



TEST REPORT

Test Report No. : UL-RPT-RP14428636-416A

Customer : Luminary ROLI Ltd.

Model No. / HVIN : RISE 2

PMN : Seaboard RISE 2

FCC ID : 2AFT3-SBR049

ISED Certification No. : IC: 20629-SB049

Technology : *Bluetooth* – Low Energy

Test Standard(s) : FCC Parts 15.207, 15.209(a) & 15.247
Innovation, Science and Economic Development Canada
RSS-247 Issue 2 February 2017
RSS-Gen Issue 5 February 2021

Test Laboratory : UL International (UK) Ltd, Basingstoke, Hampshire, RG24 8AH, United Kingdom

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3. The sample tested is in compliance with the above standard(s).
4. The test results in this report are traceable to the national or international standards.
5. Version 1.0.

Date of Issue: 29 November 2022

Checked by: 
Ben Mercer
Lead Project Engineer, Radio Laboratory

Company Signatory: 
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Customer Information

Company Name:	Luminary ROLI Ltd.
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Report Revision History

Version Number	Issue Date	Revision Details	Revised By
1.0	29/11/2022	Initial Version	Ben Mercer

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1 Attestation of Test Results

1.1 Description of EUT

The equipment under test was an expressive MIDI controller containing a *Bluetooth* Low Energy transceiver.

1.2 General Information

Specification Reference:	47CFR15.247
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) – Section 15.247
Specification Reference:	47CFR15.207 and 47CFR15.209
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) – Sections 15.207 and 15.209
Specification Reference:	RSS-Gen Issue 5 February 2021
Specification Title:	General Requirements for Compliance of Radio Apparatus
Specification Reference:	RSS-247 Issue 2 February 2017
Specification Title:	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices
Site Registration:	FCC: 685609, ISEDC: 20903
FCC Lab. Designation No.:	UK2011
ISEDC CABID:	UK0001
Location of Testing:	Unit 3 Horizon, Wade Road, Kingsland Business Park, Basingstoke, Hampshire, G24 8AH, United Kingdom
Test Dates:	09 November 2022 to 25 November 2022

1.3 Summary of Test Results

FCC Reference (47CFR)	ISED Canada Reference	Measurement	Result
N/A	RSS-Gen 6.7	Transmitter 99% Occupied Bandwidth	✓
Part 15.247(a)(2)	RSS-Gen 6.7 / RSS-247 5.2(a)	Transmitter Minimum 6 dB Bandwidth	✓
Part 15.247(b)(3)	RSS-Gen 6.12 / RSS-247 5.4(d)	Transmitter Maximum Peak Output Power	✓
Part 15.247(e)	RSS-247 5.4(b)	Transmitter Power Spectral Density	Note 1
Part 15.247(d) & 15.209(a)	RSS-Gen 6.13 / RSS-247 5.5	Transmitter Radiated Emissions	✓
Part 15.247(d) & 15.209(a)	RSS-Gen 6.13 / RSS-247 5.5	Transmitter Band Edge Radiated Emissions	✓
Part 15.207	RSS-Gen 8.8	Transmitter AC Conducted Emissions	✓

Key to Results

✓ = Complied ✘ = Did not comply

Note(s):

1. In accordance with ANSI C63.10 Section 11.10.1, PSD measurements are not required if the maximum conducted output power is less than the PSD limit of 8 dBm / 3 kHz. The PSD level is therefore deemed to be equal to the measured output power.

1.4 Deviations from the Test Specification

For the measurements contained within this test report, there were no deviations from, additions to, or exclusions from the test specification identified above.

2 Summary of Testing

2.1 Facilities and Accreditation

The test site and measurement facilities used to collect data are located at Unit 3 Horizon, Wade Road, Kingsland Business Park, Basingstoke, Hampshire, RG24 8AH, United Kingdom. The following table identifies which facilities were utilised for radiated emission measurements documented in this report. Specific facilities are also identified in the test results sections.

Site 1	X
Site 2	-
Site 17	X

UL International (UK) Ltd is accredited by the United Kingdom Accreditation Service (UKAS). UKAS is one of the signatories to the International Laboratory Accreditation Co-operation (ILAC) Arrangement for the mutual recognition of test reports. The tests reported herein have been performed in accordance with its terms of accreditation.

2.2 Methods and Procedures

Reference:	ANSI C63.10-2013
Title:	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
Reference:	KDB 558074 D01 15.247 Meas Guidance v05r02, April 2, 2019
Title:	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
Reference:	KDB 174176 D01 Line Conducted FAQ v01r01 June 3, 2015
Title:	AC Power-Line Conducted Emissions Frequently Asked Questions

2.3 Calibration and Uncertainty

Measuring Instrument Calibration

In accordance with UKAS requirements all the measurement equipment is on a calibration schedule. All equipment was within the calibration period on the date of testing.

Measurement Uncertainty & Decision Rule

Overview

No measurement or test can ever be perfect and the imperfections give rise to error of measurement in the results. Consequently the result of a measurement is only an approximation to the value of the measurand (the specific quantity subject to measurement) and is only complete when accompanied by a statement of the uncertainty of the approximation.

The expression of uncertainty of a measurement result allows realistic comparison of results with reference values and limits given in specifications and standards.

Decision Rule

The decision rule applied is based upon the accuracy method criteria. The measurement uncertainty is met and the result is considered in conformance with the requirement criteria if the observed value is within the prescribed limit.

Measurement Uncertainty

The reported expanded uncertainties below are based on a standard uncertainty multiplied by an appropriate coverage factor such that a confidence level of approximately 95% is maintained. For the purposes of this document "approximately" is interpreted as meaning "effectively" or "for most practical purposes".

Measurement Type	Range	Confidence Level (%)	Calculated Uncertainty
Duty Cycle	2.4 GHz to 2.4835 GHz	95%	±1.14 %
99% Occupied Bandwidth	2.4 GHz to 2.4835 GHz	95%	±3.92 %
Minimum 6 dB Bandwidth	2.4 GHz to 2.4835 GHz	95%	±4.59 %
Radiated Spurious Emissions	9 kHz to 30 MHz	95%	±5.32 dB
Radiated Spurious Emissions	30 MHz to 1 GHz	95%	±3.30 dB
Radiated Spurious Emissions	1 GHz to 25 GHz	95%	±3.16 dB
AC Conducted Spurious Emissions	0.15 MHz to 30 MHz	95%	±1.96 dB

The methods used to calculate the above uncertainties are in line with those recommended within the various measurement specifications. Where measurement specifications do not include guidelines for the evaluation of measurement uncertainty the published guidance of the appropriate accreditation body is followed.

2.4 Test and Measurement Equipment

Test Equipment Used for Transmitter Conducted / Minimum 6 dB Bandwidth Tests

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2072	Thermohygrometer	Testo	608-H1	45257961	08 Dec 2022	12
A213953	Attenuator	Atlantic Microwave Limited	ATT10KXP-483082-N4N5	21415050	Calibrated before use	-
M2033	Signal Analyser	Rohde & Schwarz	FSV13	101667	11 Aug 2023	12
G217350	Vector Signal Generator	Rohde & Schwarz	SMM100A	101777	04 April 2025	36

Test Equipment Used for Transmitter Duty Cycle Tests

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2072	Thermohygrometer	Testo	608-H1	45257961	08 Dec 2022	12
A213953	Attenuator	Atlantic Microwave Limited	ATT10KXP-483082-N4N5	21415050	Calibrated before use	-
M2033	Signal Analyser	Rohde & Schwarz	FSV13	101667	11 Aug 2023	12
G217350	Vector Signal Generator	Rohde & Schwarz	SMM100A	101777	04 April 2025	36

Test Equipment Used for Transmitter Maximum Peak Output Power Tests

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2072	Thermohygrometer	Testo	608-H1	45257961	08 Dec 2022	12
A213953	Attenuator	Atlantic Microwave Limited	ATT10KXP-483082-N4N5	21415050	Calibrated before use	-
M2033	Signal Analyser	Rohde & Schwarz	FSV13	101667	11 Aug 2023	12
G217350	Vector Signal Generator	Rohde & Schwarz	SMM100A	101777	04 April 2025	36

