

Report on the Testing of the Cooper Lighting LLC Insight's Ceiling Sensor

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

Prepared for: Cooper Lighting LLC
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America

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Divya Adusumilli	Senior Wireless Engineer TUV SUD America Inc.	Authorized Signatory	6/9/2022

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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	6/9/2022

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	Simi Kaur
Manufacturer	Cooper Lighting LLC
Applicant's Email Address	simi.kaur@cooperlighting.com
Model Name	Insights Ceiling Sensor
Model Number	ECS-Z-M05-LV
Serial Number	2214000368 0725-000026-002 (Radiated sample) 2215000417 0725-000026-002 (Conducted sample)
FCC ID	2AKCY-0580000038
ISED Certification Number	4706A-0580000038
Hardware Version(s)	0725-000052-00 (Upper PCBA) 0725-000053-00 (Lower PCBA)
Software Version(s)	4090-000214-00
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	72179470
Date of Receipt of EUT	4/28/2022
Start of Test	4/28/2022



Finish of Test

5/17/2022

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	-----	11
6 dB Bandwidth	Yes	Pass	15.247(a)(2)	RSS-247 5.2(a)	18
99% Bandwidth	Yes	Pass	-----	RSS-GEN 6.7	18
Fundamental Emission Output Power	Yes	Pass	15.247(b)(3)	RSS-247 5.4(d)	15
Band-Edge Compliance of RF Conducted Emissions	Yes	Pass	15.247(d)	RSS-247 5.5	27
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)	24
AC Power Line Conducted Emissions	Yes	Pass	15.207	RSS-GEN 8.8	12

1.4 Product Information

1.4.1 Technical Description

Insights Ceiling Sensor which consists of camera, PIR, daylight, LED and IR sensor. Sensors communicate via Zigbee (U601) and has 2nd radio for BLE (U602)

Table 1.4-1 – Wireless Technical Information

Detail	Description
FCC ID	2AKCY-0580000038
IC ID	4706A-0580000038
Transceiver Model #	ECS-Z-M05-LV
Frequency Range (MHz)	2405 – 2480 MHz
Modulation Format	OQPSK
Number of Channels	16
Channel Spacing	5 MHz
Data Rates	250 kbps
Operating voltage	24 VDC
Antenna Type / Gain:	Isolated Magnetic Dipole / 2.6dBi

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

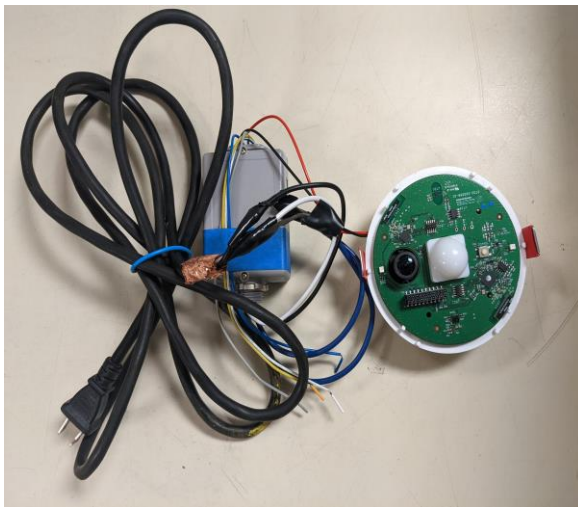


Photo 1.4.1-1 – Front view of the conducted EUT

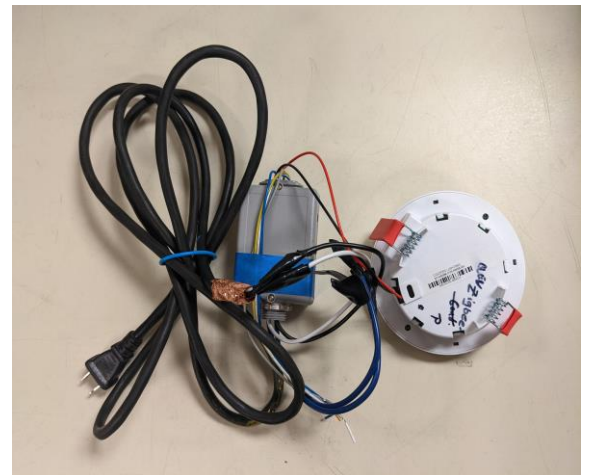


Photo 1.4.1-2 – Back view of the conducted EUT



Photo 1.4.1-3 – Front view of the Radiated EUT

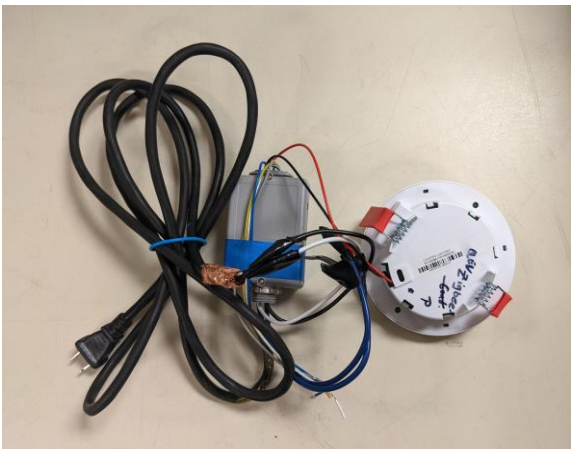


Photo 1.4.1-4 – Back view of the Radiated EUT

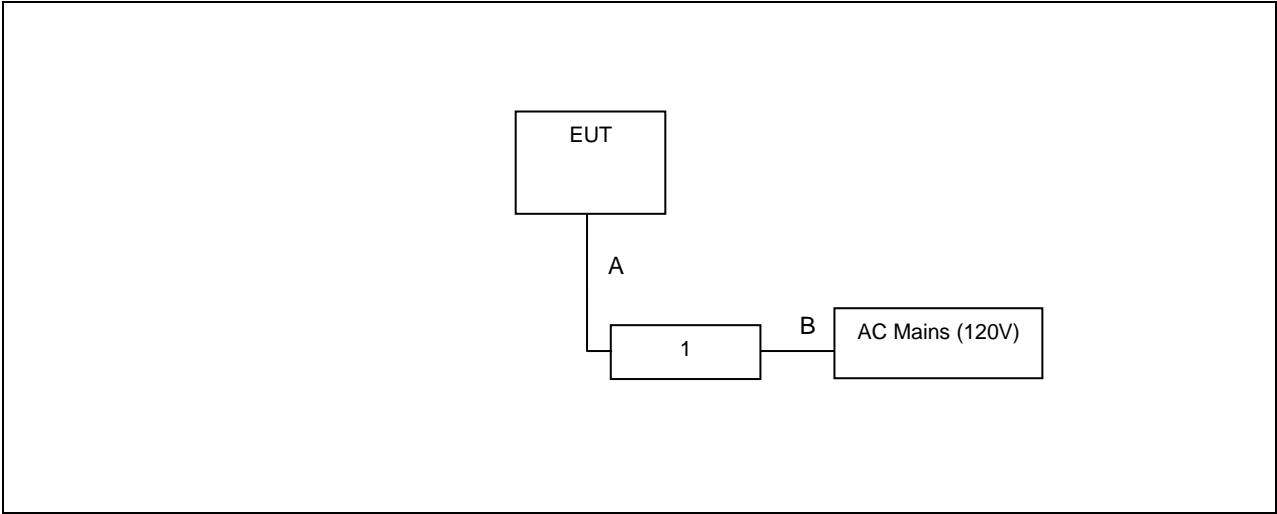


Figure 1.4.1-5: Test Setup Block Diagram

Table 1.4.1-2 – Cable Descriptions

Item	Cable/Port	Length	Shield
A	DC Power cable	20 cm	No
B	AC Power Cord	100 cm	No



Table 1.4.1-3 – Support Equipment Descriptions

Item	Make/Model	Description
1	EATON / SP20-RD4 SWITCHPACK	LED Electronic Driver Power Supply



1.4.2 Modes of Operation

ECS-Z-M05-LV model provides 1 modes of operation using BLE classifications as outlined below.

Mode of Operation	Frequency Range (MHz)	Number of Channels	Stack / Mode	Data Rates Supported	Classification
1	2405 – 2480	16	OQPSK	250 kbps	Zigbee

1.4.3 Monitoring of Performance

For radiated emissions, the EUT was evaluated in three orthogonal orientations. The worst-case orientation was the X-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: CH 11 (2405 MHz) – CH 25 (2475 MHz) – 12.5 dBm
CH 26 (2480MHz) – 0dBm

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

4/29/2022

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 Magnetic Dipole antenna with 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
0.58	60	36.3	26.7	9.655	23.7	PASS
0.71	60	22.3	12.7	9.663	37.7	PASS
0.8	60	21.9	12.2	9.668	38.1	PASS
1.77	60	23.8	14	9.742	36.2	PASS
1.9	60	23.3	13.5	9.758	36.7	PASS
2.23	60	19.7	9.9	9.779	40.3	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
0.58	73	39.7	30.1	9.655	33.3	PASS
0.71	73	29.9	20.3	9.663	43.1	PASS
0.8	73	29.6	19.9	9.668	43.4	PASS
1.77	73	29.7	20	9.742	43.3	PASS
1.9	73	29.3	19.5	9.758	43.7	PASS
2.23	73	27.8	18	9.779	45.2	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
0.5	60	27.8	18.2	9.63	32.2	PASS
0.5	60	27.8	18.2	9.63	32.2	PASS
0.58	60	38.6	28.9	9.635	21.4	PASS
0.87	60	22.3	12.6	9.652	37.7	PASS
1.08	60	25	15.3	9.669	35	PASS
1.8	60	24.8	15.1	9.744	35.2	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
0.5	73	31.7	22.1	9.63	41.3	PASS
0.5	73	31.7	22	9.63	41.3	PASS
0.58	73	41.9	32.3	9.635	31.1	PASS
0.87	73	26	16.3	9.652	47	PASS
1.08	73	28.1	18.4	9.669	44.9	PASS
1.8	73	28	18.2	9.744	45	PASS

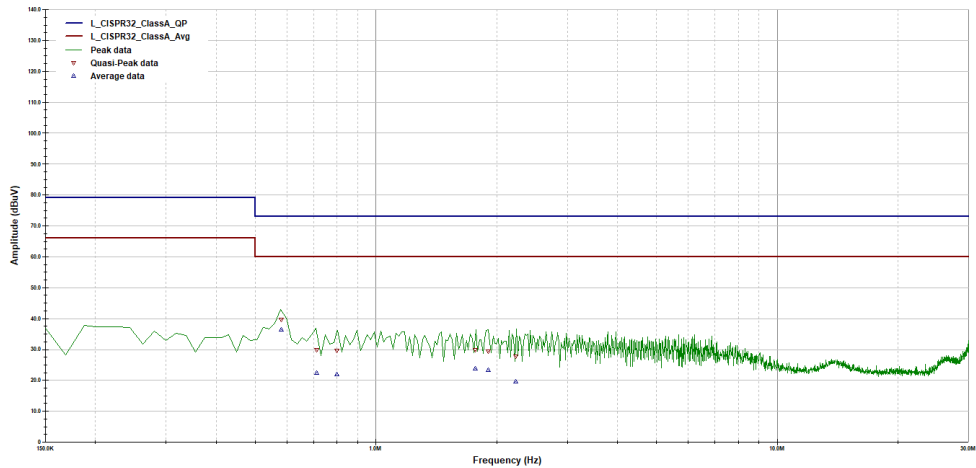


CISPR 32-2012, Class A

Conducted RF Emissions, 150 kHz to 30 MHz

Line Under Test Number 1 Results

EUT Name - 72179470 - Cooper Lighting
Model Number - Insights Ceiling Sensor & ECS-ZM05-LV
Part Number -
Serial Number -
Voltage - Class A; 120 V / 60 Hz
Operating Mode - Powered on



