Excellence in Compliance Testing

Certification Test Report

FCC ID: RAB-IM711-200

FCC Rule Part: 15.247

ACS Report Number: 13-0413.W03.1B

Manufacturer: Comverge Inc
Model: DirectLink WiFi

Test Begin Date: June 11, 2014
Test End Date: July 31, 2014

Report Issue Date: August 29, 2014

FOR THE SCOPE OF ACCREDITATION UNDER LAB Code 200612-0

This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the Federal Government.

Reviewed by:

Kirby Munroe
Director, Wireless Certifications
ACS, Inc.

This report contains 28 pages

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1 GENERAL

1.1 Purpose

The purpose of this report is to demonstrate compliance with Part 15 Subpart C of the FCC's Code of Federal Regulations and Industry Canada's Radio Standards Specification RSS-210 for single modular approval certification.

1.2 Product Description

The DirectLink WiFi is a pluggable radio module that can be plugged into and removed from a compatible device, such as a thermostat chassis.

Technical Information:

Detail	Description
Frequency Range	802.11b/g/n HT20: 2412 – 2462 MHz
Number of Channels	802.11b/g/n HT20: 11
Modulation Format	802.11b: DSSS (DBPSK / DQPSK / CCK) 802.11g/n: OFDM (BPSK / QPSK / 16QAM / 64QAM)
Data Rates	802.11b: 1 – 11 Mbps 802.11g: 6 – 54 Mbps 802.11n HT 20: 6.5 – 65 Mbps
Number of Inputs/Outputs	1T1R
Operating Voltage	3.3Vdc
Antenna Type / Gain	Ceramic Chip Antenna / 0.5dBi

Manufacturer Information:
Comverge Inc
5390 Triangle Pkwy Suite 300
Norcross GA, 30092

Test Sample Serial Number: FCC #1

Test Sample Condition: The test samples were provided in good working order with no visible defects.

1.3 Test Methodology and Considerations

Testing was performed to determine worst-case mode of operation with respect to modulation and data rate. The following table details the parameters used for testing.

Table 1.3-1: Test Parameters

Mode of Operation	Data Rate (Mbps)	Channels Evaluated
802.11b	1	1, 6, 11
802.11g	6	1, 6, 11
802.11n HT20	6.5 (MCS0)	1, 6, 11

For the purpose of providing power and test mode programming, the EUT was evaluated connected to a test board.

For radiated emissions the EUT was tested in multiple orientations. The worst-case orientation was Y-position. The data provided in this report reflects the worst-case orientation and mode of operation.

2 TEST FACILITIES

2.1 Location

The radiated and conducted emissions test sites are located at the following address:

Advanced Compliance Solutions
5015 B.U. Bowman Drive
Buford, GA 30518
Phone: (770) 831-8048
Fax: (770) 831-8598

2.2 Laboratory Accreditations/Recognitions/Certifications

ACS is accredited to ISO/IEC 17025 by the National Institute of Standards and Technology under their National Voluntary Laboratory Accreditation Program (NVLAP), Lab Code 200612-0. Unless otherwise specified, all tests methods described within this report are covered under the ISO/IEC 17025 scope of accreditation.

The Semi-Anechoic Chamber Test Site, Open Area Test Site (OATS) and Conducted Emissions Site have been fully described, submitted to, and accepted by the FCC, Industry Canada and the Japanese Voluntary Control Council for Interference by information technology equipment.

FCC Registration Number: 511277
Industry Canada Lab Code: IC 4175A
VCCI Member Number: 1831

- VCCI OATS Registration Number R-1526
- VCCI Conducted Emissions Site Registration Number: C-1608

2.3 Radiated Emissions Test Site Description

2.3.1 Semi-Anechoic Chamber Test Site

The Semi-Anechoic Chamber Test Site consists of a 20' x 30' x 18' shielded enclosure. The chamber is lined with Toyo Ferrite Grid Absorber, model number FFG-1000. The ferrite tile grid is 101 x 101 x 19mm thick and weighs approximately 550 grams. These tiles are mounted on steel panels and installed directly on the inner walls of the chamber.

The turntable is 150cm in diameter and is located 160cm from the back wall of the chamber. The chamber is grounded via 1 - 8' copper ground rod, installed at the center of the back wall, it is bound to the ground plane using 3/4" stainless steel braided cable.

The turntable is all steel, flush mounted table installed in an all steel frame. The table is remotely operated from inside the control room located 25' from the range. The turntable is electrically bonded to the surrounding ground plane via steel fingers installed on the edge of the turn table. The steel fingers make constant contact with the ground plane during operation.

Behind the turntable is a 3' x 6' x 4' deep shielded pit used for support equipment if necessary. The pit is equipped with 1 - 4" PVC chases from the turntable to the pit that allow for cabling to the EUT if necessary. The underside of the turntable can be accessed from the pit so cables can be supplied to the EUT from the pit.

A diagram of the Semi-Anechoic Chamber Test Site is shown in Figure 2.3-1 below:

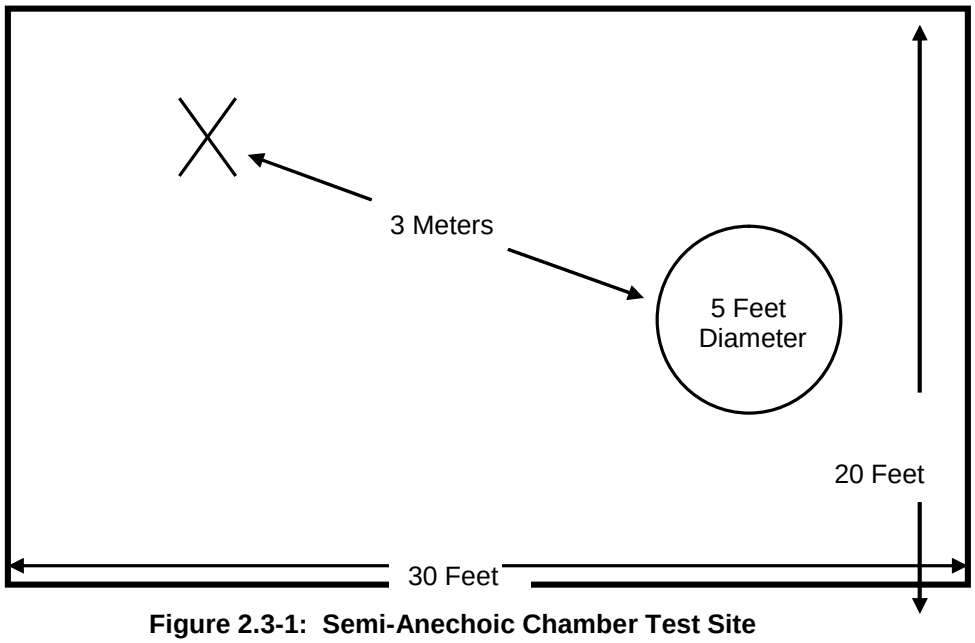

Figure 2.3-1: Semi-Anechoic Chamber Test Site

2.3.2 Open Area Tests Site (OATS)

The open area test site consists of a 40' x 66' concrete pad covered with a perforated electro-plated galvanized sheet metal. The perforations in the sheet metal are 1/8" holes that are staggered every 3/16". The individual sheets are placed to overlap each other by 1/4" and are riveted together to provide a continuous seam. Rivets are spaced every 3" in a 3 x 20 meter perimeter around the antenna mast and EUT area. Rivets in the remaining area are spaced as necessary to properly secure the ground plane and maintain the electrical continuity.

The entire ground plane extends 12' beyond the turntable edge and 16' beyond the antenna mast when set to a 10 meter measurement distance. The ground plane is grounded via 4 - 8' copper ground rods, each installed at a corner of the ground plane and bound to the ground plane using 3/4" stainless steel braided cable.

The turntable is an all aluminum 10' flush mounted table installed in an all aluminum frame. The table is remotely operated from inside the control room located 40' from the range. The turntable is electrically bonded to the surrounding ground plane via steel fingers installed on the edge of the turn table. The steel fingers make constant contact with the ground plane during operation.

Adjacent to the turntable is a 7' x 7' square and 4' deep concrete pit used for support equipment if necessary. The pit is equipped with 5 - 4" PVC chases from the pit to the control room that allow for cabling to the EUT if necessary. The underside of the turntable can be accessed from the pit so cables can be supplied to the EUT from the pit. The pit is covered with 2 sheets of 1/4" diamond style re-enforced steel sheets. The sheets are painted to match the perforated steel ground plane; however the underside edges have been masked off to maintain the electrical continuity of the ground plane. All reflecting objects are located outside of the ellipse defined in ANSI C63.4.

A diagram of the Open Area Test Site is shown in Figure 2.3-2 below:

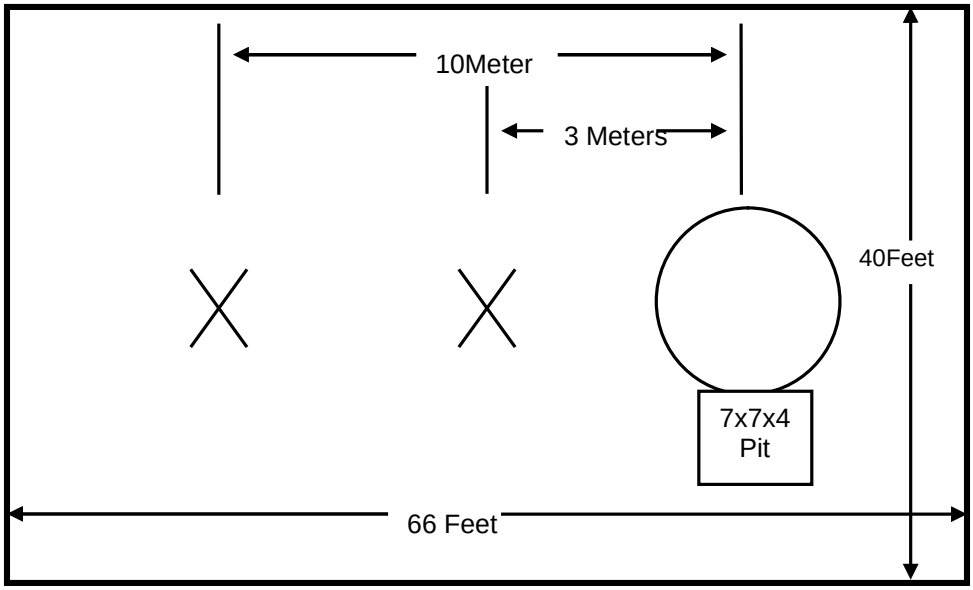

Figure 2.3-2: Open Area Test Site

2.4 Conducted Emissions Test Site Description

The AC mains conducted EMI site is located in the main EMC lab. It consists of an 8' x 8' solid aluminum horizontal ground reference plane (GRP) bonded every 3" to an 8' X 8' vertical ground plane.

The site is of sufficient size to test table top and floor standing equipment in accordance with section 6.1.4 of ANSI C63.4.

