INTENTIONAL RADIATOR
TEST REPORT

Report Reference Number:	E11289-2201_Jacknife_FCC_IC_Rev_1.1
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Laboratory Accreditations (per ISO/IEC 17025:2017)

CERT #3657.02

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Manufacturer:	Jacknife Gamer Inc
Address:	5007 Irmin Street, Burnaby, BC, V5J 1Y6, Canada
Equipment Tested:	**Bluetooth Gamepad**
Model Number(s):	JKG2022A
FCC ID:	2A8RW-JKGPAD
ISED ID:	29448-JKGPAD
FVIN:	20220926A

REVISION HISTORY

Date	Report Number	Details	Author's Initials
November 23, 2022	E11289-2201_Jacknife_FCC_IC10.1	1.1	Added Bandedge Table
October 14, 2022	E11289-2201_Jacknife_FCC_IC10.0	1.0	Initial Release
All previous versions of this report have been superseded by the latest dated revision as listed in the above table. Please dispose of all previous electronic and paper printed revisions accordingly.			

REPORT AUTHORIZATION

The data documented in this report is for the test equipment and sample provided by Jacknife. Tests were conducted on the sample equipment for the purpose of demonstrating compliance with applicable test standard mentioned above as agreed upon by Jacknife as per Quote 22RH09121.
Jacknife is responsible for the tested product configuration, continued product compliance, and for the appropriate auditing of subsequent products as required. This report may comprise partial list of tests that are required for FCC & IC Declaration of Conformity and can only be produced by the manufacturer.

This is to certify that the following report is true and correct to the best of our knowledge.

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QAI EMC ACCREDITATION

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EMC Laboratory Location	FCC Designation (3m SAC)	IC Registration (3m SAC)	A2LA Certificate
Burnaby, BC, Canada	CA9543	9543A	3657.02

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1 EXECUTIVE SUMMARY

1.1 Purpose

The purpose of this report is to demonstrate and document the compliance of Bluetooth Gamepad as per Sections 1.2.
The radio module activates only the first minute of when the product puts in the charger. Therefore, the product is categorized as Mobile.

1.2 Scope

The information documented in this report is based on the test methods and levels as per Quote Quote Number:

- **FCC Title 47 Part 15** – Radio Frequency Devices, Subpart B – Intentional Radiators 15.109: Radiated emission limits
- **FCC Title 47 Part 15** – Radio Frequency Devices, Subpart C – Intentional Radiators 15.203: Antenna Requirement
- **FCC Title 47 Part 15** – Radio Frequency Devices, Subpart C – Intentional Radiators 15.205: Restricted bands of operation
- **FCC Title 47 Part 15** – Radio Frequency Devices, Subpart C – Intentional Radiators 15.209: Radiated emission limits; general requirements
- **FCC Title 47 Part 15** – Radio Frequency Devices, Subpart C – Intentional Radiators 15.247: Operation in the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz
- **RSS-Gen Issue 5 –** General Requirements for Compliance of Radio Apparatus
- **RSS-102 Issue 5** – Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)
- **RSS-247 Issue 2 –** Digital Transmission Systems (DTSs), Frequency Hopping Systems (GHSs) and License-Exempt Local Area Network (LE-LAN) Devices
- **ICES-003 Issue 7 –** Information Technology Equipment (including Digital Apparatus)

1.3 Test Equipment List

The tables below contain all the equipment used by QAI Laboratories in conducting all tests on the Equipment Under Test (EUT) as per Section 1.

Emissions Test Equipment

Note: Equipment listed above have 3 years calibration interval.

Measurement Software List Emissions Test Equipment

Sl. NO.	Manufacturer	Model	Description	Serial No.	S/W Version	Calibration Due Date
1	AH Systems	PAM118	Amplifier (10KHz-18GHz)	189	N/A	Conditional Use
2	EMCO	3825/2	LISN (150kHz-30MHz)	9002-1601	N/A	2023-Oct-01
3	ETS Lindgren	2165	Turntable	00043677	N/A	N/A
4	ETS Lindgren	2125	Mast	00077487	N/A	N/A
5	ETS Lindgren	S201	5-meter Semi-Anechoic Chamber	1030	N/A	N/A
6	Hewlett Packard	8449B	Preamplifier (1-26 GHz)	2933A00198	N/A	2025-Feb-15
7	Rohde & Schwarz	ESU40	EMI Receiver	100011	EMC32 v10.35.10/ FV 4.73 SP4	2023-Jul-05
8	Sunol Sciences	DRH-118	Horn Antenna, 1.0-18 GHz	A050905	N/A	2023-07-28
9	Sunol Sciences	SM46C	Turntable	051204-2	N/A	N/A
10	Sunol Sciences	TWR95	Mast	TREML0001	N/A	N/A
11	Sunol Sciences	JB3	Biconilog Antenna 30MHz – 3GHz	A042004	N/A	2023-Jul-30
14	Rigol	RSA5065-TG	Spectrum Analyser	39775	N/A	4/11/2023

Note: Equipment listed above have 3 years calibration interval.

Measurement Software List

Sl. No.	Manufacturer	Model	Version	Description
1	Rhode & Schwarz	EMC 32	10.35.10	Emissions Test Software
2	TESEQ	WIN 3000	1.2.0	Surge, EFT & Voltage Dips Immunity Test Program
3	Thurlby Thandar Instruments	HA-PC Link Version	2.02	Harmonics and Flicker Test Program
4	VI Automation	Via EMC Immunity Executive	1.0.308	Radiated and Conducted Immunity Test Program

1.4 Summary of Results

The following testing was performed pursuant to FCC Title 47 Part 15 and Industry Canada ICES-003 to demonstrate the testimony to "FCC, IC, & CE" mark Electromagnetic Compatibility testing for the product.

No.	Test	Applicable Standard	Description	Result
1	Antenna Requirement	FCC 47 CFR Part 15.203 RSS-Gen Issue 5 Section 7.1.2	Soldered, non-replaceable antenna	Complies
2	RF Peak Output Power	FCC 47 CFR Part 15.247 (b)(2) RSS-247 Issue 2 (5.1) (b)	Maximum peak conducted output power shall not exceed 1 W for systems employing at least 50 hopping channels.	Complies
3	20 dB Bandwidth	FCC 47 CFR Part 15.247 (a)(1)(iii) RSS-247 Issue 2 (5.1) (c)	Maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz	Complies
4	99% Occupied Bandwidth	RSS-247 Issue 2 RSS-Gen Issue 5	99% of the signal shall fall completely within the frequency range specified by the standard.	Complies
5	Out-of-Band Emmisions (Band Edge)	FCC 47 CFR Part 15.247 (d)	In any 100 kHz bandwidth outside the frequency band in which the device is operating, the RF power shall be at least 20dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power.	Complies
6	Channel Separation	FCC 47 CFR Part 15.247 (a)(1) RSS-247 Issue 2 (5.1) (b)	Frequency hopping systems shall have channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.	Complies
7	Number of Channels	FCC 47 CFR Part 15.247 (a)(1)(iii) RSS-247 Issue 2 (5.1) (c)	If the 20 dB bandwidth of the hopping channel is <250 kHz, the system shall use at least 50 hopping channels.	Complies
8	Time of Occupancy	FCC 47 CFR Part 15.247 (a)(1)(iii) RSS-247 Issue 2 (5.1) (c)	Average time of occupancy on any frequency shall not be greater than 0.4 s within a 20 s period.	Complies
10	Hopping Requirements	FCC 47 CFR Part 15.247 (a)(1) RSS-247 Issue 2 (5.1) (a)	Each pseudo random hopping frequency must be used equally on the average by each transmitter.	Complies
11	Radiated Spurious Emissions	FCC 47 CFR Part 15.205 (a), 15.209 (a), and 15.247 (d) FCC 47 CFR Part 15.109 RSS-247 Issue 2 (8.9) (8.10)	Radiated emissions requirements as stated in the Standards	Complies
12	Spurious Emissions – Receiver Mode	FCC 47 CFR Part 15.109 ICES-003 Issue 7	Radiated emissions requirements as stated in the Standards	Complies
13	RF Exposure Evaluation	FCC 47 CFR 2.1093 (e) FCC 47 CFR 1.1310 (d) RSS-102 Issue 2 (2.5.1)	RF exposure evaluation is required if the separation distance between the user and/or bystander and the device's radiating element is greater than 20 cm	Provided in seperated test report Complies

Table 1: Applicable test standards and descriptions

Note: The gain of the antenna(s) is provided by the client to measure or calculate test results and is not independently measured by QAI.

2 GENERAL INFORMATION

2.1 Product Description

The information provided in this section is for the Equipment Under Test (EUT) and the corresponding Auxiliary Equipment needed to perform the tests as a complete system.

Figure 1: EUT

Equipment Under Test (EUT)

Equipment	Bluetooth Gamepad
Description	Bluetooth mini gamepad for mobile phones
Manufacturer	Jacknife Gamer Inc.
Model No.	JKG2022A
Serial No.	2022A-001
Clock frequencies tuned upon within the EUT: Highest frequency generated within the EUT:	2400MHz to 2483.5MHz 2480MHz

Equipment Under Test (EUT) – RF Information

Operating frequency	**2400MHz to 2483.5MHz**
Number of available channels/Transmitter	**Bluetooth BLE v5.0**
Modulation type	**Nrf52832**
Test Channels (L, M, H)	**xx MHz, xx MHz, xx MHz**
Data Rate	**1Mbits to 2 MBits**
Adaptive	**N/A**
Geo-location-capable	**N/A**
Number of antennas	**1**
Antenna type	**Trace**
Antenna gain	**+1.0**

Notes: None.

