CISCO SYSTEMS WiMAX BASE STATION REPORT

Against the following Specifications:
CFR 47; FCC Rule Parts: Part 2, Part 27 Subparts C and M, Parts 1.1307, 1.1310
"Part 2: Frequency allocations and Radio Treaty Matters; General Rules and Regulations | Part 27, C & M: Wireless communications Service: Technical Standard & Broadband Radio Service and Educational Broadband Service | Parts 1.1307, 1.1310: Radio Frequency Radiation Exposure limits"

FCC ID: PL6-2484-B8415-R1
MODEL: BWX8415-2.5-R1
Company: Cisco Systems, Inc.

125 West Tasman Drive
San Jose, CA 95134

ACCREDITED

Testing - Certificate Number: 1178.01

Test Begin date: 6 April, 2009
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TABLE OF CONTENTS

1. OVERVIEW

1.1 NUMBER OF ITEMS FOR TYPE TESTING

Two (2) samples of the equipment were used for testing. The second sample contains modifications specific to the digital board power line filters and included EMI foam absorber material. Neither of these modifications affect the transmit functionality or performance of the equipment. These changes only affect EMC performance, which is covered in a separate report. Both units have the same versions of digital, low power radio and high power RF boards.

1.2 EMISSION DESIGNATORS

10 MHz; 9M40W7D
5MHz; 4M70W7D

1.3 TEST MODES AND MODULATIONS USED FOR TESTING

The modulation bandwidth of the Base Station can be either 5 MHz or 10 MHz. All modes and modulations were investigated. Worst case results are presented in this report. The mode and modulation that produced the maximum power did not necessarily produce the worst case result for all tests.

Modes and modulations used:

ABBREVIATION	TERMS	DEFINITION
AMC	Adaptive Modulation and Coding	The power of the transmitted signal is held constant over a frame interval and the modulation and coding format is changed to match the current received signal quality or channel conditions.
PUSC	Partial Usage of Sub Channels	Sub channels are grouped into six major groups and assigned to three segments (three sectors) of a cell. Assigning two major groups to each segment, the cell can be viewed as frequency reused by a factor of three.
QAM	Quadrature Amplitude Modulation	A modulation technique used in wireless systems, whereby two out-of- phase carriers are amplitude modulated by separate base-band signals. Modulations are either 16 QAM or 64 QAM
QPSK	Quadrature Phase Shift Keying	A modulation technique used in wireless systems, where four different phase angles are used to increase the bandwidth.

1.4 ANTENNA PORTS AND TERMINATION

All eight (8) RF output ports have the same characteristics and gain since they are driven by eight identical high power RF modules. Each RF module is individually controlled by software and, together with the eight panel antennas, radiates a beamformed composite signal that increases system performance. One port was used for testing while the other ports were terminated into a 50 ohm load. Significant pre-testing using all other ports showed that there is no practical performance differences between the eight different outputs.

2. ASSESSMENT INFORMATION

2.1 GENERAL

This report contains an assessment of an apparatus against the following specifications based upon tests carried out on the samples submitted:

- **CFR 47 Part 2,**
- **CFR 47 Part 27 Subpart C and M**

The testing was performed by and for the use of Cisco Systems Inc. As such, this test report may be used to prove compliance with the above standards.

With regard to this assessment, the following points should be noted:

a) Measurements were made in accordance with EIA/TIA-603-C: 2004 Land Mobile FM or PM Communications Equipment Measurement and Performance Standards

b) EIA/TIA-102-CAAA:1999 Digital C4FM/CQPSK Transceiver Measurement Methods (ANSI/TIA/EIA-102.CAAA-1999)

c) ITU-R Recommendation SM.329-10 (2003)

d) ANSI C63.4: 2003 Methods of Measurement of Radio-Noise Emissions from Low Voltage Electrical and Electronic. Equipment in the Range of 9 kHz to 40 GHz

e) The results contained in this report relate only to the items tested and were obtained in the period between the date of the initial assessment and the date of issue of the report. Manufactured products will not necessarily give identical results due to production and measurement tolerances.

f) The apparatus was set up and exercised using the configuration and modes of operation defined in this report only.

g) All testing was performed under the following environmental conditions:

Temperature:	+0°C to 50°C
Humidity:	10% to 75*%

All testing was performed at the following suppy voltage, except where noted:

Voltage Supply:	48VDC (± 20%)

h) No deviations to the test were done and no modifications were done to the unit or supporting hardware that will affect the reliability and consistency of the results of the tests covered in this report except those as stated in 1.1.

i) The mode and modulation that produced the maximum power did NOT necessarily produce the worst case results for other tests. Each test was pre-tested, and the mode and modulation that produced the worst case result was reported herein.

j) Generally the test frequencies used are:

MODULATION BANDWIDTH (MHz)	TEST FREQUENCIES		
	LOW (MHz)	MID (CENTER) (MHz)	HIGH (MHz)
5	2,498.75	2,593.25	2,687.25
10	2,501.25	2,593.25	2,684.75

2.2 START OF TESTING DATE

April 6, 2009.

2.3 REPORT ISSUE DATE

January 13, 2010

Cisco uses an electronic system to issue, store and control the revision of test reports. This system is called the Engineering Document Control System (EDCS). The actual report issue date is embedded into the original file on EDCS. Any copies of this report, either electronic or paper, that are not in the EDCS must be considered uncontrolled.

2.4 TESTING FACILITIES

Cisco Systems Inc. is accredited by the American Association for Laboratory Accreditation (A2LA). For the specific scope of accreditation under certificate number 1178-01 see appendix E for further details.

This assessment was performed by:

Cisco Testing Laboratory
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2.5 EQUIPMENT ASSESSED (EUT)

Model Number	BWX8415-2.5-R1
Model Name	2.5/2.6 Base Station
RF Exposure	RF Exposure is addressed at time of licensing
Output Power	Rated for 33dBm but tested at 35 dBm for performance margin purposes.
BW/Channels/Frequency range	5 MHz and 10 MHz Band Widths; 2498.75-2687.25 MHz Tuning Range, 2496-2690 MHz Authorized band
Modulation	OFDMA (PUSC: QPSK,16QAM,64QAM) (AMC: QPSK,16QAM,64QAM)
Emission designators	4M70W7D, 9M40W7D
TX Antenna details	• Panel type antenna, eight per system, 16 dBi gain each antenna. • Each antenna have similar characteristics and, by software controlled, their individual beam forming characteristics are adjusted to produce the desired total beam forming gain of the panel.
Functional Description	The BWX8415-2.5-R1 WiMAX Base Station operates in a broadband wireless network that allows users to access high speed data networks.
Voltage operating Range	-40.5 to – 60 VDC

2.6 EUT DESCRIPTION

The BWX8415-2.5-R1 WiMAX Basestation system is a tower-top unit comprised of two subsystems, the Antenna Unit (AU) and the Radio Unit (RU). These two units together are referred to as the “Basestation.” The Basestation product tested is an 802.16e TDD (time division duplex) system. It operates with either a 5 or 10 MHz signal bandwidth.

2.7 UNITS OF MEASUREMENTS AND UNCERTAINTIES

The units of measurements defined in the test results are reported in specific terms, which are test dependent. Where radiated measurements are concerned these are defined at a particular distance. Basic voltage measurements are defined in units of [dBuV]. As an example, the basic calculation for all measurements is as follows:

Emission level [dBuV] = Indicated voltage level [dBuV] + Cable Loss [dB] + Other correction factors [dB]

The combinations of correction factors are dependent upon the exact test configurations [see test equipment lists for further details] and may include: Antenna Factors, Pre Amplifier Gain, LISN Loss, Pulse Limiter Loss and Filter Insertion Loss.

Note: to convert the results from dBuV/m to uV/m use the following formula: Level in uV/m = Common Antilogarithm [(X dBuV/m)/20] = Y uV/m

Table 2.7-1 Measurement uncertainties

Measurement	Uncertainty
Voltage and power measurements (dB)	**± 2**
Conducted measurements (dB)	**± 1.4**
Radiated measurements (dB)	**± 3.2**
Frequency measurements (MHz)	**± 2.4 10^{-7}**
Temperature measurements (°C)	**± 0.54**
Humidity measurements (%)	**± 2.3**
DC and low frequency measurements (%)	**± 2.5**

3. TEST RESULTS SUMMARY

The following table summarizes the essential requirements defined in CFR 47 parts 2 & part 27 and the corresponding results for the tested EUT.

Table 3-1 Transmitter Results Summary

FCC Measurement Specification	TRANSMITTER PARAMETERS	RESULTS	REPORT PAGE NUMBER
2.1046 27.50 (h)	**Maximum Channel Power**	PASSED	11
2.1049 27.53(i)	**Occupied Bandwidth**	PASSED	13
27.53(m)	**Band Edge Compliance**	PASSED	15
2.1051 27.53 (a)(1)	**Spurious Emissions at antenna terminal**	PASSED	17
2.1053 27.53(a)(3)	**Radiated Spurious Emissions**	PASSED	22
2.1055 27.54	**Frequency Stability**	PASSED	24
1.1307, 1.1310	**Maximum Permissible Exposure (MPE) Calculation**	170.12 cm	29

4. DETAILED TEST RESULTS

4.1 RF POWER OUTPUT

4.1.1 TEST SPECIFICATIONS

CFR 47, Part 2
Paragraph 2.1046

(a) For transmitters other than single sideband, independent sideband and controlled carrier radiotelephone, power output shall be measured at the RF output terminals when the transmitter is adjusted in accordance with the tune-up procedure to give the values of current and voltage on the circuit elements specified in § 2.1033(c)(8). The electrical characteristics of the radio frequency load attached to the output terminals when this test is made shall be stated.

(b) For single sideband, independent sideband, and single channel, controlled carrier radiotelephone transmitters the procedure specified in paragraph (a) of this section shall be employed and, in addition, the transmitter shall be modulated during the test as follows. In all tests, the input level of the modulating signal shall be such as to develop rated peak envelope power or carrier power, as appropriate, for the transmitter.

(c) For measurements conducted pursuant to paragraphs (a) and (b) of this section, all calculations and methods used by the applicant for determining carrier power or peak envelope power, as appropriate, on the basis of measured power in the radio frequency load attached to the transmitter output terminals shall be shown. Under the test conditions specified, no components of the emission spectrum shall exceed the limits specified in the applicable rule parts as necessary for meeting occupied bandwidth or emission limitations.

CFR 47 Part 27
Paragraph 27.50 (h)

The following power limits shall apply in the BRS and EBS:

(1) Main, booster and base stations.

(i) The maximum EIRP of a main, booster or base station shall not exceed 33 dBW + 10log(X/Y) dBW, where X is the actual channel width in MHz and Y is either 6 MHz if prior to transition or the station is in the MBS following transition or 5.5 MHz if the station is in the LBS and UBS following transition, except as provided in paragraph (h)(1)(ii) of this section.

(ii) If a main or booster station sectorizes or otherwise uses one or more transmitting antennas with a non-omnidirectional horizontal plane radiation pattern, the maximum EIRP in dBW in a given direction shall be determined by the following formula: EIRP = 33 dBW + 10 log(X/Y) dBW + 10 log(360/beamwidth) dBW, where X is the actual channel width in MHz, Y is either (i) 6 MHz if prior to transition or the station is in the MBS following transition or (ii) 5.5 MHz if the station is in the LBS and UBS following transition, and beamwidth is the total horizontal plane beamwidth of the individual transmitting antenna for the station or any sector measured at the half-power points.

For this system, the parameter values used in determining the limit are as follows

Solving for the 10 MHz BW power limit (dBW):

TPL_L = 33 + 10 log (9.7/5.5) + 10 log (360/120)

TPL_L = 40 dBW = 70 dBm

Solving for the 5 MHz BW power limit (dBW):

TPL_L = 33 + 10 log (4.9/5.5) + 10 log (360/120)

TPL_L = 37 dBW = 67 dBm

where TPL_L = Transmit Power Level (limit)

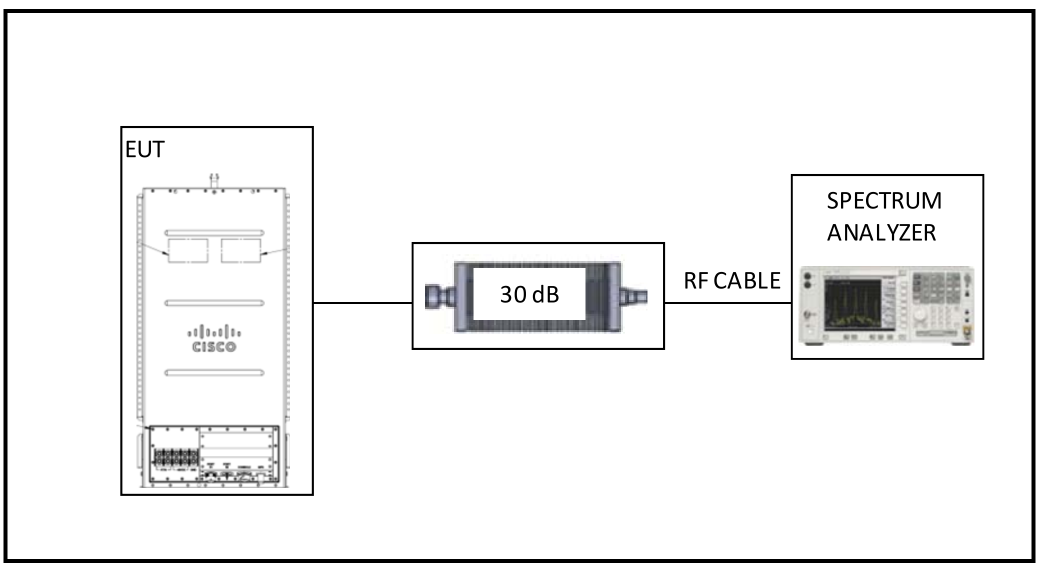
From the specifications stated above, the calculated limits are 70 dBm and 67 dBm (peak) for the 10 MHz BW and 5 MHz BW, respectively.

4.1.2 TEST PROCEDURE

The RF output of the equipment under test was directly connected to the input of the Spectrum Analyzer through a passive attenuator. The resolution and video bandwidths of the spectrum analyzer were set at sufficient levels much greater than signal bandwidth, to produce accurate results. The internal correction factors of the spectrum analyzer were used to correct for any cable and attenuator losses.

The worst case mode and modulation was determined and is shown below in Tables 4.1.4-1 and 4.1.4-2.

4.1.3 TEST SET-UP



4.1.4 TEST RESULTS

Table 4.1.4-1 Transmitter Output Power (Modulation Type: 64 QAM, 10 MHz)

64 QAM, 10 MHz	LOW 2501.25 (MHz)	MID 2593.25 (MHz)	HIGH 2684.75 (MHz)
Power Level	**Pout (dBm)**	**Pout (dBm)**	**Pout (dBm)**
Average	35.38	35.03	35.05
Peak	46.55	46.57	46.03

Table 4.1.4-2 Transmitter Output Power (Modulation Type: 64 QAM, 5 MHz)

64 QAM, 5 MHz	LOW 2498.75 (MHz)	MID 2593.25 (MHz)	HIGH 2687.25 (MHz)
Power Level	**Pout (dBm)**	**Pout (dBm)**	**Pout (dBm)**
Average	35.30	35.11	35.56
Peak	46.14	45.64	45.05

4.1.5 CONCLUSION

With an antenna gain of 16 dBi, total calculated peak transmit output power using the worst case measured value above are:

For 10 MHz BW worst case:
Peak power measured = 46.57
Antenna gain= 16
Final EIRP = 62.57 dBm

For 5 MHz BW worst case:
Peak power measured = 46.14
Antenna gain= 16
Final EIRP = 62.14 dBm

The calculated limits are 70 dBm and 67 dBm (peak) for the 10 MHz BW and 5 MHz BW, respectively. Therefore the EUT Passed.

