Report on the Testing of the

Mitsubishi Electric US
PAC-USWHS002-WF-2

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

Prepared for: MuRata Electronics North America
2200 Lake Park Drive
Smyrna, Georgia 30080 USA

America

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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.

A2LA Cert. No. 2955.09

ACCREDITATION

Our A2LA Accreditation does not cover opinions and interpretations and any expressed are outside the scope of our A2LA Accreditation.

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Contents

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	2/2/2023
1	Second Issue	5/1/2023

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.

Applicant	Rodney Olson
Applicant Company	Mitsubishi Electric US
Manufacturer	Murata Electronics North America
Applicant's Email Address	ROlson@hvac.mea.com
Model Name / Number	PAC-USWHS002-WF-2
Serial Number	N/A
FCC ID	2AIGWFB004
ISED Certification Number	31190-WFB004
Hardware Version(s)	3
Software Version(s)	3
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	72185560
Date of Receipt of EUT	12/12/2022
Start of Test	12/12/2022
Finish of Test	1/5/2023

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, 15.204	-------	11
6 dB Bandwidth	Yes	Pass	15.247(a)(2)	RSS-247 5.2(a)	19
99% Bandwidth	Yes	Pass	-------	RSS-GEN 6.7	19
Fundamental Emission Output Power	Yes	Pass	15.247(b)(3)	RSS-247 5.4(d)	17
Band-Edge Compliance of RF Conducted Emissions	Yes	Pass	15.247(d)	RSS-247 5.5	28
RF Conducted Spurious Emissions	Yes	Pass	15.247(d)	RSS-247 5.5	30
Radiated Spurious Emissions into Restricted Frequency Bands	Yes	Pass	15.205, 15.209	RSS-GEN 8.9, 8.10	32
Power Spectral Density	Yes	Pass	15.247(e)	RSS-247 5.2(b)	25
AC Power Line Conducted Emissions	Yes	Pass	15.207	RSS-GEN 8.8	12

1.4 Product Information

1.4.1 Technical Description

The PAC-USWHS002-WF-3 WIFI-BLE adapter is the third generation in its series. It wirelessly monitors and controls a MEUS HVAC unit via WIFI link. This device communicates wirelessly using either 802.11b/g/n WIFI mode or Bluetooth Smart (i.e. BLE) mode

Table 1.4-1 – Wireless Technical Information

Detail	Description
FCC ID	2AIGWFB004
ISED Canada Certification Number	31190-WFB004
Transceiver Model Name / Number	PAC-USWHS002-WF-2
Frequency Range (MHz)	2402 – 2480 MHz
Modulation Format	GFSK
Number of Channels	40
Maximum Rated Power	10 dBm
Data Rates	1 Mbps
Operating voltage	5VAC, 12 VAC
Antenna Type / Gain:	PCB Trace / 3.3 dBi

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

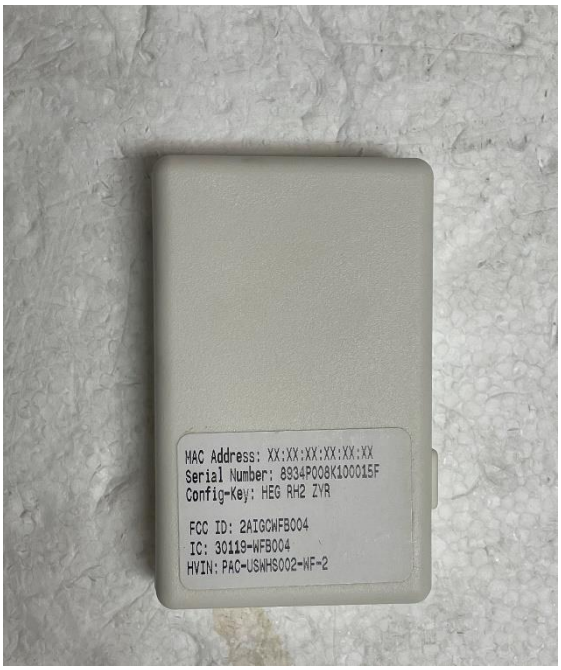

Photo 1.4.1-1 – Front view of Radiated EUT

Photo 1.4.1-2 – Front view of Radiated EUT

Photo 1.4.1-3 – Front view of Conducted EUT

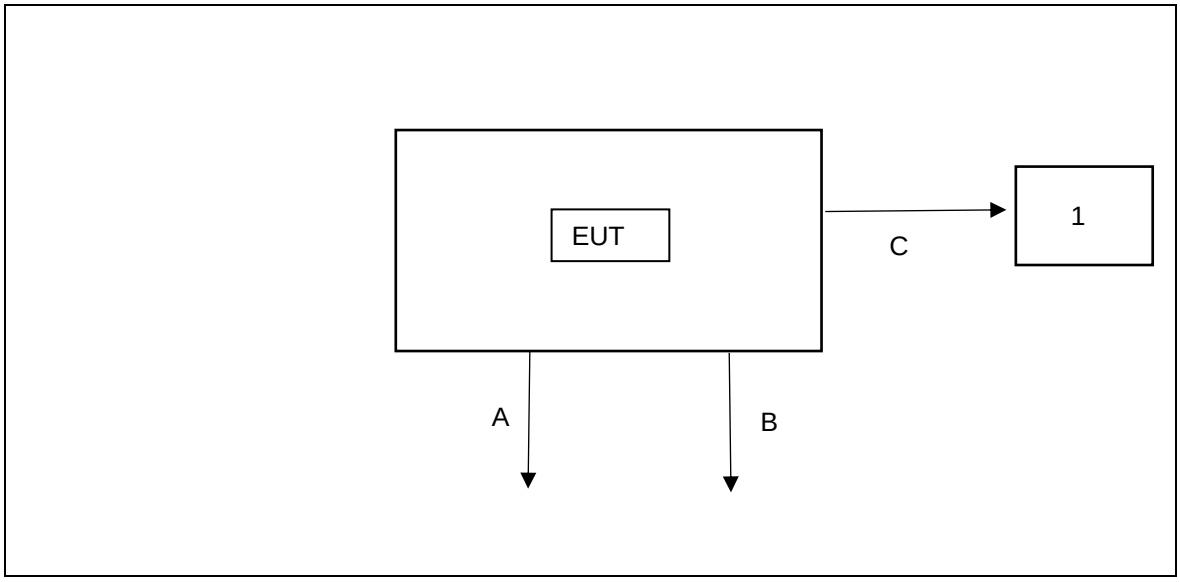

Figure 1.4.1-5 – Test Setup Block Diagram

Table 1.4.1-1 – Cable Descriptions

Item	Cable/Port	Description
A	DC Power supply	12VDC power supply to EUT
B	Power supply Wall adapter	5VAC Wall adapter
C	USB programming cable	Used for BLE radio configuration

Table 1.4.1-2 – Support Equipment Descriptions

Item	Make/Model	Description
1	ThinkPad	Laptop for configuration

1.4.2 Modes of Operation

Module provides 1 mode of operation using BLE classifications as outlined below.

Mode of Operation	Frequency Range (MHz)	Number of Channels	Stack / Mode	Data Rates Supported	Classification
1	2402 – 2480	40	GFSK	1 Mbps	BLE

1.4.3 Monitoring of Performance

For radiated emissions, the EUT was evaluated in multiple orientations and performed final on worst case orientation. 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 (standalone module) was connected to the test equipment with a temporary antenna port to SMA connector.

Power setting during test: 10 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	Date Modification Fitted
0	Initial State	
1	Updated test setup pictures with host enclosure, IC ID & HVIN Number	5/01/2023

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
AC Power Line Conducted Emissions	Divya Adusumilli	A2LA
Fundamental Emission Output Power	Divya Adusumilli	A2LA
6dB / 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
Power Spectral Density	Divya Adusumilli	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 “1”, as noted in §1.6.

2.1.3 Date of Observation

12/12/2022

2.1.4 Test Method

N/A

2.1.5 Environmental Conditions

N/A

2.1.6 Test Results

The EUT utilizes the PCB trace antenna with 3.3 dBi which is internal to the enclosure and affixed to the PCB, 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 “1”, as noted in §1.6.

2.2.3 Date of Test

1/5/2023

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	24 °C
Relative Humidity	43 %
Atmospheric Pressure	982.1 mbar

2.2.6 Test Results

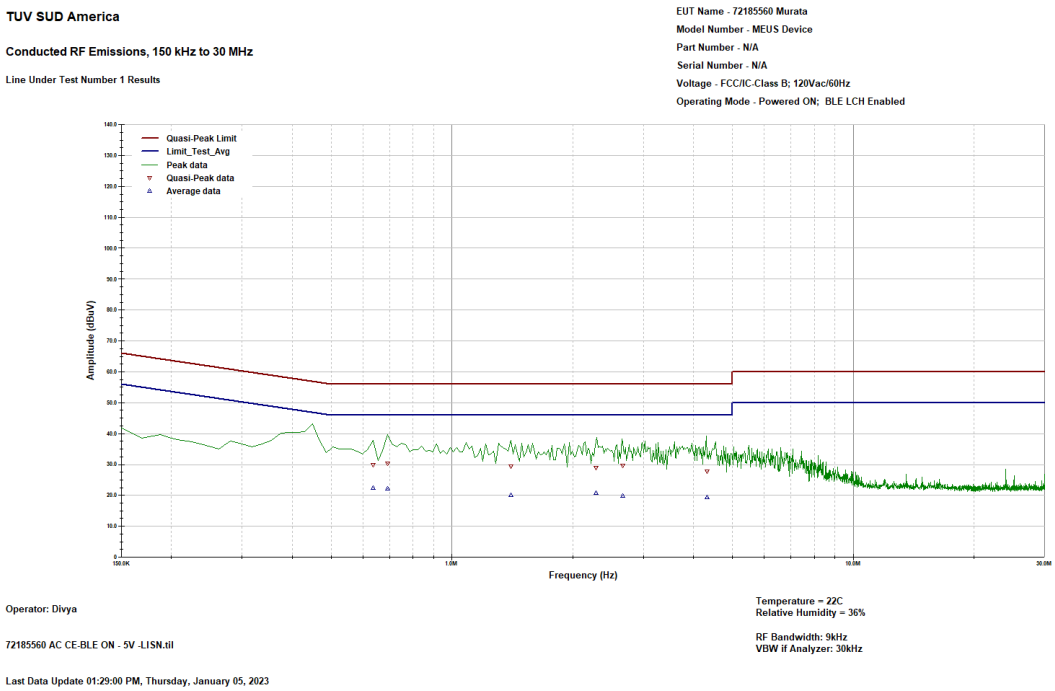

Figure 2.2.6-1 – Graphical Results – AC Mains L1 Plot – 5V adapter

Table 2.2.6-1 – Conducted Emissions Results on the AC Power Port (L1) – 5V adapter

