Wireless Test Report

FCC ID: QZC-MNIC
IC: 4557A-MNIC

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

Report Number: 72124703.100

Manufacturer: Elster Solutions
Model: SynergyNet mNIC

Test Begin Date: March 01, 2017
Test End Date: April 24, 2017

Report Issue Date: April 24, 2017

FOR THE SCOPE OF ACCREDITATION UNDER LAB Code AT-1921

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

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This report contains 37 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 ISED Canada's Radio Standards Specification RSS-247 Certification for limited modular approval.

1.2 Product description

The Model MNIC Printed Circuit Board Assembly (PCBA) module contains a frequency hopping spread spectrum (FHSS) radio operating in the 902-928 MHz ISM frequency band. It also contains circuitry for application control and communications with a host product. The MNIC module connects hosts using Advanced Metering Infrastructure (AMI) that utilizes a proprietary network architecture and protocol devised by Elster Electricity LLC.
The 900 MHz radio may operate in two modes: (Mode 1) The Energy Axis (EA) mode at low power or (Mode 2) SynergyNet mode at high power. The EA mode is Elster's legacy mode of operation while the SynergyNet mode is for future use and is compliant with the IEEE 802.15.4g standard for Smart Metering Utility Networks.

Technical Information:

Mode of Operation	Frequency Range (MHz)	Number of Channels	Data Rates Supported (kbps)
1	902.4 - 927.6	25	35.5, 142.2
2	902.4 - 927.6	64	50, 150, 200

Modulation Format: FSK
Operating Voltage: 4Vdc
Antenna Type / Gain:

Antenna Type	**Antenna Gain**
Spiral	3dBi
Half-Wave Dipole	5.15dBi
Inverted F	3.49dBi

Manufacturer Information:
Elster Solutions
208 S. Rogers Lane
Raleigh, NC 27610

EUT Serial Numbers: 5D26162G01-1001170600014

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 available data rates were evaluated for each mode. The data presented in this report represents the worst case where applicable.

For radiated emissions, the EUT was evaluated in three orthogonal orientations with the highest gain antenna for each type. The worst-case orientation was the Y-orientation with the spiral 3dBi gain antenna. Based on radiated measurements of all data rates, the worst-case data rate for mode 1 was 35.5kbps and 150kbps for mode 2.

For AC power line conducted emissions the EUT was evaluated with a typical host in the high power mode.

The EUT utilizes 25 hopping channels in operating mode 1 in the range from 902.4 MHz to 927.6 MHz using multiple hopping tables. Data was collected using multiple hopping tables to show compliance for all possible operating conditions (i.e. hopping band-edge at extreme operating band-edges).

Software power settings during test for mode 1: 24 (Low Channel), 21 (Mid Channel), 19 (High Channel)
Software power setting during test for mode 2: 38 (Low Channel), 34 (Mid Channel), 31 (High Channel)

2 TEST FACILITIES

2.1 Location

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

TÜV SÜD America Inc.
2320 Presidential Drive, Suite 101
Durham, NC 27703
Phone: (919) 381-4235

2.2 Laboratory Accreditations/Recognitions/Certifications

TÜV SÜD America Inc. is accredited to ISO/IEC 17025 by ANSI-ASQ National Accreditation Board under their ANAB program and has been issued certificate number AT-1921 in recognition of this accreditation. Unless otherwise specified, all test methods described within this report are covered under the ISO/IEC 17025 scope of accreditation.

FCC Registered Test Site Number: 637011
ISED Canada Test Site Registration Number: 20446

2.3 Radiated Emissions Test Site Description

2.3.1 Semi-Anechoic Chamber Test Site

The Semi-Anechoic Chamber Test Site consists of a 18' x 28' x 18' shielded enclosure. The chamber is lined with Samwha Electronics Co. LTD Ferrite Absorber, model number SFA300 (HSN-1). The ferrite tile is 10cm x 10 cm and weighs approximately 1.4lbs. These tiles are mounted on steel panels and installed directly on the inner walls of the chamber. On top of the ferrite tiles is DMAS HT-45 (Dutch Microwave Absorber Solutions) hybrid absorber on all walls except the wall behind the antenna mast which has a shorter DMAS HT-25 absorber.

The turntable is 1.50m in diameter and is located 150cm 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 short #6 copper wire. 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 turntable. 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.

Behind the turntable is a 2' x 6' x 1.5' deep shielded pit used for support equipment if necessary. The pit is equipped with 2 - 4" PVC chase 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:

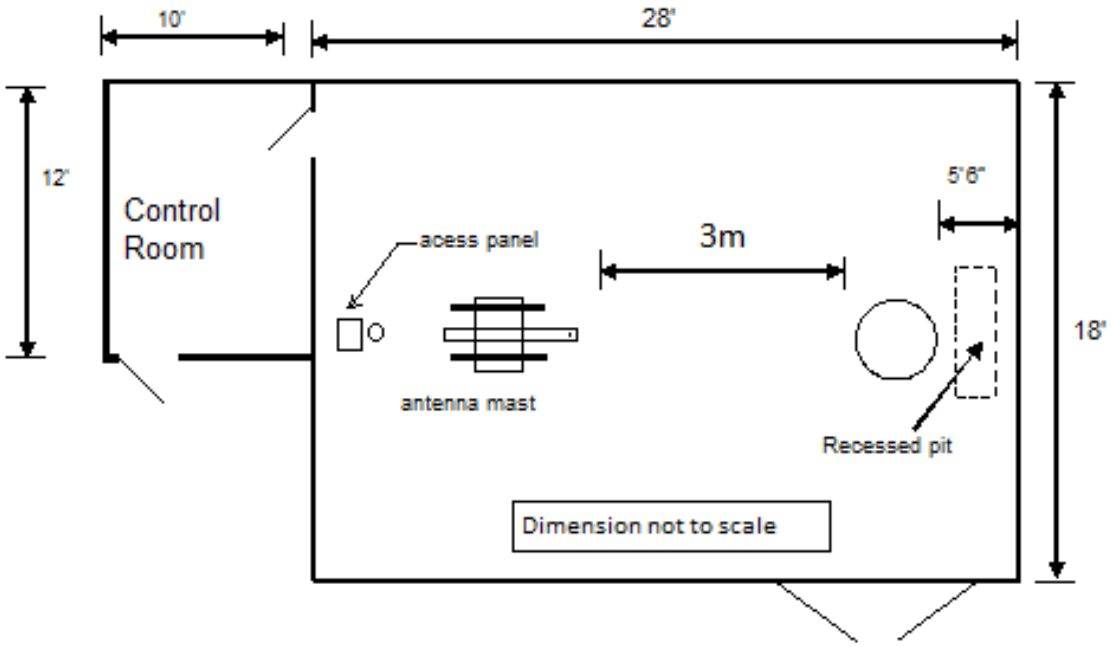


Figure 2.3-1: Semi-Anechoic Chamber Test Site

2.4 Conducted Emissions Test Site Description

The AC mains conducted EMI site is located in the main EMC lab. It consists of an 8’ x 10’ sheet galvanized steel horizontal ground reference plane (GRP) bonded every 6” to an 8’ X 8’ aluminum vertical ground plane.

A diagram of the room is shown below in figure 2.4-1:

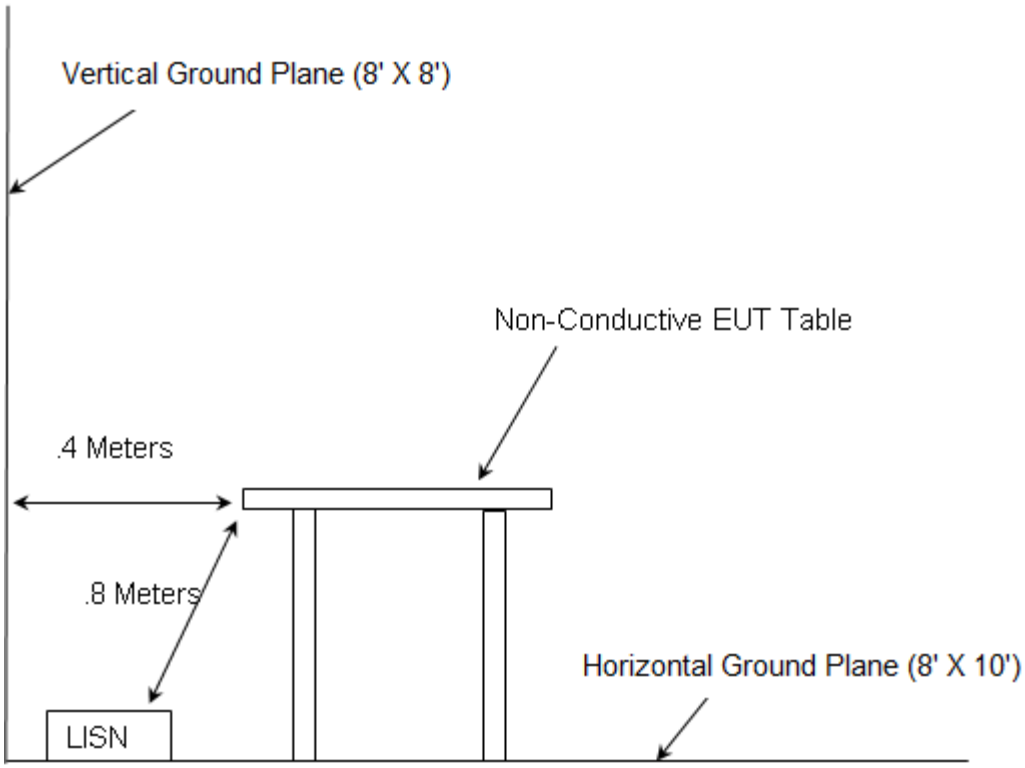


Figure 2.4-1: AC Mains Conducted EMI Site

3 APPLICABLE STANDARD REFERENCES

The following standards were used:

- ANSI C63.4-2014: 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 C63.10-2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
- US Code of Federal Regulations (CFR): Title 47, Part 15, Subpart C: Radio Frequency Devices, Intentional Radiators, 2017
- US Code of Federal Regulations (CFR): Title 47, Part 2, Subpart J: Equipment Authorization Procedures, 2016
- ISED Canada Radio Standards Specification: RSS-247, Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and License-Exempt Local Area Network (LE-LAN) Devices, Issue 2, February 2017
- 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

Asset ID	Manufacturer	Model #	Equipment Type	Serial #	Last Calibration Date	Calibration Due Date
277	EMCO	93146	Antennas	9904-5199	9/12/2016	9/12/2018
731	EMCO	3110B	Antennas	9411-1945	11/09/2016	11/09/2018
3002	Rohde & Schwarz	ESU40	Receiver	100346	1/12/2017	1/12/2018
3006	Rohde & Schwarz	TS-PR18	Amplifiers	122006	1/11/2017	1/11/2018
3008	Rohde & Schwarz	NRP2	Meter	103131	2/6/2017	2/6/2018
3009	Rohde & Schwarz	NRP-Z81	Meter	102397	2/6/2017	2/6/2018
3011	Rohde & Schwarz	ENV216	LISN	3011	1/12/2017	1/12/2018
3012	Rohde & Schwarz	EMC32-EB	Software	100731	NCR	NCR
3016	Fei Teng Wireless Technology	HA-07M18G-NF	Antennas	2013120203	1/26/2016	1/26/2018
3029	Micro-Tronics	HPM50108	Filter	134	1/13/2017	1/13/2018
3036	Hasco, Inc.	HLL142-S1-S1-24	Cables	2450	1/11/2017	1/11/2018
3038	Florida RF Labs	NMSE-290AW-60.0-NMSE	Cable Set	1448	1/3/2017	1/3/2018
3039	Florida RF Labs	NMSE-290AW-396.0-NMSE	Cable Set	1447	1/3/2017	1/3/2018
3049	Aeroflex Inmet	26AH-20	Attenuator	1443	1/11/2017	1/11/2018
3051	Mountain View Cable	BMS-RG400-264.0-BMS	Cables	3051	1/3/2017	1/3/2018
3055	Rohde & Schwarz	3005	Cables	3055	1/3/2017	1/3/2018
3085	Rohde & Schwarz	FSW43	Spectrum Analyzer	103997	8/9/2016	8/9/2017

NCR = No Calibration Required
DMAS MT-25 RF absorber material was used on the floor for all final measurements above 1 GHz.
Asset 3002: Firmware Version: ESU40 is 4.73 SP4
Asset 3012: Software Version: EMC32-B is 9.15
Asset 3085: Instrument Firmware 2.41 SP1

5 SUPPORT EQUIPMENT

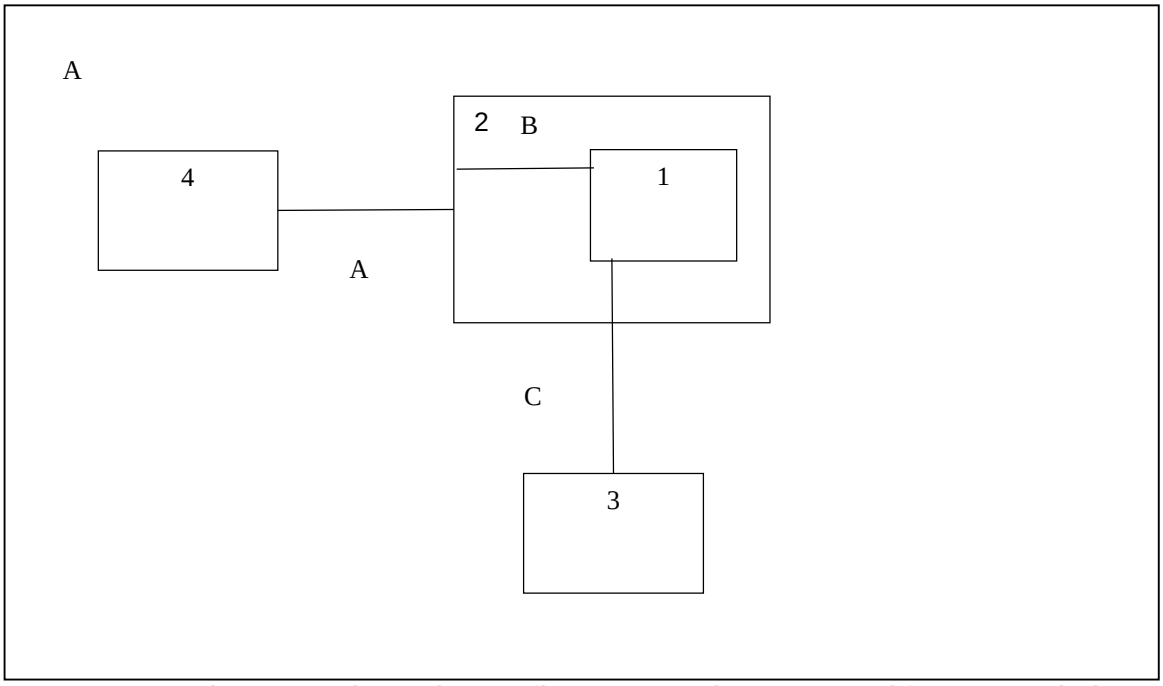
Table 5-1: EUT and Support Equipment Description

Item #	Type Device	Manufacturer	Model/Part #	Serial #
1	EUT	Elster Solutions	MNIC	5D26162G01 1001170600014
2	Circuit Board	Adaptor Board	N/A	TUV 19
3	Power Supply	Agilent	E3646A	MY54116460
4	Computer	Dell	7510	9T1PRC2

Table 5-2: Cable Description

Cable #	Cable Type	Length	Shield	Termination
A	Serial to USB	30cm	Yes	2 - 4
B	Ribbon Cable	15cm	No	2 - 1
C	Power	40cm	No	3 - 1

6 EQUIPMENT UNDER TEST SETUP BLOCK DIAGRAM



Note: Item 4 and A were only used to configure EUT and was removed from setup during radiated measurements

Figure 6-1: Test Setup Block Diagram

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 RF Connector is a MCX connector and satifies the requirements in FCC Part 15.203.

