FCC CFR47 PART 90 SUBPART Z

Test Report

3.65 GHz Fixed Wireless Base Station Transceiver

Model Numbers: Quantum 6636, Quantum 2236

FCC ID: XN3-QUANTUM6636
IC: 8974A-QUANTUM6636

Report Number: 11PRO009

Issue Date: 15 November 2011

Prepared for
PureWave Networks Inc.
2660-C Marine Way
Mountain View, CA 94043

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Report Revision History

Revision No.	Description	Revised by	Date
-	Original issue	T.N. Cokenias	15 Nov 2011

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1. TEST AND TEST LOCATION INFORMATION

COMPANY NAME: PureWave Networks, Inc.
2660-C Marine Way
Mountain View, CA 94043

EUT DESCRIPTION: FCC Part 90Z Base Station
Frequency Range: 3650-3675MHz
WiMax 6x6 MIMO Configuration
Channel Bandwidths: 5 MHz, 10 MHz
Modulations: QPSK, 16QAM, 64QAM

FCC ID: XN3-QUANTUM6636
IC: 8974A-QUANTUM6636

MODEL: Quantum 6636 (6x6)
Quantum 2236 (2x2)

DATE TESTED: 26-29 September, 25October, 11 November 2011

Testing performed at:

PureWave Networks, Inc.
2660-C Marine Way
Mountain View, CA 94043

15 November 2011

T.N. Cokenias
Agent for PureWave Networks, Inc.

2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with EIA/TIA 603, FCC CFR 47 Part 2 and FCC CFR 47 Part 90Subpart Z.

3. EQUIPMENT UNDER TEST

3.1. DESCRIPTION OF EUT

The EUT is a WiMAX base station radio operating in the 3650-3675 MHz restricted contention-based protocol frequency band. Modulation is 802.16d/e in 5 MHz and 10 MHz channel bandwidths. The EUT is capable of operation in 2x2 MIMO and 6x6 MIMO modes. This report shows data taken on 6x6 MIMO configuration. A 2x2 MIMO configuration is also available, this configuration is identical to the 6x6 configuration but with only two of the chains populated. The maximum per chain output power of the 2x2 configuration is the same as that for the 6x6 configuration: 30 dBm setting for 5 MHz EBW channels and 33 dBm for 10 MHz EBW channels.

3.2. MAXIMUM OUTPUT POWER

5 MHz EBW		QPSK	16QAM	64QAM
	(MHz)	**(dBm)**	**(dBm)**	**(dBm)**
High	3697.5	33.44	33.4	33.4

10 MHz EBW		QPSK	16QAM	64QAM
	(MHz)	**(dBm)**	**(dBm)**	**(dBm)**
High	3695	35.5	35.3	35.4

3.3. ANTENNA SELECTION AND EIRP LIMITS

The licensee can select a variety of antenna types and gains from a variety of manufacturers in addition to PureWave Networks. It is the responsibility of the licensee to adjust transmitter output power such that the eirp limits specified in section 90.1321 (a) of the Rules are not exceeded:

90.1321(a) Base stations and fixed stations are limited to 25watts/25 MHz equivalent isotropic radiated power (EIRP). In any event the EIRP power density shall not exceed 1 watt in any on-megahertz slice of spectrum.

The antenna port output powers for this product are calculated based on the following typical installation parameters:

1. A minimum 6 dBi antenna for use with base stations,
2. 30m cable loss for TMC LMR-400 at 3.65 MHz = 8.3 dB
3. Effective antenna gain: 6 – 8.3 = -2.3 dBi

The PureWave installation manual provides the installer guidance on how to calculate the maximum input power to the antenna so as to remain within the regulatory EIRP limits.