Equipment Under Test (EUT) – General Information

Tested as	Portable
Dimensions	6.4x2.9x2.7 cm
Declared operating temperature range:	-20 to 45 °C
Input power	0.9W
Grounded	No
Device use	Click or tap here to enter text.

Notes: None.

2.2 Environmental Conditions

The equipment under test was operated and tested under the following environmental conditions:

Parameter	Conditions
Location	Indoors
Temperature	23-24ºC
Relative Humidity	39.7 - 54.4%

2.3 Measurement Uncertainty

Parameter	Uncertainty
Radiated Emissions, 30MHz-1GHz	± 2.40 dB
Radiated Emissions, 1GHz-40GHz	± 2.48 dB
Radio Frequency	±1.5 x 10-5 MHz

Total RF Power Conducted	±1.36 dB
Spurious Emissions, Conducted	±1.36 dB
RF Power Density, Conducted	±1.36 dB
Temperature	±1ºC
Humidity	±5 %
DC and low frequency voltages	±3 %

2.4 Worst Test Case

Worst-case orientation was determined during the preliminary testing. The final radiated emissions were performed in the worst-case orientation.

2.5 Sample Calculations of Emissions Data

Radiated and conducted emissions were performed using EMC32 software developed by Rohde & Schwarz. Transducer factors such as antenna factors, cable losses and amplifier gains were stored in the test templates which are used to perform the emissions measurements. After the test is finished, data is generated from the EMC32 consisting of product details, emission plots and final data tables as shown below.

Frequency (MHz)	Q-Peak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Ant. Ht. (cm)	Pol	Turntable Position (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
42.663900	33.0	1000.000	120.000	100.0	H	70.0	13.2	7.5	40.5

Table 2: Sample Quasi-Peak Correction Data - Radiated

Quasi-Peak reading shown in the table above is already corrected by the software using the correction factor shown in column “Corr.” The correction factor listed under “Corr.” table calculated as:

Corr.(dB) = Antenna factor + Cable loss

Or

Corr.(dB) = Antenna factor + Cable Loss - Amp gain (if pre-amplifier was used)

The final Quasi peak reading shown in the data is calculated by the software using following equation:

Corrected Quasi-Peak (dBµV/m) = Raw Quasi-Peak Reading + Antenna factor + Cable loss

To obtain the final Quasi-Peak or Average reading during power line conducted emissions, transducer factors are included in the final measurement as shown below.

Frequency (MHz)	Q-Peak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	PE	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.150	44.3	1000.000	9.000	GND	0.6	21.7	66.0

Table 3: Sample Quasi-Peak Correction Data - Conducted Emissions

Frequency (MHz)	Average (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	PE	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.150	27.2	1000.000	9.000	GND	0.6	28.8	56.0

Table 4: Sample Average Correction Data- Radiated Emissions

Quasi Peak or Average reading shown in above table is already corrected by the software using the correction factor shown in column “Corr.” The correction factor listed under “Corr.” table calculated as:

Corr.(dB) = Antenna factor + Cable loss

The final Quasi-peak or Average reading shown in the data is calculated by the software using following equation:

Corr. Quasi-Peak/Average Reading (dBµV) = Raw Quasi-Peak/Average Reading + Antenna factor + Cable loss

The allowable margin from the limits, as per the standards, were calculated for both radiated and conducted emissions:

Margin(dB) = Limit – Quasi-Peak or Average reading

3 DATA & TEST RESULTS

3.1 Antenna Requirements

Date Performed:	September 29, 2022
Test Standard:	FCC CFR 47 Part 15.203 IC RSS-Gen Issue 7 Section 7.1.2
Test Method:	ANSI C63.10:2013
Modifications:	No modification was required to comply for this test.
Final Result:	The antenna is a trace antenna that was replicated from another design with a (1.0 dBi) peak gain.

Applicable Regulations:

The purpose of this requirement is to make certain that no other antenna, except for that provided by the responsible party, shall be used with the Equipment-Under-Test (EUT) as defined in Section 1.1.

"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 use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that the user can replace a broken antenna, but the use of a standard antenna jack or electrical connector is prohibited. The installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this Part are not exceeded."

3.2 RF Peak Power Output

Date Performed: September 29, 2022

Test Standard: FCC CFR 47 Part 15.247 (b)(1)
IC RSS-247 Issue 2

Test Method: FCC KDB 558074 D01 DTS Measurement Guidance V04
Span = 1 MHz, RBW = 120 kHz, VBW = 300 kHz
Detector: Peak, Trace: Max Hold

Modifications: No modification was required to comply for this test.

Final Result: The EUT complies with the applicable standard.

Applicable Regulation:

For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

Test Setup:

The EUT was tested outside the SAC via output conducted measurements per FCC KDB 558074 D01 DTS Measurement Guidance V04.

Measurement Data and Plots:

Carrier Frequency (MHz)	Raw Peak (dBm)	Correction Factor (dB)	Corrected Peak Conducted Output Power (dBm)	Limit (dBm)	Margin (dB)	Results
2401	-30.96	20.90	-10.06	30	40.06	Complies
2441	-30.69	20.90	-9.79	30	39.79	Complies
2480	-30.44	20.90	-9.54	30	39.54	Complies

Table 5: RF Peak Power Output

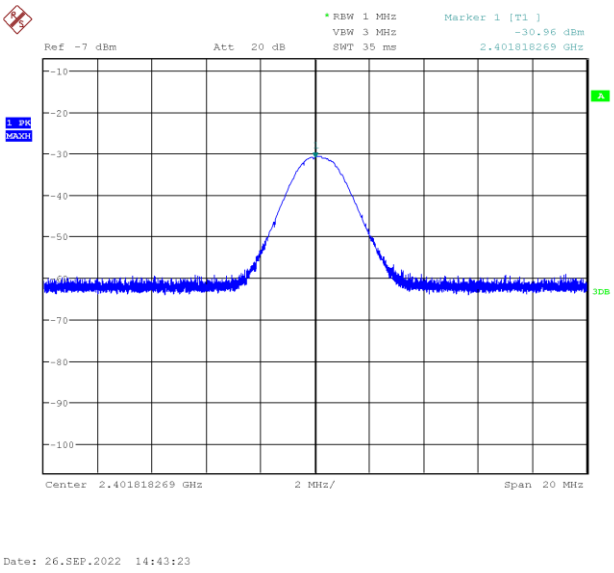

Figure 2: Peak Output Power - Lowest Frequency

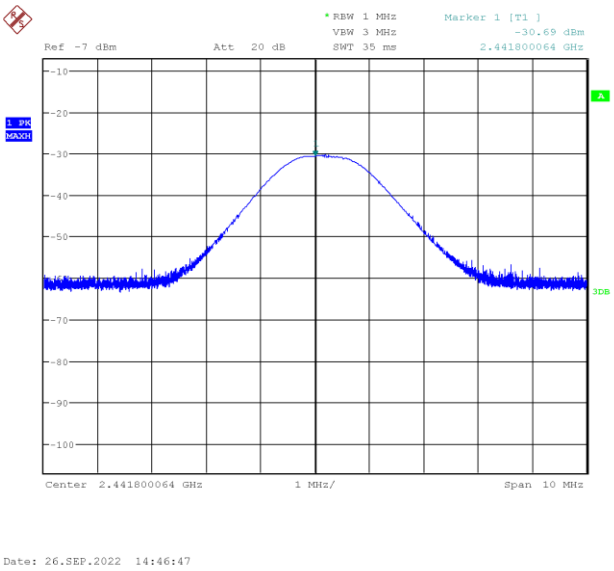

Figure 3: Peak Output Power - Middle Frequency

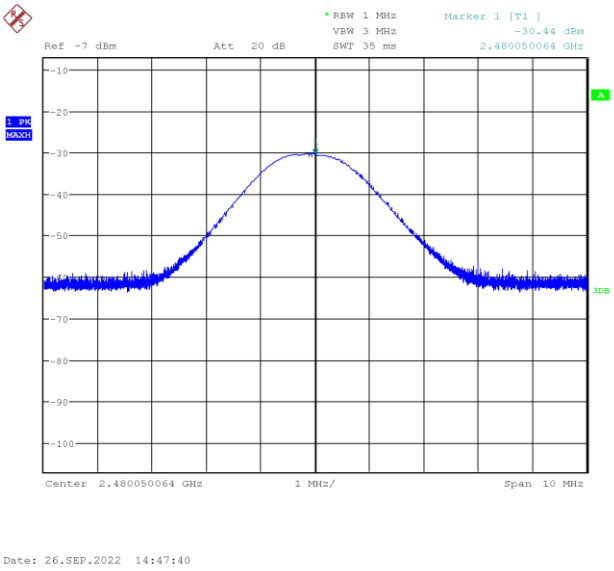

Figure 4: Peak Output Power - Highest Frequency

3.3 20dB Occupied Bandwidth

Date Performed: September 29, 2022

Test Standard: FCC CFR 47 Part 15.247
IC RSS-247 Issue 2
IC RSS-Gen Issue 5

Test Method: ANSI C63.10:2013
Span = 2 to 5 x OBW, RBW = 1 to 5% of OBW, VBW = 3 x RBW
Ref Level > 10log(OBW/RBW) above signal peak
Detector: Peak, Trace: Max Hold

Modifications: No modification was required to comply for this test.