A diagram of the room is shown below in figure 4.1.3-1:

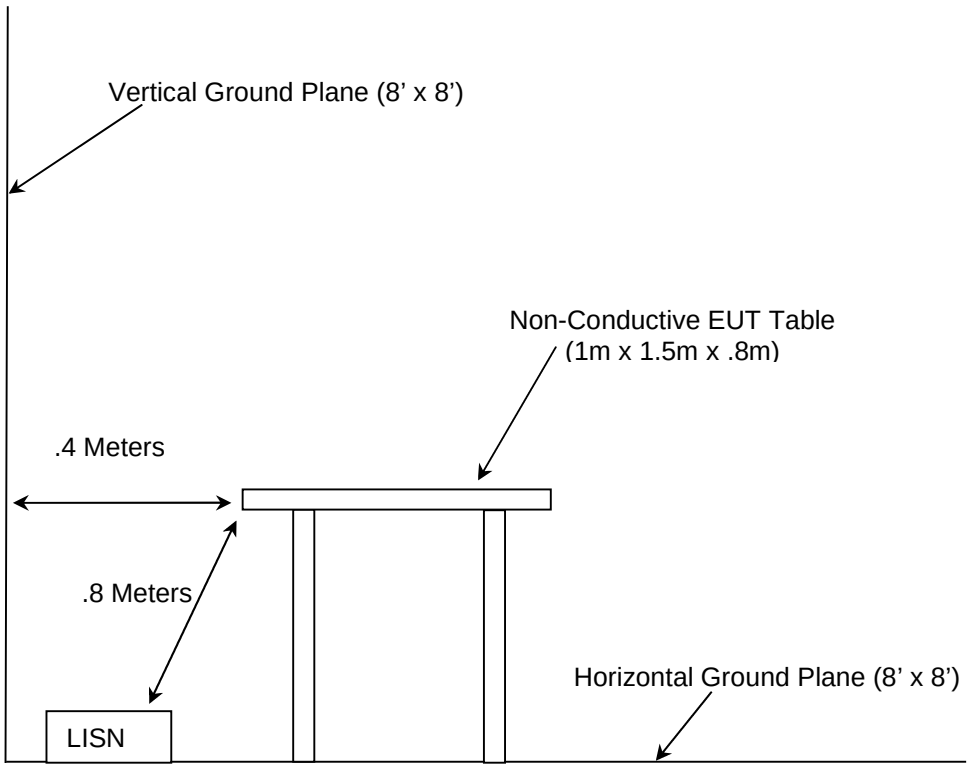

Figure 2.4-1: AC Mains Conducted EMI Site

3 APPLICABLE STANDARD REFERENCES

The following standards were used:

- ANSI C63.4-2009: American National Standard for Methods of Measurement of Radio-Noise Emissions from low-voltage electrical and electronic equipment in the range of 9kHz to 40 GHz
- ANSI C63.10-2009: American National Standard for Testing Unlicensed Wireless Devices
- US Code of Federal Regulations (CFR): Title 47, Part 2, Subpart J: Equipment Authorization Procedures, 2014
- US Code of Federal Regulations (CFR): Title 47, Part 15, Subpart C: Radio Frequency Devices, Intentional Radiators, 2014
- FCC KDB 558074 D01 DTS Meas Guidance v03r01 - Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247, April 9, 2013
- Industry Canada Radio Standards Specification: RSS-210 - Low-power License-exempt Radiocommunication Devices (All Frequency Bands): Category I Equipment, Issue 8, Dec 2010
- Industry Canada Radio Standards Specification: RSS-GEN – General Requirements and Information for the Certification of Radiocommunication Equipment, Issue 3, Dec 2010.

4 LIST OF TEST EQUIPMENT

The calibration interval of test equipment is annually or the manufacturer's recommendations. Where the calibration interval deviates from the annual cycle based on the instrument manufacturer's recommendations, it shall be stated below.

Table 4-1: Test Equipment

AssetID	Manufacturer	Model #	Equipment Type	Serial #	Last Calibration Date	Calibration Due Date
1	Rohde & Schwarz	ESMI - Display	Spectrum Analyzers	833771/007	8/2/2012	8/2/2014
1	Rohde & Schwarz	ESMI - Display	Spectrum Analyzers	833771/007	7/11/2014	7/11/2016
2	Rohde & Schwarz	ESMI-Receiver	Spectrum Analyzers	839587/003	8/2/2012	8/2/2014
2	Rohde & Schwarz	ESMI-Receiver	Spectrum Analyzers	839587/003	7/11/2014	8/2/2014
30	Spectrum Technologies	DRH-0118	Antennas	970102	4/23/2013	4/23/2015
40	EMCO	3104	Antennas	3211	2/14/2013	2/14/2015
73	Agilent	8447D	Amplifiers	2727A05624	7/16/2013	7/16/2014
73	Agilent	8447D	Amplifiers	2727A05624	7/15/2014	7/15/2015
167	ACS	Chamber EMI Cable Set	Cable Set	167	11/7/2013	11/7/2014
168	Hewlett Packard	11947A	Attenuators	44829	1/27/2014	1/27/2015
267	Agilent	N1911A	Meters	MY45100129	7/30/2013	7/30/2015
268	Agilent	N1921A	Sensors	MY45240184	7/30/2013	7/30/2015
277	Emco	93146	Antennas	9904-5199	8/24/2012	8/24/2014
292	Florida RF Cables	SMR-290AW-480.0-SMR	Cables	None	3/17/2014	3/17/2015
316	Rohde Schwarz	ESH3-Z5	LISN	861189-010	8/15/2013	8/15/2015
324	ACS	Belden	Cables	8214	6/4/2014	6/4/2015
334	Rohde&Schwarz	3160-09	Antennas	49404	11/4/2010	NCR
335	Suhner Sucoflex	SF-102A	Cables	882/2A	7/29/2013	7/29/2014
338	Hewlett Packard	8449B	Amplifiers	3008A01111	7/30/2013	7/30/2015
340	Aeroflex/Weinschel	AS-20	Attenuators	7136	7/14/2014	7/14/2015
345	Suhner Sucoflex	102A	Cables	1077/2A	7/29/2013	7/29/2014
422	Florida RF	SMS-200AW-72.0-SMR	Cables	805	11/7/2013	11/7/2014
432	Microwave Circuits	H3G020G4	Filters	264066	6/2/2014	6/2/2015
616	Florida RF Cables	SMRE-200W-12.0-SMRE	Cables	N/A	9/26/2013	9/26/2014
622	Rohde & Schwarz	FSV40	Analyzers	101338	11/19/2013	11/19/2014
RE361	Agilent	AT/E7405A	Analyzers	MY42000089	5/30/2014	5/30/2016

Note: All testing was performed during the active calibration cycle of the equipment used.

5 SUPPORT EQUIPMENT

Table 5-1: Support Equipment

Item	Equipment Type	Manufacturer	Model Number	Serial Number
1	Evaluation Board	Comverge	MCI Extender Board	475347-01
2	Wall Wart Power Supply	Meanwell	GPSU15U-0	N/A

6 EQUIPMENT UNDER TEST SETUP BLOCK DIAGRAM

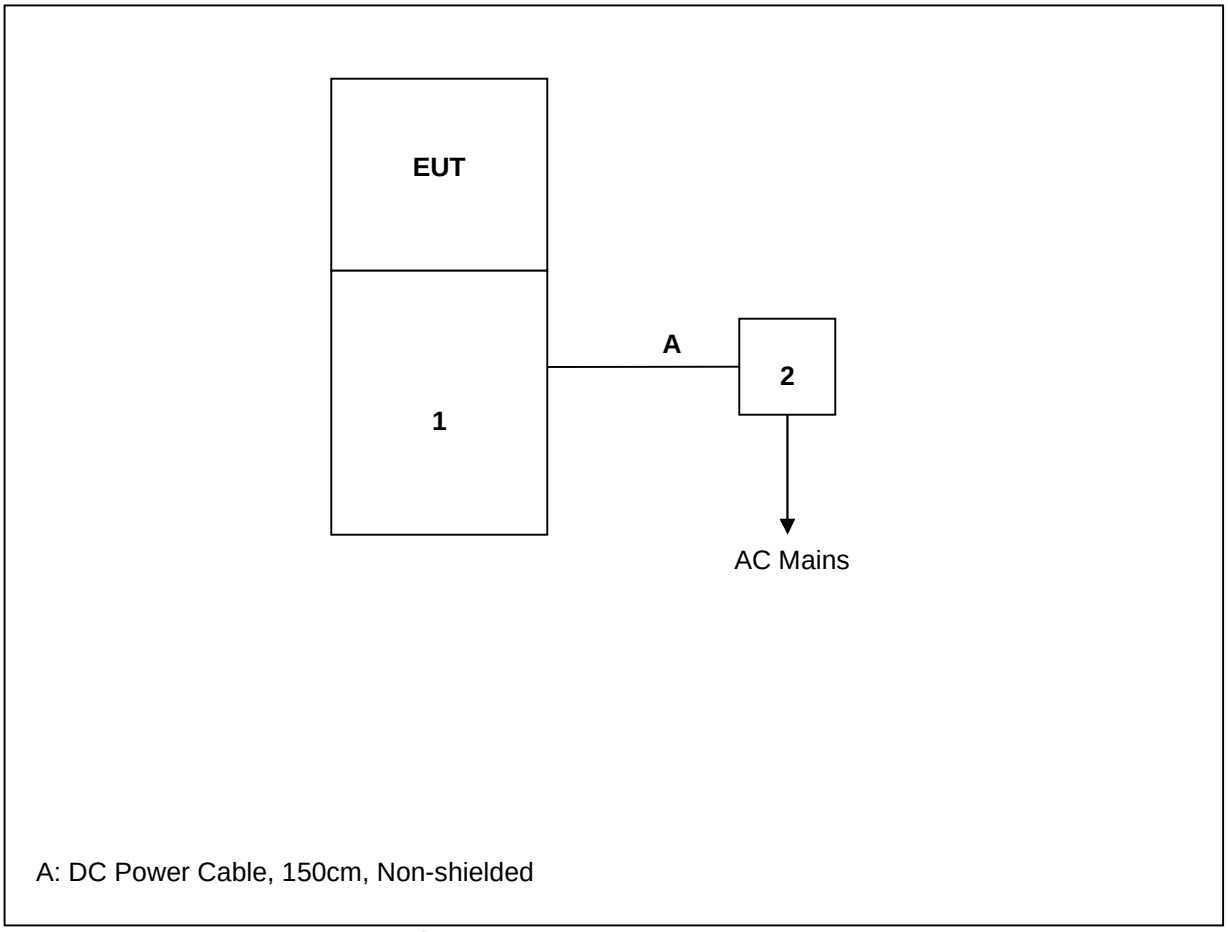

Figure 6-1: EUT Test Setup

7 SUMMARY OF TESTS

Along with the tabular data shown below, plots were taken of all signals deemed important enough to document.

7.1 Antenna Requirement – FCC 15.203

The EUT utilizes an SM ceramic antenna. The antenna is integral to the device and cannot be removed or replaced by the end user. The gain of the antenna is 0.5dBi.

7.2 Power Line Conducted Emissions – FCC 15.207, IC: RSS-Gen 7.2.4

7.2.1 Measurement Procedure

Conducted emissions were performed from 150kHz to 30MHz with the spectrum analyzer's resolution bandwidth set to 9kHz and the video bandwidth set to 30kHz. The calculation for the conducted emissions is as follows:

Corrected Reading = Analyzer Reading + LISN Loss + Cable Loss
Margin = Applicable Limit - Corrected Reading

7.2.2 Measurement Results

Results of the test are shown below in Tables 7.2.2-1 – 7.2.2-2.

Table 7.2.2-1: Conducted EMI Results – Line 1

Frequency (MHz)	Uncorrected Reading		Total Correction Factor (dB)	Corrected Level		Limit		Margin (dB)	
	Quasi-Peak	Average		Quasi-Peak	Average	Quasi-Peak	Average	Quasi-Peak	Average
0.151381	35.803	27.423	10.209	46.011	37.631	65.961	55.961	19.949	18.329
0.5123	13.843	10.701	10.202	24.045	20.904	56	46	31.955	25.096
0.56675	22.36	19.948	10.213	32.573	30.161	56	46	23.427	15.839
3.34612	16.51	13.764	10.343	26.852	24.107	56	46	29.148	21.893
4.99605	7.425	3.416	10.34	17.765	13.756	56	46	38.235	32.244
5.0078	7.378	3.449	10.34	17.718	13.789	60	50	42.282	36.211

Table 7.2.2-2: Conducted EMI Results – Line 2

Frequency (MHz)	Uncorrected Reading		Total Correction Factor (dB)	Corrected Level		Limit		Margin (dB)	
	Quasi-Peak	Average		Quasi-Peak	Average	Quasi-Peak	Average	Quasi-Peak	Average
0.160888	36.155	28.087	10.209	46.364	38.296	65.689	55.689	19.325	17.392
0.245338	28.093	20.823	10.18	38.273	31.003	63.276	53.276	25.003	22.273
0.5162	14.598	11.597	10.202	24.799	21.799	56	46	31.201	24.201
0.565468	23.226	20.937	10.207	33.432	31.144	56	46	22.568	14.856
3.53231	17.306	14.824	10.215	27.52	25.039	56	46	28.48	20.961
4.9991	7.941	4.097	10.21	18.151	14.307	56	46	37.849	31.693

7.3 6dB / 99% Bandwidth – FCC 15.247(a)(2), IC: RSS-210 A8.2(a)

7.3.1 Measurement Procedure

The 6dB bandwidth was measured in accordance with the FCC KDB 558074 D01 DTS Meas Guidance v03r01. The Resolution Bandwidth (RBW) of the spectrum analyzer was set to 100 kHz. The Video Bandwidth (VBW) was set to ≥ 3 times the RBW. The trace was set to max hold with a peak detector active. The marker-delta function of the spectrum analyzer was utilized to determine the 6 dB bandwidth of the emission.

