FCC and ISED Canada Testing of the

Acuity Brands Lighting, Inc.
BMODIT2

In accordance with FCC 47 CFR part 15.247 and ISED Canada's Radio Standards Specifications RSS-247

America

Add value.
Inspire trust.

Prepared for: Acuity Brands Lighting, Inc.
One Lithonia Way
Conyers GA, 30012

FCC ID: 2ADCB-BMODIT2
IC: 6715C-BMODIT2

COMMERCIAL-IN-CONFIDENCE

Document Number: TP72158565.102 | Version Number: 03

RESPONSIBLE FOR	NAME	DATE	SIGNATURE
Authorized Signatory	Peter Walsh	2020 -May-01	
Testing	Thierry Jean Charles	2020-May-01	

Signatures in this approval box have checked this document in line with the requirements of TÜV SÜD Product Service document control rules.

FCC Accreditation Designation Number US1063 Tampa, FL Test Laboratory	Innovation, Science, and Economic Development Canada Accreditation Site Number 2087A-2 Tampa, FL Test Laboratory

EXECUTIVE SUMMARY
Samples of this product were tested and found to be in compliance with 15.247 and ISED Canada's RSS-247.

A2LA Cert. No. 2955.15

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Contents

1 Report Summary

1.1 Report Modification Record

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

Issue	Description of Change	Date of Issue
1	First Issue	2020-April-16
2	Corrected typos in Sections 2.5.6 and 2.6.6	2020-April-20
3	Corrected typos in Sections 2.2.6 and 2.3.6	2020-May-01

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	Acuity Brands Lighting, Inc.
Manufacturer	Acuity Brands Lighting, Inc.
Applicant's Email Address	Alex.Bahk@AcuityBrands.com
Model Number(s)	BMODIT2
Serial Number(s)	N/A
FCC ID	2ADCB-BMODIT2
ISED Certification Number	6715C-BMODIT2
Hardware Version(s)	N/A
Software Version(s)	N/A
Number of Samples Tested	2
Test Specification/Issue/Date	US Code of Federal Regulations (CFR): Title 47, Part 15, Subpart C: Radio Frequency Devices, Intentional Radiators, 2019 Innovation, Science and Economic Development Canada Radio Standards Specification: RSS-247 — Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices, Issue 2, February 2017
Test Plan/Issue/Date	2020-March-03
Order Number	72158565
Date	2020-March-13
Date of Receipt of EUT	2020-March-25
Start of Test	2020-March-25
Finish of Test	2020-April-09
Name of Engineer(s)	Jean N. Rene, Thierry Jean-Charles
Related Document(s)	ANSI C63.10-2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices. US Code of Federal Regulations (CFR): Title 47, Part 2, Subpart J: Equipment Authorization Procedures, 2018. 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. Innovation, Science and Economic Development Canada Radio Standards Specification: RSS-GEN - General Requirements for Compliance of Radio Apparatus, Issue 5, Amendment 1, March 2019

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)	11
99% Bandwidth	Yes	Pass	-------	RSS-GEN 6.6	14
Peak 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	20
RF Conducted Spurious Emissions	Yes	Pass	15.247(d)	RSS-247 5.5	23
Radiated Spurious Emissions into Restricted Frequency Bands	Yes	Pass	15.205, 15.209	RSS-GEN 8.9, 8.10	26
Power Spectral Density	Yes	Pass	15.247(e)	RSS-247 5.2(b)	34
Power Line Conducted Emissions	Yes	Pass	15.207	RSS-GEN 8.8	37

1.4 Product Information

1.4.1 Technical Description

The EUT is a BLE module to provide wireless connectivity to LED lighting and control products.

The EUT was tested for two antenna configurations: integrated trace antenna and an integrated chip antenna. The device does not support simultaneous transmissions.

Technical Details

Mode of Operation:	IEEE 802.15.1 Bluetooth Low Energy (BLE 5.0)
Frequency Range:	2402 MHz - 2480 MHz
Number of Channels:	40
Channel Separation:	2 MHz
Data Rate:	1 Mbps
Modulations:	GFSK
Antenna Type/Gain:	Trace Antenna / 3.2 dBi
	Chip Antenna / 3 dBi
Input Power:	3.3 VDC

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

Table 1.4.1-1 – Cable Descriptions

Cable/Port	Description
Power Leads	0.1 m, Not shielded, Battery Holder to EUT
Power	1.5 m, Not Shielded, Molded Ferrite, Power Supply to EUT

Table 1.4.1-2 – Support Equipment Descriptions

Make/Model	Description
COMF / SBH-341-1	4x AA Safety Battery Holder
Volgen / KTPS05-03315U-VI	3.3VDC AC Adapter

Declaration of Build Status

EQUIPMENT DESCRIPTION	
Model Name/Number	BMODIT2
Part Number	501-01250-101, 501-01250-102, 501-01250-103
Hardware Version	NA
Software Version	NA
FCC ID (if applicable)	2ADCB-BMODIT2
ISED ID (if applicable)	6715C-BMODIT2
Technical Description (Please provide a brief description of the intended use of the equipment)	BMODIT2 is a BLE module to provide wireless connectivity to LED lighting and control products.

UN-INTENTIONAL RADIATOR	
Highest frequency generated or used in the device or on which the device operates or tunes	**2480 MHz**
Lowest frequency generated or used in the device or on which the device operates or tunes	2402 MHz
Class A Digital Device (Use in commercial, industrial or business environment) ☒ Class B Digital Device (Use in residential environment only) ☒	

Power Source			
AC	Single Phase	Three Phase	Nominal Voltage
	☒	☐	
External DC	Nominal Voltage		Maximum Current
	3.3V		30mA
Battery	Nominal Voltage		Battery Operating End Point Voltage
	3V		3V

EXTREME CONDITIONS					
Maximum temperature	+85	°C	Minimum temperature	-40	°C

Ancillaries
Please list all ancillaries which will be used with the device.
NA

I hereby declare that the information supplied is correct and complete.

Name: Alex Bahk

Position held: Lead RF Engineer Date: 4/1/2020

1.4.2 Modes of Operation

The EUT was to the continuous TX mode for the BLE radio using a software power setting of 90.

1.4.3 Monitoring of Performance

The EUT was evaluated for radiated, power line and RF Conducted Emissions.

TX radiated emissions were performed for the EUT in multiple orientations for both antenna configurations. The results documented in this test report correspond to the orientations leading to the highest emissions with respect to the limits.

EUT with Trace Antenna:

- TX Radiated Spurious and Band-Edge Emissions: Flat orientation

EUT with Chip Antenna:

- TX Radiated Spurious Emissions: Standing Orientation
- TX Radiated Band-Edge Emissions: Side Orientation

The RF conducted emissions measurements were performed on a test sample modified with a U.FL. connector to allow direct coupling to a spectrum analyzer.

The Power Line Conducted Emissions measurements were performed for both antenna configurations. PCB Trace Antenna configuration test results were the worst case and are documented in this test report.

1.4.4 Performance Criteria

The parameters evaluated are summarized below.

Table 1.4.4 -1: Performance Criteria

Parameter	Requirement
Antenna Requirement	FCC: Section 15.203. 15.204
6 dB Bandwidth	FCC: Section 15.247(a)(2); ISED Canada: RSS-247 5.2(a)
99% Bandwidth	ISED Canada: RSS-GEN 6.6
Peak Output Power	FCC: Section 15.247(b)(3); ISED Canada:RSS-247 5.4(d)
Band-Edge Compliance of RF Conducted Emissions	FCC: Section 15.247(d); ISED Canada: RSS-247 5.5
RF Conducted Spurious Emissions	FCC: Section 15.247(d); ISED Canada: RSS-247 5.5
Radiated Spurious Emissions into Restricted Frequency Bands	FCC: Sections 15.205, 15.209; ISED Canada: RSS-GEN 8.9, 8.10
Power Spectral Density	FCC: Section 15.247(e); ISED Canada: RSS-247(b)
Power Line Conducted Emissions	FCC: Section 15.207; ISED Canada: RSS-GEN 8.8

1.5 Deviations from the Standard

The EUT was evaluated without any deviations from the test standards.

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

The equipment was tested as provided without any modifications.

1.7 Test Location

TÜV SÜD Product Service conducted the following tests at our Tampa FL Test Laboratory.

Test Name	Name of Engineer(s)	Accreditation
AC Powered Operating		
Antenna Requirement	Thierry Jean-Charles	A2LA
6 dB Bandwidth	Thierry Jean-Charles	A2LA
99% Bandwidth	Thierry Jean-Charles	A2LA
Peak Output Power	Thierry Jean-Charles	A2LA
Band-Edge Compliance of RF Conducted Emissions	Thierry Jean-Charles	A2LA
RF Conducted Spurious Emissions	Thierry Jean-Charles	A2LA
Radiated Spurious Emissions into Restricted Frequency Bands	Jean N. Rene	A2LA
Power Spectral Density	Thierry Jean-Charles	A2LA
Power Line Conducted Emissions	Jean N. Rene	A2LA

Office Address:

TÜV SÜD America, Inc.
5610 W. Sligh Ave, Suite 100
Tampa, FL 33634
USA

2 Test Details

2.1 Antenna Requirements

2.1.1 Specification Reference

FCC: Section 15.203, 15.204

2.1.2 Equipment Under Test and Modification State

S/N: N/A

2.1.3 Date of Test

3/25/2020

2.1.4 Test Method

N/A

2.1.5 Environmental Conditions

Ambient Temperature	N/A
Relative Humidity	N/A
Atmospheric Pressure	N/A

2.1.6 Test Results

Limit Clause FCC Sections: 15.203, 15,204

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device.

The EUT uses either an integral 3 dBi chip antenna or a 3.2 dBi PCB trace antenna. The antennas are not replaceable and therefore meet the requirements of FCC Section 15.203.

2.1.7 Test Location and Test Equipment Used

This test was carried out in TÜV SÜD America, Inc., 5610 W. Sligh Ave, Suite 100, Tampa, FL 33634, USA.

As this is a visual inspection, no test equipment was used.

2.2 6 dB Bandwidth

2.2.1 Specification Reference

FCC: Section 15.247(a)(2)
ISED Canada: RSS-247 5.2(a)

2.2.2 Equipment Under Test and Modification State

S/N: N/A

2.2.3 Date of Test

3/25/2020

2.2.4 Test Method

The 6dB bandwidth was measured in accordance with ANSI C63.10 Subclause 11.8.1 Option 1. The RBW of the spectrum analyzer was set to 100 kHz and VBW 300 kHz. Span was set large enough to capture the emissions and >> RBW. A peak detector was used for the measurements.

2.2.5 Environmental Conditions

Ambient Temperature	25.6°C
Relative Humidity	37.3 %
Atmospheric Pressure	1013.8 mbar

2.2.6 Test Results

AC Powered Operating

Limit Clause FCC Part 15.247(a)(2), ISED RSS-247 5.2(a)

The minimum 6 dB bandwidth shall be at least 500 kHz.

