

Report on the Testing of the Kimberly-Clark Corporation EHRTMODULE

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

Prepared for: Kimberly-Clark Corporation
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America

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Kirby Munroe	Wireless / EMC Technical and Certification Manager, NA TUV SUD America Inc.	Authorized Signatory	2/7/2022

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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.



A2LA Cert. No. 2955.09

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1 Report Summary

1.1 Report Modification Record

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

Table 1.1-1 – Modification Record

Issue	Description of Change	Date of Issue
0	First Issue	2/7/2022

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 as a limited modular approval for the tests documented herein.

The EHRT module was evaluated, where appropriate in the hosts detailed in this report for demonstrating compliance as a limited modular device.

Applicant	Kimberly-Clark Corporation
Manufacturer	Kimberly-Clark Corporation
Applicant’s Email Address	richard.thrasher1@kcc.com
Host Model Name	EHRT
Host Model Number	EHRTWALLMNT, EHRTRECCSD
Module Model Name	EHRTMODULE
Module Model Number	EHRTMODULE V1
Module FCC ID	2AQVAEHRTMODULE
Module ISED Certification Number	24318-EHRTMODULE
Hardware Version(s)	0.1
Software Version(s)	Dispenser V3.0.127 Release - commit 84ba968c
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 (DTs), Frequency Hopping Systems (FHSs) and License-Exempt Local Area Network (LE-LAN) Devices, Issue 2, February 2017.



Order Number	72174064
Date of Receipt of EUT	11/29/2021
Start of Test	12/2/2021
Finish of Test	12/7/2021
Related Document(s)	<p>ANSI C63.10-2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Device.</p> <p>FCC OET KDB 558074 D01 15.247 Meas Guidance v05r02: Guidance for Compliance Measurements on Digital Transmission System, Frequency Hopping Spread Spectrum System, and Hybrid System Devices Operating under Section 15.247 of the FCC Rules, April 2, 2019</p> <p>US Code of Federal Regulations (CFR): Title 47, Part 2, Subpart J: Equipment Authorization Procedures, 2021.</p> <p>ISED Canada Radio Standards Specification: RSS-GEN – General Requirements for Compliance of Radio Apparatus, Issue 5, Amendment 1 (March 2019), Amendment 2 (February 2021)</p>



1.3 Brief Summary of Results

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

Table 1.3-1: Test Result Summary

Test Parameter	Test Plan (Yes/No)	Test Result	FCC 47 CFR Rule Part	ISED Canada's RSS	Test Report Page No
Antenna Requirement	Yes	Pass	15.203	-----	11
6 dB Bandwidth	Yes	Pass	15.247(a)(2)	RSS-247 5.2(a)	20
99% Bandwidth	Yes	Pass	-----	RSS-GEN 6.7	20
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

EHRTMODULE that connects to a board with sensors and enables BLE communications with gateway and it can be installed in multiple host devices. The EHRTWALLMNT and EHRTRECCSD host devices are Electronic Hard Rolled Towel Dispensers and has a hand motion sensor that allows the user to simply wave their hand in front of the sensor and the dispensers will automatically dispense the paper towels. It also gathers sensor data (amount of mounted towel) and send them over Bluetooth to the central device (cellular Bluetooth Gateway).

Table 1.4-1 – Wireless Technical Information

Detail	Description
FCC ID	2AQVAEHRTMODULE
IC ID	24318-EHRTMODULE
Transceiver Module Model #	EHRTWALLMNT V1
Transceiver Host Model #	ERTWALLMNT, EHRTRECCSD
Modulation Format	GFSK / 1 Mbps
Antenna Type / Description:	Printed Inverted-F type antenna with impedance matching circuit / Maximum peak gain 4.2 dBi (WALLMNT) and 3.3dBi (Recessed)

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



Photo 1.4.1-1 – Front view of the EUT (Wall mount Host)



Photo 1.4.1-2 – Back view of the EUT (Wall mount Host)

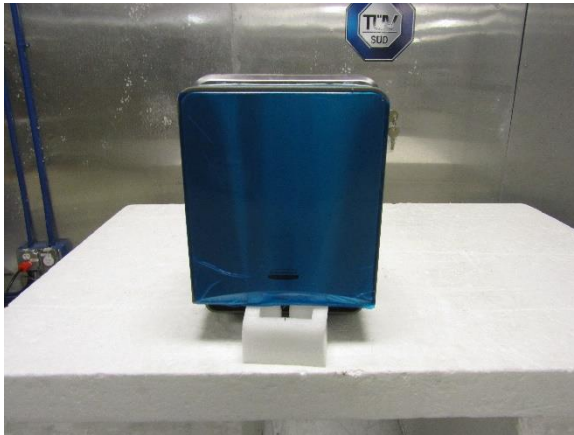


Photo 1.4.1-3 – Front view of the EUT (Recessed Host)



Photo 1.4.1-4 – Back view of the EUT (Recessed Host)



Photo 1.4.1-5 – Standalone Module

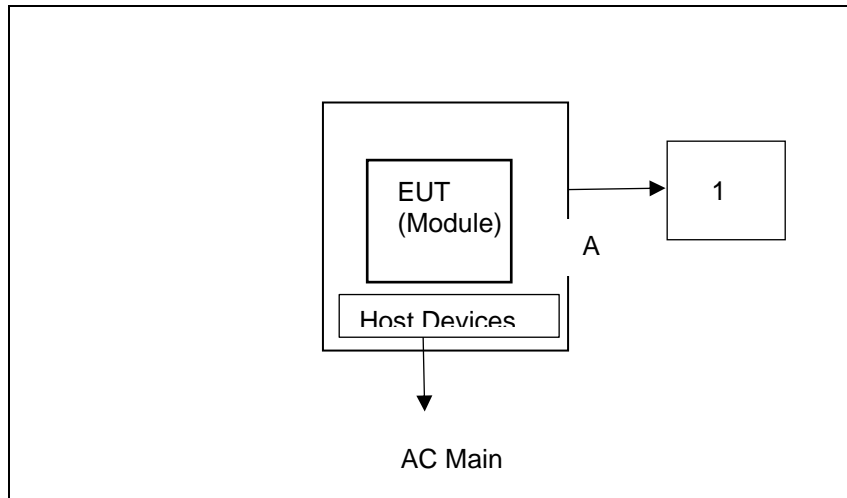


Figure 1.4.1-6 – Test Setup Block Diagram

Table 1.4.1-1 – Cable Descriptions

Item	Cable/Port	Description
A	Serial USB cable	Programming cable

Table 1.4.1-2 – Support Equipment Descriptions

Item	Make/Model	Description
1	Lenovo	Laptop used for configuring wireless module



1.4.2 Modes of Operation

eHRT 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 (kbps)	Classification
1	2402 – 2480	40	GFSK	1 Mbps	BLE

1.4.3 Monitoring of Performance

For radiated emissions, the EUT was evaluated in an orientation of typical use. See test setup photos for more information. Radiated emissions were performed on 2 host configurations, wallmount and recessed versions containing the eHRT limited module. 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.

Worst case mode for all parameters measured listed below:

Test case	Tested Frequency (MHz)	Module or module/host combination
AC Power Line Conducted Emissions	2402	Host (Wallmount and Recessed)
6dB / 99% BW	2402 – 2440 - 2480	Standalone Module
Peak Output Power	2402 – 2440 - 2480	Standalone Module
Power Spectral density	2402 – 2440 - 2480	Standalone Module
RF conducted Spurious Emissions	2402 – 2440 - 2480	Standalone Module
Band Edge RF Conducted emissions	2402 – 2440 - 2480	Standalone Module
RSE into Restricted Bands	2402 – 2440 - 2480	Host (Wall mount and Recessed)
Band Edge RF radiated Emissions	2402 – 2440 - 2480	Host (Wallmount and Recessed)



Power setting during test: Mode of operation 1: 8 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	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 "0", as noted in §1.6.

2.1.3 Date of Test

12/3/2021

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 printed Inverted-F type antenna with impedance matching circuit with maximum peak gain 4.2 dBi for Wallmount Host and 3.3 dBi for Recessed Host which is mounted on the bottom side of the printed circuit board, therefore satisfying the requirements of Section 15.203.



2.2 Power Line Conducted Emissions

2.2.1 Specification Reference

FCC Section: 15.207
 ISED Canada: RSS-Gen 8.8

2.2.2 Equipment Under Test and Modification State

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

2.2.3 Date of Test

12/7/2021

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 – WALLMNT HOST

Frequency (MHz)	Avg Limit	Avg Level Corrected	Avg Level	Correction Fact.	Avg Margin	Result
0.91	46	20.2	10.5	9.675	-25.8	PASS
1.13	46	19.4	9.7	9.675	-26.6	PASS
1.91	46	19.4	9.8	9.668	-26.6	PASS
2.82	46	19.7	10	9.69	-26.3	PASS
2.94	46	19.3	9.6	9.69	-26.7	PASS
4.36	46	18.6	8.9	9.68	-27.4	PASS



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

Frequency (MHz)	QP Limit	QP Level Corrected	QP Level	Correction Fact.	QP Margin	Result
0.91	56	30.2	20.5	9.675	-25.8	PASS
1.13	56	29.9	20.2	9.675	-26.1	PASS
1.91	56	29.5	19.8	9.668	-26.5	PASS
2.82	56	29.1	19.4	9.69	-26.9	PASS
2.94	56	29.3	19.6	9.69	-26.7	PASS
4.36	56	28	18.3	9.68	-28	PASS

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

Frequency (MHz)	Avg Limit	Avg Level Corrected	Avg Level	Correction Fact.	Avg Margin	Result
0.5	46	16.7	7	9.63	-29.3	PASS
0.68	46	17.2	7.6	9.641	-28.8	PASS
4.09	46	16.1	6.4	9.7	-29.9	PASS
4.13	46	16.3	6.6	9.7	-29.7	PASS
4.5	46	16.2	6.5	9.7	-29.8	PASS
4.86	46	15.2	5.6	9.693	-30.8	PASS

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

Frequency (MHz)	QP Limit	QP Level Corrected	QP Level	Correction Fact.	QP Margin	Result
0.5	56	23.6	13.9	9.63	-32.4	PASS
0.68	56	25.8	16.2	9.641	-30.2	PASS
4.09	56	24.6	14.9	9.7	-31.4	PASS
4.13	56	25.1	15.4	9.7	-30.9	PASS
4.5	56	25	15.3	9.7	-31	PASS
4.86	56	23.5	13.8	9.693	-32.5	PASS



