

Report on the Testing of the Cooper Lighting Solutions WaveLinx Wireless Adapter 0028-000021

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

Prepared for: Cooper Lighting Solutions
1121 Highway 74 South
Peachtree City, Georgia 30269 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.



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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	5/31/2022

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	Vrajesh Patel
Manufacturer	Cooper Lighting Solutions
Applicant's Email Address	Vrajesh.Patel@cooperlighting.com
Model Name	WaveLinx Wireless Adapter 0028-000021
Model Number	N/A
Serial Number	N/A
FCC ID	2AKCY-0028000021
ISED Certification Number	4706A-0028000021
Hardware Version(s)	EP2'
Software Version(s)	Mushroomsensor_fcc_railtest.s37
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, 2021 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	72177304
Date of Receipt of EUT	4/25/2022
Start of Test	4/25/2022
Finish of Test	5/12/2022



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, 2021.

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	-----	10
6 dB Bandwidth	Yes	Pass	15.247(a)(2)	RSS-247 5.2(a)	17
99% Bandwidth	Yes	Pass	-----	RSS-GEN 6.7	17
Fundamental Emission Output Power	Yes	Pass	15.247(b)(3)	RSS-247 5.4(d)	14
Band-Edge Compliance of RF Conducted Emissions	Yes	Pass	15.247(d)	RSS-247 5.5	25
RF Conducted Spurious Emissions	Yes	Pass	15.247(d)	RSS-247 5.5	27
Radiated Spurious Emissions into Restricted Frequency Bands	Yes	Pass	15.205, 15.209	RSS-GEN 8.9, 8.10	29
Power Spectral Density	Yes	Pass	15.247(e)	RSS-247 5.2(b)	22
AC Power Line Conducted Emissions	Yes	Pass	15.207	RSS-GEN 8.8	11

1.4 Product Information

1.4.1 Technical Description

WaveLinx Wireless Adapter 0028-000021 is a wireless control module for integration into light fixtures.

Table 1.4-1 – Wireless Technical Information

Detail	Description
FCC ID	2AKCY-0028000021
IC ID	4706A-0028000021
Transceiver Model #	WaveLinx Wireless Adapter 0028-000021
Frequency Range (MHz)	2402 – 2480 MHz
Modulation Format	GFSK
Number of Channels	40
Channel Spacing	2 MHz
Data Rates	1 Mbps
Operating voltage	12 ~ 24 VDC
Antenna Type / Gain:	Dipole / 2.6dBi Peak

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



Photo 1.4.1-1 – Front view of the EUT



Photo 1.4.1-2 – EUT with programming board



Photo 1.4.1-3 – Conducted EUT



Photo 1.4.1-4 – Conducted EUT with programming board

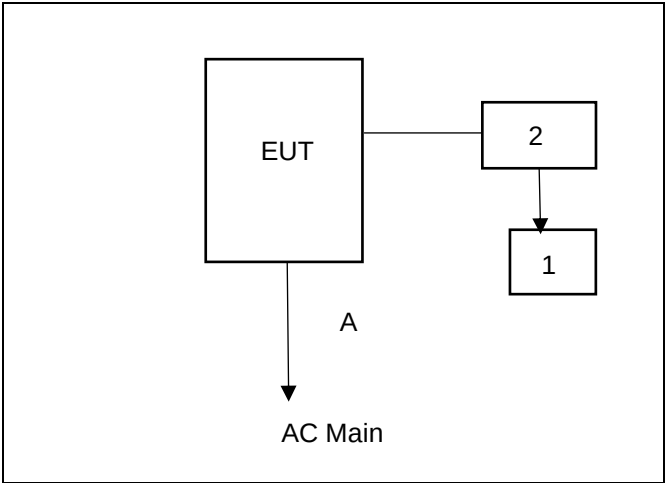


Figure 1.4.1-5 – Test Setup Block Diagram

Table 1.4.1-1 – Cable Descriptions

Item	Cable/Port	Description
A	Power Supply Driver	DC – AC adapter with power supply cable

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

Item	Make/Model	Description
1	Lenovo	Laptop used for configuring wireless module
2	Silicon Labs	Programming board

1.4.2 Modes of Operation

WaveLinx Wireless Adapter 0028-000021 provides 1 mode of operation using BLE Mesh 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 worst orientations. 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: 12 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
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	Paul Villarreal	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 "0", as noted in §1.6.

2.1.3 Date of Test

4/25/2022

2.1.4 Test Method

N/A

2.1.5 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

2.1.6 Test Results

The EUT utilizes Isolated Dipole antenna with peak gain of 2.6 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 “0”, as noted in §1.6.

2.2.3 Date of Test

4/29/2022

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 (MHz)	Avg Limit	Avg Level Corrected	Avg Level	Correction Fact.	Avg Margin	Result
0.15	56	32.3	22.6	9.682	23.7	PASS
0.53	46	19.7	10.1	9.652	26.3	PASS
0.93	46	19.3	9.6	9.676	26.7	PASS
2.07	46	18.8	9.0	9.773	27.2	PASS
2.21	46	18.0	8.3	9.778	28.0	PASS
30.00	50	13.9	3.8	10.13	36.1	PASS

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

Frequency (MHz)	QP Limit	QP Level Corrected	QP Level	Correction Fact.	QP Margin	Result
0.15	66	41.8	32.1	9.682	24.2	PASS
0.53	56	25.0	15.4	9.652	31.0	PASS
0.93	56	24.8	15.1	9.676	31.2	PASS
2.07	56	24.5	14.7	9.773	31.5	PASS
2.21	56	24.5	14.8	9.778	31.5	PASS
30.00	60	18.1	8.0	10.13	41.9	PASS

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

Frequency (MHz)	Avg Limit	Avg Level Corrected	Avg Level	Correction Fact.	Avg Margin	Result
0.15	56	33.5	23.8	9.675	22.5	PASS
0.21	54.4	28.0	18.3	9.669	26.4	PASS
0.50	46	16.0	6.4	9.630	30.0	PASS
1.01	46	15.7	6.1	9.661	30.3	PASS
2.55	46	14.6	4.8	9.772	31.4	PASS
0.15	56	33.5	23.8	9.675	22.5	PASS

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

Frequency (MHz)	QP Limit	QP Level Corrected	QP Level	Correction Fact.	QP Margin	Result
0.15	66	41.8	32.2	9.675	24.2	PASS
0.21	64.4	34.8	25.1	9.669	29.6	PASS
0.50	56	20.2	10.6	9.630	35.8	PASS
1.01	56	20.0	10.4	9.661	36.0	PASS
2.55	56	19.0	9.3	9.772	37.0	PASS
0.15	66	41.8	32.2	9.675	24.2	PASS

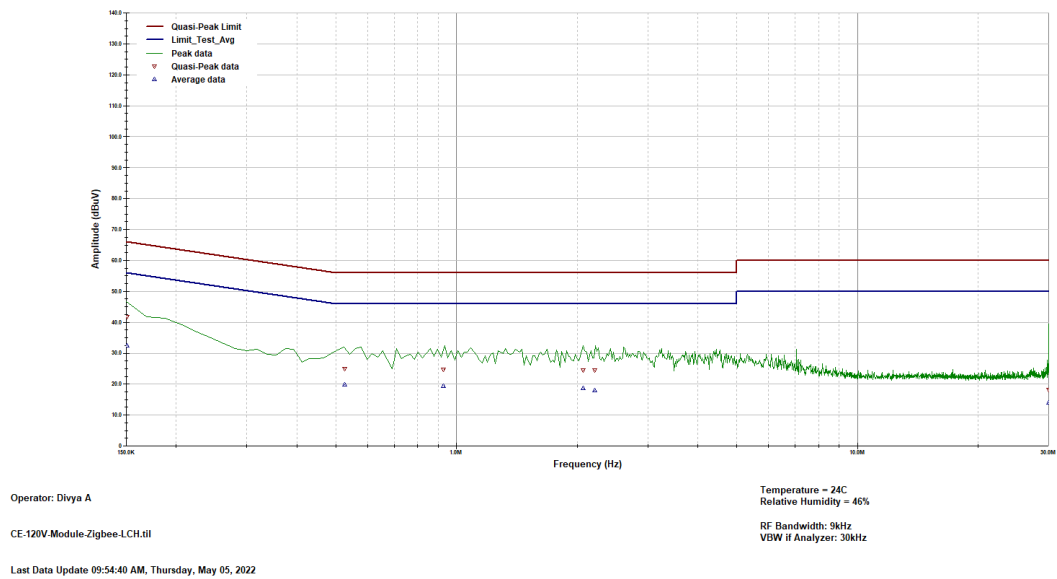


Figure 2.2.6-1: Conducted Emission Plot – Line 1

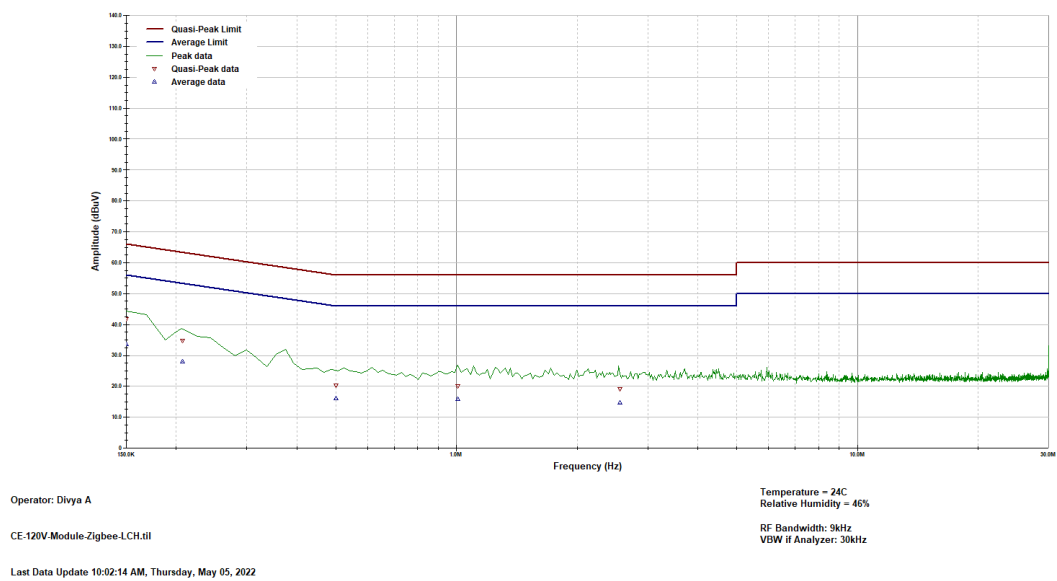


Figure 2.2.6-2: Conducted Emission Plot – Nuetral



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

5/12/2022

2.3.4 Test Method

The maximum peak conducted output power was measured in accordance with ANSI C63.10 Subclause 11.9.1.1 utilizing the RBW $\geq$ DTS Bandwidth method. The RF output of the equipment under test was directly connected to the input of the analyzer applying suitable attenuation.