Operator: Sam K

Temperature ~ 22C
Relative Humidity ~ 43%
RF Bandwidth: 9kHz
VBW if Analyzer: 30kHz

AC Mains Class A.ttl

Last Data Update 02:45:10 PM, Friday, April 29, 2022

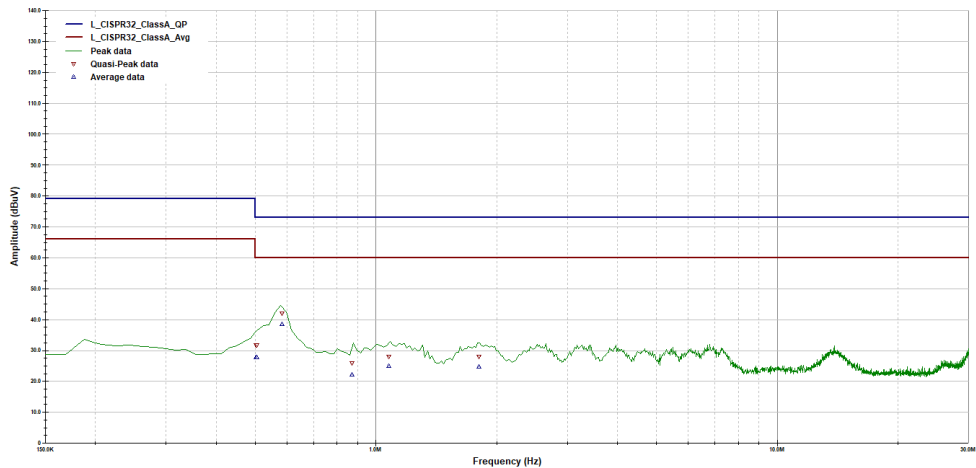
Figure 2.2.6-1: Conducted Emission Plot – Line 1

CISPR 32-2012, Class A

Conducted RF Emissions, 150 kHz to 30 MHz

Line Under Test Number 2 Results

EUT Name - 72179470 - Cooper Lighting
Model Number - Insights Ceiling Sensor & ECS-ZM05-LV
Part Number -
Serial Number -
Voltage - Class A; 120 V / 60 Hz
Operating Mode - Powered on



Operator: Sam K

Temperature ~ 22C
Relative Humidity ~ 43%
RF Bandwidth: 9kHz
VBW if Analyzer: 30kHz

AC Mains Class A.ttl

Last Data Update 02:53:52 PM, Friday, April 29, 2022

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

4/28/2022

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
2405	12.3	250 kbps
2440	11.8	250 kbps
2475	11.4	250 kbps
2480	-0.8	250 kbps

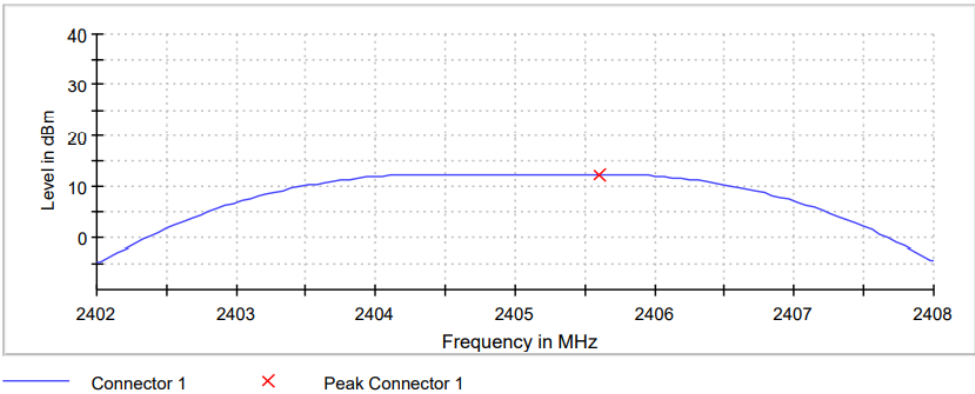


Figure 2.3.6-1: Output Power - LCH

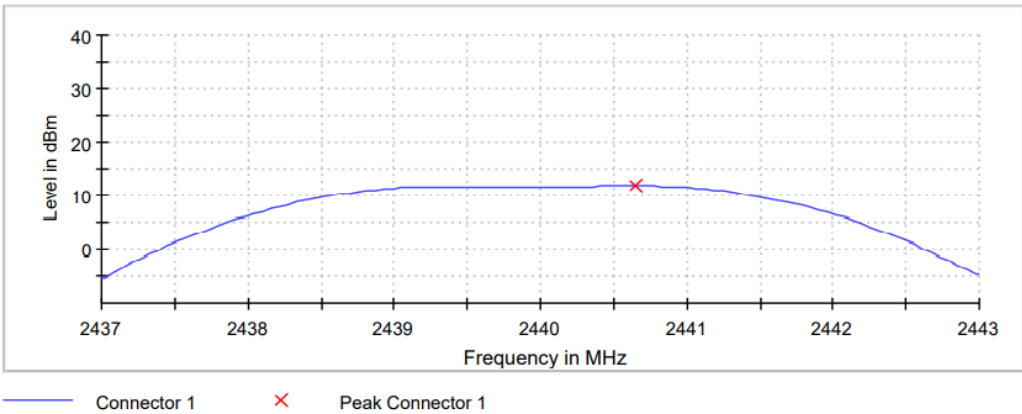


Figure 2.3.6-2: Output Power - MCH

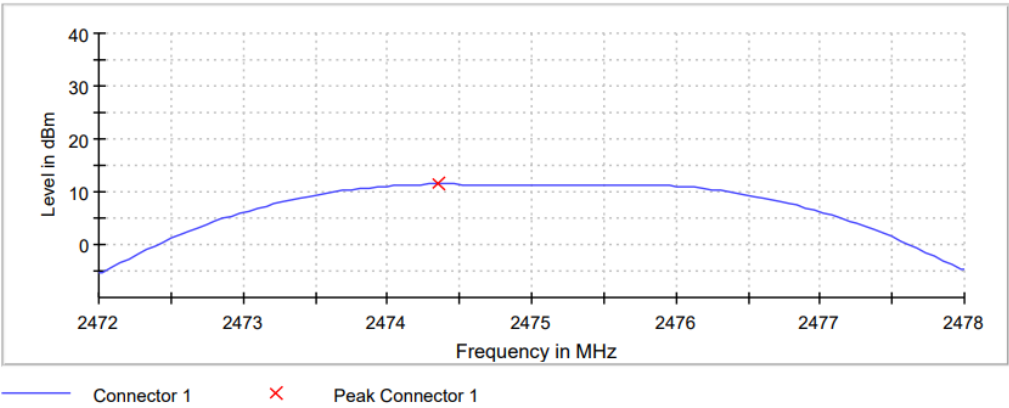


Figure 2.3.6-3: Output Power - HCH – 2475MHz

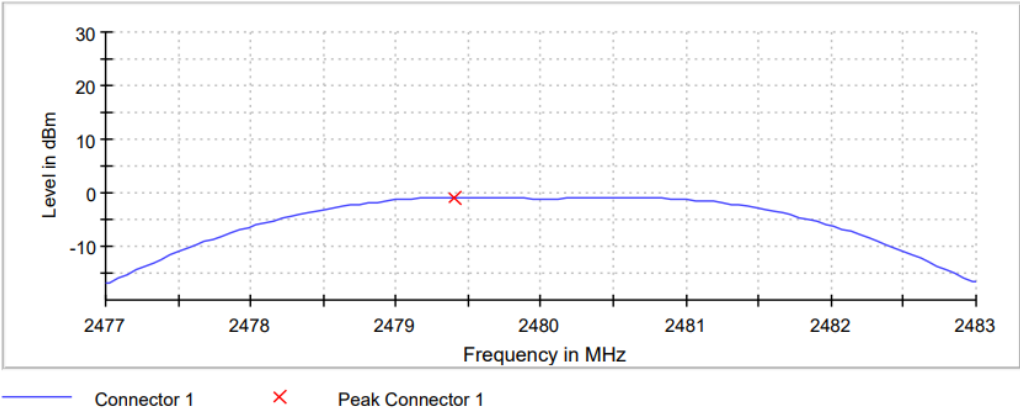


Figure 2.3.6-4: Output Power - HCH – 2480MHz

Table 2.3.6-2: Sample Measurement Settings

Setting	Instrument Value	Target Value
Start Frequency	2.40200 GHz	2.40200 GHz
Stop Frequency	2.40800 GHz	2.40800 GHz
Span	6.000 MHz	6.000 MHz
RBW	2.000 MHz	>= 1.782 MHz
VBW	10.000 MHz	>= 6.000 MHz
Sweep Points	101	~ 101
Sweep time	1953.450 ns	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	0.08 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

4/28/2022

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 (MHz)	99% Bandwidth (MHz)	Data Rate
2405	1.782	2.220	250 kbps
2440	1.782	2.220	250 kbps
2475	1.782	2.220	250 kbps
2480	1.782	2.220	250 kbps

