

Report on the Testing of the

Elster Solutions LLC Honeywell
International Company
GNIC

In accordance with:
FCC 47 CFR part 15.247
ISED RSS-247 Issue 2, February 2017

Prepared for: Elster Solutions LLC Honeywell International
Company
208 South Rogers Lane
Raleigh, North Carolina 27610 USA



America

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Kirby Munroe	Wireless / EMC Technical and Certification Manager, NA TUV SUD America Inc.	Authorized Signatory	2/21/2023

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FCC Accreditation Designation Number US1233
FCC Test Site Registration Number 967699
Innovation, Science, and Economic Development Canada Lab Code 23932

EXECUTIVE SUMMARY

A sample of this product was tested and found to be compliant with the standards listed above.



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1 Report Summary

1.1 Report Modification Record

Alterations and additions to this report will be issued to the holders of each copy in the form of a complete document.

Table 1.1-1 – Modification Record

Issue	Description of Change	Date of Issue
0	First Issue	2/21/2023

1.2 Introduction

The purpose of this report is to demonstrate compliance with Part 15 Subpart C of the FCC's Code of Federal Regulations Section 15.247 and Innovation Science and Economic Development Canada's Radio Standards Specification RSS-247 for the tests documented herein to add the 3 new modes to pre-approved 900 MHz module FCC ID: QZC-GNIC / IC: 4557A-GNIC through a class II Permissive change and to ensure continued compliance of the module within the host meter configuration.

Applicant	Mr. Charles Greene
Manufacturer	Elster Solutions LLC Honeywell International Company
Applicant's Email Address	Charles.Greene@Honeywell.com
Module Model Name(s)	GNIC
Module Model Number(s)	5D26423
Host Model / Marketing Names(s)	A4 Alpha Meter
Serial Number(s)	6007013B Conducted Mesh IP Module sample 6007013A Conducted Mesh Module sample G033050768 Radiated Mesh Host meter sample 6007013E Radiated Mesh Module sample
Module FCC ID	QZC-GNIC
Module ISED Certification Number	4557A-GNIC
Hardware Version(s)	G42-02
Software Version(s)	Mesh - S5GS3F-21.58.001 Mesh Ip - S5SR3F-24.58.001
Number of Samples Tested	3
Test Specification/Issue/Date	US Code of Federal Regulation (CFR): Title 47, Part 15, Subpart C: Radio Frequency Devices, Intentional Radiators, 2022



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.

Order Number	72181647
Date of Receipt of EUT	11/29/2022
Start of Test	11/29/2022
Finish of Test	12/20/2022
Related Document(s)	ANSI C63.10-2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Device. FCC OET 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 US Code of Federal Regulations (CFR): Title 47, Part 2, Subpart J: Equipment Authorization Procedures, 2022. ISED Canada Radio Standards Specification: RSS-GEN – General Requirements for Compliance of Radio Apparatus, Issue 5, Amendment 1 (March 2019), Amendment 2 (February 2021)



1.3 Brief Summary of Results

A brief summary of the tests carried out in accordance with FCC Part 15.247 and ISED Canada's RSS-247 is shown below.

Table 1.3-1: Test Result Summary

Test Parameter	Test Plan (Yes/No)	Test Result	FCC 47 CFR Rule Part	ISED Canada's RSS	Test Report Page No
Antenna Requirement	Yes	Pass	15.203	-----	13
Carrier Frequency Separation	Yes	Pass	15.247(a)(1)	RSS-247 5.1(b)	19
Number of Hopping Channels	Yes	Pass	15.247(a)(1)(i)	RSS-247 5.1(c)	21
Channel Dwell Time	No	Not Tested	15.247(a)(1)(i)	RSS-247 5.1(c)	25
20 dB Bandwidth	Yes	Pass	15.247(a)(1)(i)	RSS-247 5.1(c)	26
99% Bandwidth	Yes	Pass	-----	RSS-GEN 6.7	26
Peak Output Power	Yes	Pass	15.247(b)(2)	RSS-247 5.4(a)	17
Band-Edge Compliance of RF Conducted Emissions	Yes	Pass	15.247(d)	RSS-247 5.5	38
RF Conducted Spurious Emissions	Yes	Pass	15.247(d)	RSS-247 5.5	41
Radiated Spurious Emissions into Restricted Frequency Bands	Yes	Pass	15.205, 15.209	RSS-GEN 8.9, 8.10	44
Power Line Conducted Emissions	Yes	Pass	15.207	RSS-GEN 8.8	14
Duty Cycle	No	-----			-----

1.4 Product Information

1.4.1 Technical Description

The GNIC module printed circuit board assembly is a limited module that contains a frequency hopping spread spectrum (FHSS) radio operating in a 902 – 928 MHz ISM frequency band. It also contains circuitry for application control and communications with a host product. The GNIC module connects hosts using Advanced Metering infrastructure (AMI) that utilizes a proprietary network architecture and protocol devised by Elster Electricity LLC.

The module is authorized as a limited modular approval (LMA) as it does not contain power regulation. The module was evaluated in a representative host device. The host is a A4 electric watt hour meter.

Only 900 MHz data is represented in this report. Simultaneous transmission between the Zigbee pre-approved module FCC ID: QOQ13 / IC: 5123A-13 and GNIC 900 MHz module FCC ID: QZC-GNIC / IC: 4557A-GNIC is addressed in a separate report.

Table 1.4-1 – Wireless Technical Information

Detail	Description
Module FCC ID	QZC-GNIC
Module ISED Certification Number	4557A-GNIC
Module Model Name	GNIC
Frequency Range	902.3 – 927.8 MHz
Modulation Format	FSK
Antenna Type / Description:	Stamped metal dipole / 2.1 dBi Gain for 900 MHz

A full description and detailed product specification details are available from the manufacturer.



Figure 1.4.1-1 –Front view of the EUT module Figure 1.4.1-2 – Back view of the EUT module



Figure 1.4.1-3 –Front view of the host meter

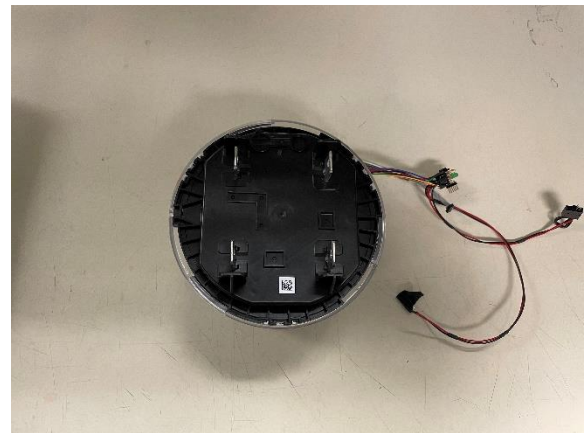


Figure 1.4.1-4 – Back view of the host meter

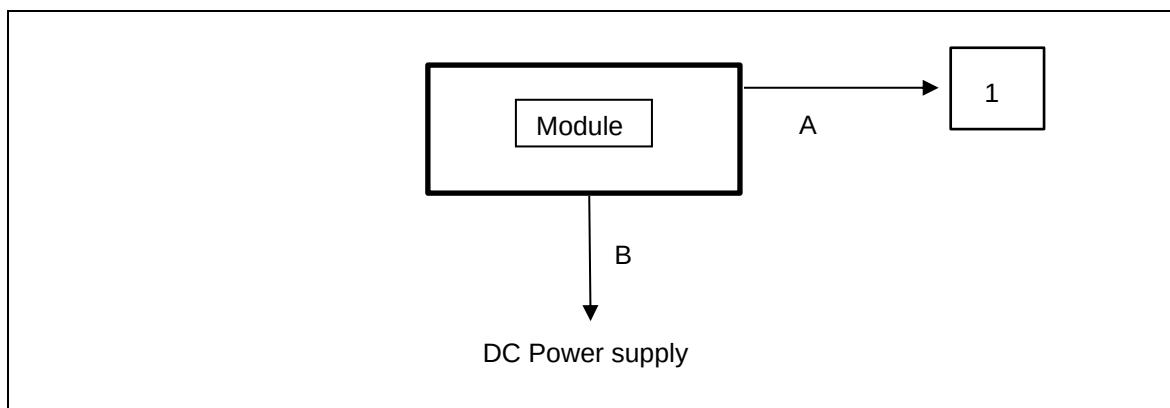


Figure 1.4.1-5 – Conducted Test Setup Block Diagram

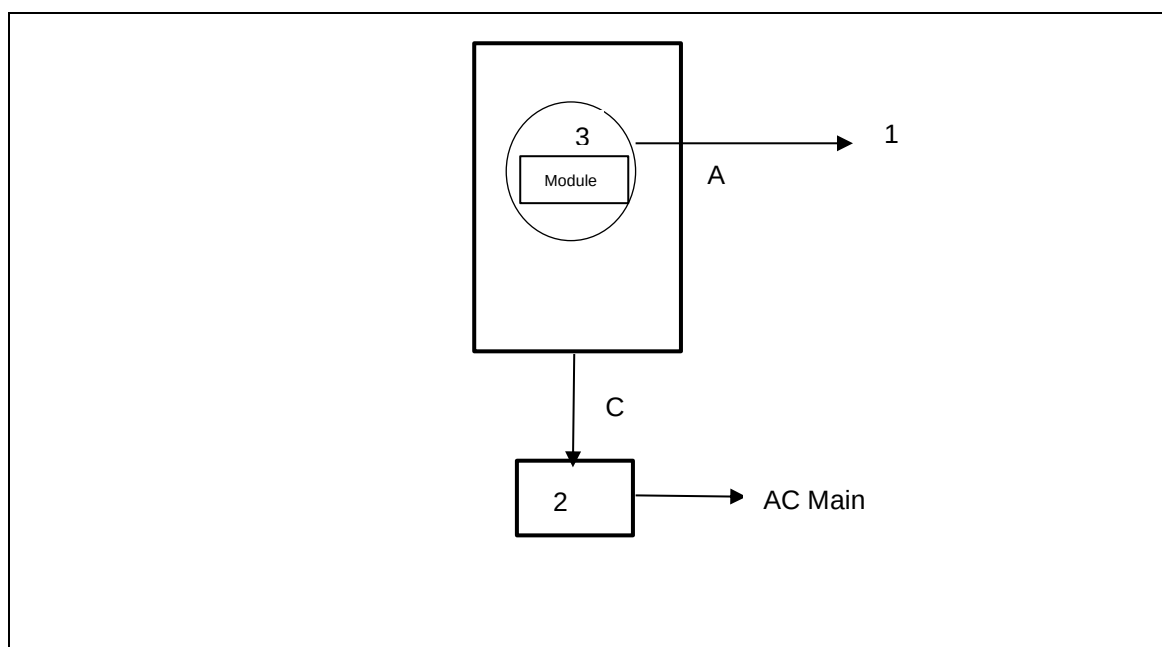


Figure 1.4.1-6 – Radiated Test Setup Block Diagram

**Table 1.4.1-1 – Cable Descriptions**

Item	Cable/Port	Description
A	USB Serial cable	Programming cable connected to laptop
B	DC Power Supply Cable	Power Supply DC power supply
C	AC Power cable	Connected to AC Main

Table 1.4.1-2 – Support Equipment Descriptions

Item	Make/Model	Description
1	Thinkpad	Laptop for configuration
2	L+G	Isolation Transformer
3	A4	L+G Host Meter



1.4.2 Modes of Operation

GNIC model provides 3 distinct proprietary modes of operation using FHSS classifications as outlined below. These modes are in addition to the existing modes included in the original evaluation.

Mode of Operation	Frequency Range (MHz)	Number of Channels	Channel Separation (kHz)	Data Rates Supported (kbps)	Classification
1	902.3 – 927.5	85	300	9.6, 19.2 38.4, 115.2	FHSS
2	904.0 – 927.8	239	100	9.6, 19.2, 38.4	FHSS
3	902.4 – 927.6	64	400	50, 150, 200	FHSS



1.4.3 Monitoring of Performance

For radiated emissions and AC Power Line conducted emissions, the combination EUT and host meter was evaluated in an orientation of typical use. See test setup photos for more information. The EUT was programmed to generate a continuously modulated signal on each channel evaluated.

For RF conducted measurements, the EUT was connected to the test equipment with a temporary antenna connector to SMA connector.

The worst-case mode for all parameters measured is listed below:

Mode	Classification	20dB/99% Bandwidth	Number of Hopping Channels	Carrier Frequency Separation	Peak Output Power	Average Output Power	RF Conducted Spurious Emissions	Band-Edge RF Conducted Emissions	RSE into Restricted Frequency Bands	Power Spectral Density
		Data Rate (kbps)								
1	FHSS	9.6, 19.2, 38.4, 115.2	9.6	9.6	9.6, 19.2, 38.4, 115.2	NA	115.2	115.2	9.6	NA
2	FHSS	9.6, 19.2, 38.4	9.6	9.6	*	NA	*	38.4	*	NA
3	FHSS	50, 150, 200	50	50	50, 150, 200	NA	*	200	*	NA

* Addressed by mode 1

Power setting during test: Mode of operation 1: 295
 Mode of operation 2: 295
 Mode of operation 3: 295



1.5 Deviations from the Standard

No deviations from the applicable test standard were made during testing.

1.6 EUT Modification Record

The table below details modifications made to the EUT during the test program. The modifications incorporated during each test are recorded on the appropriate test pages.

Modification State	Description of Modification still fitted to EUT	Modification Fitted By	Date Modification Fitted
0	Initial State		

The equipment was tested as provided without any modifications.

1.7 Test Location

TÜV SÜD conducted the following tests at our Alpharetta, GA test laboratory.

Test Name	Name of Engineer(s)	Accreditation
Antenna Requirement	Divya Adusumilli	A2LA
Power Line Conducted Emissions	Bhagyashree Chaudhary	A2LA
Peak Output Power	Divya Adusumilli	A2LA
Carrier Frequency Separation	Divya Adusumilli	A2LA
Number of Hopping Channels	Divya Adusumilli	A2LA
20dB / 99% Bandwidth	Divya Adusumilli	A2LA
Band-Edge Compliance of RF Conducted Emissions	Divya Adusumilli	A2LA
RF Conducted Spurious Emissions	Divya Adusumilli	A2LA
Radiated Spurious Emissions into Restricted Frequency Bands	Bhagyashree Chaudhary	A2LA

Office address:
TÜV SÜD America
5945 Cabot Parkway, Suite 100
Alpharetta, GA 30005, USA



2 Test Details

2.1 Antenna Requirement

2.1.1 Specification Reference

FCC Section: 15.203

2.1.2 Equipment Under Test and Modification State

As shown in §1.4 with modification state "0", as noted in §1.6.

2.1.3 Date of Observation

11/29/2022

2.1.4 Test Method

N/A

2.1.5 Environmental Conditions

N/A

2.1.6 Observation

The EUT utilizes onboard printed stamped metal dipole with peak gain 2.1 dBi which is provided by the printed circuit board, therefore satisfying the requirements of Section 15.203.



2.2 Power Line Conducted Emissions

2.2.1 Specification Reference

FCC Section: 15.207
ISED Canada: RSS-Gen 8.8

2.2.2 Equipment Under Test and Modification State

As shown in §1.4 with modification state "0", as noted in §1.6.

2.2.3 Date of Test

12/20/2022

2.2.4 Test Method

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

2.2.5 Environmental Conditions

The EUT was evaluated within the temperature, humidity and pressure range of the EUT as specified by the standard. The laboratory shall have an ambient temperature range of 15°C to 35°C, relative humidity range of 30% to 60% and atmospheric pressure range of 86 kPa to 106 kPa.