Test and Measurement Equipment (continued)**Test Equipment Used for Transmitter Radiated Emissions Tests**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
K0017	3m RSE Chamber	Rainford EMC	N/A	N/A	8 Nov 2023	12
M2003	Thermohygrometer	Testo	608-H1	45046641	09 Dec 2022	12
M1995	Test Receiver	Rohde & Schwarz	ESU40	100428	02 Nov 2023	12
A223628	Pre-Amplifier	Atlantic Microwave	A-LNAKX-380116-S5S5	210837001	28 Sep 2023	12
A2889	Antenna	Schwarzbeck	BBHA 9120 B	00653	02 Nov 2023	12
A2890	Antenna	Schwarzbeck	HWRD 750	014	02 Nov 2023	12
A2916	Attenuator	AtlanTecRF	AN18W5-10	832827#2	26 Jan 2023	12
A2947	High Pass Filter	AtlanTecRF	AFH-07000	1601900001	25 Jan 2023	12
K0001	3m RSE Chamber	Rainford EMC	N/A	N/A	05 Sep 2023	12
M2040	Thermohygrometer	Testo	608-H1	45124934	09 Dec 2022	12
M2044	Test Receiver	Rohde & Schwarz	ESU26	100122	29 Apr 2023	12
A3154	Pre-Amplifier	Com-Power	PAM-103	18020012	18 Aug 2023	12
A222867	Pre-Amplifier	Atlantic Microwave	A-LNAKX-380116-S5S5	210865001	26 Aug 2023	12
A3179	Pre-Amplifier	Hewlett Packard	8449B	3008A00934	14 Sep 2023	12
A3265	Pre-Amplifier	Schwarzbeck	BBV 9721	9721-069	31 Oct 2023	12
A3165	Antenna	ETS-Lindgren	6502	00224383	05 May 2023	12
A3161	Antenna	TESEQ	CBL6111D	50859	03 May 2023	12
A3138	Antenna	Schwarzbeck	BBHA 9120 B	00702	22 Aug 2023	12
A2892	Antenna	Schwarzbeck	BBHA 9170	9170-727	31 Oct 2023	12
A3093	High Pass Filter	AtlanTecRF	AFH-03000	18051800077	27 Jan 2023	12
A2523	Attenuator	AtlanTecRF	AN18W5-10	832827#1	27 Jan 2023	12
A3085	Low Pass Filter	AtlanTecRF	AFL-02000	18051600014	27 Jan 2023	12

Test Equipment Used for Transmitter Band Edge Radiated Emissions Tests

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
K0017	3m RSE Chamber	Rainford EMC	N/A	N/A	8 Nov 2023	12
M2003	Thermohygrometer	Testo	608-H1	45046641	09 Dec 2022	12
M1995	Test Receiver	Rohde & Schwarz	ESU40	100428	02 Nov 2023	12
A223628	Pre-Amplifier	Atlantic Microwave	A-LNAKX-380116-S5S5	210837001	28 Sep 2023	12
A2889	Antenna	Schwarzbeck	BBHA 9120 B	00653	02 Nov 2023	12
A2916	Attenuator	AtlanTecRF	AN18W5-10	832827#2	26 Jan 2023	12

Test and Measurement Equipment (continued)**Test Equipment Used for Transmitter AC Conducted Spurious Emissions:**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2037	Thermohygrometer	Testo	608-H1	45124925	08 Dec 2022	12
M1273	Test Receiver	Rohde & Schwarz	ESIB 26	100275	25 Nov 2022	12
A649	Single Phase LISN	Rohde & Schwarz	ESH3-Z5	825562/008	01 Sept 2023	12
A1830	Pulse Limiter	Rohde & Schwarz	ESH3-Z2 Pulse Limiter	100668	31 May 2023	12
A3130	Noise Generator	York EMC	CNE V	2646	11 Mar 2023	12

Test Measurement Software/Firmware Used:

Name	Version	Release Date
Rohde & Schwarz EMC32	6.30.0	2018

3 Equipment Under Test (EUT)

3.1 Identification of Equipment Under Test (EUT)

Brand Name:	Luminary ROLI
Model Name or Number / HVIN:	RISE 2
PMN:	Seaboard RISE 2
Test Sample Serial Number:	RI2CERTUNIT1 (<i>Conducted sample #1</i>)
Hardware Version:	LH Rev D / RH Rev F
Software Version:	2.0.0
FCC ID:	2AFT3-SBR049
ISED Canada Certification Number:	IC: 20629-SB049

Brand Name:	Luminary ROLI
Model Name or Number / HVIN:	RISE 2
PMN:	Seaboard RISE 2
Test Sample Serial Number:	RI2CERTUNIT6 (<i>Radiated sample #1</i>)
Hardware Version:	LH Rev D / RH Rev F
Firmware Version:	2.0.0
FCC ID:	2AFT3-SBR049
ISED Canada Certification Number:	IC: 20629-SB049

3.2 Modifications Incorporated in the EUT

No modifications were applied to the EUT during testing.

3.3 Additional Information Related to Testing

Technology Tested:	<i>Bluetooth Low Energy (Digital Transmission System)</i>		
Type of Unit:	Transceiver		
Channel Spacing:	2 MHz		
Modulation:	GFSK		
Data Rate: LE	1 Mbps		
Power Supply Requirement(s):	Nominal	5.0 VDC	
Maximum Conducted Output Power:	6.7 dBm		
Transmit Frequency Range:	2402 MHz to 2480 MHz		
Transmit Channels Tested:	Channel ID	Channel Number	Channel Frequency (MHz)
	Bottom	0	2402
	Middle	20	2442
	Top	39	2480

3.4 Description of Available Antennas

The radio utilizes an integrated antenna, with the following maximum gain:

Frequency Range (MHz)	Antenna Gain (dBi)
2400-2480	-8.5

3.5 Description of Test Setup

Support Equipment

The following support equipment was used to exercise the EUT during testing:

Description:	Support Laptop
Brand Name:	Lenovo
Model Name or Number:	L480
Serial Number:	PF1EHZPL

Description:	Support Laptop
Brand Name:	Lenovo
Model Name or Number:	L480
Serial Number:	PF1EHZQQ

Description:	Support Laptop
Brand Name:	Lenovo
Model Name or Number:	L480
Serial Number:	PF1EJ3BY

Description:	USB-A to USB-C Cable
Brand Name:	Not Marked
Model Name or Number:	Not Marked
Serial Number:	Not Marked

Description:	Sustain Pedal
Brand Name:	Pianonova
Model Name or Number:	P80A
Serial Number:	MUM04200500304

Description:	MIDI Interface
Brand Name:	Miditech
Model Name or Number:	Midiface 4x4
Serial Number:	Not Marked

Description:	AC/DC Charger
Brand Name:	Mackertop
Model Name or Number:	PD-29W
Serial Number:	Not Marked

Operating Modes

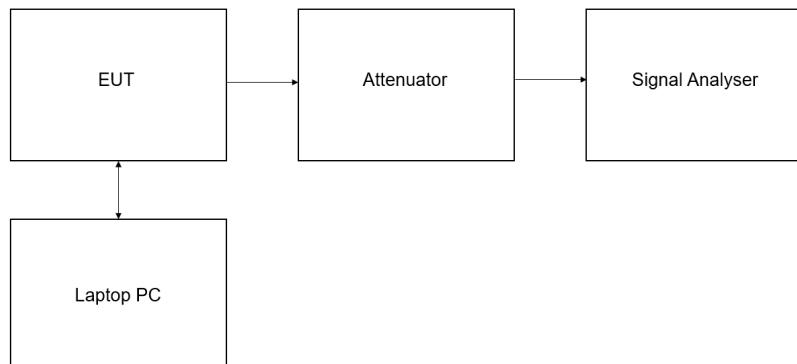
The EUT was tested in the following operating mode(s):

