



Wireless Test Report

**FCC ID: QZC-SNREM
IC: 4557A-SNREM**

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

Report Number: RD72140849.200

**Manufacturer: Elster Solutions, LLC
Model: SNREM**

**Test Begin Date: July 16, 2018
Test End Date: August 3, 2018**

Report Issue Date: August 8, 2018



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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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 SNREM Printed Circuit Board Assembly (PCBA) 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 an external metering device. The SNREM PCBA enables operation in an Advanced Metering Infrastructure (AMI) that uses a proprietary network architecture and protocol devised by Elster Electricity LLC.

The 900 MHz radio may operate in two modes: The Energy Axis (EA) mode or SynergyNet mode. The EA mode is Elster's legacy mode of operation while the SynergyNet mode 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 (EA Mode) | 902.4 - 927.6 | 25 | 35.5, 142.2 |
| 2 (SynergyNet Mode) | 902.4 - 927.6 | 64 | 50, 150, 200 |

Modulation Format: FSK
Operating Voltage: 3.6VDC
Antenna Type / Gain: Monopole / 1.36dBi

Manufacturer Information:

Elster Solutions, LLC
208 S. Rogers Lane
Raleigh, NC 27610

EUT Serial Numbers: Conducted N/A, Radiated 90086

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.

A DC power supply set to 3.6VDC was used to support testing because the batteries cannot sustain continuous transmit.

For radiated emissions, the EUT was evaluated in three orthogonal orientations. The worst-case orientation was the Z-orientation. Based on radiated measurements of all data rates, the worst-case data rate for mode 1 was 142.2kbps and 200kbps for mode 2.

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 with the hop table including multiple channels at both band-edges (i.e. hopping band-edge at extreme operating band-edges).

The module is designed to only operate with battery power devices. Therefore, AC Mains Conducted Emissions was not preformed.

Software power settings during test for mode 1: 23 (Low Channel), 24 (Mid Channel), 23 (High Channel)

Software power setting during test for mode 2: 42 (Low Channel), 43 (Mid Channel), 44 (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:

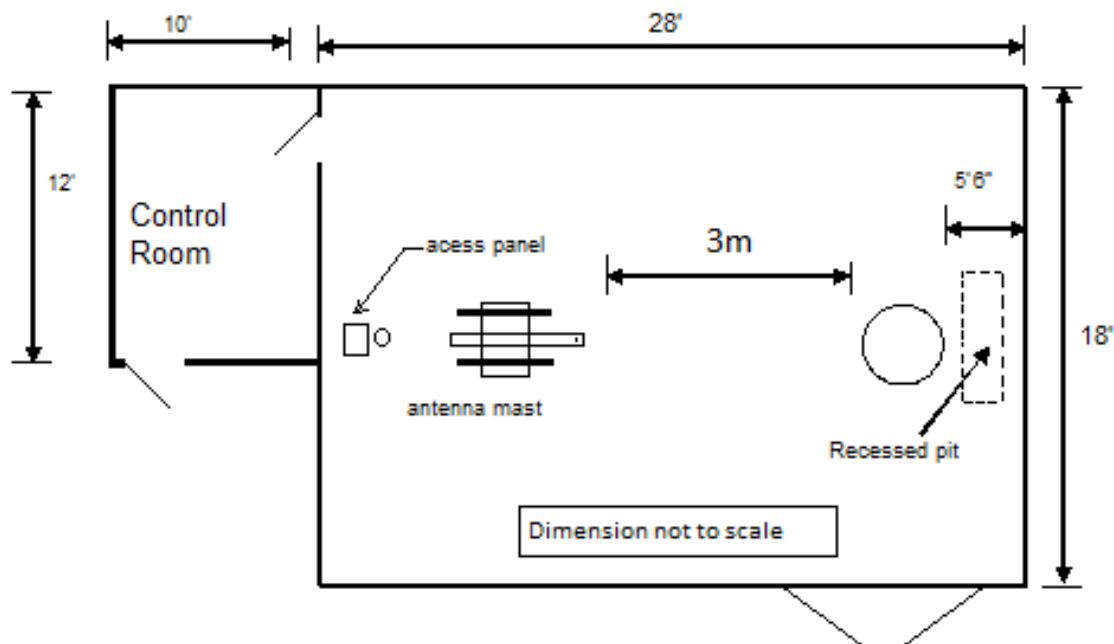


Figure 2.3-1: Semi-Anechoic Chamber Test Site

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:

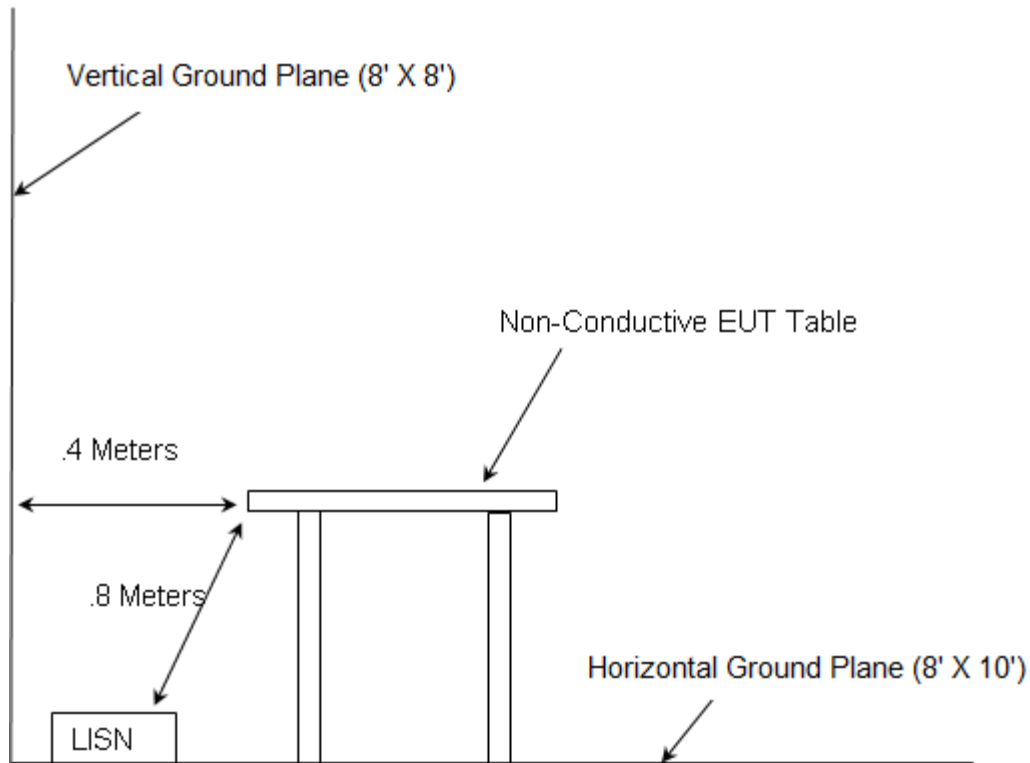


Figure 2.4-1: AC Mains Conducted EMI Site

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 |
|----------|------------------------------|-----------------------|-------------------|------------|-----------------------|----------------------|
| DEMC0277 | EMCO | 93146 | Antennas | 9904-5199 | 9/12/2016 | 9/12/2018 |
| DEMC0626 | EMCO | 3110B | Antennas | 9411-1945 | 3/21/2017 | 3/21/2019 |
| DEMC3002 | Rohde & Schwarz | ESU40 | Receiver | 100346 | 7/24/2017 | 10/24/2018 |
| DEMC3006 | Rohde & Schwarz | TS-PR18 | Amplifiers | 122006 | 1/10/2018 | 1/10/2019 |
| DEMC3008 | Rohde & Schwarz | NRP2 | Meter | 103131 | 2/15/2018 | 2/15/2019 |
| DEMC3009 | Rohde & Schwarz | NRP-Z81 | Meter | 102397 | 2/15/2018 | 2/15/2019 |
| DEMC3012 | Rohde & Schwarz | EMC32-EB | Software | 100731 | NCR | NCR |
| DEMC3016 | Fei Teng Wireless Technology | HA-07M18G-NF | Antennas | 2013120203 | 2/7/2018 | 2/7/2020 |
| DEMC3029 | Micro-Tronics | HPM50108 | Filter | 134 | 1/7/2018 | 1/7/2019 |
| DEMC3038 | Florida RF Labs | NMSE-290AW-60.0-NMSE | Cable Set | 1448 | 1/5/2018 | 1/5/2019 |
| DEMC3039 | Florida RF Labs | NMSE-290AW-396.0-NMSE | Cable Set | 1447 | 1/5/2018 | 1/5/2019 |
| DEMC3050 | Aeroflex Inment | 26AH-30 | Attenuator | 1447 | 1/9/2018 | 1/9/2019 |
| DEMC3055 | Rohde & Schwarz | 3005 | Cables | 3055 | 1/8/2018 | 1/8/2019 |
| DEMC3064 | Times | LMR195 | Cables | 3064 | 8/28/2017 | 8/28/2018 |
| DEMC3085 | Rohde & Schwarz | FSW43 | Spectrum Analyzer | 103997 | 3/15/2018 | 3/15/2019 |

NCR = No Calibration Required

DMAS MT-25 RF absorber material was used on the floor for all final measurements above 1 GHz.

Asset DEMC3002: Firmware Version: ESU40 is 4.73 SP4

Asset DEMC3012: Software Version: EMC32-B is 9.15

Asset DEMC3085: Instrument Firmware 2.90 SP1

5 SUPPORT EQUIPMENT

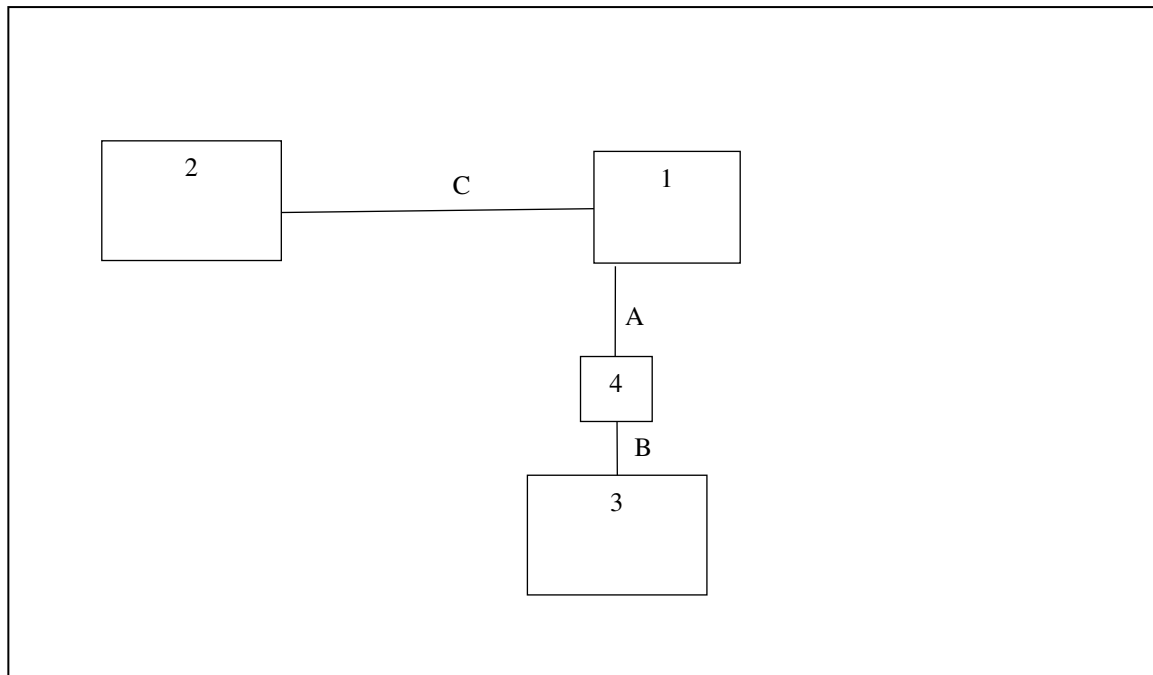
Table 5-1: EUT and Support Equipment Description

| Item # | Type Device | Manufacturer | Model/Part # | Serial # |
|--------|---------------|------------------|--------------|------------|
| 1 | EUT | Elster Solutions | SNREM | 90086 |
| 2 | Power Supply | Keysight | E35103A | MY57387438 |
| 3 | Computer | Dell | 7510 | 9T1PRC2 |
| 4 | TTL Converter | BB Electronics | 232LPTTTL33 | 02 |

Table 5-2: Cable Description

| Cable # | Cable Type | Length | Shield | Termination |
|---------|---------------|--------|--------|-------------|
| A | 3 wire Serial | 12cm | No | 1 - 4 |
| B | RS-232 Cable | 167cm | 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 were 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 antenna is an integral antenna.

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

The module will always operate while powered via battery. Therefore, AC Mains Conducted Emissions is not required.