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

7.2.1 Measurement Procedure

ANSI C63.10-2013 section 6 was the guiding document for this evaluation. 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)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Filter	Corr. (dB)
0.194000	---	26.85	53.70	26.85	2000.0	9.000	L1	OFF	9.6
0.194000	39.45	---	63.72	24.27	2000.0	9.000	L1	OFF	9.6
0.704000	---	25.80	46.00	20.20	2000.0	9.000	L1	OFF	9.6
0.704000	26.62	---	56.00	29.38	2000.0	9.000	L1	OFF	9.6
3.664000	---	22.82	46.00	23.18	2000.0	9.000	L1	OFF	9.8
3.664000	34.90	---	56.00	21.10	2000.0	9.000	L1	OFF	9.8
3.880000	---	24.01	46.00	21.99	2000.0	9.000	L1	OFF	9.8
3.880000	36.03	---	56.00	19.97	2000.0	9.000	L1	OFF	9.8
9.606000	---	28.08	50.00	21.92	2000.0	9.000	L1	OFF	9.9
9.606000	36.69	---	60.00	23.31	2000.0	9.000	L1	OFF	9.9
12.122000	---	36.33	50.00	13.67	2000.0	9.000	L1	OFF	10.0
12.122000	44.91	---	60.00	15.09	2000.0	9.000	L1	OFF	10.0
13.798000	---	38.38	50.00	11.62	2000.0	9.000	L1	OFF	10.0
13.798000	46.19	---	60.00	13.81	2000.0	9.000	L1	OFF	10.0
15.046000	---	28.14	50.00	21.86	2000.0	9.000	L1	OFF	10.0
15.046000	36.82	---	60.00	23.18	2000.0	9.000	L1	OFF	10.0
22.602000	---	34.22	50.00	15.78	2000.0	9.000	L1	OFF	10.1
22.602000	42.23	---	60.00	17.77	2000.0	9.000	L1	OFF	10.1
26.578000	---	29.40	50.00	20.60	2000.0	9.000	L1	OFF	10.2
26.578000	38.44	---	60.00	21.56	2000.0	9.000	L1	OFF	10.2

Table 7.2.2-2: Conducted EMI Results – Neutral

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Filter	Corr. (dB)
0.660000	---	19.22	46.00	26.78	2000.0	9.000	N	OFF	9.6
0.660000	32.28	---	56.00	23.72	2000.0	9.000	N	OFF	9.6
1.300000	---	20.98	46.00	25.02	2000.0	9.000	N	OFF	9.6
1.300000	35.35	---	56.00	20.65	2000.0	9.000	N	OFF	9.6
2.064000	---	20.94	46.00	25.06	2000.0	9.000	N	OFF	9.7
2.064000	37.18	---	56.00	18.82	2000.0	9.000	N	OFF	9.7
3.620000	---	34.67	46.00	11.33	2000.0	9.000	N	OFF	9.7
3.620000	47.88	---	56.00	8.12	2000.0	9.000	N	OFF	9.7
3.836000	---	35.75	46.00	10.25	2000.0	9.000	N	OFF	9.8
3.836000	48.46	---	56.00	7.54	2000.0	9.000	N	OFF	9.8
9.710000	---	35.92	50.00	14.08	2000.0	9.000	N	OFF	9.9
9.710000	45.58	---	60.00	14.42	2000.0	9.000	N	OFF	9.9
11.846000	---	41.57	50.00	8.43	2000.0	9.000	N	OFF	10.0
11.846000	51.11	---	60.00	8.89	2000.0	9.000	N	OFF	10.0
12.942000	---	38.67	50.00	11.33	2000.0	9.000	N	OFF	10.0
12.942000	47.38	---	60.00	12.62	2000.0	9.000	N	OFF	10.0
13.590000	---	41.95	50.00	8.05	2000.0	9.000	N	OFF	10.0
13.590000	50.27	---	60.00	9.73	2000.0	9.000	N	OFF	10.0
22.758000	---	35.63	50.00	14.37	2000.0	9.000	N	OFF	10.1
22.758000	42.69	---	60.00	17.31	2000.0	9.000	N	OFF	10.1

7.3 Peak Output Power – FCC: 15.247(b)(2); ISED Canada: RSS-247 5.4(a)

7.3.1 Measurement Procedure (Conducted Method)

The RF output port of the EUT was directly connected to the input of a power meter using suitable attenuation. The device employs < 50 channels at any given time in Mode 1 therefore the power is limited to 0.25 Watt. The device employs > 50 channels at any given time in Mode 2 therefore the power is limited to 1 Watt.

7.3.2 Measurement Results

Table 7.3.2-1: RF Output Power

Frequency (MHz)	Level (dBm)	Data Rate (kbps)
902.4	23.970	35.5
902.4	23.964	142.2
902.4	29.983	50
902.4	29.905	150
902.4	29.919	200
916	23.779	35.5
916	23.870	142.2
916	29.914	50
916	29.985	150
916	29.919	200
927.6	23.351	35.5
927.6	23.529	142.2
927.6	29.895	50
927.6	29.869	150
927.6	29.911	200

7.4 Channel Usage Requirements

7.4.1 Carrier Frequency Separation – FCC: 15.247(a)(1); ISED Canada: RSS-247 5.1(b)

7.4.1.1 Measurement Procedure

The RF output port of the EUT was directly connected to the input of the spectrum analyzer using suitable attenuation. The span of the spectrum analyzer was set wide enough to capture two adjacent peaks. The RBW was set to approximately 30% of the channel spacing and adjusted as necessary to best identify the center of each channel. The VBW was set > RBW.

7.4.1.2 Measurement Results

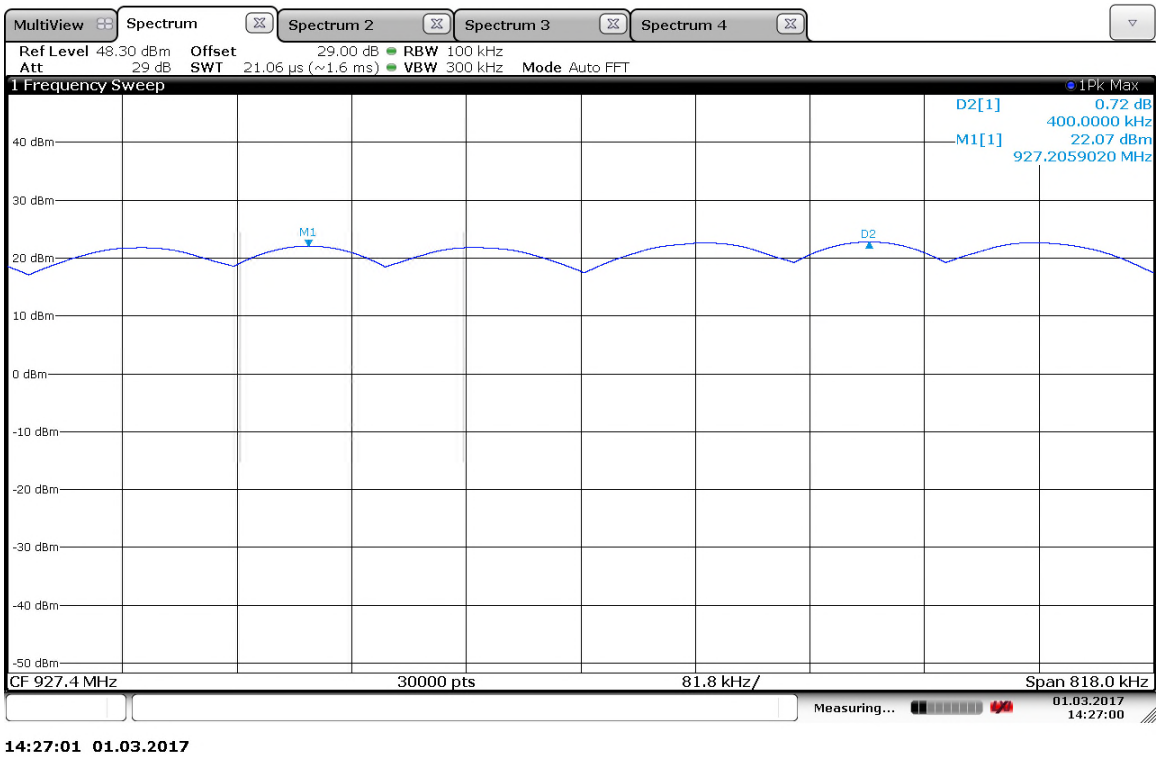


Figure 7.4.1.2-1: Carrier Frequency Separation 35.5kbps

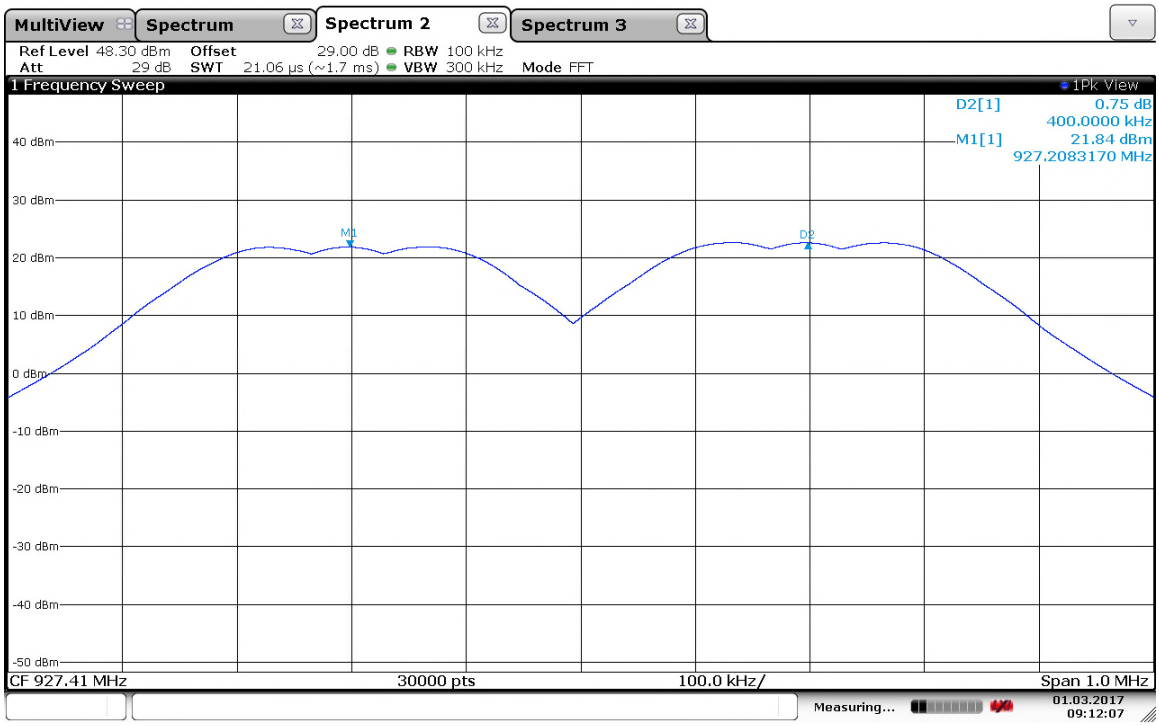


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Figure 7.4.1.2-2: Carrier Frequency Separation 142.2kbps

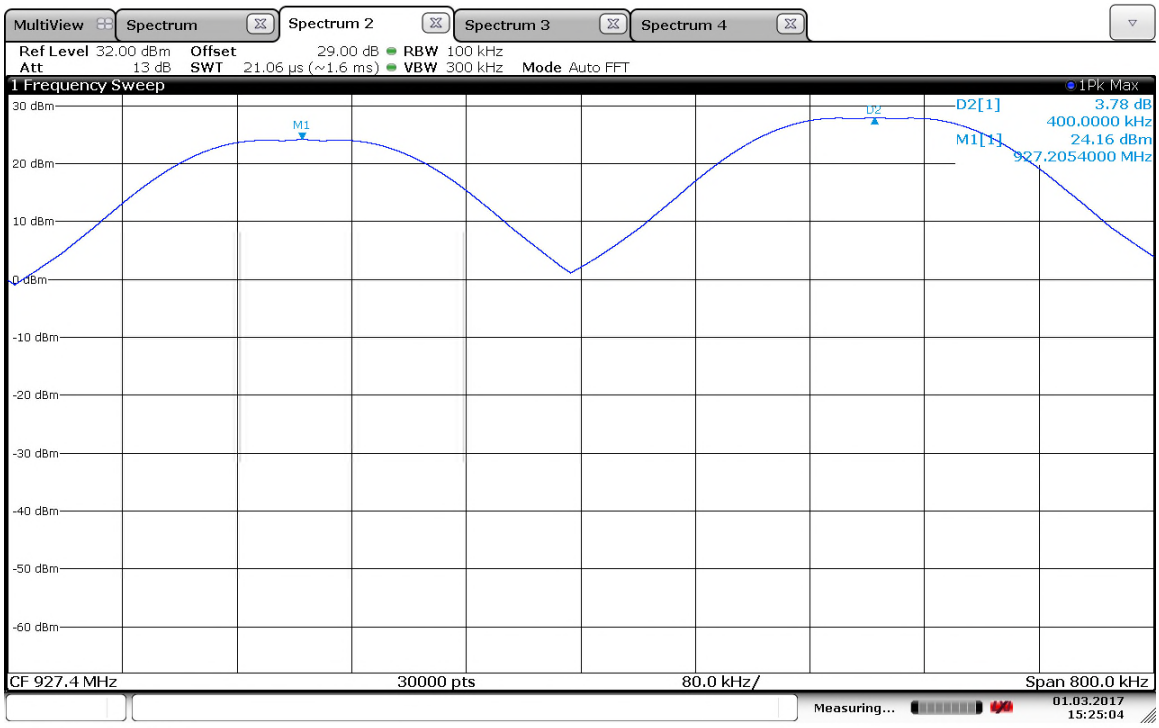

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Figure 7.4.1.2-3: Carrier Frequency Separation 50kbps