3.4. SOFTWARE AND FIRMWARE

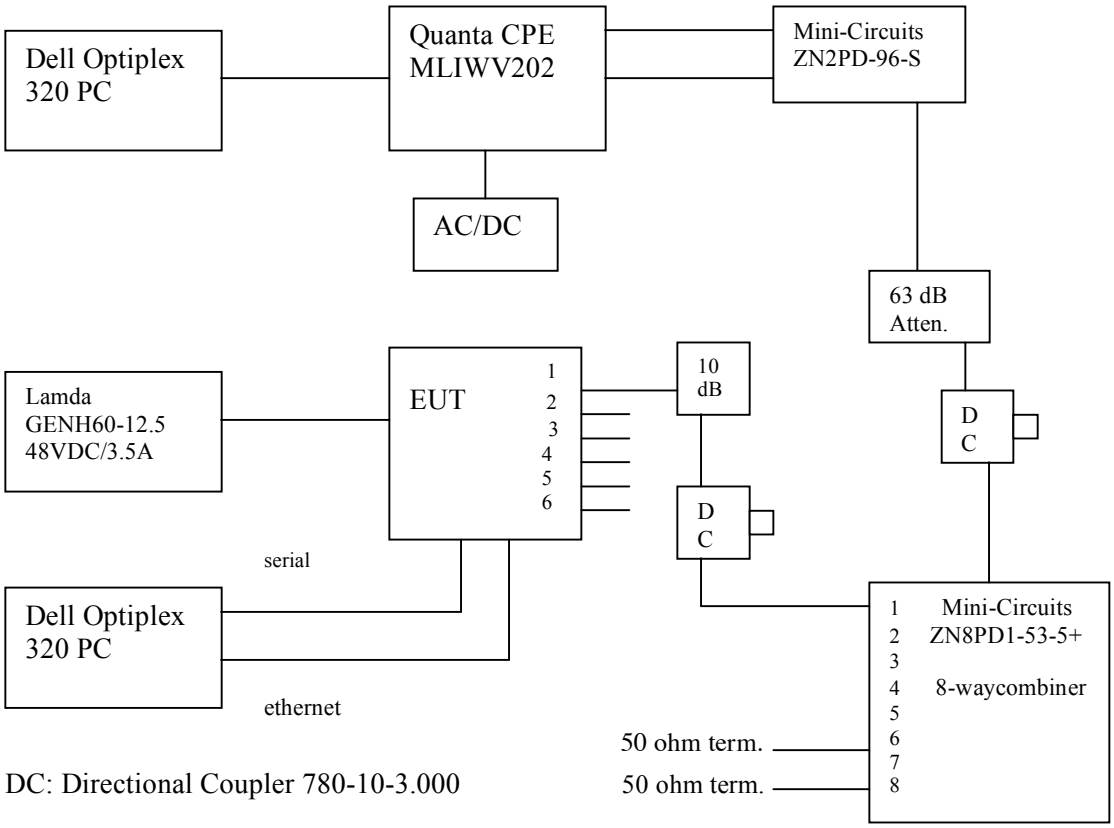
The software controlling the EUT during testing was PureWave OS v1.1.1.

3.5. WORST-CASE CONFIGURATION AND MODE

Radiated and conducted emissions tests were performed for both 5 MHz and 10 MHz emission bandwidth channels. Testing was performed for all available modulations: QPSK, 16QAM and 64QAM. Worst-case emissions for both emissions bandwidths are reported.

3.6. DESCRIPTION OF TEST SETUP

SETUP DIAGRAM FOR TESTS



DC: Directional Coupler 780-10-3.000

3.7 Modifications to EUT

None.

TEST AND MEASUREMENT EQUIPMENT

PureWave: Antenna Port Conducted Tests

Description	Manufacturer	Model	Asset/Serial Number	Cal Due
N9020A Signal Analyze	Agilent	N9020A	MY46472174	07/09/12

LIMITS AND RESULTS

3.7. ANTENNA PORT CHANNEL TESTS

3.7.1. -26 dB and 99%OCCUPIED BANDWIDTH

REQUIREMENT

2.1049 Measurements required: Occupied bandwidth.

The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission shall be measured.

TEST PROCEDURE

The transmitter output is connected to a spectrum analyzer. The RBW is set to 1% to 3% of the 99% bandwidth. The VBW is set to 3 times the RBW. The sweep time is coupled. The internal OCC BW function of the spectrum analyzer was activated to display both 99% BW and -26 dB BW values.

TEST RESULTS

For each EBW and modulation, occupied bandwidth was measured for each chain. The values obtained were very similar chain by chain, within 2% of each other. The same can be said for the different modulations – for a given EBW, the measured value changed very little from modulation to modulation or from chain to chain.

Spectrum analyzer plots for all chains and all modulations at 5 MHz EBW channel are presented below to document the fact that there are only small variations in value from chain to chain (B).

The second set of spectrum analyzer plots (C) show only the highest value single chain occupied bandwidth for each modulation at Low, Mid, and High channels. These values are summarized in the table below (A).

A. Occupied BW Summary

5MHz EBW QPSK

Channel	Frequency MHz	99% Occupied Bandwidth, MHz	-26 dB Bandwidth, MHz
High	3697.5	4.5714	4.792

5MHz EBW 16QAM

Channel	Frequency MHz	99% Occupied Bandwidth, MHz	-26 dB Bandwidth, MHz
High	3697.5	4.5693	4.791

5MHz EBW 64QAM

Channel	Frequency MHz	99% Occupied Bandwidth, MHz	-26 dB Bandwidth, MHz
High	3697.5	4.5738	4.768

10 MHz EBW QPSK

Channel	Frequency MHz	99% Occupied Bandwidth, MHz	-26 dB Bandwidth, MHz
High	3695	9.1249	9.503

10 MHz EBW 16QAM

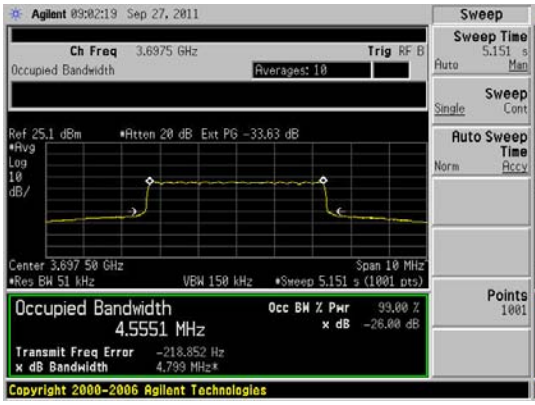
Channel	Frequency MHz	99% Occupied Bandwidth, MHz	-26 dB Bandwidth, MHz
High	3695	9.1242	9.505

