Information of 802.16e/WiMAX Permit-But-Ask Guidance for Non-TCBs

Table 1: 802.16e/WiMAX Device and System Operating Parameters

Description	Parameter	Comment
FCC ID	NM8QUAR100	Identify all related FCC ID
Radio Service	Part 27M	Rule parts
Transmit Frequency Range (MHz)	2501MHz-2685MHz	System parameter
System/Channel Bandwidth (MHz)	10MHz	System parameter
System Profile	3A-10	Defined by WiMAX Forum
Modulation Schemes	QPSK1/2, QPSK3/4 16QAM1/2, 16QAM3/4	Identify all applicable UL modulations
Sampling Factor	28/25	System parameter
Sampling Frequency (MHz)	11.2MHz	(Fs)
Sample Time (ns)	89ns	(1/Fs)
FFT Size (NFFT)	1024	(NFFT)
Sub-Carrier Spacing (kHz)	10.94KHz	(Δf)
Useful Symbol time (μs)	91.43us	(Tb=1/Δf)
Guard Time (μs)	11.43us	(Tg=Tb/cp); cp = cyclic prefix
OFDMA Symbol Time (μs)	102.857us	(Ts=Tb+Tg)
Frame Size (ms)	5ms	System parameter
TTG + RTG (μs or number of symbols)	165.8us	Idle time, system parameter
Number of DL OFDMA Symbols per Frame	Max:29, Min:35	Identify the allowed & maximum symbols, including both traffic & control symbols
Number of UL OFDMA Symbols per Frame	Max:18, Min:12	
DL:UL Symbol Ratio	Max 29:18 (UL duty factor: 18/47=38.3%) Min 35:12 (UL duty factor: 12/47=25.53%)	For determining UL duty factor
Power Class (dBm) Identify power	Power class 1 QPSK,16QAM: 20<= PTX,max <23	Identify power class and tolerance
Wave1 / Wave2	Wave2:Two antennas, Antenna 1(Main) is for	Describe antenna diversity info and MIMO

	Tx/Rx, Antenna 2(Aux.) is for Rx only	requirements separately
UL Zone Types (FUSC, PUSC, OFUSC, OPUSC, AMC, TUSC1, TUSC2)	PUSC only. UL AMC is not used in the current profile.	Describe separately the symbol and sub-carrier/sub-channel structures applicable to each zone type
Maximum Number of UL Sub-Carriers	Null Sub-carriers:184 Pilot Sub-carriers:280 Data Sub-carriers:560	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
UL Burst Maximum Average Power	10MHz/:21.36dBm	
Number and type of UL Control Symbols	Total: 10. 1 for preamble 6 for DL control overhead 3 for UL control overhead	
UL Control Symbol Maximum Average Power	10MHz BW: 28.57mW	
UL Burst Peak-to-Average Power Ratio (PAR)	With DL:UL ratio=29:18, PAR is between 8.53~9.09dB. With DL:UL ratio=35:12, PAR is between 7.95~8.39dB.	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 (%)	The duty cycle is 31.7%. Crest factor is 1/0.317=3.15 with 29:18 DL:UL ration.	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

802.16e/WiMAX

1. Product/ PBA Description

a. HTC QUAR100 (FCC ID: NM8QUAR100) is WiMAX/GSM/WiFi phone that operates in the 2.6 GHz for WiMAX, 1900 MHz PCS for GSM and 2.4 GHz for WiFi.

The phone is capable of delivering up to 4 Mbps UL/10 Mbps DL over WiMAX.

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

c. FCC Permit-But-Ask Category:

i. 1)b)iii) 802.16e Device and 1)b)vii) Test Procedure for SAR - devices for which an acceptable SAR test procedure has not been established.

d. WiMAX and GSM co-location conditions:

WiMAX will transmit with GSM simultaneously. The antenna separation between WiMAX and GSM antennas is 9 cm. The pre-test maximum SAR summations of WiMAX and GSM are 0.734 W/kg for head SAR and 0.622 W/kg for body SAR, which is smaller than 1.6 W/kg. Therefore, SAR volume scan is not required.

e. WiMAX and WiFi co-location conditions:

WiMAX and WiFi can not transmit at the same time by firmware control, which the end users can not enable the co-transmission.

2. WiMAX Zone Types

a. 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.