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

Tested By: Randy Sherian

Table 7.3.2-1: RF Output Power

| Frequency (MHz) | Level (dBm) | Limit in dBm | Data Rate (kbps) |
|------------------------|--------------------|---------------------|-------------------------|
| 902.4 | 23.7 | 23.98 | 35.5 |
| 902.4 | 23.73 | 23.98 | 142.2 |
| 902.4 | 26.99 | 30.00 | 50 |
| 902.4 | 27.00 | 30.00 | 150 |
| 902.4 | 27.00 | 30.00 | 200 |
| 915.2 | 23.88 | 23.98 | 35.5 |
| 915.2 | 23.91 | 23.98 | 142.2 |
| 915.2 | 26.97 | 30.00 | 50 |
| 915.2 | 26.96 | 30.00 | 150 |
| 915.2 | 26.97 | 30.00 | 200 |
| 927.6 | 23.71 | 23.98 | 35.5 |
| 927.6 | 23.69 | 23.98 | 142.2 |
| 927.6 | 27.00 | 30.00 | 50 |
| 927.6 | 27.02 | 30.00 | 150 |
| 927.6 | 27.03 | 30.00 | 200 |

7.4 Channel Usage Requirements

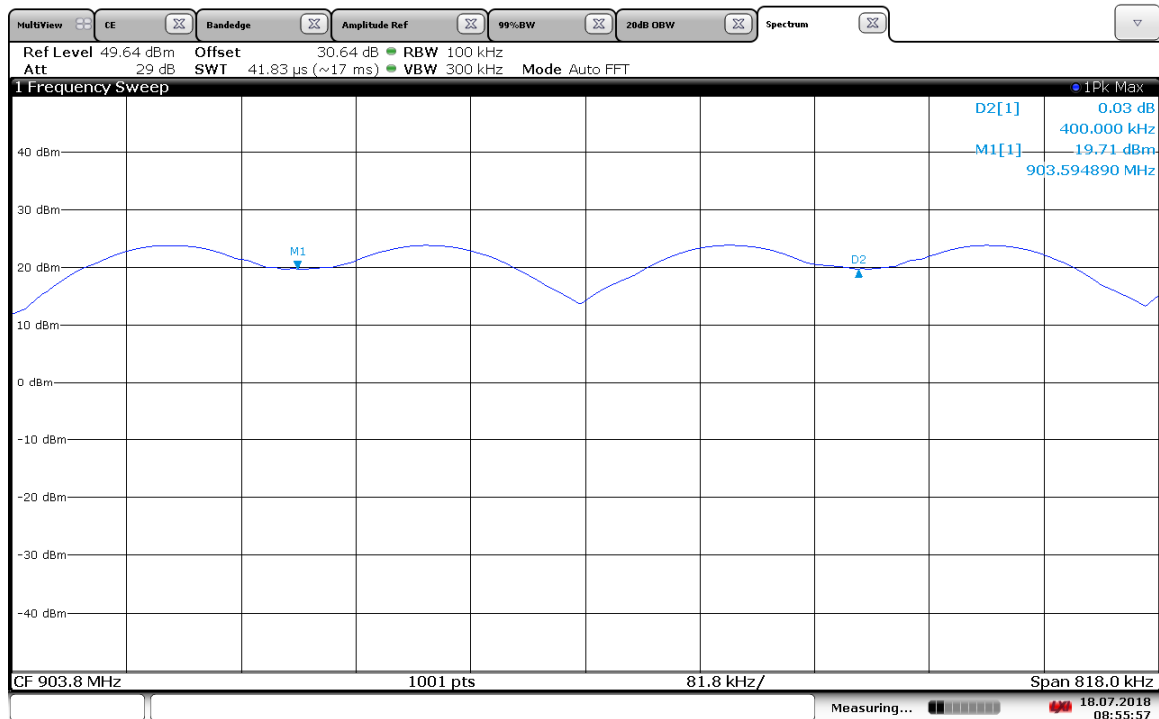
7.4.1 Carrier Frequency Separation – FCC: 15.247(a)(1); ISED Canada: RSS-247 5.1(b)

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.