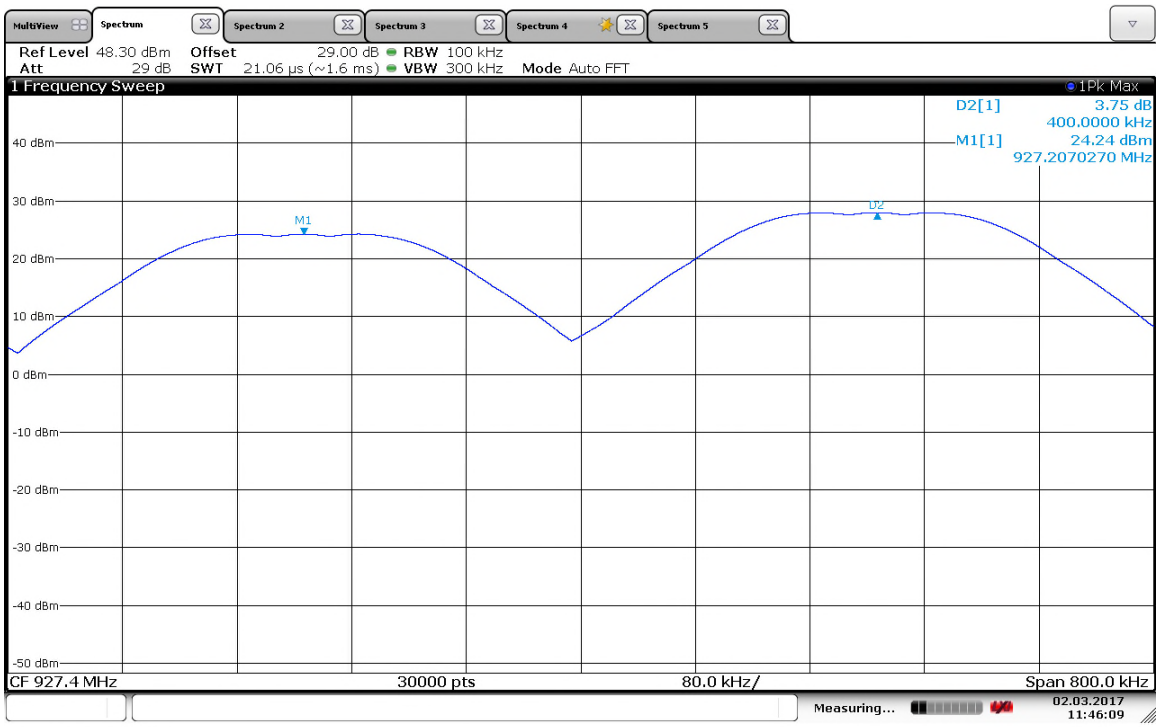

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Figure 7.4.1.2-4: Carrier Frequency Separation 150kbps

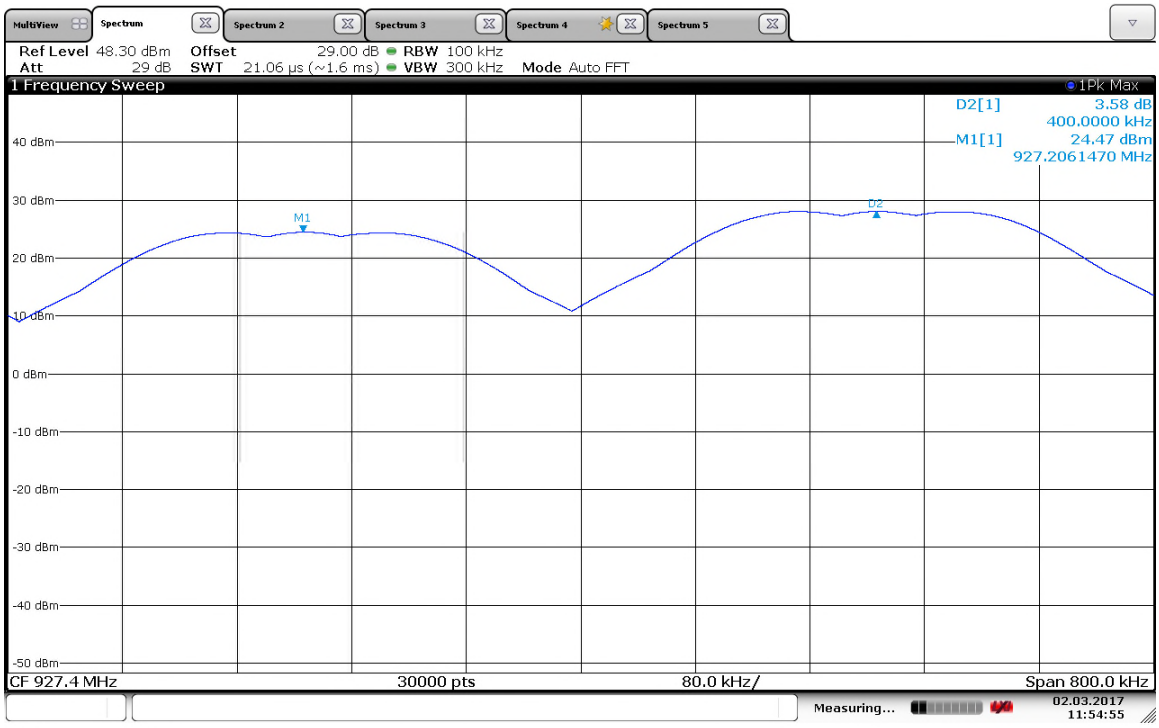

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Figure 7.4.1.2-5: Carrier Frequency Separation 200kbps

7.4.2 Number of Hopping Channels – FCC: 15.247(a)(1)(i); ISED Canada: RSS-247 5.1(c)

7.4.2.1 Measurement Procedure

The RF output port of the EUT was directly connected to the input of the spectrum analyzer using suitable attenuation. The span of the spectrum analyzer was set wide enough to capture the frequency band of operation. The RBW was set to < 30% of the channel spacing and VBW set to ≥ RBW.

7.4.2.2 Measurement Results

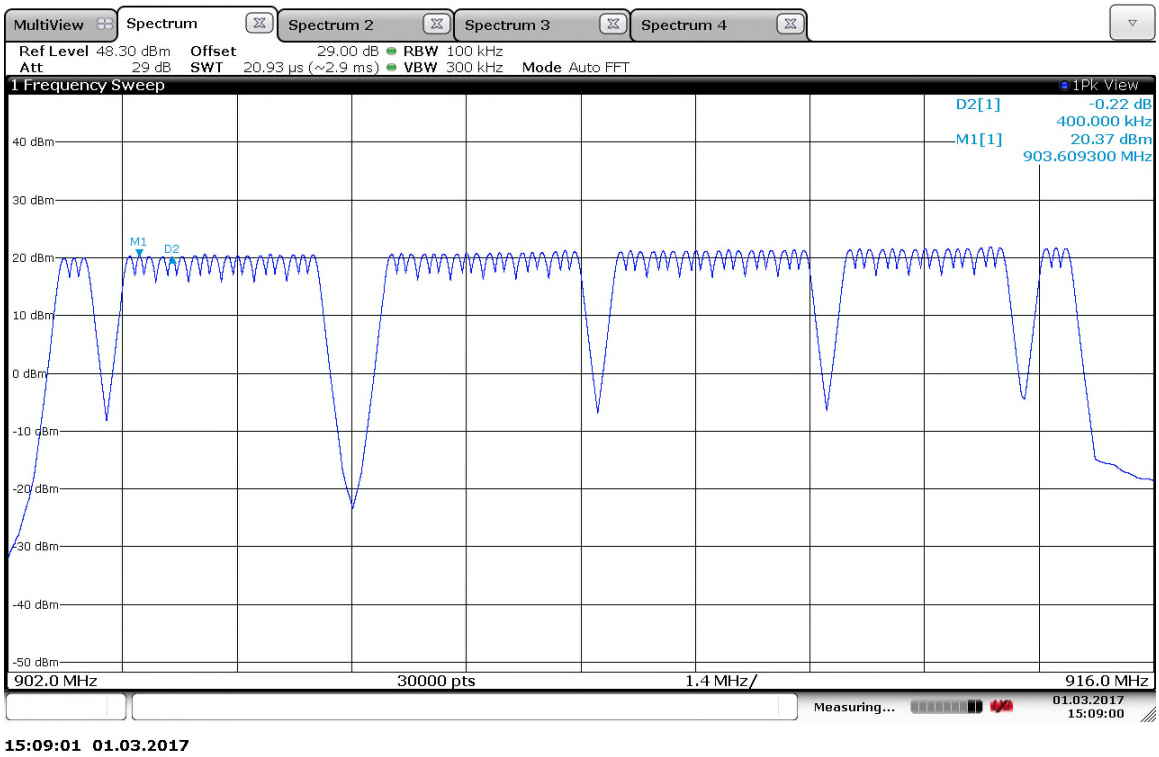

Figure 7.4.2.2-1: Number of Hopping Channels 35.5kbps

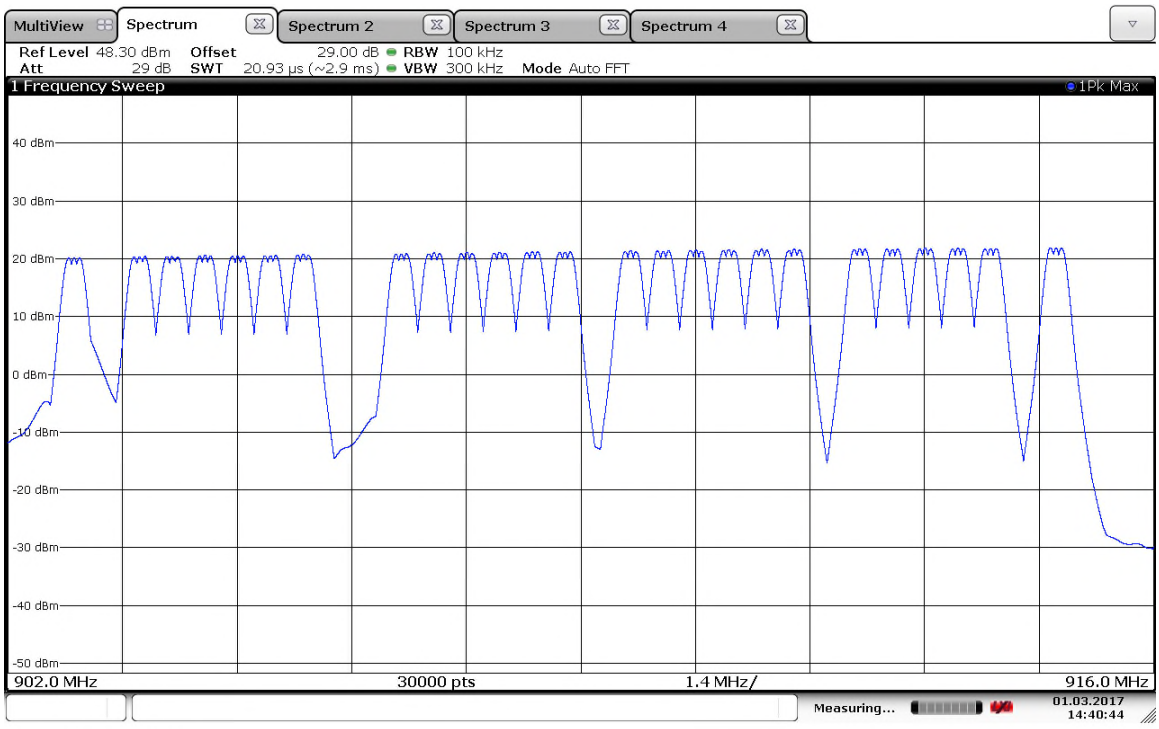

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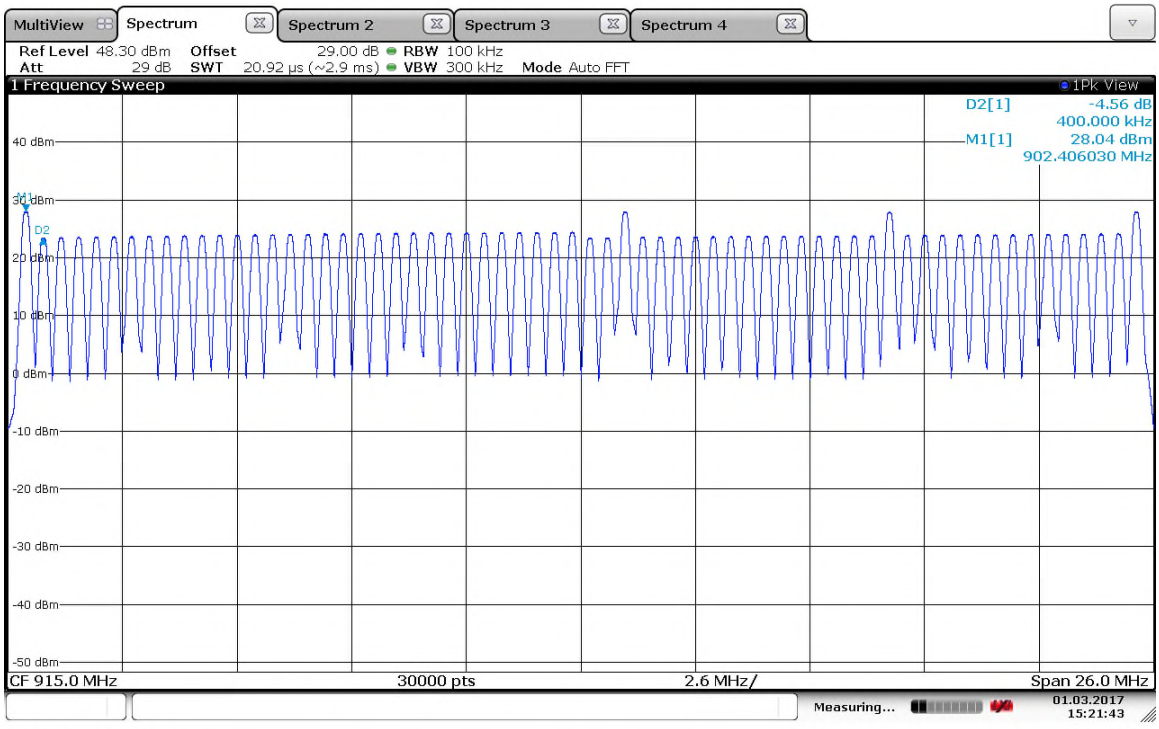
Figure 7.4.2.2-2: Number of Hopping Channels 142.2kbps



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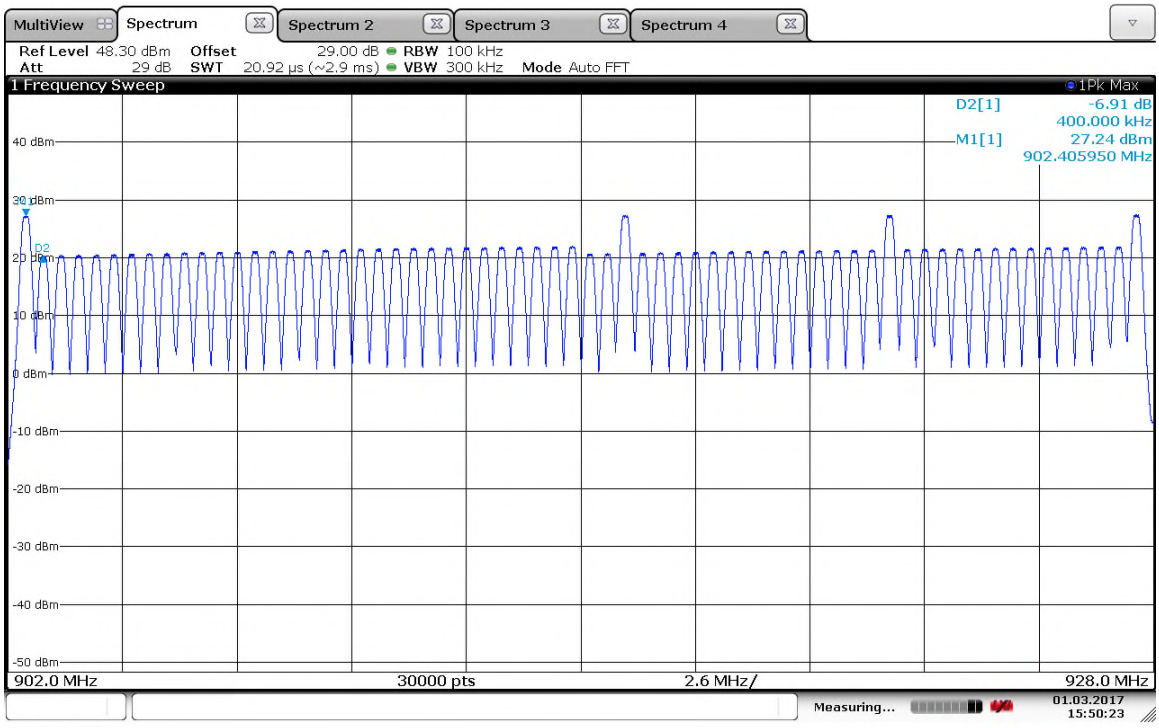
Note: For testing purposes, only the Low, Mid, and High Channel output power was tuned for maximum output.