3. Duty Factor Considerations

a. HTC QUAR100 is only supplied to BRS/EBS WiMAX operators with agreements to transmit at a maximum DL/UL symbol ratio of 29:18. HTC QUAR100 is limited by firmware and the corresponding WiMAX system to operate at or below this

maximum duty factor. And the maximum duty cycle was used for SAR measurement and power measurement. The system can transmit up to 48 OFDMA symbols in each 5 ms frame, including 1.6 symbols for TTG and RTG. If all the 18 uplink symbols transmit at the maximum power, the duty factor is estimated to be 18/48 or 37.5%. However, the first three uplink symbols are reserved for control signals/channels, which are transmitted at reduced power; the condition for the SAR measurement is exactly the same in the normal operation, i.e. with 3 reduced control signals, because the EUT is connected to WiMAX base station emulator, which will make the EUT to transmit the reduced power of the control signals and transmit the maximum power of traffic signals during the SAR measurement and power measurement.

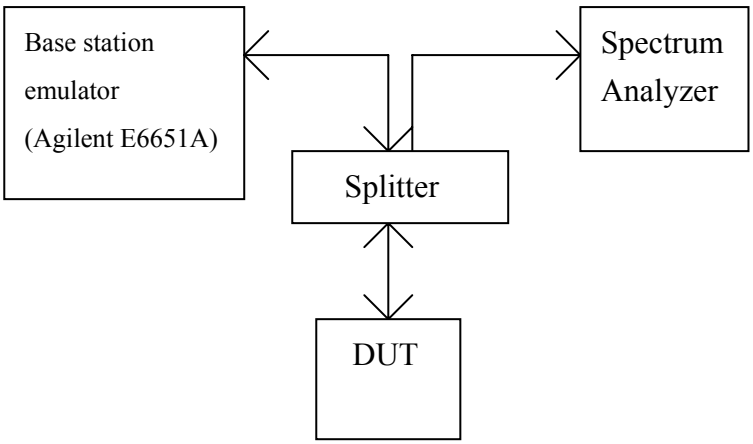
b. Duty Factor and Crest Factor: Since 3 control symbols powers were reduced in the SAR measurement, the duty factor = ((28.57/200)x3x102.857+15x 102.857us)/5000us=0.317, assuming the control signal power=28.57mW and the traffic signal power=200 mW. Crest Factor = 1/(duty factor)=3.15 for this periodic pulse signal device.

BW	DL/UL symbols	UL duty cycle	Crest factor	UL modulation	DL modulation
10MHz	29/18	31.7%	3.15	QPSK-1/2	64QAM-5/6
10MHz	29/18	31.7%	3.15	16QAM-3/4	QPSK-1/2

4. Test Method

a. The test software, and the vector signal generator are not required for this product since all the test for SAR measurement and power measurement are conducted through the WiMAX base station emulator (BSE), Agilent E6651A. By using the BSE to connect the phone, BSE will make the WiMAX phone to transmit at modulation type of DL:UL =29:18 ratio and to transmit the traffic signal at the maximum power during the SAR testing and power measurement.

b. Connection diagram:



c. Communication Test Set Details

Modulation and channel bandwidth is controlled by the BSE, the test set details are listed bellow.

Bandwidth	10MHz	10MHz	10MHz	10MHz	
FFT size	1024	1024	1024	1024	
DL/UL ratio	29:18	29:18	29:18	29:18	
Down link					
Zone profiles	PUSC	PUSC	PUSC	PUSC	
MCS	64QAM-4/5	QPSK-1/2	64QAM-4/5	QPSK-1/2	
Up link					
MCS	PUSC	PUSC	PUSC	PUSC	
Up link	QPSK-1/2	16QAM-3/4	QPSK-3/4	16QAM-1/2	

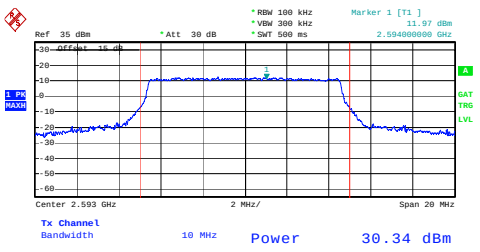
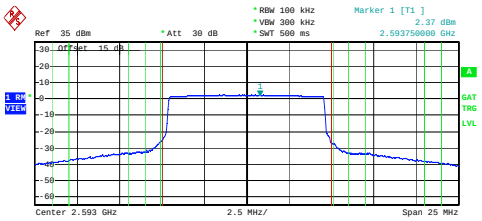
5. Power Measurement