Ambient Temperature 22.3 °C
Relative Humidity 53.8 %
Atmospheric Pressure 972.2 mbar

2.2.6 Test Results

Table 2.2.6-1: Conducted EMI Results-Avg – Line 1

Frequency	Avg Limit	Avg Level Corr	Avg Level	CF	Avg Margin	Result
MHz	dBuV	dBuV	dBuV	dB	dB	
0.17	55.5	28.1	18.4	9.68	-27.4	PASS
0.86	46	17.6	7.9	9.672	-28.4	PASS
2.09	46	17	7.2	9.774	-29	PASS
2.23	46	17	7.3	9.779	-29	PASS
4.84	46	16.5	6.7	9.807	-29.5	PASS



Table 2.2.6-2: Conducted EMI Results-QP – Line 1

Frequency	QP Limit	QP Level Corr	QP Level	CF	QP Margin	Result
MHz	dBuV	dBuV	dBuV	dB	dB	
0.17	65.5	35.9	26.2	9.68	-29.6	PASS
0.86	56	26.1	16.5	9.672	-29.9	PASS
2.09	56	24.6	14.8	9.774	-31.4	PASS
2.23	56	24.4	14.6	9.779	-31.6	PASS
4.84	56	22.8	13	9.807	-33.2	PASS

Table 2.2.6-3: Conducted EMI Results-Avg – Line 2

Frequency	Avg Limit	Avg Level Corr	Avg Level	CF	Avg Margin	Result
MHz	dBuV	dBuV	dBuV	dB	dB	
0.15	56	23.1	13.4	9.675	-32.9	PASS
0.5	46.1	17.6	8	9.631	-28.5	PASS
0.5	46.1	17.7	8.1	9.63	-28.4	PASS
1.82	46	24.7	14.9	9.746	-21.3	PASS
2.24	46	26.7	16.9	9.765	-19.3	PASS
30	50	13.9	3.7	10.22	-36.1	PASS

Table 2.2.6-4: Conducted EMI Results-QP – Line 2

Frequency	QP Limit	QP Level Corr	QP Level	CF	QP Margin	Result
MHz	dBuV	dBuV	dBuV	dB	dB	
0.15	66	42.2	32.5	9.675	-23.8	PASS
0.5	56.1	34	24.4	9.631	-22.1	PASS
0.5	56.1	34	24.3	9.63	-22.1	PASS
1.82	56	29.1	19.3	9.746	-26.9	PASS
2.24	56	30.7	20.9	9.765	-25.3	PASS
30	60	17.9	7.7	10.22	-42.1	PASS



TUV SUD America

Conducted RF Emissions, 150 kHz to 30 MHz

Line Under Test Number 1 Results

EUT Name - 72185647 L+G (Elster)

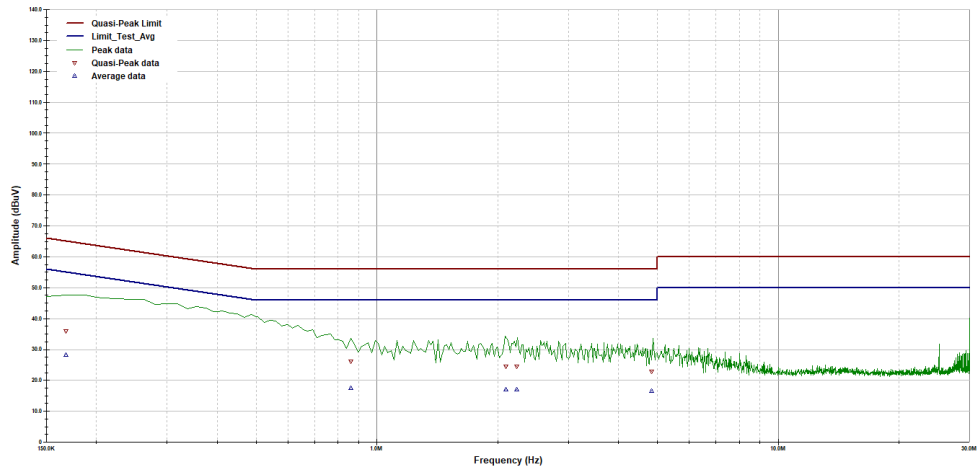
Model Number - GNIC

Part Number - N/A

Serial Number - N/A

Voltage - FCC/IC Class B; 120Vac/60Hz

Operating Mode - Radio on 902.3MHz



Operator: Shree

Temperature = 23C
Relative Humidity = 22%

AC Mains Class B.til

RF Bandwidth: 9kHz
VBW if Analyzer: 30kHz

Last Data Update 04:06:55 PM, Tuesday, December 20, 2022

Figure 1: Conducted Emission Plot – Line 1

TUV SUD America

Conducted RF Emissions, 150 kHz to 30 MHz

Line Under Test Number 2 Results

EUT Name - 72185647 L+G (Elster)

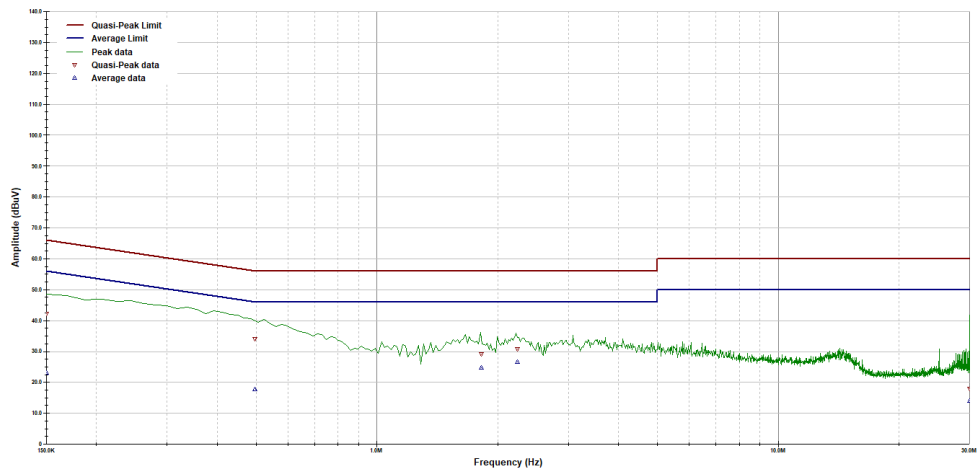
Model Number - GNIC

Part Number - N/A

Serial Number - N/A

Voltage - FCC/IC Class B; 120Vac/60Hz

Operating Mode - Radio on 902.3MHz



Operator: Shree

Temperature = 23C
Relative Humidity = 22%

AC Mains Class B.til

RF Bandwidth: 9kHz
VBW if Analyzer: 30kHz

Last Data Update 04:19:10 PM, Tuesday, December 20, 2022

Figure 2: Conducted Emission Plot – Nuetral



2.3 Peak Output Power

2.3.1 Specification Reference

FCC Sections: 15.247(b)(2)
ISED Canada: RSS-247 5.4(a)

2.3.2 Equipment Under Test and Modification State

As shown in §1.4 with modification state "0", as noted in §1.6.

2.3.3 Date of Test

11/29/2022 to 12/02/2022

2.3.4 Test Method

The maximum conducted peak output power was measured in accordance with ANSI C63.10 Subclause 7.8.5 Method PKPM (Peak Power meter). The RF output port of the EUT was directly connected to the input of a peak power meter. The resulting peak value was recorded.

2.3.5 Environmental Conditions

The EUT was evaluated within the temperature, humidity and pressure range of the EUT as specified by the standard. The laboratory shall have an ambient temperature range of 15°C to 35°C, relative humidity range of 30% to 60% and atmospheric pressure range of 86 kPa to 106 kPa.

Ambient Temperature	22.3 °C
Relative Humidity	53.8 %
Atmospheric Pressure	972.2 mbar

2.3.6 Test Results

Test Summary: EUT was set to transmit mode as per sections 1.4.2 / 1.4.3.

Test Results: Pass

See data below for detailed results.



Table 2.3.6-1: RF Output Power – FHSS

Frequency [MHz]	Peak Output Power (dBm)	EIRP (dBm)	Data Rate (kbps)	Mode(s)
902.3	29.74	31.84	9.6	1
902.3	29.63	31.73	19.2	1
902.3	29.62	31.72	38.4	1
902.3	29.76	31.86	115.2	1
902.4	29.55	31.65	50	3
902.4	29.66	31.76	150	3
902.4	29.75	31.85	200	3
914.9	29.61	31.71	9.6	1
914.9	29.52	31.62	19.2	1
914.9	29.64	31.74	38.4	1
914.9	29.78	31.88	115.2	1
915.2	29.36	31.46	50	3
915.2	29.55	31.65	150	3
915.2	29.63	31.73	200	3
927.5	29.47	31.57	9.6	1
927.5	29.57	31.67	19.2	1
927.5	29.56	31.66	38.4	1
927.5	29.66	31.76	115.2	1
927.6	29.26	31.36	50	3
927.6	29.38	31.48	150	3
927.6	29.49	31.59	200	3



2.4 Carrier Frequency Separation

2.4.1 Specification Reference

FCC Sections: 15.247(a)(1)
ISED Canada: RSS-247 5.1(b)

2.4.2 Equipment Under Test and Modification State

As shown in §1.4 with modification state “0”, as noted in §1.6.

2.4.3 Date of Test

11/29/2022 to 12/02/2022

2.4.4 Test Method

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 $\geq$ RBW.

2.4.5 Environmental Conditions

The EUT was evaluated within the temperature, humidity and pressure range of the EUT as specified by the standard. The laboratory shall have an ambient temperature range of 15°C to 35°C, relative humidity range of 30% to 60% and atmospheric pressure range of 86 kPa to 106 kPa.

Ambient Temperature	22.3 °C
Relative Humidity	53.8 %
Atmospheric Pressure	972.2 mbar

2.4.6 Test Results

Test Summary: EUT was set to transmit mode as per sections 1.4.2 / 1.4.3.

Test Results: Pass

See below plots for detailed results.

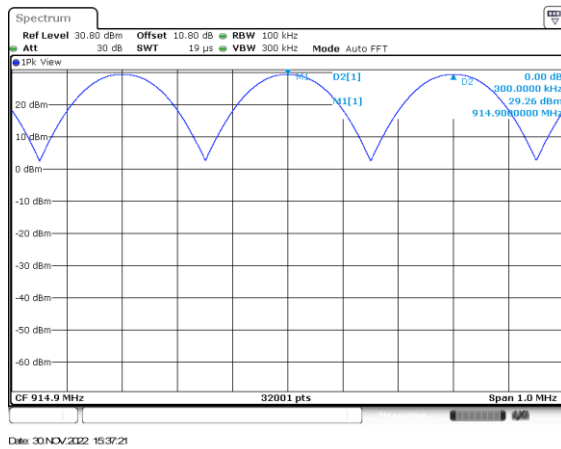


Figure 2.4.6-1: Channel Separation – Mode 1 – 9.6 kbps

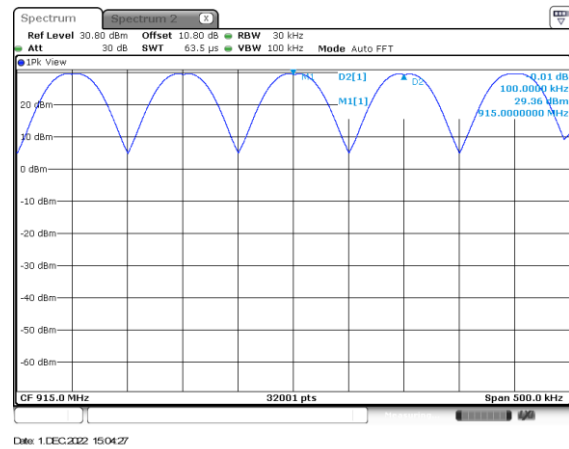


Figure 2.4.6-2: Channel Separation – Mode 2 – 9.6 kbps

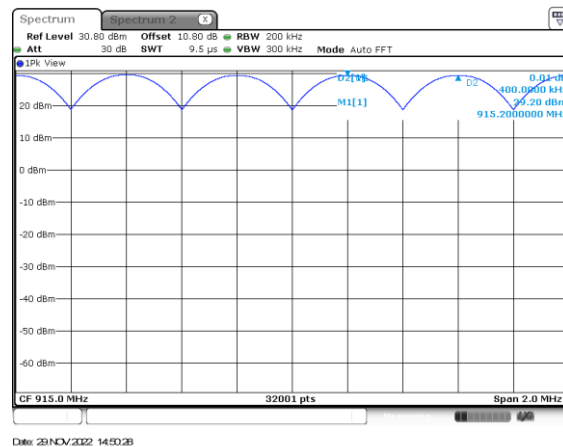


Figure 2.4.6-3: Channel Separation – Mode 3 – 50 kbps



2.5 Number of Hopping Channels

2.5.1 Specification Reference

FCC Sections: 15.247(a)(1)(i)
ISED Canada: RSS 247 5.1 (c)

2.5.2 Equipment Under Test and Modification State

As shown in §1.4 with modification state "0", as noted in §1.6.

2.5.3 Date of Test

11/29/2022 to 12/02/2022

2.5.4 Test Method

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 $\geq$ RBW.

2.5.5 Environmental Conditions

The EUT was evaluated within the temperature, humidity and pressure range of the EUT as specified by the standard. The laboratory shall have an ambient temperature range of 15°C to 35°C, relative humidity range of 30% to 60% and atmospheric pressure range of 86 kPa to 106 kPa.

Ambient Temperature	22.3 °C
Relative Humidity	53.8 %
Atmospheric Pressure	972.2 mbar

2.5.6 Test Results

Test Summary: EUT was set to transmit mode as per sections 1.4.2 / 1.4.3.

Test Results: Pass

See below plots for detailed results.

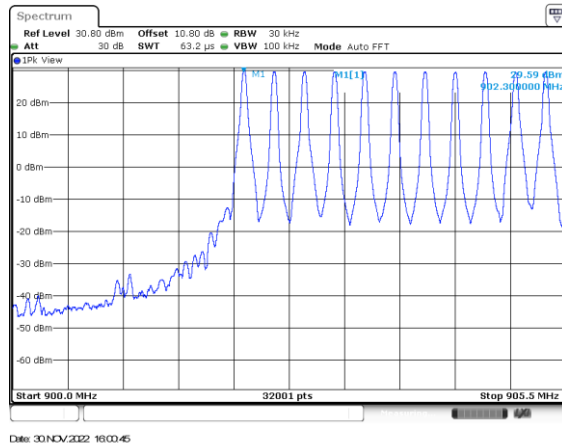


Figure 2.5.6-1: Mode 1 – 9.6 kbps (85 Channels)

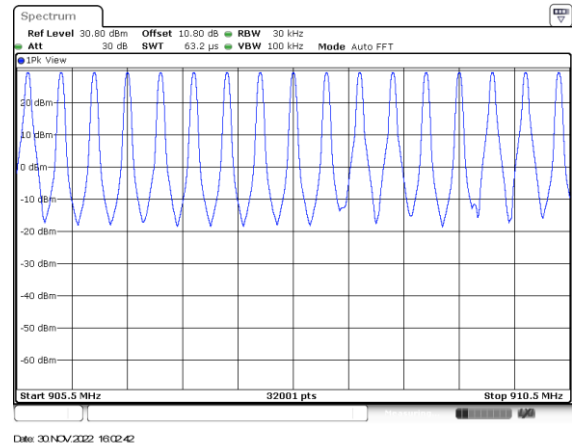


Figure 2.5.6-2: Mode 1 – 9.6 kbps (85 Channels)

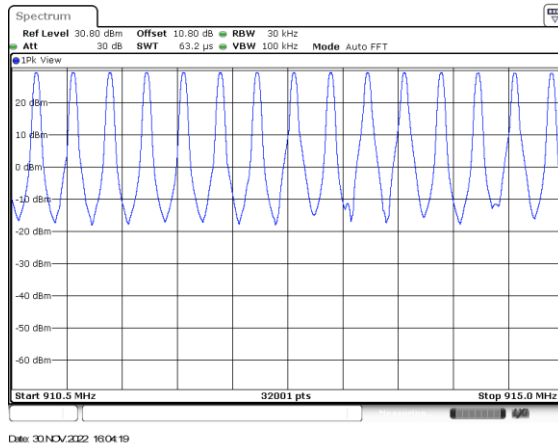


Figure 2.5.6-3: Mode 1 – 9.6 kbps (85 Channels)

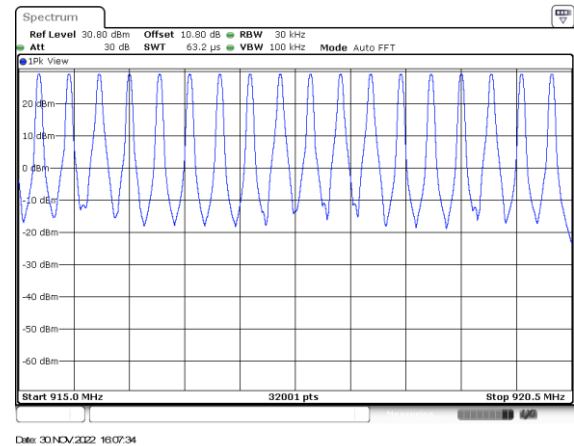


Figure 2.5.6-4: Mode 1 – 9.6 kbps (85 Channels)

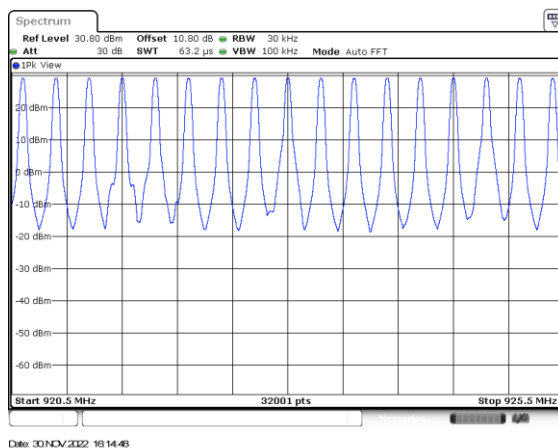


Figure 2.5.6-5: Mode 1 – 9.6 kbps (85 Channels)