Table 2.2.6-1: 6 dB Bandwidth Test Results

Frequency (MHz)	6 dB Bandwidth (kHz)
2402	695.250
2440	696.000
2480	696.000

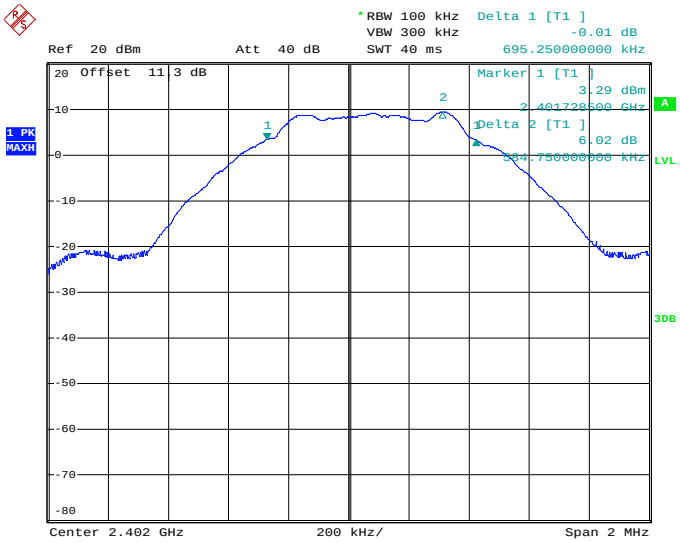

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Figure 2.2.6-1: 6 dB Bandwidth Test Results Low Channel

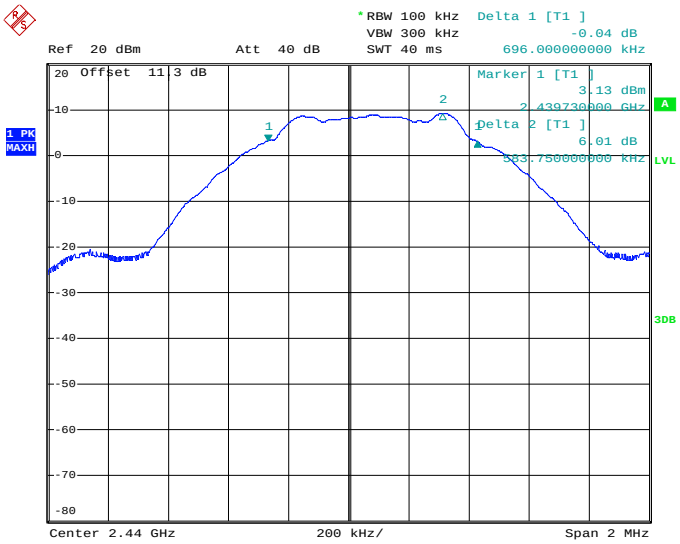

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Figure 2.2.6-2: 6 dB Bandwidth Test Results Middle Channel

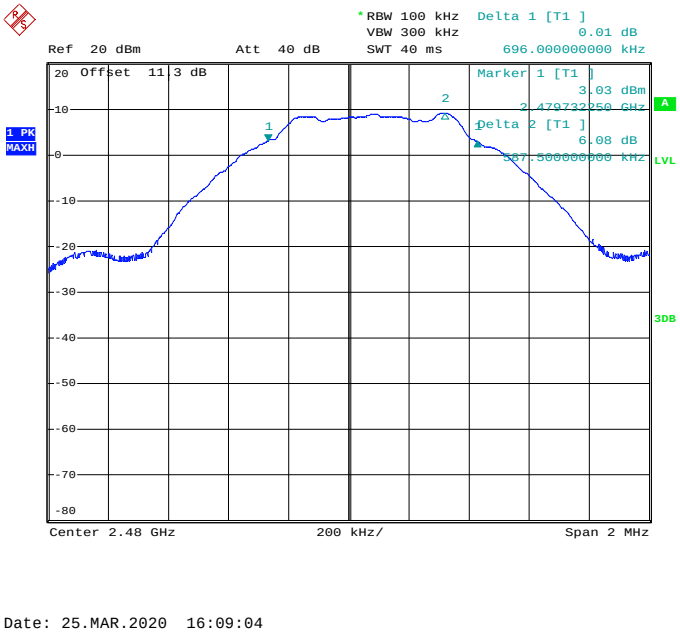

Figure 2.2.6-3: 6 dB Bandwidth Test Results High Channel

2.2.7 Test Location and Test Equipment Used

This test was carried out in TÜV SÜD America, Inc., 5610 W. Sligh Ave, Suite 100, Tampa, FL 33634, USA.

Instrument	Manufacturer	Type No	TE No	Software / Firmware Revision	Calibration Period (months)	Calibration Due
Spectrum Analyzer	Rohde & Schwarz	FSP40	BEMC00283	4.50 SP5	24	04-Oct-2021
Attenuator 10dB, 2.9 mm-M/F, DC-40GHz 2 W	Aeroflex Inmet	40AH2W-10	BEMC02110	N/A	12	27-Jul-2020

TU - Traceability Unscheduled
O/P MON - Traceability Unscheduled
N/A - Not Applicable

2.3 99% Bandwidth

2.3.1 Specification Reference

ISED Canada: RSS-GEN 6.7

2.3.2 Equipment Under Test and Modification State

S/N: N/A

2.3.3 Date of Test

3/25/2020

2.3.4 Test Method

The 99% occupied bandwidth was measured with the spectrum analyzer span set to fully display the emission. The RBW was set to 1% to 5% of the approximated bandwidth. The occupied 99% bandwidth was measured by using 99% bandwidth equipment function of the spectrum analyzer using a peak detector.

2.3.5 Environmental Conditions

Ambient Temperature	25.5°C
Relative Humidity	37.7 %
Atmospheric Pressure	1013.7 mbar

2.3.6 Test Results

AC Powered Operating

Limit Clause ISED RSS-GEN 6.7

Table 2.3.6-1: 99% Bandwidth Test Results

Frequency (MHz)	99% Bandwidth (kHz)
2402	1041.250
2440	1041.250
2480	1041.250

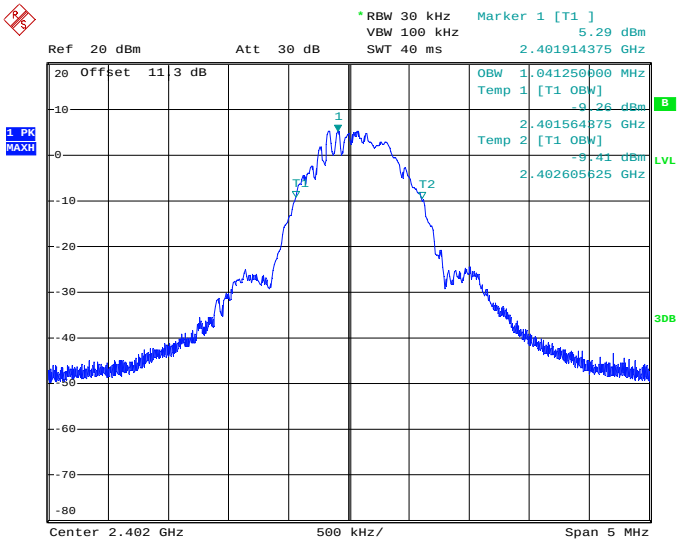

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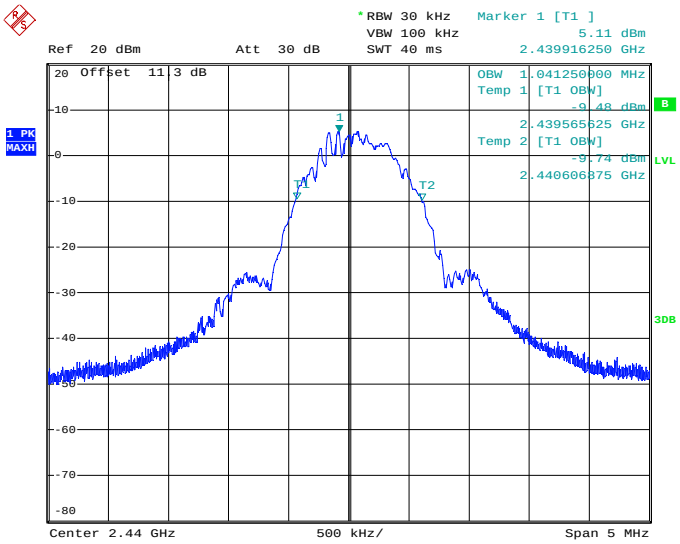
Figure 2.3.6-1: 99% Bandwidth Test Results Low Channel



Date: 25.MAR.2020 16:32:04

Figure 2.3.6-2: 99% Bandwidth Test Results Middle Channel

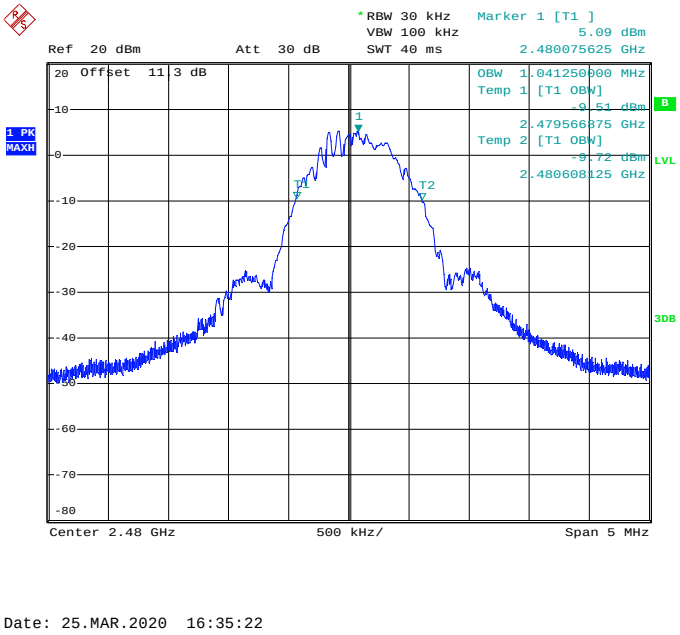


Figure 2.3.6-3: 99% Bandwidth Test Results High Channel

2.3.7 Test Location and Test Equipment Used

This test was carried out in TÜV SÜD America, Inc., 5610 W. Sligh Ave, Suite 100, Tampa, FL 33634, USA.

Instrument	Manufacturer	Type No	TE No	Software / Firmware Revision	Calibration Period (months)	Calibration Due
Spectrum Analyzer	Rohde & Schwarz	FSP40	BEMC00283	4.50 SP5	24	04-Oct-2021
Attenuator 10dB, 2.9 mm-M/F, DC-40GHz 2 W	Aeroflex Inmet	40AH2W-10	BEMC02110	N/A	12	27-Jul-2020

TU - Traceability Unscheduled
O/P MON - Traceability Unscheduled
N/A - Not Applicable

2.4 Peak Output Power

2.4.1 Specification Reference

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

2.4.2 Equipment Under Test and Modification State

S/N: N/A

2.4.3 Date of Test

3/25/2020

2.4.4 Test Method

The fundamental emission output power was measured in accordance with ANSI C63.10 Subclause 11.9.1.1 RBW ≥ DTS bandwidth. The RF output of the equipment under test was directly connected to the input of the spectrum analyzer through suitable attenuation.

