

Report on the Testing of the Landis + Gyr Technology, Inc. Series-6 RF Mesh mSBR Card

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

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



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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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TÜV SÜD America
5945 Cabot Parkway, Suite 100
Alpharetta, GA 3005

Phone: 678-341-5900
www.tuv-sud-america.com

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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	2/6/2023

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 3 additional transmission modes and two new antennas (dipole and sector antenna) to the 900 MHz radio on pre-approved module FCC ID: R7PNG0R1S4 / IC: 5294A-NG0R1S4.

This evaluation also addresses a reduction of power output to accommodate the use of higher gain antennas.

The Series-6 RF Mesh mSBR Card radio module contains both 900 MHz and 2.4 GHz radios. The additional transmission modes and antennas addressed in this report are only applicable to the 900 MHz radio.

Applicant	Mr. Raghav Goteti
Manufacturer	Landis + Gyr Technology, Inc.
Applicant's Email Address	Raghav.Goteti@landisgyr.com
Model Name(s)	Series 6 RF Mesh mSBR Card
Product Marketing Name(s)	N651
Serial Number(s)	LAN ID: 612946CA (Conducted measurement) LAN ID: 612949B1 (Radiated measurement)
FCC ID	R7PNG0R1S4
ISED Certification Number	5294A-NG0R1S4
Hardware Version(s)	40-2060
Software Version(s)	Wi-SUN: 26.56 Mesh IP: 24.21
Number of Samples Tested	2
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	72185765
Date of Receipt of EUT	12/15/2022
Start of Test	12/16/2022
Finish of Test	1/25/2023
Related Document(s)	<p>ANSI C63.10-2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Device.</p> <p>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</p> <p>US Code of Federal Regulations (CFR): Title 47, Part 2, Subpart J: Equipment Authorization Procedures, 2022.</p> <p>ISED Canada Radio Standards Specification: RSS-GEN – General Requirements for Compliance of Radio Apparatus, Issue 5, Amendment 1 (March 2019), Amendment 2 (February 2021)</p>



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, 15.204	-----	12
Carrier Frequency Separation	Yes	Pass	15.247(a)(1)	RSS-247 5.1(b)	22
Number of Hopping Channels	Yes	Pass	15.247(a)(1)(i)	RSS-247 5.1(c)	24
Channel Dwell Time	No	Not Tested	15.247(a)(1)(i) 15.247(f)	RSS-247 5.1(c) RSS-247 5.3(a)	26
20 dB Bandwidth	Yes	Pass	15.247(a)(1)(i)	RSS-247 5.1(c)	27
99% Bandwidth	Yes	Pass	-----	RSS-GEN 6.7	27
Peak Output Power	Yes	Pass	15.247(b)(2)	RSS-247 5.4(a)	18
Average Output Power	Yes	Pass	15.247(b)(3)	RSS-247 5.4(a)	20
Band-Edge Compliance of RF Conducted Emissions	Yes	Pass	15.247(d)	RSS-247 5.5	33
RF Conducted Spurious Emissions	Yes	Pass	15.247(d)	RSS-247 5.5	36
Radiated Spurious Emissions into Restricted Frequency Bands	Yes	Pass	15.205, 15.209	RSS-GEN 8.9, 8.10	39
Power Spectral Density	Yes	Pass	15.247(e)	RSS-247 5.2(b)	31
Power Line Conducted Emissions	Yes	Pass	15.207	RSS-GEN 8.8	13
Duty Cycle	No	-----			-----

1.4 Product Information

1.4.1 Technical Description

The Series-6 RF Mesh platform supports half-duplex operation in both the Sub-GHz and 2.4-GHz bands. There are 2 types of RF Mesh Communication Stacks supported by the Series-6 platform: Mesh IP (SBS) and Wi-SUN (WSN).

Table 1.4-1 – Wireless Technical Information

Detail	Description
FCC ID	R7PNG0R1S4
ISED Certification Number	5294A-NG0R1S4
Model(s) / HVIN(s)	Series 6 RF Mesh mSBR Card
PMN(s)	N651
Frequency Range	902.2 – 927.8 MHz
Modulation Format	FSK, OFDM
Antenna Type / Description:	Dipole Antenna / 5.15 dBi Gain Sector Antenna / 9.0 dBi Gain

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

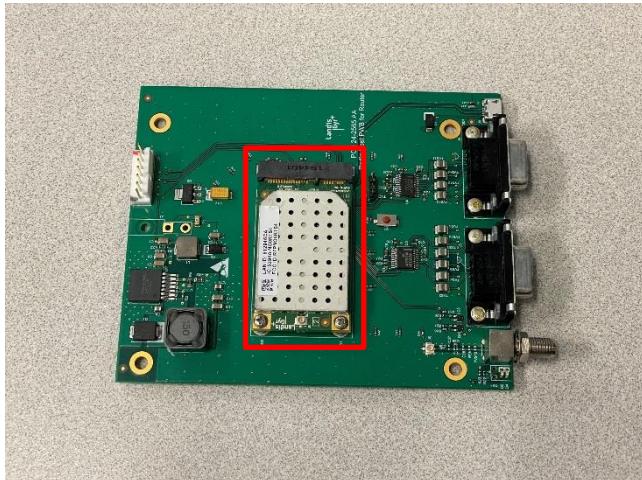


Figure 1.4.1-1 –Front view of the Conducted EUT module with evaluation board

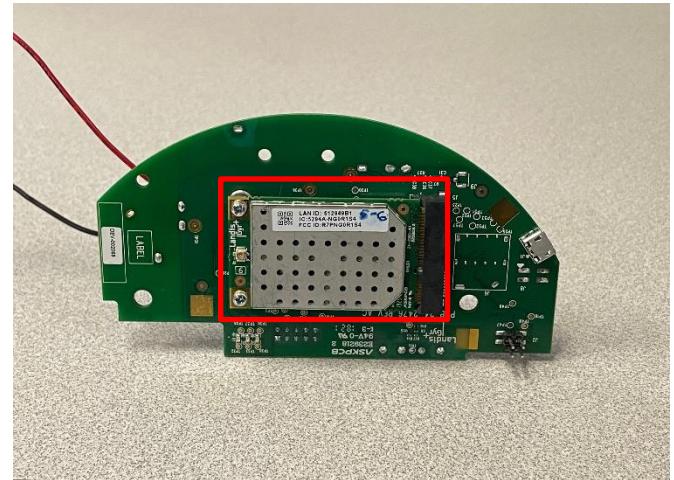


Figure 1.4.1-2 –Front view of the Radiated EUT module with evaluation board

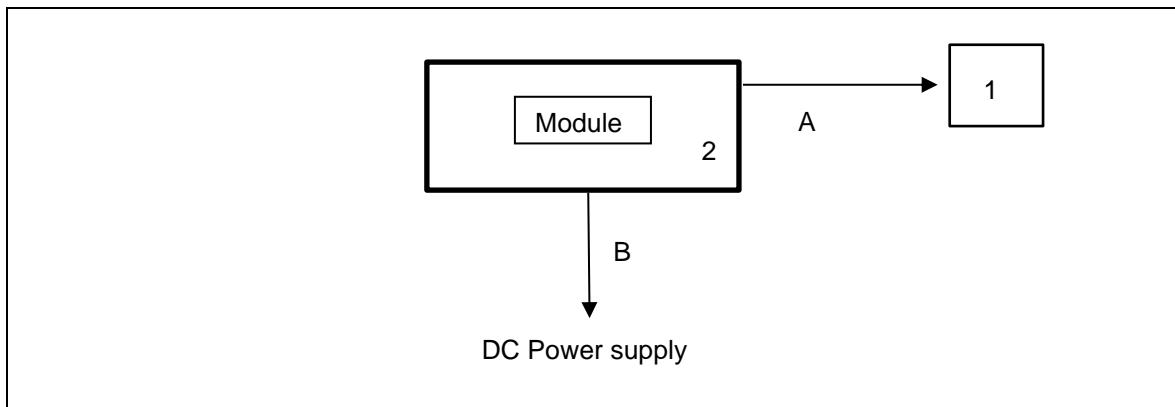


Figure 1.4.1-3 – Conducted Test Setup Block Diagram

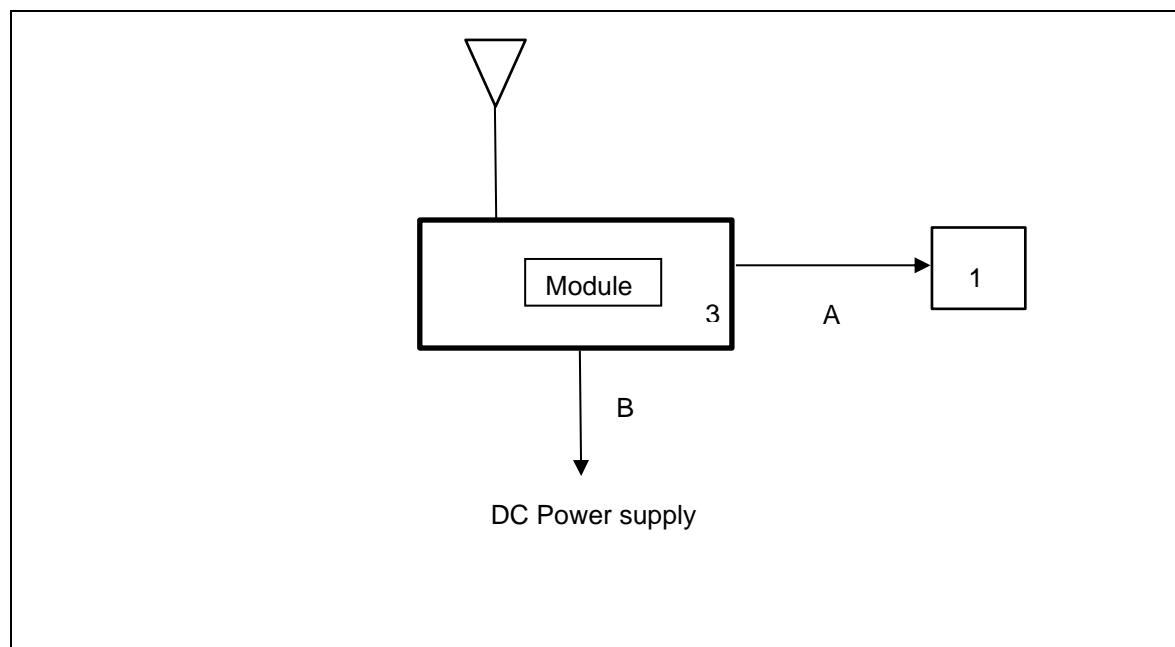


Figure 1.4.1-4 – Radiated Test Setup Block Diagram

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

**Table 1.4.1-2 – Support Equipment Descriptions**

Item	Make/Model	Description
1	Thinkpad	Laptop for configuration
2	Landis & Gyr	Evaluation Board
3	Landis & Gyr	Evaluation Board

Two different evaluation boards were used for conducted and radiated measurements to stay consistent with the original FCC unit setup photos.