Final Result: The EUT complies with the applicable standard.

Test Setup:

The EUT was tested outside the SAC via output conducted measurements per ANSI C63.10:2013.

Channel	Carrier Frequency (MHz)	20dB Bandwidth (kHz)	Result
Low	2401	1084	Complies
Middle	2441	1112	Complies
High	2480	1112	Complies

Table 6: 20 dB Bandwidth Results

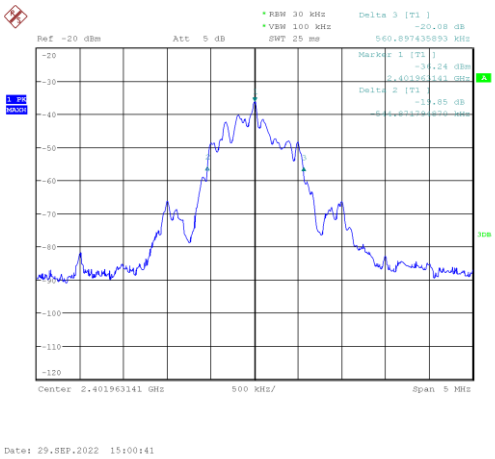

Figure 5: 20 dB Bandwidth - Low Channel

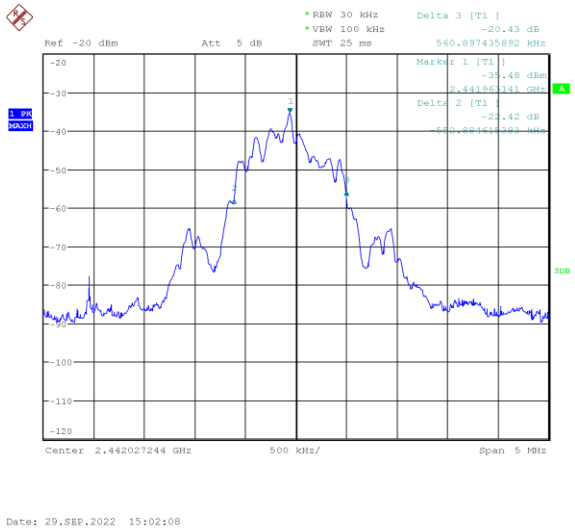

Figure 6: 20 dB Bandwidth - Mid Channel

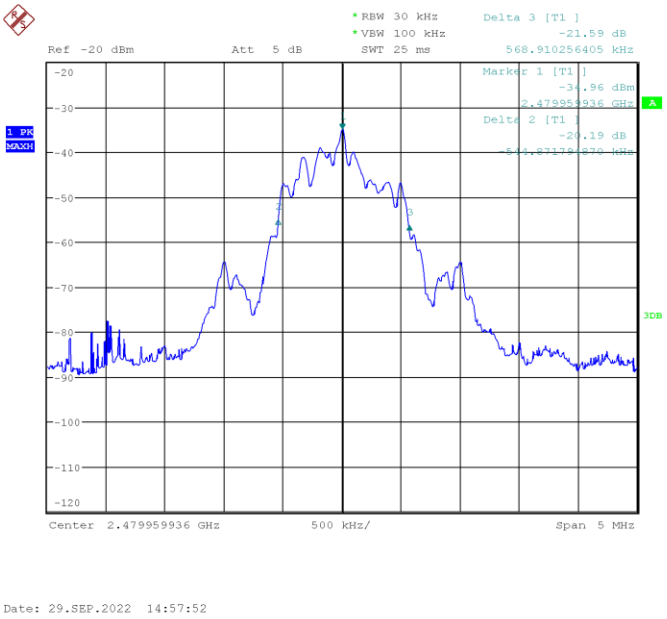

Figure 7: 20 dB Bandwidth - High Channel

3.4 99% Occupied Bandwidth

Date Performed: September 27, 2022

Test Standard: IC RSS-247 Issue 2
IC RSS-Gen Issue 5

Test Method: ANSI C63.10:2013
Span = 1.5 to 5 x OBW, RBW = 1 to 5% of OBW, VBW = 3 x RBW
Ref Level > 10log(OBW/RBW) above signal peak
Trace Detector: Sample, Sweep: Single

Modifications: No modification was required to comply for this test

Final Result: The EUT Comply with the applicable standard.

Applicable Regulation:

The Occupied Channel Bandwidth is the bandwidth that contains 99% of the signal power. The bandwidth shall fall completely within the range specified by the standard.

Test Setup:

The EUT was tested outside the SAC via output conducted measurements per ANSI C63.10:2013.

Channel	Carrier Frequency (MHz)	99% Bandwidth (kHz)	Result
Low	2401	1052	Complies
Middle	2441	1056	Complies
High	2480	1058	Complies

Table 7: 99% Occupied Bandwidth Results

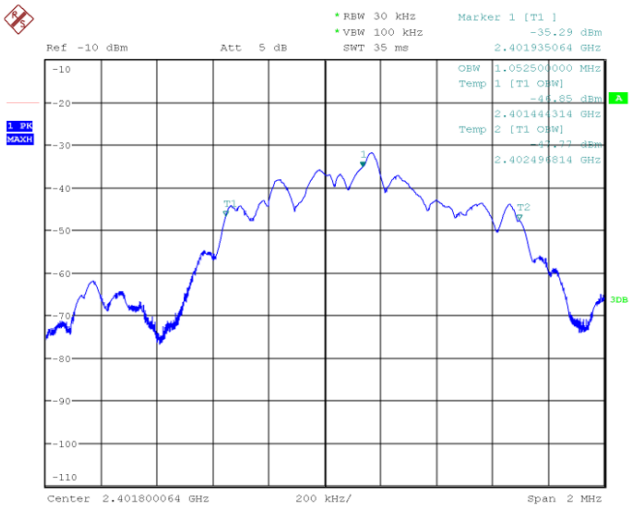

Figure 8: 99% Occupied Bandwidth - Low Channel

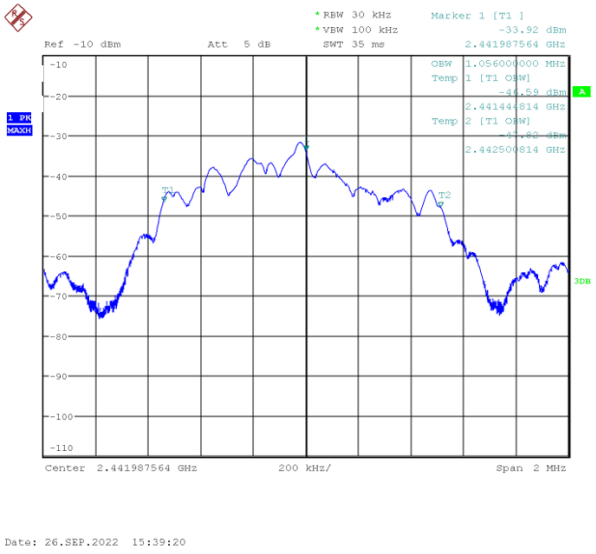

Figure 9: 99% Bandwidth - Mid Channel

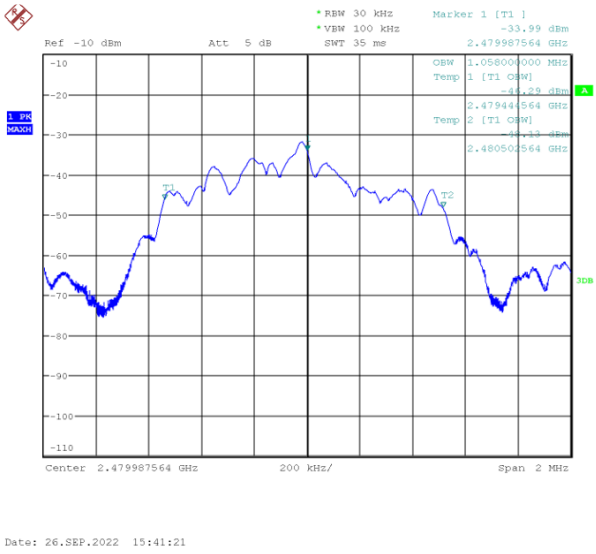

Figure 10: 99% Bandwidth - High Channel

3.5 Out-Of-Band Emissions (Band Edge)

Date Performed:	September 26, 2022
Test Standard:	FCC CFR 47 Part 15.247 (d) IC RSS-247 Issue 2
Test Method:	ANSI C63.10:2013 Span = Wide enough to capture the peak level of the emission closest to the band edge, as well as any modulation products that fall outside of the band. Ref Level = High enough to keep the signal from overdriving the input mixer RBW = 100 kHz, VBW = 300 kHz Trace Detector: Peak, Trace: Max Hold
Modifications:	No modification was required to comply for this test.
Final Result:	Complies

Applicable Regulation:

In any 100kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, shall be at least 20 dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section A8.4 (4) of the standard, the attenuation required shall be 30 dB instead of 20dB.

Test Setup:

The EUT was tested outside the SAC via output conducted measurements per ANSI C63.10:2013.

