SAR TEST REPORT

REPORT NO.: SA970425H03

MODEL NO.: PC200

RECEIVED: Apr. 24, 2008

TESTED: Feb. 09 ~ Feb. 10, 2009

ISSUED: Feb. 17, 2009

APPLICANT: Accton Wireless Broadband Corp.

ADDRESS: 3F, No. 1 Creation Rd. III, Science-based Industrial Park Hsinchu 30077, Taiwan, R.O.C.

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

LAB ADDRESS: No. 47, 14th Ling, Chia Pau Tsuen, Lin Kou Hsiang, Taipei Hsien 244, Taiwan, R.O.C.

TEST LOCATION: No. 19, Hwa Ya 2nd Rd, Wen Hwa Tsuen, Kwei Shan Hsiang, Taoyuan Hsien 333, Taiwan, R.O.C.

Testing Laboratory
2021

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1. CERTIFICATION

PRODUCT: WiMAX 802.16e Wave 2 PC Card
MODEL: PC200
BRAND: AWB
APPLICANT: Accton Wireless Broadband Corp.
TESTED: Feb. 09 ~ Feb. 10, 2009
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: PC200) 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 : ______________________ , **DATE:** Feb. 17, 2009
Peggy Chen / Specialist

TECHNICAL ACCEPTANCE : ______________________ , **DATE:** Feb. 17, 2009
Responsible for RF
James Fan / Engineer

APPROVED BY : ______________________ , **DATE:** Feb. 17, 2009
Gary Chang / Assistant Manager

2. GENERAL INFORMATION

2.1 GENERAL DESCRIPTION OF EUT

PRODUCT	WiMAX 802.16e Wave 2 PC Card
MODEL NO.	PC200
FCC ID	V8YFW638PC25000W
POWER SUPPLY	3.3Vdc from host equipment
MODULATION TYPE	QPSK, 16QAM, 64QAM (refer to NOTE 1 for more details)
CODING RATE	1/2, 2/3, 3/4, 5/6 (refer to NOTE 1 for more details)
MODULATION TECHNOLOGY	OFDMA
MULTIPLE ACCESS METHOD	OFDMA
DUPLEX METHOD	TDD
OPERATING FREQUENCY	2500MHz to 2690MHz
CHANNEL BANDWIDTH	5MHz, 10MHz
CONDUCTED OUTPUT POWER	Refer to Note 2
AVERAGE SAR (1g)	0.728W/kg
ANTENNA TYPE	Omni-Directional antenna with 2dBi gain
DATA CABLE	NA
I/O PORTS	NA
ACCESSORY DEVICE	NA

NOTE:

1. For the EUT with modulation type and coding rate:

DOWN LINK		UP LINK	
MODULATION	**CODING RATE**	**MODULATION**	**CODING RATE**
QPSK	1/2	QPSK	1/2
	3/4		3/4
16QAM	1/2	16QAM	1/2
	3/4		3/4
64QAM	1/2		
	2/3		
	3/4		
	5/6		

2. The conducted output powers were listed as below.

Communication	5MHz QPSK 1/2	5MHz QPSK 3/4	5MHz 16QAM 1/2	5MHz 16QAM 3/4
Channel (MHz)	CONDUCTED OUTPUT POWER (dBm)			
2505	21.51	21.46	21.49	21.41
2600	21.81	21.77	21.76	21.71
2685	22.28	22.23	22.20	22.18
Communication	10MHz QPSK 1/2	10MHz QPSK 3/4	10MHz 16QAM 1/2	10MHz 16QAM 3/4
Channel (MHz)	CONDUCTED OUTPUT POWER (dBm)			
2505	21.40	21.35	21.31	21.28
2600	20.86	20.83	20.74	20.75
2685	21.05	21.00	20.98	20.94

3. The above EUT information was declared by manufacturer and for more detailed features description, please refers 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

DASY4 **(software 4.7 Build 53)** 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 DASY4 software defined. The DASY4 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.

EX3DV3 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	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 GENERAL DESCRIPTION OF THE SPATIAL PEAK SAR EVALUATION

The DASY4 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 together with other necessary accessories or support units. The following support units or accessories were used to form a representative test configuration during the tests.

NO.	PRODUCT	BRAND	MODEL NO.	SERIAL NO.	FCC ID
1	NOTEBOOK	DELL	D400	NA	FCC Doc Approved
2	VECTOR SIGNAL GENERATOR	Agilent	E4438C	MY47271120	NA
3	BCS200 CONTROL PANEL TEST SOFTWARE	NA	NA	NA	NA

NO.	SIGNAL CABLE DESCRIPTION OF THE ABOVE SUPPORT UNITS
1	NA
2	NA
3	NA

NOTE: Item 1 & 3 were supplied from client.

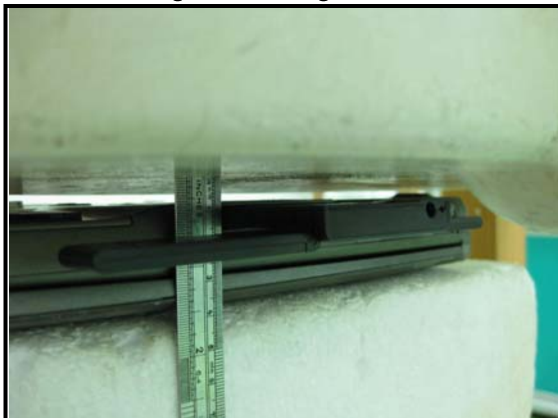
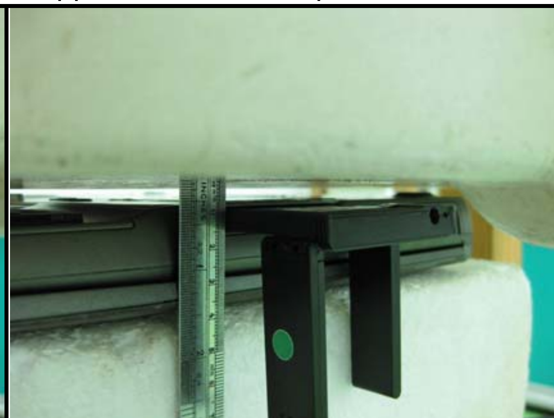
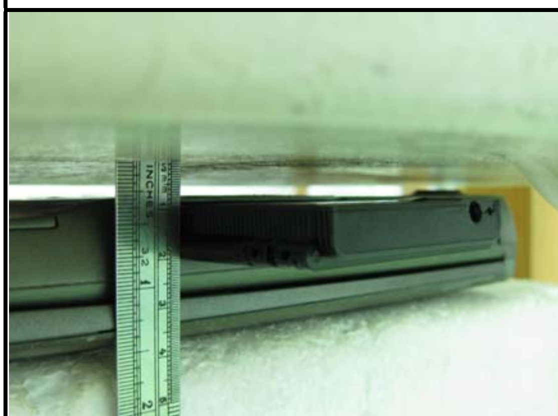
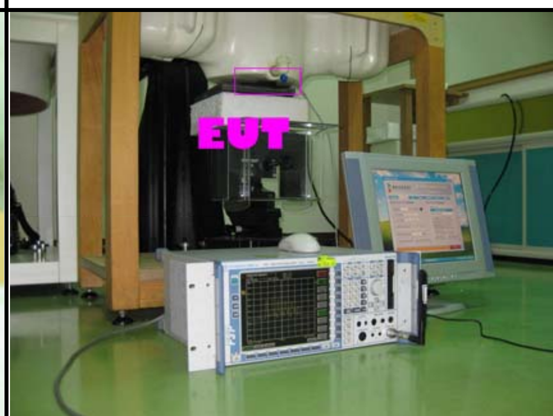
4. DESCRIPTION OF TEST MODES AND CONFIGURATIONS

4.1. DESCRIPTION OF ANTENNA LOCATION

NOTE: Only one antenna can transmit. This product has no antenna diversity function.

4.2. DESCRIPTION OF ASSESSMENT POSITION

The following test configurations have been applied in this test report:

	
A: NOTEBOOK MODEL: D400 The bottom of the EUT face to the phantom with 10mm-separation distance.	**B: NOTEBOOK MODEL: D400** The bottom of the EUT face to the phantom with 10mm-separation distance.
	
C: NOTEBOOK MODEL: D400 The bottom of the EUT face to the phantom with 10mm-separation distance.	**Setup Photo**

NOTE: The bottom of the notebook contacts to the bottom of the flat phantom with 0mm-separation distance.

4.3. DESCRIPTION OF TEST MODE

TEST MODE	COMMUNICATION	MODULATION TYPE	ASSESSMENT POSTITION	TESTED CHANNEL	REMARK
1	WiMAX – 5M-QPSK 1/2	QPSK	A	L, M, H	Antenna State: 180°
2	WiMAX – 5M-QPSK 3/4	QPSK	A	L, M, H	Antenna State: 180°
3	WiMAX – 5M-16QAM 1/2	16QAM	A	L, M, H	Antenna State: 180°
4	WiMAX – 5M-16QAM 3/4	16QAM	A	L, M, H	Antenna State: 180°
5	WiMAX – 10M-QPSK 1/2	QPSK	A	L, M, H	Antenna State: 180°
6	WiMAX – 10M-QPSK 3/4	QPSK	A	L, M, H	Antenna State: 180°
7	WiMAX – 10M-16QAM 1/2	16QAM	A	L, M, H	Antenna State: 180°
8	WiMAX – 10M-16QAM 3/4	16QAM	A	L, M, H	Antenna State: 180°
9	WiMAX – 5M-QPSK 1/2	QPSK	B	L, M, H	Antenna State: 90°
10	WiMAX – 5M-QPSK 3/4	QPSK	B	L, M, H	Antenna State: 90°
11	WiMAX – 5M-16QAM 1/2	16QAM	B	L, M, H	Antenna State: 90°
12	WiMAX – 5M-16QAM 3/4	16QAM	B	L, M, H	Antenna State: 90°
13	WiMAX – 10M-QPSK 1/2	QPSK	B	L, M, H	Antenna State: 90°
14	WiMAX – 10M-QPSK 3/4	QPSK	B	L, M, H	Antenna State: 90°
15	WiMAX – 10M-16QAM 1/2	16QAM	B	L, M, H	Antenna State: 90°
16	WiMAX – 10M-16QAM 3/4	16QAM	B	L, M, H	Antenna State: 90°
17	WiMAX – 5M-QPSK 1/2	QPSK	C	L, M, H	Antenna State: 0°
18	WiMAX – 5M-QPSK 3/4	QPSK	C	L, M, H	Antenna State: 0°
19	WiMAX – 5M-16QAM 1/2	16QAM	C	L, M, H	Antenna State: 0°
20	WiMAX – 5M-16QAM 3/4	16QAM	C	L, M, H	Antenna State: 0°
21	WiMAX – 10M-QPSK 1/2	QPSK	C	L, M, H	Antenna State: 0°
22	WiMAX – 10M-QPSK 3/4	QPSK	C	L, M, H	Antenna State: 0°
23	WiMAX – 10M-16QAM 1/2	16QAM	C	L, M, H	Antenna State: 0°
24	WiMAX – 10M-16QAM 3/4	16QAM	C	L, M, H	Antenna State: 0°

4.4. TEST SETUP AND TEST SIGNAL DETAIL

Table 1: 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"></td><td>Identify all related FCC ID</td></tr>
<tr><td>Radio Service</td><td colspan="2">Part 27 subpart M</td><td>Rule parts</td></tr>
<tr><td>Transmit Frequency Range (MHz)</td><td colspan="2">2496MHz-2690MHz</td><td>System parameter</td></tr>
<tr><td>System/Channel Bandwidth (MHz)</td><td>5MHz</td><td>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">QPSK,16QAM</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>5.6MHz</td><td>11.2MHz</td><td>(Fs)</td></tr>
<tr><td>Sample Time (ns)</td><td>178.581ns</td><td>89.3ns</td><td>(1/Fs)</td></tr>
<tr><td>FFT Size (NFFT)</td><td>512</td><td>1024</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>(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">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">18</td></tr>
<tr><td>DL:UL Symbol Ratio</td><td colspan="2">29:18</td><td>For determining UL duty factor</td></tr>
<tr><td>Power Class (dBm)</td><td colspan="2">Power Class 2, 23±1dBm</td><td>Identify power class and tolerance</td></tr>
<tr><td>Wave1 / Wave2</td><td colspan="2">Wave2, 2 antenna with receive MRC diversity,
DL MIMO matrix A and B.</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">Segmented PUSC
Unsegmented PUSC</td><td>Describe separately the symbol and sub-carrier/sub-channel structures applicable to each zone type</td></tr>
<tr><td>Maximum Number of UL Sub-Carriers</td><td>409</td><td>841</td><td rowspan="4">Identify the allowed and tested/to be tested parameters; include separate</td></tr>
<tr><td>UL Burst Maximum Average Power</td><td colspan="2">22.28dBm</td></tr>
<tr><td>Number and type of UL Control Symbols</td><td colspan="2">3 PUSC symbols (used for ranging, CQICH and ACK/NACK)</td></tr>
<tr><td>UL Control Symbol Maximum Average Power</td><td>49.72mW</td><td>19.72mW</td></tr>
</table>

Description	Parameter	Comment
UL Burst Peak-to-Average Power Ratio (PAR)		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
Frame Averaged UL Transmission Duty Factor	Due to the limitation of test software, the SAR was conducted with DL:UL symbol ratio of 31:15 consisting of 12 traffic symbols and no power on 3 control symbols. This lead to duty factor of (12 x 102.857μs) / 5000μs = 24.69%. The crest factor (CF) equals to 1/0.2469 = 4.05.	Show calculation 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

Output Power Measurement

The maximum average conducted output power was measured at uplink burst-on period with different modulations. The same setup and device operating configurations were used for SAR & EMC power measurements. Power was measured with a spectrum analyzer (Agilent / E4440A) and the device was connected to the vector signal generator through a directional coupler.