4.2 OCCUPIED AND EMISSION BANDWIDTH

4.2.1 TEST SPECIFICATIONS

CFR 47 Part 2
Paragraph 2.1049 (h)

"The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above it s upper frequency limits, the mean powers radiated are each equal to 0.5 % of the total mean power radiated by a given emission shall be measured under the following conditions:

(h) Transmitters employing digital modulation techniques – when modulated by an input signal such that its amplitude and symbol rate represent the maximum rated conditions under which the equipment will be operated. The signal shall be applied through any filter networks, pseudo-random generators or other devices required in normal service. Additionally, the occupied bandwidth shall be shown for operation with any devices used for modifying the spectrum when such devices are optional at the discretion of the user."

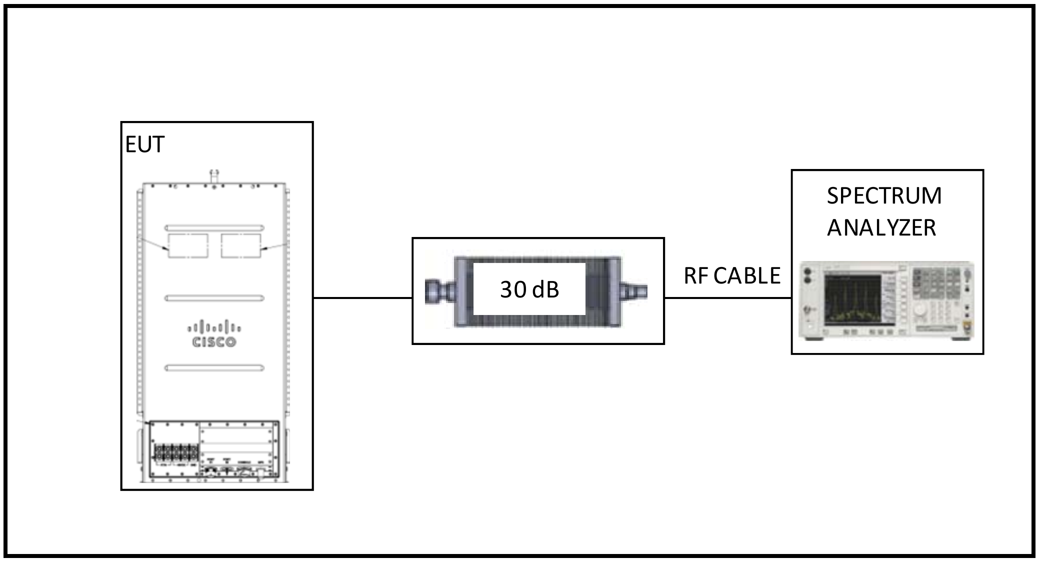
CFR 47 part 27
Paragraph 27.53 (m) (6)

"…The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power…"

4.2.2 TEST PROCEDURE

The RF output of the equipment under test was directly connected to the input of the Spectrum Analyzer through a 30 dB passive attenuator. The spectrum analyzer resolution and video bandwidths were set to at least 1% of the signal Bandwidth. The internal correction factors of the spectrum analyzer were employed to correct for any cable and attenuator losses. All modes and modulations were investigated. Worst case is shown below in Tables 4.2.4-1 and 4.2.4-2.

4.2.3 TEST SET-UP



4.2.4 TEST RESULTS

Please refer to Appendix A for detailed plots (Appendix A: OCCUPIED AND EMISSIONS BANDWIDTH).
Note: 99% = Occupied Bandwidth; 26 dB = Emission Bandwidth

Table 4.3.4-1 AMC 64 QAM, 5 MHz Occupied & Emission Bandwidth

5 MHz BW AMC 64 QAM	Low Frequency		Mid Frequency		High Frequency	
	2498.75MHz		2593.25MHz		2687.25MHz	
Bandwidths	99%	26dB	99%	26dB	99%	26dB
Measured bandwidth in MHz	4.7	4.9	4.7	4.9	4.7	4.9

Table 4.3.4-2 AMC 64 QAM, 10 MHz Occupied & Emission Bandwidth

10 MHz BW AMC 64 QAM	Low Frequency		Mid Frequency		High Frequency	
	2501.25MHz		2593.25MHz		2684.75Mhz	
Bandwidths	99%	26dB	99%	26dB	99%	26dB
Measured bandwidth (MHz)	9.4	9.7	9.4	9.7	9.1	9.5

4.2.5 CONCLUSION

The occupied and emission bandwidth of the unit is within the specified limits. Therefore, the EUT passed.

Please refer to Appendix A for detailed plots (Appendix A: OCCUPIED AND EMISSIONS BANDWIDTH).

4.3 BAND EDGE COMPLIANCE

4.3.1 TEST SPECIFICATIONS

47 CFR Part 27
Paragraph 27.53 (m)

"For BRS and EBS stations, the power of any emissions outside the licensee's frequency bands of operation shall be attenuated below the transmitter power (P) measured in watts. If a licensee has multiple contiguous channels, out-of-band emissions shall be measured from the upper and lower edges of the contiguous channels.

For digital base stations, the attenuation shall be not less than 43 + 10 log (P) in watts."

Solving for the limit in dBm:
For output power = 33 dBm (2 W),
43 + 10 log(2) = 43+ 3 = 46 dB

Solving for the limit,
Limit = 33 - 46
Limit = -13 dBm

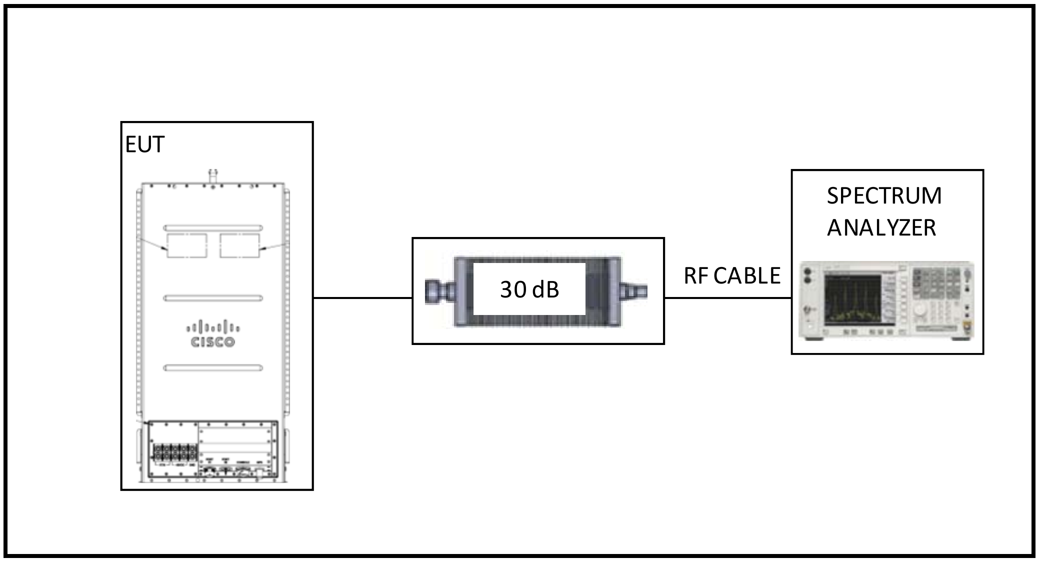
To test for worst case, a 250 KHz guard band was used between the band edge and the edge of the 10 or 5 MHz signal.

MODULATION BANDWIDTH (MHz)	Test Center Frequency (MHz)	Band Edge Frequency (MHz)	Guard Band (KHz)
10	2,501.25	2,496.00	250
10	2,684.75	2,690.00	250
5	2,498.75	2,496.00	250
5	2,687.24	2,690.00	250

4.3.2 TEST PROCEDURE

The center of the signal was placed at the edge of each band. A marker was placed at the end of the band and a limit line was placed to show compliance. All Modes and modulations were investigated. The worst case is shown in Tables 4.3.4-1.

4.3.3 TEST SET-UP



4.3.4 TEST RESULTS

Table 4.3.4-1 Band Edge 10 and 5 MHz Signal

MODULATION	Test Center Frequency (MHz)	Emission Frequency (MHz)	Emission Level (dBm)	LIMIT (dB)	MARGIN (dB)
PUSC QPSK 10 MHz	2,501.25	2,496.00	-23.7	-13	10.7
PUSC QPSK 10 MHz	2,684.75	2,690.00	-27.0	-13	14.0
PUSC 64 QAM 5 MHz	2,498.75	2,496.00	-23.2	-13	10.2
PUSC 64 QAM 5 MHz	2,687.24	2,690.00	-27.0	-13	14.0

Note: Please refer to Appendix B for detailed plots (Appendix B Band Edge).

4.3.5 CONCLUSION

From the band edge to the edge of the modulated signal the emission levels are below the limit. Therefore the EUT passed.

4.4 CONDUCTED SPURIOUS EMISSIONS AT THE ANTENNA PORT

4.4.1 TEST SPECIFICATIONS

CFR 47 Part 2
Paragraph 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 [Measurements required: Occupied bandwidth] as appropriate. The magnitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be specified.

CFR 47 Part 27
Paragraph 27.53 (m) (2)

For BRS and EBS stations, the power of any emissions outside the licensee's frequency bands of operation shall be attenuated below the transmitter power (P) measured in watts.

For fixed and temporary fixed digital stations, the attenuation shall be not less than 43 + 10 log (P) dB. For mobile digital stations, the attenuation factor shall be not less than 43 + 10 log (P) dB.

For digital base stations, the attenuation shall be not less than 43 + 10 log (P) in watts.

Solving for the limit:
For output power = 33 dBm (2 W),
43 + 10 log(2) = 43+ 3 = 46 dB

Solving for the limit,
Limit = 33 - 46
Limit = -13 dBm

4.4.2 TEST PROCEDURE

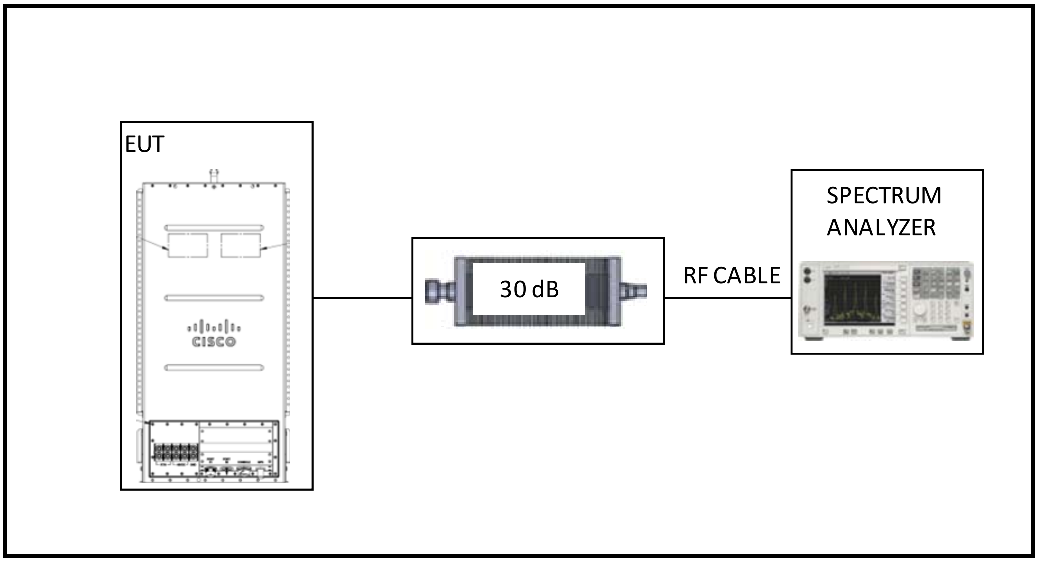
CFR 47 Part 27
Paragraph 27.53 (m)(6)

The RF output of the equipment under test was directly connected to the input of the Spectrum Analyzer through a 30 dB passive attenuator. The internal correction factors of the spectrum analyzer were used to correct for any cable and attenuator losses. All modes and modulations were investigated. The worst case Mode and modulations are shown in Tables 4.4.4-1 through 4.4.4-6.

For Resolution Bandwidth (RBW) setting of the equipment:

< 1 MHz from block edge = 100 KHz RBW
≥ 1 MHz from block edge = 1 MHz RBW

4.4.3 TEST SET-UP



4.4.4 TEST RESULTS

Please refer to Appendix C for detailed plots (Appendix C: Spurious Emissions at Antenna Terminals)

Table 4.4.4-1 Conducted Spurious Emissions, 10 MHz, QPSK

Test Signal	10 MHz, QPSK			
Center Frequency (MHz)	**Emission Frequency (MHz)**	**Emission Level (dBm)**	**Limit (dBm)**	**Margin (dB)**
LO 2501.25	540.30	-56.93	-13	43.93
	5,000.00	-68.09	-13	55.09
	7,500.00	-28.54	-13	15.54
	10,000.00	-62.09	-13	49.09
	12,510.00	-56.43	-13	43.43
	26,301.00	-37.18	-13	24.18
MID 2593.25	973.90	-59.72	-13	46.72
	7,770.00	-59.38	-13	46.38
	12,960.00	-70.61	-13	57.61
	26,303.00	-37.09	-13	24.09
HI 2684.75	70.50	-61.29	-13	48.29
	723.70	-57.28	-13	44.28
	5,370.00	-69.46	-13	56.46
	8,050.00	-64.37	-13	51.37
	10,740.00	-72.27	-13	59.27
	26,301.00	-37.10	-13	24.10

Table 4.4.4-2 Conducted Spurious Emissions, 5 MHz, 64 QAM

Test Signal	5 MHz, 64 QAM			
Center Frequency (MHz)	**Emission Frequency (MHz)**	**Emission Level (dBm)**	**Limit (dBm)**	**Margin (dB)**
LO 2498.75	537.60	-55.20	-13	42.20
	5,000.00	-65.54	-13	52.54
	7,490.00	-25.69	-13	12.69
	9,990.00	-61.21	-13	48.21
	12,490.00	-54.21	-13	41.21
	26,300.00	-36.99	-13	23.99
MID 2593.25	970.00	-59.45	-13	46.45
	5,190.00	-61.20	-13	48.20
	7,780.00	-42.73	-13	29.73
	10,370.00	-51.93	-13	38.93
	12,970.00	-54.98	-13	41.98
	26,291.00	-47.09	-13	34.09
HI 2687.25	73.10	-60.47	-13	47.47
	726.20	-56.04	-13	43.04
	5,380.00	-52.69	-13	39.69
	8,060.00	-48.99	-13	35.99
	10,750.00	-59.51	-13	46.51
	13,430.00	-64.22	-13	51.22
	16,120.00	-67.12	-13	54.12
	26,303.00	-36.99	-13	23.99

4.4.5 CONCLUSION

The conducted spurious emissions are below the limit. Therefore the EUT passed.

Please refer to Appendix C for detailed plots (Appendix C: Spurious Emissions at Antenna Terminals)

4.5 FIELD STRENGTH OF SPURIOUS EMISSIONS

4.5.1 TEST SPECIFICATIONS

CFR 47 Part 2.1053
CFR 47 Part 27.53 (a)(1)(3)

For BRS and EBS stations, the power of any emissions outside the licensee's frequency bands of operation shall be attenuated below the transmitter power (P) measured in watts.

For fixed and temporary fixed digital stations, the attenuation shall be not less than 43 + 10 log (P) dB.