This test was performed twice: once with the hopping function turned OFF and then repeated with the hopping function turn ON. The purpose of the test with the hopping function turned on is to confirm that the RF power remains OFF while the device is changing frequencies, and that the oscillator stabilizes at the new frequency before RF power is turned back ON. Overshoot of any oscillator, including phase-lock-loop stabilized oscillators, can cause the device to be temporarily tuned to frequencies outside the authorized band, and it is important that no transmissions occur during such temporary periods.

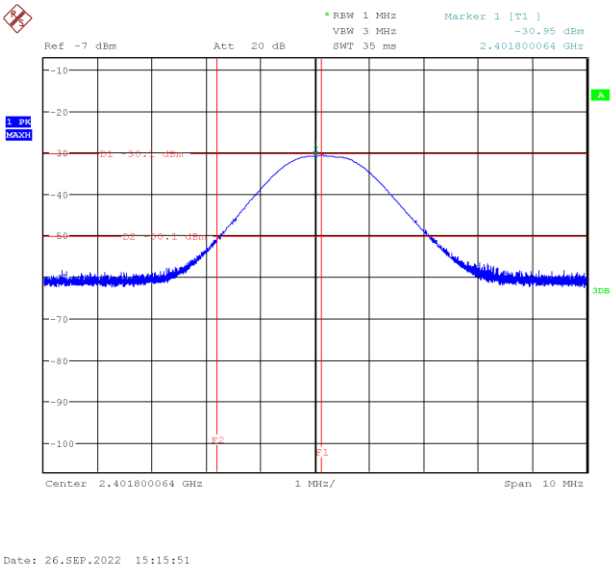

Figure 11: Band Edge, Hopping ON - Low Channel

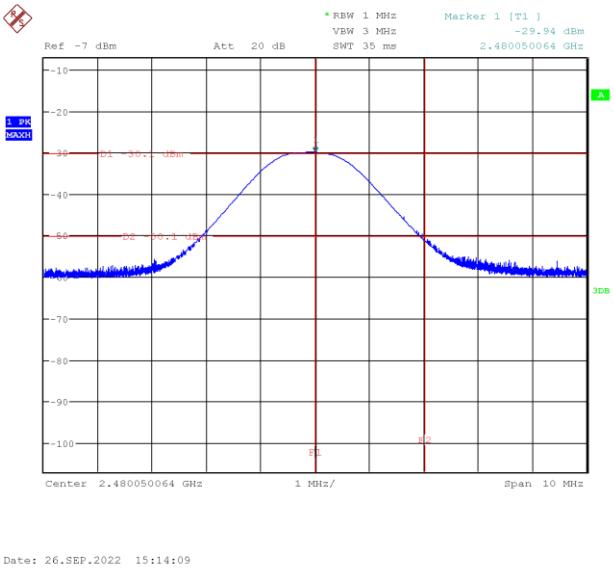

Figure 12: Band Edge, Hopping ON - High Channel

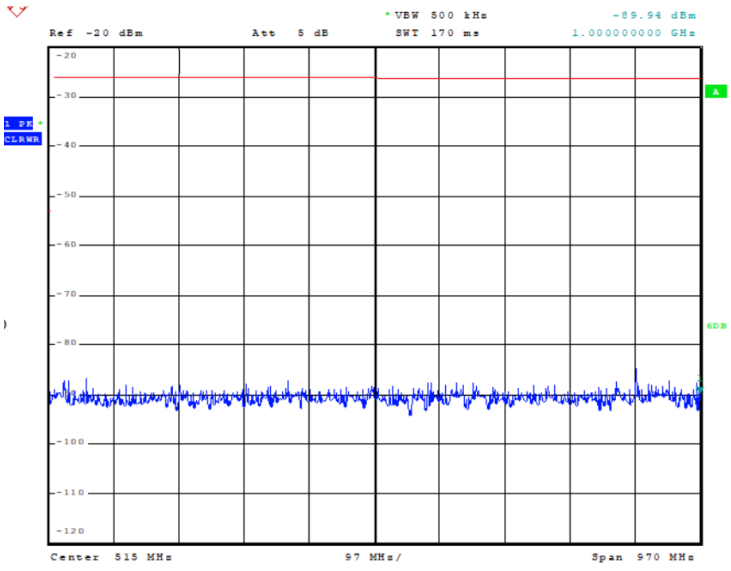

Figure 13: Band Edge, Hopping ON -Worst case of below 1GHz

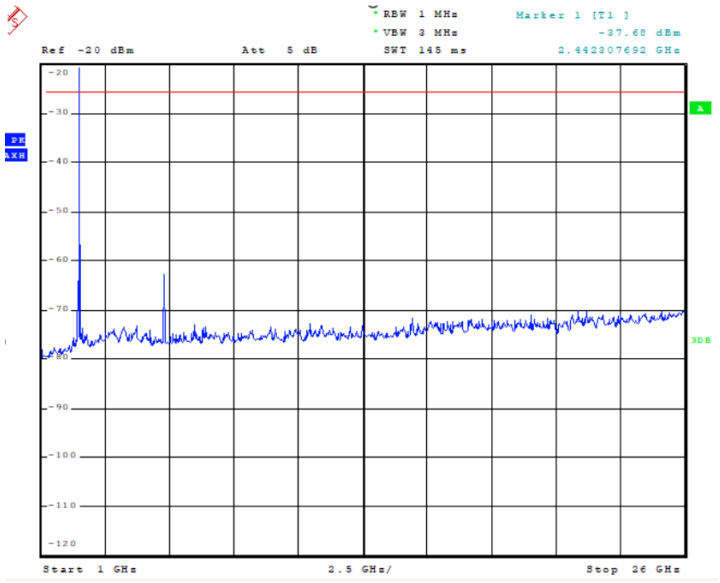

Figure 14: Band Edge, Hopping ON -Worst case of above 1GHz

andedge Frequency (MHz)	Out of Bands Peak (dBm)	Limit (dBm)	Margin (dB)	Result
2.4	-62.3	-50.1	-11.2	Complies

Table 8: Bandedge Results

3.6 Channel Separation

Date Performed: September 29, 2022

Test Standard: FCC CFR 47 Part 15.247 (a)(1)
IC RSS-247 Issue 2 (5.1)(c)

Test Method: ANSI C63.10:2013
Span = Wide enough to capture the peak of two adjacent channels.
Ref Level = High enough to keep the signal from overdriving the input mixer
RBW = Approximately 30% of the channel spacing; adjusted as necessary to identify the center of each individual channel.
VBW ≥ RBW
Trace Detector: Peak, Trace: Max Hold

Modifications: No modification was required to comply for this test.

Final Result: Complies

Applicable Standard:

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

Test Setup:

The EUT was tested outside the SAC via output conducted measurements per ANSI C63.10:2013.

The channel separation measurement was made by connecting the spectrum analyzer to the active antenna port using a 20 dB attenuator. Testing was done using the maximum power output with the system configured for normal operation using a pseudorandom hopping pattern.

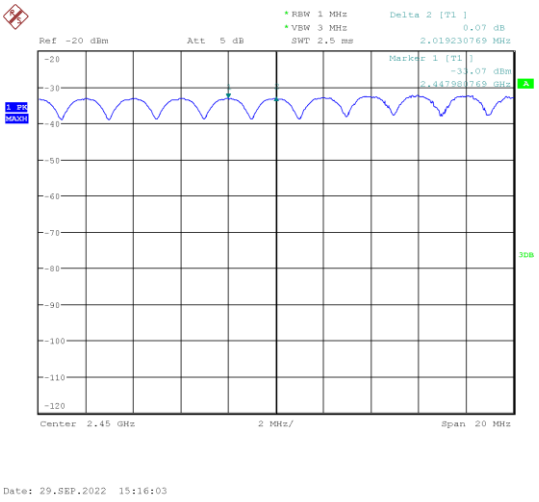

Figure 15: Channel Separation plot

Modulation	Channel Separation (kHz)	Maximum Limit (kHz)	Result
GFSK	2000	25 kHz	Complies

Table 9: Channel Separation Results

3.7 Number of Hopping Channels and channel separation

Date Performed:	September 26, 2022
Test Standard:	FCC CFR 47 Part 15.247 (a)(1)(iii) IC RSS-247 Issue 2 (5.1)(c)
Test Method:	ANSI C63.10:2013 **Span** = The frequency band of operation. Depending on the number of channels the device supports, it may be necessary to divide the frequency range of operation across multiple spans, to allow the individual channels to be clearly seen. **RBW** = 30% of the channel spacing or the 20 dB BW, whichever is smaller. **VBW** ≥ RBW **Detector:** Peak, **Trace:** Max Hold
Modifications:	No modification was required to comply for this test.
Final Result:	Complies

Applicable Standard:

Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

Test Setup:

The EUT was tested outside the SAC via output conducted measurements per ANSI C63.10:2013.

The channel separation measurement was made by connecting the spectrum analyzer to the active antenna port using a 20 dB attenuator. Testing was done using the maximum power output with the system configured for normal operation using a pseudorandom hopping pattern.