Setting of S.A is as below:

	5MHz Channel BW	10MHz Channel BW
RBW	51kHz	100kHz
VBW	150kHz	300kHz
Detector	RMS	RMS
Sweep time	Auto	Auto
Tirgger / Gating	on	on
Measure Mode	Channel power	Channel power

The output powers were listed as below.

Communication	5MHz QPSK 1/2	5MHz QPSK 3/4	5MHz 16QAM 1/2	5MHz 16QAM 3/4
Channel (MHz)	**CONDUCTED OUTPUT POWER (dBm)**			
2505	21.51	21.46	21.49	21.41
2600	21.81	21.77	21.76	21.71
2685	22.28	22.23	22.20	22.18
Communication	**10MHz QPSK 1/2**	**10MHz QPSK 3/4**	**10MHz 16QAM 1/2**	**10MHz 16QAM 3/4**
Channel (MHz)	**CONDUCTED OUTPUT POWER (dBm)**			
2505	21.40	21.35	21.31	21.28
2600	20.86	20.83	20.74	20.75
2685	21.05	21.00	20.98	20.94

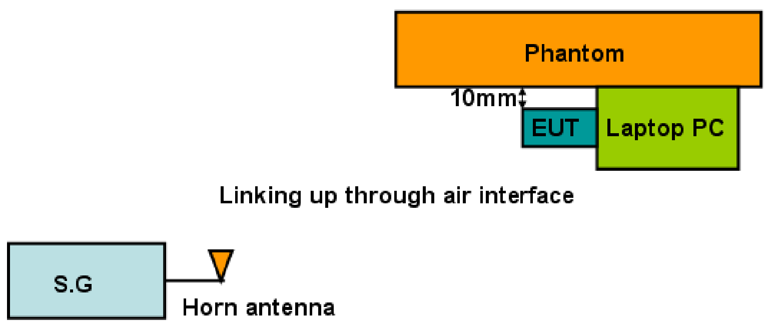
Communication Test Setup

The test set-up is shown in the below picture. The EUT is plugged into the notebook computer and configured exactly as it would be in the field on a normal network.
The BCS200 control panel test tool is used on the laptop.
BCS200 control panel is used to instruct the EUT to go to full power.

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 VSG (Vector Signal Generator) that emulates a 31:15 WiMAX frame, the EUT detects the “network” and begins to transmit based on the commands from the VSG signal and the measurements are then taken on the EUT.



Output power of S.G is - 20dBm

Horn antenna has 10.6dBi gain at 2.5GHz

Distance between horn antenna and EUT is 4m

Information on Typical Device and System Operating Parameters

The PC200 configuration using Beceem chipset which supports 1xTx and 2xRx for this device. Only one antenna is used for both transmitting and receiving signal and the other antenna is strictly used for RX diversity. The uplink is capable of both 10 MHz and 5 MHz bandwidths. For the 10 MHz bandwidth, it has 35 sub-channels structured from 1024 subcarriers; 184 are used as spare/safeguard subcarriers, leaving 840 available for transmission. From this, 560 subcarriers for data transmission with 280 subcarriers intended for pilot use. For the 5 MHz bandwidth, it contains 17 sub-channels using 512 subcarriers; 104 subcarriers as spare/safeguard subcarriers, 272 for data transmission, and 136 for pilot. The up-link sub-frame is triggered by an Allocation Start Time contained in the information of UL-MAP. This information specifies the starting times of the Up-link and Down-link frames. In any UL sub-frame, the duty factor ranging and bandwidth information is used to ensure optimal system operation. In normal device transmission the device will transmit control signaling at the first 3 up-link symbols and then use the rest of the up-link symbols for data traffic bursts in the uplink sub-frame. Since the first 3 symbols are also used for ranging detection purposes and are shared among other device users, its transmitting power is much smaller than the data burst symbol power. During the testing modes no information and power were transmitted in the first 3 symbols and the data traffic bursts are always running at the maximum output power level. A scaling factor is required to account for the power in the first 3 symbols. In the real usage, the data burst power will be adjusted according to the distance form the BS but will always be less than the maximum power presented in this report. In this way, by using the test mode arrangement we are transmitting at a worst case RF level.

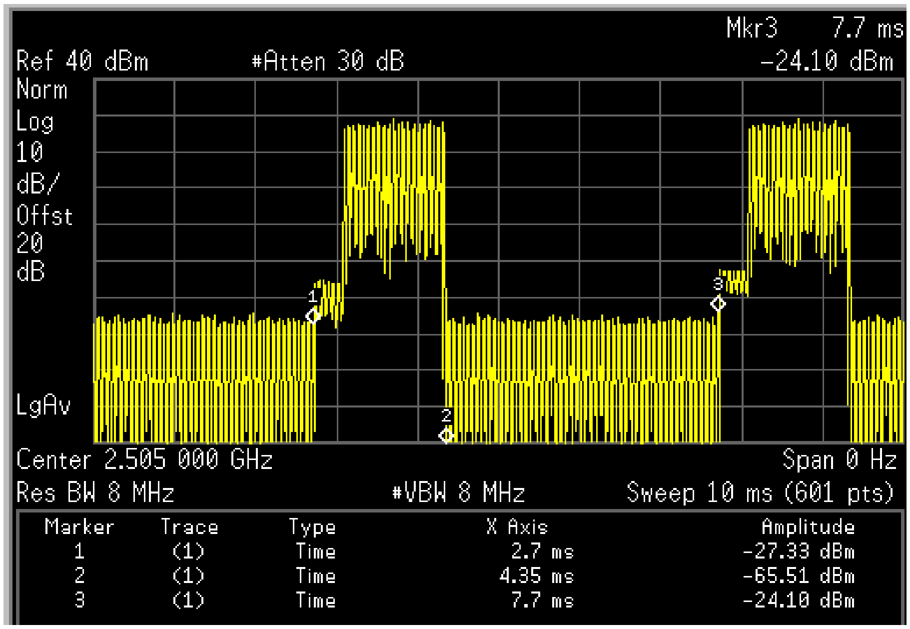
Duty Factor Considerations

Due to the limitation of the test software, the testing was conducted with 31:15 ratio. The 31 indicates the number of downlink symbols (from the base station to MS), and the 15 indicates the number of uplink symbols (transmitted from the MS). Inside the uplink, 12 of the symbols are used for data, and three of the symbols are used for sending control information to the network. During the testing, the control symbols contained no information and power, so scaling up is required for correcting the SAR reading. Since the first 3 control symbols didn't have power transmitted, the correct duty factor should be (12*102.8571uS)/5000uS = 24.69% and Crest factor for SAR evaluation is 1/0.2469=4.05.

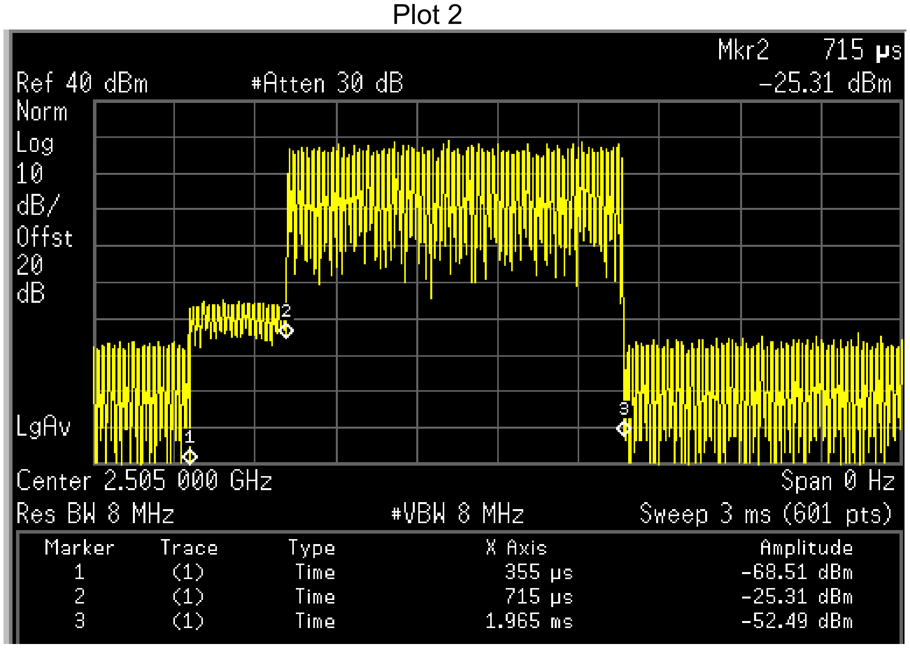
Below are the output waveforms of 5M channel

31U15 waveform (QPSK 1/2, duty cycle : 24.69 %)

Plot 1

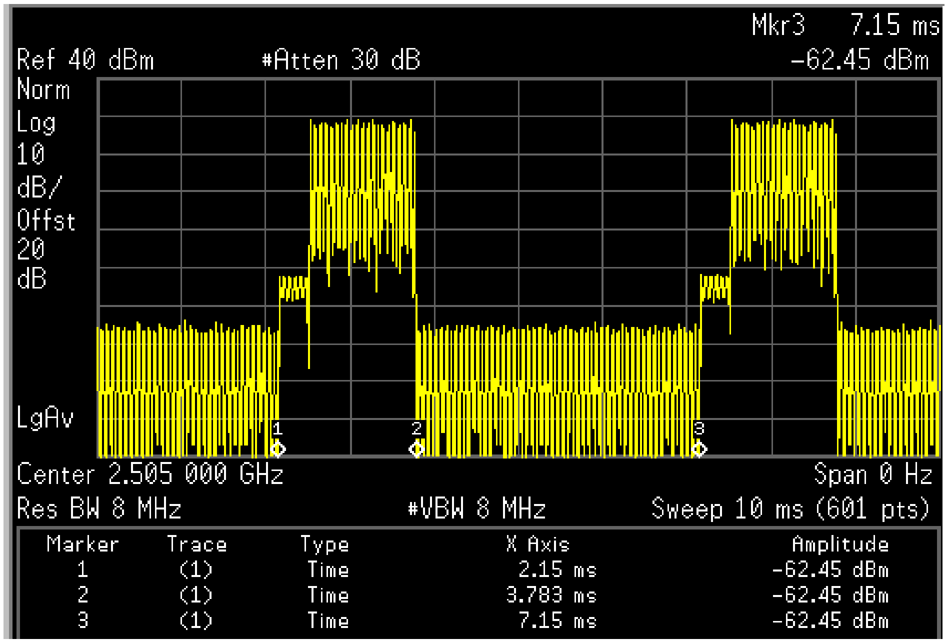


Plot 2

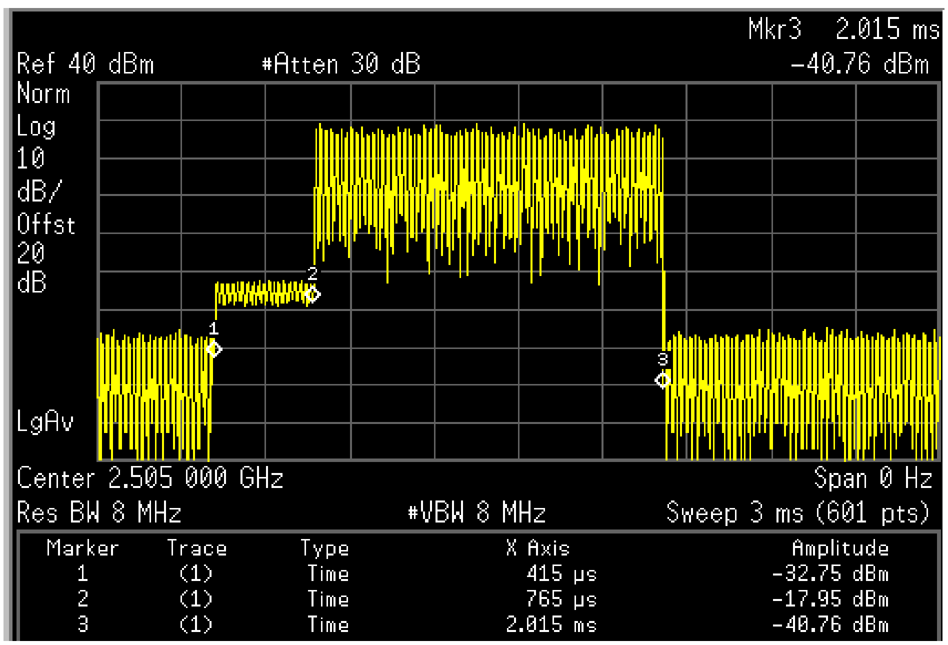


31U15 waveform (QPSK 3/4, duty cycle : 24.69 %)