For digital base stations, the attenuation shall be not less than 43 + 10 log (P) in watts.
Sample equation:
For output power = 33 dBm (2 W),
43 + 10 log(2) = 43+ 3 = 46 dB

Solving for the limit,
Limit = 33 – 46
Limit = -13 dBm

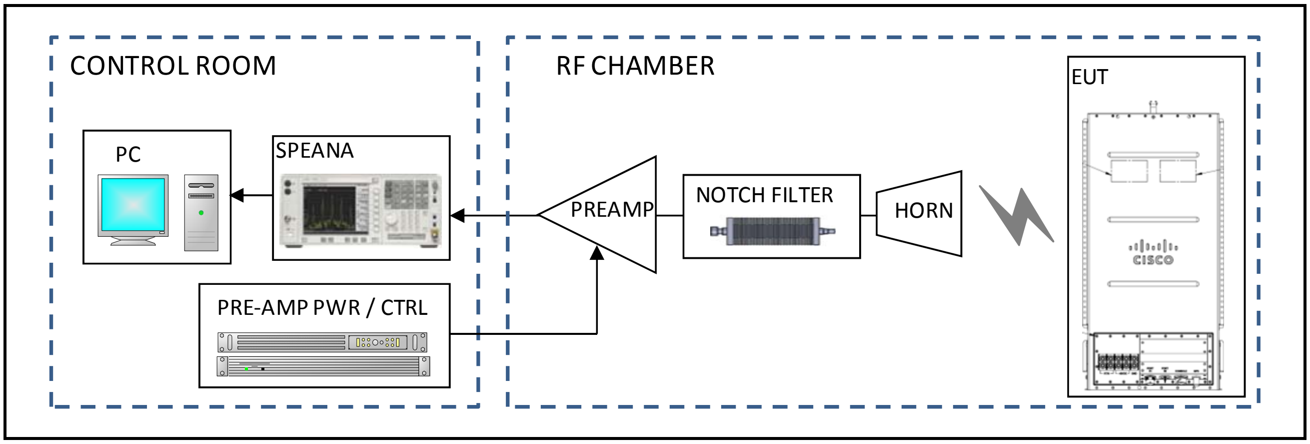
4.5.2 TEST PROCEDURE

The equipment under test (EUT) is placed in a Semi-Anechoic Chamber on a wooden table at the turntable center. All the EUT eight antenna ports are terminated with a 50 load. For each spurious emission, the turntable is rotated 360º and the antenna mast is raised and lowered from one to four meters and the maximum reading on the spectrum analyzer is recorded. This was repeated for both horizontal and vertical polarizations of the receive antenna.

The equipment under test is then replaced with a substitution antenna fed by a signal generator. The signal generator’s frequency is set to that of the spurious emission recorded from the equipment under test. The antenna mast is raised and lowered from one to four meters to obtain a maximum reading on the spectrum analyzer. The output of the signal generator is then adjusted until the reading on the spectrum analyzer matches that obtained from the equipment under test. The signal generator level is recorded. The power in dBm of each spurious emission is calculated by correcting the signal generator level for the cable loss and gain of the substitution antenna. The spectrum was investigated up to 10 times the fundamental emission.

All emissions that were at or just above the noise floor were not reported. All modes and modulations were investigated. The worst cases are shown in Tables 4.5.5-1 through 4.5.5-6

4.5.3 TEST SET-UP



4.5.4 TEST RESULTS

Table 4.5.4-1 Field Strength of Spurious Emissions, 10 MHz, PUSC QPSK

Center Frequency (MHz)	Emission Frequency (MHz)	Spectrum Analyzer Level (dBuV/m)	Generator Level (dBm)	Antenna Polarity	Correction (dB)	Result (dBm)	Limit (dBm)	Margin (dB)
2,501.25	5,002.50	66.70	-27.00	H	1.4	-25.6	-13	12.6
	5,002.50	65.90	-28.30	V	1.4	-26.9	-13	13.9
	7,503.50	46.40	-46.50	H	-0.5	-47.0	-13	34.0
	7,503.50	46.50	-48.10	V	-0.5	-48.6	-13	35.6
	10,005.00	55.10	-33.70	H	-2.6	-36.3	-13	23.3
	10,005.00	48.30	-45.30	V	-2.6	-47.9	-13	34.9
	12,506.30	45.40	-49.80	H	-2.2	-52.0	-13	39.0
	12,506.30	48.20	-46.50	V	-2.2	-48.7	-13	35.7
	15,007.50	54.80	-35.40	H	-4.3	-39.7	-13	26.7
	15,007.50	54.50	-35.60	V	-4.3	-39.9	-13	26.9
	17,508.75	47.00	-52.50	H	-8.9	-61.4	-13	48.4
	17,508.75	46.50	-50.00	V	-8.9	-58.9	-13	45.9
2,593.25	5,186.50	70.50	-22.50	H	0.8	-21.7	-13	8.7
	5,186.50	66.20	-28.30	V	0.8	-27.5	-13	14.5
	7,779.75	44.60	-48.80	H	-0.3	-49.1	-13	36.1
	7,779.75	46.00	-48.20	V	-0.3	-48.5	-13	35.5
	10,373.00	59.60	-33.30	H	-2.4	-35.7	-13	22.7
	10,373.00	55.00	-38.50	V	-2.4	-40.9	-13	27.9
	12,966.30	45.80	-54.00	H	-3.0	-57.0	-13	44.0
	12,966.30	46.20	-52.00	V	-3.0	-55.0	-13	42.0
	15,559.50	50.10	-41.70	H	-1.7	-43.4	-13	30.4
	15,559.50	51.70	-40.20	V	-1.7	-41.9	-13	28.9
2,684.75	5,369.50	77.60	-16.40	H	0.6	-15.8	-13	2.8
	5,369.50	72.70	-22.30	V	0.6	-21.7	-13	8.7
	8,054.25	58.10	-32.50	H	-0.8	-33.3	-13	20.3
	8,054.25	57.90	-34.70	V	-0.8	-35.5	-13	22.5
	10,739.00	58.80	-34.00	H	-2.1	-36.1	-13	23.1
	10,739.00	53.90	-39.40	V	-2.1	-41.5	-13	28.5
	13,423.80	45.50	-50.00	H	-3.8	-53.8	-13	40.8
	13,423.80	45.30	-51.50	V	-3.8	-55.3	-13	42.3
	16,108.50	52.40	-39.00	H	-1.5	-40.5	-13	27.5
	16,108.50	50.80	-40.50	V	-1.5	-42.0	-13	29.0

Table 4.5.4-2 Field Strength of Spurious Emissions, 5 MHz, PUSC 64 QAM

Center Frequency (MHz)	Emission Frequency (MHz)	Spectrum Analyzer Level (dBuV/m)	Generator Level (dBm)	Antenna Polarity	Correction (dB)	Result (dBm)	Limit (dBm)	Margin (dB)
2,498.75	4,997.50	65.60	-28.40	H	1.4	-27.0	-13	14.0
	4,997.50	65.60	-27.50	V	1.4	-26.1	-13	13.1
	7,496.25	51.10	-39.10	V	-0.4	-39.5	-13	26.5
	7,496.25	52.00	-39.40	H	-4.0	-39.8	-13	26.8
	9,995.00	54.10	-34.50	H	-2.6	-37.1	-13	24.1
	9,995.00	51.20	-36.30	V	-2.6	-38.9	-13	25.9
	12,493.80	47.10	-46.80	H	-2.2	-49.0	-13	36.0
	12,493.80	49.10	-44.00	V	-2.2	-46.2	-13	33.2
	14,992.50	56.80	-33.60	H	-4.3	-37.9	-13	24.9
	14,992.50	57.20	-33.00	V	-4.3	-37.3	-13	24.3
	17,491.30	46.50	48.00	V	-9.1	-57.1	-13	44.1
	17,491.30	46.20	-53.00	H	-9.1	-62.1	-13	49.1
2,593.25	5,186.50	70.70	-21.80	H	0.9	-20.9	-13	7.9
	5,186.50	69.50	-22.60	V	0.9	-21.7	-13	8.7
	7,779.75	44.20	-45.70	V	-0.3	-46.0	-13	33.0
	7,779.75	61.80	-29.00	H	-0.3	-29.3	-13	16.3
	10,373.00	61.60	-31.10	H	-2.3	-33.4	-13	20.4
	10,373.00	61.30	-31.00	V	-2.3	-33.3	-13	20.3
	12,966.30	47.40	-47.40	V	-3.0	-50.4	-13	37.4
	12,966.30	46.10	-48.40	H	-3.0	-51.4	-13	38.4
	15,559.50	51.70	-41.70	V	-1.7	-43.4	-13	30.4
	15,559.50	54.00	-39.40	H	-1.7	-41.1	-13	28.1
2,687.25	5,374.50	73.90	-19.20	H	0.6	-18.6	-13	5.6
	5,374.50	76.90	-16.90	V	0.6	-16.3	-13	3.3
	8,061.75	61.00	-30.30	H	-0.8	-31.1	-13	18.1
	8,061.75	63.50	-26.90	V	-0.8	-27.7	-13	14.7
	10,749.00	60.60	-31.20	H	-2.0	-33.2	-13	20.2
	10,749.00	62.90	-29.80	V	-2.0	-31.8	-13	18.8
	13,436.30	49.30	-41.40	V	-3.7	-45.1	-13	32.1
	13,436.30	51.40	-40.00	H	-3.7	-43.7	-13	30.7
	16,123.50	52.00	-41.60	H	-1.7	-43.3	-13	30.3
	16,123.50	51.20	-42.10	V	-1.7	-43.8	-13	30.8

4.5.5 CONCLUSION

The field strength of spurious emissions are below the specified limit. Therefore the EUT passed.

4.6 FREQUENCY STABILITY

4.6.1 TEST SPECIFICATIONS

CFR 47 Part 27.54
The frequency stability shall be sufficient to ensure that the fundamental emissions stay within the authorized bands of operation.

CFR 47 Part 2.1055
The frequency stability shall be measured with the following variation of voltage and ambient temperature:
Voltage:

- Nominal (48 DC),
- 85% of Nominal (40.5 VDC),
- 115% of Nominal (60VDC)

Temperature:

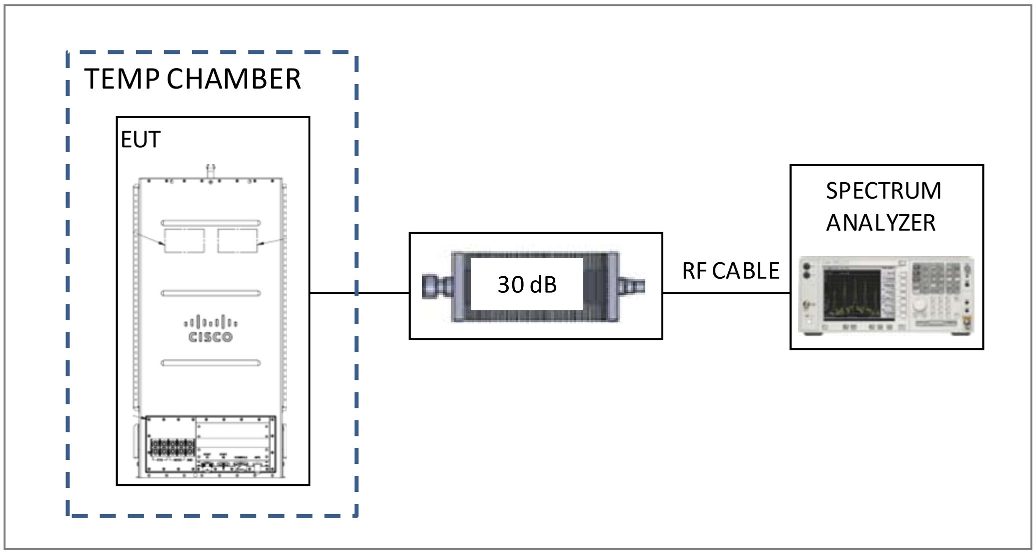
- -30 °C to +50 °C at intervals of +10 °C
- **NOTE:** The EUT contains an active thermal management system that maintains the temperature of the air forced into the active electronics above 0 °C, regardless of external temperature. If, for any reason, this air temperature falls below 0 °C, then all active electronics are turned off and will remain off until this air temperature rises above 0 °C.

4.6.2 TEST PROCEDURE

The frequency stability shall be measured with variation of ambient temperature from 0 °C to +50 °C (the unit's active electronics are turned off below 0 °C and will remain off until this air temperature rises above 0 °C). Frequency measurements shall be made at the extremes of the specified temperature range and at intervals of not more than 10 °C through the range. A period of time sufficient to stabilize all of the components of the oscillator circuit at each temperature level shall be allowed prior to frequency measurement. The frequency stability was measured with variation of primary supply voltage from 84 to 125% of the nominal value. The frequency stability shall be sufficient to ensure that the fundamental emissions stay within the authorized bands of operation.

The EUT was connected to a Spectrum Analyzer via RF cables and attenuator pads. All modes and modulations were investigated. The worst case results are shown in Tables 4.6.4-1 through 4.6.4-3.

4.6.3 TEST SET-UP



4.6.4 TEST RESULTS

Table 4.6.4-1 Frequency Stability (CW Output)

TEMPERATURE	FREQUENCY	FREQUENCY ERROR	FREQUENCY ERROR	VOLTAGE	VOLTAGE
°C	(Hz)	(Hz)	(PPM)	%	DC
50	2,498,750,000	59	0.0236	100	48
40		43	0.0172	100	48
30		35	0.014	100	48
20		39	0.0156	100	48
10		39	0.0156	100	48
0		28	0.0112	100	48
20		30	0.011	84	40.5
20		21	0.0081	125	60
50	2,593,250,000	26	0.01	100	48
40		34	0.013	100	48
30		42	0.0162	100	48
20		47	0.018	100	48
10		54	0.02	100	48
0		56	0.02	100	48
20		30	0.012	84	40.5
20		21	0.008	125	60
50	2,687,250,000	54	0.02	100	48
40		46	0.017	100	48
30		57	0.021	100	48
20		53	0.0197	100	48
10		58	0.021	100	48
0		35	0.013	100	48
20		51	0.019	84	40.5
20		53	0.0197	125	60

4.6.5 CONCLUSION

The frequencies measured at specified voltage and temperature variations show that the frequency stability is sufficient to ensure that the fundamental emissions stay within the authorized bands of operation. Therefore the EUT passed.

5. MAXIMUM PERMISSIBLE EXPOSURE (MPE) CALCULATIONS

CFR 47 Parts 1 & 2
Paragraphs 1.1307 (b), 1.1310

REQUIREMENT:

U-NII devices are subject to the radio frequency radiation exposure requirements specified in Sec. 1.1307(b), 1.1310 of this chapter, as appropriate. Applications for equipment authorization of devices operating under this section must contain a statement confirming compliance with these requirements for both fundamental emissions and unwanted emissions. Technical information showing the basis for this statement must be submitted to the Commission upon request.

From the Table 1 (A) Limits for Occupational/Controlled Exposure (Paragraph 1.1310) shown below:

FCC / Canada Limits for Maximum Permissible Exposure (MPE)

(A) Limits for Occupational/Controlled Exposure

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/cm^2)	Averaging Time $\|E\|^2$, $\|H\|^2$ or S (minutes)
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

The MPE limit for the EUT is
Power Density (S) = 5 mW/cm^2
Average Time = 6 minutes

MAXIMUM PERMISSIBLE EXPOSURE CALCULATIONS:

Given
E=√(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 mW/cm^2

Combine equations and rearrange the terms to express the distance as a function of the remaining variables:
d=√((30*P*G)/(3770*S))

Changing to units of power in mW and distance in cm, using:
P(mW)=P(W)/1000 d(cm)=100*d(m)

yields
d=100*√((30*(P/1000)*G)/(3770*S))
d=0.282*√(P*G/S)

where

d=Distance in cm
P=Power in mW
G=Numerical Antenna Gain
S=Power Density in mW/cm^2

Substituting the logarithmic form of power and gain using:

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

yields

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

and

s=((0.282*10^((P+G)/20))/d)^2 Equation (2)

where

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

Equation (1) and the measured peak power are used to calculate the MPE distance. Note that for mobile or fixed location transmitters such as an access point, the minimum separation distance is 20 cm even if the calculations indicate that the MPE distance may be less.

