Excellence in Compliance Testing

Certification Test Report

FCC ID: SK9ACT1
IC: 864G-ACT1

FCC Rule Part: 15.247
ISED Canada Radio Standards Specification: RSS-247

ACS Report Number: 16-0130.W06.2A

Manufacturer: Itron, Inc.
Model: ACT1

Test Begin Date: June 21, 2016
Test End Date: July 18, 2016

Report Issue Date: August 26, 2016

ANAB ACCREDITED ISO/IEC 17025 TESTING LABORATORY

FOR THE SCOPE OF ACCREDITATION UNDER Certificate Number: AT-2021

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

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This report contains 35 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 Innovation, Science, and Economic Development Canada's Radio Standards Specification RSS-247 Certification for modular approval.

1.2 Product Description

The Itron ACT1 is an electricity metering module which includes a 902.4 MHz to 927.6 MHz transmitter as well as WiFi. The module operates on AC as well as DC voltage which is supplied by a host device.

This test report documents the compliance of the WiFi transceiver mode of operation.

Technical Information:

Detail	Description
Frequency Range	2412 – 2462 MHz
Number of Channels	802.11b/g/n (HT 20): 11 802.11n (HT 40): 9
Modulation Format	802.11b: DSSS (DBPSK / DQPSK / CCK) 802.11g/n (HT 20/40): OFDM (BPSK / QPSK / 16QAM / 64QAM)
Data Rates	802.11b: 1 – 11 Mbps 802.11g: 6 – 54 Mbps 802.11n (HT 20): 6.5 – 72 Mbps 802.11n (HT 40): 13.5 – 150 Mbps
Number of Inputs/Outputs	1T1R
Operating Voltage	24Vdc
Antenna Type / Gain	¼ Wave Embedded Slot Antenna / 2.5dBi

Manufacturer Information:
Itron, Inc.
313 N Hwy 11
West Union, SC 29696

Test Sample Serial Number: Radiated Emissions: 9840001196
Power Line Conducted Emissions: 9840001301
RF Conducted Emissions: 9840001498

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

1.3 Test Methodology and Considerations

All modes of operation, including all data rates, were evaluated and the data presented in this report represents the worst case where applicable. The worst case data rate for 802.11b mode was 5.5MBPS. The worst case data rate for 802.11g mode was 9MBPS. The worst case data rate for 802.11n (HT 20) mode was MCS4. The worst case data rate for 802.11n (HT 40) mode was MCS4.

For radiated emissions, the EUT was evaluated in three orthogonal orientations. The worst case orientation was X-orientation. See test setup photos for more information.

For AC power line conducted emissions the EUT was evaluated with a commercially available wall wart power supply.

For RF Conducted Emissions, the EUT was modified with an u.fl antenna connector to facilitate connection to the test equipment.

Radiated inter-modulation testing was performed for all combinations of simultaneous transmission and found to be in compliance.

Power setting during test – 802.11b:	20
Power setting during test – 802.11g:	15
Power setting during test – 802.11n (HT 20):	15
Power setting during test – 802.11n (HT 40):	11

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 ANSI-ASQ National Accreditation Board/ANAB accreditation program, and has been issued certificate number AT-2021 in recognition of this accreditation. 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, ISED Canada and the Japanese Voluntary Control Council for Interference by information technology equipment.

FCC Registration Number: 391271
ISED 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:

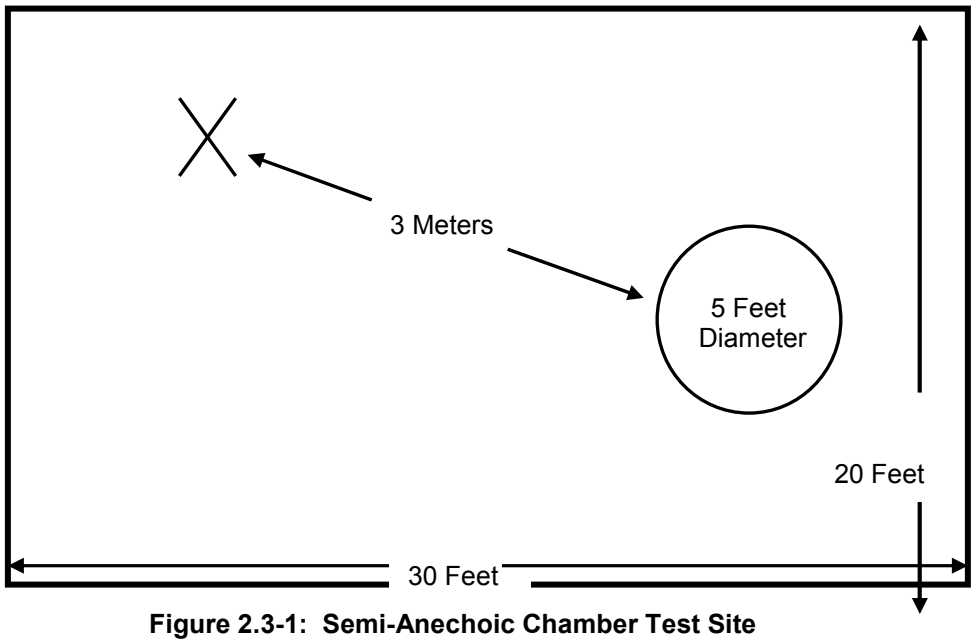

Figure 2.3-1: Semi-Anechoic Chamber Test Site

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:

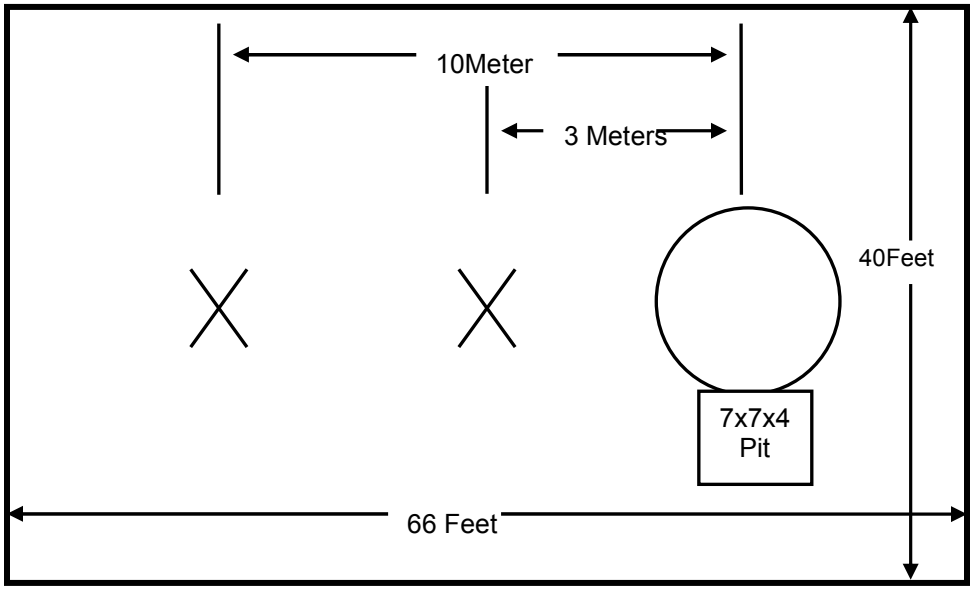

Figure 2.3-2: Open Area Test Site

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 C63.10.

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

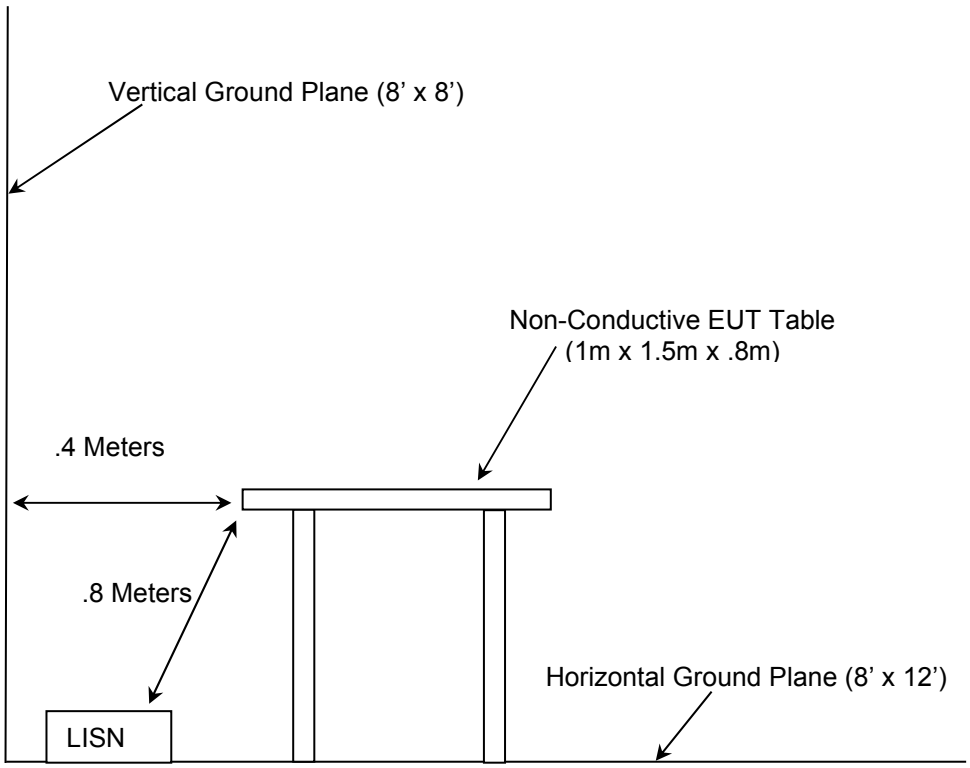

Figure 2.4-1: AC Mains Conducted EMI Site

3 APPLICABLE STANDARD REFERENCES

The following standards were used:

- ANSI C63.10-2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.
- US Code of Federal Regulations (CFR): Title 47, Part 2, Subpart J: Equipment Authorization Procedures, 2016
- US Code of Federal Regulations (CFR): Title 47, Part 15, Subpart C: Radio Frequency Devices, Intentional Radiators, 2016
- FCC KDB 558074 D01 DTS Meas Guidance v03r05 - Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247, April 8, 2016
- ISED Canada Radio Standards Specification: RSS-247 – Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices, Issue 1, May 2015.
- ISED Canada Radio Standards Specification: RSS-GEN – General Requirements for Compliance of Radio Apparatus, Issue 4, Nov 2014.

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	7/14/2015	7/14/2016
2	Rohde & Schwarz	ESMI-Receiver	Spectrum Analyzers	839587/003	7/14/2015	7/14/2016
30	Spectrum Technologies	DRH-0118	Antennas	970102	4/30/2015	4/30/2017
40	EMCO	3104	Antennas	3211	2/10/2015	2/10/2017
73	Agilent	8447D	Amplifiers	2727A05624	7/15/2015	7/15/2016
167	ACS	Chamber EMI Cable Set	Cable Set	167	10/20/2015	10/20/2016
267	Agilent	N1911A	Meters	MY45100129	8/24/2015	8/24/2017
268	Agilent	N1921A	Sensors	MY45240184	8/13/2015	8/13/2017
324	ACS	Belden	Cables	8214	5/2/2016	5/2/2017
334	Rohde&Schwarz	3160-09	Antennas	49404	11/4/2010	NCR
335	Suhner Sucoflex	SF-102A	Cables	882/2A	7/14/2015	7/14/2016
338	Hewlett Packard	8449B	Amplifiers	3008A01111	8/21/2015	8/21/2017
340	Aeroflex/Weinschel	AS-20	Attenuators	7136	7/13/2015	7/13/2016
340	Aeroflex/Weinschel	AS-20	Attenuators	7136	7/12/2016	7/12/2017
345	Suhner Sucoflex	102A	Cables	1077/2A	7/14/2015	7/14/2016
412	Electro Metrics	LPA-25	Antennas	1241	7/24/2014	7/24/2016
422	Florida RF	SMS-200AW-72.0-SMR	Cables	805	10/30/2015	10/30/2016
432	Microwave Circuits	H3G020G4	Filters	264066	5/13/2016	5/13/2017
616	Florida RF Cables	SMRE-200W-12.0-SMRE	Cables	N/A	9/3/2015	9/3/2016
622	Rohde & Schwarz	FSV40	Analyzers	101338	7/15/2015	7/15/2016
622	Rohde & Schwarz	FSV40	Analyzers	101338	7/15/2016	7/15/2018
676	Florida RF Labs	SMS-290AW-480.0-SMS	Cables	MFR2Y194	9/3/2015	9/3/2016
3010	Rohde & Schwarz	ENV216	LISN	3010	7/10/2015	7/10/2016
RE112	Rohde & Schwarz	ESIB26	Receiver	836119/012	7/16/2015	7/16/2016

NOTE: All test equipment was used only during active calibration cycles.