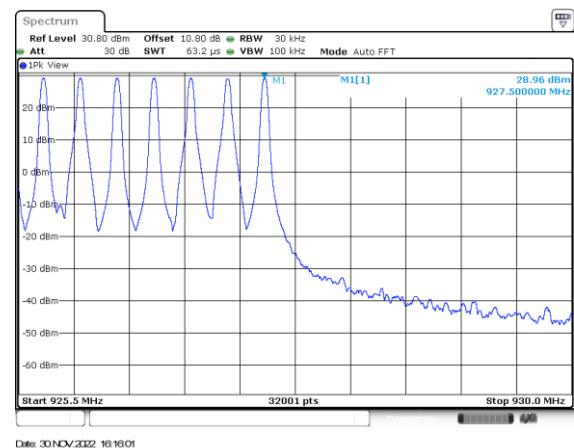


Figure 2.5.6-6: Mode 1 – 9.6 kbps (85 Channels)

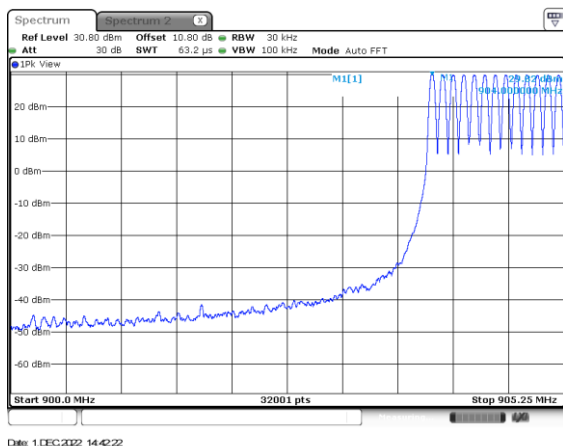


Figure 2.5.6-7: Mode 2 – 9.6 kbps (239 Channels)

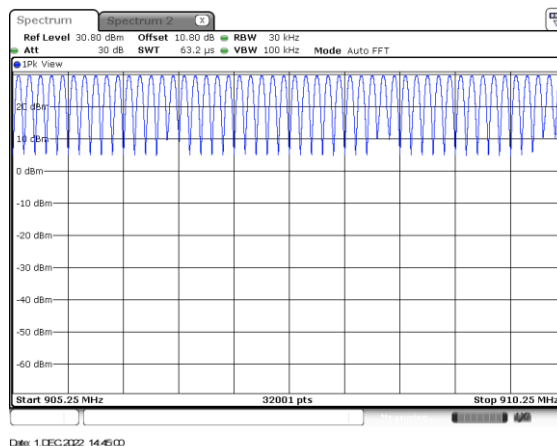


Figure 2.5.6-8: Mode 1 – 9.6 kbps (239 Channels)

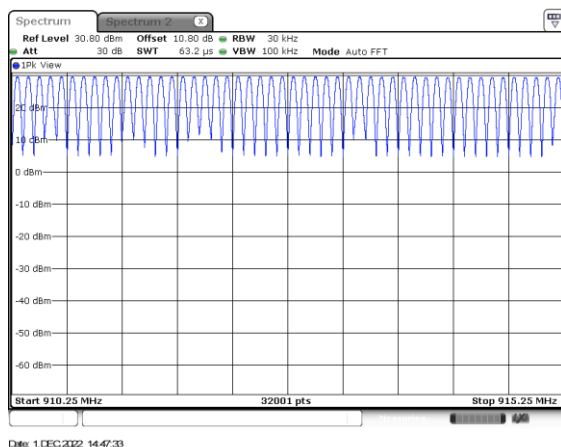


Figure 2.5.6-9: Mode 2 – 9.6 kbps (239 Channels)

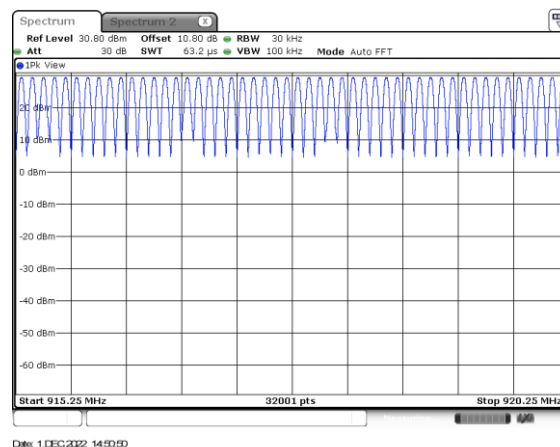


Figure 2.5.6-10: Mode 2 – 9.6 kbps (239 Channels)

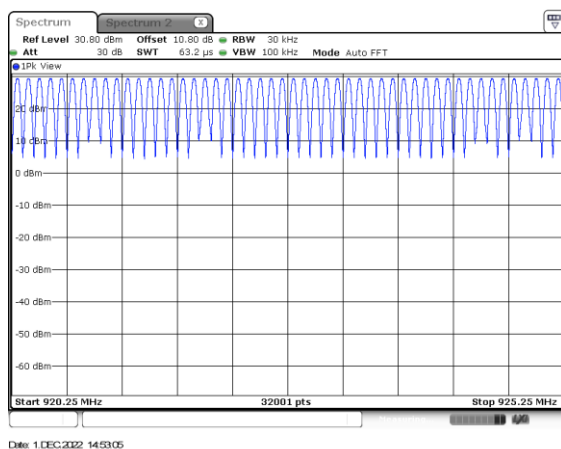


Figure 2.5.6-11: Mode 2 – 9.6 kbps (239 Channels)

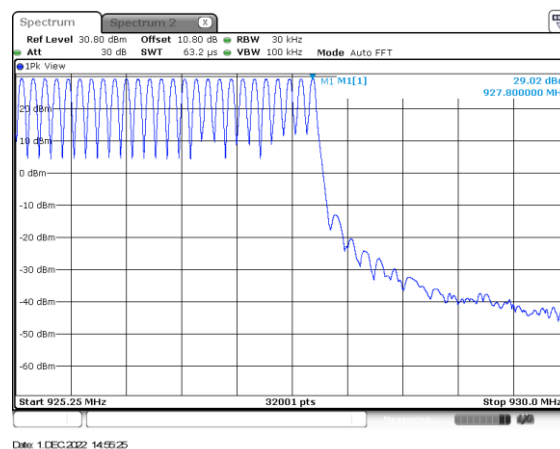


Figure 2.5.6-12: Mode 2 – 9.6 kbps (239 Channels)

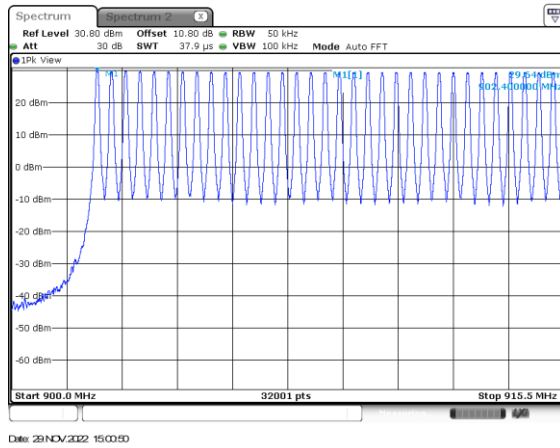


Figure 2.5.6-13: Mode 3 – 50 kbps (64 Channels)

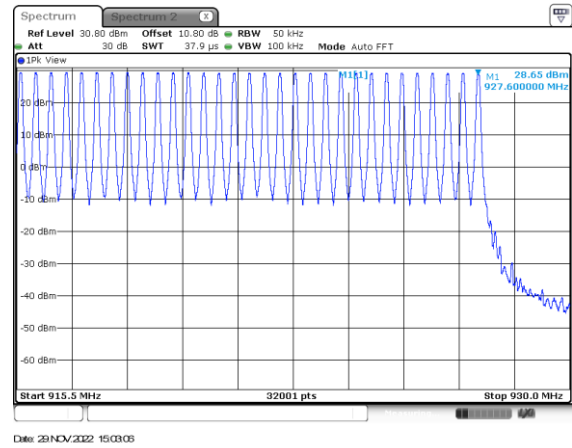


Figure 2.5.6-14: Mode 3 – 50 kbps (64 Channels)



2.6 Channel Dwell Time

2.6.1 Specification Reference

FCC Sections: 15.247(a)(1)(i), 15.247 (f)
ISED: RSS-247 5.1(c), RSS-247 5.3(a)

2.6.2 Equipment Under Test and Modification State

As shown in §1.4 with modification state "0", as noted in §1.6.

2.6.3 Date of Test

12/2/2022

2.6.4 Test Method

N/A

2.6.5 Environmental Conditions

N/A

2.6.6 Test Results

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.



2.7 20dB / 99% Bandwidth

2.7.1 Specification Reference

FCC Sections: 15.247(a)(1)(i)
ISED Canada: RSS-247 5.1(c), RSS-GEN 6.7

2.7.2 Equipment Under Test and Modification State

As shown in §1.4 with modification state "0", as noted in §1.6.

2.7.3 Date of Test

11/29/2022 to 12/02/2022

2.7.4 Test Method

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.

2.7.5 Environmental Conditions

The EUT was evaluated within the temperature, humidity and pressure range of the EUT as specified by the standard. The laboratory shall have an ambient temperature range of 15°C to 35°C, relative humidity range of 30% to 60% and atmospheric pressure range of 86 kPa to 106 kPa.

Ambient Temperature	22.3 °C
Relative Humidity	53.8 %
Atmospheric Pressure	972.2 mbar

2.7.6 Test Results

Test Summary: EUT was set to transmit mode as per sections 1.4.2 / 1.4.3.

Test Results: Pass

See data below for detailed results.



Table 2.7.6-1: 20dB / 99% Bandwidth

Frequency [MHz]	20dB Bandwidth (kHz)	99% Bandwidth (kHz)	Data Rate (kbps)	Mode(s)
902.3	21.530	21.033	9.6	1
902.3	23.955	22.911	19.2	1
902.3	88.255	86.192	38.4	1
902.3	254.942	239.842	115.2	1
904.0	21.518	21.014	9.6	2
904.0	23.921	22.868	19.2	2
904.0	87.028	86.567	38.4	2
902.4	64.139	61.810	50	3
902.4	165.307	159.776	150	3
902.4	209.697	214.305	200	3
914.9	21.480	20.927	9.6	1
914.9	24.180	22.974	19.2	1
914.9	87.591	85.645	38.4	1
914.9	255.042	238.967	115.2	1
915.0	21.355	21.002	9.6	2
915.0	24.205	22.789	19.2	2
915.0	87.208	86.630	38.4	2
915.2	63.889	62.091	50	3
915.2	164.339	160.244	150	3
915.2	209.947	214.180	200	3
927.5	21.418	21.089	9.6	1
927.5	24.043	22.930	19.2	1
927.5	87.247	86.380	38.4	1
927.5	252.817	239.792	115.2	1
927.8	21.536	21.018	9.6	2
927.8	24.136	23.008	19.2	2
927.8	86.637	86.161	38.4	2
927.6	64.873	61.482	50	3
927.6	164.198	160.291	150	3
927.6	211.197	213.915	200	3