S=5 mW/cm^2 maximum. The highest supported antenna gain is 16 dBi. Using the peak power levels recorded in the test report along with Equation 1 above, the MPE distances are calculated as follows.

Table 5-1   10 MHZ AMC 64 QAM

Frequency (MHz)	Power Density (mW/cm^2)	Peak Transmit Power (dBm)	Antenna Gain (dBi)	MPE Distance (cm)
2,501.25	5	46.6	16	**170.12**
2,593.25	5	46.6	16	**170.12**
2,684.75	5	46.0	16	**158.77**

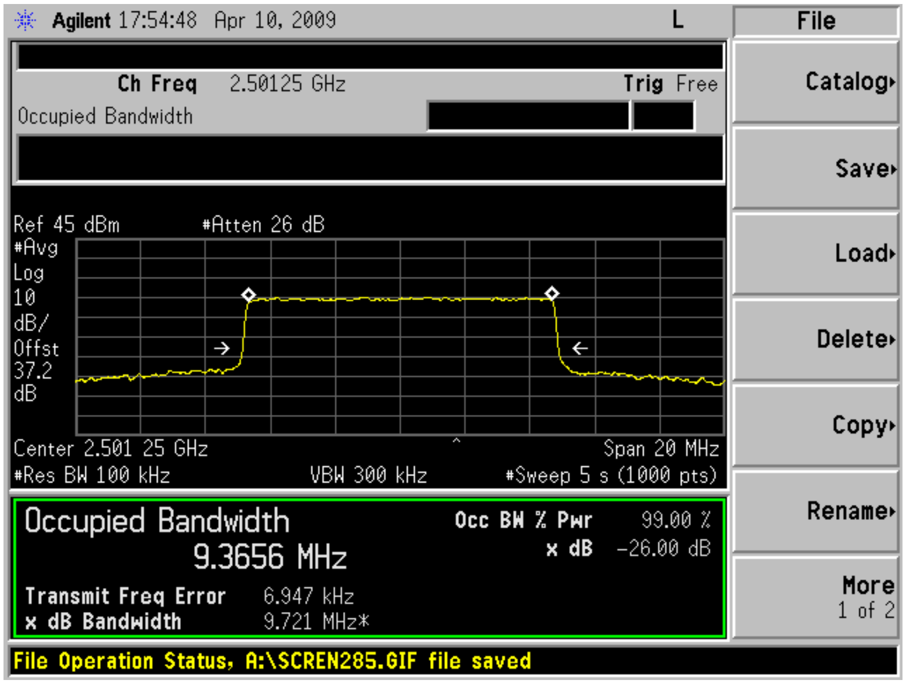
Table 5-2   5 MHz AMC 64 QAM

Frequency (MHz)	Power Density (mW/cm^2)	Peak Transmit Power (dBm)	Antenna Gain (dBi)	MPE Distance (cm)
2,498.75	5	46.1	16	**160.61**
2,593.25	5	45.6	16	**151.62**
2,687.25	5	45.1	16	**143.14**

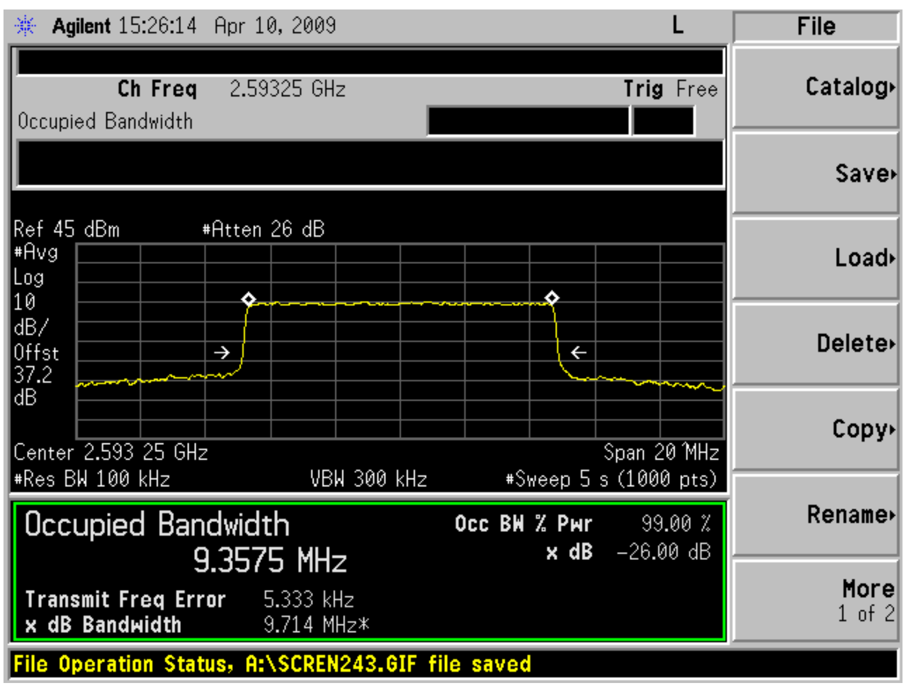
This MPE evaluation is for engineering information purposes only. The on-site provider will perform an evaluation and/or survey for each individual installation. The User's Manual and warning labels on the equipment state that a separation distance of at least 2 meters shall be maintained, which is more than the above mentioned minimum MPE distance.

APPENDIX A. OCCUPIED AND EMISSION BANDWIDTH

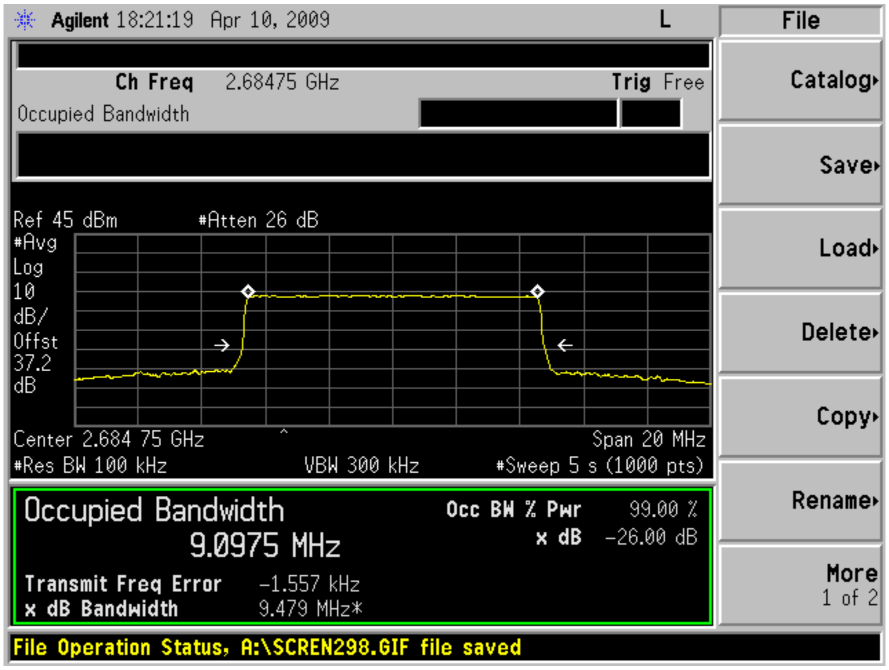
PLOT A-1.1 *BW: 10 MHz, Modulation: 64 QAM, F_o: 2501.25 MHz*



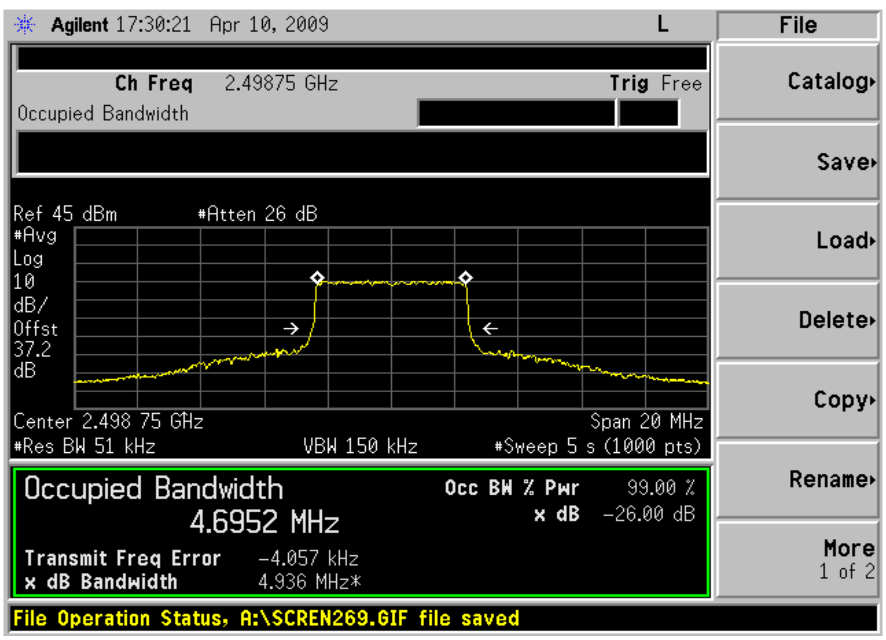
PLOT A-1.2 *BW: 10 MHz, Modulaiton: 64 QAM, F_o: 2593.25 MHz*



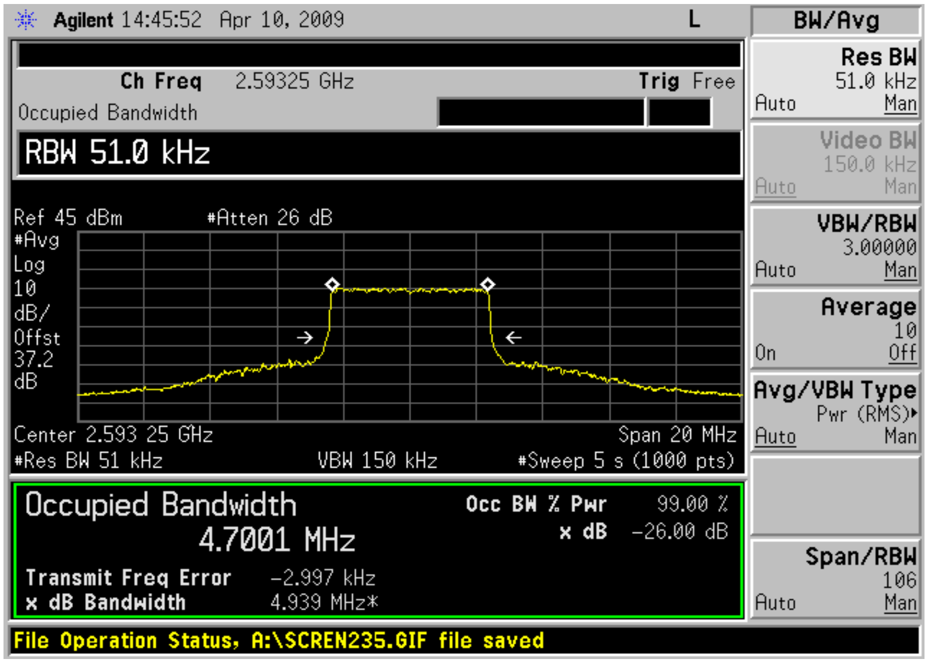
PLOT A-1.3 ***BW: 10 MHz, Modulation: 64 QAM, F_o: 2684.75 MHz***



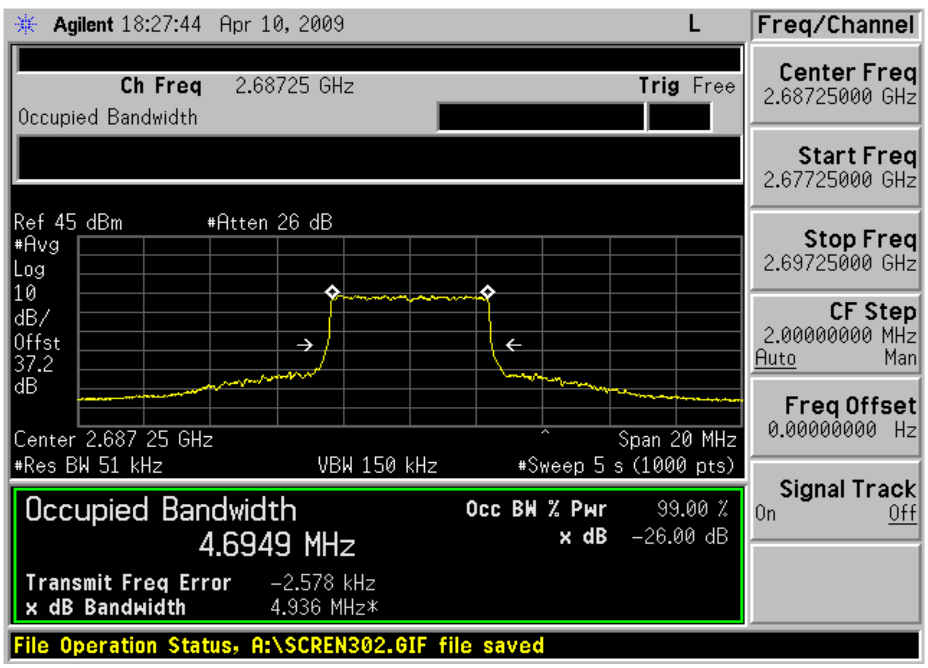
PLOT A-1.4 ***BW: 5MHz, Modulation: 64 QAM, F_o: 2498.75MHz***