Plot 1

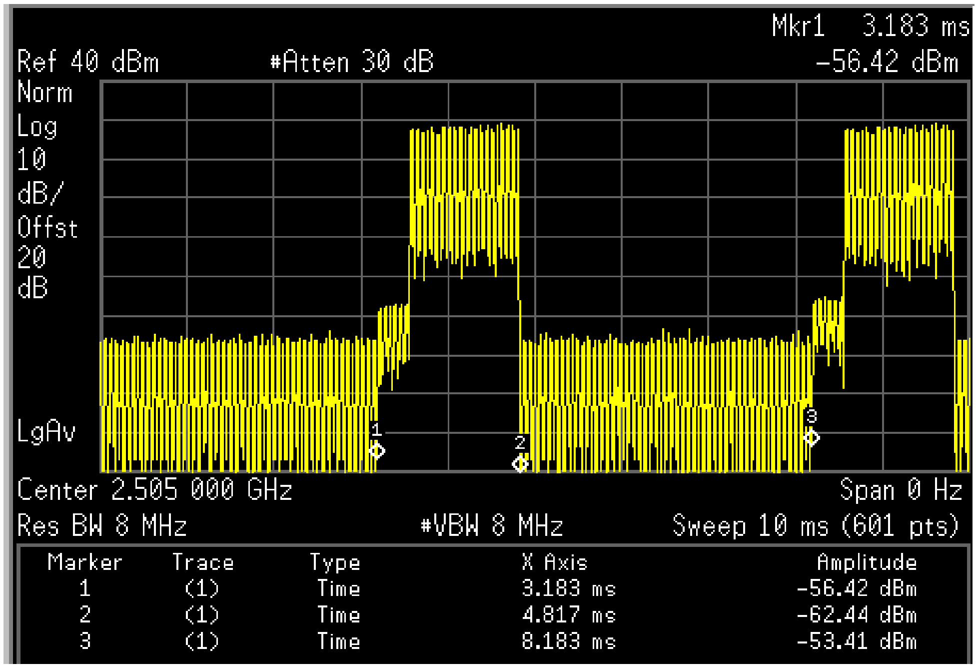


Plot 2

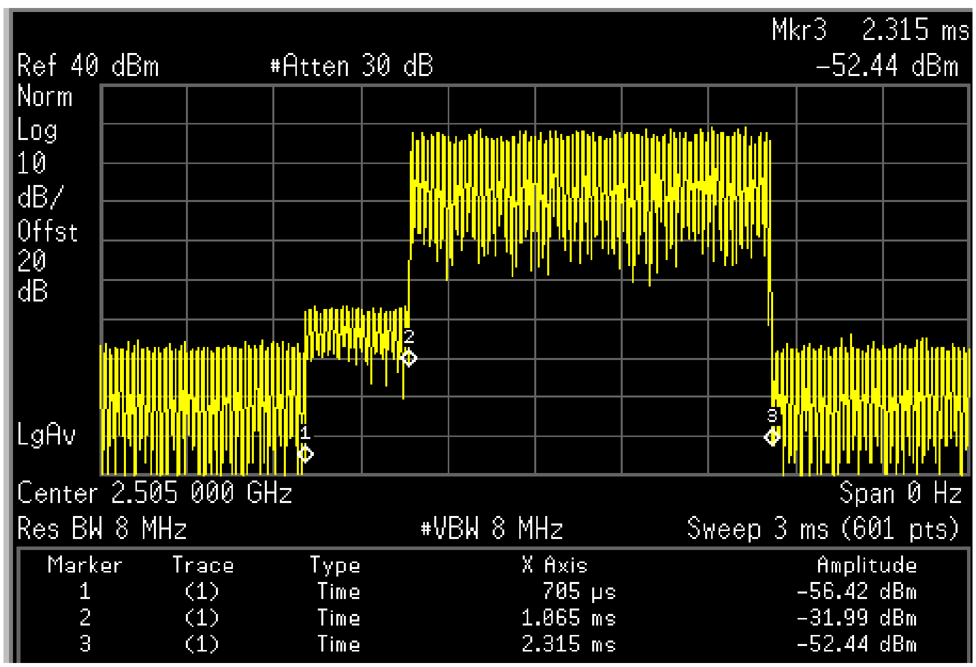


31U15 waveform (16QAM 1/2, duty cycle : 24.69 %)

Plot 1

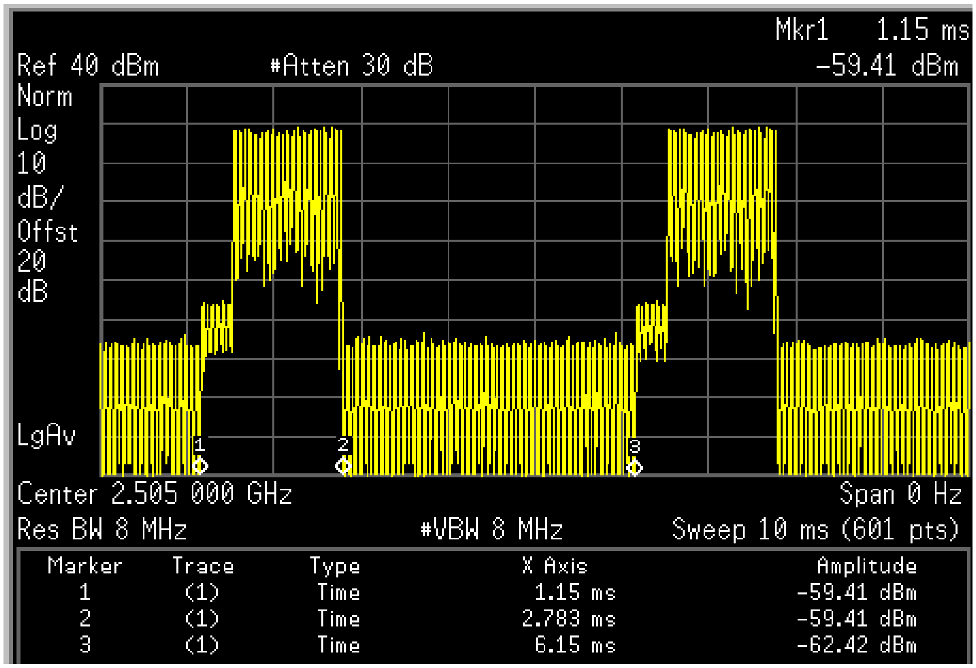


Plot 2

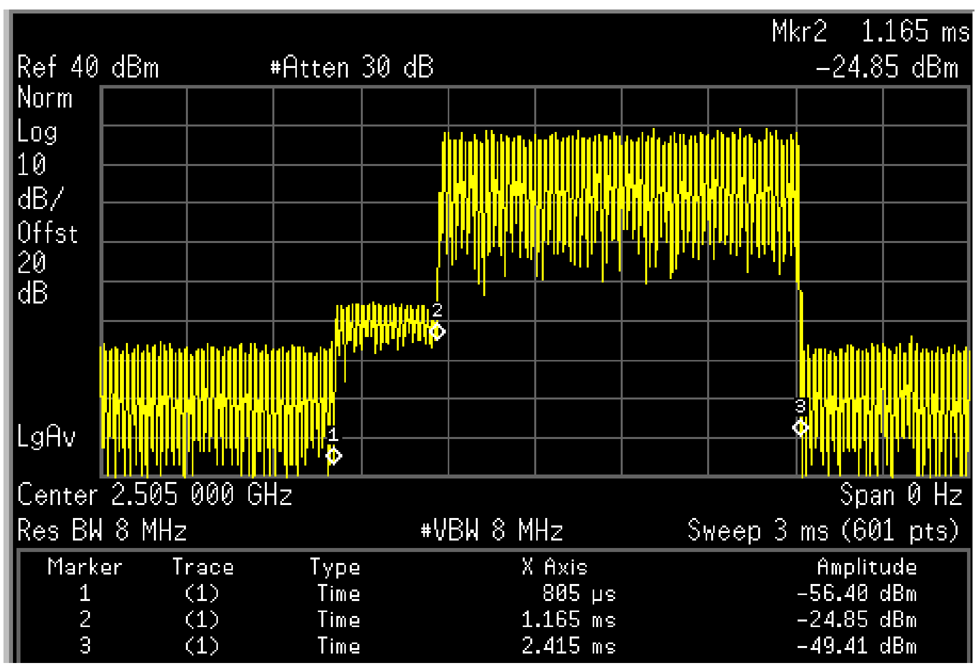


31U15 waveform (16QAM 3/4, duty cycle : 24.69 %)

Plot 1



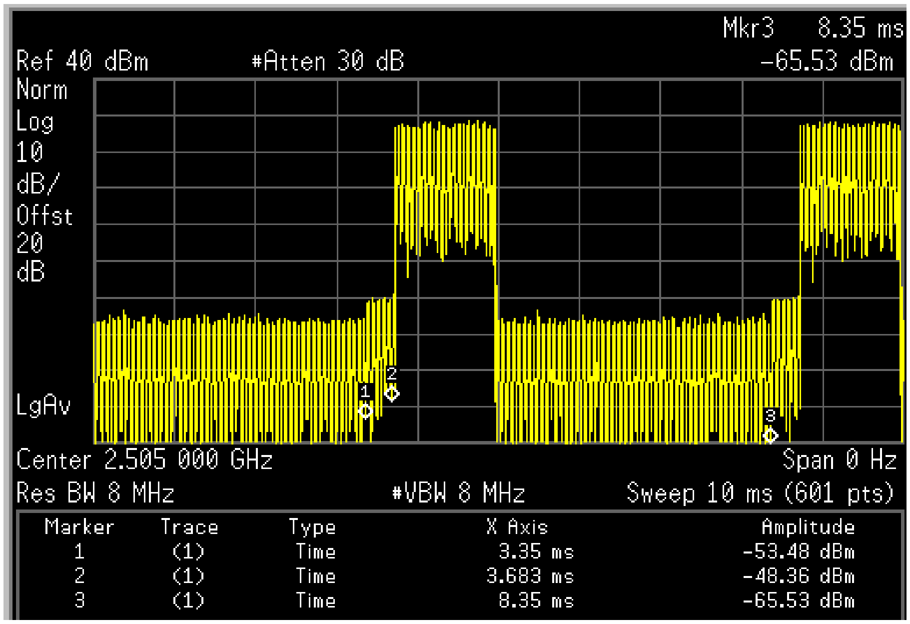
Plot 2



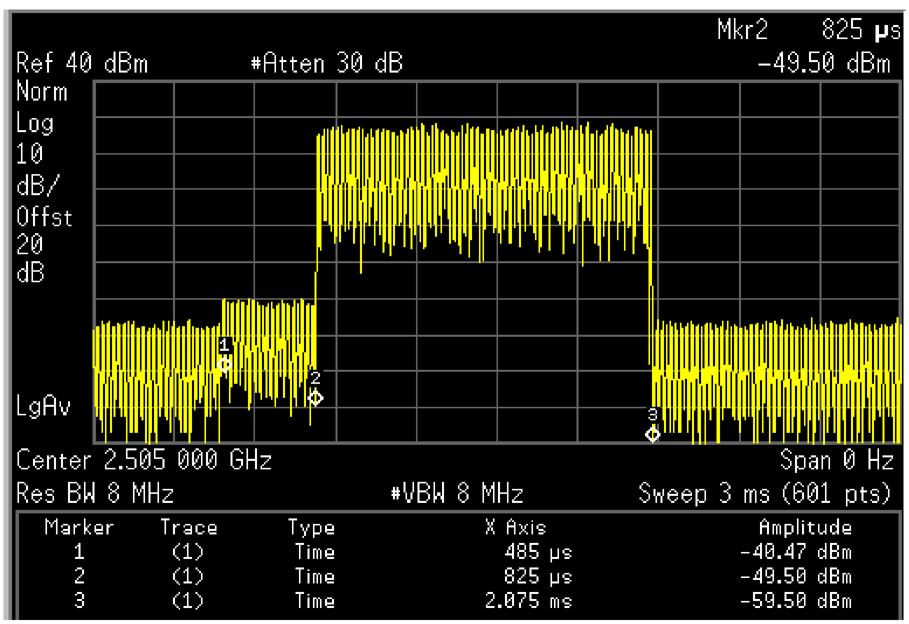
Below are the output waveforms of 10M channel

31U15 waveform (QPSK 1/2, duty cycle : 24.69 %)

