Certification Test Report

FCC ID: R7PNG0R1S7
IC: 5294A-NG0R1S7

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

Report Number: AT72162780-1C1

Manufacturer: Landis+Gyr Technology, Inc
Model: S5-MCM0

Test Begin Date: Feb 08, 2021
Test End Date: July 20, 2021

Report Issue Date: August 04, 2021

FOR THE SCOPE OF ACCREDITATION UNDER Certificate Number: 2955.09

This report must not be used by the client to claim product certification, approval, or endorsement by A2LA, NIST, or any agency of the Federal Government.

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TÜV SÜD America Inc.

This report contains 47 pages

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1 GENERAL

1.1 Purpose

The purpose of this report is to demonstrate compliance with Part 15 Subpart C of the FCC's Code of Federal Regulations and Innovation, Science and Economic Development Canada's Radio Standards Specification RSS-247 for the tests documented herein.

1.2 Product description

The S5-MCM0 manufactured by Landis+Gyr Technology, Inc. is a fully functional, radio-on-chip that is enabled for simple sensor device integration.

Technical Information:
The model S5-MCM0 provides 4 distinct frequency hopping modes of operation as outlined below.

Mode of Operation	Frequency Range (MHz)	Number of Channels	Channel Separation (kHz)	Data Rates Supported (kbps)
1	902.3 - 927.8	86	300	9.6, 19.2, 38.4, 115.2
2	904.0 - 927.8	239	100	9.6, 19.2, 38.4
3	902.4 - 927.6	64	400	10.0, 20.0, 50.0, 150.0, 200.0
4	902.2 - 927.8	129	200	50.0, 150.0

Modulation Format: FSK
Antenna Type / Gain: Printed-F Antenna / 0 dBi
Voltage: 4 Vdc (supplied via evaluation board)

Manufacturer Information:
Landis+Gyr Technology, Inc.
30000 Mill Creek Ave., Suite 100
Alpharetta, GA 30022

EUT Serial Numbers: 92008A92 (Radiated Emissions)
Mode 1 & 2: 930082CC (RF Antenna Port Measurements)
Mode 3 & 4: Not labelled (RF Antenna Port Measurements)

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. The data presented in this report represents the worst case where applicable. The worst-case mode and data rate for the radiated emission measurements was Mesh with 9.6kbps and WiSUN with 50kbps.

For radiated emissions, the EUT was evaluated in three orthogonal orientations. The worst-case orientation was X-position. See test setup photos for more information. The EUT was programmed to generate a continuously modulated signal on each channel evaluated.

For power line conducted emissions, the EUT was evaluated with a commercially available off-the shelf power supply provided by the applicant.

The EUT was programmed to generate a continuously modulated signal on a single Channel.

For RF Conducted measurements, the EUT was connected to the test equipment with a temporary antenna connector which was soldered to the board. The EUT was programmed to generate a continuously modulated signal on each channel evaluated.

Software power setting during test: All modes: 270

2 TEST FACILITIES

2.1 Location

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

TÜV SÜD America, Inc.
5945 Cabot Pkwy, Suite 100
Alpharetta, GA 30005
Phone: (678) 341-5900

2.2 Laboratory Accreditations/Recognitions/Certifications

TÜV SÜD America, Inc. is accredited to ISO/IEC 17025 by the American Association for Laboratory Accreditation/A2LA accreditation program and has been issued certificate number 2955.09 in recognition of this accreditation.

Unless otherwise specified, all test methods described within this report are covered under the ISO/IEC 17025 scopes of accreditation.

The Semi-Anechoic Chamber Test Sites and Conducted Emissions Sites have been fully described, submitted to, and accepted by the FCC, ISED Canada and the Japanese Voluntary Control Council for Interference by information technology equipment.

FCC Designation Accreditation Number:	US1233
FCC Test Site Registration Number:	967699
ISED Canada Lab Code:	23932
VCCI Member Number:	1831
• VCCI Registration Number	A-0295

2.3 Radiated Emissions Test Site Description

2.3.1 Semi-Anechoic Chamber Test Site – Chamber A

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

The turntable is 5’ in diameter and is located 5’6” from the back wall of the chamber. The chamber is grounded via 1 - 8’ copper ground rod, installed at the center of the back wall, it is bound to the ground plane using 3/4" stainless steel braided cable.

The turntable is all steel, flush mounted EMCO Model 1060 installed in an all-steel frame. The table is remotely operated from inside the control room located 25’ from the range. The turntable is electrically bonded to the surrounding ground plane via steel fingers installed on the edge of the turn table. The steel fingers make constant contact with the ground plane during operation.

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

The chamber rear wall is covered with a mixture of Siepel pyramidal absorber. The side walls of the chamber are partially covered with Siepel pyramidal absorber.

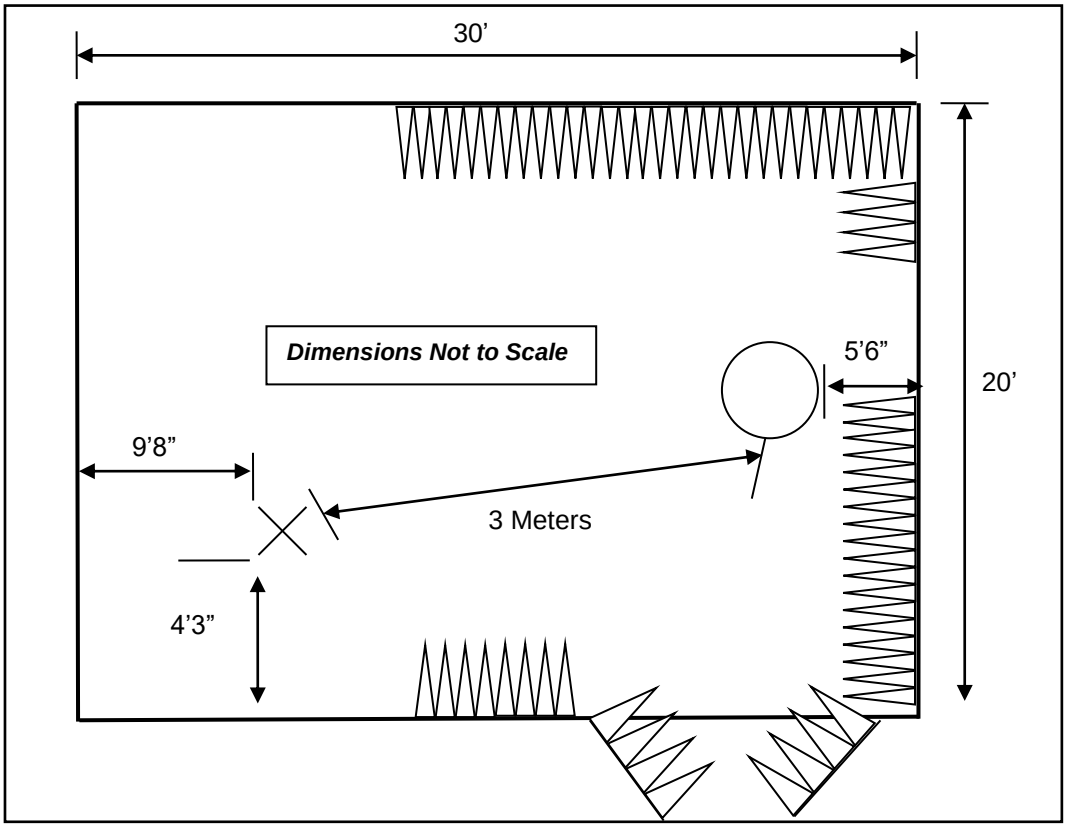

Figure 2.3.1-1: Semi-Anechoic Chamber Test Site – Chamber A

2.3.2 Semi-Anechoic Chamber Test Site – Chamber B

The Semi-Anechoic Chamber Test Site consists of a 20'W x 30'L x 20'H shielded enclosure. The chamber is lined with ETS-Lindgren Ferrite Absorber, model number FT-1500. The ferrite tile 600 mm x 600 mm (2.62 in x 23.62 in) panels and are mounted directly on the inner walls of the chamber shield.

The specular regions of the chamber are lined with additional ETS-Lindgren PS-600 hybrid absorber to extend its frequency range up to 18GHz and beyond.

The turntable is a 2m ETS-Lindgren Model 2170 and installed off the center axis is located 5'6" 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 shield using #8 solid copper wire.

The antenna mast is an EMCO 1060 and is remotely controlled from the control room for both antenna height and polarization.

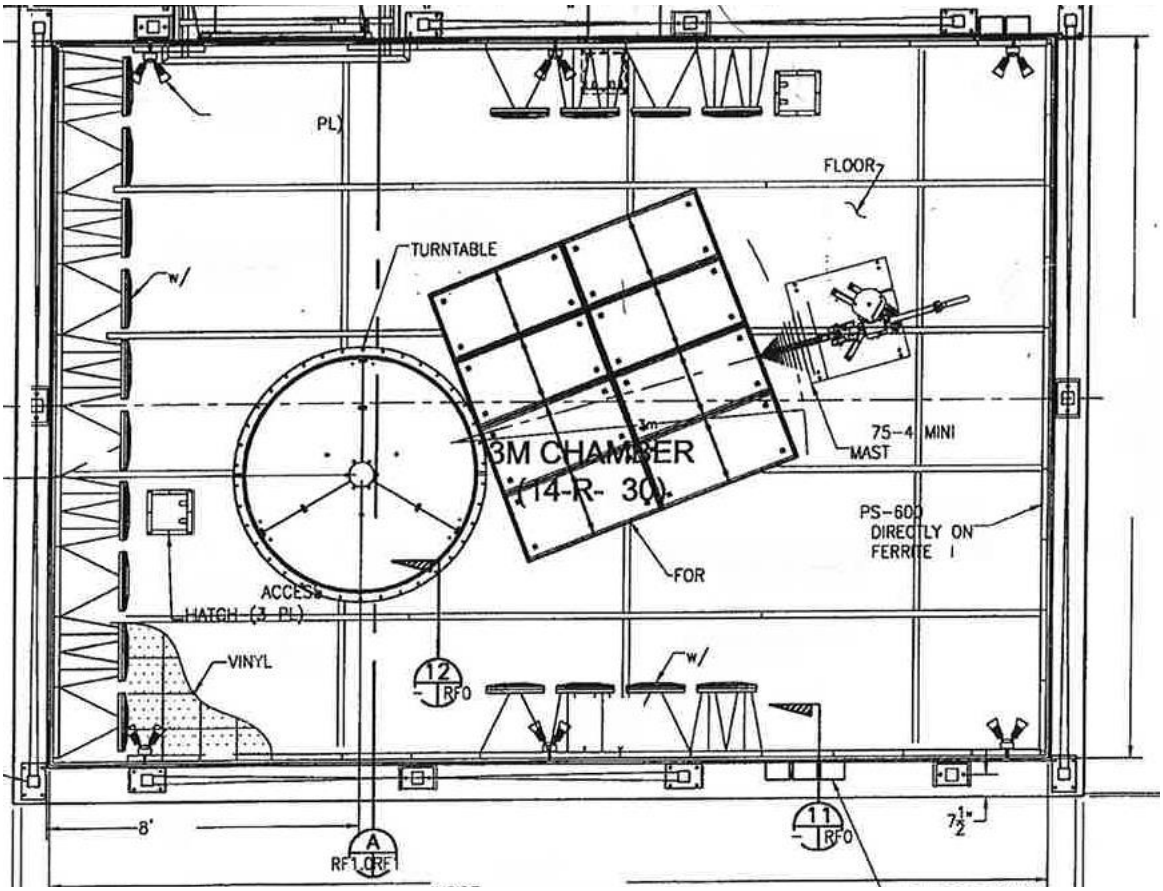

Figure 2.3.2-1: Semi-Anechoic Chamber Test Site – Chamber B

2.4 Conducted Emissions Test Site Description

2.4.1 Conducted Emissions Test Site

The AC mains conducted EMI site is located in the main EMC lab. It consists of a 12' x 10' horizontal coupling plane (HCP) as well as a 12'x8' vertical coupling plane (VCP). The HGP is constructed of 4' x 10' sheets of particle board sandwiched by galvanized steel sheets. These panels are bonded using 11AWG 1/8" x 2" by 10' galvanized sheet steel secured to the panels via by screws. The VCP is constructed of three 4'x8' sheets of 11AWG solid aluminum.

The HCP and VCP are electrically bonded together using 1"x1" angled aluminum secured with screws.

The site is of sufficient size to test tabletop and floor standing equipment in accordance with section 6.1.4 of ANSI C63.10.

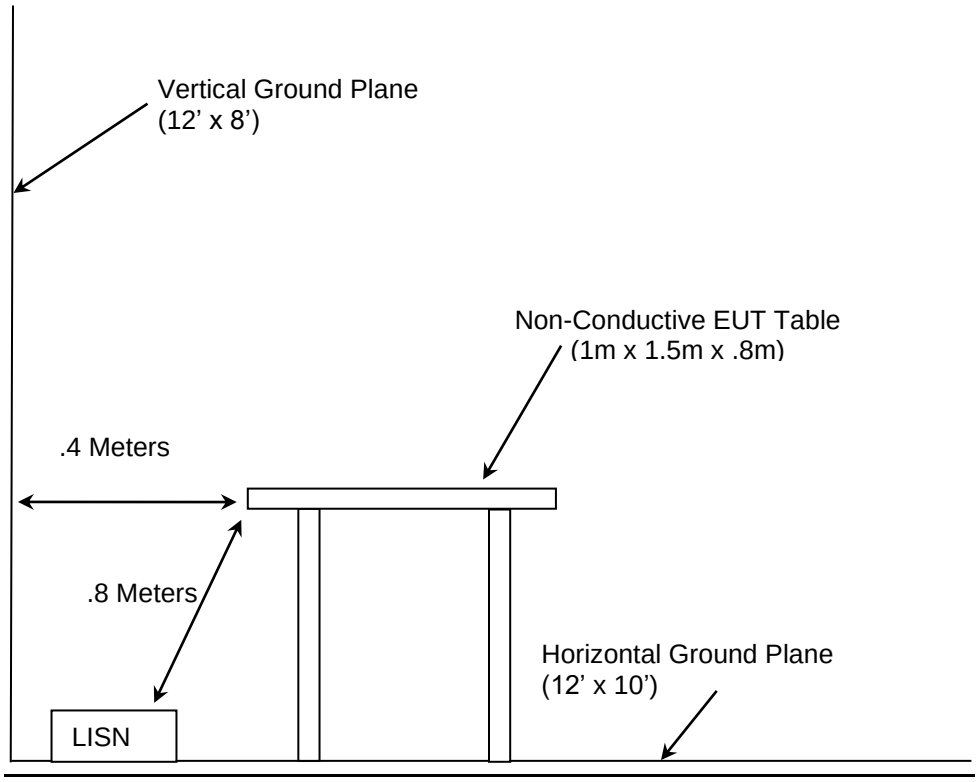

Figure 2.4.1-1: AC Mains Conducted EMI Site

3 APPLICABLE STANDARD REFERENCES

The following standards were used:

- ANSI C63.10-2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.
- US Code of Federal Regulations (CFR): Title 47, Part 2, Subpart J: Equipment Authorization Procedures, 2021
- US Code of Federal Regulations (CFR): Title 47, Part 15, Subpart C: Radio Frequency Devices, Intentional Radiators, 2021
- FCC KDB 558074 D01 15.247 Meas Guidance v05r02 – Guidance for Compliance Measurements on Digital Transmission System, Frequency Hopping Spread Spectrum System, and Hybrid System Devices Operating Under Section 15.247 of the FCC Rules, April 2, 2019
- 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 5, Amendment 1 (March 2019), Amendment 2 (February 2021)

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 Number	Last Calibration Date	Calibration Due Date
872	Agilent	E7402A	EMC Spectrum Analyzer	US40240258	6/22/2021	6/22/2022
3010	Rohde & Schwarz	ENV216	Two-Line V-Network	3010	6/23/2021	6/23/2022
324	ACS	Belden	Conducted EMI Cable	8214	6/8/2021	6/8/2022
22	Hewlett Packard	8449B	High Frequency Pre-Amp	3008A00526	10/19/2020	10/19/2021
836	ETS Lindgren	SAC Cable Set	SAC Cable Set includes 620, 837, 838	N/A	05/11/2020	05/11/2021
836	ETS Lindgren	SAC Cable Set	SAC Cable Set includes 620, 837, 838	N/A	5/11/2021	5/11/2022
857	ETS Lindgren	3117	Horn Antenna 1-18GHz	00153608	11/12/2019	11/12/2021
628	EMCO	6502	Active Loop Antenna 10kHz-30MHz	9407-2877	02/11/2019	05/11/2021
628	EMCO	6502	Active Loop Antenna 10kHz-30MHz	9407-2877	6/8/2021	6/8/2023
3161	Teseq; Huber+Suhner	CBL6112D;6804-17-A	Bilog Antenna; Attenuator	51323;01252019A	3/19/2021	3/19/2022
622	Rohde & Schwarz	FSV40 (v3.40)	FSV Signal Analyzer 10Hz to 40GHz	101338	08/24/2020	08/24/2021
321	Hewlett Packard	HPC 8447D	Low Freq. Pre-Amp	1937A02809	08/10/2020	08/10/2021
827	Rohde & Schwarz	TS8997 Rack Cable Set	TS8997 Rack Cable Set	N/A	09/04/2020	09/04/2021
882	Rohde & Schwarz	ESW44	ESW44 EMI TEST RECEIVER	101961	07/28/2020	07/28/2021
882	Rohde & Schwarz	ESW44	ESW44 EMI TEST RECEIVER	101961	6/24/2021	6/24/2022

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

5 SUPPORT EQUIPMENT

Table 5-1: Support Equipment

Item	Equipment Type	Manufacturer	Model Number	Serial Number
1	EUT	Landis + Gyr	S5-MCMO	92008A92 (1) 930082CC (2)
2	DC Power Supply	Hewlett Packard	6622A	3448A03980
3	AC Power Adapter	Radio Shack	N/A	N/A