Frequency (MHz)	Avg Limit	Avg Level Corr	Avg Level	Corr Fact.	Avg Margin	Result
0.63	46	22.5	12.8	9.658	-23.5	PASS
0.69	46	22.2	12.5	9.661	-23.8	PASS
1.4	46	20	10.3	9.704	-26	PASS
2.29	46	20.8	11	9.781	-25.2	PASS
2.67	46	19.8	10	9.79	-26.2	PASS
4.32	46	19.4	9.6	9.78	-26.6	PASS

Frequency (MHz)	QP Limit	QP Level Corr	QP Level	Corr Fact.	QP Margin	Result
0.63	56	29.9	20.2	9.658	-26.1	PASS
0.69	56	30.3	20.6	9.661	-25.7	PASS
1.4	56	29.5	19.8	9.704	-26.5	PASS
2.29	56	28.9	19.2	9.781	-27.1	PASS
2.67	56	29.6	19.8	9.79	-26.4	PASS
4.32	56	27.8	18	9.78	-28.2	PASS

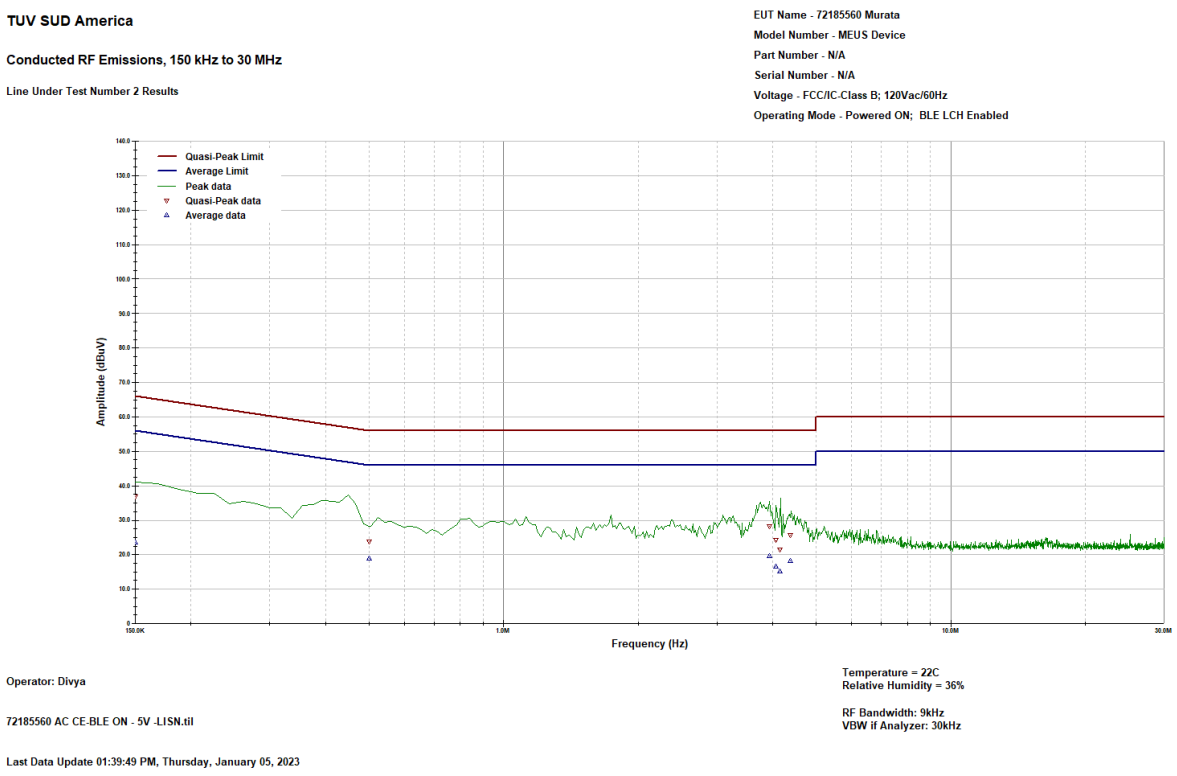

Figure 2.2.6-2 – Graphical Results – AC Mains N Plot – 5V adapter

Table 2.2.6-2 – Conducted Emissions Results on the AC Power Port (N) – 5V adapter

Frequency (MHz)	Avg Limit	Avg Level Corr	Avg Level	Corr Fact.	Avg Margin	Result
0.15	56	23.4	13.8	9.675	-32.6	PASS
0.5	46	18.9	9.3	9.63	-27.1	PASS
3.93	46	19.5	9.7	9.8	-26.5	PASS
4.06	46	16.6	6.8	9.8	-29.4	PASS
4.15	46	15.1	5.3	9.8	-30.9	PASS
4.38	46	18.1	8.3	9.8	-27.9	PASS

Frequency (MHz)	QP Limit	QP Level Corr	QP Level	Corr Fact.	QP Margin	Result
0.15	66	36.9	27.2	9.675	-29.1	PASS
0.5	56	23.9	14.3	9.63	-32.1	PASS
3.93	56	28.3	18.5	9.8	-27.7	PASS
4.06	56	24.1	14.3	9.8	-31.9	PASS
4.15	56	21.5	11.7	9.8	-34.5	PASS
4.38	56	25.6	15.8	9.8	-30.4	PASS

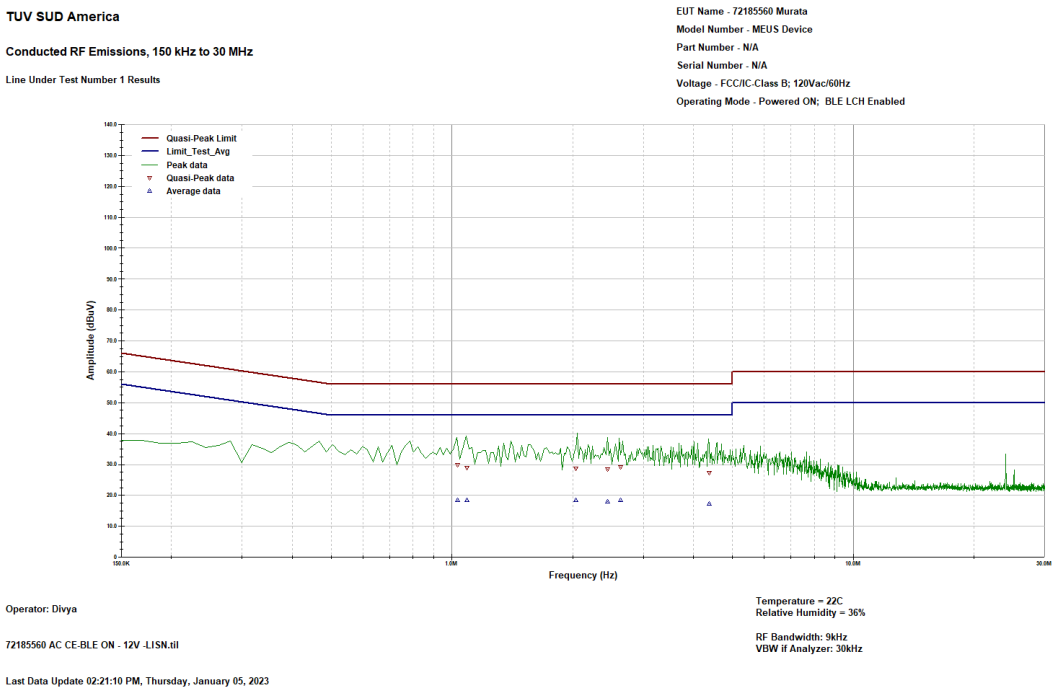

Figure 2.2.6-3 – Graphical Results – AC Mains L1 Plot – 12V adapter

Table 2.2.6-3 – Conducted Emissions Results on the AC Power Port (L1) – 12V adapter

Frequency (MHz)	Avg Limit	Avg Level Corr	Avg Level	Corr Fact.	Avg Margin	Result
1.03	46	18.4	8.8	9.682	-27.6	PASS
1.09	46	18.4	8.8	9.685	-27.6	PASS
2.04	46	18.4	8.6	9.771	-27.6	PASS
2.44	46	17.9	8.1	9.788	-28.1	PASS
2.63	46	18.3	8.5	9.79	-27.7	PASS
4.38	46	17.2	7.4	9.78	-28.8	PASS

Frequency (MHz)	QP Limit	QP Level Corr	QP Level	Corr Fact.	QP Margin	Result
1.03	56	29.9	20.2	9.682	-26.1	PASS
1.09	56	29	19.3	9.685	-27	PASS
2.04	56	28.8	19	9.771	-27.2	PASS
2.44	56	28.4	18.6	9.788	-27.6	PASS
2.63	56	29.1	19.3	9.79	-26.9	PASS
4.38	56	27.3	17.5	9.78	-28.7	PASS

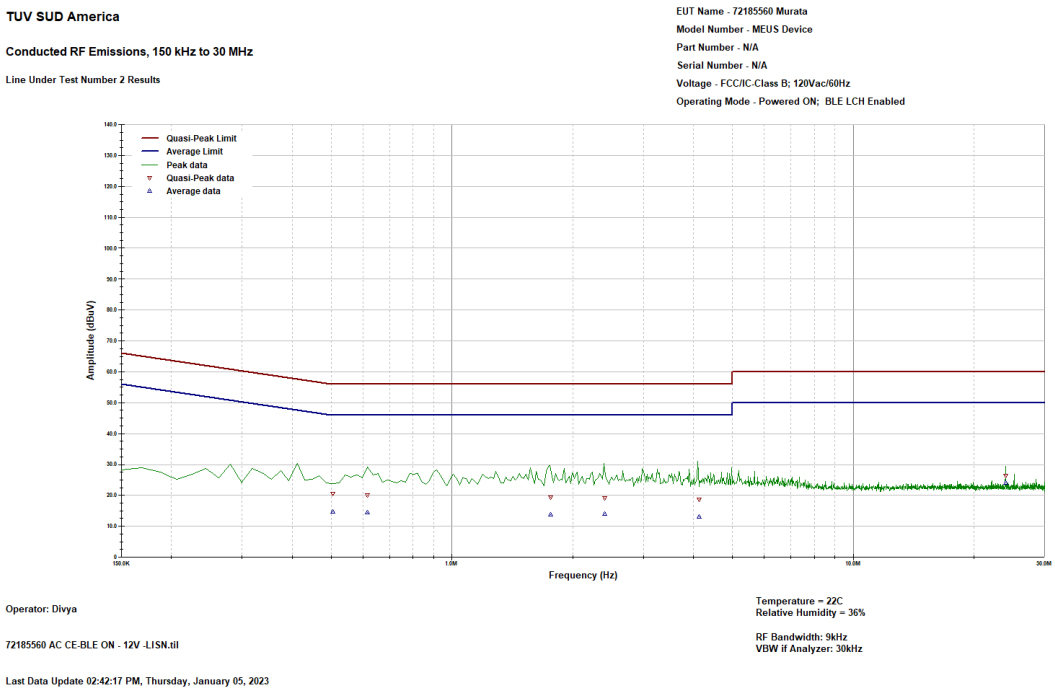

Figure 2.2.6-4 – Graphical Results – AC Mains N Plot – 12V adapter

Table 2.2.6-4 – Conducted Emissions Results on the AC Power Port (N) – 12V adapter