PLOT A-1.5 ***BW: 5MHZ, Modulation: 64 QAM, F_o: 2593.25MHz***

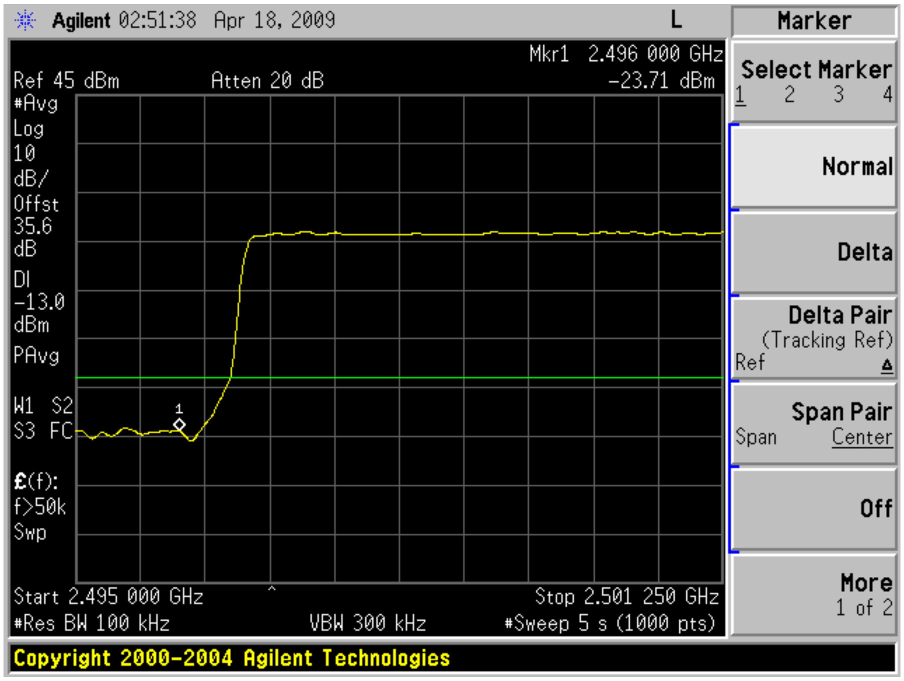


PLOT A-1.6 ***BW: 5MHZ, Modulation: 64 QAM, F_o: 2687.25MHz***

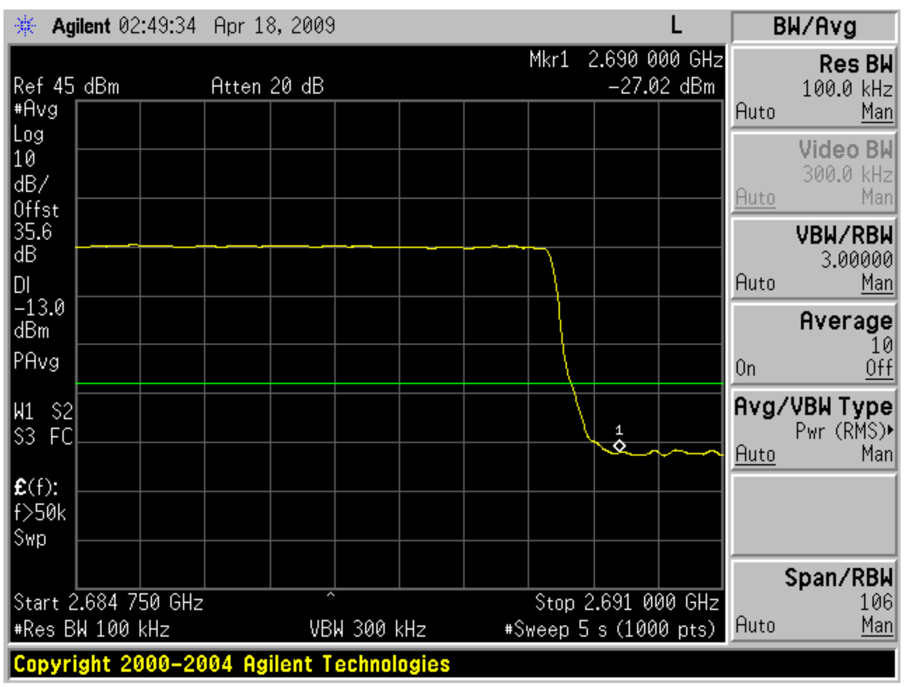


APPENDIX B. BAND EDGE

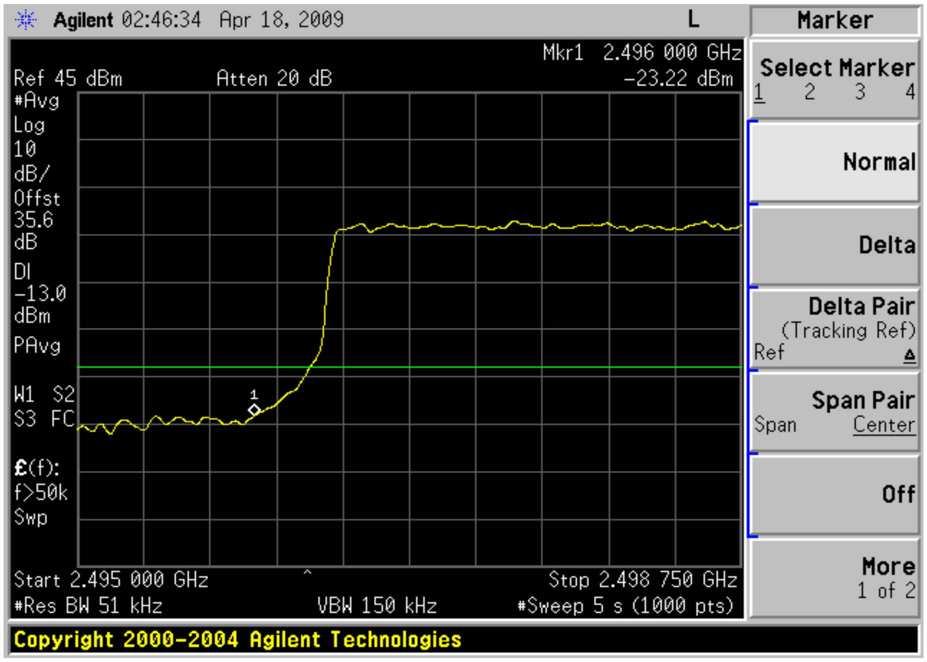
PLOT B-1.1 *BW: 10 MHz, Modulation: PUSC, QPSK, F_o:2501.25MHz*



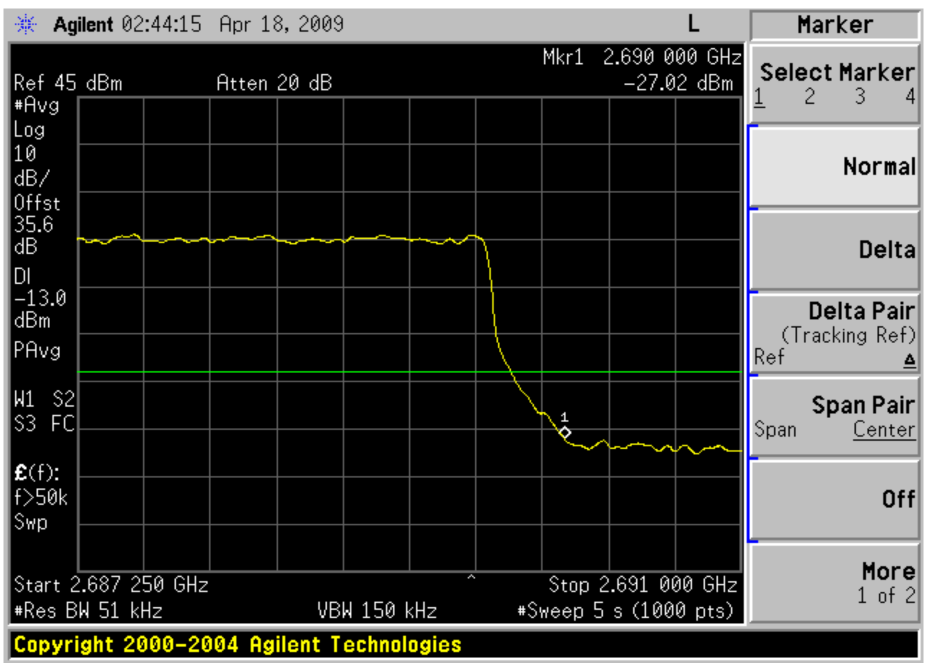
PLOT B-1.2 *BW: 10 MHz, Modulation: PUSC, QPSK, F_o: 2684.75MHz*



PLOT B-1.3 ***BW: 5 MHz, Modulation: PUSC, 64 QAM, F_o: 2498.75 MHz***

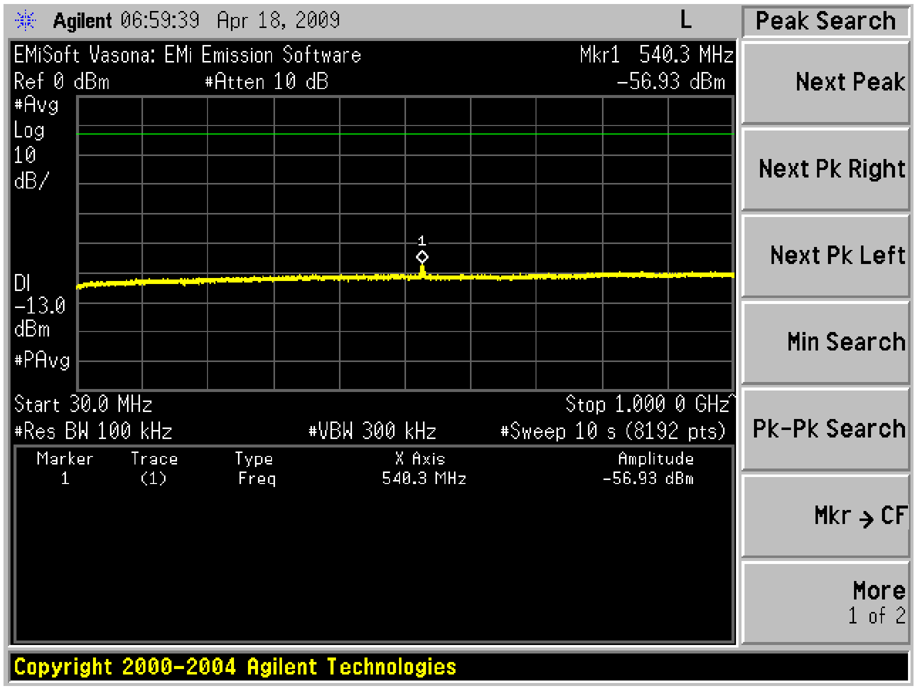


PLOT B-1.4 ***BW: 5MHz, Modulation: PUSC, 64 QAM, F_o: 2687.25 MHz***

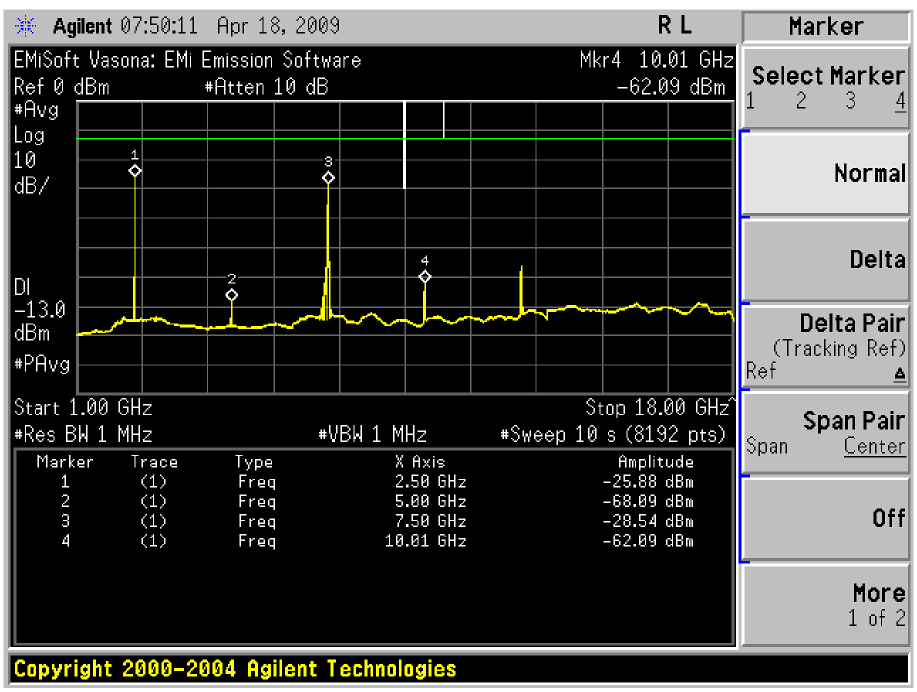


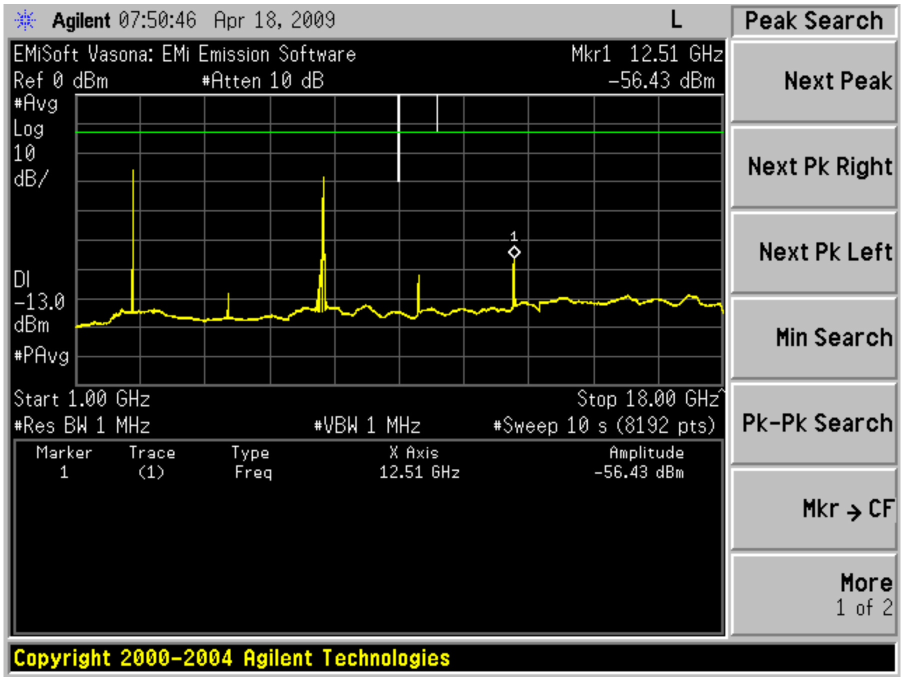
APPENDIX C. SPURIOUS EMISSIONS AT ANTENNA TERMINALS

PLOT C-1.1 ***BW: 10 MHz, Modulation: PUSC, QPSK, F_o: 2501.25 MHz, Range:30 MHz-1.0 GHz***

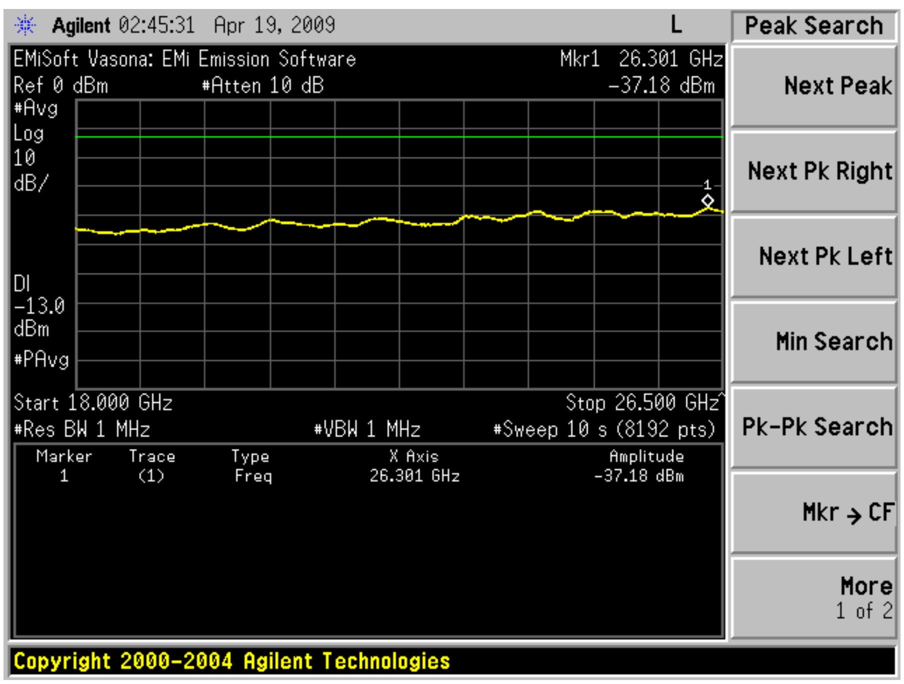


PLOT C-1.2 ***BW: 10 MHz, Modulation: PUSC, QPSK, F_o: 2501.25 MHz, Range:1.0 GHz-18.0 GHz***