The occupied bandwidth measurement function of the spectrum analyzer was used to measure the 99% bandwidth. The span of the analyzer was set to capture all products of the modulation process, including the emission sidebands. The resolution bandwidth was set to as close to 1% of the selected span as is possible without being below 1%. The video bandwidth was set to 3 times the resolution bandwidth. A sampling detector was used.

7.3.2 Measurement Results

Results are shown below in Tables 7.3.2-1 to 7.3.2-3 and Figures 7.3.2-1 to 7.3.2-18:

Table 7.3.2-1: 6dB / 99% Bandwidth – 802.11b

Frequency [MHz]	6dB Bandwidth [MHz]	99% Bandwidth [MHz]
2412	8.068	12.981
2437	8.518	12.981
2462	8.548	12.981

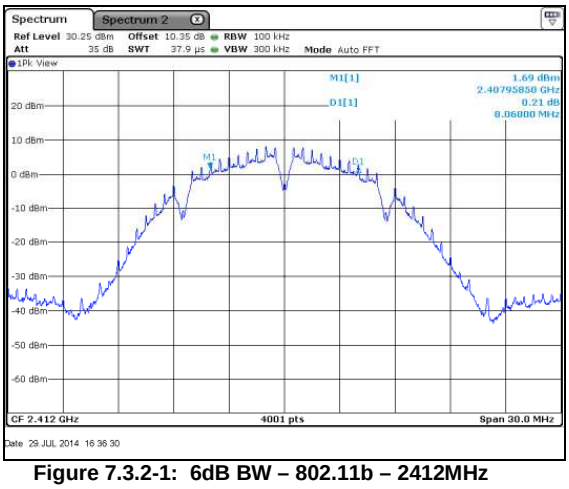

Figure 7.3.2-1: 6dB BW – 802.11b – 2412MHz

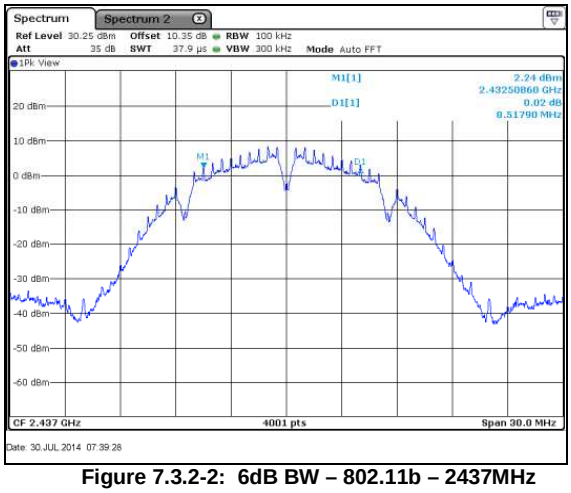

Figure 7.3.2-2: 6dB BW – 802.11b – 2437MHz

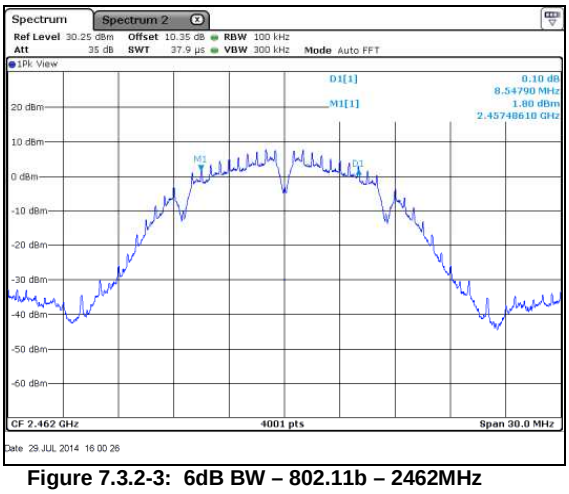

Figure 7.3.2-3: 6dB BW – 802.11b – 2462MHz

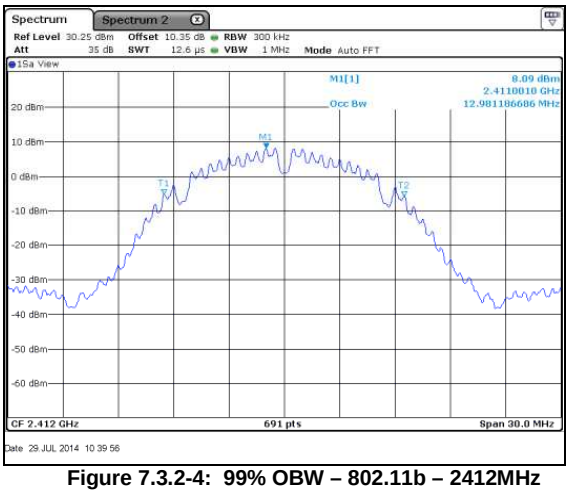

Figure 7.3.2-4: 99% OBW – 802.11b – 2412MHz

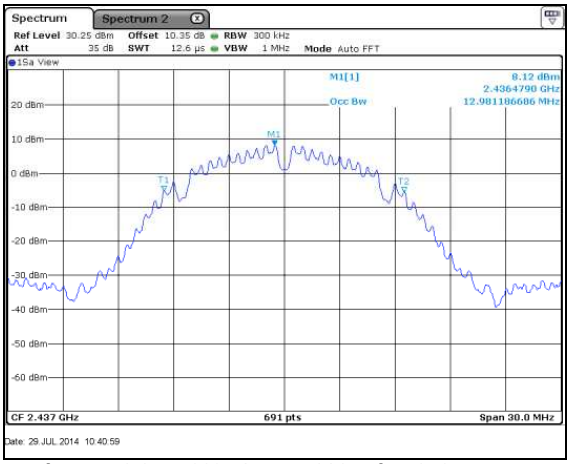

Figure 7.3.2-5: 99% OBW – 802.11b – 2437MHz

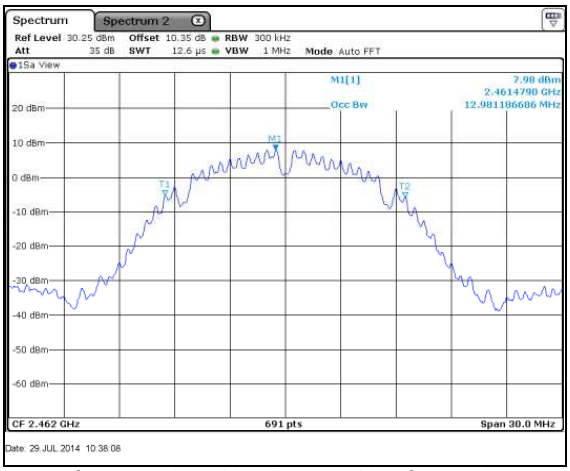

Figure 7.3.2-6: 99% OBW – 802.11b – 2462MHz

Table 7.3.2-2: 6dB / 99% Bandwidth – 802.11g

Frequency [MHz]	6dB Bandwidth [MHz]	99% Bandwidth [MHz]
2412	15.116	16.628
2437	15.116	16.628
2462	15.109	16.498

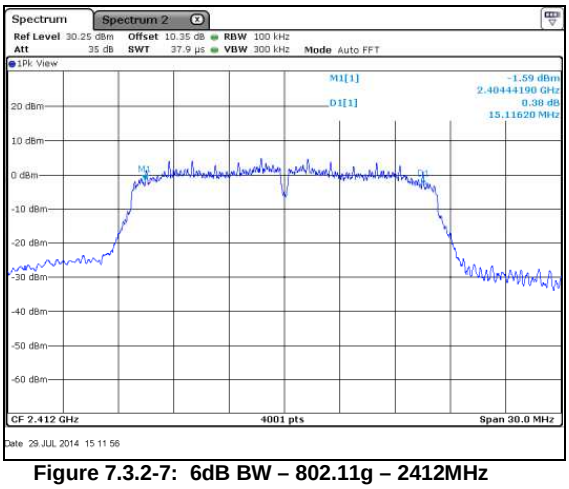

Figure 7.3.2-7: 6dB BW – 802.11g – 2412MHz

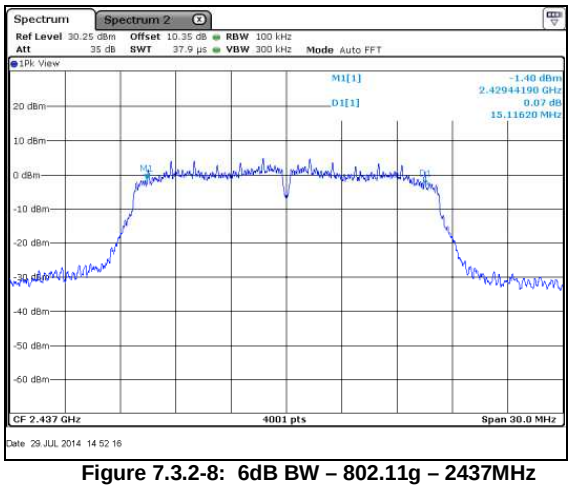

Figure 7.3.2-8: 6dB BW – 802.11g – 2437MHz

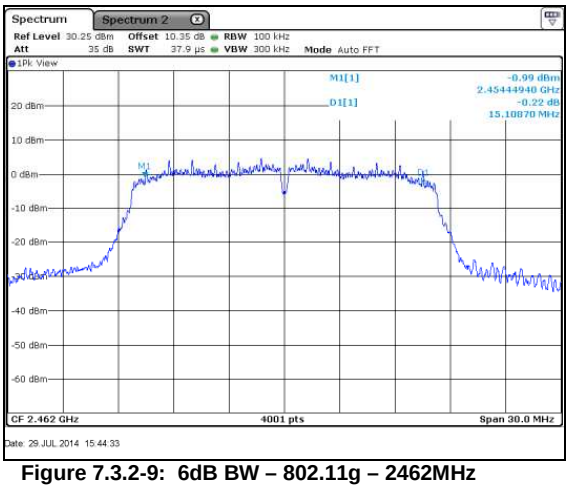

Figure 7.3.2-9: 6dB BW – 802.11g – 2462MHz

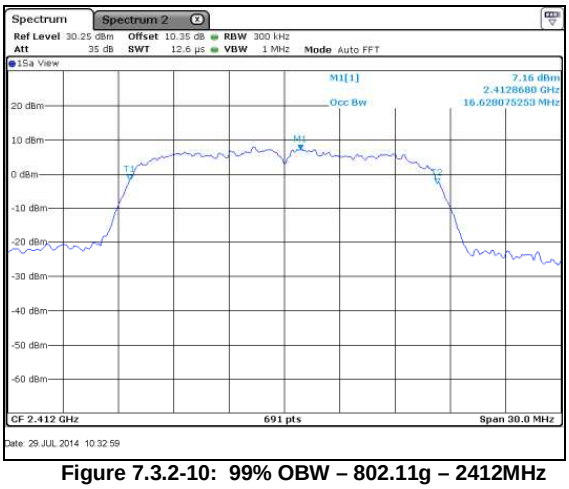

Figure 7.3.2-10: 99% OBW – 802.11g – 2412MHz

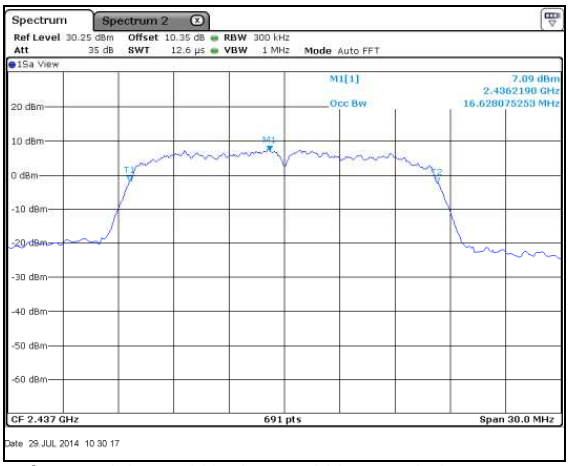

Figure 7.3.2-11: 99% OBW – 802.11g – 2437MHz

Figure 7.3.2-12: 99% OBW – 802.11g – 2462MHz

Table 7.3.2-3: 6dB / 99% Bandwidth – 802.11n HT20

Frequency [MHz]	6dB Bandwidth [MHz]	99% Bandwidth [MHz]
2412	15.116	17.453
2437	15.109	17.453
2462	15.109	17.496