Table 2.2.6-5: Conducted EMI Results-Avg – Line 1 – RECCSD HOST

Frequency (MHz)	Avg Limit	Avg Level Corrected	Avg Level	Correction Fact.	Avg Margin	Result
0.85	46	19.5	9.9	9.671	-26.5	PASS
1.32	46	19.4	9.7	9.667	-26.6	PASS
1.48	46	19.1	9.4	9.661	-26.9	PASS
2.59	46	18.8	9.2	9.69	-27.2	PASS
3.75	46	19	9.3	9.68	-27	PASS
3.85	46	18.3	8.6	9.68	-27.7	PASS

Table 2.2.6-6: Conducted EMI Results-QP – Line 1 – RECCSD HOST

Frequency (MHz)	QP Limit	QP Level Corrected	QP Level	Correction Fact.	QP Margin	Result
0.85	56	29.1	19.4	9.671	-26.9	PASS
1.32	56	29.4	19.8	9.667	-26.6	PASS
1.48	56	29.1	19.4	9.661	-26.9	PASS
2.59	56	28.7	19	9.69	-27.3	PASS
3.75	56	28.4	18.7	9.68	-27.6	PASS
3.85	56	27.8	18.1	9.68	-28.2	PASS

Table 2.2.6-7: Conducted EMI Results-Avg – Line 2 – RECCSD HOST

Frequency (MHz)	Avg Limit	Avg Level Corrected	Avg Level	Correction Fact.	Avg Margin	Result
0.5	46.1	16.6	6.9	9.63	-29.5	PASS
0.66	46	18.2	8.6	9.639	-27.8	PASS
4.15	46	15.7	6	9.7	-30.3	PASS
4.52	46	16	6.3	9.7	-30	PASS
4.52	46	15.8	6.1	9.7	-30.2	PASS
4.89	46	15.3	5.6	9.692	-30.7	PASS

Table 2.2.6-8: Conducted EMI Results-QP – Line 2 – RECCSD HOST

Frequency (MHz)	QP Limit	QP Level Corrected	QP Level	Correction Fact.	QP Margin	Result
0.5	56.1	23.6	14	9.63	-32.4	PASS
0.66	56	26.9	17.2	9.639	-29.1	PASS
4.15	56	24	14.3	9.7	-32	PASS
4.52	56	24.5	14.8	9.7	-31.5	PASS
4.52	56	24.6	14.9	9.7	-31.4	PASS
4.89	56	23.7	14	9.692	-32.3	PASS

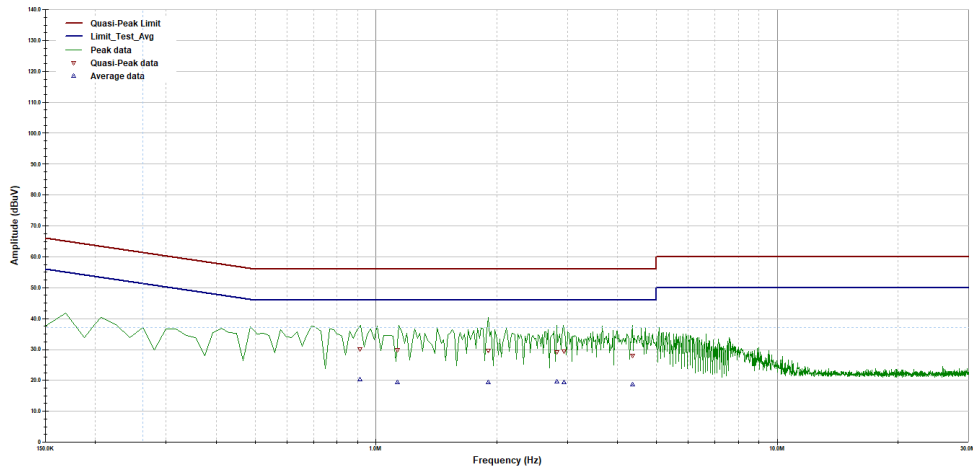


TUV SUD America

Conducted RF Emissions, 150 kHz to 30 MHz

Line Under Test Number 1 Results

EUT Name - 72174064-Kimberly Clark
 Model Number - eHRT WallMount
 Part Number - N/A
 Serial Number - N/A
 Voltage - FCC/IC Class B; 120Vac/60Hz
 Operating Mode - Powered on; BLE TX ON LCH 2402M



Operator: Divya A

CE-eHRT Wallmount.ttl

Last Data Update 11:22:23 AM, Tuesday, December 07, 2021

Temperature = 22C
 Relative Humidity = 26%
 RF Bandwidth: 9kHz
 VBW if Analyzer: 30kHz

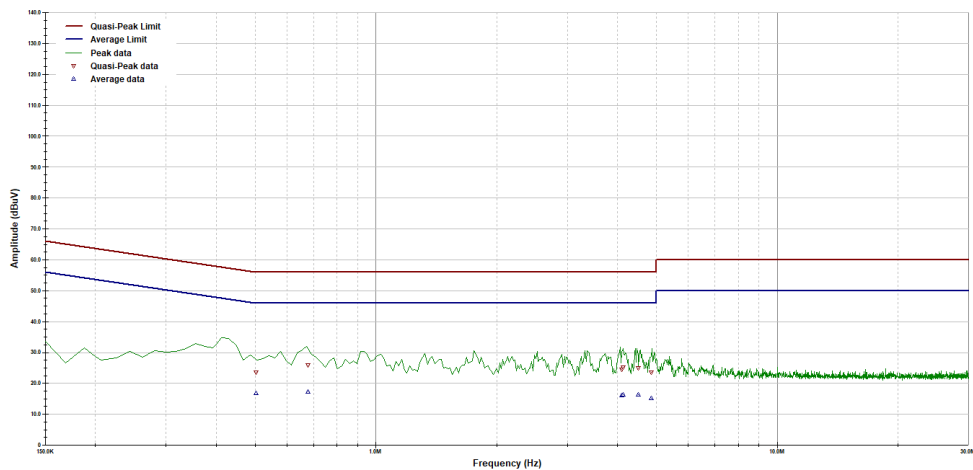
Figure 1: Conducted Emission Plot – Line 1 - WALLMNT HOST

TUV SUD America

Conducted RF Emissions, 150 kHz to 30 MHz

Line Under Test Number 2 Results

EUT Name - 72174064-Kimberly Clark
 Model Number - eHRT WallMount
 Part Number - N/A
 Serial Number - N/A
 Voltage - FCC/IC Class B; 120Vac/60Hz
 Operating Mode - Powered on; BLE TX ON LCH 2402M



Operator: Divya A

CE-eHRT Wallmount.ttl

Last Data Update 11:33:50 AM, Tuesday, December 07, 2021

Temperature = 22C
 Relative Humidity = 26%
 RF Bandwidth: 9kHz
 VBW if Analyzer: 30kHz

Figure 2: Conducted Emission Plot – Neutral - WALLMNT HOST

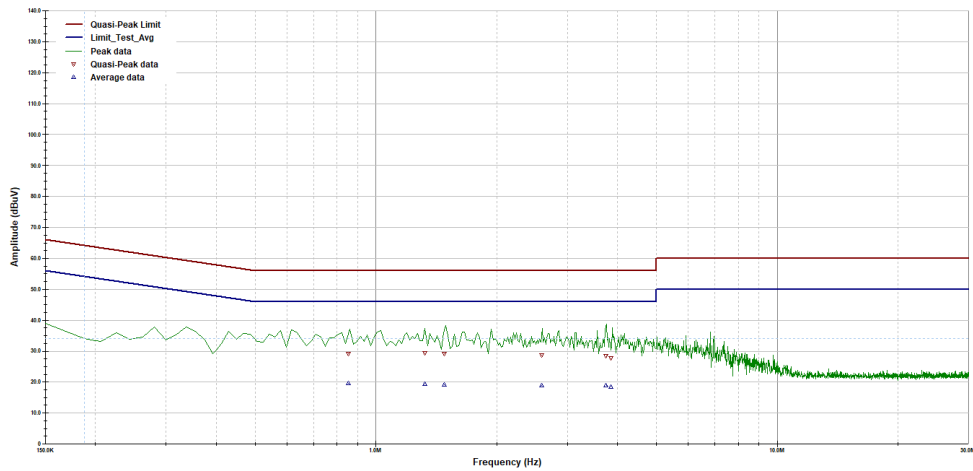


TUV SUD America

Conducted RF Emissions, 150 kHz to 30 MHz

Line Under Test Number 1 Results

EUT Name - 72174064-Kimberly Clark
Model Number - eHRT Recessed
Part Number - N/A
Serial Number - N/A
Voltage - FCC/IC Class B; 120Vac/60Hz
Operating Mode - Powered on; BLE TX ON LCH 2402M



Operator: Diviya A

CE-eHRT Recessed.til

Last Data Update 12:02:58 PM, Tuesday, December 07, 2021

Temperature = 22C
Relative Humidity = 26%
RF Bandwidth: 9kHz
VBW if Analyzer: 30kHz

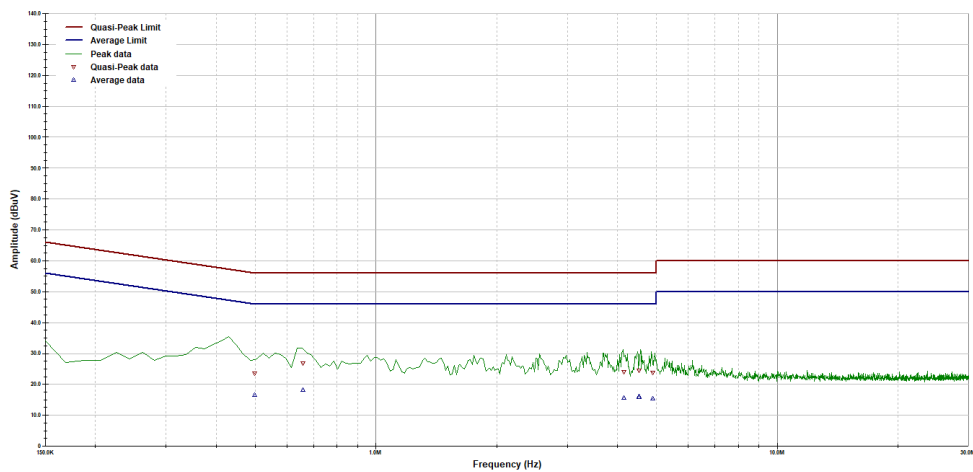
Figure 3: Conducted Emission Plot – Line 1 - RECCSD HOST