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.

Test Results: Pass

See data below for detailed results.

Table 2.3.6-1: RF Output Power

Frequency [MHz]	Peak Output Power (dBm)	Data Rate
2402	12.3	1 Mbps
2440	11.9	1 Mbps
2480	11.5	1 Mbps

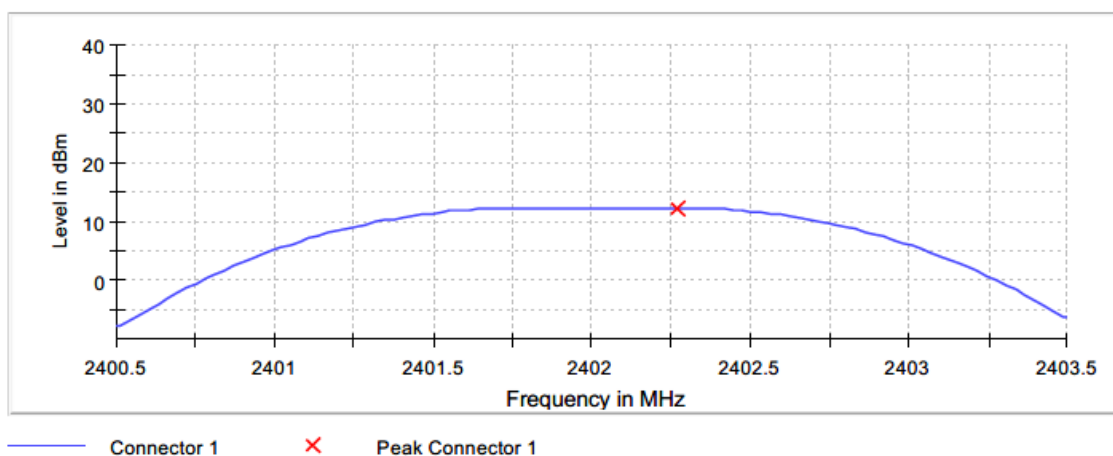


Figure 2.3.6-1: Output Power - LCH

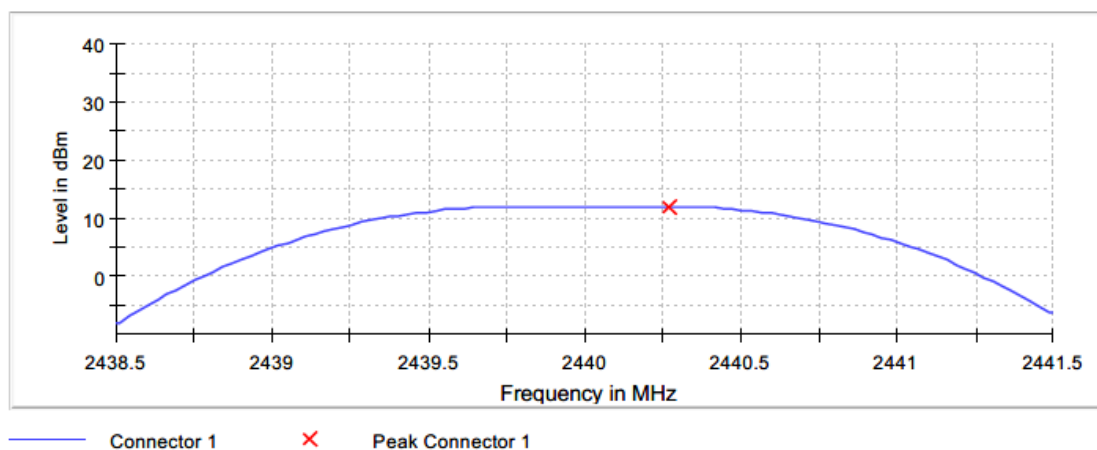


Figure 2.3.6-2: Output Power - MCH

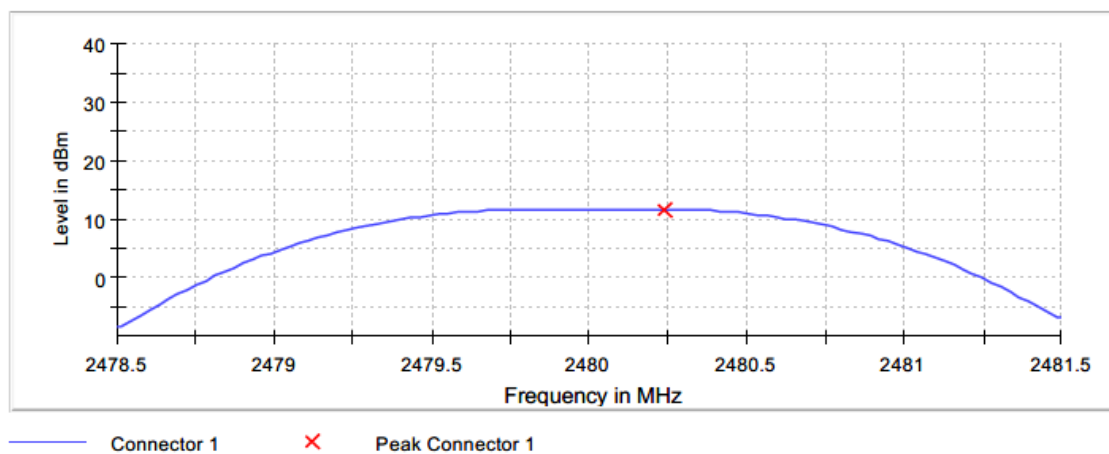


Figure 2.3.6-3: Output Power - HCH

Table 2.3.6.1-1: Sample Measurement Settings

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	1.000 MHz	≥ 752.477 kHz
VBW	3.000 MHz	≥ 3.000 MHz
Sweep Points	101	~ 101
Sweep time	1.907 μ s	AUTO
Reference Level	20.000 dBm	20.000 dBm
Attenuation	40.000 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	4 / max. 150	max. 150
Stable	3 / 3	3
Max Stable Difference	0.02 dB	0.50 dB



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

5/12/2022

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	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.

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	752.476	1.050	1 Mbps
2440	752.476	1.050	1 Mbps
2480	752.476	1.040	1 Mbps