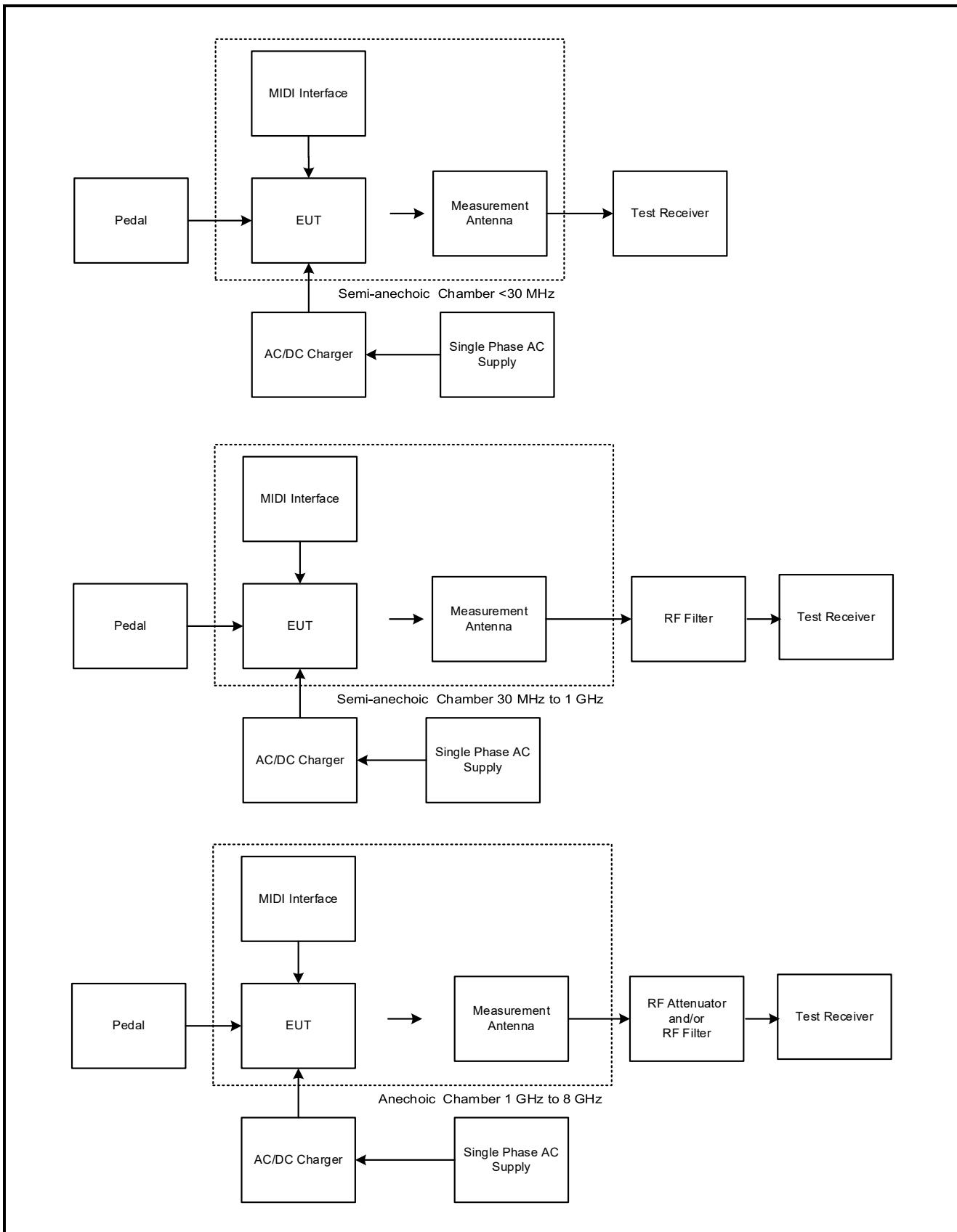
- Transmitting at maximum power in *Bluetooth* LE test mode with modulation, maximum possible data length available and Pseudorandom Bit Sequence 9.

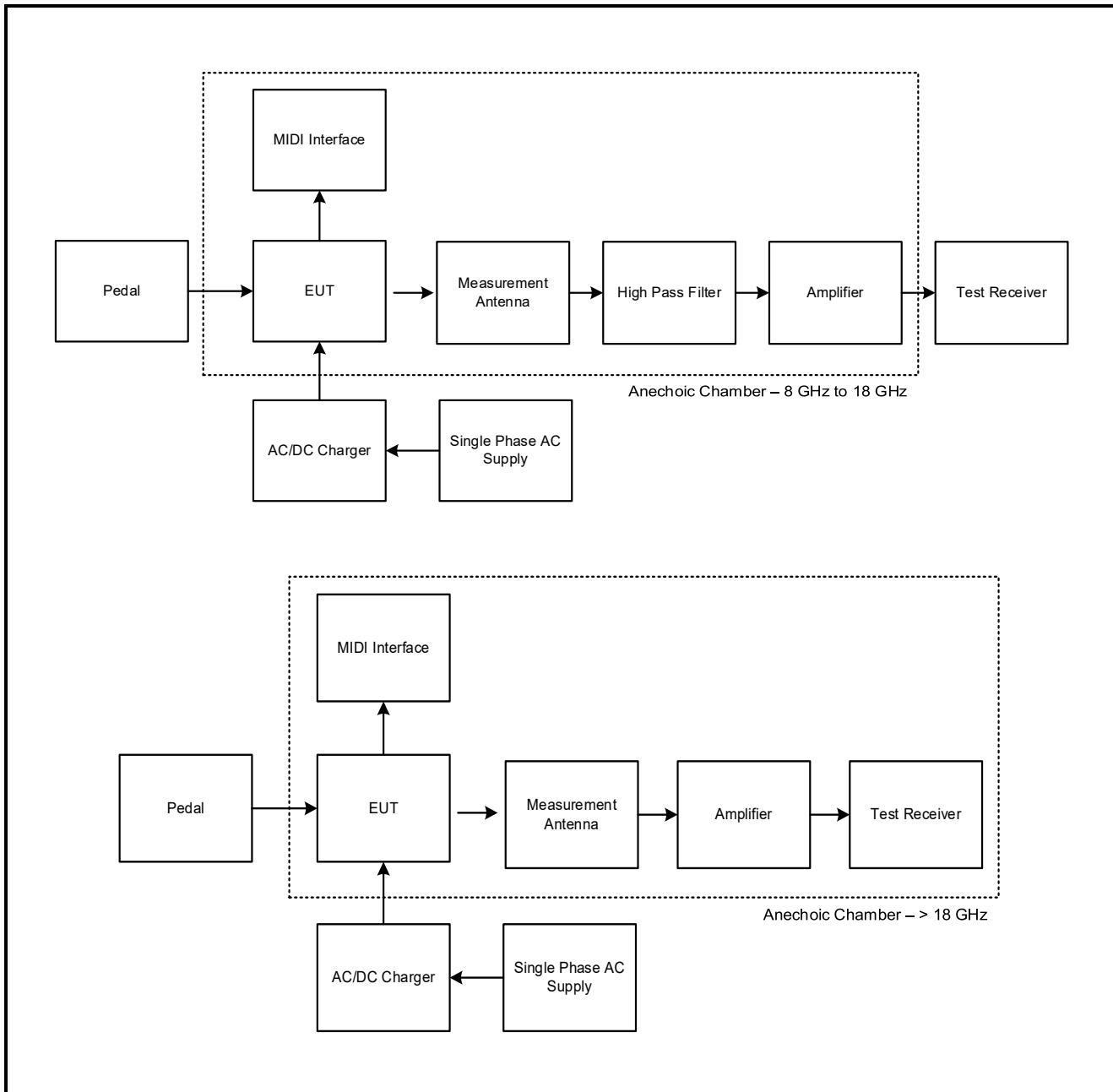
Configuration and Peripherals

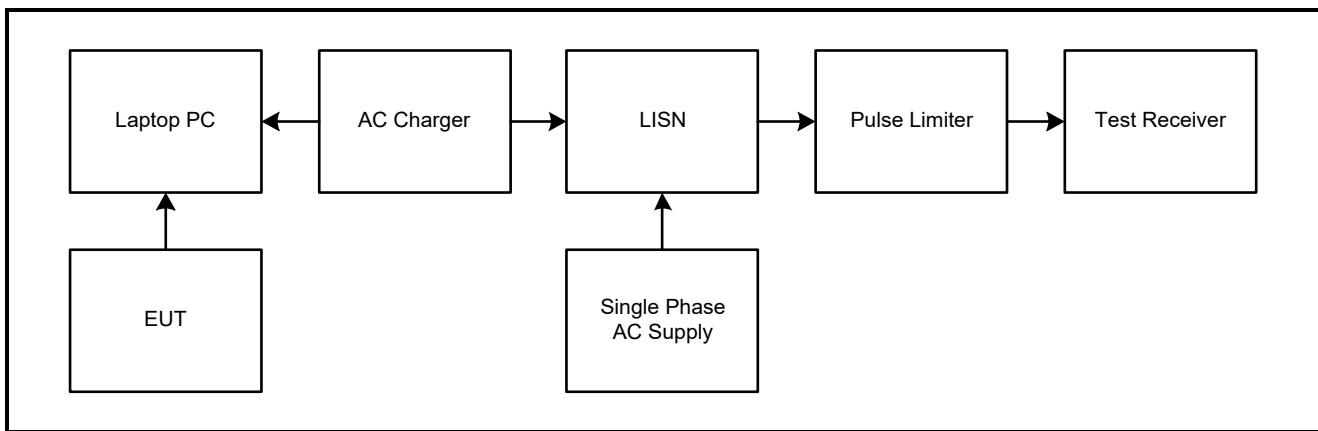
The EUT was tested in the following configuration(s):

- A test laptop with the customer's test application was used to place the EUT into *Bluetooth* LE test mode via a diagnostic cable. The application was used to enable continuous transmission and to select the test channels & packet types as required. The customer supplied instructions to configure the EUT into test mode "Roli Rise 49 Test Instructions.docx".
- For conducted tests, the EUT was powered by the internal battery. The battery voltage was monitored throughout testing.
- Transmitter radiated spurious emissions and band edge tests were performed with the EUT in the worst-case position with a representative AC/DC charger connected to the EUT. The AC/DC charger was connected to a 120 VAC 60 Hz single phase supply.
- The pedal and MIDI ports on the EUT were terminated into a sustain pedal and a MIDI interface. There were no other ports to populate.