1) Radiated Measurements
2) Conducted Measurements

Table 5-2: Cable Description

Item	Cable Type	Length	Shield
A	DC Power Cable	2m	No
B	AC Power Cable	2m	Yes

6 EQUIPMENT UNDER TEST SETUP BLOCK DIAGRAM

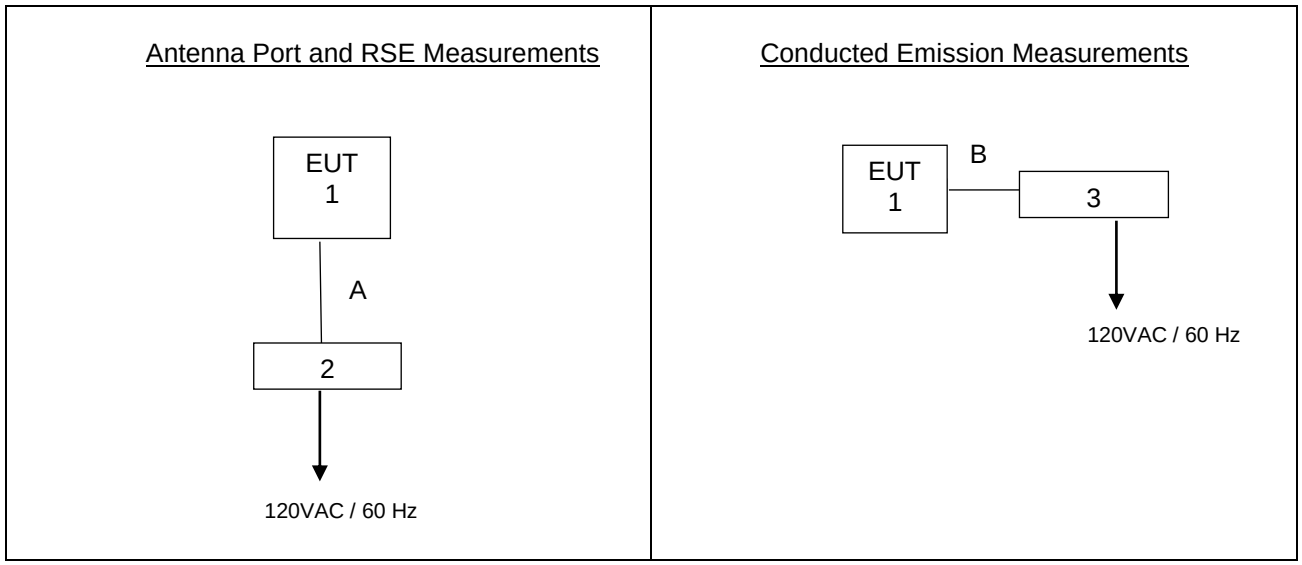

Figure 6-1: Test Setup Block Diagram

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 EUT utilizes an integral onboard printed F (PIFA) antenna with 0 dBi gain, therefore satisfying the requirements of Section 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 section 6 was the guiding documents 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 = Corrected Reading - Applicable Limit

7.2.2 Measurement Results

Performed by Sean Vick

Table 7.2.2-1: Conducted EMI AVG Results – Line 1

Frequency (MHz)	Avg Limit	Avg Level Corr	Avg Level	Corr Fact.	Avg Margin	Result
0.17	55.5	45.3	35.6	9.68	-10.2	PASS
5.73	50	47.4	37.7	9.715	-2.6	PASS
5.9	50	46	36.3	9.712	-4	PASS
6.17	50	38.7	29	9.71	-11.3	PASS
6.26	50	37.6	27.9	9.71	-12.4	PASS
6.28	50	37.8	28.1	9.71	-12.2	PASS

Table 7.2.2-2: Conducted EMI Peak Results – Line 1

Frequency (MHz)	QP Limit	QP Level Corr	QP Level	Corr Fact.	QP Margin	Result
0.17	65.5	51.9	42.2	9.68	-13.6	PASS
5.73	60	49.8	40.1	9.715	-10.2	PASS
5.9	60	48.9	39.1	9.712	-11.1	PASS
6.17	60	41.6	31.9	9.71	-18.4	PASS
6.26	60	40.6	30.9	9.71	-19.4	PASS
6.28	60	41.7	32	9.71	-18.3	PASS

Table 7.2.2-3: Conducted EMI AVG Results – Line 2

Frequency (MHz)	Avg Limit	Avg Level Corr	Avg Level	Corr Fact.	Avg Margin	Result
0.17	55.5	48.8	39.1	9.673	-6.7	PASS
5.77	50	39.9	30.2	9.715	-10.1	PASS
5.77	50	40	30.3	9.715	-10	PASS
5.81	50	41.1	31.3	9.716	-8.9	PASS
5.9	50	42.2	32.4	9.718	-7.8	PASS
7.04	50	38.3	28.6	9.731	-11.7	PASS

Table 7.2.2-4: Conducted EMI Peak Results – Line 2

Frequency (MHz)	QP Limit	QP Level Corr	QP Level	Corr Fact.	QP Margin	Result
0.17	65.5	52.2	42.5	9.673	-13.3	PASS
5.77	60	45.7	36	9.715	-14.3	PASS
5.77	60	44.2	34.5	9.715	-15.8	PASS
5.81	60	43.2	33.5	9.716	-16.8	PASS
5.9	60	48	38.2	9.718	-12	PASS
7.04	60	41.6	31.8	9.731	-18.4	PASS

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

7.3.1 Measurement Procedure

The RF output port of the EUT was directly connected to the input of a peak power meter. The device employs >50 channels therefore the power is limited to 1 Watt. All data rates were evaluated.

7.3.2 Measurement Results

Performed by: Divya Adusumilli

Table 7.3.2-1: RF Output Power

Frequency [MHz]	Peak Output Power (dBm)	Data Rate (kbps)	Mode(s)
902.3	28.08	9.6	1 / 2
902.3	28.04	19.2	1 / 2
902.3	28.12	38.4	1 / 2
902.3	28.15	115.2	1
902.4	27.72	10.0	3
902.4	27.86	20.0	3
902.4	27.88	50.0	3
902.4	27.92	150.0	3
902.4	27.90	200.0	3
902.2	28.86	50.0	4
902.2	28.48	150.0	4
915.0	27.90	9.6	1 / 2
915.0	27.92	19.2	1 / 2
915.0	27.94	38.4	1 / 2
915.0	27.94	115.2	1
915.2	27.88	10.0	3
915.2	27.93	20.0	3
915.2	27.97	50.0	3 / 4
915.2	28.03	150.0	3 / 4
915.2	28.03	200.0	3
927.8	27.19	9.6	1 / 2
927.8	27.19	19.2	1 / 2
927.8	27.19	38.4	1 / 2
927.8	27.17	115.2	1
927.6	27.12	10.0	3
927.6	27.17	20.0	3
927.6	27.2	50.0	3
927.6	27.28	150.0	3
927.6	27.31	200.0	3
927.8	27.09	50.0	4
927.8	27.13	150.0	4

7.4 Channel Usage Requirements

7.4.1 Carrier Frequency Separation – FCC Section 15.247(a)(1); ISED Canada: RSS-2475.1(b)

7.4.1.1 Measurement Procedure

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

Carrier frequency separation was measured for all Modes and data presented in section 7.4.1.2 below.

7.4.1.2 Measurement Results

Performed by: Divya Adusumilli

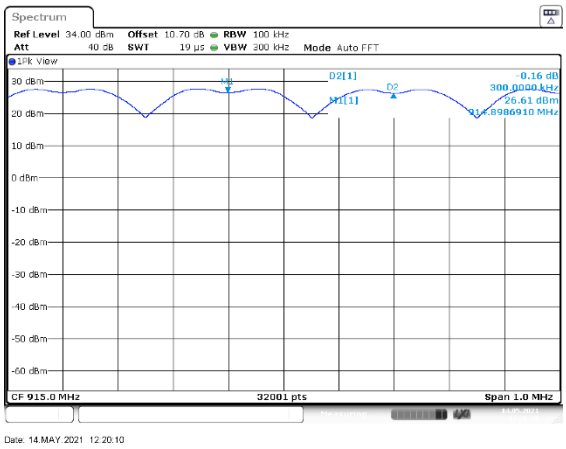

Figure 7.4.1.2-1: Channel Separation – Mode 1

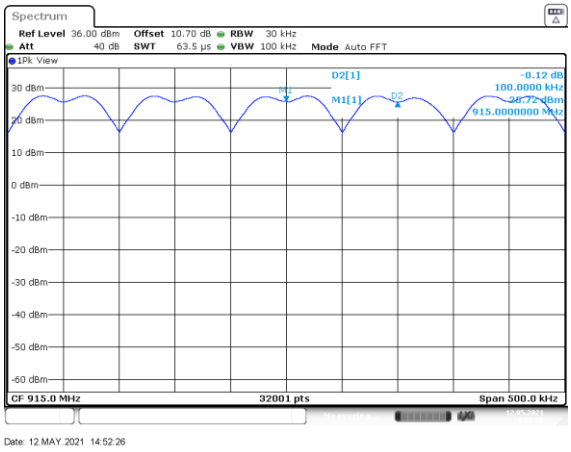

Figure 7.4.1.2-2: Channel Separation – Mode 2

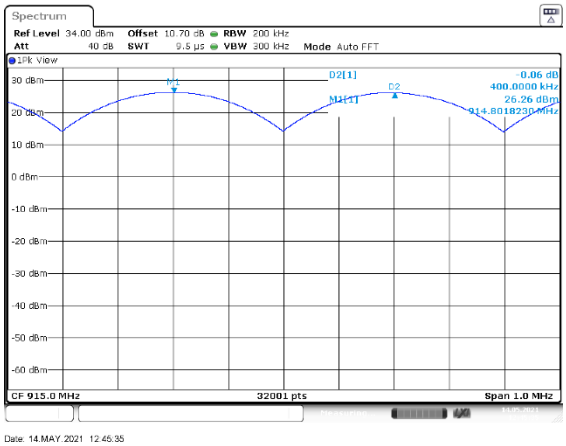

Figure 7.4.1.2-3: Channel Separation – Mode 3

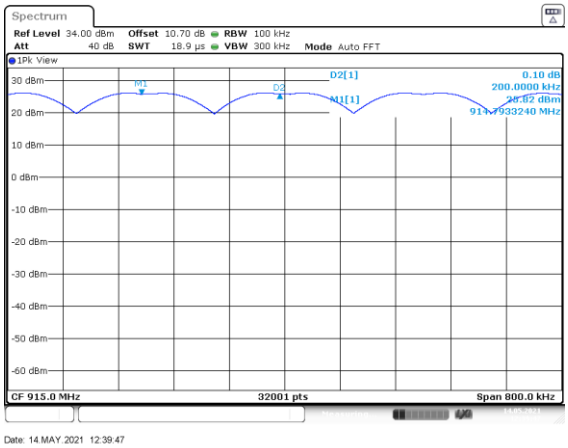

Figure 7.4.1.2-4: Channel Separation – Mode 4

7.4.2 Number of Hopping Channels – FCC Section 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 with suitable attenuation. The span of the spectrum analyzer was set wide enough to capture the frequency band of operation. The RBW was set to less than 30% of the channel spacing or the 20dB bandwidth, whichever is smaller. The VBW was set to ≥ RBW.

The number of hopping channels was measured for all modes and data presented in section 7.4.2.2 below.

7.4.2.2 Measurement Results

Performed by: Divya Adusumilli

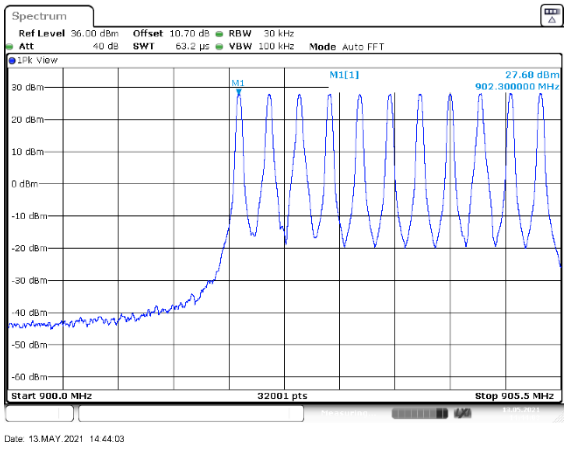

Figure 7.4.2.2-1: Mode 1 (86 Channels)

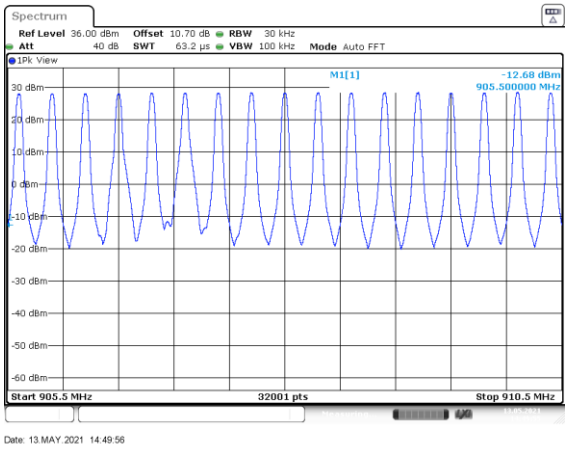

Figure 7.4.2.2-2: Mode 1 (86 Channels)

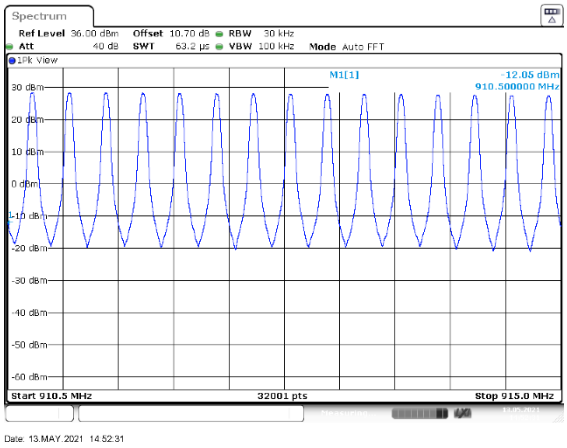

Figure 7.4.2.2-3: Mode 1 (86 Channels)

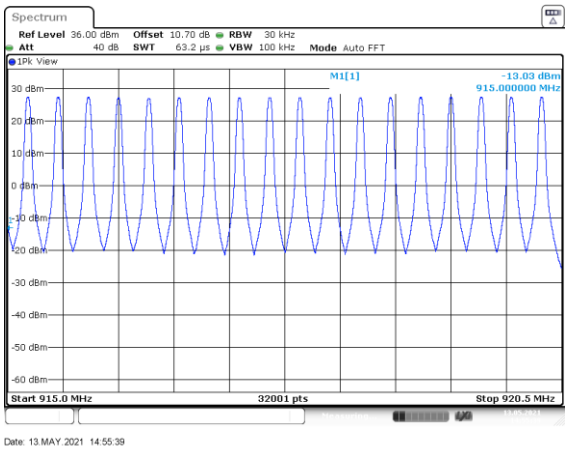

Figure 7.4.2.4-10: Mode 1 (86 Channels)

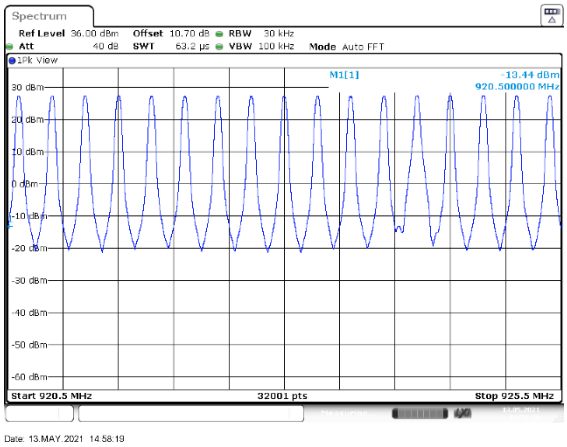

Figure 7.4.2.2-5: Mode 1 (86 Channels)

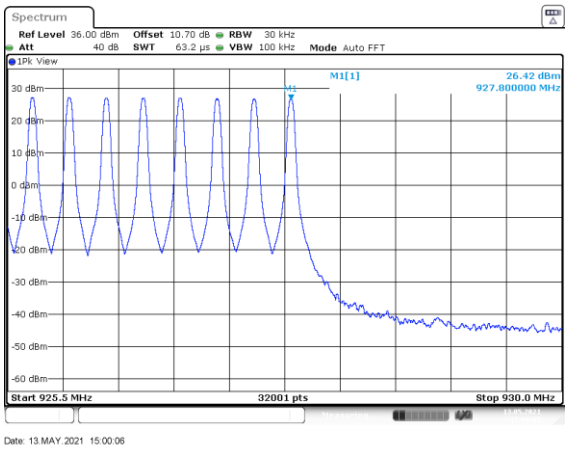

Figure 7.4.2.2-6: Mode 1 (86 Channels)

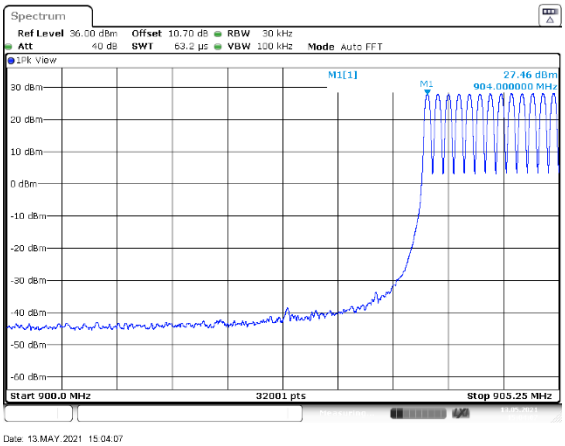

Figure 7.4.2.2-7: Mode 2 (239 Channels)

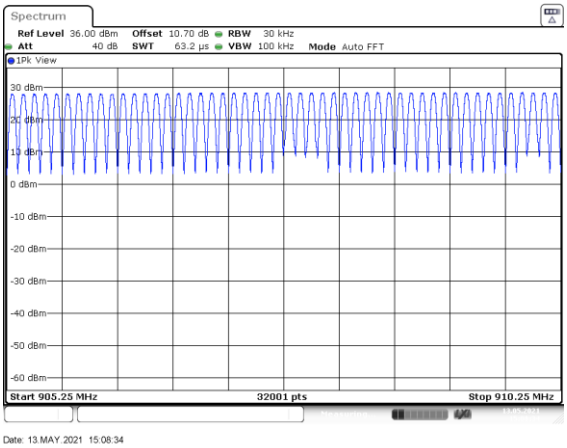

Figure 7.4.2.2-8: Mode 2 (239 Channels)

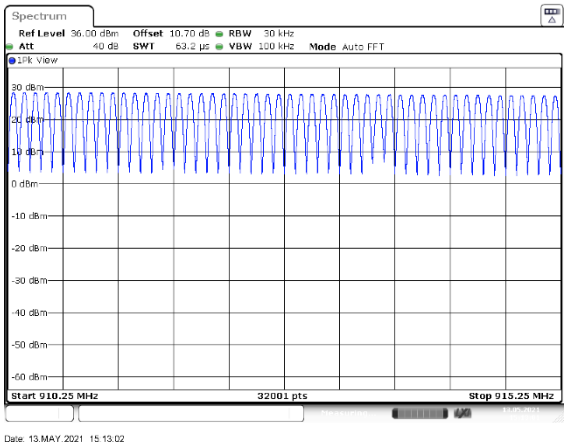

Figure 7.4.2.2-9: Mode 2 (239 Channels)

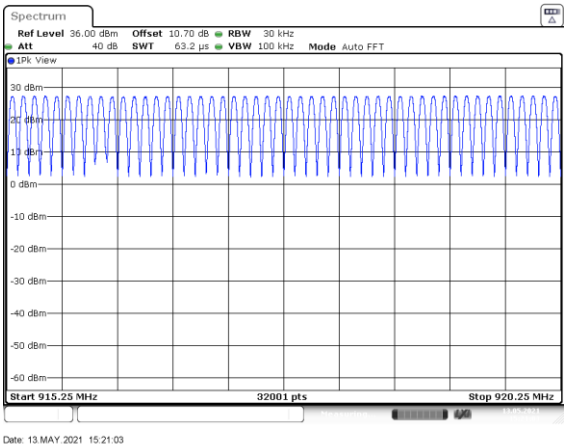

Figure 7.4.2.2-10: Mode 2 (239 Channels)

