

ELECTROMAGNETIC COMPATIBILITY TEST REPORT

PREPARED FOR JSF TECHNOLOGIES INC.
BY QAI LABORATORIES



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Laboratory Accreditations (per ISO/IEC 17025:2017)



American Association for Laboratory Accreditation Certificate Number: 3657.02

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Applicable Test Standards:
FCC Title 47 Part 15 - Radio Frequency Devices, Subpart C – 15.249
15.212
CFR Title 47 FCC Part 15 - Subpart B – Unintentional Radiators.
RSS-210 Issue 10, RSS-Gen Issue 5, ICES-003 Issue 6, RSP-100 Issue 12

Equipment Under Tested: WP5 Wireless Platform 5
Model Number(s): WP5
FCC ID: SFIWP5
IC ID: 5301A-WP5
Manufacturer: JSF Technologies Inc.



REVISION HISTORY

Date	Report Number	Rev #	Details	Author's Initials
July 28, 2020	E11168-2002_JSF-WP5	0.0	Initial Release	JQ
August 4, 2020	E11168-2002_JSF-WP5	1.0	Updated photos	JQ
<i>All previous versions of this report have been superseded by the latest dated revision as listed in the above table.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.</i>				

REPORT AUTHORIZATION

The data documented in this report is for the test equipment provided by JSF Technologies Inc. The tests were conducted on the sample equipment as requested by JSF Technologies Inc. for the purpose of demonstrating compliance with FCC Title 47 Part 15 - Radio Frequency Devices, Subpart C – 15.249, CFR Title 47 FCC Part 15 - Subpart B – Unintentional Radiators, RSS-210 Issue 10, RSS-Gen Issue 5, ICES-003 Issue 6 and RSP-100 Issue 12 as agreed upon by JSF Technologies Inc. as per Quote 20SH07221.

JSF Technologies Inc. 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 and ISSED. 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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Testing Done by Jack Qin
EMC Test Engineer



Report Prepared by Raksha Rawat
EMC Technical Writer

QAI FACILITIES

Founded in 1994 by a group of experienced certification and testing experts, QAI is an independent third-party testing, inspection and certification organization which serves the building industry, government and individuals with cost effective solutions through our in-house capabilities / services, and an established world-wide network of qualified affiliates. To help get your product to market, trust the provider that many leading global manufacturers do: QAI.

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QAI EMC ACCREDITATION

QAI EMC is your one-stop regulatory compliance partner for electromagnetic compatibility (EMC) and electromagnetic interference (EMI). Products are tested to the latest and applicable EMC/EMI requirements for domestic and international markets. QAI EMC goes above and beyond being a testing facility—we are your regulatory compliance partner. QAI EMC has the capability to perform RF Emissions and Immunity for all types of electronics manufacturing including Industrial, Scientific, Medical, Information Technology, Telecom, Wireless, Automotive, Marine and Avionics.

EMC Laboratory Location	FCC Designation (3m SAC)	IC Registration (3m SAC)	A2LA Certificate
Burnaby, BC, Canada	CA9543	21146-1	3657.02



Headquarters & EMC Laboratory in

Burnaby, BC

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Section I: EXECUTIVE SUMMARY

1.1 Purpose

The purpose of this report is to demonstrate and document the compliance of “WP5 Wireless Platform 5” as per Sections 1.2 & 1.3 of this report.

1.2 Scope

The information documented in this report is based on the test methods and levels as per Quote 20SH07221:

CFR Title 47 FCC Part 15 – Radio Frequency Devices, Subpart C – Intentional Radiators

- 15.249: Operation within the bands 902-928 MHz, 2400-2483.5 MHz, 5725-5875 MHz, and 24.0-24.25 GHz.
- 15.212 Modular Transmitters

CFR Title 47 FCC Part 15 - Radio Frequency Devices, Subpart B – Unintentional Radiators

RSS-210 Issue 10 – Licence-Exempt Radio Apparatus: Category I Equipment

- B.10 Bands 902-928 MHz, 2400-2483.5 MHz, 5725-5875 MHz and 24-24.25 GHz

ICES-003 Issue 6 – Information Technology Equipment (Including Digital Apparatus) – Limits and Methods of Measurement

RSS-Gen Issue 5 – General Requirements for Compliance of Radio Apparatus

RSP-100 Issue 12 – Certification of Radio Apparatus and Broadcasting Equipment

- 8.2 Modular approval and limited modular approval requirements.]