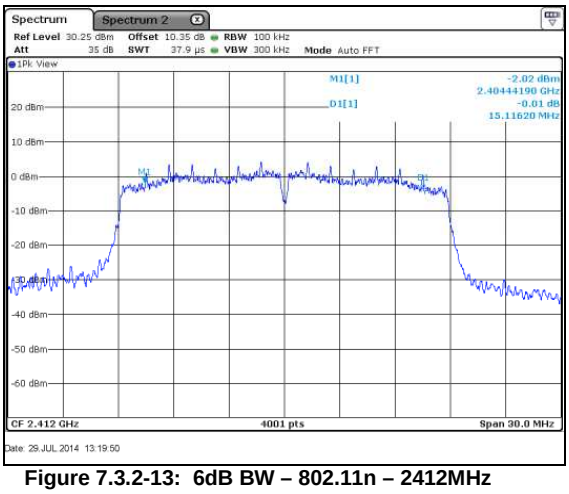

Figure 7.3.2-13: 6dB BW – 802.11n – 2412MHz

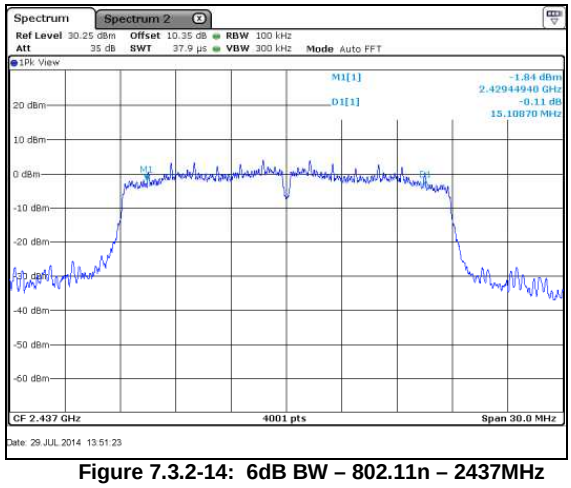

Figure 7.3.2-14: 6dB BW – 802.11n – 2437MHz

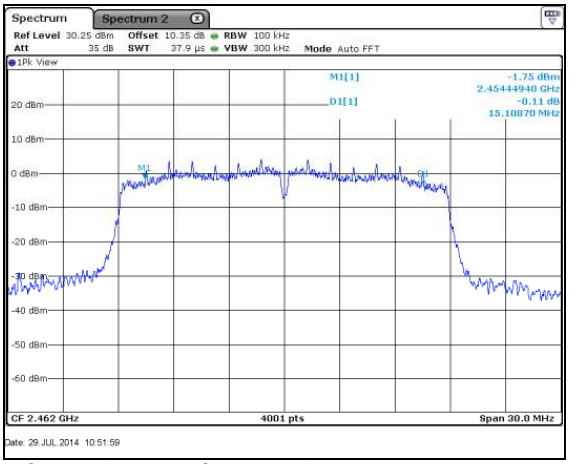

Figure 7.3.2-15: 6dB BW – 802.11n – 2462MHz

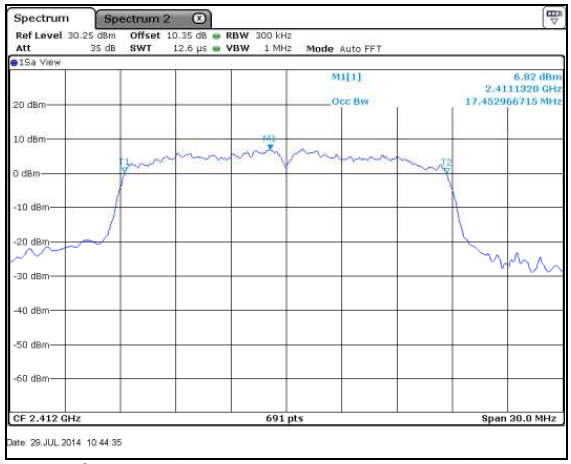

Figure 7.3.2-16: 99% OBW – 802.11n – 2412MHz

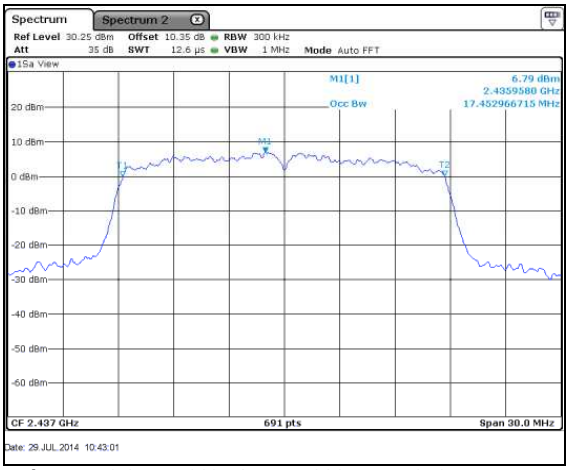

Figure 7.3.2-17: 99% OBW – 802.11n – 2437MHz

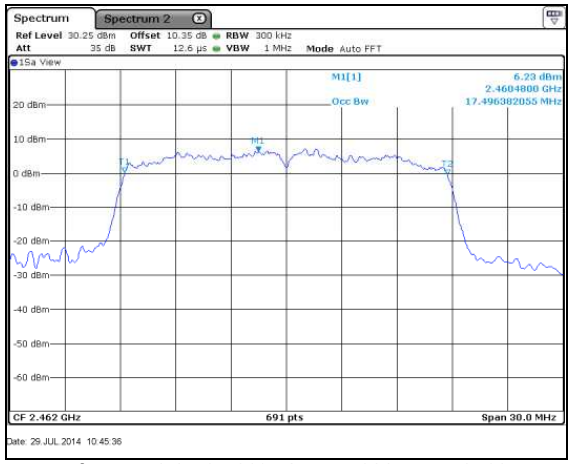

Figure 7.3.2-18: 99% OBW – 802.11n – 2462MHz

7.4 Fundamental Emission Output Power – FCC 15.247(b)(3), IC: RSS-210 A8.4(4)

7.4.1 Measurement Procedure

The maximum peak conducted output power was measured in accordance with FCC KDB 558074 D01 DTS Meas Guidance v03r01 utilizing the PKPM1 Peak power meter method. The RF output of the equipment under test was directly connected to the input of the peak power meter applying suitable attenuation.

7.4.2 Measurement Results

Results are shown below in Tables 7.4.2-1 to 7.4.2-3.

Table 7.4.2-1: Maximum Peak Conducted Output Power – 802.11b

Frequency (MHz)	Output Power (dBm)
2412	19.13
2437	19.08
2462	19.12

Table 7.4.2-2: Maximum Peak Conducted Output Power – 802.11g

Frequency (MHz)	Output Power (dBm)
2412	25.33
2437	25.30
2462	25.01

Table 7.4.2-3: Maximum Peak Conducted Output Power – 802.11n HT20

Frequency (MHz)	Output Power (dBm)
2412	25.21
2437	25.14
2462	24.69

7.5 Emission Levels – FCC 15.247(d), 15.205, 15.209; IC RSS-210 2.2/A8.5, RSS-Gen 7.2.2

7.5.1 Emissions into Non-restricted Frequency Bands

7.5.1.1 Measurement Procedure

The unwanted emissions into non-restricted bands were measured conducted in accordance with FCC KDB 558074 D01 DTS Meas Guidance v03r01. The RF output of the equipment under test was directly connected to the input of the spectrum analyzer applying suitable attenuation. The Resolution Bandwidth (RBW) of the spectrum analyzer was set to 100 kHz. The Video Bandwidth (VBW) was set to ≥ 300 kHz. Span was set to 1.5 times the DTS bandwidth. The trace was set to max hold with a peak detector active. The resulting spectrum analyzer peak level was used to determine the reference level with respect to the 20 dBc limit. The spectrum span was then adjusted for the measurement of spurious emissions from 30MHz to 25GHz, 10 times the highest fundamental frequency.

Band-edge compliance was determined using the conducted marker-delta method in which the radio frequency power that is produced by the EUT is at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of desired power.

7.5.1.2 Measurement Results

RF Conducted Emissions are displayed in Figures 7.5.1.2-1 through 7.5.1.2-33.