Frequency (MHz)	Avg Limit	Avg Level Corr	Avg Level	Corr Fact.	Avg Margin	Result
0.5	46	14.6	5	9.63	-31.4	PASS
0.62	46	14.5	4.8	9.637	-31.5	PASS
1.76	46	13.7	4	9.741	-32.3	PASS
2.4	46	13.9	4.1	9.768	-32.1	PASS
4.13	46	13.2	3.4	9.8	-32.8	PASS
24	50	24.1	14	10.09	-25.9	PASS

Frequency (MHz)	QP Limit	QP Level Corr	QP Level	Corr Fact.	QP Margin	Result
0.5	56	20.4	10.8	9.63	-35.6	PASS
0.62	56	20	10.3	9.637	-36	PASS
1.76	56	19.4	9.6	9.741	-36.6	PASS
2.4	56	19.2	9.4	9.768	-36.8	PASS
4.13	56	18.8	9	9.8	-37.2	PASS
24	60	26.4	16.3	10.09	-33.6	PASS

2.3 Fundamental Emission Output Power

2.3.1 Specification Reference

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

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

12/12/2022

2.3.4 Test Method

The maximum peak conducted output power may be measured using a broadband peak RF power meter with ANSI C63.10 Subclause 11.9.1.3. The power meter shall have a video bandwidth that is greater than or equal to the DTS bandwidth and shall use a fast-responding diode detector.

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	24 °C
Relative Humidity	43 %
Atmospheric Pressure	982.1 mbar

2.3.6 Test Results

Test Summary: EUT was set to transmit mode.

Test Results: Pass

See data below for detailed results.

Table 2.3.6-1: RF Output Power

Frequency [MHz]	Peak Output Power (dBm)	E.I.R.P (dBm)	Data Rate
2402	7.17	10.47	1 Mbps
2440	7.42	10.72	1 Mbps
2480	7.71	11.01	1 Mbps

2.4 6dB / 99% Bandwidth

2.4.1 Specification Reference

FCC Sections: 15.247(a)(2)
ISED Canada: RSS-247 5.2(a), RSS-GEN 6.7

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

12/12/2022

2.4.4 Test Method

The 6dB bandwidth was measured in accordance with the ANSI C63.10 Section 11.8. The Resolution Bandwidth (RBW) of the spectrum analyzer was set to 100 kHz. The Video Bandwidth (VBW) was set to ≥ 3 times the RBW. The trace was set to max hold with a peak detector active. The marker-delta function of the spectrum analyzer was utilized to determine the 6 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.

2.4.5 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	24 °C
Relative Humidity	43 %
Atmospheric Pressure	982.1 mbar

2.4.6 Test Results

Test Summary: EUT was set to transmit mode.

Test Results: Pass

See data below for detailed results.

Table 2.4.6-1: 6dB / 99% Bandwidth

Frequency [MHz]	6dB Bandwidth (kHz)	99% Bandwidth (MHz)	Data Rate
2402	792.080	1.060	1 Mbps
2440	792.080	1.060	1 Mbps
2480	752.476	1.050	1 Mbps