10 MHz EBW 64QAM

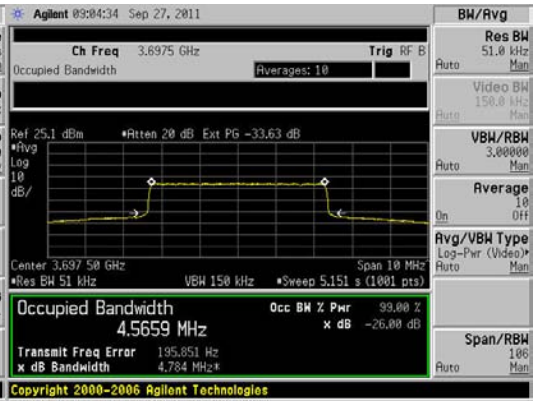
Channel	Frequency MHz	99% Occupied Bandwidth, MHz	-26 dB Bandwidth, MHz
High	3695	9.1245	9.509

B. Chains 1-6, 5 MHz EBW, QPSK

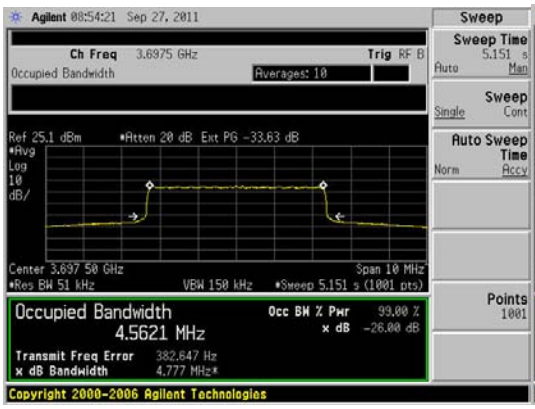
Chain 1



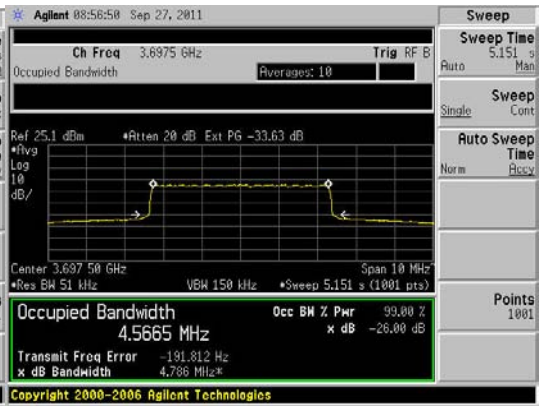
Chain 2



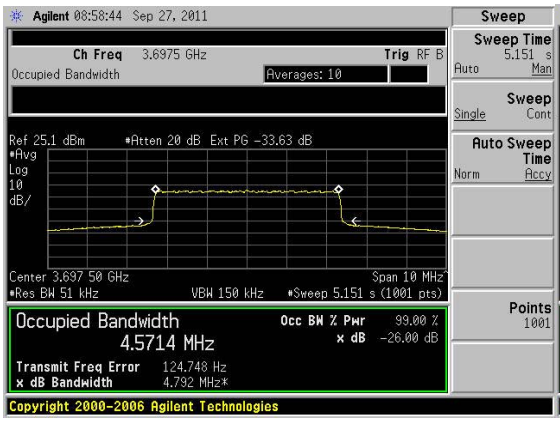
Chain 3



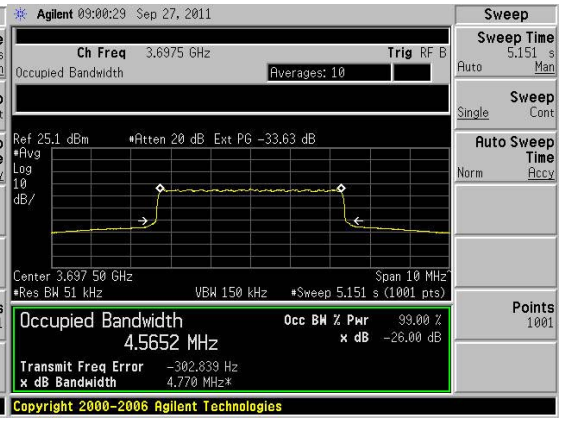
Chain 4



Chain 5



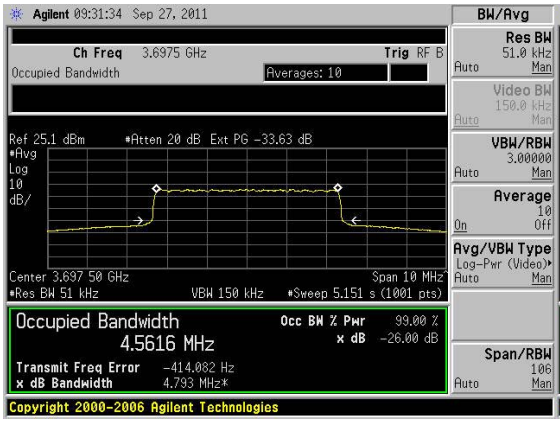
Chain 6



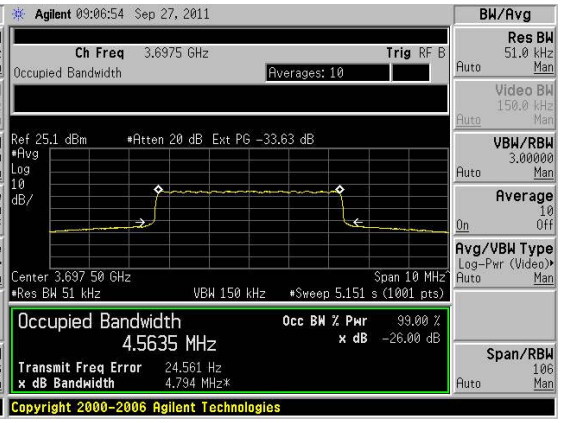
Highest Occ BW: 4.5714 MHz (Chain 5)

B. Chains 1-6, 5MHz EBW, 16QAM

Chain 1



Chain 2



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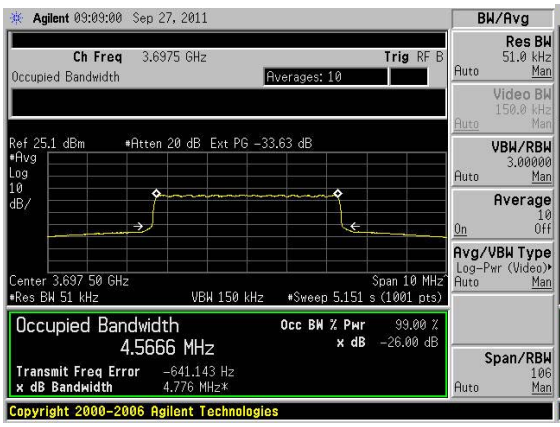
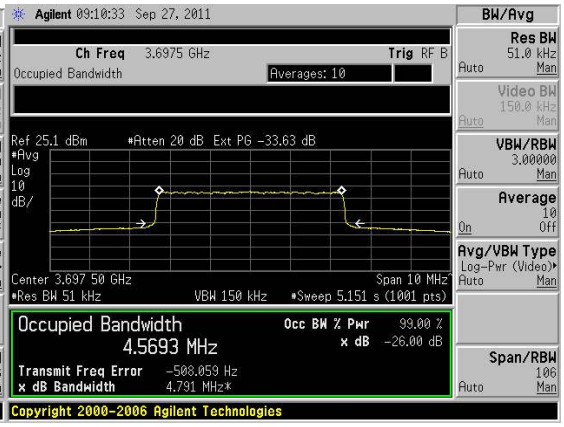
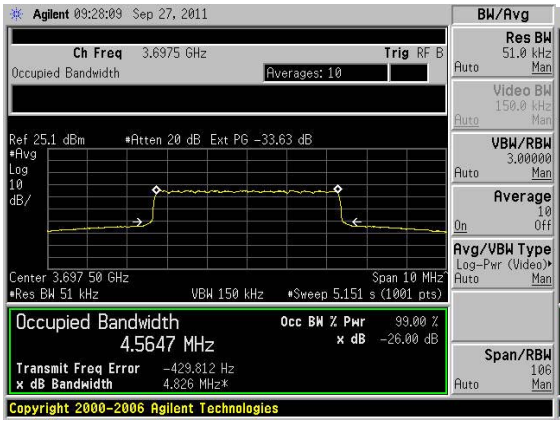


