test sample related								
Sample positioning	1.90	Normal	1	1	1	1.90	1.90	4
Device holder	2.80	Normal	1	1	1	2.80	2.80	4
Output power variation-SAR drift	4.42	Rectangular	√3	1	1	2.55	2.55	1
Dipole Related								
Dipole Axis to Liquid Distance	1.60	Rectangular	√3	1	1	0.92	0.92	4
Input Power Drift	3.94	Rectangular	√3	1	1	2.27	2.27	1
Phantom and Tissue parameters								
Phantom Uncertainty	4.00	Rectangular	√3	1	1	2.31	2.31	∞
Liquid Conductivity (target)	5.00	Rectangular	√3	0.64	0.43	1.85	1.24	∞
Liquid Conductivity (measurement)	2.56	Normal	1	0.64	0.43	1.64	1.10	9
Liquid Permittivity (target)	5.00	Rectangular	√3	0.6	0.49	1.73	1.41	∞
Liquid Permittivity (measurement)	3.98	Normal	1	0.6	0.49	2.39	1.95	9
Combined Standard Uncertainty						**9.33**	**8.99**	
Coverage Factor for 95%						**Kp=2**		
Expanded Uncertainty (K=2)						**18.67**	**17.98**	

NOTE: About the system validation uncertainty assessment, please reference the section 7.

6. 802.16e/WiMax DEVICE AND SYSTEM OPERATING PARAMETERS

<table>
<tr><th>Description</th><th colspan="2">Parameter</th><th>Comment</th></tr>
<tr><td>FCC ID</td><td colspan="2">UXX-PCK2005</td><td>Identify all related FCC ID</td></tr>
<tr><td>Radio Service</td><td colspan="2">Part 27M</td><td>Rule parts</td></tr>
<tr><td>Transmit Frequency Range (MHz)</td><td colspan="2">5 MHz BW: 2498.5 – 2687.5 MHz
10MHz BW:2501 - 2685 MHz</td><td>System parameter</td></tr>
<tr><td>System/Channel Bandwidth (MHz)</td><td colspan="2">5MHz/10MHz</td><td>System parameter</td></tr>
<tr><td>System Profile</td><td colspan="2">Revision 1.7.0</td><td>Defined by WiMAX Forum</td></tr>
<tr><td>Modulation Schemes</td><td colspan="2">QPSK1/2, QPSK3/4
16QAM1/2, 16QAM3/4</td><td>Identify all applicable UL modulations</td></tr>
<tr><td>Sampling Factor</td><td colspan="2">28/25</td><td>System parameter</td></tr>
<tr><td>Sampling Frequency (MHz)</td><td colspan="2">5 MHZ BW:5.6MHz
10MHz BW:11.2MHz</td><td>(Fs)</td></tr>
<tr><td>Sample Time (ns)</td><td colspan="2">89.3ns/ 10 MHz
178.58ns / 5MHz</td><td>(1/Fs)</td></tr>
<tr><td>FFT Size (NFFT)</td><td colspan="2">1024 / 10MHz
512 / 5 MHz</td><td>(NFFT)</td></tr>
<tr><td>Sub-Carrier Spacing (kHz)</td><td colspan="2">10.9375KHz</td><td>(Δf)</td></tr>
<tr><td>Useful Symbol time (μs)</td><td colspan="2">91.43us</td><td>(Tb=1/Δf)</td></tr>
<tr><td>Guard Time (μs)</td><td colspan="2">11.43us</td><td>(Tg=Tb/cp); cp = cyclic prefix</td></tr>
<tr><td>OFDMA Symbol Time (μs)</td><td colspan="2">102.857us</td><td>(Ts=Tb+Tg)</td></tr>
<tr><td>Frame Size (ms)</td><td colspan="2">5ms</td><td>System parameter</td></tr>
<tr><td>TTG + RTG (μs or number of symbols)</td><td colspan="2">165.7143us</td><td>Idle time, system parameter</td></tr>
<tr><td>Number of DL OFDMA Symbols per Frame</td><td colspan="2">Max:29</td><td rowspan="2">Identify the allowed & maximum symbols, including both traffic & control symbols</td></tr>
<tr><td>Number of UL OFDMA Symbols per Frame</td><td colspan="2">Max:18</td></tr>
<tr><td>DL:UL Symbol Ratio</td><td colspan="2">Max 29:18</td><td>For determining UL duty factor</td></tr>
<tr><td>Rated Power Class (dBm) Identify power</td><td colspan="2">Power class 2
23.5dBm+/-0.5</td><td>Identify power class and tolerance</td></tr>
<tr><td>Wave1 / Wave2</td><td colspan="2">Wave2: Two antennas for TX/RX diversity. ANT1 and ANT2 cannot transmit simultaneously.</td><td>Describe antenna diversity info and MIMO requirements separately</td></tr>
<tr><td>UL Zone Types (FUSC, PUSC, OFUSC, OPUSC, AMC, TUSC1, TUSC2)</td><td colspan="2">PUSC only.</td><td>Describe separately the symbol and sub-carrier/sub-channel structures applicable to each zone type</td></tr>
<tr><td rowspan="2">Maximum Number of UL Sub-Carriers</td><td>10 MHz BW</td><td>5 MHz BW</td><td rowspan="5">Identify the allowed and tested / to be tested parameters; include separate explanations on the types of control symbols and how the power levels are determined</td></tr>
<tr><td>841</td><td>409</td></tr>
<tr><td rowspan="3">Rated UL Burst Maximum Average Power (dBm)</td><td>ANT 1 (Main)</td><td>ANT 2 (AUX)</td></tr>
<tr><td>24dBm @ 10MHz</td><td>24dBm @ 10MHz</td></tr>
<tr><td>24dBm @ 5MHz</td><td>24dBm @ 5MHz</td></tr>
<tr><td>Number and type of UL Control Symbols</td><td colspan="2">3pusc symbols (used for ranging, CQICH and ACK/NACK)</td><td></td></tr>
</table>

<table>
<tr><td rowspan="10">UL Control Symbol Maximum Average Power</td><td>ANT 1(Main)</td><td>Calculation</td><td rowspan="10"></td></tr>
<tr><td>36.89mW for 10MHz / QPSK</td><td>258.23mW x 5/35</td></tr>
<tr><td>36.89mW for 10MHz / 16QAM</td><td>258.23mW x 5/35</td></tr>
<tr><td>75.95mW for 5MHz / QPSK</td><td>258.23 mW x 5/17</td></tr>
<tr><td>75.95mW for 5MHz / 16QAM</td><td>258.23 mW x 5/17</td></tr>
<tr><td>ANT 2 (AUX)</td><td>Calculation</td></tr>
<tr><td>36.89mW for 10MHz / QPSK</td><td>258.23mW x 5/35</td></tr>
<tr><td>36.89mW for 10MHz / 16QAM</td><td>258.23mW x 5/35</td></tr>
<tr><td>75.95 mW for 5MHz / QPSK</td><td>258.23 mW x 5/17</td></tr>
<tr><td>75.95 mW for 5MHz / 16QAM</td><td>258.23 mW x 5/17</td></tr>
<tr><td>UL Burst Peak-to-Average Power Ratio (PAR)</td><td colspan="2">With DL:UL ratio=29:18,
PAR is between 6.8 to 7.54 dB.</td><td>Identify the expected range and measured/tested PAR; explain separately the methods used / to be used to address SAR probe calibration and measurement error issues</td></tr>
<tr><td>Frame Averaged UL Transmission Duty Factor (%)</td><td colspan="2">The duty cycle is 31.25%.
15/48 = 0.3125
Crest factor is 1/0.3125=3.2 with 29:18 DL:UL ratio.
Control symbols are accounted by S.F. (scaling factor)
S.F. = (CCP x 3 control symbols + MOP x 15 Traffic symbols) / (actual_OP x 15)

CCP: Control Channel Power

MOP: Maximum Rated Output Power. Note the MOP is the higher among max rated output power and actual measured max.

Actual_OP: Actual Output Power measured</td><td>Show calculations separately and explain how the applicable CF (crest factor) used / to be use in the SAR measurements is derived and how the control symbols are accounted for</td></tr>
</table>

7. WIMAX/802.16e DEVICE SPECIFICATION

7.1 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 the test device 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.

7.2 POWER MEASUREMENT

Set the transmitter under transmission condition continuously at specific mode with maximum output. The power meter was used to read the response of the power sensor. Record the power level and PK to AV ratio.
The maximum conducted output power is measured for the uplink burst at DL:UL ratio=29:18 that is measured for the uplink bursts through triggering and gating.

An Anritus wideband power meter was used for measuring this item. The power was taken during the burst-on period (exclude 3 control symbols) by means of triggering and gating function.

The measured results are as below table:

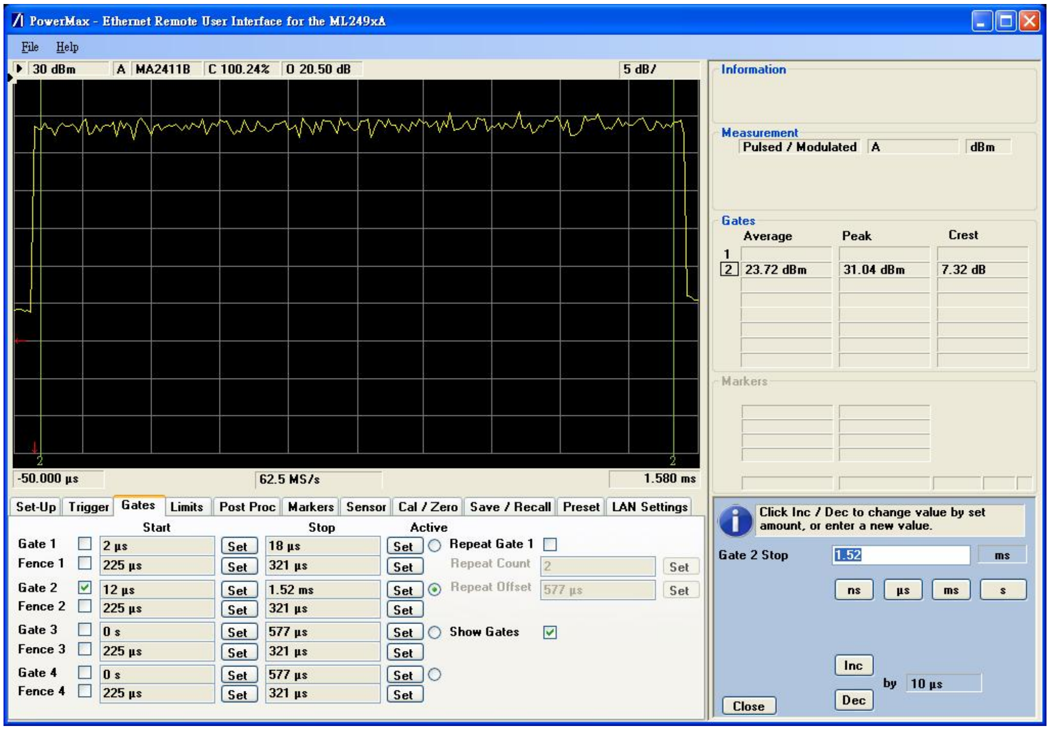
Output power table of Antenna 1

Channel BW	UL zone type / DL/UL Ratio	Channel Frequency (MHz)	Conducted Power (dBm)		Peak to Average ratio (dB)	UL modulation
			AV	PK		
5MHz	PUSC / 29:18	2498.5	23.54	31.08	7.54	QPSK 1/2
			23.45	30.73	7.28	QPSK 3/4
			23.36	30.77	7.40	16QAM 1/2
			23.44	30.98	7.53	16QAM 3/4
		2587.0	23.72	31.04	7.32	QPSK 1/2
			23.58	30.79	7.21	QPSK 3/4
			23.6	30.93	7.33	16QAM 1/2
			23.62	31.02	7.40	16QAM 3/4
		2687.5	23.70	31.00	7.30	QPSK 1/2
			23.69	30.84	7.15	QPSK 3/4
			23.55	31.03	7.48	16QAM 1/2
			23.67	30.99	7.32	16QAM 3/4
10MHz	PUSC / 29:18	2501	24.04	31.03	6.99	QPSK 1/2
			24.03	31.11	7.08	QPSK 3/4
			23.98	30.93	6.95	16QAM 1/2
			23.92	31.08	7.16	16QAM 3/4
		2593	24.12	30.98	6.86	QPSK 1/2
			24.06	31.02	6.97	QPSK 3/4
			23.88	30.96	7.08	16QAM 1/2
			24.00	31.03	7.03	16QAM 3/4
		2685	24.11	30.98	6.86	QPSK 1/2
			23.69	30.94	7.25	QPSK 3/4
			23.66	30.91	7.26	16QAM 1/2
			23.66	30.96	7.30	16QAM 3/4