Plot 1

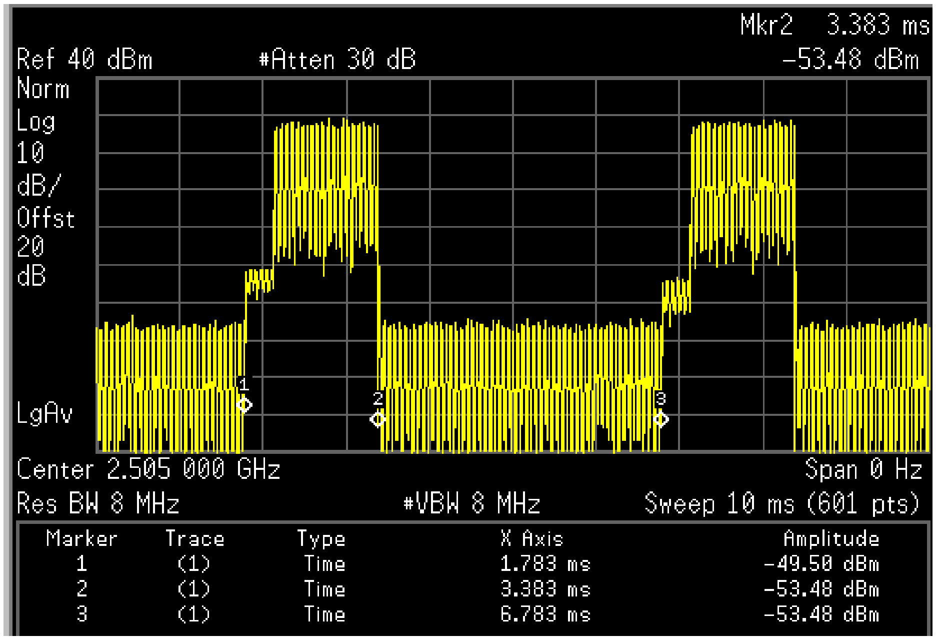


Plot 2

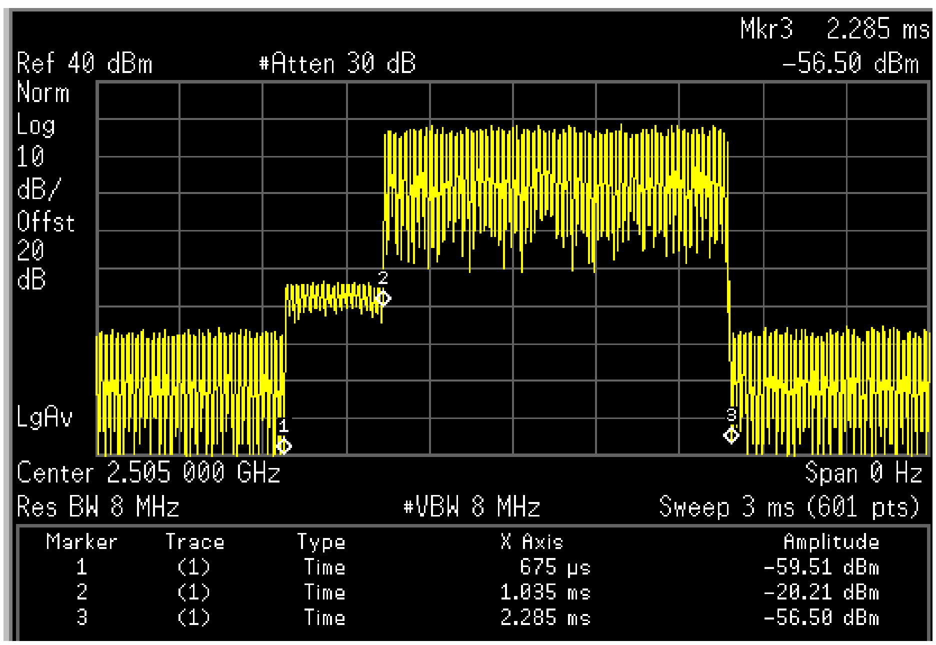


31U15 waveform (QPSK 3/4, duty cycle : 24.69 %)

Plot 1

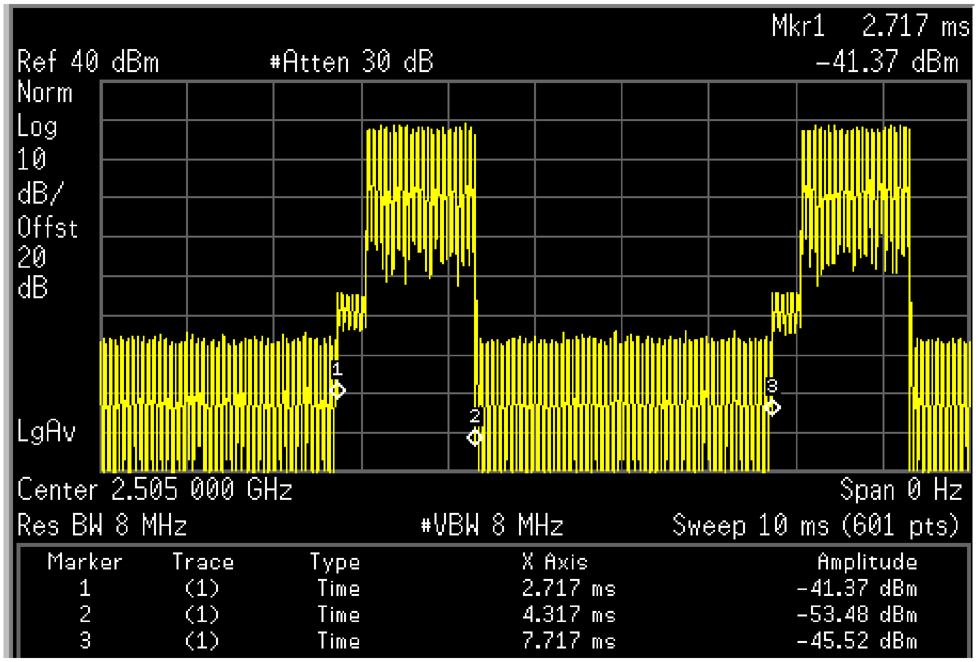


Plot 2

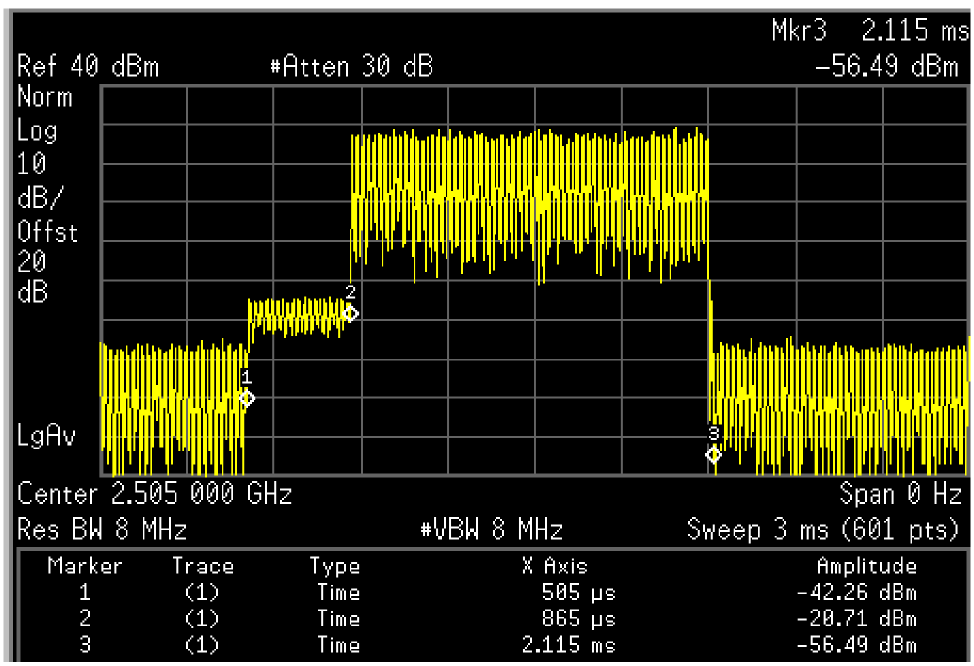


31U15 waveform (16QAM 1/2, duty cycle : 24.69 %)

Plot 1

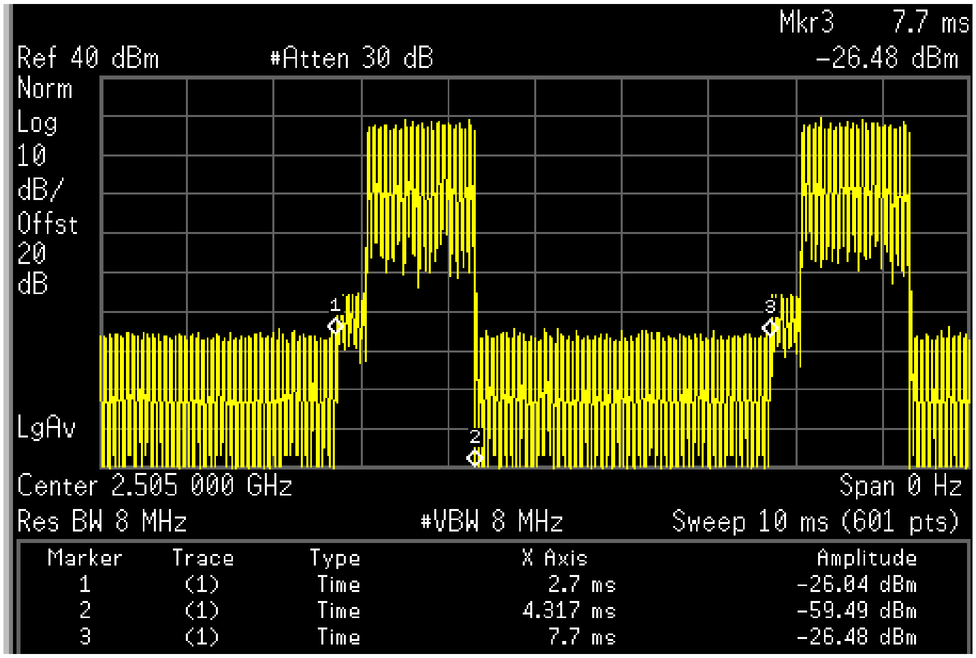


Plot 2

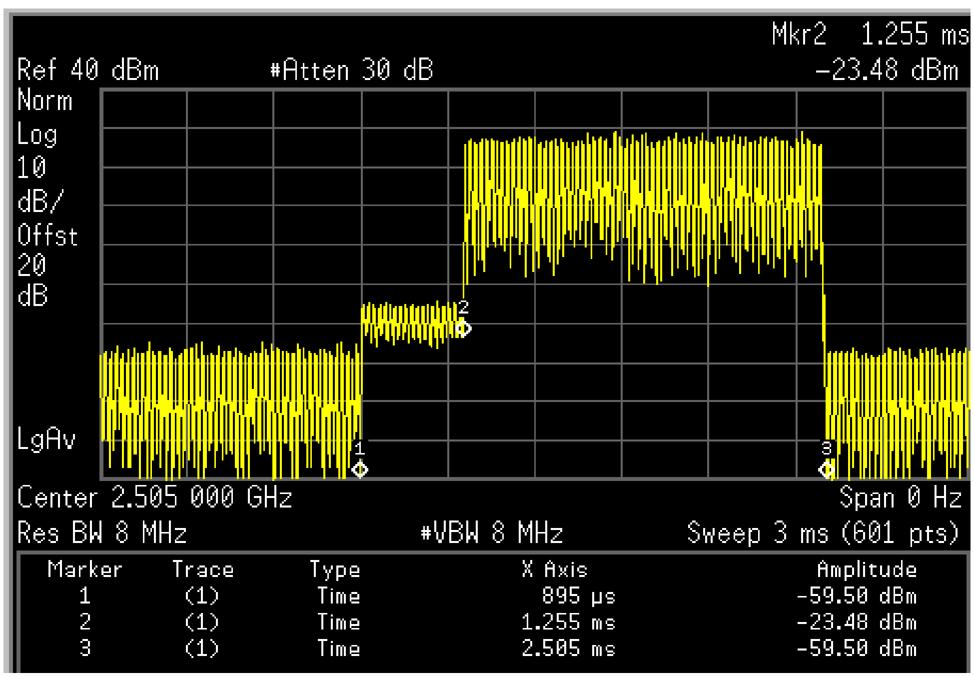


31U15 waveform (16QAM 3/4, duty cycle : 24.69 %)

Plot 1



Plot 2

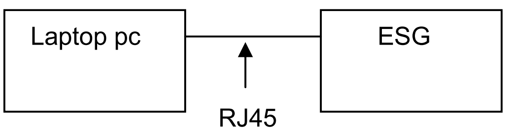


Signal Generator Details

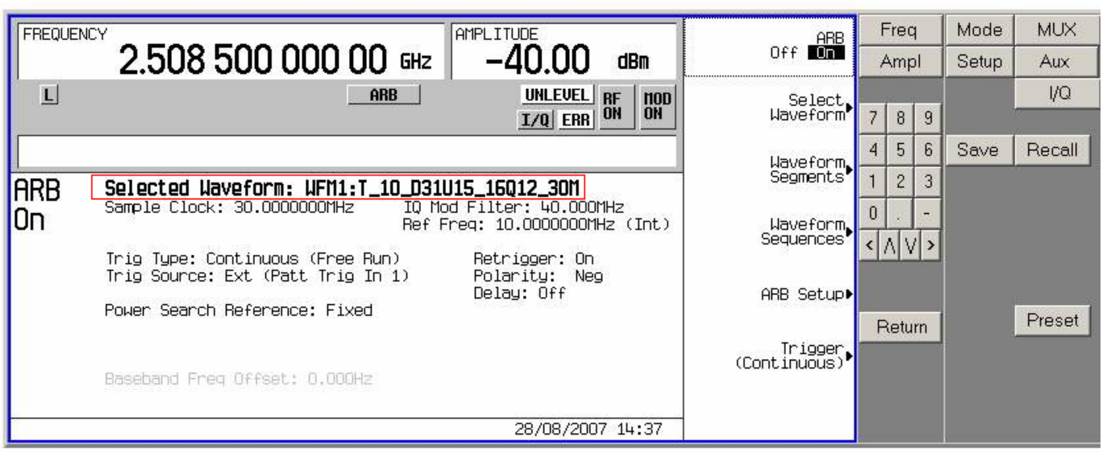
A vector signal generator is used in conjunction with manufacturer supplied chipset test software to configure the test device for the SAR evaluation. An Agilent E4438C vector signal generator (VSG) is loaded with the downlink signal, containing the respective FCH, DL-MAP and UL-MAP required by the test device to configure the uplink transmission.

ESG setup

1) Load test waveform (31U15) to ESG.