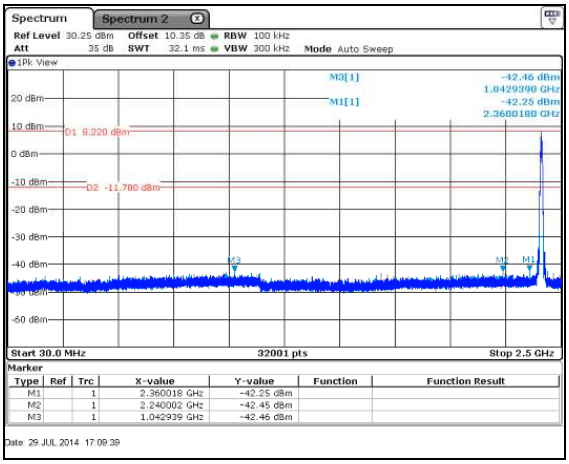

Figure 7.5.1.2-1: 802.11b – 2412MHz – 30MHz – 2.5GHz

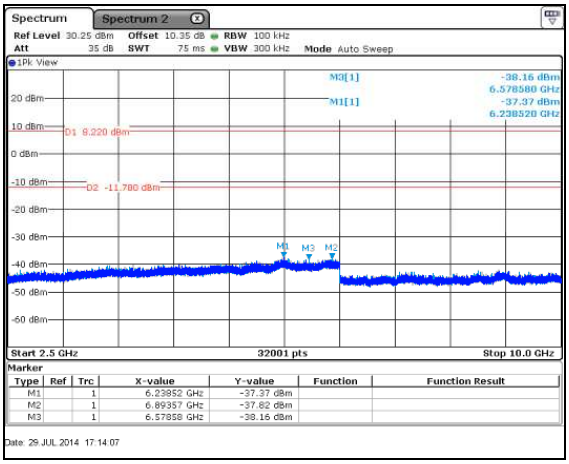

Figure 7.5.1.2-2: 802.11b – 2412MHz – 2.5GHz – 10GHz

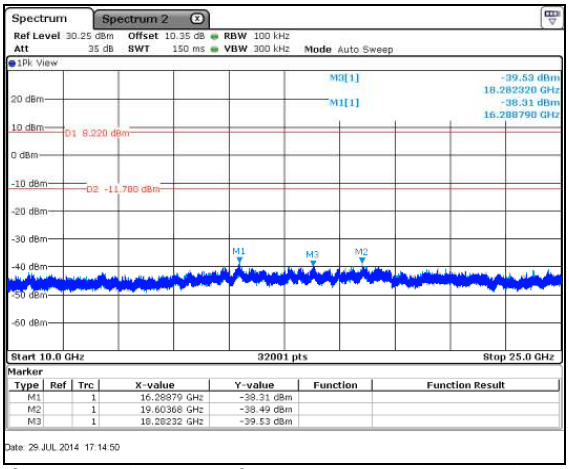

Figure 7.5.1.2-3: 802.11b – 2412MHz – 10GHz – 25GHz

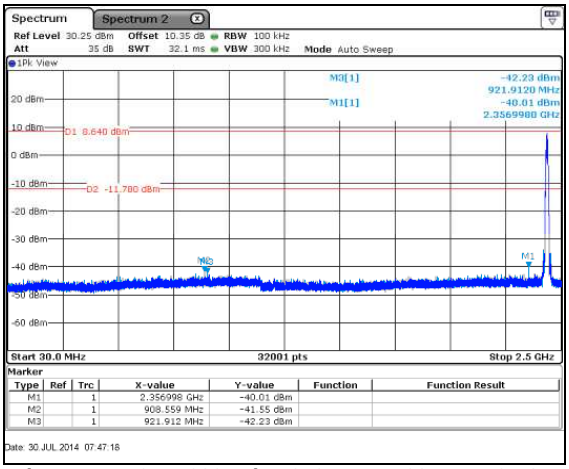

Figure 7.5.1.2-4: 802.11b – 2437MHz – 30MHz – 2.5GHz

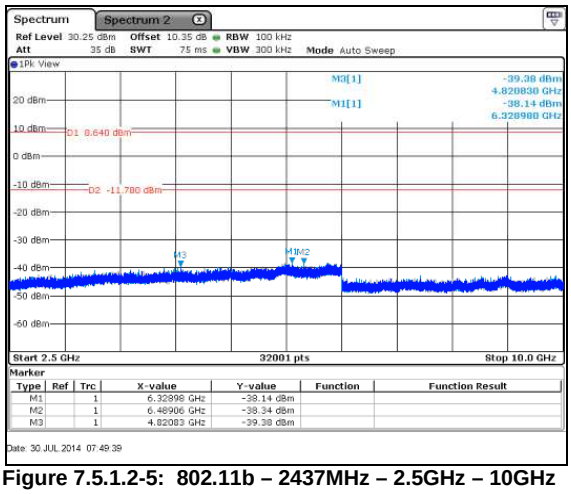

Figure 7.5.1.2-5: 802.11b – 2437MHz – 2.5GHz – 10GHz

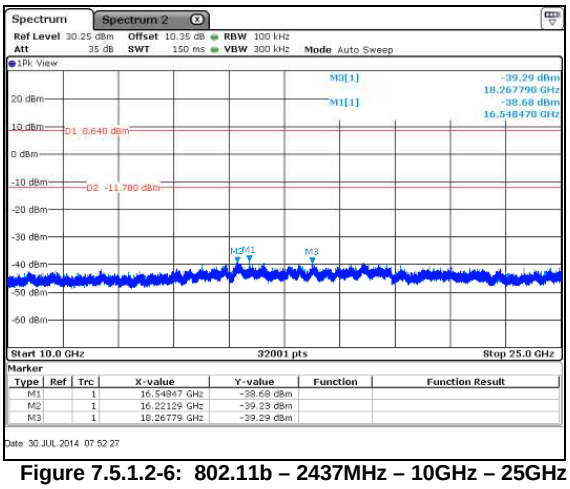

Figure 7.5.1.2-6: 802.11b – 2437MHz – 10GHz – 25GHz

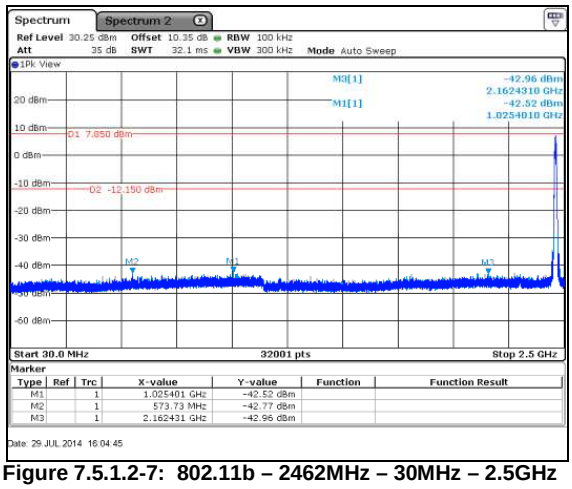

Figure 7.5.1.2-7: 802.11b – 2462MHz – 30MHz – 2.5GHz

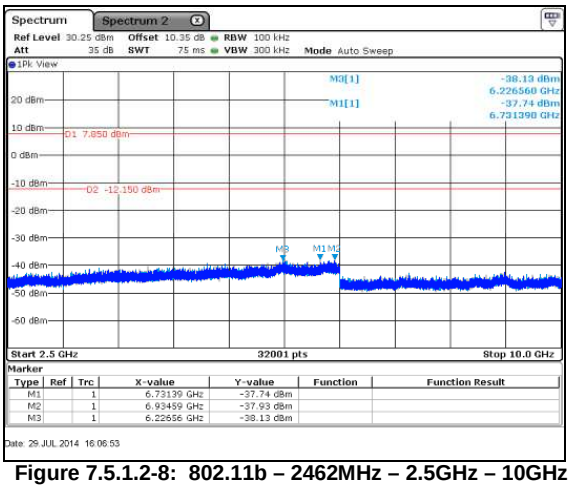

Figure 7.5.1.2-8: 802.11b – 2462MHz – 2.5GHz – 10GHz

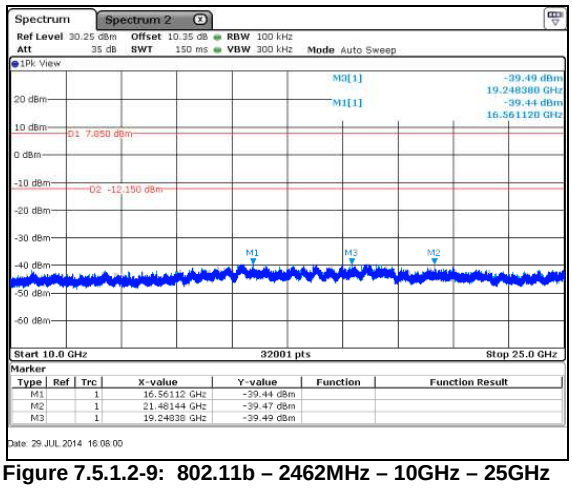

Figure 7.5.1.2-9: 802.11b – 2462MHz – 10GHz – 25GHz

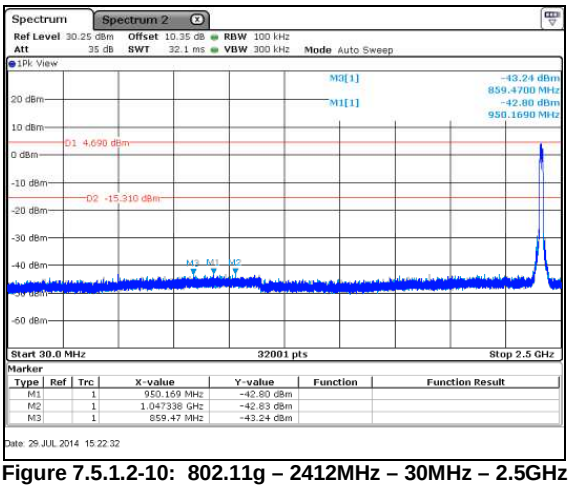

Figure 7.5.1.2-10: 802.11g – 2412MHz – 30MHz – 2.5GHz

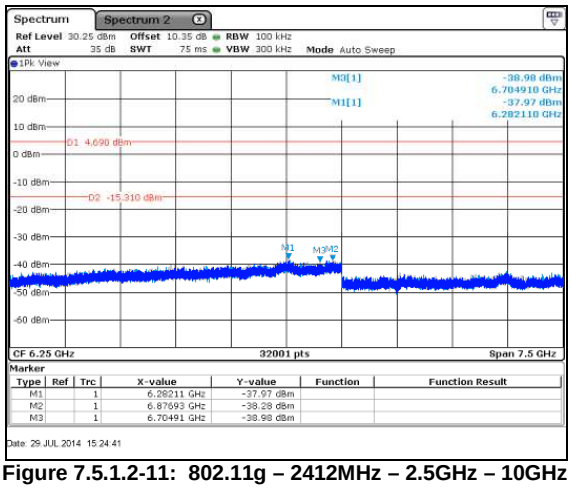

Figure 7.5.1.2-11: 802.11g – 2412MHz – 2.5GHz – 10GHz

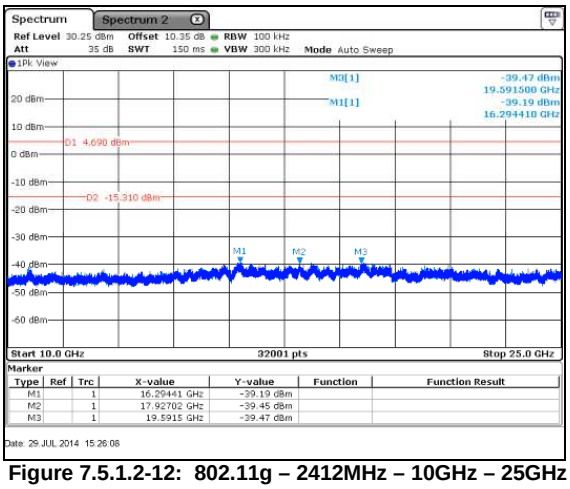

Figure 7.5.1.2-12: 802.11g – 2412MHz – 10GHz – 25GHz

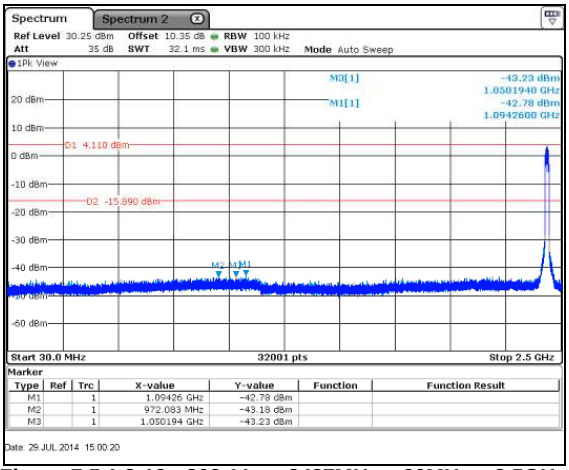

Figure 7.5.1.2-13: 802.11g – 2437MHz – 30MHz – 2.5GHz

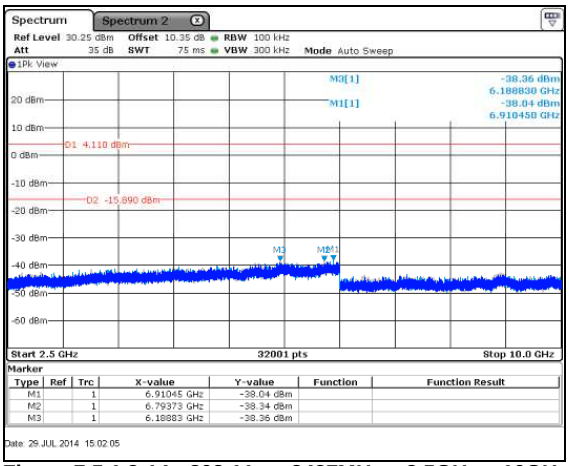

Figure 7.5.1.2-14: 802.11g – 2437MHz – 2.5GHz – 10GHz

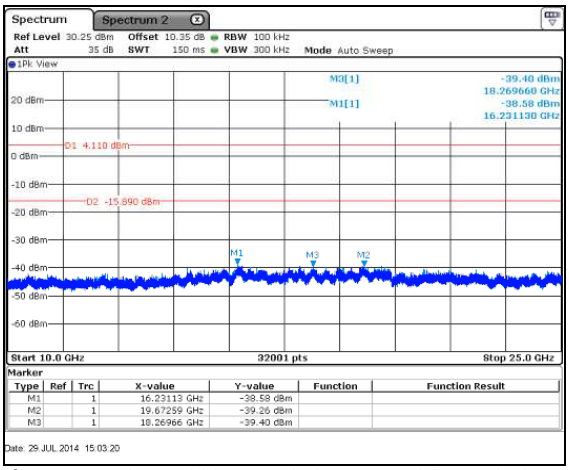

Figure 7.5.1.2-15: 802.11g – 2437MHz – 10GHz – 25GHz

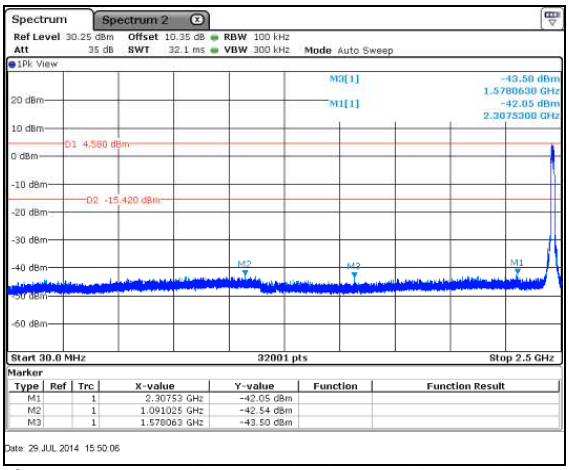

Figure 7.5.1.2-16: 802.11g – 2462MHz – 30MHz – 2.5GHz

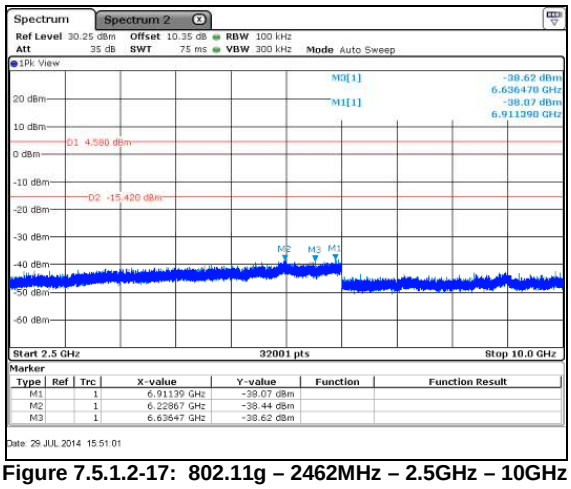

Figure 7.5.1.2-17: 802.11g – 2462MHz – 2.5GHz – 10GHz

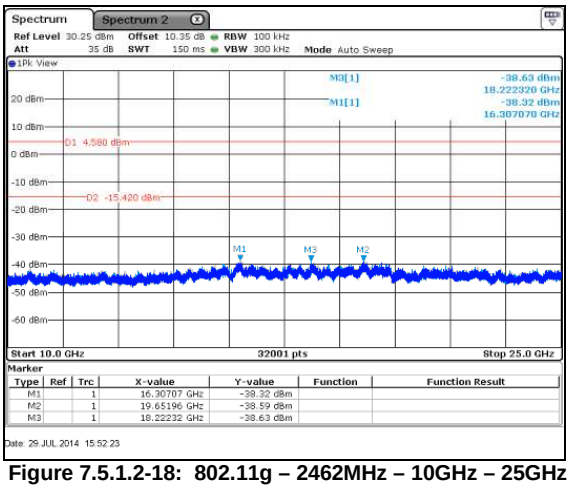

Figure 7.5.1.2-18: 802.11g – 2462MHz – 10GHz – 25GHz

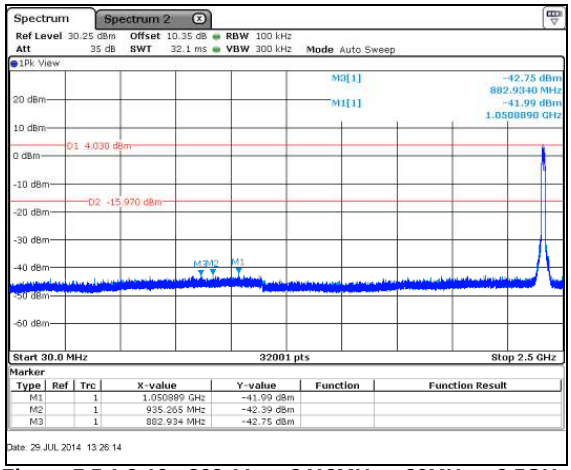

Figure 7.5.1.2-19: 802.11n – 2412MHz – 30MHz – 2.5GHz

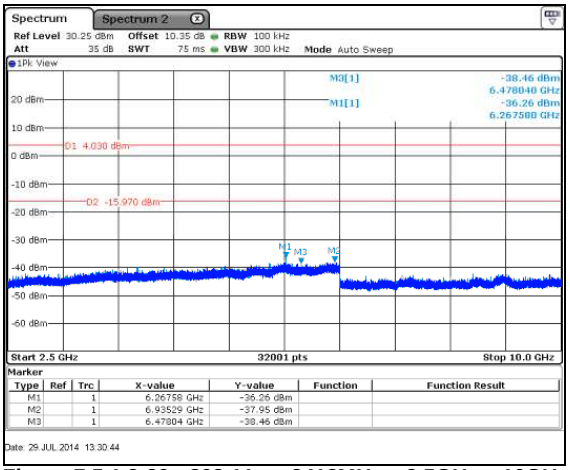

Figure 7.5.1.2-20: 802.11n – 2412MHz – 2.5GHz – 10GHz

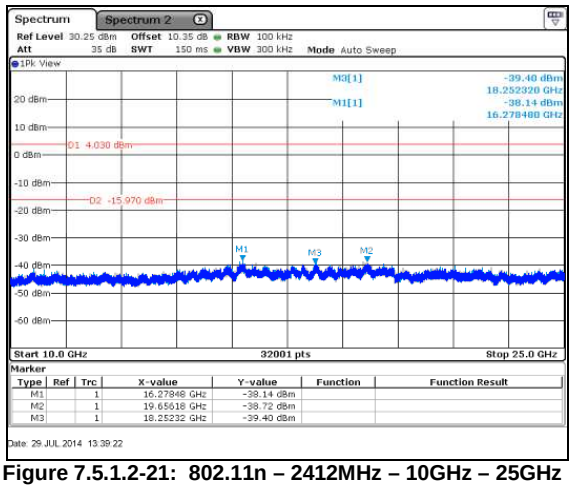

Figure 7.5.1.2-21: 802.11n – 2412MHz – 10GHz – 25GHz