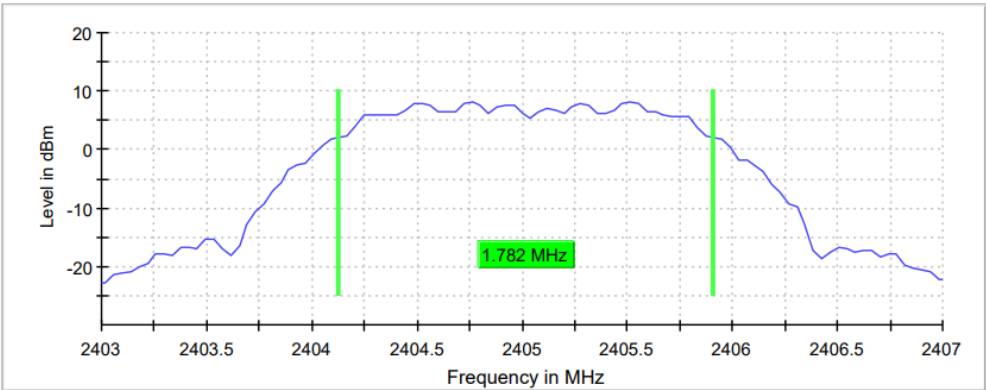


Figure 2.4.6-1: 6 dB BW - LCH

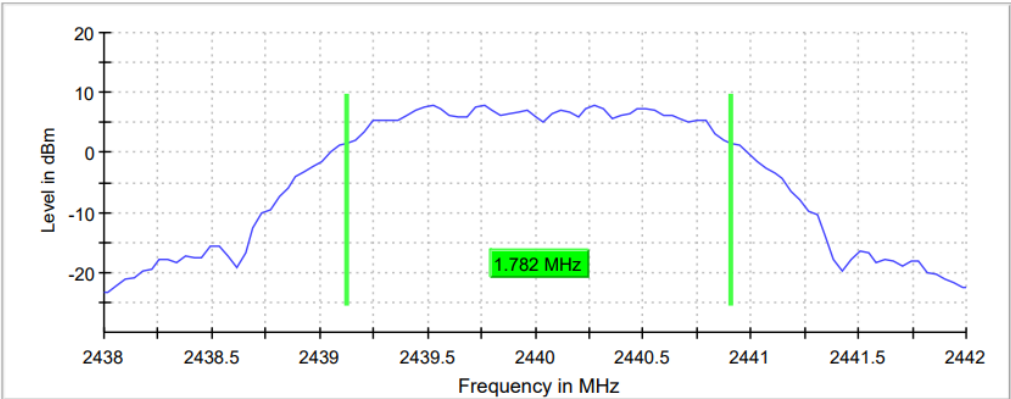


Figure 2.4.6-2: 6 dB BW - MCH

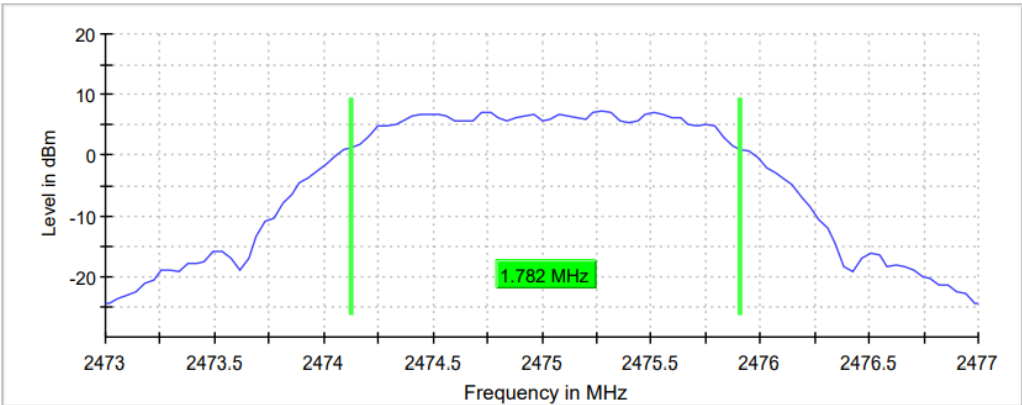


Figure 2.4.6-3: 6 dB BW - HCH – 2475MHz

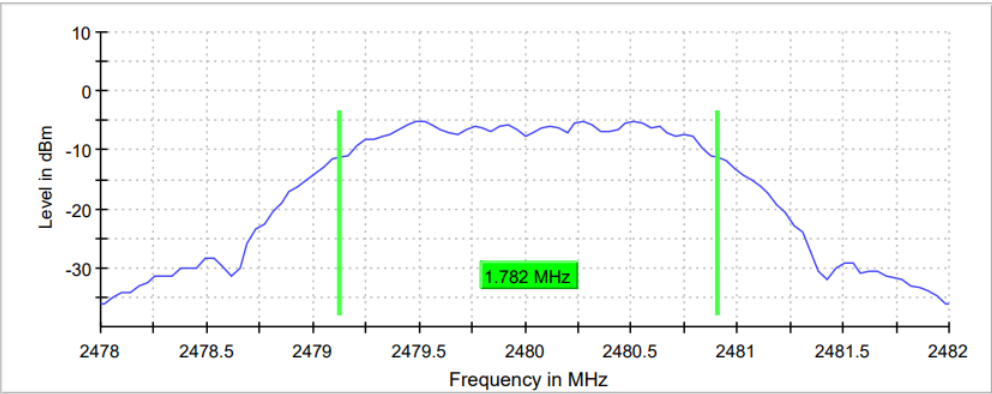


Figure 2.4.6-4: 6 dB BW - HCH – 2480MHz

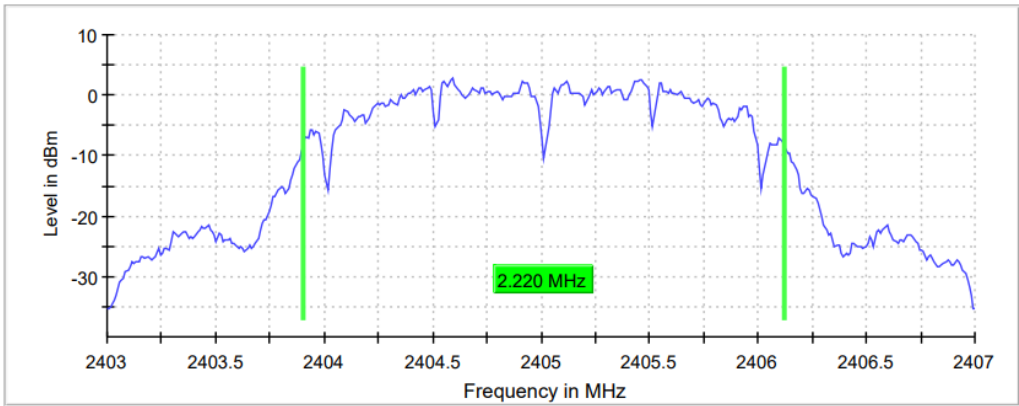


Figure 2.4.6-5: 99% BW - LCH

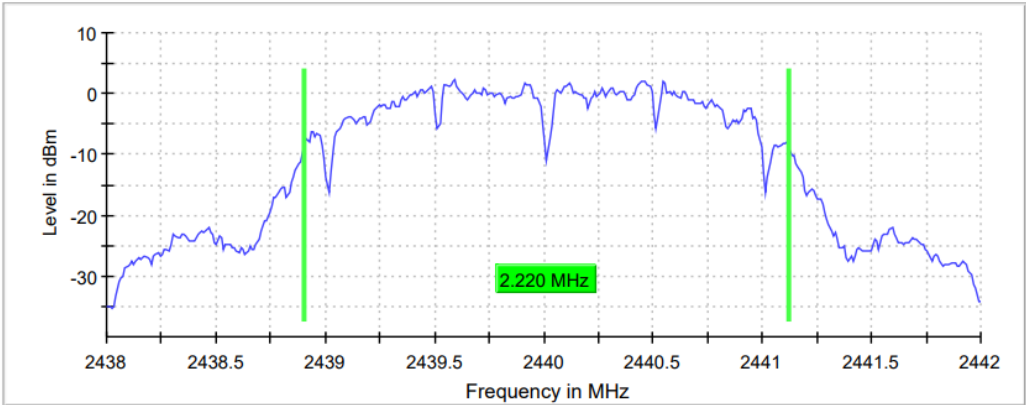


Figure 2.4.6-6: 99% BW - MCH

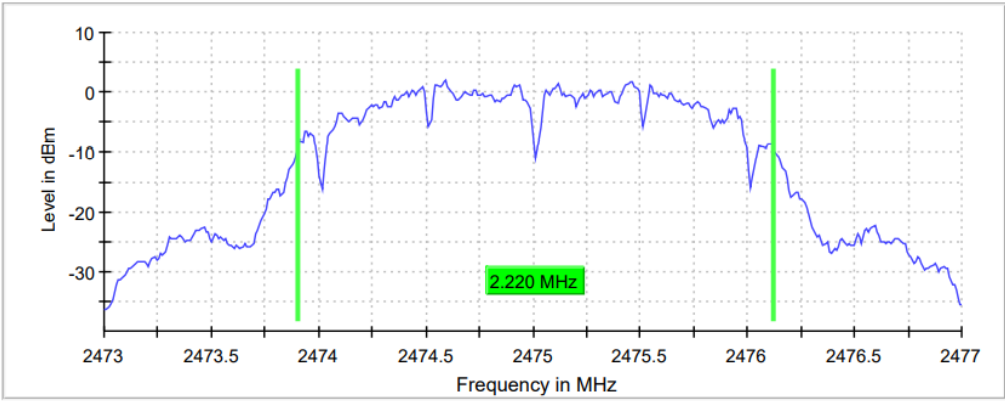


Figure 2.4.6-7: 99% BW - HCH – 2475 MHz

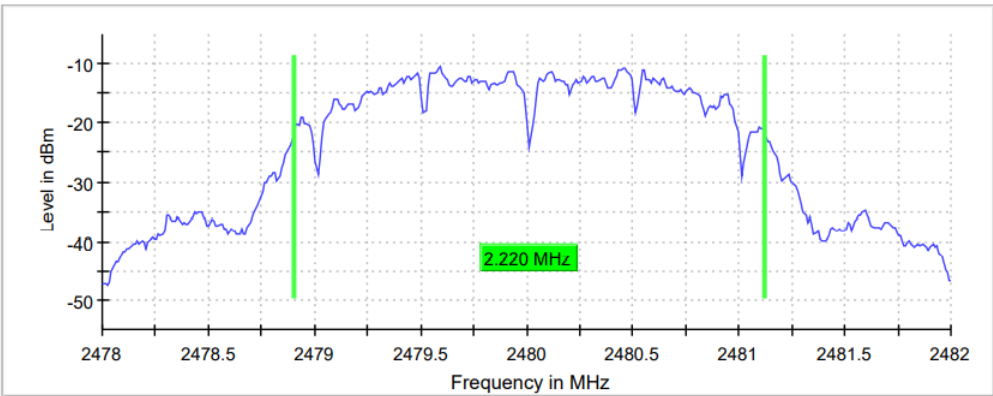


Figure 2.4.6-8: 99% BW - HCH – 2480 MHz

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

Setting	Instrument Value	Target Value
Start Frequency	2.40300 GHz	2.40300 GHz
Stop Frequency	2.40700 GHz	2.40700 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	16 / max. 150	max. 150
Stable	5 / 5	5
Max Stable Difference	0.21 dB	0.50 dB

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

Setting	Instrument Value	Target Value
Start Frequency	2.40300 GHz	2.40300 GHz
Stop Frequency	2.40700 GHz	2.40700 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	18 / max. 150	max. 150
Stable	3 / 3	3
Max Stable Difference	0.16 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

4/28/2022

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
2405	1.247	250 kbps
2440	0.767	250 kbps
2475	0.456	250 kbps
2480	-12.139	250 kbps