2) Select test waveform



3) Meaning of symbol

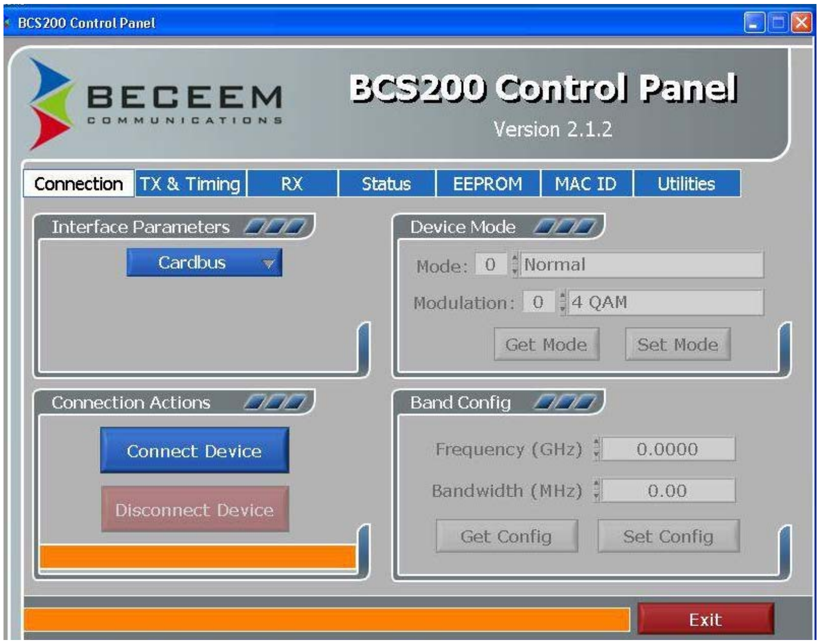
T:	Transmit
10:	Bandwidth 10MHz
D31U15:	Downlink 31 symbols, uplink 15 symbols
16Q12:	16Q: Modulation type, 12: coding rate
30M:	sample clock

Test Software Details

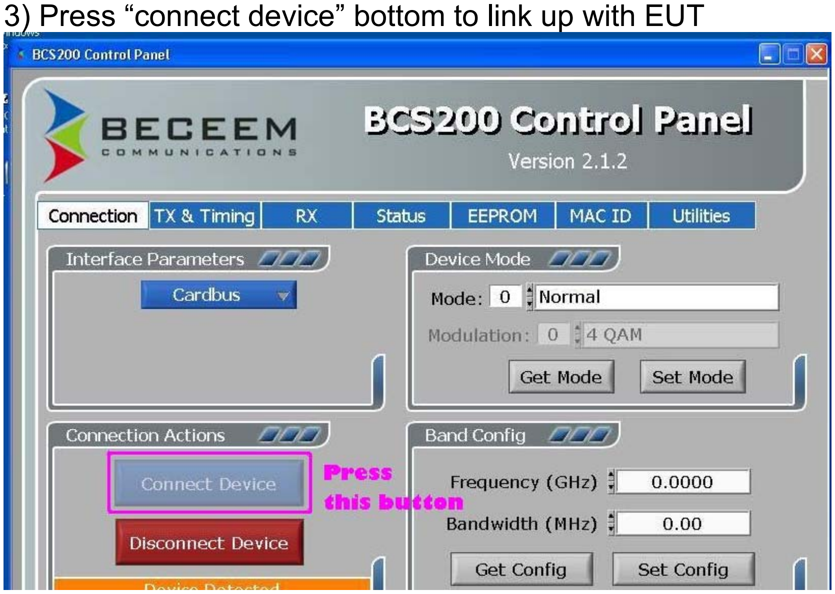
The test software is installed on a host laptop computer to configure the test device, a PC card, to transmit at maximum output power.

Software setup

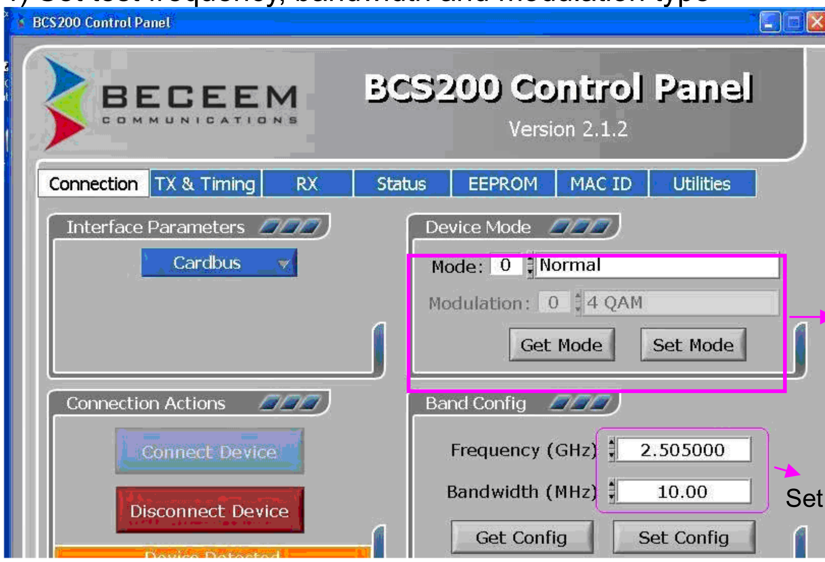
1) Connect EUT to laptop pc
2) Run BCS200 control panel test tool.



3) Press "connect device" bottom to link up with EUT



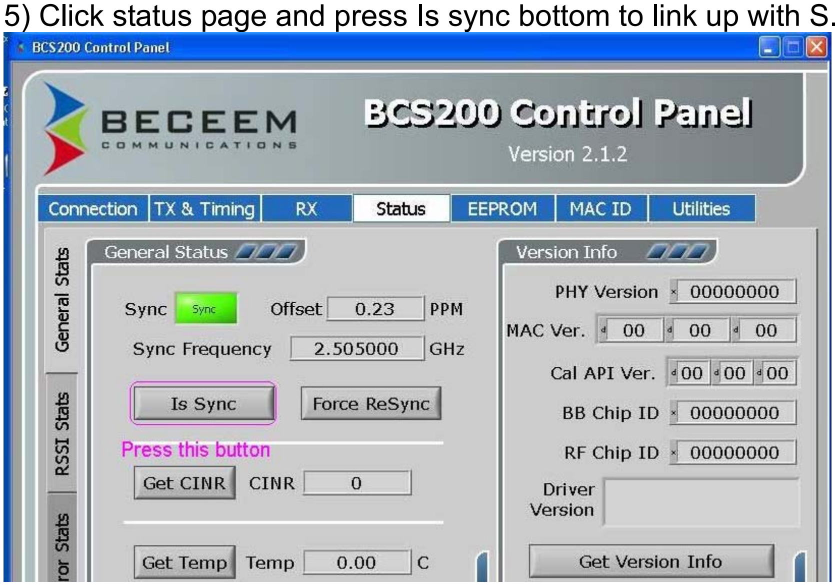
4) Set test frequency, bandwidth and modulation type



Set modulation type

Set frequency and bandwidth

5) Click status page and press Is sync bottom to link up with S.G



6) Set output power level

7) Press setx1 power to transmit continuously.

This test tool is provided by client.
It can control power setting of EUT only.
If other parameters need to be changed, executing step 4 is not enough, re-setting of S.G and re-Link up again between MS and S.G is required for the correct result.

4.5. SUMMARY OF TEST RESULTS

Due to the limitation of test software, the SAR test was originally performed at 31,15 (15 uplink symbols per frame with 12 data symbols) and later discovered that the product is capable of working up to 29,18 (18 uplink symbols per frame with 15 data symbols). Therefore a conservative SAR scaling up is required for converting measured SAR value to desired symbols per frame. Below is a detail description of how such scaling factors are derived. These scaling factors are identical for QPSK channels and for 16QAM modulation.

For a 5MHz channel

Maximum power seen in the control symbols. For SAR testing the worst case occurs when the data symbols are at max power 22.28dBm. Under this scenario the worst case TX power for the control channel symbols is as follows:

The first 3 symbols have a total of 17 slots in a 5 MHz channel. The maximum number of slots that an active device can occupy in any frame is:

(A) 2 slots for CQICH report – maximum of 2 simultaneous CQICH reports are allowed by the Standard from any MS

(B) 3 slots for HARQ ACK/NAK (5 ACK/NAK bits corresponding to maximum of 5 DL HARQ bursts in previous DL frame allowed by the standard – each HARQ ACK/NAK bit is transmitted using 1/2 slot)

These 5 slots occupy 5/17 of the total number of available UL slots.

The control channels using 5/17 the total number of slots transmitting at the maximum power should use 22.28 dBm – 10log(17/5) = (22.28 – 5.31) dBm = 16.97 dBm=49.72mW.

BW requests from the MS to the BS are piggy-backed on the data symbols if the MS is transmitting in the frame.

For a 5 MHz channel using the maximum 49.72mW for each control symbol, and 169.04mW on the data symbols, the math for the scale factor is as follows:

Scale factor for 31:15 (12 data symbols used):

Scale Factor to include control channels
= (3*49.72+12*169.04)/(12*169.04) = 1.074 above tested value

Scale factor for 29:18 (15 data symbols are used):

Scale Factor to include control channels and 15 data symbols
= (3*49.72+15*169.04)/(12*169.04) = 1.324 above tested value

For a 10MHz channel

Maximum power seen in the control symbols. For SAR testing the worst case occurs when the data symbols are at max power 21.4dBm. *A slot is a sub-channel that has a time duration of three symbols.* Under this scenario the worst case TX power for the control channel symbols is as follows:

The first 3 symbols have a total of 35 slots in a 10 MHz channel bandwidth. The maximum number of slots that an active device can occupy in any frame is:

(C) 2 slots for CQICH report – maximum of 2 simultaneous CQICH reports are allowed by the Standard from any MS
(D) 3 slots for HARQ ACK/NAK (5 ACK/NAK bits corresponding to maximum of 5 DL HARQ bursts in previous DL frame allowed by the standard – each HARQ ACK/NAK bit is transmitted using 1/2 slot)

These 5 slots occupy 5/35 = 1/7 of the total number of available UL slots.

The control channels using 1/7th the total number of slots transmitting at the maximum power should use 21.4 dBm – 10log(7) = (21.4 – 8.45) dBm = 12.95 dBm=19.72mW.

BW requests from the MS to the BS are piggy-backed on the data symbols if the MS is transmitting in the frame.

For a 10 MHz channel bandwidth using the maximum 19.72mW for each control symbol, and 138.04mW on the data symbols, the math to compute the scale factor is as follows:

Scale factor for 31:15 (12 data symbols used):

Scale Factor to include control channels
= (3*19.72+12*138.04)/(12*138.04) = 1.036 above tested value

Scale factor for 29:18 (15 data symbols are used):

Scale Factor to include control channels and 15 data symbols
= (3*19.72+15*138.04)/(12*138.04) = 1.286 above tested value

Measured Data

MODULATION TYPE	QPSK		16QAM	
	MEASURED VALUE OF 1g SAR (W/kg)			
TEST MODE	**1**	**2**	**3**	**4**
BANDWIDTH	5MHz	5MHz	5MHz	5MHz
LOW CHANNEL	0.496	0.493	0.520	0.508
MID. CHANNEL	0.461	0.452	0.483	0.465
HIGH CHANNEL	0.359	0.347	0.362	0.361

NOTE: The worst value has been marked by boldface.

31:15

MODULATION TYPE	QPSK		16QAM	
	MEASURED VALUE OF 1g SAR (W/kg)			
TEST MODE	**1**	**2**	**3**	**4**
BANDWIDTH	5MHz	5MHz	5MHz	5MHz
SCALING FACTOR	1.074	1.074	1.074	1.074
LOW CHANNEL	0.533	0.529	0.558	0.546
MID. CHANNEL	0.495	0.485	0.519	0.499
HIGH CHANNEL	0.386	0.373	0.389	0.388

NOTE: The worst value has been marked by boldface.

29:18

MODULATION TYPE	QPSK		16QAM	
	MEASURED VALUE OF 1g SAR (W/kg)			
TEST MODE	**1**	**2**	**3**	**4**
BANDWIDTH	5MHz	5MHz	5MHz	5MHz
SCALING FACTOR	1.324	1.324	1.324	1.324
LOW CHANNEL	0.657	0.653	0.688	0.673
MID. CHANNEL	0.610	0.598	0.639	0.616
HIGH CHANNEL	0.475	0.459	0.479	0.478

NOTE: The worst value has been marked by boldface.

Measured Data

MODULATION TYPE	QPSK		16QAM	
	MEASURED VALUE OF 1g SAR (W/kg)			
TEST MODE	**5**	**6**	**7**	**8**
BANDWIDTH	10MHz	10MHz	10MHz	10MHz
LOW CHANNEL	0.546	0.532	**0.566**	0.521
MID. CHANNEL	0.454	0.447	0.470	0.463
HIGH CHANNEL	0.289	0.299	0.308	0.311

NOTE: The worst value has been marked by boldface.

31:15

MODULATION TYPE	QPSK		16QAM	
	MEASURED VALUE OF 1g SAR (W/kg)			
TEST MODE	**5**	**6**	**7**	**8**
BANDWIDTH	10MHz	10MHz	10MHz	10MHz
SCALING FACTOR	1.036	1.036	1.036	1.036
LOW CHANNEL	0.566	0.551	0.586	0.540
MID. CHANNEL	0.470	0.463	0.487	0.480
HIGH CHANNEL	0.299	0.310	0.319	0.322

NOTE: The worst value has been marked by boldface.