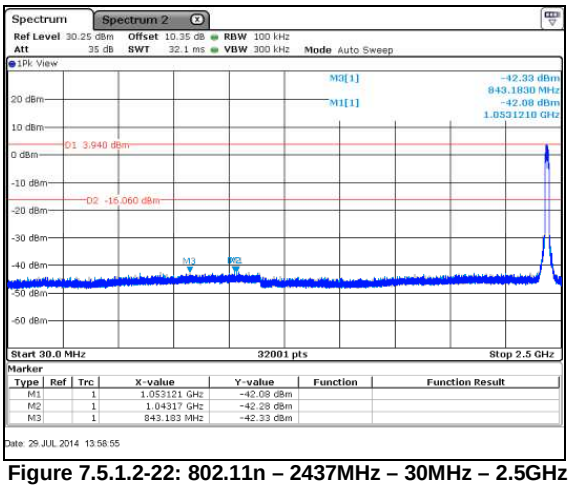

Figure 7.5.1.2-22: 802.11n – 2437MHz – 30MHz – 2.5GHz

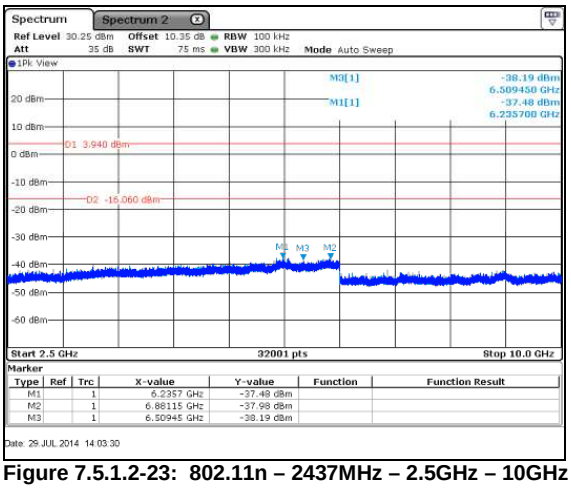

Figure 7.5.1.2-23: 802.11n – 2437MHz – 2.5GHz – 10GHz

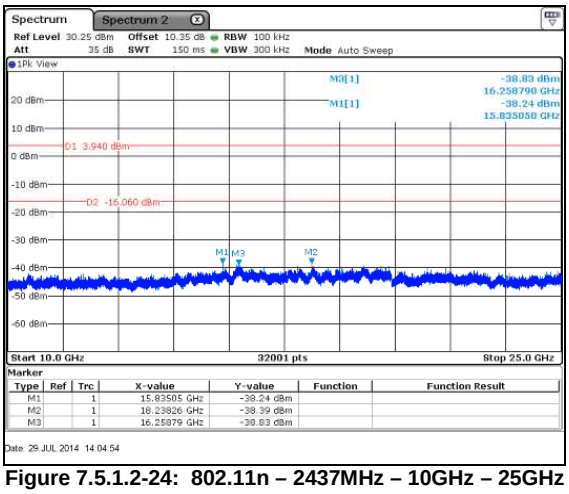

Figure 7.5.1.2-24: 802.11n – 2437MHz – 10GHz – 25GHz

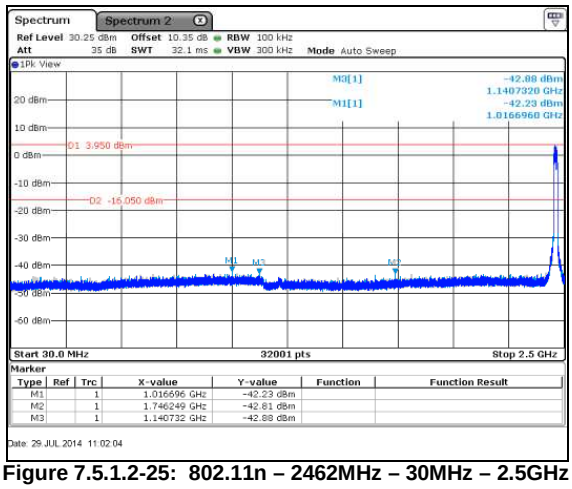

Figure 7.5.1.2-25: 802.11n – 2462MHz – 30MHz – 2.5GHz

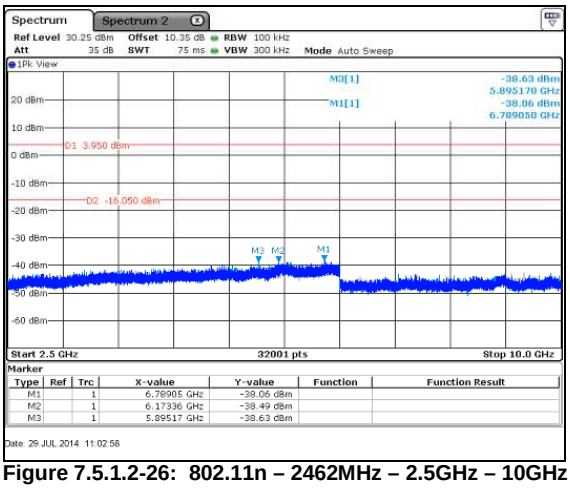

Figure 7.5.1.2-26: 802.11n – 2462MHz – 2.5GHz – 10GHz

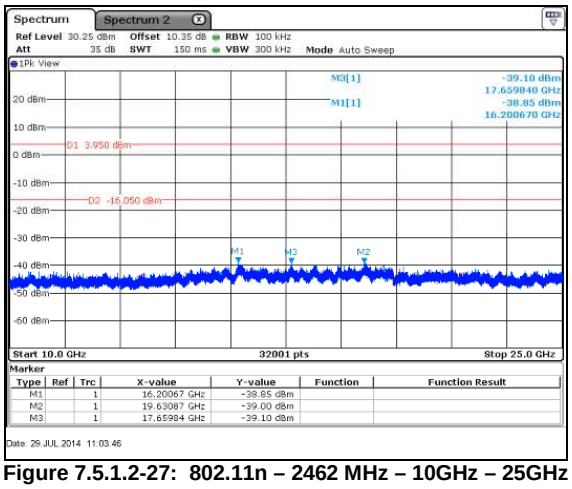

Figure 7.5.1.2-27: 802.11n – 2462 MHz – 10GHz – 25GHz

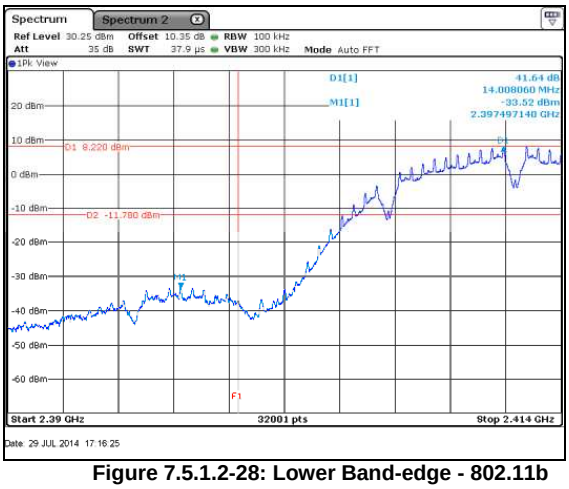

Figure 7.5.1.2-28: Lower Band-edge - 802.11b

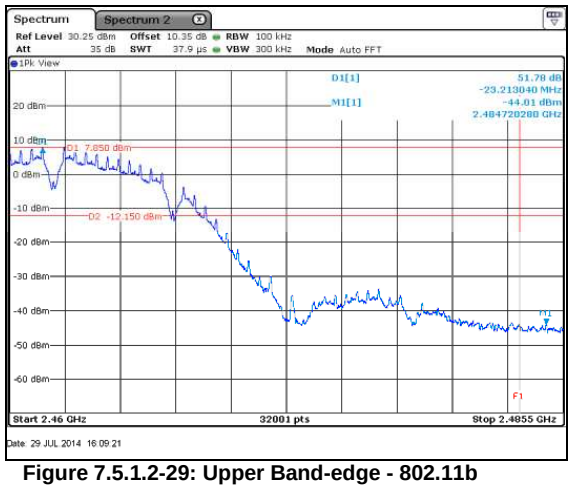

Figure 7.5.1.2-29: Upper Band-edge - 802.11b

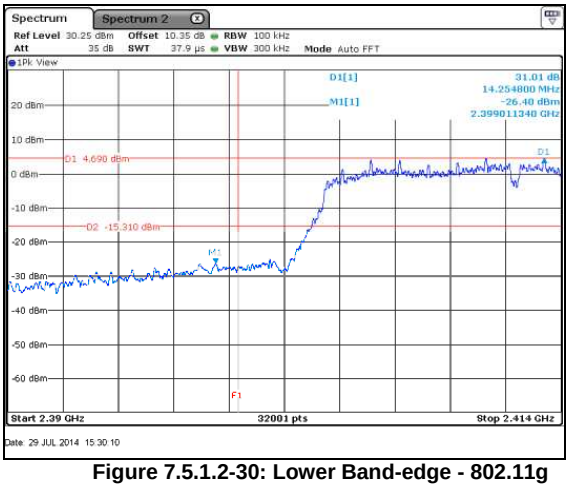

Figure 7.5.1.2-30: Lower Band-edge - 802.11g

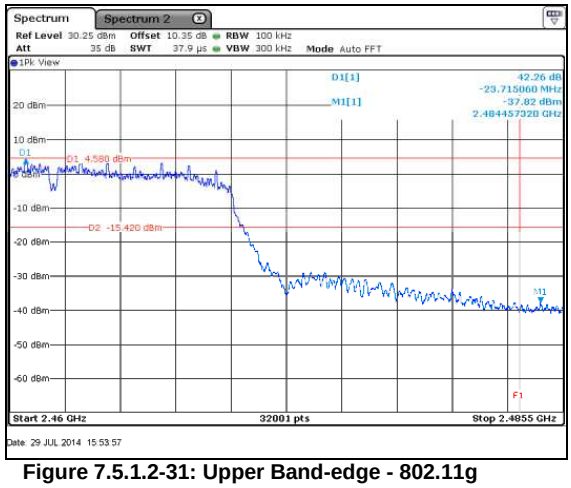

Figure 7.5.1.2-31: Upper Band-edge - 802.11g

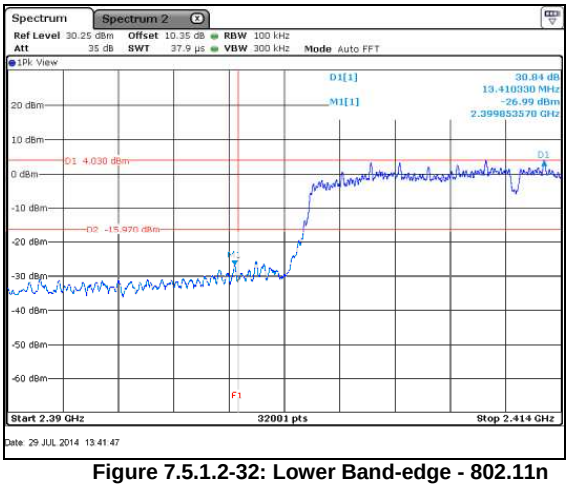

Figure 7.5.1.2-32: Lower Band-edge - 802.11n

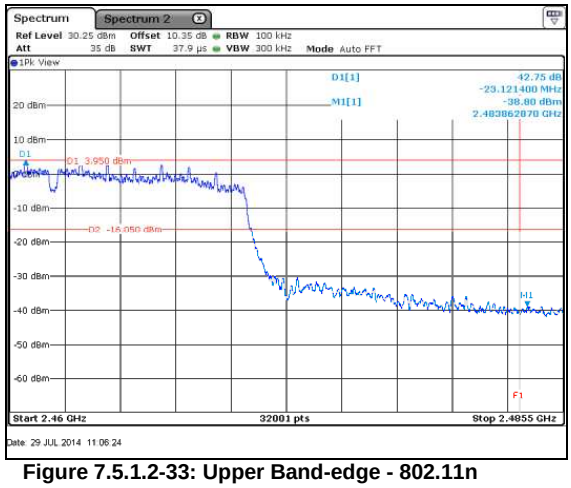

Figure 7.5.1.2-33: Upper Band-edge - 802.11n

7.5.2 Emissions into Restricted Frequency Bands

7.5.2.1 Measurement Procedure

The unwanted emissions into restricted bands were measured radiated over the frequency range of 30MHz to 25GHz, 10 times the highest fundamental frequency.

The EUT was rotated through 360° and the receive antenna height was varied from 1m to 4m so that the maximum radiated emissions level would be detected. For frequencies below 1000MHz, quasi-peak measurements were made using a resolution bandwidth RBW of 120 kHz and a video bandwidth VBW of 300 kHz. For frequencies above 1000MHz, peak and average measurements were made with RBW and VBW of 1 MHz and 3 MHz respectively.

Each emission found to be in a restricted band as defined by section 15.205, including any emission at the operational band-edge, was compared to the radiated emission limits as defined in section 15.209.