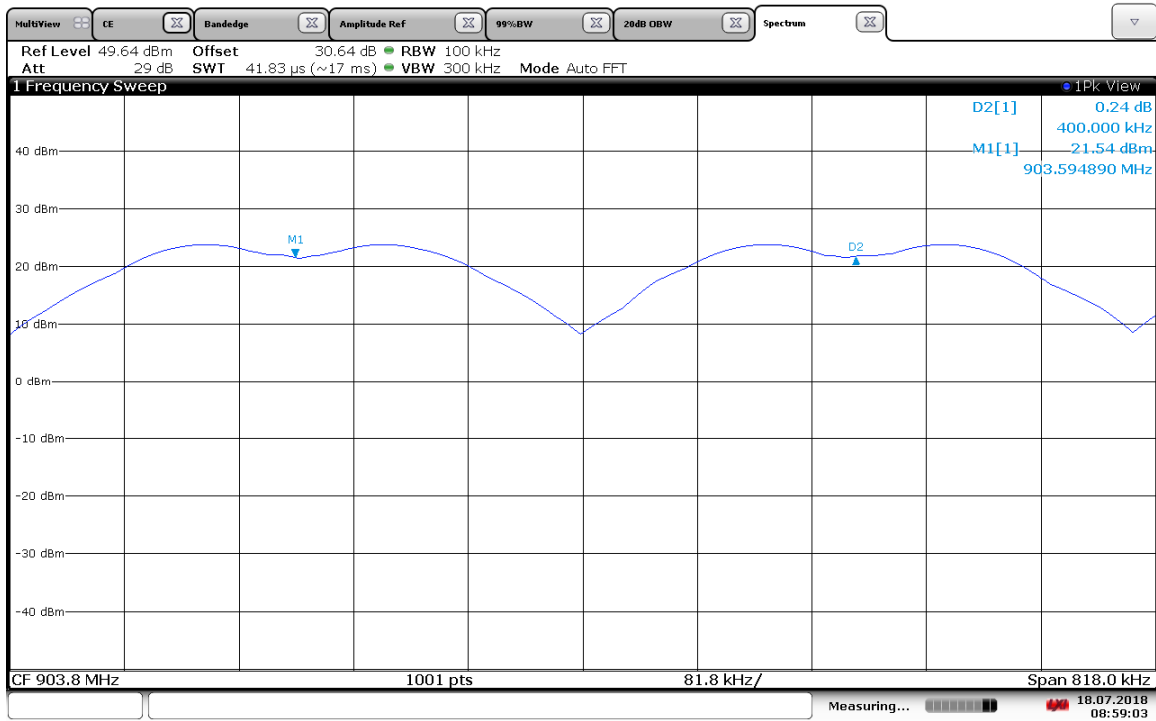
7.4.1.2 Measurement Results

Tested By: Randy Sherian



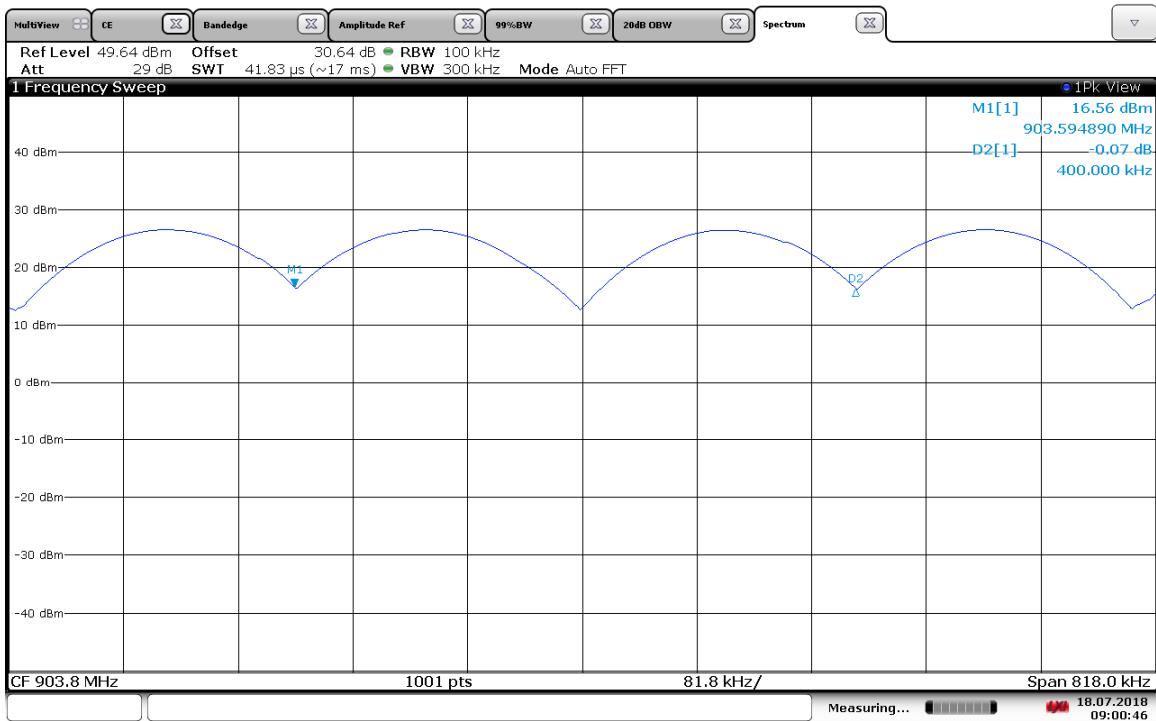
08:55:57 18.07.2018

Figure 7.4.1.2-1: Carrier Frequency Separation 35.5kbps



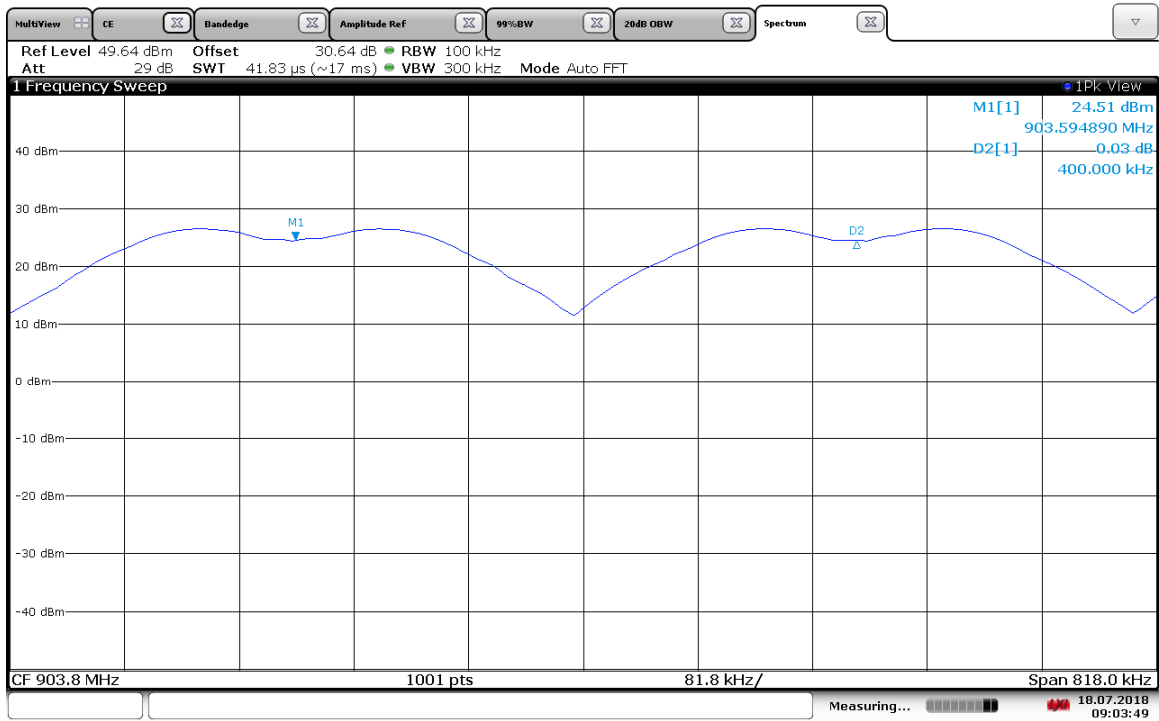
08:59:04 18.07.2018

Figure 7.4.1.2-2: Carrier Frequency Separation 142.2kbps



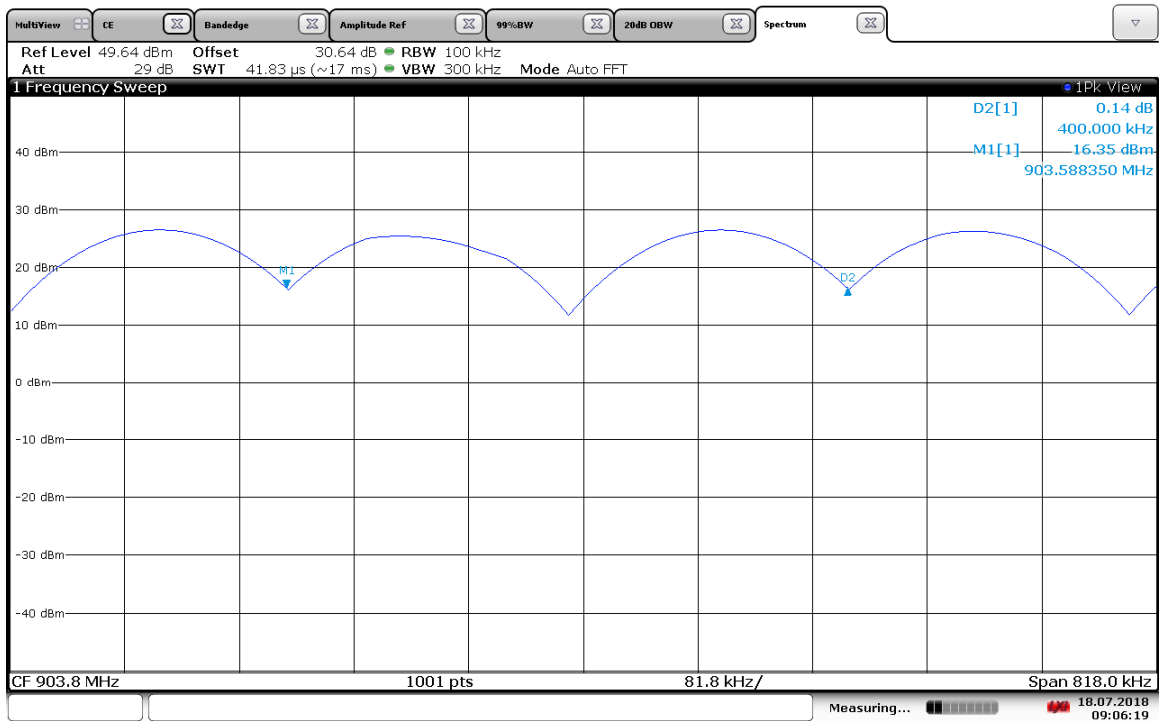
09:00:46 18.07.2018

Figure 7.4.1.2-3: Carrier Frequency Separation 50kbps



09:03:49 18.07.2018

Figure 7.4.1.2-4: Carrier Frequency Separation 150kbps



09:06:20 18.07.2018

Figure 7.4.1.2-5: Carrier Frequency Separation 200kbps

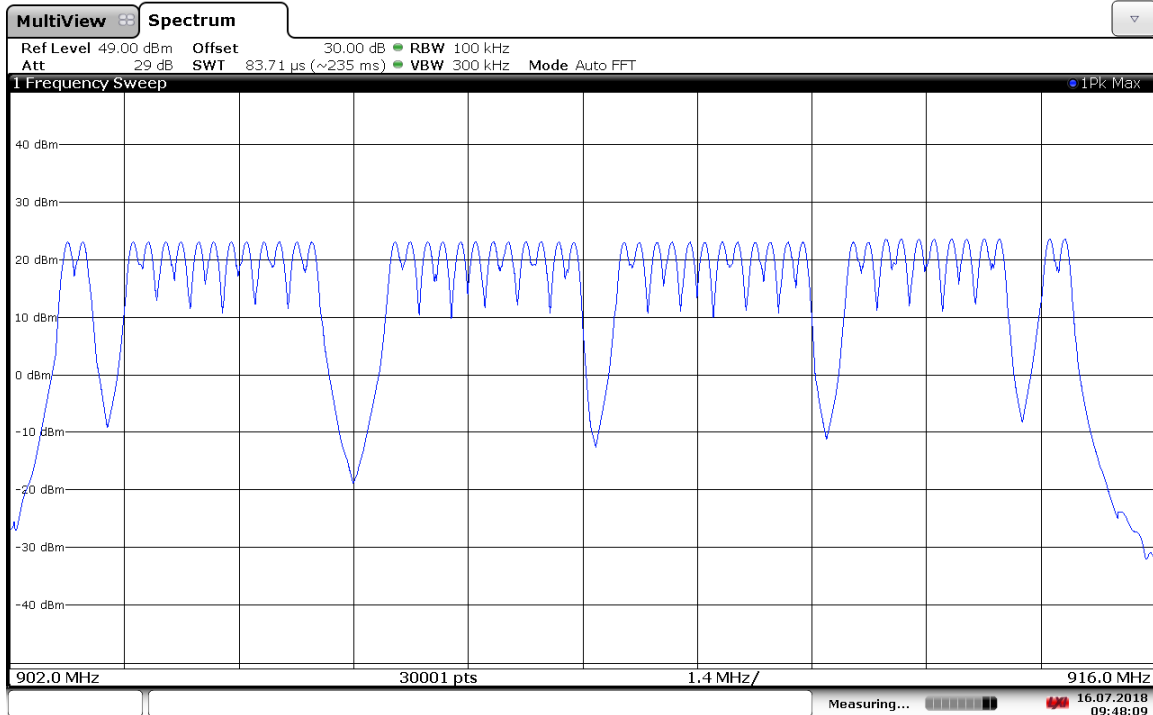
7.4.2 Number of Hopping Channels – FCC: 15.247(a)(1)(i); ISED Canada: RSS-247 5.1(c)

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 \geq RBW.

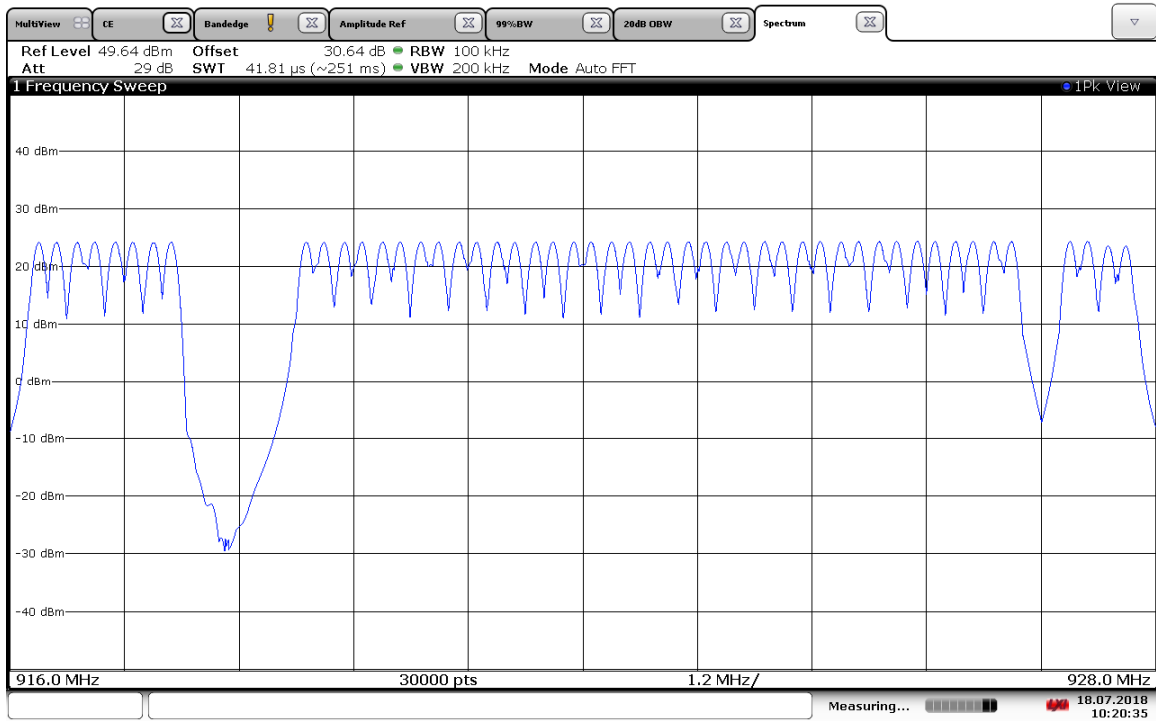
7.4.2.2 Measurement Results

Tested By: Randy Sherian



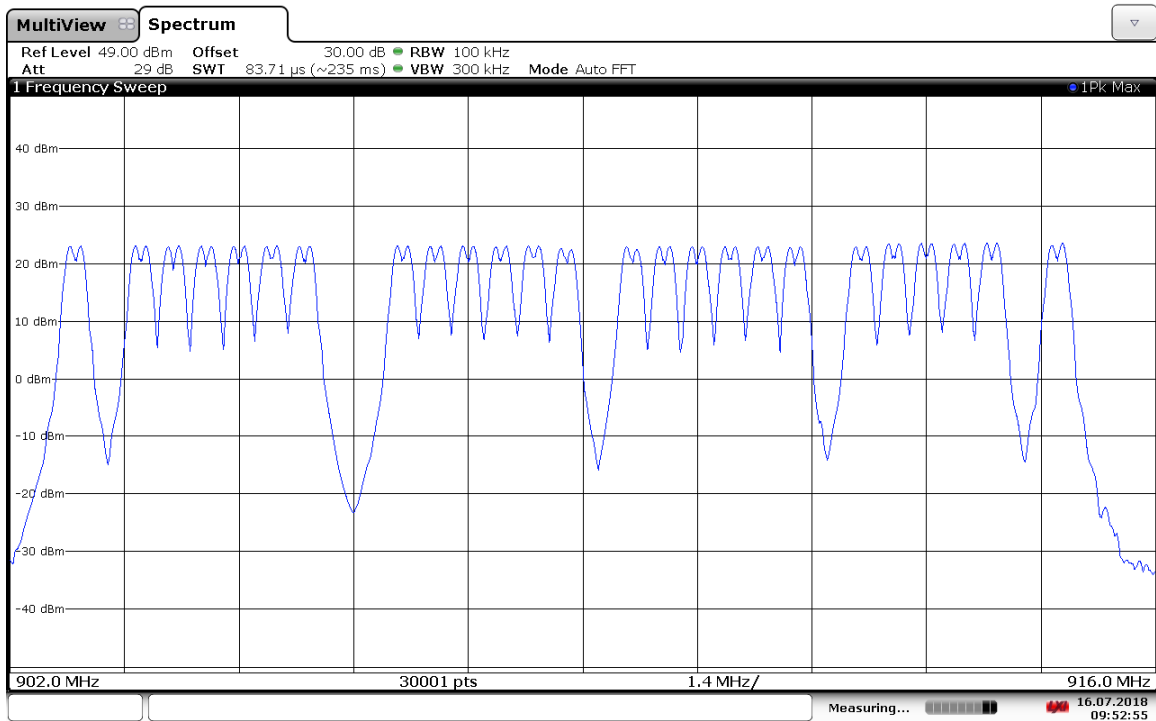
09:48:10 16.07.2018

Figure 7.4.2.2-1: Number of Hopping Channels 35.5kbps (Lower Hopping Table)



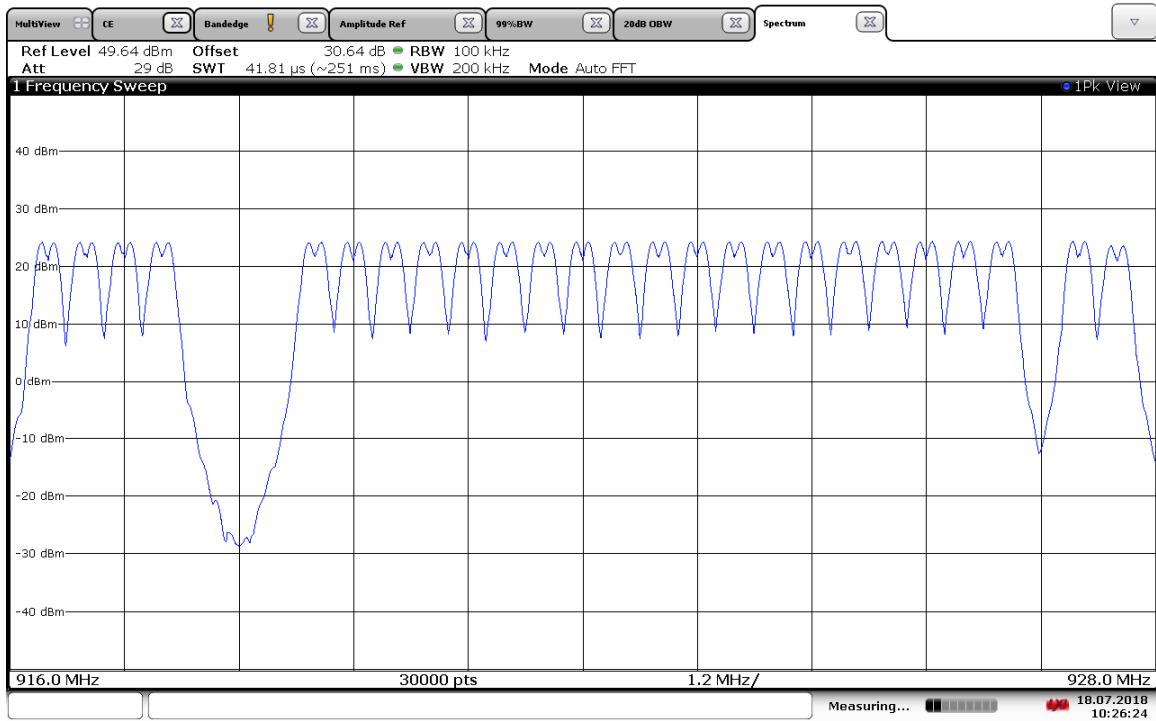
10:20:36 18.07.2018

Figure 7.4.2.2-2: Number of Hopping Channels 35.5kbps (Upper Hopping Table)



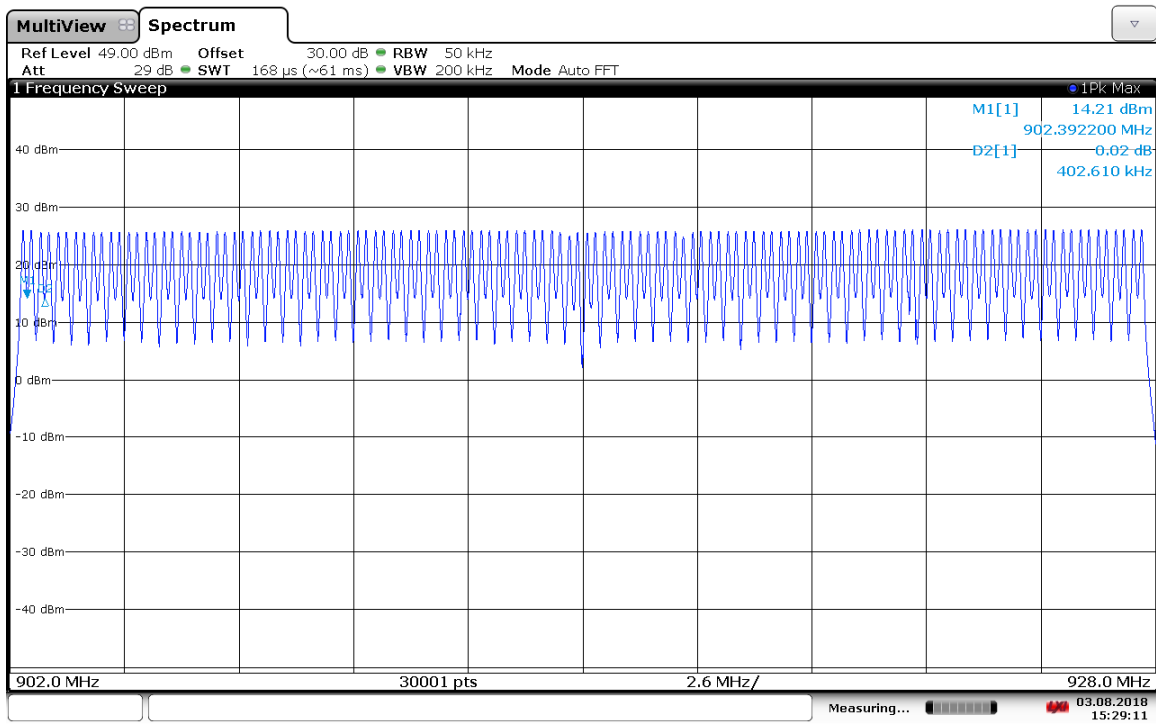
09:52:55 16.07.2018

Figure 7.4.2.2-3: Number of Hopping Channels 142.2kbps (Lower Hopping Table)