1.4.2 Modes of Operation

The Landis + Gyr Series-6 RF Mesh mSBR Card radio is an electricity metering module which includes a 900 MHz ISM transmitter as well as a 2.4 GHz OFDM transmitter.

This test report documents the compliance of the 900 MHz Frequency Hopping Spread Spectrum transceiver mode of operation. This model provides distinct proprietary modes of operation using both FHSS and hybrid 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)	Stack / Mode	Data Rates (kbps) / Coding Schemes	Classification
1	902.2 – 927.8	129	200	WSN (802.15.4 SUN FSK)	50	FHSS
2	902.4 – 927.6	64	400	SBS (802.15.4 SUN OFDM)	MCS3 – MCS6	Hybrid
3	902.4 – 927.6	64	400	WSN (802.15.4 SUN OFDM)	MCS2 – MCS3	Hybrid



1.4.3 Monitoring of Performance

For radiated emissions and AC Power Line conducted emissions, the EUT was evaluated with external dipole and sector antennas. For radiated emissions, the EUT was evaluated in three orthogonal orientations. The worst-case orientation was Y-position. 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 U.fl 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
1	FHSS	50	50	50	50	NA	50	50	50***	NA
2	Hybrid	**	NA	**	**	**	**	**	**	**
3	Hybrid	MCS2	NA	MCS2	NA	MCS2	MCS2	MCS2	MCS2***	MCS2

** Addressed by mode 3

*** RSE testing was performed with both Dipole and sector antennas and covers legacy modes declared in the original certification.

Power setting during test: Mode of operation 1: 30 dBm for Dipole antenna
 Mode of operation 1: 26 dBm for Sector antenna
 Mode of operation 2/3: 25 dBm



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	Divya Adusumilli	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, 15.204

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

12/16/2022

2.1.4 Test Method

N/A

2.1.5 Environmental Conditions

N/A

2.1.6 Observation

The EUT utilizes two external antennas, dipole antenna with peak gain 5.15 dBi and sector antenna with peak gain 9 dBi. Connection to the module is via U.fl to SMA adapter cable, 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

1/25/2023

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

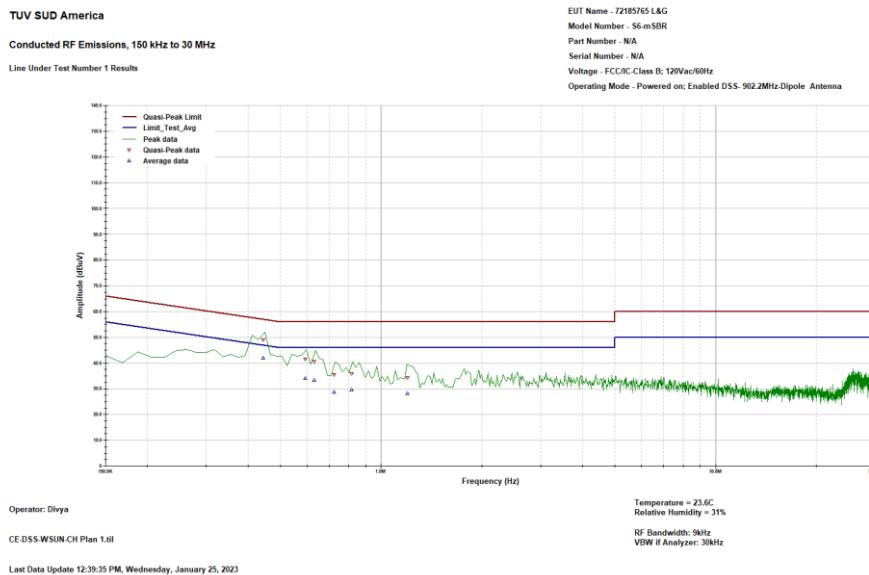


Figure 1: Conducted Emission Plot – Line 1 – Dipole Antenna

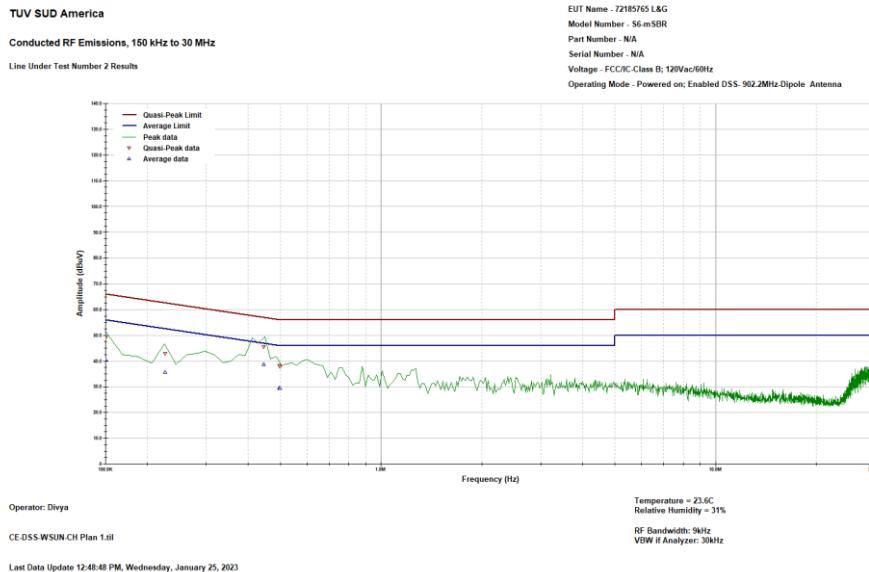


Figure 2: Conducted Emission Plot – Neutral - – Dipole Antenna

**Table 2.2.6-1: Conducted EMI Results-Avg – Line 1 – Dipole Antenna**

Frequency	Avg Limit	Avg Level Corr	Avg Level	CF	Avg Margin	Result
MHz	dBuV	dBuV	dBuV	dB	dB	
0.44	47.6	41.9	32.2	9.653	-5.7	PASS
0.59	46	34.1	24.5	9.656	-11.9	PASS
0.63	46	33.3	23.6	9.658	-12.7	PASS
0.72	46	28.8	19.1	9.663	-17.2	PASS
0.82	46	29.6	19.9	9.669	-16.4	PASS
1.2	46	28.1	18.4	9.692	-17.9	PASS

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

Frequency	QP Limit	QP Level Corr	QP Level	CF	QP Margin	Result
MHz	dBuV	dBuV	dBuV	dB	dB	
0.44	57.6	48.9	39.2	9.653	-8.7	PASS
0.59	56	41.5	31.8	9.656	-14.5	PASS
0.63	56	40.6	31	9.658	-15.4	PASS
0.72	56	35.6	25.9	9.663	-20.4	PASS
0.82	56	35.9	26.2	9.669	-20.1	PASS
1.2	56	34.2	24.5	9.692	-21.8	PASS

Table 2.2.6-3: Conducted EMI Results-Avg – Neutral – Dipole Antenna

Frequency	Avg Limit	Avg Level Corr	Avg Level	CF	Avg Margin	Result
MHz	dBuV	dBuV	dBuV	dB	dB	
0.15	56	40.5	30.9	9.675	-15.5	PASS
0.23	53.8	35.7	26	9.667	-18.2	PASS
0.45	47.5	38.8	29.2	9.638	-8.7	PASS
0.5	46.1	29.7	20.1	9.63	-16.4	PASS
0.5	46	29.4	19.8	9.63	-16.6	PASS

Table 2.2.6-4: Conducted EMI Results-QP – Neutral – Dipole Antenna

Frequency	QP Limit	QP Level Corr	QP Level	CF	QP Margin	Result
MHz	dBuV	dBuV	dBuV	dB	dB	
0.15	66	49	39.4	9.675	-17	PASS
0.23	63.8	43	33.4	9.667	-20.8	PASS
0.45	57.5	45.6	35.9	9.638	-12	PASS
0.5	56.1	38.2	28.6	9.63	-17.9	PASS
0.5	56	37.8	28.2	9.63	-18.2	PASS

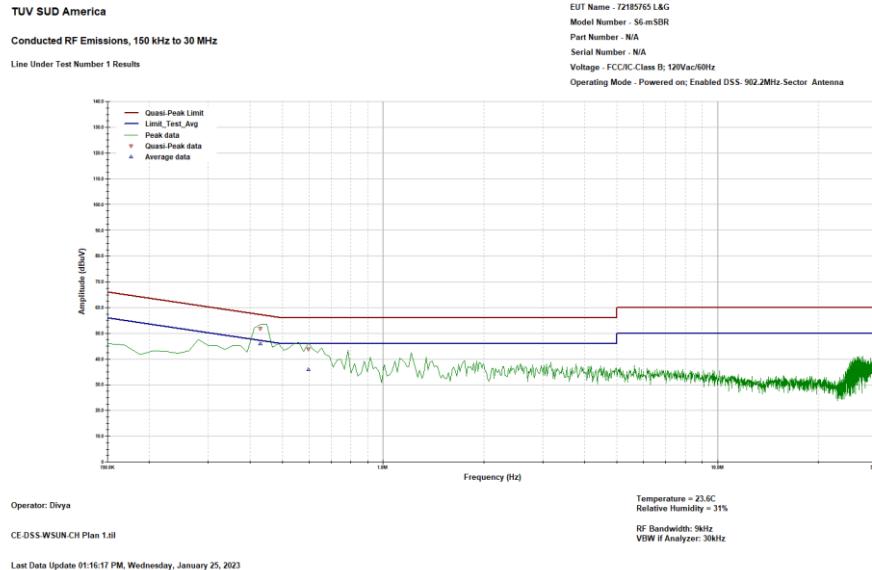


Figure 3: Conducted Emission Plot – Line 1 – Sector Antenna

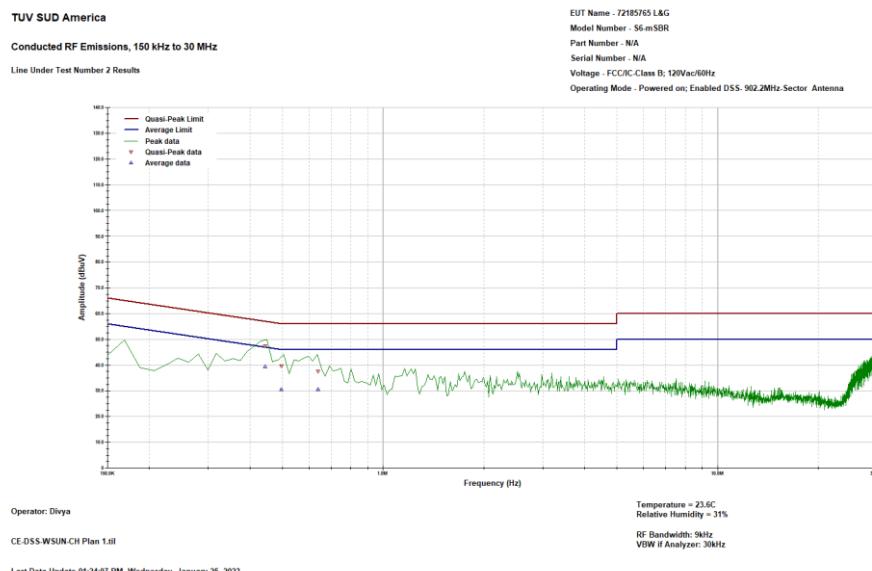


Figure 4: Conducted Emission Plot – Neutral - – Sector Antenna

**Table 2.2.6-5: Conducted EMI Results-Avg – Line 1 – Sector Antenna**

Frequency	Avg Limit	Avg Level Corr	Avg Level	CF	Avg Margin	Result
MHz	dBuV	dBuV	dBuV	dB	dB	
0.43	48	46	36.3	9.654	-2	PASS
0.6	46	36	26.3	9.656	-10	PASS
29.94	50	32.7	22.6	10.127	-17.3	PASS
29.99	50	32.7	22.6	10.13	-17.3	PASS
30	50	32.7	22.6	10.13	-17.3	PASS