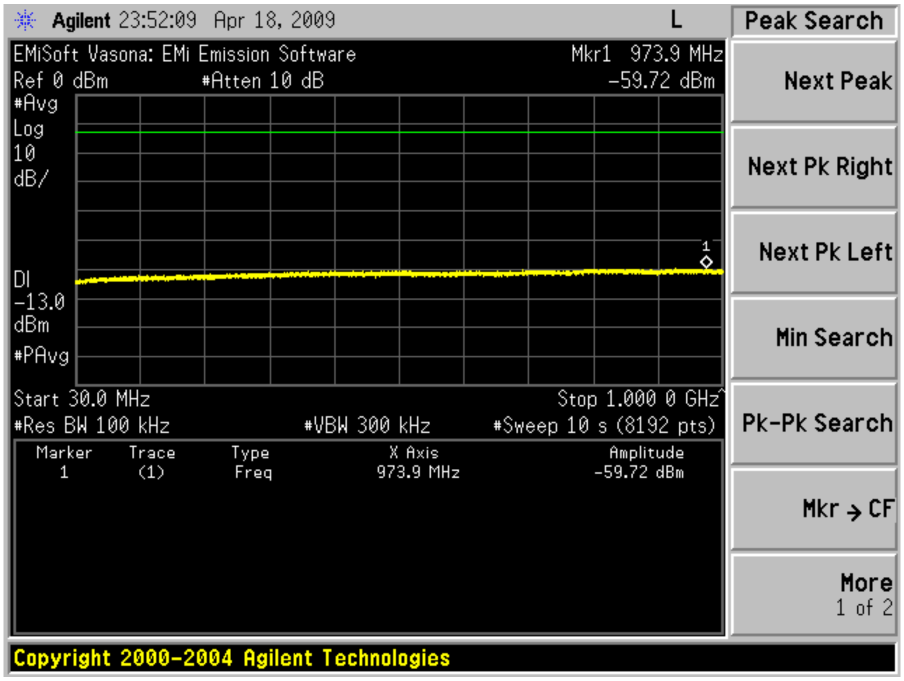




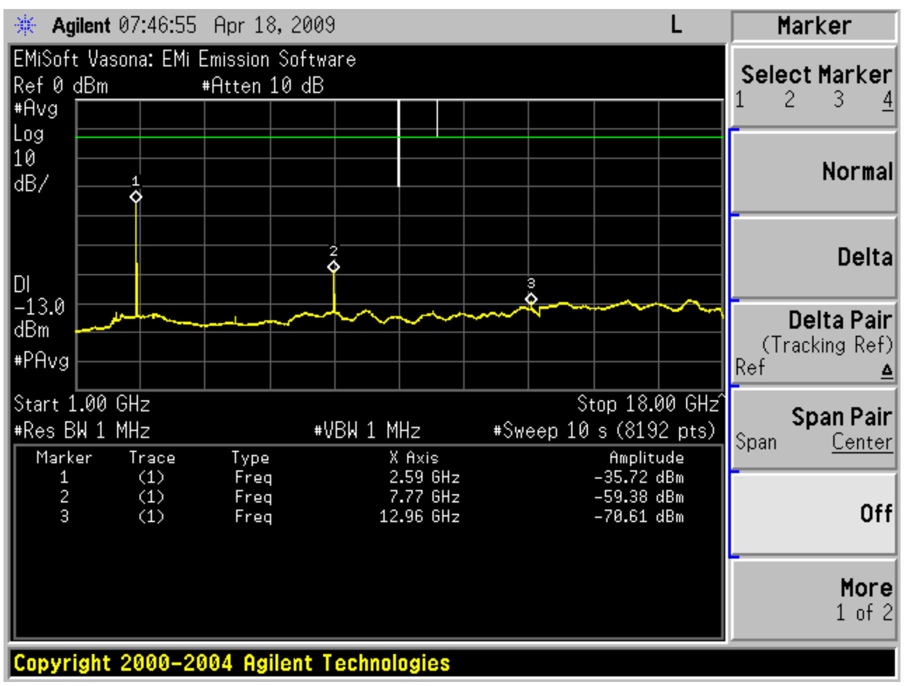
PLOT C-1.3 ***BW: 10 MHz, Modulaiton: PUSC, QPSK, F_o: 2501.25 MHz, Range:18.0 GHz- 26.5 GHz***



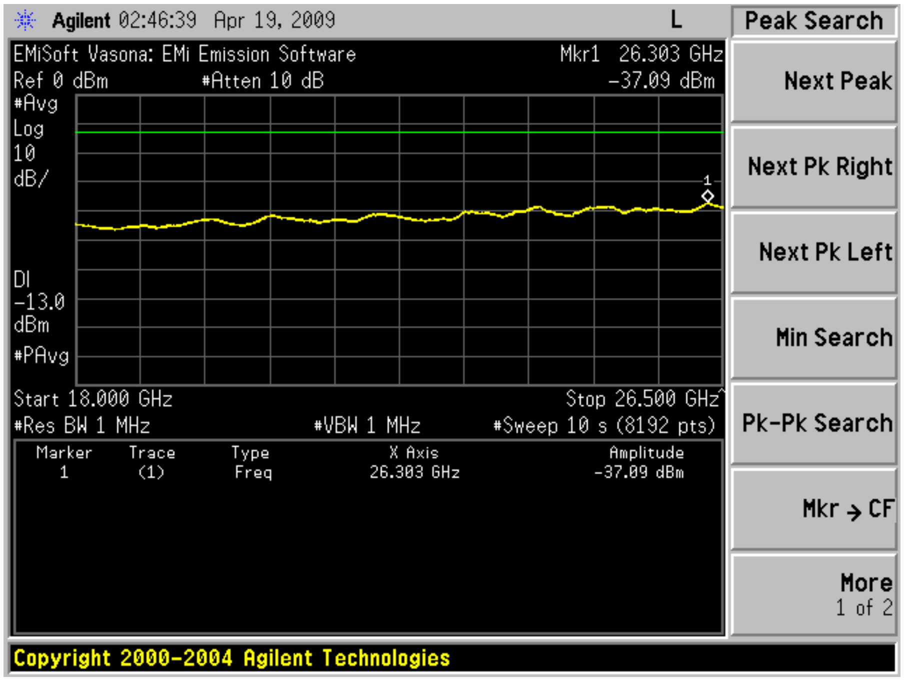
PLOT C-1.4 ***BW: 10 MHz, Modulation: PUSC, QPSK, F_o: 2593.25 MHz, Range:30 MHz-1.0 GHz***



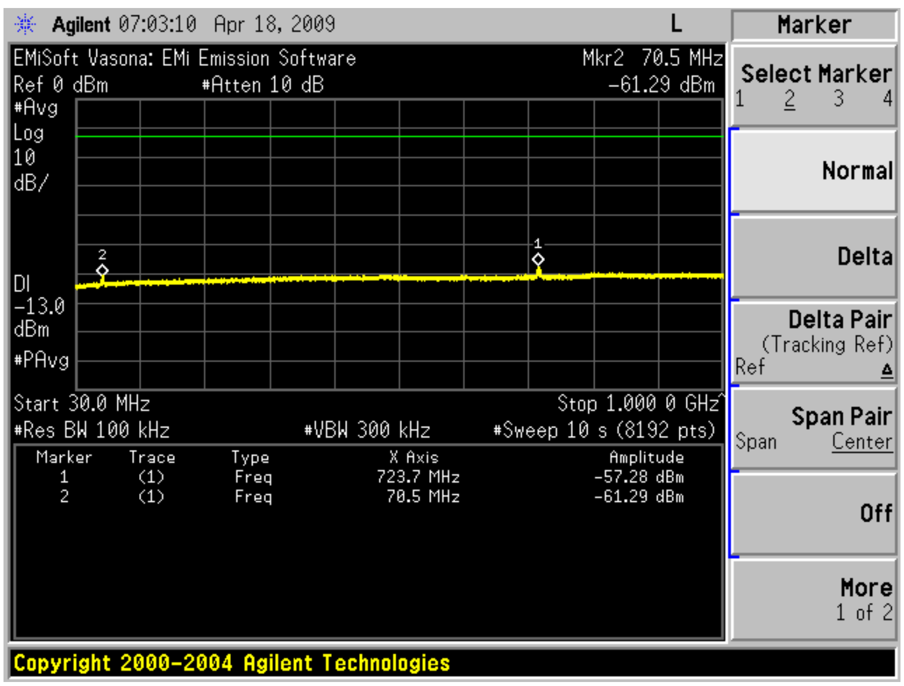
PLOT C-1.5 ***BW: 10 MHz, Modulation: PUSC, QPSK, F_o: 2593.25 MHz, Range:1.0 GHz-18.0 GHz***



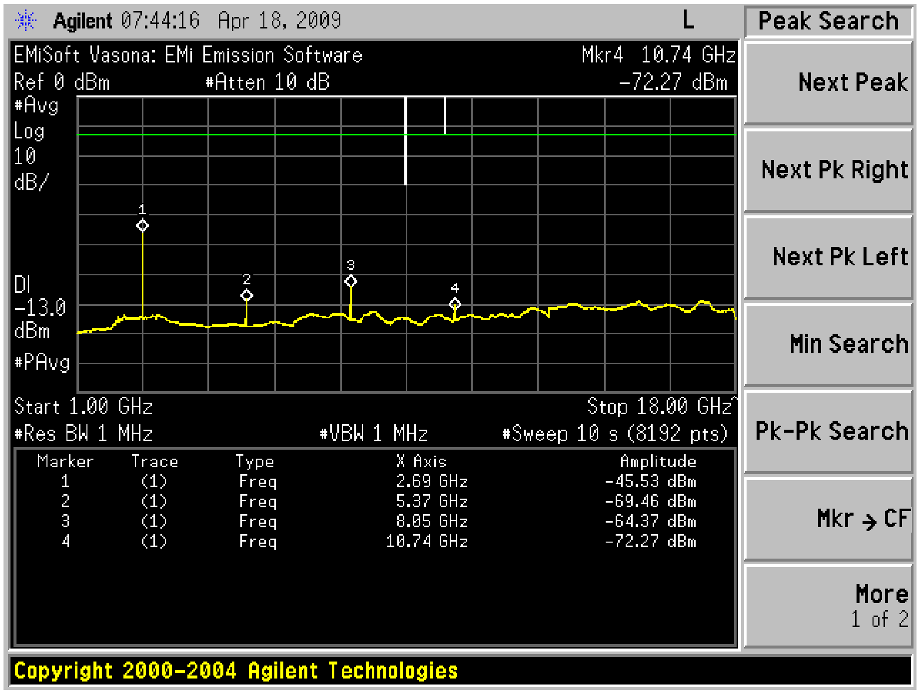
PLOT C-1.6 ***BW: 10 MHz, Modulation: PUSC, QPSK, F_o: 2593.25 MHz, Range:18.0 GHz- 26.5 GHz***



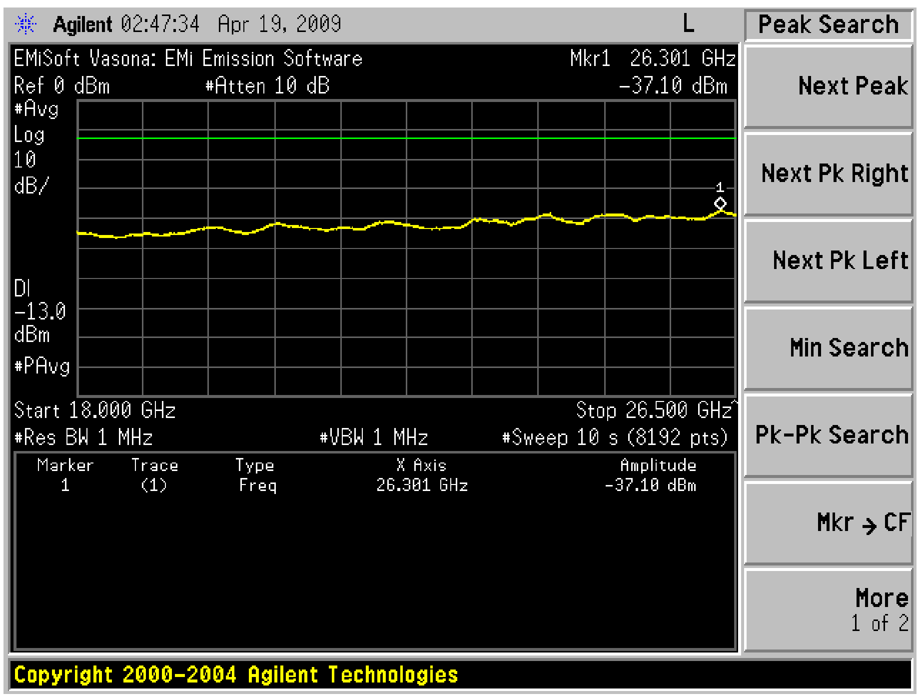
PLOT C-1.7 ***BW: 10 MHz, Modulation: PUSC, QPSK, F_o: 2684.75 MHz, Range:30 MHz-1.0 GHz***



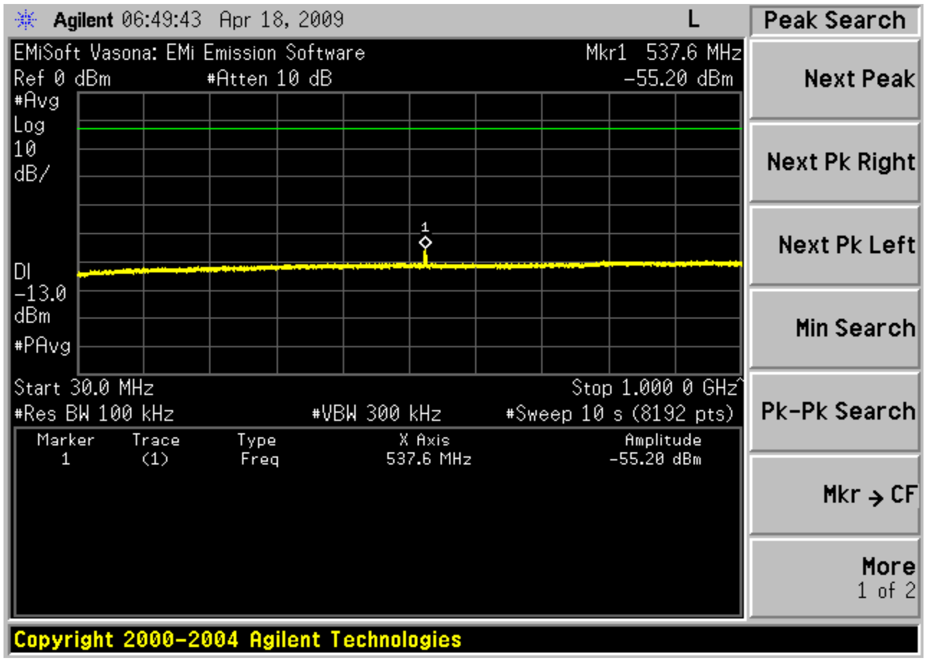
PLOT C-1.8 ***BW: 10 MHz, Modulation: PUSC, QPSK, F_o: 2684.75 MHz, Range:1.0 GHz-18.0 GHz***



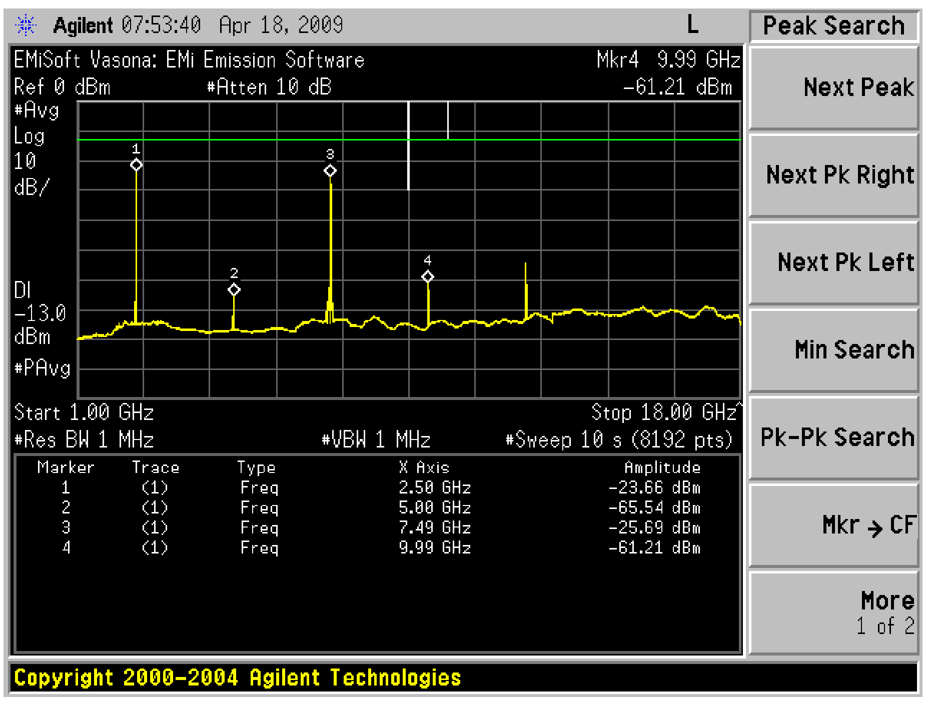
PLOT C-1.9 ***BW:10 MHz, Modulation: PUSC, QPSK, F_o: 2684.75 MHz, Range:30 MHz-1.0 GHz***