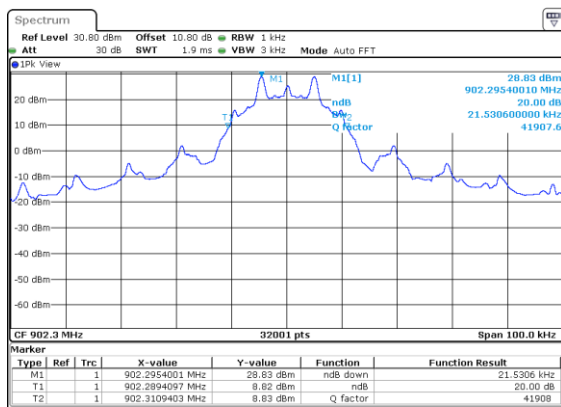


Figure 2.7.6-1: Mode 1 – 20 dB BW – LCH – 9.6 kbps

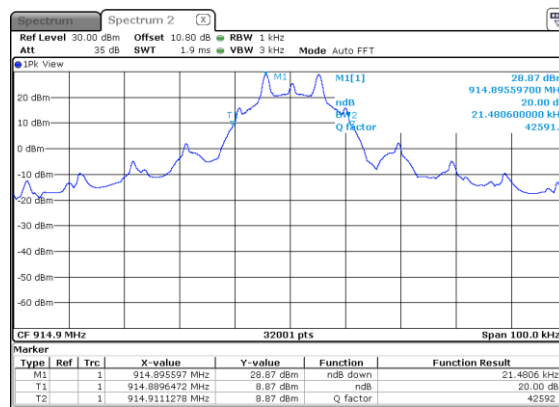


Figure 2.7.6-2: Mode 1 – 20 dB BW – MCH – 9.6 kbps

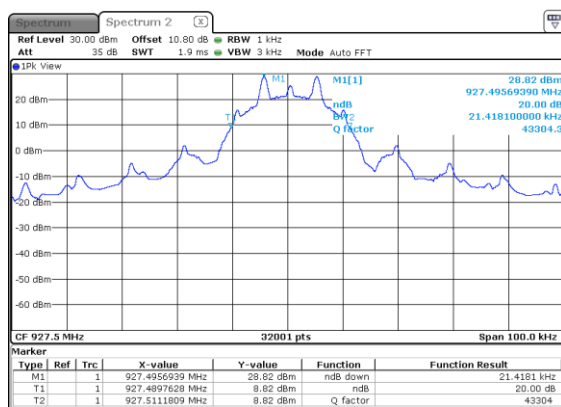


Figure 2.7.6-3: Mode 1 – 20 dB BW – HCH – 9.6 kbps

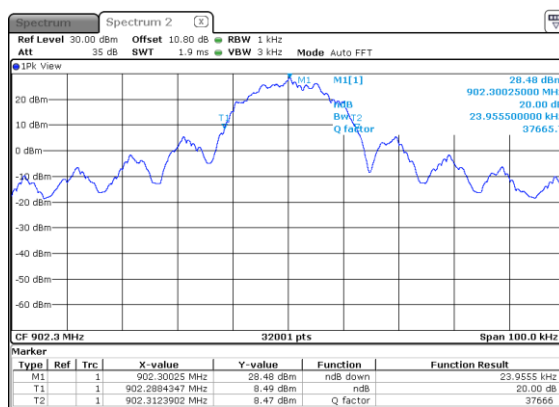


Figure 2.7.6-4: Mode 1 – 20 dB BW – LCH – 19.2 kbps

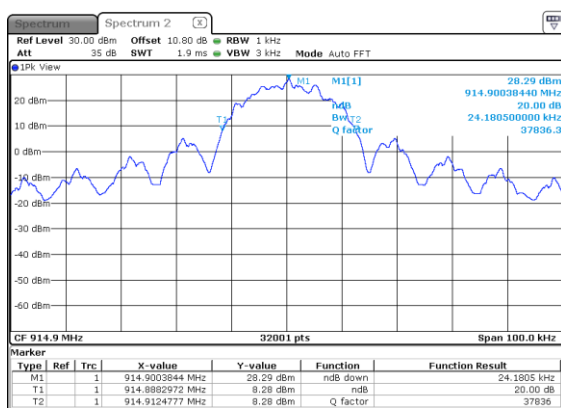


Figure 2.7.6-5: Mode 1 – 20 dB BW – MCH – 19.2 kbps

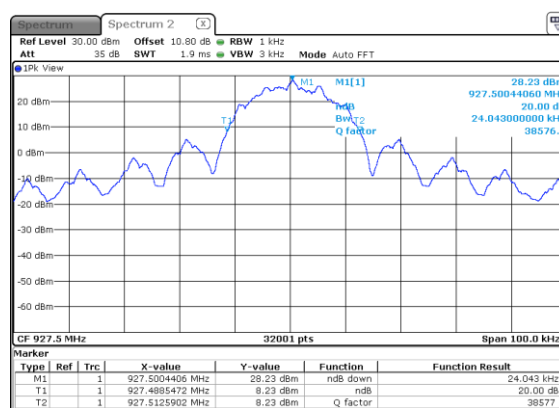


Figure 2.7.6-6: Mode 1 – 20 dB BW – HCH – 19.2 kbps

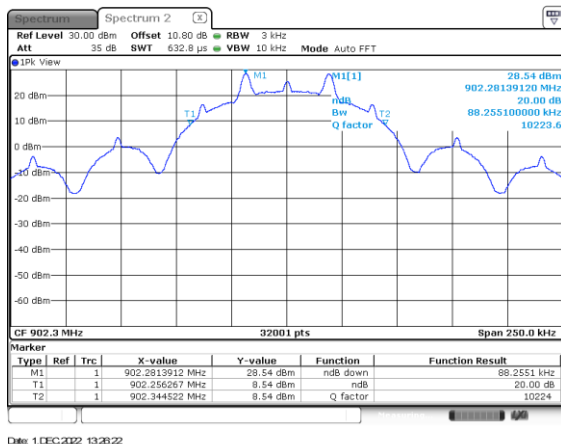


Figure 2.7.6-7: Mode 1 – 20 dB BW – LCH – 38.4 kbps



Figure 2.7.6-8: Mode 1 – 20 dB BW – MCH – 38.4 kbps

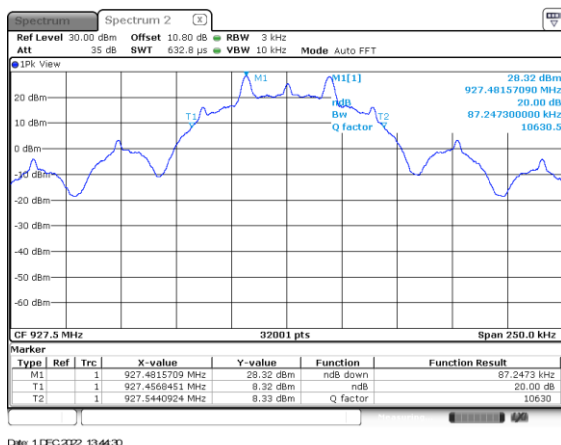


Figure 2.7.6-9: Mode 1 – 20 dB BW – HCH – 38.4 kbps



Figure 2.7.6-10: Mode 1 – 20 dB BW – LCH – 115.2 kbps



Figure 2.7.6-11: Mode 1 – 20 dB BW – MCH – 115.2 kbps



Figure 2.7.6-12: Mode 1 – 20 dB BW – HCH – 115.2 kbps

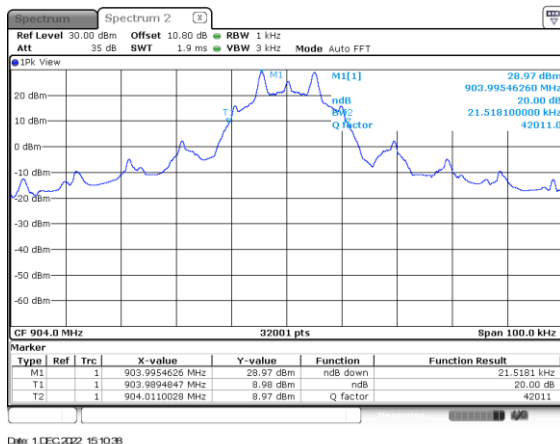


Figure 2.7.6-13: Mode 2 – 20 dB BW – LCH – 9.6 kbps



Figure 2.7.6-14: Mode 2 – 20 dB BW – MCH – 9.6 kbps

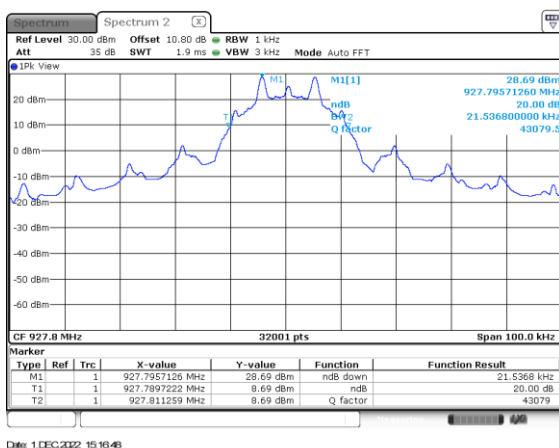


Figure 2.7.6-15: Mode 2 – 20 dB BW – HCH – 9.6 kbps

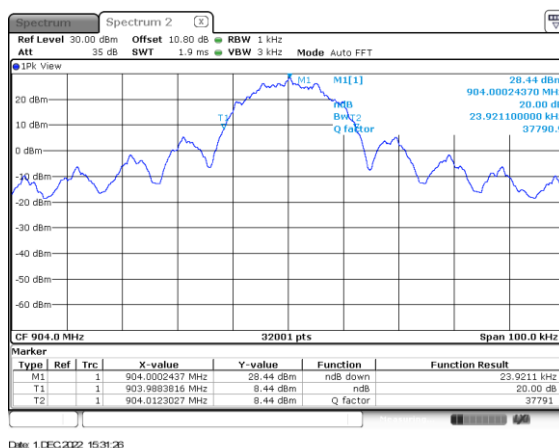


Figure 2.7.6-16: Mode 2 – 20 dB BW – LCH – 19.2 kbps

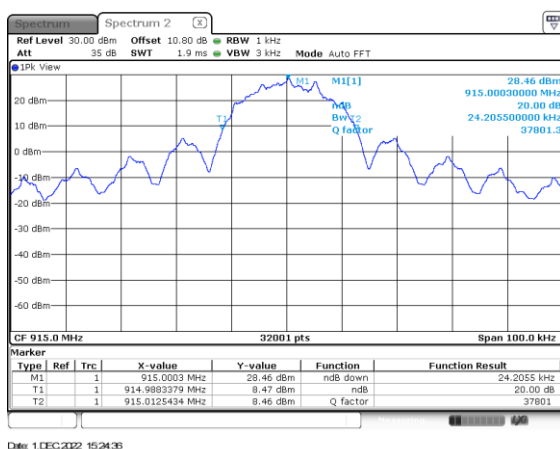


Figure 2.7.6-17: Mode 2 – 20 dB BW – MCH – 19.2 kbps

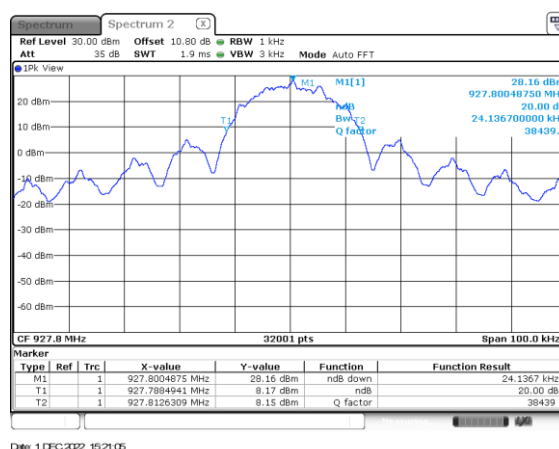


Figure 2.7.6-18: Mode 2 – 20 dB BW – HCH – 19.2 kbps

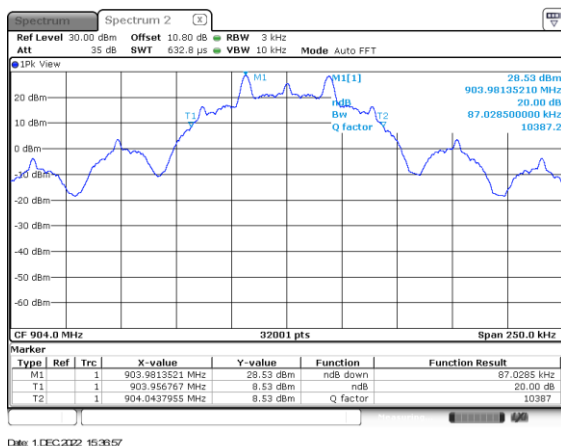


Figure 2.7.6-19: Mode 2 – 20 dB BW – LCH – 38.4 kbps

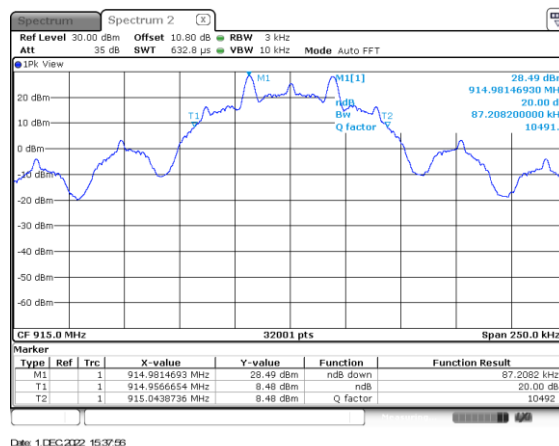


Figure 2.7.6-20: Mode 2 – 20 dB BW – MCH – 38.4 kbps

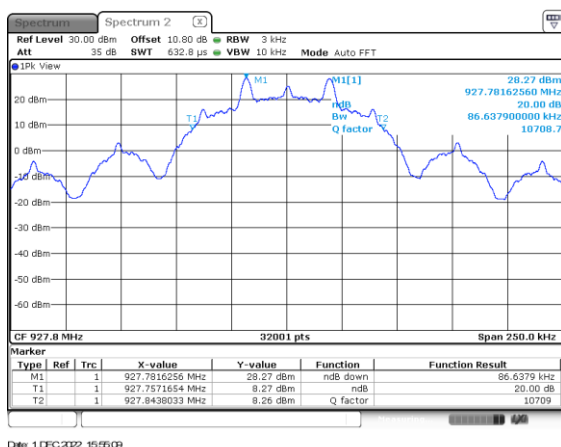


Figure 2.7.6-21: Mode 2 – 20 dB BW – HCH – 38.4 kbps

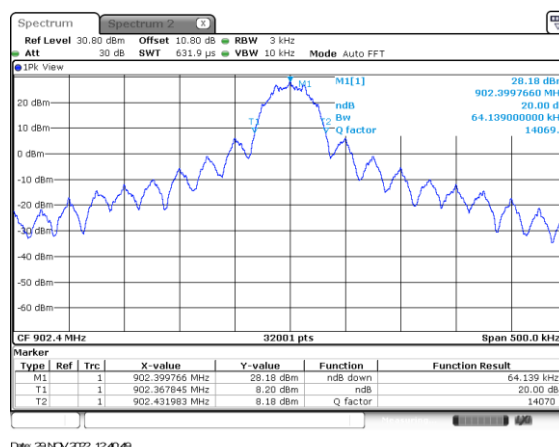


Figure 2.7.6-22: Mode 3 – 20 dB BW – LCH – 50 kbps

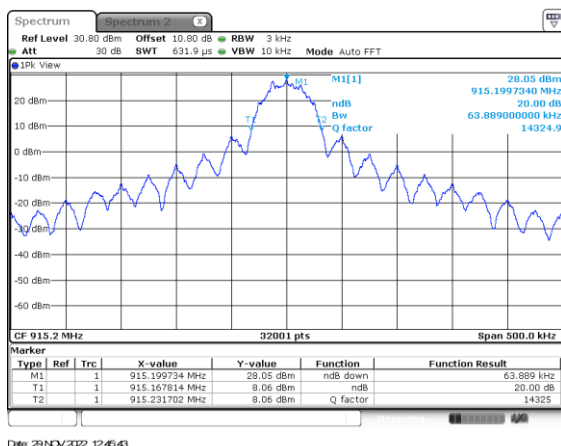


Figure 2.7.6-23: Mode 3 – 20 dB BW – MCH – 50 kbps

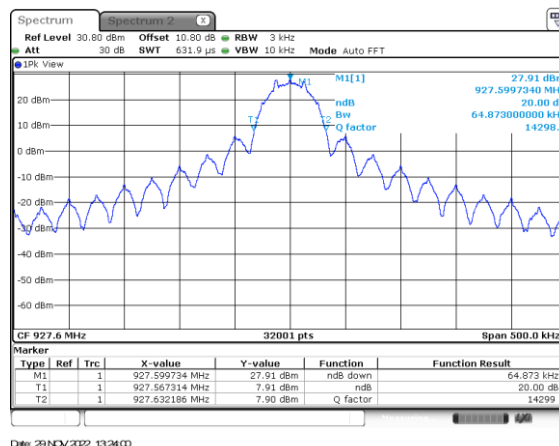
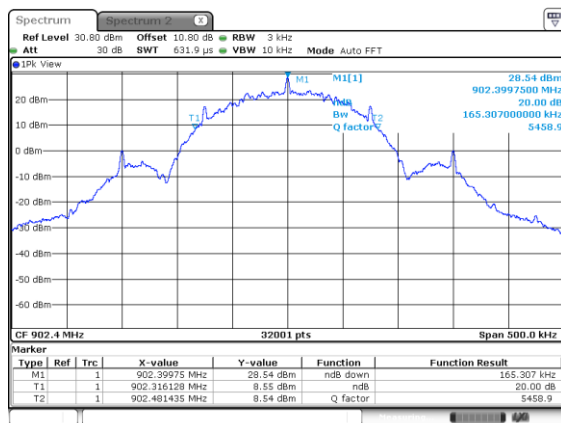
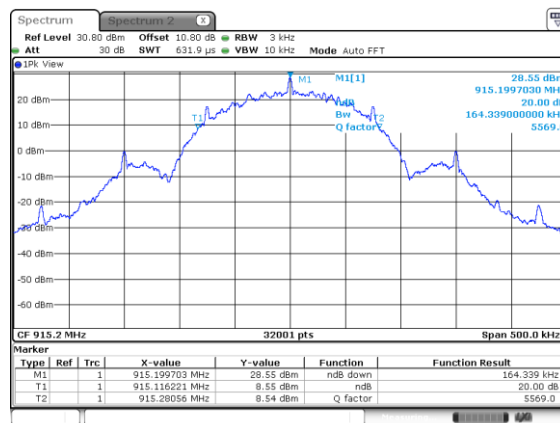