Table 2.2.6-6: Conducted EMI Results-QP – Line 1 – Sector Antenna

Frequency	QP Limit	QP Level Corr	QP Level	CF	QP Margin	Result
MHz	dBuV	dBuV	dBuV	dB	dB	
0.43	58	51.8	42.1	9.654	-6.2	PASS
0.6	56	43.9	34.3	9.656	-12.1	PASS
29.94	60	38.9	28.8	10.127	-21.1	PASS
29.99	60	39.1	28.9	10.13	-20.9	PASS
30	60	38.9	28.8	10.13	-21.1	PASS

Table 2.2.6-7: Conducted EMI Results-Avg – Neutral – Sector Antenna

Frequency	Avg Limit	Avg Level Corr	Avg Level	CF	Avg Margin	Result
MHz	dBuV	dBuV	dBuV	dB	dB	
0.44	47.6	39.5	29.8	9.638	-8.1	PASS
0.5	46.1	30.5	20.9	9.631	-15.6	PASS
0.64	46	30.5	20.9	9.638	-15.5	PASS
29.37	50	33.2	23	10.207	-16.8	PASS
29.78	50	34.6	24.4	10.216	-15.4	PASS
30	50	35	24.8	10.22	-15	PASS

Table 2.2.6-8: Conducted EMI Results-QP – Neutral – Sector Antenna

Frequency	QP Limit	QP Level Corr	QP Level	CF	QP Margin	Result
MHz	dBuV	dBuV	dBuV	dB	dB	
0.44	57.6	47.2	37.6	9.638	-10.3	PASS
0.5	56.1	39.7	30	9.631	-16.5	PASS
0.64	56	37.5	27.9	9.638	-18.5	PASS
29.37	60	38.9	28.7	10.207	-21.1	PASS
29.78	60	40.1	29.9	10.216	-19.9	PASS
30	60	40.6	30.3	10.22	-19.4	PASS



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

12/16/2022 to 01/20/2023

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 – Mode 1 – Power Setting 30 dBm (Dipole Antenna)**

Frequency [MHz]	Peak Output Power (dBm)	E.I.R.P (dBm)	Data Rate (kbps)	Mode(s)
902.2	29.96	35.11	50	1
915.0	29.80	34.95	50	1
927.8	28.92	34.07	50	1

Table 2.3.6-2: RF Output Power – FHSS – Mode 1 – Power Setting 26 dBm (Sector Antenna)

Frequency [MHz]	Peak Output Power (dBm)	E.I.R.P (dBm)	Data Rate (kbps)	Mode(s)
902.2	25.77	34.77	50	1
915.0	25.75	34.75	50	1
927.8	25.73	34.73	50	1



2.4 Average Output Power

2.4.1 Specification Reference

FCC Sections: 15.247(b)(3)
ISED Canada: RSS-247 5.4(a)

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

12/16/2022

2.4.4 Test Method

The Average conducted output power was measured in accordance with ANSI C63.10 Subclause 11.9.2.3.1 Method AVGPM (Average Power Meter). The RF output port of the EUT was directly connected to the input of an Average power meter. The resulting average value was recorded.

Note: This measurement method was evaluated for Hybrid Classification.

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 data below for detailed results.

**Table 2.4.6-1: RF Output Power – Hybrid – Mode 3 – Power Setting 25 dBm (Dipole Antenna)**

Frequency [MHz]	Average Output Power (dBm)	E.I.R.P (dBm)	Coding Scheme	Mode(s)
902.4	25.11	30.26	MCS2	3
915.2	25.00	30.15	MCS2	3
927.6	23.67	28.82	MCS2	3

Table 2.4.6-2: RF Output Power – Hybrid – Mode 3 – Power Setting 25 dBm (Sector Antenna)

Frequency [MHz]	Average Output Power (dBm)	E.I.R.P (dBm)	Coding Scheme	Mode(s)
902.4	25.11	34.11	MCS2	3
915.2	25.00	34.00	MCS2	3
927.6	23.67	32.67	MCS2	3



2.5 Carrier Frequency Separation

2.5.1 Specification Reference

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

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

12/16/2022

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 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.

2.5.5 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.

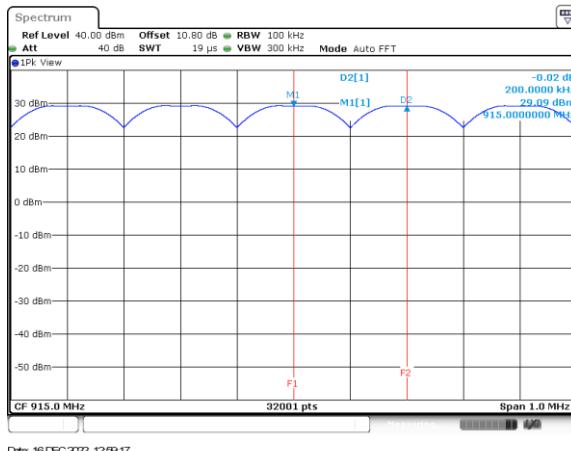


Figure 2.5.6-1: Channel Separation – Mode 1 – 50kbps

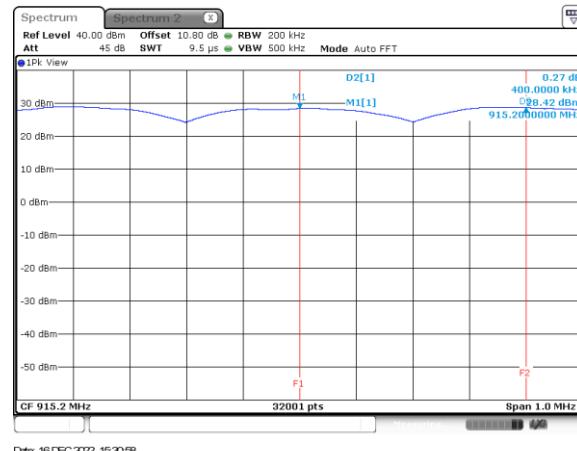


Figure 2.5.6-2: Channel Separation – Mode 3 – MCS2



2.6 Number of Hopping Channels

2.6.1 Specification Reference

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

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

12/16/2022

2.6.4 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.

2.6.5 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

2.6.6 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.

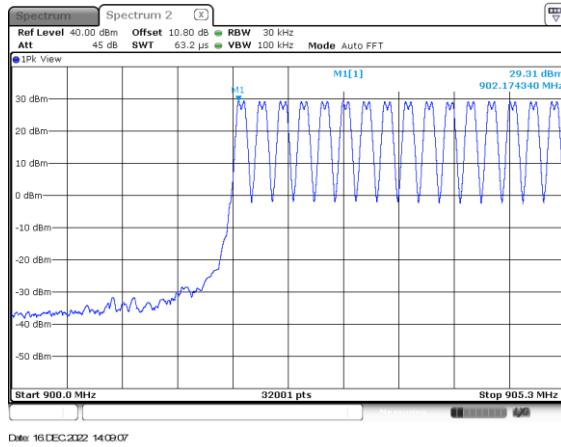


Figure 2.6.6-1: Mode 1 – 50 kbps (129 Channels)

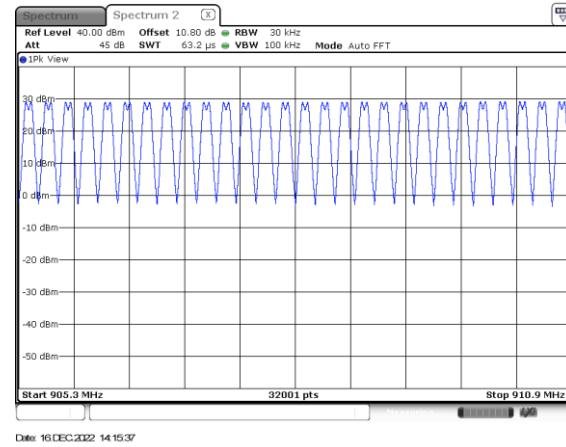


Figure 2.6.6-2: Mode 1 – 50 kbps (129 Channels)

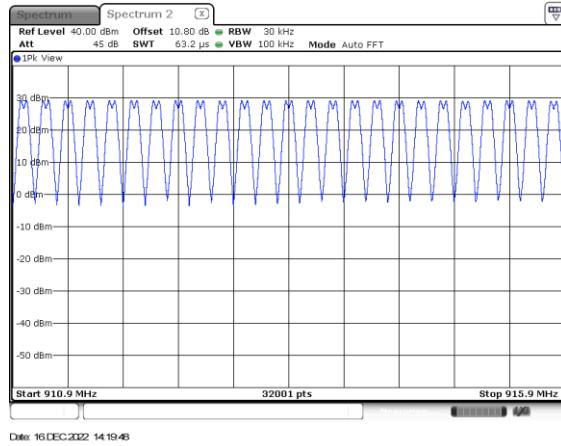


Figure 2.6.6-3: Mode 1 – 50 kbps (129 Channels)