29:18

MODULATION TYPE	QPSK		16QAM	
	MEASURED VALUE OF 1g SAR (W/kg)			
TEST MODE	**5**	**6**	**7**	**8**
BANDWIDTH	10MHz	10MHz	10MHz	10MHz
SCALING FACTOR	1.286	1.286	1.286	1.286
LOW CHANNEL	0.702	0.684	**0.728**	0.670
MID. CHANNEL	0.584	0.575	0.604	0.595
HIGH CHANNEL	0.372	0.385	0.396	0.400

NOTE: The worst value has been marked by boldface.

Measured Data

MODULATION TYPE	QPSK		16QAM	
	MEASURED VALUE OF 1g SAR (W/kg)			
TEST MODE	9	10	11	12
BANDWIDTH	5MHz	5MHz	5MHz	5MHz
LOW CHANNEL	0.076	0.069	0.095	0.093
MID. CHANNEL	0.069	0.080	0.088	0.087
HIGH CHANNEL	0.065	0.074	0.080	0.076

NOTE: The worst value has been marked by boldface.

31:15

MODULATION TYPE	QPSK		16QAM	
	MEASURED VALUE OF 1g SAR (W/kg)			
TEST MODE	9	10	11	12
BANDWIDTH	5MHz	5MHz	5MHz	5MHz
SCALING FACTOR	1.074	1.074	1.074	1.074
LOW CHANNEL	0.082	0.074	0.102	0.100
MID. CHANNEL	0.074	0.086	0.095	0.093
HIGH CHANNEL	0.070	0.079	0.086	0.082

NOTE: The worst value has been marked by boldface.

29:18

MODULATION TYPE	QPSK		16QAM	
	MEASURED VALUE OF 1g SAR (W/kg)			
TEST MODE	9	10	11	12
BANDWIDTH	5MHz	5MHz	5MHz	5MHz
SCALING FACTOR	1.324	1.324	1.324	1.324
LOW CHANNEL	0.101	0.091	0.126	0.123
MID. CHANNEL	0.091	0.106	0.117	0.115
HIGH CHANNEL	0.086	0.098	0.106	0.101

NOTE: The worst value has been marked by boldface.

Measured Data

MODULATION TYPE	QPSK		16QAM	
	MEASURED VALUE OF 1g SAR (W/kg)			
TEST MODE	13	14	15	16
BANDWIDTH	10MHz	10MHz	10MHz	10MHz
LOW CHANNEL	0.091	0.093	0.097	0.065
MID. CHANNEL	0.083	0.085	0.083	0.061
HIGH CHANNEL	0.079	0.071	0.078	0.063

NOTE: The worst value has been marked by boldface.

31:15

MODULATION TYPE	QPSK		16QAM	
	MEASURED VALUE OF 1g SAR (W/kg)			
TEST MODE	13	14	15	16
BANDWIDTH	10MHz	10MHz	10MHz	10MHz
SCALING FACTOR	1.036	1.036	1.036	1.036
LOW CHANNEL	0.094	0.096	0.100	0.067
MID. CHANNEL	0.086	0.088	0.086	0.063
HIGH CHANNEL	0.082	0.074	0.081	0.065

NOTE: The worst value has been marked by boldface.

29:18

MODULATION TYPE	QPSK		16QAM	
	MEASURED VALUE OF 1g SAR (W/kg)			
TEST MODE	13	14	15	16
BANDWIDTH	10MHz	10MHz	10MHz	10MHz
SCALING FACTOR	1.286	1.286	1.286	1.286
LOW CHANNEL	0.117	0.120	0.125	0.084
MID. CHANNEL	0.107	0.109	0.107	0.078
HIGH CHANNEL	0.102	0.091	0.100	0.081

NOTE: The worst value has been marked by boldface.

Measured Data

MODULATION TYPE	QPSK		16QAM	
	MEASURED VALUE OF 1g SAR (W/kg)			
TEST MODE	**17**	**18**	**19**	**20**
BANDWIDTH	5MHz	5MHz	5MHz	5MHz
LOW CHANNEL	0.122	0.088	0.115	0.090
MID. CHANNEL	0.090	0.082	0.078	0.083
HIGH CHANNEL	0.053	0.054	0.066	0.056

NOTE: The worst value has been marked by boldface.

31:15

MODULATION TYPE	QPSK		16QAM	
	MEASURED VALUE OF 1g SAR (W/kg)			
TEST MODE	**17**	**18**	**19**	**20**
BANDWIDTH	5MHz	5MHz	5MHz	5MHz
SCALING FACTOR	1.074	1.074	1.074	1.074
LOW CHANNEL	0.131	0.095	0.124	0.097
MID. CHANNEL	0.097	0.088	0.084	0.089
HIGH CHANNEL	0.057	0.058	0.071	0.060

NOTE: The worst value has been marked by boldface.

29:18

MODULATION TYPE	QPSK		16QAM	
	MEASURED VALUE OF 1g SAR (W/kg)			
TEST MODE	**17**	**18**	**19**	**20**
BANDWIDTH	5MHz	5MHz	5MHz	5MHz
SCALING FACTOR	1.324	1.324	1.324	1.324
LOW CHANNEL	0.162	0.117	0.152	0.119
MID. CHANNEL	0.119	0.109	0.103	0.110
HIGH CHANNEL	0.070	0.071	0.087	0.074

NOTE: The worst value has been marked by boldface.

Measured Data

MODULATION TYPE	QPSK		16QAM	
	MEASURED VALUE OF 1g SAR (W/kg)			
TEST MODE	**21**	**22**	**23**	**24**
BANDWIDTH	10MHz	10MHz	10MHz	10MHz
LOW CHANNEL	0.129	0.126	0.140	0.135
MID. CHANNEL	0.079	0.085	0.078	0.077
HIGH CHANNEL	0.060	0.056	0.056	0.057

NOTE: The worst value has been marked by boldface.

31:15

MODULATION TYPE	QPSK		16QAM	
	MEASURED VALUE OF 1g SAR (W/kg)			
TEST MODE	**21**	**22**	**23**	**24**
BANDWIDTH	10MHz	10MHz	10MHz	10MHz
SCALING FACTOR	1.036	1.036	1.036	1.036
LOW CHANNEL	0.134	0.131	0.145	0.140
MID. CHANNEL	0.082	0.088	0.081	0.080
HIGH CHANNEL	0.062	0.058	0.058	0.059

NOTE: The worst value has been marked by boldface.

29:18

MODULATION TYPE	QPSK		16QAM	
	MEASURED VALUE OF 1g SAR (W/kg)			
TEST MODE	**21**	**22**	**23**	**24**
BANDWIDTH	10MHz	10MHz	10MHz	10MHz
SCALING FACTOR	1.286	1.286	1.286	1.286
LOW CHANNEL	0.166	0.162	0.180	0.174
MID. CHANNEL	0.102	0.109	0.100	0.099
HIGH CHANNEL	0.077	0.072	0.072	0.073

NOTE: The worst value has been marked by boldface.

Enhanced Energy Coupling At Increased Separation Distances

Initial Position:

The probe tip is positioned at the peak SAR location of worst case configuration, low channel in test mode 7 of 10M BW, at a distance of one half the probe tip diameter from the phantom surface.

5mm Increments From Initial Position:

With the probe fixed at this location, the device is moved away from the phantom in 5 mm increments from the initial touching or minimum separation position. A single point SAR is measured for each of these device positions until the SAR is less than 50% of that measured at the initial position.

TEST POSITION	SAR VALUE (mW/g)
INITIAL POSITION	1.17
5mm INCREMENTS FROM INITIAL POSITION	0.387

Result: No Enhancement Energy Coupling observed.

5. TEST RESULTS

5.1 TEST PROCEDURES

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 DASY4 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%.

5.2 MEASURED SAR RESULTS

ENVIRONMENTAL CONDITION	Air Temperature：22.4°C, Liquid Temperature：21.2°C Humidity：61%RH					
TESTED BY	Sam Onn		**DATE**	Feb. 09, 2009		

FREQ. (MHz)	MODULATION Type	CONDUCTED POWER (W)		POWER DRIFT (%)	DEVICE TEST MODE	MEASURED 1g SAR (W/kg)
		BEGIN TEST	AFTER TEST			
2505 (Low)	**QPSK**	0.142	0.140	-1.41	1	0.496
2600 (Mid.)	**QPSK**	0.152	0.146	-3.95	1	0.461
2685 (High)	**QPSK**	0.169	0.164	-2.96	1	0.359
2505 (Low)	**QPSK**	0.140	0.135	-3.57	2	0.493
2600 (Mid.)	**QPSK**	0.150	0.147	-2.00	2	0.452
2685 (High)	**QPSK**	0.167	0.163	-2.40	2	0.347

NOTE:

1. Test configuration of each mode is described in section 4.3.
2. In this testing, the limit for General Population Spatial Peak averaged over 1g, **1.6 W/kg**, is applied.
3. Please see the Appendix A for the data.
4. The variation of the EUT conducted power measured before and after SAR testing should not over 5%.

ENVIRONMENTAL CONDITION	Air Temperature：22.4°C, Liquid Temperature：21.2°C Humidity：61%RH						
TESTED BY	Sam Onn			DATE		Feb. 09, 2009	
FREQ. (MHz)	MODULATION Type	CONDUCTED POWER (W)		POWER DRIFT (%)	DEVICE TEST MODE	MEASURED 1g SAR (W/kg)	
		BEGIN TEST	AFTER TEST				
2505 (Low)	16QAM	0.141	0.136	-3.55	3	0.520	
2600 (Mid.)	16QAM	0.150	0.147	-2.00	3	0.483	
2685 (High)	16QAM	0.166	0.164	-1.20	3	0.362	
2505 (Low)	16QAM	0.138	0.136	-1.45	4	0.508	
2600 (Mid.)	16QAM	0.187	0.182	-2.67	4	0.465	
2685 (High)	16QAM	0.165	0.161	-2.42	4	0.361	

NOTE:

1. Test configuration of each mode is described in section 4.3.
2. In this testing, the limit for General Population Spatial Peak averaged over 1g, **1.6 W/kg**, is applied.
3. Please see the Appendix A for the data.
4. The variation of the EUT conducted power measured before and after SAR testing should not over 5%.

ENVIRONMENTAL CONDITION	Air Temperature：22.4°C, Liquid Temperature：21.2°C Humidity：61%RH					
TESTED BY	Sam Onn			DATE	Feb. 09, 2009	

FREQ. (MHz)	MODULATION Type	CONDUCTED POWER (W)		POWER DRIFT (%)	DEVICE TEST MODE	MEASURED 1g SAR (W/kg)
		BEGIN TEST	AFTER TEST			
2505 (Low)	**QPSK**	0.138	0.136	-1.45	5	0.546
2600 (Mid.)	**QPSK**	0.122	0.116	-4.92	5	0.454
2685 (High)	**QPSK**	0.127	0.122	-3.94	5	0.289
2505 (Low)	**QPSK**	0.136	0.131	-3.68	6	0.532
2600 (Mid.)	**QPSK**	0.121	0.118	-2.48	6	0.447
2685 (High)	**QPSK**	0.126	0.122	-3.17	6	0.299

NOTE:

1. Test configuration of each mode is described in section 4.3.
2. In this testing, the limit for General Population Spatial Peak averaged over 1g, **1.6 W/kg**, is applied.
3. Please see the Appendix A for the data.
4. The variation of the EUT conducted power measured before and after SAR testing should not over 5%.

ENVIRONMENTAL CONDITION	Air Temperature：22.4°C, Liquid Temperature：21.2°C Humidity：61%RH		
TESTED BY	Sam Onn	**DATE**	Feb. 09, 2009

FREQ. (MHz)	MODULATION Type	CONDUCTED POWER (W)		POWER DRIFT (%)	DEVICE TEST MODE	MEASURED 1g SAR (W/kg)
		BEGIN TEST	AFTER TEST			
2505 (Low)	**16QAM**	0.135	0.130	-3.70	7	**0.566**
2600 (Mid.)	**16QAM**	0.119	0.116	-2.52	7	0.470
2685 (High)	**16QAM**	0.125	0.123	-1.60	7	0.308
2505 (Low)	**16QAM**	0.134	0.132	-1.49	8	0.521
2600 (Mid.)	**16QAM**	0.119	0.116	-2.52	8	0.463
2685 (High)	**16QAM**	0.124	0.122	-1.61	8	0.311

NOTE:

1. Test configuration of each mode is described in section 4.3.
2. In this testing, the limit for General Population Spatial Peak averaged over 1g, **1.6 W/kg**, is applied.
3. Please see the Appendix A for the data.
4. The variation of the EUT conducted power measured before and after SAR testing should not over 5%.

ENVIRONMENTAL CONDITION	Air Temperature：22.4°C, Liquid Temperature：21.2°C Humidity：61%RH		
TESTED BY	Sam Onn	DATE	Feb. 09, 2009

FREQ. (MHz)	MODULATION Type	CONDUCTED POWER (W)		POWER DRIFT (%)	DEVICE TEST MODE	MEASURED 1g SAR (W/kg)
		BEGIN TEST	AFTER TEST			
2505 (Low)	**QPSK**	0.142	0.141	-0.70	9	0.076
2600 (Mid.)	**QPSK**	0.152	0.149	-1.97	9	0.069
2685 (High)	**QPSK**	0.169	0.166	-1.78	9	0.065
2505 (Low)	**QPSK**	0.140	0.136	-2.86	10	0.069
2600 (Mid.)	**QPSK**	0.150	0.146	-2.67	10	0.080
2685 (High)	**QPSK**	0.167	0.164	-1.80	10	0.074

NOTE:

1. Test configuration of each mode is described in section 4.3.
2. In this testing, the limit for General Population Spatial Peak averaged over 1g, **1.6 W/kg**, is applied.
3. Please see the Appendix A for the data.
4. The variation of the EUT conducted power measured before and after SAR testing should not over 5%.