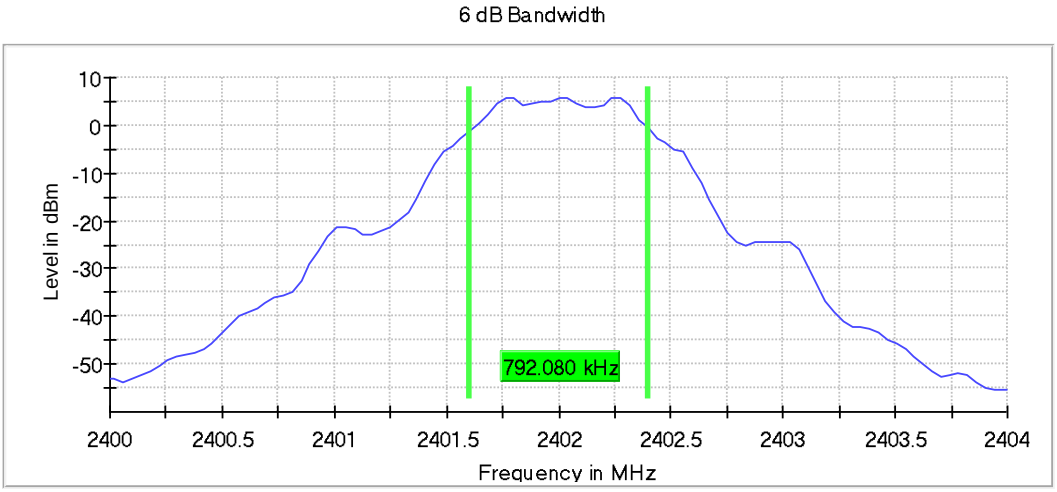

Figure 2.4.6-1: 6 dB BW - LCH

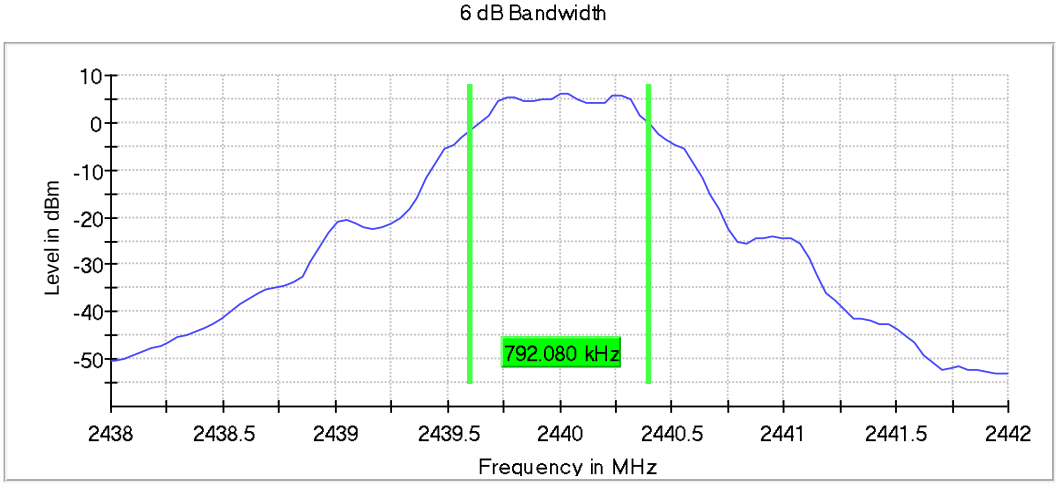

Figure 2.4.6-2: 6 dB BW - MCH

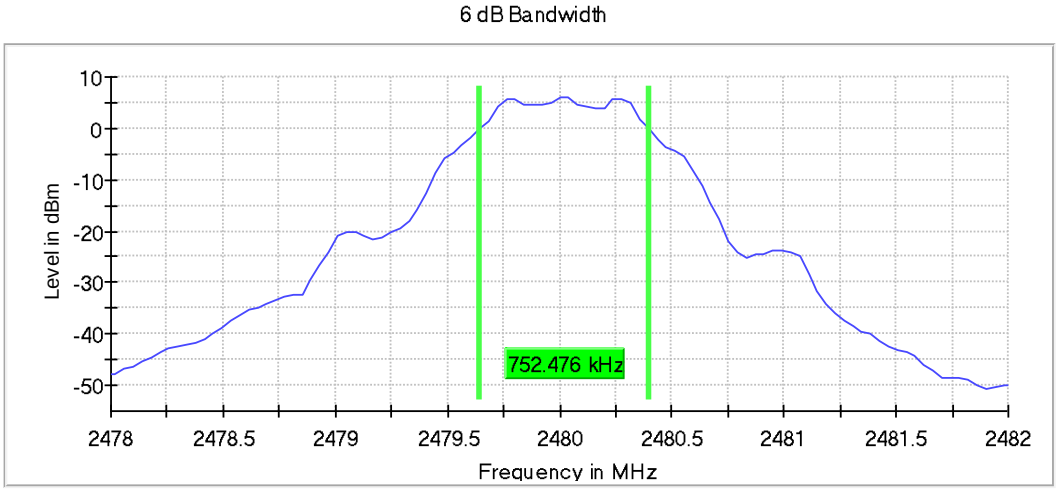

Figure 2.4.6-3: 6 dB BW - HCH

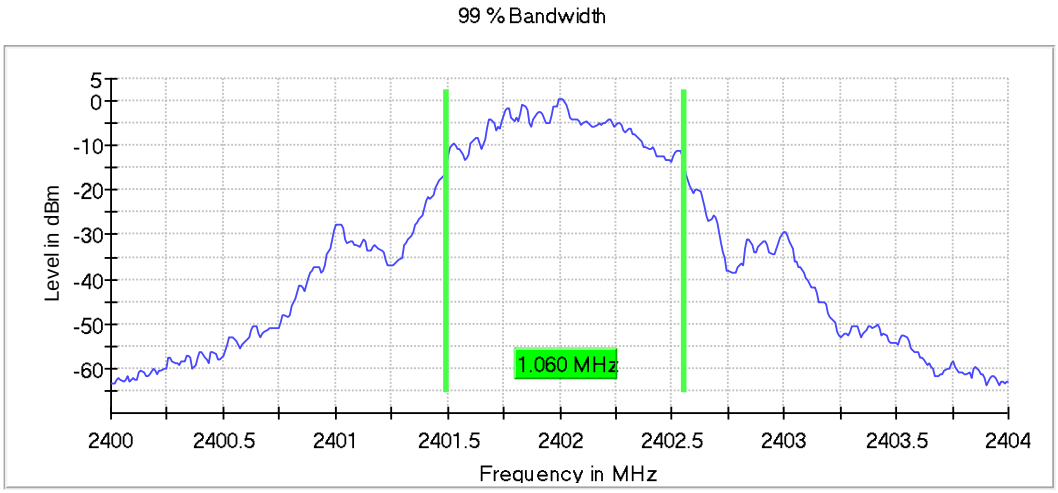

Figure 2.4.6-4: 99% BW - LCH

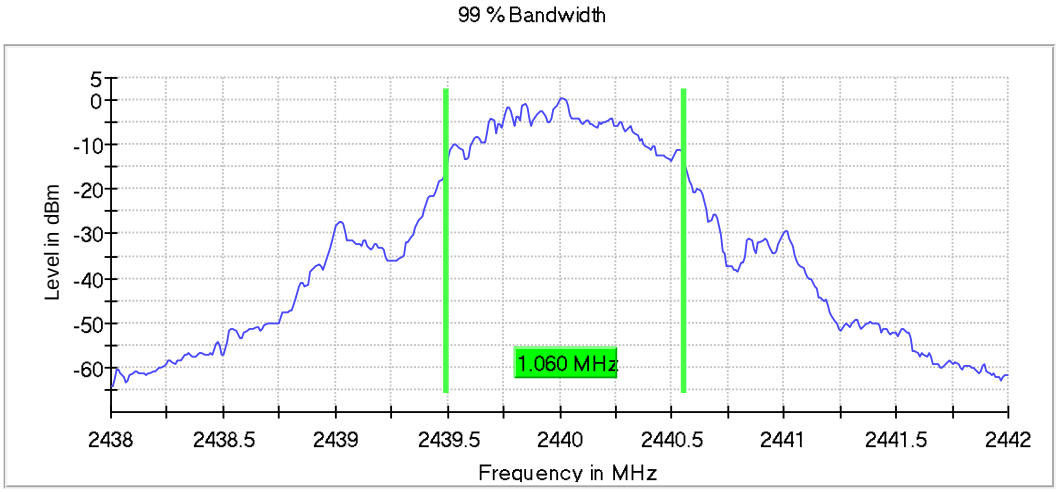

Figure 2.4.6-5: 99% BW - MCH

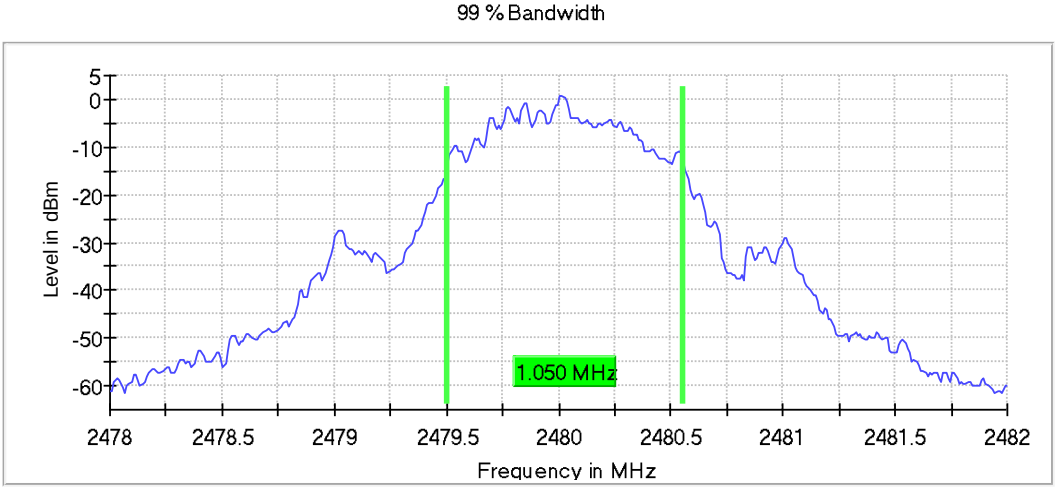

Figure 2.4.6-6: 99% BW - HCH

Table 2.4.6-2: Sample Measurement Setting (6dB BW)

Setting	Instrument Value	Target Value
Start Frequency	2.40000 GHz	2.40000 GHz
Stop Frequency	2.40400 GHz	2.40400 GHz
Span	4.000 MHz	4.000 MHz
RBW	100.000 kHz	~ 100.000 kHz
VBW	300.000 kHz	~ 300.000 kHz
Sweep Points	101	~ 80
Sweep time	18.938 µs	AUTO
Reference Level	0.000 dBm	0.000 dBm
Attenuation	15.000 dB	AUTO
Detector	Max Peak	Max Peak
Sweep Count	100	100
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweep type	FFT	AUTO
Preamp	off	off
Stable mode	Trace	Trace
Stable value	0.50 dB	0.50 dB
Run	7 / max. 150	max. 150
Stable	5 / 5	5
Max Stable Difference	0.35 dB	0.50 dB

Table 2.4.6-3: Sample Measurement Setting (99% BW)

Setting	Instrument Value	Target Value
Start Frequency	2.40000 GHz	2.40000 GHz
Stop Frequency	2.40400 GHz	2.40400 GHz
Span	4.000 MHz	4.000 MHz
RBW	20.000 kHz	>= 20.000 kHz
VBW	100.000 kHz	>= 60.000 kHz
Sweep Points	400	~ 400
Sweep time	94.824 µs	AUTO
Reference Level	0.000 dBm	0.000 dBm
Attenuation	20.000 dB	AUTO
Detector	Max Peak	Max Peak
Sweep Count	100	100
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweep type	FFT	AUTO
Preamp	off	off
Stable mode	Trace	Trace
Stable value	0.30 dB	0.30 dB
Run	6 / max. 150	max. 150
Stable	3 / 3	3
Max Stable Difference	0.09 dB	0.30 dB

2.5 Maximum Power Spectral Density in the Fundamental Emission

2.5.1 Specification Reference

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

12/12/2022

2.5.4 Test Method

The power spectral density was measured in accordance with the ANSI C63.10 Section 11.10.2 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 10 kHz. The Video Bandwidth (VBW) was set to 30 kHz. Span was set to 1.5 times the channel bandwidth. The trace was set to max hold with the peak detector active.

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	24 °C
Relative Humidity	43 %
Atmospheric Pressure	982.1 mbar

2.5.6 Test Results

Test Summary: EUT was set to transmit mode.

Test Results: Pass

See data below for detailed results.

Table 2.5.6-1: RF Power Spectral Density

Frequency [MHz]	PSD (dBm)	Data Rate
2402	-4.290	1 Mbps
2440	-4.102	1 Mbps
2480	-4.028	1 Mbps

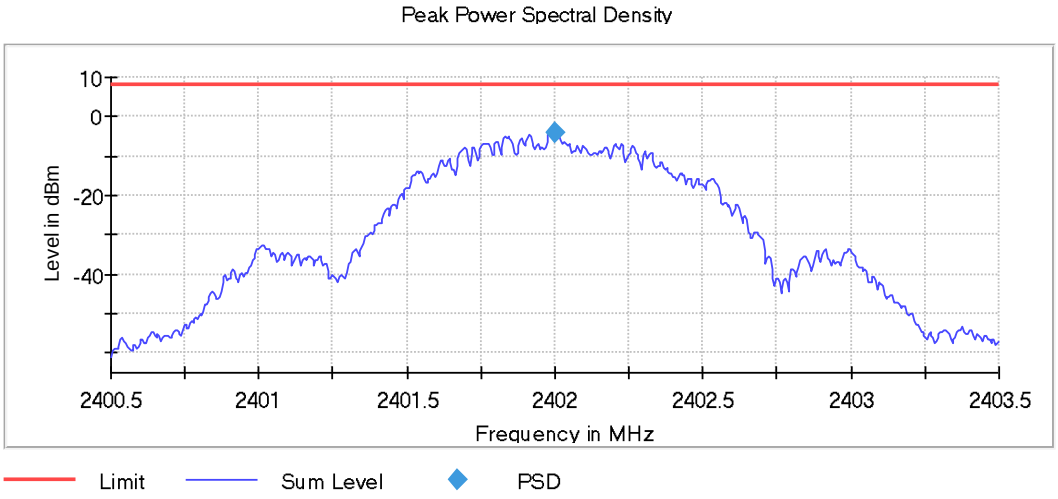

Figure 2.5.6-1: PSD – LCH

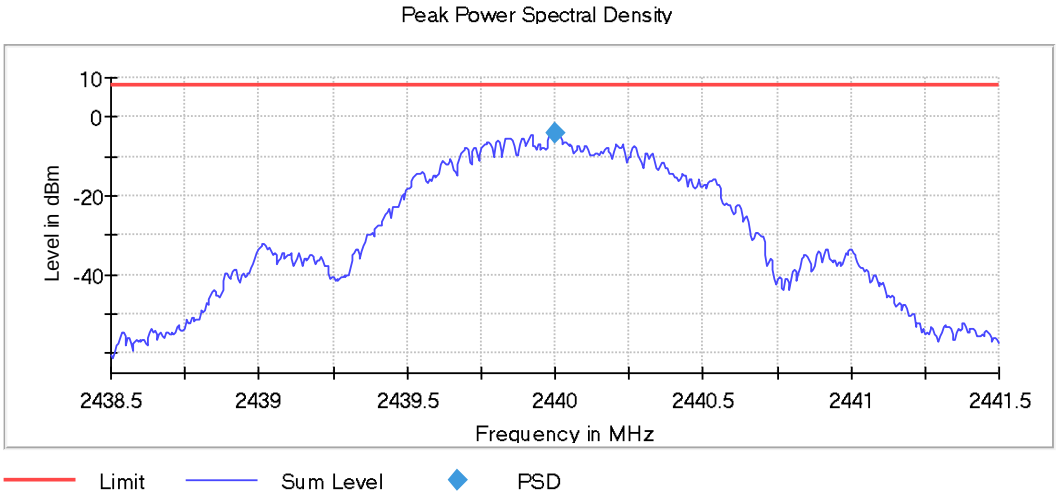

Figure 2.5.6-2: PSD – MCH

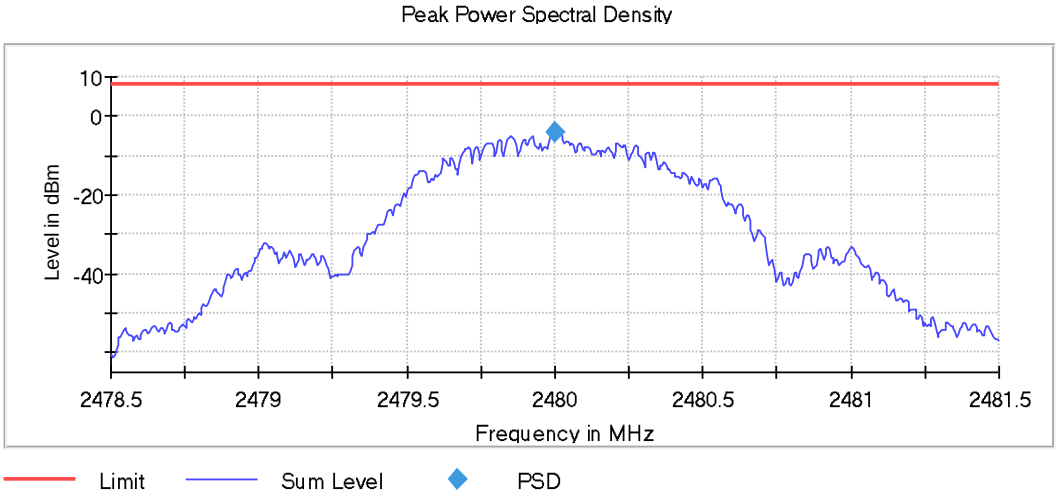

Figure 2.5.6-3: PSD – HCH

Table 2.5.6-2: Sample Measurement Settings (PSD)