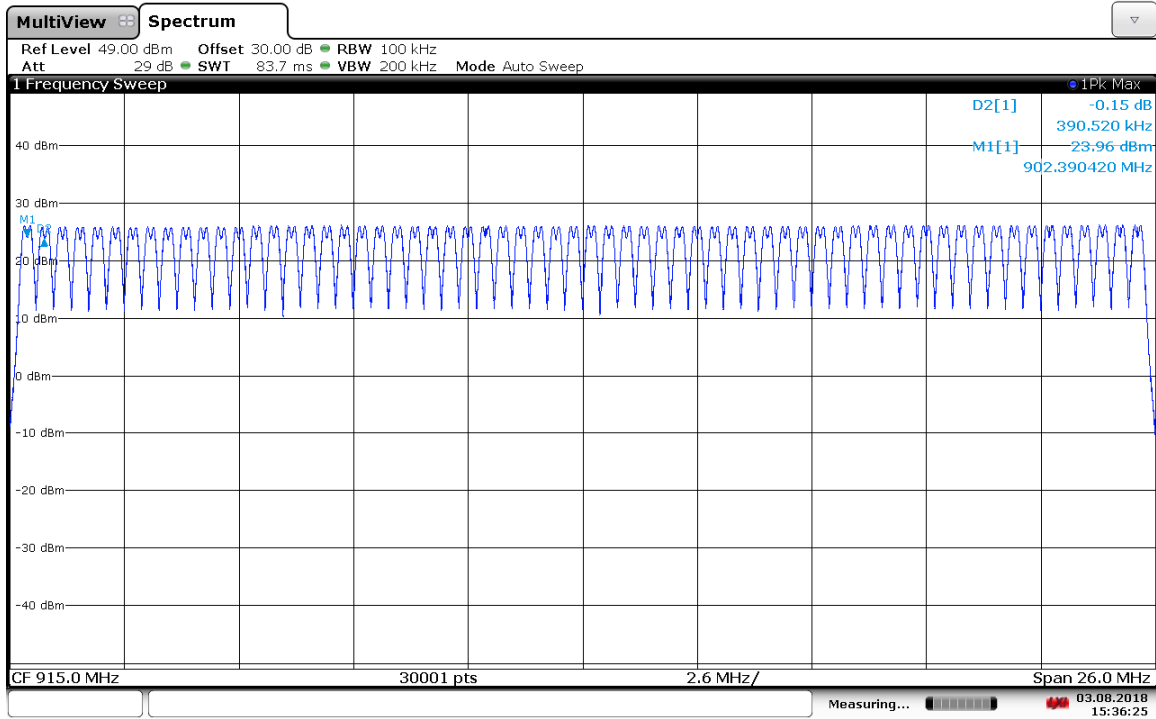
10:26:24 18.07.2018

Figure 7.4.2.2-4: Number of Hopping Channels 142.2kbps (Upper Hopping Table)



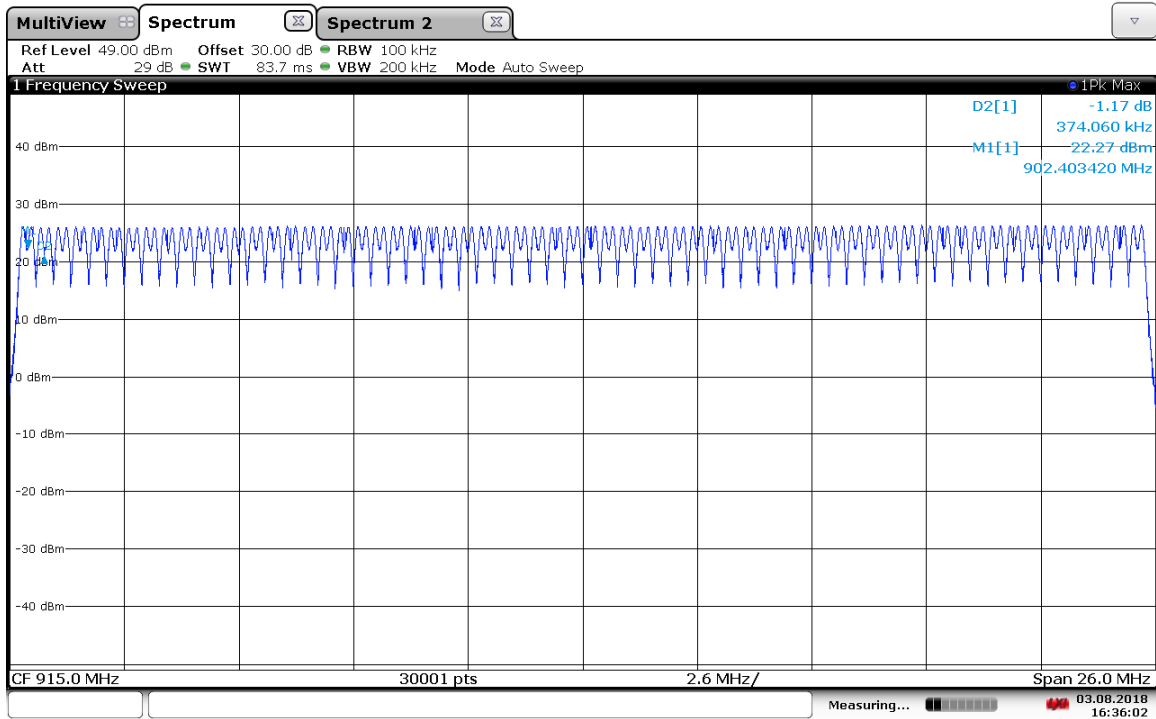
15:29:12 03.08.2018

Figure 7.4.2.2-5: Number of Hopping Channels 50kbps



15:36:25 03.08.2018

Figure 7.4.2.2-6: Number of Hopping Channels 150kbps



16:36:02 03.08.2018

Figure 7.4.2.2-7: 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 \leq the EUT channel spacing and VBW set to \geq RBW. The Marker Delta function of the analyzer was utilized to determine the dwell time.

7.4.3.2 Measurement Results

Tested By: Randy Sherian

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 | 99.92 | 2 | 199.84 |
| 1 | 142.2kbps | 26.58 | 7 | 186.06 |
| 2 | 150kbps | 24.86 | 4 | 99.44 |
| 2 | 200kbps | 24.87 | 4 | 99.48 |

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 | 24.86 | 8 | 198.88 |

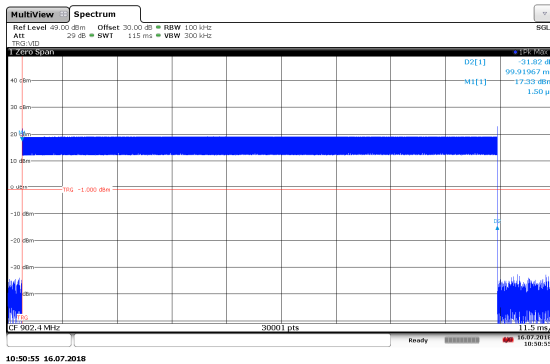


Figure 7.4.3.2-1: Dwell Time 35.5kbps

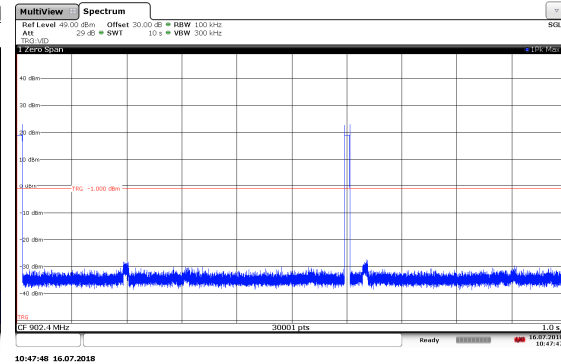


Figure 7.4.3.2-2: Number of Occurrences 35.5kbps

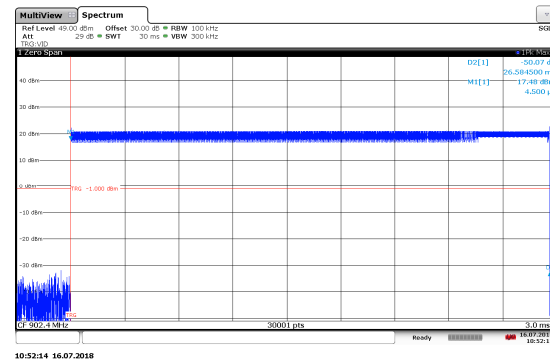


Figure 7.4.3.2-3: Dwell Time 142.2kbps

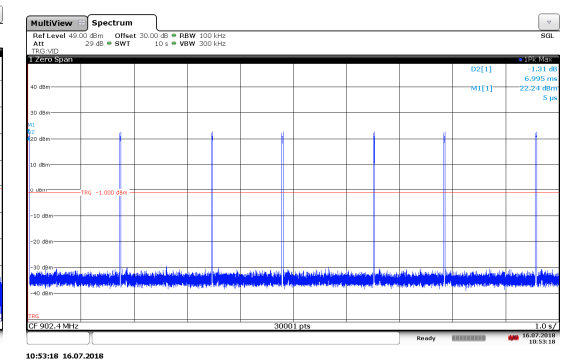


Figure 7.4.3.2-4: Number of Occurrences 142.2kbps

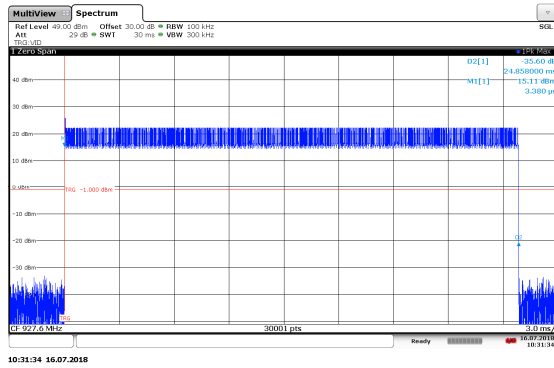


Figure 7.4.3.2-5: Dwell Time 50kbps

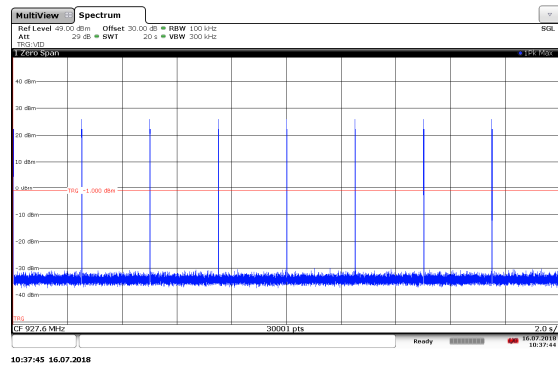


Figure 7.4.3.2-6: Number of Occurrences 50kbps

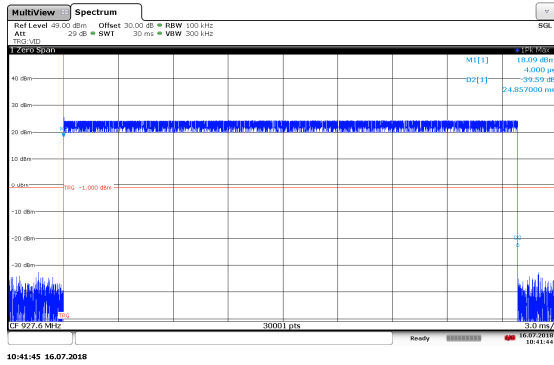


Figure 7.4.3.2-7: Dwell Time 150kbps

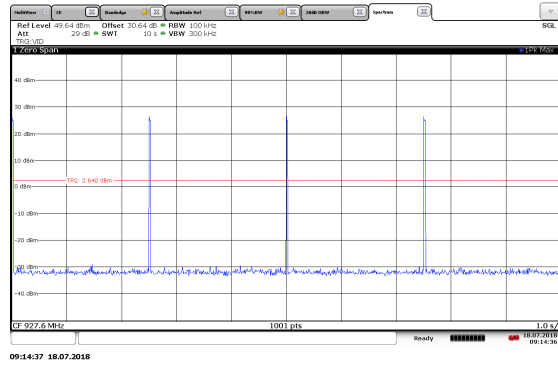


Figure 7.4.3.2-8: Number of Occurrences 150kbps

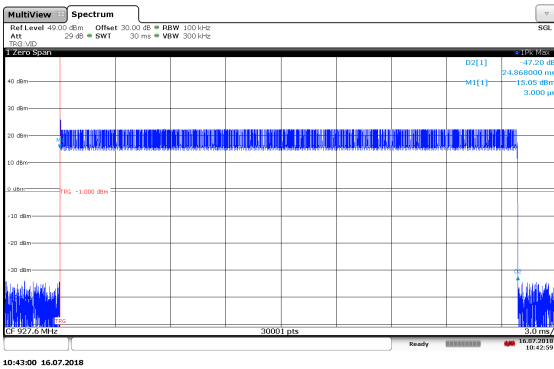


Figure 7.4.3.2-9: Dwell Time 200kbps

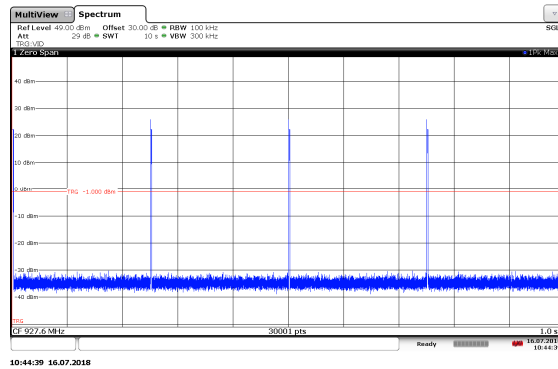


Figure 7.4.3.2-10: Number of Occurrences 200kbps

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.