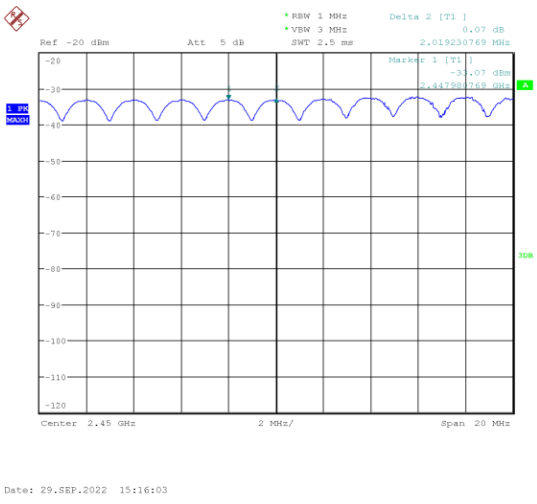

Figure 16: Channel separation

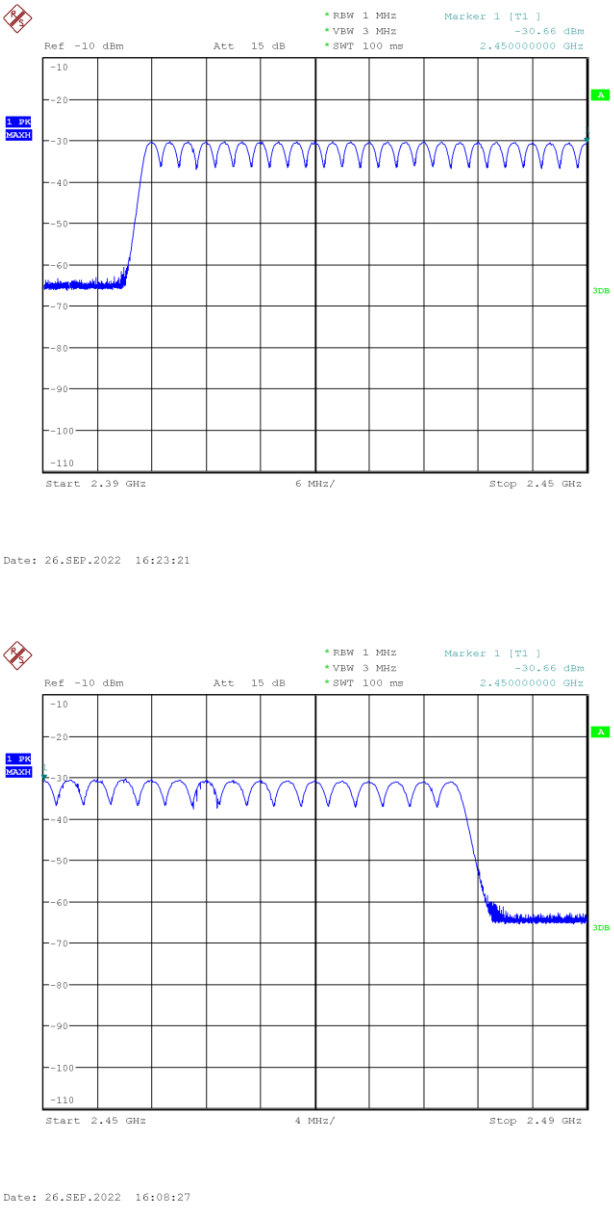

Figure 17: Number of Hopping Channels

Modulation	Number of Hopping Channels	Minimum Number of Channels	Result
FSK	40	15	Complies

Table 10: Number of Hopping Channels Results

3.8 Time of Occupancy (Dwell Time)

Date Performed:	September 29, 2022
Test Standard:	FCC CFR 47 Part 15.247 (a)(1)(iii) IC RSS-247 Issue 2 (5.1)(c)
Test Method:	ANSI C63.10:2013 **Span** = Zero span on a hopping channel. **RBW** = ≤ Channel spacing and where possible RBW >> 1/*T* where *T* is the expected dwell time. **Detector:** Peak, **Trace:** Max Hold
Modifications:	No modification was required to comply for this test.
Final Result:	Complies

Applicable Standard:

Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

Test Setup:

Bandwidth and band-edge measurements for frequency-hopping spread spectrum systems are typically made by connecting the spectrum analyzer to the active antenna port using a suitable RF attenuator. These measurements require verification that the antenna port selected is the active one if the system has more than one antenna. Testing shall be done using the maximum power output. The system shall be configured for normal operation using a pseudorandom hopping pattern.

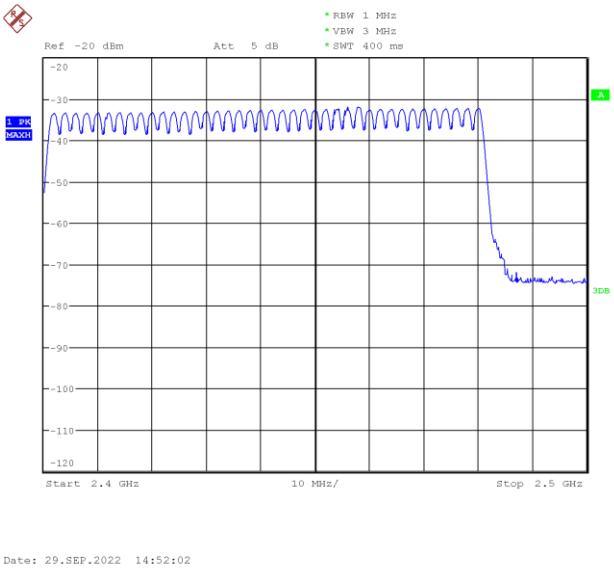

Figure 18: Number of hoping

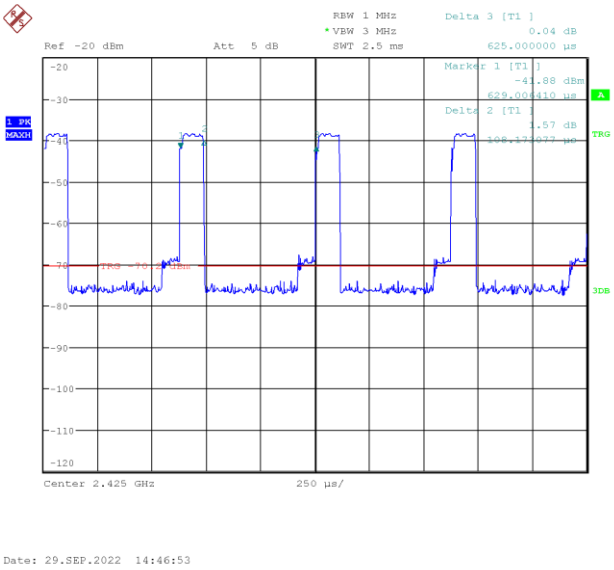

Figure 19: Transmit Time per Hop Plot

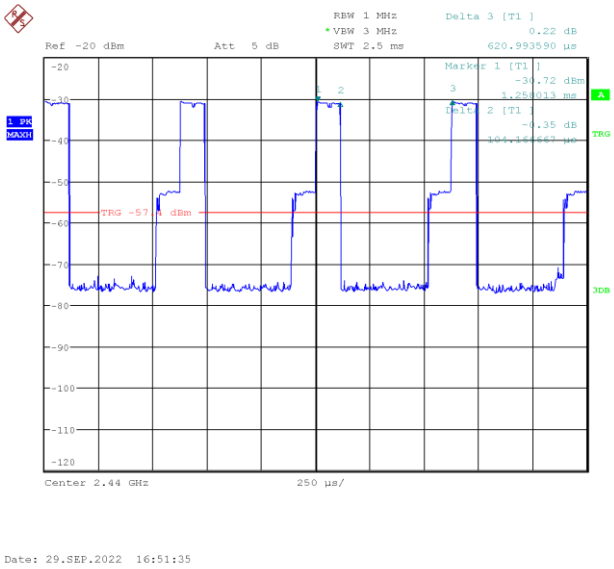

Figure 20: Dwelling time

The average time of occupancy is calculated from the transmit time per hop multiplied by the number of hops in the period specified in the standard.

$$Time\ of\ Occupancy = N_{Bursts} \times T_{Burst}$$

Where,
N_{Bursts} is the number of bursts
T_{Burst} is the transmit time of each burst

The sweep time used to measure the time of occupancy is calculated as:

$$T_{Measurement} = 0.4 \times N_{channels}$$

Where,
$N_{channels}$ is the number of channels used

Modulation	Number of Hopping Channels	Burst Pulse Width (ms)	Time of Occupancy (ms)	Burst duty cycle %	Max Limit ms	Result
GFSK	40	0.108	4.32	14	400	Complies

Table 11: Time of Occupancy (Dwell Time) Results

3.9 Radiated Spurious Emissions

Date Performed: September 26, 2022

Test Standard: FCC CFR 47 Part 15.205, 15.209, 15.247
IC RSS-247 Issue 2
IC RSS-Gen Issue 5

Test Method: ANSI C63.10:2013

Modifications: No modification was required to comply for this test.

Final Result: Complies

Applicable Standard:

Test or Measurement	Applicable Standards	Investigated Spectrum
Radiated Emissions	ICES-003 Issue 6 CFR Title 47 FCC Part 15 Subpart B	The radiated emissions are measured in the 30-1000MHz range or **upto** the highest EUT frequency required by the standard.
	RSS-247-Issue 2, RSS-Gen Issue 5 (8.9) & (8.10) FCC Subpart C §15.205(a), 15.209(a) & 15.247(d) and 15.33(a)(1) & (4)	From the lowest radio frequency signal generated in the device, without going below 9 kHz, up to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

Required Limits:

1) Radiated emission limits; general requirements – unintentional radiators:

The field strength of radiated emissions from a Class A digital device, as determined at a distance of 3 meters, shall not exceed the following as per §15.109:

Frequency, *f* (MHz)	Maximum Field strength Quasi-peak (dBµV/m at 3 m)
30 – 88	49.50
88 – 216	53.5
216 – 960	56.0
above 960	59.50

Note 1: The above field strength limits are specified at a distance of 3 meters. The tighter limits apply at the band edges.
Note 2: The emissions limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz.
Radiated emission limits in these three bands are based on measurements employing an average detector.