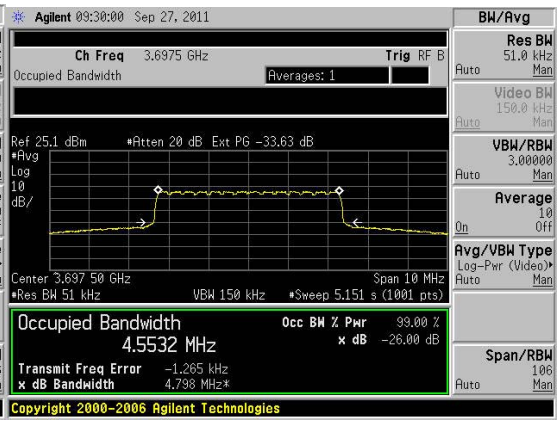
Chain 4



Chain 5



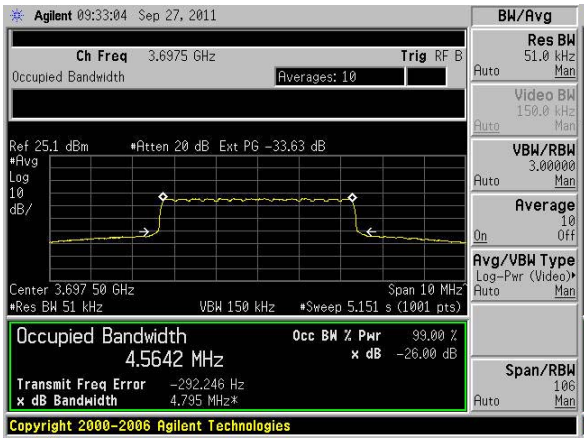
Chain 6



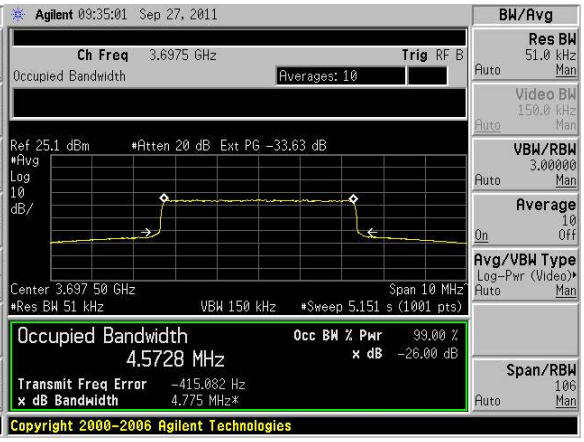
Highest Occ BW: 4.5693 MHz (Chain 4)