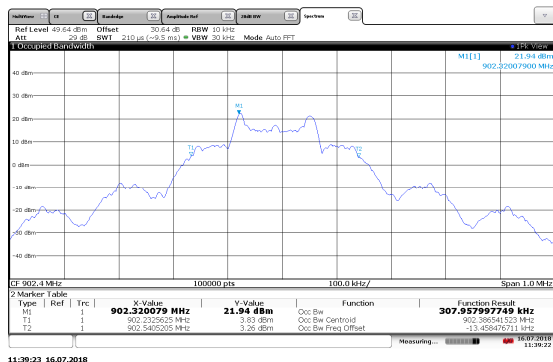
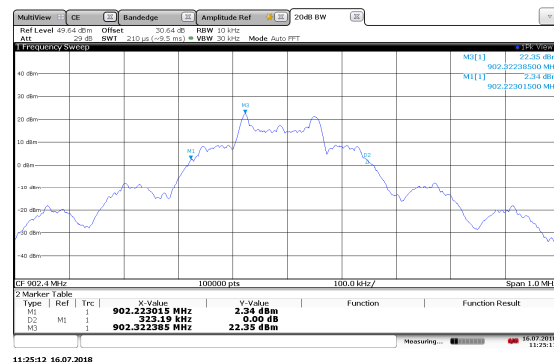
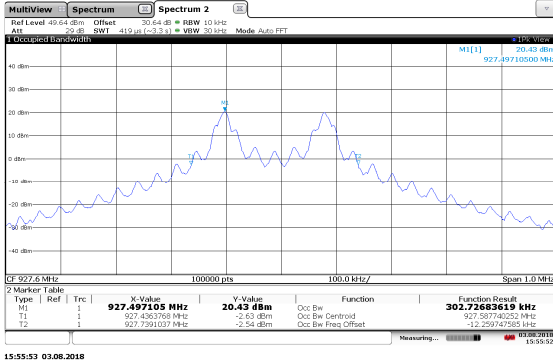
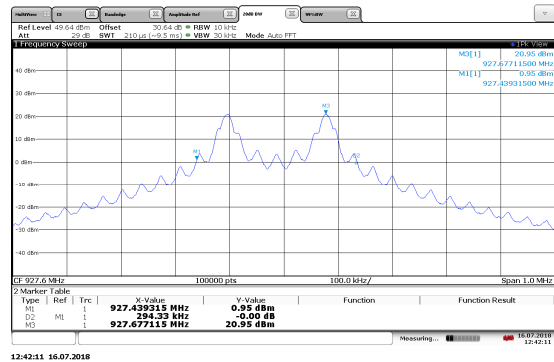
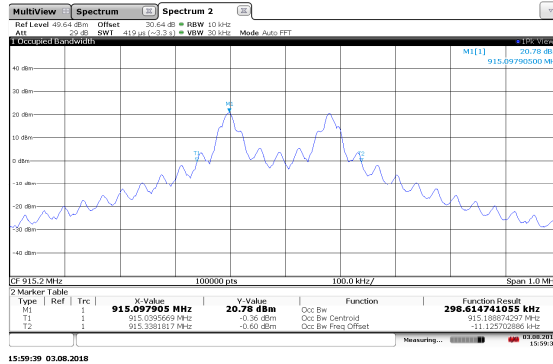
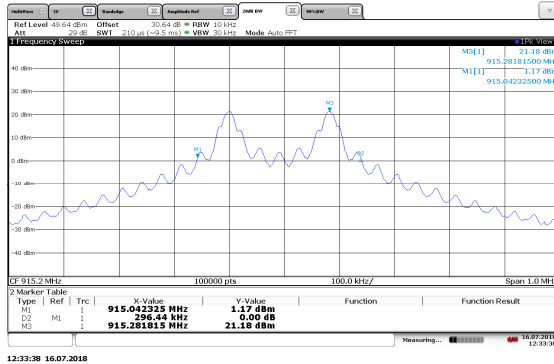
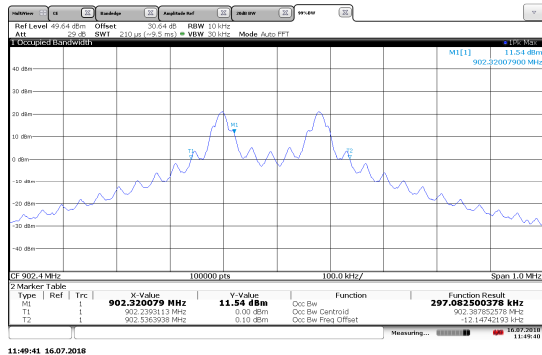
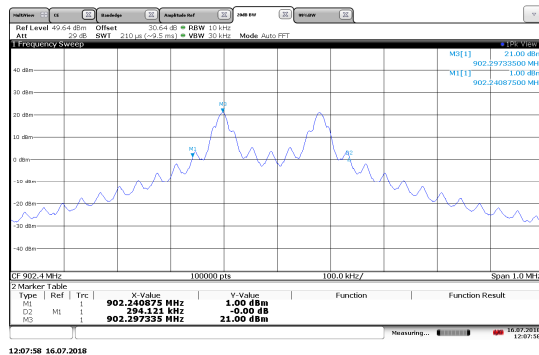
The occupied bandwidth measurement function of the spectrum analyzer was used to measure the 99% bandwidth. The span of the analyzer was set to capture all products of the modulation process, including the emission sidebands. The resolution bandwidth was set to 1% to 5% of the occupied bandwidth. The video bandwidth was set to 3 times the resolution bandwidth. A peak detector was used.

7.4.4.2 Measurement Results

Tested By: Randy Sherian

Table 7.4.4.2-1: 20dB / 99% Bandwidth

| Frequency (MHz) | 20dB Bandwidth (kHz) | 99% Bandwidth (kHz) | Data Rate (kbps) |
|----------------------------|---------------------------------|--------------------------------|-----------------------------|
| 902.4 | 294.12 | 297.08 | 35.5 |
| 902.4 | 323.19 | 307.96 | 142.2 |
| 902.4 | 111.56 | 115.93 | 50 |
| 902.4 | 315.96 | 279.49 | 150 |
| 902.4 | 257.40 | 249.01 | 200 |
| 915.2 | 296.44 | 298.61 | 35.5 |
| 915.2 | 323.33 | 310.16 | 142.2 |
| 915.2 | 113.66 | 116.16 | 50 |
| 915.2 | 315.73 | 280.90 | 150 |
| 915.2 | 260.33 | 253.09 | 200 |
| 927.6 | 294.33 | 302.73 | 35.5 |
| 927.6 | 322.96 | 310.83 | 142.2 |
| 927.6 | 110.77 | 114.51 | 50 |
| 927.6 | 315.17 | 281.86 | 150 |
| 927.6 | 263.6 | 251.13 | 200 |