Setting	Instrument Value	Target Value
Start Frequency	2.40050 GHz	2.40050 GHz
Stop Frequency	2.40350 GHz	2.40350 GHz
Span	3.000 MHz	3.000 MHz
RBW	10.000 kHz	<= 10.000 kHz
VBW	30.000 kHz	>= 30.000 kHz
Sweep Points	600	~ 600
Sweep time	3.000 ms	AUTO
Reference Level	0.000 dBm	0.000 dBm
Attenuation	20.000 dB	AUTO
Detector	Max Peak	Max Peak
Sweep Count	100	100
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweep type	Sweep	Sweep
Preamp	Off	off
Stable mode	Trace	Trace
Stable value	0.50 dB	0.50 dB
Run	5 / max. 150	max. 150
Stable	2 / 2	2
Max Stable Difference	0.24 dB	0.50 dB

2.6 Band-Edge Compliance of RF Conducted Emissions

2.6.1 Specification Reference

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

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

12/12/2022

2.6.4 Test Method

The unwanted emissions into non-restricted bands were measured conducted in accordance with ANSI C63.10 Section 11.11. 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 100 kHz. The Video Bandwidth (VBW) was set to ≥ 300 kHz. The resulting spectrum analyzer peak level was used to determine the reference level with respect to the 20 dBc limit at the band edges.

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	24 °C
Relative Humidity	43 %
Atmospheric Pressure	982.1 mbar

2.6.6 Test Results

Test Summary: EUT was set to transmit mode.

Test Results: Pass

See data below for detailed results.

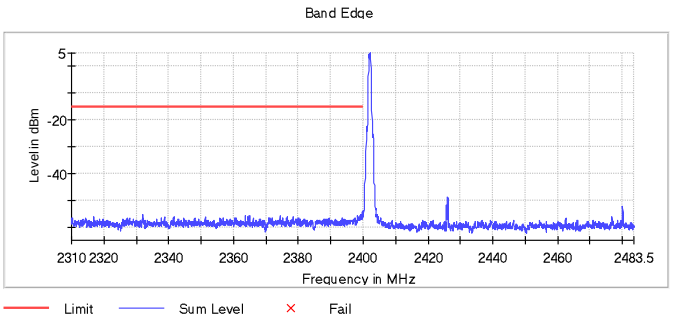

Figure 2.6.6-1: Lower Band-edge

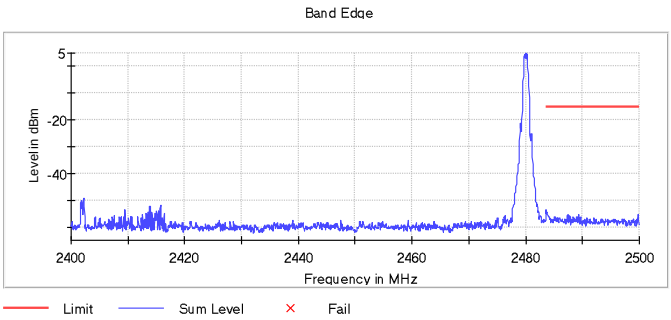

Figure 2.6.6-2: Upper Band-edge

Table 2.6.6-1: Lower Band-edge- Low Channel

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)	Result
2399.825000	-53.9	38.8	-15.1	PASS
2399.975000	-53.9	38.8	-15.1	PASS
2399.875000	-54.0	38.9	-15.1	PASS
2399.925000	-54.4	39.3	-15.1	PASS
2399.775000	-54.6	39.5	-15.1	PASS
2399.725000	-55.1	40.1	-15.1	PASS
2399.275000	-55.3	40.2	-15.1	PASS
2399.325000	-55.3	40.2	-15.1	PASS
2331.875000	-55.4	40.3	-15.1	PASS
2331.925000	-55.6	40.5	-15.1	PASS
2364.875000	-55.6	40.6	-15.1	PASS
2399.075000	-55.7	40.7	-15.1	PASS
2374.325000	-55.8	40.7	-15.1	PASS
2399.125000	-55.8	40.7	-15.1	PASS
2398.275000	-55.8	40.8	-15.1	PASS

Table 2.6.6-2: Upper Band-edge – High Channel

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)	Result
2483.625000	-53.7	38.6	-15.1	PASS
2483.575000	-54.0	38.9	-15.1	PASS
2483.525000	-54.1	39.0	-15.1	PASS
2483.725000	-54.7	39.6	-15.1	PASS
2483.675000	-54.9	39.8	-15.1	PASS
2483.775000	-55.0	39.9	-15.1	PASS
2483.825000	-55.0	39.9	-15.1	PASS
2483.875000	-55.2	40.1	-15.1	PASS
2487.375000	-55.3	40.2	-15.1	PASS
2499.775000	-55.4	40.4	-15.1	PASS
2489.375000	-55.5	40.4	-15.1	PASS
2499.825000	-55.6	40.5	-15.1	PASS
2489.325000	-55.6	40.6	-15.1	PASS
2483.975000	-55.7	40.6	-15.1	PASS
2483.925000	-55.7	40.6	-15.1	PASS

2.7 RF Conducted Spurious Emissions

2.7.1 Specification Reference

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

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

12/12/2022

2.7.4 Test Method

The unwanted emissions into non-restricted bands were measured conducted in accordance with ANSI C63.10 Section 11.11. 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 100 kHz. The Video Bandwidth (VBW) was set to ≥ 300 kHz. The resulting spectrum analyzer peak level was used to determine the reference level with respect to the 20 dBc limit at the band edges. The spectrum span was then adjusted for the measurement of spurious emissions from 30MHz to 26GHz, 10 times the highest fundamental frequency.

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	24 °C
Relative Humidity	43 %
Atmospheric Pressure	982.1 mbar

2.7.6 Test Results

Test Summary: EUT was set to transmit mode.

Test Results: Pass

See data below for detailed results.

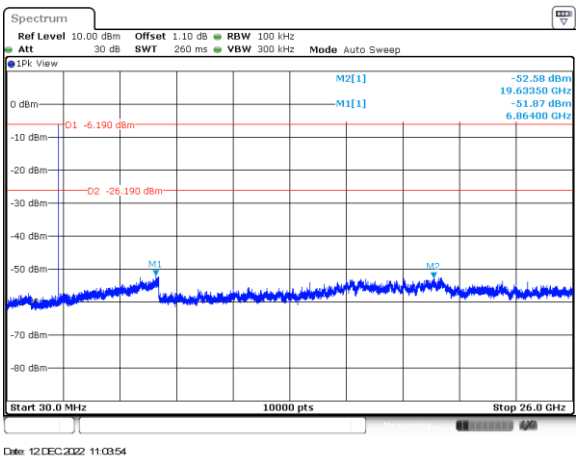

Figure 2.7.6-1: 30MHz – 26GHz – LCH

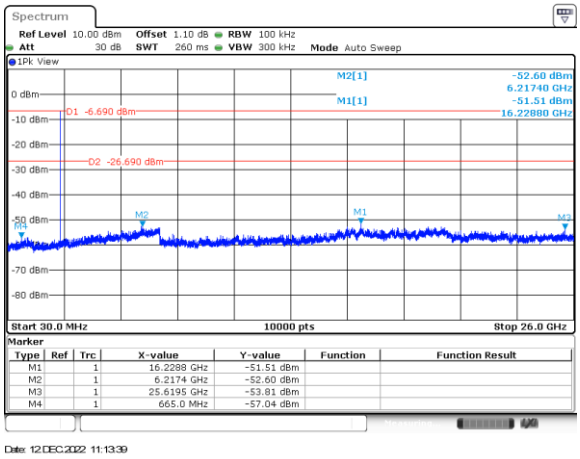

Figure 2.7.6-2: 30MHz – 26GHz – MCH

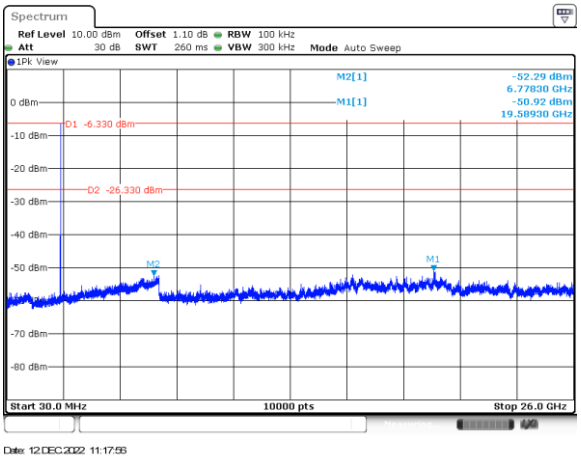

Figure 2.7.6-3: 30MHz – 26GHz – HCH

2.8 Radiated Spurious Emissions into Restricted Frequency Bands

2.8.1 Specification Reference

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

2.8.2 Equipment Under Test and Modification State

As shown in §1.4 with modification state “1”, as noted in §1.6.

2.8.3 Date of Test

12/13/2022 to 12/16/2022

2.8.4 Test Method

Radiated emissions tests were made over the frequency range of 9 kHz to 26 GHz, 10 times the highest fundamental frequency of 2.4 GHz. 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

2.8.5 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	24 °C
Relative Humidity	43 %
Atmospheric Pressure	982.1 mbar

2.8.6 Test Results

Test Summary: EUT was set to transmit mode.

Test Results: Pass

See data below for detailed results.