B. Chains 1-6, 5MHz EBW, High 64QAM

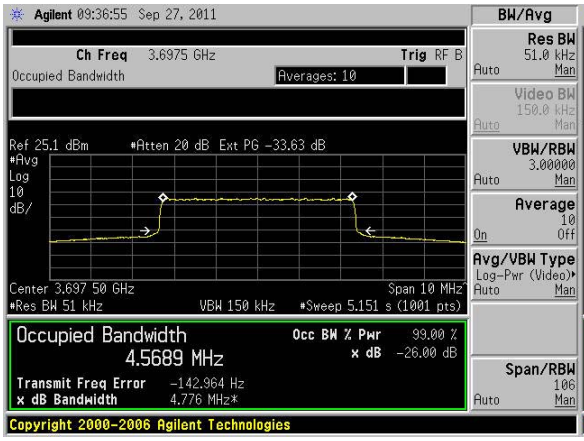
Chain 1



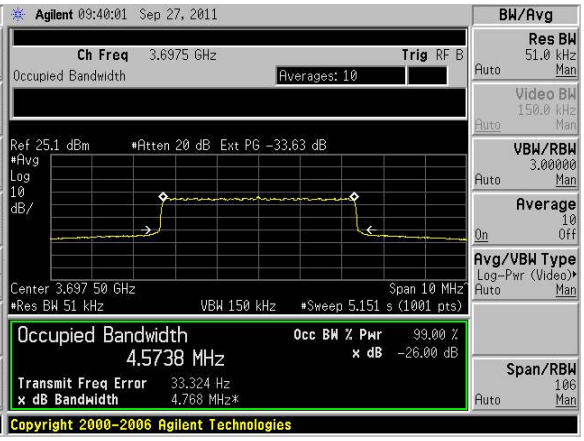
Chain 2



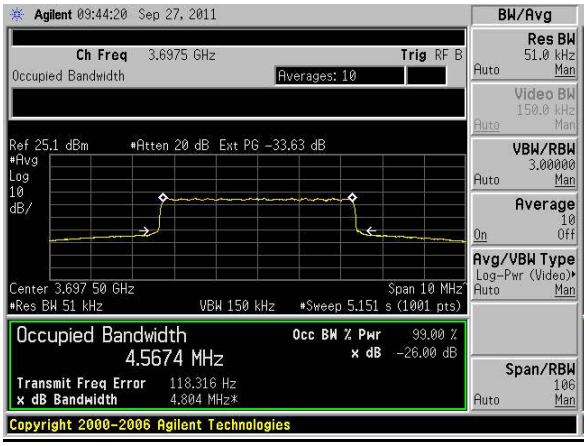
Chain 3



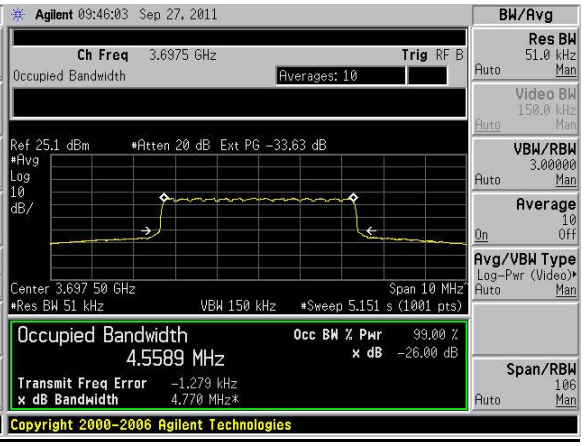
Chain 4



Chain 5



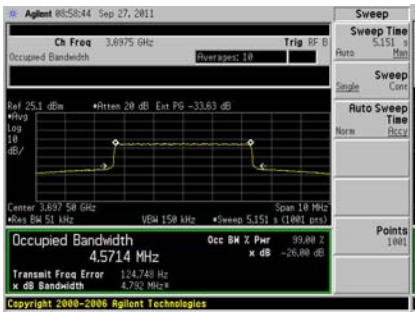
Chain 6



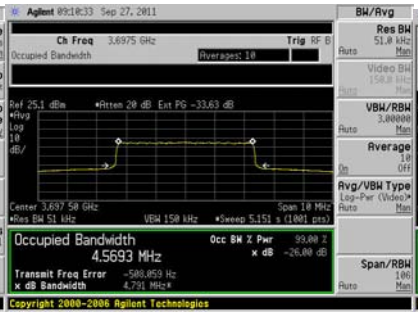
Highest Occ BW: 4.5738 MHz (Chain 4)

C. OCC BW Highest Values

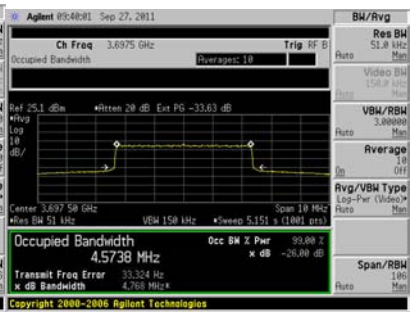
5MHz QPSK
Chain 5



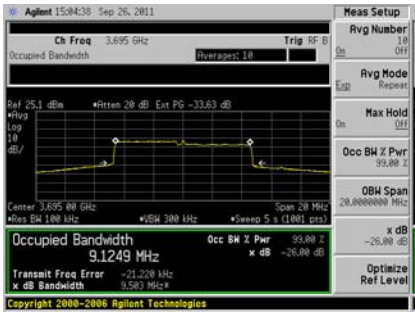
5MHz 16QAM
Chain 4



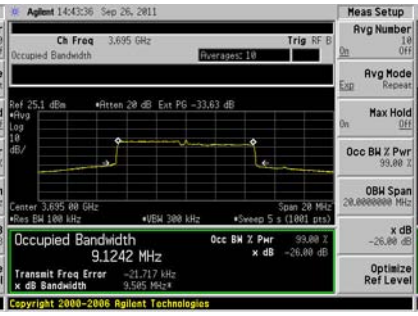
5MHz 64QAM
Chain 4



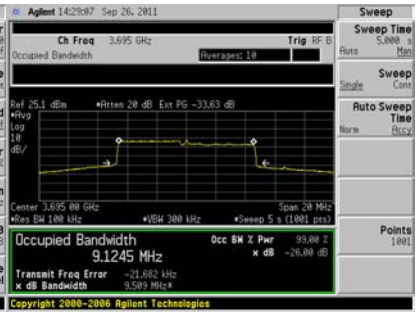
10MHz QPSK
Chain 2



10MHz 16QAM
Chain 2



10MHz 64QAM
Chain 2



PEAK OUTPUT POWER

PEAK EIRP LIMIT

90.1321(a) Base stations and fixed stations are limited to 25watts/25 MHz equivalent isotropic radiated power (EIRP). In any event the EIRP power density shall not exceed 1 watt in any on-megahertz slice of spectrum.

The maximum permitted antenna port output powers for this product are calculated based on the following typical installation parameters:

-A minimum 6 dBi antenna for use with base stations,
-30m cable loss for TMC LMR-400 at 3.65 MHz = 8.3 dB
-Effective antenna gain: 6 – 8.3 = -2.3 dBi

TEST PROCEDURE