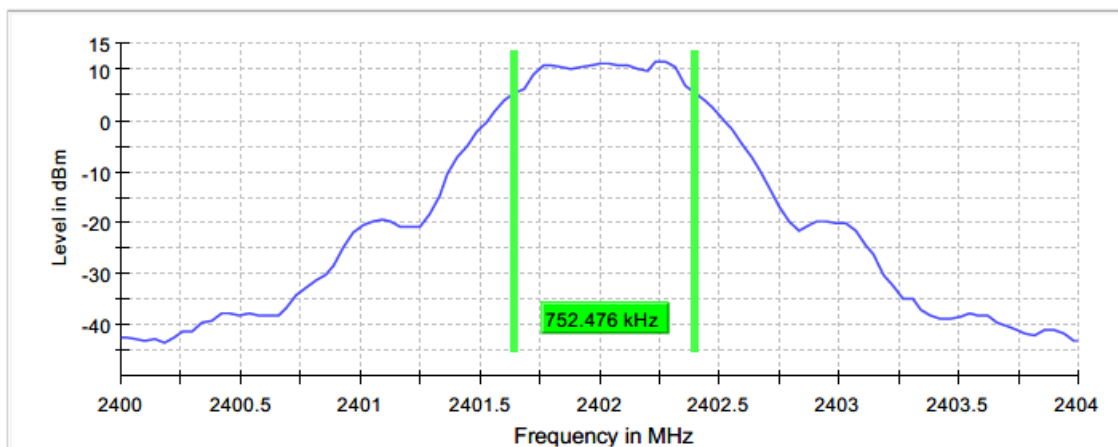


Figure 2.4.6-1: 6 dB BW - LCH

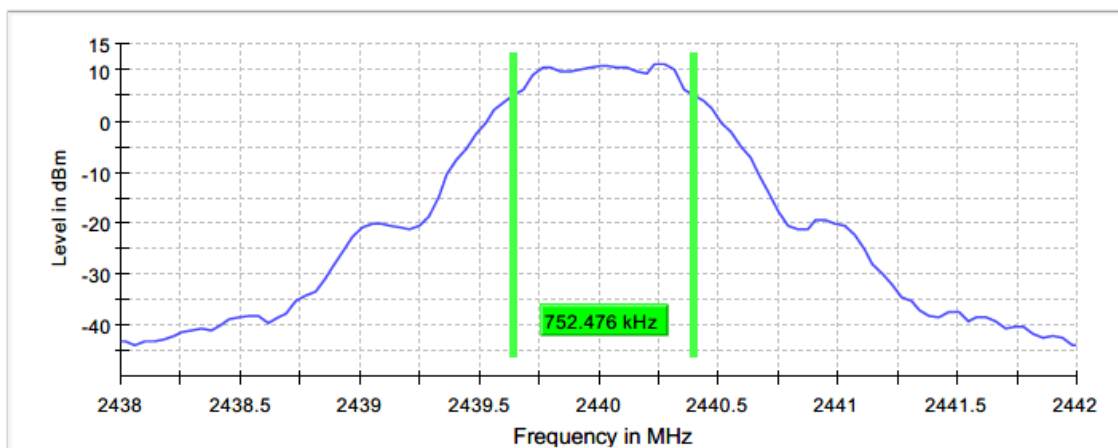


Figure 2.4.6-2: 6 dB BW - MCH

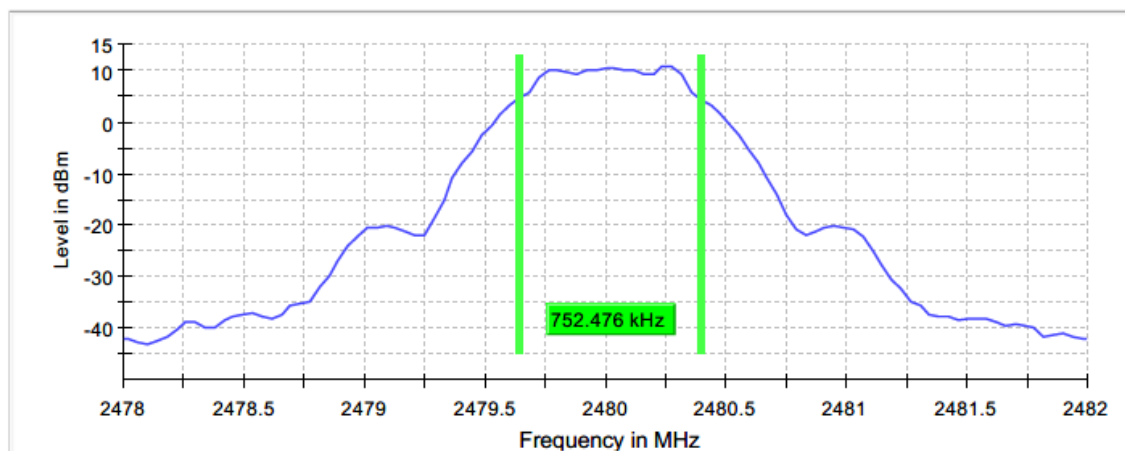


Figure 2.4.6-3: 6 dB BW - HCH

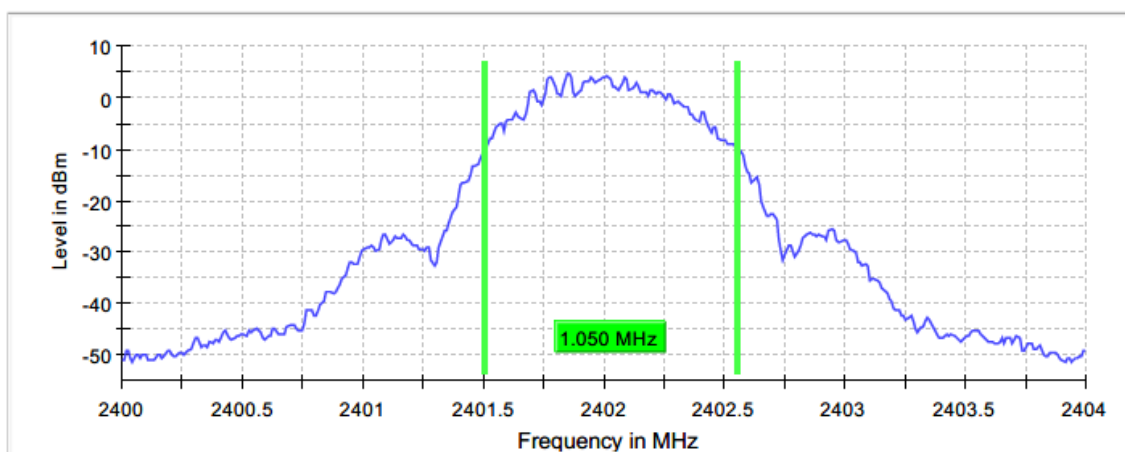


Figure 2.4.6-4: 99% BW - LCH

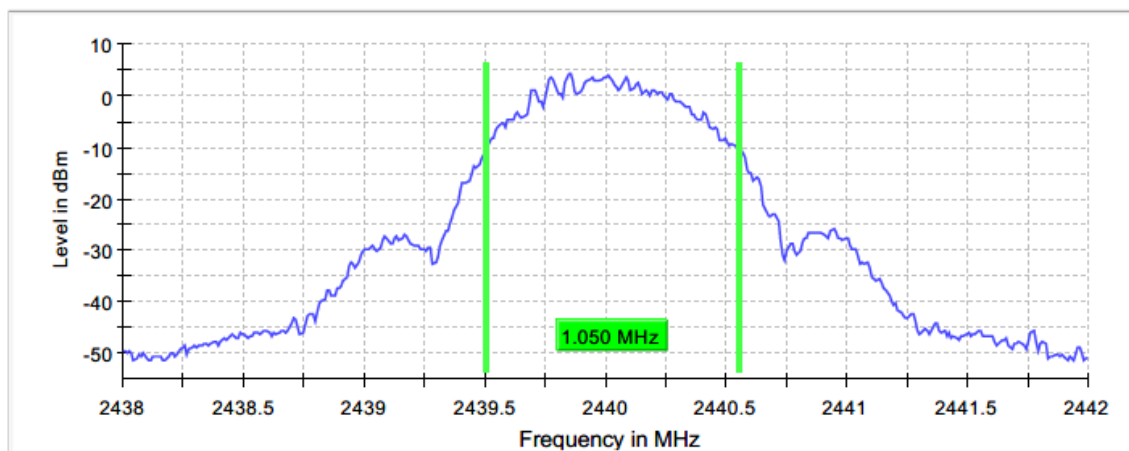


Figure 2.4.6-5: 99% BW - MCH

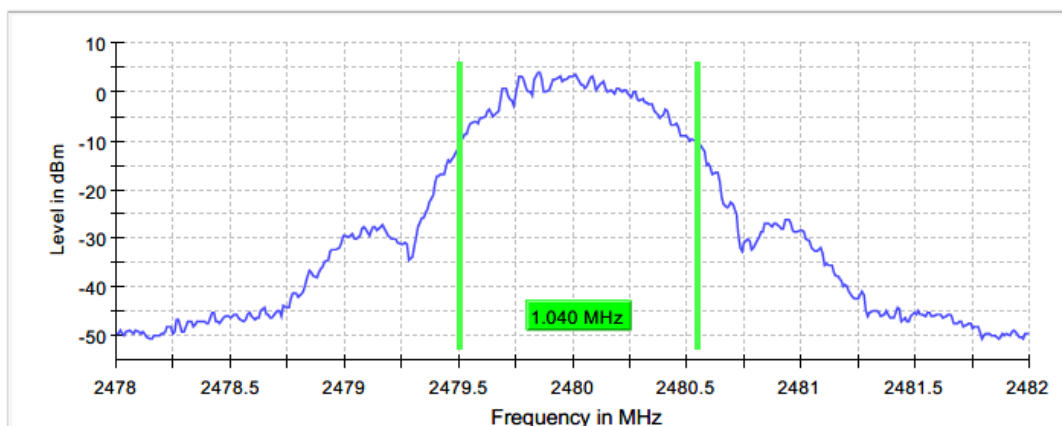


Figure 2.4.6-6: 99% BW - HCH

Table 2.4.6.1-1: 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 μ s	AUTO
Reference Level	10.000 dBm	10.000 dBm
Attenuation	30.000 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	0.20 dB	0.50 dB

**Table 2.4.6.1-2: 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 μ s	AUTO
Reference Level	10.000 dBm	10.000 dBm
Attenuation	30.000 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	5 / max. 150	max. 150
Stable	3 / 3	3
Max Stable Difference	0.10 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

5/12/2022

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	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.

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	2.083	1 Mbps
2440	1.813	1 Mbps
2480	1.509	1 Mbps

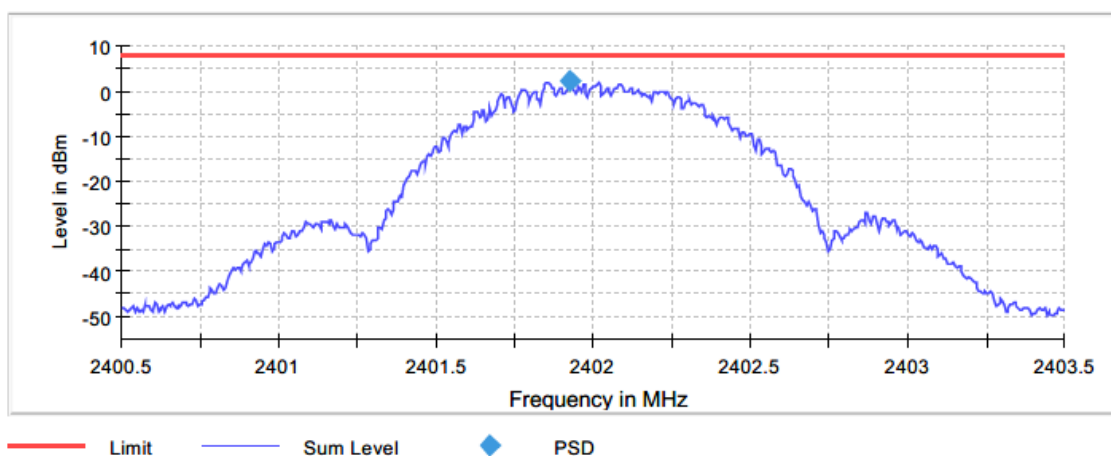


Figure 2.5.6-1: PSD – LCH

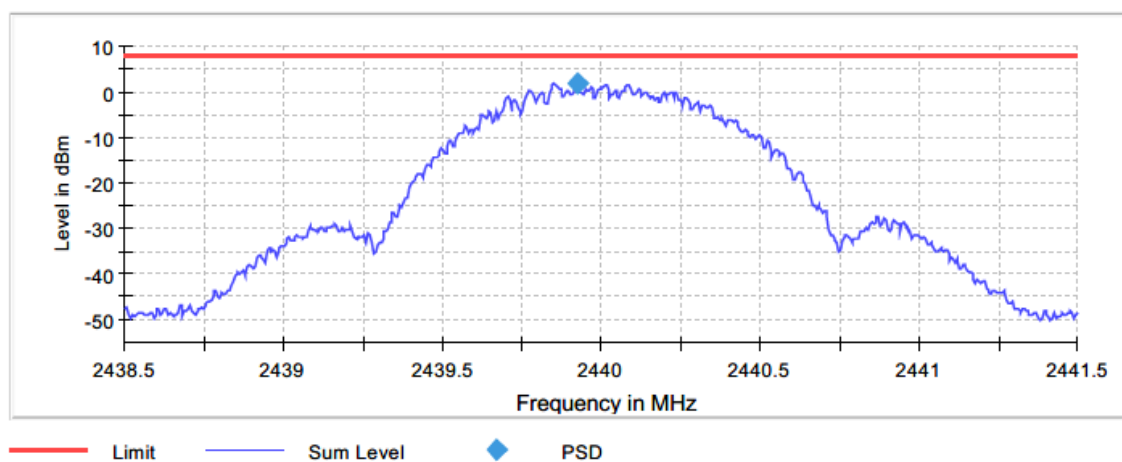


Figure 2.5.6-2: PSD – MCH

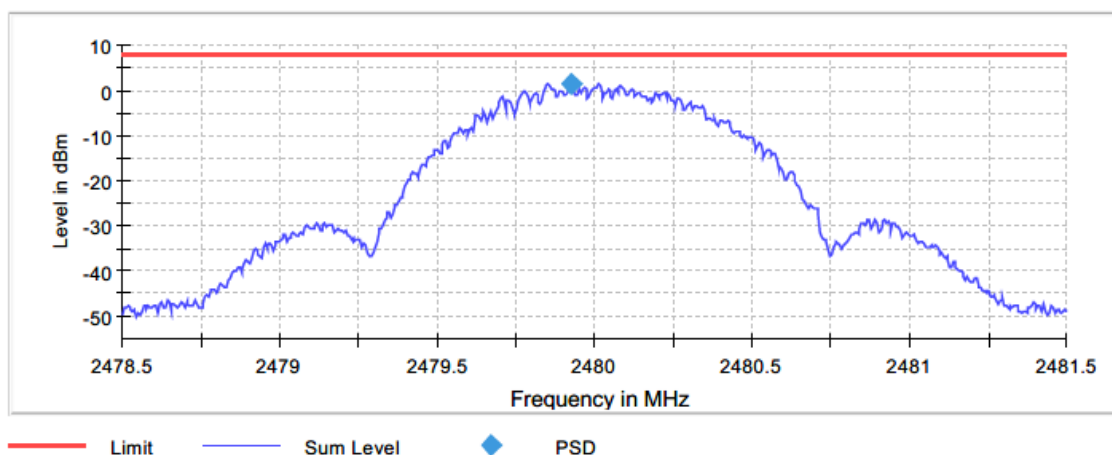


Figure 2.5.6-3: PSD – HCH

Table 2.5.6-1: 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	10.000 dBm	10.000 dBm
Attenuation	30.000 dB	AUTO
Detector	MaxPeak	MaxPeak
Sweep Count	100	100
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweep type	Sweep	Sweep
Preamplifier	off	off
Stable mode	Trace	Trace
Stable value	0.50 dB	0.50 dB
Run	4 / max. 150	max. 150
Stable	2 / 2	2
Max Stable Difference	0.09 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

5/12/2022

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	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.