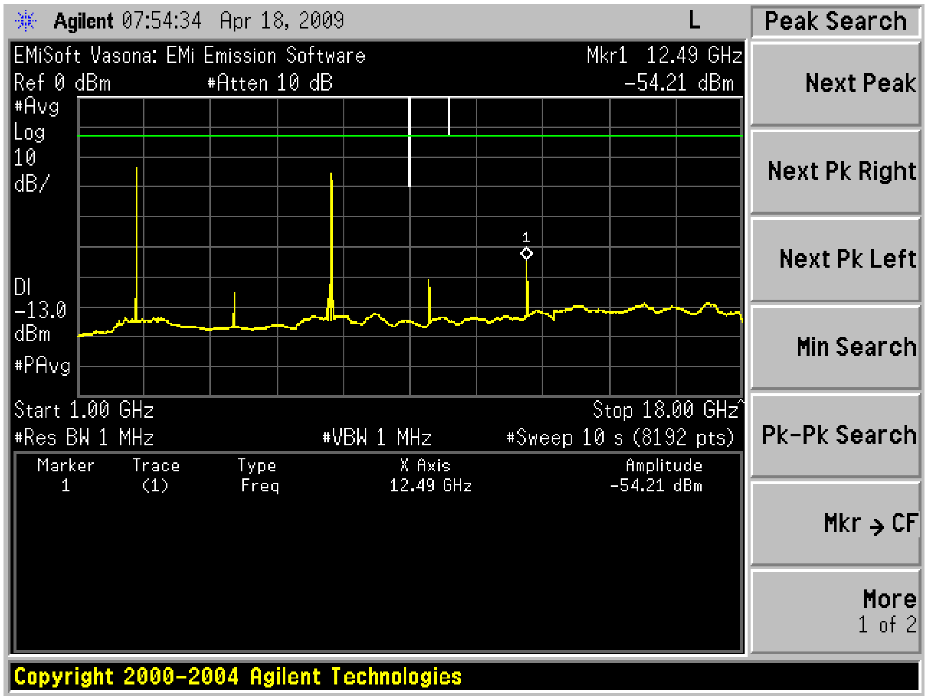


PLOT C-1.10 ***BW: 5 MHz, Modulation:PUSC, 64 QAM, F_o: 2498.75 MHz, Range:30 MHz – 1.0 GHz***

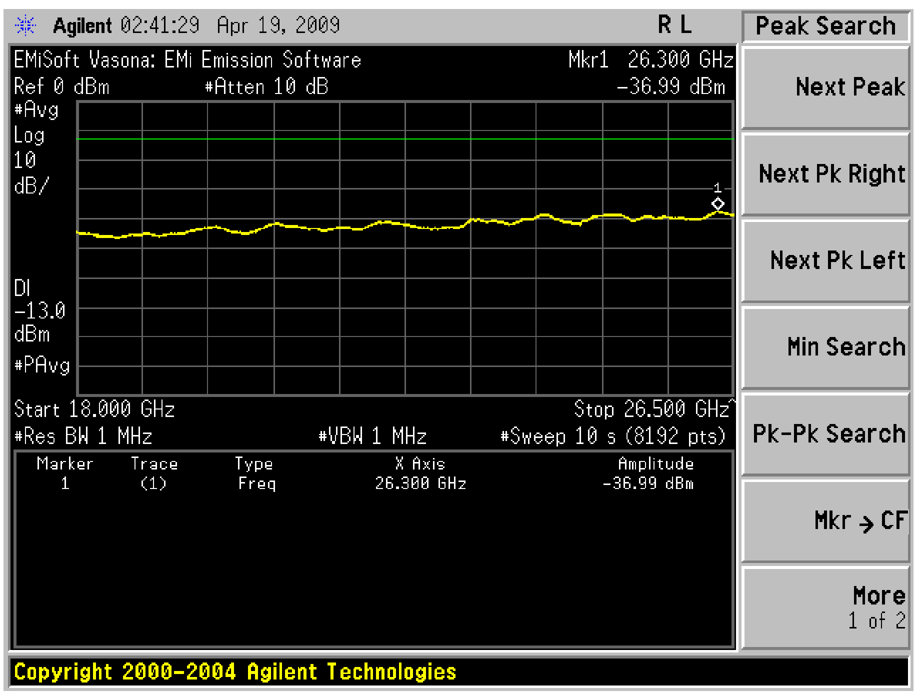


PLOT C-1.11 ***BW: 5 MHz, Modulation: PUSC, 64 QAM, F_o: 2498.75 MHz, Range:1.0- 18.0 GHz***

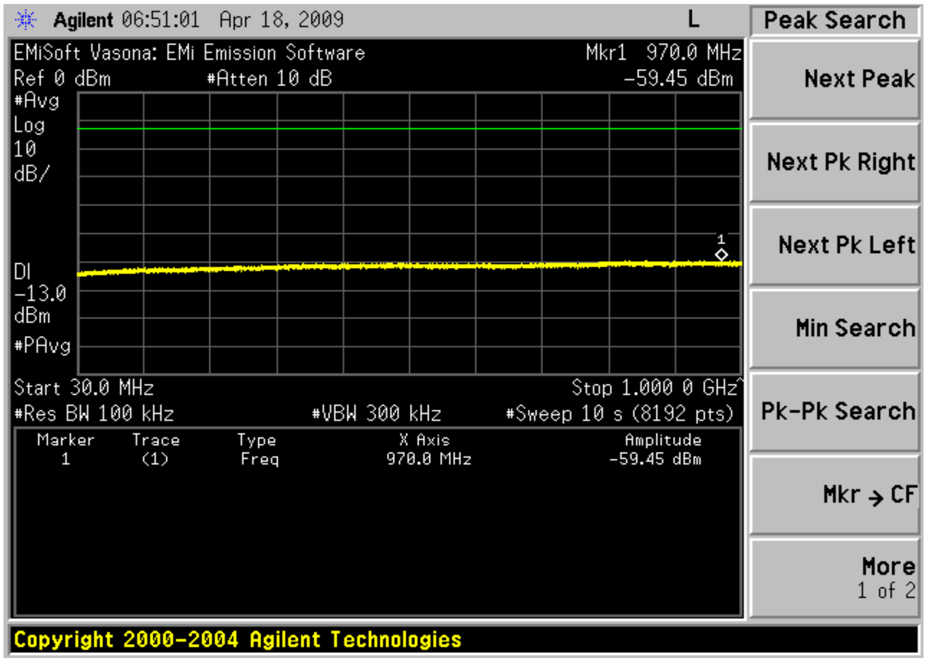




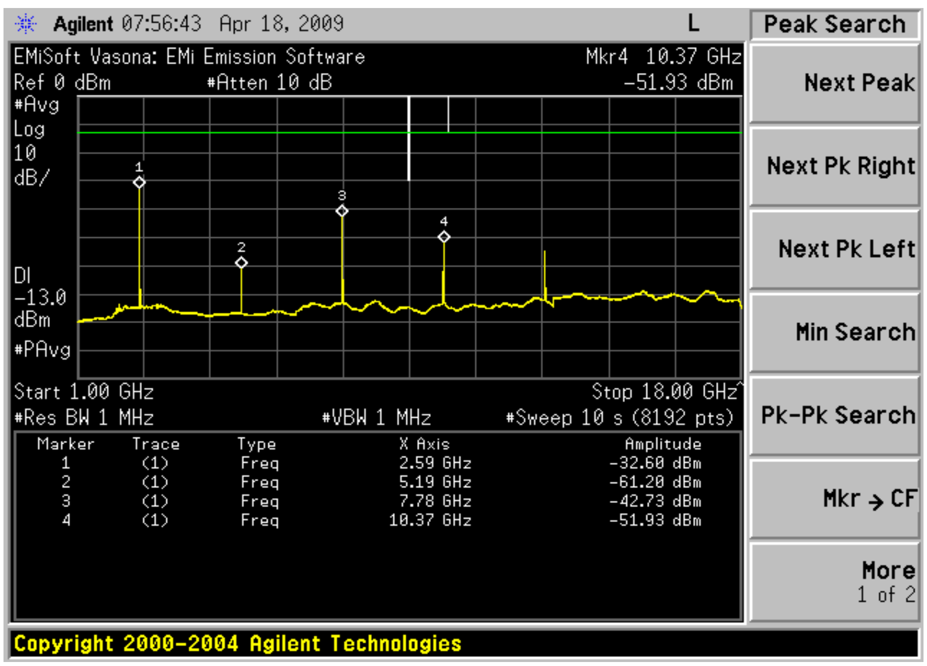
PLOT C-1.12 ***BW: 5 MHz, Modulation: PUSC, 64 QAM, F_0: 2498.75 MHz, Range:18.0 – 26.5 GHz***

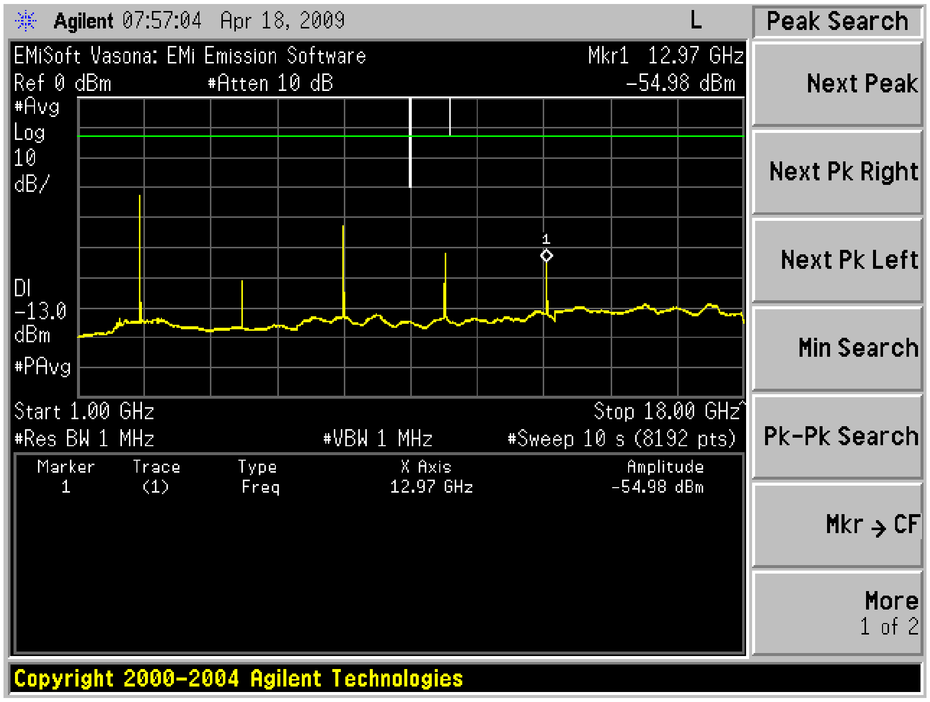


PLOT C-1.13 ***BW: 5 MHz, Modulation: PUSC, 64 QAM, F_o: 2593.25 MHz, Range:30 MHz – 1.0 GHz***

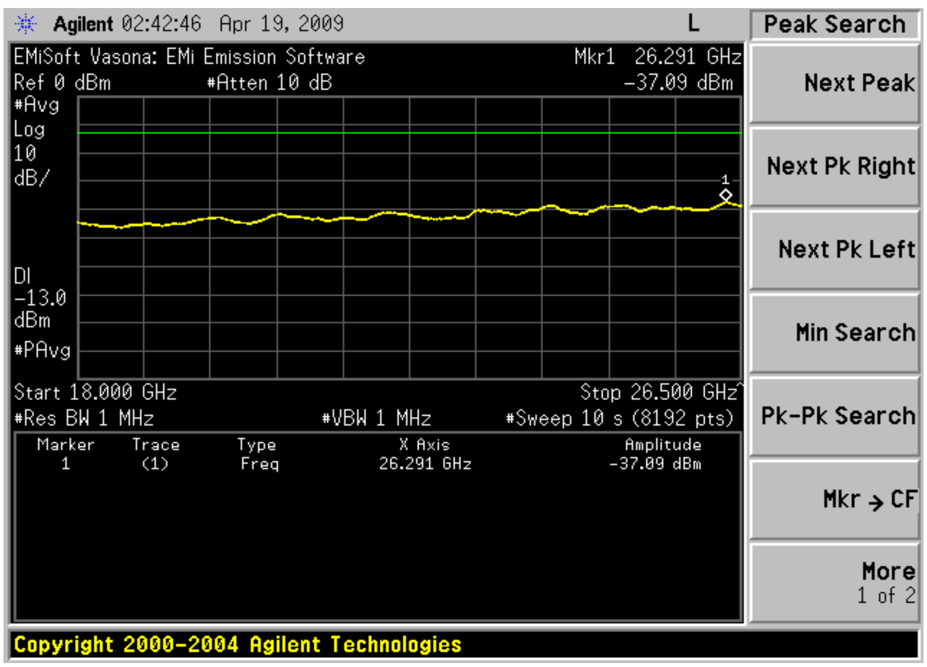


PLOT C-1.14 ***BW: 5 MHz, Modulation: PUSC, 64 QAM, F_o: 2593.25 MHz, Range:1.0 – 18.0 GHz***