5 SUPPORT EQUIPMENT

Table 5-1: Support Equipment

Item	Equipment Type	Manufacturer	Model/Part Number	Serial Number
1	DC Power Supply	Volgen	KTPS24-24010WA	N/A

6 EQUIPMENT UNDER TEST SETUP BLOCK DIAGRAM

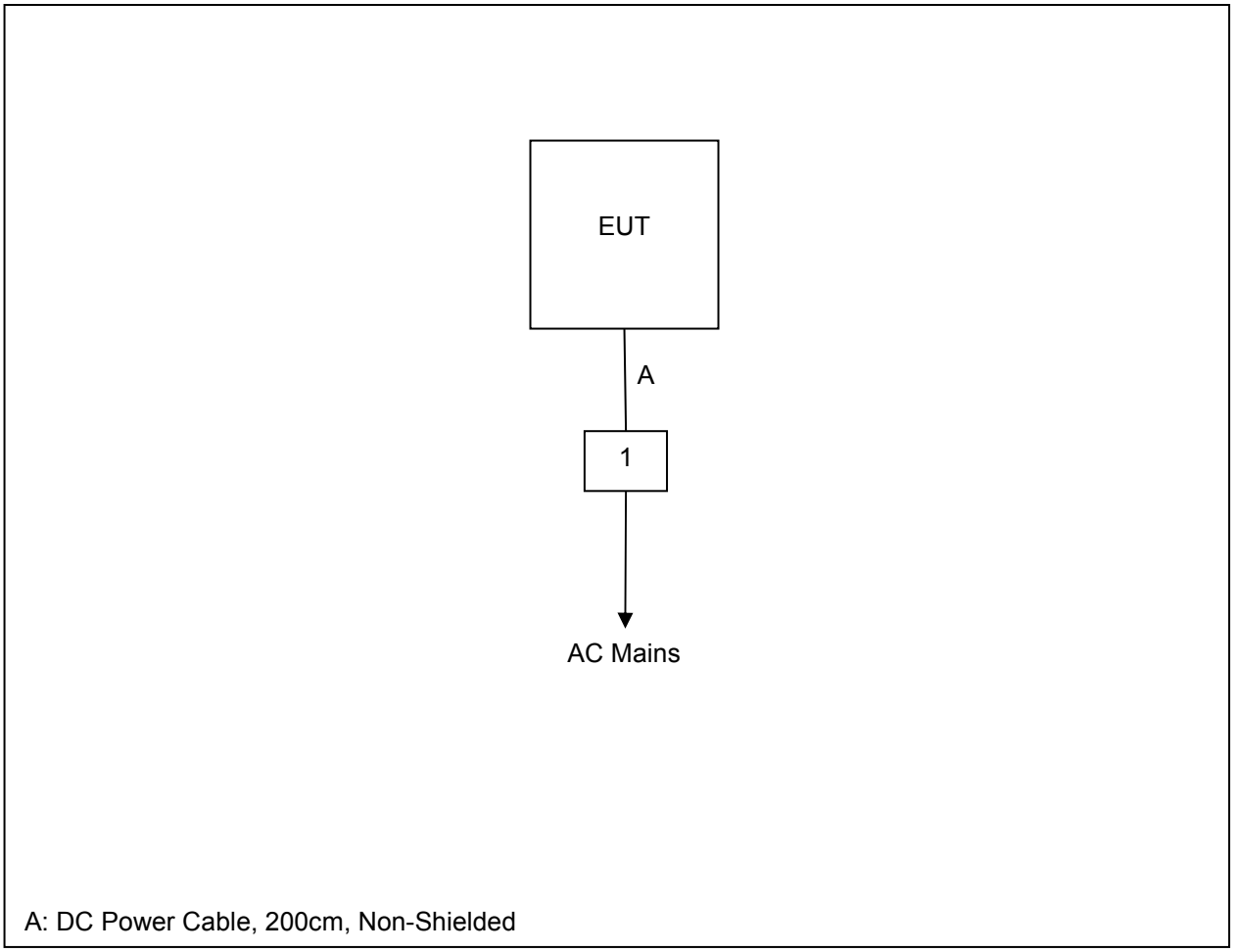

Figure 6-1: EUT Test Setup

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 a ¼ wave embedded slot antenna. The antenna is integral to the device and cannot be removed or replaced by the end user. The gain of the antenna is 2.5dBi.

7.2 Power Line Conducted Emissions – FCC 15.207, ISED Canada: RSS-Gen 8.8

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

Table 7.2.2-1: Conducted EMI Results – Line 1

Frequency (MHz)	Corrected Reading		Limit (dBuV)	Margin (dB)	Line	Correction (dB)
	Quasi-Peak (dBuV)	Average (dBuV)				
0.475451	---	23.16	46.38	23.22	L1	9.7
0.475451	37.84	---	56.39	18.55	L1	9.7
1.302705	---	12.68	46.00	33.32	L1	9.8
1.302705	26.06	---	56.00	29.94	L1	9.8
4.965231	---	10.74	46.00	35.26	L1	9.9
4.965231	21.33	---	56.00	34.67	L1	9.9
10.593888	---	9.11	50.00	40.89	L1	10.0
10.593888	21.70	---	60.00	38.30	L1	10.0
10.622345	---	6.53	50.00	43.47	L1	10.0
10.622345	17.19	---	60.00	42.81	L1	10.0
10.622946	---	6.76	50.00	43.24	L1	10.0
10.622946	15.91	---	60.00	44.09	L1	10.0

Table 7.2.2-2: Conducted EMI Results – Line 2

Frequency (MHz)	Corrected Reading		Limit (dBuV)	Margin (dB)	Line	Correction (dB)
	Quasi-Peak (dBuV)	Average (dBuV)				
0.480361	---	18.85	46.30	27.45	N	9.7
0.480361	31.82	---	56.31	24.49	N	9.7
0.616533	---	10.01	46.00	35.99	N	9.7
0.616533	22.98	---	56.00	33.02	N	9.7
3.936080	---	8.58	46.00	37.42	N	9.8
3.936080	20.38	---	56.00	35.62	N	9.8
4.109318	---	8.56	46.00	37.44	N	9.8
4.109318	19.44	---	56.00	36.56	N	9.8
4.198898	---	7.17	46.00	38.83	N	9.9
4.198898	18.37	---	56.00	37.63	N	9.9
10.094088	---	6.76	50.00	43.24	N	10.0
10.094088	17.19	---	60.00	42.81	N	10.0

7.3 6dB / 99% Bandwidth – FCC 15.247(a)(2), ISED Canada: RSS-247 5.2(1)

7.3.1 Measurement Procedure

The 6dB bandwidth was measured in accordance with the FCC KDB 558074 D01 DTS Meas Guidance. 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 from 1% to 5% of the occupied bandwidth and the video bandwidth set to at least 3 times the resolution bandwidth. A peak detector was used.

7.3.2 Measurement Results

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

Frequency [MHz]	6dB Bandwidth [MHz]	99% Bandwidth [MHz]
2412	8.299	12.250
2437	8.358	12.231
2462	8.324	12.248

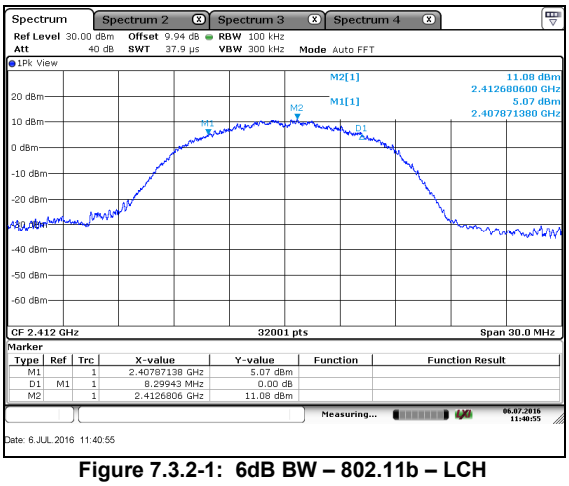

Figure 7.3.2-1: 6dB BW – 802.11b – LCH

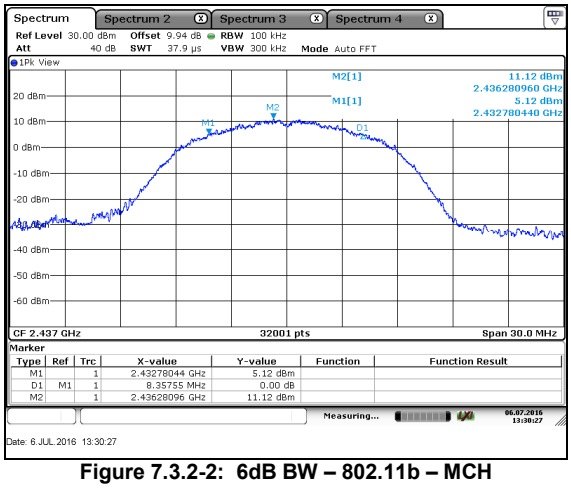

Figure 7.3.2-2: 6dB BW – 802.11b – MCH

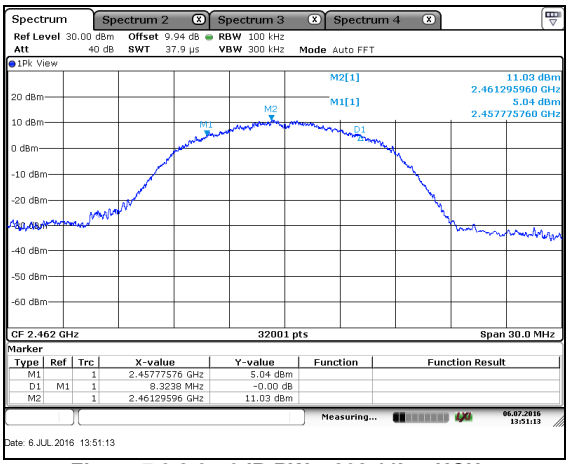

Figure 7.3.2-3: 6dB BW – 802.11b – HCH

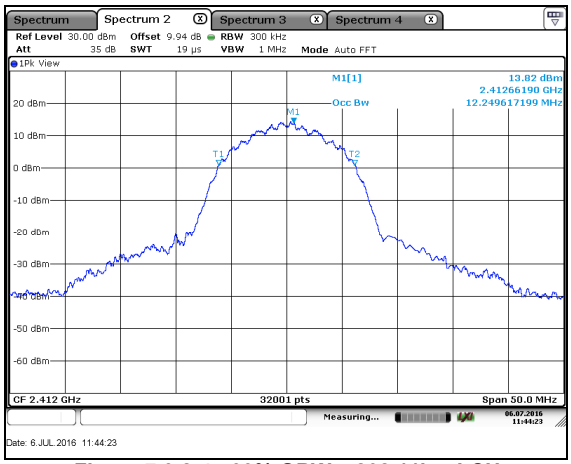

Figure 7.3.2-4: 99% OBW – 802.11b – LCH

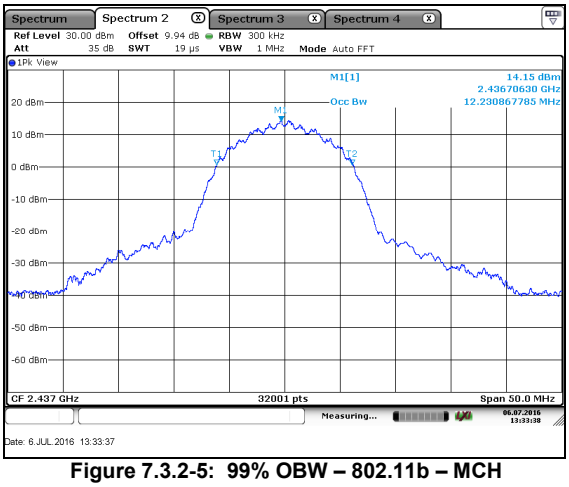

Figure 7.3.2-5: 99% OBW – 802.11b – MCH

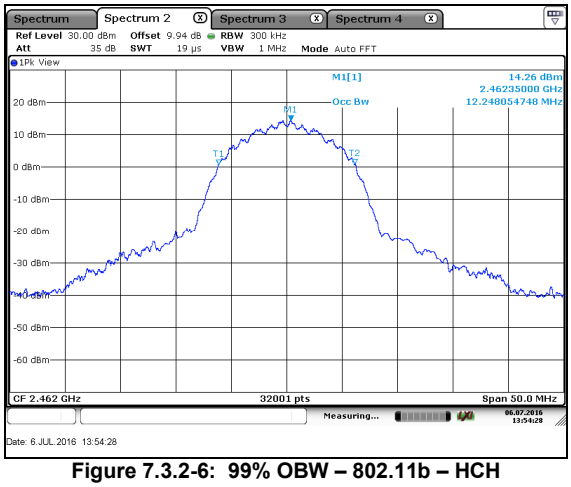

Figure 7.3.2-6: 99% OBW – 802.11b – HCH

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

Frequency [MHz]	6dB Bandwidth [MHz]	99% Bandwidth [MHz]
2412	15.116	16.465
2437	15.111	16.398
2462	15.116	16.365