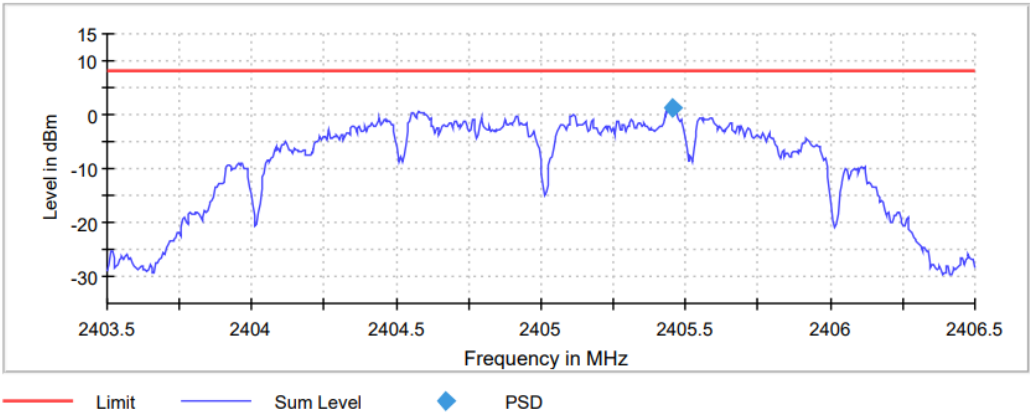


Figure 2.5.6-1: PSD – LCH

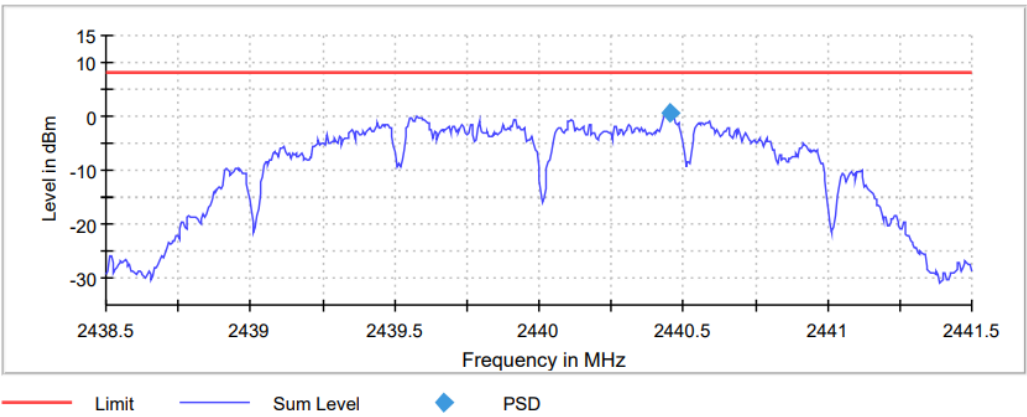


Figure 2.5.6-2: PSD – MCH

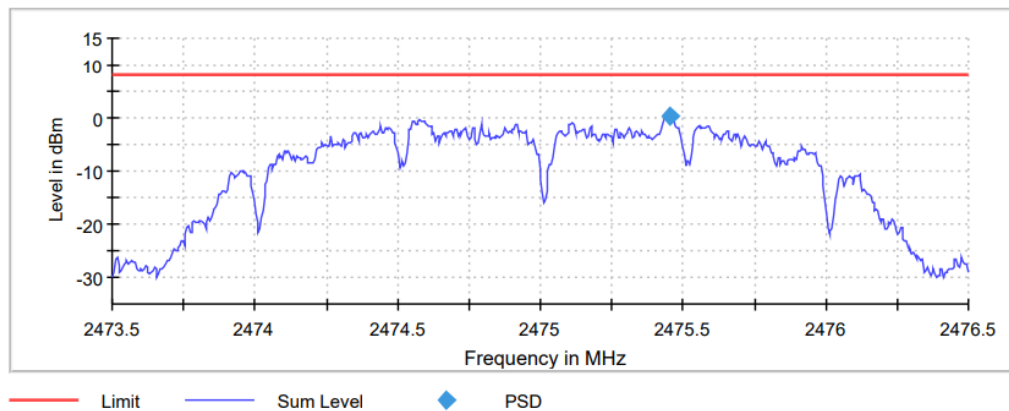


Figure 2.5.6-3: PSD – HCH -2475 MHz

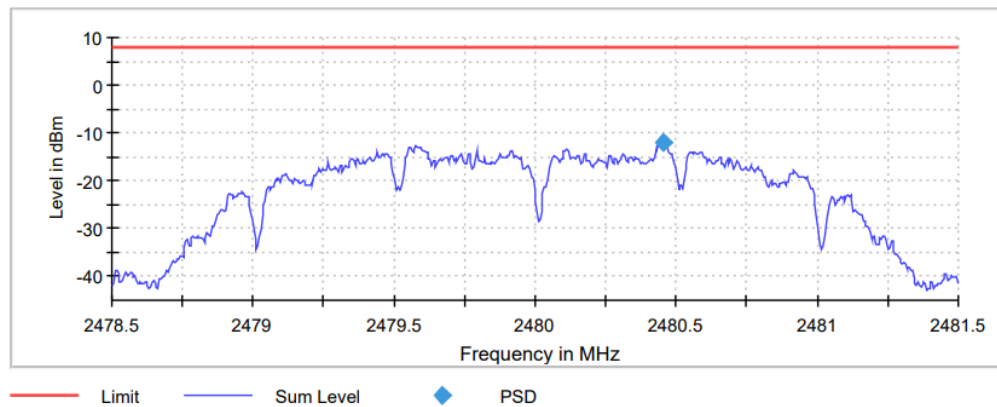


Figure 2.5.6-4: PSD – HCH -2480 MHz

Table 2.5.6-2: Sample Measurement Settings (PSD)

Setting	Instrument Value	Target Value
Start Frequency	2.40350 GHz	2.40350 GHz
Stop Frequency	2.40650 GHz	2.40650 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
Preamp	off	off
Stable mode	Trace	Trace
Stable value	0.50 dB	0.50 dB
Run	11 / max. 150	max. 150
Stable	2 / 2	2
Max Stable Difference	0.22 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

4/28/2022

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. 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

2.6.5 Test Results

Test Summary: EUT was set to transmit mode.

Test Results: Pass

See data below for detailed results.

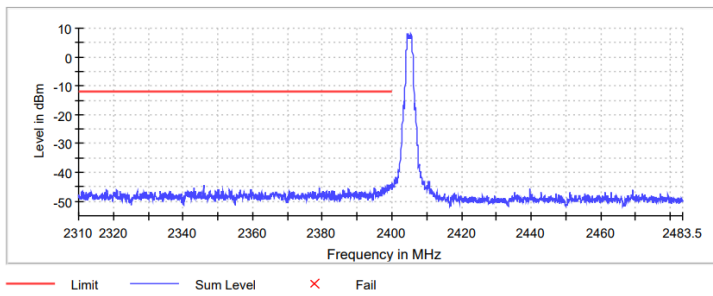


Figure 2.6.6-1: Lower Band-edge

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

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)	Result
2399.875000	-43.5	31.7	-11.8	PASS
2399.925000	-44.0	32.2	-11.8	PASS
2399.625000	-44.0	32.2	-11.8	PASS
2399.975000	-44.2	32.4	-11.8	PASS
2399.675000	-44.2	32.4	-11.8	PASS
2398.725000	-44.2	32.4	-11.8	PASS
2399.325000	-44.3	32.5	-11.8	PASS
2399.825000	-44.3	32.5	-11.8	PASS
2398.775000	-44.4	32.6	-11.8	PASS
2399.275000	-44.5	32.6	-11.8	PASS
2345.875000	-44.6	32.8	-11.8	PASS
2399.725000	-44.7	32.8	-11.8	PASS
2345.825000	-44.8	33.0	-11.8	PASS
2399.375000	-44.9	33.1	-11.8	PASS
2398.925000	-44.9	33.1	-11.8	PASS

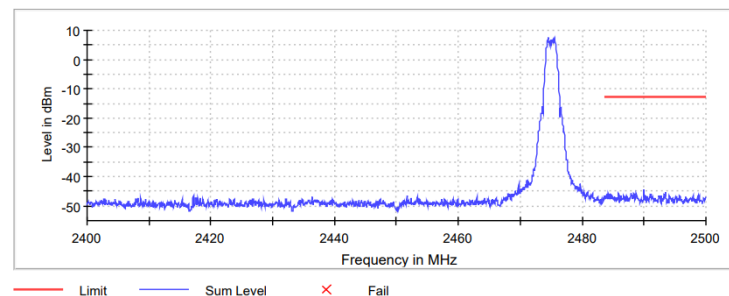


Figure 2.6.6-2: Upper Band-edge – 2475MHz

Table 2.6.6-2: Upper Band-edge – High Channel – 2475MHz

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)	Result
2489.975000	-44.4	31.8	-12.6	PASS
2489.925000	-44.6	32.0	-12.6	PASS
2493.425000	-45.1	32.5	-12.6	PASS
2493.475000	-45.3	32.7	-12.6	PASS
2484.225000	-45.6	33.0	-12.6	PASS
2485.925000	-45.6	33.0	-12.6	PASS
2490.025000	-45.6	33.0	-12.6	PASS
2484.275000	-45.7	33.1	-12.6	PASS
2488.725000	-45.7	33.1	-12.6	PASS
2488.775000	-45.7	33.1	-12.6	PASS
2485.875000	-45.8	33.2	-12.6	PASS
2488.375000	-45.8	33.2	-12.6	PASS
2487.875000	-45.9	33.2	-12.6	PASS
2484.075000	-45.9	33.3	-12.6	PASS
2488.325000	-45.9	33.3	-12.6	PASS

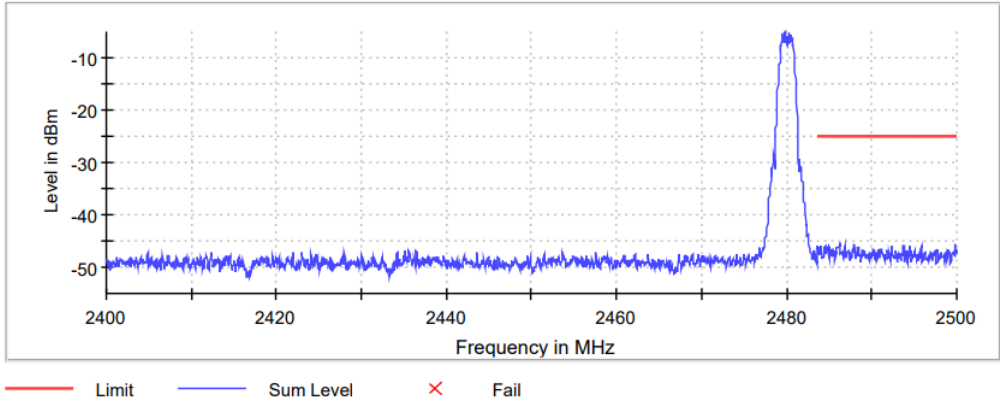


Figure 2.6.6-3: Upper Band-edge – 2480MHz

Table 2.6.6-3: Upper Band-edge- 2480 MHz

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)	Result
2486.225000	-45.2	20.0	-25.1	PASS
2499.825000	-45.5	20.4	-25.1	PASS
2499.775000	-45.6	20.5	-25.1	PASS
2487.925000	-45.7	20.5	-25.1	PASS
2487.975000	-45.8	20.6	-25.1	PASS
2486.825000	-45.8	20.7	-25.1	PASS
2486.275000	-45.8	20.7	-25.1	PASS
2492.425000	-45.9	20.7	-25.1	PASS
2495.825000	-45.9	20.8	-25.1	PASS
2483.625000	-45.9	20.8	-25.1	PASS
2486.775000	-45.9	20.8	-25.1	PASS
2484.525000	-45.9	20.8	-25.1	PASS
2493.775000	-46.0	20.8	-25.1	PASS
2495.875000	-46.0	20.8	-25.1	PASS
2494.425000	-46.0	20.9	-25.1	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

4/28/2022

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.