Figure 7.4.2.2-3: Number of Hopping Channels 50kbps



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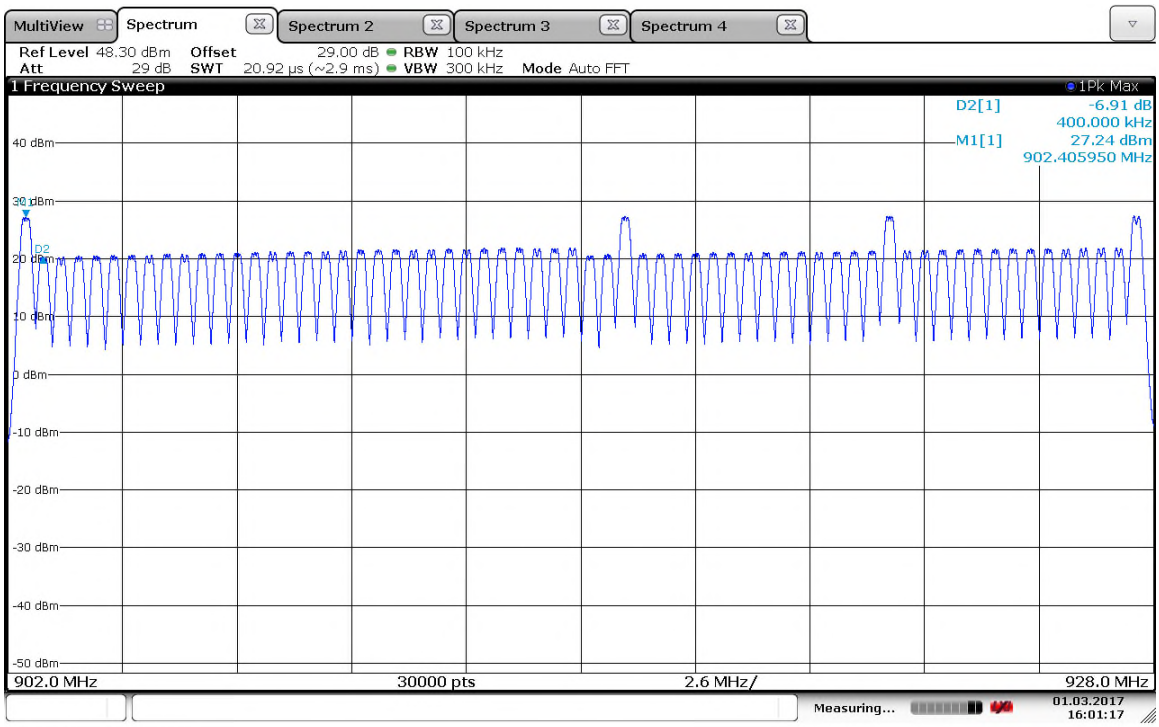
Note: For testing purposes, only the Low, Mid, and High Channel output power was tuned for maximum output.

Figure 7.4.2.2-4: Number of Hopping Channels 150kbps



16:01:17 01.03.2017

Note: For testing purposes, only the Low, Mid, and High Channel output power was tuned for maximum output.

Figure 7.4.2.2-5: Number of Hopping Channels 200kbps

7.4.3 Channel Dwell Time – FCC: 15.247(a)(1)(i); ISED Canada: RSS-247 5.1(c)

7.4.3.1 Measurement Procedure

The RF output port of the EUT was directly connected to the input of the spectrum analyzer using suitable attenuation. The span of the spectrum analyzer display was set 0 Hz centered on a hopping channel. The RBW of the spectrum analyzer was set to ≤ the EUT channel spacing and VBW set to ≥ RBW. The Marker Delta function of the analyzer was utilized to determine the dwell time.

7.4.3.2 Measurement Results

Table 7.4.3.2-1: Channel Dwell Time (10 Second Sweep)

Mode	Data Rate (kbps)	Single Occurrence	Number of Occurrences	Total Dwell Time (ms)
1	35.5kbps	103.03ms	2	206.06ms
1	142.2kbps	27.44ms	7	192.08ms
2	200kbps	25.25ms	4	101ms

Table 7.4.3.2-2: Channel Dwell Time (20 Second Sweep)

Mode	Data Rate (kbps)	Single Occurrence	Number of Occurrences	Total Dwell Time (ms)
2	50kbps	25.61ms	7	179.27ms
2	150kbps	25.16ms	7	176.12ms

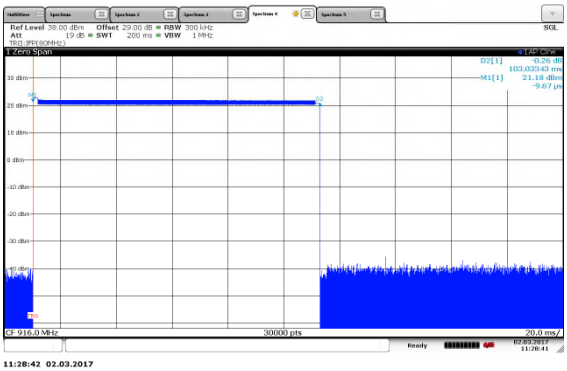


Figure 7.4.3.2-1: Dwell Time 35.5kbps

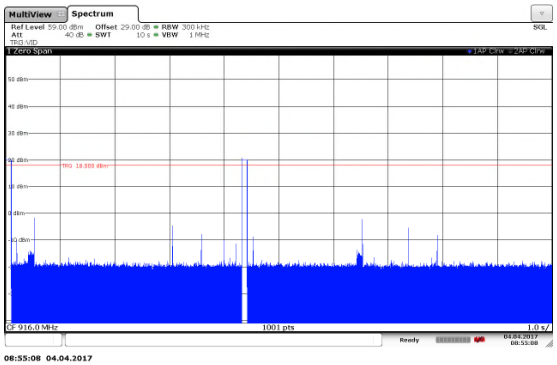


Figure 7.4.3.2-2: Number of Occurrences 35.5kbps

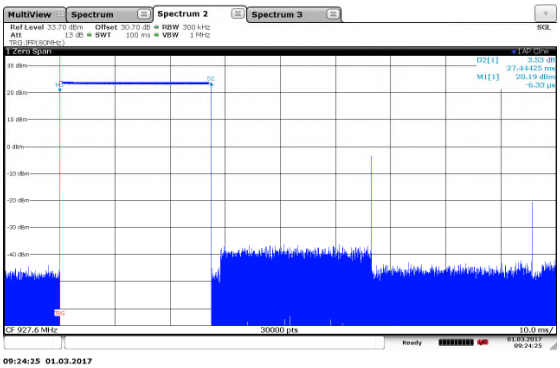


Figure 7.4.3.2-3: Dwell Time 142.2kbps

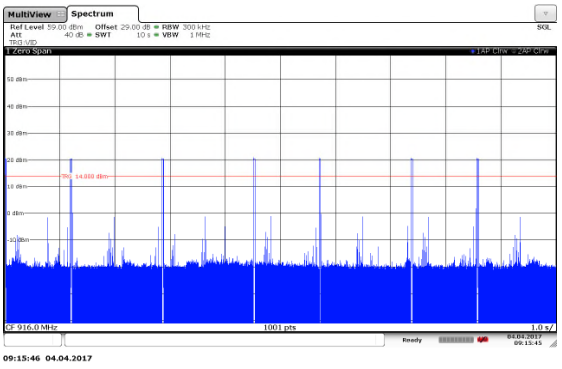


Figure 7.4.3.2-4: Number of Occurrences 142.2kbps

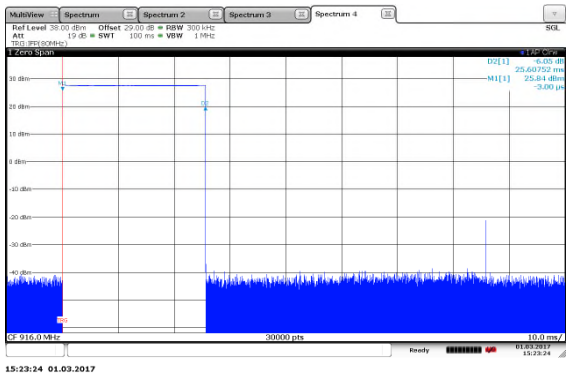


Figure 7.4.3.2-5: Dwell Time 50kbps

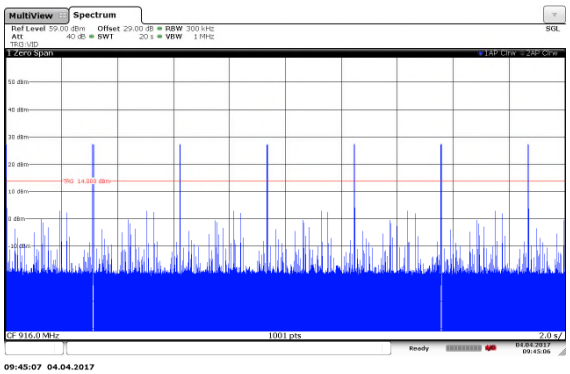


Figure 7.4.3.2-6: Number of Occurrences 50kbps

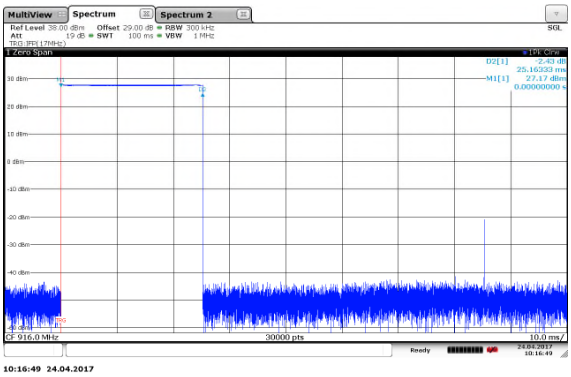


Figure 7.4.3.2-7: Dwell Time 150kbps

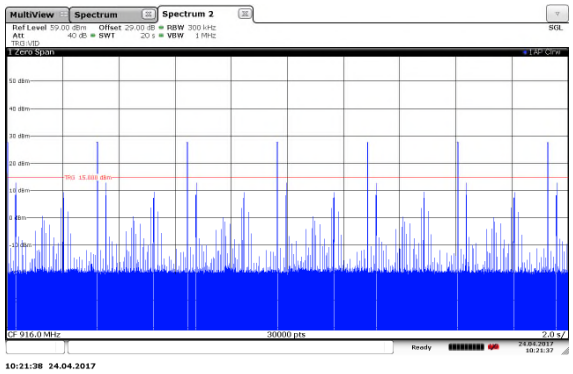


Figure 7.4.3.2-8: Number of Occurrences 150kbps

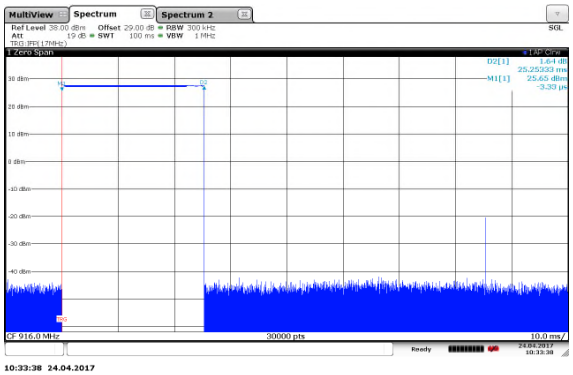


Figure 7.4.3.2-9: Dwell Time 200kbps

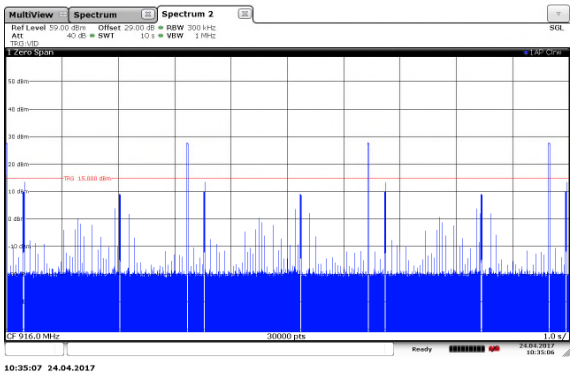


Figure 7.4.3.2-10: Number of Occurrences 200kbps

7.4.4 20dB / 99% Bandwidth – FCC: 15.247(a)(1)(i), ISED Canada: RSS-247 5.1(c)

7.4.4.1 Measurement Procedure

The RF output port of the EUT was directly connected to the input of the spectrum analyzer using suitable attenuation. The span of the spectrum analyzer display was set between two times and five times the occupied bandwidth (OBW) of the emission. The RBW of the spectrum analyzer was set to approximately 1 % to 5 % of the OBW. The trace was set to max hold with a peak detector active. The marker delta measurement function of the analyzer was utilized to determine the 20 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 1% to 5% of the occupied bandwidth. The video bandwidth was set to 3 times the resolution bandwidth. A peak detector was used.