2.4.5 Environmental Conditions

Ambient Temperature	25.3°C
Relative Humidity	37.4 %
Atmospheric Pressure	1013.5 mbar

2.4.6 Test Results

AC Powered Operating

Limit Clause FCC Part 15.247(b)(3), ISED RSS-247 5.4(d)

The Maximum Output Power allowed for systems using digital modulation is 1 Watt (30 dBm)

Table 2.4.6-1: Maximum Output Power Results

Frequency (MHz)	Output Power (dBm)
2402	10.48
2440	10.27
2480	10.3

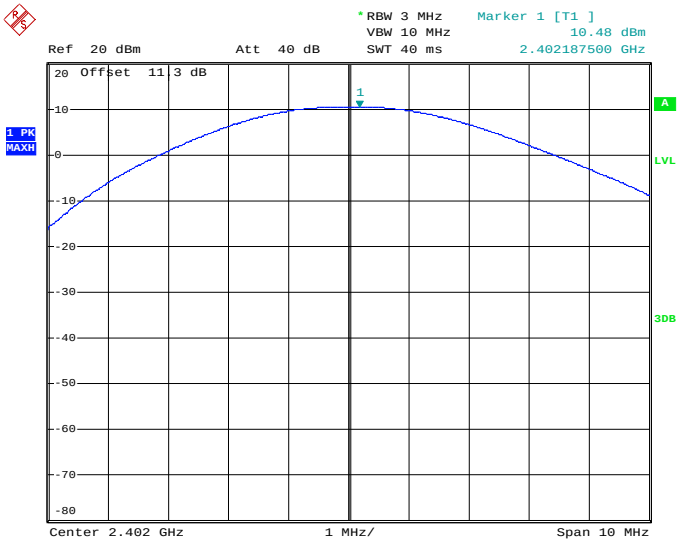


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Figure 2.4.6-1: Maximum Output Power Results Low Channel

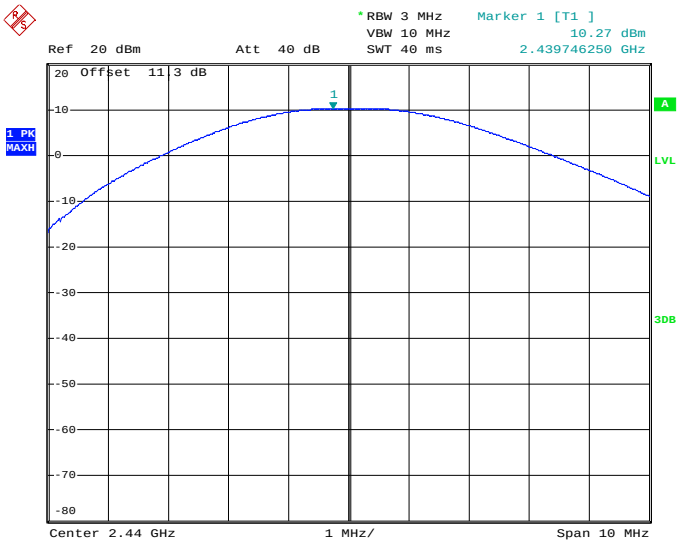

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Figure 2.4.6-2: Maximum Output Power Results Middle Channel

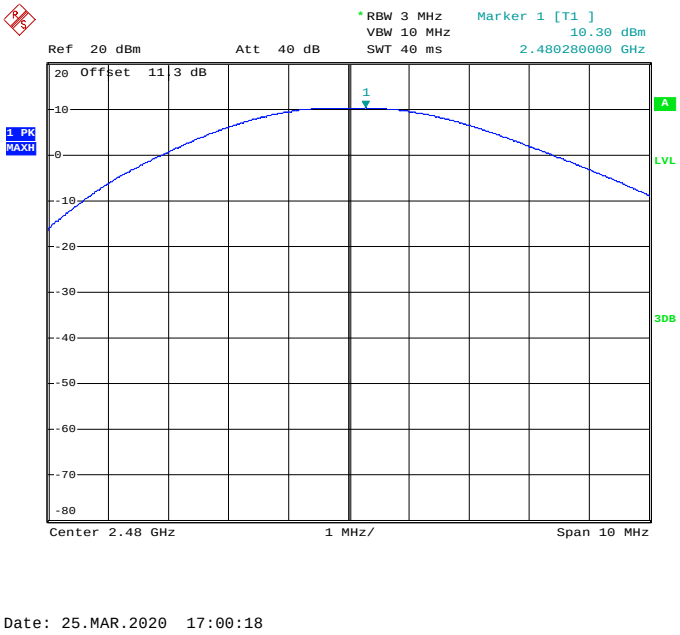


Figure 2.4.6-3: Maximum Output Power Results High Channel

2.4.7 Test Location and Test Equipment Used

This test was carried out in TÜV SÜD America, Inc., 5610 W. Sligh Ave, Suite 100, Tampa, FL 33634, USA.

Instrument	Manufacturer	Type No	TE No	Software / Firmware Revision	Calibration Period (months)	Calibration Due
Spectrum Analyzer	Rohde & Schwarz	FSP40	BEMC00283	4.50 SP5	24	04-Oct-2021
Attenuator 10dB, 2.9 mm-M/F, DC-40GHz 2 W	Aeroflex Inmet	40AH2W-10	BEMC02110	N/A	12	27-Jul-2020

TU - Traceability Unscheduled
O/P MON - Traceability Unscheduled
N/A - Not Applicable

2.5 Band-Edge Compliance of RF Conducted Emissions

2.5.1 Specification Reference

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

2.5.2 Equipment Under Test and Modification State

S/N: N/A

2.5.3 Date of Test

3/25/2020

2.5.4 Test Method

The RF Conducted Emissions at the Band-Edges were measured in accordance with Subclause 11.11 of ANSI C63.10. The RF output port of the EUT was connected to the input of the spectrum analyzer through suitable attenuation. The EUT was investigated at the lowest and highest channel available to determine band-edge compliance. For each measurement the spectrum analyzer's RBW was set to 100 kHz, and the VBW was set to >= 300 kHz.

2.5.5 Environmental Conditions

Ambient Temperature	25.7 °C
Relative Humidity	37.1 %
Atmospheric Pressure	1013.6 mbar

2.5.6 Test Results

AC Powered Operating

Limit Clause FCC Section 15.247(d), ISED Canada: RSS-247 5.5

In any 100 kHz bandwidth outside of the frequency band the radio frequency power shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of desired power. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required shall be 30 dB instead of 20 dB.

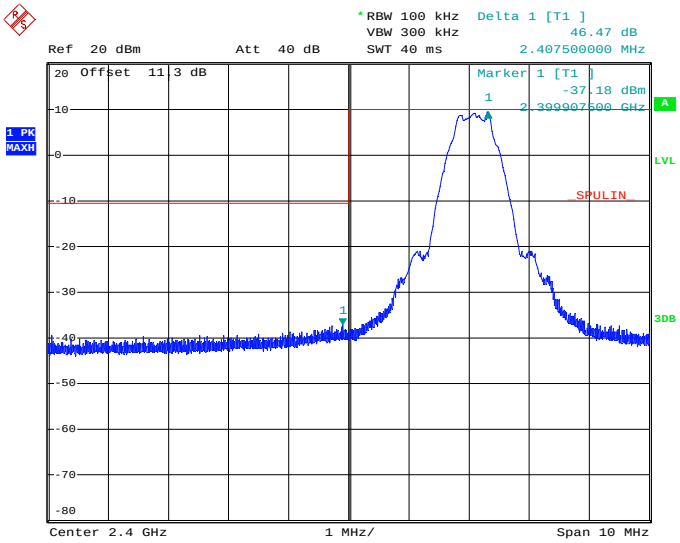


Figure 2.5.6-1: RF Conducted Band-Edge Results Low Channel

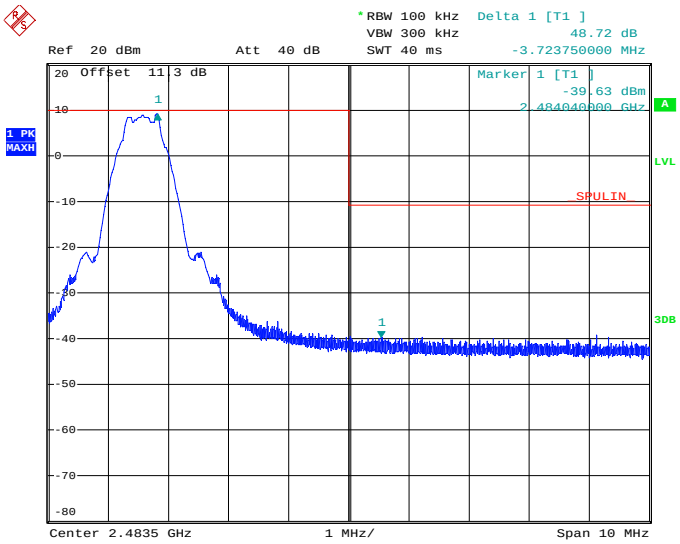


Figure 2.5.6-2: RF Conducted Band-Edge Results High Channel

2.5.7 Test Location and Test Equipment Used

This test was carried out in TÜV SÜD America, Inc., 5610 W. Sligh Ave, Suite 100, Tampa, FL 33634, USA.

Instrument	Manufacturer	Type No	TE No	Software / Firmware Revision	Calibration Period (months)	Calibration Due
Spectrum Analyzer	Rohde & Schwarz	FSP40	BEMC00283	4.50 SP5	24	04-Oct-2021
Attenuator 10dB, 2.9 mm-M/F, DC-40GHz 2 W	Aeroflex Inmet	40AH2W-10	BEMC02110	N/A	12	27-Jul-2020

TU - Traceability Unscheduled
O/P MON - Traceability Unscheduled
N/A - Not Applicable

2.6 RF Conducted Spurious Emissions

2.6.1 Specification Reference

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

2.6.2 Equipment Under Test and Modification State

S/N: N/A

2.6.3 Date of Test

3/25/2020

2.6.4 Test Method

The RF Conducted Spurious Emissions were measured in accordance with Subclause 11.11 of ANSI C63.10. The RF output port of the equipment under test was directly connected to the input of the spectrum analyzer. The EUT was investigated for conducted spurious emissions from 30 MHz to 25 GHz, 10 times the highest fundamental frequency. Measurements were made at the low, center and high channels of the EUT. For each measurement, the spectrum analyzer's RBW was set to 100 kHz and the VBW was set to 300 kHz. The peak Max Hold function of the analyzer was utilized.

2.6.5 Environmental Conditions

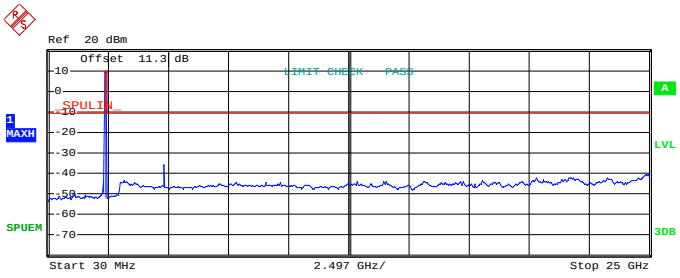
Ambient Temperature	25.6 °C
Relative Humidity	37.2 %
Atmospheric Pressure	1013.5 mbar

2.6.6 Test Results

AC Powered Operating

Limit Clause FCC Section 15.247(d), ISED Canada: RSS-247 5.5

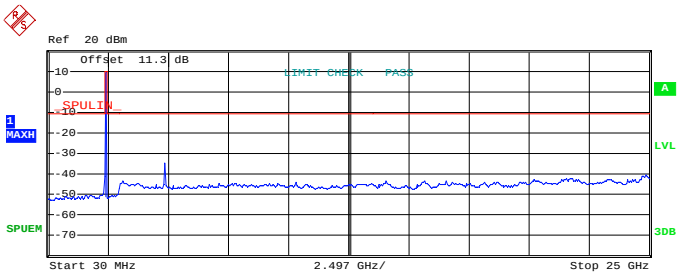
In any 100 kHz bandwidth outside of the frequency band the radio frequency power shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of desired power. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required shall be 30 dB instead of 20 dB.