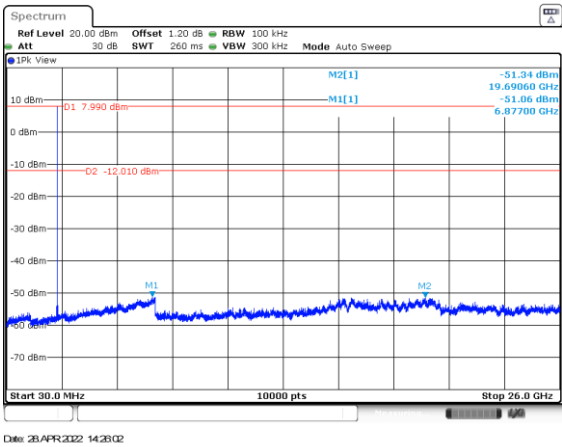


Figure 2.7.6-1: 30MHz – 26GHz – LCH

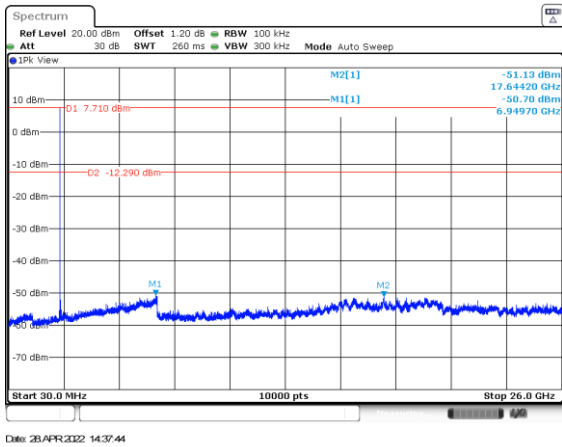


Figure 2.7.6-2: 30MHz – 26GHz – MCH

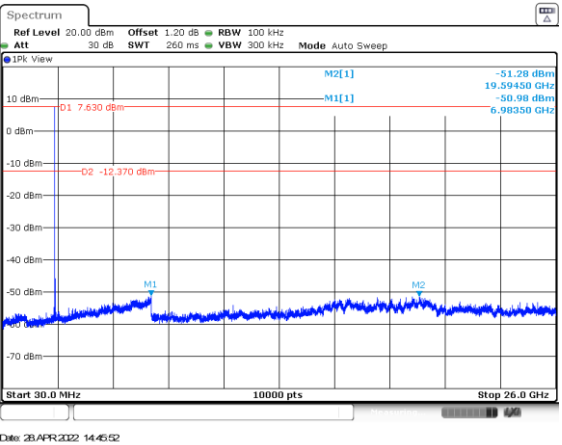


Figure 2.7.6-3: 30MHz – 26GHz – HCH – 2475MHz

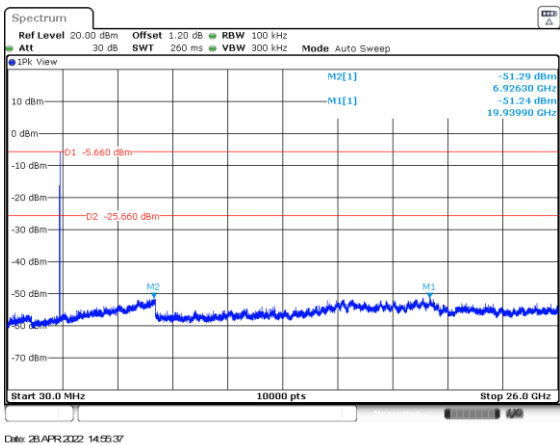


Figure 2.7.6-4: 30MHz – 26GHz – HCH – 2480MHz



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

4/28/2022 to 5/17/2022

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 Polarity (H/V)	Limit (dBuV/m)		Margin (dB)	
	pk	Qpk/Avg		pk	Qpk/Avg	pk	Qpk/Avg
LCH - 2405 MHz							
329.053	----	30.577	H	----	46	----	15.42
2367.35	51.945	40.072	H	74	54	22.055	13.93
2441.1	47.458	33.256	H	74	54	26.542	20.74
2479.925	52.302	33.163	H	74	54	21.698	20.84
5218.5	59.076	37.01	H	74	54	14.92	16.99
5785.125	64.703	38.386	H	74	54	9.30	15.61
9871.625	59.405	44.973	H	74	54	14.60	9.03
12024.75	51.941	38.365	H	74	54	22.06	15.64
25804.125	64.087	50.347	H	74	54	9.91	3.65
116.039	----	30.054	V	----	43.5	----	13.45
2331.325	47.674	33.202	V	74	54	26.33	20.80
2480.025	50.748	33.121	V	74	54	23.25	20.88
2583.575	48.884	33.35	V	74	54	25.12	20.65
4809.05	52.464	39.719	V	74	54	21.54	14.28
5218.675	56.054	37.081	V	74	54	17.95	16.92
5785.8	64.679	38.485	V	74	54	9.32	15.52
9994.775	58.346	44.575	V	74	54	15.65	9.43
12025.05	52.276	38.413	V	74	54	21.72	15.59
25866.475	64.804	50.465	V	74	54	9.20	3.54
MCH - 2440 MHz							
2402.375	49.529	36.478	H	74	54	24.47	17.52
2479.55	47.595	33.518	H	74	54	26.41	20.48
5237.375	50.905	36.791	H	74	54	23.10	17.21
5746.9	52.566	37.908	H	74	54	21.43	16.09
9756.5	58.983	45.142	H	74	54	15.02	8.86
12200.2	52.155	38.32	H	74	54	21.85	15.68
25792.375	63.784	50.324	H	74	54	10.22	3.68
116.184	----	31.069	V	----	43.5	----	12.43
2377.85	47.217	32.704	V	74	54	26.78	21.30
2417.85	47.664	32.818	V	74	54	26.34	21.18
2480.15	47.218	33.138	V	74	54	26.78	20.86
4881.025	52.615	39.171	V	74	54	21.39	14.83
5223.675	62.115	37.111	V	74	54	11.89	16.89
5786.1	59.001	40.621	V	74	54	15.00	13.38

9740.25	58.887	45.01	V	74	54	15.11	8.99
12200.1	51.488	38.298	V	74	54	22.51	15.70
25790.3	64.872	50.313	V	74	54	9.13	3.69
HCH - 2475 MHz							
327.089	----	30.952	H	----	46	----	15.05
1229.875	43.364	29.468	H	74	54	30.64	24.53
2426.35	52.171	32.956	H	74	54	21.83	21.04
2437.1	50.812	38.937	H	74	54	23.19	15.06
5218.6	55.569	36.843	H	74	54	18.43	17.16
5785.725	63.553	38.426	H	74	54	10.45	15.57
9827	58.04	44.457	H	74	54	15.96	9.54
12375.125	52.38	38.214	H	74	54	21.62	15.79
25956.575	64.319	50.497	H	74	54	9.68	3.50
116.669	----	30.094	V	----	43.5	----	13.41
1356.85	43.703	29.948	V	74	54	30.30	24.05
1703.325	45.188	30.486	V	74	54	28.81	23.51
2401.75	55.8	33.196	V	74	54	18.20	20.80
2425.85	48.849	32.916	V	74	54	25.15	21.08
4949.025	53.939	41.301	V	74	54	20.06	12.70
5223.35	60.881	37.098	V	74	54	13.12	16.90
5785.55	63.429	39.466	V	74	54	10.57	14.53
5792.55	58.112	38.227	V	74	54	15.89	15.77
9797.525	58.361	44.266	V	74	54	15.64	9.73
12375.125	52.579	38.375	V	74	54	21.42	15.63
25827.5	63.848	50.366	V	74	54	10.15	3.63
HCH - 2480 MHz							
325.003	----	30.823	H	----	46	----	15.18
2401.85	52.895	33.077	H	74	54	21.11	20.92
2425.75	54.008	33.023	H	74	54	19.99	20.98
2446.1	47.096	32.936	H	74	54	26.90	21.06
5223.375	59.618	37.009	H	74	54	14.38	16.99
5805.5	52.302	38.241	H	74	54	21.70	15.76
9725.675	58.268	44.667	H	74	54	15.73	9.33
12400.025	52.566	38.48	H	74	54	21.43	15.52
25888.175	64.278	50.527	H	74	54	9.72	3.47
116.136	----	30.682	V	----	43.5	----	12.82
2418.65	46.75	32.808	V	74	54	27.25	21.19
2442.95	47.185	33.141	V	74	54	26.82	20.86
5222.975	60.803	37.025	V	74	54	13.20	16.98
5808.9	52.158	38.144	V	74	54	21.84	15.86



9732.8	58.376	44.81	V	74	54	15.62	9.19
12400.175	52.31	38.432	V	74	54	21.69	15.57
25919.55	64.083	50.562	V	74	54	9.92	3.44

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
2405 MHz - Lower Band Edge										
2390	47.30	34.10	H	0.08	47.38	34.18	74.0	54.0	26.6	19.8
2475 MHz - Upper Band Edge										
2483.5	56.00	41.60	H	0.36	56.36	41.96	74.0	54.0	17.6	12.0
2480 MHz - Upper Band Edge										
2483.5	57.40	43.40	H	0.36	57.76	43.76	74.0	54.0	16.2	10.2

Note: Only Worst-Case Polarization was evaluated and reported.

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: $57.40 + 0.36 = 57.76 \text{ dB}\mu\text{V/m}$

Margin: $74 \text{ dB}\mu\text{V/m} - 57.76 \text{ dB}\mu\text{V/m} = 16.2 \text{ dB}$

Example Calculation: Average

Corrected Level: $43.40 + 0.36 - 0 = 43.76 \text{ dB}\mu\text{V}$

Margin: $54 \text{ dB}\mu\text{V} - 43.76 \text{ dB}\mu\text{V} = 10.2 \text{ dB}$