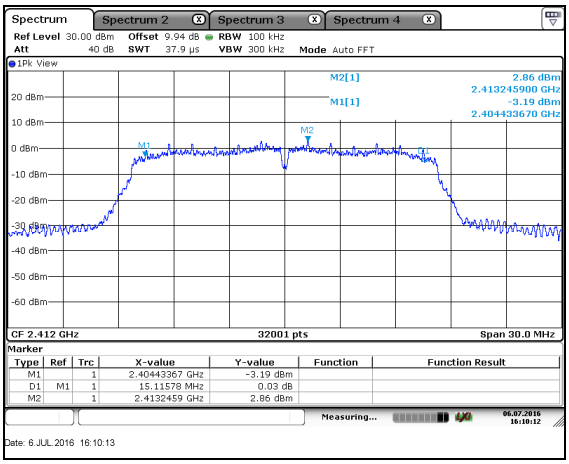

Figure 7.3.2-7: 6dB BW – 802.11g – LCH

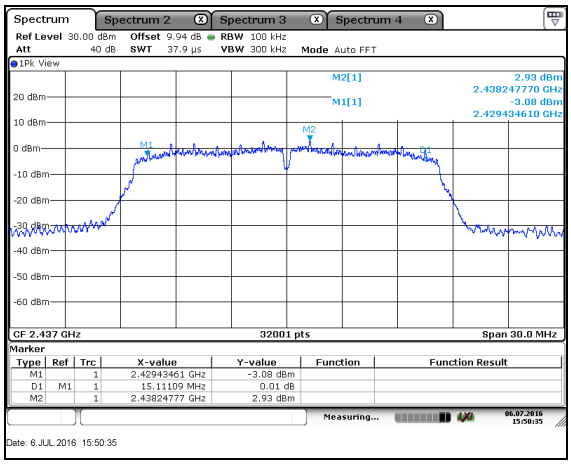

Figure 7.3.2-8: 6dB BW – 802.11g – MCH

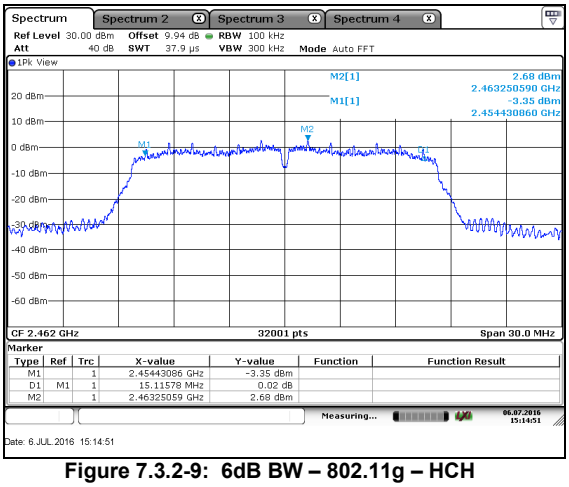

Figure 7.3.2-9: 6dB BW – 802.11g – HCH

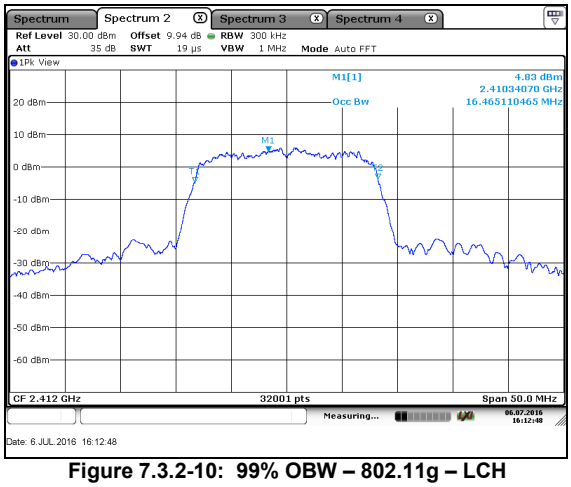

Figure 7.3.2-10: 99% OBW – 802.11g – LCH

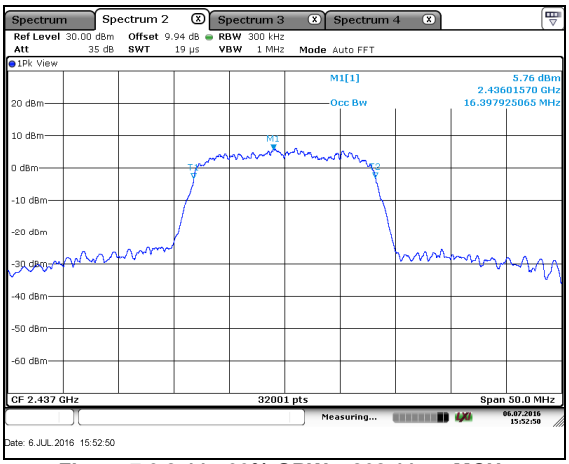

Figure 7.3.2-11: 99% OBW – 802.11g – MCH

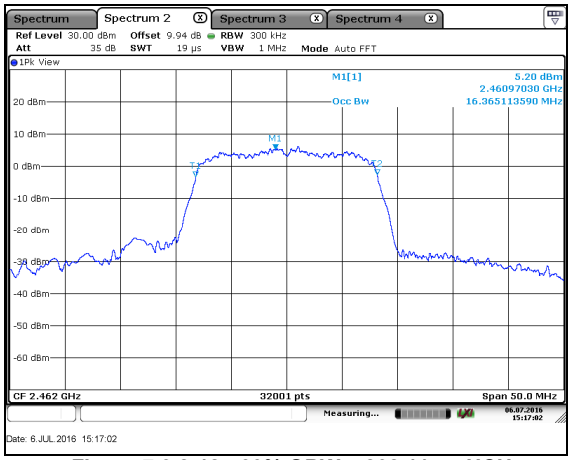

Figure 7.3.2-12: 99% OBW – 802.11g – HCH

Table 7.3.2-3: 6dB / 99% Bandwidth – 802.11n (HT 20)

Frequency [MHz]	6dB Bandwidth [MHz]	99% Bandwidth [MHz]
2412	17.564	17.546
2437	17.580	17.517
2462	17.628	17.546

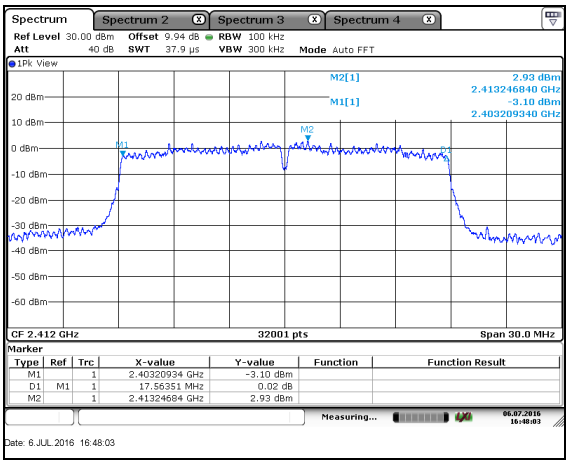

Figure 7.3.2-13: 6dB BW – 802.11n20 – LCH

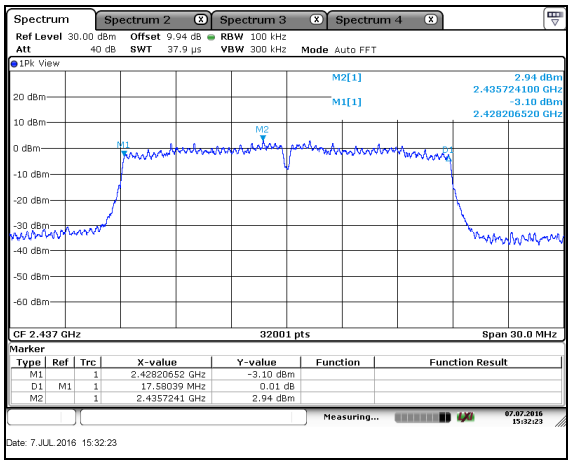

Figure 7.3.2-14: 6dB BW – 802.11n20 – MCH

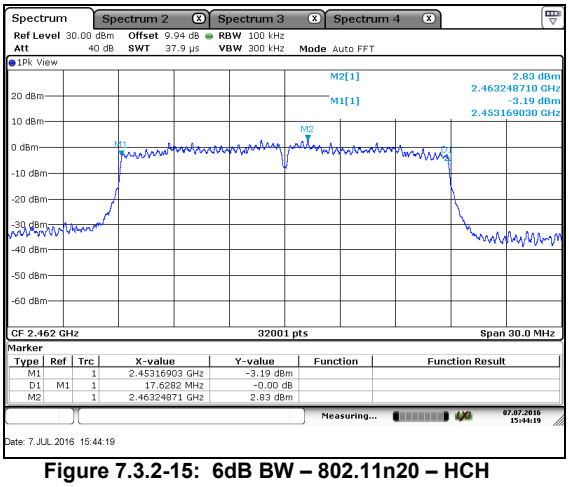

Figure 7.3.2-15: 6dB BW – 802.11n20 – HCH

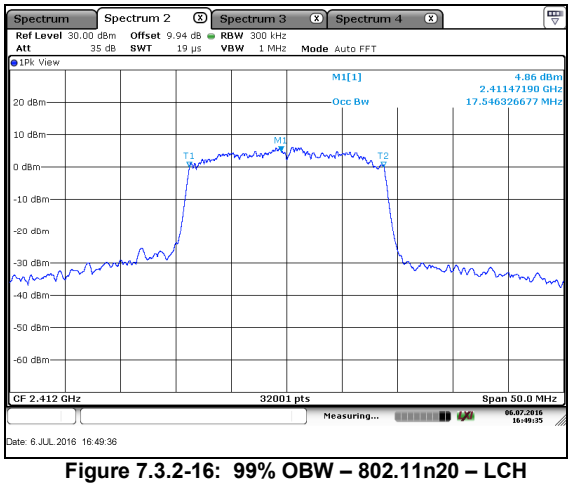

Figure 7.3.2-16: 99% OBW – 802.11n20 – LCH

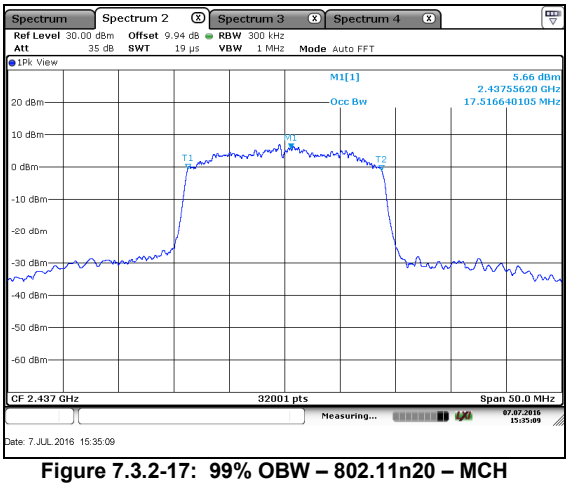

Figure 7.3.2-17: 99% OBW – 802.11n20 – MCH

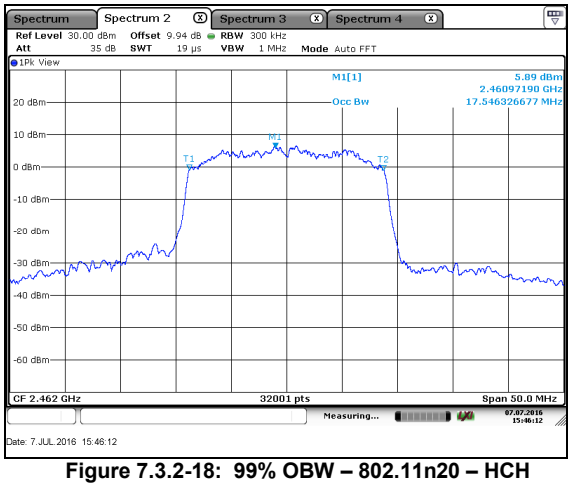

Figure 7.3.2-18: 99% OBW – 802.11n20 – HCH

Table 7.3.2-4: 6dB / 99% Bandwidth – 802.11n (HT 40)