TUV SUD America

Conducted RF Emissions, 150 kHz to 30 MHz

Line Under Test Number 2 Results

EUT Name - 72174064-Kimberly Clark
Model Number - eHRT Recessed
Part Number - N/A
Serial Number - N/A
Voltage - FCC/IC Class B; 120Vac/60Hz
Operating Mode - Powered on; BLE TX ON LCH 2402M



Operator: Diviya A

CE-eHRT Recessed.til

Last Data Update 12:12:51 PM, Tuesday, December 07, 2021

Temperature = 22C
Relative Humidity = 26%
RF Bandwidth: 9kHz
VBW if Analyzer: 30kHz

Figure 4: Conducted Emission Plot – Nuetral - RECCSD HOST



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

12/2/2021

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	6.4	1 Mbps
2440	6.5	1 Mbps
2480	6.7	1 Mbps

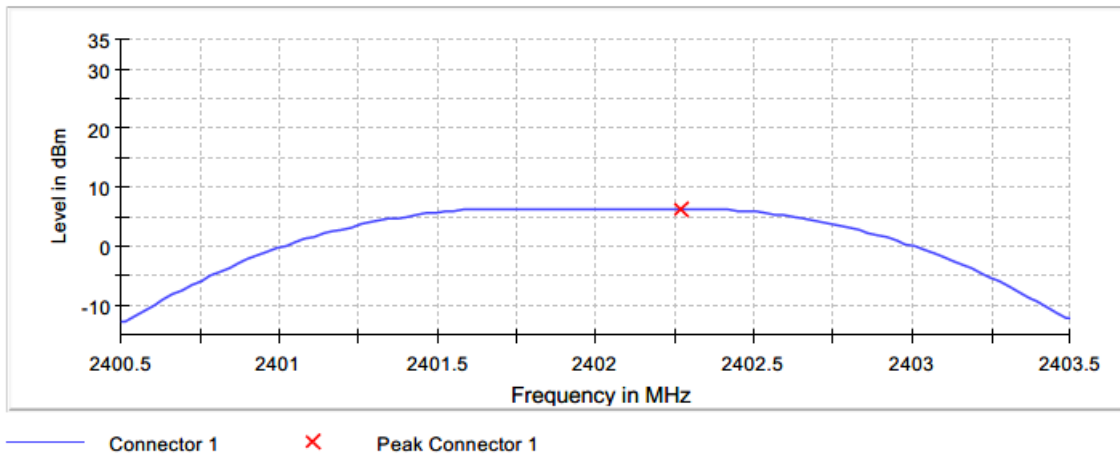


Figure 2.3.6-1: Output Power - LCH

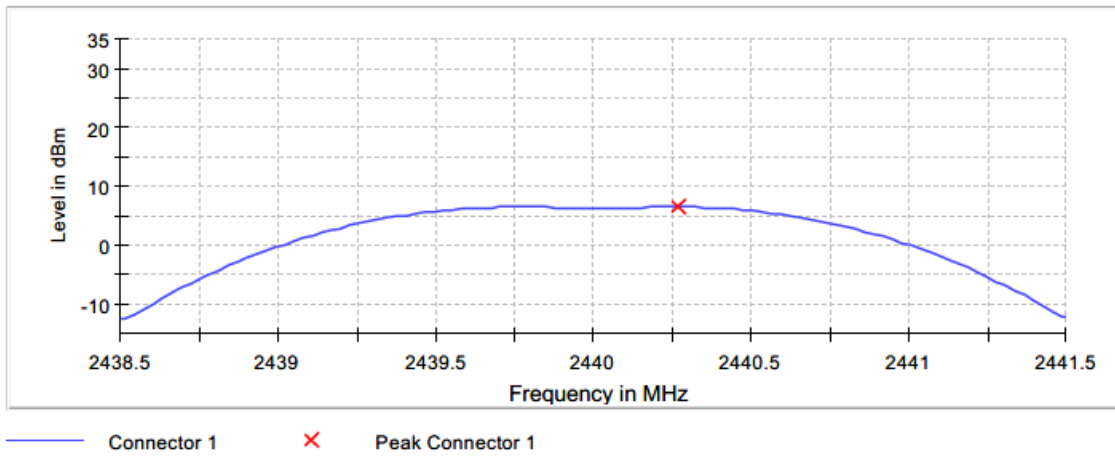


Figure 2.3.6-2: Output Power - MCH

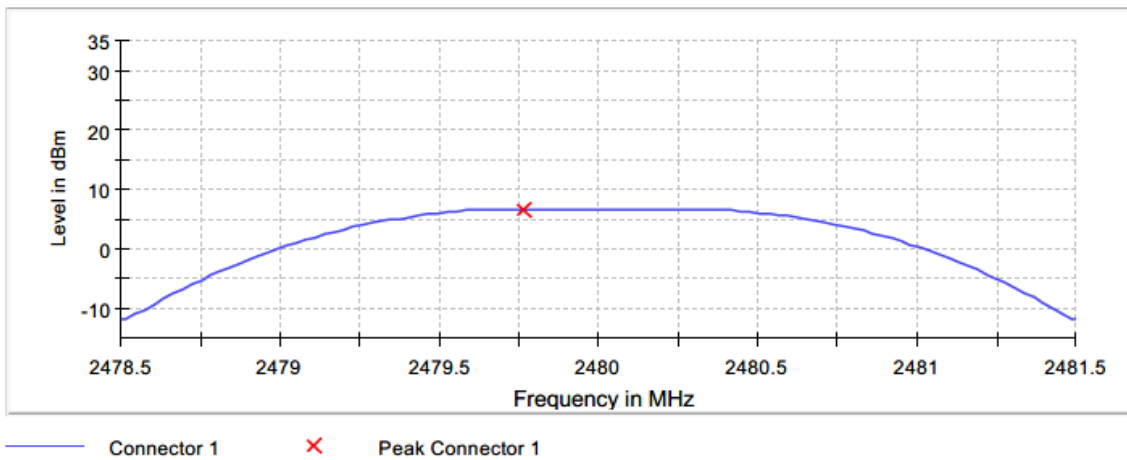


Figure 2.3.6-3: Output Power - HCH

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	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	0.50 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

12/2/2021

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	772.278	1.055	1 Mbps
2480	772.278	1.055	1 Mbps