1.3 Summary of Results

The following tests demonstrate the testimony to “FCC and ISED” Mark Electromagnetic compatibility testing for “WP5 Wireless Platform 5” manufactured by JSF Technologies Inc..

Test or Measurement	Applicable FCC and IC Standard	Performance Criteria
Antenna Requirement	FCC CFR 47 Part 15.203	Complies
	RSS-Gen Issue 5	
Intentional Radiated Emissions	FCC CFR 47 Part 15.249 FCC CFR 47 Part 15.209 FCC CFR 47 Part 15.205	Complies
	RSS-210 Issue 10 RSS-Gen Issue 5	
20dB Occupied Bandwidth	RSS-Gen Issue 5	Complies
99% Occupied Bandwidth	RSS-Gen Issue 5	Complies
Band Edge	FCC CFR 47 Part 15.249	Complies
	RSS-210 Issue 10	
Unintentional Radiated Emissions	FCC CFR 47 Part 15.209 (a)	Complies
	ICES-003 Issue 6 RSS-Gen Issue 5	
Frequency Stability	FCC CFR 47 Part 15.215(c)	Complies
	RSS-Gen Issue 5	

Section II: GENERAL INFORMATION

2.1 Product Description

Equipment Under Test (EUT) Information

EUT	WP5 Wireless Platform 5
FCC ID	SFIWP5
IC Number	5301A-WP5
Manufacturer	JSF Technologies Inc.
Model No.	WP5
FVIN	1.29.3
Frequency Range	902MHz – 928 MHz



EUT – WP5 Wireless Platform 5

2.2 Environmental Conditions

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

Parameter	Conditions
Location	Indoors
Temperature	22-28°C
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	$\pm 1.5 \times 10^{-5}$ MHz
Total RF Power Conducted	± 1.36 dB
Spurious Emissions, Conducted	± 1.36 dB
RF Power Density, Conducted	± 1.36 dB
Temperature	$\pm 1^{\circ}\text{C}$
Humidity	$\pm 5\%$
DC and low frequency voltages	$\pm 3\%$

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 Rohdes & Schwarz. Transducer factors like Antenna factors, Cable Losses and Amplifier gains were stored in the test templates which are used to perform the emissions measurements. After 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 (dB μ V/m)	Meas. Time (ms)	Bandwidth (kHz)	Ant. Ht. (cm)	Pol	Turntable position (deg)	Corr. (dB)	Margin (dB)	Limit (dB μ V/m)
42.663900	33.0	1000.000	120.000	100.0	H	70.0	13.2	7.5	40.5

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

$$\text{Corr. (dB)} = \text{Antenna factor} + \text{Cable loss}$$

Or

$$\text{Corr. (dB)} = \text{Antenna factor} + \text{Cable Loss} - \text{Amp gain (if pre-amplifier was used)}$$

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

$$\text{Corrected Quasi-Peak (dB}\mu\text{V/m)} = \text{Raw Quasi-Peak Reading} + \text{Antenna factor} + \text{Cable loss}$$

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 (dB μ V)	Meas. Time (ms)	Bandwidth (kHz)	PE	Corr. (dB)	Margin (dB)	Limit (dB μ V)
0.150	44.3	1000.000	9.000	GND	0.6	21.7	66.0

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

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:

$$\text{Corr. (dB)} = \text{Antenna factor} + \text{Cable loss}$$

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

$$\text{Corr. Quasi-Peak/Average Reading (dB}\mu\text{V)} = \text{Raw Quasi-Peak/Average Reading} + \text{Antenna factor} + \text{Cable loss}$$

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

$$\text{Margin(dB)} = \text{Limit} - \text{Quasi-Peak or Average reading}$$

2.6 Test Equipment List

The tables below contain all the equipment used by QAI Laboratories in performing all tests on the Equipment Under Test (EUT).