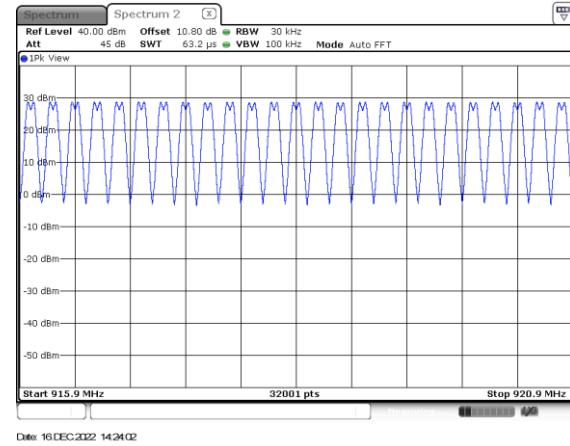


Figure 2.6.6-4: Mode 1 – 50 kbps (129 Channels)

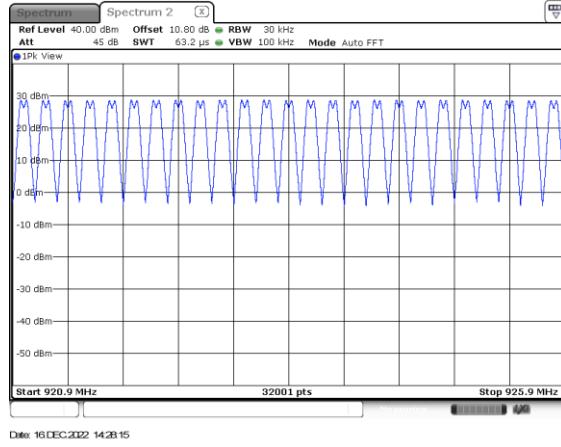


Figure 2.6.6-5: Mode 1 – 50 kbps (129 Channels)

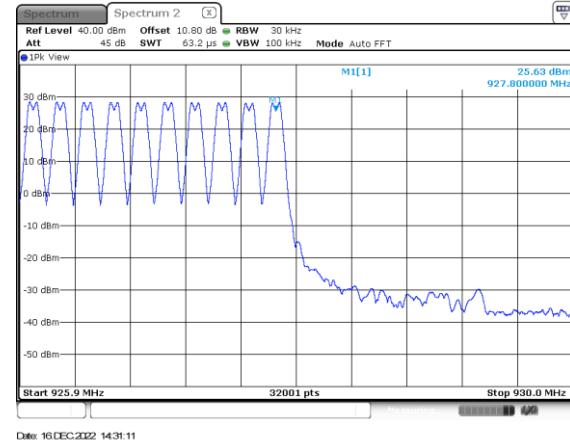


Figure 2.6.6-6: Mode 1 – 50 kbps (129 Channels)



2.7 Channel Dwell Time

2.7.1 Specification Reference

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

2.7.2 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

12/16/2022

2.7.4 Test Method

N/A

2.7.5 Environmental Conditions

N/A

2.7.6 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 for both FHSS and Hybrid modes of operation.



2.8 20dB / 99% Bandwidth

2.8.1 Specification Reference

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

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

12/16/2022

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 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.

2.8.5 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.



Table 2.8.6-1: 20dB / 99% Bandwidth

Frequency [MHz]	20dB Bandwidth (kHz)	99% Bandwidth (kHz)	Data Rate	Mode(s)
902.2	106.500	103.300	50 kbps	1
902.4	399.956	347.600	MCS2	3
915.0	106.300	103.100	50 kbps	1
915.2	398.863	350.400	MCS2	3
927.8	106.200	103.100	50 kbps	1
927.6	396.706	335.600	MCS2	3

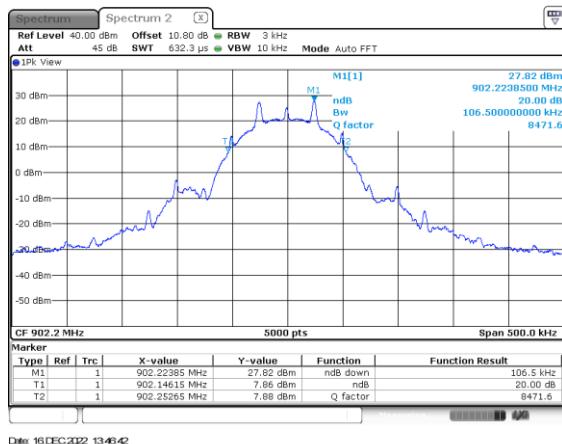


Figure 2.8.6-1: Mode 1 – 20 dB BW – LCH – 50 kbps



Figure 2.8.6-2: Mode 1 – 20 dB BW – MCH – 50 kbps

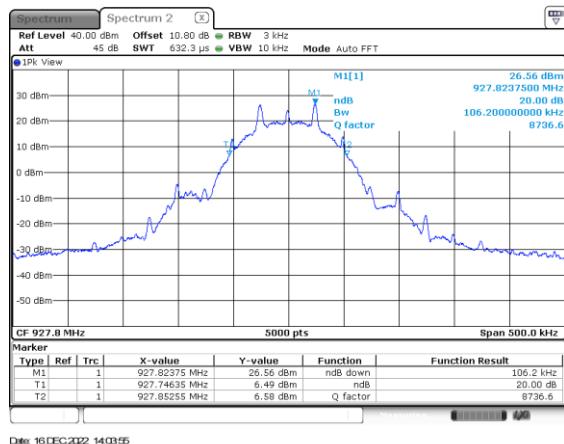


Figure 2.8.6-3: Mode 1 – 20 dB BW – HCH – 50 kbps

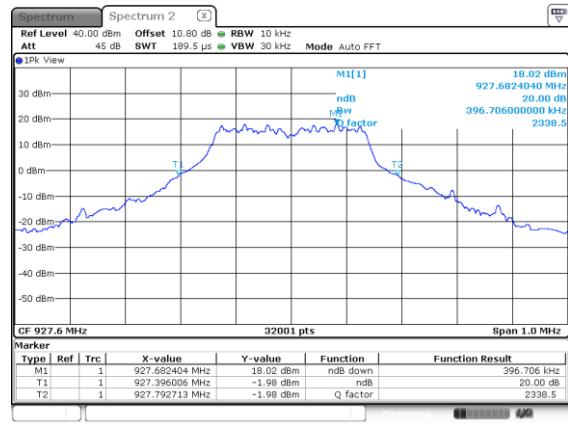


Figure 2.8.6-4: Mode 3 – 20 dB BW – LCH – MCS2



Date: 16 DEC 2022 15:05:57

Figure 2.8.6-5: Mode 3 – 20 dB BW – MCH – MCS2



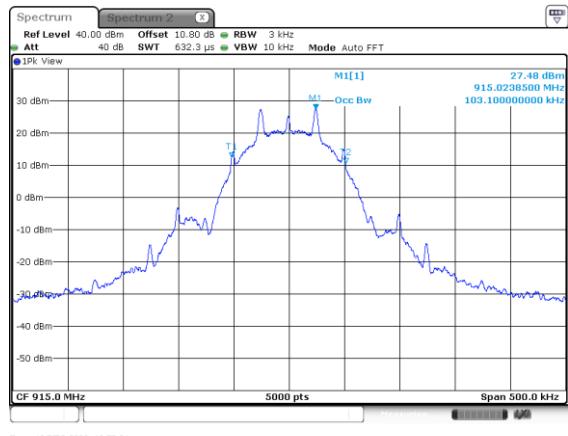
Date: 16 DEC 2022 15:14:24

Figure 2.8.6-6: Mode 3 – 20 dB BW – HCH – MCS2



Date: 16 DEC 2022 13:38:32

Figure 2.8.6-7: Mode 1 – 99% OBW – LCH – 50 kbps



Date: 16 DEC 2022 13:52:31

Figure 2.8.6-8: Mode 1 – 99% OBW – MCH – 50 kbps



Date: 16 DEC 2022 14:02:36

Figure 2.8.6-9: Mode 1 – 99% OBW – HCH – 50 kbps



Date: 16 DEC 2022 14:51:23

Figure 2.8.6-10: Mode 3 – 99% OBW – LCH – MCS2

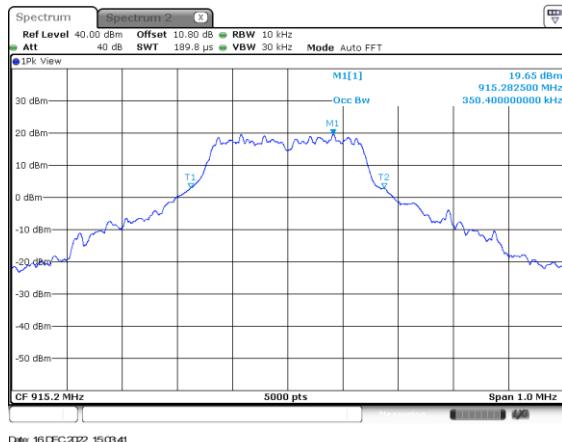


Figure 2.8.6-11: Mode 3 – 99% OBW – MCH –MCS2

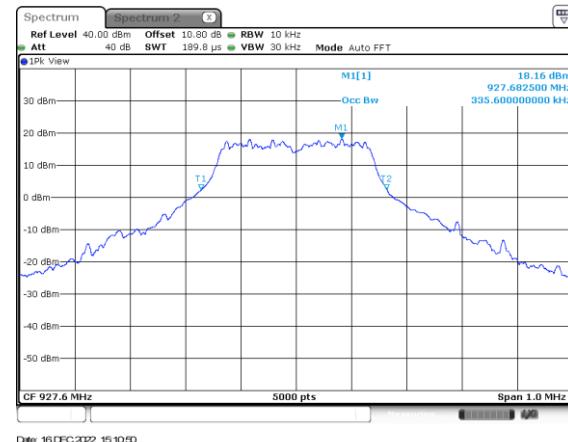


Figure 2.8.6-12: Mode 3 – 99% OBW – HCH –MCS2



2.9 Maximum Power Spectral Density in the Fundamental Emission

2.9.1 Specification Reference

FCC Sections: 15.247(e)
ISED Canada: RSS-247 5.2(b)

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

12/16/2022

2.9.4 Test Method

The power spectral density was measured in accordance with the ANSI 63.10 Subclause 11.10.3 Method AVGPSD (AVGPSD). The RF output of the equipment under test was directly connected to the input of the spectrum analyzer applying suitable attenuation. The Resolution Bandwidth (RBW) of the spectrum analyzer was set to 3 kHz. The Video Bandwidth (VBW) was set to 10 kHz. Span was set to 1.5 times the OBW. The RMS average detector is used, with the trace set to average hold. The marker is placed on the highest peak of the resulting trace.

Note: This test requirement is evaluated for only Hybrid Classification.

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.

Test Results: Pass

See data below for detailed results.