Frequency [MHz]	6dB Bandwidth [MHz]	99% Bandwidth [MHz]
2422	35.361	36.277
2437	35.433	36.396
2452	35.669	36.305

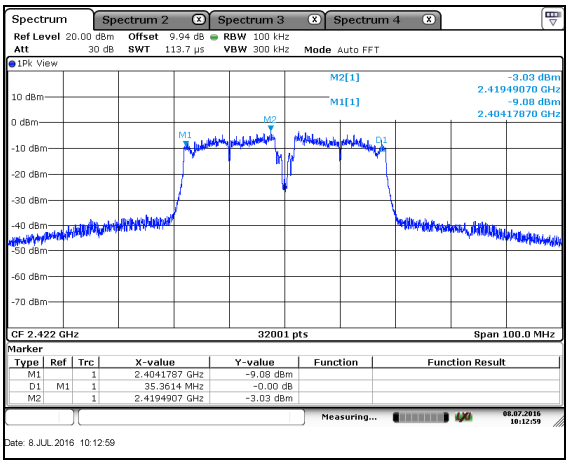

Figure 7.3.2-19: 6dB BW – 802.11n40 – LCH

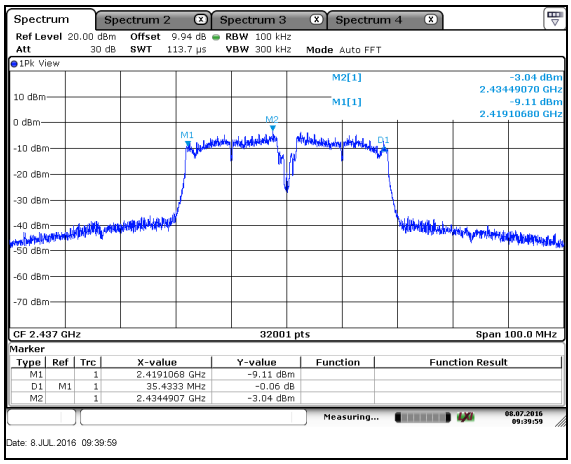

Figure 7.3.2-20: 6dB BW – 802.11n40 – MCH

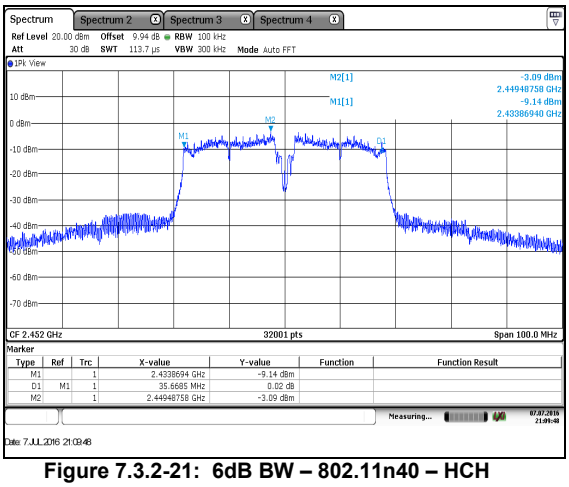

Figure 7.3.2-21: 6dB BW – 802.11n40 – HCH

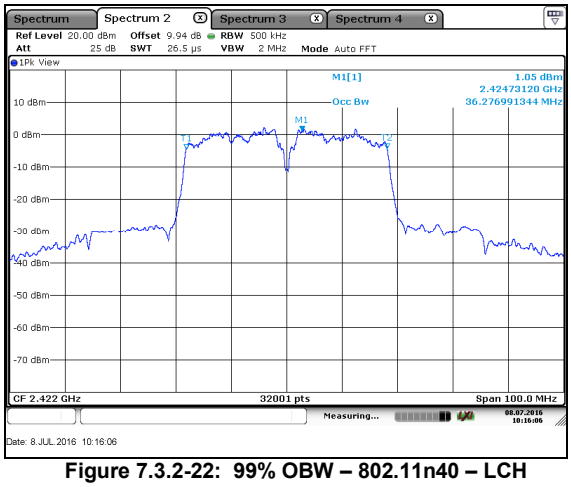

Figure 7.3.2-22: 99% OBW – 802.11n40 – LCH

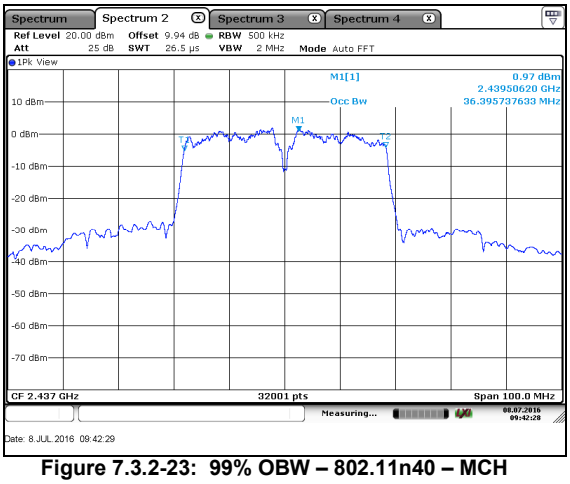

Figure 7.3.2-23: 99% OBW – 802.11n40 – MCH

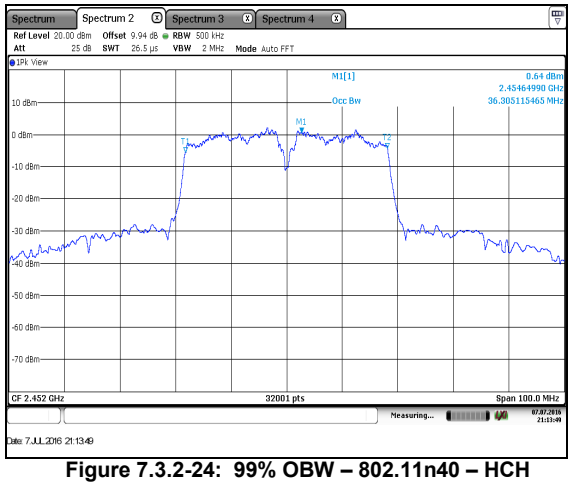

Figure 7.3.2-24: 99% OBW – 802.11n40 – HCH

7.4 Fundamental Emission Output Power – FCC 15.247(b)(3), ISED Canada: RSS-247 5.4(4)

7.4.1 Measurement Procedure

The maximum conducted output power was measured in accordance with FCC KDB 558074 D01 DTS Meas Guidance utilizing the AVGSA-2 procedure. The RF output of the equipment under test was directly connected to the input of the spectrum analyzer applying suitable attenuation. Justification for the Duty Cycle Correction Factor used is provided in Section 7.7 of this report.

7.4.2 Measurement Results

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

Frequency [MHz]	Level [dBm]	Duty Cycle Correction Factor [dB]	Corrected Level [dBm]
2412	18.34	0.08	18.42
2437	18.46	0.08	18.54
2462	18.42	0.08	18.50

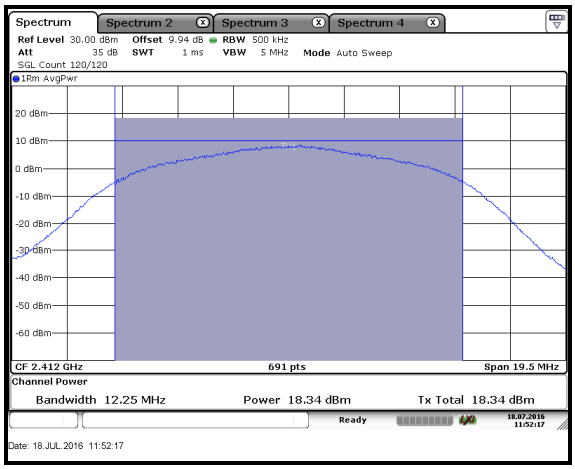

Figure 7.4.2-1: Output Power – 802.11b – LCH

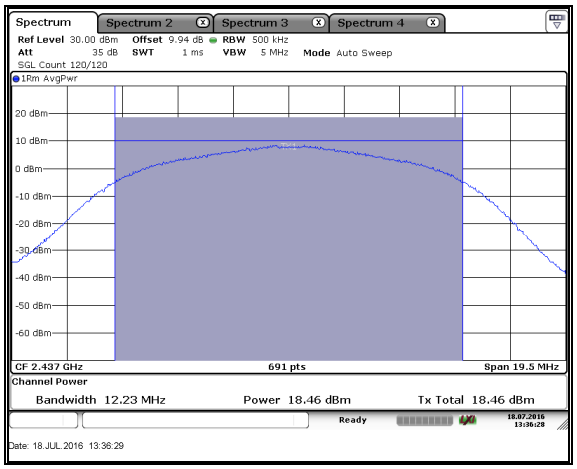

Figure 7.4.2-2: Output Power – 802.11b – MCH

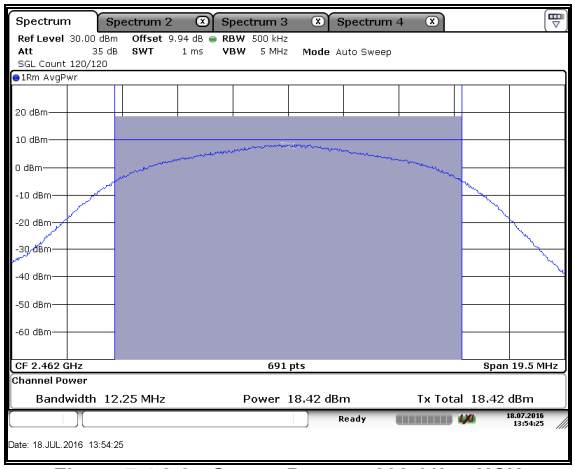

Figure 7.4.2-3: Output Power – 802.11b – HCH

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

Frequency [MHz]	Level [dBm]	Duty Cycle Correction Factor [dB]	Corrected Level [dBm]
2412	13.15	0.15	13.30
2437	13.22	0.15	13.37
2462	13.08	0.15	13.23

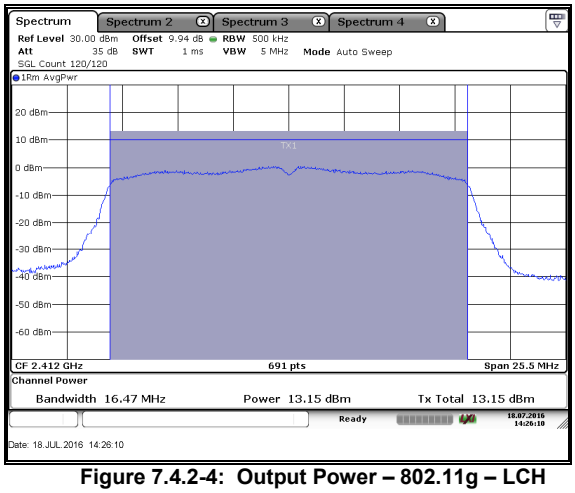

Figure 7.4.2-4: Output Power – 802.11g – LCH

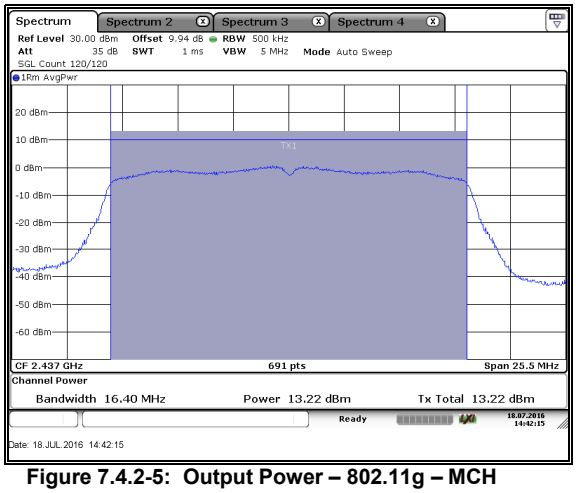

Figure 7.4.2-5: Output Power – 802.11g – MCH

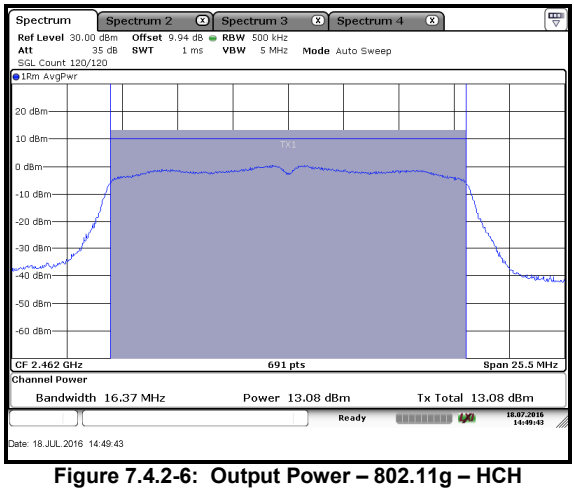

Figure 7.4.2-6: Output Power – 802.11g – HCH

Table 7.4.2-3: Maximum Peak Conducted Output Power – 802.11n (HT 20)