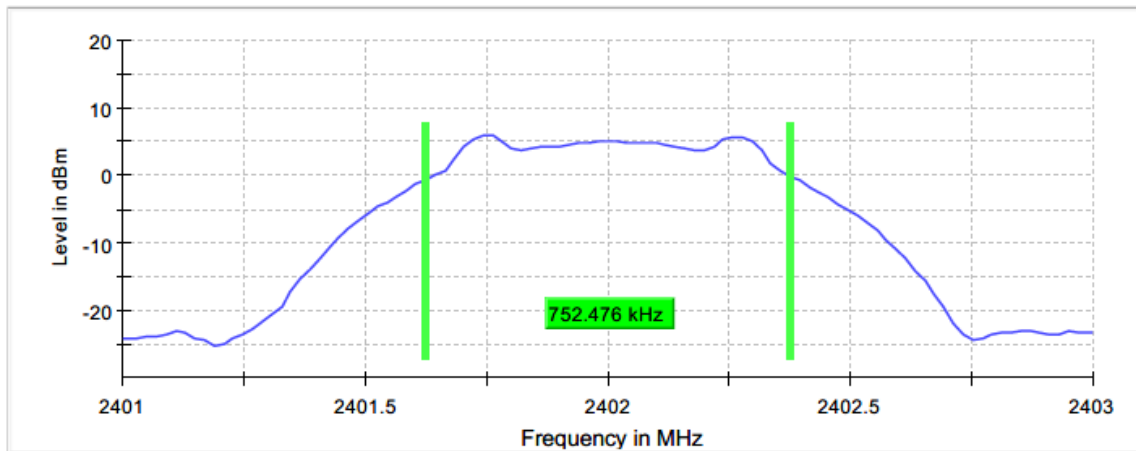


Figure 2.4.6-1: 6 dB BW - LCH

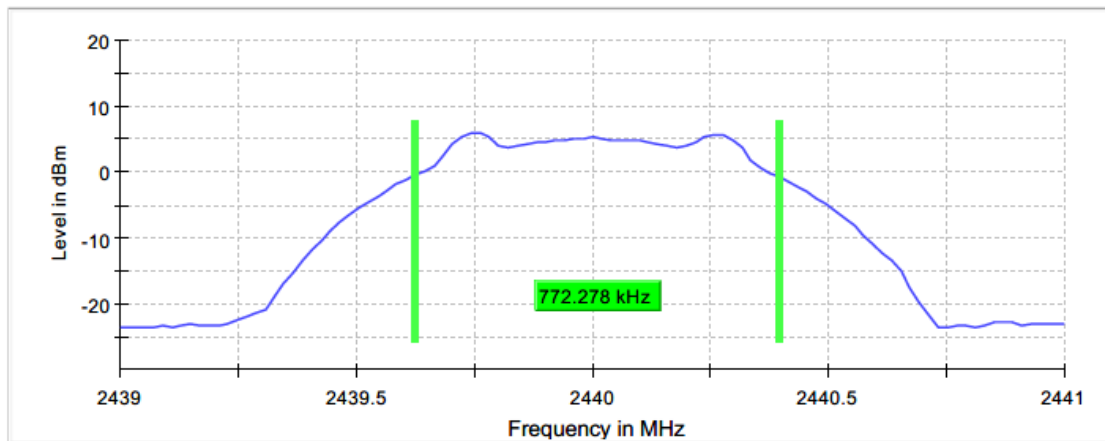


Figure 2.4.6-2: 6 dB BW - MCH

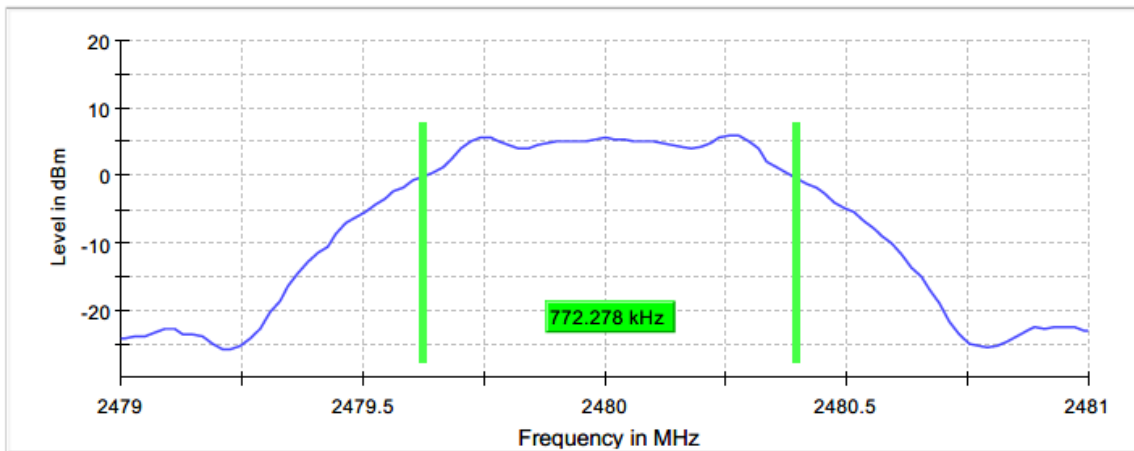


Figure 2.4.6-3: 6 dB BW - HCH

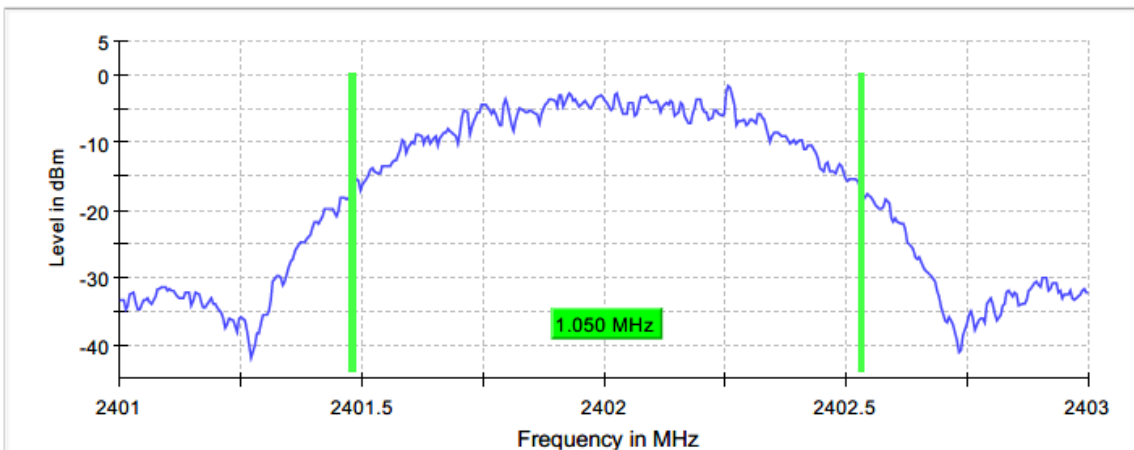


Figure 2.4.6-5: 99% BW - LCH

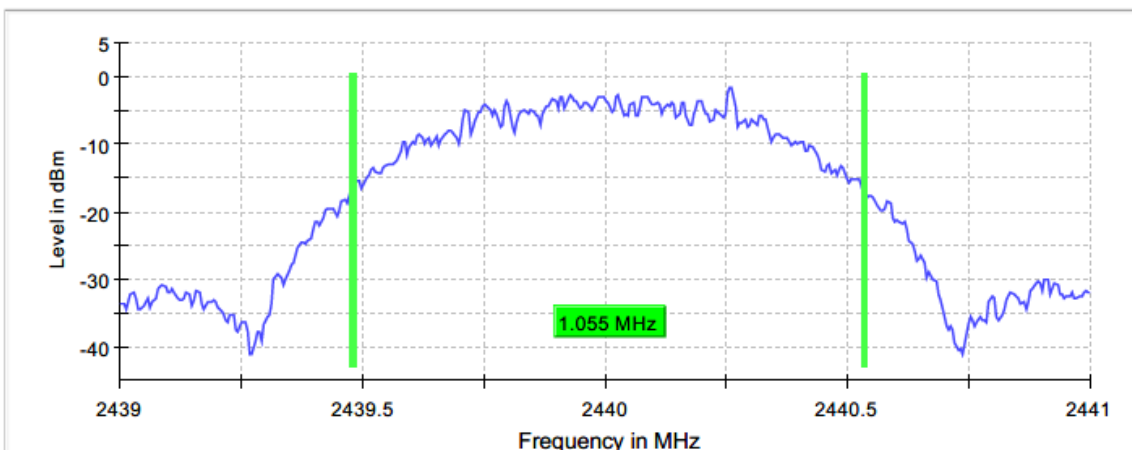


Figure 2.4.6-6: 99% BW - MCH

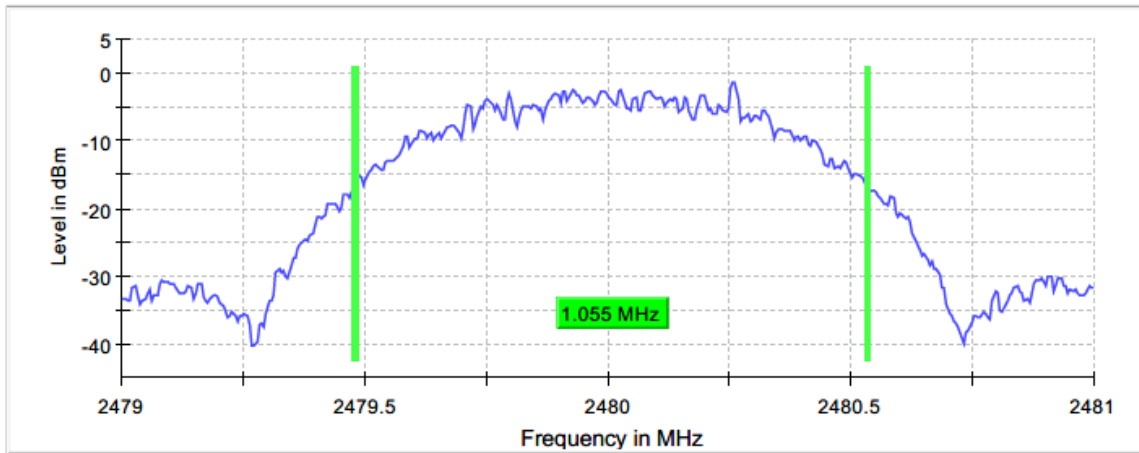


Figure 2.4.6-7: 99% BW - HCH

Table 2.4.6.1-1: Sample Measurement Setting (6dB BW)

Setting	Instrument Value	Target Value
Start Frequency	2.40100 GHz	2.40100 GHz
Stop Frequency	2.40300 GHz	2.40300 GHz
Span	2.000 MHz	2.000 MHz
RBW	100.000 kHz	~ 100.000 kHz
VBW	300.000 kHz	~ 300.000 kHz
Sweep Points	101	~ 40
Sweep time	18.938 μ s	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	0.50 dB	0.50 dB
Run	10 / max. 150	max. 150
Stable	5 / 5	5
Max Stable Difference	0.05 dB	0.50 dB



Table 2.4.6.1-2: Sample Measurement Setting (99% BW)

Setting	Instrument Value	Target Value
Start Frequency	2.40100 GHz	2.40100 GHz
Stop Frequency	2.40300 GHz	2.40300 GHz
Span	2.000 MHz	2.000 MHz
RBW	10.000 kHz	>= 10.000 kHz
VBW	30.000 kHz	>= 30.000 kHz
Sweep Points	400	~ 400
Sweep time	189.648 μ s	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	10 / max. 150	max. 150
Stable	3 / 3	3
Max Stable Difference	0.19 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

12/2/2021

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	-1.477	1 Mbps
2440	-1.355	1 Mbps
2480	-1.162	1 Mbps