7.4.4.2 Measurement Results

Table 7.4.4.2-1: 20dB / 99% Bandwidth

Frequency (MHz)	20dB Bandwidth (kHz)	99% Bandwidth (kHz)	Data Rate (kbps)
902.4	358.60	370.97	35.5
902.4	334.17	321.87	142.2
902.4	119.93	119.03	50
902.4	201.55	193.26	150
902.4	268.00	257.71	200
916.0	359.97	372.96	35.5
916.0	337.77	323.75	142.2
916.0	119.70	118.42	50
916.0	201.37	193.92	150
916.0	269.30	258.91	200
927.6	319.00	367.33	35.5
927.6	338.17	323.56	142.2
927.6	119.14	118.95	50
927.6	200.78	193.77	150
927.6	268.90	258.25	200

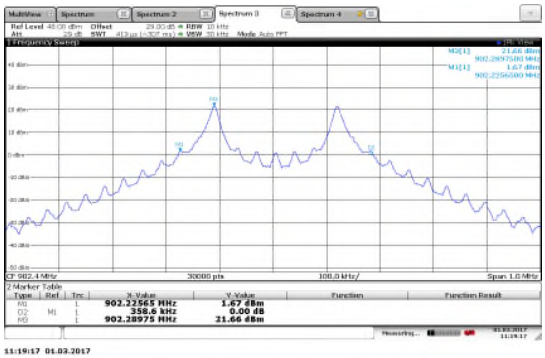


Figure 7.4.4.2-1: 20dB BW Low Channel 35.5kbps

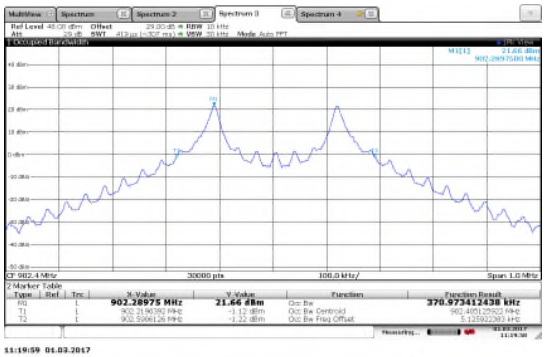


Figure 7.4.4.2-2: 99% OBW Low Channel 35.5kbps

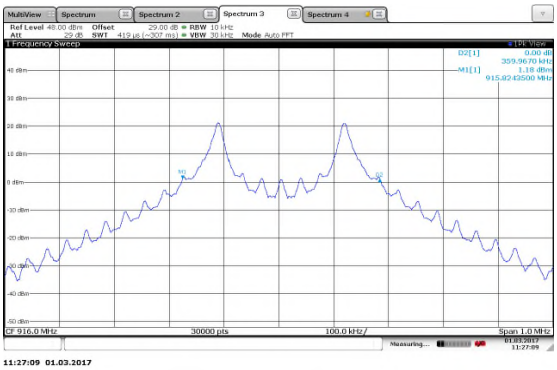


Figure 7.4.4.2-3: 20dB BW Mid Channel 35.5kbps

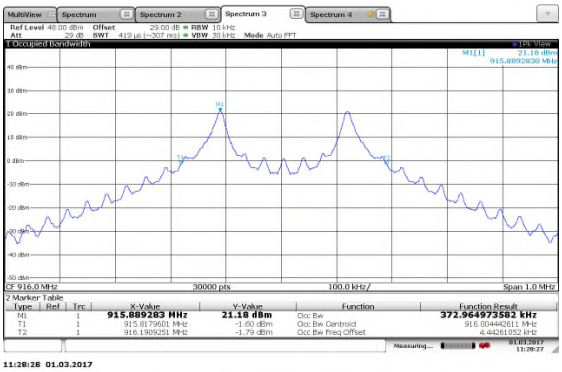


Figure 7.4.4.2-4: 99% OBW Mid Channel 35.5kbps

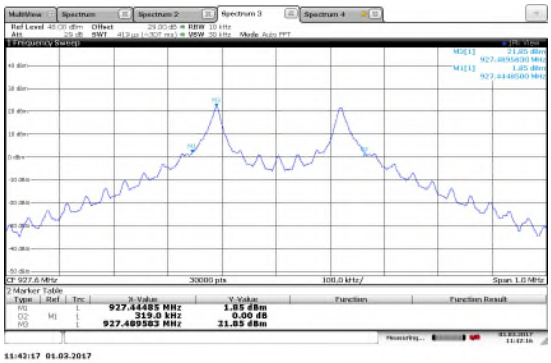


Figure 7.4.4.2-5: 20dB BW High Channel 35.5kbps

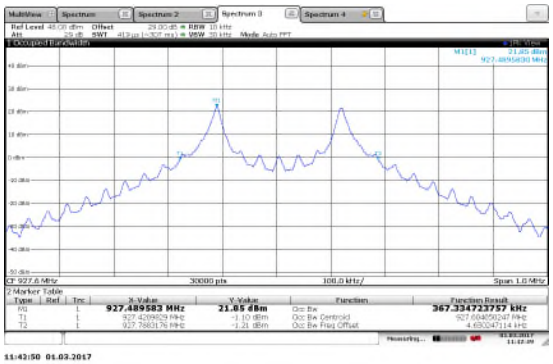


Figure 7.4.4.2-6: 99% OBW High Channel 35.5kbps

Figure 7.4.4.2-7: 20dB BW Low Channel 142.2kbps

Figure 7.4.4.2-8: 99% OBW Low Channel 142.2kbps

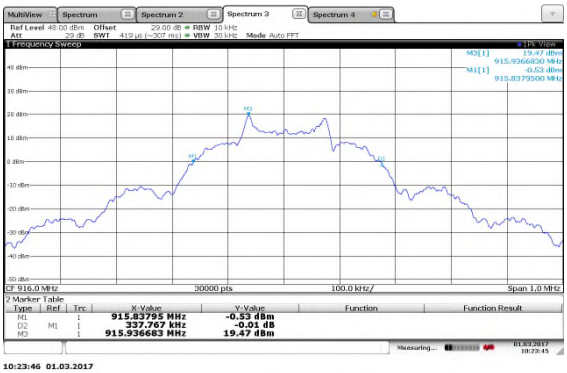


Figure 7.4.4.2-9: 20dB BW Mid Channel 142.2kbps

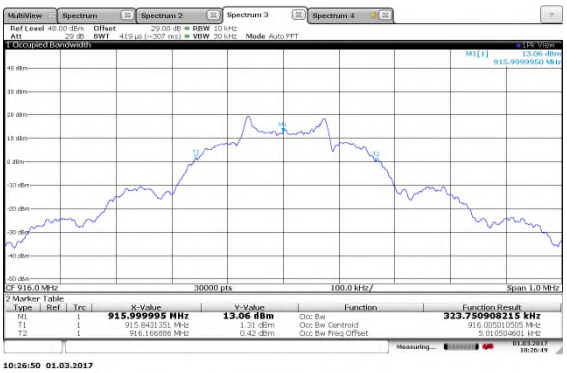


Figure 7.4.4.2-10: 99% OBW Mid Channel 142.2kbps

Figure 7.4.4.2-11: 20dB BW High Channel 142.2kbps

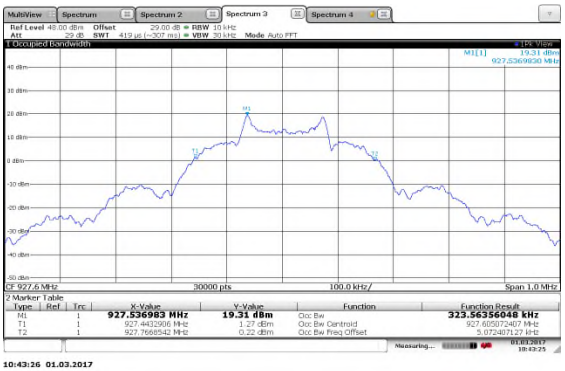


Figure 7.4.4.2-12: 99% OBW High Channel 142.2kbps

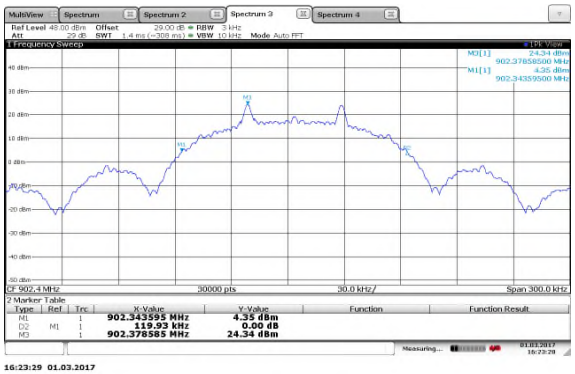


Figure 7.4.4.2-13: 20dB BW Low Channel 50kbps

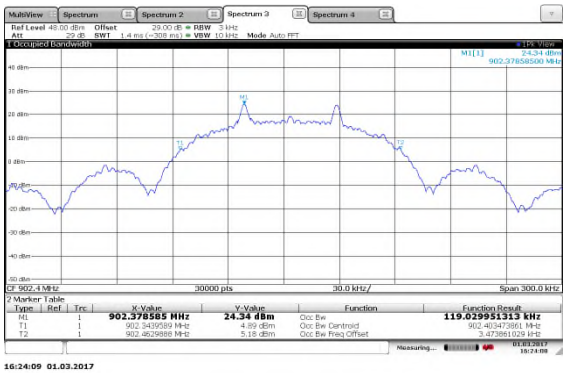


Figure 7.4.4.2-14: 99% OBW Low Channel 50kbps

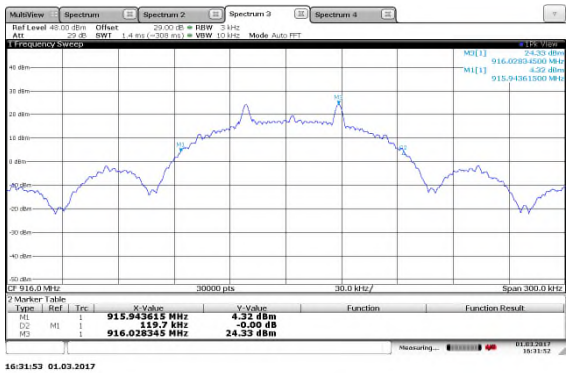


Figure 7.4.4.2-15: 20dB BW Mid Channel 50kbps

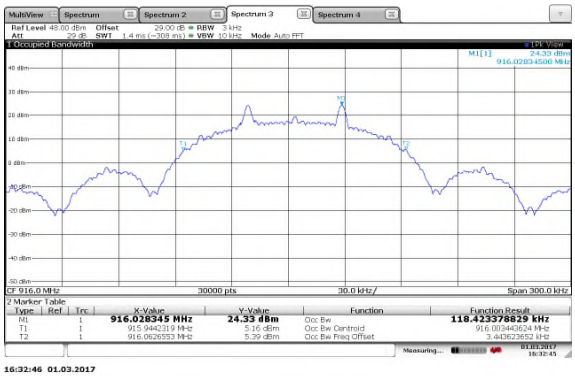


Figure 7.4.4.2-16: 99% OBW Mid Channel 50kbps

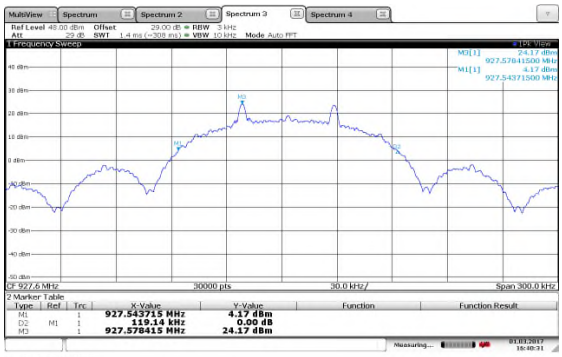


Figure 7.4.4.2-17: 20dB BW High Channel 50kbps

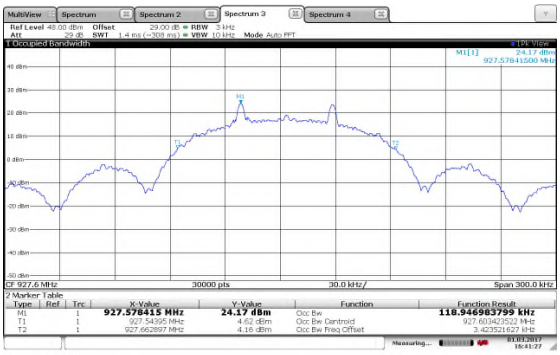


Figure 7.4.4.2-18: 99% OBW High Channel 50kbps

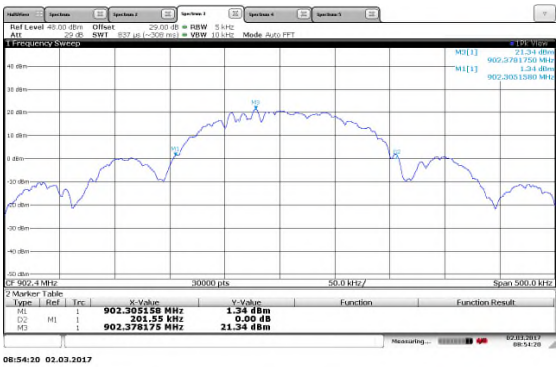


Figure 7.4.4.2-19: 20dB BW Low Channel 150kbps

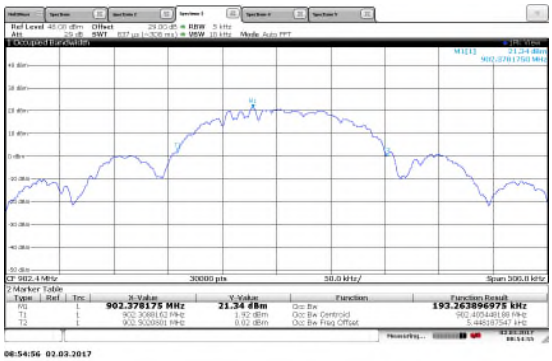


Figure 7.4.4.2-20: 99% OBW Low Channel 150kbps