Test Results: Pass

See data below for detailed results.

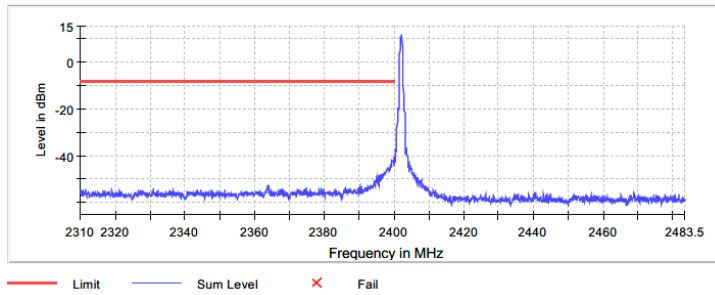


Figure 2.6.6-1: Lower Band-edge

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

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)	Result
2399.975000	-40.4	31.9	-8.5	PASS
2399.925000	-41.7	33.2	-8.5	PASS
2399.425000	-42.0	33.5	-8.5	PASS
2399.725000	-42.0	33.5	-8.5	PASS
2399.625000	-42.1	33.5	-8.5	PASS
2399.675000	-42.1	33.6	-8.5	PASS
2399.775000	-42.3	33.8	-8.5	PASS
2399.575000	-42.3	33.8	-8.5	PASS
2399.525000	-42.3	33.8	-8.5	PASS
2399.475000	-42.4	33.9	-8.5	PASS
2399.875000	-42.4	33.9	-8.5	PASS
2399.375000	-43.0	34.5	-8.5	PASS
2399.825000	-43.0	34.5	-8.5	PASS
2399.325000	-43.7	35.2	-8.5	PASS
2399.125000	-43.7	35.2	-8.5	PASS

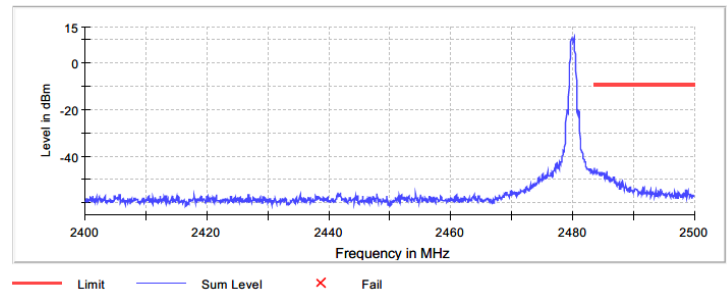


Figure 2.6.6-2: Upper Band-edge

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

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)	Result
2483.525000	-44.9	35.6	-9.3	PASS
2483.975000	-45.3	35.9	-9.3	PASS
2483.575000	-45.3	35.9	-9.3	PASS
2483.625000	-45.6	36.2	-9.3	PASS
2483.925000	-46.0	36.6	-9.3	PASS
2483.725000	-46.4	37.1	-9.3	PASS
2485.575000	-46.5	37.1	-9.3	PASS
2484.025000	-46.5	37.2	-9.3	PASS
2483.775000	-46.6	37.2	-9.3	PASS
2484.225000	-46.8	37.4	-9.3	PASS
2483.675000	-46.9	37.5	-9.3	PASS
2483.825000	-46.9	37.6	-9.3	PASS
2485.525000	-46.9	37.6	-9.3	PASS
2484.275000	-47.0	37.6	-9.3	PASS
2484.325000	-47.0	37.6	-9.3	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

4/25/2022

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	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.

Test Results: Pass

See data below for detailed results.

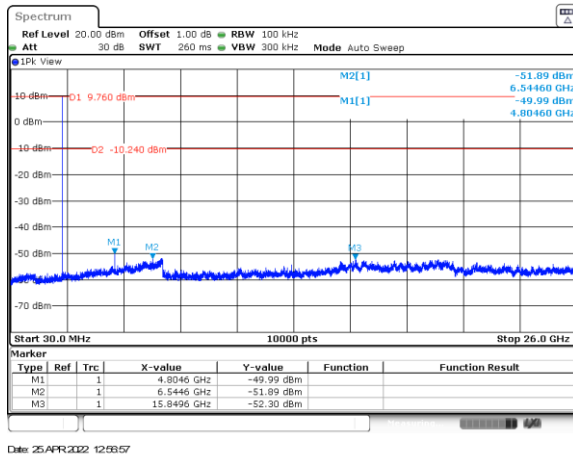


Figure 2.7.6-1: 30MHz – 26GHz – LCH

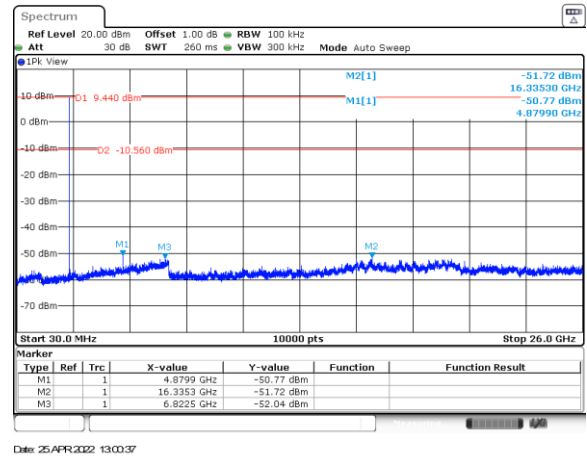


Figure 2.7.6-2: 30MHz – 26GHz – MCH

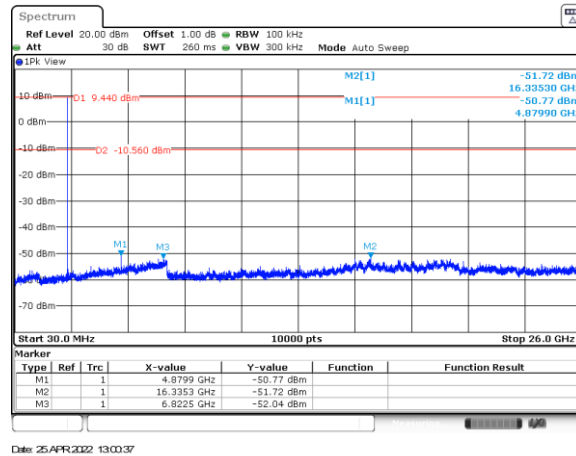


Figure 2.7.6-3: 30MHz – 26GHz – HCH



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 “0”, as noted in §1.6.

2.8.3 Date of Test

4/25/2022 to 5/11/2022

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	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.

Test Results: Pass

See data below for detailed results.



Table 2.8.6-1: Radiated Spurious Emissions Tabulated Data

Frequency (MHz)	Level (dBuV)		Antenna	Duty Cycle Correction Factor	Corrected Level (dBuV)		Limit		Margin	
			Polarity				(dBuV/m)		(dB)	
	pk	Qpk/Avg	(H/V)		pk	Qpk/Avg	pk	Qpk/Avg	pk	Qpk/Avg
LCH										
32.594	-----	19.696	H	9.31	-----	19.696	-----	40	-----	20.3
838.905	-----	18.075	H	9.31	-----	18.075	-----	46	-----	27.92
1856.725	45.822	31.494	H	9.31	45.822	22.184	74	54	28.18	31.816
5224.775	53.089	36.588	H	9.31	53.089	27.278	74	54	20.91	26.722
9943.95	58.587	44.791	H	9.31	58.587	35.481	74	54	15.41	18.519
16726.3	61.267	47.29	H	9.31	61.267	37.98	74	54	12.73	16.02
33.201	-----	19.828	V	9.31	-----	19.828	-----	40	-----	20.17
59.73	-----	20.964	V	9.31	-----	20.964	-----	40	-----	19.04
112.256	-----	15.515	V	9.31	-----	15.515	-----	43.5	-----	27.99
844.703	-----	17.895	V	9.31	-----	17.895	-----	46	-----	28.11
1857.825	45.585	31.25	V	9.31	45.585	21.94	74	54	28.41	32.06
9765.3	60.303	45.318	V	9.31	60.303	36.008	74	54	13.7	17.992
17743.38	60.852	47.35	V	9.31	60.852	38.04	74	54	13.15	15.96
MCH										
32.813	-----	19.875	H	9.31	-----	19.875	-----	40	-----	20.12
852.12	-----	18.065	H	9.31	-----	18.065	-----	46	-----	27.93
5224.975	57.065	36.882	H	9.31	57.065	27.572	74	54	16.93	26.428
9670.65	58.494	44.735	H	9.31	58.494	35.425	74	54	15.51	18.575
16737.83	61.378	47.308	H	9.31	61.378	37.998	74	54	12.62	16.002
33.734	-----	19.359	V	9.31	-----	19.359	-----	40	-----	20.64
57.694	-----	22.052	V	9.31	-----	22.052	-----	40	-----	17.95
103.671	-----	15.165	V	9.31	-----	15.165	-----	43.5	-----	28.33
951.985	-----	18.714	V	9.31	-----	18.714	-----	46	-----	27.29
5273.575	51.195	36.942	V	9.31	51.195	27.632	74	54	22.81	26.368
9771.3	59.192	45.355	V	9.31	59.192	36.045	74	54	14.81	17.955
16800.53	61.089	46.96	V	9.31	61.089	37.65	74	54	12.91	16.35
HCH										
32.739	-----	19.892	H	9.31	-----	19.892	-----	40	-----	20.11
957.686	-----	19.151	H	9.31	-----	19.151	-----	46	-----	26.85
1397.15	43.318	29.093	H	9.31	43.318	19.783	74	54	30.68	34.217
5219.175	51.891	36.681	H	9.31	51.891	27.371	74	54	22.11	26.629
9753.175	59.493	45.509	H	9.31	59.493	36.199	74	54	14.51	17.801
16732.53	60.737	47.305	H	9.31	60.737	37.995	74	54	13.26	16.005
30.534	-----	17.967	V	9.31	-----	17.967	-----	40	-----	22.03
59	-----	16.922	V	9.31	-----	16.922	-----	40	-----	23.08
105.369	-----	14.61	V	9.31	-----	14.61	-----	43.5	-----	28.89
922.448	-----	18.611	V	9.31	-----	18.611	-----	46	-----	27.39
4560.725	51.476	36.988	V	9.31	51.476	27.678	74	54	22.52	26.322
5218.5	56.134	36.815	V	9.31	56.134	27.505	74	54	17.87	26.495
9979.8	59.258	45.189	V	9.31	59.258	35.879	74	54	14.74	18.121
16907.85	61.52	47.188	V	9.31	61.52	37.878	74	54	12.48	16.122