ENVIRONMENTAL CONDITION	Air Temperature：22.4°C, Liquid Temperature：21.2°C Humidity：61%RH		
TESTED BY	Sam Onn	DATE	Feb. 09, 2009

FREQ. (MHz)	MODULATION Type	CONDUCTED POWER (W)		POWER DRIFT (%)	DEVICE TEST MODE	MEASURED 1g SAR (W/kg)
		BEGIN TEST	AFTER TEST			
2505 (Low)	**16QAM**	0.141	0.139	-1.42	11	0.095
2600 (Mid.)	**16QAM**	0.150	0.149	-0.67	11	0.088
2685 (High)	**16QAM**	0.166	0.163	-1.81	11	0.080
2505 (Low)	**16QAM**	0.138	0.135	-2.17	12	0.093
2600 (Mid.)	**16QAM**	0.187	0.185	-1.07	12	0.087
2685 (High)	**16QAM**	0.165	0.161	-2.42	12	0.076

NOTE:

1. Test configuration of each mode is described in section 4.3.
2. In this testing, the limit for General Population Spatial Peak averaged over 1g, **1.6 W/kg**, is applied.
3. Please see the Appendix A for the data.
4. The variation of the EUT conducted power measured before and after SAR testing should not over 5%.

ENVIRONMENTAL CONDITION	Air Temperature：22.4°C, Liquid Temperature：21.2°C Humidity：61%RH		
TESTED BY	Sam Onn	DATE	Feb. 09, 2009

FREQ. (MHz)	MODULATION Type	CONDUCTED POWER (W)		POWER DRIFT (%)	DEVICE TEST MODE	MEASURED 1g SAR (W/kg)
		BEGIN TEST	AFTER TEST			
2505 (Low)	QPSK	0.138	0.137	-0.72	13	0.091
2600 (Mid.)	QPSK	0.122	0.119	-2.46	13	0.083
2685 (High)	QPSK	0.127	0.124	-2.36	13	0.079
2505 (Low)	QPSK	0.136	0.134	-1.47	14	0.093
2600 (Mid.)	QPSK	0.121	0.118	-2.48	14	0.085
2685 (High)	QPSK	0.126	0.124	-1.59	14	0.071

NOTE:

1. Test configuration of each mode is described in section 4.3.
2. In this testing, the limit for General Population Spatial Peak averaged over 1g, **1.6 W/kg**, is applied.
3. Please see the Appendix A for the data.
4. The variation of the EUT conducted power measured before and after SAR testing should not over 5%.

ENVIRONMENTAL CONDITION	Air Temperature：22.4°C, Liquid Temperature：21.2°C Humidity：61%RH		
TESTED BY	Sam Onn	DATE	Feb. 09, 2009

FREQ. (MHz)	MODULATION Type	CONDUCTED POWER (W)		POWER DRIFT (%)	DEVICE TEST MODE	MEASURED 1g SAR (W/kg)
		BEGIN TEST	AFTER TEST			
2505 (Low)	**16QAM**	0.135	0.133	-0.72	15	0.097
2600 (Mid.)	**16QAM**	0.119	0.116	-0.82	15	0.083
2685 (High)	**16QAM**	0.125	0.122	-1.57	15	0.078
2505 (Low)	**16QAM**	0.134	0.131	-2.24	16	0.065
2600 (Mid.)	**16QAM**	0.119	0.117	-1.68	16	0.061
2685 (High)	**16QAM**	0.124	0.122	-1.61	16	0.063

NOTE:

1. Test configuration of each mode is described in section 4.3.
2. In this testing, the limit for General Population Spatial Peak averaged over 1g, **1.6 W/kg**, is applied.
3. Please see the Appendix A for the data.
4. The variation of the EUT conducted power measured before and after SAR testing should not over 5%.

ENVIRONMENTAL CONDITION	Air Temperature：22.8°C, Liquid Temperature：21.9°C Humidity：58%RH		
TESTED BY	Sam Onn	DATE	Feb. 10, 2009

FREQ. (MHz)	MODULATION Type	CONDUCTED POWER (W)		POWER DRIFT (%)	DEVICE TEST MODE	MEASURED 1g SAR (W/kg)
		BEGIN TEST	AFTER TEST			
2505 (Low)	QPSK	0.142	0.140	-1.41	17	0.122
2600 (Mid.)	QPSK	0.152	0.150	-1.32	17	0.090
2685 (High)	QPSK	0.169	0.167	-1.18	17	0.053
2505 (Low)	QPSK	0.140	0.137	-2.14	18	0.088
2600 (Mid.)	QPSK	0.150	0.149	-0.67	18	0.082
2685 (High)	QPSK	0.167	0.165	-1.20	18	0.054

NOTE:

1. Test configuration of each mode is described in section 4.3.
2. In this testing, the limit for General Population Spatial Peak averaged over 1g, **1.6 W/kg**, is applied.
3. Please see the Appendix A for the data.
4. The variation of the EUT conducted power measured before and after SAR testing should not over 5%.

ENVIRONMENTAL CONDITION	Air Temperature：22.8°C, Liquid Temperature：21.9°C Humidity：58%RH					
TESTED BY	Sam Onn		**DATE**	Feb. 10, 2009		

FREQ. (MHz)	MODULATION Type	CONDUCTED POWER (W)		POWER DRIFT (%)	DEVICE TEST MODE	MEASURED 1g SAR (W/kg)
		BEGIN TEST	AFTER TEST			
2505 (Low)	**16QAM**	0.141	0.139	-1.42	19	0.115
2600 (Mid.)	**16QAM**	0.150	0.147	-2.00	19	0.078
2685 (High)	**16QAM**	0.166	0.163	-1.81	19	0.066
2505 (Low)	**16QAM**	0.138	0.135	-2.17	20	0.090
2600 (Mid.)	**16QAM**	0.187	0.185	-1.07	20	0.083
2685 (High)	**16QAM**	0.165	0.161	-2.42	20	0.056

NOTE:

1. Test configuration of each mode is described in section 4.3.
2. In this testing, the limit for General Population Spatial Peak averaged over 1g, **1.6 W/kg**, is applied.
3. Please see the Appendix A for the data.
4. The variation of the EUT conducted power measured before and after SAR testing should not over 5%.

ENVIRONMENTAL CONDITION	Air Temperature：22.8°C, Liquid Temperature：21.9°C Humidity：58%RH		
TESTED BY	Sam Onn	DATE	Feb. 10, 2009

FREQ. (MHz)	MODULATION Type	CONDUCTED POWER (W)		POWER DRIFT (%)	DEVICE TEST MODE	MEASURED 1g SAR (W/kg)
		BEGIN TEST	AFTER TEST			
2505 (Low)	**QPSK**	0.138	0.136	-1.45	21	0.129
2600 (Mid.)	**QPSK**	0.122	0.120	-1.64	21	0.079
2685 (High)	**QPSK**	0.127	0.124	-2.36	21	0.060
2505 (Low)	**QPSK**	0.136	0.133	-2.21	22	0.126
2600 (Mid.)	**QPSK**	0.121	0.120	-0.83	22	0.085
2685 (High)	**QPSK**	0.126	0.124	-1.59	22	0.056

NOTE:

1. Test configuration of each mode is described in section 4.3.
2. In this testing, the limit for General Population Spatial Peak averaged over 1g, **1.6 W/kg**, is applied.
3. Please see the Appendix A for the data.
4. The variation of the EUT conducted power measured before and after SAR testing should not over 5%.

ENVIRONMENTAL CONDITION	Air Temperature：22.8°C, Liquid Temperature：21.9°C Humidity：58%RH		
TESTED BY	Sam Onn	**DATE**	Feb. 10, 2009

FREQ. (MHz)	MODULATION Type	CONDUCTED POWER (W)		POWER DRIFT (%)	DEVICE TEST MODE	MEASURED 1g SAR (W/kg)
		BEGIN TEST	AFTER TEST			
2505 (Low)	**16QAM**	0.135	0.133	-1.48	23	0.140
2600 (Mid.)	**16QAM**	0.119	0.116	-2.52	23	0.078
2685 (High)	**16QAM**	0.125	0.122	-2.40	23	0.056
2505 (Low)	**16QAM**	0.134	0.131	-2.24	24	0.135
2600 (Mid.)	**16QAM**	0.119	0.117	-1.68	24	0.077
2685 (High)	**16QAM**	0.124	0.121	-2.42	24	0.057

NOTE:

1. Test configuration of each mode is described in section 4.3.
2. In this testing, the limit for General Population Spatial Peak averaged over 1g, **1.6 W/kg**, is applied.
3. Please see the Appendix A for the data.
4. The variation of the EUT conducted power measured before and after SAR testing should not over 5%.

5.3 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.

5.4 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
- **SUGAR-** Refined sugar in crystals, as available in food shops - to reduce relative permittivity
- **SALT-** Pure NaCl - to increase conductivity
- **CELLULOSE-** Hydroxyethyl-cellulose, medium viscosity (75-125mPa.s, 2% in water, 20_C),
  CAS # 54290 - to increase viscosity and to keep sugar in solution
- **PRESERVATIVE-** Preventol D-7 Bayer AG, D-51368 Leverkusen, CAS # 55965-84-9 - to prevent the spread of bacteria and molds
- **DGMBE-** Diethylenglycol-monobuthyl ether (DGMBE), Fluka Chemie GmbH, CAS # 112-34-5 - to reduce relative permittivity

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 $\sigma = \omega\, \varepsilon_0\, \varepsilon'' = \varepsilon''\, f\,[\mathrm{GHz}] / 18$.
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 DASY4 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 WIMAX BAND SIMULATING LIQUID

LIQUID TYPE		MSL-2600		
SIMULATING LIQUID TEMP.		21.2		
TEST DATE		Feb. 09, 2009		
TESTED BY		Sam Onn		
FREQ. (MHz)	**LIQUID PARAMETER**	**STANDARD VALUE**	**MEASUREMENT VALUE**	**ERROR PERCENTAGE (%)**
2505	Permitivity (ε)	52.6	53.6	1.90
2600		52.5	53.3	1.52
2685		52.4	53.0	1.15
2505	Conductivity (σ) S/m	2.03	2.08	2.46
2600		2.16	2.17	0.46
2685		2.28	2.26	0.88
Dielectric Parameters Required at 22℃		**f= 2600MHz** **ε= 52.5 ± 5%** **σ= 2.16 ± 5% S/m**		

LIQUID TYPE		MSL-2600		
SIMULATING LIQUID TEMP.		21.9		
TEST DATE		Feb. 10, 2009		
TESTED BY		Sam Onn		
FREQ. (MHz)	**LIQUID PARAMETER**	**STANDARD VALUE**	**MEASUREMENT VALUE**	**ERROR PERCENTAGE (%)**
2505	Permitivity (ε)	52.6	52.9	0.57
2600		52.5	52.6	0.19
2685		52.4	52.3	0.19
2505	Conductivity (σ) S/m	2.03	2.05	0.99
2600		2.16	2.14	0.93
2685		2.28	2.24	1.75
Dielectric Parameters Required at 22℃		**f= 2600MHz** **ε= 52.5 ± 5%** **σ= 2.16 ± 5% S/m**		

5.5 TEST EQUIPMENT FOR TISSUE PROPERTY

ITEM	NAME	BRAND	TYPE	SERIES NO.	DATE OF CALIBRATION	DUE DATE OF CALIBRATION
1	Network Analyzer	Agilent	E8358A	US41480538	Nov. 27, 2008	Nov. 26, 2009
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.

6. 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.

6.1 TEST EQUIPMENT

ITEM	NAME	BRAND	TYPE	SERIES NO.	DATE OF CALIBRATION	DUE DATE OF CALIBRATION
1	SAM Phantom	S & P	QD000 P40 CA	TP-1150	NA	NA
2	Signal Generator	Anritsu	68247B	984703	May 27, 2008	May 26, 2009
3	E-Field Probe	S & P	EX3DV3	3506	Sep. 30, 2008	Sep. 29, 2009
4	DAE	S & P	DAE	579	Mar. 13, 2008	Mar. 12, 2009
5	Robot Positioner	Staubli Unimation	NA	NA	NA	NA
6	Validation Dipole	S & P	D2600V2	1020	Jan. 15, 2009	Jan. 14, 2010

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

6.2 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. The difference between the optical surface detection and the actual surface depends on the probe and is specified with each probe. (It does not depend on the surface reflectivity or the probe angle to the surface within $\pm 30^{O}$.) However, varying breaking indices of different liquid compositions might also influence the distance. If the indicated difference varies from the actual setting, the probe parameter” optical surface.

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 DASY4 system is less than ±0.1mm.