Test plots of conducted power and PAR ratio for middle channel

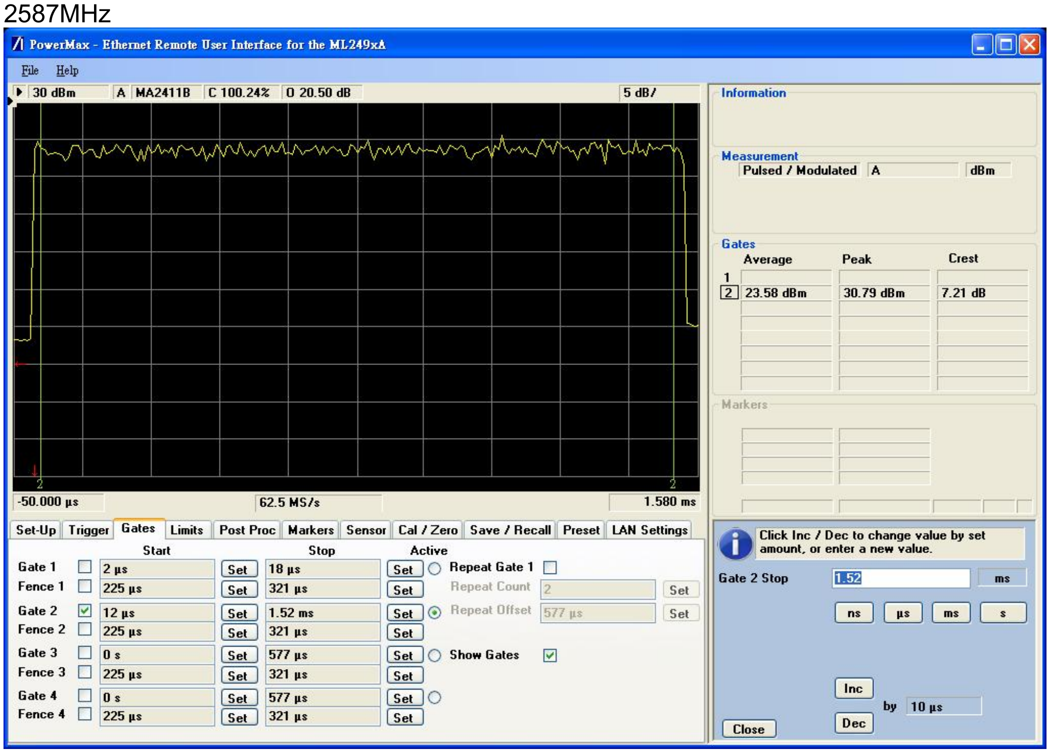
Bandwidth 5MHz / Modulation : QPSK1/2

2587MHz



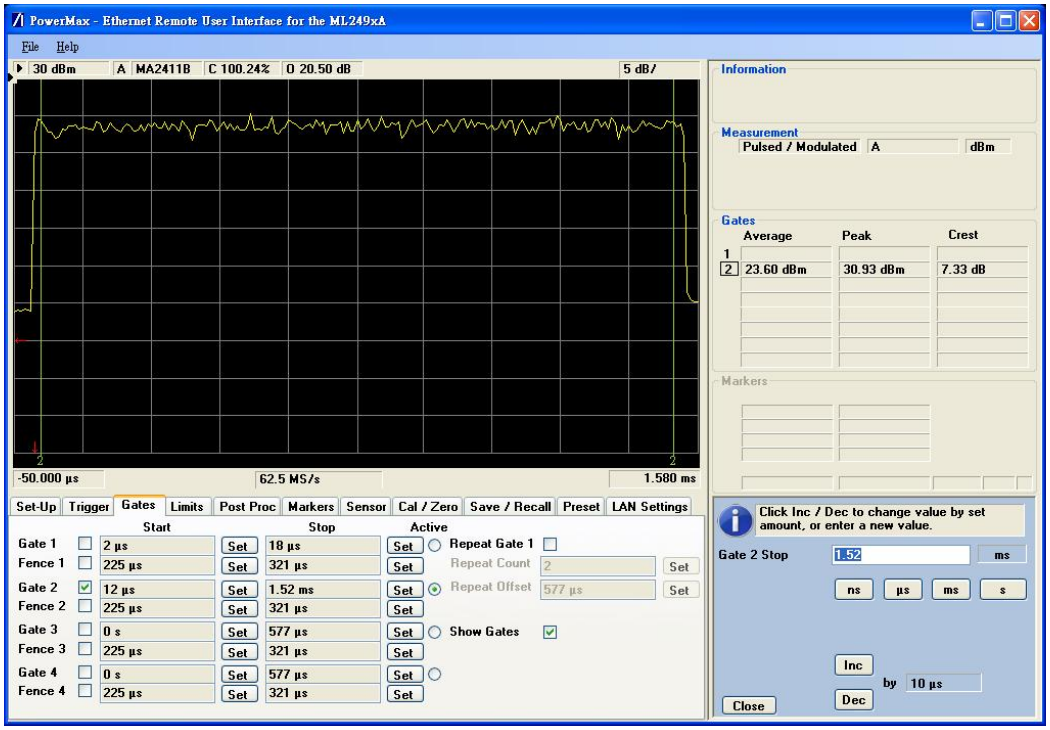
Bandwidth 5MHz / Modulation : QPSK 3/4

2587MHz



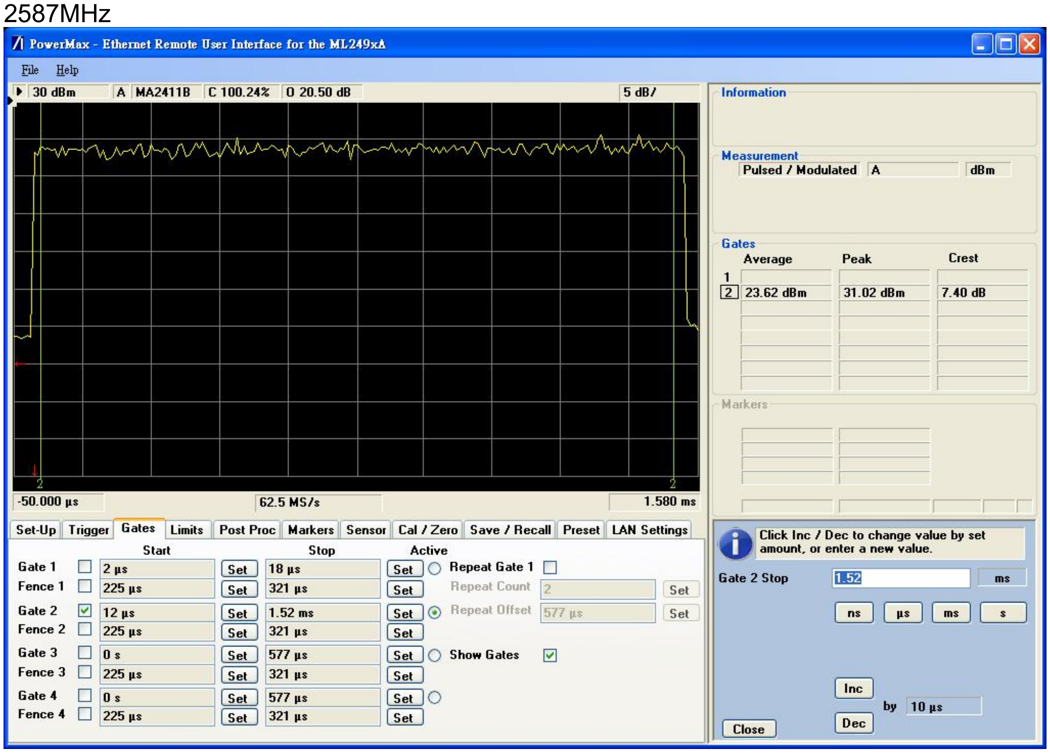
Bandwidth 5MHz / Modulation : 16QAM 1/2

2587MHz



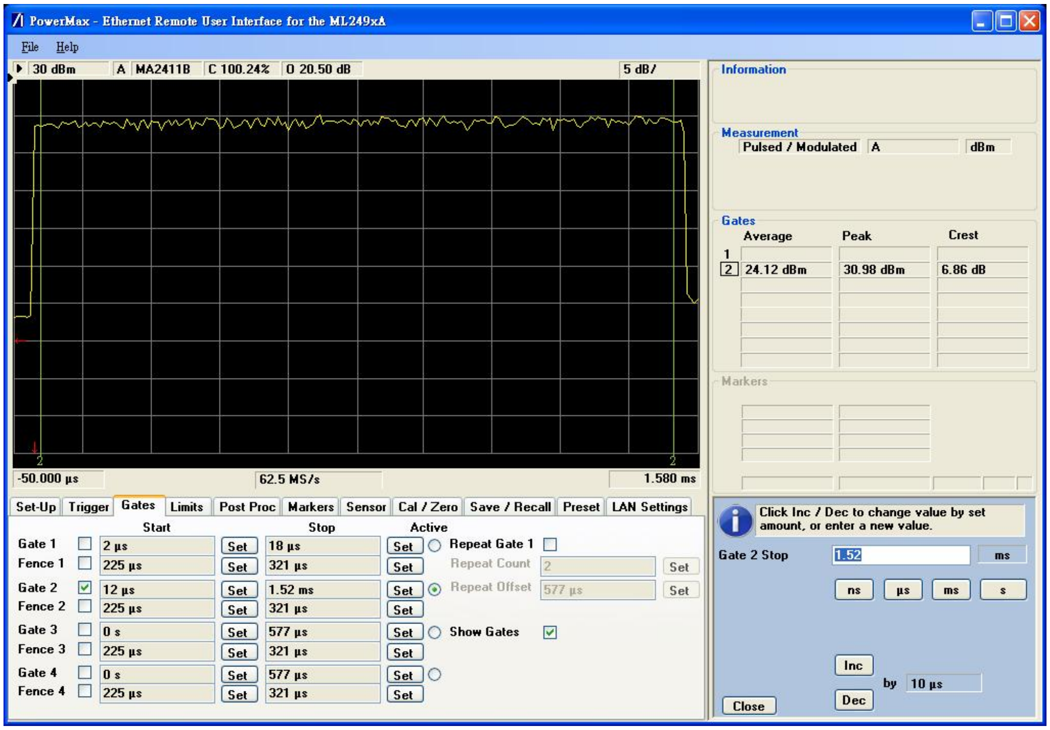
Bandwidth 5MHz / Modulation : 16QAM 3/4

2587MHz



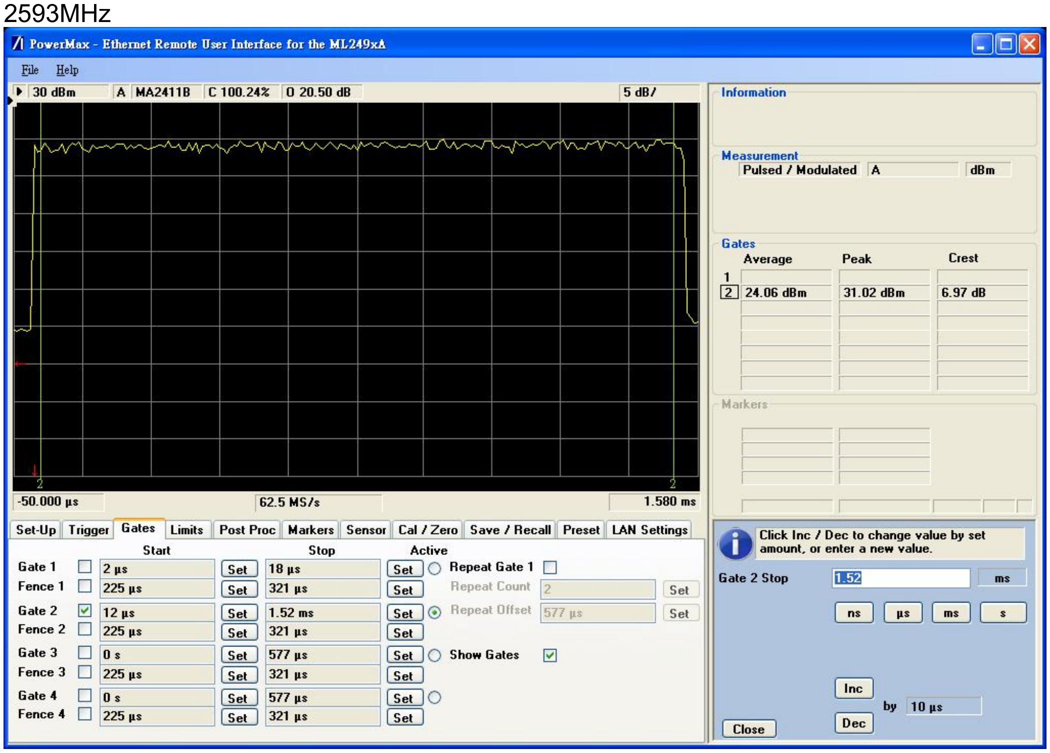
Bandwidth 10MHz / Modulation : QPSK 1/2

2593MHz



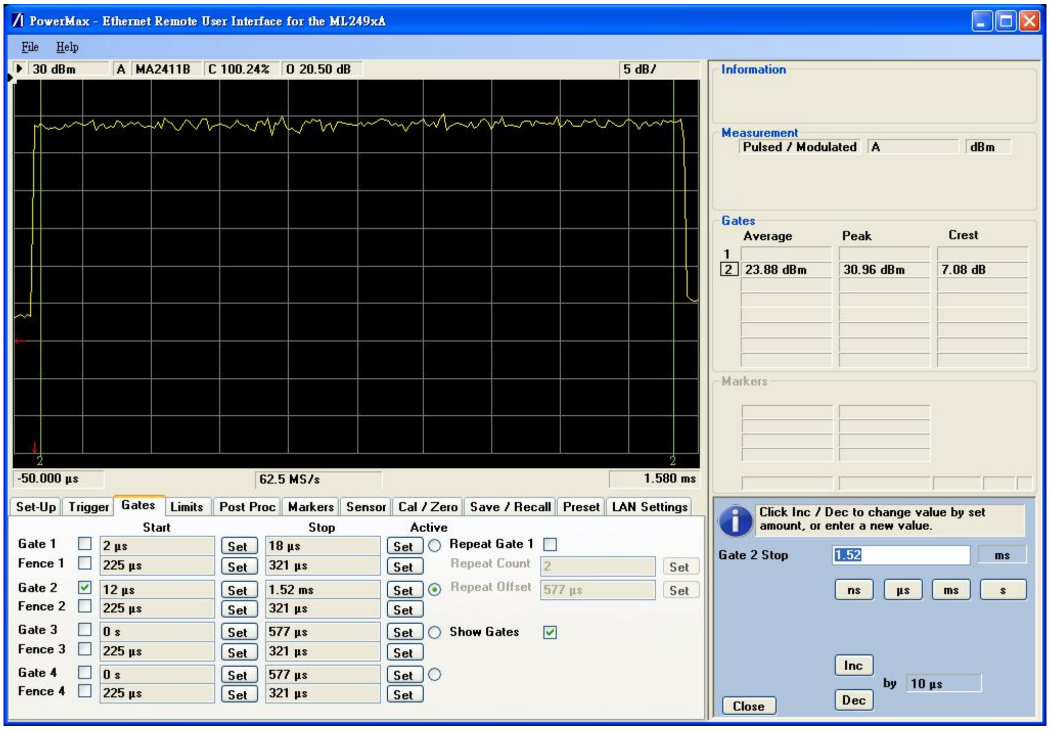
Bandwidth 10MHz / Modulation : QPSK 3/4

2593MHz



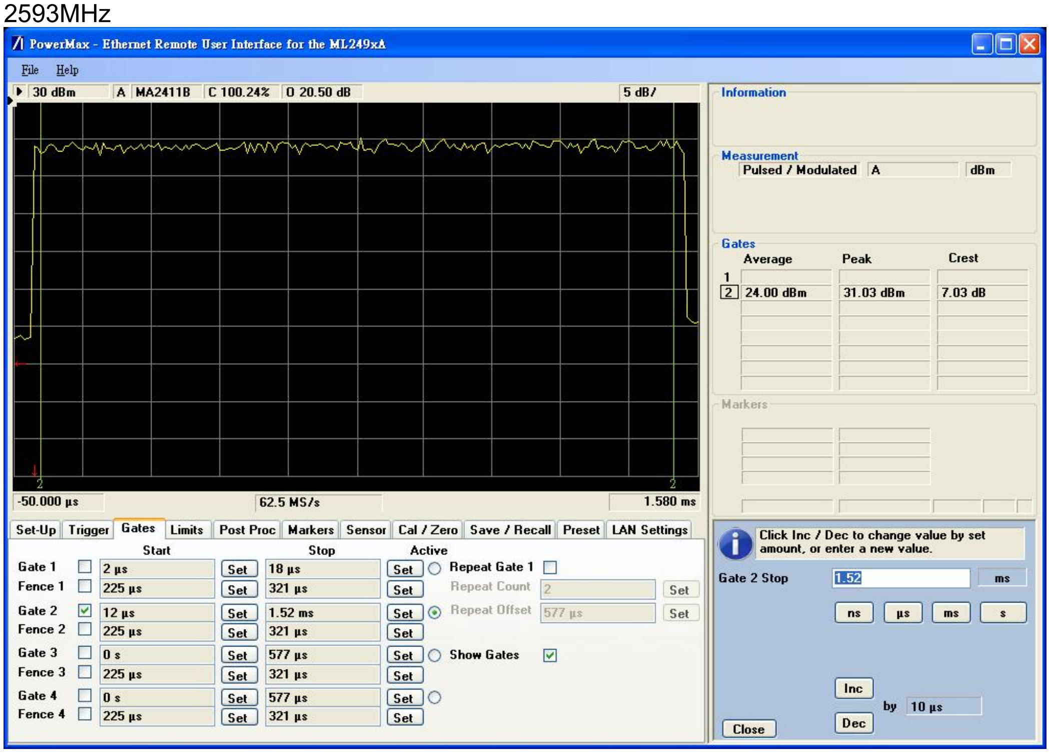
Bandwidth 10MHz / Modulation : 16QAM 1/2