Test Setup Diagrams**Conducted Tests:****Test Setup for Transmitter Minimum 6 dB Bandwidth, Power Spectral Density & Maximum Peak Output Power**

Test Setup Diagrams (continued)**Radiated Tests:****Test Setup for Transmitter Radiated Emissions**

Test Setup Diagrams (continued)**Test Setup for Transmitter Radiated Emissions (continued)**

Test Setup Diagrams (continued)**Test Setup for Transmitter AC Conducted Spurious Emissions**

4 Antenna Port Test Results

4.1 Transmitter 99% Occupied Bandwidth

Test Summary:

Test Engineer:	Raghavendra Katti	Test Date:	10 November 2022
Test Sample Serial Number:	RI2CERTUNIT1		

FCC Reference:	N/A
ISED Canada Reference:	RSS-Gen 6.7
Test Method Used:	RSS-Gen 6.7 and notes below

Environmental Conditions:

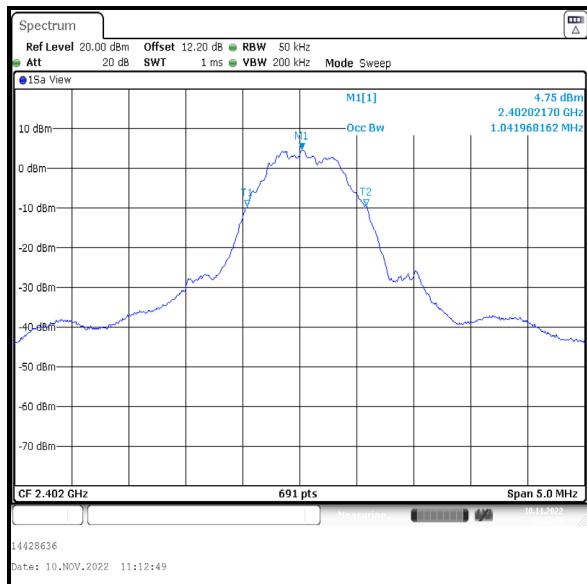
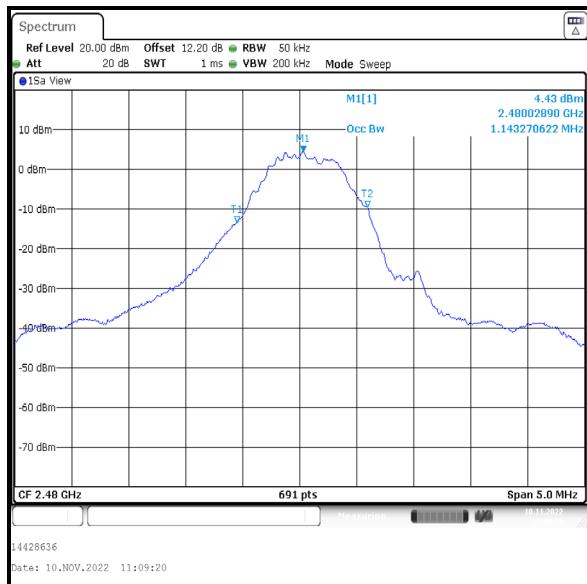
Temperature (°C):	22
Relative Humidity (%):	51

Note(s):

1. The 99% emission bandwidth was measured using the signal analyser occupied bandwidth function. The resolution bandwidth was set in the range of 1% to 5% of the occupied bandwidth and the video bandwidth set to 3 times the resolution bandwidth. The span was set to capture all products of the modulation process including emission skirts.
2. The signal analyser resolution bandwidth was set to 50 kHz and video bandwidth 200 kHz. A sample detector was used, sweep time was set to auto and the trace mode was Max Hold. The span was set to 5 MHz. The signal analyser function set the measurements to be made at 99% of the emission bandwidth. The results are given in the tables below.
3. The signal analyser was connected to the RF port on the EUT using suitable attenuation and coax cable.

Transmitter 99% Occupied Bandwidth (continued)**Results:**

Channel	99% Occupied Bandwidth (kHz)
Bottom	1041.968
Middle	1056.440
Top	1143.271

**Bottom Channel****Middle Channel****Top Channel**

4.2 Transmitter Minimum 6 dB Bandwidth

Test Summary:

Test Engineer:	Raghavendra Katti	Test Date:	10 November 2022
Test Sample Serial Number:	RI2CERTUNIT1		

FCC Reference:	Part 15.247(a)(2)
ISED Canada Reference:	RSS-Gen 6.7 / RSS-247 5.2(a)
Test Method Used:	FCC KDB 558074 Section 8.2 referencing ANSI C63.10 Section 11.8.1

Environmental Conditions:

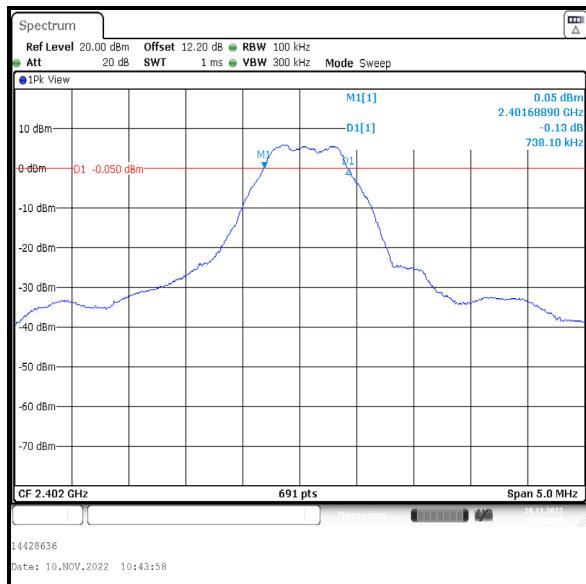
Temperature (°C):	22
Relative Humidity (%):	51

Note(s):

1. 6 dB DTS bandwidth tests were performed using a signal analyser in accordance with ANSI C63.10 Section 11.8.1 Option 1 measurement procedure. The signal analyser resolution bandwidth was set to 100 kHz and video bandwidth 300 kHz. A peak detector was used, sweep time was set to auto and the trace mode was Max Hold. The DTS bandwidth was measured at 6 dB down from the peak of the signal.
2. The signal analyser was connected to the RF port on the EUT using suitable attenuation and coax cable.

Transmitter Minimum 6 dB Bandwidth (continued)**Results:**

Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Bottom	738.100	≥500	238.100	Complied
Middle	745.300	≥500	245.300	Complied
Top	780.800	≥500	280.800	Complied

**Bottom Channel****Middle Channel****Top Channel**

4.3 Transmitter Maximum Peak Output Power

Test Summary:

Test Engineer:	Raghavendra Katti	Test Date:	10 November 2022
Test Sample Serial Number:	RI2CERTUNIT1		

FCC Reference:	Part 15.247(b)(3)
ISED Canada Reference:	RSS-Gen 6.12 / RSS-247 5.4(d)
Test Method Used:	FCC KDB 558074 Section 8.3.1.1 referencing ANSI C63.10 Section 11.9.1.1 and notes below

Environmental Conditions:

Temperature (°C):	22
Relative Humidity (%):	51

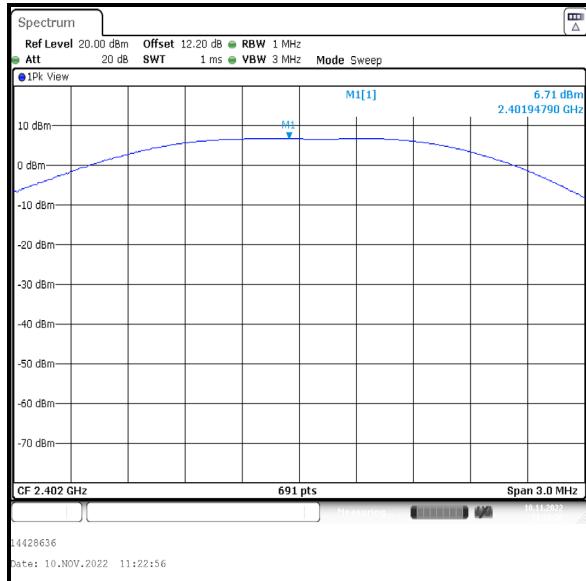
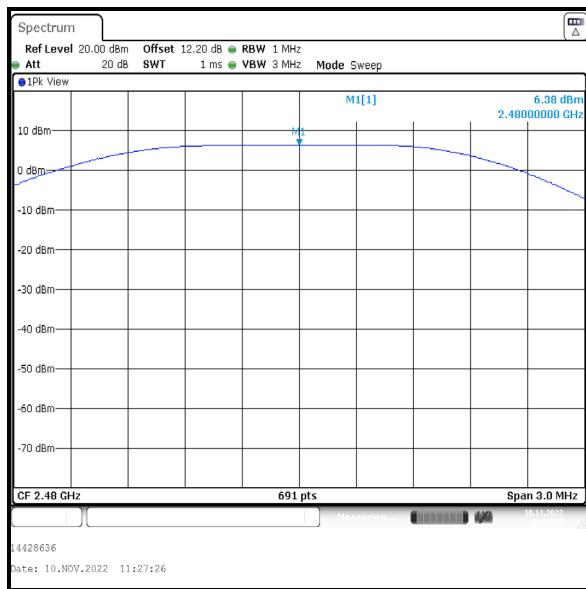
Note(s):

- Conducted power tests were performed using a signal analyser in accordance with ANSI C63.10 Section 11.9.1.1 with the $RBW \geq DTS$ bandwidth procedure.
- The signal analyser resolution bandwidth was set to 1 MHz and video bandwidth of 3 MHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold. The span was set to 3 MHz. A marker was placed at the peak of the signal and the results recorded in the tables below.
- The signal analyser was connected to the RF port on the EUT using suitable attenuation and coax cable. An RF level offset was entered on the signal analyser to compensate for the loss of the attenuator and cable.
- The conducted power was added to the declared antenna gain to obtain the EIRP.