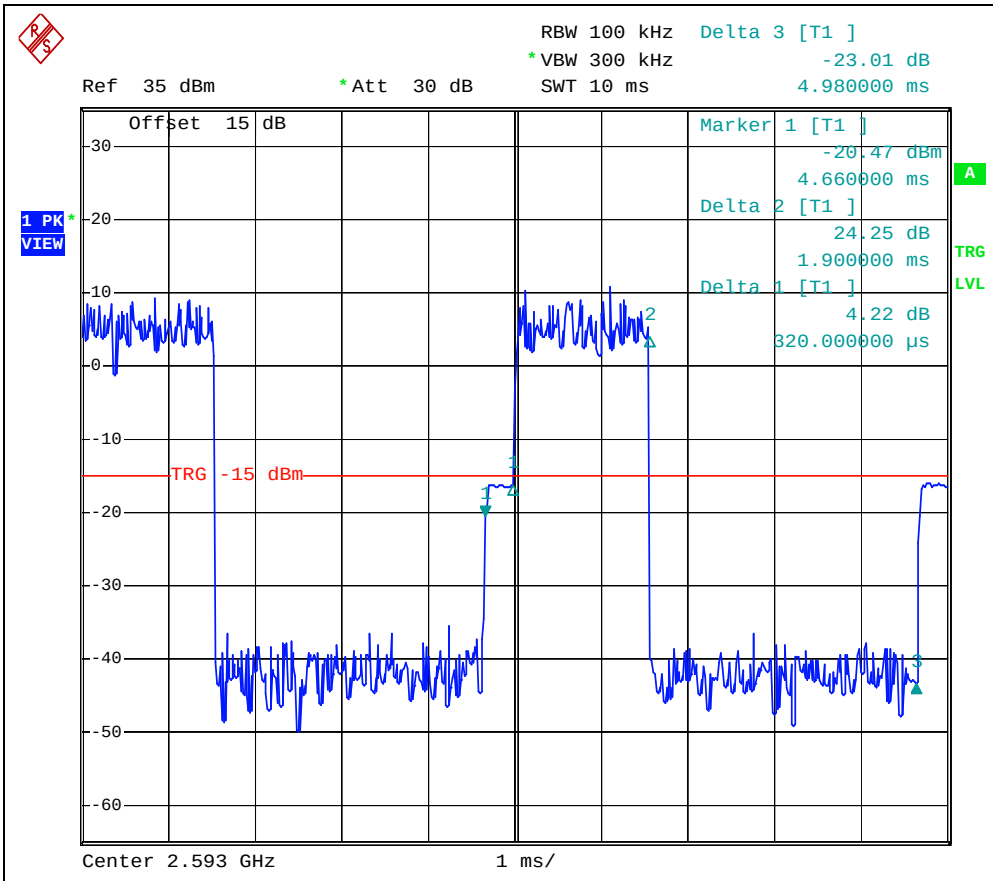
The maximum average conducted output power is measured for the uplink burst at DL:UL ratio=29:18. Conducted average output power were measured with the phone connected to the BSE and spectrum analyzer through power splitter. During SAR evaluation, the phone is connected to the BSE on the air communication link. The average output power is measured for the uplink bursts through triggering and gating.

With Spectrum Analyzer with Gate-On, Channel Power. Measure with peak and average detector. DL:UL ratio of 29:18 for 10 MHz channel BW.

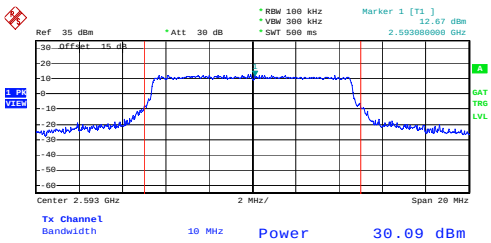
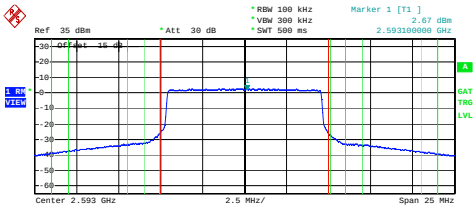
UL modulation	DL/UL symbols	Channel BW (MHz)	Channel number	Frequency (MHz)	Conducted Power (dBm)		Peak to Average ratio (dB)	UL duty cycle
					Peak	Average		
			0	2501	29.52	20.69	8.83	
			368	2593	30.34	21.25	9.09	
QPSK-1/2	29/18	10	736	2685	29.68	20.89	8.79	
			0	2501	29.26	20.73	8.53	
			368	2593	30.09	21.36	8.73	
16QAM-3/4	29/18	10	736	2685	29.72	21	8.72	31.7%