2593MHz



Bandwidth 10MHz / Modulation : 16QAM 3/4

2593MHz



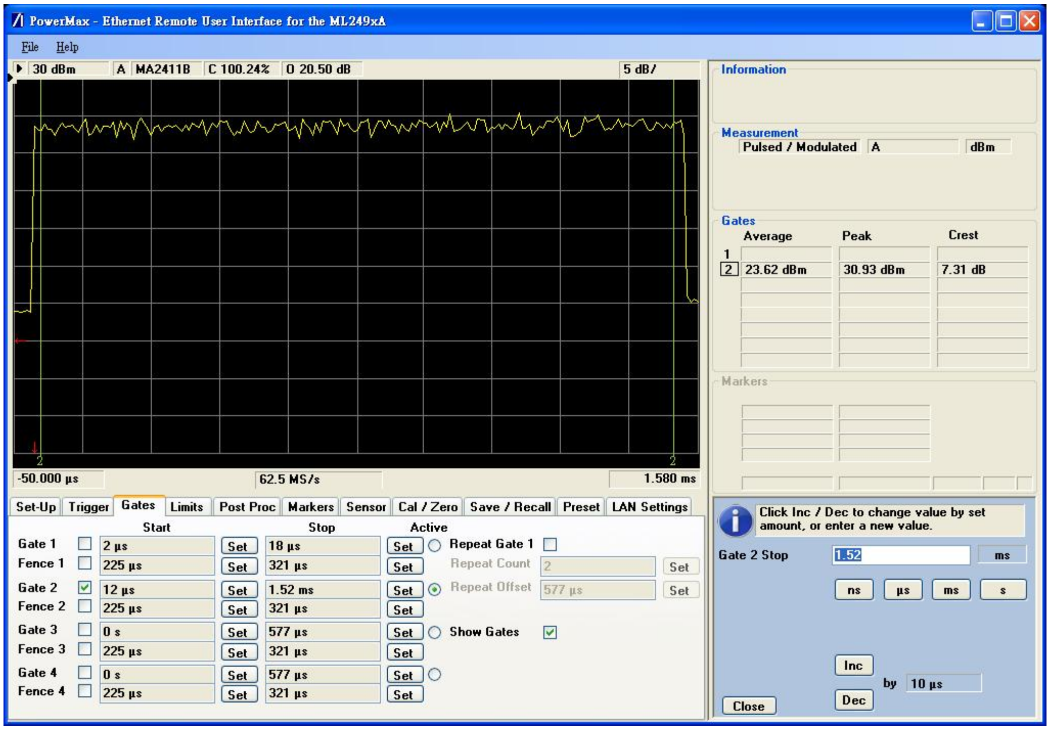
Output power table of Antenna 2

Channel BW	UL zone type / DL/UL Ratio	Channel Frequency (MHz)	Conducted Power (dBm)		Peak to Average ratio (dB)	UL modulation
			AV	PK		
5MHz	PUSC / 29:18	2498.5	23.49	30.88	7.39	QPSK 1/2
			23.41	30.59	7.18	QPSK 3/4
			23.23	30.63	7.40	16QAM 1/2
			23.40	30.83	7.43	16QAM 3/4
		2587	23.62	30.93	7.31	QPSK 1/2
			23.57	30.72	7.15	QPSK 3/4
			23.38	30.78	7.40	16QAM 1/2
			23.44	30.90	7.46	16QAM 3/4
		2687.5	23.56	30.91	7.36	QPSK 1/2
			23.57	30.78	7.21	QPSK 3/4
			23.46	30.94	7.48	16QAM 1/2
			23.53	30.91	7.38	16QAM 3/4
10MHz	PUSC / 29:18	2501	24.03	30.90	6.86	QPSK 1/2
			23.95	30.98	7.04	QPSK 3/4
			23.94	30.85	6.91	16QAM 1/2
			23.84	30.96	7.12	16QAM 3/4
		2593	24.11	30.90	6.80	QPSK 1/2
			24.03	30.98	6.96	QPSK 3/4
			23.87	30.86	6.99	16QAM 1/2
			23.87	30.94	7.07	16QAM 3/4
		2685	24.03	30.9	6.80	QPSK 1/2
			23.68	30.83	7.15	QPSK 3/4
			23.53	30.8	7.27	16QAM 1/2
			23.59	30.86	7.27	16QAM 3/4