Figure 2.7.6-24: Mode 3 – 20 dB BW – HCH – 50 kbps



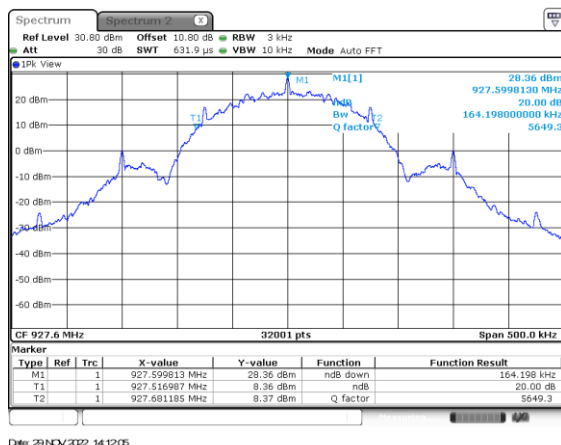
Date: 29 NOV 2022 13:51:37

Figure 2.7.6-25: Mode 3 – 20 dB BW – LCH – 150 kbps



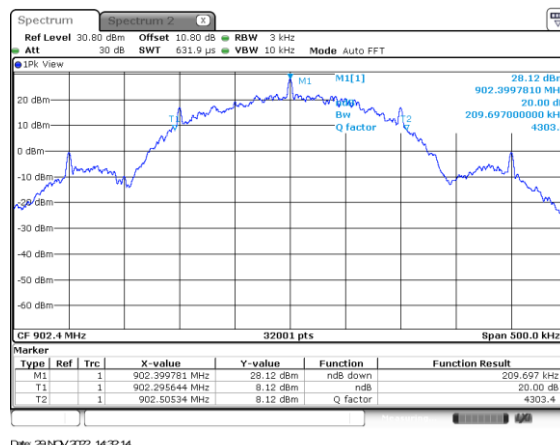
Date: 29 NOV 2022 13:55:50

Figure 2.7.6-26: Mode 3 – 20 dB BW – MCH – 150 kbps



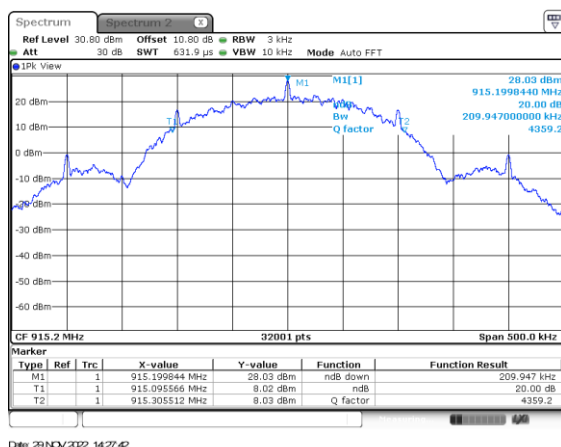
Date: 29 NOV 2022 14:12:05

Figure 2.7.6-27: Mode 3 – 20 dB BW – HCH – 150 kbps



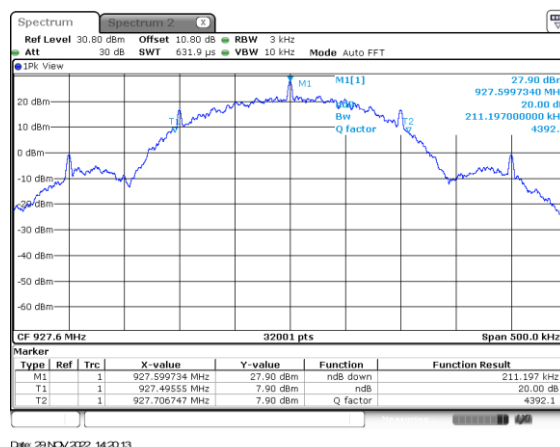
Date: 29 NOV 2022 14:32:14

Figure 2.7.6-28: Mode 3 – 20 dB BW – LCH – 200 kbps



Date: 29 NOV 2022 14:27:42

Figure 2.7.6-29: Mode 3 – 20 dB BW – MCH – 200 kbps



Date: 29 NOV 2022 14:20:13

Figure 2.7.6-30: Mode 3 – 20 dB BW – HCH – 200 kbps



Figure 2.7.6-31: Mode 1 – 99% OBW – LCH – 9.6 kbps

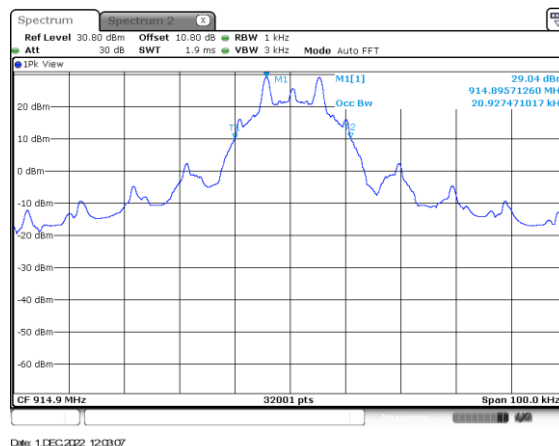


Figure 2.7.6-32: Mode 1 – 99% OBW – MCH – 9.6 kbps

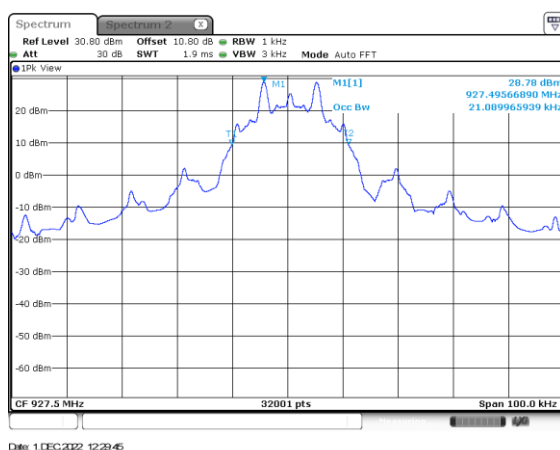


Figure 2.7.6-33: Mode 1 – 99% OBW – HCH – 9.6 kbps

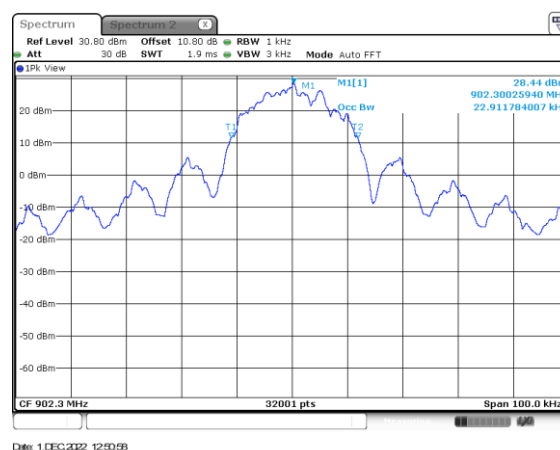


Figure 2.7.6-34: Mode 1 – 99% OBW – LCH – 19.2 kbps

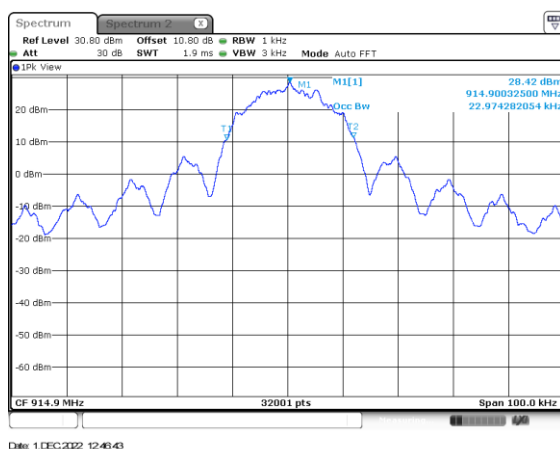


Figure 2.7.6-35: Mode 1 – 99% OBW – MCH – 19.2 kbps

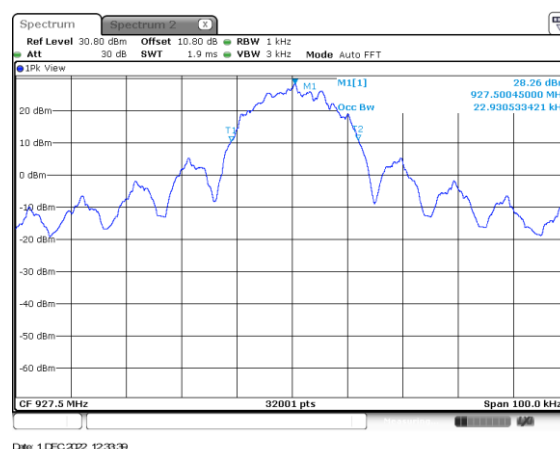


Figure 2.7.6-36: Mode 1 – 99% OBW – HCH – 19.2 kbps

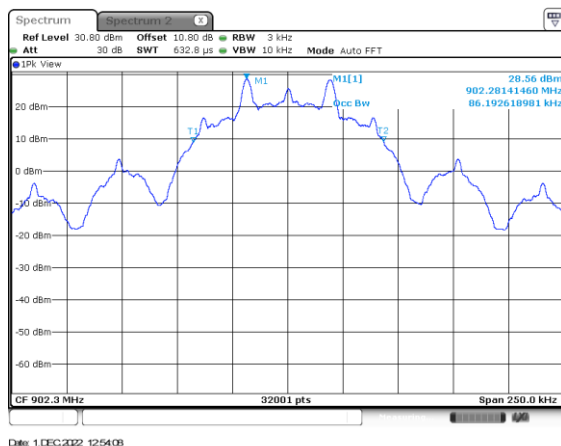


Figure 2.7.6-37: Mode 1 – 99% OBW – LCH – 38.4 kbps

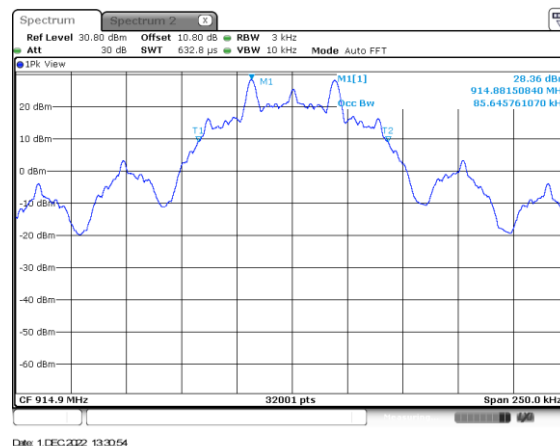


Figure 2.7.6-38: Mode 1 – 99% OBW – MCH – 38.4 kbps

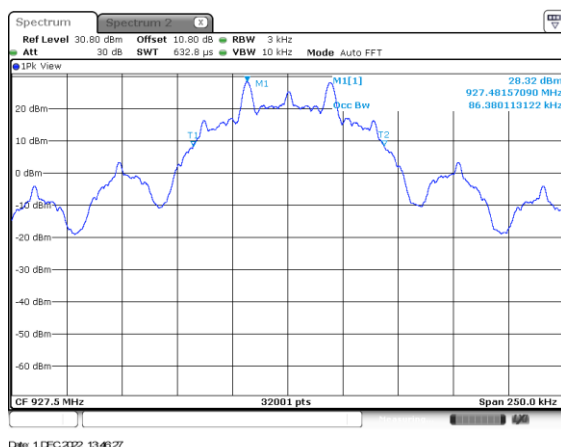


Figure 2.7.6-39: Mode 1 – 99% OBW – HCH – 38.4 kbps

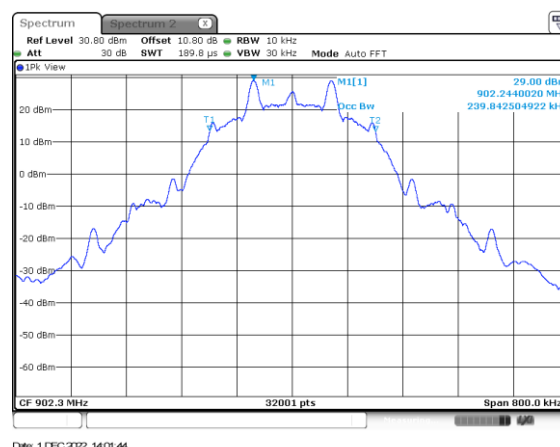


Figure 2.7.6-40: Mode 1 – 99% OBW – LCH – 115.2 kbps

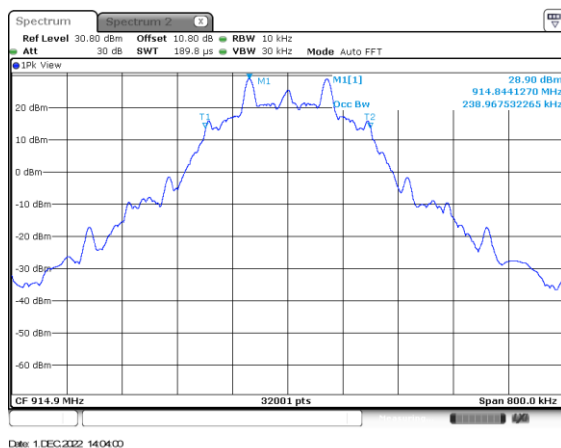


Figure 2.7.6-41: Mode 1 – 99% OBW – MCH – 115.2 kbps

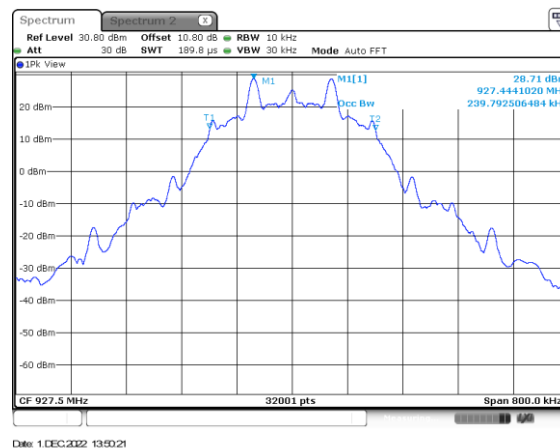


Figure 2.7.6-42: Mode 1 – 99% OBW – HCH – 115.2 kbps

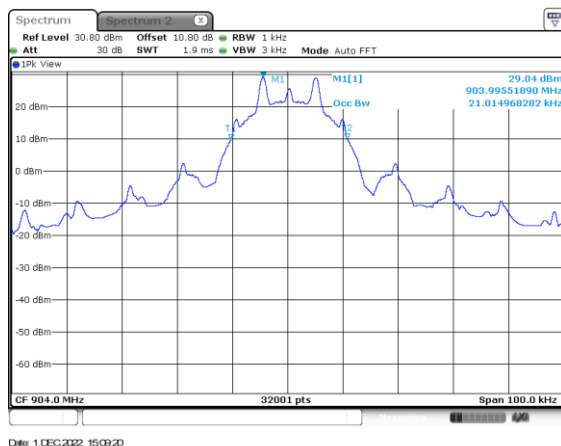


Figure 2.7.6-43: Mode 2 – 99% OBW – LCH – 9.6 kbps

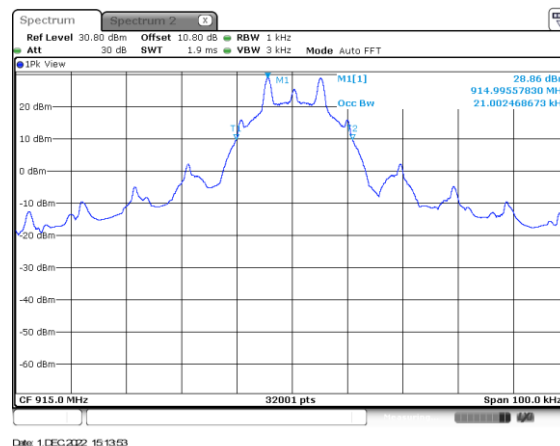


Figure 2.7.6-44: Mode 2 – 99% OBW – MCH – 9.6 kbps

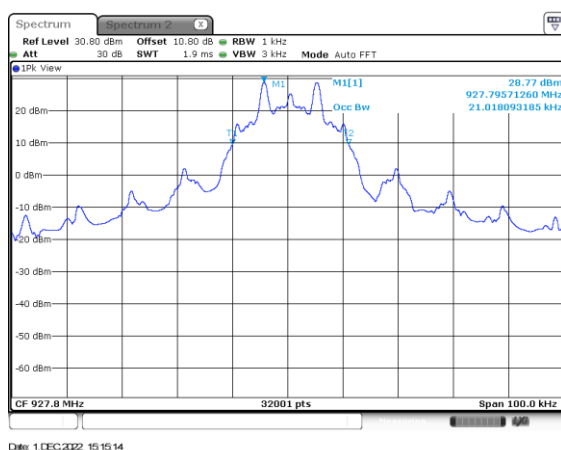


Figure 2.7.6-45: Mode 2 – 99% OBW – HCH – 9.6 kbps

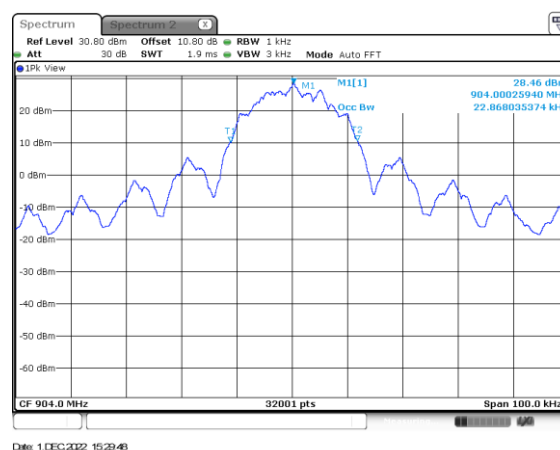


Figure 2.7.6-46: Mode 2 – 99% OBW – LCH – 19.2 kbps

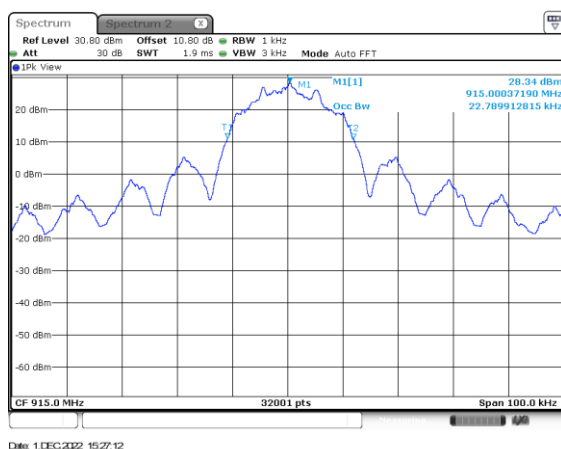


Figure 2.7.6-47: Mode 2 – 99% OBW – MCH – 19.2 kbps

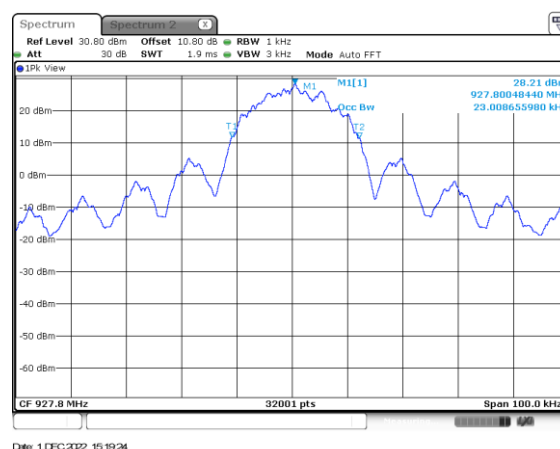


Figure 2.7.6-48: Mode 2 – 99% OBW – HCH – 19.2 kbps

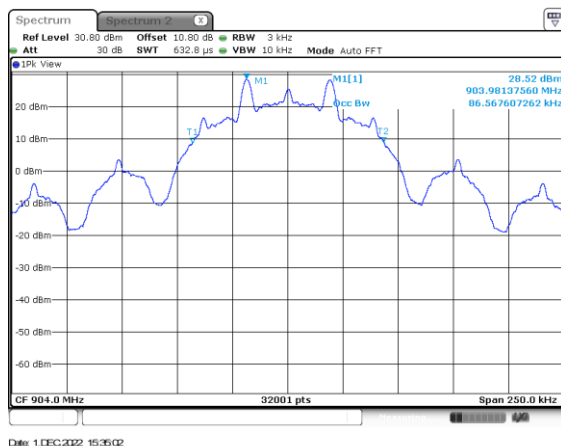


Figure 2.7.6-49: Mode 2 – 99% OBW – LCH – 38.4 kbps