Table 2.9.6-1: RF Power Spectral Density- Hybrid

Frequency [MHz]	Average PSD (dBm)	Coding Scheme	Mode(s)
902.4	4.31	MCS2	3
915.2	3.18	MCS2	3
927.6	2.26	MCS2	3

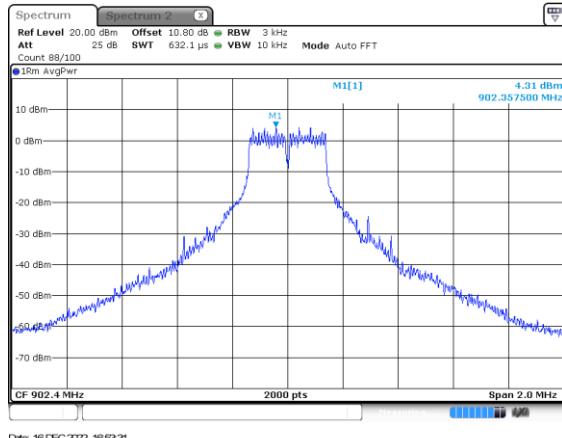


Figure 2.9.6-1: Mode 3 – PSD – LCH – MCS2

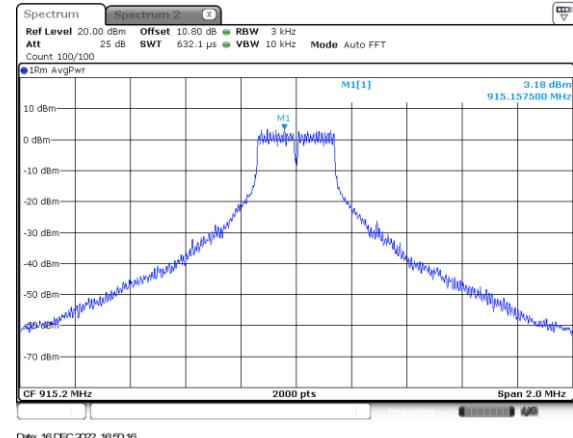


Figure 2.9.6-2: Mode 3 – PSD – MCH – MCS2

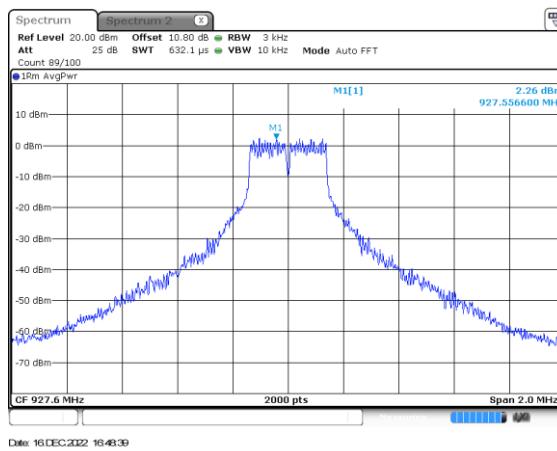


Figure 2.9.6-3: Mode 3 – PSD – HCH – MCS2



2.10 Band-Edge Compliance of RF Conducted Emissions

2.10.1 Specification Reference

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

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

12/16/2022

2.10.4 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

If maximum conducted (average) output power was used to determine compliance, then the peak power in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 30 dB relative to the maximum in-band peak PSD level in 100 kHz (i.e., 30 dBc). Mode 5 band edge frequency attenuated by 30 dBc.

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.



HOPPING MODE:

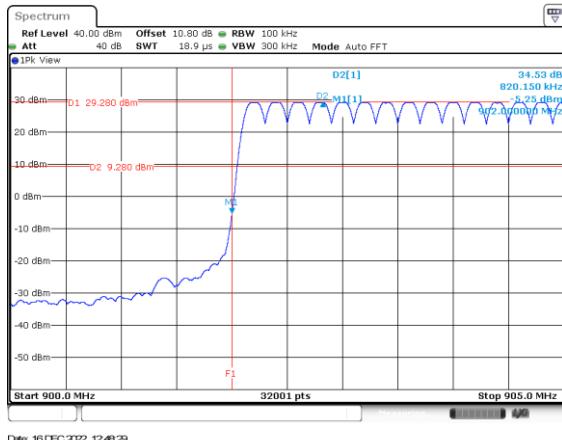


Figure 2.10.6-1: Lower Band edge – Mode 1 – 50kbps

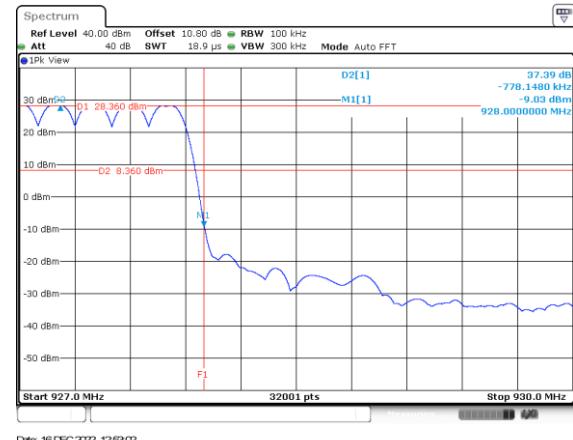


Figure 2.10.6-2: Upper Band edge – Mode 1 – 50kbps

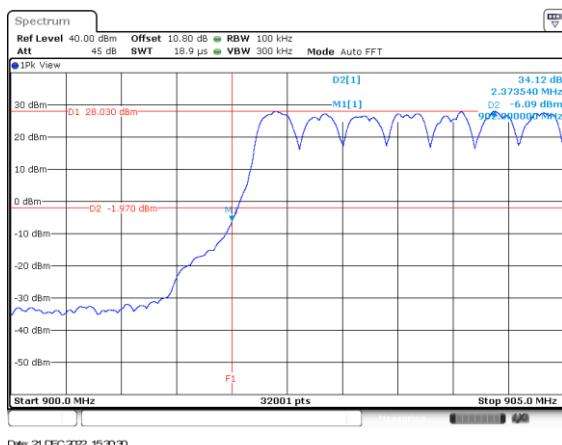


Figure 2.10.6-3: Lower Band edge – Mode 3 – MCS2

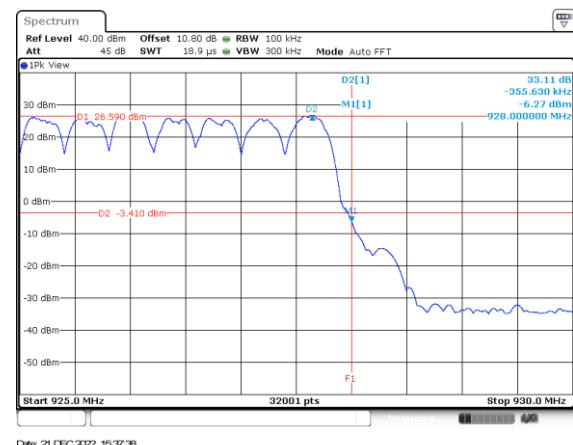


Figure 2.10.6-4: Upper Band edge – Mode 3 – MCS2

NON-HOPPING MODE:

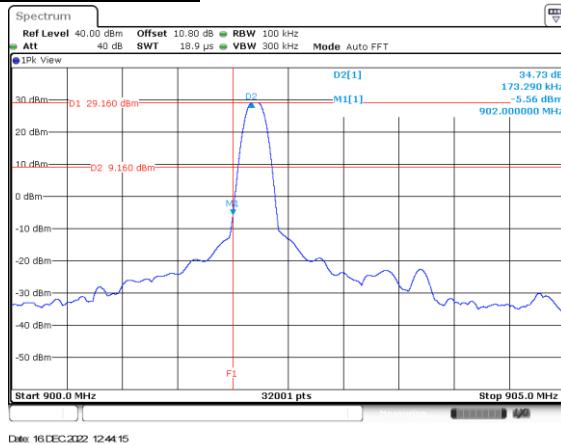


Figure 2.10.6-5: Lower Band edge – Mode 1 – 50kbps

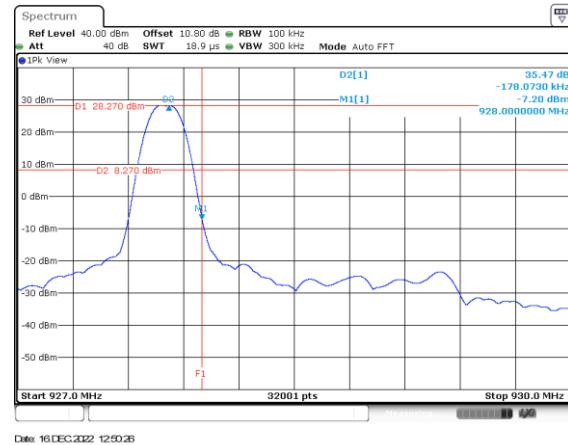


Figure 2.10.6-6: Upper Band edge – Mode 1 – 50kbps

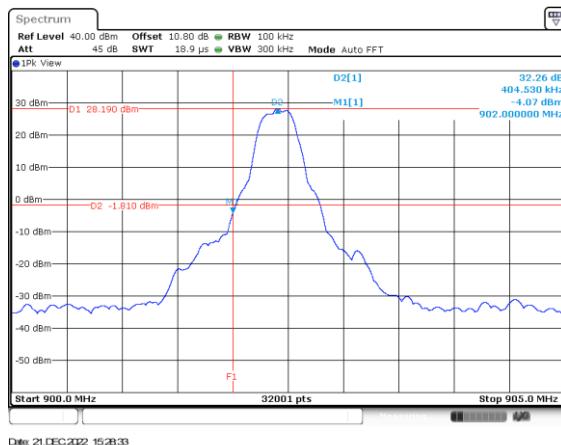


Figure 2.10.6-7: Lower Band edge – Mode 3 – MCS2

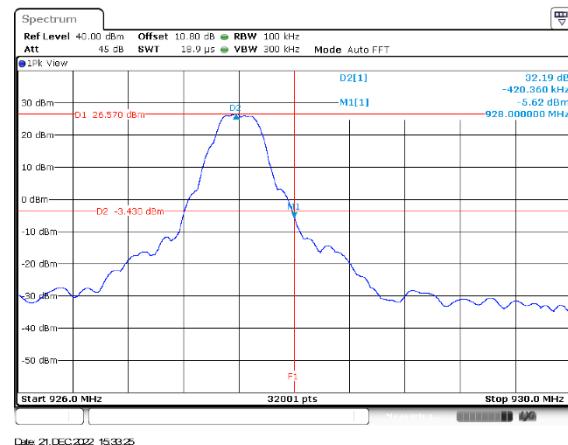


Figure 2.10.6-8: Upper Band edge – Mode 3 – MCS2



2.11 RF Conducted Spurious Emissions

2.11.1 Specification Reference

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

2.11.2 Equipment Under Test and Modification State

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

2.11.3 Date of Test

12/16/2022

2.11.4 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.