Test plots of conducted power and PAR ratio for middle channel

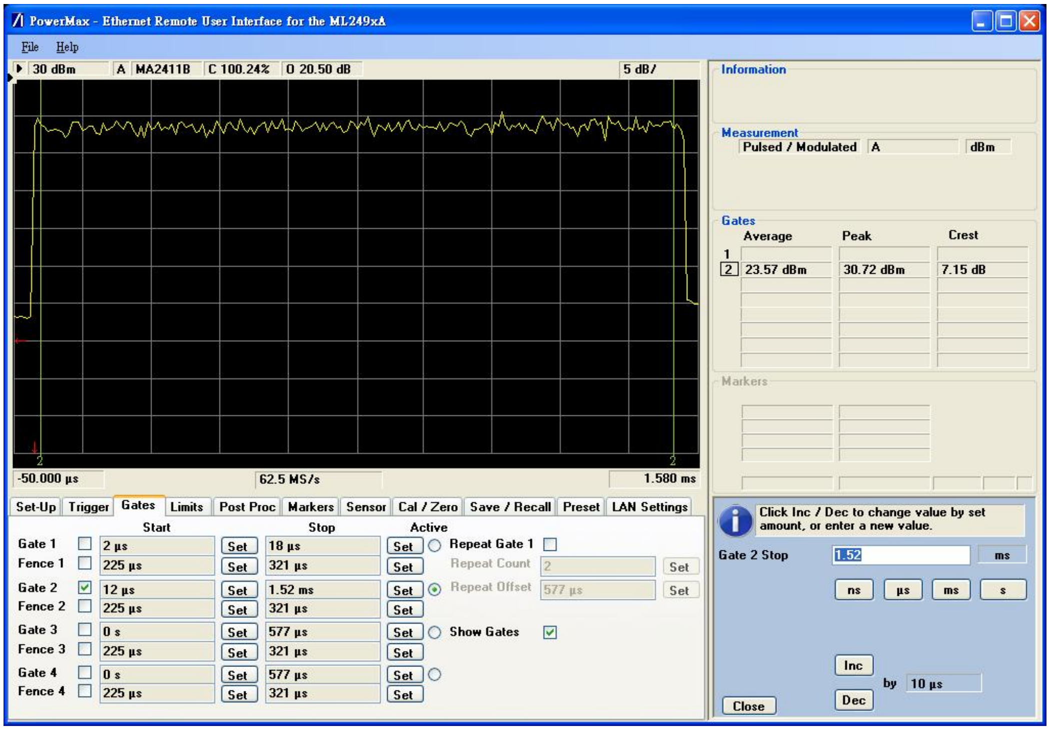
Bandwidth 5MHz / Modulation : QPSK1/2

2587MHz



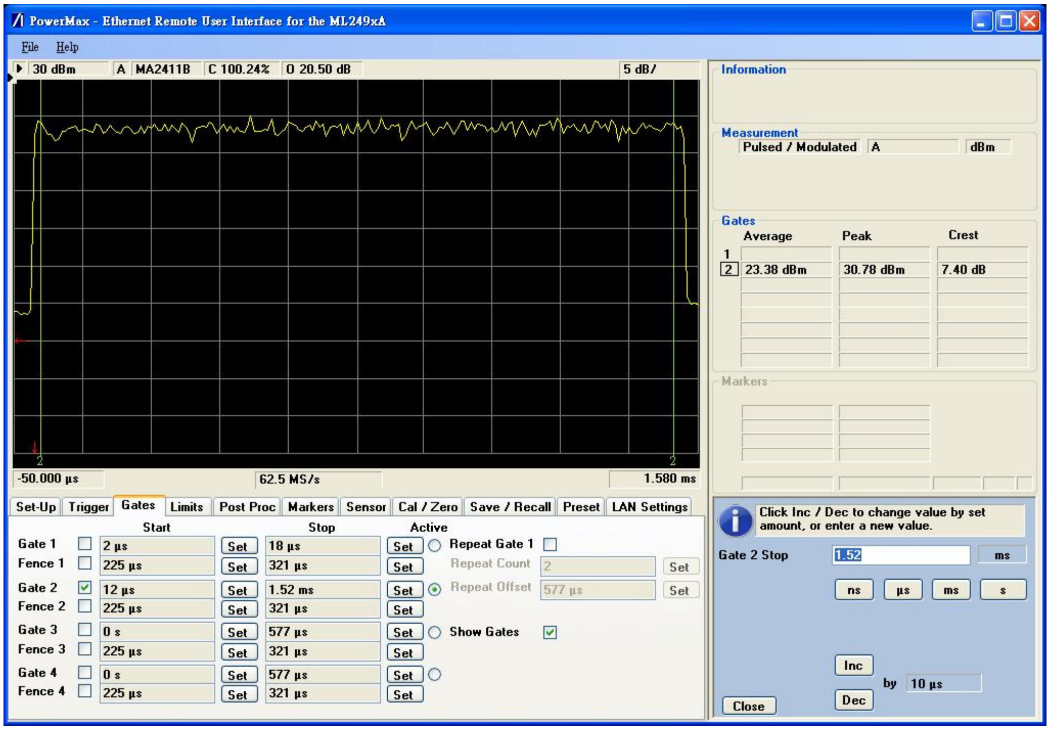
Bandwidth 5MHz / Modulation : QPSK 3/4

2587MHz



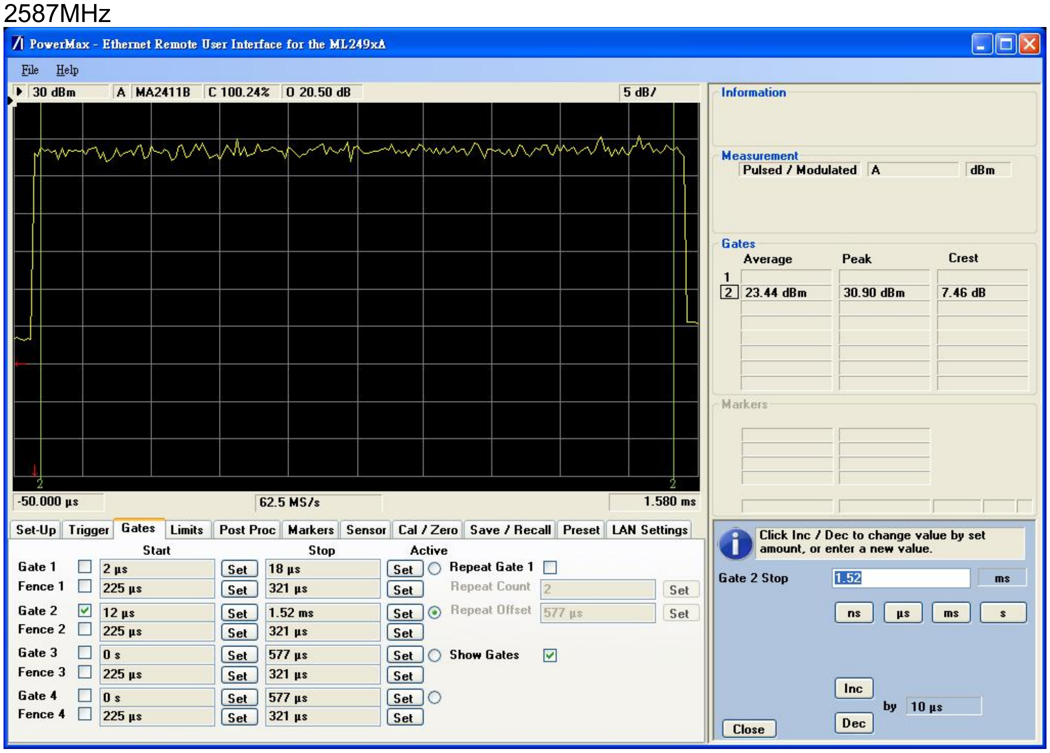
Bandwidth 5MHz / Modulation : 16QAM 1/2

2587MHz



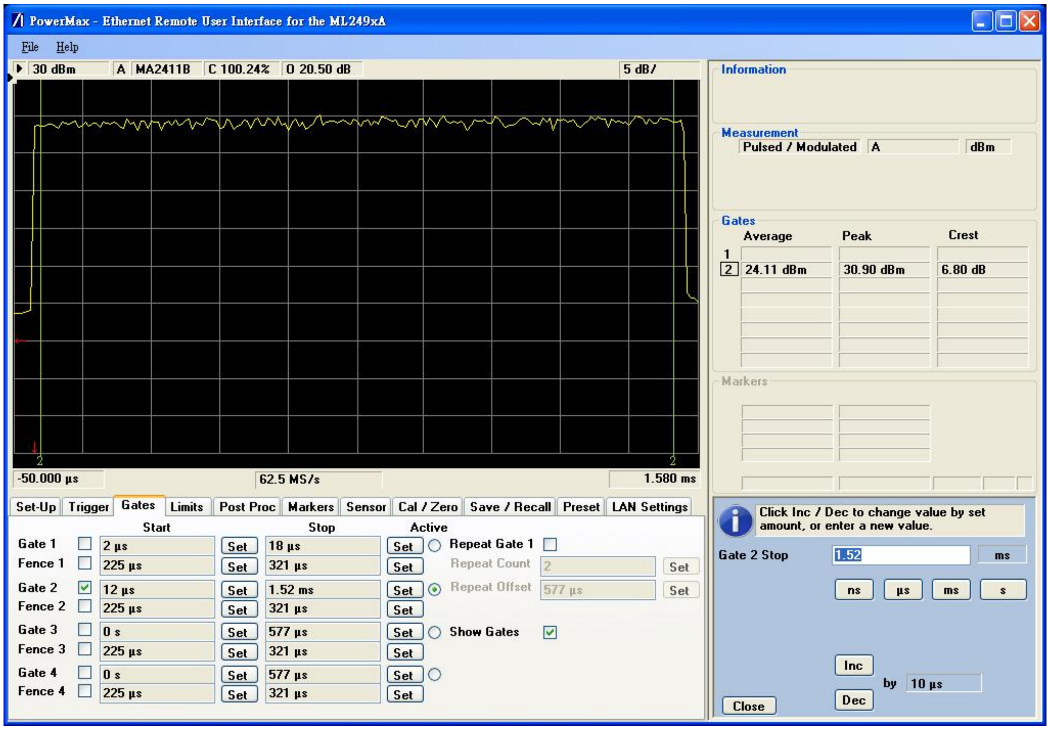
Bandwidth 5MHz / Modulation : 16QAM 3/4

2587MHz



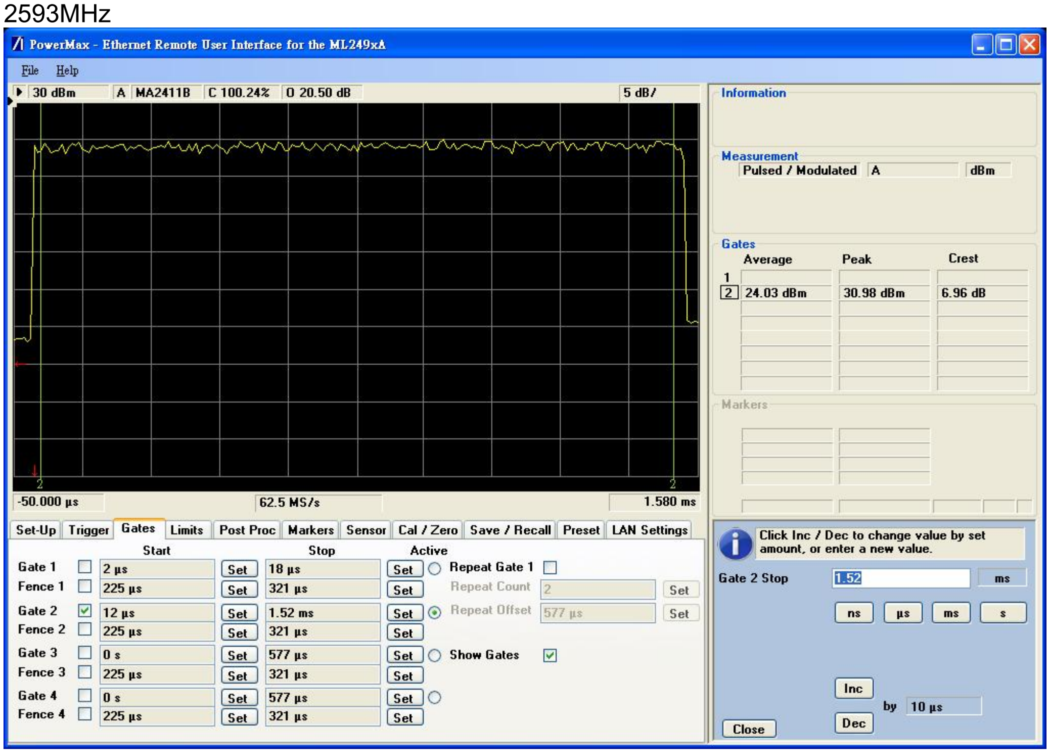
Bandwidth 10MHz / Modulation : QPSK 1/2

2593MHz



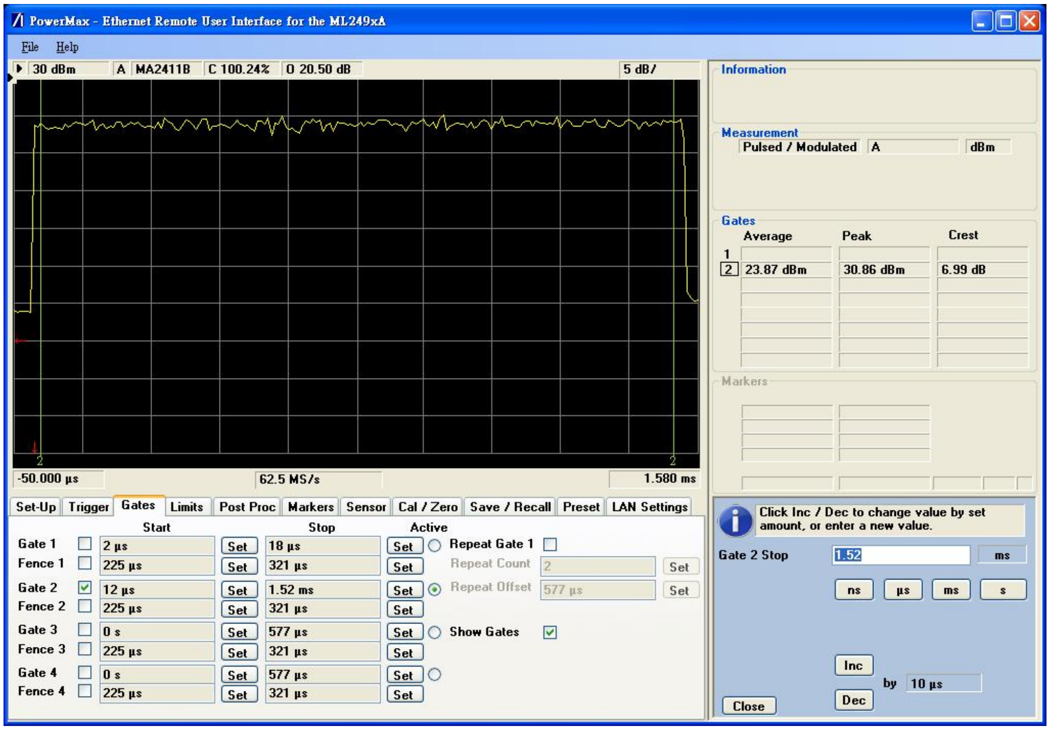
Bandwidth 10MHz / Modulation : QPSK 3/4

2593MHz



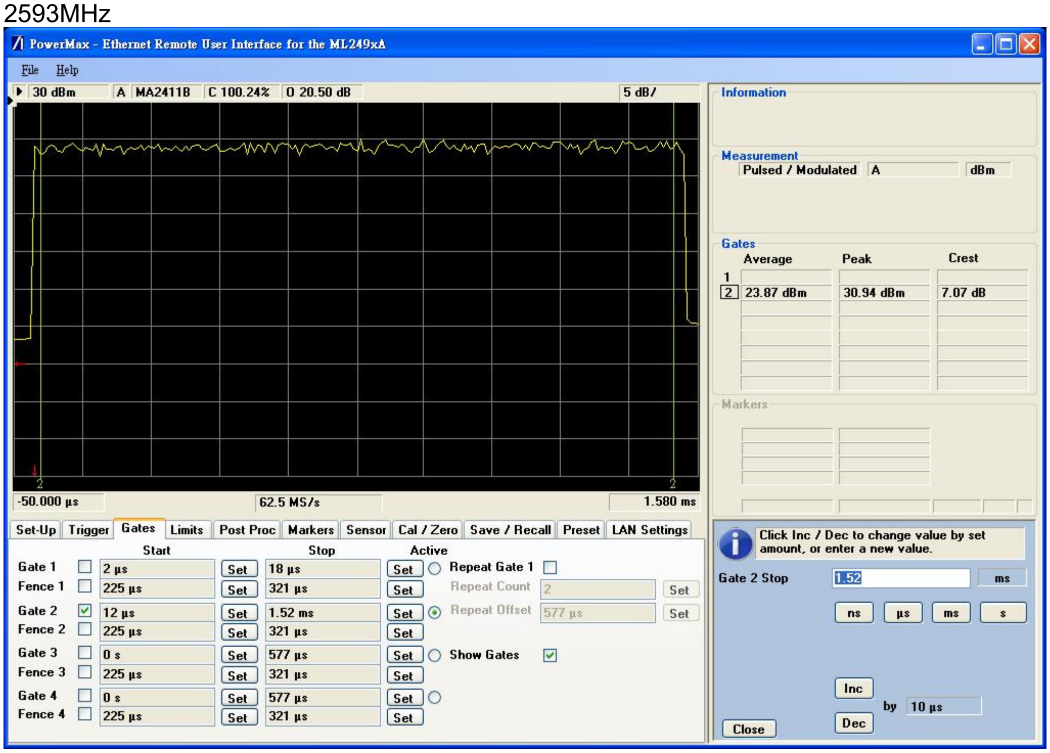
Bandwidth 10MHz / Modulation : 16QAM 1/2

2593MHz



Bandwidth 10MHz / Modulation : 16QAM 3/4

2593MHz



7.3 DUTY FACTOR

The transmitter maximum DL/UL symbol ratio is 29:18 with 15 traffic symbol transmitting at the max. power and three control symbols are not activate nor used in the SAR measurement, the duty cycle = **15/48** =0.3125.
Duty Factor = 1/(duty cycle)=3.2 for this periodic pulse signal device.

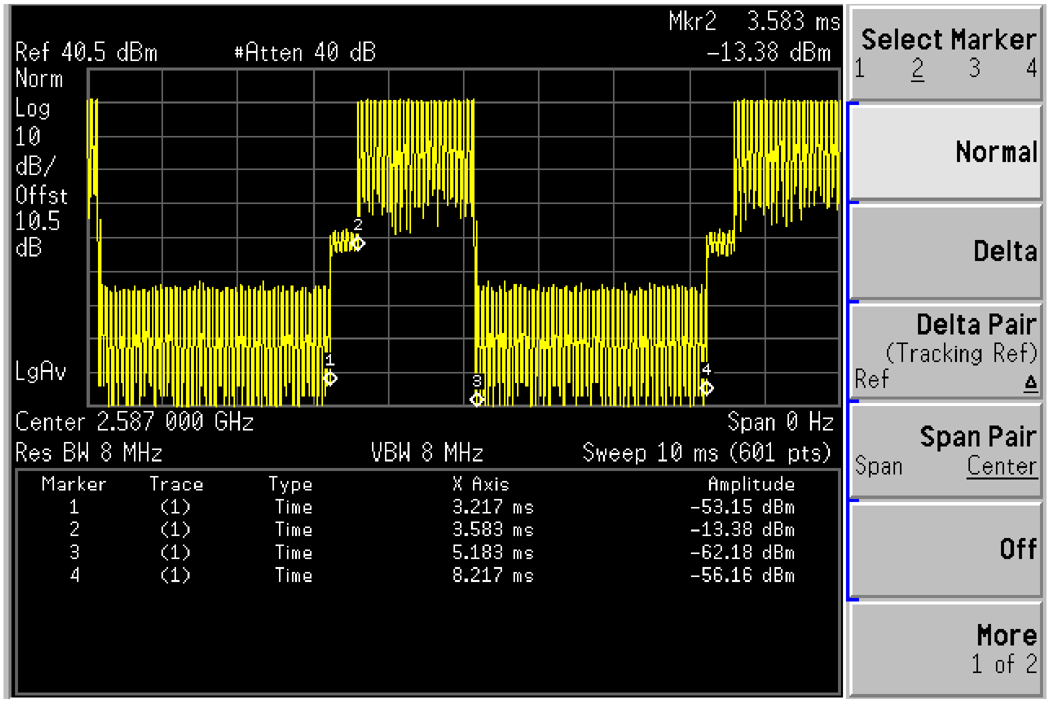
The SAR measurement is compensated using factors is as the below list:

Channel BW	**UL zone type**	**DL/UL Ratio**	**UL duty cycle**	***cf factor***	**UL modulation**
5MHz	PUSC	29/18	32%	*3.2*	QPSK-1/2 QPSK-3/4 16QAM-1/2 16QAM-3/4
10MHz	PUSC	29/18	32%	*3.2*	QPSK-1/2 QPSK-3/4 16QAM-1/2 16QAM-3/4

Test plot of Duty cycle (Only show the plots of 5MHz / QPSK / middle channel)