Figure 7.4.4.2-21: 20dB BW Mid Channel 150kbps

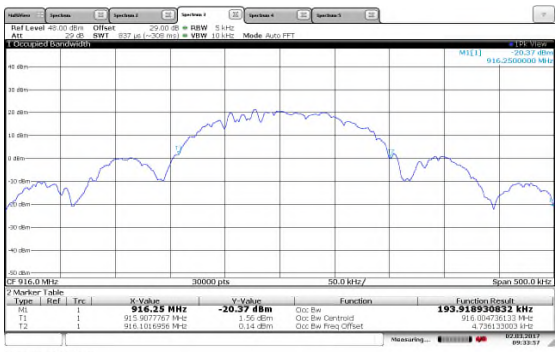


Figure 7.4.4.2-22: 99% OBW Mid Channel 150kbps

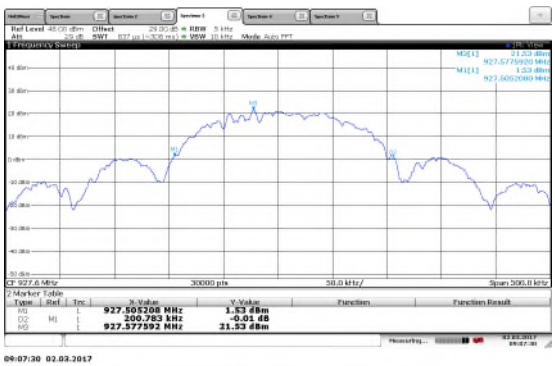


Figure 7.4.4.2-23: 20dB BW High Channel 150kbps

Figure 7.4.4.2-24: 99% OBW High Channel 150kbps

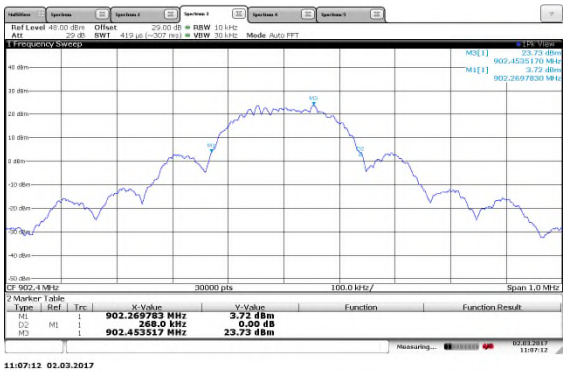


Figure 7.4.4.2-25: 20dB BW Low Channel 200kbps

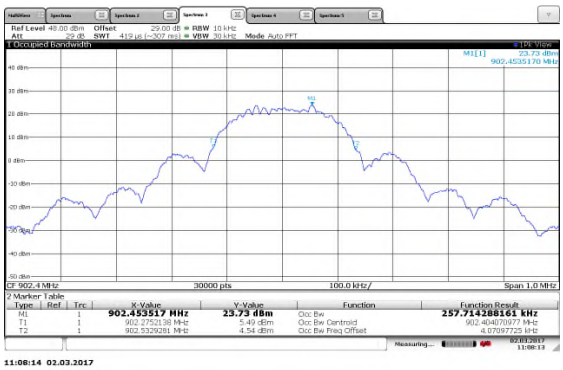


Figure 7.4.4.2-26: 99% OBW Low Channel 200kbps

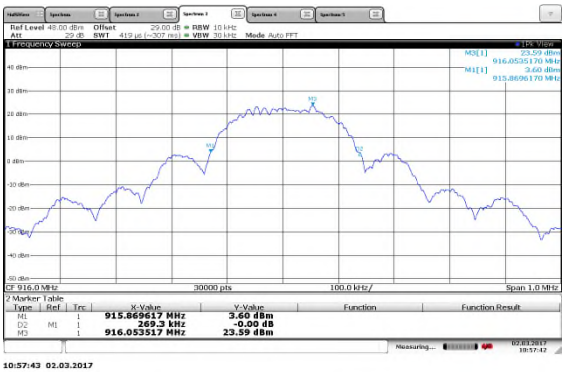


Figure 7.4.4.2-27: 20dB BW Mid Channel 200kbps

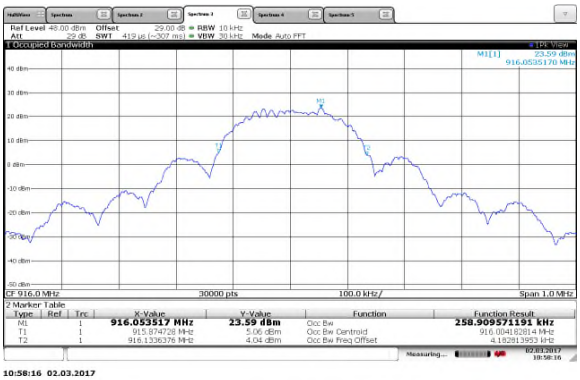


Figure 7.4.4.2-28: 99% OBW Mid Channel 200kbps

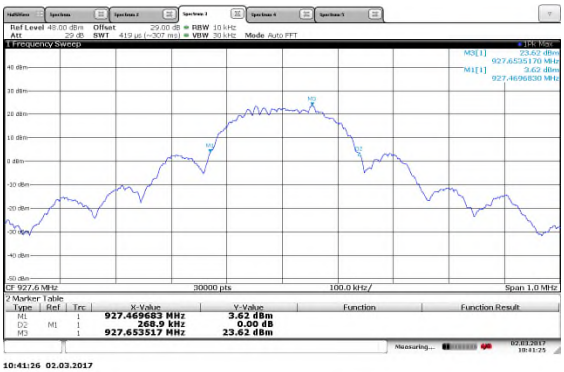


Figure 7.4.4.2-29: 20dB BW High Channel 200kbps

Figure 7.4.4.2-30: 99% OBW High Channel 200kbps

7.5 Band-Edge Compliance and Spurious Emissions

7.5.1 Band-Edge Compliance of RF Conducted Emissions – FCC: 15.247(d); ISED Canada RSS-247 5.5

7.5.1.1 Measurement Procedure

The RF output port of the EUT was directly connected to the input of the spectrum analyzer using suitable attenuation. The EUT was investigated at the lowest and highest channel available to determine band-edge compliance. For each measurement, the spectrum analyzer's RBW was set to 100 kHz, and the VBW was set to 300 kHz.

7.5.1.2 Measurement Results

NON-HOPPING MODE:

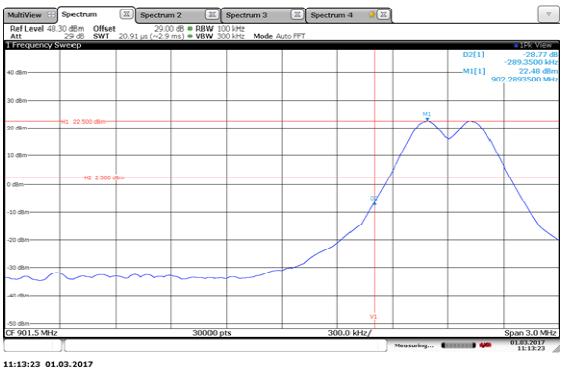


Figure 7.5.1.2-1: Lower Band-edge 35.5kbps

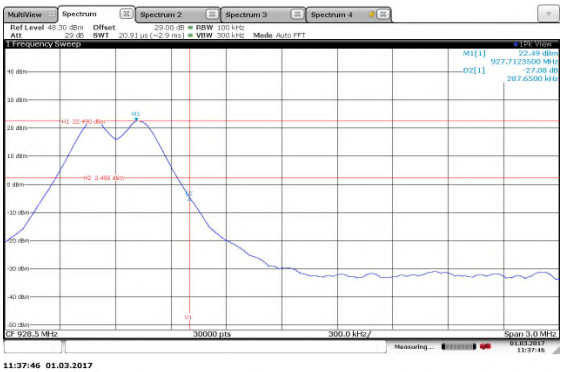


Figure 7.5.1.2-2: Upper Band-edge 35.5kbps

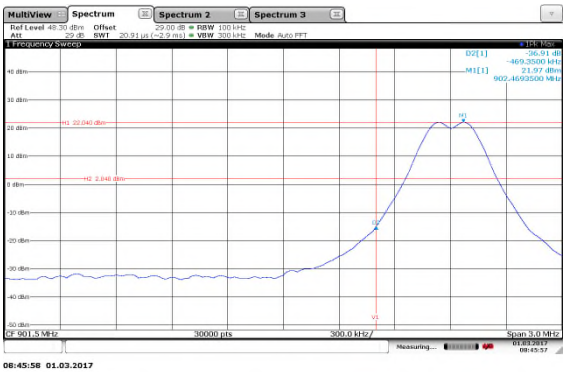


Figure 7.5.1.2-3: Lower Band-edge 142.2kbps

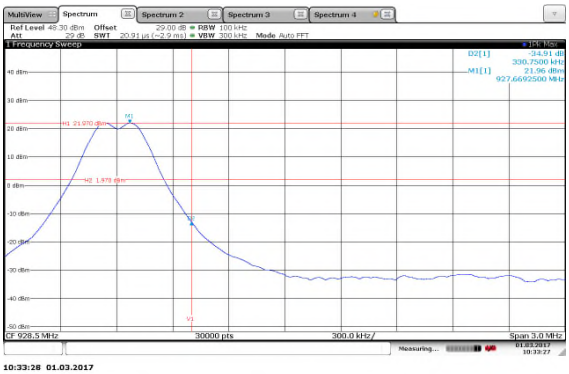


Figure 7.5.1.2-4: Upper Band-edge 142.2kbps

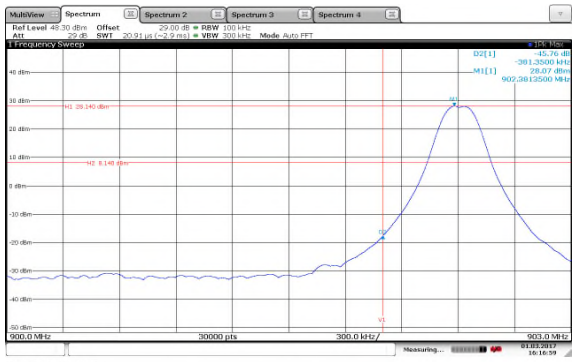


Figure 7.5.1.2-5: Lower Band-edge 50kbps

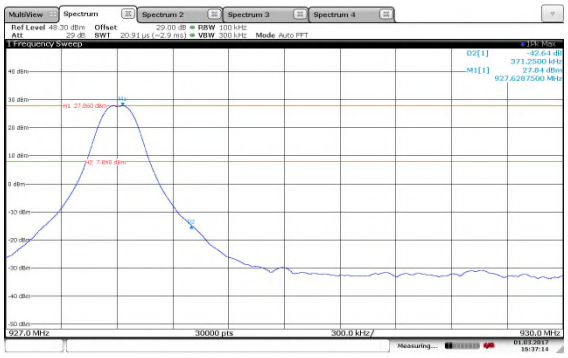


Figure 7.5.1.2-6: Upper Band-edge 50kbps

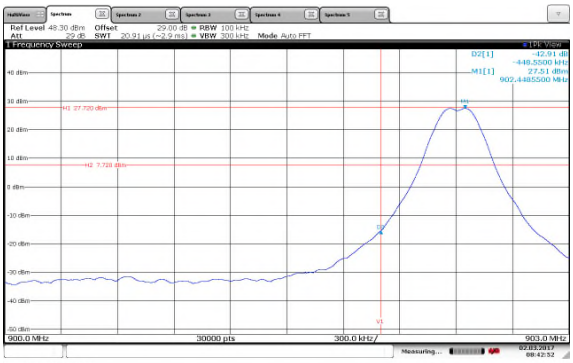


Figure 7.5.1.2-7: Lower Band-edge 150kbps

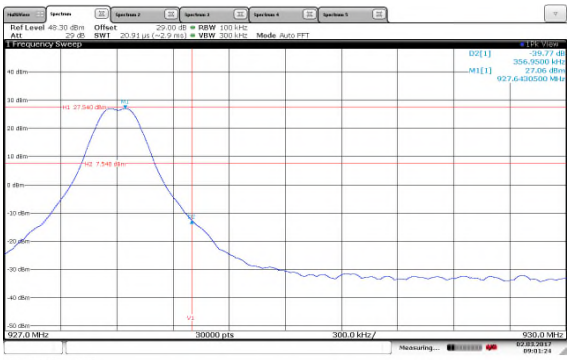


Figure 7.5.1.2-8: Upper Band-edge 150kbps

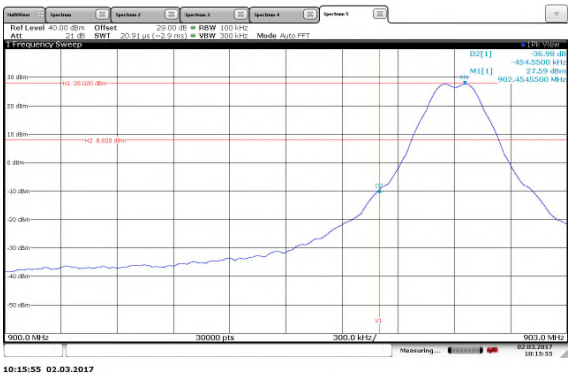


Figure 7.5.1.2-9: Lower Band-edge 200kbps

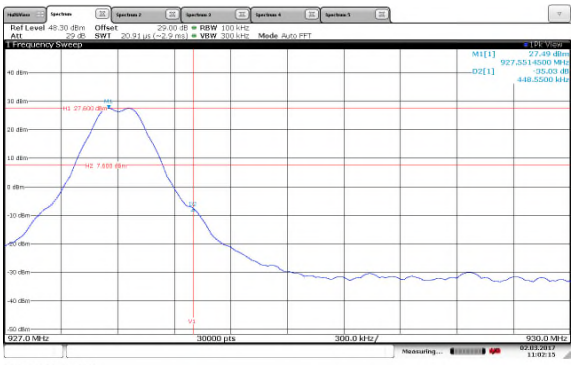


Figure 7.5.1.2-10: Upper Band-edge 200kbps

HOPPING MODE:

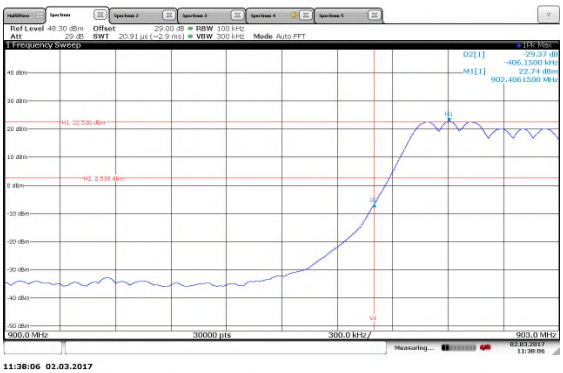


Figure 7.5.1.2-11: Lower Band-edge 35.5kbps

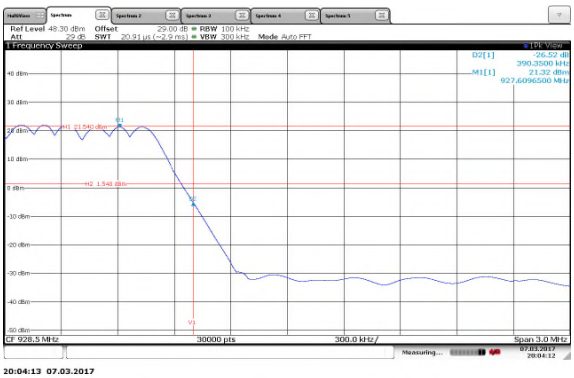


Figure 7.5.1.2-12: Upper Band-edge 35.5kbps

Figure 7.5.1.2-13: Lower Band-edge 142.2kbps

Figure 7.5.1.2-14: Upper Band-edge 142.2kbps

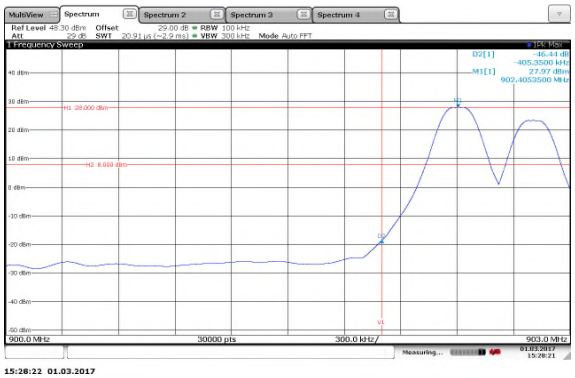


Figure 7.5.1.2-15: Lower Band-edge 50kbps

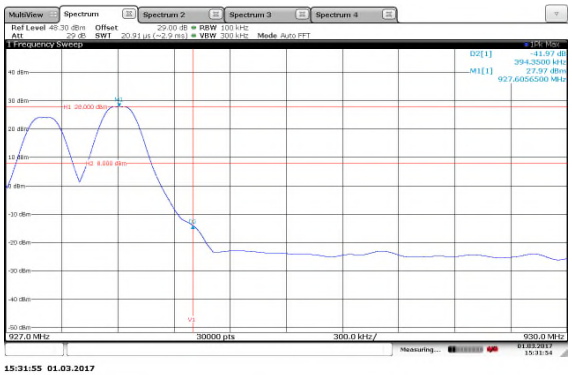


Figure 7.5.1.2-16: Upper Band-edge 50kbps

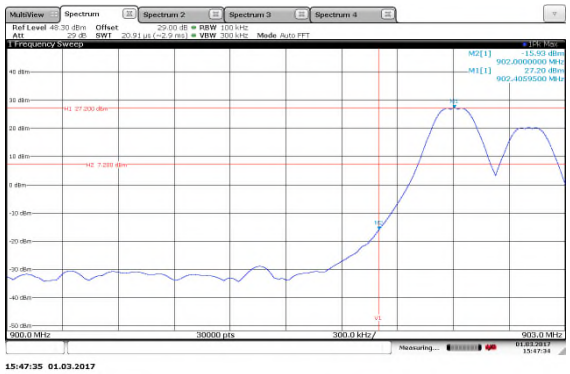


Figure 7.5.1.2-17: Lower Band-edge 150kbps

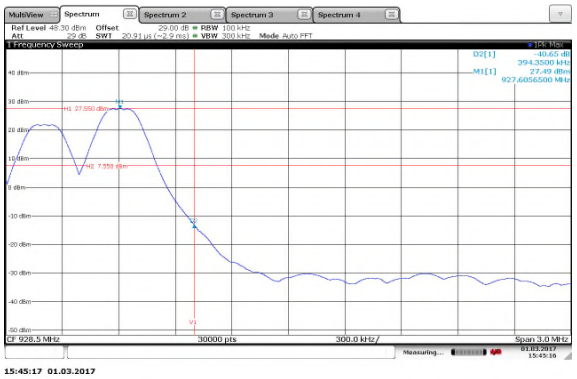


Figure 7.5.1.2-18: Upper Band-edge 150kbps

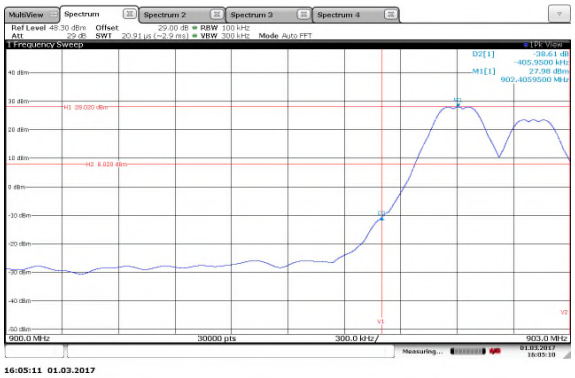


Figure 7.5.1.2-19: Lower Band-edge 200kbps

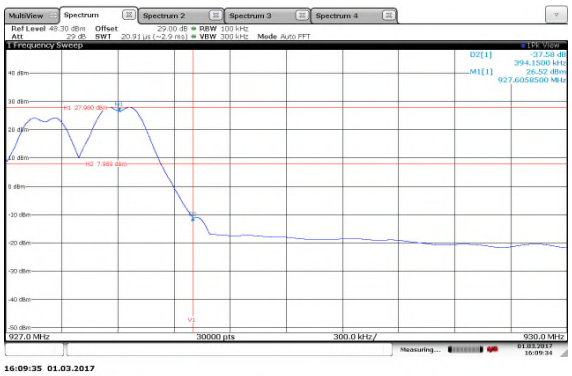


Figure 7.5.1.2-20: Upper Band-edge 200kbps

7.5.2 RF Conducted Spurious Emissions – FCC: 15.247(d); ISED Canada RSS-247 5.5

7.5.2.1 Measurement Procedure

The RF output port of the EUT was directly connected to the input of the spectrum analyzer using suitable attenuation. The EUT was investigated for conducted spurious emissions from 30MHz to 10GHz, 10 times the highest fundamental frequency. Measurements were made at the low, center and high channels of the EUT. For each measurement, the spectrum analyzer's RBW was set to 100kHz. A peak detector function was used with the trace set to max hold.

7.5.2.2 Measurement Results

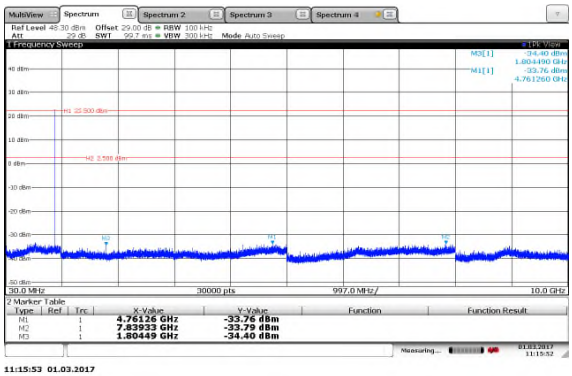


Figure 7.5.2.2-1: 30MHz–10GHz Low Channel 35.5kbps

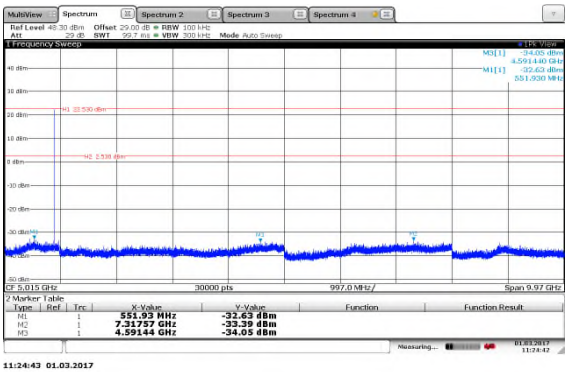


Figure 7.5.2.2-2: 30MHz–10GHz Mid Channel 35.5kbps

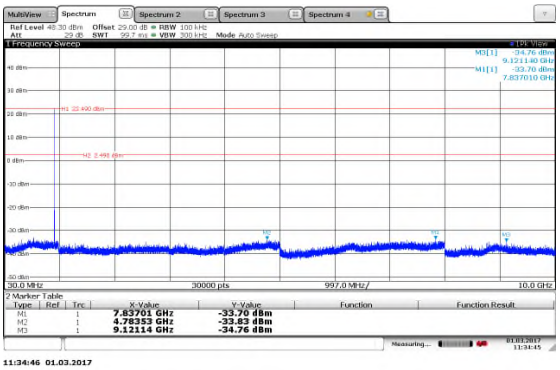


Figure 7.5.2.2-3: 30MHz–10GHz High Channel 35.5kbps

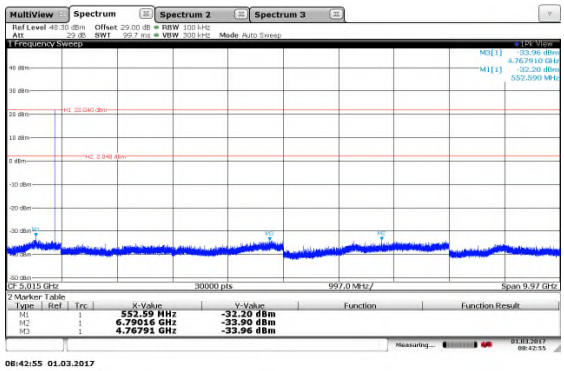


Figure 7.5.2.2-4: 30MHz–10GHz Low Channel 142.2kbps

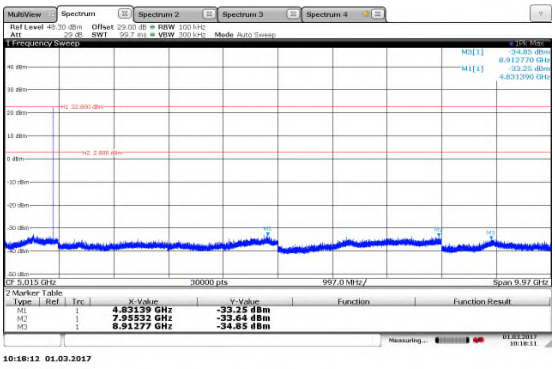


Figure 7.5.2.2-5: 30MHz–10GHz Mid Channel 142.2kbps

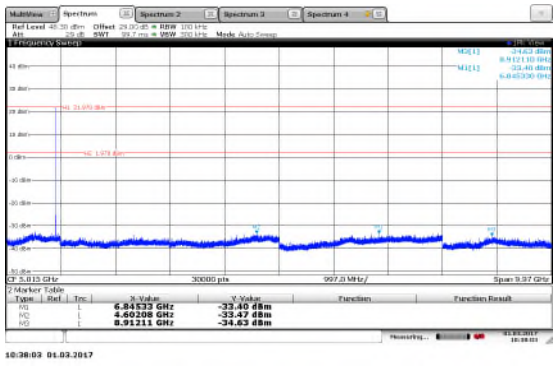


Figure 7.5.2.2-6: 30MHz–10GHz High Channel 142.2kbps

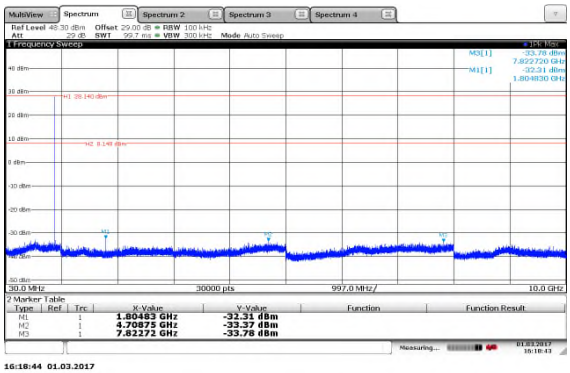


Figure 7.5.2.2-7: 30MHz–10GHz Low Channel 50kbps

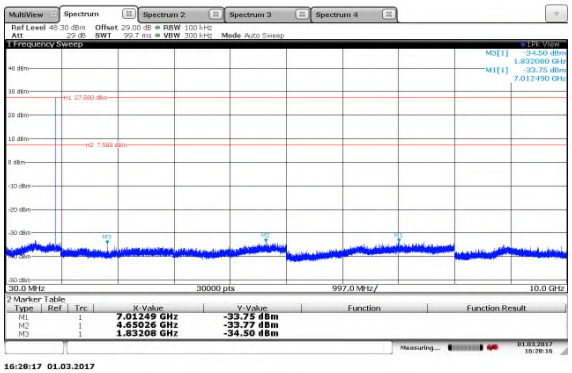


Figure 7.5.2.2-8: 30MHz–10GHz Mid Channel 50kbps

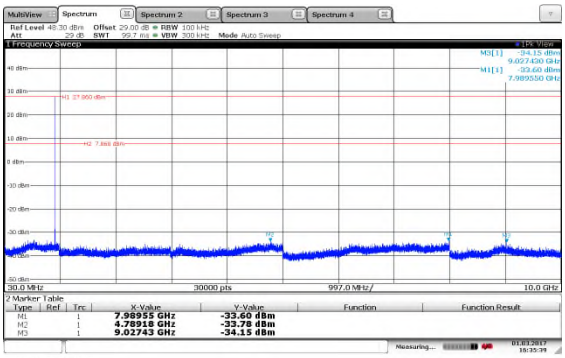


Figure 7.5.2.2-9: 30MHz–10GHz High Channel 50kbps

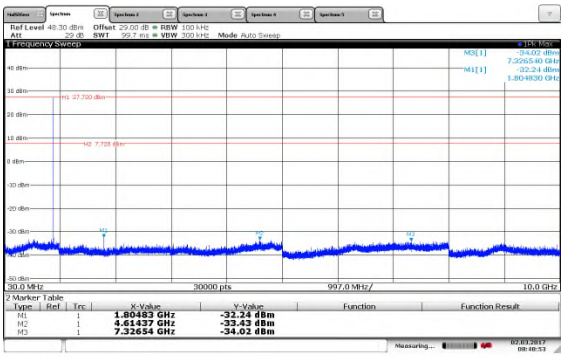


Figure 7.5.2.2-10: 30MHz–10GHz Low Channel 150kbps

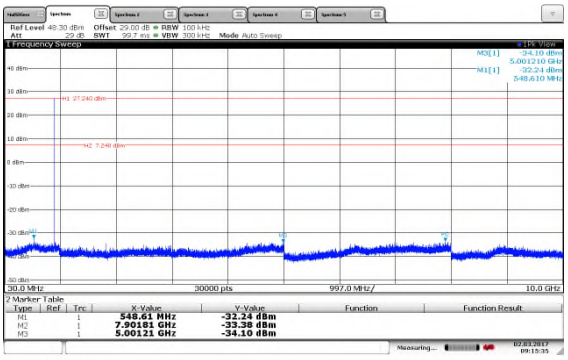


Figure 7.5.2.2-11: 30MHz–10GHz Mid Channel 150kbps

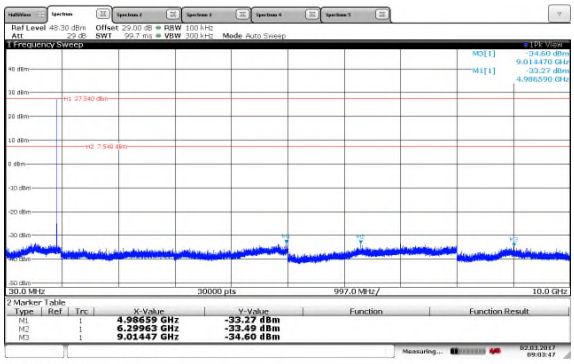


Figure 7.5.2.2-12: 30MHz–10GHz High Channel 150kbps

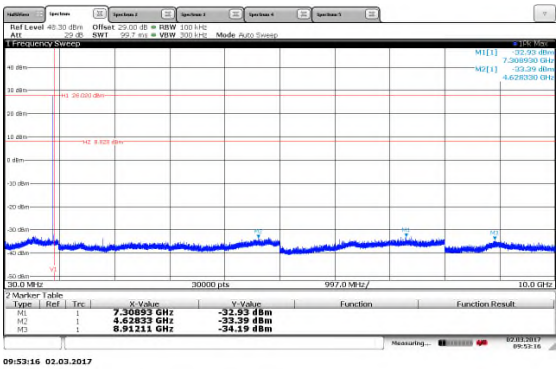


Figure 7.5.2.2-13: 30MHz–10GHz Low Channel 200kbps

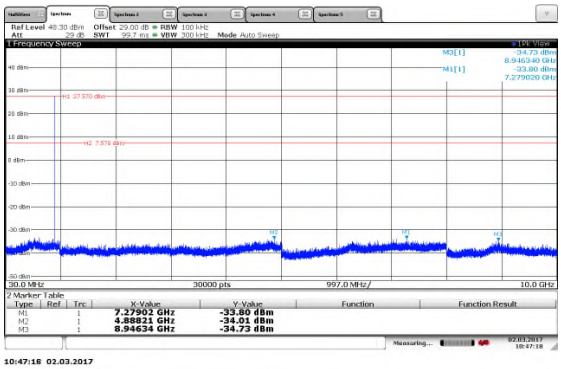


Figure 7.5.2.2-14: 30MHz–10GHz Mid Channel 200kbps

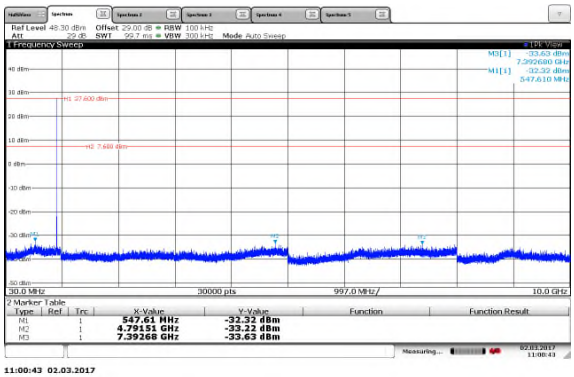


Figure 7.5.2.2-15: 30MHz–10GHz Mid Channel 200kbps

7.5.3 Radiated Spurious Emissions – FCC: 15.205, 15.209; RSS-Gen 8.9/8.10

7.5.3.1 Measurement Procedure

Radiated emissions tests were made over the frequency range of 30MHz to 10GHz, 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 120kHz and a video bandwidth VBW of 300kHz. For frequencies above 1000MHz, peak and average measurements were made with RBW and VBW of 1MHz and 3MHz respectively.