7.5.2.2 Measurement Results

Radiated spurious emissions found in the band of 30MHz to 25GHz are reported in the Tables 7.5.2.2-1 to 7.5.2.2-3 below.

Table 7.5.2.2-1: Radiated Spurious Emissions Tabulated Data – 802.11b

Frequency (MHz)	Level (dBuV)		Antenna Polarity	Correction Factors	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	pk	Qpk/Avg	(H/V)	(dB)	pk	Qpk/Avg	pk	Qpk/Avg	pk	Qpk/Avg
2412 MHz										
2390	51.44	39.34	H	-6.39	45.05	32.95	74.0	54.0	28.9	21.0
2390	54.20	42.54	V	-6.39	47.81	36.15	74.0	54.0	26.2	17.8
3617.93	49.84	40.72	H	-1.20	48.64	39.52	74.0	54.0	25.4	14.5
4824	50.21	43.53	H	1.74	51.95	45.27	74.0	54.0	22.0	8.7
4824	48.39	41.77	V	1.74	50.13	43.51	74.0	54.0	23.9	10.5
2437 MHz										
3655.47	49.41	40.74	H	-1.03	48.38	39.71	74.0	54.0	25.6	14.3
4874	49.35	42.59	H	1.84	51.19	44.43	74.0	54.0	22.8	9.6
4874	48.22	39.68	V	1.84	50.06	41.52	74.0	54.0	23.9	12.5
2462 MHz										
2483.5	48.24	36.63	H	-5.88	42.36	30.75	74.0	54.0	31.6	23.2
2483.5	50.85	39.12	V	-5.88	44.97	33.24	74.0	54.0	29.0	20.8
3692.88	49.23	40.87	H	-0.86	48.37	40.01	74.0	54.0	25.6	14.0
4924	50.40	42.67	H	1.94	52.34	44.61	74.0	54.0	21.7	9.4
4924	48.93	40.72	V	1.94	50.87	42.66	74.0	54.0	23.1	11.3

Table 7.5.2.2-2: Radiated Spurious Emissions Tabulated Data – 802.11g

Frequency (MHz)	Level (dBuV)		Antenna Polarity	Correction Factors	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	pk	Qpk/Avg	(H/V)	(dB)	pk	Qpk/Avg	pk	Qpk/Avg	pk	Qpk/Avg
2412 MHz										
2390	76.44	53.97	H	-6.39	70.05	47.58	74.0	54.0	3.9	6.4
2390	80.11	58.28	V	-6.39	73.72	51.89	74.0	54.0	0.3	2.1
4824	48.15	35.61	H	1.74	49.89	37.35	74.0	54.0	24.1	16.6
4824	46.49	34.70	V	1.74	48.23	36.44	74.0	54.0	25.8	17.6
2437 MHz										
3655.47	49.61	40.67	H	-1.03	48.58	39.64	74.0	54.0	25.4	14.4
4874	47.24	35.16	H	1.84	49.08	37.00	74.0	54.0	24.9	17.0
2462 MHz										
2483.5	64.20	45.54	H	-5.88	58.32	39.66	74.0	54.0	15.7	14.3
2483.5	68.11	50.01	V	-5.88	62.23	44.13	74.0	54.0	11.8	9.9
3692.88	49.10	41.05	H	-0.86	48.24	40.19	74.0	54.0	25.8	13.8