Table 2.8.6-1: Radiated Spurious Emissions Tabulated Data

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	Limit_Avg	dB	dB	H/V	Pass/Fail	Pass/Fail
LCH - 2402 MHz									
409.73	----	28.941	----	46	----	-17.06	H	----	Pass
4803.525	57.345	46.57	74	54	-16.65	-7.43	H	Pass	Pass
4803.525	51.889	39.668	74	54	-22.11	-14.33	V	Pass	Pass
12010.175	48.223	34.28	74	54	-25.78	-19.72	H	Pass	Pass
12009.75	48.3	34.249	74	54	-25.7	-19.75	V	Pass	Pass
19215.825	52.512	37.966	74	54	-21.49	-16.03	H	Pass	Pass
19216.025	51.978	37.956	74	54	-22.02	-16.04	V	Pass	Pass
MCH – 2440 MHz									
4880.525	58.615	47.174	74	54	-15.38	-6.83	H	Pass	Pass
7320.8	52.347	38.604	74	54	-21.65	-15.4	H	Pass	Pass
4879.525	50.52	37.048	74	54	-23.48	-16.95	V	Pass	Pass
12199.9	48.743	34.157	74	54	-25.26	-19.84	H	Pass	Pass
12199.775	48.368	34.281	74	54	-25.63	-19.72	V	Pass	Pass
19519.85	52.992	38.597	74	54	-21.01	-15.4	H	Pass	Pass
19519.825	52.57	38.6	74	54	-21.43	-15.4	V	Pass	Pass
HCH – 2480 MHz									
408.396	----	26.087	----	46	----	-19.91	V	----	Pass
4960.525	59.659	48.486	74	54	-14.34	-5.51	H	Pass	Pass
7439.3	51.363	38.211	74	54	-22.64	-15.79	H	Pass	Pass
4959.55	53.301	40.954	74	54	-20.7	-13.05	V	Pass	Pass
12399.975	48.665	34.436	74	54	-25.33	-19.56	H	Pass	Pass
12400.25	47.984	34.566	74	54	-26.02	-19.43	V	Pass	Pass
19839.825	53.525	39.814	74	54	-20.48	-14.19	H	Pass	Pass
22319.975	57.28	43.038	74	54	-16.72	-10.96	H	Pass	Pass
19839.85	53.598	39.821	74	54	-20.4	-14.18	V	Pass	Pass
22319.75	57.561	43.071	74	54	-16.44	-10.93	V	Pass	Pass

Table 2.8.6-2: Radiated Band-Edge Tabulated Data

Frequency (MHz)	Level (dBuV)		Antenna Polarity	Correction Factors	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	pk	Qpk/Avg	(H/V)	(dB)	pk	Qpk/Avg	pk	Qpk/Avg	pk	Qpk/Avg
LCH										
2390	48.80	34.10	H	-2.04	46.76	32.06	74.0	54.0	27.2	21.9
2390	48.10	33.60	V	-2.04	46.06	31.56	74.0	54.0	27.9	22.4
HCH										
2483.5	61.90	40.40	H	-1.78	60.12	38.62	74.0	54.0	13.9	15.4
2483.5	56.50	36.40	V	-1.78	54.72	34.62	74.0	54.0	19.3	19.4

Sample Calculation:

$R_C = R_U + CF_T$

Where:

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

Example Calculation: Peak

Corrected Level: 61.90 + -1.78 = 60.12dBµV/m
Margin: 74dBµV/m – 60.12dBµV/m = 13.9dB

Example Calculation: Average

Corrected Level: 40.40 + -1.78 – 0 = 38.62dBµV
Margin: 54dBµV – 38.62dBµV = 15.4dB

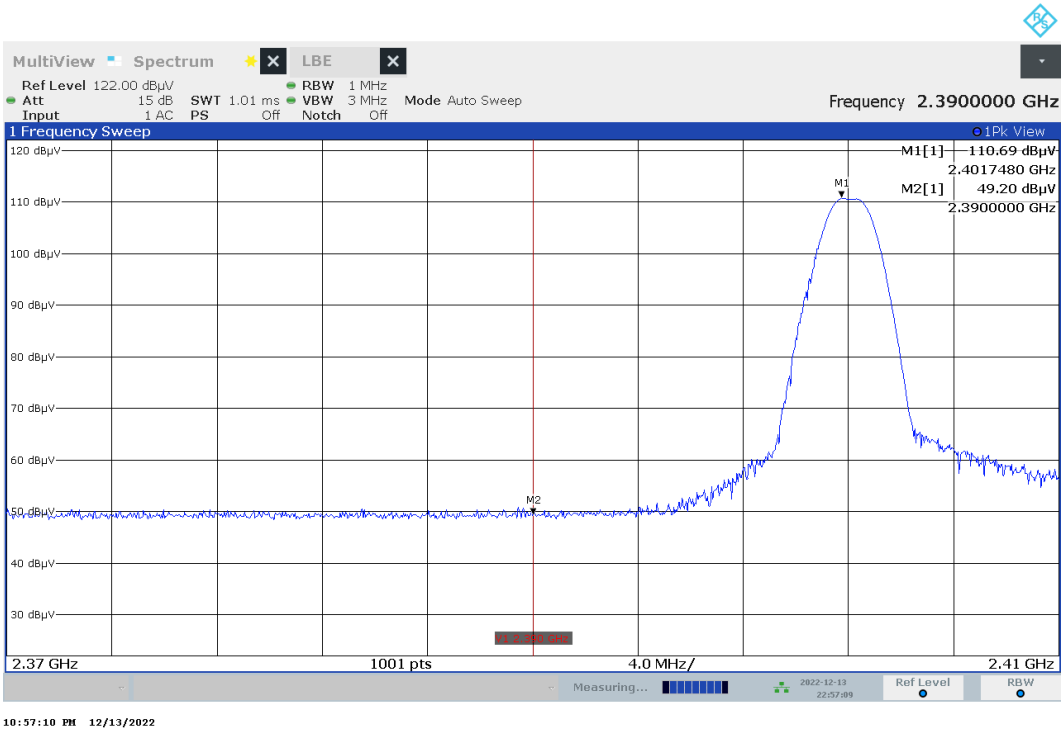

Figure 2.8.6-1: Reference plot Radiated Lower Band-edge – LCH

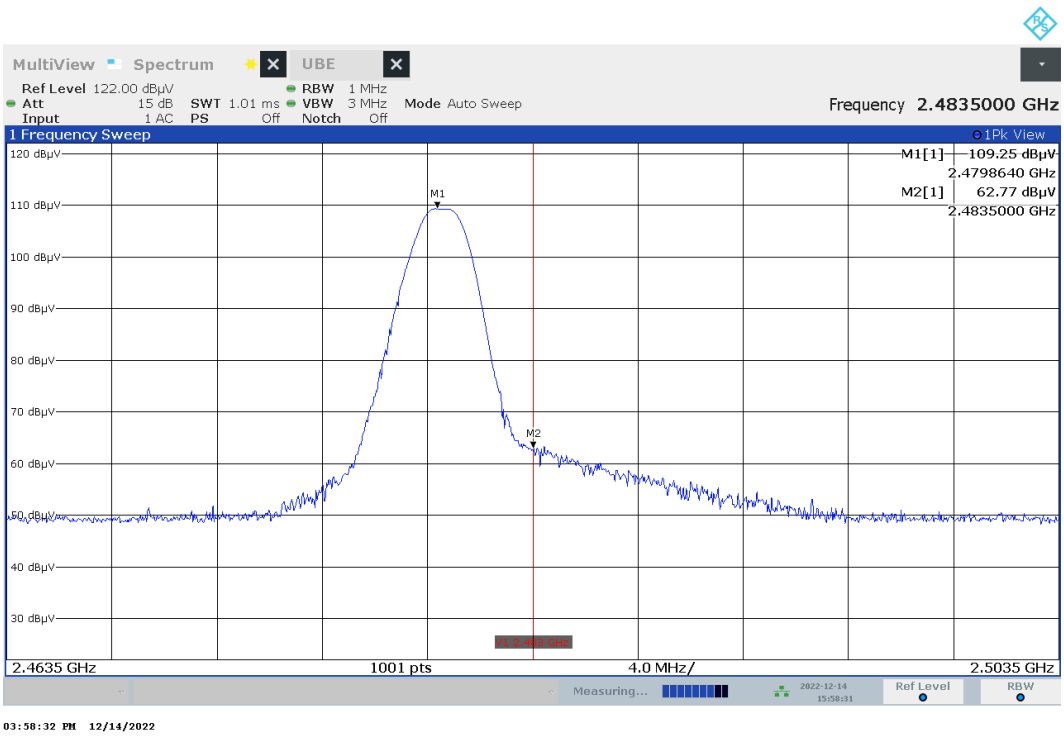

Figure 2.8.6-2: Reference plot Radiated Upper Band-edge – HCH

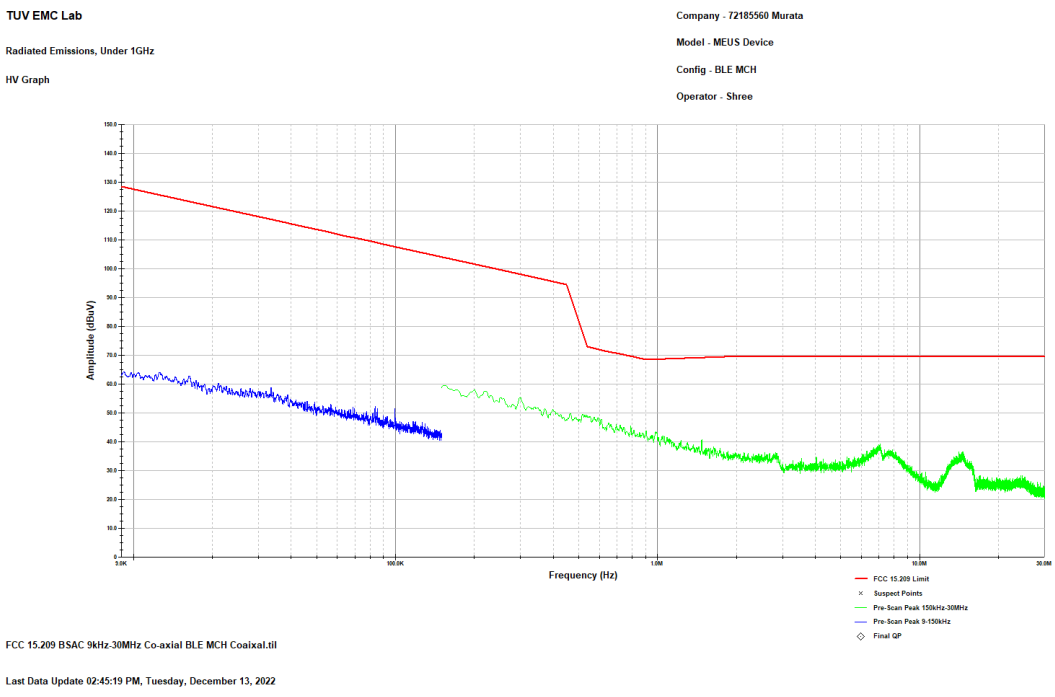

Figure 2.8.6-3: Reference plot for Radiated Spurious Emissions – 9 kHz – 30 MHz - MCH
Note: Emissions above the noise floor are ambient not associated with the EUT.