Bandwidth 5MHz / Modulation : QPSK 1/2

2587MHz



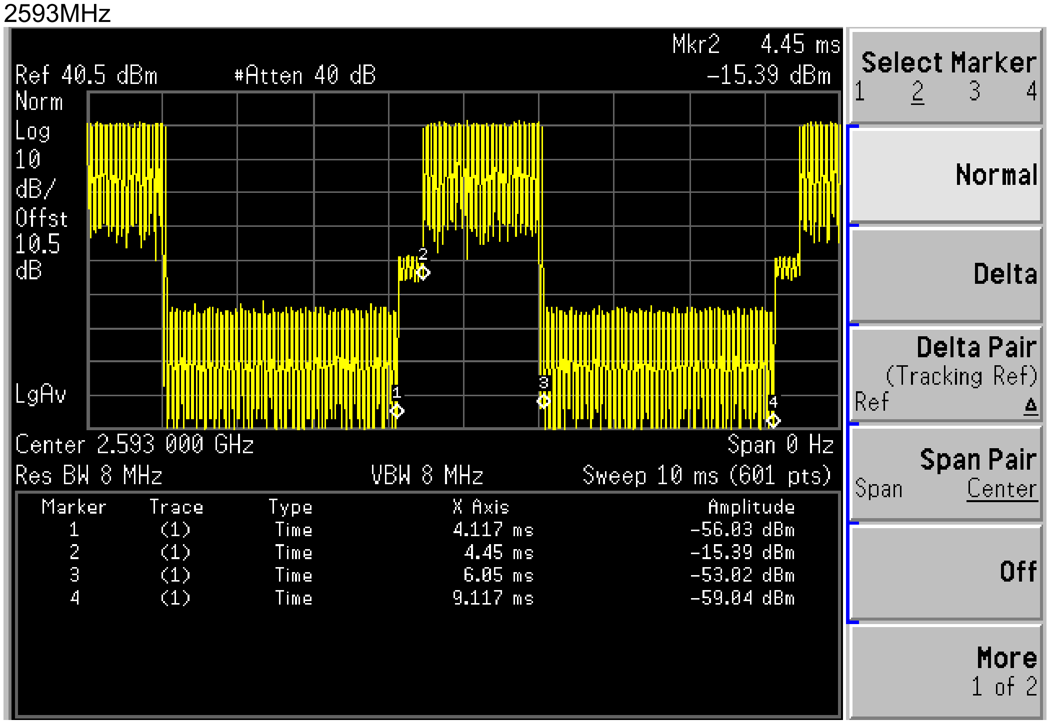
Burst lengh = Mark4 – Mark1=8.217ms- 3.217ms = 5ms

15 symbols UL = Mark3 – Mark2 = 5.183ms-3.583ms = 1.6ms

Duty cycle = 1.6 / 5 *100 % = 32 %

Bandwidth 10MHz / Modulation : QPSK 1/2

2593MHz



Burst lengh = Mark4 – Mark1=9.117ms- 4.117ms = 5ms

15 symbols UL = Mark3 – Mark2 = 6.05ms-4.45ms = 1.6ms

Duty cycle = 1.6 / 5 *100 % = 32 %

7.4 SCALING FACTOR

Step-by-step control symbols Power and scaling parameters are as the following calculation:

a. Maximum Rated Output Power (MROP) is provided by applicant.

b. For 5 MHz Channel BW: 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 5 MHz channel configuration. A maximum of two simultaneous CQICH reports are possible, which can occupy up to 2 slots. A maximum of three slots can be used for HARQ ACK/NAK by the five possible DL HARQ bursts in the DL frame. The 5 ACK/NAK bits each occupies ½ a slot. These 5 slots correspond to 5/17 of the total number of uplink slots.

For 5M BW

MOP (Max output power)	Calculation	Result CCP
258.23 mW	258.23 mW x 5/17	75.95 mW

c. For 10MHz Channel BW: 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. A maximum of two simultaneous CQICH reports are possible, which can occupy up to 2 slots. A maximum of three slots can be used for HARQ ACK/NAK by the five possible DL HARQ bursts in the DL frame. The 5 ACK/NAK bits each occupies ½ a slot. These 5 slots correspond to 5/35 of the total number of uplink slots.