Results:

Channel	Conducted Peak Power (dBm)	Conducted Peak Power Limit (dBm)	Margin (dB)	Result
Bottom	6.7	30.0	23.3	Complied
Middle	6.6	30.0	23.4	Complied
Top	6.4	30.0	23.6	Complied

Channel	Conducted Peak Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	6.7	-8.5	-1.8	36.0	37.8	Complied
Middle	6.6	-8.5	-1.9	36.0	37.9	Complied
Top	6.4	-8.5	-2.1	36.0	38.1	Complied

Transmitter Maximum Peak Output Power (continued)**Results:****Bottom Channel****Middle Channel****Top Channel**

5 Radiated Test Results

5.1 Transmitter Radiated Emissions <1 GHz

Test Summary:

Test Engineer:	Jose Bayona	Test Date:	21 November 2022
Test Sample Serial Number:	RI2CERTUNIT6		

FCC Reference:	Parts 15.247(d) & 15.209(a)
ISED Canada Reference:	RSS-Gen 6.13 & 8.9 / RSS-247 5.5
Test Method Used:	ANSI C63.10 Sections 6.3, 6.4 and 6.5
Frequency Range	9 kHz to 1000 MHz

Environmental Conditions:

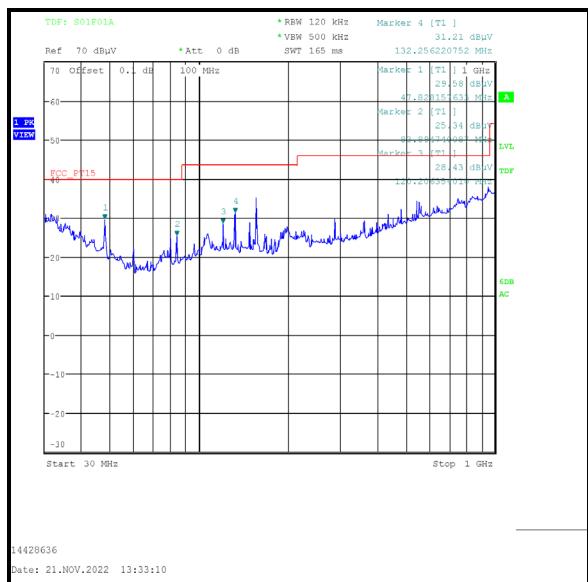
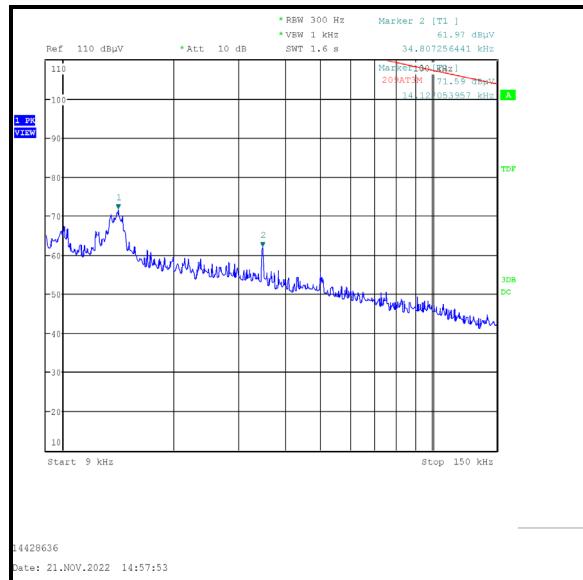
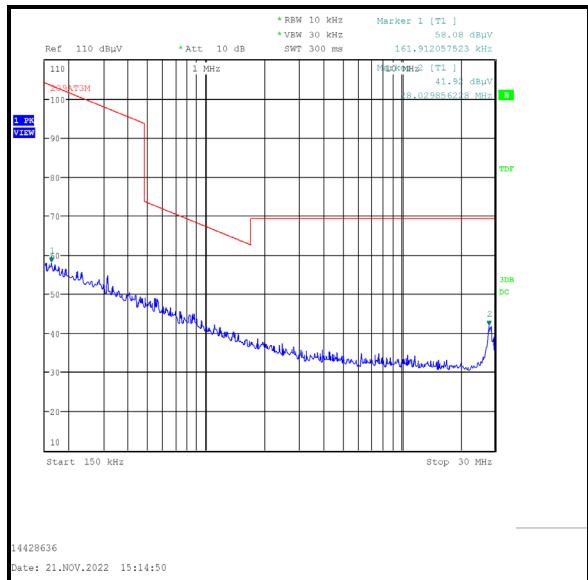
Temperature (°C):	21
Relative Humidity (%):	44

Note(s):

1. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
2. All other emissions shown on the pre-scans were investigated and found to be ambient, or > 20 dB below the appropriate limit or below the noise floor of the measurement system.
3. The preliminary scans showed similar emission levels below 1 GHz, for each channel of operation. Therefore final radiated emissions measurements were performed with the EUT set to the middle channel only.
4. Measurements below 1 GHz were performed in a semi-anechoic chamber (Asset Number K0001) at a distance of 3 metres. The EUT was placed at a height of 80 cm above the reference ground plane in the centre of the chamber turntable. Maximum emission levels were determined by height searching the measurement antenna over the range 1 metre to 4 metres.
5. Pre-scans were performed and markers placed on the highest measured levels. The test receiver was configured as follows: For 9 kHz to 150 kHz, the resolution bandwidth was set to 300 Hz and video bandwidth 1 kHz. A peak detector was used and trace mode was Max Hold. For 150 kHz to 30 MHz, the resolution bandwidth was set to 10 kHz and video bandwidth 30 kHz, trace mode was Max Hold. For 30 MHz to 1 GHz, the resolution bandwidth was set to 120 kHz and video bandwidth 500 kHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold.
6. Final measurements were performed on the marker frequencies and the results entered into the table below. The test receiver resolution bandwidth was set to 120 kHz, using a CISPR quasi-peak detector and span wide enough to see the whole emission.

Transmitter Radiated Emissions (continued)**Results: Quasi-Peak / Middle Channel**

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
131.875	Horizontal	28.9	43.5	14.6	Complied



Note: This plot is a pre-scan and for indication purposes only. For final measurements, see accompanying table.

5.2 Transmitter Radiated Emissions >1 GHz

Test Summary:

Test Engineers:	John Ferdinand & Jose Bayona	Test Dates:	11 November 2022 to 25 November 2022
Test Sample Serial Number:	RI2CERTUNIT6		

FCC Reference:	Parts 15.247(d) & 15.209(a)
ISED Canada Reference:	RSS-Gen 6.13 & 8.9 / RSS-247 5.5
Test Method Used:	FCC KDB 558074 Sections 8.1 c)3), 8.5 & 8.6 referencing ANSI C63.10 Sections 6.3, 6.6, 7.5, 11.11 & 11.12.2.4
Frequency Range	1 GHz to 25 GHz

Environmental Conditions:

Temperature (°C):	21 to 23
Relative Humidity (%):	43 to 48

Note(s):

1. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
2. All other emissions shown on the pre-scans were investigated and found to be ambient, or > 20 dB below the appropriate limit or below the noise floor of the measurement system.
3. The emission shown on the 1 GHz to 3 GHz plot is the EUT fundamental.
4. Pre-scans above 1 GHz were performed in a fully anechoic chamber (Asset Number K0001/K0017) at a distance of 3 metres. The EUT was placed at a height of 1.5 metres above the test chamber floor in the centre of the chamber turntable. All measurement antennas were placed at a fixed height of 1.5 metres above the test chamber floor, in line with the EUT.
5. Final measurements above 1 GHz were performed in an anechoic chamber (Asset Number K0001/K0017) at a distance of 3 metres. The EUT was placed at a height of 1.5 m above the reference ground plane in the centre of the chamber turntable. Maximum emission levels were determined by height searching the measurement antenna over the range 1 metre to 4 metres.
6. Pre-scans were performed and a marker placed on the highest measured level of the appropriate plot. The test receiver resolution bandwidth was set to 1 MHz and video bandwidth 3 MHz. The sweep time was set to auto. Peak and average measurements were performed with their respective detectors during the pre-scan measurements.
7. The reference level for the emission in the non-restricted band was established by following ANSI C63.10 Section 11.11.2 procedure.
8. *-20 dBc limit applies in non-restricted band as the conducted output power measurements were performed using a peak detector.
9. Average levels were determined by applying a duty cycle correction factor to the peak level, in accordance with ANSI C63.10 Section 7.5. More detail can be found in Annex A.