Channel power measurements were made using the spectrum analyzer built-in function. The settings and procedures followed are found in FCC KDB document 965270 D01 Pwr Meas Part 90 Z Equipment v01.

Measurements were taken for each modulation and for each chain at High frequencies, and the results summed algebraically to determine total output power and EIRP.

Power output calculations are found in the spreadsheet below. Spectrum analyzer plots of conducted antenna port channel power are located in Annex A of this report for reference.

Note: Power output measurements were taken at same transmitter power settings that were used for PSD tests, as PSD is the limiting factor.

Output Power High Channel eirp

Single Element Minimum Antenna Gain	6 dBi
Single Element Maximum Cable Loss	8.3 dB
Single Element Net Antenna Gain	-2.3 dBi

NOTE: Power readings 1-6 below in units of dBm eirp

5MHz

3697.5MHz		Pout	30dBm	setting	
QPSK					
1	2	3	4	5	6
26.24	25.4	25.56	25.81	25.52	25.37
QAM16					
1	2	3	4	5	6
26.37	25.47	24.7	25.94	25.57	25.48
QAM64					
1	2	3	4	5	6
26.62	24.66	24.85	26	25.75	25.8

10MHz

3695		Pout	33dBm	setting	
QPSK					
1	2	3	4	5	6
28.37	27.01	27.22	27.32	27.1	29.04
QAM16					
1	2	3	4	5	6
27.72	27.06	27.29	27.32	26.66	28.67
QAM64					
1	2	3	4	5	6
27.83	27.3	27.29	27.76	27.13	28.51