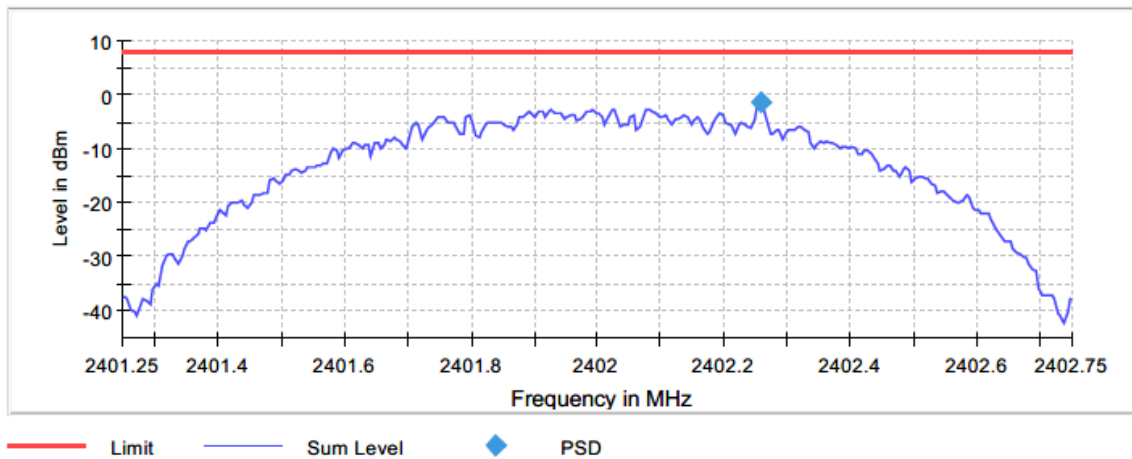


Figure 2.5.6-1: PSD – LCH

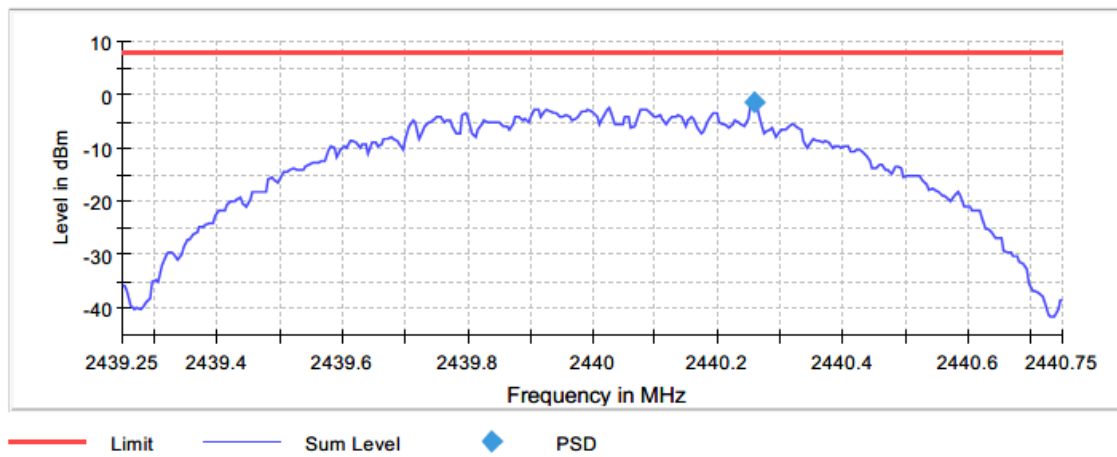


Figure 2.5.6-2: PSD – MCH

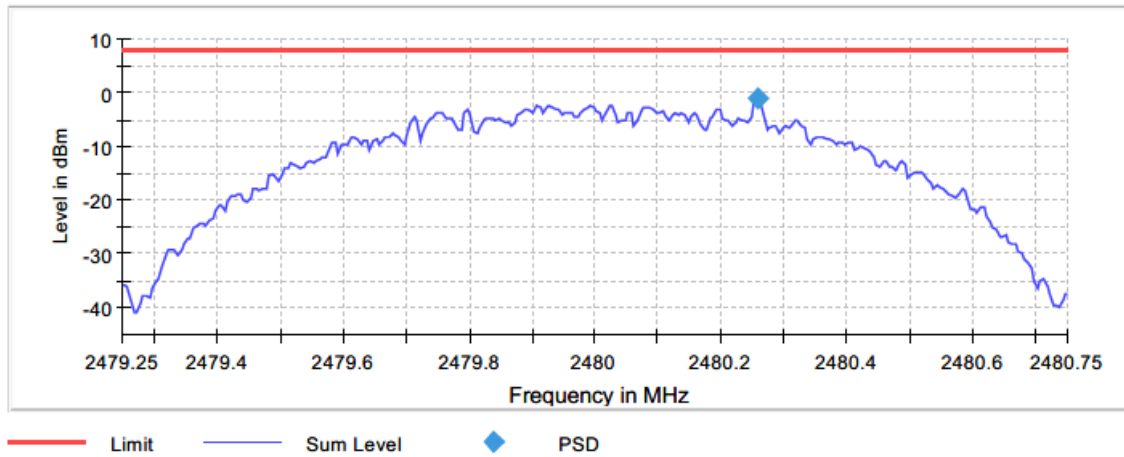


Figure 2.5.6-3: PSD – HCH

Table 2.5.6-1: Sample Measurement Settings (PSD)

Setting	Instrument Value	Target Value
Start Frequency	2.40125 GHz	2.40125 GHz
Stop Frequency	2.40275 GHz	2.40275 GHz
Span	1.500 MHz	1.500 MHz
RBW	10.000 kHz	<= 10.000 kHz
VBW	30.000 kHz	>= 30.000 kHz
Sweep Points	300	~ 300
Sweep time	1.500 ms	AUTO
Reference Level	1.500 dBm	1.500 dBm
Attenuation	0.000 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	5 / max. 150	max. 150
Stable	2 / 2	2
Max Stable Difference	0.38 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

12/2/2021

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.

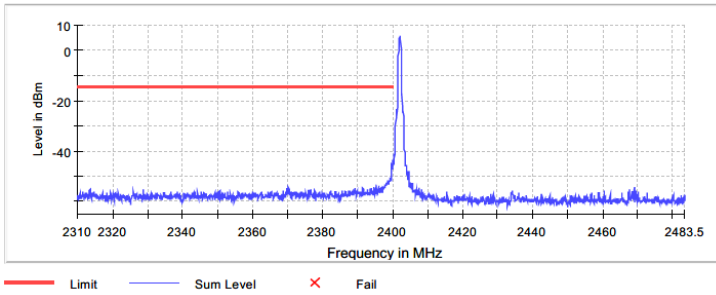


Figure 2.6.6-1: Lower Band-edge

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

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)	Result
2399.975000	-43.7	29.5	-14.2	PASS
2399.725000	-45.2	31.0	-14.2	PASS
2399.775000	-45.4	31.2	-14.2	PASS
2399.675000	-45.6	31.4	-14.2	PASS
2399.925000	-45.7	31.6	-14.2	PASS
2399.825000	-46.2	32.0	-14.2	PASS
2399.625000	-47.0	32.8	-14.2	PASS
2399.875000	-47.1	32.9	-14.2	PASS
2399.575000	-48.8	34.6	-14.2	PASS
2399.525000	-50.5	36.3	-14.2	PASS
2399.375000	-50.7	36.5	-14.2	PASS
2399.425000	-50.7	36.5	-14.2	PASS
2399.325000	-50.9	36.7	-14.2	PASS
2399.175000	-51.0	36.9	-14.2	PASS
2399.475000	-51.4	37.2	-14.2	PASS

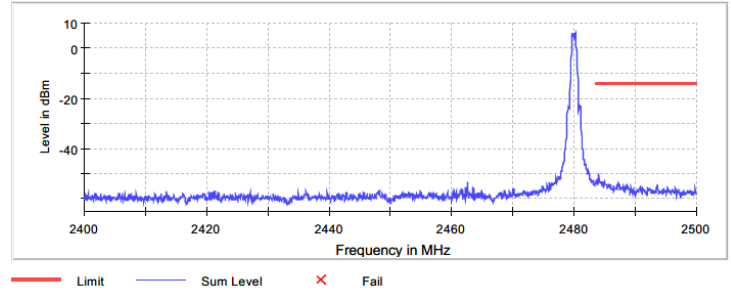


Figure 2.6.6-2: Upper Band-edge

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

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)	Result
2484.025000	-50.0	35.9	-14.1	PASS
2484.075000	-50.1	36.0	-14.1	PASS
2483.975000	-51.9	37.8	-14.1	PASS
2484.975000	-52.2	38.1	-14.1	PASS
2483.725000	-52.5	38.4	-14.1	PASS
2483.675000	-52.8	38.7	-14.1	PASS
2484.925000	-53.0	38.9	-14.1	PASS
2484.225000	-53.1	39.1	-14.1	PASS
2484.475000	-53.2	39.1	-14.1	PASS
2484.125000	-53.2	39.1	-14.1	PASS
2484.275000	-53.2	39.2	-14.1	PASS
2484.775000	-53.3	39.2	-14.1	PASS
2485.025000	-53.3	39.2	-14.1	PASS
2484.525000	-53.4	39.3	-14.1	PASS
2484.375000	-53.4	39.3	-14.1	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

12/2/2021

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.

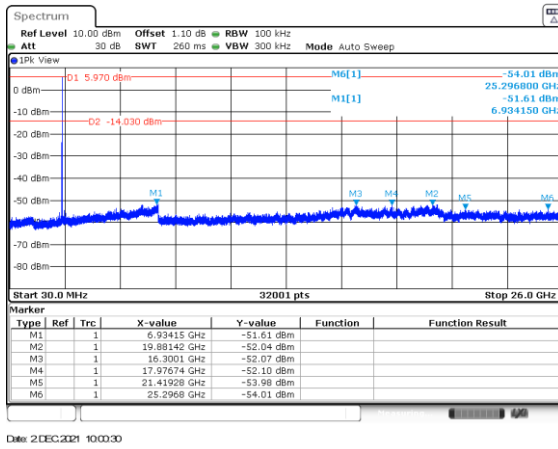


Figure 2.7.6-1: 30MHz – 10GHz – LCH

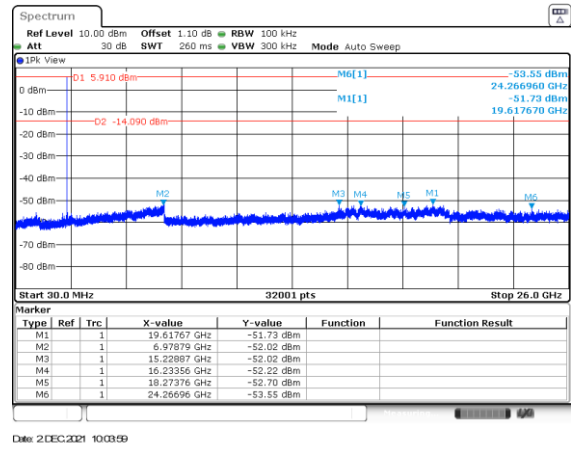


Figure 2.7.6-2: 30MHz – 10GHz – MCH

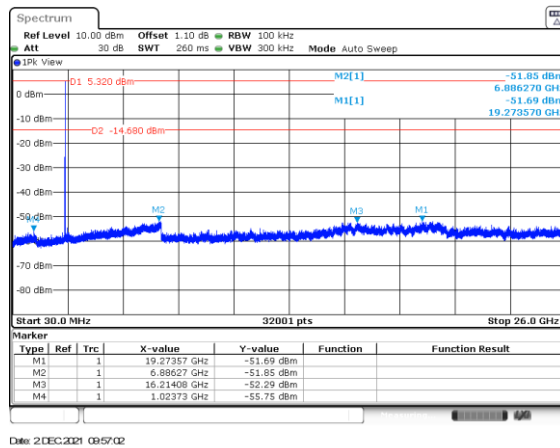


Figure 2.7.6-3: 30MHz – 10GHz – HCH



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

12/2/2021 to 12/6/2021

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 – WALLMNT HOST

Frequency (MHz)	Level (dBuV)		Antenna Polarity (H/V)	Correction Factors (dB)	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)		Notes
	pk	Qpk/Avg			pk	Qpk/Avg	pk	Qpk/Avg	pk	Qpk/Avg	
LCH											
4804	53.30	47.30	H	3.12	56.42	50.42	74.0	54.0	17.6	3.6	
4804	50.60	42.70	V	3.12	53.72	45.82	74.0	54.0	20.3	8.2	
2390	49.20	35.00	H	0.08	49.28	35.08	74.0	54.0	24.7	18.9	1
2390	48.30	33.70	V	0.08	48.38	33.78	74.0	54.0	25.6	20.2	1
MCH											
4880	52.70	45.90	H	3.17	55.87	49.07	74.0	54.0	18.1	4.9	
4880	49.10	39.30	V	3.17	52.27	42.47	74.0	54.0	21.7	11.5	
HCH											
4960	50.80	42.70	H	3.22	54.02	45.92	74.0	54.0	20.0	8.1	
4960	48.40	38.30	V	3.22	51.62	41.52	74.0	54.0	22.4	12.5	
2383.5	59.30	43.60	H	0.06	59.36	43.66	74.0	54.0	14.6	10.3	2
2383.5	53.20	38.31	V	0.06	53.26	38.37	74.0	54.0	20.7	15.6	2