Results: Bottom Channel / Peak

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
4803.486	Vertical	64.7	74.0	9.3	Complied
7206.846	Vertical	53.2	72.1*	18.9	Complied
9609.136	Vertical	58.7	72.1*	13.4	Complied
12011.622	Vertical	61.7	74.0	12.3	Complied
14413.688	Horizontal	47.9	72.1*	24.2	Complied
16816.020	Horizontal	62.7	72.1*	9.4	Complied
19218.179	Vertical	56.3	74.0	17.7	Complied
24017.949	Vertical	45.4	72.1*	26.7	Complied

Results: Bottom Channel / Average

Frequency (MHz)	Antenna Polarity	Peak Level (dB μ V/m)	Duty Cycle Correction (dB)	Corrected Level (dB μ V/m)	Average Limit (dB μ V/m)	Margin (dB)	Result
4803.486	Vertical	64.7	15.9	48.8	54.0	5.2	Complied
12011.622	Vertical	61.7	15.9	45.8	54.0	8.2	Complied
19218.179	Vertical	56.3	15.9	40.4	54.0	13.6	Complied

Results: Middle Channel / Peak

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
4883.612	Vertical	65.9	74.0	8.1	Complied
7325.438	Vertical	60.2	74.0	13.8	Complied
9767.172	Vertical	59.2	70.4*	11.2	Complied
12209.060	Vertical	58.8	74.0	15.2	Complied
14650.892	Horizontal	51.5	70.4*	18.9	Complied
17092.532	Horizontal	62.9	70.4*	7.5	Complied
19534.253	Vertical	58.6	74.0	15.4	Complied
24417.949	Vertical	45.7	70.4*	24.7	Complied

Results: Middle Channel / Average

Frequency (MHz)	Antenna Polarity	Peak Level (dB μ V/m)	Duty Cycle Correction (dB)	Corrected Level (dB μ V/m)	Average Limit (dB μ V/m)	Margin (dB)	Result
4883.612	Vertical	65.9	15.9	50.0	54.0	4.0	Complied
7325.438	Vertical	60.2	15.9	44.3	54.0	9.7	Complied
12209.060	Vertical	58.8	15.9	42.9	54.0	11.1	Complied
19534.253	Vertical	58.6	15.9	42.7	54.0	11.3	Complied

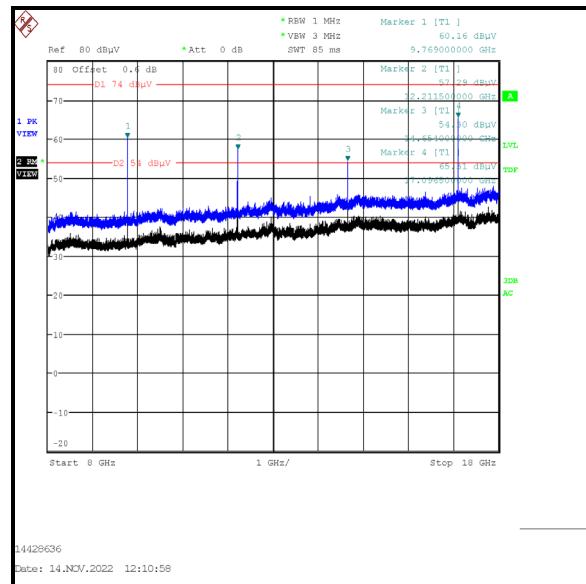
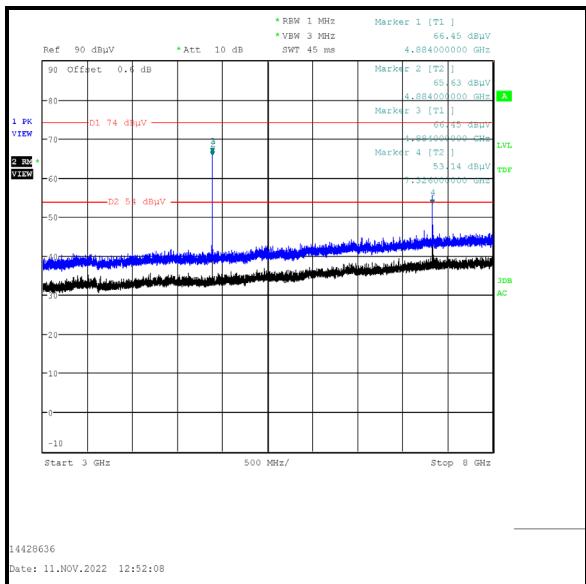
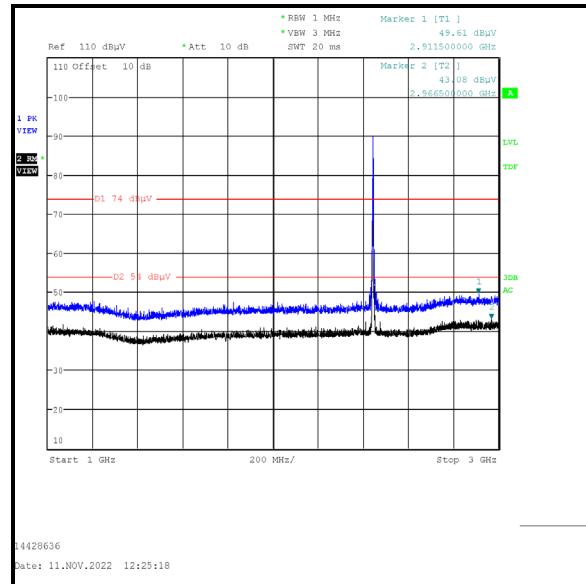
Transmitter Radiated Emissions (continued)**Results: Top Channel / Peak**

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
4959.716	Vertical	65.6	74.0	8.4	Complied
7440.827	Vertical	60.5	74.0	13.5	Complied
9919.144	Vertical	54.8	69.6*	14.8	Complied
12398.790	Vertical	58.6	74.0	15.4	Complied
14878.708	Vertical	53.6	69.6*	16.0	Complied
17358.496	Horizontal	55.9	69.6*	13.7	Complied
19838.301	Vertical	59.4	74.0	14.6	Complied
24797.869	Vertical	48.9	69.6*	20.7	Complied

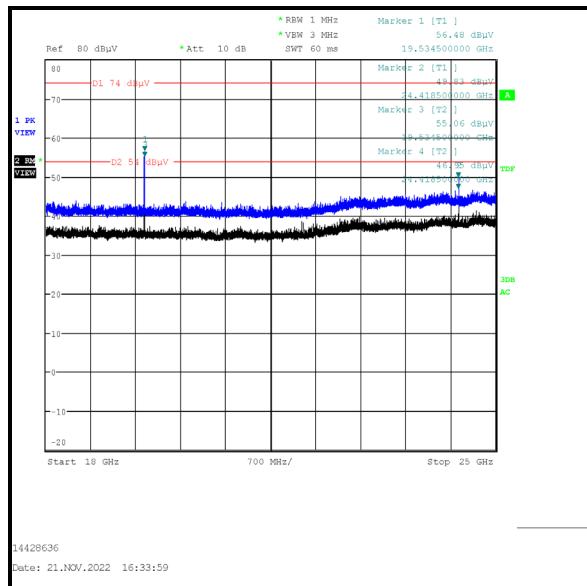
Results: Top Channel / Average

Frequency (MHz)	Antenna Polarity	Peak Level (dB μ V/m)	Duty Cycle Correction (dB)	Corrected Level (dB μ V/m)	Average Limit (dB μ V/m)	Margin (dB)	Result
4959.716	Vertical	65.6	15.9	49.7	54.0	4.3	Complied
7440.827	Vertical	60.5	15.9	44.6	54.0	9.4	Complied
12398.790	Vertical	58.6	15.9	42.7	54.0	11.3	Complied
19838.301	Vertical	59.4	15.9	43.5	54.0	10.5	Complied

Transmitter Radiated Emissions (continued)



Note: The above plots are pre-scans for indication purposes only. For final measurements, see accompanying tables.

Transmitter Radiated Emissions (continued)

Note: The above plots are pre-scans for indication purposes only. For final measurements, see accompanying tables.