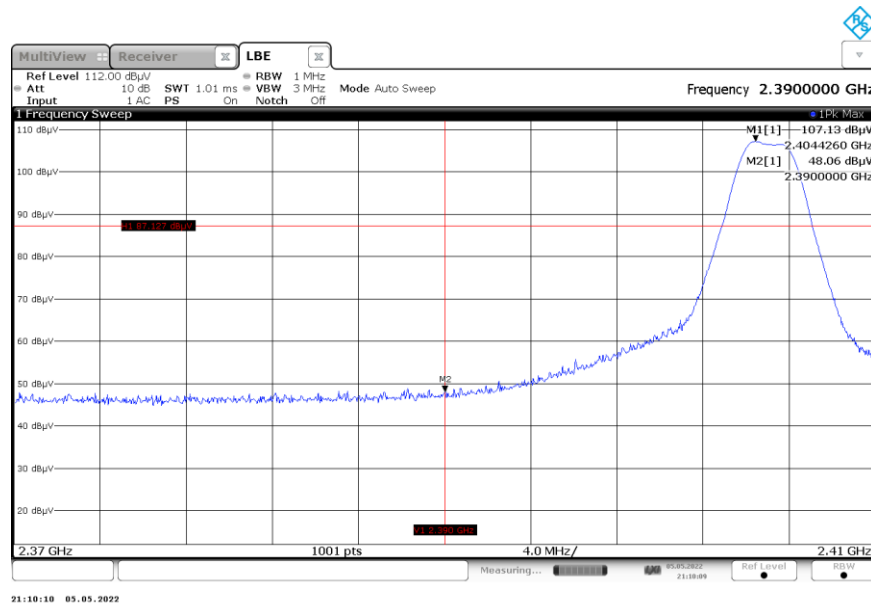


Figure 2.8.6-1: Reference plot Radiated Lower Band-edge – LCH

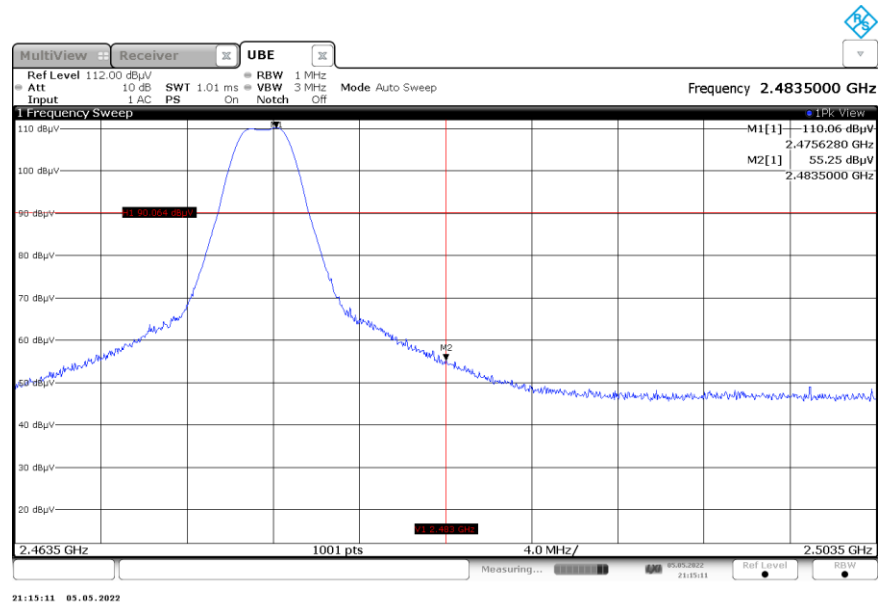


Figure 2.8.6-2: Reference plot Radiated Upper Band-edge – HCH – 2475MHz

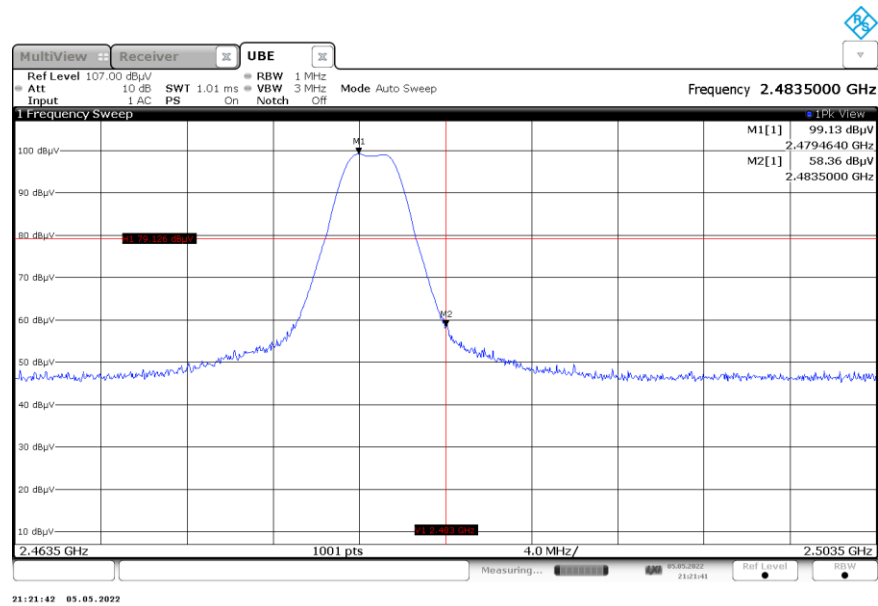


Figure 2.8.6-3: Reference plot Radiated Upper Band-edge – HCH – 2480MHz

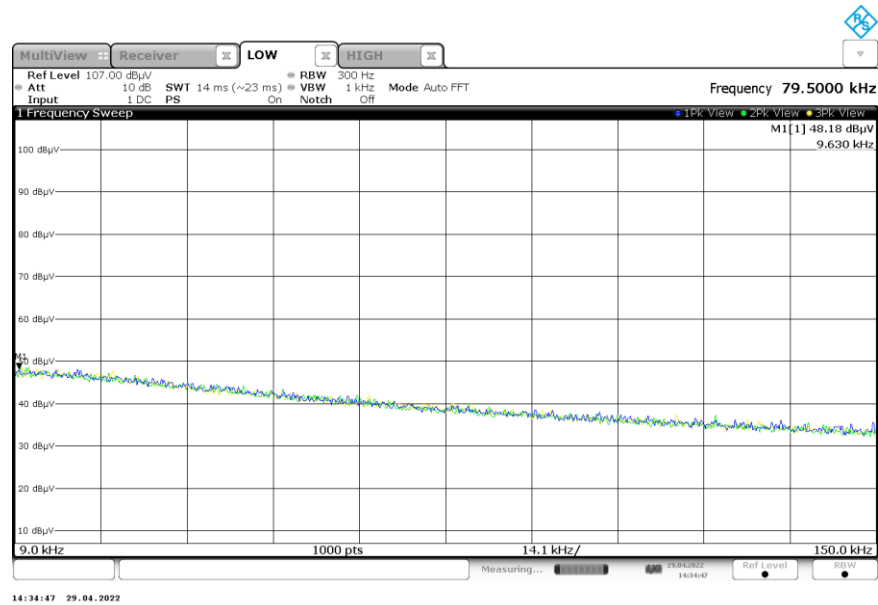


Figure 2.8.6-4: Reference plot for Radiated Spurious Emissions – 9 kHz – 150 kHz

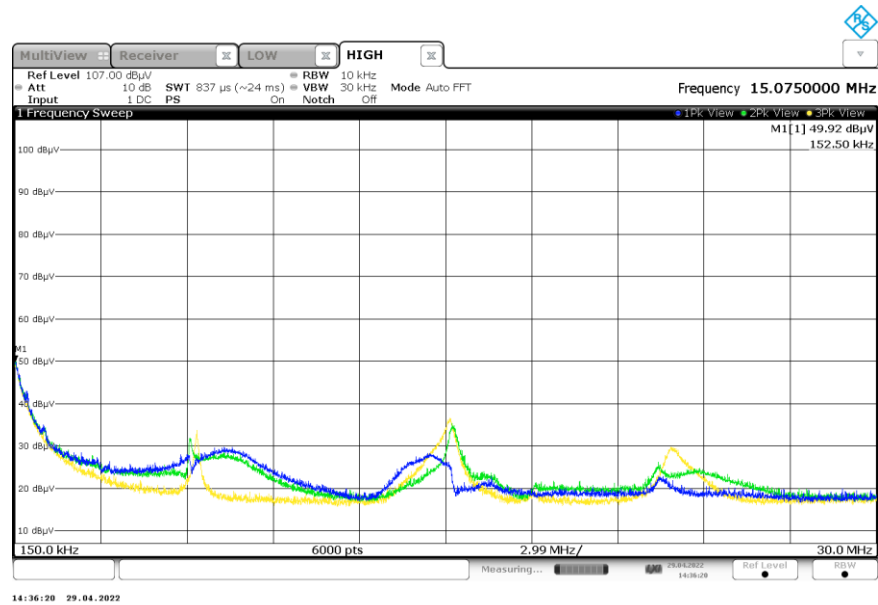


Figure 2.8.6-5: Reference plot for Radiated Spurious Emissions– 150 kHz – 30MHz
Note: Emissions above the noise floor are ambient not associated with the EUT.

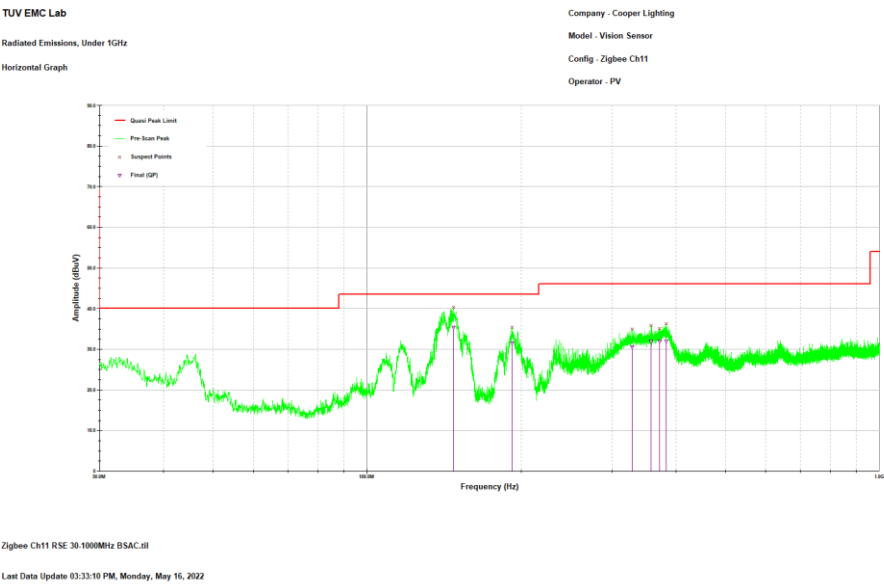


Figure 2.8.6-6: Reference plot for Radiated Spurious Emissions – 30 MHz – 1 GHz – H Polarity
Note: Frequencies that falls under restricted band are only evaluated and reported.

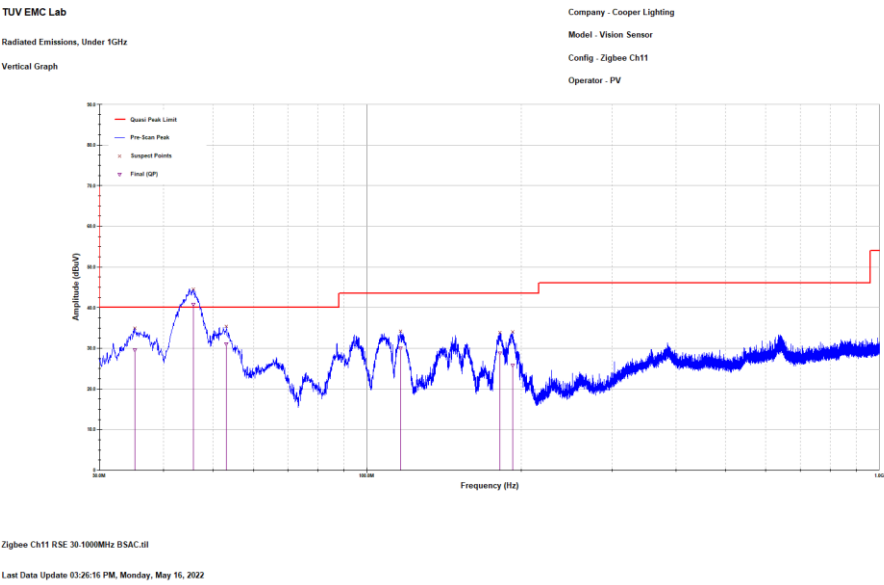


Figure 2.8.6-7: Reference plot for Radiated Spurious Emissions – 30 MHz – 1 GHz – V Polarity
Note: Frequencies that falls under restricted band are only evaluated and reported.
Emission above the limit line is ambient noise not associated with the radio of the EUT.