If maximum conducted (average) output power was used to determine compliance, then the peak power in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 30 dB relative to the maximum in-band peak PSD level in 100 kHz (i.e., 30 dBc). Mode 5 band edge frequency attenuated by 30 dBc.

2.11.5 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.

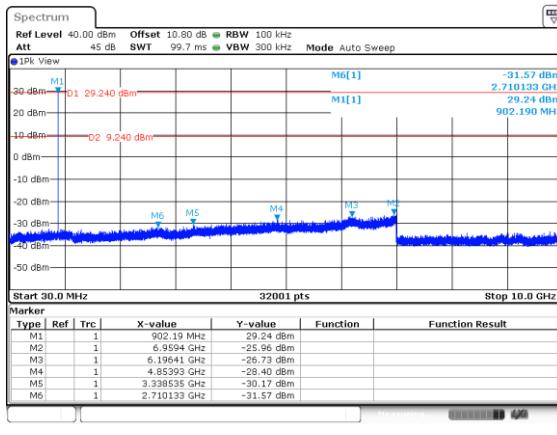
Ambient Temperature	22.3 °C
Relative Humidity	53.8 %
Atmospheric Pressure	972.2 mbar

2.11.6 Test Results

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

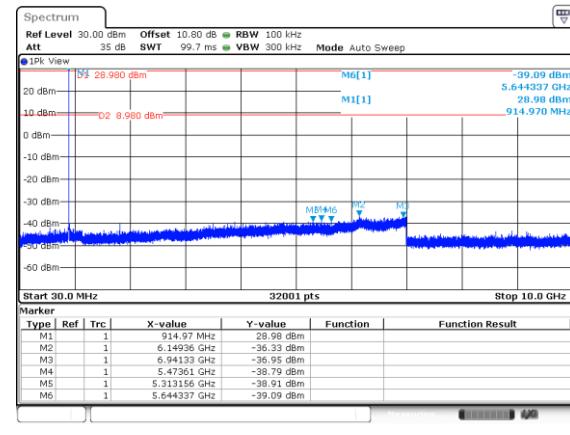
Test Results: Pass

See data below for detailed results.



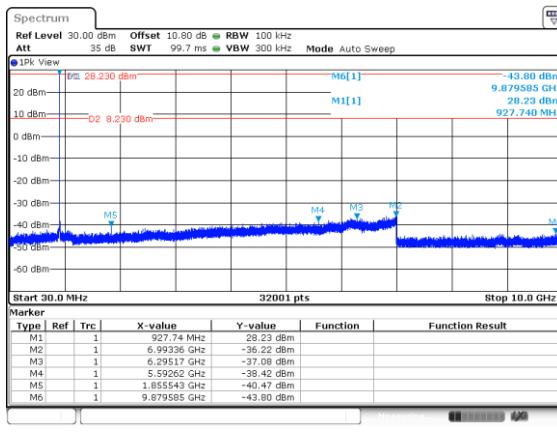
Date: 16 DEC 2022 12:41:59

Figure 2.11.6-1:30MHz – 10GHz – LCH – Mode 1



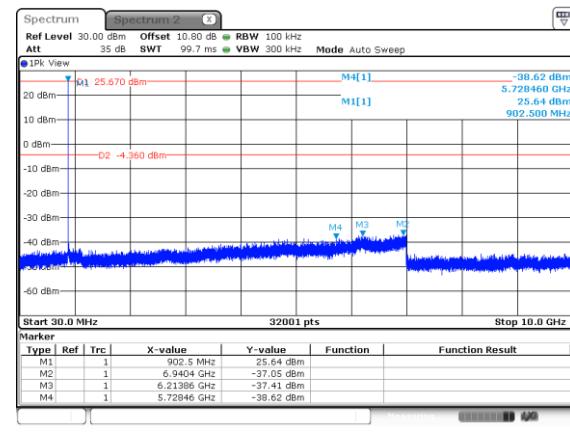
Date: 16 DEC 2022 12:39:42

Figure 2.11.6-2:30MHz – 10GHz – MCH – Mode 1



Date: 16 DEC 2022 12:37:46

Figure 2.11.6-3:30MHz – 10GHz – HCH – Mode 1



Date: 16 DEC 2022 16:36:00

Figure 2.11.6-4:30MHz – 10GHz – LCH – Mode 3

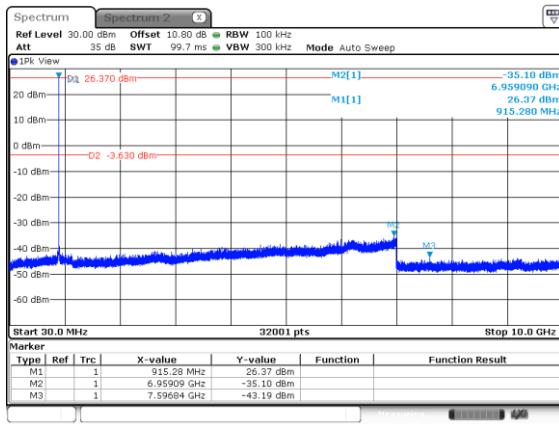


Figure 2.11.6-5:30MHz – 10GHz – MCH – Mode 3

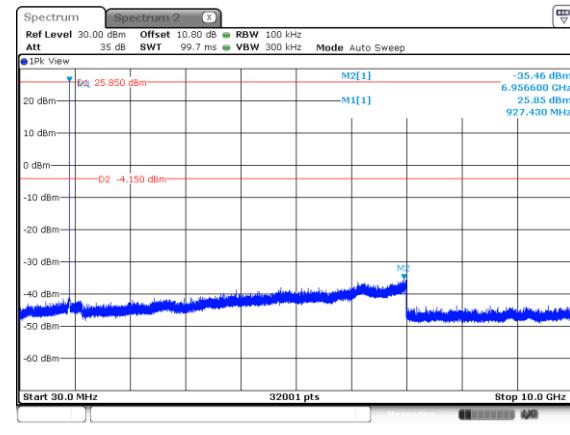


Figure 2.11.6-6:30MHz – 10GHz – HCH – Mode 3



2.12 Radiated Spurious Emissions into Restricted Frequency Bands

2.12.1 Specification Reference

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

2.12.2 Equipment Under Test and Modification State

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

2.12.3 Date of Test

12/20/2022 to 01/23/2023

2.12.4 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.

2.12.5 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



2.12.6 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 2.12.6-1: Radiated Spurious Emissions Tabulated Data – Mode 1 – 50 kbps – Dipole Antenna

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	dB μ V/m	dB μ V/m	dB μ V/m	dB μ V/m	dB	dB	H/V	Pass/Fail	Pass/Fail
LCH - 902.2 MHz									
166.967	----	33.043	----	43.5	----	-10.46	V	----	PASS
2706.775	45.812	30.706	74	54	-28.19	-23.29	H	PASS	PASS
3608.6	47.513	32.138	74	54	-26.49	-21.86	H	PASS	PASS
5413.3	48.225	34.222	74	54	-25.78	-19.78	H	PASS	PASS
2706.625	45.42	30.801	74	54	-28.58	-23.2	V	PASS	PASS
3608.9	46.651	32.272	74	54	-27.35	-21.73	V	PASS	PASS
5413.275	50.173	37.504	74	54	-23.83	-16.5	V	PASS	PASS
MCH - 915.0 MHz									
165.606	----	35.769	----	43.5	----	-7.73	V	----	PASS
2745.25	45.07	30.361	74	54	-28.93	-23.64	H	PASS	PASS
3659.75	47.338	32.703	74	54	-26.66	-21.3	H	PASS	PASS
2745.15	44.907	30.359	74	54	-29.09	-23.64	V	PASS	PASS
3659.775	47.602	32.749	74	54	-26.4	-21.25	V	PASS	PASS
HCH - 927.8 MHz									
2783.275	45.068	30.509	74	54	-28.93	-23.49	H	PASS	PASS
3711.25	46.717	32.53	74	54	-27.28	-21.47	H	PASS	PASS
2783.55	45.429	30.613	74	54	-28.57	-23.39	V	PASS	PASS
3711.275	46.877	32.568	74	54	-27.12	-21.43	V	PASS	PASS



Table 2.12.6-2: Radiated Spurious Emissions Tabulated Data – Mode 1 – 50 kbps – Sector Antenna

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	dB μ V/m	dB μ V/m	dB μ V/m	dB μ V/m	dB	dB	H/V	Pass/Fail	Pass/Fail
LCH - 902.2 MHz									
163.083	----	30.415	----	43.5	----	-13.08	H	----	PASS
2706.675	45.773	31.448	74	54	-28.23	-22.55	H	PASS	PASS
3608.75	47.786	34.091	74	54	-26.21	-19.91	H	PASS	PASS
4510.9	48.274	33.45	74	54	-25.73	-20.55	H	PASS	PASS
2706.675	46.923	34.719	74	54	-27.08	-19.28	V	PASS	PASS
3608.7	48.505	34.833	74	54	-25.49	-19.17	V	PASS	PASS
4510.95	47.755	33.48	74	54	-26.25	-20.52	V	PASS	PASS
MCH - 915.0 MHz									
163.131	----	32.148	----	43.5	----	-11.35	H	----	PASS
108.353	----	26.562	----	43.5	----	-16.94	V	----	PASS
2706.725	45.402	31.014	74	54	-28.6	-22.99	H	PASS	PASS
3608.925	47.16	32.81	74	54	-26.84	-21.19	H	PASS	PASS
4511	48.253	33.251	74	54	-25.75	-20.75	H	PASS	PASS
2706.55	46.307	31.1	74	54	-27.69	-22.9	V	PASS	PASS
3608.675	47.35	32.875	74	54	-26.65	-21.13	V	PASS	PASS
4511.25	48.226	33.352	74	54	-25.77	-20.65	V	PASS	PASS
HCH - 927.8 MHz									
163.107	----	26.77	----	43.5	----	-16.73	H	----	
2706.65	45.39	30.954	74	54	-28.61	-23.05	H	PASS	PASS
3608.825	47.031	32.715	74	54	-26.97	-21.29	H	PASS	PASS
4510.95	47.647	33.147	74	54	-26.35	-20.85	H	PASS	PASS
2783.05	46.563	32.645	74	54	-27.44	-21.36	V	PASS	PASS
3672.775	47.467	33.059	74	54	-26.53	-20.94	V	PASS	PASS
4770.575	47.863	33.232	74	54	-26.14	-20.77	V	PASS	PASS



Table 2.12.6-3: Radiated Spurious Emissions Tabulated Data – Mode 3 – MCS2 – Dipole Antenna