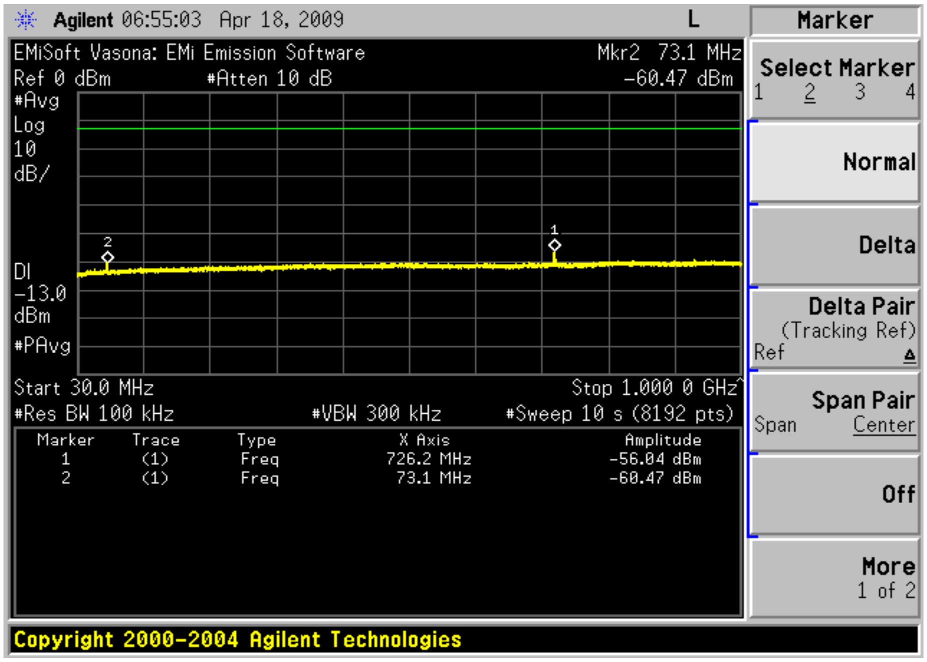




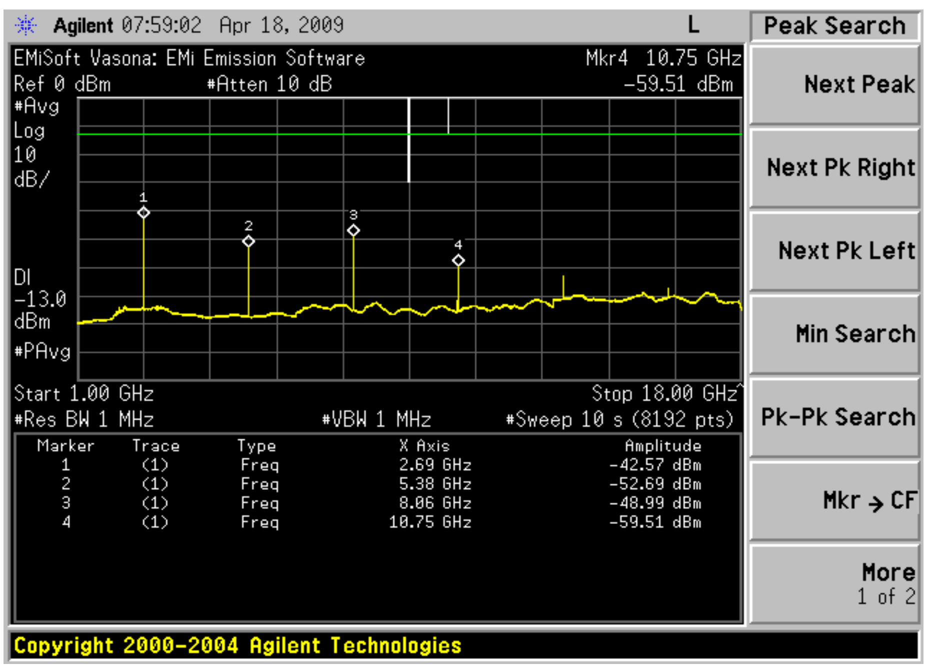
PLOT C-1.15 ***BW: 5 MHz, Modulation: PUSC, 64 QAM, F_o: 2593.25 MHz, Range:18.0 – 26.5 GHz***

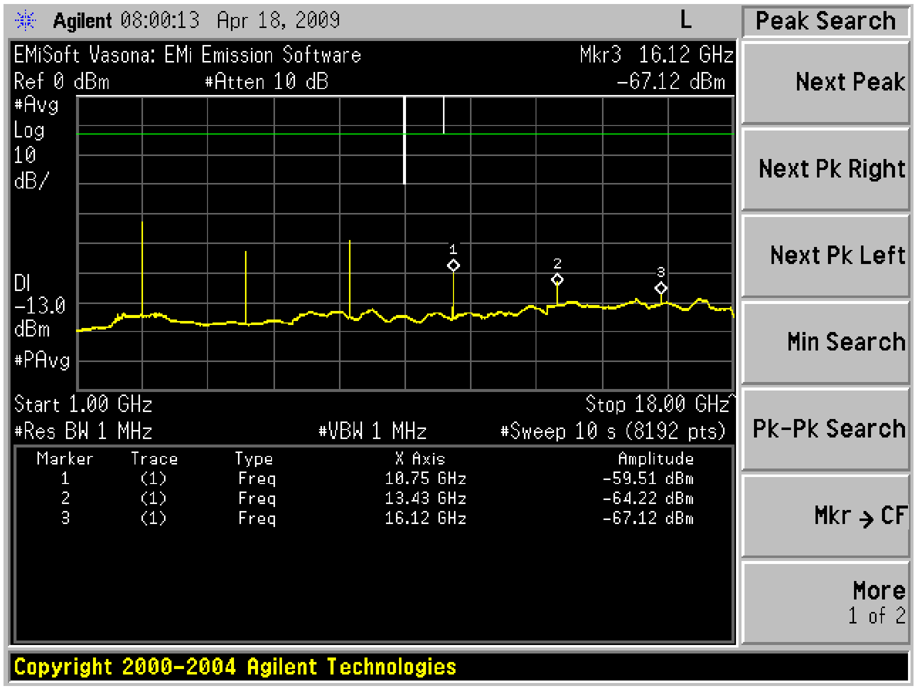


PLOT C-1.16 ***BW: 5 MHz, Modulation: PUSC, 64 QAM, F_o: 2687.25 MHz, Range:30 MHz- 1.0 GHz***

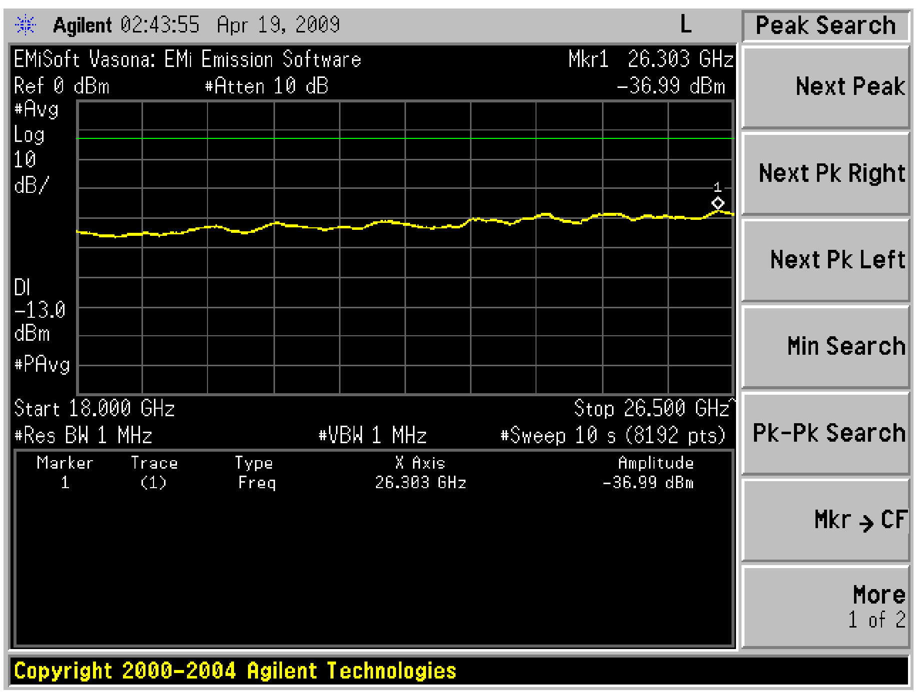


PLOT C-1.17 ***BW: 5 MHz, Modulation: PUSC, 64 QAM, F_o: 2687.25 MHz, Range:1.0 – 18.0 GHz***



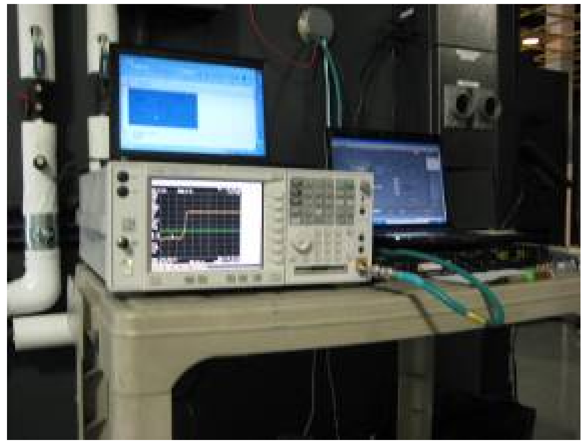


PLOT C-1.18 ***BW: 5MHz, Modulation: PUSC, 64 QAM, F_o: 2687.25 MHz, Range:18.0 – 26.5 GHz***



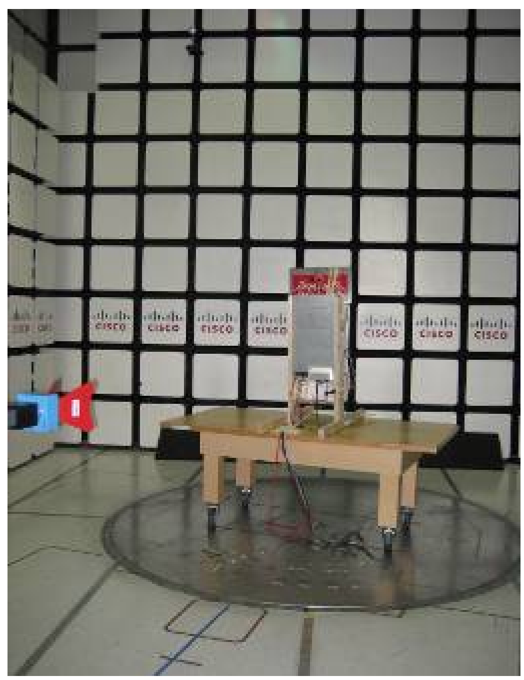
APPENDIX D. TEST SET-UP PHOTOS

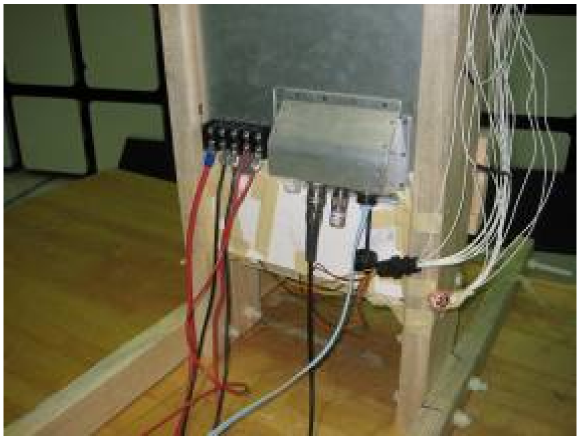
Band Edge, Spurious Emissions Setup:

Radiated Emission 1 GHz to 18 GHz

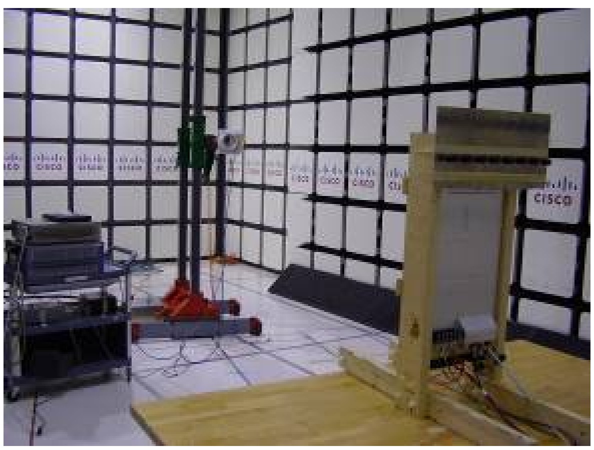

EUT Front side facing receiver antenna (Horn)

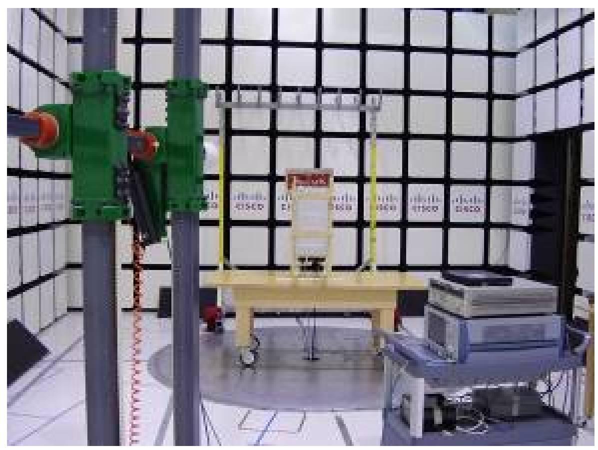

EUT Back side facing receiver antenna (Horn)


EUT Back side: Power & communication ports


EUT Back side: Antenna Terminations

Radiated Emission 18 GHz to 40 GHz





APPENDIX E. SCOPE OF ACCREDITATION

A2LA certificate number1178-01

Summary:

Radio

Building P: LP0002

Technical Requirements for the Radio Equipment of Other Services than the Other Broadcasting, Maritime, Aeronautical and Telecommunication Service (RRL No. 2007-80, October 17, 2007);
HKTA 1039
EN 302 326-2
EN 302 544-1
EN 302 544-2
EN 302 774
EN 302 623
CFR 47, Part 2
CFR 47, Part 15, Subpart C, using ANSI C63.4
CFR 47, Part 15.247
CFR 47, Part 15.407
CFR 47, Part 25, Subpart C
CFR 47, Part 27, Subpart D
CFR 47, Part 27, Subpart M
RSS-210
RSS-192
RSS-193
RSS-195

APPENDIX F. TEST EQUIPMENT / SOFTWARE USED TO PERFORM THE TEST

Equip #	Model	Manufacture	Description	Cal Due Date
CIS030654	JB1	Sunol Sciences	Combination Antenna, 30MHz-2GHz	6-Aug-09
CIS032801	3117	ETS-Lindgren	Double Ridged Waveguide Horn Antenna 1-18GHz	8-Aug-09
CIS030564	UFB311A-1-0950-504504	Micro-Coax	RF Coaxial Cable, to 18GHz, 95 in	18-Aug-09
CIS008448	NSA 5m Chamber	Cisco	NSA 5m Chamber	17-Oct-09
CIS038371	TH0118	Cisco	Mast Mount Preamplifier Array, 1-18GHz	14-Nov-09
CIS041935	iBTHP-5-DB9	Newport	5 inch Temp/RH/Press Sensor w/20ft cable	11-Feb-10
CIS044005	EM18-NKNK-320	MegaPhase	RF N Type Cable 18GHz	12-Feb-10
CIS044061	BRM15788	Micro-Tronics	Notch Filter, 3.40-3.80GHz	3-Apr-10
CIS044057	BRM15786	Micro-Tronics	Notch Filter, 2.495-2.690GHz	3-Apr-10
CIS040641	ESU26	Rohde & Schwarz	EMI Test Receiver	20-May-10
CIS035613	BRM50702-02	Micro-Tronics	Notch Filter, SB:2.4-2.5GHz, to 18GHz	8-Jun-10
CIS034075	RSG 2000	Schaffner	Reference Spectrum Generator, 1-18GHz	
CIS027236	CNE V	York	Comparison Noise Emitter	
CIS004883	3115	EMC Test Systems	Double Ridged Guide Horn Antenna	
CIS038397	UFB293C-Q-1200-50U50L	Micro-Coax	RF Coaxial Cable, 120 Inches, to 18GHz	11-Jul-09
CIS043315	HMM30C	Vaisala	Relative Humidity Sensor	26-Aug-09
CIS043303	8800	Thermotron	Controller	26-Aug-09
CIS043301	DR45AT-1100-00	Honeywell	Temperature Recorder	26-Aug-09
CIS040503	E4440A	Agilent	Precision Spectrum Analyzer	17-Oct-09
CIS036717	RF Coaxial Cable-SMA	Cisco	Radio Test Cable, SMA-SMA	11-Dec-09
CIS004927	NSP1000-S1	Miteq	Pre-Amplifier (1 to 10 GHz)	2-Feb-10
CIS044055	2	Aeroflex/Weinschel	Attenuator, 30dB, DC-18.0GHz	26-Mar-10
CIS025717	11500E	HP	Radio testing cable 3.5mm	30-Apr-10
CIS042006	BWS30W2+	Mini-Circuits	SMA 30dB Attenuator	28-May-10
CIS023770	UFB197C-1-0788-504504		RF Coaxial Cable, to 18GHz, 78.8 in S/N 01K1450	3/6/2010
CIS033988	E4446A	Agilent	PSA Spectrum Analyzer S/N US44300372	11/12/2009

NOTE: All equipment were within their calibration period when they were used during the evaluation testing.