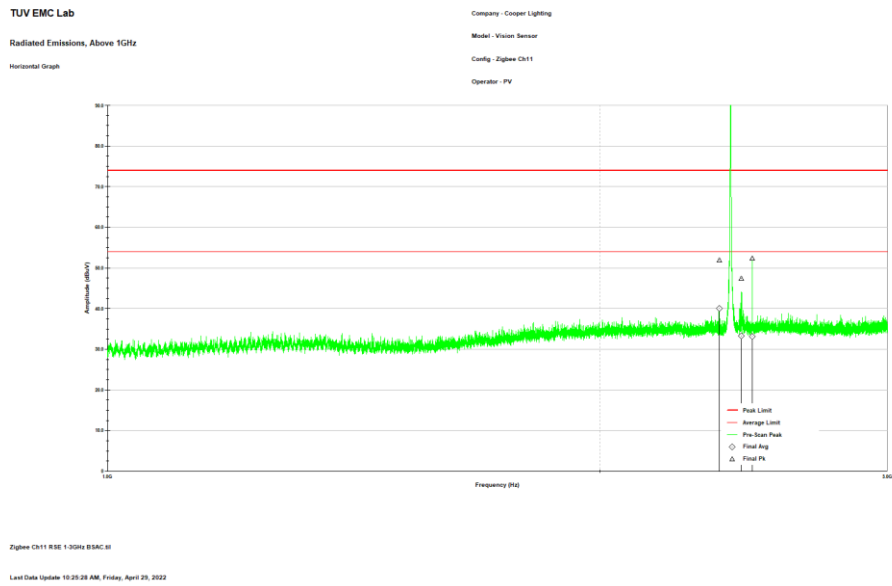


Figure 2.8.6-8: Reference plot for Radiated Spurious Emissions – 1 GHz – 3 GHz – H Polarity

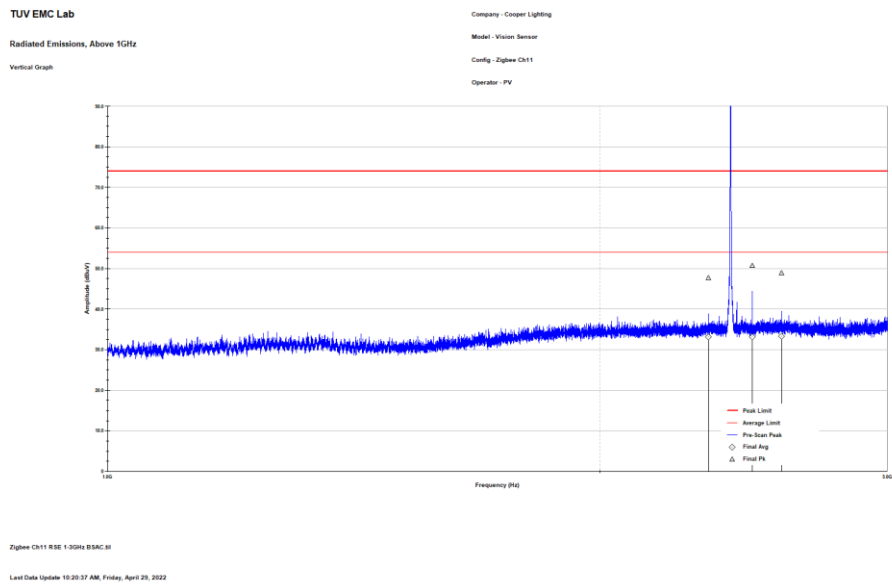


Figure 2.8.6-9: Reference plot for Radiated Spurious Emissions – 1 GHz – 3 GHz – V Polarity

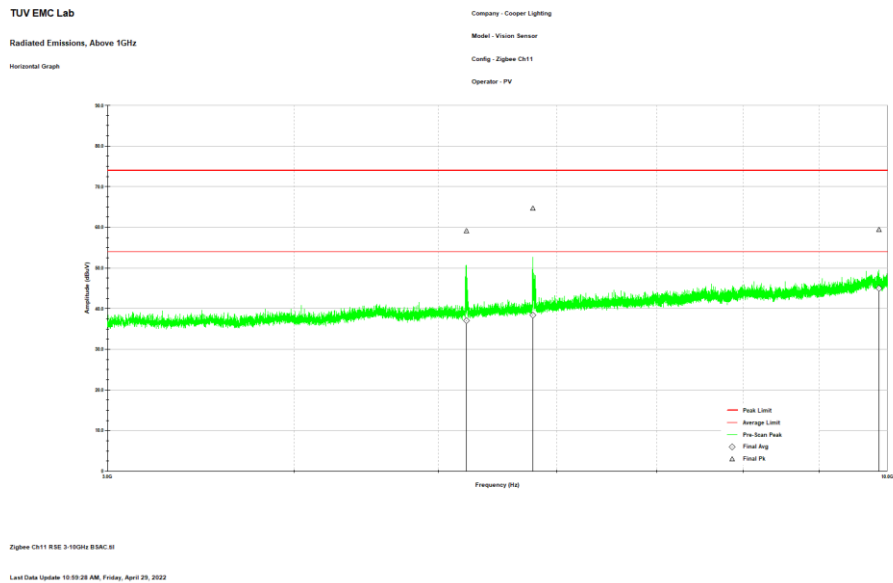


Figure 2.8.6-10: Reference plot for Radiated Spurious Emissions – 3 GHz – 10 GHz – H Polarity

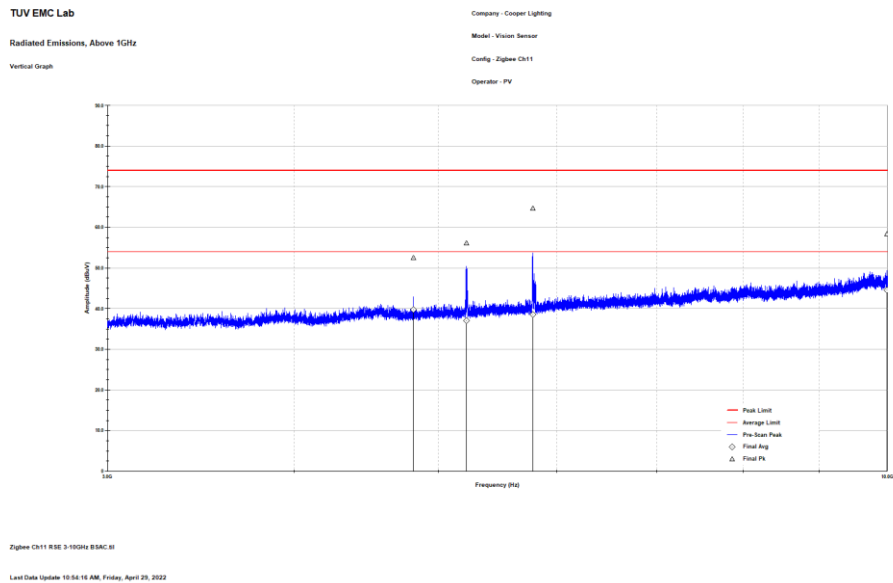


Figure 2.8.6-11: Reference plot for Radiated Spurious Emissions – 3 GHz – 10 GHz – V Polarity

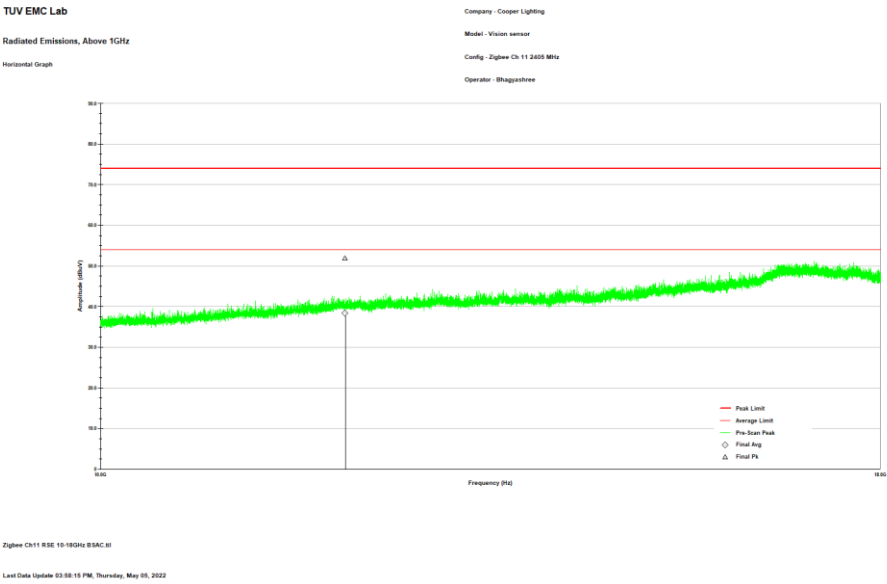


Figure 2.8.6-12: Reference plot for Radiated Spurious Emissions – 10 GHz – 18 GHz – H Polarity

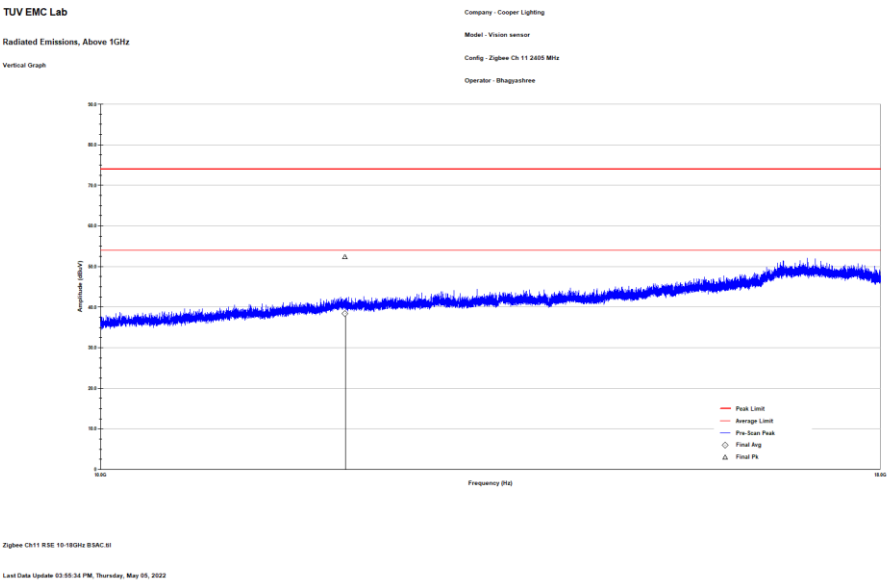


Figure 2.8.6-13: Reference plot for Radiated Spurious Emissions – 10 GHz – 18 GHz – V polarity

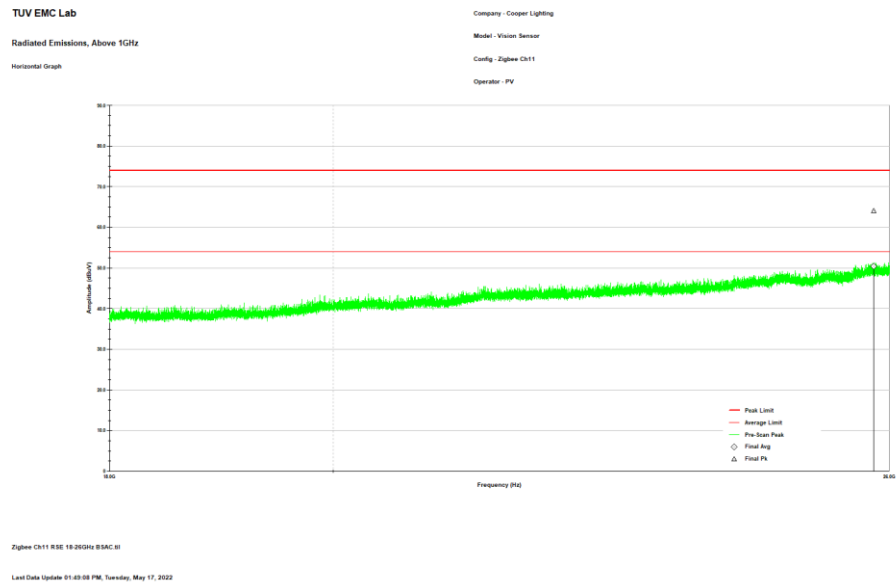


Figure 2.8.6-14: Reference plot for Radiated Spurious Emissions – 18 GHz – 26 GHz – H Polarity