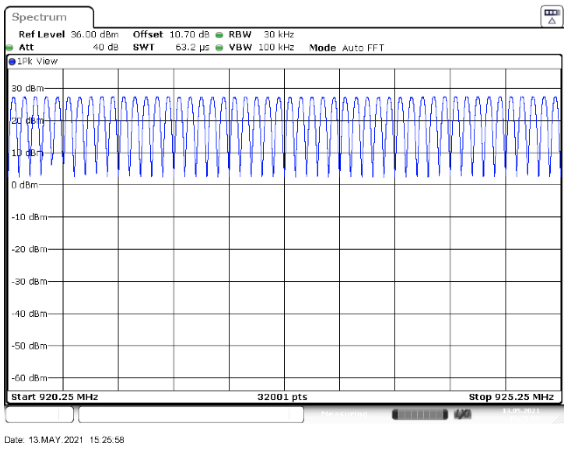

Figure 7.4.2.2-11: Mode 2 (239 Channels)

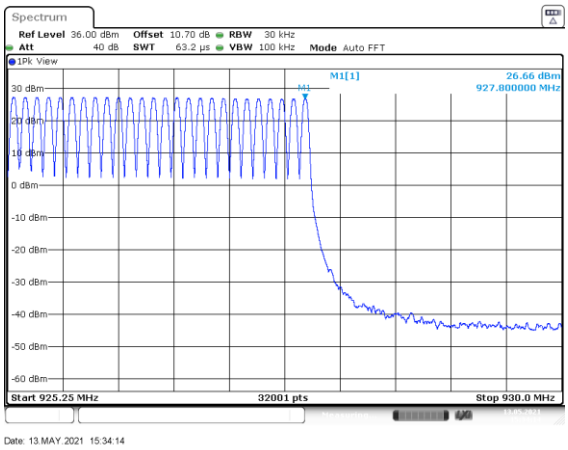

Figure 7.4.2.2-12: Mode 2 (239 Channels)

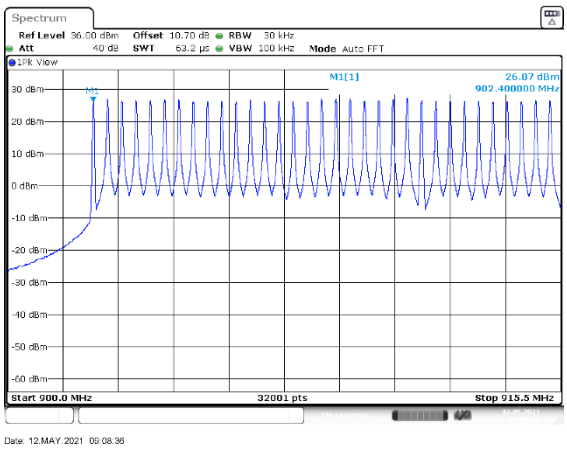

Figure 7.4.2.2-13: Mode 3 (64 Channels)

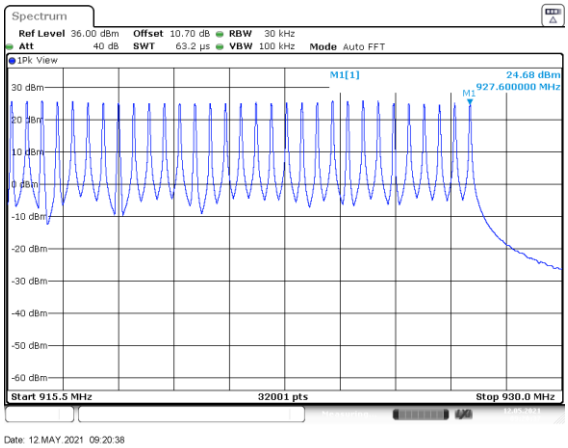

Figure 7.4.2.2-14: Mode 3 (64 Channels)

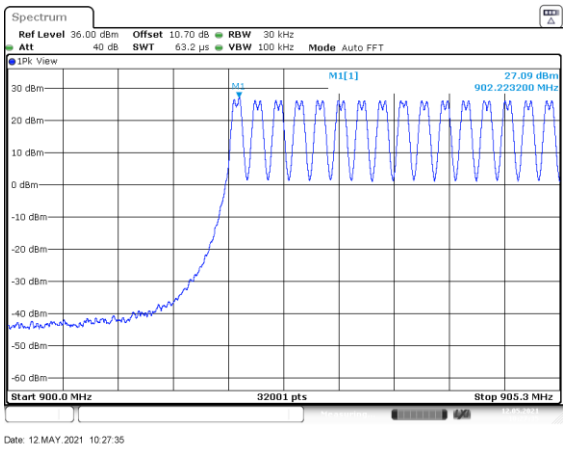

Figure 7.4.2.2-15: Mode 4 (129 Channels)

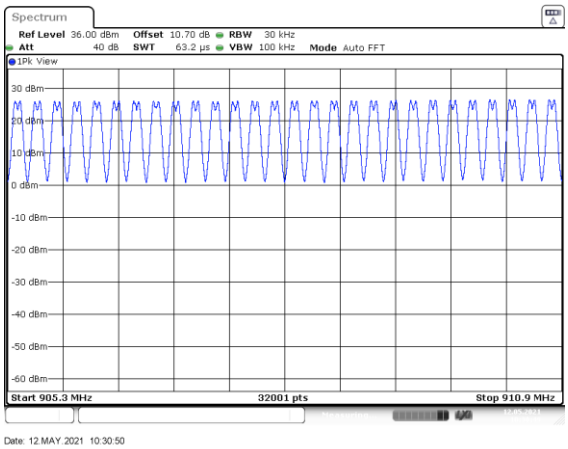

Figure 7.4.2.2-16: Mode 2 (129 Channels)

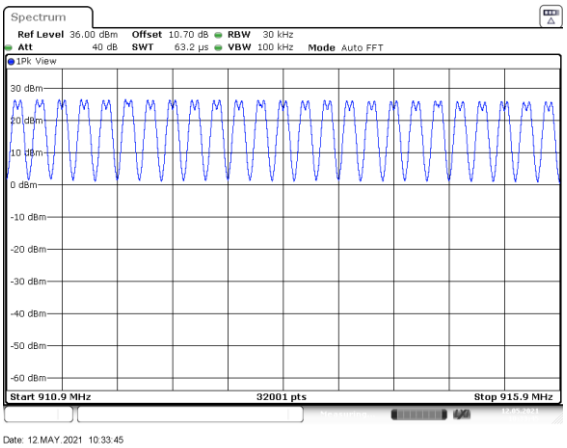

Figure 7.4.2.2-17: Mode 4 (129 Channels)

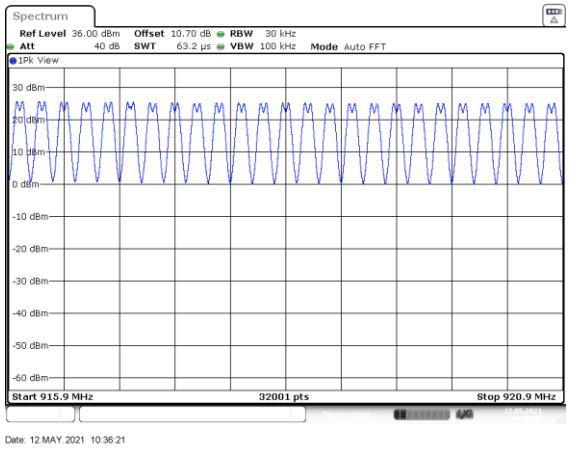

Figure 7.4.2.2-18: Mode 4 (129 Channels)

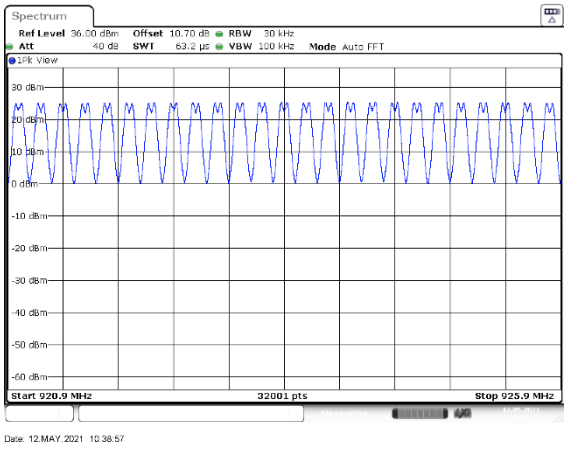

Figure 7.4.2.2-19: Mode 4 (129 Channels)

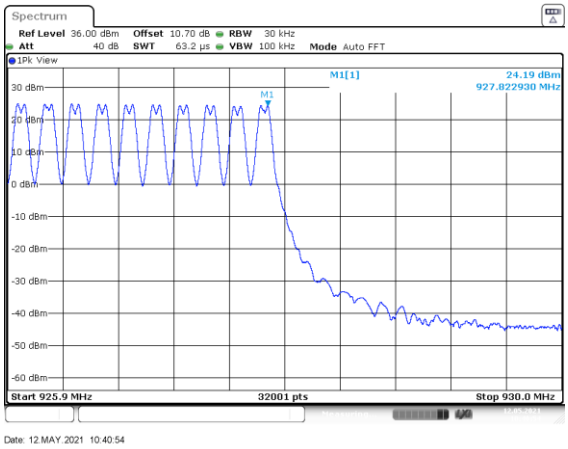

Figure 7.4.2.2-20: Mode 4 (129 Channels)

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

7.4.3.1 Measurement Procedure

The EUT test mode does not generate a worst-case channel dwell time therefore a detailed engineering analysis is provided in the theory of operation.

7.4.4 20dB / 99% Bandwidth – FCC Section 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 with 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 Delta and ndB down functions of the analyzer were 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

Performed by: Divya Adusumilli

Table 7.4.4.2-1: 20dB / 99% Bandwidth

Frequency [MHz]	20dB Bandwidth [kHz]	99% Bandwidth [kHz]	Data Rate (kbps)	Mode(s)
902.3	21.5228	20.6712	9.6	1 / 2
902.3	43.2174	41.7221	19.2	1 / 2
902.3	85.8801	83.8880	38.4	1 / 2
902.3	245.5670	238.0675	115.2	1
902.4	22.3946	21.6321	10.0	3
902.4	43.4705	45.2938	20.0	3
902.4	112.9960	116.2776	50.0	3
902.4	158.5420	158.8231	150.0	3
902.4	208.9310	211.7590	200.0	3
902.2	144.4500	116.6369	50.0	4
902.2	164.6510	160.9949	150.0	4
915.0	21.4431	20.7056	9.6	1 / 2
915.0	42.6784	42.1955	19.2	1 / 2
915.0	85.0520	83.2552	38.4	1 / 2
915.0	245.5670	237.4425	115.2	1
915.2	22.2493	21.5727	10.0	3
915.2	44.4830	45.5048	20.0	3
915.2	112.2930	116.6057	50.0	3 / 4
915.2	158.5890	159.7918	150.0	3 / 4
915.2	198.1660	211.8683	200.0	3

Frequency [MHz]	20dB Bandwidth [kHz]	99% Bandwidth [kHz]	Data Rate (kbps)	Mode(s)
927.8	21.4540	20.6134	9.6	1 / 2
927.8	42.6971	42.3877	19.2	1 / 2
927.8	90.0753	84.1067	38.4	1 / 2
927.8	245.9170	239.5175	115.2	1
927.6	22.2321	21.6821	10.0	3
927.6	43.4799	45.4860	20.0	3
927.6	112.4030	116.9182	50.0	3
927.6	158.8080	160.3231	150.0	3
927.6	198.3530	212.4777	200.0	3
927.8	114.4500	116.6994	50.0	4
927.8	165.5730	161.2293	150.0	4