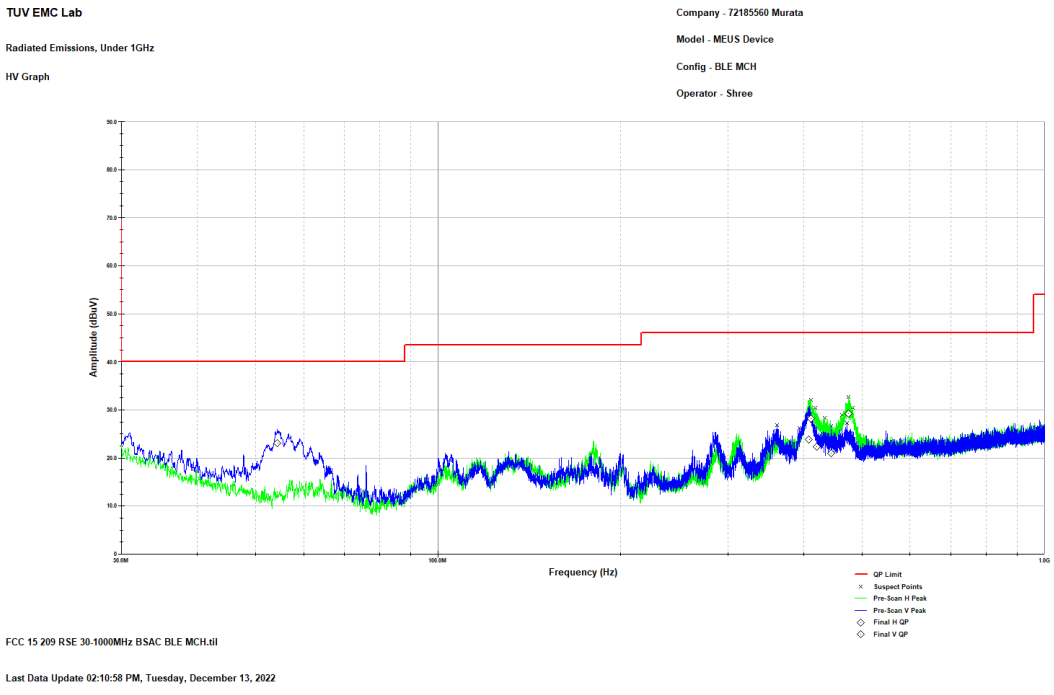

Figure 2.8.6-4: Reference plot for Radiated Spurious Emissions – 30 MHz – 1 GHz – MCH

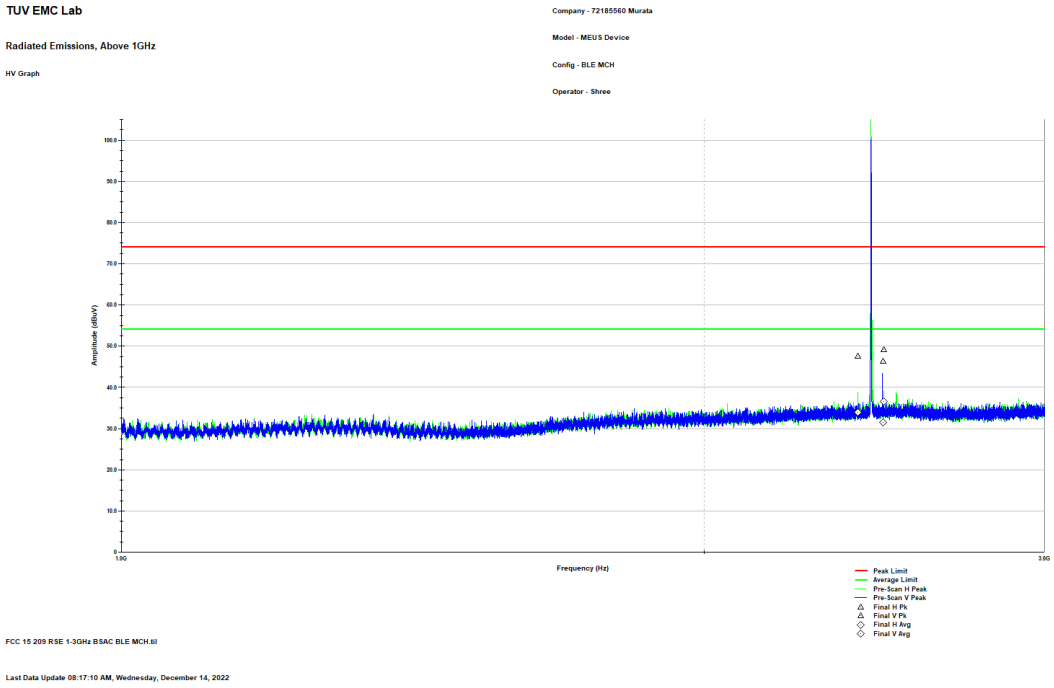

Figure 2.8.6-5: Reference plot for Radiated Spurious Emissions – 1 GHz – 3 GHz – MCH
Note:Emission above limit line is fundamental frequency.

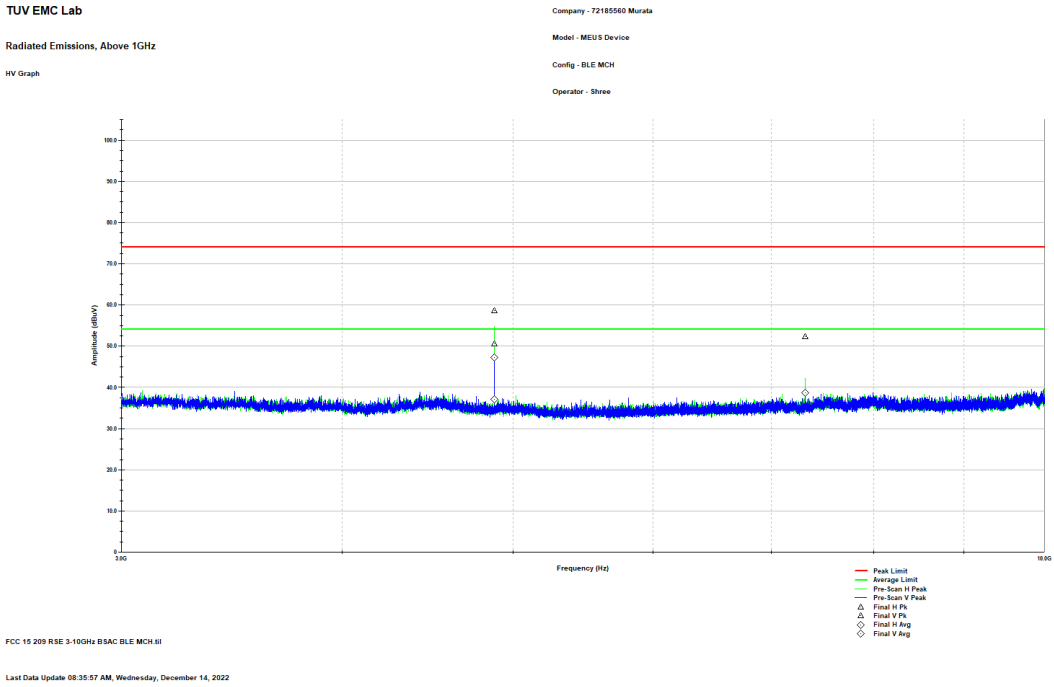

Figure 2.8.6-6: Reference plot for Radiated Spurious Emissions – 3 GHz – 10 GHz – MCH

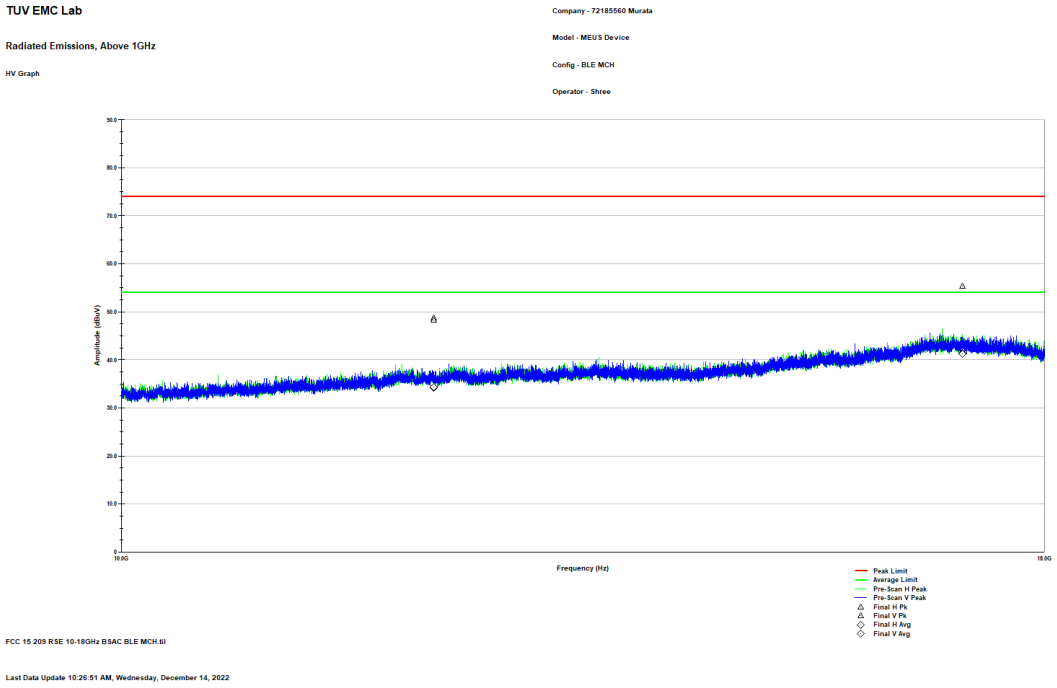

Figure 2.8.6-7: Reference plot for Radiated Spurious Emissions – 10 GHz – 18 GHz – MCH