For 10M BW

MOP (Max output power)	Calculation	Antenna 1
258.23mW	258.23mW x 5/35	36.89mW

d. Scaling Factor

S.F. = (CCP x 3 control symbols + MOP x 15 Traffic symbols) / (actual_OP x 15)

NOTE:
CCP: Control Channel Power
MOP: Maximum Output Power
Actual_OP: actual (measured) maximum power

CCP result

For 5M BW

MOP (Max output power)	Calculation	Result CCP
258.23 mW	258.23 mW x 5/17	75.95 mW

For 10M BW

MOP (Max output power)	Calculation	Antenna 1
258.23mW	258.23mW x 5/35	36.89mW

Actual (measured) maximum power table (Actual_OP)

Bandwidth(MHz)	Frequency (MHz)	Antenna 1	Antenna 2
5	middle channel 2587	23.72 dBm (235.50mW)	23.62dBm(230.14mW)
10	middle channel 2593	24.12 dBm (258.23mW)	24.11 dBm(257.63mW)

S.F. = (CCP x 3 control symbols + MOP x 15 Traffic symbols) / (actual_OP x 15)

5M BW
Scaling factor for Antenna-1 5MHz middle channel QPSK 1/2 modulation
=(75.95x 3)+(258.23 x 15)/(235.50 x15)=1.161

Scaling factor for Antenna-2 5MHz middle channel QPSK 1/2 modulation
=(75.95x 3)+(258.23 x 15)/(230.14 x15)=1.188

10M BW
Scaling factor for Antenna-1 10MHz middle channel QPSK 1/2 modulation
=(36.89 x 3)+(258.23 x 15)/(258.23 x15)=1.029

Scaling factor for Antenna-2 10MHz middle channel QPSK 1/2 modulation
=(36.89 x 3)+(258.23 x 15)/(257.63 x15)=1.031

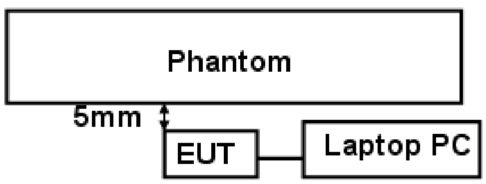
8. TEST SETUP

a. The test set-up is shown in the below picture. The USB Adapter (EUT) is plugged into the notebook computer and configured exactly as it would be in the field on a normal network.

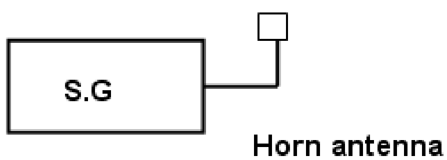
The Beceem test tool is used on the laptop.
Beceem is used to instruct the USB dongle to go to full power. Under normal operating conditions the BS would be responsible for controlling the MS Tx power. When working with a BS, the MS cannot Tx at a power greater than the max power requested by Kannon.
On the network side, there is a vector signal generator as below:

Agilent E4438C ESG with below options:
N7613A: Signal Studio for 802.16-2004 WiMAX
N7615B: Signal studio for 802.16 WiMAX
Software is loaded into the E4438C ESG that produces an output signal that looks like a 29:18 WiMAX frame, the EUT detects the “network” and begins to transmit based on the commands from the ESG signal and the measurements are then taken on the EUT.

b. Connection diagram:



Linking up through air interface



Output power of S.G is - 20dBm

Horn antenna has 10.6dBi gain at 2.5GHz

Distance between horn antenna and EUT is 4m

c. Communication Test Set Details
Modulation and channel bandwidth is controlled by the BSE, the test set details are listed bellow.

Bandwidth	10MHz	5MHz	10MHz	5MHz	10MHz	5MHz	10MHz	5MHz
FFT size	1024	512	1024	512	1024	512	1024	512
DL/UL ratio	29:18							
Up link								
MCS	PUSC		PUSC		PUSC		PUSC	
Up link	QPSK-1/2		16QAM-3/4		QPSK-3/4		16QAM-1/2	

9. TEST RESULTS

9.1 TEST PROCEDURES

The EUT plugged into the notebook. Use the software to control the EUT channel and transmission power. Then record the conducted power before the testing. Place the EUT to the specific test location. After the testing, must writing down the conducted power of the EUT into the report. The SAR value was calculated via the 3D spline interpolation algorithm that has been implemented in the software of DASY5 SAR measurement system manufactured and calibrated by SPEAG. According to the IEEE 1528 standards, the recommended procedure for assessing the peak spatial-average SAR value consists of the following steps:

• Power reference measurement

• Verification of the power reference measurement

• Area scan

• Zoom scan

• Power reference measurement

The area scan was performed for the highest spatial SAR location. The zoom scan with 30mm x 30mm x 30mm volume was performed for SAR value averaged over 1g and 10g spatial volumes.

In the zoom scan, the distance between the measurement point at the probe sensor location (geometric center behind the probe tip) and the phantom surface is 3mm and maintained at a constant distance of ±0.5mm during a zoom scan to determine peak SAR locations. The distance is 3mm between the first measurement point and the bottom surface of the phantom. The secondary measurement point to the bottom surface of the phantom is with 8mm separation distance. The cube size is 7 x 7 x 7 points consists of 343 points and the grid space is 5mm.

The measurement time is 0.5s at each point of the zoom scan. The probe boundary effect compensation shall be applied during the SAR test. Because of the tip of the probe to the Phantom surface separated distances are longer than half a tip probe diameter.

In the area scan, the separation distance is 3mm between the each measurement point and the phantom surface. The scan size shall be included the transmission portion of the EUT. The measurement time is the same as the zoom scan. At last the reference power drift shall be less than ±5%.

9.2 MEASURED SAR RESULTS

FOR WiMAX:
For 5MHz / QPSK 1/2

SAR (W/ kg)			Top		Back		Edge	
ANTENNA			Ant. 1		Ant. 1		Ant. 1	
Channel	Freq (MHz)	Scaling factor	Meas.	Scaled	Meas.	Scaled	Meas.	Scaled
Middle	2587	1.161	0.204	0.237	0.091	0.106	0.140	0.163
ANTENNA			Ant. 2		Ant. 2		Ant. 2	
Channel	Freq (MHz)	Scaling factor	Meas.	Scaled	Meas.	Scaled	Meas.	Scaled
Middle	2587	1.188	0.393	**0.467**	0.245	0.291	0.339	0.403

For 10MHz/ QPSK 1/2

SAR (W/ kg)			Top		Back		Edge	
ANTENNA			Ant. 1		Ant. 1		Ant. 1	
Channel	Freq (MHz)	Scaling factor	Meas.	Scaled	Meas.	Scaled	Meas.	Scaled
Middle	2593	1.029	0.270	0.278	0.096	0.099	0.174	0.179
ANTENNA			Ant. 2		Ant. 2		Ant. 2	
Channel	Freq (MHz)	Scaling factor	Meas.	Scaled	Meas.	Scaled	Meas.	Scaled
Middle	2593	1.031	0.337	0.347	0.263	0.271	0.392	0.404

NOTE:

1. In this testing, the limit for General Population Spatial Peak averaged over 1g, **1.6 W/kg**, is applied.
2. Please see the Appendix A for the data.
3. The variation of the EUT conducted power measured before and after SAR testing should not over 5%.

FOR WIFI:

Stand-alone SAR (1g)			
	BODY		
Position	Top	Back	Edge
11b			
Ant 1: 2437MHz	0.030	0.044	0.027
Ant 2: 2437 MHz	0.031	**0.070**	0.028

NOTE:

1. In this testing, the limit for General Population Spatial Peak averaged over 1g, **1.6 W/kg**, is applied.
2. Please see the Appendix A for the data.
3. The variation of the EUT conducted power measured before and after SAR testing should not over 5%.
4. SAR for 802.11g/802.11n (20MHz)/802.11n (40MHz) mode is not required since max average power of 802.11g/802.11n (20MHz)/802.11n (40MHz) is less than 802.11b.
5. Per KDB 447498, when 1-g SAR for the highest output channel is less than 0.8 W/kg, where the transmission band. corresponding to all channels is ≤ 100 MHz, testing for the other channels is not required

9.3 POWER DRIFT TABLE

Power drift table for WiMAX test

Tx antenna	BW (MHz)	Frequency (MHz)	Position	Conducted power (dBm)		Power drift (%)
				Before test	After test	
Antenna 1	5	2587	TOP	23.72	23.61	-2.50
			BACK	23.72	23.63	-2.05
			EDGE	23.72	23.58	-3.17
	10	2593	TOP	24.12	23.95	-3.84
			BACK	24.12	23.98	-3.17
			EDGE	24.12	24.02	-2.28
Antenna 2	5	2587	TOP	23.62	23.49	-2.95
			BACK	23.62	23.45	-3.84
			EDGE	23.62	23.52	-2.28
	10	2593	TOP	24.11	23.94	-3.84
			BACK	24.11	23.96	-3.39
			EDGE	24.11	24.00	-2.50

Power drift table for WLAN test

Tx antenna	Mode	Frequency (MHz)	Position	Conducted power (dBm)		Power drift (%)
				Before test	After test	
Antenna 1	11b	2437	TOP	12	11.87	-2.95
			BACK	12	11.91	-2.05
			EDGE	12	11.85	-3.39
Antenna 2	11b	2437	TOP	11.3	11.18	-2.73
			BACK	11.3	11.13	-3.84
			EDGE	11.3	11.17	-2.95

10. SAR LIMITS

HUMAN EXPOSURE	SAR (W/kg)	
	(GENERAL POPULATION / UNCONTROLLED EXPOSURE ENVIRONMENT)	(OCCUPATIONAL / CONTROLLED EXPOSURE ENVIRONMENT)
Spatial Average (whole body)	0.08	0.4
Spatial Peak (averaged over 1 g)	**1.6**	8.0
Spatial Peak (hands / wrists / feet / ankles averaged over 10 g)	4.0	20.0

NOTE:

1. This limits accord to 47 CFR 2.1093 – Safety Limit.
2. The EUT property been complied with the partial body exposure limit under the general population environment.