5.3 Transmitter Band Edge Radiated Emissions

Test Summary:

Test Engineer:	John Ferdinand	Test Date:	14 November 2022
Test Sample Serial Number:	RI2CERTUNIT6		

FCC Reference:	Parts 15.247(d) & 15.209(a)
ISED Canada Reference:	RSS-Gen 6.13 / RSS-247 5.5
Test Method Used:	KDB 558074 Section 8.7 referencing ANSI C63.10 Sections 11.11, 11.12 & 11.13

Environmental Conditions:

Temperature (°C):	21
Relative Humidity (%):	48

Note(s):

1. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
2. As the lower band edge is adjacent to a non-restricted band, only peak measurements are required. In accordance with ANSI C63.10 Section 11.11.1, the test method in Section 11.11.3 was followed: the test receiver resolution bandwidth was set to 100 kHz and video bandwidth 300 kHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold. The test receiver was left to sweep for a sufficient length of time in order to maximise the carrier level and out-of-band emissions. A marker and corresponding reference level line were placed on the peak of the carrier. As the maximum peak conducted output power was measured using a peak detector in accordance with ANSI C63.10 Section 11.9.1.1 an out-of-band limit line was placed 20 dB (ANSI C63.10 Section 11.11.1(a)) below the peak level. A marker was placed on the band edge spot frequencies. Marker frequency and levels were recorded.
3. As the upper band edge is adjacent to a restricted band, both peak and average measurements were recorded by placing a marker at the edge of the band. For peak measurements the test receiver resolution bandwidth was set to 1 MHz and the video bandwidth 3 MHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold. For average measurements the test receiver resolution bandwidth was set to 1 MHz and the video bandwidth 3 MHz. An RMS detector was used, sweep time was set to auto and trace mode was Max Hold. A marker was placed on the band edge spot frequencies and a second marker placed on the highest emission level in the adjacent restricted band of operation (where a higher level emission was present). Marker frequencies and levels were recorded.
4. There is a restricted band 10 MHz below the lower band edge. The test receiver was set up as follows: the RBW set to 1 MHz, the VBW set to 3 MHz, with the sweep time set to auto couple. Peak and average measurements were performed with peak and RMS detectors respectively. Markers were placed on the highest point on each trace.
5. * -20 dBc limit.
6. Average levels were determined by applying a duty cycle correction factor to the peak level, in accordance with ANSI C63.10 Section 7.5. More detail can be found in Annex A.

Transmitter Band Edge Radiated Emissions (continued)**Results: Peak**

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2400.000	Horizontal	52.0	72.1*	20.1	Complied
2483.500	Horizontal	60.9	74.0	13.1	Complied
2483.740	Horizontal	61.0	74.0	13.0	Complied

Results: Average

Frequency (MHz)	Antenna Polarity	Peak Level (dB μ V/m)	Duty Cycle Correction (dB)	Corrected Level (dB μ V/m)	Average Limit (dB μ V/m)	Margin (dB)	Result
2483.500	Horizontal	60.9	15.9	45.0	54.0	9.0	Complied
2483.740	Horizontal	61.0	15.9	45.1	54.0	8.9	Complied

Results: 2310 MHz to 2390 MHz Restricted Band / Peak

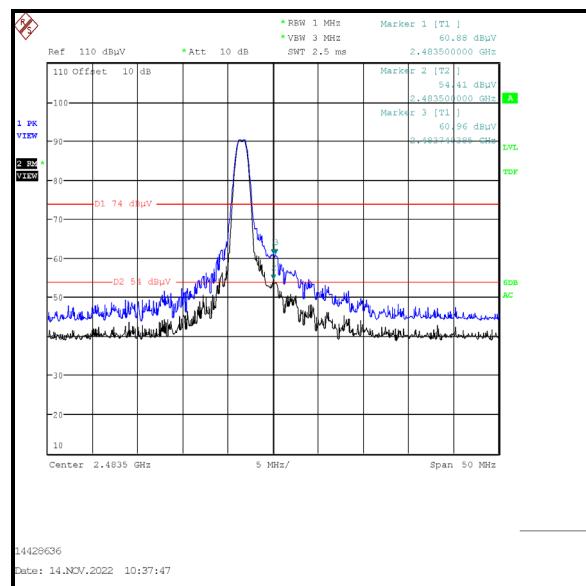
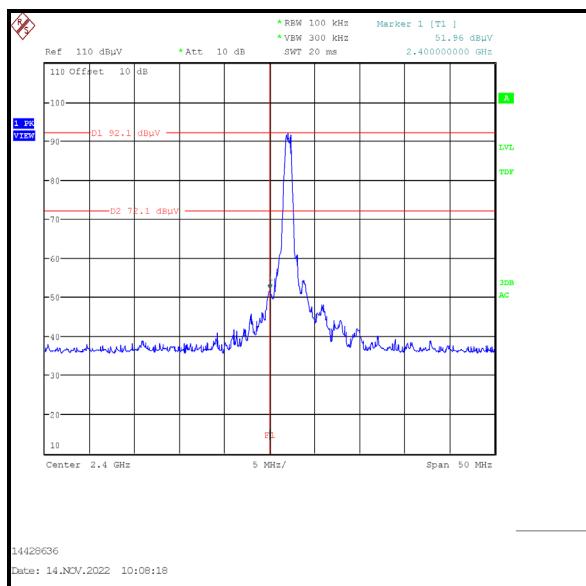
Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2370.128	Horizontal	52.8	74.0	21.2	Complied
2387.051	Horizontal	54.5	74.0	19.5	Complied

Results: 2310 MHz to 2390 MHz Restricted Band / Average

Frequency (MHz)	Antenna Polarity	Peak Level (dB μ V/m)	Duty Cycle Correction (dB)	Corrected Level (dB μ V/m)	Average Limit (dB μ V/m)	Margin (dB)	Result
2370.128	Horizontal	52.8	15.9	36.9	54.0	17.1	Complied
2387.051	Horizontal	54.5	15.9	38.6	54.0	15.4	Complied

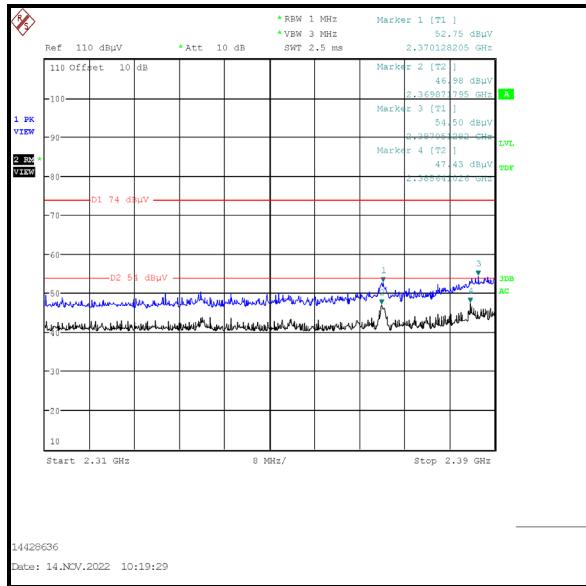
Transmitter Band Edge Radiated Emissions (continued)

Results:



Lower Band Edge

Upper Band Edge



2310 MHz to 2390 MHz Restricted Band

6 AC Power Line Conducted Emissions Test Results

6.1 Transmitter AC Conducted Spurious Emissions

Test Summary:

Test Engineer:	Alison Johnston	Test Date:	09 November 2022
Test Sample Serial Number:	RI2CERTUNIT6		

FCC Reference:	Part 15.207
ISED Canada Reference:	RSS-Gen 8.8
Test Method Used:	ANSI C63.10 Section 6.2 / FCC KDB 174176 and notes below

Environmental Conditions:

Temperature (°C):	24
Relative Humidity (%):	46

Note(s):

1. The EUT was powered by a test laptop via a USB cable. The test laptop was used to enable/disable the transmitter and select the channel.
2. In accordance with FCC KDB 174176 Q4, tests were performed with a 240 VAC 60 Hz single phase supply as this was within the voltage range marked on the laptop power supply.
3. A pulse limiter was fitted between the LISN and the test receiver.
4. Pre-scans were performed, and markers placed on the highest live and neutral measured levels. Final measurements were performed on the marker frequencies and the results entered in the tables below.