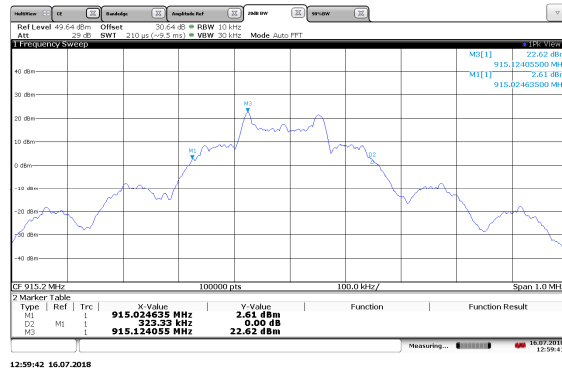


Figure 7.4.4.2-9: 20dB BW Mid Channel 142.2kbps



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

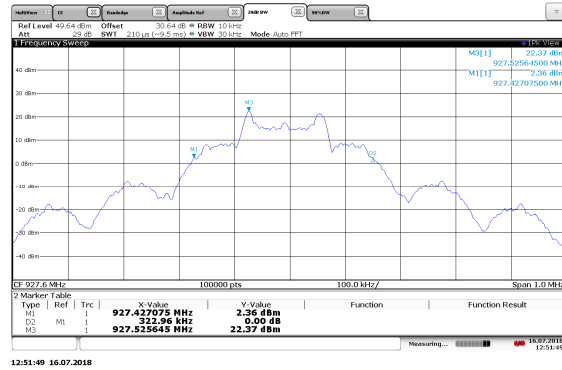


Figure 7.4.4.2-11: 20dB BW High Channel 142.2kbps

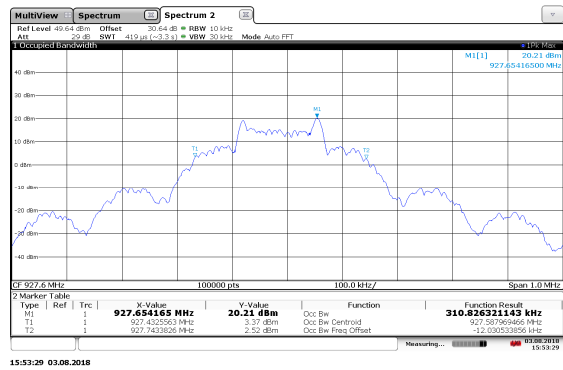


Figure 7.4.4.2-12: 99% OBW High Channel 142.2kbps

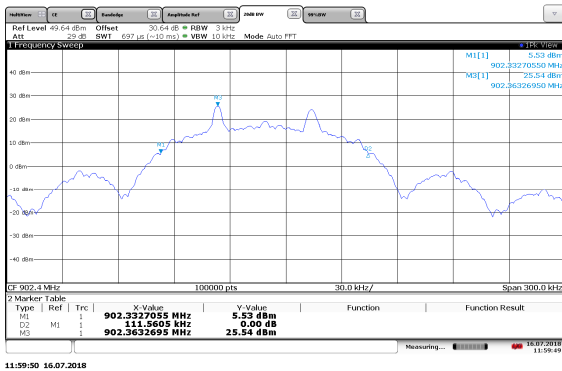


Figure 7.4.4.2-13: 20dB BW Low Channel 50kbps

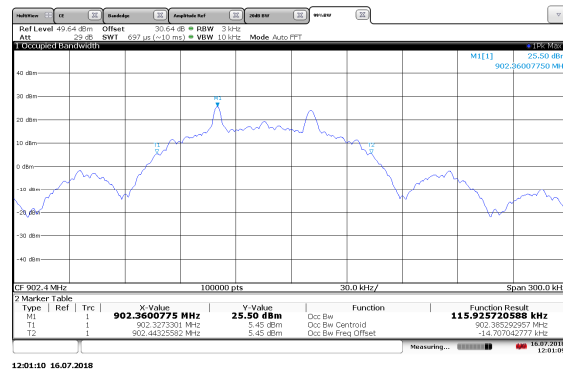


Figure 7.4.4.2-14: 99% OBW Low Channel 50kbps

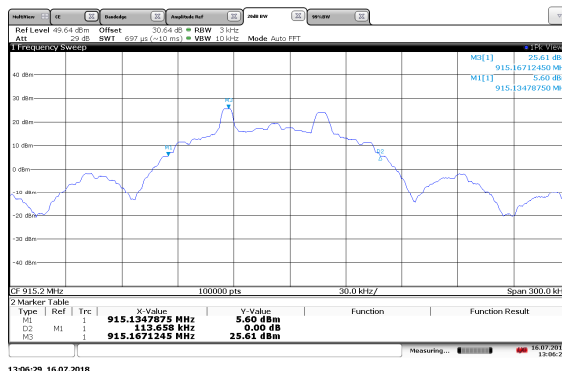


Figure 7.4.4.2-15: 20dB BW Mid Channel 50kbps

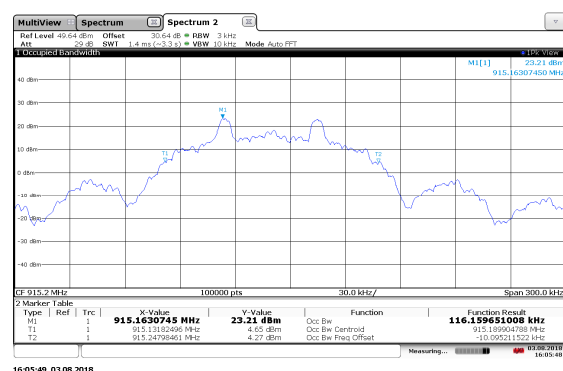


Figure 7.4.4.2-16: 99% OBW Mid Channel 50kbps

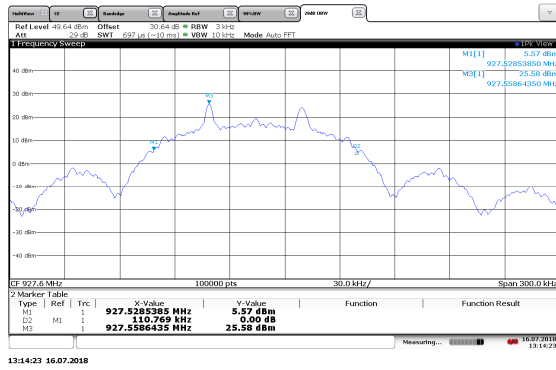


Figure 7.4.4.2-17: 20dB BW High Channel 50kbps

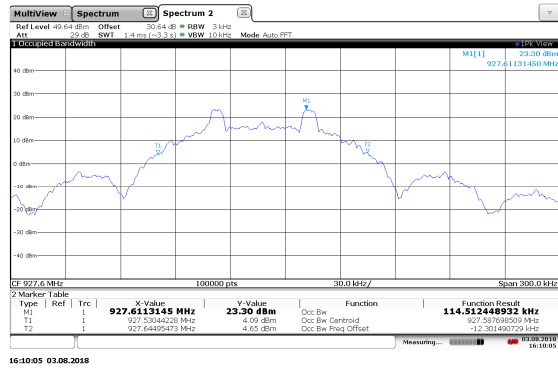


Figure 7.4.4.2-18: 99% OBW High Channel 50kbps

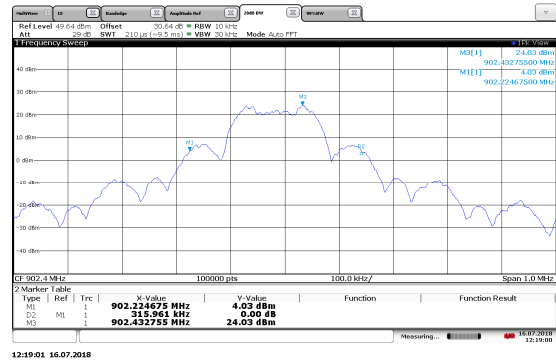


Figure 7.4.4.2-19: 20dB BW Low Channel 150kbps

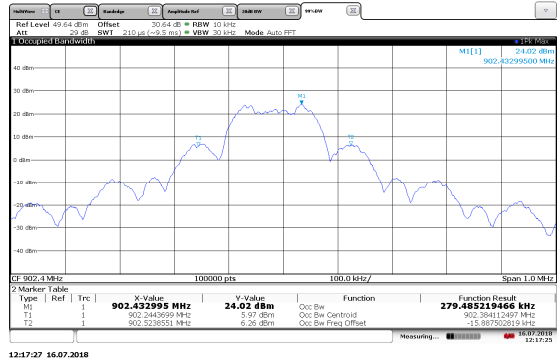


Figure 7.4.4.2-20: 99% OBW Low Channel 150kbps

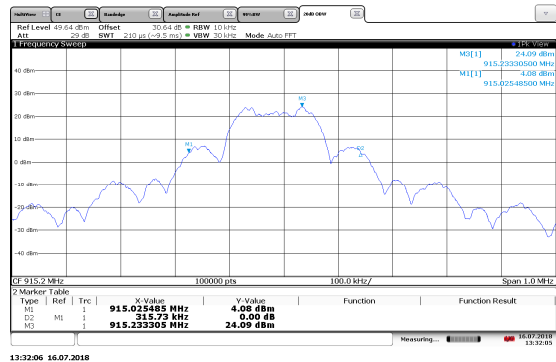


Figure 7.4.4.2-21: 20dB BW Mid Channel 150kbps

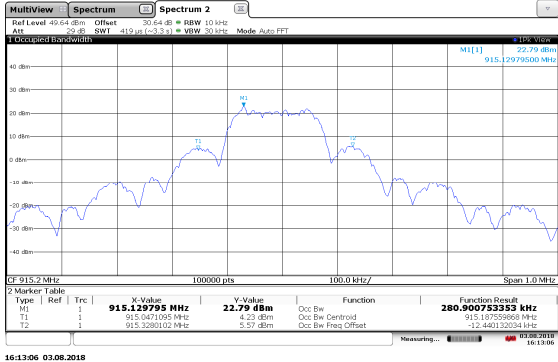


Figure 7.4.4.2-22: 99% OBW Mid Channel 150kbps

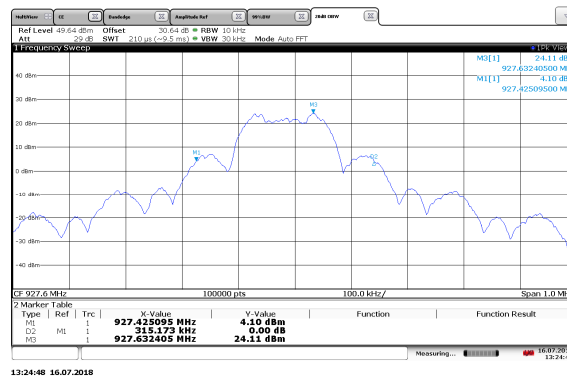


Figure 7.4.4.2-23: 20dB BW High Channel 150kbps

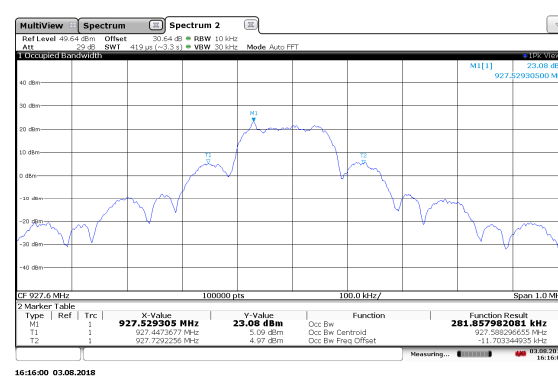


Figure 7.4.4.2-24: 99% OBW High Channel 150kbps

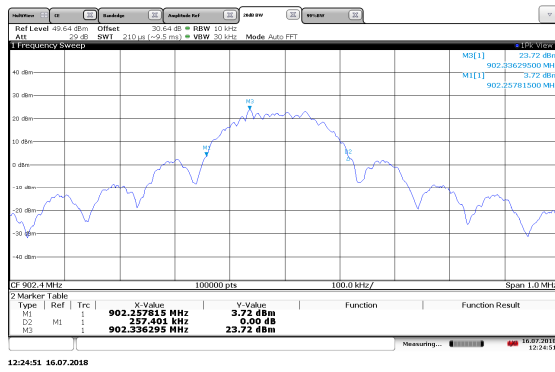


Figure 7.4.4.2-25: 20dB BW Low Channel 200kpbs

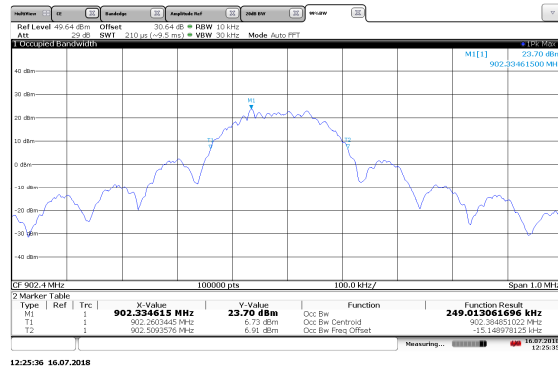


Figure 7.4.4.2-26: 99% OBW Low Channel 200kpbs

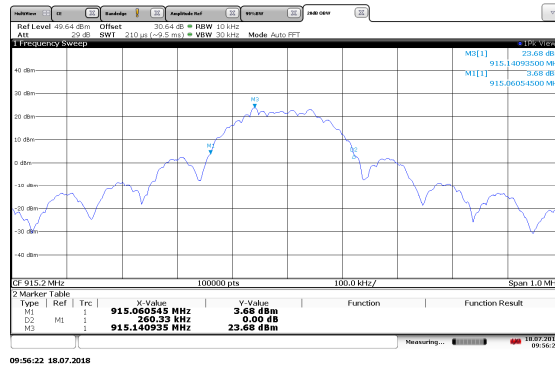


Figure 7.4.4.2-27: 20dB BW Mid Channel 200kpbs

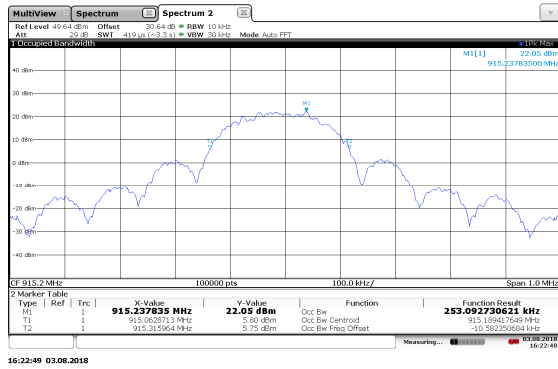


Figure 7.4.4.2-28: 99% OBW Mid Channel 200kpbs

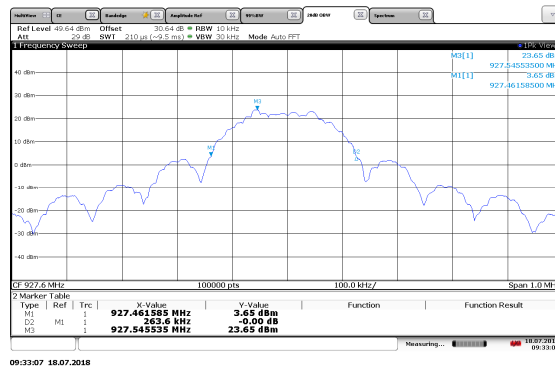


Figure 7.4.4.2-29: 20dB BW High Channel 200kpbs

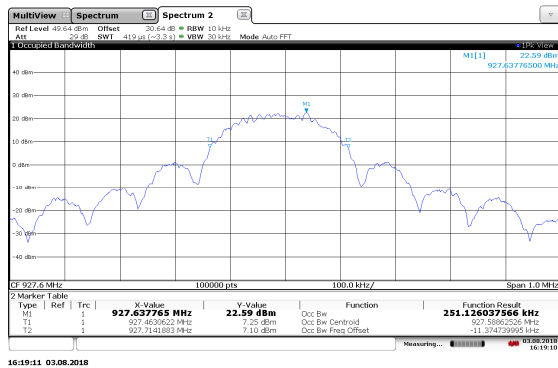


Figure 7.4.4.2-30: 99% OBW High Channel 200kpbs

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

Tested By: Randy Sherian

NON-HOPPING MODE:

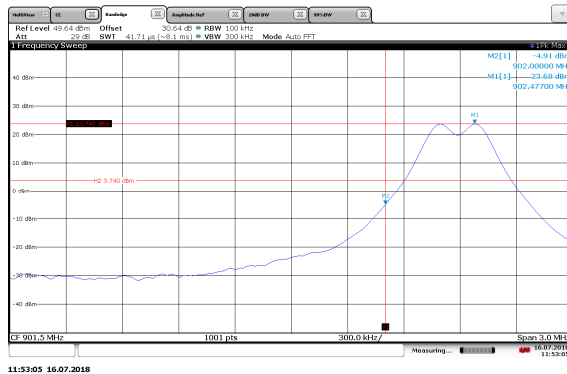


Figure 7.5.1.2-1: Lower Band-edge 35.5kbps

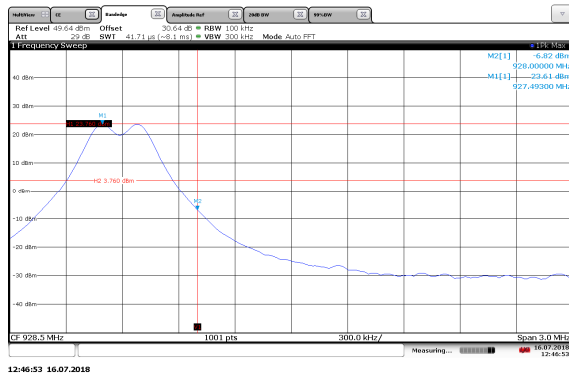


Figure 7.5.1.2-2: Upper Band-edge 35.5kbps

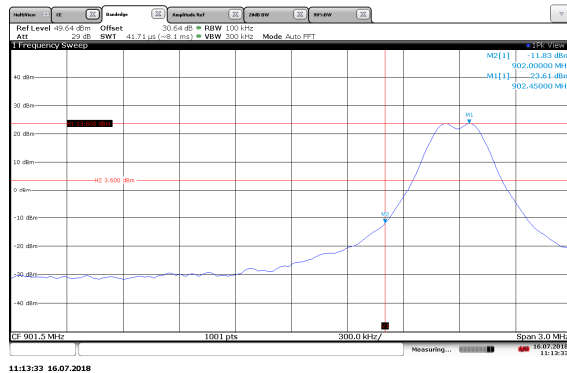


Figure 7.5.1.2-3: Lower Band-edge 142.2kbps

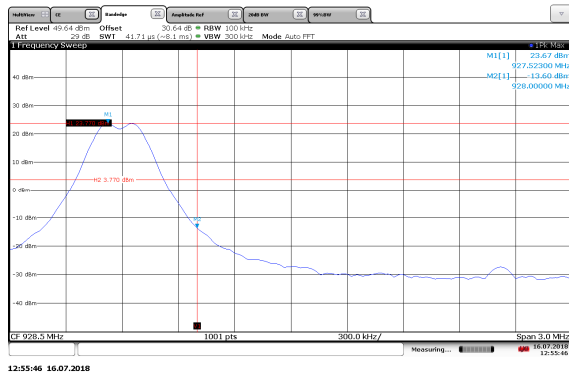


Figure 7.5.1.2-4: Upper Band-edge 142.2kbps

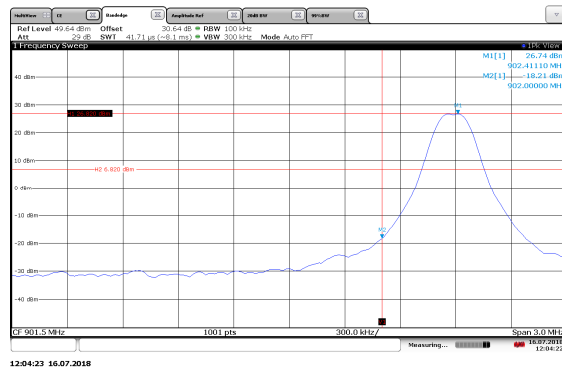


Figure 7.5.1.2-5: Lower Band-edge 50kbps

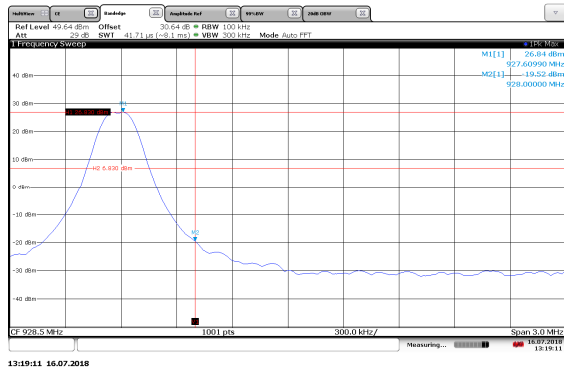


Figure 7.5.1.2-6: Upper Band-edge 50kbps

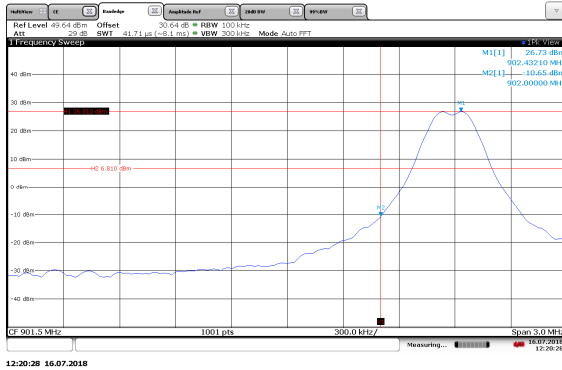


Figure 7.5.1.2-7: Lower Band-edge 150kbps

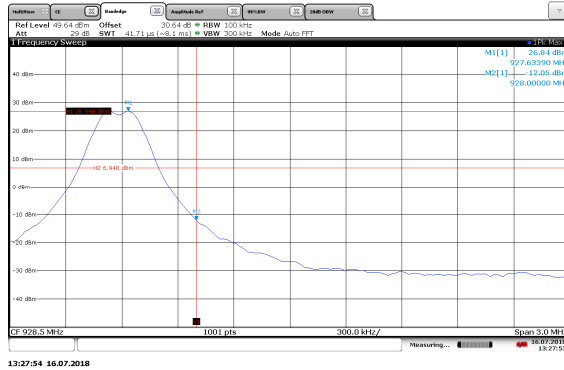


Figure 7.5.1.2-8: Upper Band-edge 150kbps

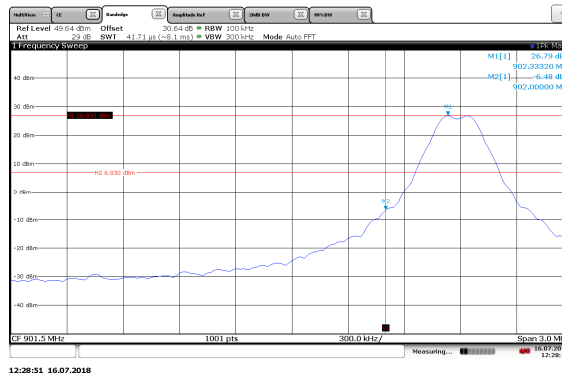


Figure 7.5.1.2-9: Lower Band-edge 200kbps

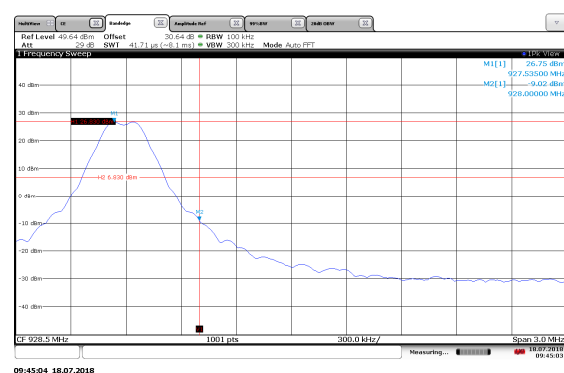


Figure 7.5.1.2-10: Upper Band-edge 200kbps

HOPPING MODE:

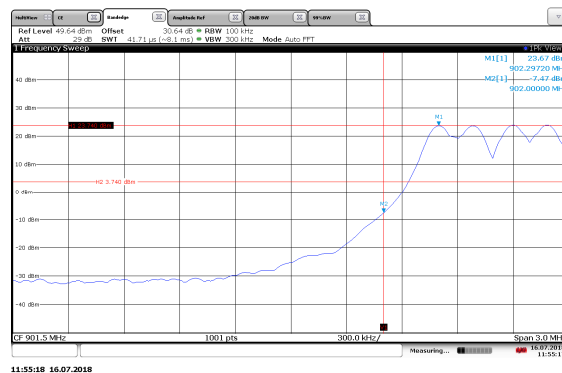


Figure 7.5.1.2-11: Lower Band-edge 35.5kbps

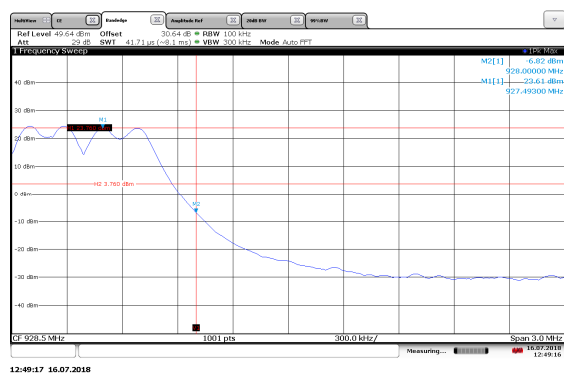


Figure 7.5.1.2-12: Upper Band-edge 35.5kbps

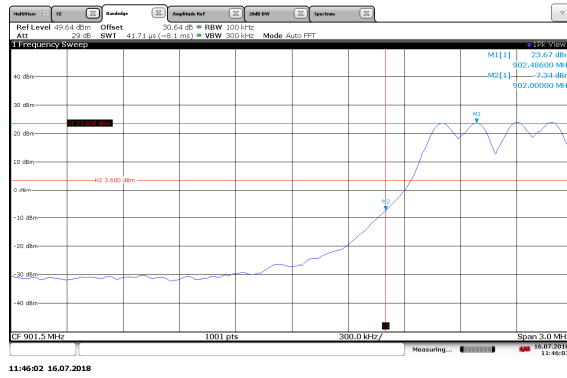


Figure 7.5.1.2-13: Lower Band-edge 142.2kbps

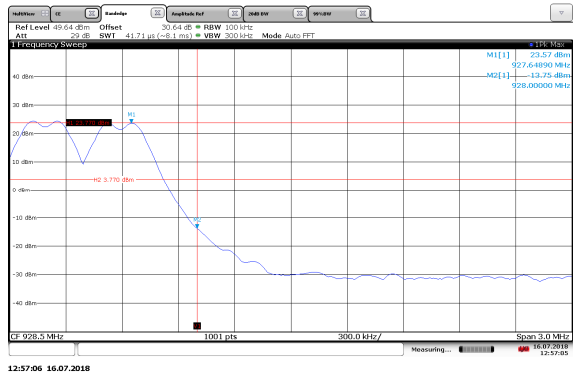


Figure 7.5.1.2-14: Upper Band-edge 142.2kbps

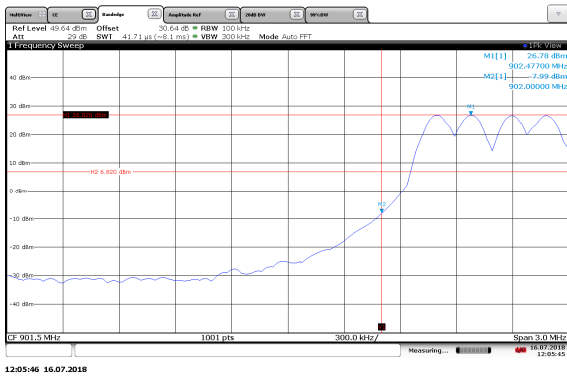


Figure 7.5.1.2-15: Lower Band-edge 50kbps

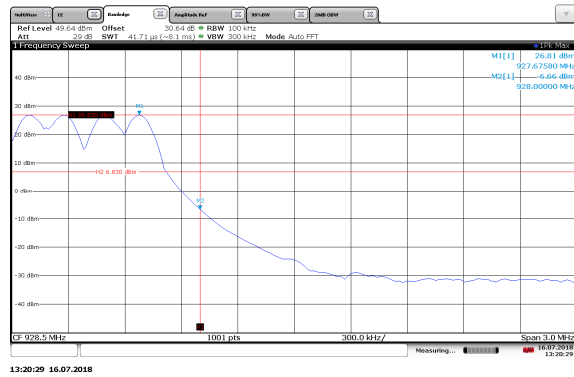


Figure 7.5.1.2-16: Upper Band-edge 50kbps

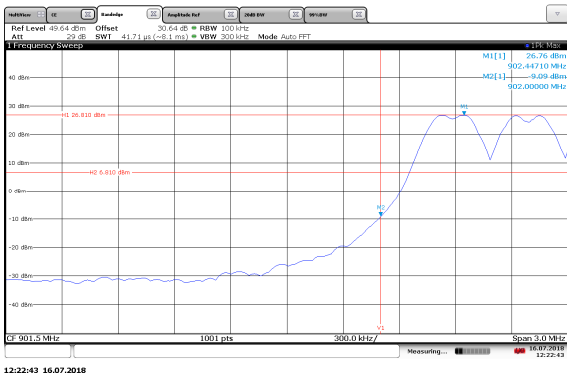


Figure 7.5.1.2-17: Lower Band-edge 150kbps

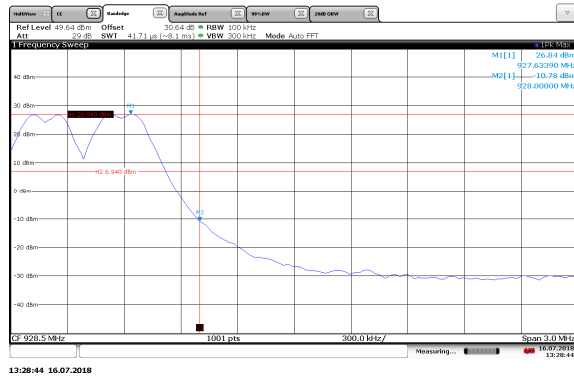


Figure 7.5.1.2-18: Upper Band-edge 150kbps

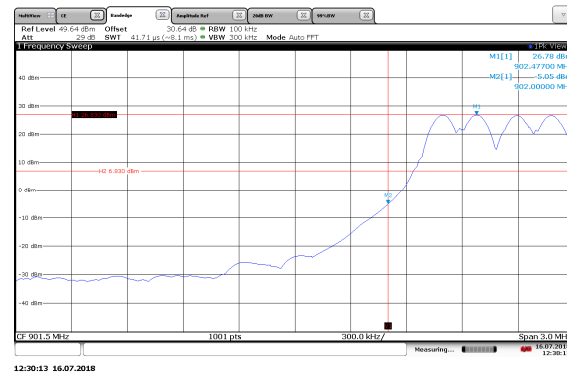


Figure 7.5.1.2-19: Lower Band-edge 200kbps

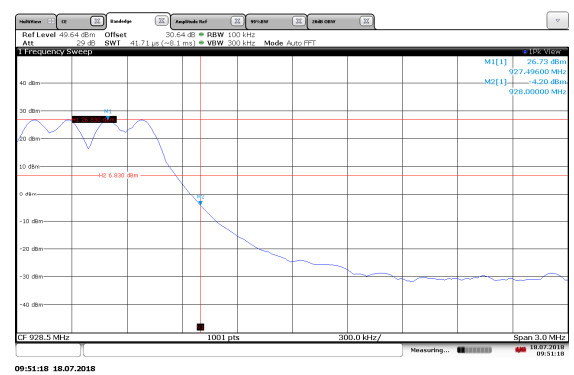


Figure 7.5.1.2-20: Upper Band-edge 200kbps

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

Tested By: Randy Sherian

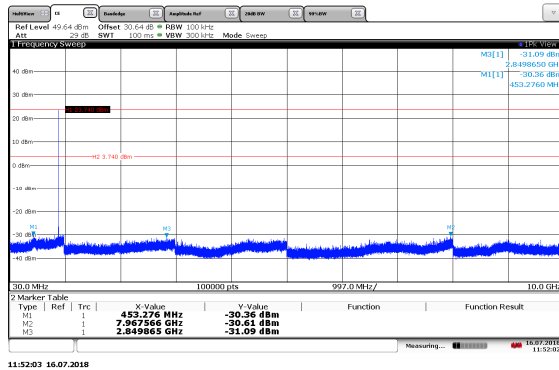


Figure 7.5.2.2-1: 30MHz–10GHz Low Channel 35.5kbps

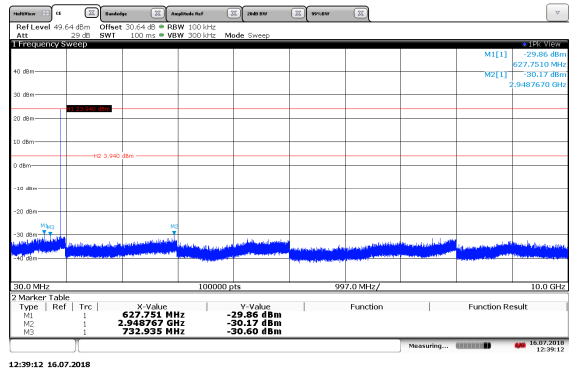


Figure 7.5.2.2-2: 30MHz–10GHz Mid Channel 35.5kbps

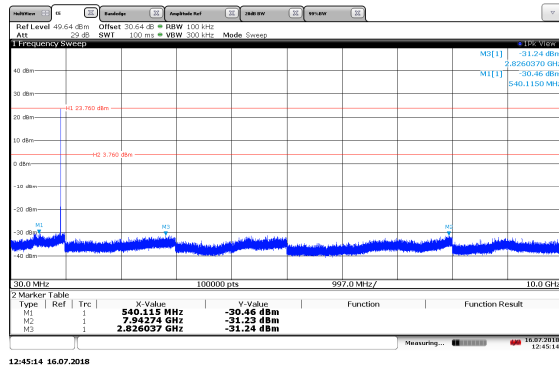


Figure 7.5.2.2-3: 30MHz–10GHz High Channel 35.5kbps

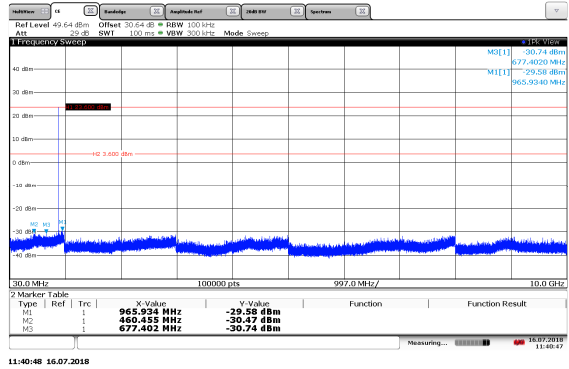


Figure 7.5.2.2-4: 30MHz–10GHz Low Channel 142.2kbps

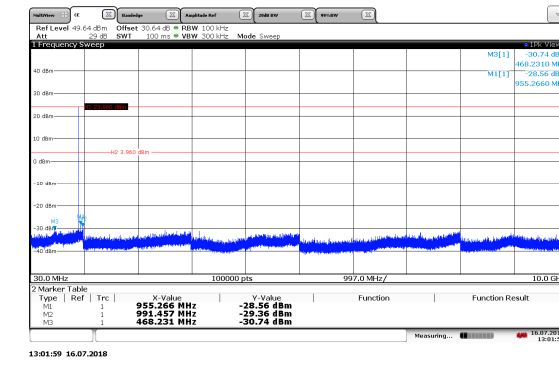


Figure 7.5.2.2-5: 30MHz–10GHz Mid Channel 142.2kbps

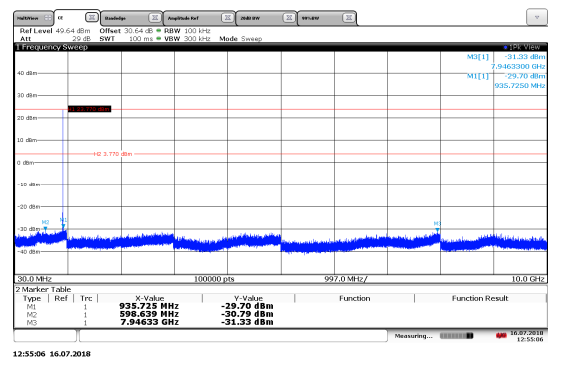


Figure 7.5.2.2-6: 30MHz–10GHz High Channel 142.2kbps

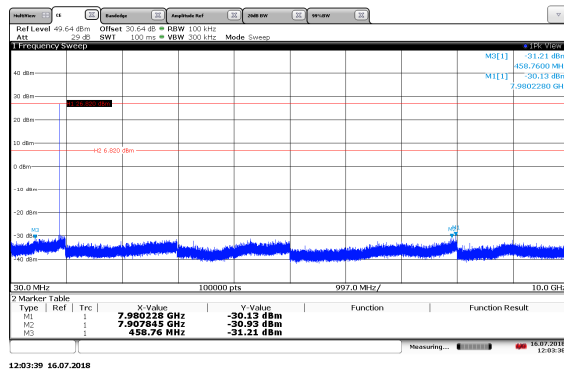


Figure 7.5.2.2-7: 30MHz-10GHz Low Channel 50kbps

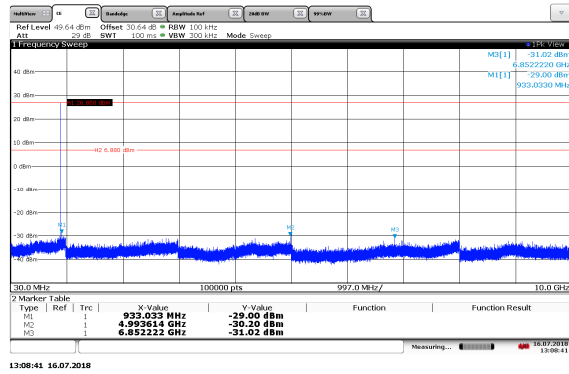


Figure 7.5.2.2-8: 30MHz-10GHz Mid Channel 50kbps

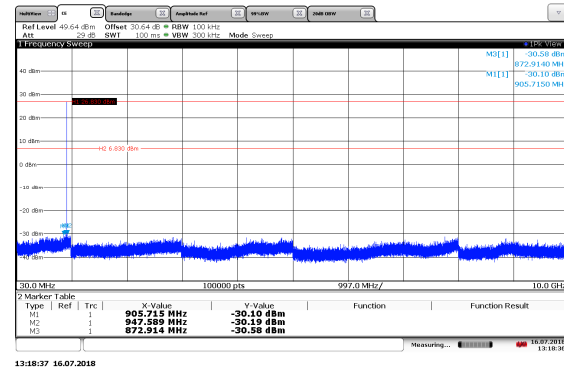


Figure 7.5.2.2-9: 30MHz-10GHz High Channel 50kbps

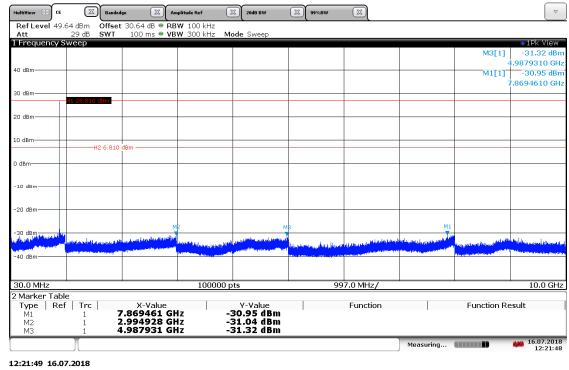


Figure 7.5.2.2-10: 30MHz-10GHz Low Channel 150kbps

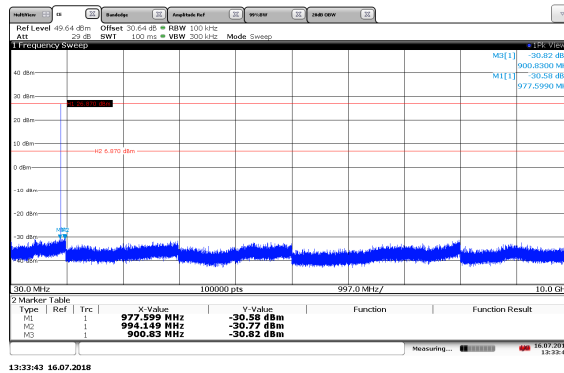


Figure 7.5.2.2-11: 30MHz-10GHz Mid Channel 150kbps

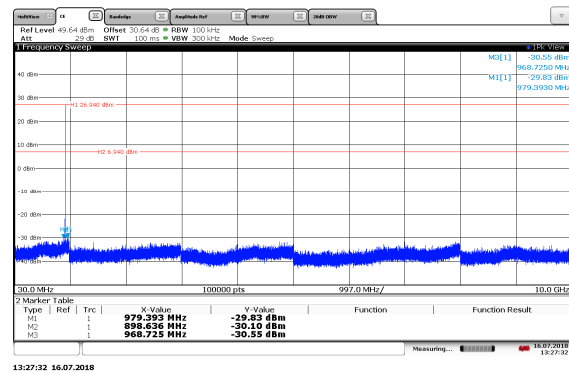


Figure 7.5.2.2-12: 30MHz-10GHz High Channel 150kbps

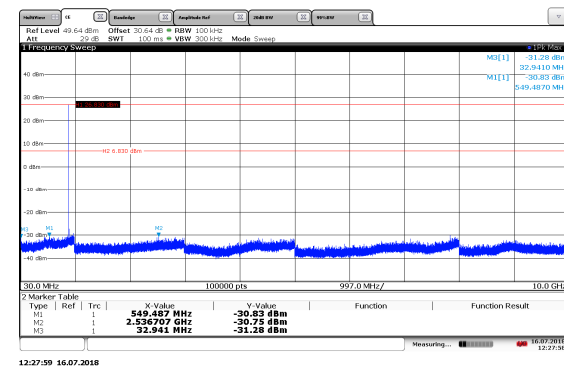


Figure 7.5.2.2-13: 30MHz-10GHz Low Channel 200kbps

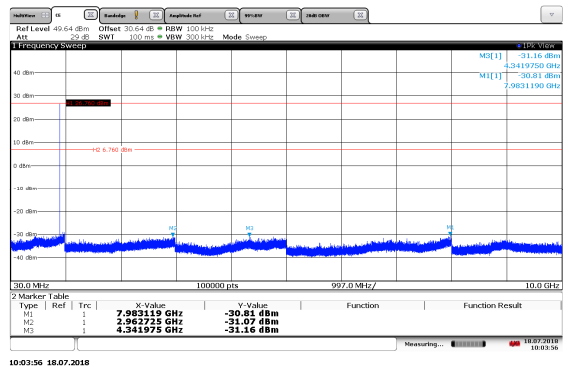


Figure 7.5.2.2-14: 30MHz-10GHz Mid Channel 200kbps

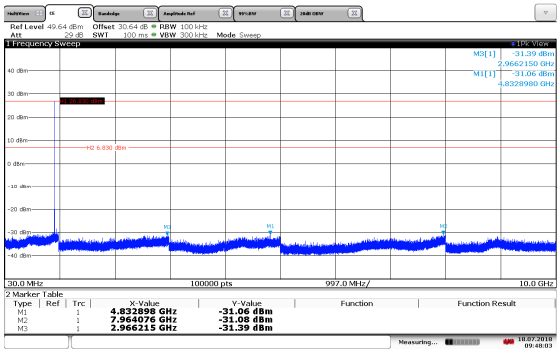


Figure 7.5.2.2-15: 30MHz–10GHz High Channel 200kbps

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

Mode 1:

No Duty Cycle Correction was used.

Mode 2:

For average radiated measurements, using a 50% duty cycle, the measured level was reduced by a factor 6.02dB. The duty cycle correction factor is determined using the formula: $20\log(50/100) = -6.02\text{dB}$.

A detailed analysis of the duty cycle timing is provided in the Theory of Operation accompanying the application for certification.

7.5.3.3 Measurement Results

Tested By: Charlie Callis

Table 7.5.3.3-1: Radiated Spurious Emissions Tabulated Data Mode 1

| Frequency (MHz) | Level (dBuV) | | Antenna Polarity (H/V) | Correction Factors (dB) | Corrected Level (dBuV/m) | | Limit (dBuV/m) | | Margin (dB) | |
|--------------------|-----------------|---------|------------------------------|-------------------------------|-----------------------------|---------|-------------------|---------|----------------|---------|
| | pk | Qpk/Avg | | | pk | Qpk/Avg | pk | Qpk/Avg | pk | Qpk/Avg |
| Low Channel | | | | | | | | | | |
| 2707.2 | 47.70 | 44.10 | H | -2.70 | 45.00 | 41.40 | 74.0 | 54.0 | 29.0 | 12.6 |
| 2707.2 | 53.60 | 51.50 | V | -2.70 | 50.90 | 48.80 | 74.0 | 54.0 | 23.1 | 5.2 |
| 3609.6 | 44.80 | 38.70 | H | 0.22 | 45.02 | 38.92 | 74.0 | 54.0 | 29.0 | 15.1 |
| 3609.6 | 43.20 | 35.20 | V | 0.22 | 43.42 | 35.42 | 74.0 | 54.0 | 30.6 | 18.6 |
| Mid Channel | | | | | | | | | | |
| 2745.6 | 49.40 | 46.40 | H | -2.58 | 46.82 | 43.82 | 74.0 | 54.0 | 27.2 | 10.2 |