Start [Hz]	Stop [Hz]	RBW [Hz]	Freq [Hz]	PwrAbs [dBm]	ΔLimit [dB]
30.000 M	1.000 G	100.00 k	463.105000 M	-51.29	-40.62
1.000 G	2.400 G	100.00 k	2.399650 G	-43.84	-33.17
2.400 G	2.483 G	100.00 k	2.402317 G	9.26	-0.74
2.483 G	3.000 G	100.00 k	2.972948 G	-50.41	-39.74
3.000 G	13.500 G	100.00 k	4.804688 G	-36.00	-25.33
13.500 G	25.000 G	100.00 k	24.946813 G	-40.56	-29.89

Date: 25.MAR.2020 18:18:32

Figure 2.6.6-1: RF Conducted Spurious Emissions Results Low Channel



Start [Hz]	Stop [Hz]	RBW [Hz]	Freq [Hz]	PwrAbs [dBm]	ΔLimit [dB]
30.000 M	1.000 G	100.00 k	784.902500 M	-50.79	-39.97
1.000 G	2.400 G	100.00 k	2.399650 G	-49.51	-38.69
2.400 G	2.483 G	100.00 k	2.440320 G	9.06	-0.94
2.483 G	3.000 G	100.00 k	2.974627 G	-49.98	-39.16
3.000 G	13.500 G	100.00 k	4.879500 G	-34.76	-23.94
13.500 G	25.000 G	100.00 k	24.836125 G	-40.71	-29.89

Date: 25.MAR.2020 18:37:25

Figure 2.6.6-2: RF Conducted Spurious Emissions Results Middle Channel

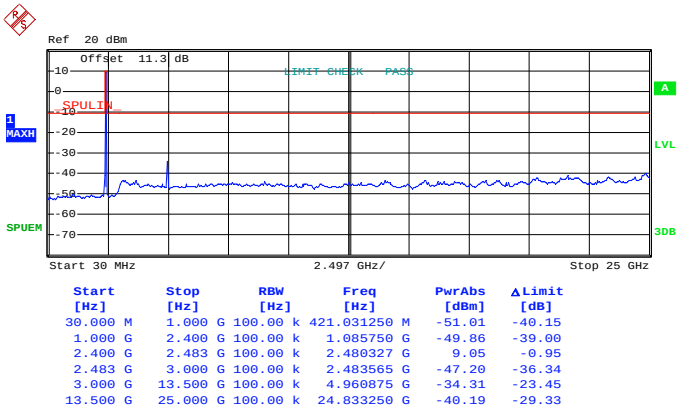


Figure 2.6.6-3: RF Conducted Spurious Emissions Results High Channel

2.6.7 Test Location and Test Equipment Used

This test was carried out in TÜV SÜD America, Inc., 5610 W. Sligh Ave, Suite 100, Tampa, FL 33634, USA.

Instrument	Manufacturer	Type No	TE No	Software / Firmware Revision	Calibration Period (months)	Calibration Due
Spectrum Analyzer	Rohde & Schwarz	FSP40	BEMC00283	4.50 SP5	24	04-Oct-2021
Attenuator 10dB, 2.9 mm-M/F, DC-40GHz 2 W	Aeroflex Inmet	40AH2W-10	BEMC02110	N/A	12	27-Jul-2020

TU - Traceability Unscheduled
O/P MON - Traceability Unscheduled
N/A - Not Applicable

2.7 Radiated Spurious Emissions into Restricted Frequency Bands

2.7.1 Specification Reference

FCC Sections: 15.205, 15.209;
ISED Canada: RSS-GEN 8.9, 8.10

2.7.2 Equipment Under Test and Modification State

S/N: N/A

2.7.3 Date of Test

3/25/2020 to 4/9/2020

2.7.4 Test Method

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

For measurements below 30 MHz, the receive antenna height was set to 1 m and the EUT was rotated through 360 degrees. The resolution bandwidth was set to 200 Hz below 150 kHz and to 9 kHz above 150 kHz.

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 1000 MHz, quasi-peak measurements were made using a resolution bandwidth RBW of 120 kHz and a video bandwidth VBW of 300 kHz. For frequencies above 1000 MHz, peak measurements are made with RBW of 1 MHz and VBW of 3 MHz. Average measurements are performed in the linear scale using VBW of 30 Hz.

2.7.5 Duty Cycle Correction

The EUT was configured to transmit at 100% duty cycle during the evaluation. A Duty Cycle Correction of 22.04% corresponding to 20*log(22.04/100) = -13.135 dB was applied to the average measurements for the corrected average results.

2.7.6 Environmental Conditions

Ambient Temperature	25.5 °C
Relative Humidity	37.1 %
Atmospheric Pressure	1013.7 mbar

2.7.7 Test Results

AC Powered Operating

Limit Clause FCC Sections 15.205, 15.209, ISED Canada: RSS-GEN 8.9, 8.10

Frequency (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
0.009-0.490	2400/F(kHz)	300
0.4090-1.705	24000/F(kHz)	30
1.705-30.0	30	30
30-88	100**	3
88-216	150**	3
216-960	200**	3
Above 960	500	3

Table 2.7.7-1: Radiated Emissions Test Results – Trace Antenna

Frequency (MHz)	Level (dBuV)		Antenna Polarity	Correction Factors	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	pk	Qpk/Avg	(H/V)	(dB)	pk	Qpk/Avg	pk	Qpk/Avg	pk	Qpk/Avg
Low Channel										
4804	61.94	58.31	H	4.19	66.13	49.36	74.0	54.0	7.9	4.6
4804	54.07	49.69	V	4.19	58.26	40.74	74.0	54.0	15.7	13.3
12010	37.58	25.07	H	17.85	55.43	29.78	74.0	54.0	18.6	24.2
12010	38.95	27.12	V	17.85	56.80	31.83	74.0	54.0	17.2	22.2
Middle Channel										
4880	64.72	60.24	H	4.35	69.07	51.46	74.0	54.0	4.9	2.5
4880	56.55	52.53	V	4.35	60.90	43.75	74.0	54.0	13.1	10.3
7320	50.65	43.64	H	9.32	59.97	39.82	74.0	54.0	14.0	14.2
7320	49.71	42.38	V	9.32	59.03	38.56	74.0	54.0	15.0	15.4
12200	37.56	24.53	H	17.65	55.21	29.05	74.0	54.0	18.8	25.0
12200	38.35	26.43	V	17.65	56.00	30.95	74.0	54.0	18.0	23.1
High Channel										
2483.5	64.90	57.27	H	-1.54	63.36	42.60	74.0	54.0	10.6	11.4
2483.5	62.92	55.49	V	-1.54	61.38	40.82	74.0	54.0	12.6	13.2
4960	65.86	61.79	H	4.52	70.38	53.18	74.0	54.0	3.6	0.8
4960	57.62	55.38	V	4.52	62.14	46.77	74.0	54.0	11.9	7.2
7440	49.09	41.64	H	9.54	58.63	38.05	74.0	54.0	15.4	16.0
7440	48.86	41.38	V	9.54	58.40	37.79	74.0	54.0	15.6	16.2
12400	38.69	25.53	H	17.45	56.14	29.84	74.0	54.0	17.9	24.2
12400	39.07	25.67	V	17.45	56.52	29.98	74.0	54.0	17.5	24.0
22320	41.60	30.11	H	15.86	57.46	32.83	83.5	63.5	26.0	30.7
22320	42.43	31.01	V	15.86	58.29	33.73	83.5	63.5	25.2	29.8

Notes:

- A duty Cycle correction Factor of 22.04% was used for the Corrected Average Levels
- The emissions above 18 GHz were performed at a measurement distance of 1m. The limits are corrected using a distance factor of 20*log(1/3).
- All emissions above 22.32 GHz were attenuated below the noise floor of the measurement equipment and the limits.

Table 2.7.7-2: Radiated Emissions Test Results – Chip Antenna

Frequency (MHz)	Level (dBuV)		Antenna Polarity	Correction Factors	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	pk	Qpk/Avg	(H/V)	(dB)	pk	Qpk/Avg	pk	Qpk/Avg	pk	Qpk/Avg
Low Channel										
4804	44.08	36.57	H	4.19	48.27	27.62	74.0	54.0	25.7	26.4
4804	43.03	34.64	V	4.19	47.22	25.69	74.0	54.0	26.8	28.3
12010	38.87	26.23	H	17.85	56.72	30.94	74.0	54.0	17.3	23.1
12010	40.69	30.06	V	17.85	58.54	34.77	74.0	54.0	15.5	19.2
19216	39.75	26.33	H	14.98	54.73	28.17	83.5	63.5	28.8	35.3
19216	40.22	26.75	V	14.98	55.20	28.59	83.5	63.5	28.3	34.9
Middle Channel										
4880	44.26	37.34	H	4.35	48.61	28.56	74.0	54.0	25.4	25.4
4880	44.23	36.67	V	4.35	48.58	27.89	74.0	54.0	25.4	26.1
7320	50.72	43.58	H	9.32	60.04	39.76	74.0	54.0	14.0	14.2
7320	50.25	42.78	V	9.32	59.57	38.96	74.0	54.0	14.4	15.0
12200	40.17	28.65	H	17.65	57.82	33.17	74.0	54.0	16.2	20.8
12200	44.17	34.89	V	17.65	61.82	39.41	74.0	54.0	12.2	14.6
19520	38.41	24.93	H	14.83	53.24	26.63	83.5	63.5	30.3	36.9
19520	39.31	25.78	V	14.83	54.14	27.48	83.5	63.5	29.4	36.0
High Channel										
2483.5	55.04	45.29	H	-1.54	53.50	30.62	74.0	54.0	20.5	23.4
2483.5	52.17	40.36	V	-1.54	50.63	25.69	74.0	54.0	23.4	28.3
4960	46.18	39.26	H	4.52	50.70	30.65	74.0	54.0	23.3	23.4
4960	45.67	39.03	V	4.52	50.19	30.42	74.0	54.0	23.8	23.6
7440	52.68	45.54	H	9.54	62.22	41.95	74.0	54.0	11.8	12.1
7440	50.92	43.82	V	9.54	60.46	40.23	74.0	54.0	13.5	13.8
12400	40.84	29.90	H	17.45	58.29	34.21	74.0	54.0	15.7	19.8
12400	45.11	35.71	V	17.45	62.56	40.02	74.0	54.0	11.4	14.0
19840	38.43	25.31	H	14.49	52.92	26.66	83.5	63.5	30.6	36.8
19840	38.20	24.89	V	14.49	52.69	26.24	83.5	63.5	30.8	37.3
22320	43.59	33.01	H	15.86	59.45	35.73	83.5	63.5	24.1	27.8
22320	42.69	31.46	V	15.86	58.55	34.18	83.5	63.5	25.0	29.3

Notes:

- A duty Cycle correction Factor of 22.04% was used for the Corrected Average Levels
- The emissions above 18 GHz were performed at a measurement distance of 1m. The limits are corrected using a distance factor of 20*log(1/3).
- All emissions above 22.32 GHz were attenuated below the noise floor of the measurement equipment and the limits.