**Table 2.8.6-2: Radiated Band-Edge Tabulated Data**

Frequency (MHz)	Level (dBuV)		Antenna Polarity (H/V)	Correction Factors (dB)	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	pk	Qpk/Avg			pk	Qpk/Avg	pk	Qpk/Avg	pk	Qpk/Avg
LCH										
2390	50.40	36.40	H	0.08	50.48	27.16	74.0	54.0	23.5	26.8
HCH										
2483.5	67.10	52.50	H	0.36	67.46	43.55	74.0	54.0	6.5	10.5

Note:

When operating with Wireless protocol with 1Mbps physical layer, the total worse cast transmission time is 1.232ms (154 byte) with at 3.6ms period:

$$\text{Duty Cycle} = 1.232/3.6 = 34.22\%$$

$$20 * \text{LOG} (1.232/3.6) = -9.31 \text{ dB}$$

Hence, Duty cycle correction factor is considered to the average reading for above 1GHz measurements.

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

$$\text{Corrected Level: } 50.40 + 0.08 = 50.48 \text{ dB}\mu\text{V/m}$$

$$\text{Margin: } 74 \text{ dB}\mu\text{V/m} - 50.48 \text{ dB}\mu\text{V/m} = 23.5 \text{ dB}$$

Example Calculation: Average

$$\text{Corrected Level: } 36.40 + 0.08 - 9.31 = 27.16 \text{ dB}\mu\text{V}$$

$$\text{Margin: } 54 \text{ dB}\mu\text{V} - 27.16 \text{ dB}\mu\text{V} = 26.8 \text{ dB}$$