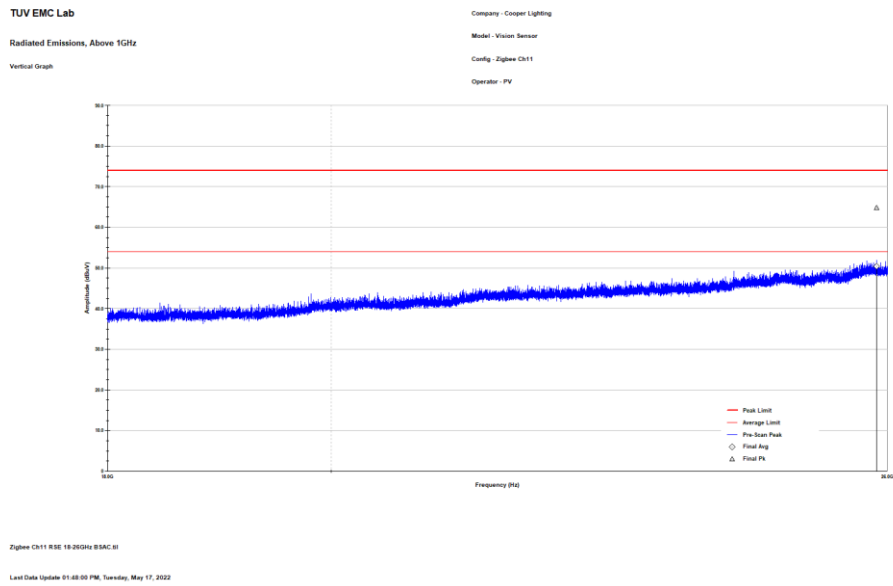


Figure 2.8.6-15: Reference plot for Radiated Spurious Emissions – 18 GHz – 26 GHz – V Polarity



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	5/6/2022
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
335	Suhner	SF-102A	Cable (40GHz)	882/2A	6/24/2021	6/24/2022
345	Suhner Sucoflex	102A	Cable (42GHz)	1077/2A	6/24/2021	6/24/2022
334	Rohde & Schwarz	3160-09	HF 18-26.5GHz Antenna	49404	4/25/2020	4/25/2022
334	Rohde & Schwarz	3160-09	HF 18-26.5GHz Antenna	49404	4/25/2022	5/25/2024
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**

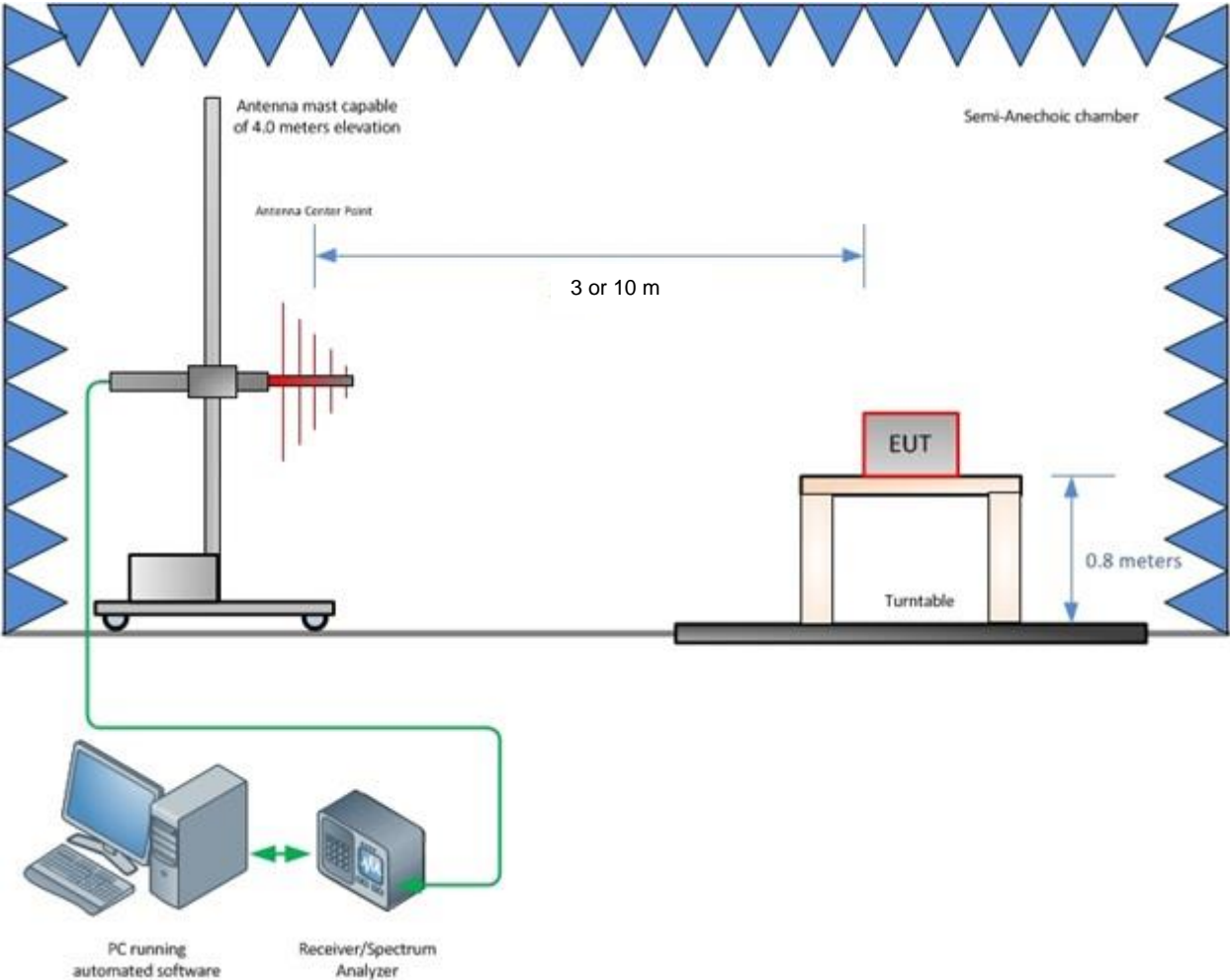


Figure 3-1 – Radiated Emissions Test Setup up to 1 GHz

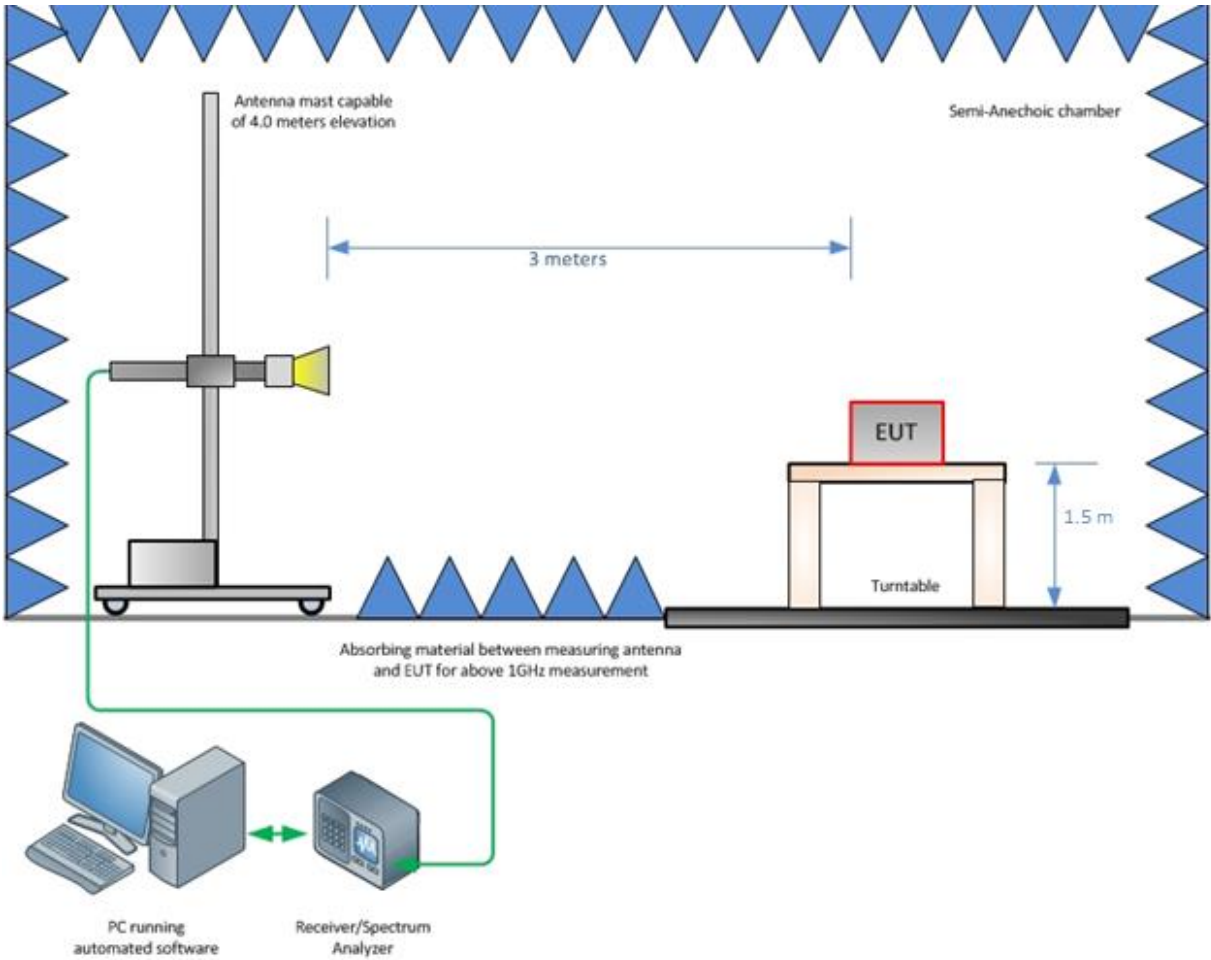


Figure 3-2 – Radiated Emissions Test Setup above 1 GHz

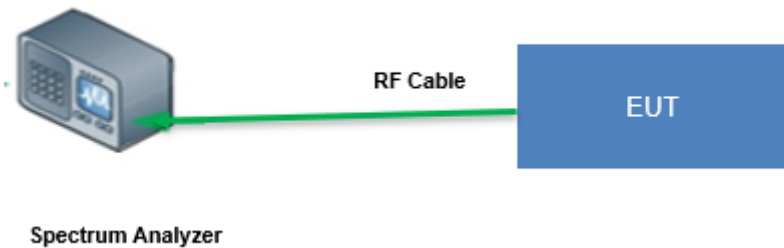


Figure 3-3 – Conducted Test Setup: Antenna Port measurement



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