NOTE: Power readings 1-6 below in units of watts eirp

							EIRP
							PoutdBm
1	2	3	4	5	6 Avg		Combined
0.420727	0.346737	0.359749	0.381066	0.356451	0.34435	0.36817995	33.4406
1	2	3	4	5	6 Avg		Combined
0.433511	0.352371	0.295121	0.392645	0.360579	0.353183	0.364568237	33.3977
1	2	3	4	5	6 Avg		Combined
0.459198	0.292415	0.305492	0.398107	0.375837	0.380189	0.368539889	33.4448
1	2	3	4	5	6 Avg		Combined
0.687068	0.502343	0.52723	0.539511	0.512861	0.801678	0.59511516	35.52601
1	2	3	4	5	6 Avg		Combined
0.591562	0.508159	0.535797	0.539511	0.463447	0.736207	0.562447062	35.28082
1	2	3	4	5	6 Avg		Combined
0.606736	0.537032	0.535797	0.597035	0.516416	0.709578	0.583765701	35.44239

EIRP POWER DENSITY

PEAK EIRP POWER DENSITY LIMIT

90.1321(a) Base stations and fixed stations are limited to 25watts/25 MHz equivalent isotropic radiated power (EIRP). In any event the EIRP power density shall not exceed 1 watt in any on-megahertz slice of spectrum.

TEST PROCEDURE

Peak PSD measurements were made using the settings and procedures in FCC KDB document 965270 D01 Pwr Meas Part 90 Z Equipment v01.

Measurements were taken for each modulation and for each chain High frequencies, and the results summed algebraically to determine total output power and EIRP.

Peak PSD EIRP calculations are found in the spreadsheet below. Spectrum analyzer plots of conducted antenna port PSD measurements are located in Annex B of this report for reference.

Note: Power output measurements were taken at same transmitter power settings that were used for PSD tests, as PSD is the limiting factor.

Hi Channel PSD

NOTE: Readings 1-6 below in units of dBm/MHz eirp

5MHz

3697.5MHz		Pout	30dBm	setting	
QPSK					
1	2	3	4	5	6
24.79	24.66	24.53	25.02	23.58	24.3
QAM16					
1	2	3	4	5	6
25.06	24.89	23.96	24.8	25.02	23.69
QAM64					
1	2	3	4	5	6
26.13	25.62	24.83	25.67	24.77	23.87

10MHz

3695		Pout	33dBm	setting	
QPSK					
1	2	3	4	5	6
24.86	23.19	23.15	23.07	25.33	25.43
QAM16					
1	2	3	4	5	6
23.55	24.37	24.18	25.23	24.95	24.48
QAM64					
1	2	3	4	5	6
24.27	25.05	24.43	24.85	23.71	23.25

NOTE: Readings 1-6 below in units of watts/MHz eirp

							PSD dBm/MH
1	2	3	4	5	6	Avg	Combin
0.301301	0.292415	0.283792	0.317687	0.228034	0.269153	0.282064	32.283
1	2	3	4	5	6	Avg	Combin
0.320627	0.308319	0.248886	0.301995	0.317687	0.233884	0.288566	32.382
1	2	3	4	5	6	Avg	Combin
0.410204	0.364754	0.304089	0.368978	0.299916	0.243781	0.331954	32.990
1	2	3	4	5	6	Avg	Combin
0.306196	0.208449	0.206538	0.202768	0.341193	0.34914	0.269047	32.078
1	2	3	4	5	6	Avg	Combin
0.226464	0.273527	0.261818	0.333426	0.312608	0.280543	0.281398	32.273
1	2	3	4	5	6	Avg	Combin
0.267301	0.31989	0.277332	0.305492	0.234963	0.211349	0.269388	32.083

MAXIMUM PERMISSIBLE EXPOSURE

LIMITS

§1.1310 The criteria listed in Table 1 shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in §1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of §2.1093 of this chapter.

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm^2)	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposures				
0.3–3.0	614	1.63	*(100)	6
3.0–30	1842/f	4.89/f	*($900/f^2$)	6
30–300	61.4	0.163	1.0	6
300–1500			f/300	6
1500–100,000			5	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3–1.34	614	1.63	*(100)	30
1.34–30	824/f	2.19/f	*($180/f^2$)	30

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)—Continued

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm^2)	Averaging time (minutes)
30–300	27.5	0.073	0.2	30
300–1500			f/1500	30
1500–100,000			1.0	30

f = frequency in MHz
* = Plane-wave equivalent power density

NOTE 1 TO TABLE 1: Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.

NOTE 2 TO TABLE 1: General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or can not exercise control over their exposure.