Emissions Test Equipment

Manufacturer	Model	Description	Serial No.	S/W Version	Calibration Due Date
AH Systems	PAM118	Amplifier (10KHz-18GHz)	189	N/A	Conditional Use
California Instruments	PACS-1	Harmonics and flicker analyzer	52117	CTS3.0 v3.2.0.35	2021-May-23
EMCO	3825/2	LISN (150kHz-30MHz)	9002-1601	N/A	2020-Aug-25
ETS Lindgren	3117	Horn Antenna, 1.0-18 GHz	75944	N/A	2020 Aug 29
ETS Lindgren	2165	Turntable	00043677	N/A	N/A
ETS Lindgren	2125	Mast	00077487	N/A	N/A
ETS Lindgren	S201	5-meter Semi-Anechoic Chamber	1030	N/A	N/A
Hewlett Packard	8449B	Preamplifier (1-26 GHz)	2933A00198	N/A	2022-Jan-22
Rohde & Schwarz	ESU40	EMI Receiver	100011	EMC32 v10.35.10/ FV 4.73 SP4	2021-Sept-20
Sunol Sciences	SM46C	Turntable	051204-2	N/A	N/A
Sunol Sciences	TWR95	Mast	TREML0001	N/A	N/A
Sunol Sciences	JB3	Biconilog Antenna 30MHz – 2GHz	A120106	N/A	2022 May 10
Sunol Sciences	JB3	Biconilog Antenna 30MHz – 2GHz	02052019A	N/A	2022 May 10
Sunol Sciences	JB1	Biconilog Antenna 30MHz – 2GHz	A070209	N/A	2020 Aug 17
Sunol Sciences	DRH-118	Horn Antenna 1GHz-18GHz	A050905	N/A	2020 Aug 17

Note: Equipment listed above have a 1 year calibration interval.

Measurement Software List

Manufacturer	Model	Version	Description
Rhode & Schwarz	EMC 32	6.20.0	Emissions Test Software
VI Automation	Via EMC Immunity Executive	1.0.308	Radiated and Conducted Immunity Test Program
TESEQ	WIN 3000	1.2.0	Surge, EFT & Voltage Dips Immunity Test Program
Thurlby Thandar Instruments	HA-PC Link Version	2.02	Harmonics and Flicker Test Program

Section III: REQUIREMENTS FOR THE US MARKET (FCC) & THE CANADIAN MARKET (ISED) - Exigences pour le Marché Canadien

3.1 Antenna Requirements

Date Performed:

July 24, 2020

Test Standard:

- FCC CFR 47 Part 15.203
- RSS-Gen Issue 5

Applicable Regulation:

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 FCC CFR 47 Part 15.203 & RSS-Gen Issue 5:

“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.”

Modifications:

No modification was required to comply for this test.

Final Result:

This device will only be used by JSF Technologies as an OEM device that will be professionally installed. Therefore this radio meets the requirements of FCC CFR 47 Part 15.203 & RSS-Gen Issue 5 as a professionally installed device.

3.2 Intentional Radiated Emissions

Date Performed:

July 24, 2020

Test Standard:

- FCC CFR 47 Part 15.249
- FCC CFR 47 Part 15.209
- FCC CFR 47 Part 15.205
- RSS-210 Issue 9
- RSS-Gen Issue 5

Test Method:

- ANSI C63.10:2013

Test Requirement:

The field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following:

Frequency (MHz)	Field Strength of Fundamental		Field Strength of Harmonics	
	mV/m	dBµV/m	µV/m	dBµV/m
902-928	50	94	500	54
2400-2483.5	50	94	500	54
5725-5875	50	94	500	54
24.0-24.25	250	108	2500	68

Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general field strength limits listed in Rss-Gen Issue 4, whichever is less stringent.

In measuring unwanted emissions, the spectrum shall be investigated from 30 MHz or the lowest radio frequency signal generated in the equipment, whichever is lower, without going below 9 kHz, up to at least the frequency if the equipment operates below 10 GHz: to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

Unwanted emissions falling into restricted bands of shall comply with the limits specified below

Frequency (MHz)	Field Strength	
	uV/m @ 3-m	Calculated dBµV/m at 3m
30 – 88	100	40.0
88 - 216	150	43.5
216 - 960	200	46.0
Above 960	500	54.0

FCC PART 15.205-RESTRICTED BANDS OF OPERATION

(a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

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			

(b) Except as provided in paragraphs (d) and (e) of this section, the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in § 15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in § 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in § 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in § 15.35 apply to these measurements.