2) Radiated emission limits; general requirements – intentional radiators:

The emissions from an intentional radiator shall not exceed the field strength levels specified in the following table as per §15.209:

Frequency, *f* (MHz)	Maximum Field strength Quasi-peak (dBµV/m at 3 m)
0.009 – 0.490	2400/F(kHz)
0.490 – 1.705	24000/F(kHz)
1.705 – 30.0	49.5
30 – 88	40.0
88 – 216	43.5
216 – 960	46.0
above 960	54.0

Note 1:	The above field strength limits are specified at a distance of 3 meters. The tighter limits apply at the band edges.
Note 2:	The emissions limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90 kHz., 110-490 kHz. and above 1000 MHz.
	Radiated emission limits in these three bands are based on measurements employing an average detector

Maximum Field Strength (dB mV/m at 3 m)		
Frequency (GHz)	**Peak**	**Average**
1-40	60	80
Note 1: The lower limit shall apply at the transition frequency		
Note 2: Additional provisions may be required for cases where interference occurs		

3) Restricted bands of operation:

Unwanted emissions that fall into the restricted bands specified on the table below shall comply with the limits specified on the table limits above as per §15.209 and Clause 8.9 of RSS-Gen.

Restricted Bands – RSS Gen Issue 5

MHz	MHz	GHz
0.090 - 0.110	149.9 - 150.05	9.0 - 9.2
0.495 - 0.505	156.52475 - 156.52525	9.3 - 9.5
2.1735 - 2.1905	156.7 - 156.9	10.6 - 12.7
3.020 - 3.026	162.0125 - 167.17	13.25 - 13.4
4.125 - 4.128	167.72 - 173.2	14.47 - 14.5
4.17725 - 4.17775	240 - 285	15.35 - 16.2
4.20725 - 4.20775	322 - 335.4	17.7 - 21.4
5.677 - 5.683	399.9 - 410	22.01 - 23.12
6.215 - 6.218	608 - 614	23.6 - 24.0
6.26775 - 6.26825	960 - 1427	31.2 - 31.8
6.31175 - 6.31225	1435 - 1626.5	36.43 - 36.5
8.291 - 8.294	1645.5 - 1646.5	Above 38.6
8.362 - 8.366	1660 - 1710	Certain frequency bands listed in table 2 and in bands above 38.6 GHz are designated for licence-exempt applications. These frequency bands and the requirements that apply to related devices are set out in the 200 and 300 series of RSSs.
8.37625 - 8.38675	1718.8 - 1722.2	
8.41425 - 8.41475	2200 - 2300	
12.29 - 12.293	2310 - 2390	
12.51975 - 12.52025	2483.5 - 2500	
12.57675 - 12.57725	2655 - 2900	
13.36 - 13.41	3260 - 3267	
16.42 - 16.423	3332 - 3339	
16.69475 - 16.69525	3345.8 - 3358	
16.80425 - 16.80475	3500 - 4400	
25.5 - 25.67	4500 - 5150	
37.5 - 38.25	5350 - 5460	
73 - 74.6	7250 - 7750	
74.8 - 75.2	8025 - 8500	
108 - 138	--	

Restricted Bands – FCC Part 15.205

MHz	MHz	MHz	GHz
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
[1]0.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2690-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	([2])
13.36-13.41			

Test Setup

The EUT was positioned at the edge of the turntable in the 3m SAC with all cables draped down the side, 40 cm off the ground plate. EUT was rotated 360 deg. at each antenna height to identify maximum emissions. Emissions were measured in the frequency range of 30MHz – 12GHz using the appropriate components and equipment.

Emissions in both horizontal and vertical polarizations were measured. EUT was placed 3 m from the antenna.

30 MHz – 12 GHz: antenna height was varied 1-4 m.

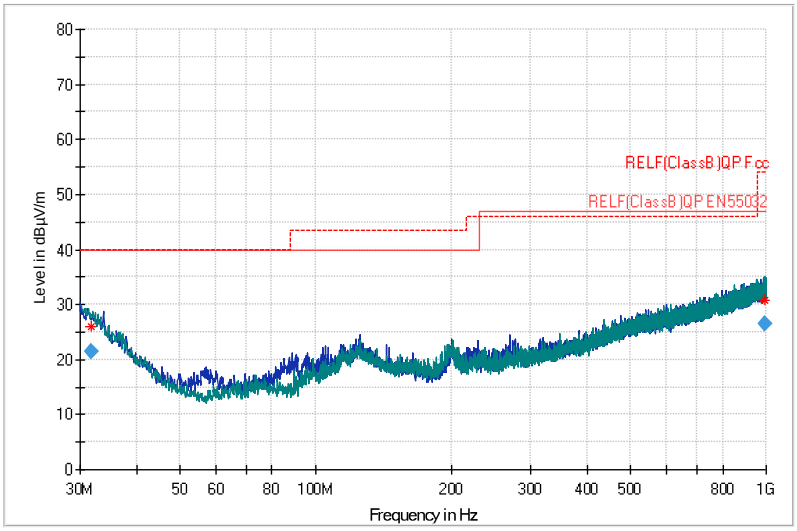

Figure 21: Radiated Emissions at 3m SAC- Battery Mode– 30M- 1GHz-Class B Limit

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
31.8106	21.97	40.00	18.03	1000	120	100.0	H	194	26.6
990.2064	35.63	47.00	11.37	1000	120	293.0	V	25	30.1

Table 12: Data of Radiated Emissions at 3m SAC Battery Mode– 30M- 1GHz -Class B Limit

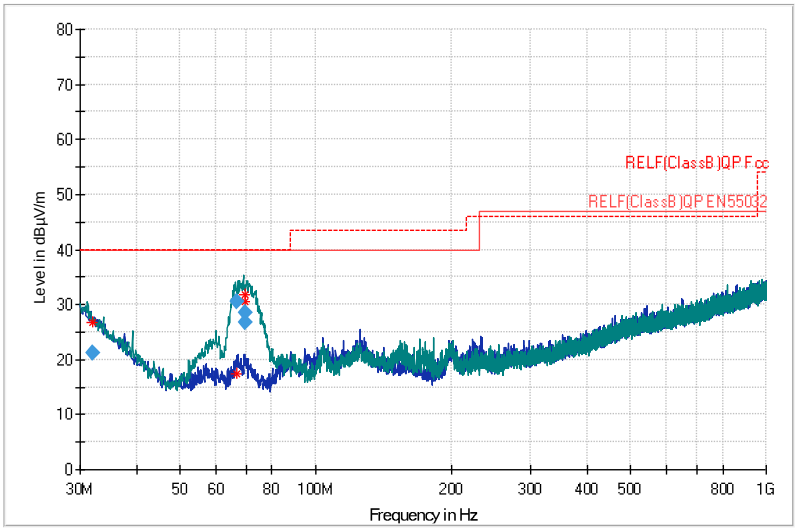

Figure 22: Radiated Emissions at 3m SAC- Charging Mode- 30M- 1GHz–Class B Limit

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
32.0343	21.18	40.00	18.82	1000.0	120.0	278.0	V	233	25.1
66.9813	30.59	40.00	9.41	1000.0	120.0	166.0	V	98	13.1
69.7755	26.84	40.00	13.16	1000.0	120.0	184.0	V	194	13.3
69.8386	28.41	40.00	11.59	1000.0	120.0	214.0	V	142	13.3

Table 13: Data of Radiated Emissions at 3m SAC Battery Mode– Mode– 30M- 1GHz -Class B Limit

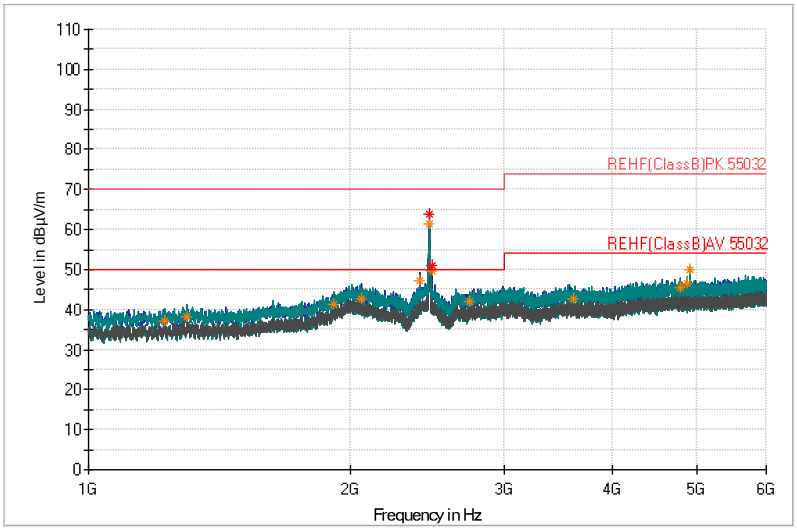

Figure 23: Radiated Emissions at 3m SAC- Charging Mode- 1GHz- 6GHz -Class B Limit Worst Case