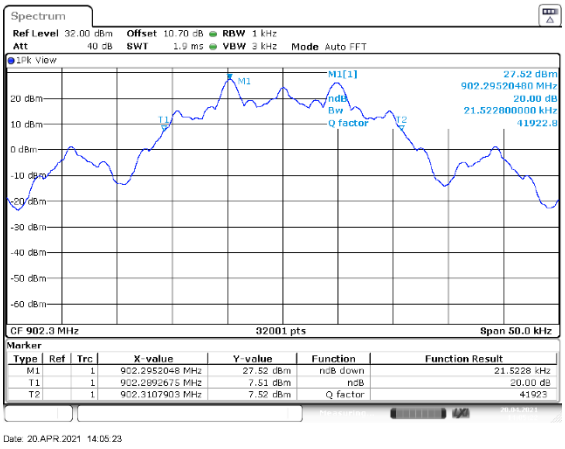

Figure 7.4.4.2-1: 20 dB BW Low Channel – 9.6kbps

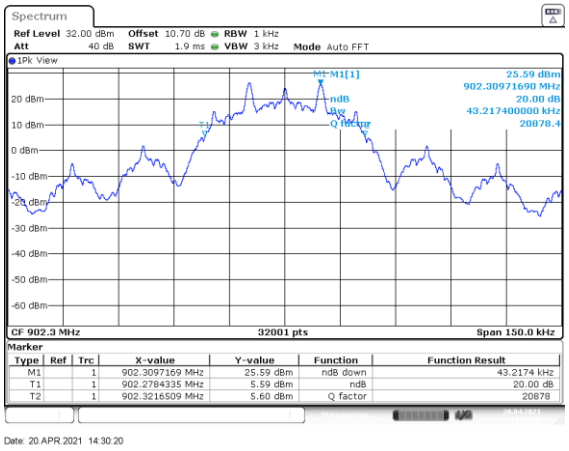

Figure 7.4.4.2-2: 20 dB BW Low Channel – 19.2kbps

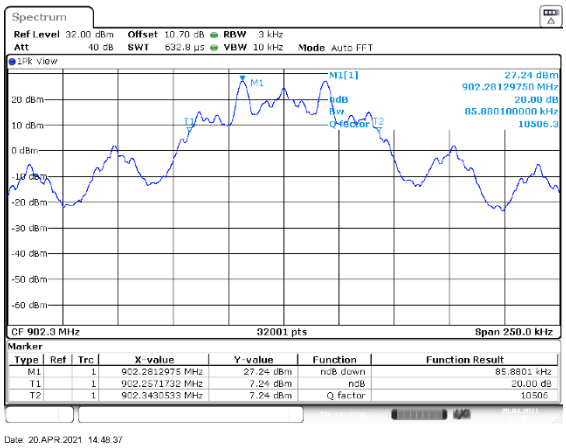

Figure 7.4.4.2-3: 20 dB BW Low Channel – 38.4kbps

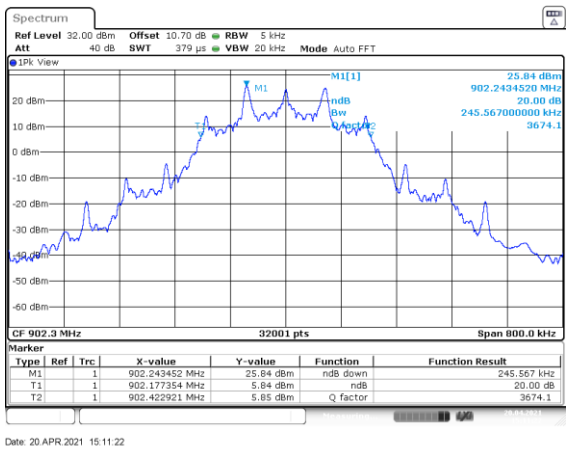

Figure 7.4.4.2-4: 20 dB BW Low Channel –115.2kbps

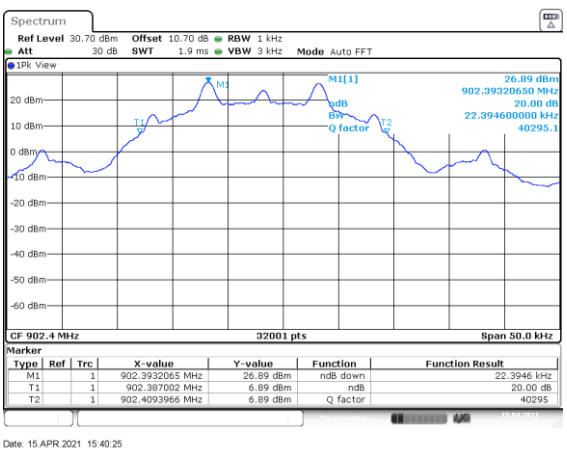

Figure 7.4.4.2-5: 20 dB BW Low Channel – 10kbps

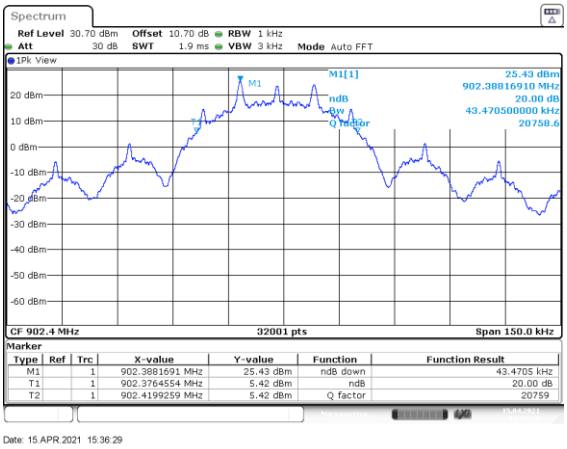

Figure 7.4.4.2-6: 20 dB BW Low Channel –20kbps

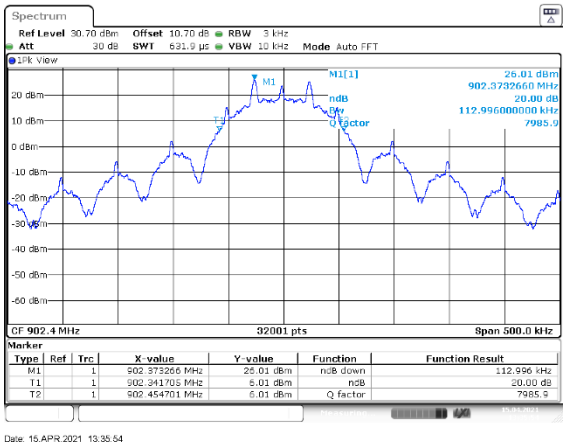

Figure 7.4.4.2-7: 20 dB BW Low Channel – 50kbps

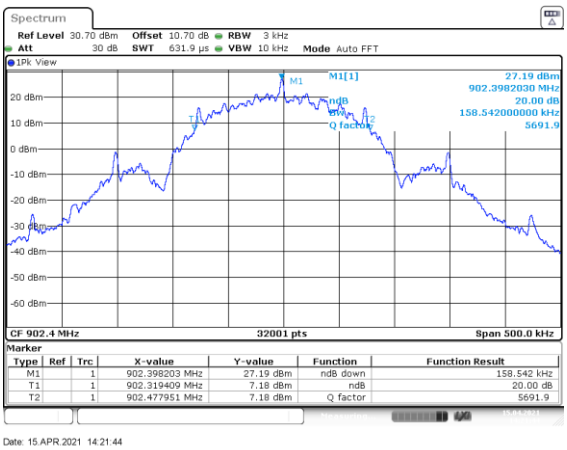

Figure 7.4.4.2-8: 20 dB BW Low Channel – 150kbps

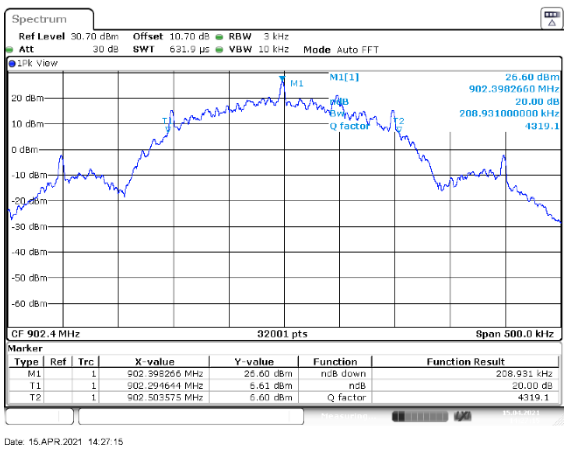

Figure 7.4.4.2-9: 20 dB BW Low Channel – 200kbps

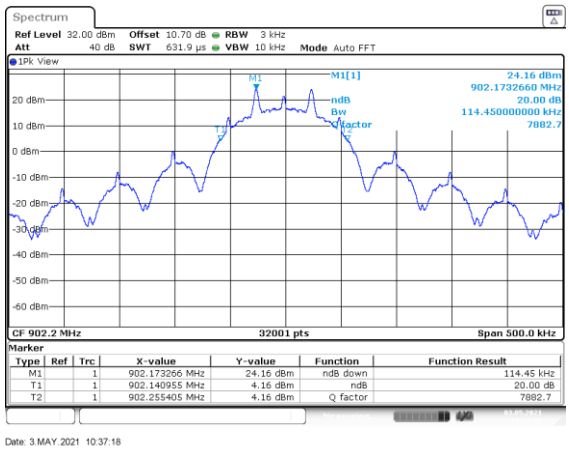

Figure 7.4.4.2-10: 20 dB BW Low Channel –50kbps

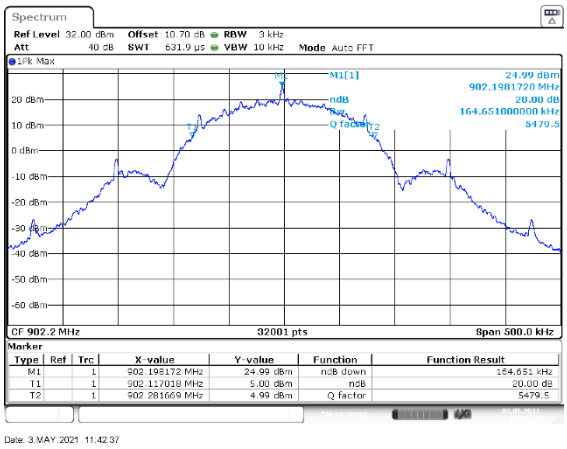

Figure 7.4.4.2-11: 20 dB BW Low Channel – 150kbps

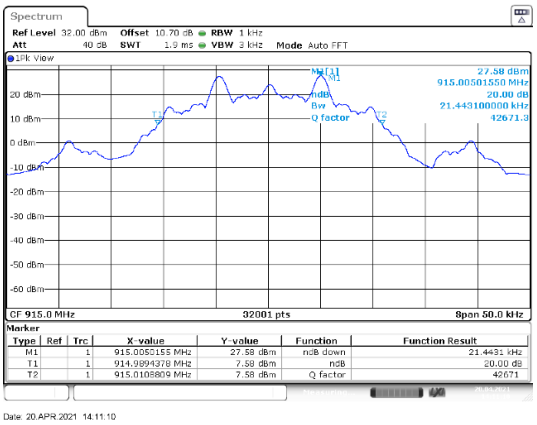

Figure 7.4.4.2-12: 20 dB BW Mid Channel – 9.6kbps

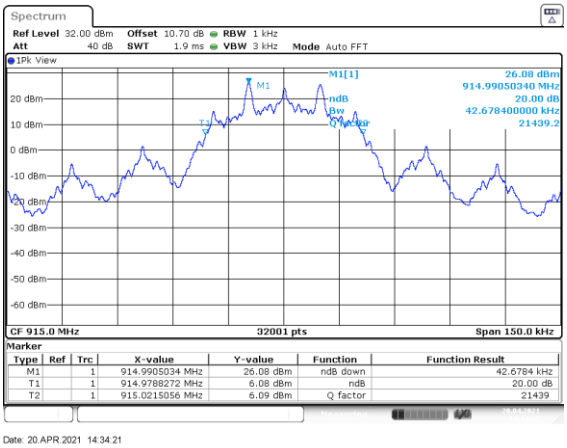

Figure 7.4.4.2-13: 20 dB BW Mid Channel –19.2kbps

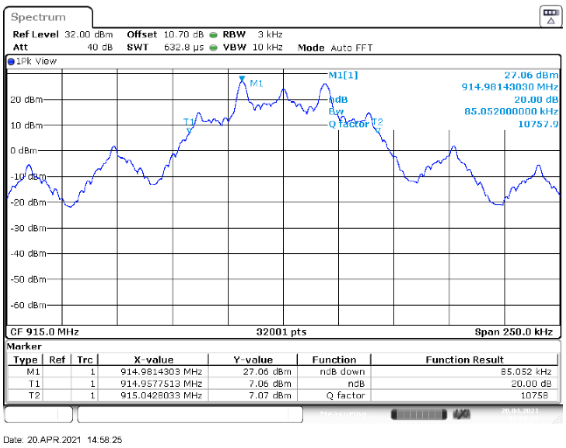

Figure 7.4.4.2-14: 20 dB BW Mid Channel – 38.4kbps

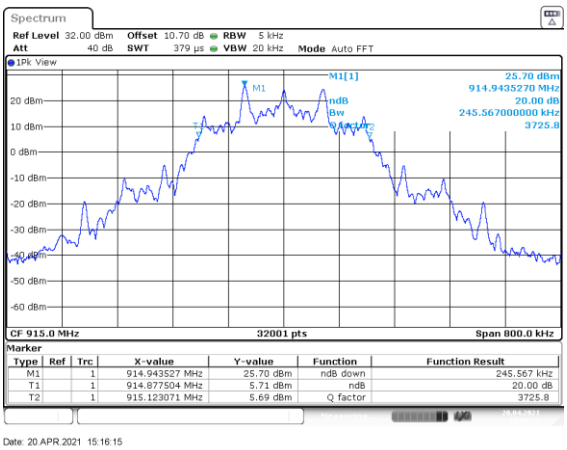

Figure 7.4.4.2-15: 20 dB BW Mid Channel –115.2kbps

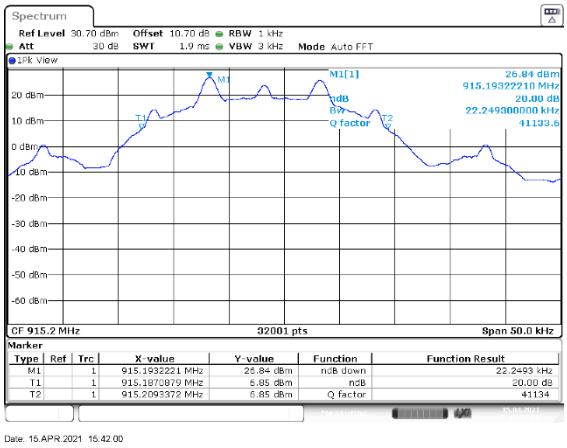

Figure 7.4.4.2-16: 20 dB BW Mid Channel – 10kbps

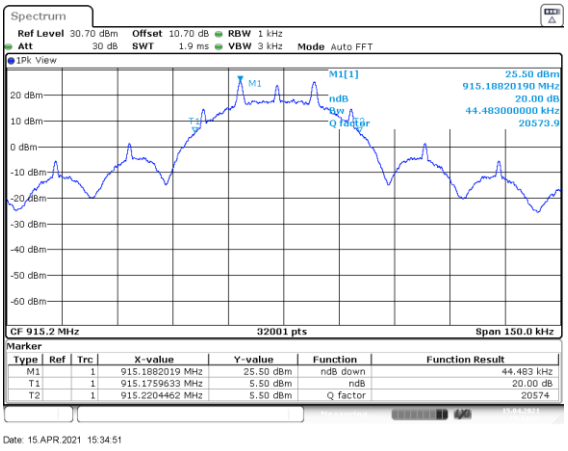

Figure 7.4.4.2-17: 20 dB BW Mid Channel –20kbps

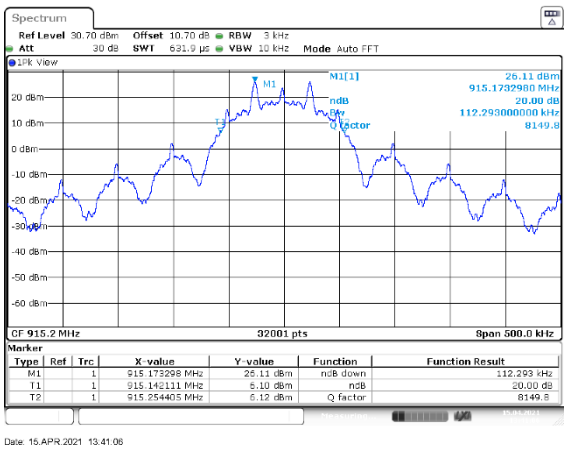

Figure 7.4.4.2-18: 20 dB BW Mid Channel – 50kbps

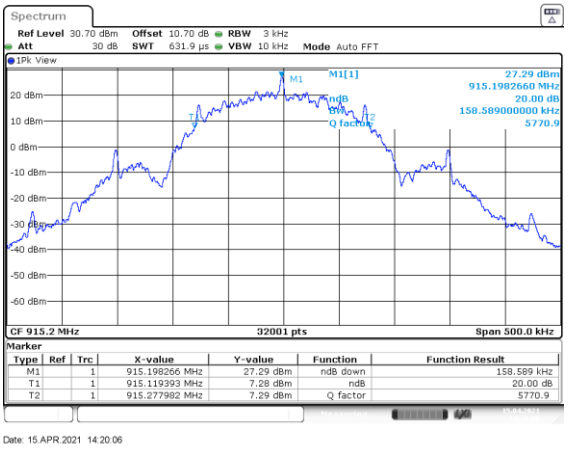

Figure 7.4.4.2-19: 20 dB BW Mid Channel –150kbps

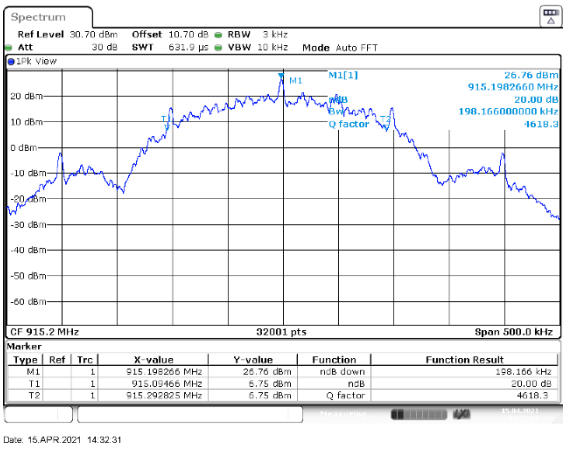

Figure 7.4.4.2-20: 20 dB BW Mid Channel – 200kbps

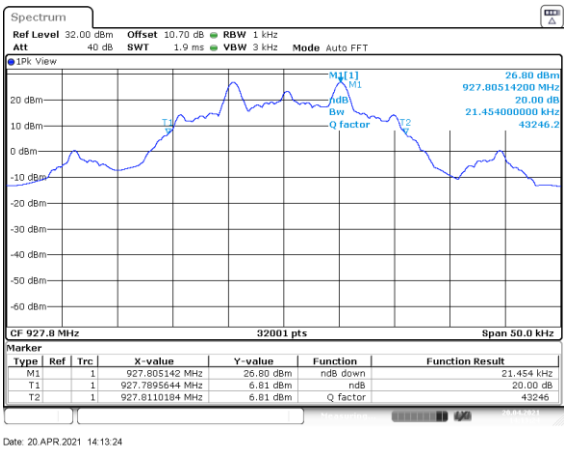

Figure 7.4.4.2-21: 20dB BW High Channel –9.6kbps

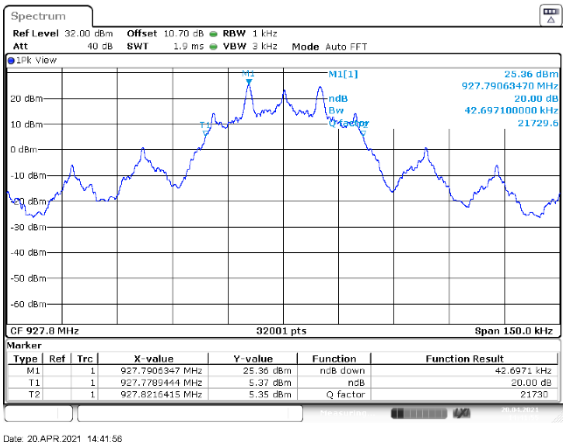

Figure 7.4.4.2-22: 20 dB BW High Channel – 19.2kbps

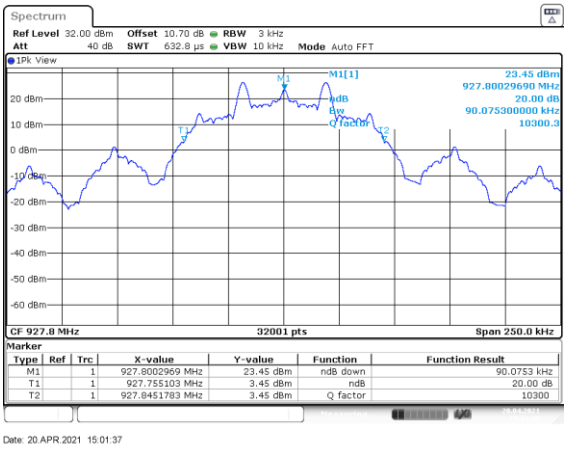

Figure 7.4.4.2-23: 20dB BW High Channel –38.4kbps

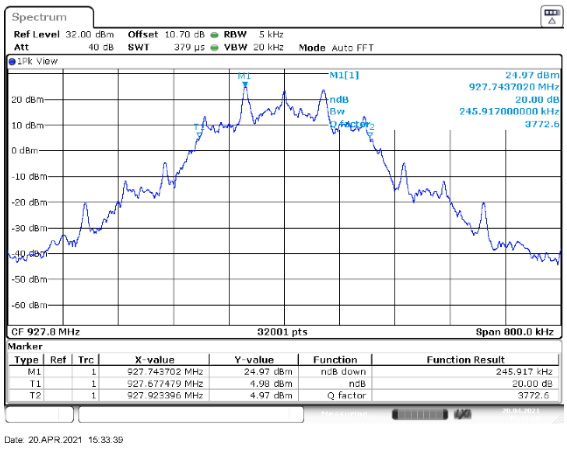

Figure 7.4.4.2-24: 20 dB BW High Channel – 115.2kbps

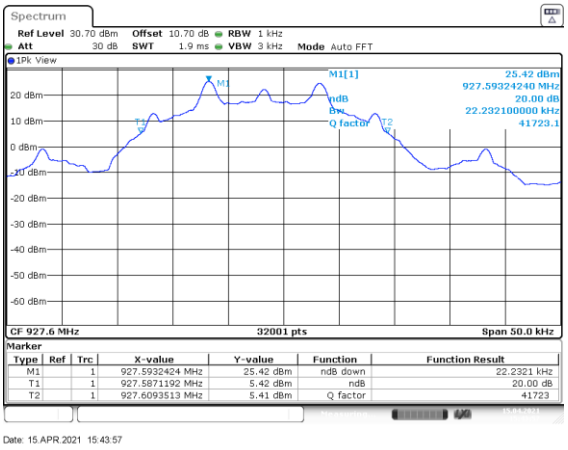

Figure 7.4.4.2-25: 20dB BW High Channel –10kbps