11. SAR ERROR CONSIDERATION

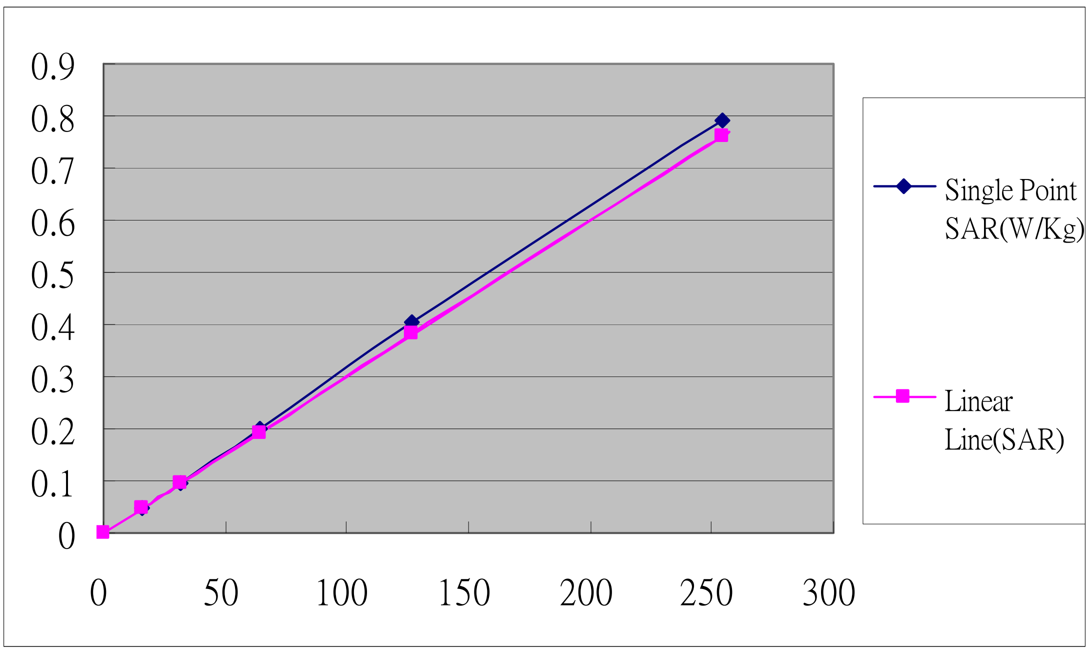
In order to estimate the measurement error due to PAR issues, the configuration with the highest SAR in each channel bandwidth and frequency band is measured at various power level. Test conditions are as below

Test position: Bottom
Test frequency: 2593MHz for 5MHz bandwidth
2685MHz for 10MHz bandwidth
Modulation: QPSK 1/2,16QAM 1/2

By tuning different power on this EUT and measuring the relative SAR to verify the high PAR of OFDM/OFDMA is as below:

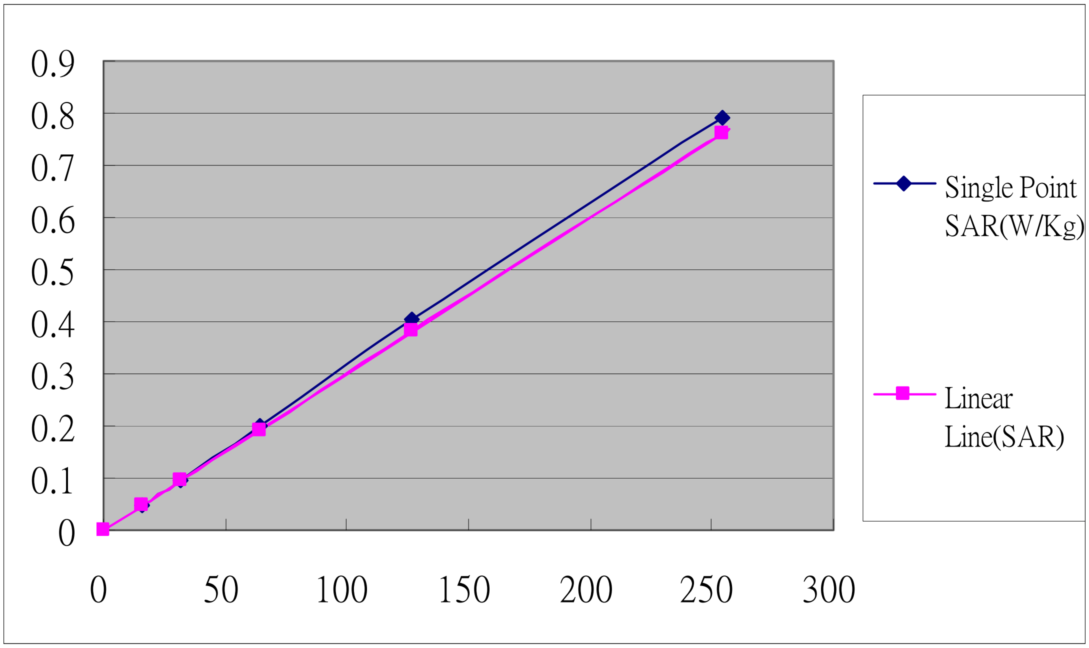
5MHz / QPSK

SAR (W/kg)	Power (mW)	16.03	31.92	63.83	127.06	254.10
5MHz	Point SAR	0.048	0.097	0.200	0.404	0.792
	Linear line	0.048	0.096	0.191	0.380	0.761
	Deviation(%)	0.00%	1.48%	4.64%	6.19%	4.09%



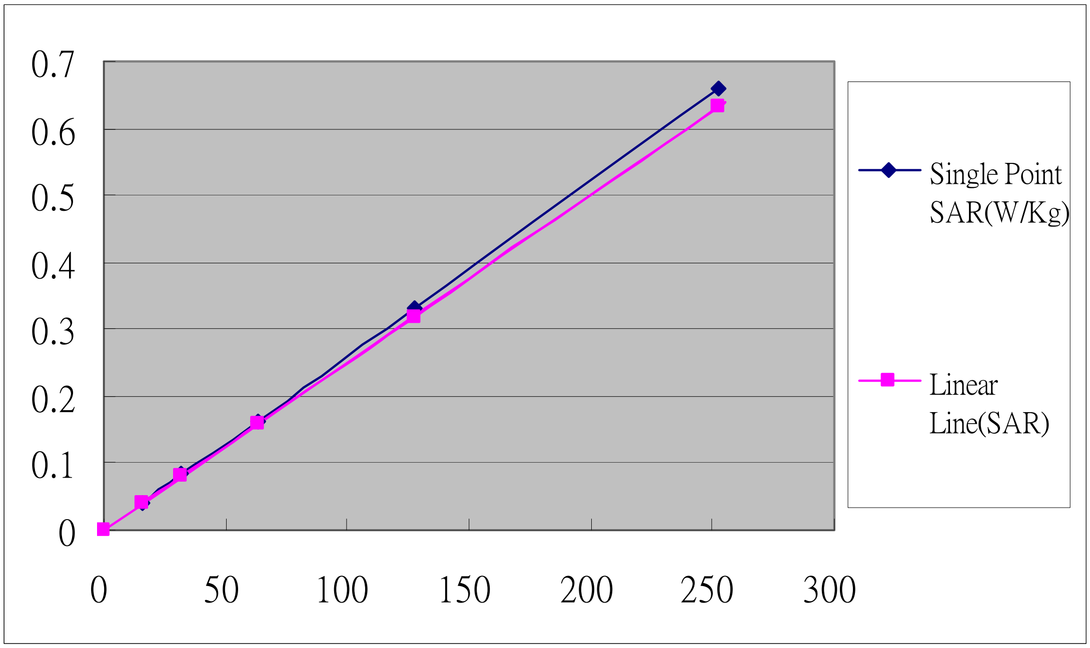
5MHz / 16QAM 1/2

SAR (W/kg)	Power (mW)	16.00	31.99	64.27	127.94	254.10
5MHz	Point SAR	0.046	0.094	0.192	0.384	0.745
	Linear line	0.046	0.092	0.185	0.368	0.731
	Deviation(%)	0.00%	2.21%	3.91%	4.40%	1.98%



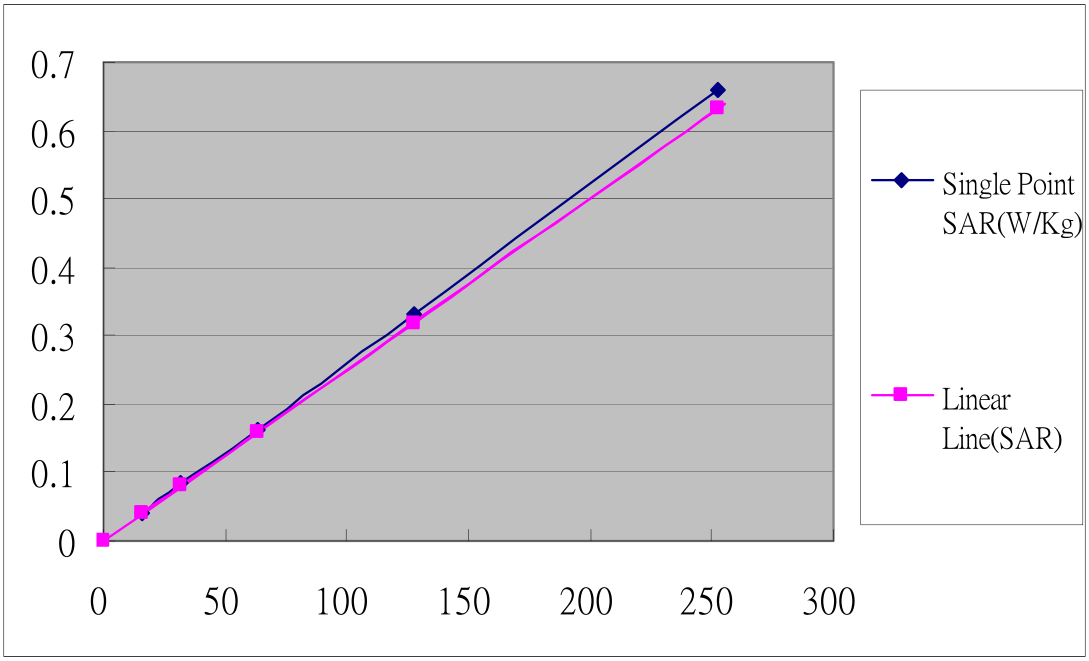
10MHz / QPSK

SAR (W/kg)	Power (mW)	15.96	31.92	63.53	127.35	252.40
10MHz	Point SAR	0.040	0.086	0.164	0.332	0.661
	Linear line	0.040	0.080	0.159	0.319	0.633
	Deviation(%)	0.00%	7.50%	3.00%	4.02%	4.49%



10MHz / 16QAM

SAR (W/kg)	Power (mW)	16.00	31.84	63.97	127.43	252.34
10MHz	Point SAR	0.039	0.083	0.162	0.324	0.654
	Linear line	0.039	0.078	0.156	0.311	0.615
	Deviation(%)	0.00%	6.94%	3.89%	4.31%	6.33%



12. INFORMATION ON THE TESTING LABORATORIES

We, Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch, were founded in 1988 to provide our best service in EMC, Radio, Telecom and Safety consultation. Our laboratories are accredited and approved according to ISO/IEC 17025.

Copies of accreditation certificates of our laboratories obtained from approval agencies can be downloaded from our web site: www.adt.com.tw/index.5/phtml. If you have any comments, please feel free to contact us at the following:

Linko EMC/RF Lab:
Tel: 886-2-26052180
Fax: 886-2-26051924

Hsin Chu EMC/RF Lab:
Tel: 886-3-5935343
Fax: 886-3-5935342

Hwa Ya EMC/RF/Safety/Telecom Lab:
Tel: 886-3-3183232
Fax: 886-3-3185050

Web Site: www.adt.com.tw

The address and road map of all our labs can be found in our web site also.

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