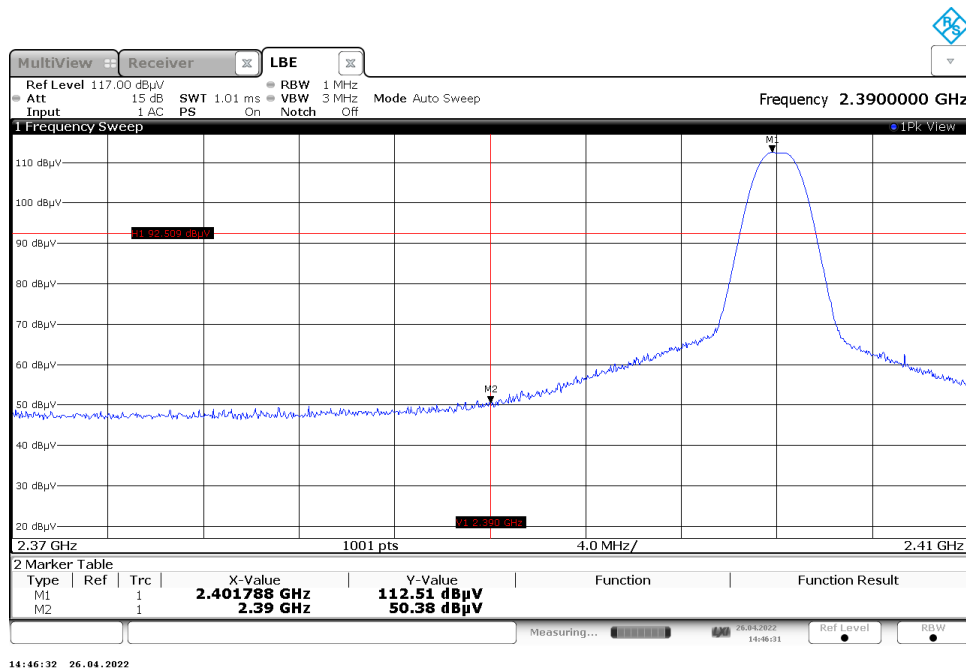


Figure 2.8.6-1: Reference plot Radiated Lower Band-edge – LCH

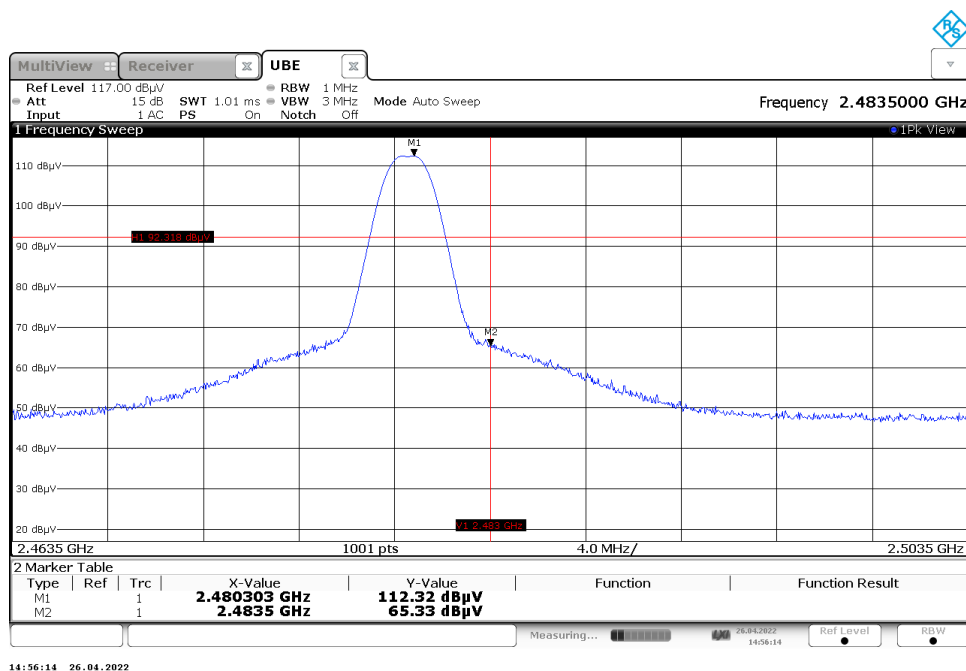


Figure 2.8.6-2: Reference plot Radiated Upper Band-edge – HCH

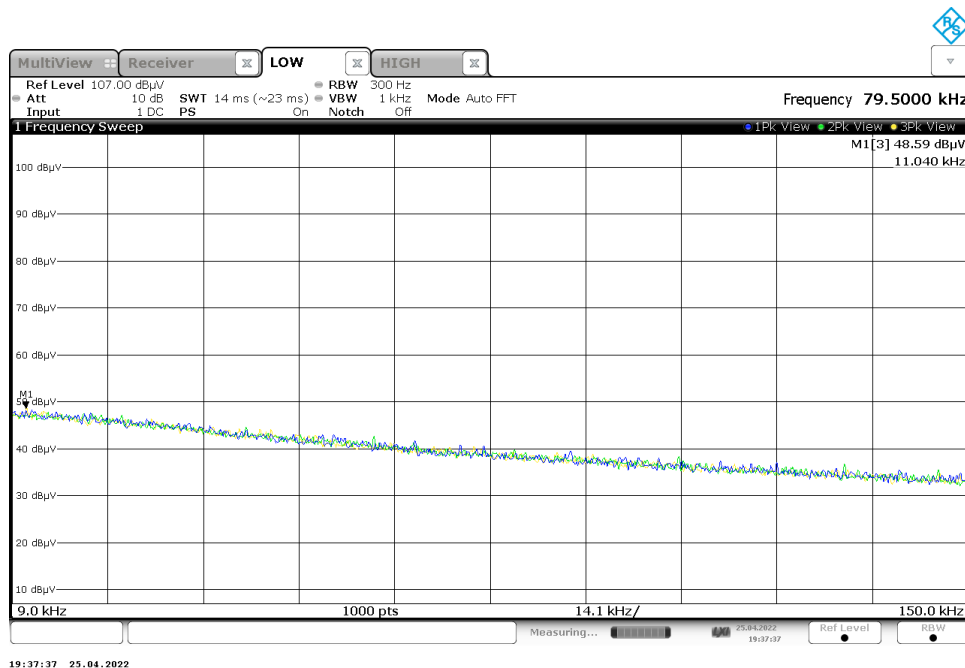


Figure 2.8.6-3: Reference plot for Radiated Spurious Emissions – 9 kHz – 150 kHz

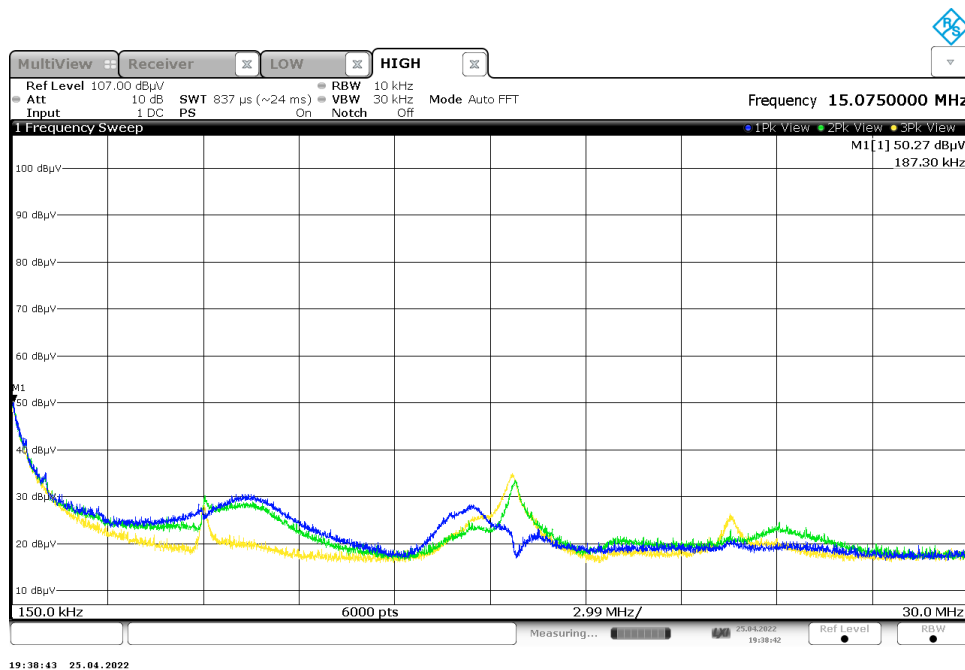


Figure 2.8.6-4: Reference plot for Radiated Spurious Emissions– 150 kHz – 30MHz

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



TUV EMC Lab

Radiated Emissions, Under 1GHz

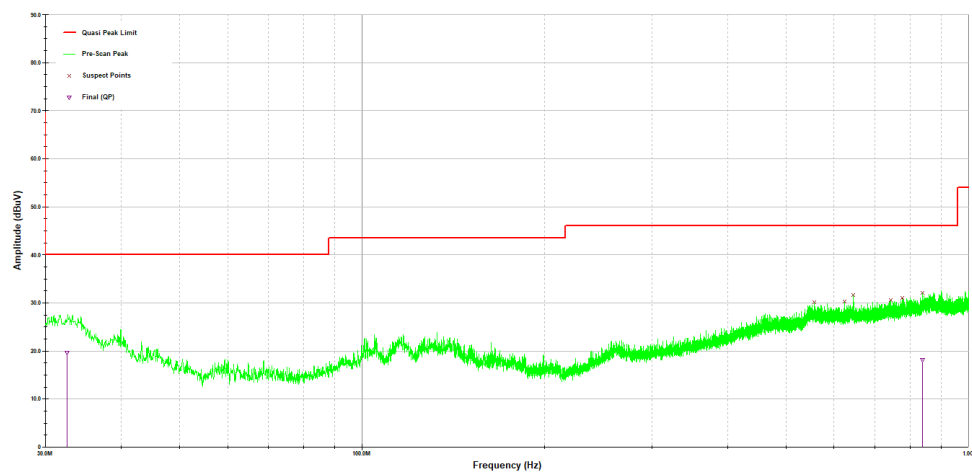
Horizontal Graph

Company - Cooper Lighting

Model - Not Listed

Config - BLE Ch0 Xpos

Operator - PV



BLE Ch0 XPOS RSE 30-1000MHz BSAC.ttl

Last Data Update 12:21:16 PM, Monday, April 25, 2022

Figure 2.8.6-5: Reference plot for Radiated Spurious Emissions – 30 MHz – 1 GHz – H Polarity

TUV EMC Lab

Radiated Emissions, Under 1GHz

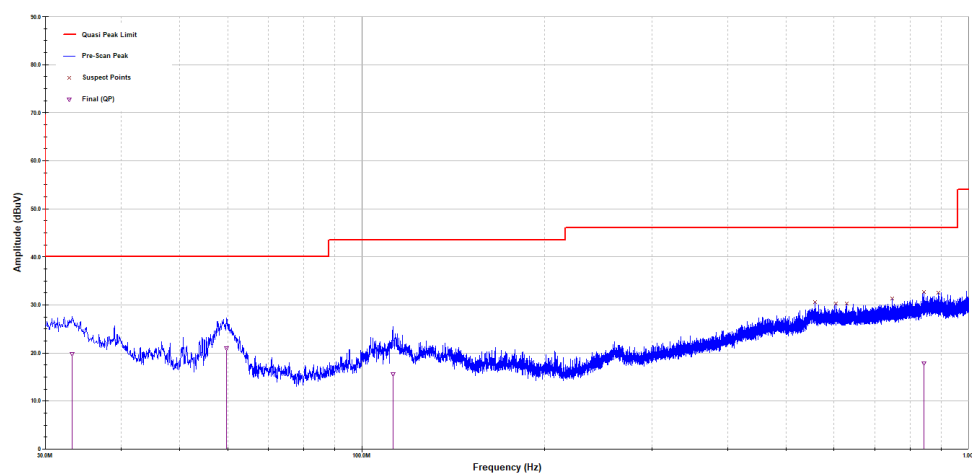
Vertical Graph

Company - Cooper Lighting

Model - Not Listed

Config - BLE Ch0 Xpos

Operator - PV



BLE Ch0 XPOS RSE 30-1000MHz BSAC.ttl

Last Data Update 12:18:25 PM, Monday, April 25, 2022

Figure 2.8.6-6: Reference plot for Radiated Spurious Emissions – 30 MHz – 1 GHz – V Polarity



Figure 2.8.6-7: Reference plot for Radiated Spurious Emissions – 1 GHz – 3 GHz – H Polarity

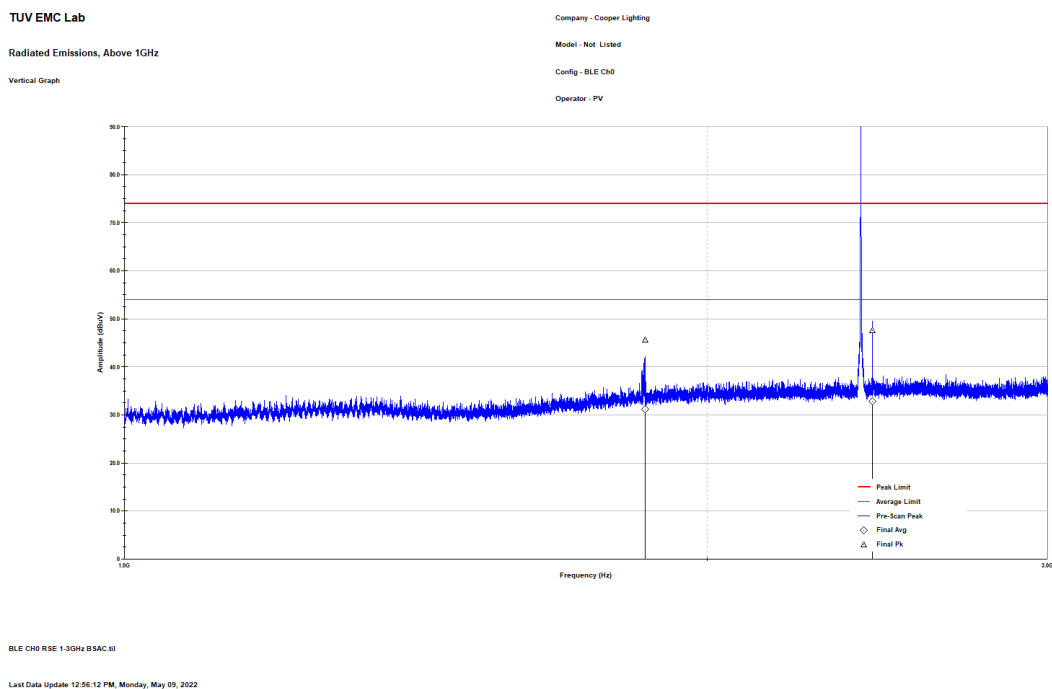


Figure 2.8.6-8: Reference plot for Radiated Spurious Emissions – 1 GHz – 3 GHz – V Polarity

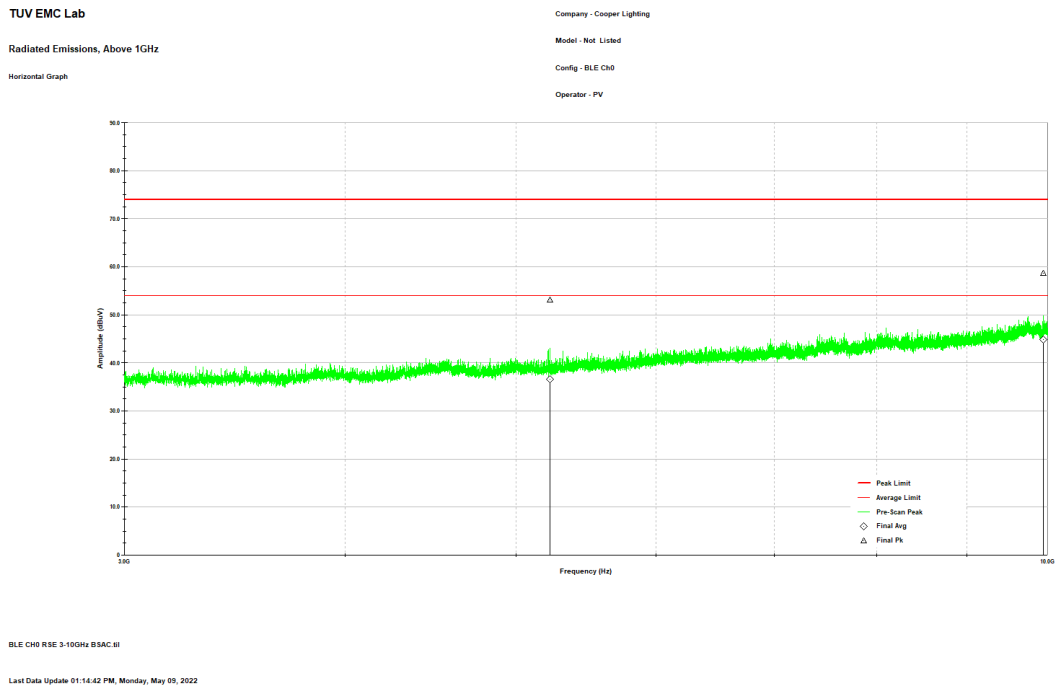


Figure 2.8.6-9: Reference plot for Radiated Spurious Emissions – 3 GHz – 10 GHz – H Polarity