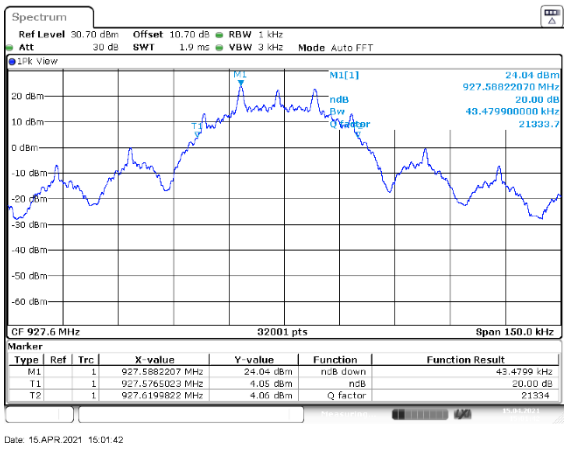

Figure 7.4.4.2-26: 20 dB BW High Channel – 20kbps

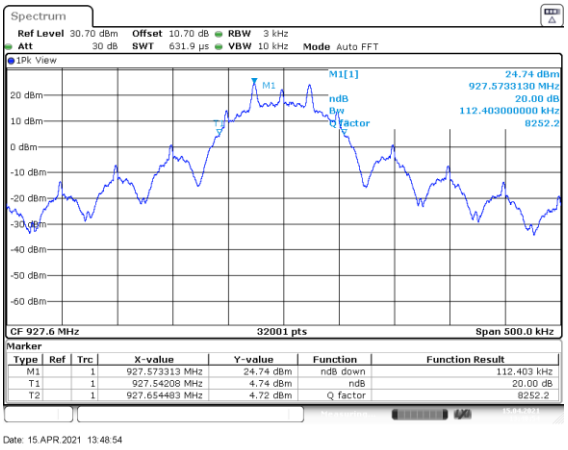

Figure 7.4.4.2-27: 20dB BW High Channel –50kbps

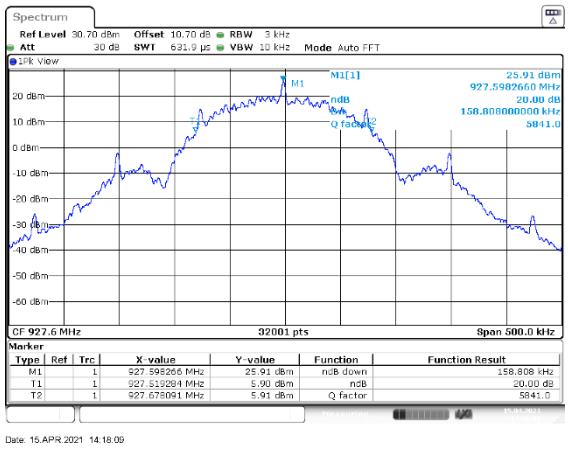

Figure 7.4.4.2-28: 20 dB BW High Channel – 150kbps

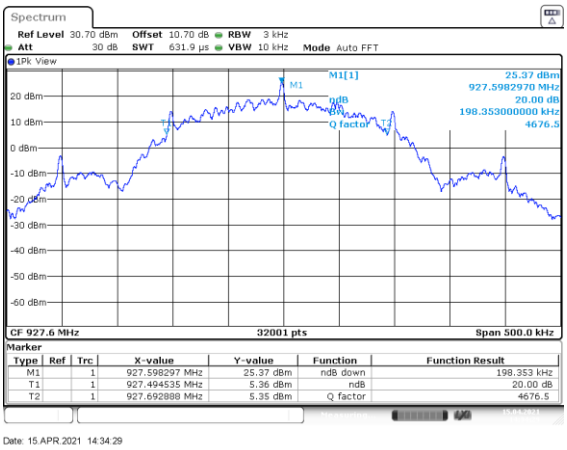

Figure 7.4.4.2-29: 20dB BW High Channel –200kbps

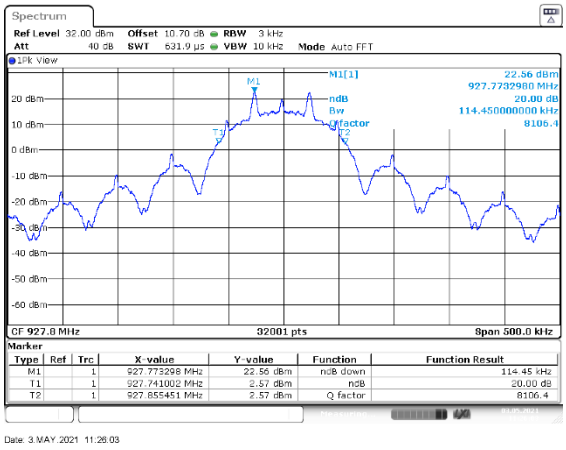

Figure 7.4.4.2-30: 20 dB BW High Channel – 50kbps

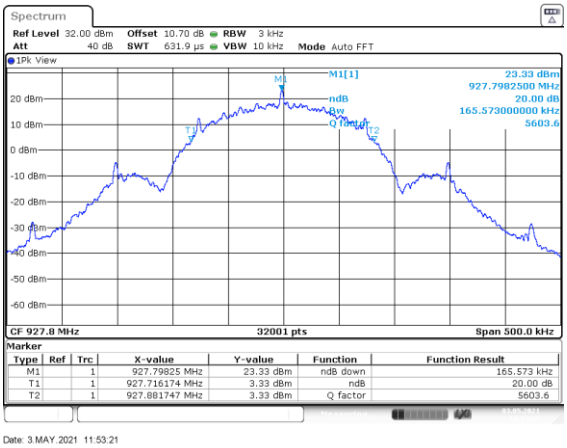

Figure 7.4.4.2-31: 20dB BW High Channel –150kbps

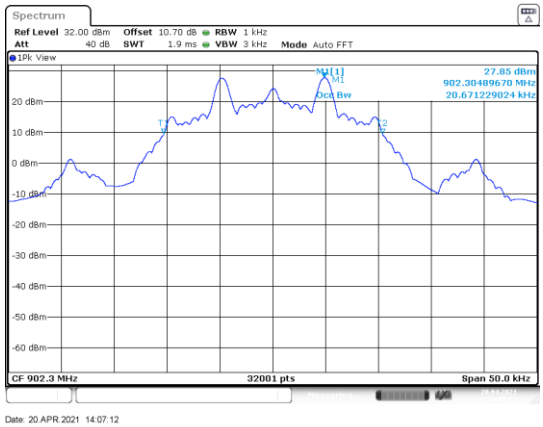

Figure 7.4.4.2-32: 99% BW Low Channel –9.6kbps

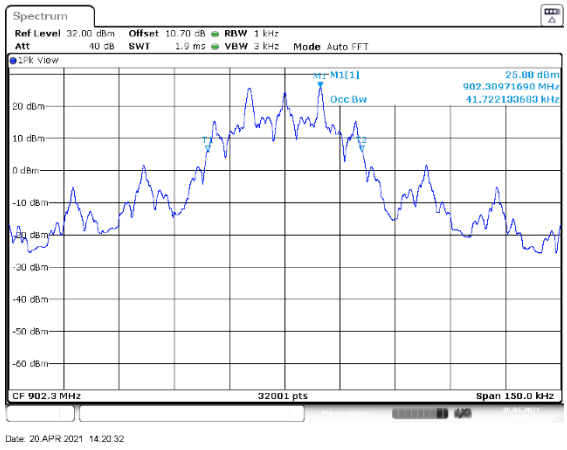

Figure 7.4.4.2-33: 99% BW Low Channel – 19.2kbps

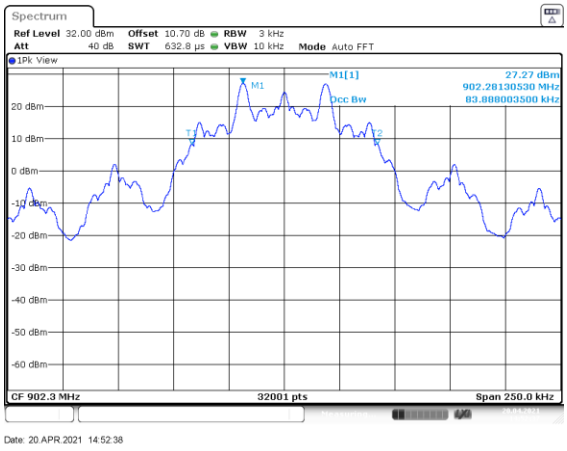

Figure 7.4.4.2-34: 99% BW Low Channel –38.4kbps

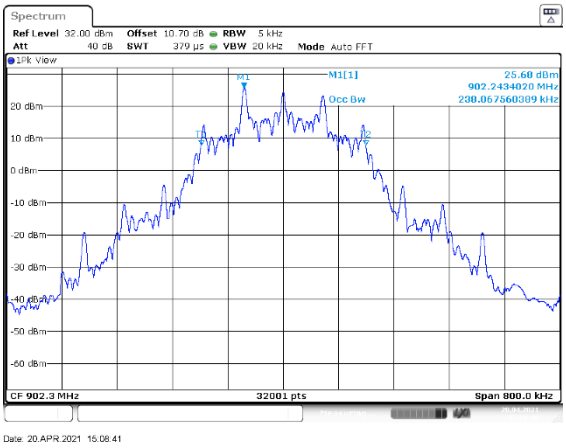

Figure 7.4.4.2-35: 99% BW Low Channel – 115.2kbps

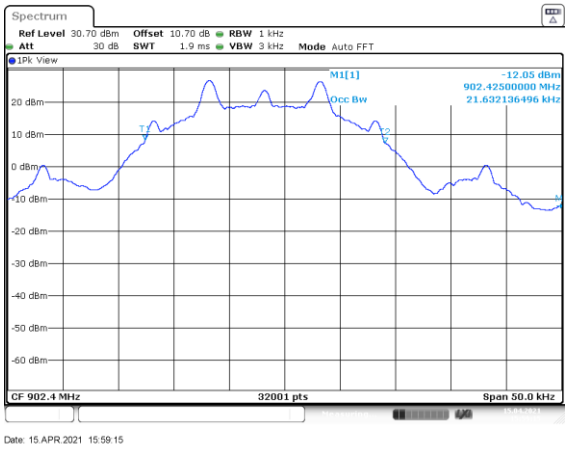

Figure 7.4.4.2-36: 99% BW Low Channel –10kbps

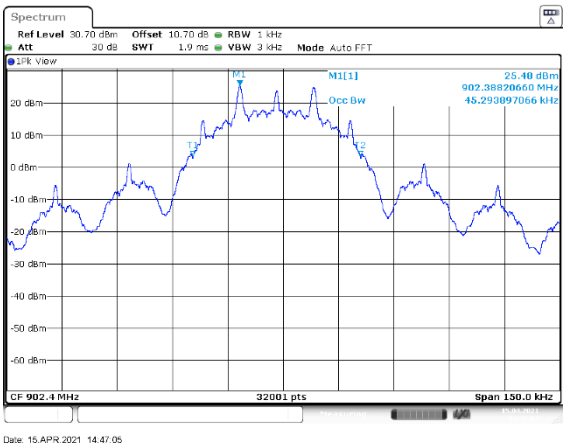

Figure 7.4.4.2-37: 99% BW Low Channel – 20kbps

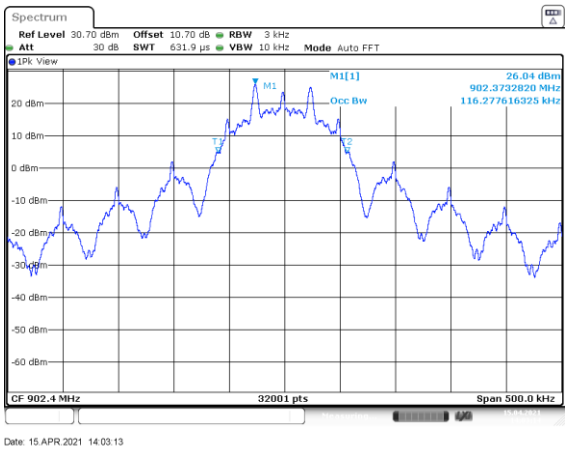

Figure 7.4.4.2-38: 99% BW Low Channel –50kbps

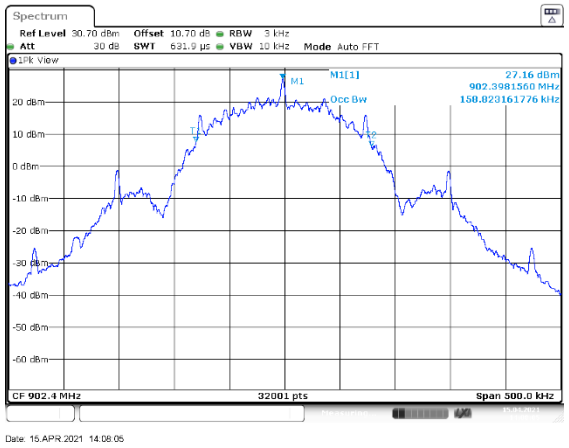

Figure 7.4.4.2-39: 99% BW Low Channel – 150kbps

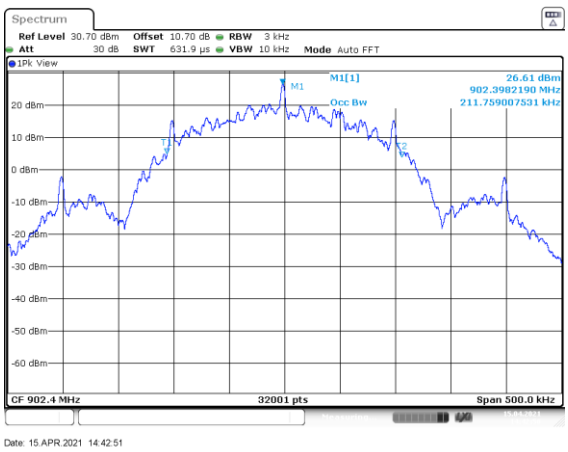

Figure 7.4.4.2-40: 99% BW Low Channel –200kbps

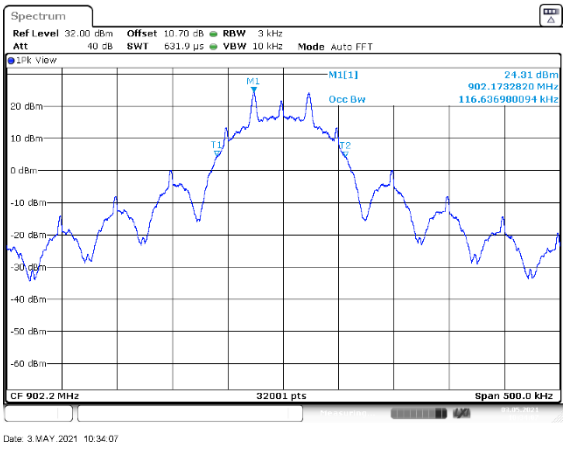

Figure 7.4.4.2-41: 99% BW Low Channel – 50kbps

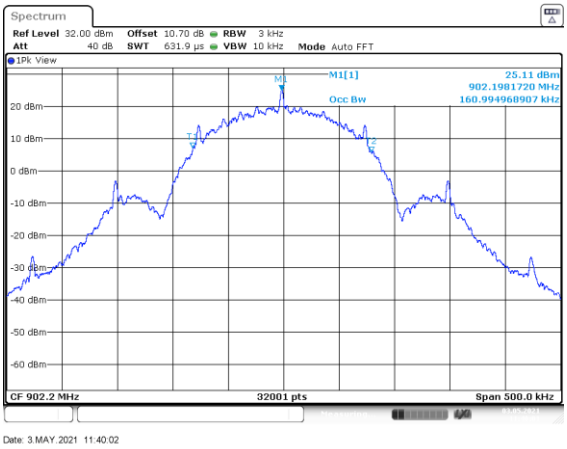

Figure 7.4.4.2-42: 99% BW Low Channel –150kbps

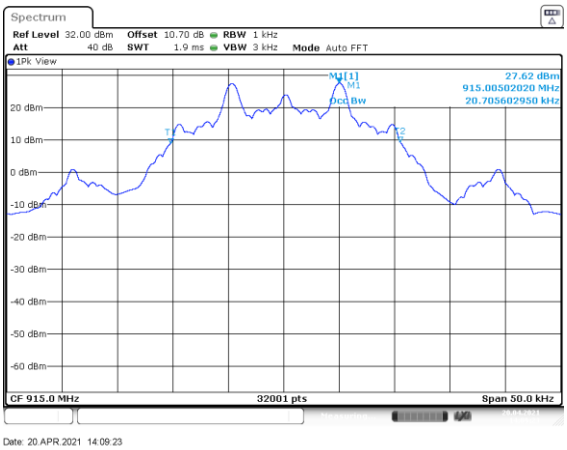

Figure 7.4.4.2-43: 99% BW Mid Channel –9.6kbps

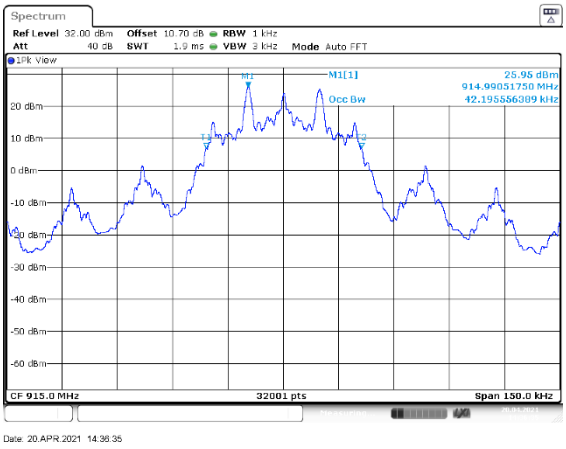

Figure 7.4.4.2-44: 99% BW Mid Channel – 19.2kbps

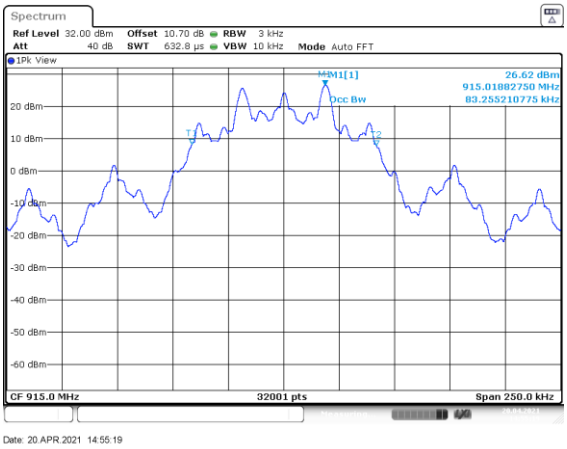

Figure 7.4.4.2-45: 99% BW Mid Channel –38.4kbps

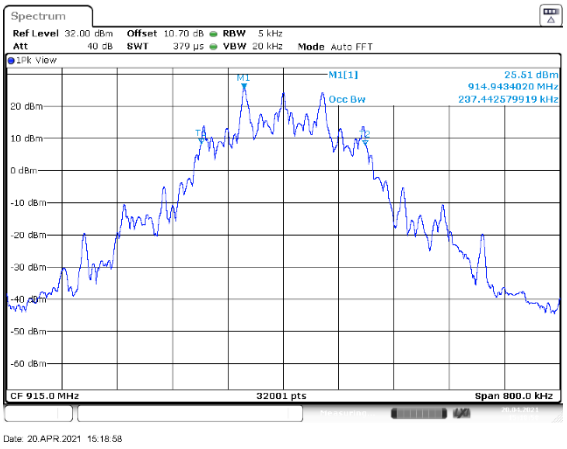

Figure 7.4.4.2-46: 99% BW Mid Channel – 115.2kbps

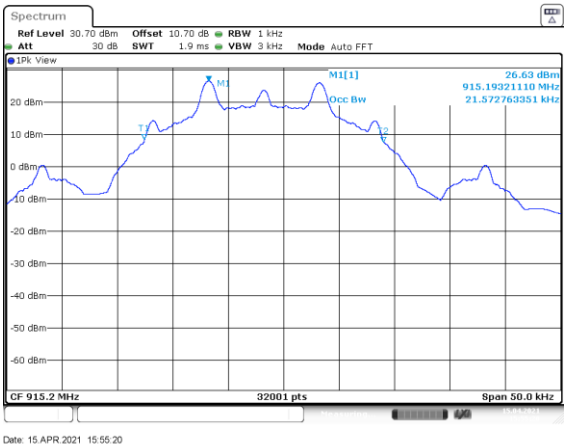

Figure 7.4.4.2-47: 99% BW Mid Channel –10kbps

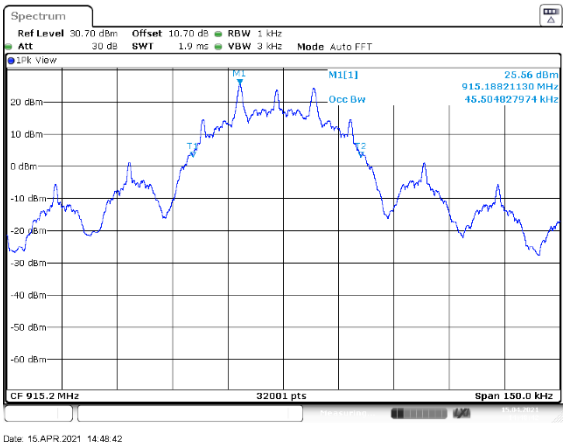

Figure 7.4.4.2-48: 99% BW Mid Channel – 20kbps

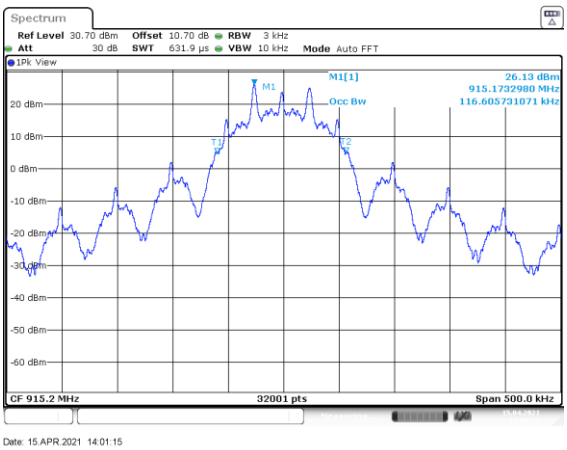

Figure 7.4.4.2-49: 99% BW Mid Channel –50kbps

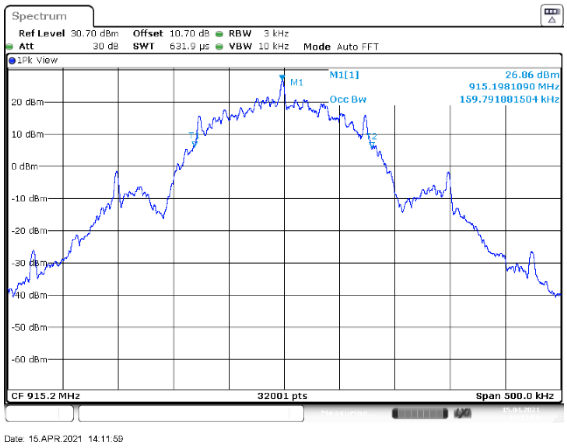

Figure 7.4.4.2-50: 99% BW Mid Channel – 150kbps

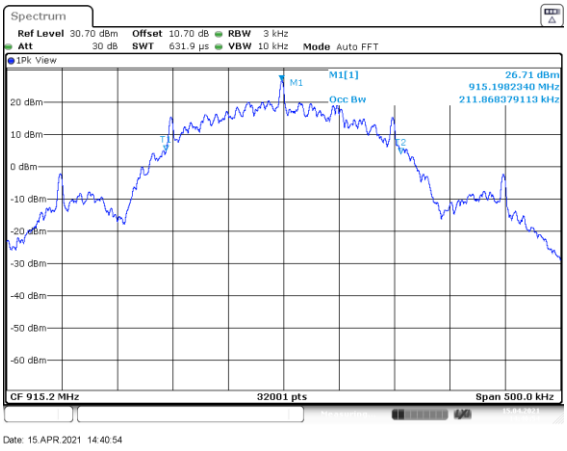