Transmitter AC Conducted Spurious Emissions (continued)**Results: Live / Quasi Peak / 120 VAC 60 Hz**

Frequency (MHz)	Line	Level (dB μ V)	Limit (dB μ V)	Margin (dB)	Result
0.208500	Live	46.4	63.3	16.9	Complied
0.361500	Live	32.5	58.7	26.2	Complied
0.460500	Live	28.3	56.7	28.4	Complied
1.477500	Live	28.2	56.0	27.8	Complied
2.634000	Live	27.6	56.0	28.4	Complied
4.452000	Live	30.7	56.0	25.3	Complied

Results: Live / Average / 120 VAC 60 Hz

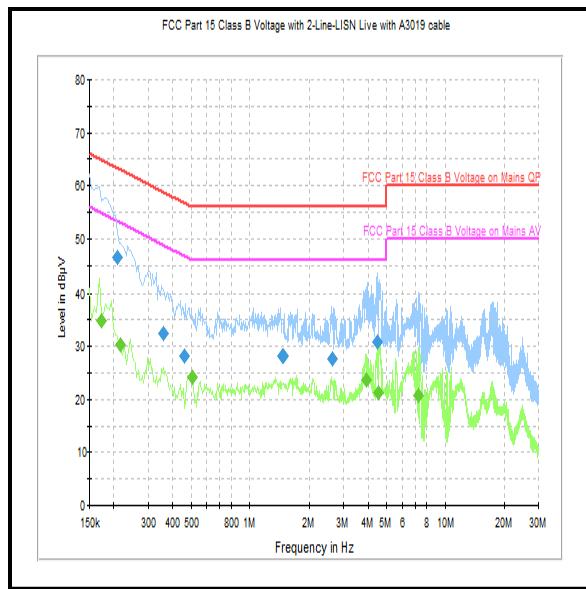
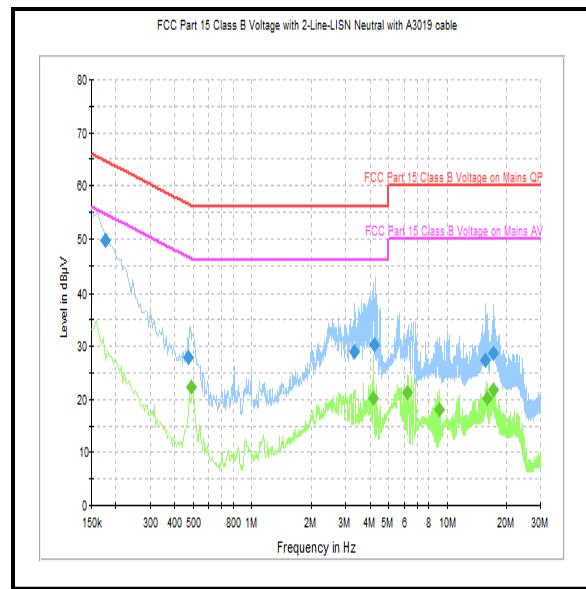
Frequency (MHz)	Line	Level (dB μ V)	Limit (dB μ V)	Margin (dB)	Result
0.172500	Live	34.9	54.8	19.9	Complied
0.217500	Live	30.2	52.9	22.7	Complied
0.505500	Live	24.2	46.0	21.8	Complied
3.939000	Live	23.7	46.0	22.3	Complied
4.533000	Live	21.2	46.0	24.8	Complied
7.269000	Live	20.6	50.0	29.4	Complied

Results: Neutral / Quasi Peak / 120 VAC 60 Hz

Frequency (MHz)	Line	Level (dB μ V)	Limit (dB μ V)	Margin (dB)	Result
0.177000	Neutral	49.6	64.6	15.0	Complied
0.474000	Neutral	28.0	56.4	28.4	Complied
3.309000	Neutral	29.0	56.0	27.0	Complied
4.222500	Neutral	30.3	56.0	25.7	Complied
15.607500	Neutral	27.4	60.0	32.6	Complied
17.232000	Neutral	28.8	60.0	31.2	Complied

Results: Neutral / Average / 120 VAC 60 Hz

Frequency (MHz)	Line	Level (dB μ V)	Limit (dB μ V)	Margin (dB)	Result
0.492000	Neutral	22.3	46.1	23.8	Complied
4.159500	Neutral	20.3	46.0	25.7	Complied
6.207000	Neutral	21.4	50.0	28.6	Complied
9.073500	Neutral	18.1	50.0	31.9	Complied
15.972000	Neutral	20.2	50.0	29.8	Complied
17.214000	Neutral	21.8	50.0	28.2	Complied

Transmitter AC Conducted Spurious Emissions (continued)**Results: 120 VAC 60 Hz****Live****Neutral**

Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

Transmitter AC Conducted Spurious Emissions (continued)**Results: Live / Quasi Peak / 240 VAC 60 Hz**

Frequency (MHz)	Line	Level (dB μ V)	Limit (dB μ V)	Margin (dB)	Result
0.150000	Live	52.7	66.0	13.3	Complied
0.235500	Live	44.4	62.3	17.9	Complied
0.528000	Live	32.2	56.0	23.8	Complied
2.706000	Live	28.5	56.0	27.5	Complied
4.141500	Live	29.2	56.0	26.8	Complied
6.985500	Live	27.7	60.0	32.3	Complied

Results: Live / Average / 240 VAC 60 Hz

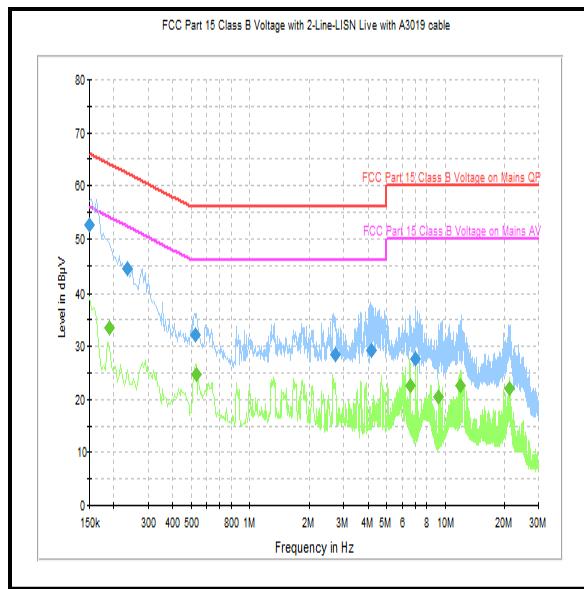
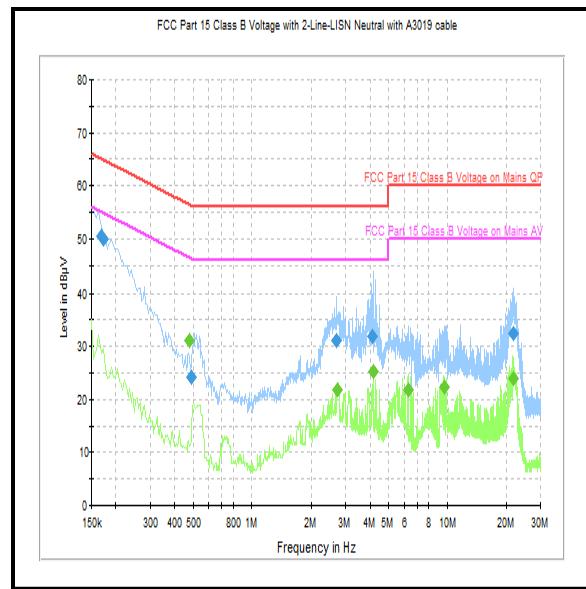
Frequency (MHz)	Line	Level (dB μ V)	Limit (dB μ V)	Margin (dB)	Result
0.190500	Live	33.4	54.0	20.6	Complied
0.532500	Live	24.7	46.0	21.3	Complied
6.585000	Live	22.6	50.0	27.4	Complied
9.240000	Live	20.6	50.0	29.4	Complied
11.967000	Live	22.5	50.0	27.5	Complied
21.268500	Live	22.0	50.0	28.0	Complied

Results: Neutral / Quasi Peak / 240 VAC 60 Hz

Frequency (MHz)	Line	Level (dB μ V)	Limit (dB μ V)	Margin (dB)	Result
0.168000	Neutral	50.4	65.1	14.7	Complied
0.172500	Neutral	50.0	64.8	14.8	Complied
0.487500	Neutral	24.3	56.2	31.9	Complied
2.679000	Neutral	31.2	56.0	24.8	Complied
4.105500	Neutral	31.9	56.0	24.1	Complied
21.718500	Neutral	32.4	60.0	27.6	Complied

Results: Neutral / Average / 240 VAC 60 Hz

Frequency (MHz)	Line	Level (dB μ V)	Limit (dB μ V)	Margin (dB)	Result
0.478500	Neutral	31.1	46.4	15.3	Complied
2.719500	Neutral	21.8	46.0	24.2	Complied
4.159500	Neutral	25.2	46.0	20.8	Complied
6.328500	Neutral	21.7	50.0	28.3	Complied
9.618000	Neutral	22.3	50.0	27.7	Complied
21.714000	Neutral	24.0	50.0	26.0	Complied

Transmitter AC Conducted Spurious Emissions (continued)**Results: 240 VAC 60 Hz****Live****Neutral**

Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

Annex A – Duty Cycle Correction

During real world use, the EUT transmits MIDI data over *Bluetooth* LE when a note is played and when a note is modulated.

The worst-case scenario would be achieved when 10 notes are played and modulated simultaneously. In this scenario, the customer declared a duty cycle of 16% over a 100 ms period, based on internal measurements.

In accordance with ANSI C63.10 Section 7.5, the duty cycle correction was calculated as follows:

$$20 \log(0.16) = 15.9 \text{ dB}$$

--- END OF REPORT ---