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	dB μ V/m	dB μ V/m	dB μ V/m	dB μ V/m	dB	dB	H/V	Pass/Fail	Pass/Fail
LCH – 902.4 MHz									
2707.425	45.299	30.954	74	54	-28.7	-23.05	H	PASS	PASS
3609.85	47.025	32.529	74	54	-26.98	-21.47	H	PASS	PASS
2707.05	45.615	31.01	74	54	-28.38	-22.99	V	PASS	PASS
3609.85	47.21	32.596	74	54	-26.79	-21.4	V	PASS	PASS
MCH – 915.2 MHz									
2745.85	45.198	30.548	74	54	-28.8	-23.45	H	PASS	PASS
3660.775	47.509	33.095	74	54	-26.49	-20.9	H	PASS	PASS
2745.7	45.421	30.554	74	54	-28.58	-23.45	V	PASS	PASS
3660.95	47.449	33.124	74	54	-26.55	-20.88	V	PASS	PASS
HCH – 927.6 MHz									
2782.725	44.913	30.733	74	54	-29.09	-23.27	H	PASS	PASS
3710.275	47.683	33.149	74	54	-26.32	-20.85	H	PASS	PASS
2782.55	45.399	30.759	74	54	-28.6	-23.24	V	PASS	PASS
3710.15	47.6	33.214	74	54	-26.4	-20.79	V	PASS	PASS



Table 2.12.6-4: Radiated Spurious Emissions Tabulated Data – Mode 3 – MCS2 – Sector Antenna

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	dB μ V/m	dB μ V/m	dB μ V/m	dB μ V/m	dB	dB	H/V	Pass/Fail	Pass/Fail
LCH - 902.4 MHz									
165.074	----	27.626	----	43.5	----	-15.87	H	----	PASS
2706.425	45.062	30.94	74	54	-28.94	-23.06	H	PASS	PASS
3608.8	47.269	32.746	74	54	-26.73	-21.25	H	PASS	PASS
4511.25	47.858	33.13	74	54	-26.14	-20.87	H	PASS	PASS
8273.2	53.207	39.102	74	54	-20.79	-14.9	H	PASS	PASS
2706.8	45.461	31.026	74	54	-28.54	-22.97	V	PASS	PASS
3608.825	46.813	32.749	74	54	-27.19	-21.25	V	PASS	PASS
4511.25	47.374	33.149	74	54	-26.63	-20.85	V	PASS	PASS
MCH – 915.2 MHz									
162.214	----	15.587	----	43.5	----	-27.91	H	----	PASS
2706.625	45.59	31.025	74	54	-28.41	-22.97	H	PASS	PASS
3608.775	47.225	32.819	74	54	-26.77	-21.18	H	PASS	PASS
4511.25	47.98	33.275	74	54	-26.02	-20.73	H	PASS	PASS
2706.625	45.47	31.049	74	54	-28.53	-22.95	V	PASS	PASS
3609	47.794	32.87	74	54	-26.21	-21.13	V	PASS	PASS
4510.95	48.894	33.302	74	54	-25.11	-20.7	V	PASS	PASS
HCH – 927.6 MHz									
2706.75	45.561	31.029	74	54	-28.44	-22.97	H	PASS	PASS
3608.975	47.696	32.846	74	54	-26.3	-21.15	H	PASS	PASS
4511.25	47.646	33.256	74	54	-26.35	-20.74	H	PASS	PASS
2706.775	45.629	31.071	74	54	-28.37	-22.93	V	PASS	PASS
3608.75	47.776	32.897	74	54	-26.22	-21.1	V	PASS	PASS
4510.775	47.78	33.309	74	54	-26.22	-20.69	V	PASS	PASS



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Radiated Emissions, Under 1GHz

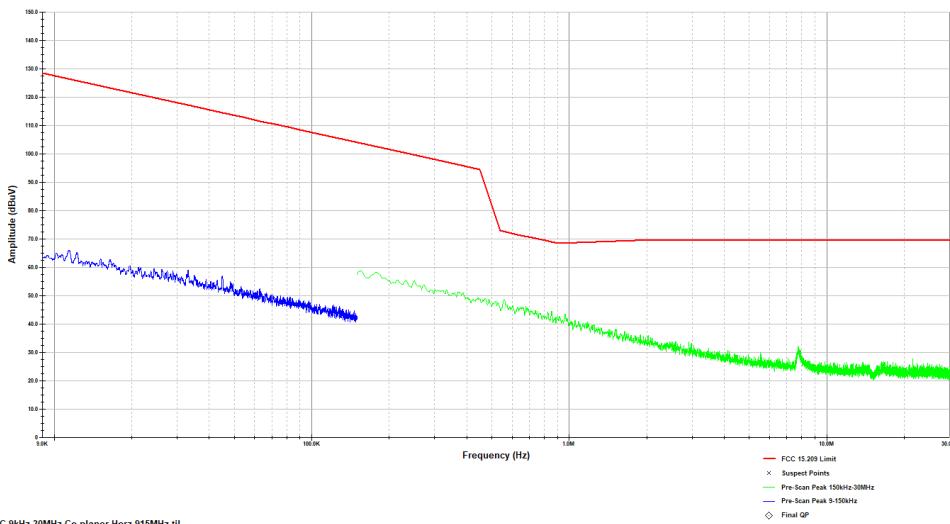
HV Graph

Company - 72185765 L+G

Model - S6-mSBR

Config - WSN 802.15.4 SUN FSK 915MHz FHSS

Operator - Shree



FCC 15.209 BSAC 9kHz-30MHz Co-planer Horz 915MHz.til

Last Data Update 09:33:38 AM, Tuesday, December 20, 2022

Figure 1: Reference plot for Radiated Spurious Emissions – 9 kHz – 30 MHz – Mode 2 – MCH – Dipole Antenna

TUV EMC Lab

Radiated Emissions, Under 1GHz

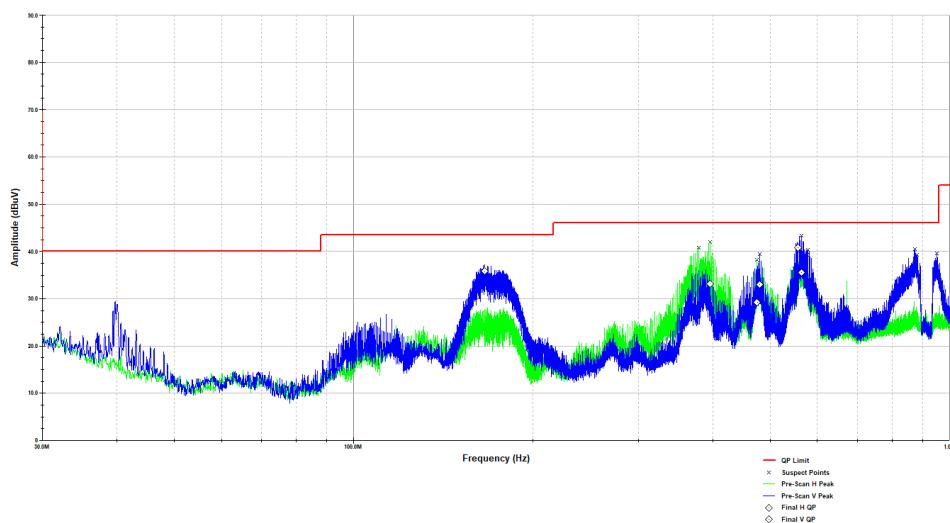
HV Graph

Company - 72185765 L+G

Model - S6-mSBR

Config - WSN 802.15.4 SUN FSK 915MHz FHSS

Operator - Shree



FCC 15.209 RSE 30-1000MHz BSAC 915MHz.til

Last Data Update 08:45:53 AM, Tuesday, December 20, 2022

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

Note: Emissions within restricted bands were evaluated.

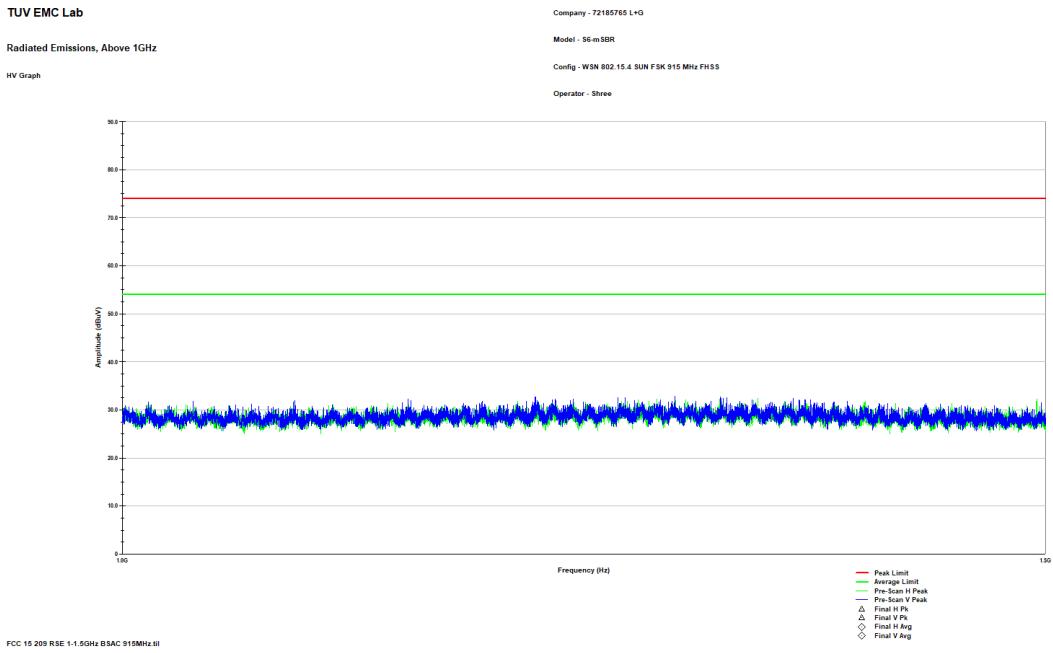


Figure 3: Reference plot for Radiated Spurious Emissions – 1 GHz – 1.5 GHz – Mode 1 – MCH – Dipole Antenna