Figure 7.4.4.2-51: 99% BW Mid Channel –200kbps

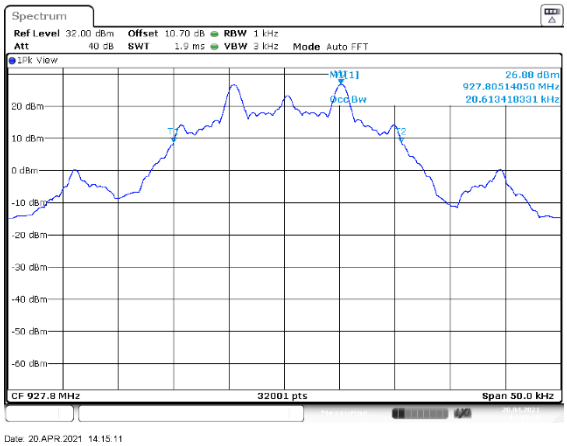

Figure 7.4.4.2-52: 99% BW High Channel – 9.6kbps

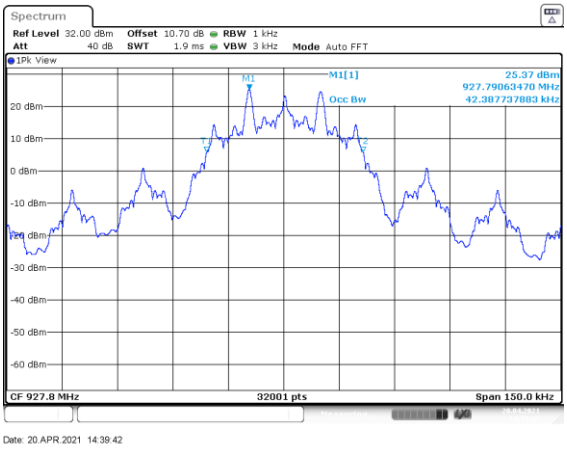

Figure 7.4.4.2-53: 99% BW High Channel –19.2kbps

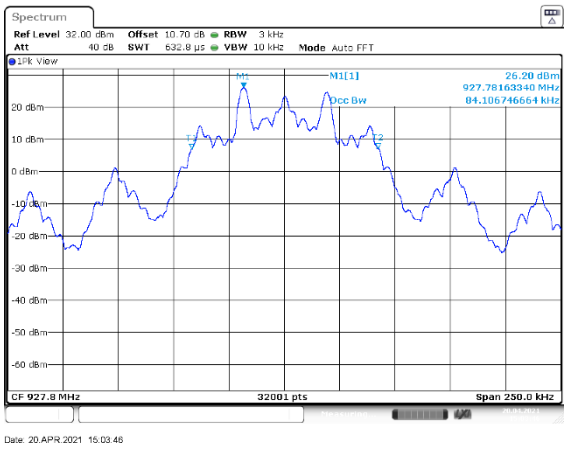

Figure 7.4.4.2-54: 99% BW High Channel – 38.4kbps

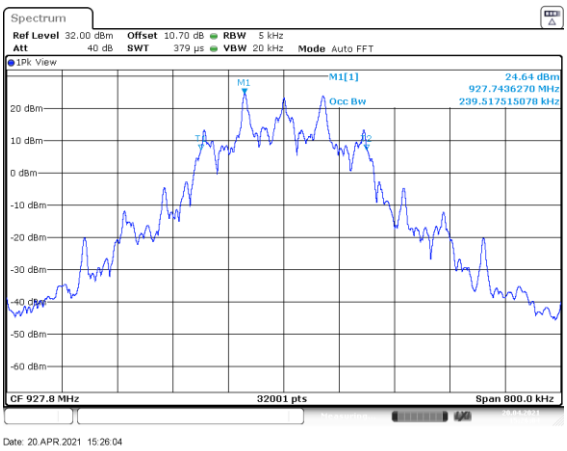

Figure 7.4.4.2-55: 99% BW High Channel –115.2kbps

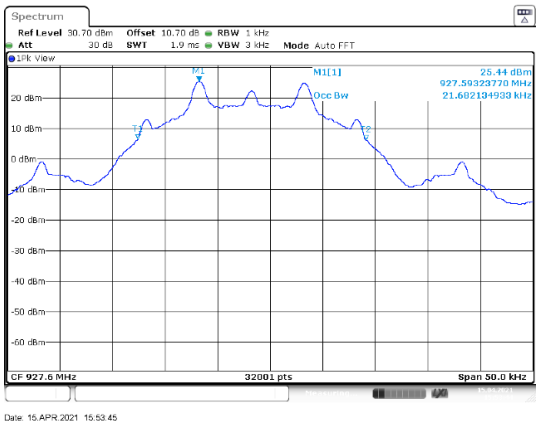

Figure 7.4.4.2-56: 99% BW High Channel – 10kbps

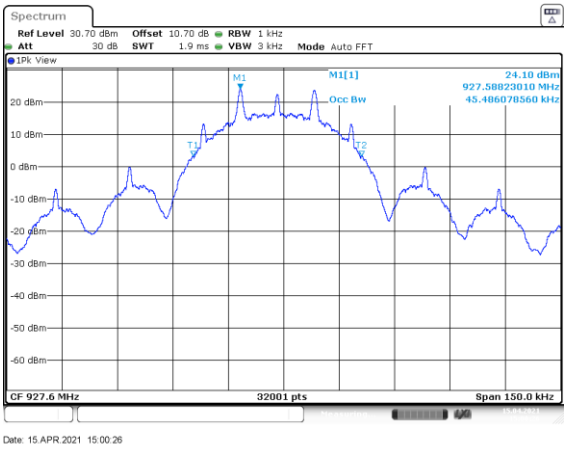

Figure 7.4.4.2-57: 99% BW High Channel –20kbps

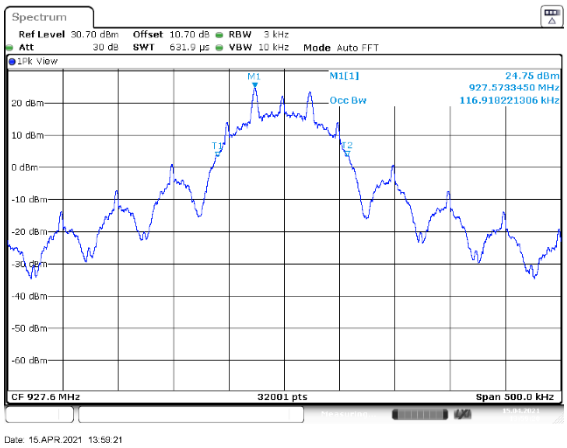

Figure 7.4.4.2-58: 99% BW High Channel – 50kbps

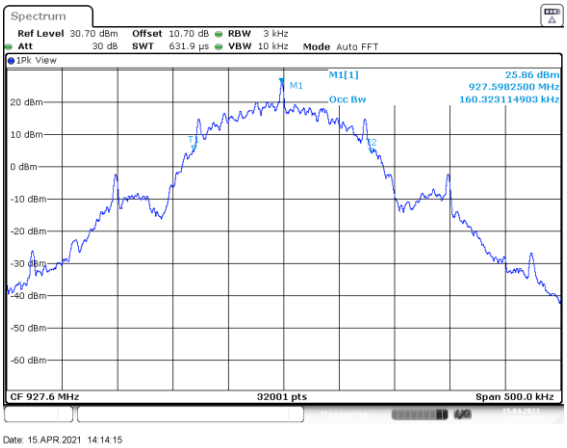

Figure 7.4.4.2-59: 99% BW High Channel –150kbps

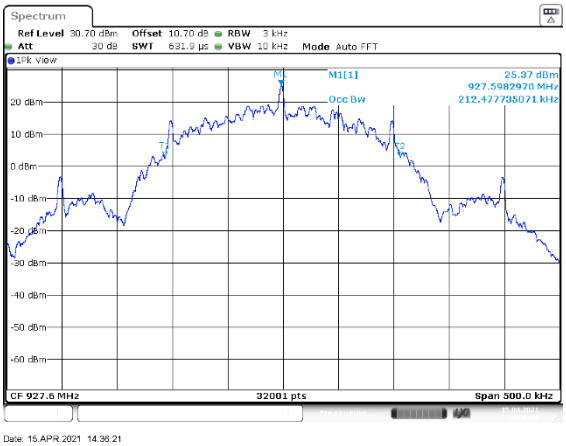

Figure 7.4.4.2-60: 99% BW High Channel – 200kbps

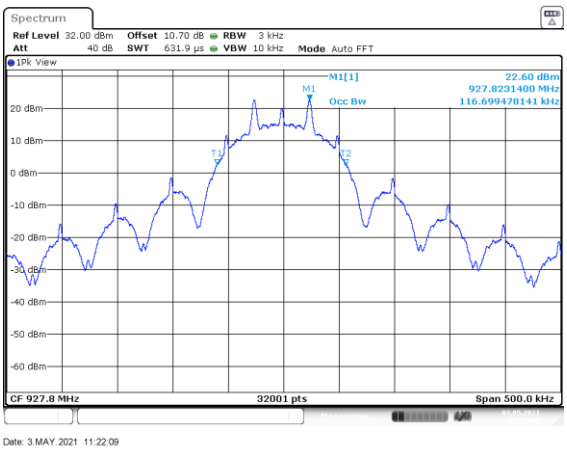

Figure 7.4.4.2-61: 99% BW High Channel –50kbps

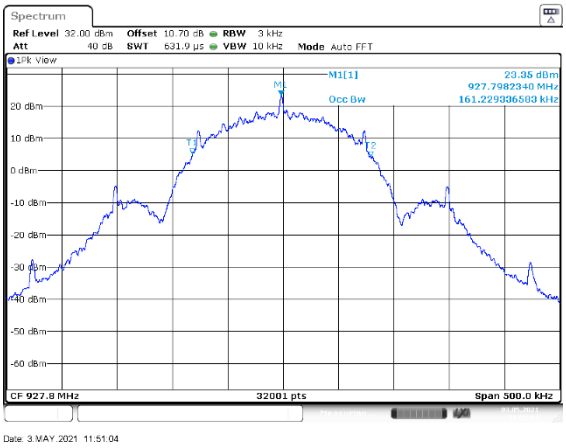

Figure 7.4.4.2-62: 99% BW High Channel – 150kbps

7.5 Band-Edge Compliance and Spurious Emissions

7.5.1 Band-Edge Compliance of RF Conducted Emissions – FCC Section 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 with 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 100kHz and the VBW was set to 300kHz.

Band-edge was evaluated for all combinations of operating modes and data rates. Worst case reported utilized 38.4kbps in Mode 1, 115.2kbps in Mode 2, 200kbps in Mode 3, and 200.0kbps in Mode 4.

7.5.1.2 Measurement Results

Performed by: Divya Adusumilli

NON-HOPPING MODE:

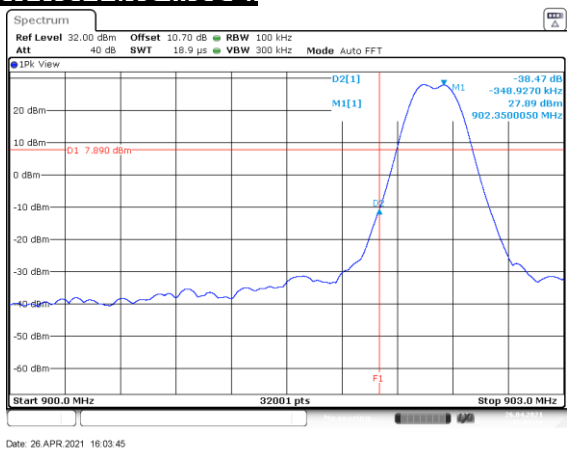

Figure 7.5.1.2-1: Lower Band edge – Mode 1

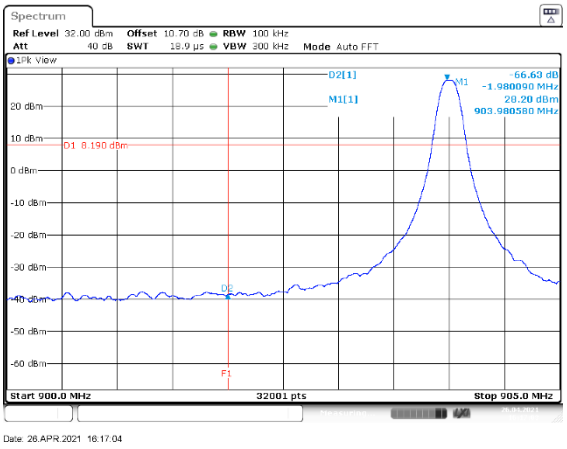

Figure 7.5.1.2-2: Lower Band edge – Mode 2

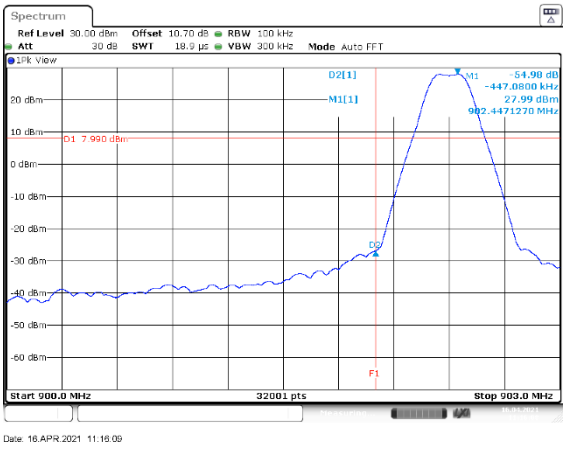

Figure 7.5.1.2-3: Lower Band edge – Mode 3

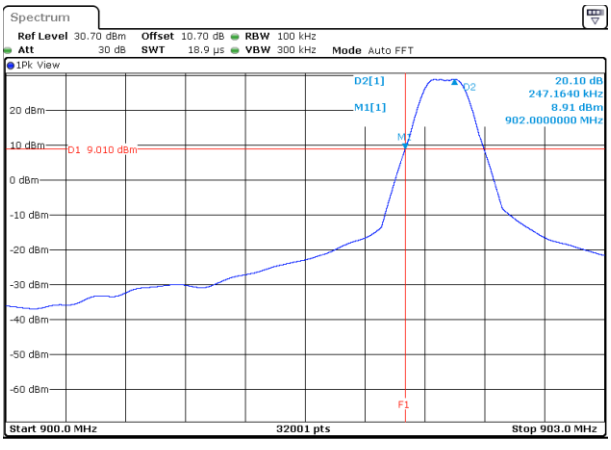

Figure 7.5.1.2-4: Lower Band edge – Mode 4

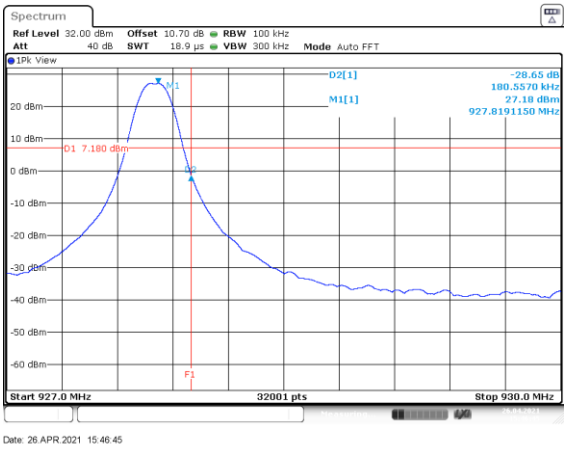

Figure 7.5.1.2-5: Upper Band edge – Mode 1

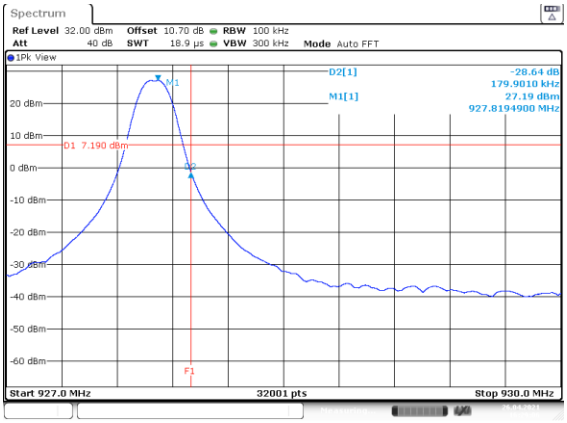

Figure 7.5.1.2-6: Upper Band edge – Mode 2

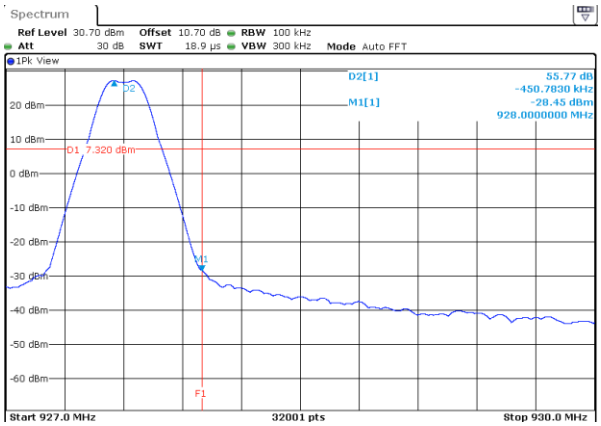

Figure 7.5.1.2-7: Upper Band edge – Mode 3

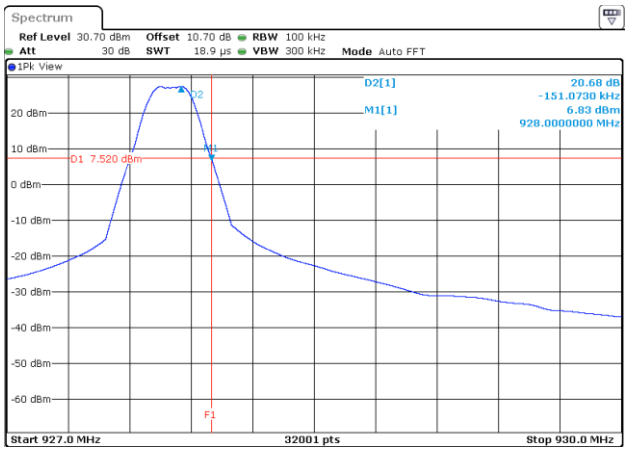

Figure 7.5.1.2-8: Upper Band edge – Mode 4

HOPPING MODE:

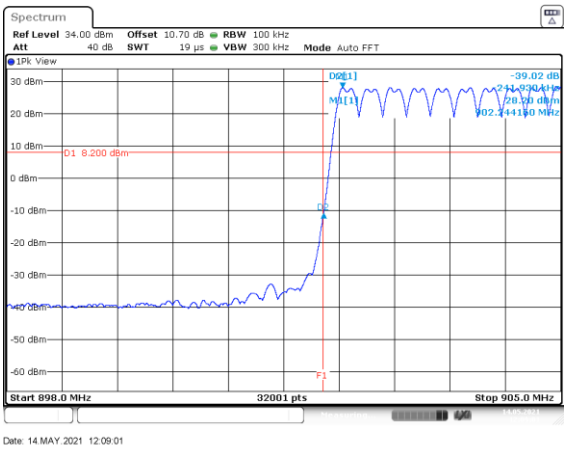

Figure 7.5.1.2-9: Lower Band edge – Mode 1

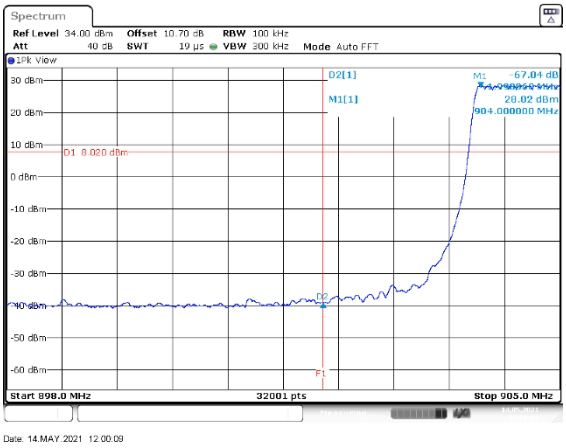

Figure 7.5.1.2-10: Lower Band edge – Mode 2

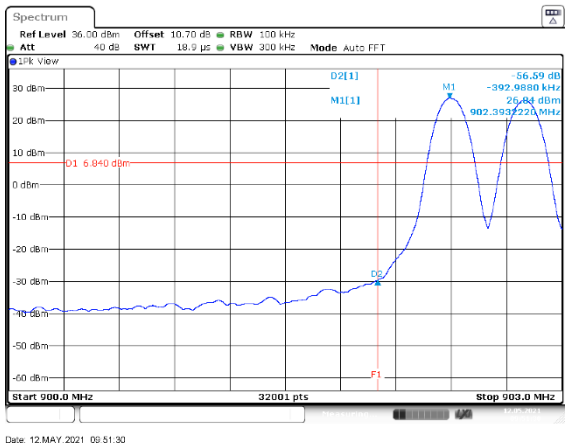

Figure 7.5.1.2-11: Lower Band edge – Mode 3

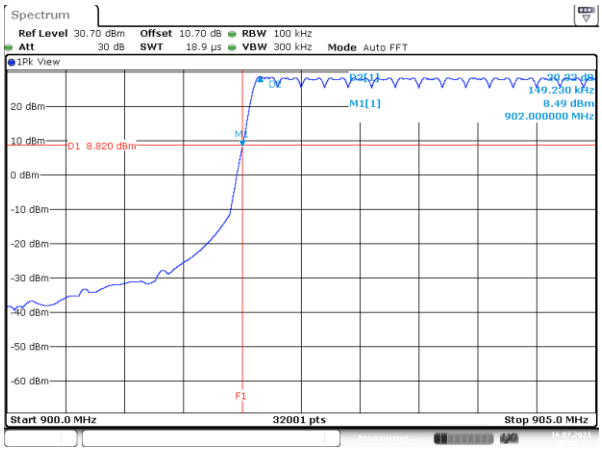

Figure 7.5.1.2-12: Lower Band edge – Mode 4

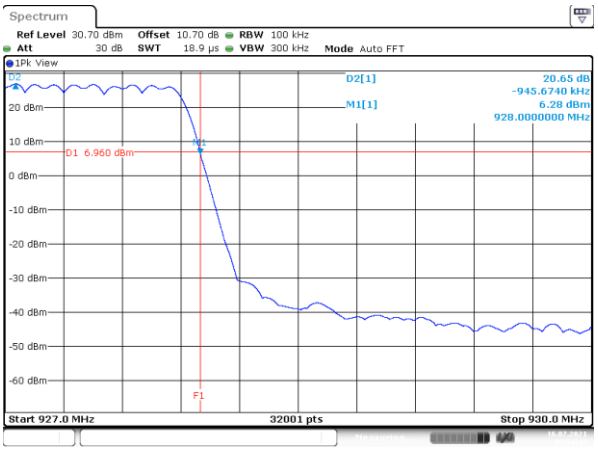

Figure 7.5.1.2-13: Upper Band edge – Mode 1

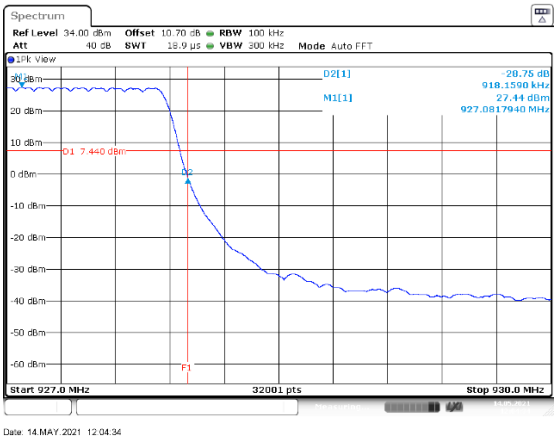

Figure 7.5.1.2-14: Upper Band edge – Mode 2

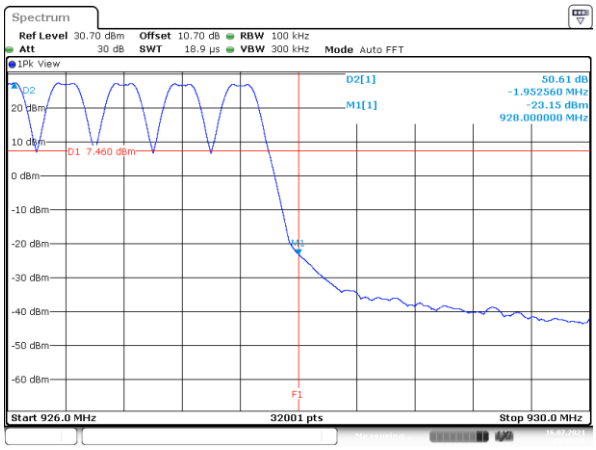

Figure 7.5.1.2-15: Upper Band edge – Mode 3

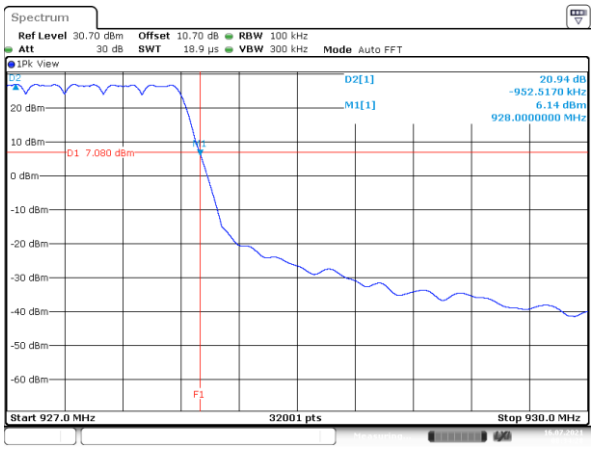

Figure 7.5.1.2-16: Upper Band edge – Mode 4

7.5.2 RF Conducted Spurious Emissions – FCC Section 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. The EUT was investigated for conducted spurious emissions from 30MHz to 10 GHz, 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.

Conducted spurious emissions were evaluated and worst- case data provided for all combinations of operating modes and data rates.

Note: Mesh IP and WiSUN were evaluated because of different DAC Power Value Settings.

7.5.2.2 Measurement Results

Performed by: Divya Adusumilli

Mode: Mesh IP

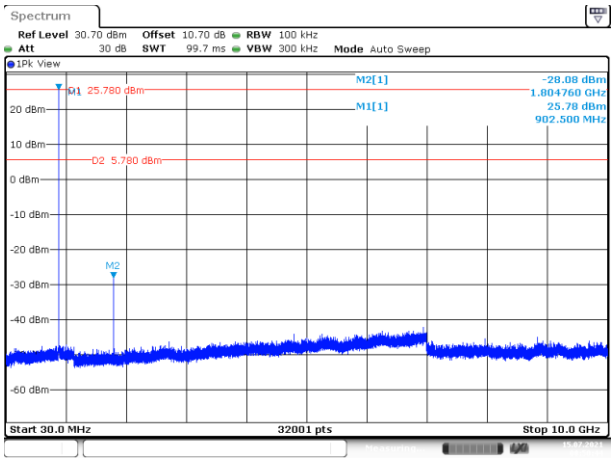

Figure 7.5.2.2-1: 30 MHz – 10 GHz – Low Channel

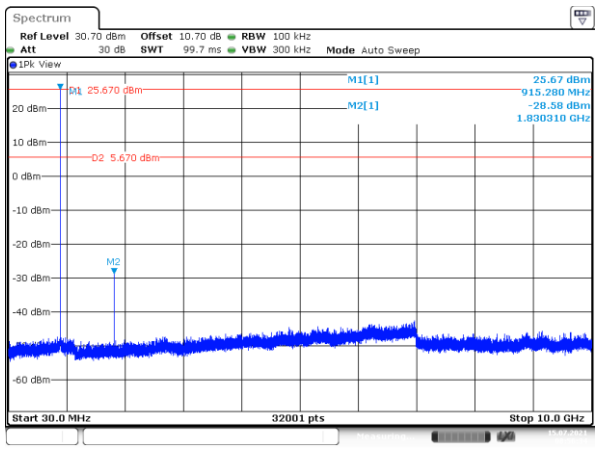

Figure 7.5.1.2-2: 30 MHz – 10 GHz – Mid Channel

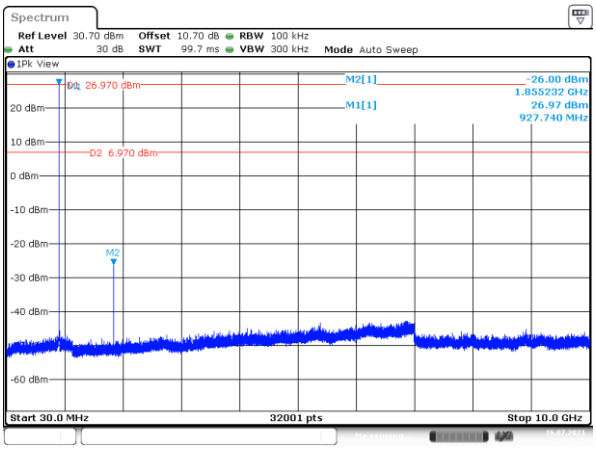

Figure 7.5.1.2-1: 30 MHz – 10 GHz – High Channel

Mode: WiSUN

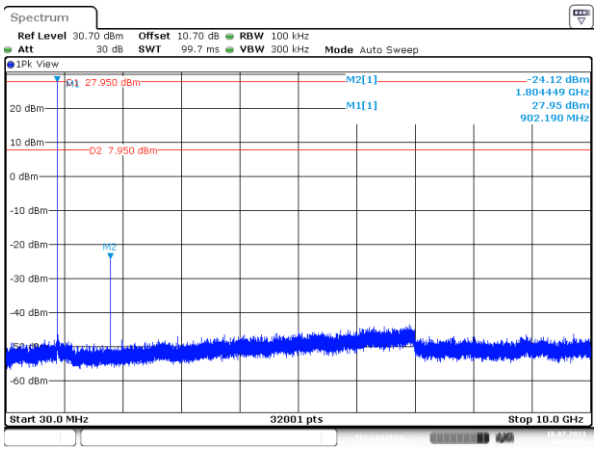

Figure 7.5.2.2-1: 30 MHz – 10 GHz – Low Channel

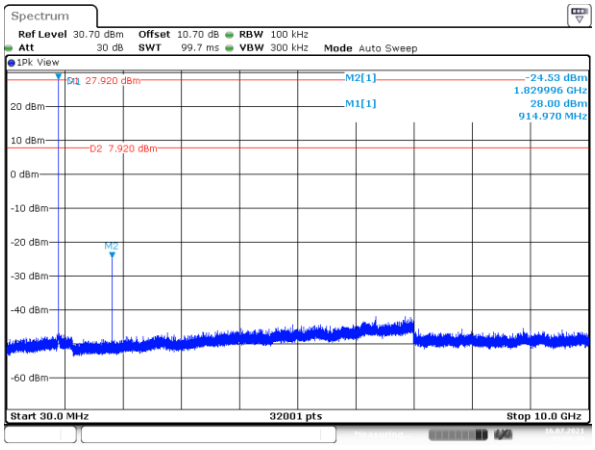

Figure 7.5.1.2-2: 30 MHz – 10 GHz – Mid Channel

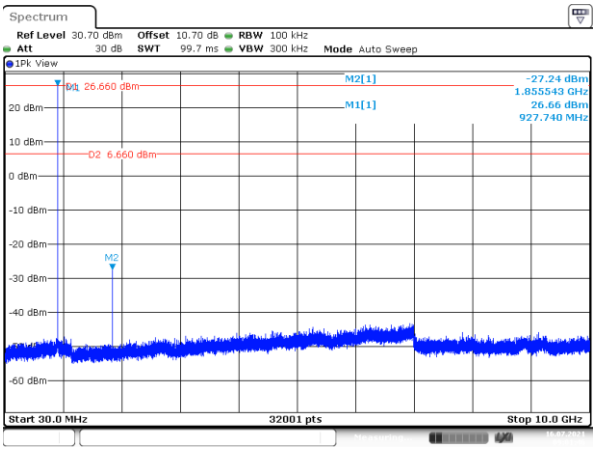

Figure 7.5.1.2-1: 30 MHz – 10 GHz – High Channel

7.5.3 Radiated Spurious Emissions – FCC Section 15.205, 15.209, ISED Canada 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 1 meter to 4 meters so that the maximum radiated emissions level would be detected. For frequencies below 1000 MHz, quasi-peak measurements were made using a resolution bandwidth RBW of 120 kHz and a video bandwidth VBW of 300 kHz. For frequencies above 1000 MHz, peak and average measurements were made with RBW and VBW of 1 MHz and 3 MHz 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.

Radiated spurious emissions were evaluated and worst- case data provided for all combinations of operating modes and data rates.

Note: Mesh and WiSUN were evaluated because of different DAC Power Value Settings.

7.5.3.2 Measurement Results

Mesh Mode Results

Table 7.5.3.2-1: Radiated Spurious Emissions Tabulated Data

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	46.5	31.5	V	5.82	52.32	37.32	74	54	21.7	16.7
2707.2	46.2	30.8	H	5.82	52.02	36.62	74	54	22	17.4
3609.6	44.2	29.6	V	7.43	51.63	37.03	74	54	22.4	17
3609.6	46.1	31.7	H	7.43	53.53	39.13	74	54	20.5	14.9
Middle Channel										
2745.6	47.9	32.7	H	5.91	53.81	38.61	74	54	20.2	15.4
2745.6	47.2	32.3	V	5.91	53.11	38.21	74	54	20.9	15.8
3660.8	44.2	29.1	H	7.53	51.73	36.63	74	54	22.3	17.4
3660.8	44.5	29.7	V	7.53	52.03	37.23	74	54	22	16.8
High Channel										
2782.8	48.3	33.1	V	6.00	54.30	39.10	74	54	19.7	14.9
2782.8	48.4	33.3	H	6.00	54.40	39.30	74	54	19.6	14.7

WiSUN Mode Test Results

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										
2706.6	43.00	35.30	H	5.99	48.99	41.29	74.0	54.0	25.0	12.7
2706.6	42.00	31.90	V	5.99	47.99	37.89	74.0	54.0	26.0	16.1
Middle Channel										
2745.6	44.80	34.80	H	6.08	50.88	40.88	74.0	54.0	23.1	13.1
2745.6	44.40	34.50	V	6.08	50.48	40.58	74.0	54.0	23.5	13.4
High Channel										
2783.4	42.60	34.30	H	6.16	48.76	40.46	74.0	54.0	25.2	13.5
2783.4	42.20	34.00	V	6.16	48.36	40.16	74.0	54.0	25.6	13.8

7.5.3.3 Sample Calculation:

$R_C = R_U + CF_T$

Where:

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

Example Calculation: Peak (Mesh)
Corrected Level: 48.40 + 6.00 = 54.40 dBuV/m
Margin: 74dBuV/m – 54.40dBuV/m = 19.60dB

Example Calculation: Average (WiSUN)
Corrected Level: 35.30 + 5.99 - 0 = 48.99dBuV
Margin: 54dBuV – 48.99dBuV = 12.7dB

8 ESTIMATION OF 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%.

Table 8-1: Estimation of Measurement Uncertainty

Parameter	U_{lab}
Occupied Channel Bandwidth	± 0.009 %
RF Conducted Output Power	± 0.349 dB
Power Spectral Density	± 0.372 dB
Antenna Port Conducted Emissions	± 1.264 dB
Radiated Emissions ≤ 1 GHz	± 5.814 dB
Radiated Emissions > 1 GHz	± 4.318 dB
Temperature	± 0.860 °C
Radio Frequency	± 2.832 x 10^{-8}
AC Power Line Conducted Emissions	± 3.360 dB

9 CONCLUSION

In the opinion of TÜV SÜD America, Inc. the S5-MCM0, manufactured by Landis+Gyr Technology, Inc. meets the requirements of FCC Part 15 subpart C and Innovation, Science and Economic Development Canada's Radio Standards Specification RSS-247.