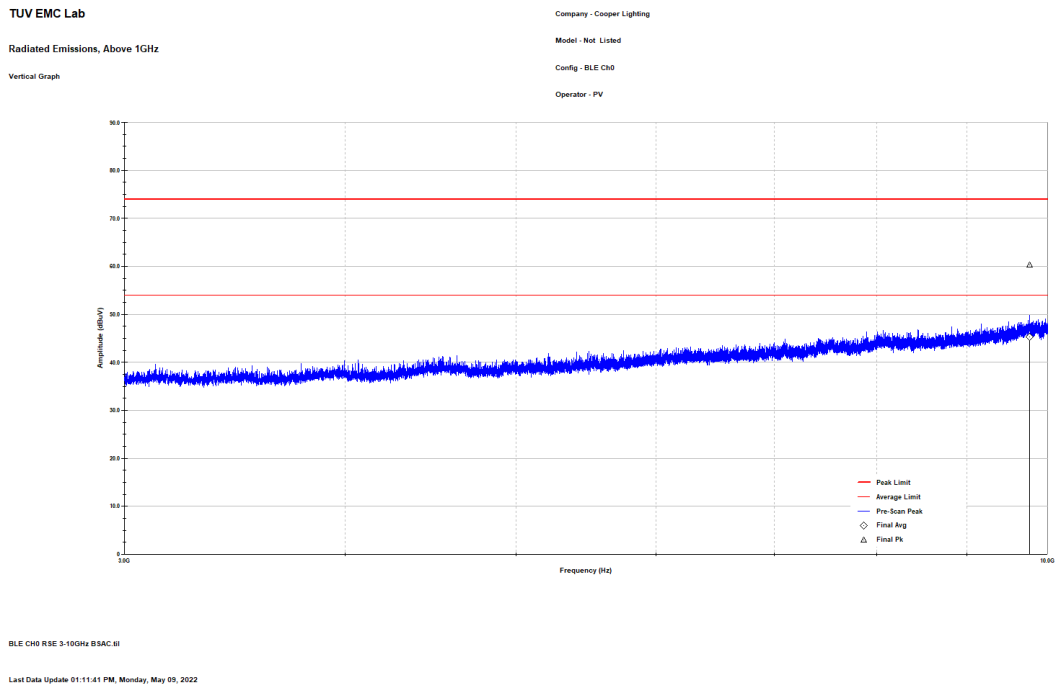


Figure 2.8.6-10: Reference plot for Radiated Spurious Emissions – 3 GHz – 10 GHz – V Polarity

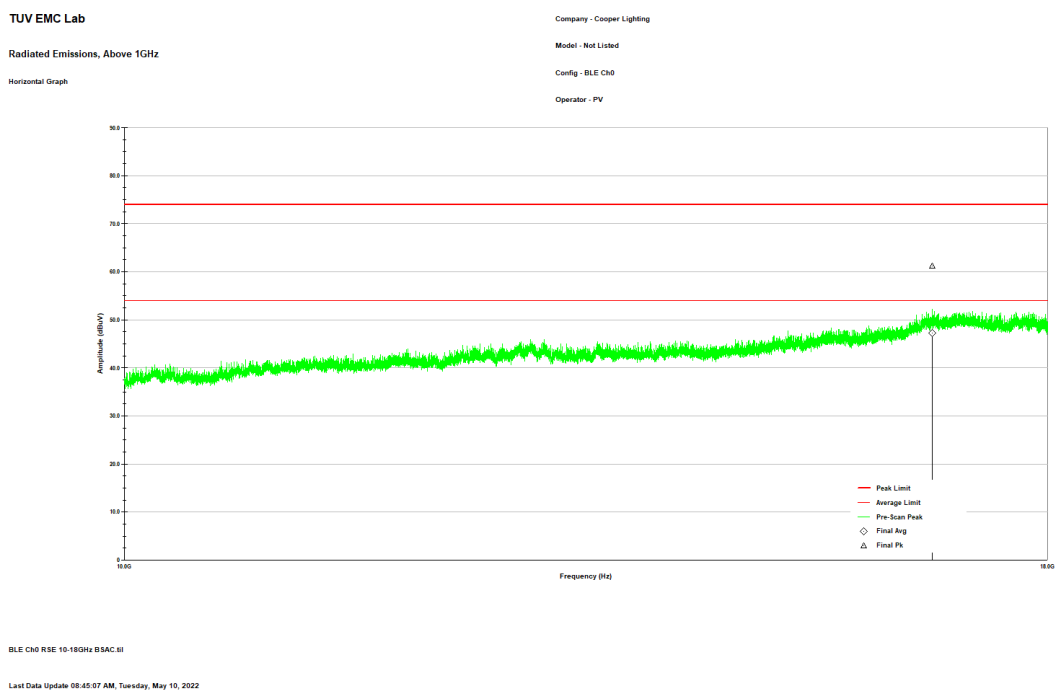


Figure 2.8.6-11: Reference plot for Radiated Spurious Emissions – 10 GHz – 18 GHz – H Polarity

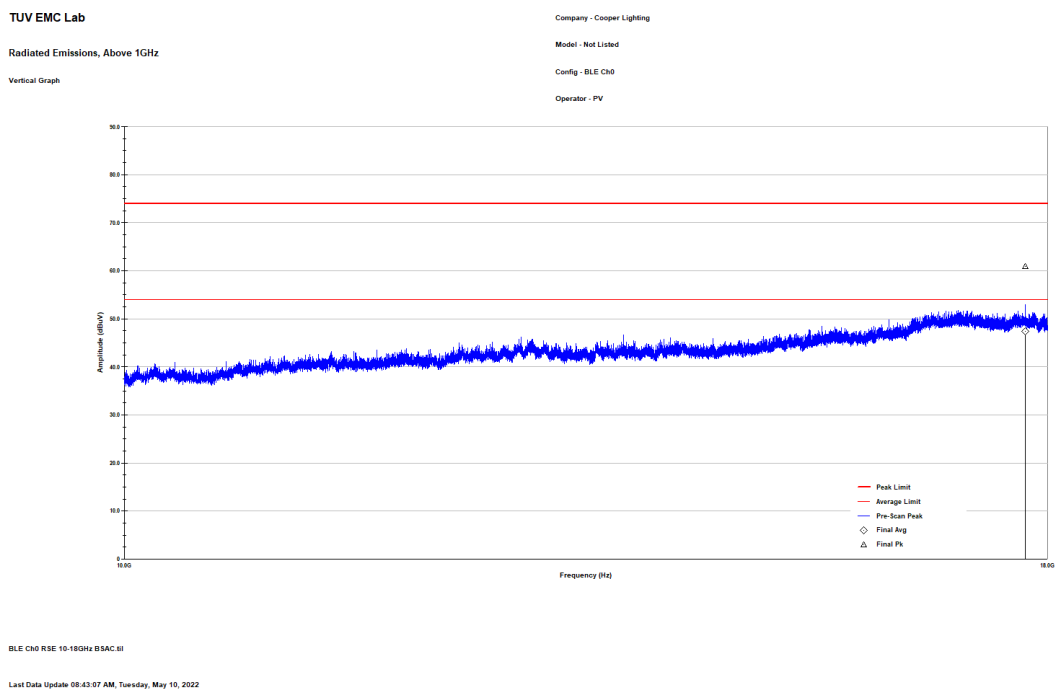


Figure 2.8.6-12: Reference plot for Radiated Spurious Emissions – 10 GHz – 18 GHz – V polarity

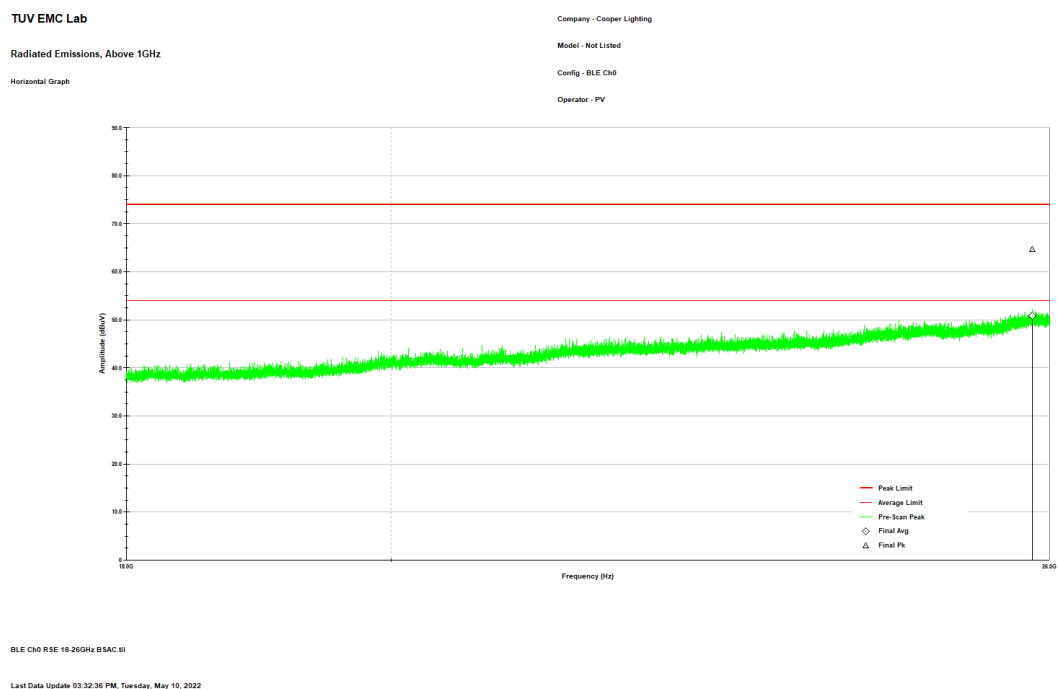


Figure 2.8.6-13: Reference plot for Radiated Spurious Emissions – 18 GHz – 26 GHz – H Polarity

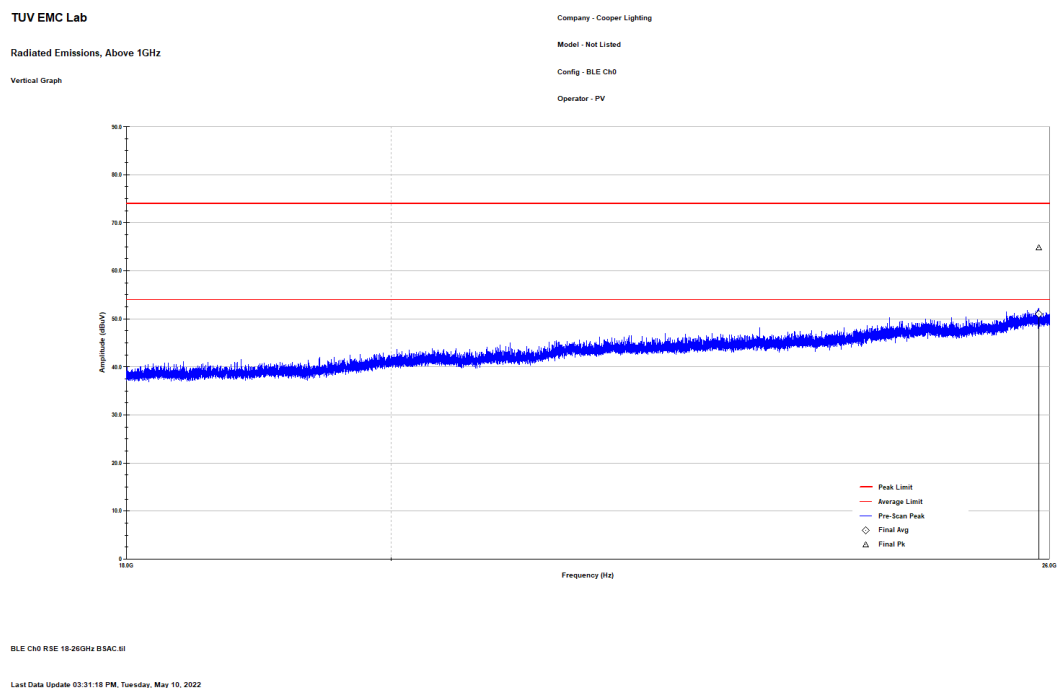


Figure 2.8.6-14: Reference plot for Radiated Spurious Emissions – 18 GHz – 26 GHz – V Polarity