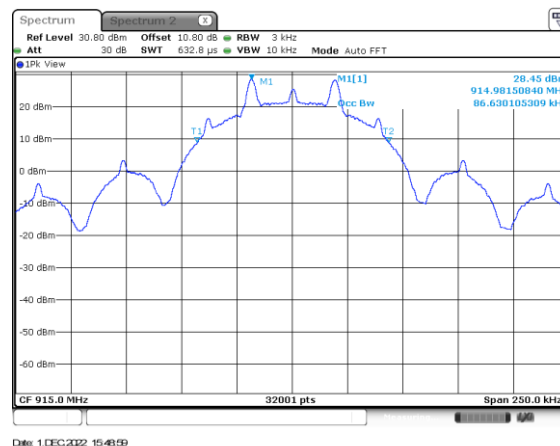


Figure 2.7.6-50: Mode 2 – 99% OBW – MCH – 38.4 kbps

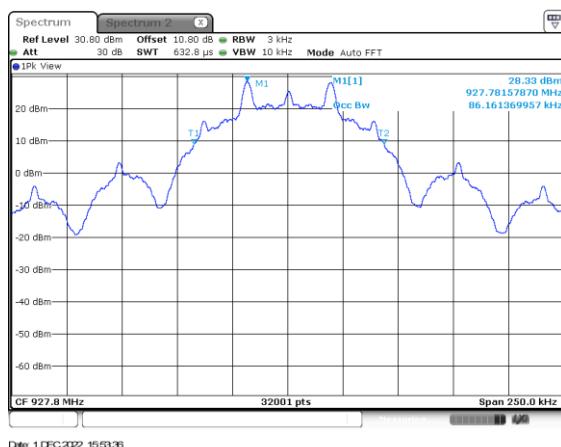


Figure 2.7.6-51: Mode 2 – 99% OBW – HCH – 38.4 kbps

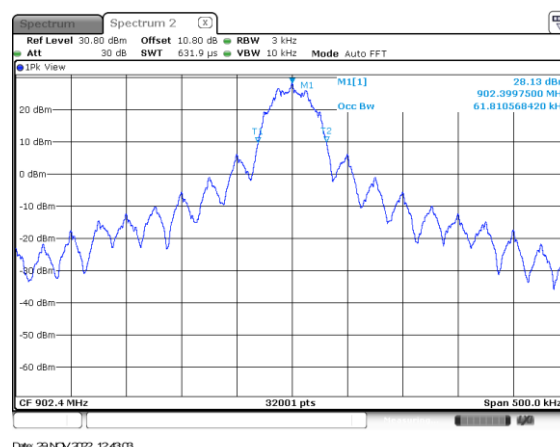


Figure 2.7.6-52: Mode 3 – 99% OBW – LCH – 50 kbps

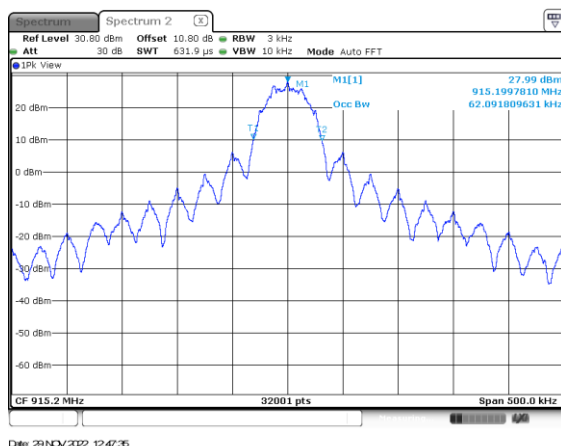


Figure 2.7.6-53: Mode 3 – 99% OBW – MCH – 50 kbps

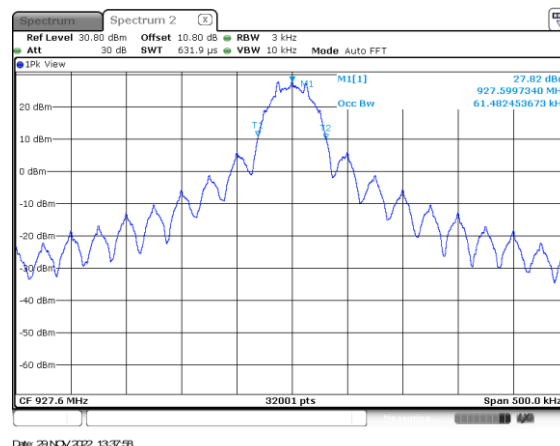


Figure 2.7.6-54: Mode 3 – 99% OBW – HCH – 50 kbps

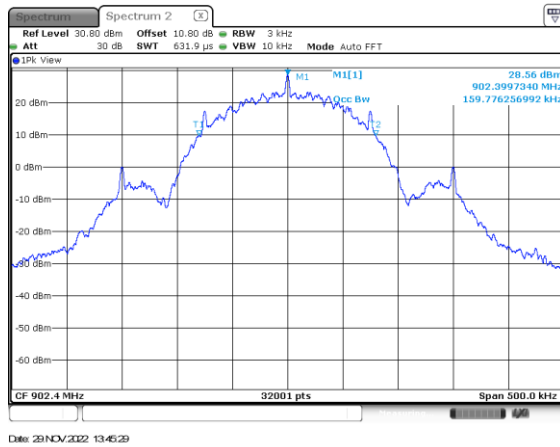


Figure 2.7.6-55: Mode 3 – 99% OBW – LCH – 150 kbps

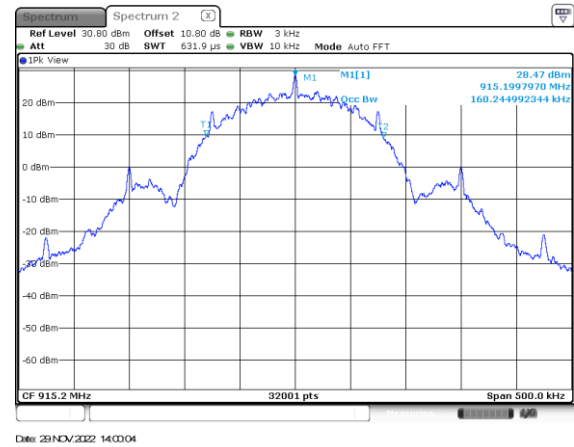


Figure 2.7.6-66: Mode 3 – 99% OBW – MCH – 150 kbps

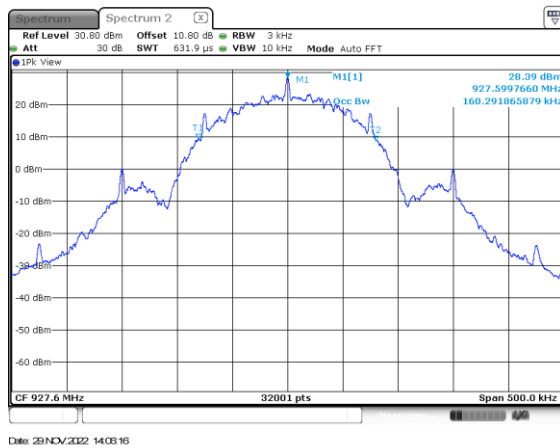


Figure 2.7.6-57: Mode 3 – 99% OBW – HCH – 150 kbps

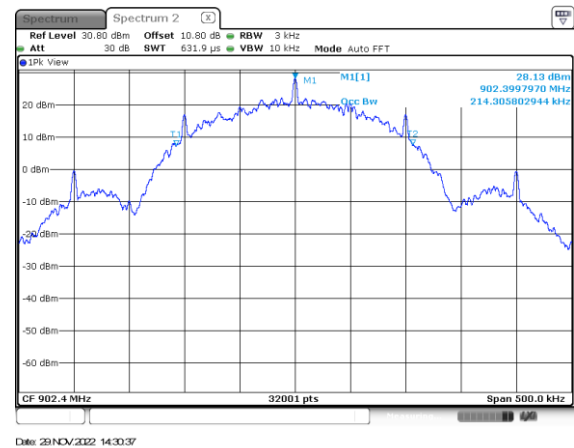


Figure 2.7.6-58: Mode 3 – 99% OBW – LCH – 200 kbps

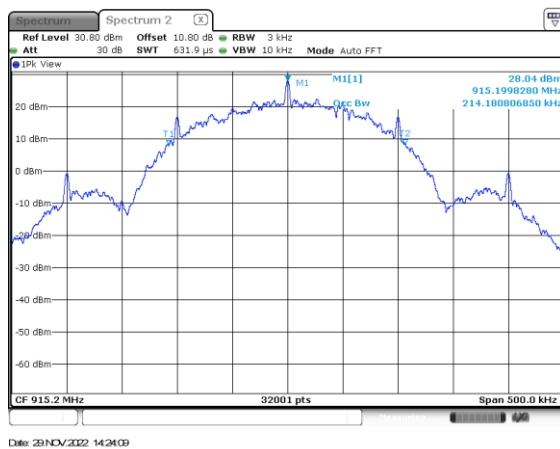


Figure 2.7.6-59: Mode 3 – 99% OBW – MCH – 200 kbps

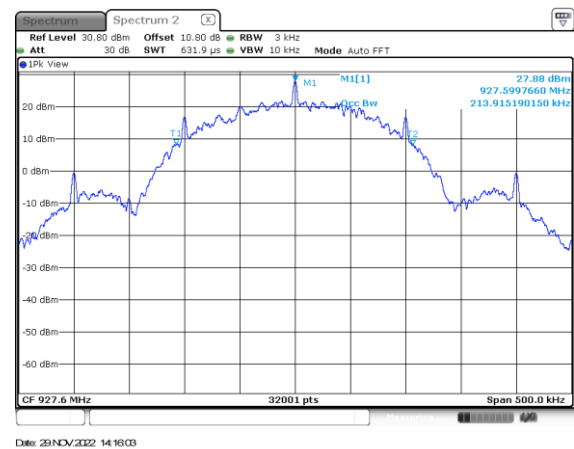


Figure 2.7.6-60: Mode 3 – 99% OBW – HCH – 200 kbps



2.8 Band-Edge Compliance of RF Conducted Emissions

2.8.1 Specification Reference

FCC Sections: 15.247(d)
ISED Canada: RSS-247 5.5

2.8.2 Equipment Under Test and Modification State

As shown in §1.4 with modification state "0", as noted in §1.6.

2.8.3 Date of Test

11/29/2022 to 12/02/2022

2.8.4 Test Method

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.

If the maximum peak conducted output power procedure was used to determine compliance, then the peak output power measured in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum in-band peak PSD level in 100 kHz (i.e., 20 dBc) Mode 1, 2 and 3 band edge frequency attenuated by 20 dBc

2.8.5 Environmental Conditions

The EUT was evaluated within the temperature, humidity and pressure range of the EUT as specified by the standard. The laboratory shall have an ambient temperature range of 15°C to 35°C, relative humidity range of 30% to 60% and atmospheric pressure range of 86 kPa to 106 kPa.

Ambient Temperature	22.3 °C
Relative Humidity	53.8 %
Atmospheric Pressure	972.2 mbar

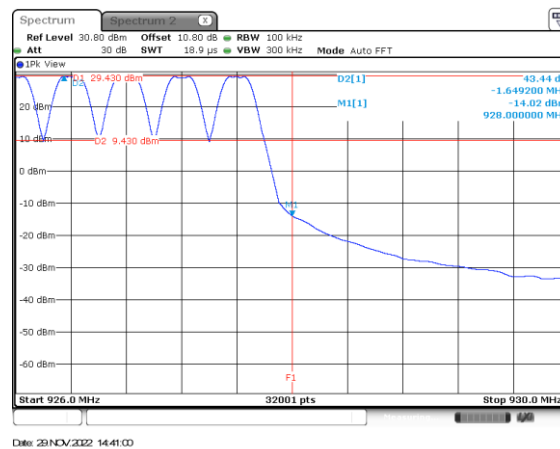
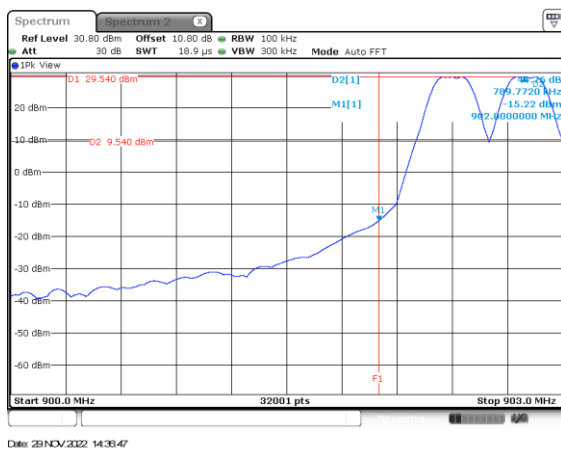
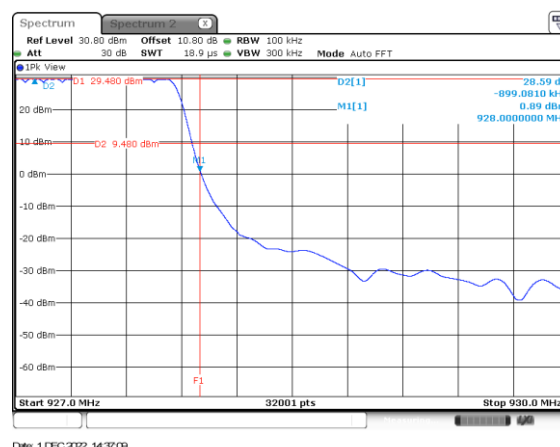
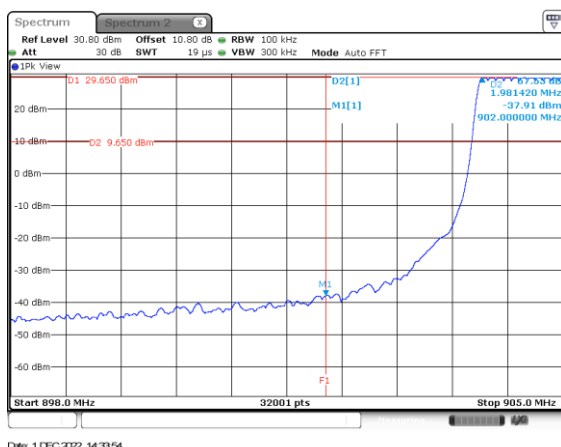
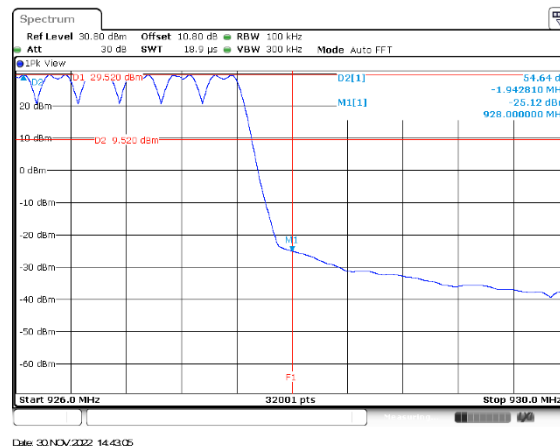
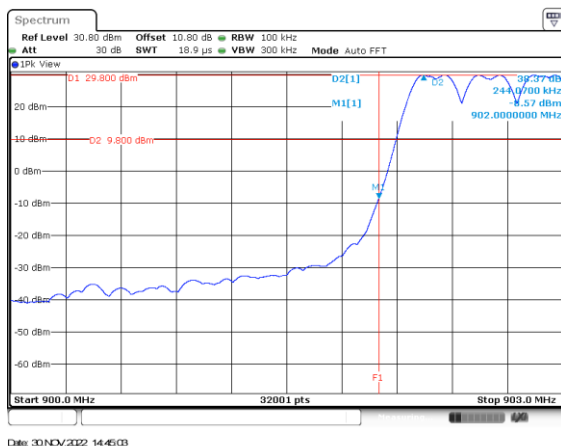
2.8.6 Test Results

Test Summary: EUT was set to transmit mode as per sections 1.4.2 / 1.4.3.

Test Results: Pass

See data below for detailed results.