| 2745.6 | 55.10 | 53.30 | V | -2.58 | 52.52 | 50.72 | 74.0 | 54.0 | 21.5 | 3.3 |
| 3660.8 | 44.20 | 38.10 | H | 0.32 | 44.52 | 38.42 | 74.0 | 54.0 | 29.5 | 15.6 |
| 3660.8 | 42.70 | 35.00 | V | 0.32 | 43.02 | 35.32 | 74.0 | 54.0 | 31.0 | 18.7 |
| High Channel | | | | | | | | | | |
| 966.03 | | 19.40 | H | 24.48 | ----- | 43.88 | ----- | 54.0 | ----- | 10.1 |
| 2782.8 | 50.70 | 48.10 | H | -2.47 | 48.23 | 45.63 | 74.0 | 54.0 | 25.8 | 8.4 |
| 2782.8 | 57.10 | 55.50 | V | -2.47 | 54.63 | 53.03 | 74.0 | 54.0 | 19.4 | 1.0 |
| 3710.4 | 42.90 | 34.90 | H | 0.42 | 43.32 | 35.32 | 74.0 | 54.0 | 30.7 | 18.7 |

Table 7.5.3.3-2: Radiated Spurious Emissions Tabulated Data Mode 2

| Frequency (MHz) | Level (dBuV) | | Antenna Polarity (H/V) | Correction Factors (dB) | Corrected Level (dBuV/m) | | Limit (dBuV/m) | | Margin (dB) | |
|--------------------|-----------------|---------|------------------------------|-------------------------------|-----------------------------|---------|-------------------|---------|----------------|---------|
| | pk | Qpk/Avg | | | pk | Qpk/Avg | pk | Qpk/Avg | pk | Qpk/Avg |
| Low Channel | | | | | | | | | | |
| 2707.2 | 52.80 | 50.70 | H | -2.70 | 50.10 | 41.98 | 74.0 | 54.0 | 23.9 | 12.0 |
| 2707.2 | 59.00 | 57.70 | V | -2.70 | 56.30 | 48.98 | 74.0 | 54.0 | 17.7 | 5.0 |
| 3609.6 | 46.40 | 41.80 | H | 0.22 | 46.62 | 36.00 | 74.0 | 54.0 | 27.4 | 18.0 |
| 3609.6 | 44.90 | 38.90 | V | 0.22 | 45.12 | 33.10 | 74.0 | 54.0 | 28.9 | 20.9 |
| Mid Channel | | | | | | | | | | |
| 2745.6 | 54.90 | 53.60 | H | -2.58 | 52.32 | 45.00 | 74.0 | 54.0 | 21.7 | 9.0 |
| 2745.6 | 60.80 | 60.10 | V | -2.58 | 58.22 | 51.50 | 74.0 | 54.0 | 15.8 | 2.5 |
| 3660.8 | 46.00 | 41.70 | H | 0.32 | 46.32 | 36.00 | 74.0 | 54.0 | 27.7 | 18.0 |
| 3660.8 | 43.70 | 37.50 | V | 0.32 | 44.02 | 31.80 | 74.0 | 54.0 | 30.0 | 22.2 |
| High Channel | | | | | | | | | | |
| 965.96 | | 21.50 | H | 24.48 | ----- | 45.98 | ----- | 54.0 | ----- | 8.0 |
| 2782.8 | 56.70 | 55.30 | H | -2.47 | 54.23 | 46.81 | 74.0 | 54.0 | 19.8 | 7.2 |
| 2782.8 | 62.70 | 61.80 | V | -2.47 | 60.23 | 53.31 | 74.0 | 54.0 | 13.8 | 0.7 |
| 3710.4 | 46.00 | 41.30 | H | 0.42 | 46.42 | 35.70 | 74.0 | 54.0 | 27.6 | 18.3 |
| 3710.4 | 44.30 | 37.50 | V | 0.42 | 44.72 | 31.90 | 74.0 | 54.0 | 29.3 | 22.1 |

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 |

Mode 1:**Example Calculation: Peak**

Corrected Level: $42.9 + 0.42 = 43.32\text{dBuV/m}$
Margin: $74\text{dBuV/m} - 43.3\text{dBuV/m} = 30.7\text{dB}$

Example Calculation: Average

Corrected Level: $34.9 + 0.42 = 35.32\text{dBuV}$
Margin: $54\text{dBuV} - 35.3\text{dBuV} = 18.7\text{dB}$

Mode 2:**Example Calculation: Peak**

Corrected Level: $44.3 + 0.42 = 44.72\text{dBuV/m}$
Margin: $74\text{dBuV/m} - 44.7\text{dBuV/m} = 29.3\text{dB}$

Example Calculation: Average

Corrected Level: $(37.5 + 0.42) - 6.02 = 31.9\text{dBuV}$
Margin: $54\text{dBuV} - 31.9\text{dBuV} = 22.1\text{dB}$

8 MEASUREMENT UNCERTAINTY

The expanded laboratory measurement uncertainty figures (U_{Lab}) provided below correspond to an expansion factor (coverage factor) $k = 1.96$ which provide confidence levels of 95%.

| Parameter | U_{lab} |
|-----------------------------------|--------------------------------------|
| Occupied Channel Bandwidth | $\pm 0.004\%$ |
| RF Conducted Output Power | $\pm 0.689 \text{ dB}$ |
| Power Spectral Density | $\pm 0.5 \text{ dB}$ |
| Antenna Port Conducted Emissions | $\pm 2.717 \text{ dB}$ |
| Radiated Emissions | $\pm 5.877 \text{ dB}$ |
| Temperature | $\pm 0.860 \text{ }^{\circ}\text{C}$ |
| Radio Frequency | $\pm 2.832 \times 10^{-8}$ |
| AC Power Line Conducted Emissions | ± 2.85 |

9 CONCLUSION

In the opinion of TÜV SÜD America Inc. the SNREM, manufactured by Elster Solutions, LLC 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