Appendix A: Plots

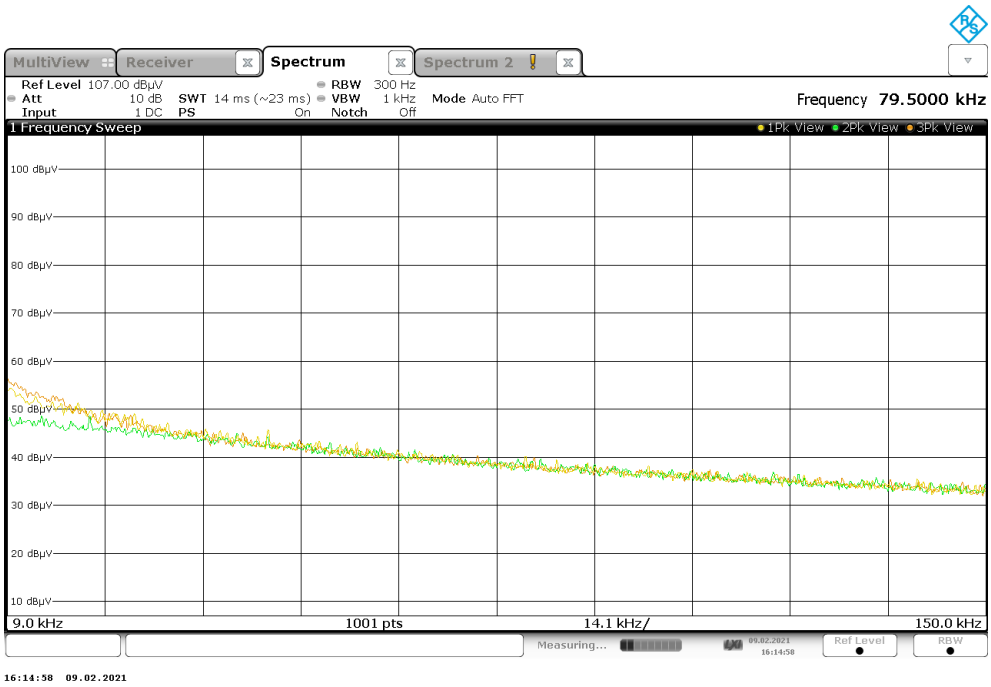

Figure A-1: Radiated Emissions – 9 kHz – 150 kHz

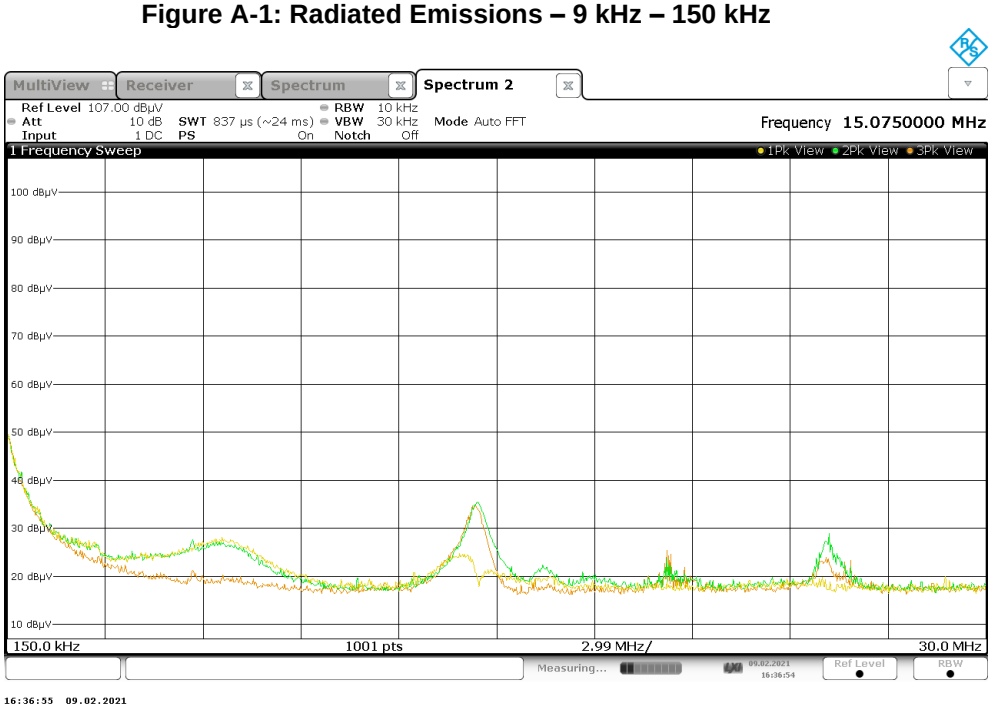

Figure A-2: Radiated Emissions – 150 kHz to 30 MHz

Note: Emissions above the noise floor are ambient noise and not associated with EUT.

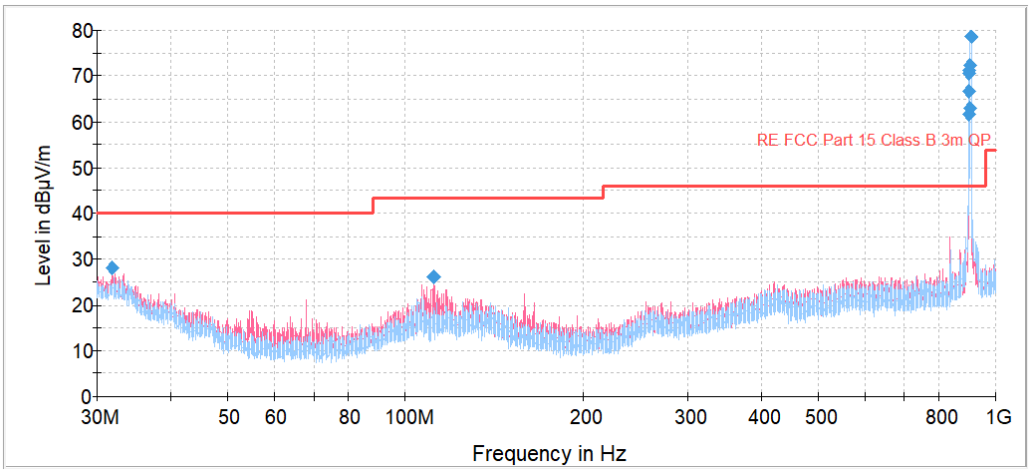

Figure A-3: Radiated Emissions – 30 MHz – 1 GHz (Mesh)

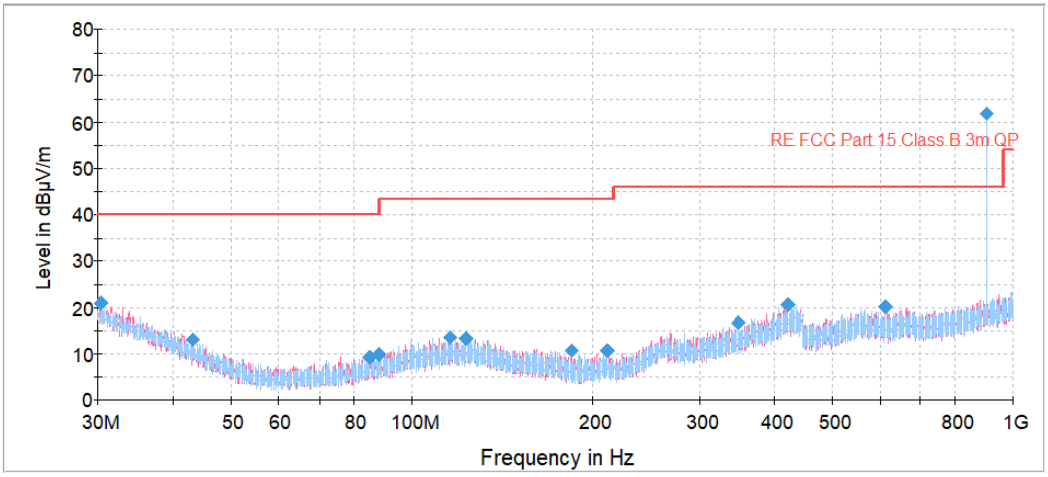

Figure A-4: Radiated Emissions – 30 MHz – 1 GHz (WiSUN)

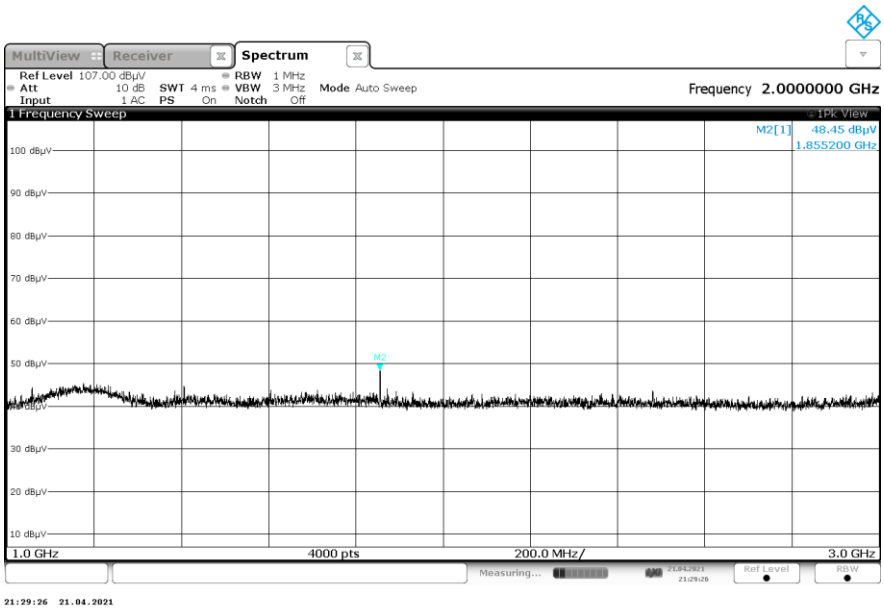

Figure A-5: Radiated Emissions – 1 GHz – 3 GHz (Mesh)

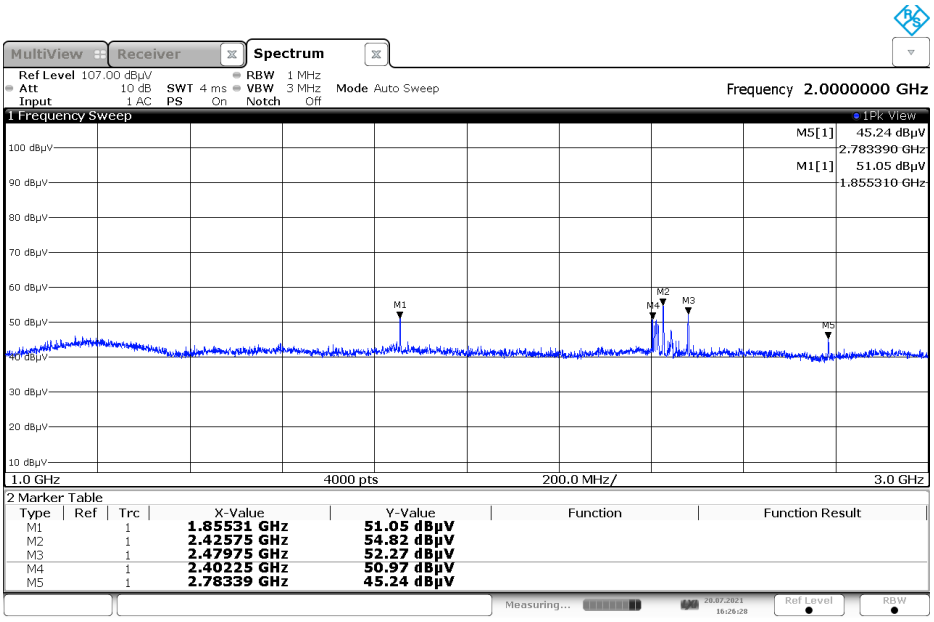

Figure A-6: Radiated Emissions – 1 GHz – 3 GHz (WiSUN)

Note: Spurious Emissions not in restricted bands were not evaluated and emissions in and around 2.4GHz are ambient noise and not associated with the DUT.

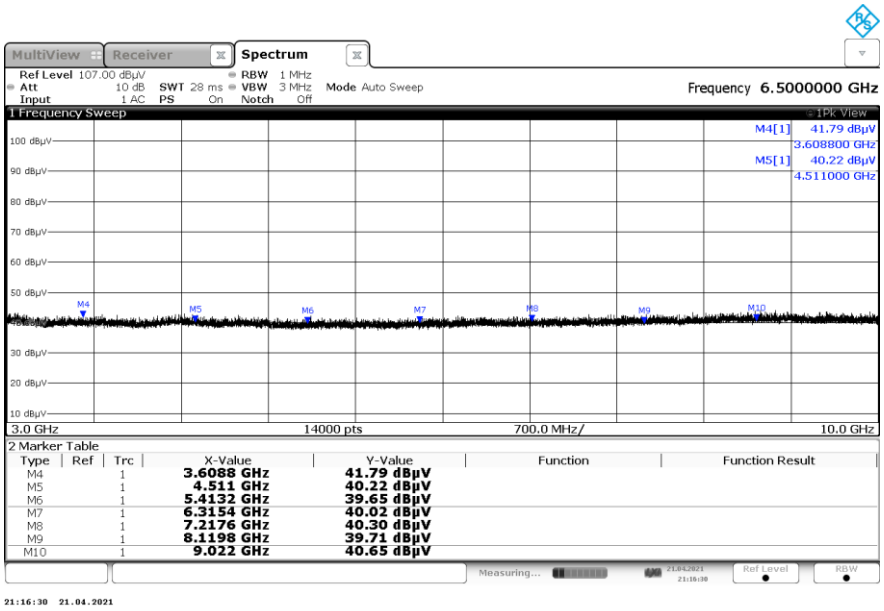

Figure A-7: Radiated Emissions – 3 GHz – 10 GHz (Mesh)

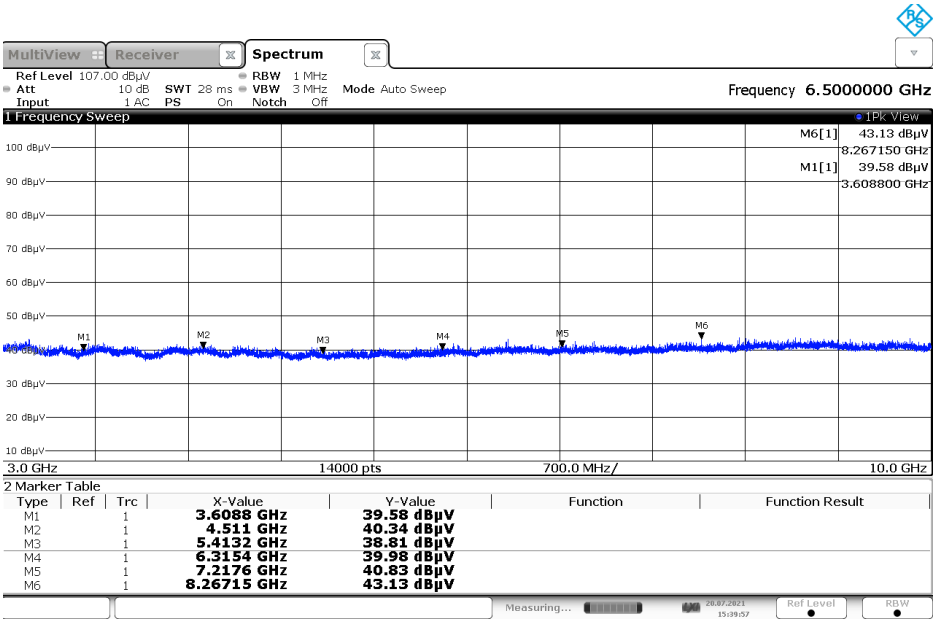

Figure A-8: Radiated Emissions – 3 GHz – 10 GHz (WiSUN)

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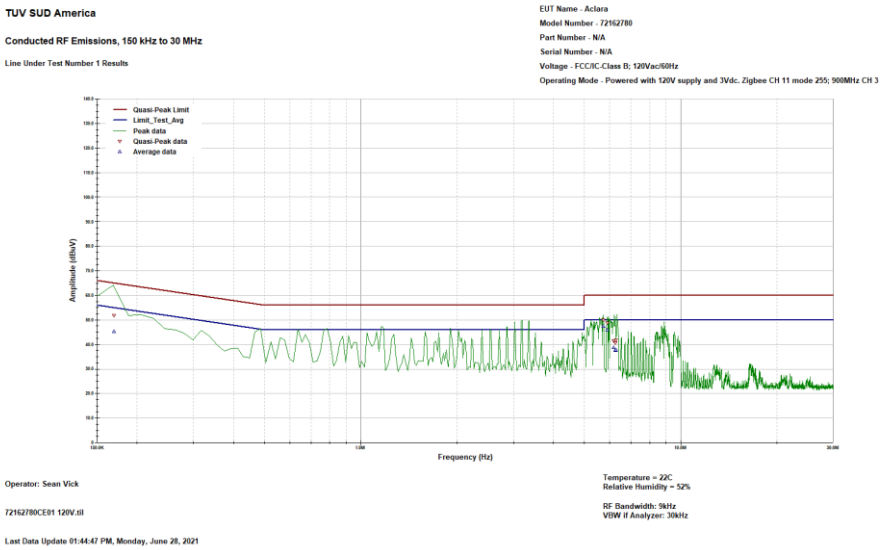

Figure A-9: Conducted Emissions – Line 1

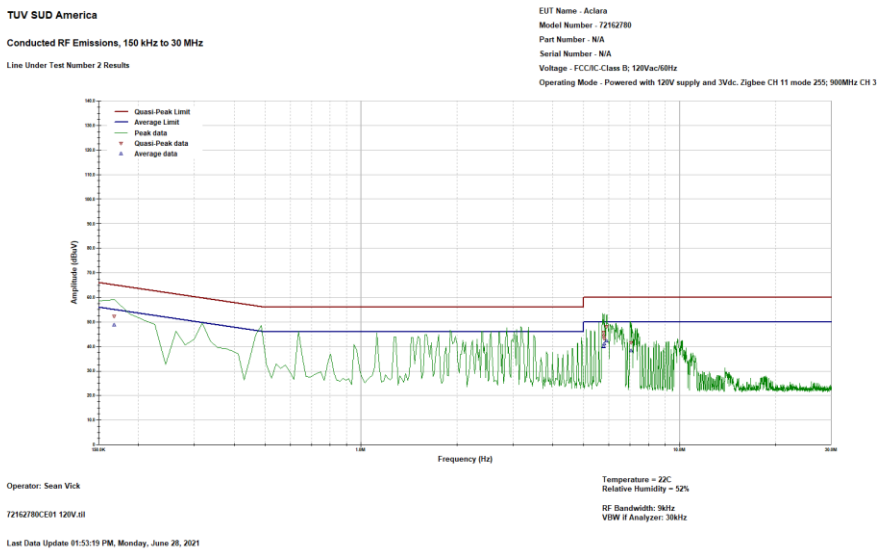

Figure A-10: Conducted Emissions – Line 2

END REPORT