Frequency [MHz]	Level [dBm]	Duty Cycle Correction Factor [dB]	Corrected Level [dBm]
2412	12.63	0.56	13.19
2437	12.65	0.56	13.21
2462	12.56	0.56	13.12

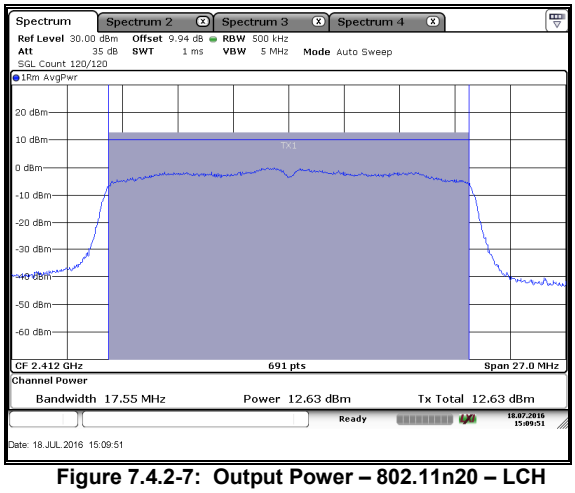

Figure 7.4.2-7: Output Power – 802.11n20 – LCH

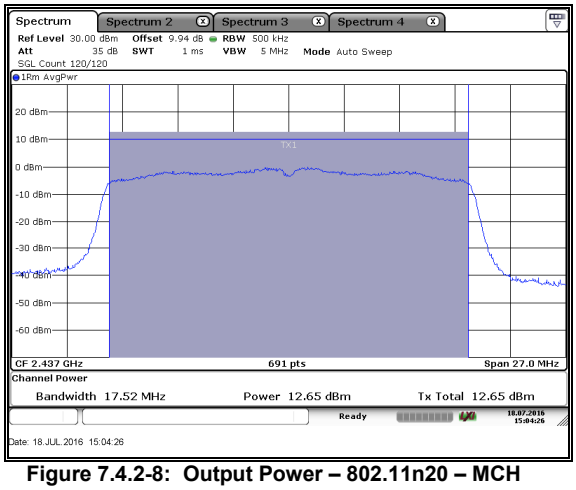

Figure 7.4.2-8: Output Power – 802.11n20 – MCH

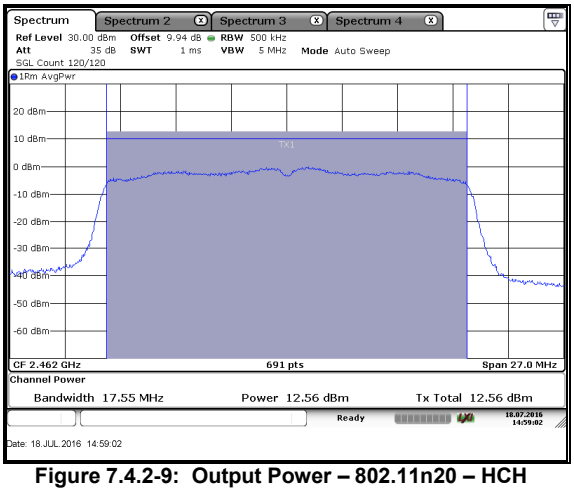

Figure 7.4.2-9: Output Power – 802.11n20 – HCH

Table 7.4.2-4: Maximum Peak Conducted Output Power – 802.11n (HT 40)

Frequency [MHz]	Level [dBm]	Duty Cycle Correction Factor [dB]	Corrected Level [dBm]
2422	8.72	0.52	9.24
2437	8.66	0.52	9.18
2452	8.72	0.52	9.24

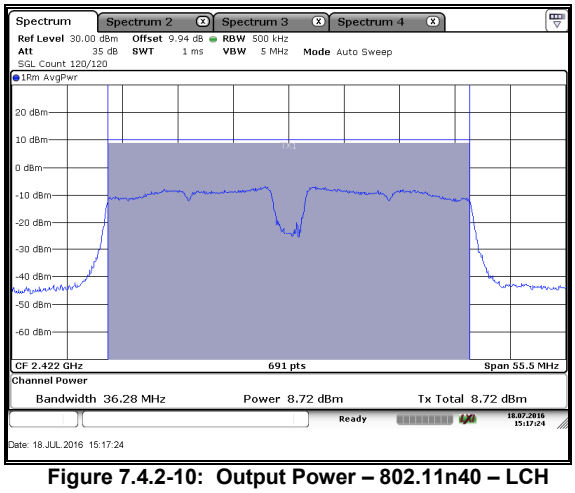

Figure 7.4.2-10: Output Power – 802.11n40 – LCH

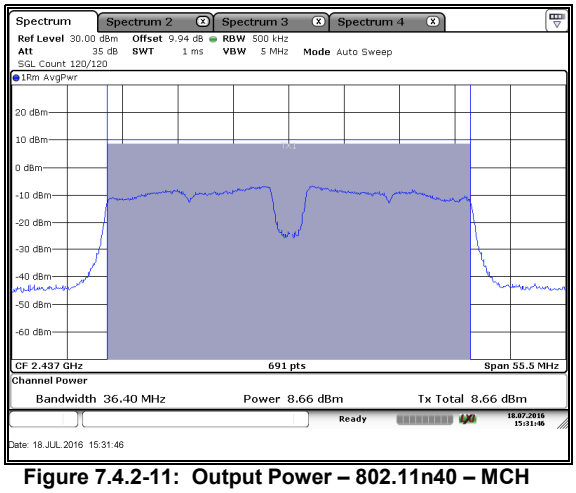

Figure 7.4.2-11: Output Power – 802.11n40 – MCH

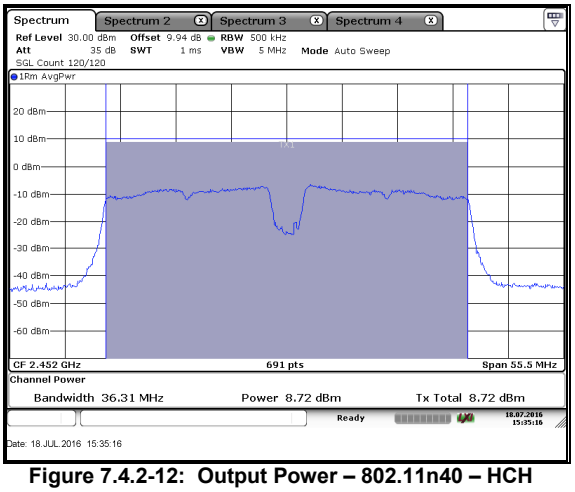

Figure 7.4.2-12: Output Power – 802.11n40 – HCH

7.5 Emission Levels

7.5.1 Emissions into Non-restricted Frequency Bands – FCC 15.247(d); ISED Canada: RSS-247 5.5

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. 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 30 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 30 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