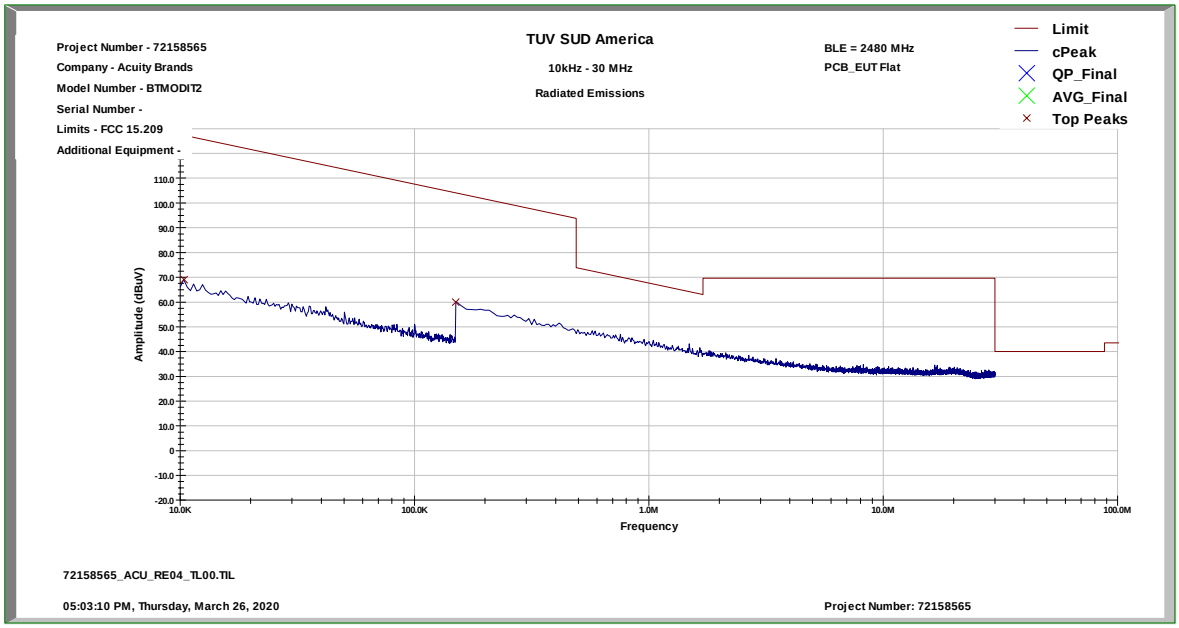


Figure 2.7.7-1: Radiated Emissions Representative Scan below 30 MHz

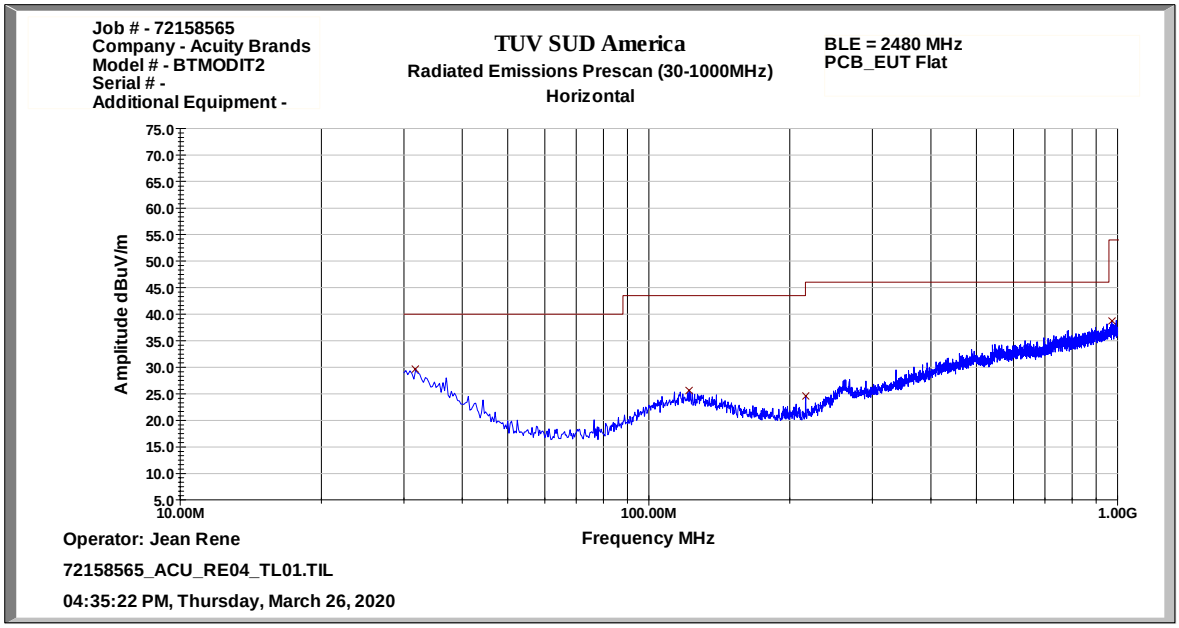


Figure 2.7.7-2: Radiated Emissions Representative Scan 30 MHz – 1 GHz – Horizontal Polarization

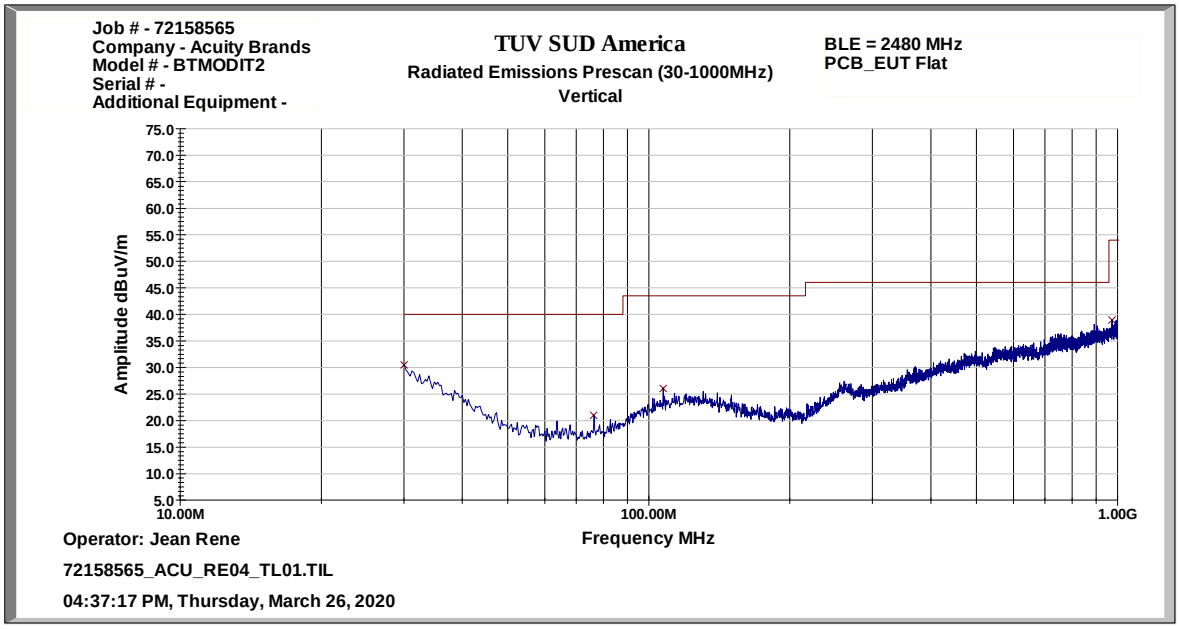


Figure 2.7.7-3: Radiated Emissions Representative Scan 30 MHz – 1 GHz – Vertical Polarization

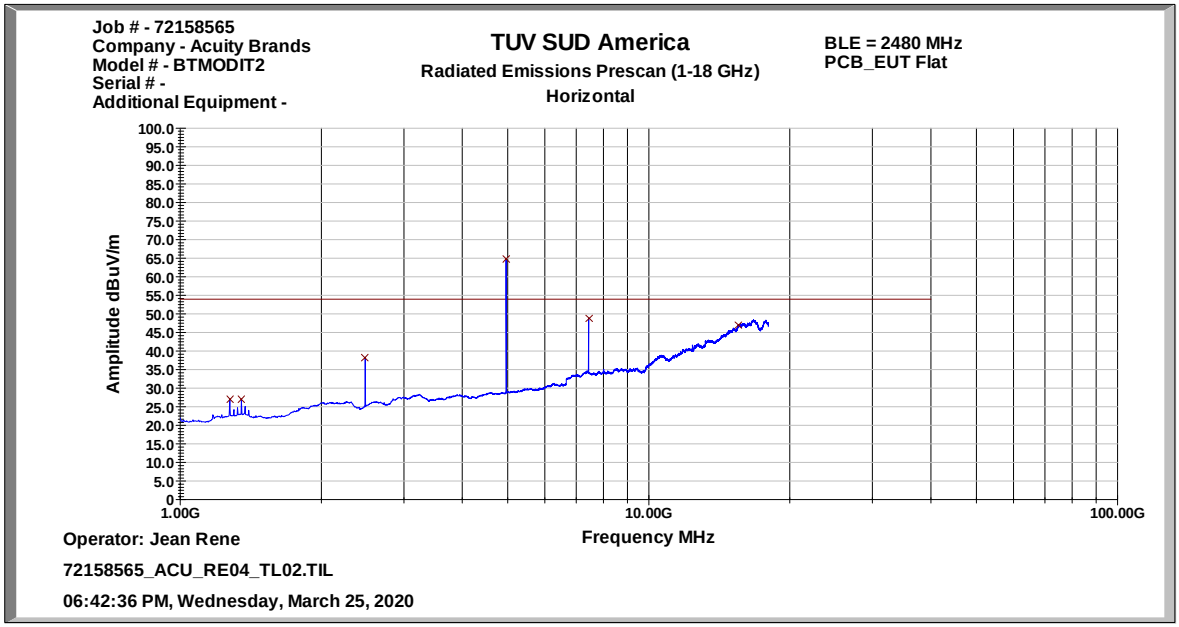


Figure 2.7.7-4: Radiated Emissions Representative Scan 1 GHz – 18 GHz – Horizontal Polarization

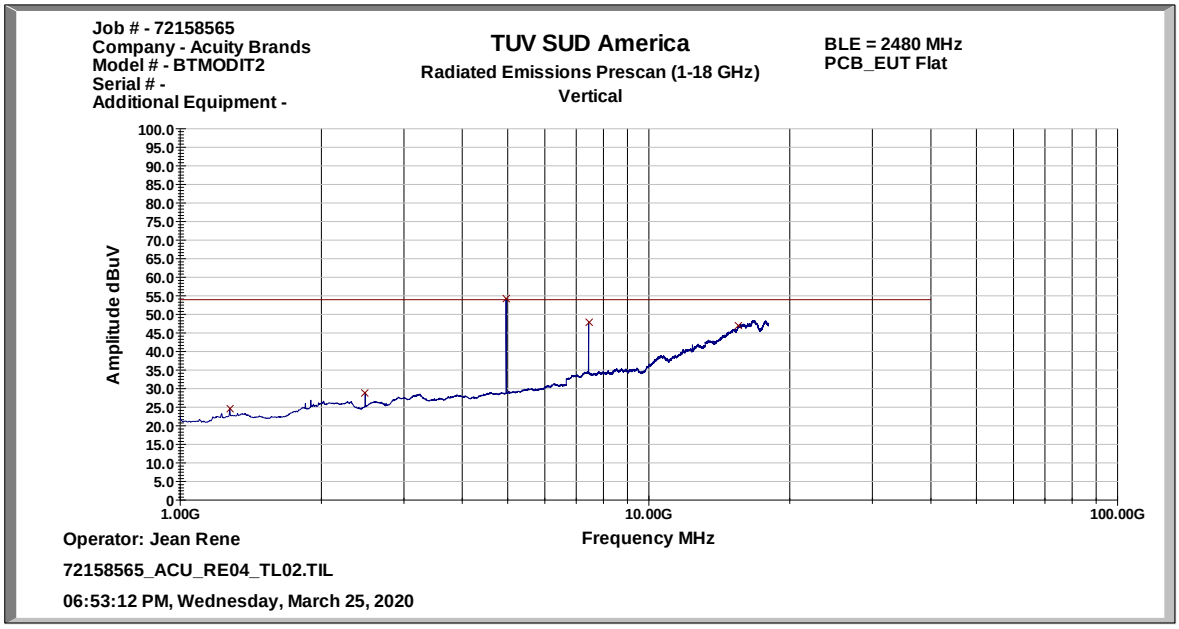


Figure 2.7.7-5: Radiated Emissions Representative Scan 1 GHz – 18 GHz – Vertical Polarization