Table 7.5.2.2-3: Radiated Spurious Emissions Tabulated Data – 802.11n

Frequency (MHz)	Level (dBuV)		Antenna Polarity	Correction Factors	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	pk	Qpk/Avg	(H/V)	(dB)	pk	Qpk/Avg	pk	Qpk/Avg	pk	Qpk/Avg
2412 MHz										
2390	69.71	48.54	H	-6.39	63.32	42.15	74.0	54.0	10.7	11.8
2390	75.03	54.20	V	-6.39	68.64	47.81	74.0	54.0	5.4	6.2
2437 MHz										
3655.47	49.12	40.74	H	-1.03	48.09	39.71	74.0	54.0	25.9	14.3
2462 MHz										
2483.5	66.94	47.37	H	-5.88	61.06	41.49	74.0	54.0	12.9	12.5
2483.5	68.32	49.43	V	-5.88	62.44	43.55	74.0	54.0	11.6	10.4
3692.88	49.39	40.62	H	-0.86	48.53	39.76	74.0	54.0	25.5	14.2

7.5.2.3 Sample Calculation:

$R_C = R_U + CF_T$

Where:

CF_T = Total Correction Factor (AF+CA+AG)-DC (Average Measurements Only)
R_U = Uncorrected Reading
R_C = Corrected Level
AF = Antenna Factor
CA = Cable Attenuation
AG = Amplifier Gain
DC = Duty Cycle Correction Factor

Example Calculation: Peak

Corrected Level: 51.44 + -6.39 = 45.05dBuV/m
Margin: 74dBuV/m – 45.05dBuV/m = 28.9dB

Example Calculation: Average

Corrected Level: 39.34 + -6.39 - 0 = 32.95dBuV
Margin: 54dBuV – 32.95dBuV = 21.0dB

7.6 Maximum Power Spectral Density in the Fundamental Emission – FCC 15.247(e) IC: RSS-210 A8.2(b)

7.6.1 Measurement Procedure

The power spectral density was measured in accordance with the FCC KDB 558074 D01 DTS Meas Guidance v03r01 utilizing the PKPSD (peak PSD) method. The RF output of the equipment under test was directly connected to the input of the spectrum analyzer applying suitable attenuation. The Resolution Bandwidth (RBW) of the spectrum analyzer was set to 3 kHz. The Video Bandwidth (VBW) was set to 10 kHz. Span was set to 1.5 times the DTS bandwidth. The trace was set to max hold with a peak detector active.

7.6.2 Measurement Results

Results are shown below in Tables 7.6.2-1 to 7.6.2-3 and Figures 7.6.2-1 – 7.6.2-9.

Table 7.6.2-1: Power Spectral Density – 802.11b

Frequency (MHz)	PSD Level (dBm)
2412	-3.69
2437	-3.82
2462	-4.30

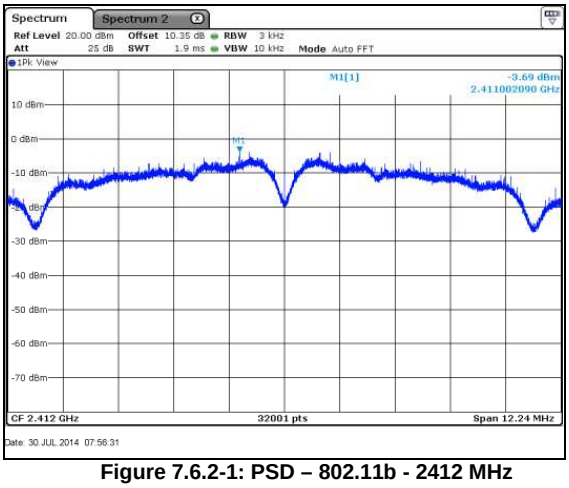

Figure 7.6.2-1: PSD – 802.11b - 2412 MHz

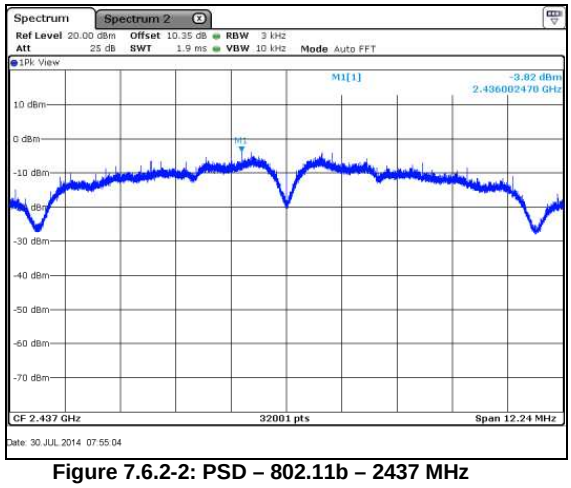

Figure 7.6.2-2: PSD – 802.11b – 2437 MHz

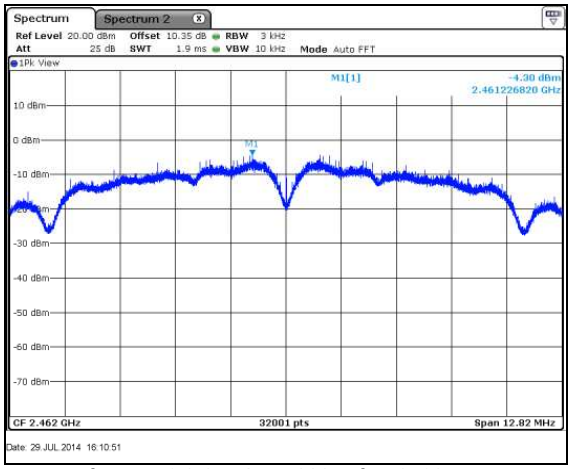

Figure 7.6.2-3: PSD – 802.11b – 2462 MHz

Table 7.6.2-2: Power Spectral Density – 802.11g

Frequency (MHz)	PSD Level (dBm)
2412	-8.23
2437	-8.12
2462	-7.61

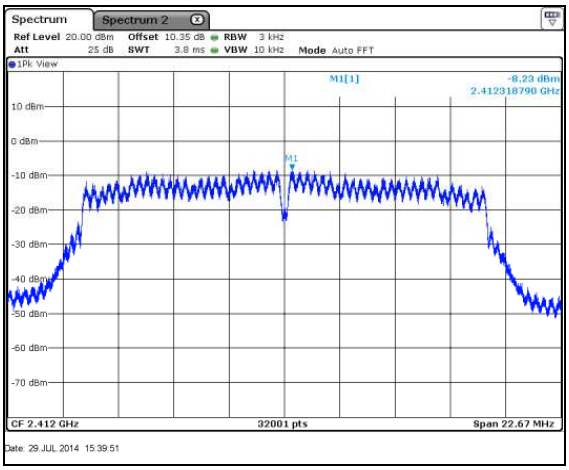

Figure 7.6.2-4: PSD – 802.11g - 2412 MHz

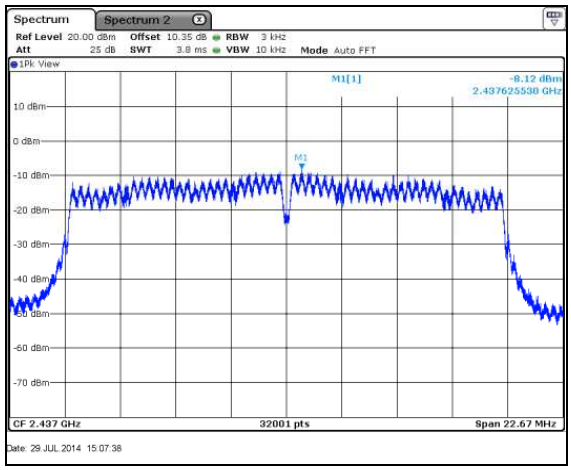

Figure 7.6.2-5: PSD – 802.11g – 2437 MHz

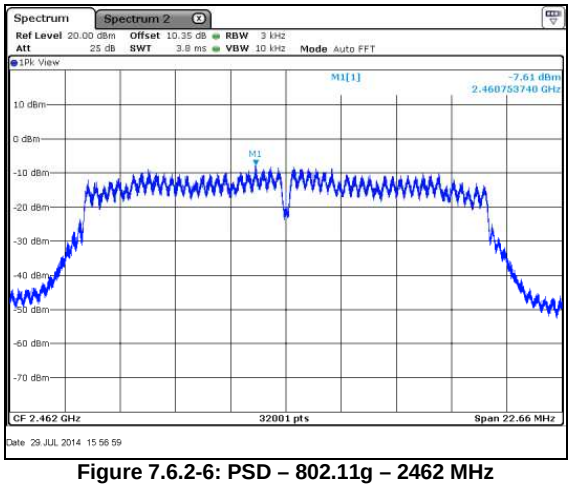

Figure 7.6.2-6: PSD – 802.11g – 2462 MHz

Table 7.6.2-3: Power Spectral Density – 802.11n

Frequency (MHz)	PSD Level (dBm)
2412	-8.11
2437	-8.90
2462	-7.89

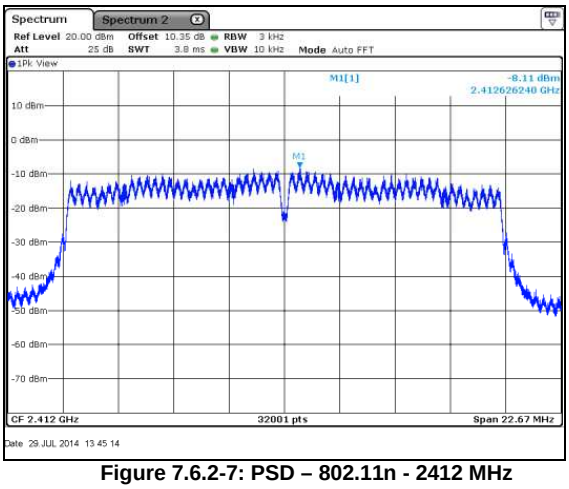

Figure 7.6.2-7: PSD – 802.11n - 2412 MHz

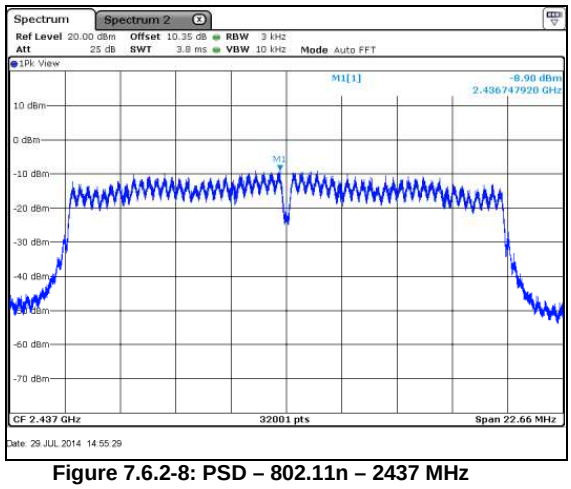

Figure 7.6.2-8: PSD – 802.11n – 2437 MHz

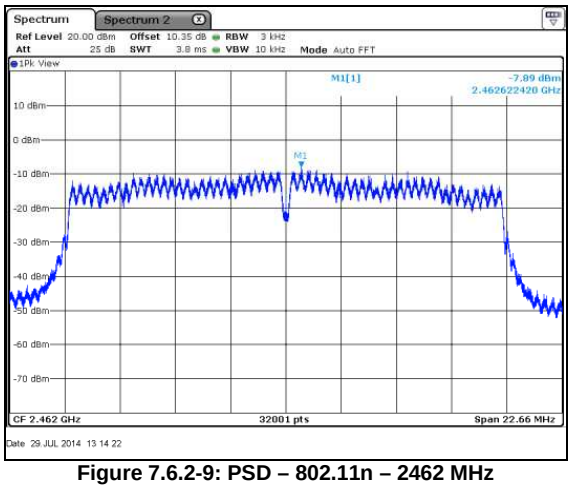

Figure 7.6.2-9: PSD – 802.11n – 2462 MHz

8 CONCLUSION

In the opinion of ACS, Inc. the DirectLink WiFi, manufactured by Comverge Inc meets the requirements of FCC Part 15 subpart C and Industry Canada's Radio Standards Specification RSS-210.

END REPORT