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

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

6.3 VALIDATION RESULTS

SYSTEM VALIDATION TEST OF SIMULATING LIQUID					
FREQUENCY (MHz)	**REQUIRED SAR (mW/g)**	**MEASURED SAR (mW/g)**	**DEVIATION (%)**	**SEPARATION DISTANCE**	**TESTED DATE**
MSL2600	14.2 (1g)	13.5	-4.93	10mm	Feb. 09, 2009
MSL2600	14.2 (1g)	13.6	-4.23	10mm	Feb. 10, 2009
TESTED BY	Sam Onn				

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

6.4 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	4.70	Rectangular	$\sqrt{3}$	0.7	0.7	1.90	1.90	∞
Hemispherical Isotropy	9.60	Rectangular	$\sqrt{3}$	0.7	0.7	3.88	3.88	∞
Boundary effects	1.00	Rectangular	$\sqrt{3}$	1	1	0.58	0.58	∞
Linearity	4.70	Rectangular	$\sqrt{3}$	1	1	2.71	2.71	∞
System Detection Limits	1.00	Rectangular	$\sqrt{3}$	1	1	0.58	0.58	∞
Readout Electronics	0.30	Normal	1	1	1	0.30	0.30	∞
Response Time	0.80	Rectangular	$\sqrt{3}$	1	1	0.46	0.46	∞
Integration Time	2.60	Rectangular	$\sqrt{3}$	1	1	1.50	1.50	∞
RF Ambient Noise	3.00	Rectangular	$\sqrt{3}$	1	1	1.73	1.73	∞
RF Ambient Reflections	3.00	Rectangular	$\sqrt{3}$	1	1	1.73	1.73	∞
Probe Positioner	0.40	Rectangular	$\sqrt{3}$	1	1	0.23	0.23	∞
Probe Positioning	2.90	Rectangular	$\sqrt{3}$	1	1	1.67	1.67	∞
Max. SAR Eval.	1.00	Rectangular	$\sqrt{3}$	1	1	0.58	0.58	∞
Dipole Related								
Dipole Axis to Liquid Distance	2.00	Rectangular	$\sqrt{3}$	1	1	1.15	1.15	145
Input Power Drift	5.00	Rectangular	$\sqrt{3}$	1	1	2.89	2.89	∞
Phantom and Tissue parameters								
Phantom Uncertainty	4.00	Rectangular	$\sqrt{3}$	1	1	2.31	2.31	∞
Liquid Conductivity (target)	5.00	Rectangular	$\sqrt{3}$	0.64	0.43	1.85	1.24	∞
Liquid Conductivity (measurement)	3.18	Normal	1	0.64	0.43	2.04	1.37	∞
Liquid Permittivity (target)	5.00	Rectangular	$\sqrt{3}$	0.6	0.49	1.73	1.41	∞
Liquid Permittivity (measurement)	2.77	Normal	1	0.6	0.49	1.66	1.36	∞
Combined Standard Uncertainty						**9.85**	**9.54**	
Coverage Factor for 95%						**Kp=2**		
Expanded Uncertainty (K=2)						**19.70**	**19.07**	

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

7. MEASUREMENT SAR PROCEDURE UNCERTAINTIES

The assessment of spatial peak SAR of the hand handheld devices is according to IEEE 1528 / EN 62209-1. All testing situation shall be met below these requirements.

- The system is used by an experienced engineer who follows the manual and the guidelines taught during the training provided by SPEAG.
- The probe has been calibrated within the requested period and the stated uncertainty for the relevant frequency bands does not exceed 4.8% (k=1).
- The validation dipole has been calibrated within the requested period and the system performance check has been successful.
- The DAE unit has been calibrated within the within the requested period.
- The minimum distance between the probe sensor and inner phantom shell is selected to be between 4 and 5mm.
- The operational mode of the DUT is CW, CDMA, FDMA or TDMA (GSM, DCS, PCS, IS136 and PDC) and the measurement/integration time per point is >500 ms.
- The dielectric parameters of the liquid have been assessed using Agilent 85070D dielectric probe kit or a more accurate method.
- The dielectric parameters are within 5% of the target values.
- The DUT has been positioned as described in section 3.

7.1. PROBE CALIBRATION UNCERTAINTY

SPEAG conducts the probe calibration in compliance with international and national standards (e.g. IEEE 1528, EN 62209-1, IEC 62209, etc.) under ISO17025. The uncertainties are stated on the calibration certificate. For the most relevant frequency bands, these values do not exceed 4.8% (k=1). If evaluations of other bands are performed for which the uncertainty exceeds these values, the uncertainty tables given in the summary have to be revised accordingly.

7.2. ISOTROPY UNCERTAINTY

The axial isotropy tolerance accounts for probe rotation around its axis while the hemispherical isotropy error includes all probe orientations and field polarizations. These parameters are assessed by SPEAG during initial calibration. In 2001, SPEAG further tightened its quality controls and warrants that the maximal deviation from axial isotropy is ±0.20dB, while the maximum deviation of hemispherical isotropy is ±0.40dB, corresponding to ±4.7% and ±9.6%, respectively. A weighting factor of cp equal to 0.5 can be applied, since the axis of the probe deviates less than 30 degrees from the normal surface orientation.

7.3. BOUNDARY EFFECT UNCERTAINTY

The effect can be estimated according to the following error approximation formula

$$SAR_{tolerance}[\%] = SAR_{be}[\%] \times \frac{(d_{be} + d_{step})^2}{2d_{step}} \frac{e^{-\frac{d_{be}}{\delta/2}}}{\delta/2}$$

$$d_{be} + d_{step} < 10mm$$

The parameter d_{be} is the distance in mm between the surface and the closest measurement point used in the averaging process; d_{step} is the separation distance in mm between the first and second measurement points; δ is the minimum penetration depth in mm within the head tissue equivalent liquids (i.e., δ= 13.95mm at 3GHz); SAR_{be} is the deviation between the measured SAR value at the distance d_{be} from the boundary and the wave-guide analytical value SAR_{ref}.DASY4 applies a boundary effect compensation algorithm according to IEEE 1528, which is possible since the axis of the probe never deviates more than 30 degrees from the normal surface orientation. SAR_{be}[%] is assessed during the calibration process and SPEAG warrants that the uncertainty at distances larger than 4mm is always less than 1%.In summary, the worst case boundary effect SAR tolerance[%] for scanning distances larger than 4mm is < ± 0.8%.

7.4. PROBE LINEARITY UNCERTAINTY

Field probe linearity uncertainty includes errors from the assessment and compensation of the diode compression effects for CW and pulsed signals with known duty cycles. This error is assessed using the procedure described in IEEE 1528 / EN 62209-1. For SPEAG field probes, the measured difference between CW and pulsed signals, with pulse frequencies between 10Hz and 1kHz and duty cycles between 1 and 100, is < ±0.20dB (< ±4.7%).

7.5. READOUT ELECTRONICS UNCERTAINTY

All uncertainties related to the probe readout electronics (DAE unit), including the gain and linearity of the instrumentation amplifier, its loading effect on the probe, and accuracy of the signal conversion algorithm, have been assessed accordingly to IEEE 1528 / EN 62209-1.The combination (root-sum-square RSS method) of these components results in an overall maximum error of ±1.0%.

7.6. RESPONSE TIME UNCERTAINTY

The time response of the field probes is assessed by exposing the probe to a well-controlled electric field producing SAR larger than 2.0W/kg at the tissue medium surface. The signal response time is evaluated as the time required by the system to reach 90% of the expected final value after an on/of switch of the power source. Analytically, it can be expressed as:

$$SAR_{tolerance}[\%] = 100 \times \left(\frac{T_m}{T_m + \tau e^{-T_m/\tau} - \tau} - 1\right)$$

where Tm is 500 ms, i.e., the time between measurement samples, and τ the time constant. The response time τ of SPEAG's probes is <5ms. In the current implementation, DASY4 waits longer than 100 ms after having reached the grid point before starting a measurement, i.e., the response time uncertainty is negligible.

7.7. INTEGRATION TIME UNCERTAINTY

If the device under test does not emit a CW signal, the integration time applied to measure the electric field at a specific point may introduce additional uncertainties due to the discretization and can be assessed as follows

$$SAR_{tolerance}[\%] = 100 \times \sum_{allsub-frames} \frac{t_{frame}}{t_{integration}} \frac{slot_{idle}}{slot_{total}}$$

The tolerances for the different systems are given in Table 7.1, whereby the worst-case $SAR_{tolerance}$ is 2.6%.

System	$SAR_{tolerance}$ %
CW	0
CDMA*	0
WCDMA*	0
FDMA	0
IS-136	2.6
PDC	2.6
GSM/DCS/PCS	1.7
DECT	1.9
Worst-Case	2.6

TABLE 7.1

7.8. PROBE POSITIONER MECHANICAL TOLERANCE

The mechanical tolerance of the field probe positioner can introduce probe positioning uncertainties. The resulting SAR uncertainty is assessed by comparing the SAR obtained according to the specifications of the probe positioner with respect to the actual position defined by the geometric enter of the probe sensors. The tolerance is determined as:

$$SAR_{tolerance}[\%] = 100 \times \frac{d_{ph}}{\delta/2}$$

The specified repeatability of the RX robot family used in DASY4 systems is ±25μm. The absolute accuracy for short distance movements is better than ±0.1mm, i.e., the $SAR_{tolerance}$[%] is better than 1.5% (rectangular).

7.9. PROBE POSITIONING

The probe positioning procedures affect the tolerance of the separation distance between the probe tip and the phantom surface as:

$$SAR_{tolerance}[\%] = 100 \times \frac{d_{ph}}{\delta/2}$$

where d_{ph} is the maximum deviation of the distance between the probe tip and the phantom surface. The optical surface detection has a precision of better than 0.2mm, resulting in an $SAR_{tolerance}$[%] of <2.9% (rectangular distribution). Since the mechanical detection provides better accuracy, 2.9% is a worst-case figure for DASY4 system.

7.10. PHANTOM UNCERTAINTY

The SAR measurement uncertainty due to SPEAG phantom shell production tolerances has been evaluated using

$$SAR_{tolerance}[\%] \cong 100 \times \frac{2d}{a}, \qquad d << a$$

For a maximum deviation d of the inner and outer shell of the phantom from that specified in the CAD file of ±0.2mm, and a 10mm spacing a between source and tissue liquid, the calculated phantom uncertainty is ±4.0%.

7.11. DASY4 UNCERTAINTY BUDGET

Error Description	Tolerance (±%)	Probability Distribution	Divisor	(C_i)		Standard Uncertainty (±%)		(v_i)
				(1g)	(10g)	(1g)	(10g)	
Measurement Equipment								
Probe Calibration	5.50	Normal	1	1	1	5.50	5.50	∞
Axial Isotropy	4.70	Rectangular	$\sqrt{3}$	0.7	0.7	1.90	1.90	∞
Hemispherical Isotropy	9.60	Rectangular	$\sqrt{3}$	0.7	0.7	3.88	3.88	∞
Boundary effects	1.00	Rectangular	$\sqrt{3}$	1	1	0.58	0.58	∞
Linearity	4.70	Rectangular	$\sqrt{3}$	1	1	2.71	2.71	∞
System Detection Limits	1.00	Rectangular	$\sqrt{3}$	1	1	0.58	0.58	∞
Readout Electronics	0.30	Normal	1	1	1	0.30	0.30	∞
Response Time	0.80	Rectangular	$\sqrt{3}$	1	1	0.46	0.46	∞
Integration Time	2.60	Rectangular	$\sqrt{3}$	1	1	1.50	1.50	∞
RF Ambient Noise	3.00	Rectangular	$\sqrt{3}$	1	1	1.73	1.73	∞
RF Ambient Reflections	3.00	Rectangular	$\sqrt{3}$	1	1	1.73	1.73	∞
Probe Positioner	0.40	Rectangular	$\sqrt{3}$	1	1	0.23	0.23	∞
Probe Positioning	2.90	Rectangular	$\sqrt{3}$	1	1	1.67	1.67	∞
Max. SAR Eval.	1.00	Rectangular	$\sqrt{3}$	1	1	0.58	0.58	∞
Test Sample Related								
Device Positioning	0.69	Normal	1	1	1	0.69	0.69	10
Device Holder	3.60	Normal	1	1	1	3.60	3.60	5
Power Drift	5.00	Rectangular	$\sqrt{3}$	1	1	2.89	2.89	∞
Phantom and Tissue parameters								
Phantom Uncertainty	4.00	Rectangular	$\sqrt{3}$	1	1	2.31	2.31	∞
Liquid Conductivity (target)	5.00	Rectangular	$\sqrt{3}$	0.64	0.43	1.85	1.24	∞
Liquid Conductivity (measurement)	3.18	Normal	1	0.64	0.43	2.04	1.37	∞
Liquid Permittivity (target)	5.00	Rectangular	$\sqrt{3}$	0.6	0.49	1.73	1.41	∞
Liquid Permittivity (measurement)	2.77	Normal	1	0.6	0.49	1.66	1.36	∞
Combined Standard Uncertainty						**10.45**	**10.15**	
Coverage Factor for 95%						**kp=2**		
Expanded Uncertainty (K=2)						**20.89**	**20.30**	

TABLE 7.2

The table 7.2: Worst-Case uncertainty budget for DASY4 assessed according to IEEE 1528. The budget is valid for the frequency range 300MHz ~ 3GHz and represents a worst-case analysis. For specific tests and configurations, the uncertainty could be considerable smaller.

8. 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 by the following approval agencies according to ISO/IEC 17025.

USA	FCC, NVLAP
GERMANY	TUV Rheinland
JAPAN	VCCI
NORWAY	NEMKO
CANADA	INDUSTRY CANADA, CSA
R.O.C.	TAF, BSMI, NCC
NETHERLANDS	Telefication
SINGAPORE	GOST-ASIA (MOU)
RUSSIA	CERTIS (MOU)

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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