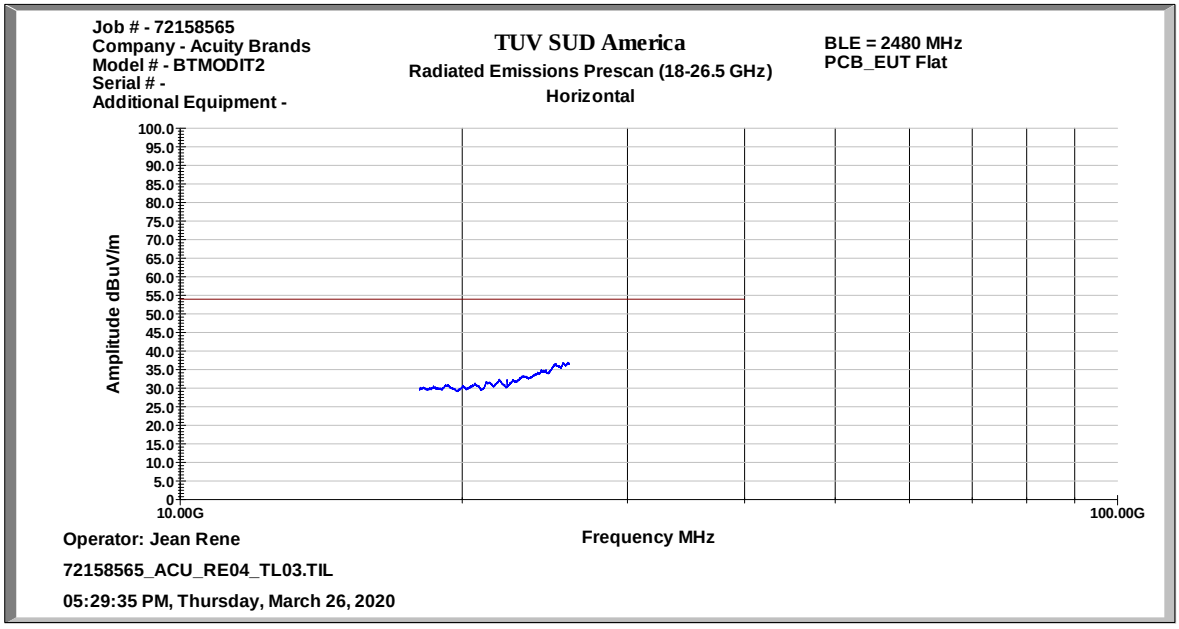


Figure 2.7.7-6: Radiated Emissions Representative Scan 18 GHz – 26 GHz – Horizontal Polarization

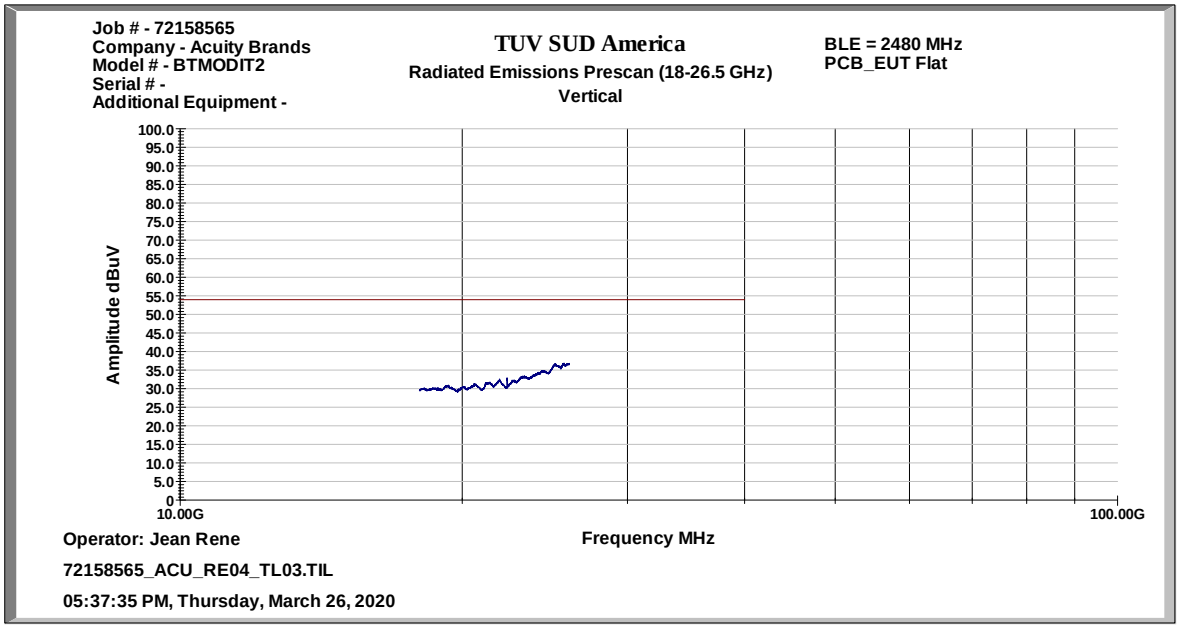


Figure 2.7.7-7: Radiated Emissions Representative Scan 18 GHz – 26 GHz – Vertical Polarization

2.7.8 Sample Calculations

$R_C = R_U + CF_T$

Where:

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

Example Calculation: Peak
Corrected Level: 61.94 + 4.19 = 66.13 dBµV/m
Margin: 74 dBµV/m – 66.13 dBµV/m = 7.87 dB

Example Calculation: Average
Corrected Level: 58.31 + 4.19 -13.135 = 49.37 dBµV/m
Margin: 54 dBµV/m – 49.37 dBµV/m = 4.63 dB

2.7.9 Test Location and Test Equipment Used

This test was carried out in TÜV SÜD America, Inc., 5610 W. Sligh Ave, Suite 100, Tampa, FL 33634, USA.

Instrument	Manufacturer	Type No	TE No	Software / Firmware Revision	Calibration Period (months)	Calibration Due
9kHz-26.5GHz EMC analyzer/HYZ	Agilent	E7405A	BEMC00523	A.14.06	24	27-Nov-2020
10dB Attenuator	Merrimac	FAN-6-10K	BEMC02086	N/A	12	12-Oct-2020
Tile Automation Software	ETS Lindgren	TILE4! - Version 4.2.A	BEMC02095	4.2A	N/A	NCR
BI LOG PERIODIC, ANTENNA	Schaffner	CBL6112B	TEMC00005	N/A	24	31-Oct-2021
Loop Antenna	Com Power	AL-130	TEMC00025	N/A	24	26-Sep-2021
Horn Antenna	Schwarzbeck	BBHA-9170	TEMC00029	N/A	60	23-Aug-2021
EMC Chamber	Panashield	N/A	TEMC00031	N/A	36	28-Jan-2021
Double Ridge Guide Horn	ETS Lindgren	3117	TEMC00061	N/A	24	07-Feb-2022
18 GHz-40 GHz Microwave Preamplifier	COM-power	PAM-840A	TEMC00147	N/A	24	30-May-2020
PAM-118A	Com-Power Corporation	PAM-118A	TEMC00160	N/A	12	27-Apr-2020
4A & 4B Test Cables	MegaPhase, LLC	1GVT4	TEMC00171	N/A	24	30-May-2020
2.4 GHz Notch Filter	Micro-Tronics	BRM50702-01	TEMC00176	N/A	12	10-Apr-2020
Radiated Cable Set 30 MHz - 1 GHz	TUV SUD Tampa	Cable 2	TEMC00179	N/A	12	07-May-2020
Radiated Cable Set 9 kHz - 30 MHz	TUV SUD Tampa	Cable 2	TEMC00186	N/A	12	08-May-2020

TU - Traceability Unscheduled
O/P MON - Traceability Unscheduled
N/A - Not Applicable
NCR – No Calibration Required

2.8 Power Spectral Density

2.8.1 Specification Reference

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

2.8.2 Equipment Under Test and Modification State

S/N: N/A

2.8.3 Date of Test

3/25/2020

2.8.4 Test Method

The power spectral density was measured in accordance with ANSI C63.10 Subclause 11.10.2 Method PKPSD (peak PSD). The RF output port of the EUT was directly connected to the input of the spectrum analyzer. Offset values were input for cable and external attenuation. The spectrum analyzer RBW was set to 3 kHz and VBW to 10 kHz. The Span was adjusted to 1.5 times the DTS bandwidth and the sweep time was set to auto. The measurements were performed using a Peak detector.

2.8.5 Environmental Conditions

Ambient Temperature	25.3 °C
Relative Humidity	37.7 %
Atmospheric Pressure	1013.6 mbar

2.8.6 Test Results

AC Powered Operating

Limit FCC: Section 15.247(e), ISED Canada: RSS-247 5.2(b)

The power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time of continuous transmission.

Table 2.8.6-1: Power Spectral Density Results

Frequency (MHz)	PSD (dBm)	Limit (dBm)	Margin (dB)
2402	-5.24	8.0	13.24
2440	-5.39	8.0	13.39
2480	-5.39	8.0	13.39

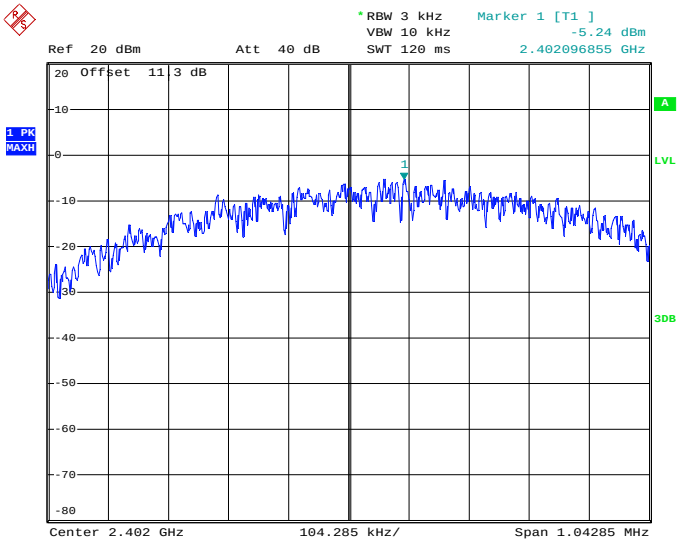


Figure 2.8.6-1: Power Spectral Density Results – Low Channel

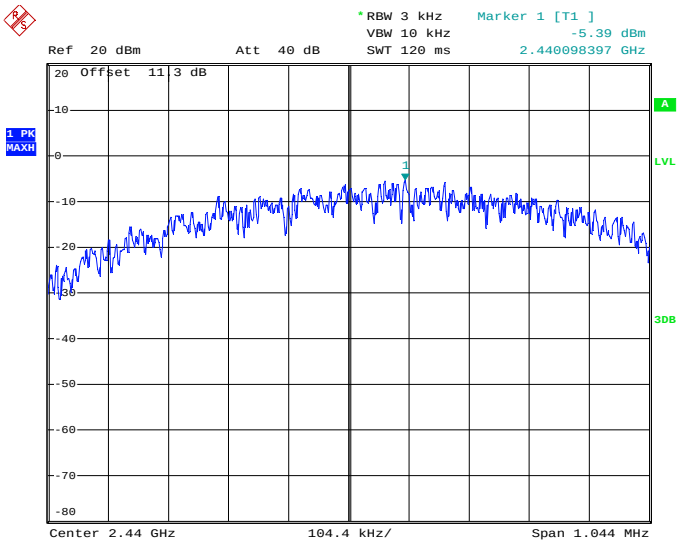


Figure 2.8.6-2: Power Spectral Density Results – Middle Channel

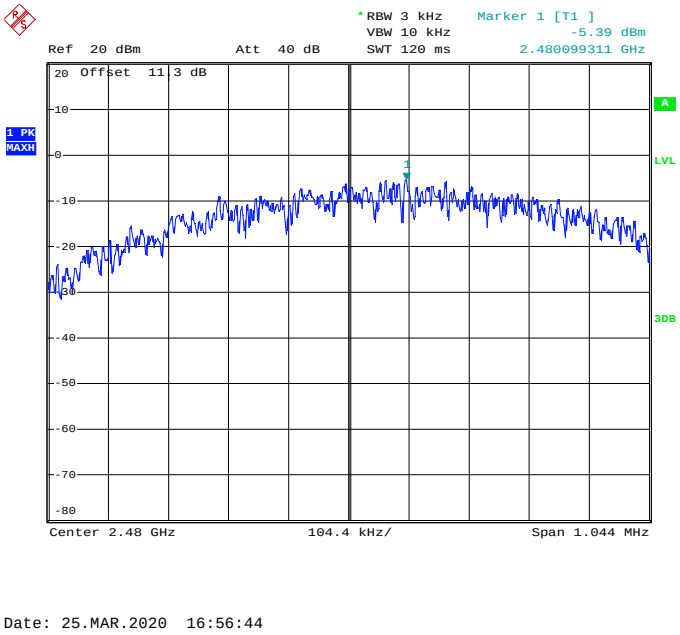


Figure 2.8.6-3: Power Spectral Density Results – High Channel

2.8.7 Test Location and Test Equipment Used

This test was carried out in TÜV SÜD America, Inc., 5610 W. Sligh Ave, Suite 100, Tampa, FL 33634, USA.