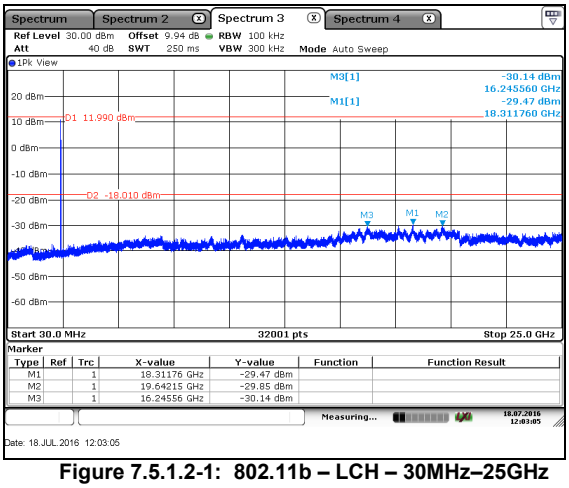

Figure 7.5.1.2-1: 802.11b – LCH – 30MHz–25GHz

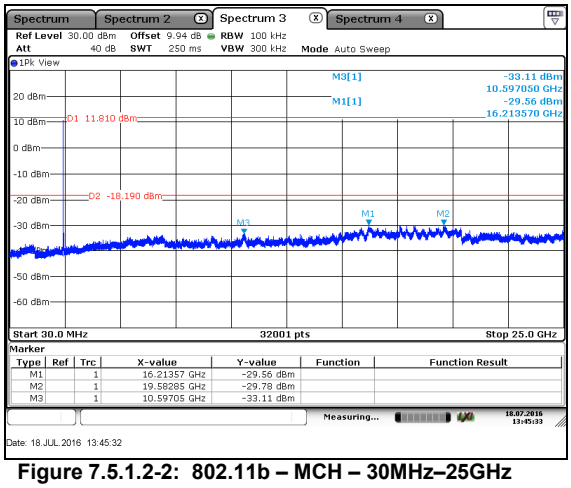

Figure 7.5.1.2-2: 802.11b – MCH – 30MHz–25GHz

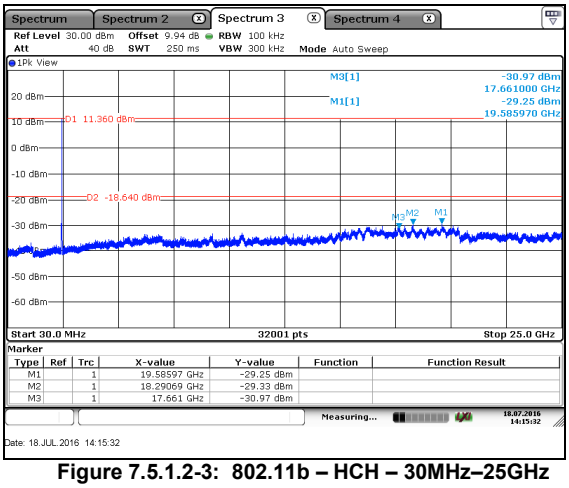

Figure 7.5.1.2-3: 802.11b – HCH – 30MHz–25GHz

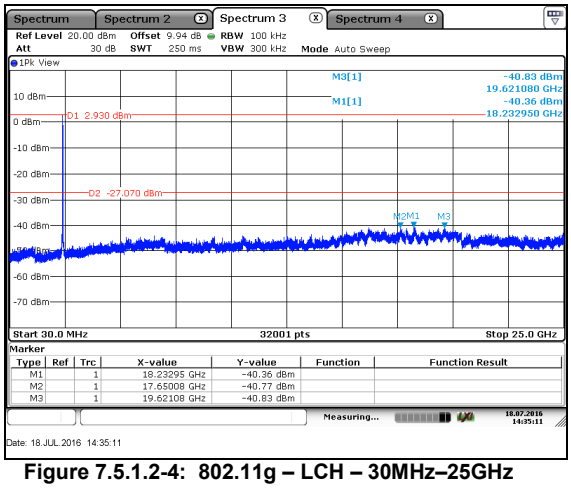

Figure 7.5.1.2-4: 802.11g – LCH – 30MHz–25GHz

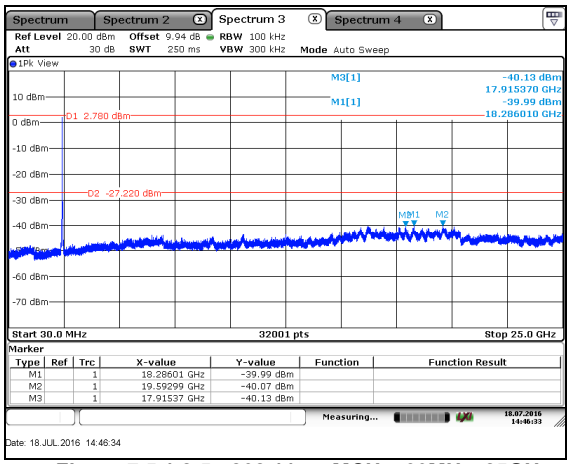

Figure 7.5.1.2-5: 802.11g – MCH – 30MHz–25GHz

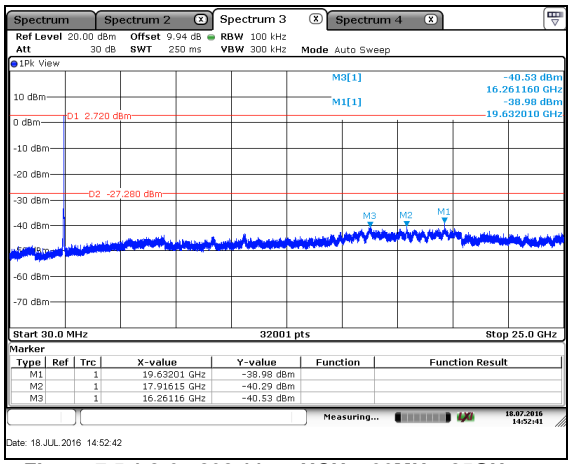

Figure 7.5.1.2-6: 802.11g – HCH – 30MHz–25GHz

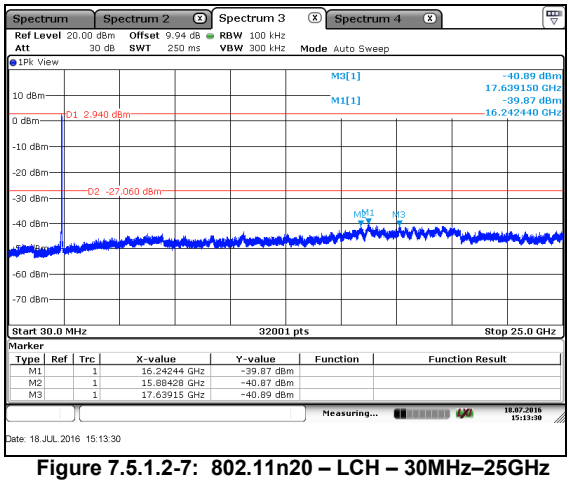

Figure 7.5.1.2-7: 802.11n20 – LCH – 30MHz–25GHz

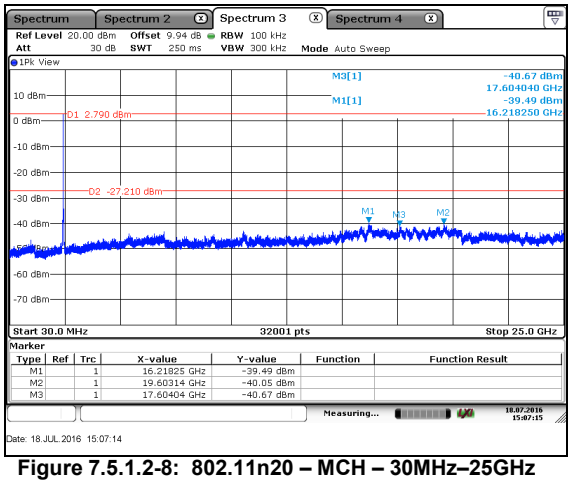

Figure 7.5.1.2-8: 802.11n20 – MCH – 30MHz–25GHz

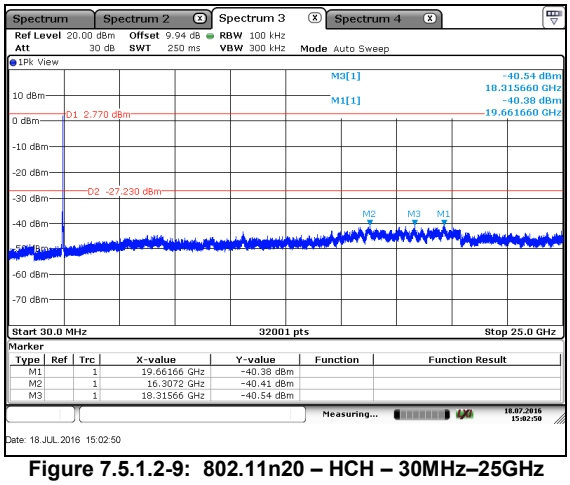

Figure 7.5.1.2-9: 802.11n20 – HCH – 30MHz–25GHz

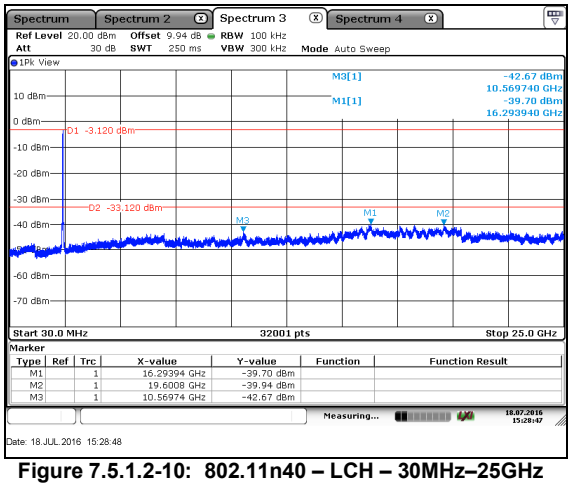

Figure 7.5.1.2-10: 802.11n40 – LCH – 30MHz–25GHz

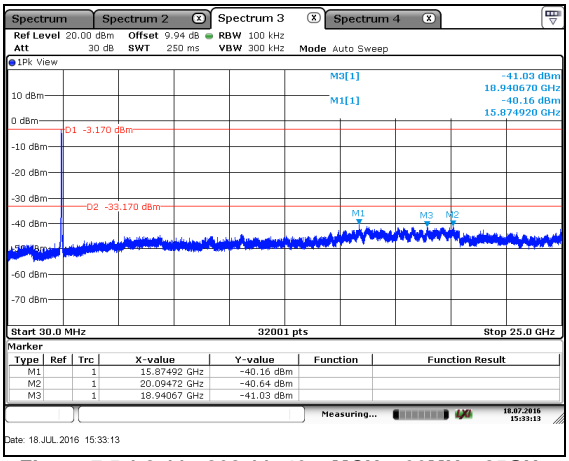

Figure 7.5.1.2-11: 802.11n40 – MCH – 30MHz–25GHz

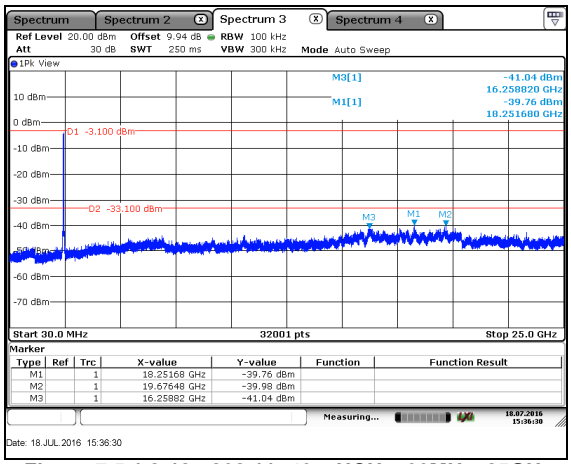

Figure 7.5.1.2-12: 802.11n40 – HCH – 30MHz–25GHz

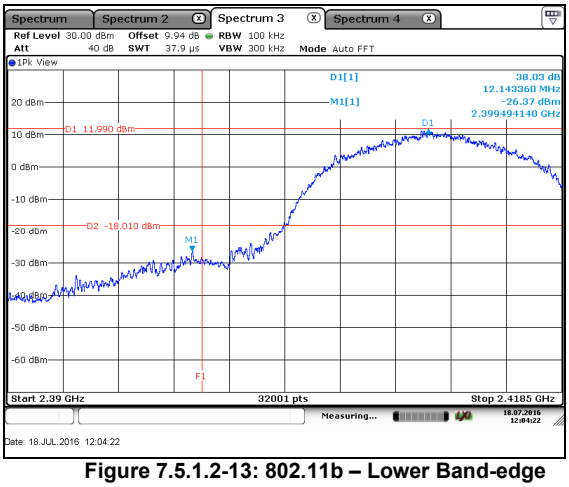

Figure 7.5.1.2-13: 802.11b – Lower Band-edge

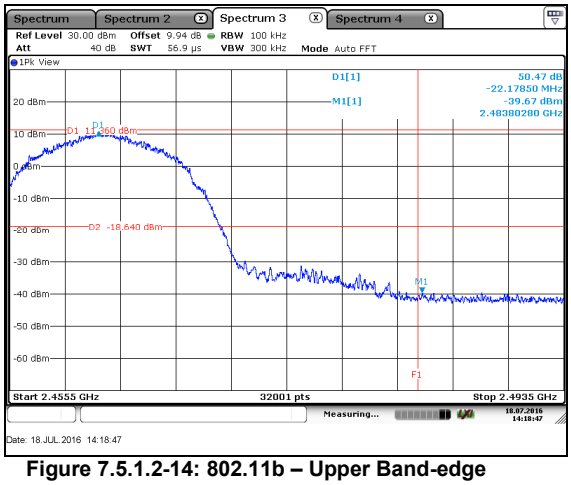

Figure 7.5.1.2-14: 802.11b – Upper Band-edge

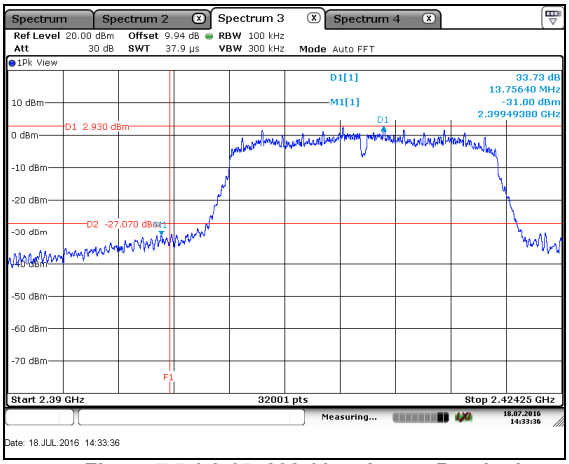

Figure 7.5.1.2-15: 802.11g – Lower Band-edge

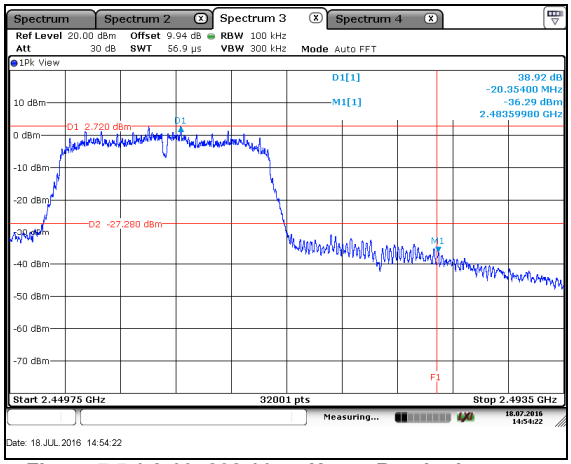

Figure 7.5.1.2-16: 802.11g – Upper Band-edge

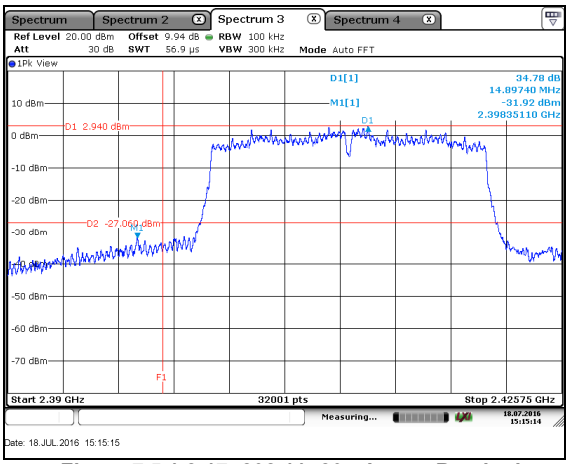

Figure 7.5.1.2-17: 802.11n20 – Lower Band-edge

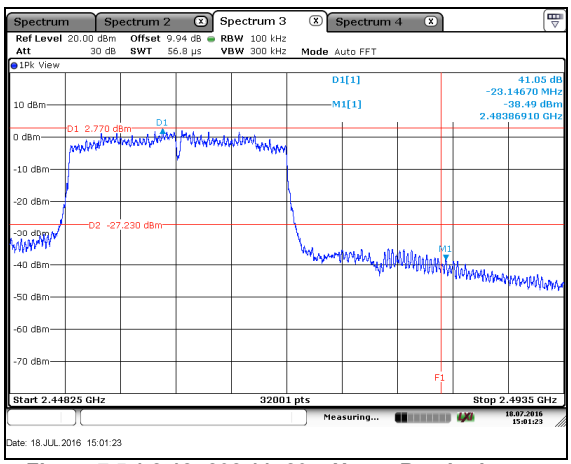

Figure 7.5.1.2-18: 802.11n20 – Upper Band-edge

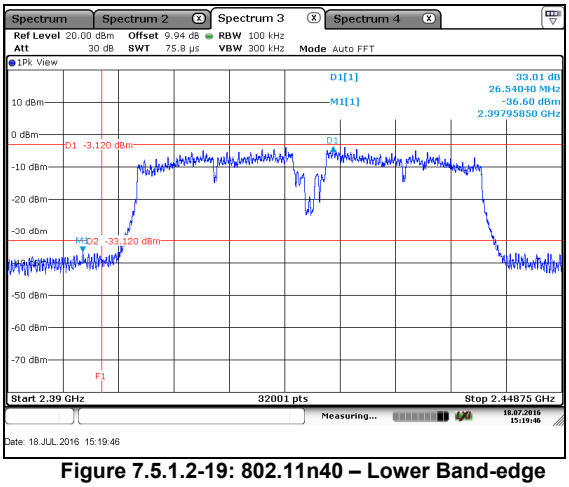

Figure 7.5.1.2-19: 802.11n40 – Lower Band-edge

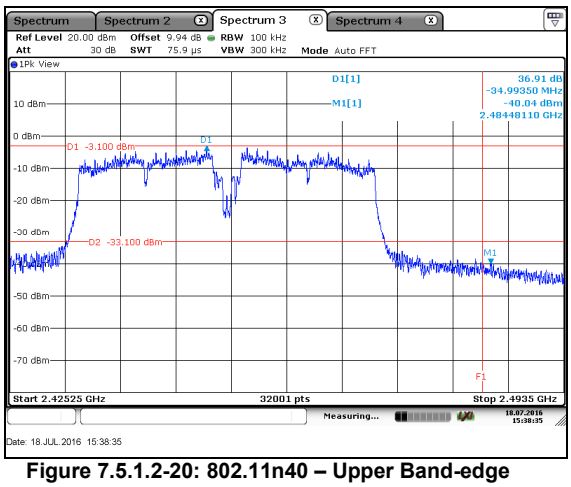

Figure 7.5.1.2-20: 802.11n40 – Upper Band-edge

7.5.2 Emissions into Restricted Frequency Bands – FCC: 15.205, 15.209; ISED Canada: RSS-Gen 8.9 / 8.10

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 7.5.2.2-4 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	65.37	51.41	H	-5.72	59.65	45.69	74.0	54.0	14.4	8.3
2390	59.64	46.41	V	-5.72	53.92	40.69	74.0	54.0	20.1	13.3
2492.1	47.11	34.90	H	-5.23	41.88	29.67	74.0	54.0	32.1	24.3
2491.2	43.57	31.93	V	-5.24	38.33	26.69	74.0	54.0	35.7	27.3
2373.5	63.41	46.78	H	-5.80	57.61	40.98	74.0	54.0	16.4	13.0
2373.5	60.13	43.87	V	-5.80	54.33	38.07	74.0	54.0	19.7	15.9
4824	50.83	47.14	H	1.53	52.36	48.67	74.0	54.0	21.60	5.30
4824	52.76	49.39	V	1.53	54.29	50.92	74.0	54.0	19.7	3.1
2437 MHz										
4874	49.39	46.00	H	1.68	51.07	47.68	74.0	54.0	22.9	6.3
4874	52.17	49.51	V	1.68	53.85	51.19	74.0	54.0	20.2	2.8
7311	46.20	39.52	H	7.31	53.51	46.83	74.0	54.0	20.5	7.2
7311	48.52	43.62	V	7.31	55.83	50.93	74.0	54.0	18.2	3.1
2462 MHz										
2483.5	66.35	48.44	H	-5.27	61.08	43.17	74.0	54.0	12.9	10.8
2483.5	62.20	44.88	V	-5.27	56.93	39.61	74.0	54.0	17.1	14.4
4924	50.19	35.59	H	1.83	52.02	37.42	74.0	54.0	22.0	16.6
4924	52.14	37.11	V	1.83	53.97	38.94	74.0	54.0	20.0	15.1

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	73.39	55.90	H	-5.72	67.67	50.18	74.0	54.0	6.3	3.8
2390	68.77	52.80	V	-5.72	63.05	47.08	74.0	54.0	11.0	6.9
4824	47.31	34.24	H	1.53	48.84	35.77	74.0	54.0	25.2	18.2