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	Active Loop Antenna 10kHz-30MHz	9407-2877	6/8/2021	6/8/2023
AEMC0884	ETS Lindgren	3117	Double ridged horn antenna	240106	5/6/2021	5/6/2023
DEMC3161	Ametek CTS Germany GmbH	CBL 6112D	Bilog Antenna; Attenuator	51323	3/19/2021	3/19/2023
213	TEC	PA 102	Amplifier	44927	7/30/2021	7/30/2022
338	Hewlett Packard	8449B	High Frequency Pre-Amp	3008A01111	6/22/2021	6/22/2023
882	Rohde & Schwarz	ESW44	Test Receiver	111961	6/24/2021	6/24/2022
836	ETS Lindgren	SAC Cable Set	SAC Cable Set includes 620, 837, 838	N/A	5/11/2021	7/11/2022
432	Microwave Circuits	H3G020G4	High pass Filter	264066	6/9/2021	6/9/2022
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	9/22/2021	9/22/2022
267	Hewlett Packard	N1911A	Power Meter	MY45100129	7/27/2021	7/27/2023
3010	Rohde & Schwarz	ENV216	Two-Line V-Network	3010	6/23/2021	6/23/2022
872	Agilent	E7402A	EMC Spectrum Analyzer	US40240258	6/22/2021	6/22/2022
871	Belden	RF Cable	RF Cable (CE Cable)	871	4/1/2022	4/1/2023
144	Omega	RH411	Temp / Humidity Meter	H0103373	12/16/2020	12/16/2022

N/A – Not Applicable

3 Diagram of Test Set-ups

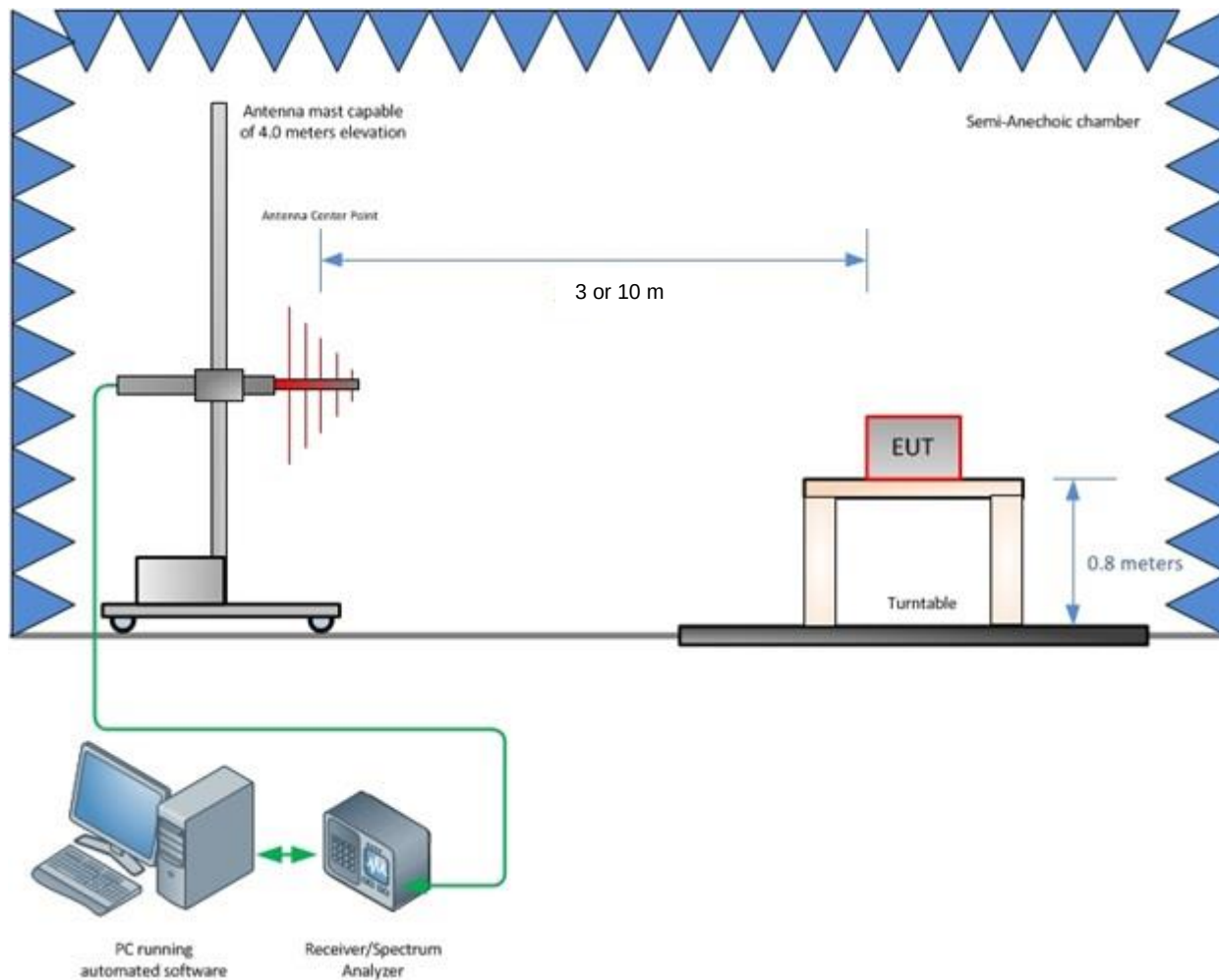


Figure 3-1 – Radiated Emissions Test Setup up to 1 GHz

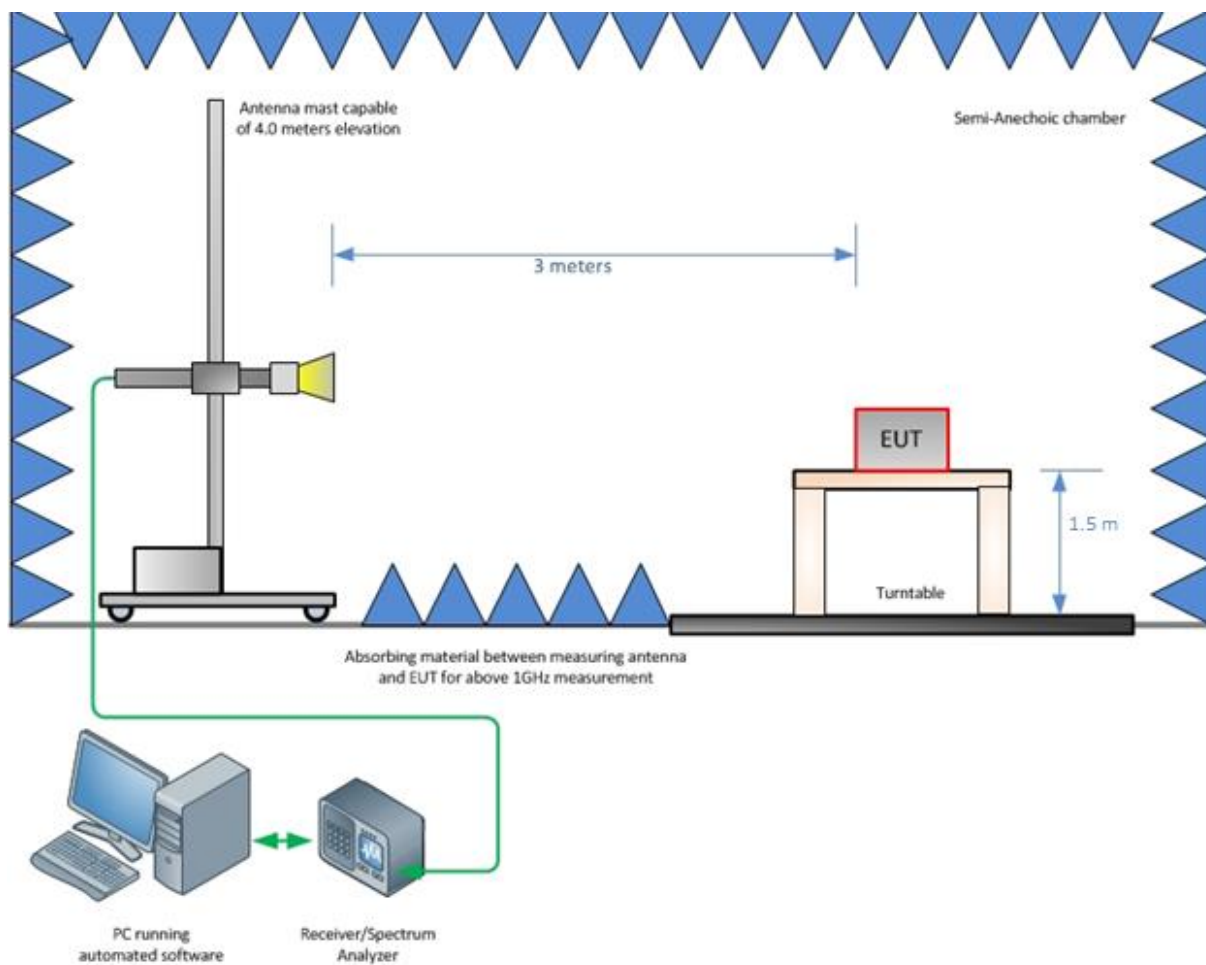


Figure 3-2 – Radiated Emissions Test Setup above 1 GHz

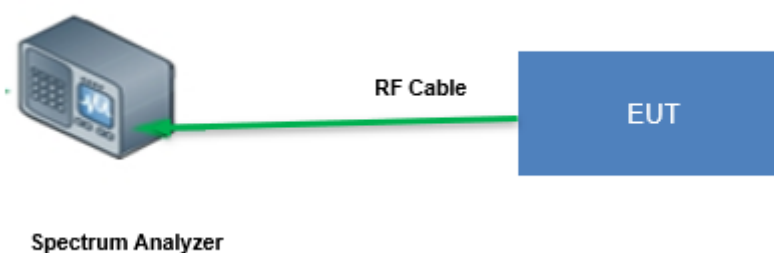


Figure 3-3 – Conducted Test Setup: Antenna Port measurement



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	$\pm 0.009 \%$
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