Instrument	Manufacturer	Type No	TE No	Software / Firmware Revision	Calibration Period (months)	Calibration Due
Spectrum Analyzer	Rohde & Schwarz	FSP40	BEMC00283	4.50 SP5	24	04-Oct-2021
Attenuator 10dB, 2.9 mm-M/F, DC-40GHz 2 W	Aeroflex Inmet	40AH2W-10	BEMC02110	N/A	12	27-Jul-2020

TU - Traceability Unscheduled
O/P MON - Traceability Unscheduled
N/A - Not Applicable

2.9 Power Line Conducted Emissions

2.9.1 Specification Reference

FCC: Section 15.207
ISED Canada; RSS-GEN 8.8

2.9.2 Equipment Under Test and Modification State

S/N: N/A

2.9.3 Date of Test

4/8/2020

2.9.4 Test Method

ANSI C63.10 section 6.2 was the guiding document for this evaluation. Conducted emissions were performed from 150 kHz to 30 MHz with the spectrum analyzer's resolution bandwidth set to 9 kHz and the video bandwidth set to 30 kHz. The calculation for the conducted emissions is as follows:

Corrected Reading = Analyzer Reading + LISN Loss + Cable Loss
Margin = Applicable Limit - Corrected Reading

2.9.5 Environmental Conditions

Ambient Temperature	25.9 °C
Relative Humidity	35.7 %
Atmospheric Pressure	1012.9 mbar

2.9.6 Test Results

Frequency of Emission (MHz)	Conducted Limit (dBµV)	
	Quasi-Peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

*Decreases with the logarithm of the frequency.

Table 2.9.6-1: Power Line Conducted Emissions – Quasi-Peak Detector Results

Frequency (MHz)	Quasi-peak (dBµV)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.294000	32.78	N	10.3	27.63	60.41
0.474000	40.26	N	10.3	16.19	56.44
0.829500	29.61	N	10.4	26.39	56.00
1.410000	27.82	N	10.5	28.18	56.00
2.319000	25.14	N	10.5	30.86	56.00
4.632000	24.32	N	10.7	31.68	56.00

Table 2.9.6-2: Power Line Conducted Emissions – Average Detector Results

Frequency (MHz)	Average (dBµV)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.474000	27.33	N	10.3	19.12	46.44
0.478500	27.28	N	10.3	19.09	46.37
0.717000	17.25	N	10.4	28.75	46.00
0.721500	17.36	N	10.4	28.64	46.00

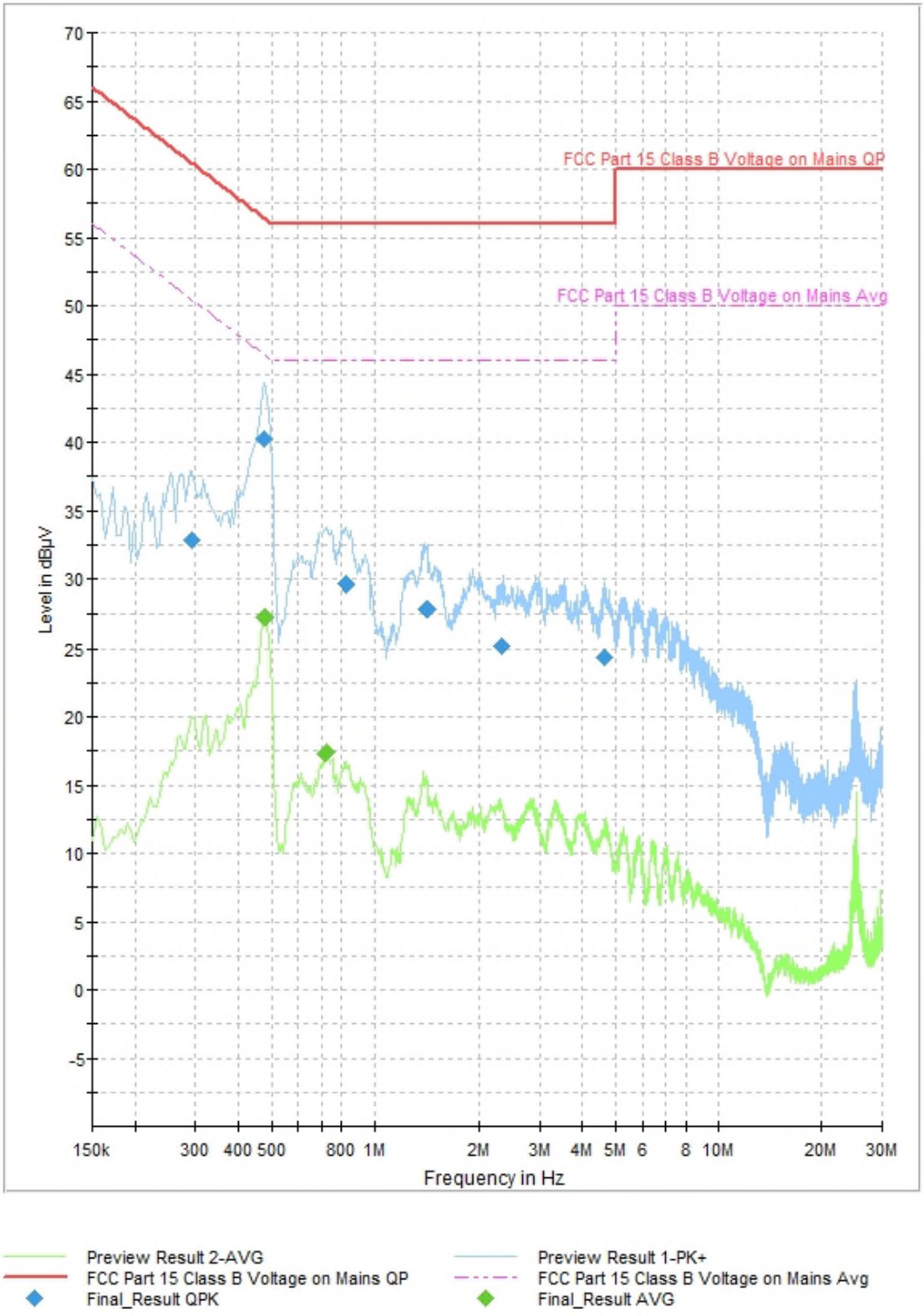


Figure 2.9.6-1: Composite Power Line Conducted Emissions Plots

2.9.7 Test Location and Test Equipment Used

This test was carried out in TÜV SÜD America, Inc., 5610 W. Sligh Ave, Suite 100, Tampa, FL 33634, USA.

Instrument	Manufacturer	Type No	TE No	Software / Firmware Revision	Calibration Period (months)	Calibration Due
LISN	Rohde & Schwarz	ESH3-Z5	TEMC00002	N/A	24	30-Sep-2021
EMI Test Receiver	Rohde & Schwarz	ESCS30	TEMC00011	2.3002.0102.36	24	03-Oct-2021
RFI/EMI Shielded Enclosure	UNIVERSAL SHIELDING CORP.	N/A	TEMC00100	N/A	N/A	NCR
Test Software	Rohde & Schwarz	EMC32	TEMC00184	10.50.00	N/A	NCR

TU - Traceability Unscheduled
O/P MON - Traceability Unscheduled
N/A - Not Applicable
NCR – No Calibration Required

3 Test Equipment Information

3.1 General Test Equipment Used

Instrument	Manufacturer	Type No	TE No	Software / Firmware Revision	Calibration Period (months)	Calibration Due
9kHz-26.5GHz EMC analyzer/HYZ	Agilent	E7405A	BEMC00523	A.14.06	24	27-Nov-2020
10dB Attenuator	Merrimac	FAN-6-10K	BEMC02086	N/A	12	12-Oct-2020
Tile Automation Software	ETS Lindgren	TILE4! - Version 4.2.A	BEMC02095	4.2A	N/A	NCR
BI LOG PERIODIC, ANTENNA	Schaffner	CBL6112B	TEMC00005	N/A	24	31-Oct-2021
Loop Antenna	Com Power	AL-130	TEMC00025	N/A	24	26-Sep-2021
Horn Antenna	Schwarzbeck	BBHA-9170	TEMC00029	N/A	60	23-Aug-2021
EMC Chamber	Panashield	N/A	TEMC00031	N/A	36	28-Jan-2021
Double Ridge Guide Horn	ETS Lindgren	3117	TEMC00061	N/A	24	07-Feb-2022
18 GHz-40 GHz Microwave Preamplifier	COM-power	PAM-840A	TEMC00147	N/A	24	30-May-2020
PAM-118A	Com-Power Corporation	PAM-118A	TEMC00160	N/A	12	27-Apr-2020
4A & 4B Test Cables	MegaPhase, LLC	1GVT4	TEMC00171	N/A	24	30-May-2020
2.4 GHz Notch Filter	Micro-Tronics	BRM50702-01	TEMC00176	N/A	12	10-Apr-2020
Radiated Cable Set 30 MHz - 1 GHz	TUV SUD Tampa	Cable 2	TEMC00179	N/A	12	07-May-2020
Radiated Cable Set 9 kHz - 30 MHz	TUV SUD Tampa	Cable 2	TEMC00186	N/A	12	08-May-2020
Spectrum Analyzer	Rohde & Schwarz	FSP40	BEMC00283	4.50 SP5	24	04-Oct-2021
Attenuator 10dB, 2.9 mm-M/F, DC-40GHz 2 W	Aeroflex Inmet	40AH2W-10	BEMC02110	N/A	12	27-Jul-2020
LISN	Rohde & Schwarz	ESH3-Z5	TEMC00002	N/A	24	30-Sep-2021
EMI Test Receiver	Rohde & Schwarz	ESCS30	TEMC00011	2.3002.0102.36	24	03-Oct-2021
RFI/EMI Shielded Enclosure	UNIVERSAL SHIELDING CORP.	N/A	TEMC00100	N/A	N/A	NCR
Test Software	Rohde & Schwarz	EMC32	TEMC00184	10.50.00	N/A	NCR

TU - Traceability Unscheduled
O/P MON - Traceability Unscheduled
N/A - Not Applicable
NCR – No Calibration Required