Note 1: Lower BE

Note 2: Upper BE

Table 2.8.6-2: Radiated Spurious Emissions Tabulated Data – RECCSD HOST

Frequency (MHz)	Level (dBuV)		Antenna Polarity (H/V)	Correction Factors (dB)	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)		Notes
	pk	Qpk/Avg			pk	Qpk/Avg	pk	Qpk/Avg	pk	Qpk/Avg	
LCH											
4804	50.40	41.20	H	3.61	54.01	44.81	74.0	54.0	20.0	9.2	
4804	50.30	42.00	V	3.61	53.91	45.61	74.0	54.0	20.1	8.4	
2390	48.40	35.30	H	-5.02	43.38	30.28	74.0	54.0	30.6	23.7	1
2390	49.40	35.80	V	-5.02	44.38	30.78	74.0	54.0	29.6	23.2	1
MCH											
4880	47.80	36.80	H	3.61	51.41	40.41	74.0	54.0	22.6	13.6	
4880	47.50	35.40	V	3.61	51.11	39.01	74.0	54.0	22.9	15.0	
HCH											
4960	46.50	33.70	H	3.60	50.10	37.30	74.0	54.0	23.9	16.7	
4960	46.40	33.40	V	3.60	50.00	37.00	74.0	54.0	24.0	17.0	
2383.5	56.60	42.30	H	-5.05	51.55	37.25	74.0	54.0	22.4	16.7	2
2383.5	56.10	42.00	V	-5.05	51.05	36.95	74.0	54.0	22.9	17.0	2

Note 1: Lower BE

Note 2: Upper BE



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: 53.30 + 3.12 = 56.42dBμV/m

Margin: 74dBμV/m – 56.42dBμV/m = 17.6dB

Example Calculation: Average

Corrected Level: 47.30 + 3.12 - 0 = 50.42dBμV

Margin: 54dBμV – 50.42dBμV = 3.6dB

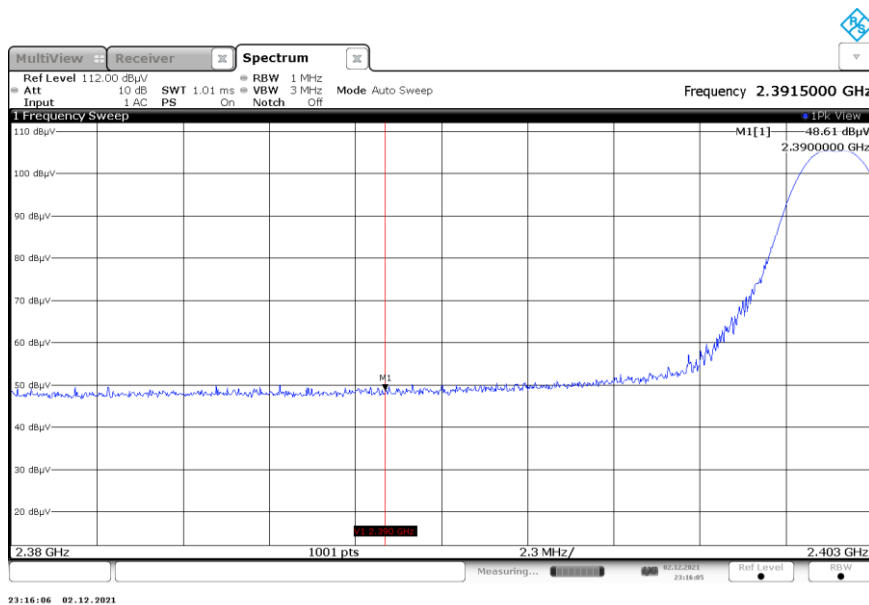


Figure 1: Reference plot Radiated Lower Band-edge – LCH – Wall mount Host

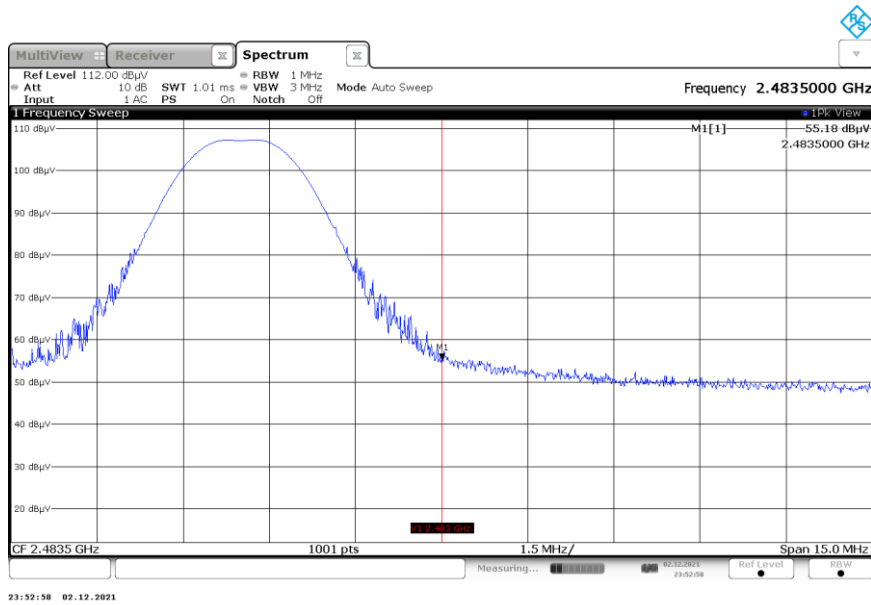


Figure 2: Reference plot Radiated Upper Band-edge – HCH – Wall mount Host

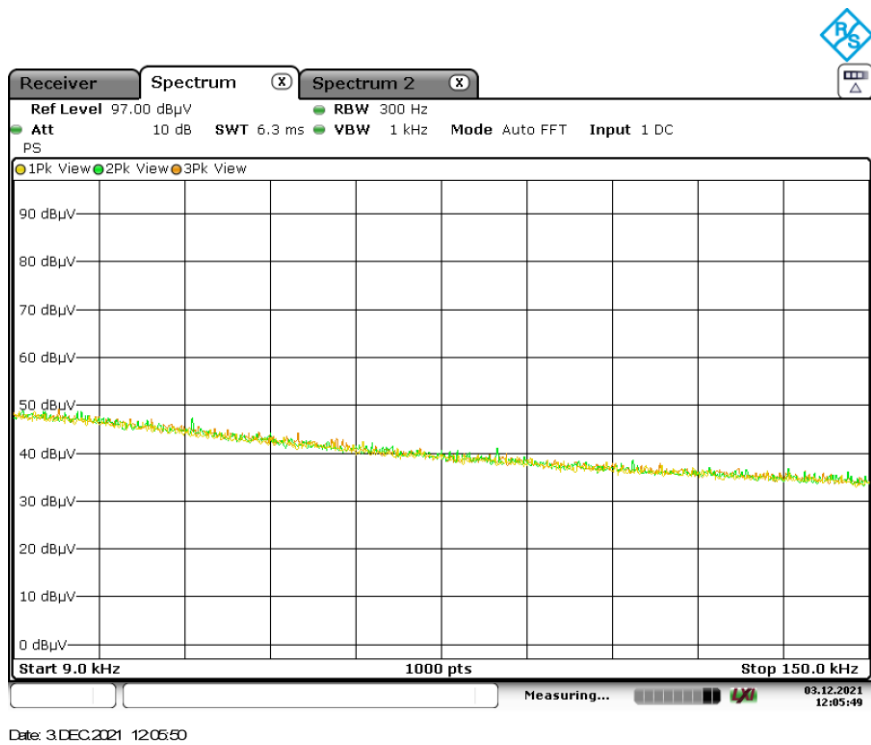


Figure 3: Reference plot for Radiated Spurious Emissions – 9 kHz – 150 kHz – Wall mount Host

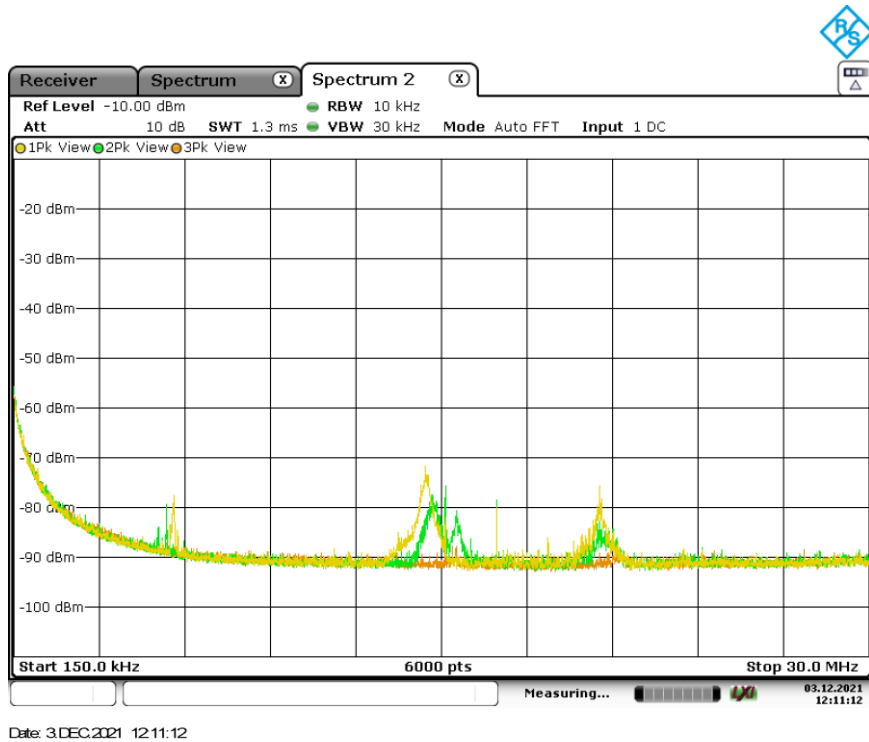


Figure 4: Reference plot for Radiated Spurious Emissions– 150 kHz – 30MHz – Wall mount Host