Note:
PSA with Channel Power function and Gate On
Peak power: RBW=100 kHz; VBW = 300 kHz with Peak detection, sweep time = 0.5s
Average power: RBW=100 kHz; VBW = 300 kHz with Avearge detection, sweep time = 0.5s

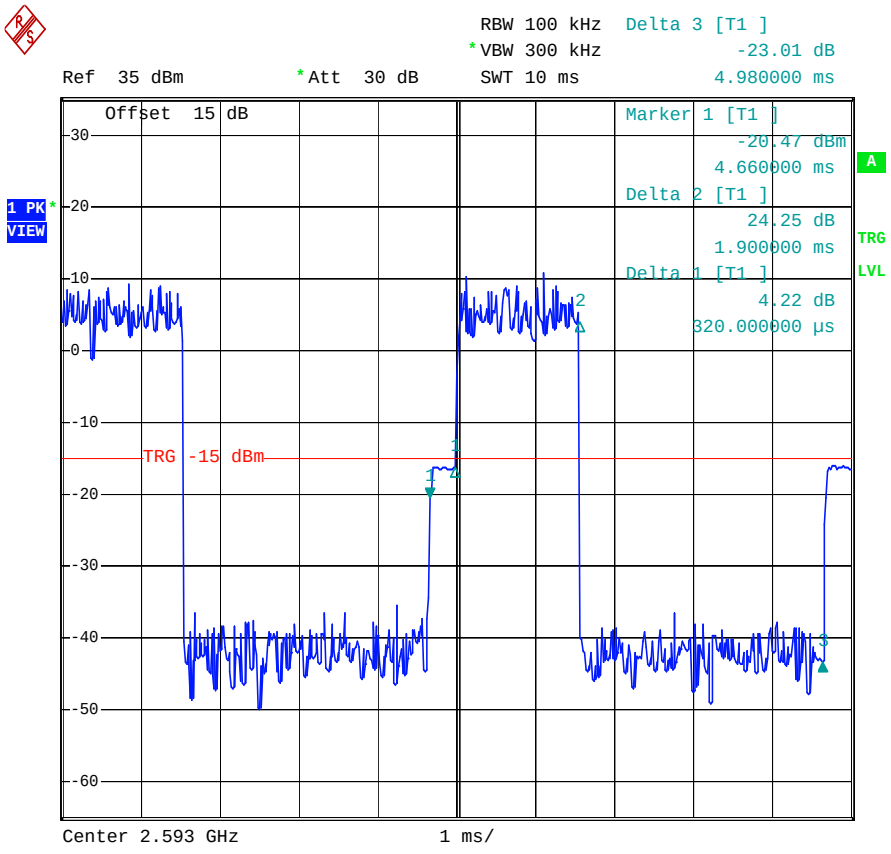
Spectrum plot for QPSK/10MHz@Central channel with DL:UL of 29:18 ratio	
Peak	Average
 Date: 18.FEB.2009 14:58:54	 Date: 18.FEB.2009 13:23:11
Duty cycle=1.9ms/4.98ms=38.15 %, considering the reduced power of control symbol, the Duty cycle=31.7%	



Date: 18.FEB.2009 08:48:43

Spectrum plot for 16QAM/10MHz@Central channel with DL:UL of 29:18 ratio	
Peak	Average
	