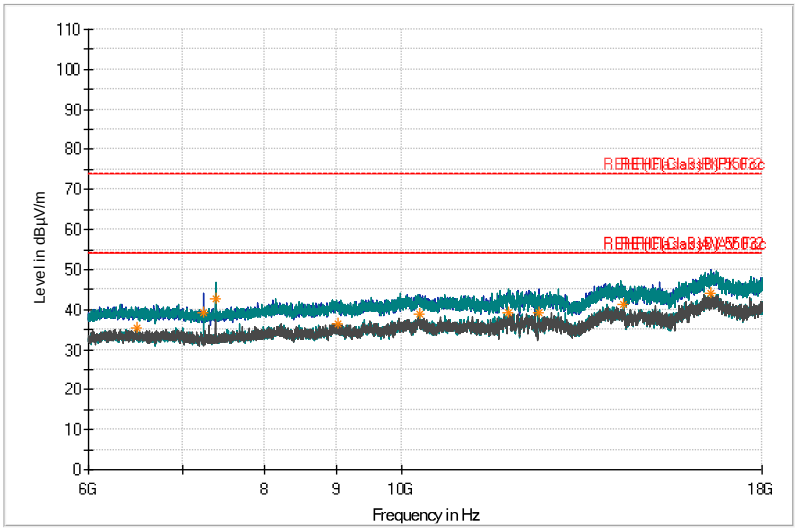

Figure 24: Radiated Emissions at 3m SAC- Charging– Mode– 6GHz- 18GHz -Class B Limit Worst case

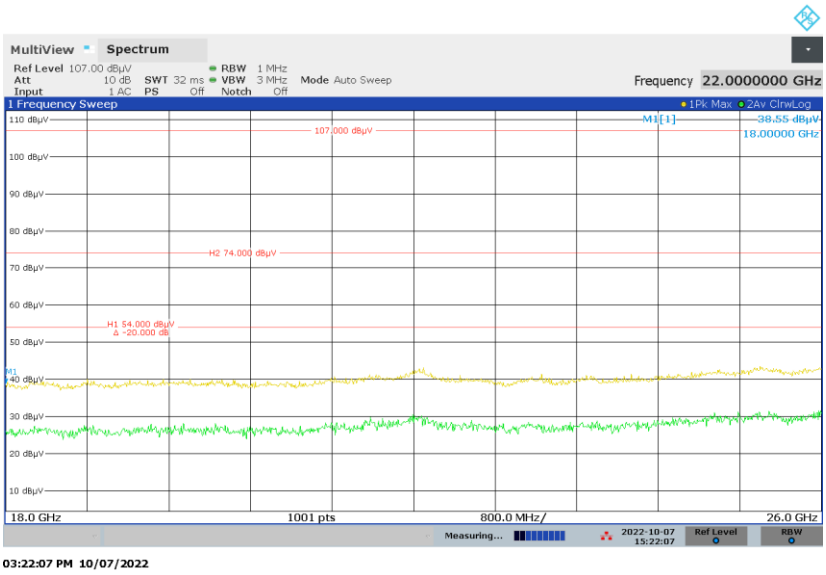

Figure 25: Radiated Emissions at 3m SAC- Charging– Mode– 18GHz- 26GHz -Class B Limit Worst case

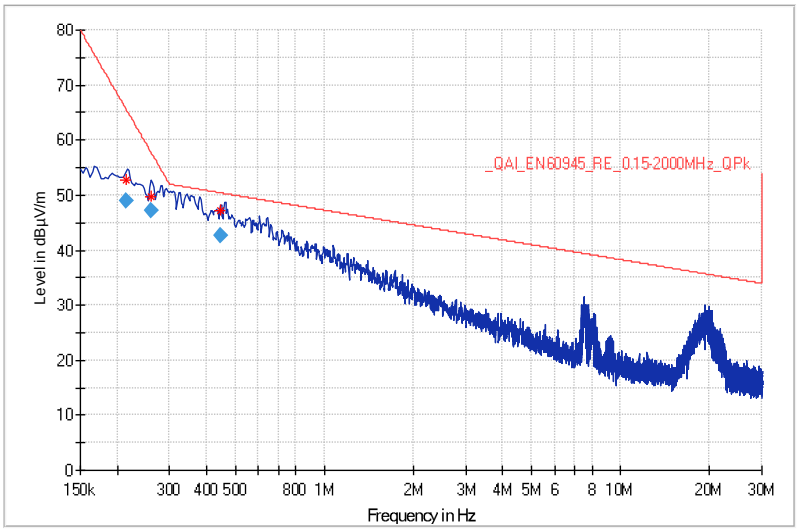

Figure 26: Radiated Emissions at 3m SAC- Charging Mode- 150k-30MHz-Horz

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
0.2135	48.99	65.75	16.76	100.0	V	273	20.5
0.2592	47.18	57.90	10.72	100.0	V	234	20.5
0.4481	42.68	50.43	7.75	100.0	V	166	20.6

Table 14: Data of Radiated Emissions at 3m SAC Battery Mode– Mode– 315 kHz – 30MHz-Horz

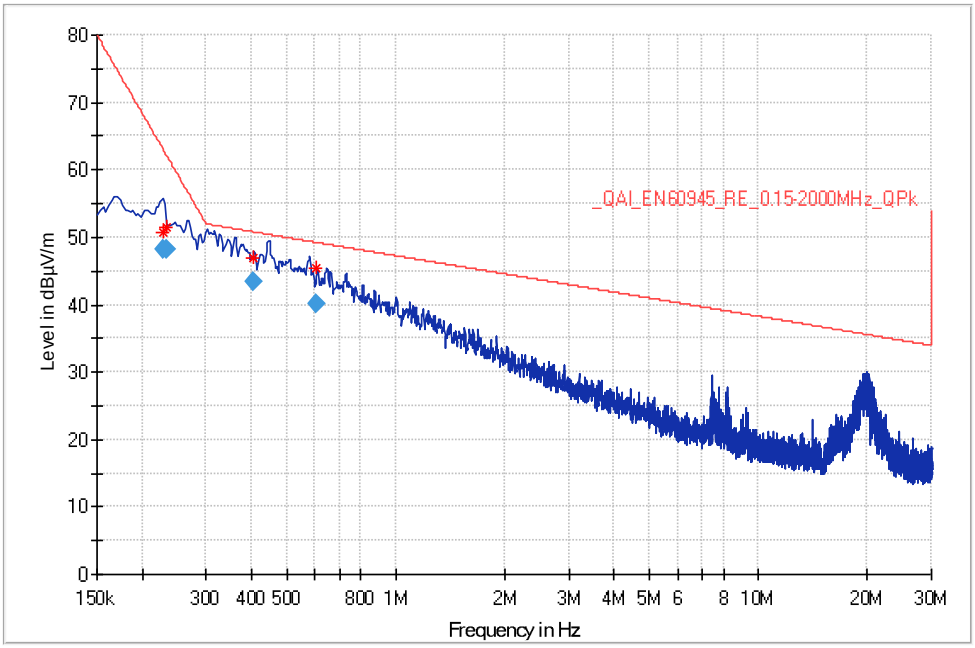

Figure 27: Radiated Emissions at 3m SAC- Charging Mode- 150k-30MHz-Vert

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
0.2283	48.32	63.03	14.71	100.0	V	82	20.5
0.2323	48.28	62.33	14.05	100.0	V	122	20.5
0.4057	43.42	50.82	7.40	100.0	V	76	20.3
0.6026	40.23	49.27	9.04	100.0	V	235	20.9

Table 15: Data of Radiated Emissions at 3m SAC Battery Mode– Mode– 315 kHz – 30MHz-Vert

3.10 Receiver Spurious Emissions

Date Performed: October 6, 2022

Test Standard: FCC CFR 47 Part 15.205, 15.209, 15.247
IC RSS-247 Issue 2
IC RSS-Gen Issue 5

Test Method: ANSI C63.10:2013

Modifications: No modification was required to comply for this test.