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

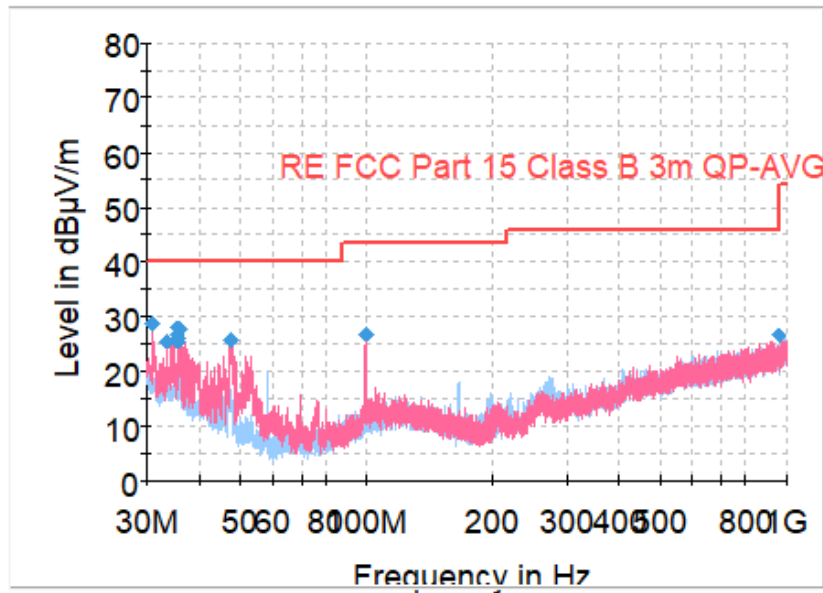


Figure 5: Reference plot for Radiated Spurious Emissions – 30 MHz – 1 GHz – Wall mount Host

Note: Emissions above the noise floor do not falls within restricted bands or are associated with the digital device.

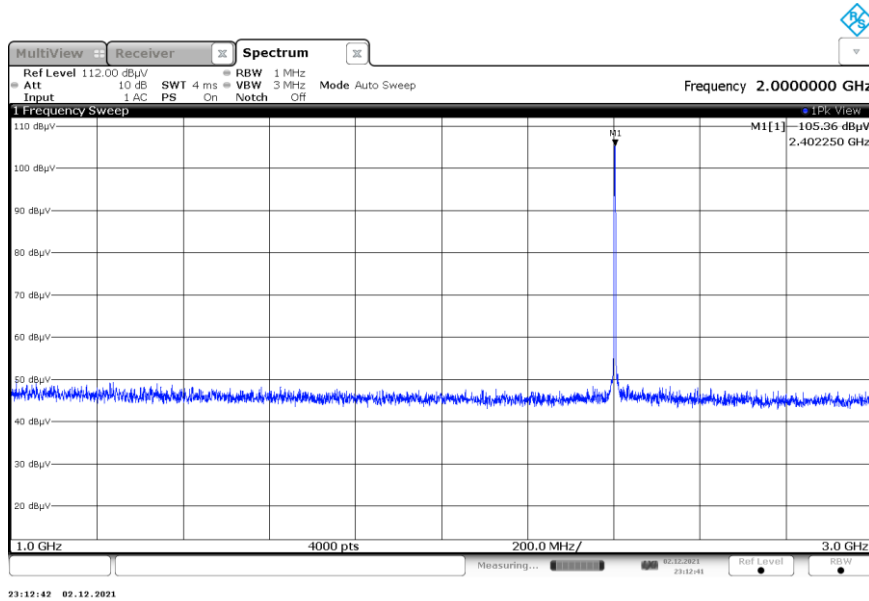


Figure 6: Reference plot for Radiated Spurious Emissions – 1 GHz – 3 GHz – Wall mount Host

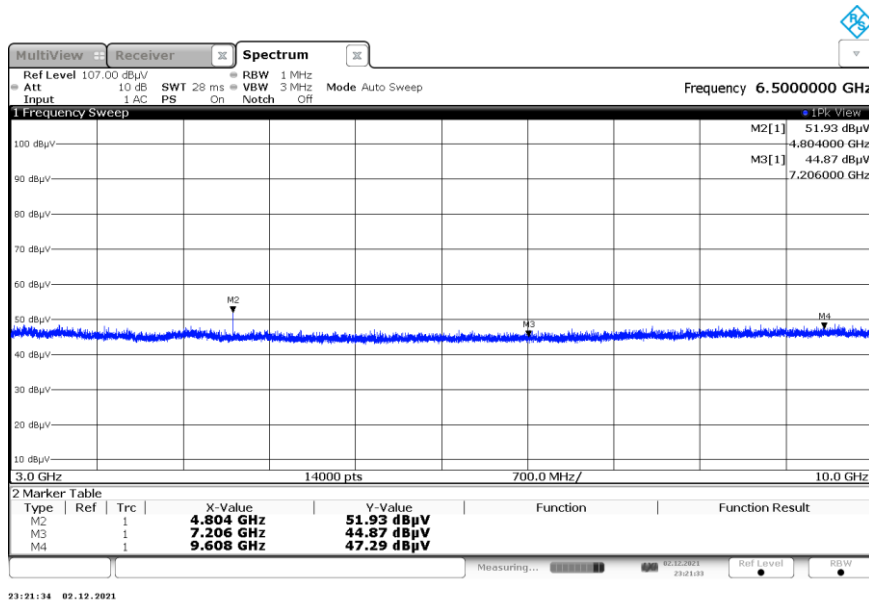
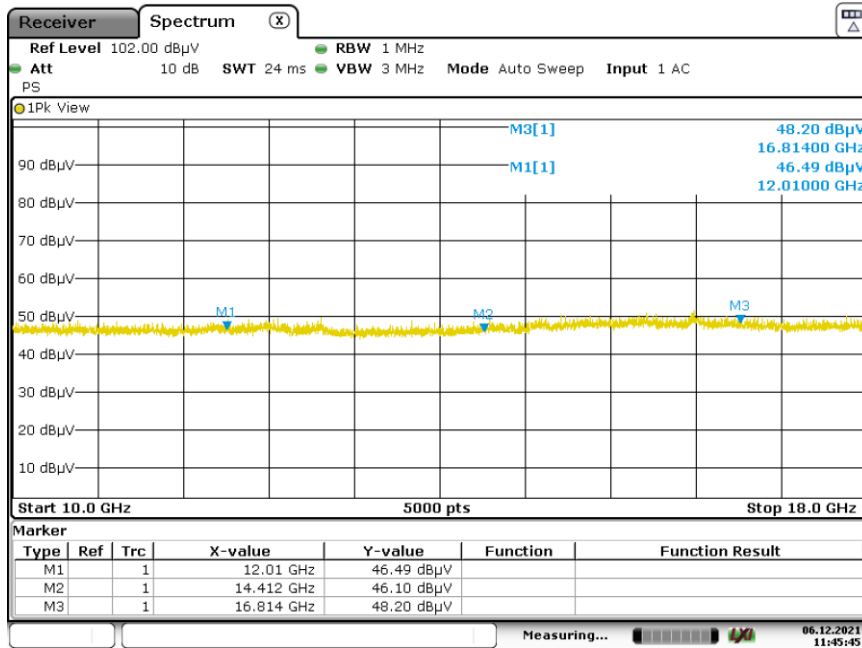
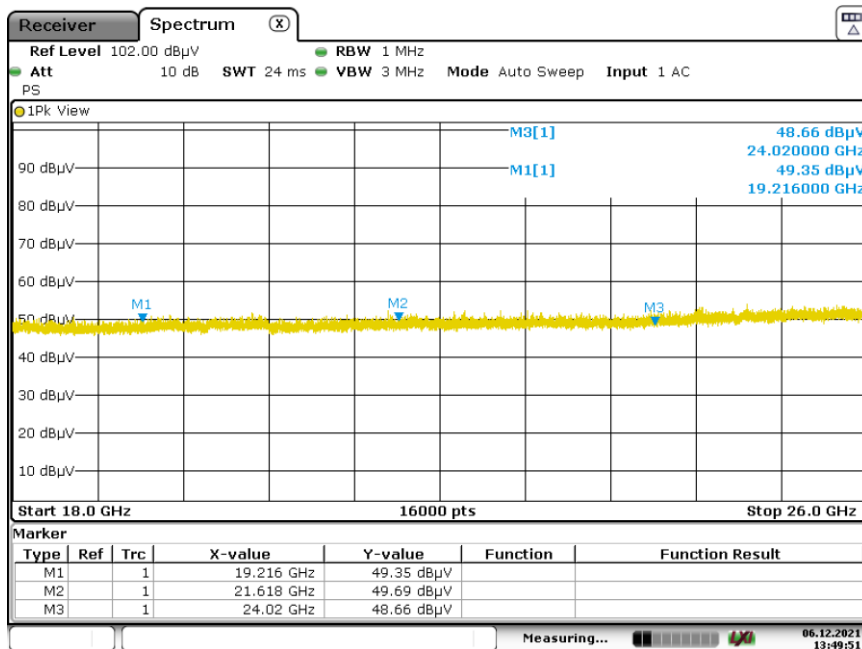


Figure 7: Reference plot for Radiated Spurious Emissions – 3 GHz – 10 GHz – Wall mount Host



Date: 6 DEC 2021 11:45:46

Figure 8: Reference plot for Radiated Spurious Emissions – 10 GHz – 18 GHz – Wall mount Host



Date: 6 DEC 2021 13:49:52

Figure 9: Reference plot for Radiated Spurious Emissions – 18 GHz – 26 GHz – Wall mount Host