4824	45.77	34.93	V	1.53	47.30	36.46	74.0	54.0	26.7	17.5
2437 MHz										
4874	46.09	35.97	H	1.68	47.77	37.65	74.0	54.0	26.2	16.4
4874	48.58	34.88	V	1.68	50.26	36.56	74.0	54.0	23.7	17.4
2462 MHz										
2483.5	72.68	51.33	H	-5.27	67.41	46.06	74.0	54.0	6.6	7.9
2483.5	67.37	48.20	V	-5.27	62.10	42.93	74.0	54.0	11.9	11.1
4924	45.34	36.02	H	1.83	47.17	37.85	74.0	54.0	26.8	16.1
4924	43.76	34.93	V	1.83	45.59	36.76	74.0	54.0	28.4	17.2

Table 7.5.2.2-3: Radiated Spurious Emissions Tabulated Data – 802.11n (HT 20)

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	74.68	56.10	h	-5.72	68.96	50.38	74.0	54.0	5.0	3.6
2390	70.49	51.81	v	-5.72	64.77	46.09	74.0	54.0	9.2	7.9
4824	44.25	34.60	H	1.53	45.78	36.13	74.0	54.0	28.2	17.9
4824	42.90	34.65	V	1.53	44.43	36.18	74.0	54.0	29.6	17.8
2437 MHz										
4874	48.15	35.56	H	1.68	49.83	37.24	74.0	54.0	24.2	16.8
4874	49.70	33.30	V	1.68	51.38	34.98	74.0	54.0	22.6	19.0
2462 MHz										
2483.5	74.51	52.60	H	-5.27	69.24	47.33	74.0	54.0	4.8	6.7
2483.5	62.60	47.01	V	-5.27	57.33	41.74	74.0	54.0	16.7	12.3
4924	44.17	36.12	H	1.83	46.00	37.95	74.0	54.0	28.0	16.0
4924	45.29	34.50	V	1.83	47.12	36.33	74.0	54.0	26.9	17.7

Table 7.5.2.2-3: Radiated Spurious Emissions Tabulated Data – 802.11n (HT 40)

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
2422 MHz										
2390	71.92	55.60	h	-5.72	66.20	49.88	74.0	54.0	7.8	4.1
2390	67.55	51.87	v	-5.72	61.83	46.15	74.0	54.0	12.2	7.9
4844	43.76	38.43	H	1.59	45.35	40.02	74.0	54.0	28.7	14.0
4844	43.94	38.08	V	1.59	45.53	39.67	74.0	54.0	28.5	14.3
2437 MHz										
4874	46.26	35.49	H	1.68	47.94	37.17	74.0	54.0	26.1	16.8
2452 MHz										
2483.5	73.19	53.44	H	-5.27	67.92	48.17	74.0	54.0	6.1	5.8
2483.5	64.46	48.51	V	-5.27	59.19	43.24	74.0	54.0	14.8	10.8
4904	46.35	35.89	H	1.77	48.12	37.66	74.0	54.0	25.9	16.3

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 – 802.11b

Corrected Level: 65.37 - 5.72 = 59.65dBuV/m
Margin: 74dBuV/m – 59.65dBuV/m = 14.4dB

Example Calculation: Average – 802.11b

Corrected Level: 51.41 - 5.72 - 0 = 45.69dBuV
Margin: 54dBuV – 45.69dBuV = 8.3dB

7.6 Maximum Power Spectral Density in the Fundamental Emission – FCC 15.247(e) ISED Canada: RSS-247 5.2(2)

7.6.1 Measurement Procedure

The power spectral density was measured in accordance with the FCC KDB 558074 D01 DTS Meas Guidance utilizing the PKPSD (peak PSD) method as a worst case. 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

Table 7.6.2-1: Power Spectral Density – 802.11b

Frequency [MHz]	PSD Level [dBm]
2412	-2.44
2437	-2.72
2462	-2.79

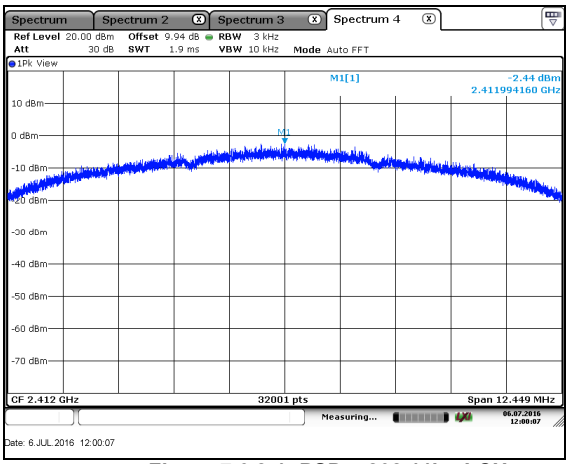

Figure 7.6.2-1: PSD – 802.11b - LCH

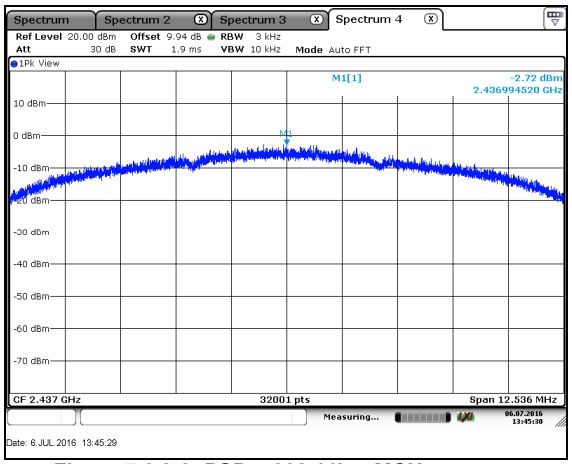

Figure 7.6.2-2: PSD – 802.11b – MCH

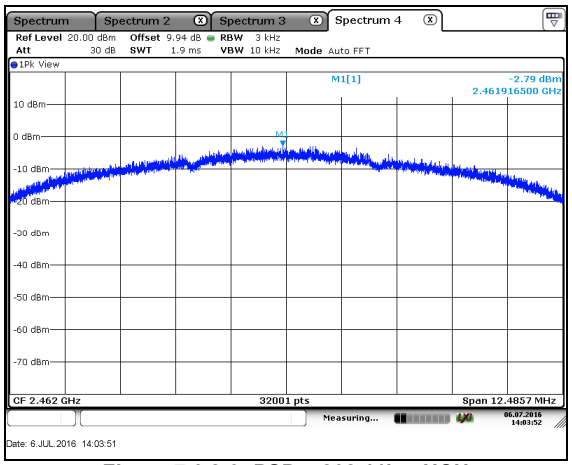

Figure 7.6.2-3: PSD – 802.11b – HCH

Table 7.6.2-2: Power Spectral Density – 802.11g

Frequency [MHz]	PSD Level [dBm]
2412	-9.07
2437	-8.95
2462	-9.85

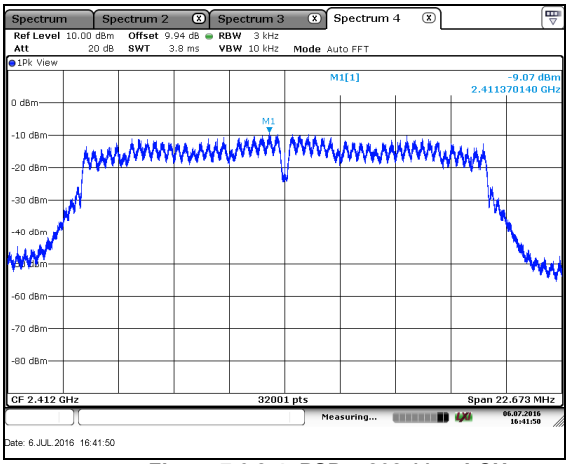

Figure 7.6.2-4: PSD – 802.11g - LCH

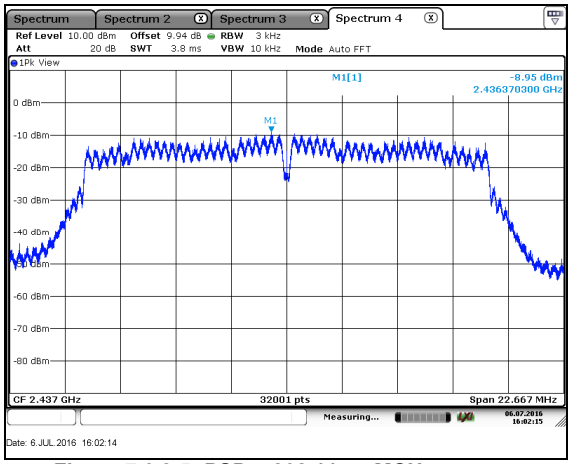

Figure 7.6.2-5: PSD – 802.11g – MCH

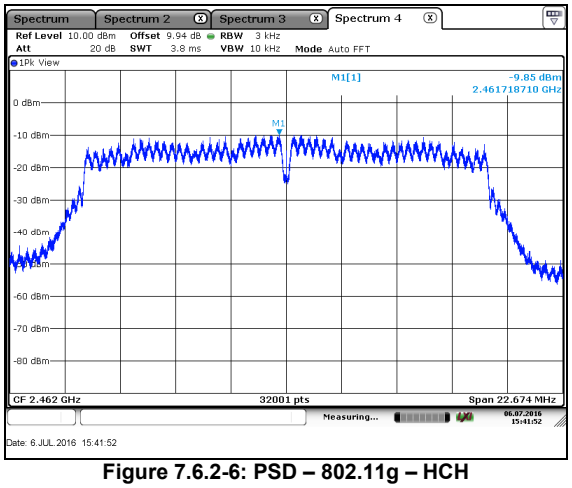

Figure 7.6.2-6: PSD – 802.11g – HCH

Table 7.6.2-3: Power Spectral Density – 802.11n (HT 20)