CALCULATIONS

Given

$E = \sqrt{(30 * P * G)} / d$

and

$S = E ^ 2 / 3770$

where

E = Field Strength in Volts/meter
P = Power in Watts
G = Numeric antenna gain
d = Distance in meters
S = Power Density in milliwatts/square centimeter

Combining equations and rearranging the terms to express the distance as a function of the remaining variables yields:

$d = \sqrt{((30 * P * G) / (3770 * S))}$

Changing to units of Power to mW and Distance to cm, using:

P (mW) = P (W) / 1000 and
d (cm) =100 * d (m)

yields

$d = 100 * \sqrt{((30 * (P / 1000) * G) / (3770 * S))}$
$d = 0.282 * \sqrt{(P * G / S)}$

where

d = distance in cm
P = Power in mW
G = Numeric antenna gain
S = Power Density in mW/cm^2

Substituting the logarithmic form of power and gain using:

P (mW) = 10 ^ (P (dBm) / 10) and
G (numeric) = 10 ^ (G (dBi) / 10)

yields

$d = 0.282 * 10 ^ ((P + G) / 20) / \sqrt{S}$ Equation (1)

where

d = MPE distance in cm
P = Power in dBm
G = Antenna Gain in dBi
S = Power Density Limit in mW/cm^2

Equation (1) and the measured peak power is used to calculate the MPE distance.

LIMITS

From §1.1310 Table 1 (B), S = 1.0 mW/cm^2

RESULTS

RF exposure considerations will be addressed by the licensee at the time of installation. The maximum eirp allowed under Part 90 for this product is 10 Watts/10 MHz channels, or 40 dBm EIRP. The MPE distance for 40 dBm eirp calculated below:

Power Density Limit (mW/cm^2)	Output Power (dBm)	Antenna Gain (dBi)	MPE Distance (cm)
1.0	40.00	0.00	28.20

3.7.2. CONDUCTED SPURIOUS EMISSIONS

REQUIREMENT

2.1051 Measurements required: Spurious emissions at antenna terminals.

The radio frequency voltage or powers generated within the equipment and appearing on a spurious frequency shall be checked at the equipment output terminals when properly loaded with a suitable artificial antenna. Curves or equivalent data shall show the magnitude of each harmonic and other spurious emission that can be detected when the equipment is operated under the conditions specified in §2.1049 as appropriate. The magnitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be specified.

90.1323(a) Emission limits.
(a) The power of any emission outside a licensee's frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, by at least 43 + 10 log (P) dB. Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 1 MHz or less, but at least one percent of the emission bandwidth of the fundamental emission of the transmitter, provided the measured energy is integrated over a 1 MHz bandwidth.

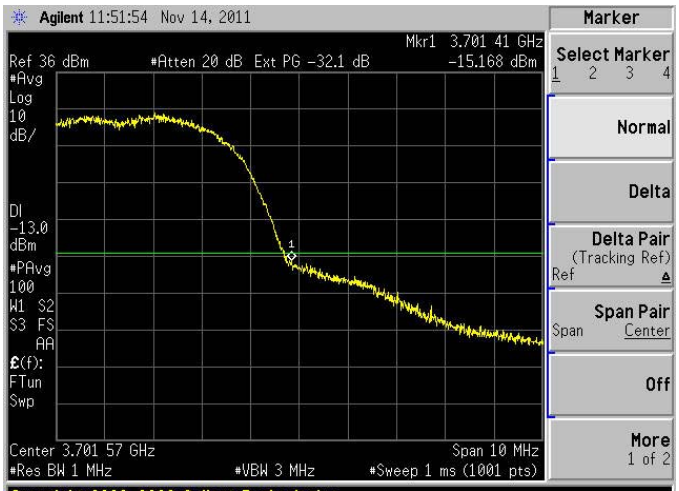
TEST PROCEDURE

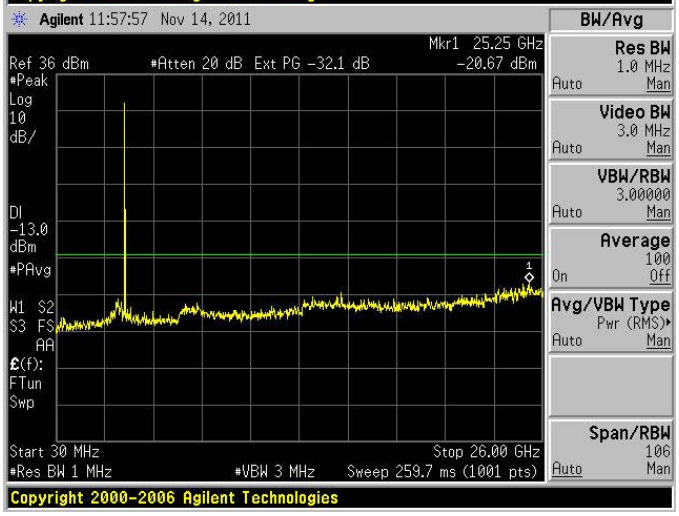
The transmitter outputs are connected to a spectrum analyzer using a combiner. At the Low and High channels, in the 1 MHz band immediately adjacent to the band edge, RBW=1% EBW, VBW=3xRBW. Elsewhere RBW = 1 MHZ, VBW=3 MHz.

RESULTS

No non-compliance noted:

5 MHZ QPSK CONDUCTED SPURIOUS, HIGH CHANNEL P=30





5 MHZ 16QAM CONDUCTED SPURIOUS, HIGH CHANNEL P=30