4 Diagram of Test Set-ups

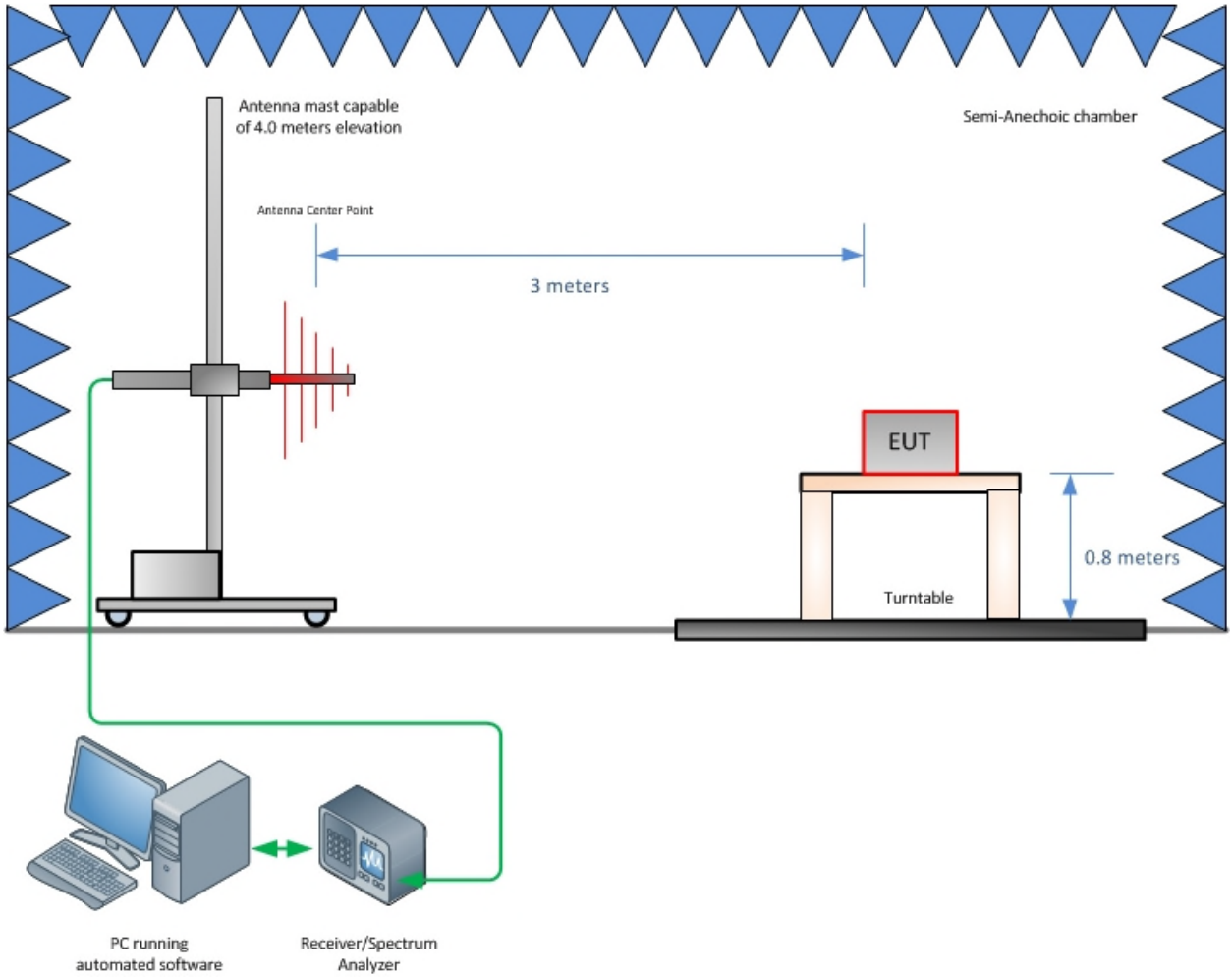


Figure 4-1 - Radiated Emissions Test Setup up to 1 GHz

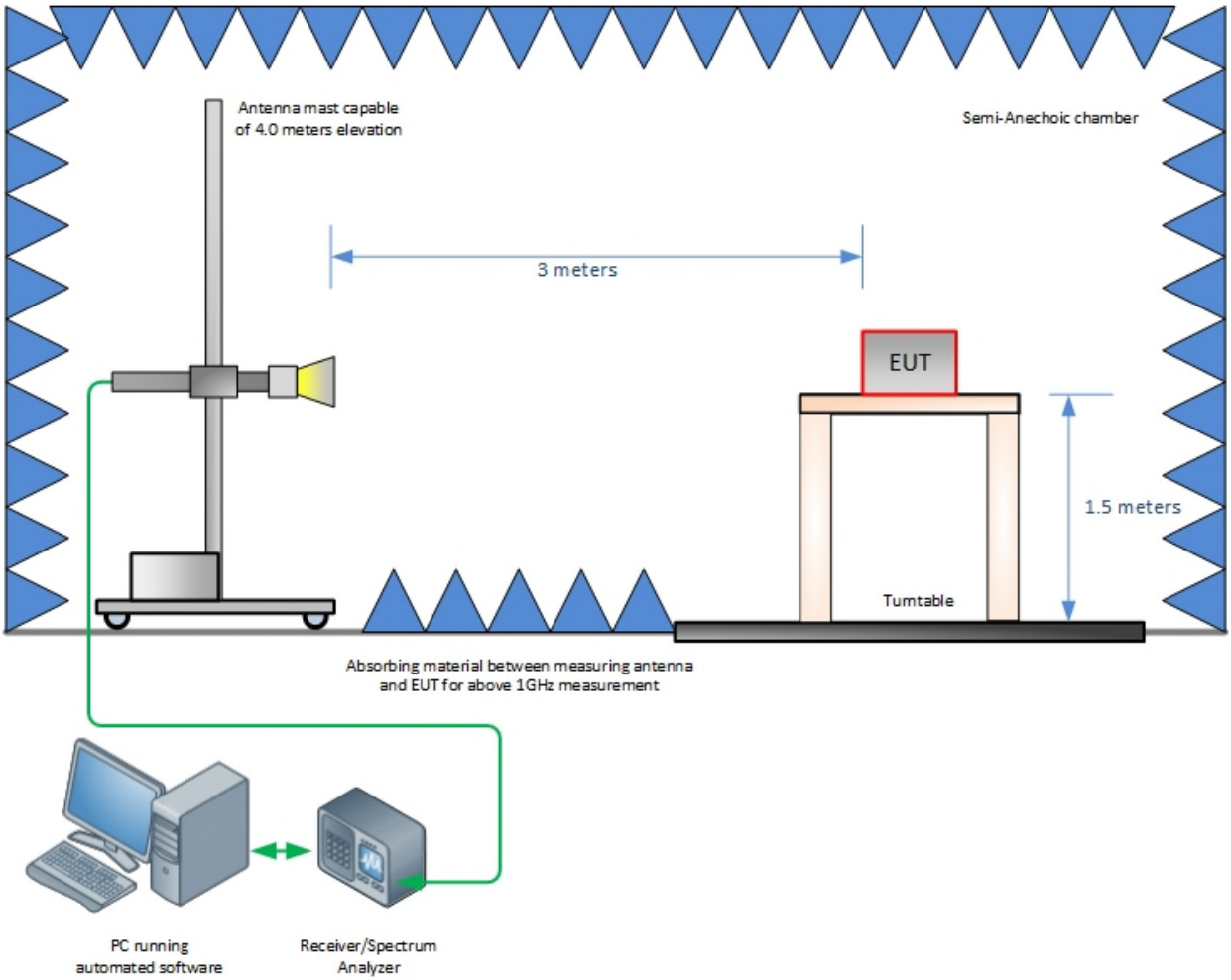


Figure 4-2 - Radiated Emissions Test Setup above 1 GHz

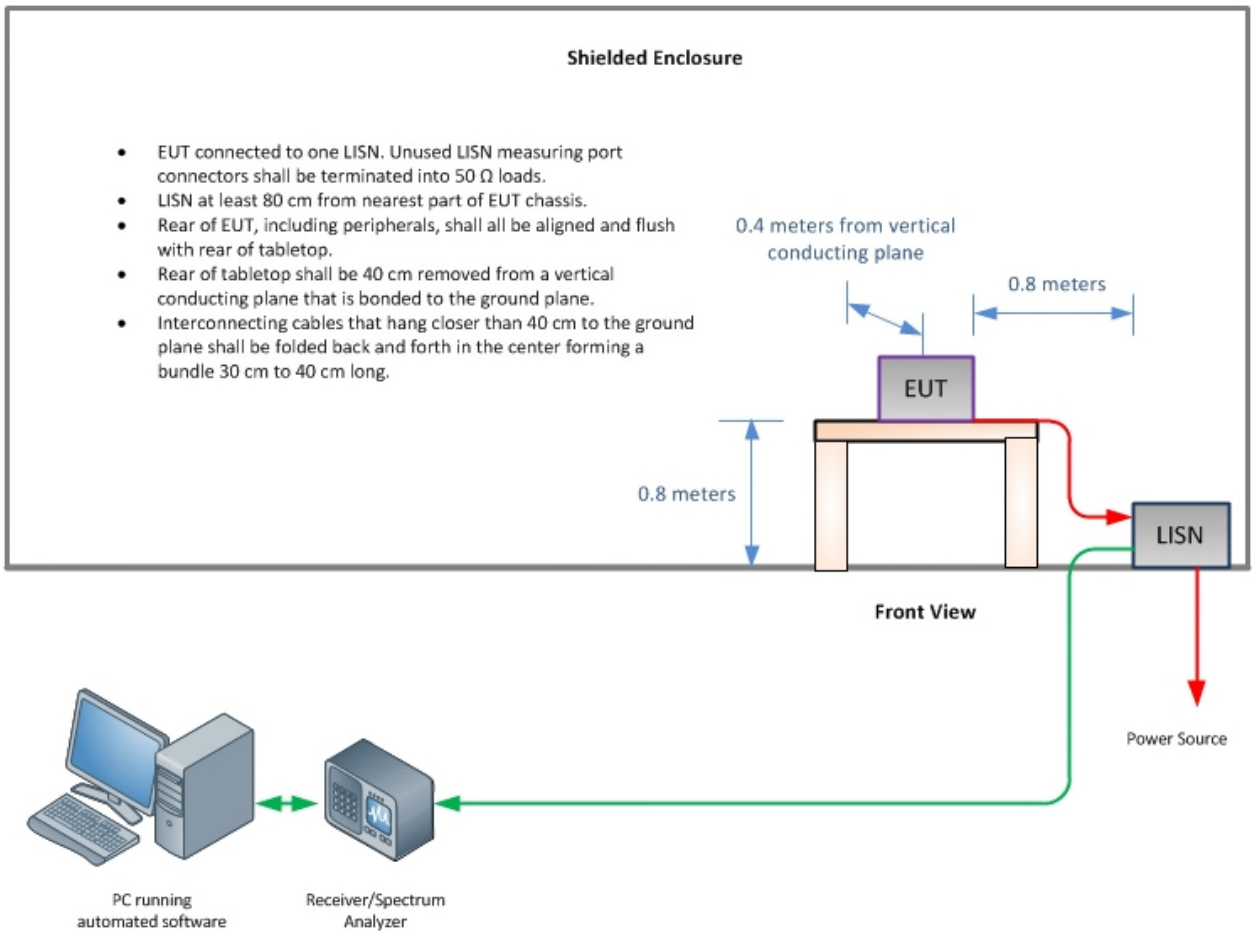


Figure 4-3 – Conducted Emissions Test Setup

5 Measurement Uncertainty

For a 95% confidence level, the measurement uncertainties for defined systems are:

Table 6-1 - Values of U_{cispr} and U_{Lab}

Measurement	U_{cispr}	U_{Lab}
Conducted disturbance (mains port) (9 kHz – 150 kHz) (150 kHz – 30 MHz)	 3.8 dB 3.4 dB	 3.71 dB 3.31 dB
Conducted disturbance (telecom port) (150 kHz – 30 MHz 55 dB LCL) (150 kHz – 30 MHz 65 dB LCL) (150 kHz – 30 MHz 75 dB LCL)	 5.0 dB 5.0 dB 5.0 dB	 4.11 dB 4.50 dB 4.94 dB
Radiated disturbance (electric field strength on an open area test site or alternative test site) (30 MHz – 1 000 MHz) (1 – 6 GHz) (6-18 GHz)	 6.3 dB 5.2 dB 5.5 dB	 5.85 dB 4.48 dB 4.48 dB

Notes:

U_{cispr} resembles a value of measurement uncertainty for a specific test, which was determined by considering uncertainties associated with the quantities listed in CISPR 16-4-2:2011.

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