HOPPING MODE:





NON-HOPPING MODE:

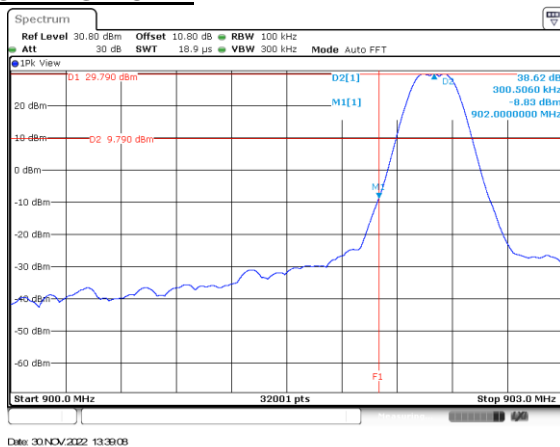


Figure 2.8.6-7: Lower Band edge – Mode 1 – 115.2kbps

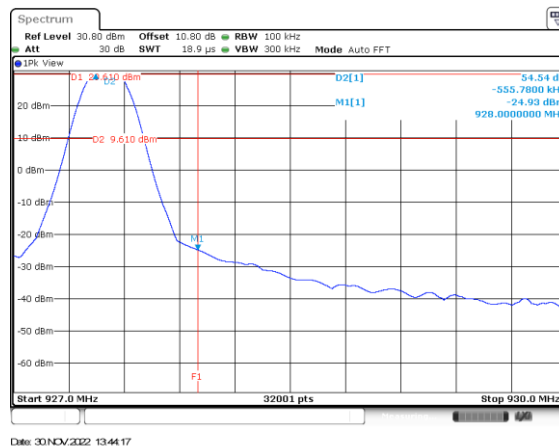


Figure 2.8.6-8: Higher Band edge – Mode 1 – 115.2kbps

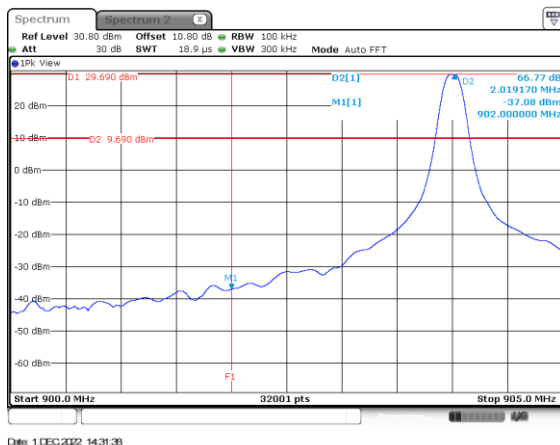


Figure 2.8.6-9: Lower Band edge – Mode 2 – 38.4kbps

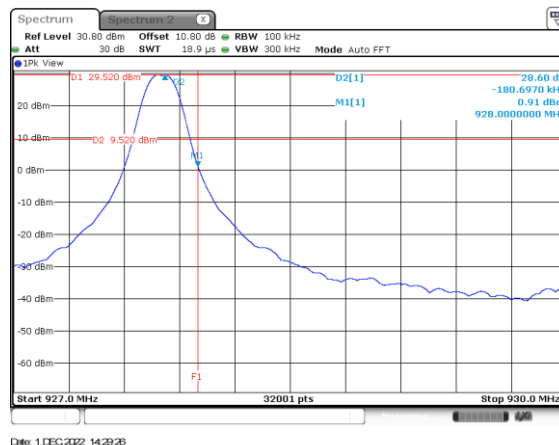


Figure 2.8.6-10: Higher Band edge – Mode 2 – 38.4kbps

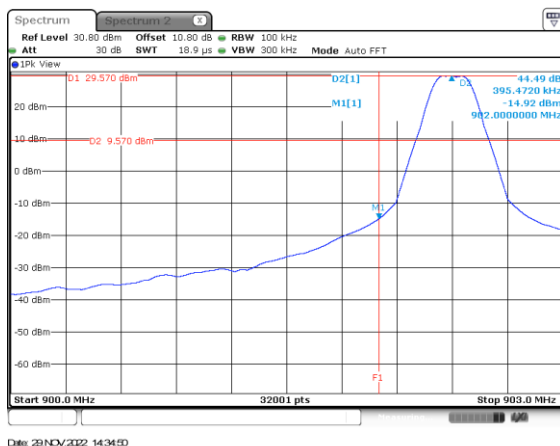


Figure 2.8.6-11: Lower Band edge – Mode 3 – 200kbps

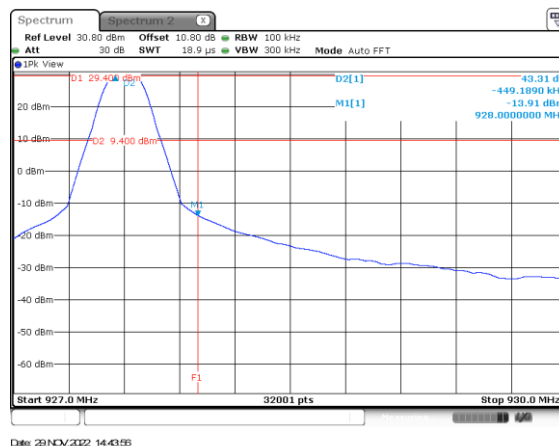


Figure 2.8.6-12: Higher Band edge – Mode 3 – 200kbps



2.9 RF Conducted Spurious Emissions

2.9.1 Specification Reference

FCC Sections: 15.247(d)
ISED Canada: RSS-247 5.5

2.9.2 Equipment Under Test and Modification State

As shown in §1.4 with modification state "0", as noted in §1.6.

2.9.3 Date of Test

11/30/2022

2.9.4 Test Method

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.

If the maximum peak conducted output power procedure was used to determine compliance, then the peak output power measured in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum in-band peak PSD level in 100 kHz (i.e., 20 dBc). Mode 1 conducted spurious emissions attenuated by 20 dBc.

2.9.5 Environmental Conditions

The EUT was evaluated within the temperature, humidity and pressure range of the EUT as specified by the standard. The laboratory shall have an ambient temperature range of 15°C to 35°C, relative humidity range of 30% to 60% and atmospheric pressure range of 86 kPa to 106 kPa.

Ambient Temperature	22.3 °C
Relative Humidity	53.8 %
Atmospheric Pressure	972.2 mbar

2.9.6 Test Results

Test Summary: EUT was set to transmit mode as per sections 1.4.2 / 1.4.3.

Test Results: Pass

See data below for detailed results.

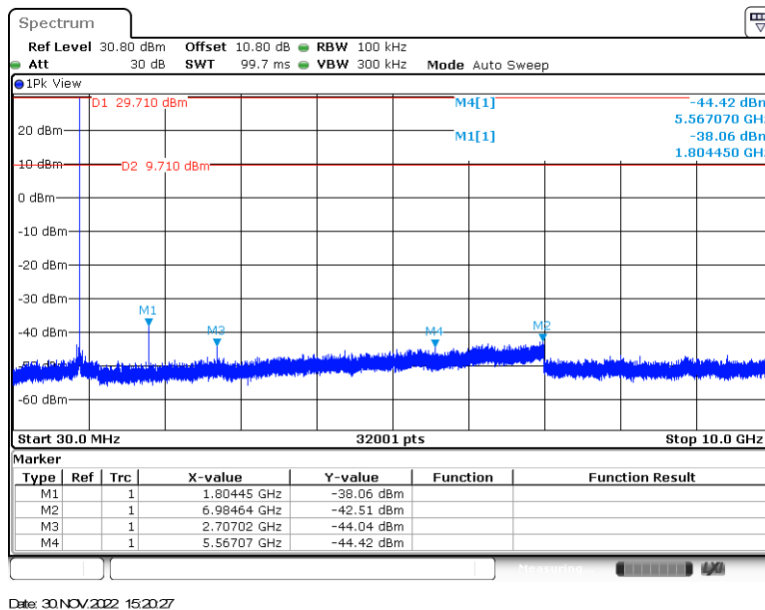


Figure 2.9.6-1:30MHz – 10GHz – LCH – Mode 1 - 115.2kbps

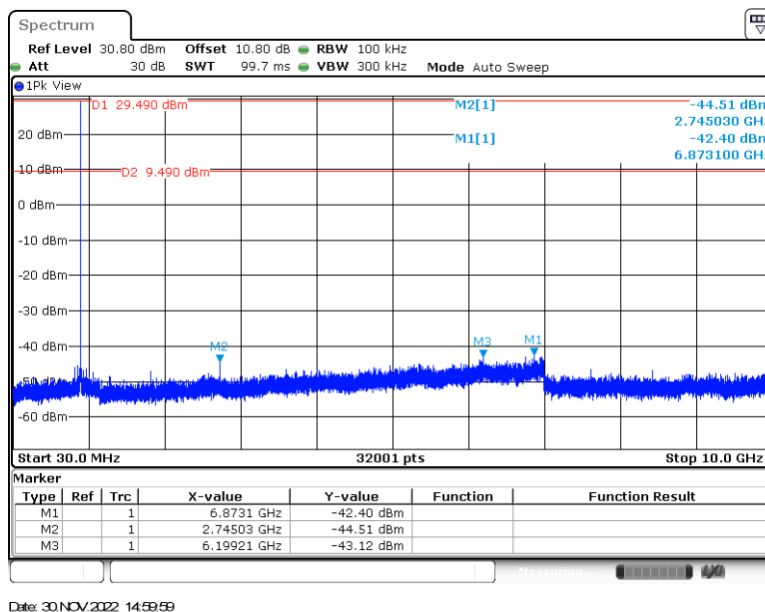


Figure 2.9.6-2:30MHz – 10GHz – MCH – Mode 1 - 115.2kbps

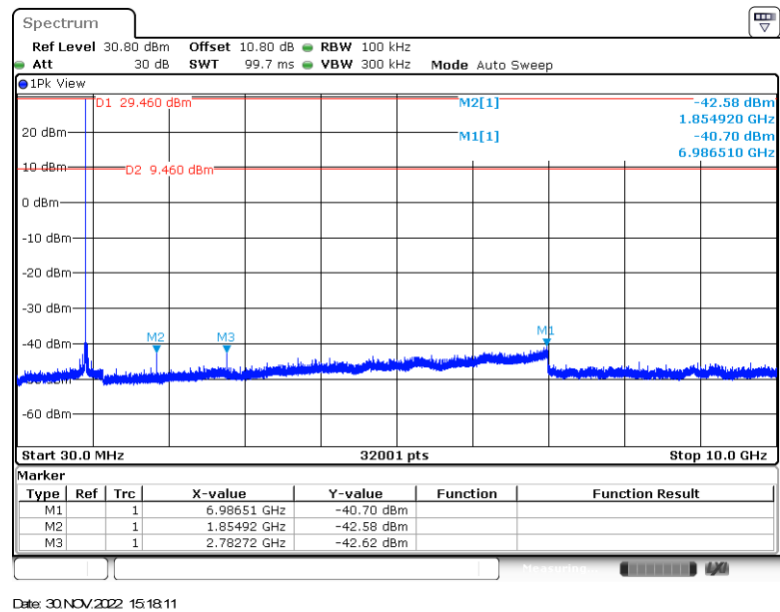


Figure 2.9.6-3:30MHz – 10GHz – HCH – Mode 1 – 115.2kbps



2.10 Radiated Spurious Emissions into Restricted Frequency Bands

2.10.1 Specification Reference

FCC Sections: 15.205, 15.209.
ISED Canada: RSS – Gen 8.9/8.10

2.10.2 Equipment Under Test and Modification State

As shown in §1.4 with modification state “0”, as noted in §1.6.

2.10.3 Date of Test

12/20/2022

2.10.4 Test Method

Radiated emissions tests were made over the frequency range of 9 kHz to 10 GHz, 10 times the highest fundamental frequency of 900 MHz. Each emission found to be in a restricted band as defined by section 15.205, including any emission at the operational band-edge, was compared to the radiated emission limits as defined in Section 15.209.

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 150 kHz, quasi-peak measurements were made using a resolution bandwidth RBW of 300 Hz and a video bandwidth VBW of 1 kHz and frequencies between 150 kHz and 30MHz, quasi-peak measurements were made using a resolution bandwidth RBW of 10 kHz and a video bandwidth VBW of 30 kHz. For frequencies between 30 MHz and 1000 MHz, quasi-peak measurements were made using a resolution bandwidth RBW of 100 kHz and a video bandwidth VBW of 300 kHz. For frequencies above 1000 MHz, peak and average measurements were made with RBW of 1 MHz and VBW of 3 MHz.

2.10.5 Environmental Conditions

The EUT was evaluated within the temperature, humidity and pressure range of the EUT as specified by the standard. The laboratory shall have an ambient temperature range of 15°C to 35°C, relative humidity range of 30% to 60% and atmospheric pressure range of 86 kPa to 106 kPa.

Ambient Temperature	22.3 °C
Relative Humidity	53.8 %
Atmospheric Pressure	972.2 mbar



2.10.6 Test Results

Test Summary: EUT was set to transmit mode as per sections 1.4.2 / 1.4.3.

Test Results: Pass

See data below for detailed results.

Table 2.10.6-1: Radiated Spurious Emissions Tabulated Data – Mode 1 – 9.6 kbps

Frequency	Peak Value	QP/Avg Value	Peak Limit	QP/Avg Limit	Peak Margin	QP/Avg Margin	Polarity	Peak Limit Results	QP/Avg Limit Results
MHz	dBμV/m	dBμV/m	dBμV/m	dBμV/m	dB	dB	H/V	Pass/Fail	Pass/Fail
LCH - 902.3 MHz									
979.095	----	38.451	----	54	----	-15.55	V	----	Pass
2706.825	52.996	46.79	74	54	-21	-7.21	H	Pass	Pass
3609.225	51.073	39.537	74	54	-22.93	-14.46	H	Pass	Pass
4511.5	49.67	36.421	74	54	-24.33	-17.58	H	Pass	Pass
5413.775	49.753	37.65	74	54	-24.25	-16.35	H	Pass	Pass
2706.825	56.76	49.157	74	54	-17.24	-4.84	V	Pass	Pass
3609.225	48.983	37.794	74	54	-25.02	-16.21	V	Pass	Pass
MCH - 915.2 MHz									
1030.4	42.9	30.783	74	54	-31.1	-23.22	H	Pass	Pass
1030.4	46.142	35.199	74	54	-27.86	-18.8	V	Pass	Pass
2745.5	54.036	42.275	74	54	-19.96	-11.72	H	Pass	Pass
3659.175	54.166	33.6	74	54	-19.83	-20.4	H	Pass	Pass
2745.5	52.927	41.477	74	54	-21.07	-12.52	V	Pass	Pass
3660.6	47.758	33.174	74	54	-26.24	-20.83	V	Pass	Pass
HCH - 927.5 MHz									
996.02	----	32.11	----	54	----	-21.89	V	Pass	Pass
2782.475	51.341	45.169	74	54	-22.66	-8.83	H	Pass	Pass
3710.025	49.069	37.456	74	54	-24.93	-16.54	H	Pass	Pass
2782.475	50.972	44.296	74	54	-23.03	-9.7	V	Pass	Pass
3710.025	49.108	37.603	74	54	-24.89	-16.4	V	Pass	Pass



TUV EMC Lab

Radiated Emissions, Under 1GHz

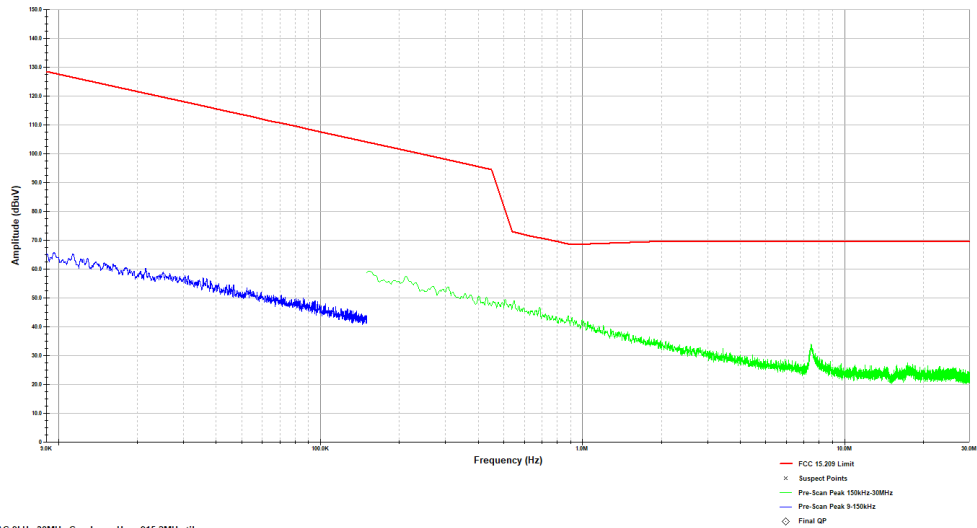
HV Graph

Company - 72181647 L+G(Elster)

Model - GNIC

Config - 9.6kbps 915.2MHz Mesh

Operator - Shree



FCC 15.209 BSAC 9kHz-30MHz Co-planer Horz 915.2MHz.tif

Last Data Update 03:29:55 PM, Tuesday, December 20, 2022

Figure 1: Reference plot for Radiated Spurious Emissions – 9 kHz – 30 MHz – Mode 1 - MCH