The EUT was caused to generate a continuous modulated carrier on the hopping channel.

Each emission found to be in a restricted band was compared to the applicable radiated emission limits.

7.5.3.2 Duty Cycle Correction

The Duty Cycle Correction was not required.

7.5.3.3 Measurement Results

Table 7.5.3.3-1: Radiated Spurious Emissions Tabulated Data Mode 1 (Spiral Antenna)

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
Low Channel										
2707.2	42.40	32.90	H	-2.45	39.95	30.45	74.0	54.0	34.0	23.5
2707.2	45.30	39.60	V	-2.45	42.85	37.15	74.0	54.0	31.1	16.8
3609.6	40.20	28.90	H	0.94	41.14	29.84	74.0	54.0	32.9	24.2
3609.6	42.10	32.50	V	0.94	43.04	33.44	74.0	54.0	31.0	20.6
4512	46.20	36.20	H	3.55	49.75	39.75	74.0	54.0	24.2	14.2
4512	48.70	39.60	V	3.55	52.25	43.15	74.0	54.0	21.7	10.8
Middle Channel										
2748	42.00	33.20	H	-2.34	39.66	30.86	74.0	54.0	34.3	23.1
2748	46.40	41.10	V	-2.34	44.06	38.76	74.0	54.0	29.9	15.2
3664	39.00	25.50	H	1.10	40.10	26.60	74.0	54.0	33.9	27.4
3664	40.30	28.90	V	1.10	41.40	30.00	74.0	54.0	32.6	24.0
4580	46.90	37.50	H	3.54	50.44	41.04	74.0	54.0	23.6	13.0
4580	45.50	35.70	V	3.54	49.04	39.24	74.0	54.0	25.0	14.8
High Channel										
2782.8	42.00	33.00	H	-2.24	39.76	30.76	74.0	54.0	34.2	23.2
2782.8	44.90	38.60	V	-2.24	42.66	36.36	74.0	54.0	31.3	17.6
3710.4	40.30	28.10	H	1.23	41.53	29.33	74.0	54.0	32.5	24.7
3710.4	40.30	28.50	V	1.23	41.53	29.73	74.0	54.0	32.5	24.3
4638	42.50	30.50	H	3.52	46.02	34.02	74.0	54.0	28.0	20.0
4638	43.70	32.90	V	3.52	47.22	36.42	74.0	54.0	26.8	17.6

Table 7.5.3.3-2: Radiated Spurious Emissions Tabulated Data Mode 2 (Spiral Antenna)

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
Low Channel										
2707.2	47.90	44.80	H	-2.45	45.45	42.35	74.0	54.0	28.5	11.6
2707.2	48.90	46.50	V	-2.45	46.45	44.05	74.0	54.0	27.5	9.9
3609.6	41.20	32.80	H	0.94	42.14	33.74	74.0	54.0	31.9	20.3
3609.6	44.70	39.10	V	0.94	45.64	40.04	74.0	54.0	28.4	14.0
4512	51.40	49.00	H	3.55	54.95	52.55	74.0	54.0	19.0	1.4
4512	53.00	50.40	V	3.55	56.55	53.95	74.0	54.0	17.4	0.0
Middle Channel										
2748	50.70	47.50	H	-2.34	48.36	45.16	74.0	54.0	25.6	8.8
2748	50.40	48.10	V	-2.34	48.06	45.76	74.0	54.0	25.9	8.2
3664	42.60	35.90	H	1.10	43.70	37.00	74.0	54.0	30.3	17.0
3664	44.10	38.80	V	1.10	45.20	39.90	74.0	54.0	28.8	14.1
4580	50.80	48.30	H	3.54	54.34	51.84	74.0	54.0	19.7	2.2
4580	51.70	49.30	V	3.54	55.24	52.84	74.0	54.0	18.8	1.2
High Channel										
2782.8	45.10	39.60	H	-2.24	42.86	37.36	74.0	54.0	31.1	16.6
2782.8	48.50	45.60	V	-2.24	46.26	43.36	74.0	54.0	27.7	10.6
3710.4	40.60	30.40	H	1.23	41.83	31.63	74.0	54.0	32.2	22.4
3710.4	43.10	37.30	V	1.23	44.33	38.53	74.0	54.0	29.7	15.5
4638	50.00	43.00	H	3.52	53.52	46.52	74.0	54.0	20.5	7.5
4638	48.90	46.10	V	3.52	52.42	49.62	74.0	54.0	21.6	4.4

Table 7.5.3.3-3: Radiated Spurious Emissions Tabulated Data Mode 1 (Inverted F Antenna)

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
Low Channel										
2707.2	46.90	41.10	H	-2.45	44.45	38.65	74.0	54.0	29.5	15.3
2707.2	48.60	43.30	V	-2.45	46.15	40.85	74.0	54.0	27.8	13.1
3609.6	45.60	34.60	H	0.94	46.54	35.54	74.0	54.0	27.5	18.5
3609.6	49.80	42.50	V	0.94	50.74	43.44	74.0	54.0	23.3	10.6
4512	51.00	41.80	H	3.55	54.55	45.35	74.0	54.0	19.4	8.6
4512	47.40	36.50	V	3.55	50.95	40.05	74.0	54.0	23.0	13.9
Middle Channel										
44.40	37.00	H	300	42.06	34.66	74.0	54.0	31.9	19.3	23.1
45.60	38.60	V	65	43.26	36.26	74.0	54.0	30.7	17.7	15.2
43.60	31.80	H	328	44.70	32.90	74.0	54.0	29.3	21.1	27.4
45.50	36.20	V	14	46.60	37.30	74.0	54.0	27.4	16.7	24.0
48.70	38.20	H	294	52.24	41.74	74.0	54.0	21.8	12.3	13.0
46.50	34.50	V	40	50.04	38.04	74.0	54.0	24.0	16.0	14.8
High Channel										
2782.8	43.70	34.50	H	-2.24	41.46	32.26	74.0	54.0	32.5	21.7
2782.8	44.20	36.80	V	-2.24	41.96	34.56	74.0	54.0	32.0	19.4
3710.4	43.70	34.50	H	1.23	44.93	35.73	74.0	54.0	29.1	18.3
3710.4	44.20	33.40	V	1.23	45.43	34.63	74.0	54.0	28.6	19.4
4638	44.50	32.10	H	3.52	48.02	35.62	74.0	54.0	26.0	18.4
4638	44.00	31.40	V	3.52	47.52	34.92	74.0	54.0	26.5	19.1

Table 7.5.3.3-4: Radiated Spurious Emissions Tabulated Data Mode 2 (Inverted F Antenna)

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
Low Channel										
2707.2	45.20	38.70	H	-2.45	42.75	36.25	74.0	54.0	31.2	17.7
2707.2	45.90	40.30	V	-2.45	43.45	37.85	74.0	54.0	30.5	16.1
3609.6	46.00	38.70	H	0.94	46.94	39.64	74.0	54.0	27.1	14.4
3609.6	49.60	45.10	V	0.94	50.54	46.04	74.0	54.0	23.5	8.0
4512	52.60	49.70	H	3.55	56.15	53.25	74.0	54.0	17.8	0.7
4512	52.30	49.00	V	3.55	55.85	52.55	74.0	54.0	18.1	1.4
Middle Channel										
2748	45.10	37.80	H	-2.34	42.76	35.46	74.0	54.0	31.2	18.5
2748	46.00	40.90	V	-2.34	43.66	38.56	74.0	54.0	30.3	15.4
3664	46.20	37.60	H	1.10	47.30	38.70	74.0	54.0	26.7	15.3
3664	48.00	42.50	V	1.10	49.10	43.60	74.0	54.0	24.9	10.4
4580	51.90	49.00	H	3.54	55.44	52.54	74.0	54.0	18.6	1.5
4580	50.50	46.70	V	3.54	54.04	50.24	74.0	54.0	20.0	3.8
High Channel										
2782.8	41.90	30.30	H	-2.24	39.66	28.06	74.0	54.0	34.3	25.9
2782.8	47.00	42.60	V	-2.24	44.76	40.36	74.0	54.0	29.2	13.6
3710.4	44.50	34.80	H	1.23	45.73	36.03	74.0	54.0	28.3	18.0
3710.4	46.80	40.40	V	1.23	48.03	41.63	74.0	54.0	26.0	12.4
4638	49.20	44.80	H	3.52	52.72	48.32	74.0	54.0	21.3	5.7
4638	47.80	42.80	V	3.52	51.32	46.32	74.0	54.0	22.7	7.7

Table 7.5.3.3-5: Radiated Spurious Emissions Tabulated Data Mode 1 (Half-Wave Dipole Antenna)

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
Low Channel										
2707.2	42.50	31.70	H	-2.45	40.05	29.25	74.0	54.0	33.9	24.7
2707.2	45.00	38.50	V	-2.45	42.55	36.05	74.0	54.0	31.4	17.9
3609.6	44.20	32.90	H	0.94	45.14	33.84	74.0	54.0	28.9	20.2
3609.6	46.60	37.60	V	0.94	47.54	38.54	74.0	54.0	26.5	15.5
4512	50.40	40.50	H	3.55	53.95	44.05	74.0	54.0	20.0	9.9
4512	49.30	39.50	V	3.55	52.85	43.05	74.0	54.0	21.1	10.9
Middle Channel										
2748	42.00	30.20	H	-2.34	39.66	27.86	74.0	54.0	34.3	26.1
2748	44.90	37.20	V	-2.34	42.56	34.86	74.0	54.0	31.4	19.1
3664	43.30	30.60	H	1.10	44.40	31.70	74.0	54.0	29.6	22.3
3664	44.80	32.60	V	1.10	45.90	33.70	74.0	54.0	28.1	20.3
4580	49.10	38.70	H	3.54	52.64	42.24	74.0	54.0	21.4	11.8
4580	47.60	36.40	V	3.54	51.14	39.94	74.0	54.0	22.9	14.1
High Channel										
2782.8	41.80	31.00	H	-2.24	39.56	28.76	74.0	54.0	34.4	25.2
2782.8	44.10	34.60	V	-2.24	41.86	32.36	74.0	54.0	32.1	21.6
3710.4	42.70	29.60	H	1.23	43.93	30.83	74.0	54.0	30.1	23.2
3710.4	42.70	29.30	V	1.23	43.93	30.53	74.0	54.0	30.1	23.5
4638	45.60	33.90	H	3.52	49.12	37.42	74.0	54.0	24.9	16.6
4638	45.30	32.70	V	3.52	48.82	36.22	74.0	54.0	25.2	17.8

Table 7.5.3.3-6: Radiated Spurious Emissions Tabulated Data Mode 2 (Half-Wave Dipole Antenna)

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
Low Channel										
2707.2	42.70	31.90	H	-2.45	40.25	29.45	74.0	54.0	33.7	24.5
2707.2	45.70	39.90	V	-2.45	43.25	37.45	74.0	54.0	30.7	16.5
3609.6	45.70	37.60	H	0.94	46.64	38.54	74.0	54.0	27.4	15.5
3609.6	49.80	45.70	V	0.94	50.74	46.64	74.0	54.0	23.3	7.4
4512	52.10	49.00	H	3.55	55.65	52.55	74.0	54.0	18.3	1.4
4512	52.20	49.20	V	3.55	55.75	52.75	74.0	54.0	18.2	1.2
Middle Channel										
2748	41.50	29.60	H	-2.34	39.16	27.26	74.0	54.0	34.8	26.7
2748	43.40	35.40	V	-2.34	41.06	33.06	74.0	54.0	32.9	20.9
3664	43.80	32.00	H	1.10	44.90	33.10	74.0	54.0	29.1	20.9
3664	45.50	37.20	V	1.10	46.60	38.30	74.0	54.0	27.4	15.7
4580	52.00	49.00	H	3.54	55.54	52.54	74.0	54.0	18.5	1.5
4580	51.60	48.20	V	3.54	55.14	51.74	74.0	54.0	18.9	2.3
High Channel										
2782.8	42.60	32.10	H	-2.24	40.36	29.86	74.0	54.0	33.6	24.1
2782.8	44.70	38.40	V	-2.24	42.46	36.16	74.0	54.0	31.5	17.8
3710.4	43.50	30.50	H	1.23	44.73	31.73	74.0	54.0	29.3	22.3
3710.4	44.20	34.10	V	1.23	45.43	35.33	74.0	54.0	28.6	18.7
4638	48.90	44.50	H	3.52	52.42	48.02	74.0	54.0	21.6	6.0
4638	49.90	45.60	V	3.52	53.42	49.12	74.0	54.0	20.6	4.9

7.5.3.4 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: 42.40 - 2.45 = 39.95dBuV/m
Margin: 74dBuV/m – 39.95dBuV/m = 34.0dB

Example Calculation: Average

Corrected Level: 32.90 - 2.45 = 30.45dBuV
Margin: 54dBuV – 30.45dBuV = 23.5dB

8 CONCLUSION

In the opinion of TÜV SÜD America Inc. the SynergyNet mNIC, manufactured by Elster Solutions meets the requirements of FCC Part 15 Subpart C and ISED Canada's Radio Standards Specification RSS-247 for the tests documented herein.

END REPORT