Final Result: Complies

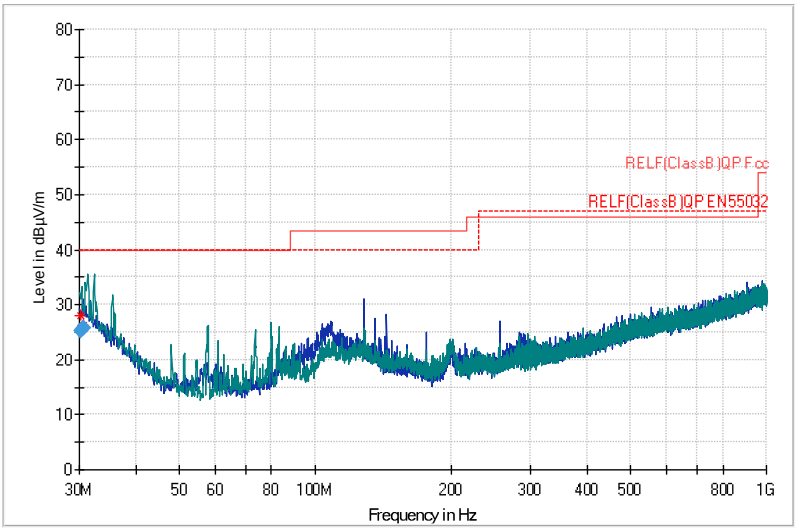

Figure 28: Radiated Emissions at 3m SAC- Charging Mode- 30MHz- 1GHz–Class B Limit

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
30.1772	25.28	40.00	14.72	1000.0	120.0	194.0	V	228	26.4
30.6970	25.70	40.00	14.30	1000.0	120.0	112.0	V	201	26.1

Table 16: Data of Radiated Emissions at 3m SAC Battery Mode– Mode– 30MHz – 1GHz -Class B Limit

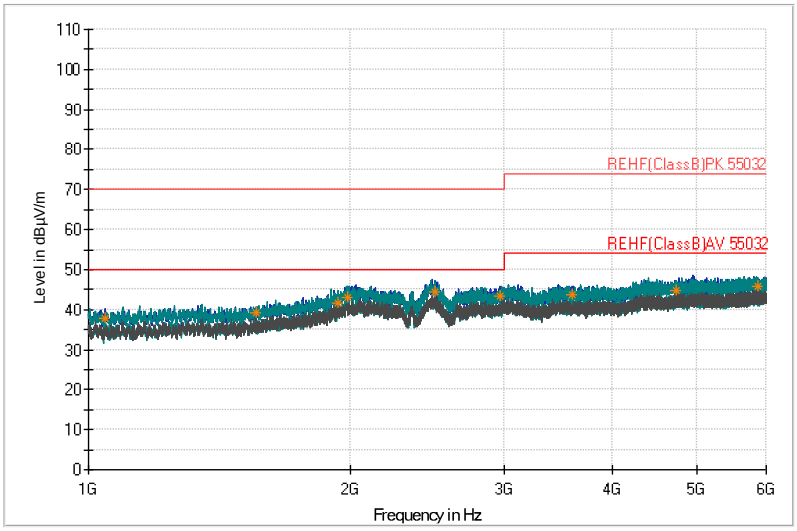

Figure 29: Radiated Emissions at 3m SAC- Charging Mode- 1GHz-6GHz–Class B Limit

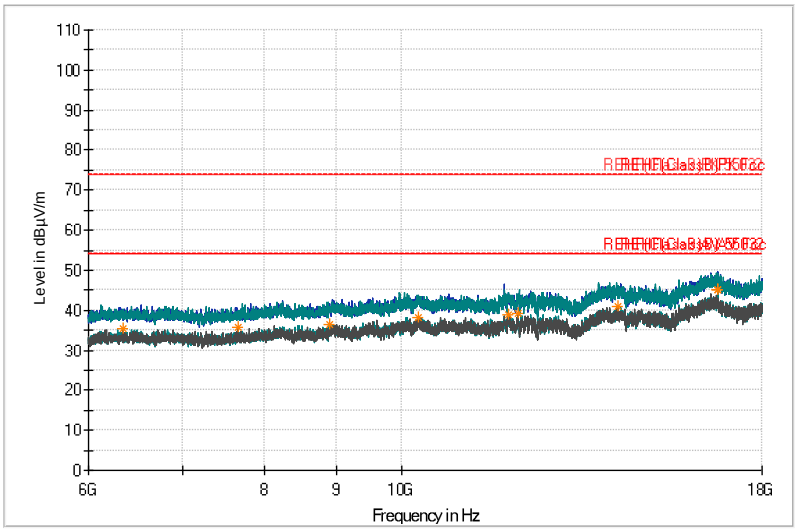

Figure 30: Radiated Emissions at 3m SAC- Charging Mode- 6GHz- 18GHz–Class B Limit

Appendix A: FIGURES

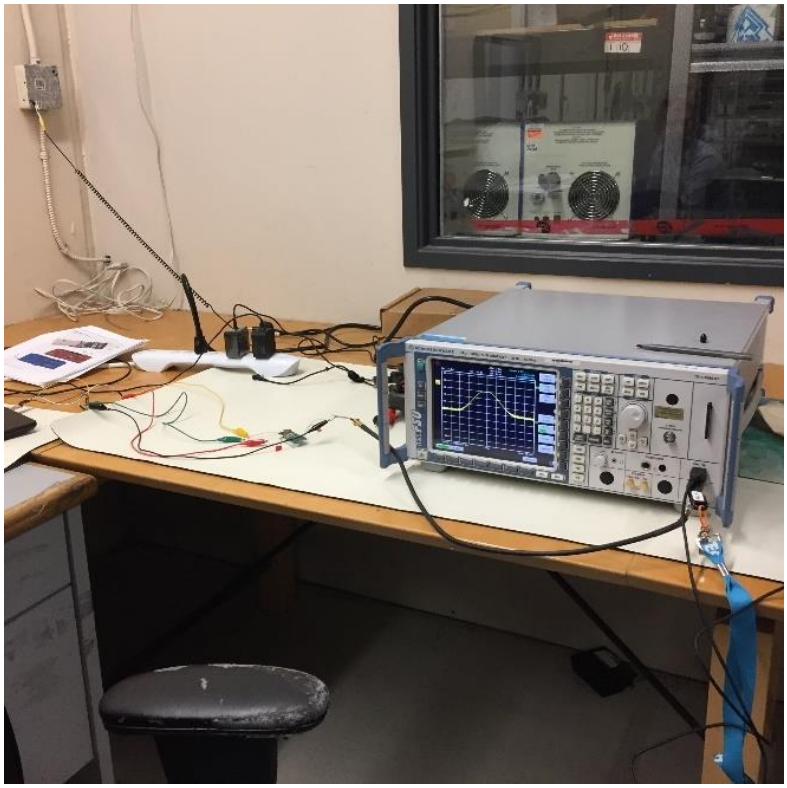

Figure 31: Radio Testing Setup Photo

Figure 32: Radiated Emissions performed at the 3m SAC, 30MHz – 1GHz Charging Mode

Figure 33: Radiated Emissions above 1GHz performed at the 3m SAC

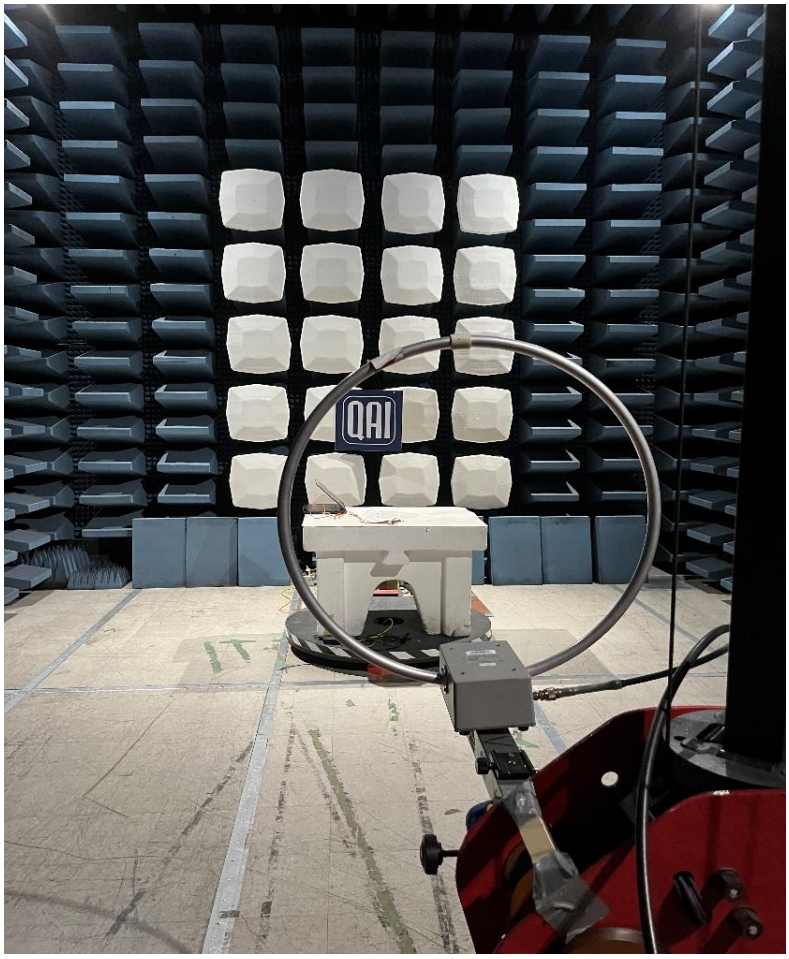

Figure 34: Radiated Emissions performed at the 3m SAC, 150kHz – 30MHz

Appendix B: ABBREVATIONS

Abbreviation	Definition
AC	Alternating Current
AM	Amplitude Modulation
CE	European Conformity
CISPR	Comité International Spécial des Perturbations Radioélectriques (International Special Committee on Radio Interference)
DC	Direct Current
EFT	Electrical Fast Transient
EMC	Electro Magnetic Compatibility
EMI	Electro Magnetic Interference
ESD	Electrostatic Discharge
EUT	Equipment Under Test
FCC	Federal Communications Commission
FVIN	Firmware Version Identification Number FVIN
IC	Industry Canada
ICES	Interference Causing Equipment Standard
IEC	International Electrotechnical Commission
LISN	Line Impedance Stabilizing Network
OATS	Open Area Test Site
RF	Radio Frequency
RMS	Root-Mean-Square
SAC	Semi-Anechoic Chamber

END OF REPORT