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
852	Teseq	CBL 6112D	Bilog Antenna; Attenuator	51617	10/13/2020	10/13/2022
1956	Fei Teng Wireless Technology	HA-07M18G-NF	Horn Antenna	2013120203	4/08/2020	4/8/2022
888	Com Power	PAM-103	Pre-Amp	18020214	9/27/2021	9/27/2022
338	Hewlett Packard	8449B	High Frequency Pre-Amp	3008A01111	6/22/2021	6/22/2023
DEMC3161	Ametek CTS Germany GmbH	CBL 6112D	Bilog Antenna; Attenuator	51323	3/19/2021	3/19/2023
884	ETS Lindgren	3117	Horn Antenna	00240106	5/6/2021	5/6/2022
213	TEC	PA 102	Amplifier	44927	7/30/2021	7/30/2022
819	Rohde & Schwarz	ESR26	EMI Test Receiver	101345	4/7/2021	4/7/2022
836	ETS Lindgren	SAC Cable Set	SAC Cable Set includes 620, 837, 838	N/A	5/11/2021	5/11/2022
432	Microwave Circuits	H3G020G4	Highpass Filter	264066	6/9/2021	6/9/2022
827	Rohde & Schwarz	RF Cable set	TS8997 Rack cable set	N/A	9/4/2021	12/4/2021
827	Rohde & Schwarz	RF Cable set	TS8997 Rack cable set	N/A	12/4/2021	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
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	5/11/2022
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	4/2/2021	4/2/2022
861	Com-Power	LI-1100C	Line Impedance Stabilization Network	20180038	2/26/2021	2/26/2022
862	Com-Power	LI01100C	Line Impedance Stabilization Network	20180039	2/26/2021	2/26/2022
144	Omega	RH411	Temp / Humidity Meter	H0103373	12/16/2020	12/16/2022

N/A – Not Applicable

NCR – No Calibration Required

3 Diagram of Test Set-ups

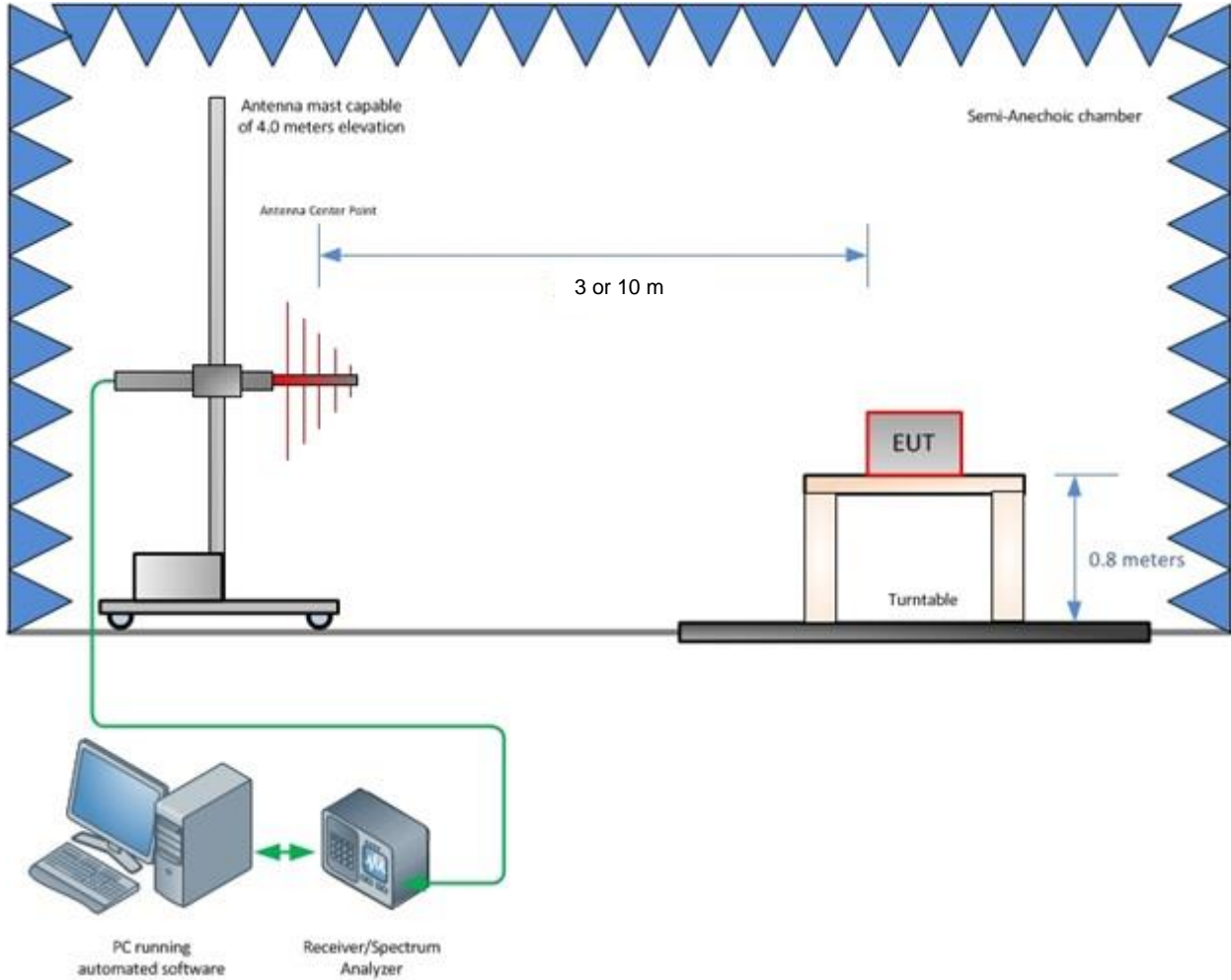


Figure 3-1 – Radiated Emissions Test Setup up to 1 GHz

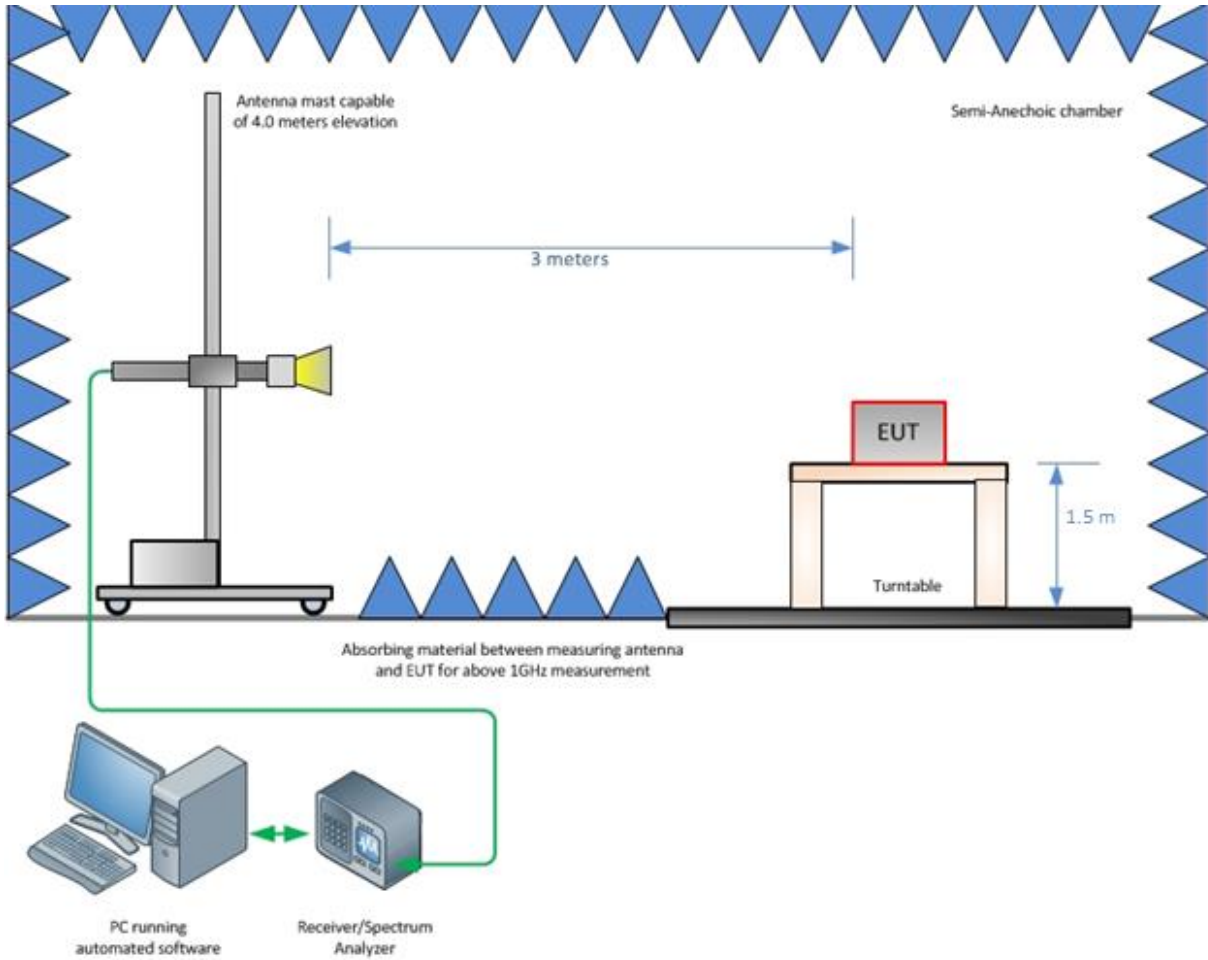


Figure 3-2 – Radiated Emissions Test Setup above 1 GHz

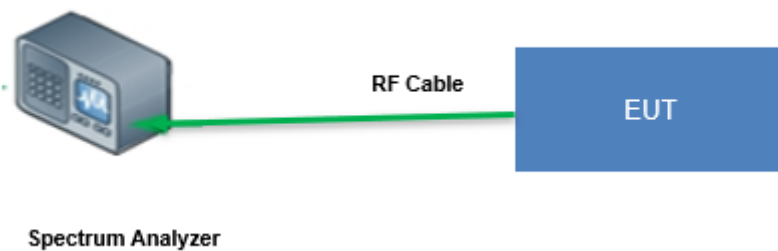


Figure 3-3 – Conducted Test Setup: Antenna Port measurement



4 Accreditation, Disclaimers and Copyright

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STATEMENT OF MEASUREMENT UNCERTAINTY – 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