Tx Channel Bandwidth 10 MHz Power 30.09 dBm	Tx Channel Bandwidth 10 MHz Power 21.36 dBm Adjacent Channel Bandwidth 100 kHz Lower -26.36 dBm Spacing 5.05 MHz Upper -26.94 dBm Alternate Channel Bandwidth 1 MHz Lower -23.29 dBm Spacing 6.5 MHz Upper -23.71 dBm 2nd Alternate Channel Bandwidth 1 MHz Lower -28.72 dBm Spacing 11 MHz Upper -29.21 dBm
Date: 18.FEB.2009 16:00:24	Date: 18.FEB.2009 14:19:38
Duty cycle=1.9ms/4.98ms=38.15 %, considering the reduced power of control	

symbol, the Duty cycle=31.7%



6. SAR Measurement

a. according to KDB648474, WiFi and WiMAX can not transmit simultaneously by firmware control. The volume scan SAR for WiFi and WiMAX is not required.

b. according to KDB648474, the separation between WiMAX and GSM antennas is 9 cm, which is larger than 5 cm. The maximum head SAR summation and body SAR summation of GSM and WiMAX is below 1.6 W/kg. The volume scan SAR for WiMAX and GSM is not required.

c. Middle channel SAR of the WiMAX modulation at band width 10MHz, QPSK1/2, 16QAM3/4, for each position, head RC, RT, LC, LT, body keypad up, and body keypad down was pre-tested to look for the maximum SAR and SAR larger than 0.8 W/kg.

d. each position with SAR larger than 0.8 W/kg and the maximum SAR position were tested for low and high channels.

e. the SAR scaling is not required because the SAR testing was performed under normal operation with reduced control signal and with the maximum power of

traffic signal at UL;DL=29:18, which will be used for USA carriers.

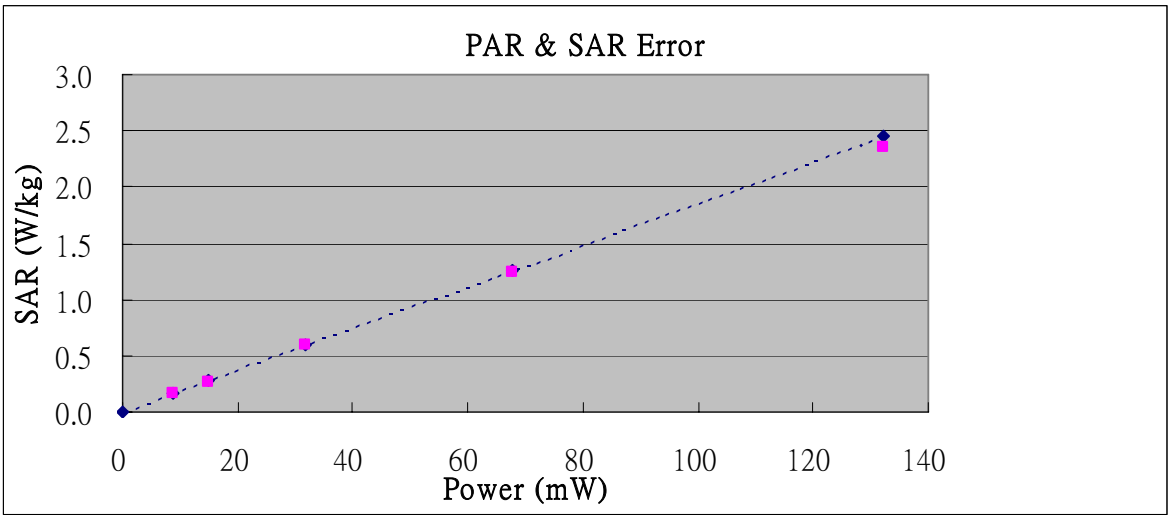
f. the maximum pre-test SAR of GSM and WiMAX is as below:

	GSM1900 (W/kg)	WiMAX 10M QPSK (W/kg)	WiMAX 10 M 16QAM (W/kg)	Summation (W/kg)
RC	**0.199**	**0.44**	**0.442**	**0.641**
RT	**0.099**	**0.631**	**0.635**	**0.734**
LC	**0.263**	**0.42**	**0.415**	**0.683**
LT	**0.092**	**0.448**	**0.452**	**0.544**
Keypad up with 1.5 cm air gap	**0.159**	**0.122**	**0.141**	**0.3**
Keypad up with 1.5 cm air gap	**0.28**	**0.301**	**0.342**	**0.622**

7. SAR Error Consideration

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

Average Power (mW)	132	68	32	15	9
Single point SAR (W/kg)	2.35	1.24	0.59	0.27	0.16



From the test data, the SAR probe can measure SAR correctly under high PAR of OFDM/OFDMA, and the pre-test SAR is not underestimated.