Frequency [MHz]	PSD Level [dBm]
2412	-9.85
2437	-9.97
2462	-10.22

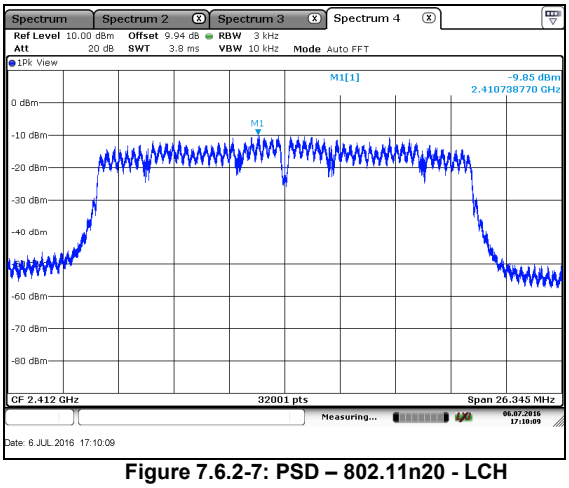

Figure 7.6.2-7: PSD – 802.11n20 - LCH

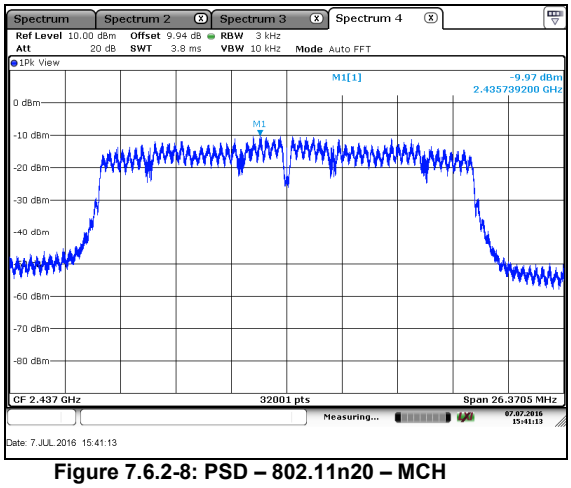

Figure 7.6.2-8: PSD – 802.11n20 – MCH

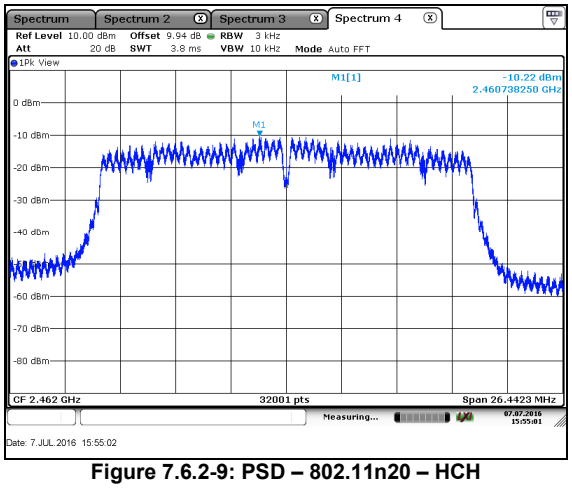

Figure 7.6.2-9: PSD – 802.11n20 – HCH

Table 7.6.2-4: Power Spectral Density – 802.11n (HT 40)

Frequency [MHz]	PSD Level [dBm]
2422	-16.04
2437	-16.02
2452	-16.33

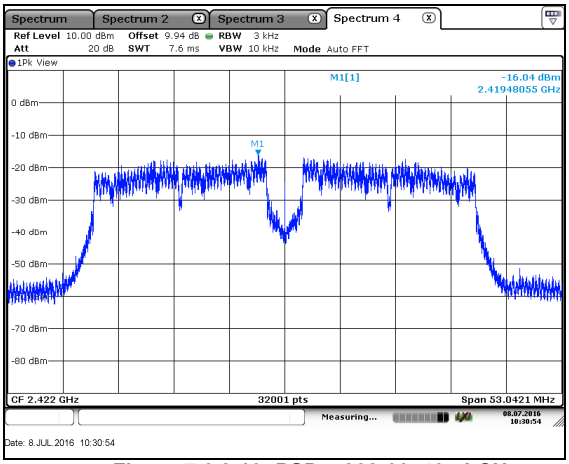

Figure 7.6.2-10: PSD – 802.11n40 - LCH

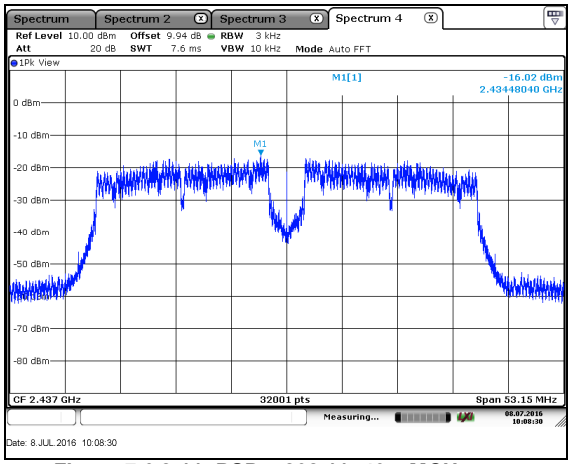

Figure 7.6.2-11: PSD – 802.11n40 – MCH

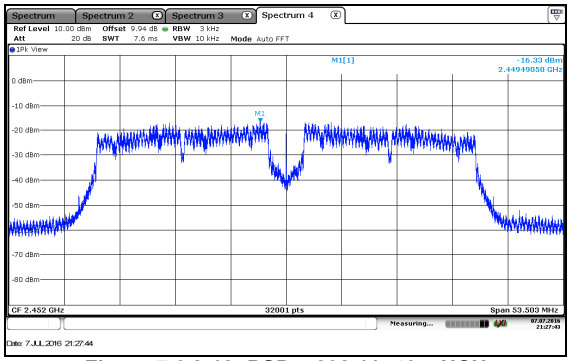

Figure 7.6.2-12: PSD – 802.11n40 – HCH

7.7 Duty Cycle

7.7.1 Measurement Procedure

The duty cycle was measured in accordance with the FCC KDB 558074 D01 DTS Meas Guidance Section 6.0 Duty cycle, transmission duration and maximum power control level. The unit was connected directly to the input of the spectrum analyzer via suitable attenuation. The RBW and VBW were set to 28 MHz and the number of sweep points across duration T was set to exceed 100.

7.7.2 Measurement Results

The results for all the modes of operation are provided below.

Table 7.7.2-1 Duty Cycle Correction Factor

Mode	Time On [ms]	Period [ms]	Duty Cycle [%]	Correction Factor [dB]
802.11b	2.317812	2.362187	98.12144	0.08
802.11g	1.38375	1.4325	96.59686	0.15
802.11n (HT 20)	0.352281	0.400719	87.91234	0.56
802.11n (HT 40)	0.379969	0.428063	88.76479	0.52

Note: The correction factor was calculated as 10*log (Period / Time ON)

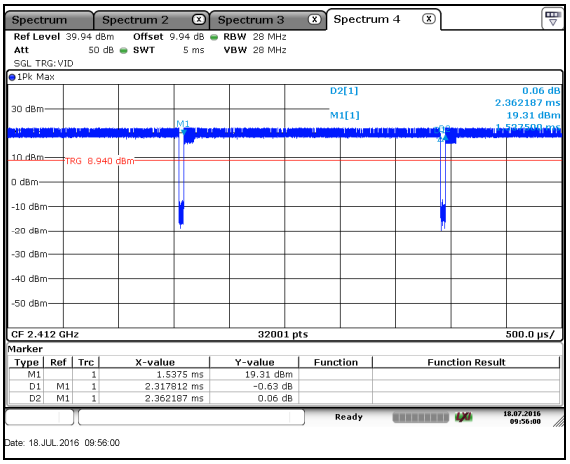

Figure 7.7.2-1: Duty Cycle 802.11b

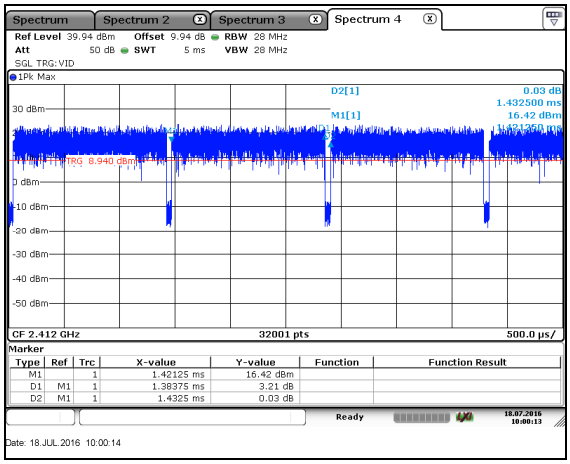

Figure 7.7.2-2: Duty Cycle 802.11g

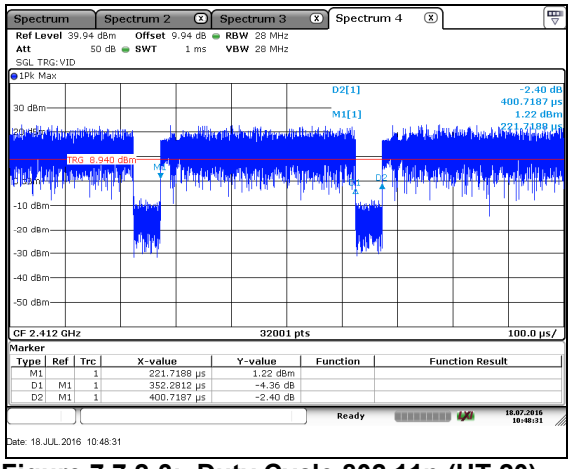

Figure 7.7.2-3: Duty Cycle 802.11n (HT 20)

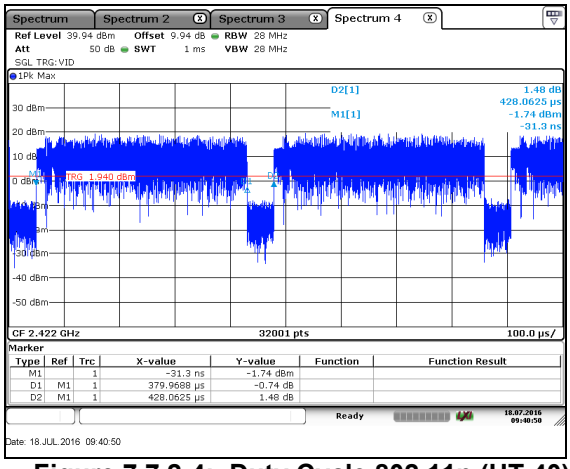

Figure 7.7.2-4: Duty Cycle 802.11n (HT 40)

8 CONCLUSION

In the opinion of ACS, Inc. the ACT1, manufactured by Itron, Inc. meets the requirements of FCC Part 15 subpart C and ISED Canada's Radio Standards Specification RSS-247.

END REPORT