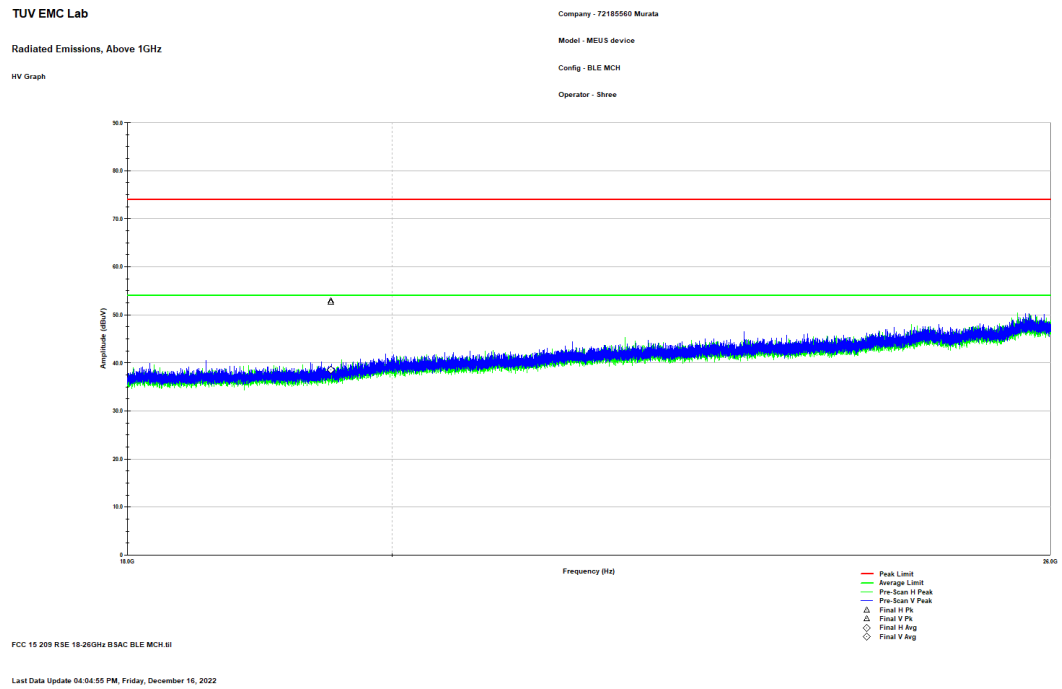

Figure 2.8.6-8: Reference plot for Radiated Spurious Emissions – 18 GHz – 26 GHz – H Polarity

2.9 Test Equipment Used

Table 2.9-1 –Equipment List

Asset ID	Manufacturer	Model	Equipment Type	Serial Number	Last Calibration Date	Calibration Due Date
628	EMCO	6502	Loop antenna	9407-2877	6/8/2021	6/8/2023
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
334	Rohde & Schwarz	3160-09	HF Antenna 18-26.5 GHz	45576	4/25/2022	5/25/2024
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
335	Suhner Sucoflex	SF-102A	RF Cable	882/2A	6/21/2022	6/21/2023
345	Suhner Sucoflex	102A	RF Cable	1077/2A	6/21/2022	6/21/2023
432	Microwave Circuits	H3G020G4	High pass Filter	264066	6/9/2022	6/9/2023
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

3 Diagram of Test Set-ups

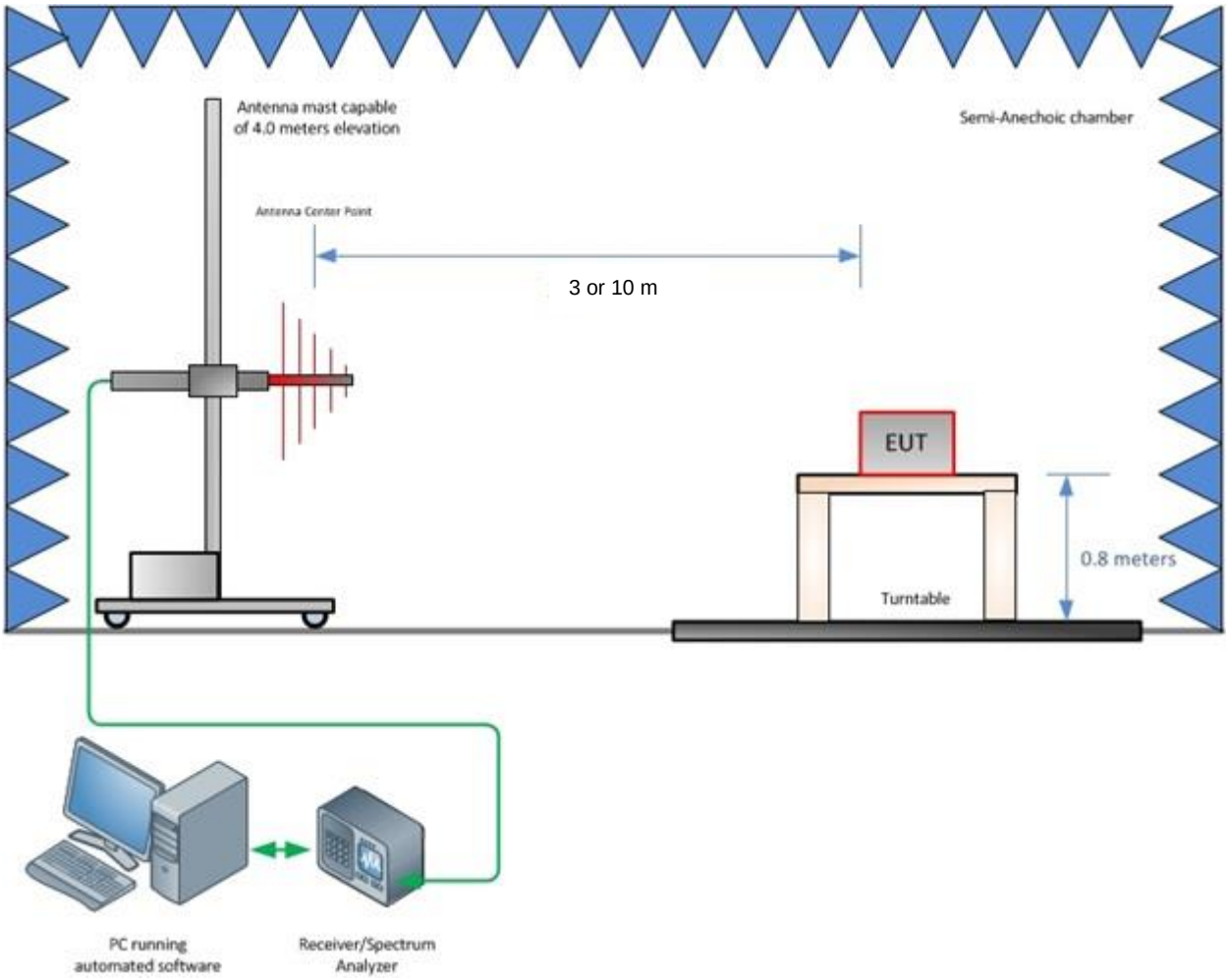

Figure 3-1 – Radiated Emissions Test Setup up to 1 GHz

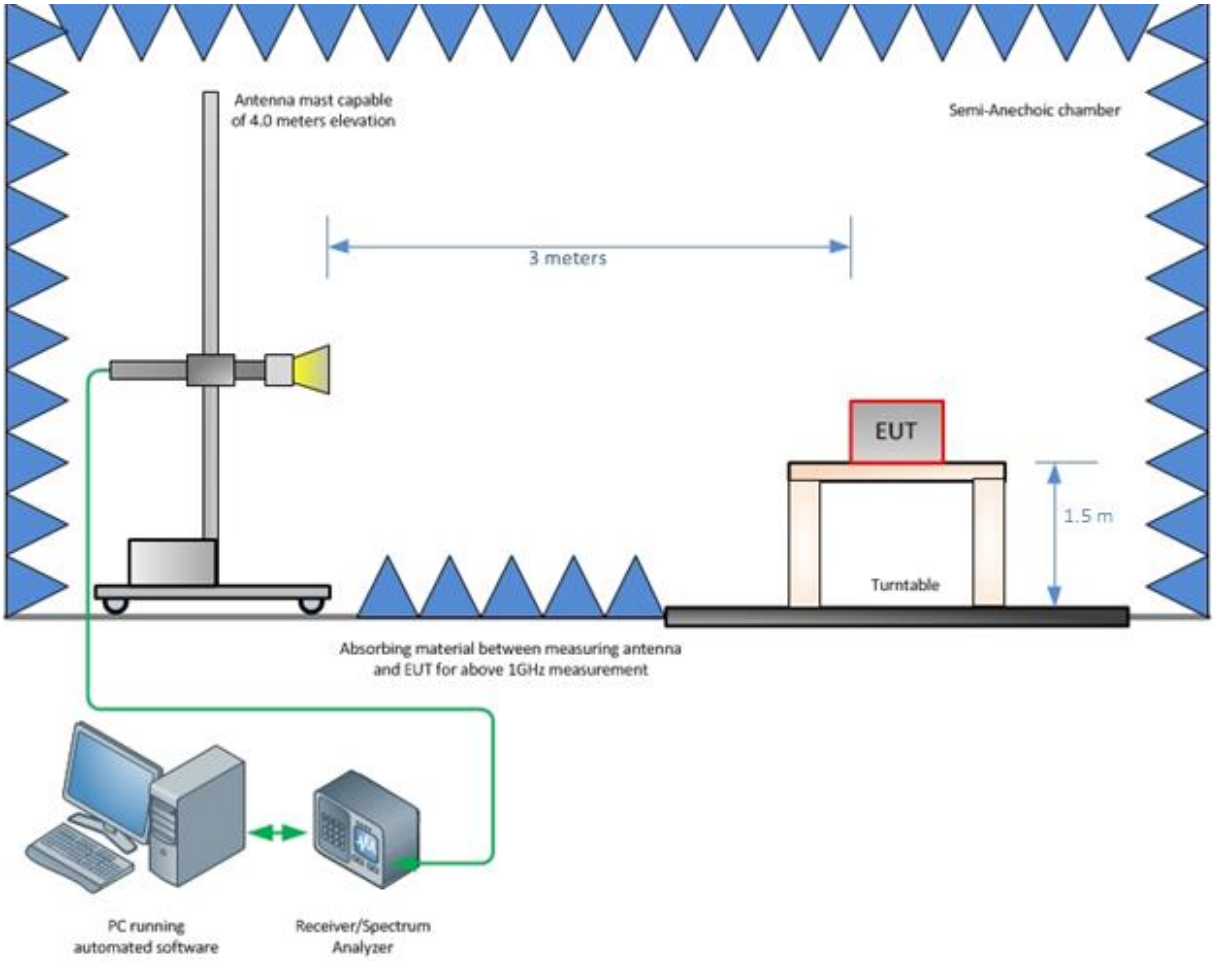

Figure 3-2 – Radiated Emissions Test Setup above 1 GHz

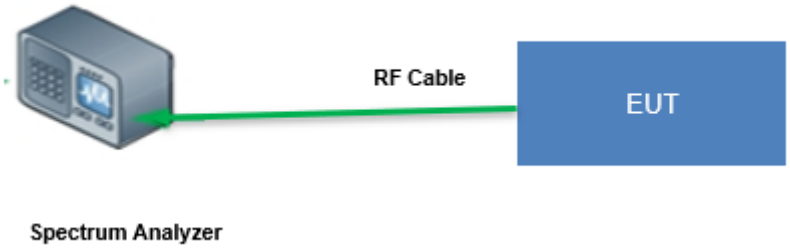

Figure 3-3 – Conducted Test Setup: Antenna Port measurement

4 Accreditation, Disclaimers and Copyright

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STATEMENT OF MEASUREMENT UNCERTAINTY – Emissions

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

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