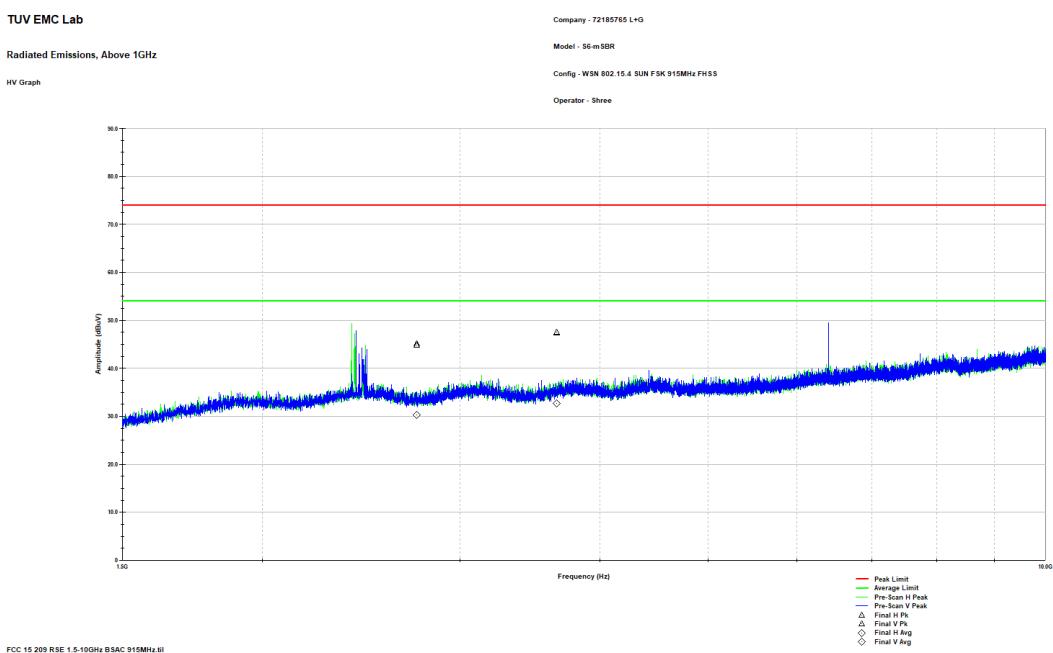


Figure 4: Reference plot for Radiated Spurious Emissions – 1.5 GHz – 10 GHz – Mode 1 – MCH – Dipole Antenna

Note: Emissions within restricted bands were evaluated.



2.13 Test Equipment Used

Table 2.13-1 –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
827	Rohde & Schwarz	RF Cable set	TS8997 Rack cable set	N/A	12/21/2022	12/21/2023
622	Rohde & Schwarz	FSV40 (v3.40)	FSV Signal Analyzer 10Hz to 40GHz	101338	10/05/2022	10/05/2023
267	Hewlett Packard	N1911A	Power Meter	MY45100129	7/27/2021	7/27/2023
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

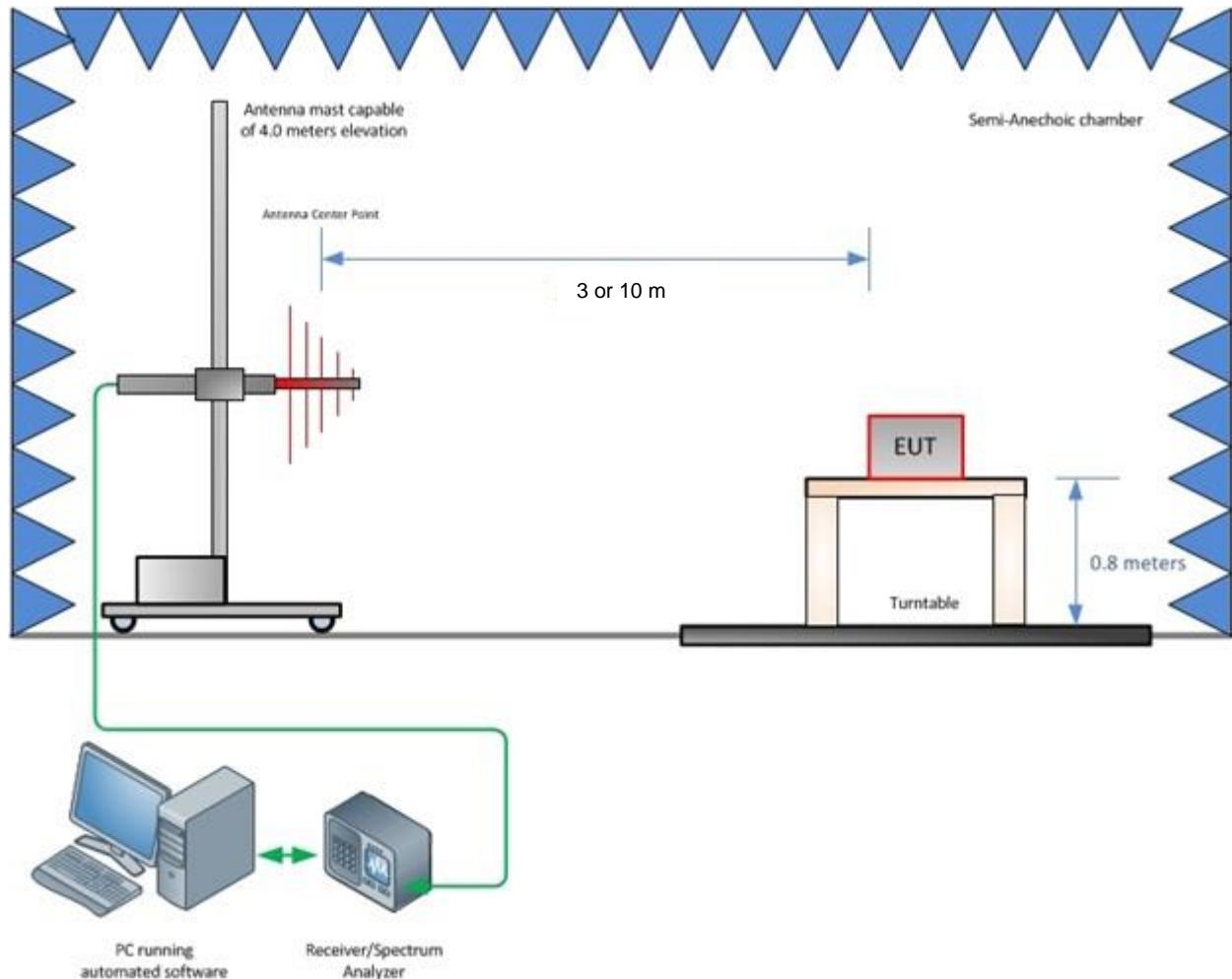


Figure 3-1 – Radiated Emissions Test Setup up to 1 GHz

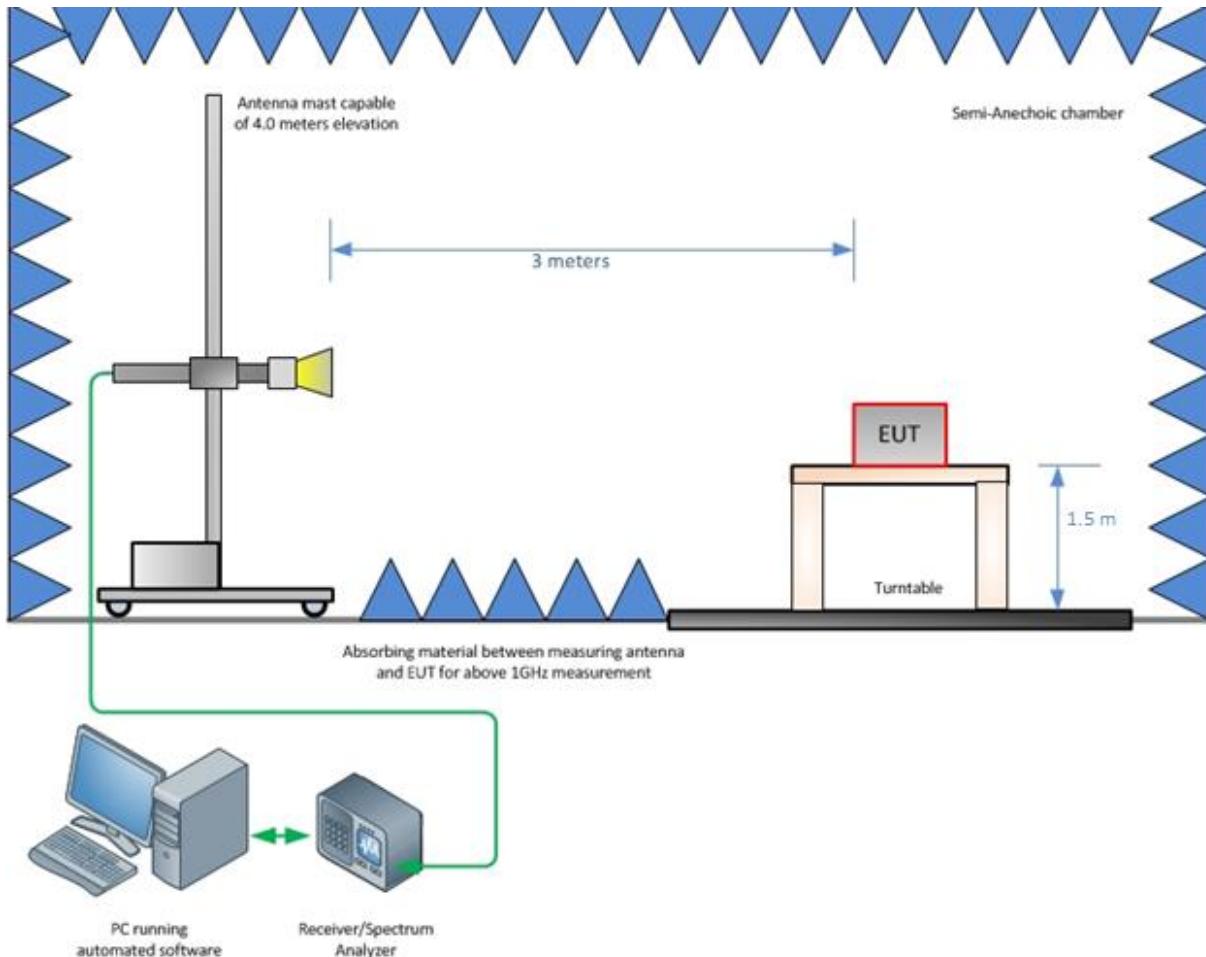


Figure 3-2 – Radiated Emissions Test Setup above 1 GHz

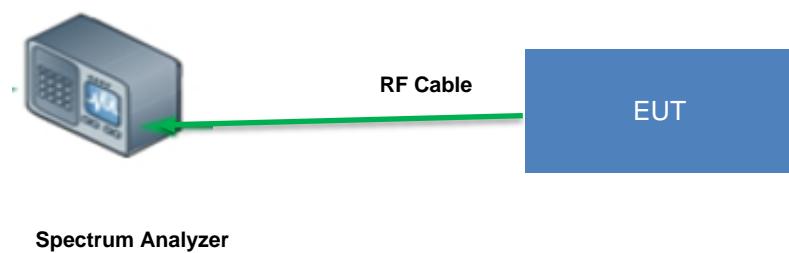


Figure 3-3 – Conducted Test Setup: Antenna Port measurement



4 Accreditation, Disclaimers and Copyright

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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.