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

TUV EMC Lab

Radiated Emissions, Under 1GHz

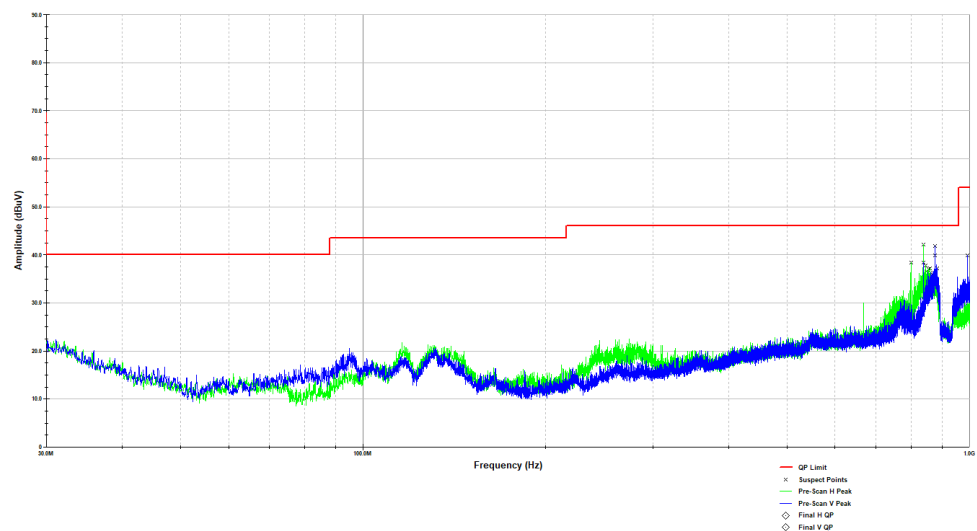
HV Graph

Company - 72181647 L+G (Elster)

Model - GNIC

Config - 9.6kbps 915.2MHz Mesh

Operator - Shree



FCC 15.209 RSE 30-1000MHz BSAC 915.2MHz.tif

Last Data Update 03:12:03 PM, Tuesday, December 20, 2022

Figure 2: Reference plot for Radiated Spurious Emissions – 30 MHz – 1 GHz – Mode 1 - MCH



TUV EMC Lab

Radiated Emissions, Above 1GHz

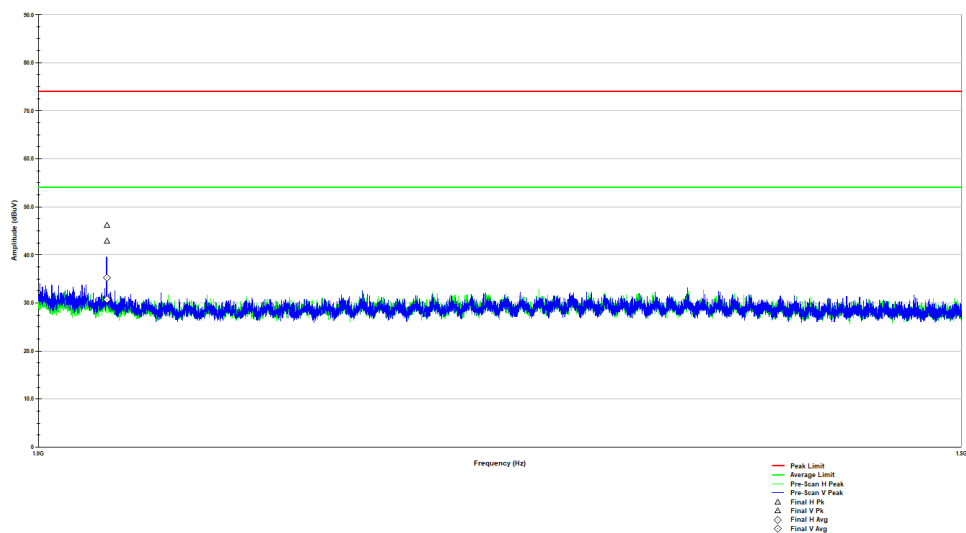
HV Graph

Company - 72181647 L+G

Model - GNIC

Config - 9.6kbps 915.2MHz Mesh

Operator - Shree

**Figure 3: Reference plot for Radiated Spurious Emissions – 1 GHz – 1.5 GHz – Mode 1 - MCH**

TUV EMC Lab

Radiated Emissions, Above 1GHz

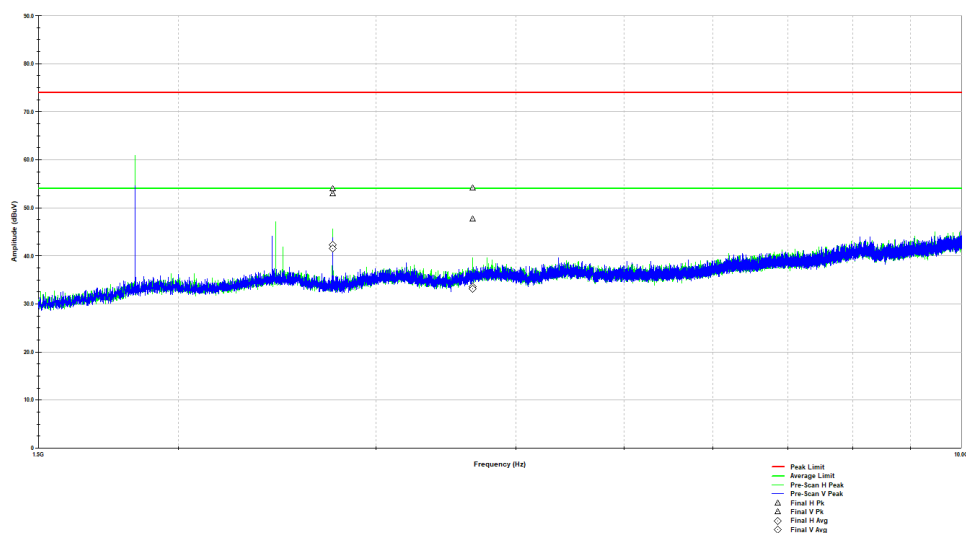
HV Graph

Company - 72181647 L+G

Model - GNIC

Config - 9.6kbps 915.2MHz Mesh

Operator - Shree

**Figure 4: Reference plot for Radiated Spurious Emissions – 1.5 GHz – 10 GHz – Mode 1 - MCH**

Note: Only emissions within restricted band were evaluated.



2.11 Test Equipment Used

Table 2.11-1 –Equipment List

Asset ID	Manufacturer	Model	Equipment Type	Serial Number	Last Calibration Date	Calibration Due Date
628	EMCO	6502	Active Loop Antenna 10kHz-30MHz	9407-2877	06/08/2021	06/08/2023
853	Teseq	CBL6112D	BiLog Antenna	51616	7/15/2021	7/15/2023
884	ETS Lindgren (EMCO)	3117	DOUBLE-RIDGED GUIDE ANTENNA	240106	5/6/2021	5/6/2023
889	Com Power	PAM 103	Pre-amplifier	18020215	9/27/2022	9/27/2023
338	Hewlett Packard	8449B	High Frequency Pre-Amp	3008A01111	6/22/2021	6/22/2023
882	Rohde & Schwarz	ESW44	ESW44 EMI TEST RECEIVER	101961	7/14/2022	7/14/2023
22	Teledyne Storm Microwave	90-195-456	BSAC Cable	N/A	10/7/2022	10/7/2023
20	Teledyne Storm Microwave	R-90-195-036	BSAC Cable	N/A	7/12/2022	7/12/2023
21	Teledyne Storm Microwave	R-90-195-072	BSAC Cable	N/A	7/12/2022	7/12/2023
337	Microwave Circuits	H1G513G1	Microwave filter	282706	5/31/2022	5/31/2023
827	Rohde & Schwarz	RF Cable set	TS8997 Rack cable set	N/A	12/20/2021	12/20/2022
622	Rohde & Schwarz	FSV40 (v3.40)	FSV Signal Analyzer 10Hz to 40GHz	101338	10/05/2022	10/05/2023
872	HP	E7402A	EMI Receiver	US40240258	6/21/2022	6/21/2023
871	ACS	n/a	Conducted EMI Cable	871	4/1/2022	4/1/2023
3010	Rohde & Schwarz	ENV216	Two-Line V-Network	3010	6/22/2022	6/22/2023

N/A – Not Applicable

NCR – No Calibration Required

3 Diagram of Test Set-ups

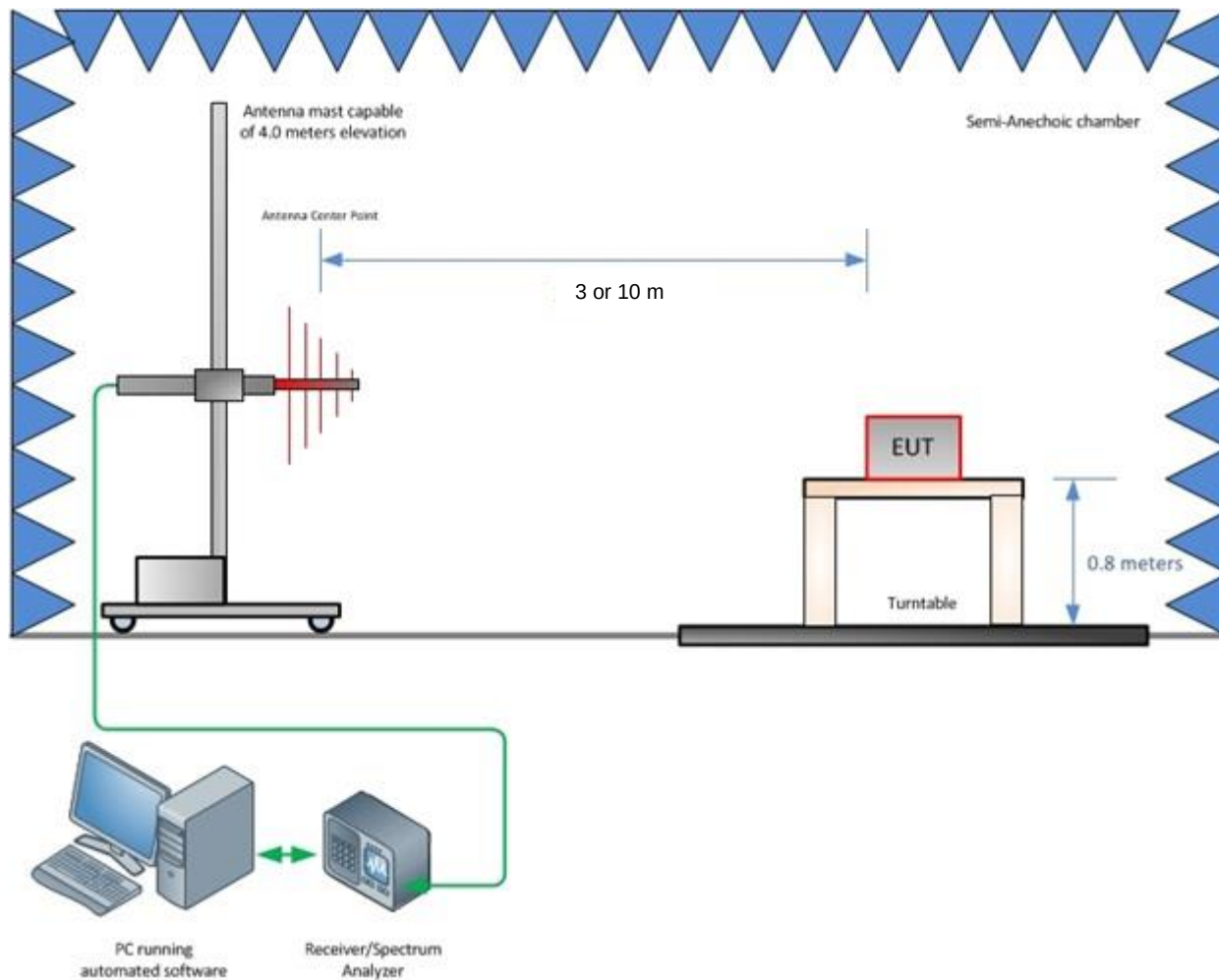


Figure 3-1 – Radiated Emissions Test Setup up to 1 GHz

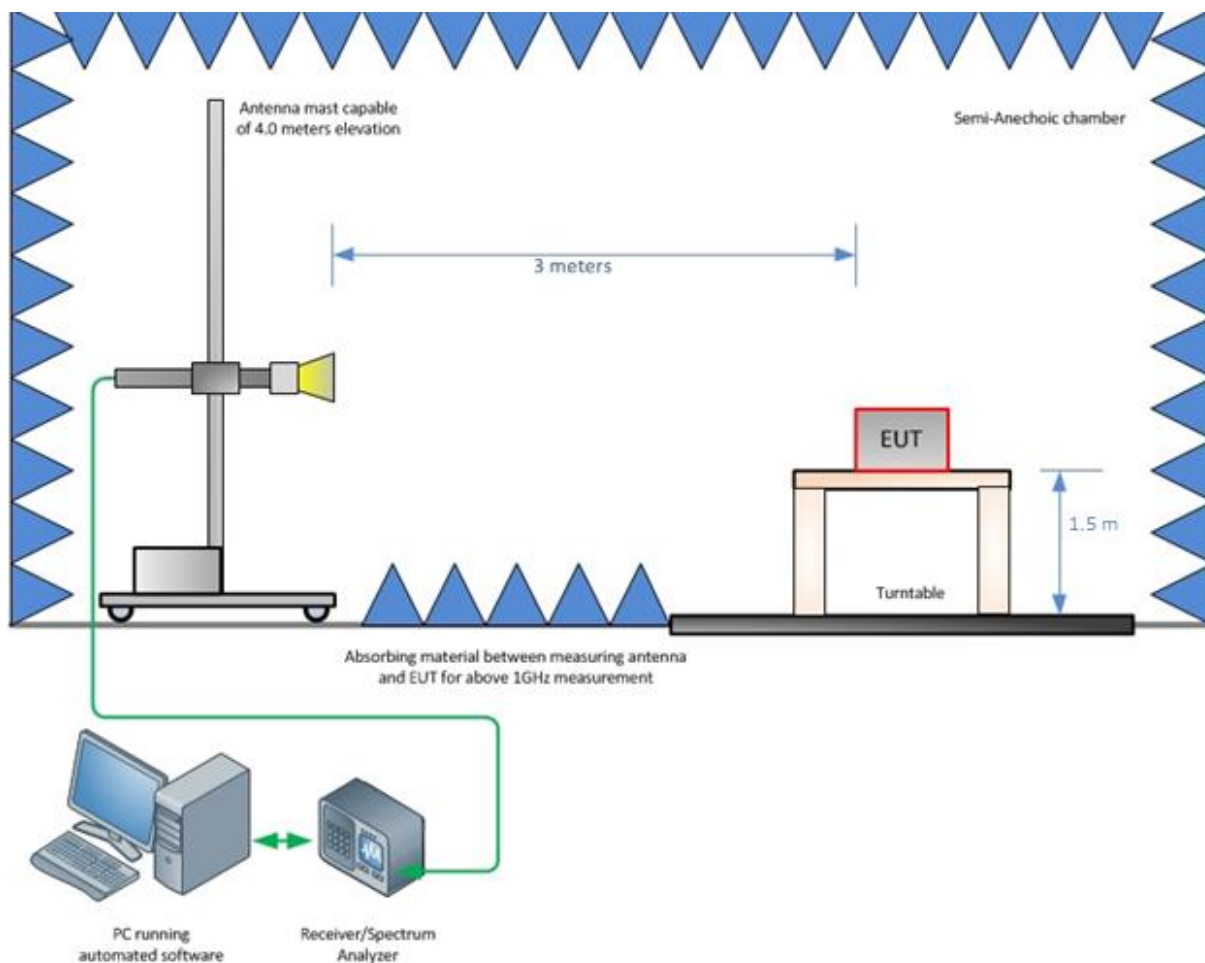


Figure 3-2 – Radiated Emissions Test Setup above 1 GHz

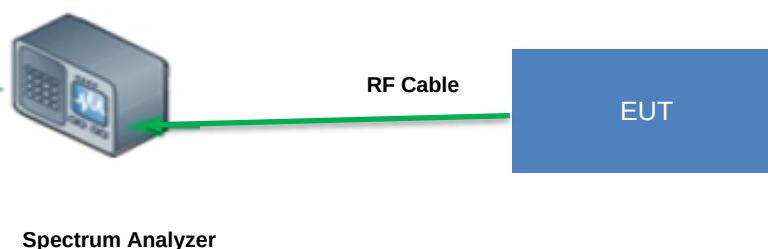


Figure 3-3 – Conducted Test Setup: Antenna Port measurement



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STATEMENT 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 4-1: Estimation of Measurement Uncertainty

Parameter	U_{lab}
Occupied Channel Bandwidth	$\pm 0.009 \%$
RF Conducted Output Power	$\pm 0.349 \text{ dB}$
Power Spectral Density	$\pm 0.372 \text{ dB}$
Antenna Port Conducted Emissions	$\pm 1.264 \text{ dB}$
Radiated Emissions $\leq 1 \text{ GHz}$	$\pm 5.814 \text{ dB}$
Radiated Emissions $> 1 \text{ GHz}$	$\pm 4.318 \text{ dB}$
Temperature	$\pm 0.860 \text{ }^{\circ}\text{C}$
Radio Frequency	$\pm 2.832 \times 10^{-8}$
AC Power Line Conducted Emissions	$\pm 3.360 \text{ dB}$

TEST EQUIPMENT

All measurement instrumentation is traceable to the National Institute of Standards and Technology and is calibrated to meet test method standard requirements and/or manufacturer's specifications.