RESTRICTED FREQUENCY BANDS (RSS-GEN ISSUE 4)

MHz	MHz	GHz
0.090-0.110	240-285	9.0-9.2
2.1735-2.1905	322-335.4	9.3-9.5
3.020-3.026	399.9-410	10.6-12.7
4.125-4.128	608-614	13.25-13.4
4.17725-4.17775	960-1427	14.47-14.5
4.20725-4.20775	1435-1626.5	15.35-16.2
5.677-5.683	1645.5-1646.5	17.7-21.4
6.215-6.218	1660-1710	22.01-23.12
6.26775-6.26825	1718.8-1722.2	23.6-24.0
6.31175-6.31225	2200-2300	31.2-31.8
8.291-8.294	2310-2390	36.43-36.5
8.362-8.366	2655-2900	Above 38.6
8.37625-8.38675	3260-3267	
8.41425-8.41475	3332-3339	
12.29-12.293	3345.8-3358	
12.51975-12.52025	3500-4400	
12.57675-12.57725	4500-5150	
13.36-13.41	5350-5460	
16.42-16.423	7250-7750	
16.69475-16.69525	8025-8500	
16.80425-16.80475		
25.5-25.67		
37.5-38.25		
73-74.6		
74.8-75.2		
108-138		
156.52475-156.52525		
156.7-156.9		

Note: Certain frequency bands listed in Table 3 and in bands above 38.6 GHz are designated for licence-exempt applications. These frequency bands and the requirements that apply to the devices are set out in the 200- and 300- series RSSs, such as RSS-210 and RSS-310, which contain the requirements that apply to licence-exempt radio apparatus.

Test Setup:

The EUT was tested in our 3 m SAC and was positioned on the center of the turntable. The transmitter was set for continuous transmission. The RF radiated emissions were measured in the frequency range of 150kHz to 18 GHz. The EUT was pre-scanned in 3 different orthogonal orientations and was found to radiate highest when placed flat on the tabletop as indicated in the test photos.

Measurement Method:

ANSI C63.10:2013 radiated emissions procedure was followed to demonstrate the compliance of Bluetooth low energy.

Modifications:

No modification was required to comply for this test.

Final Result:

The EUT complies with the applicable standard.

Measurement Data and Plot:

Data of Field Strength of Fundamental Frequency

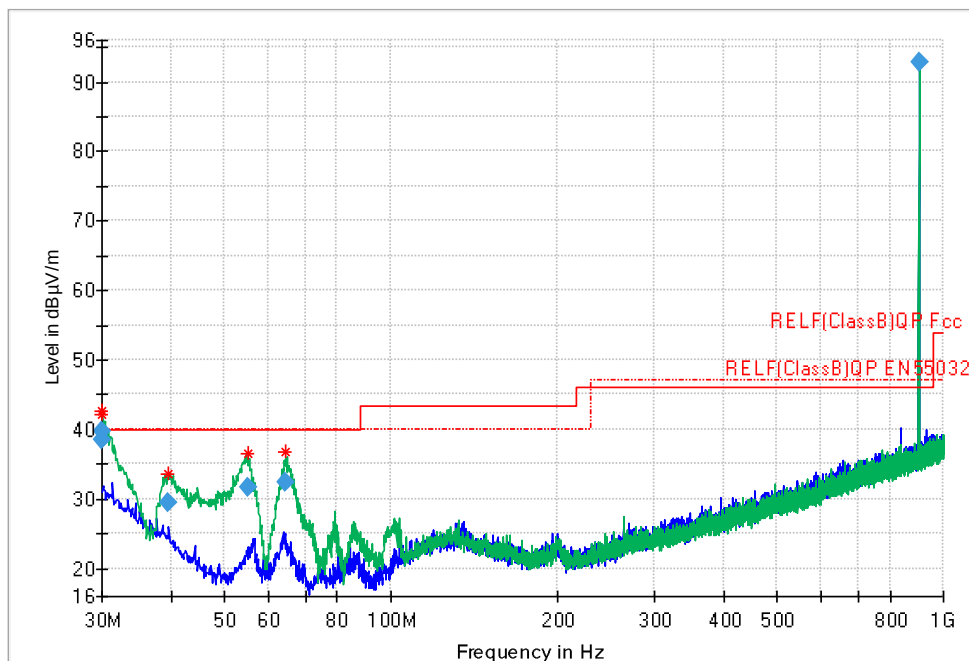
Frequency	Raw Quasi-Peak	RBW	Corr.	Quasi-Peak	limit
MHz	dBuV/m	kHz	dB	dBuV/m	dBuV/m
902.5	61	120	32	93	94
914.5	60.5	120	32	92.5	94
927	60.8	120	32	92.8	94

Data of Field Strength of Harmonica Frequency

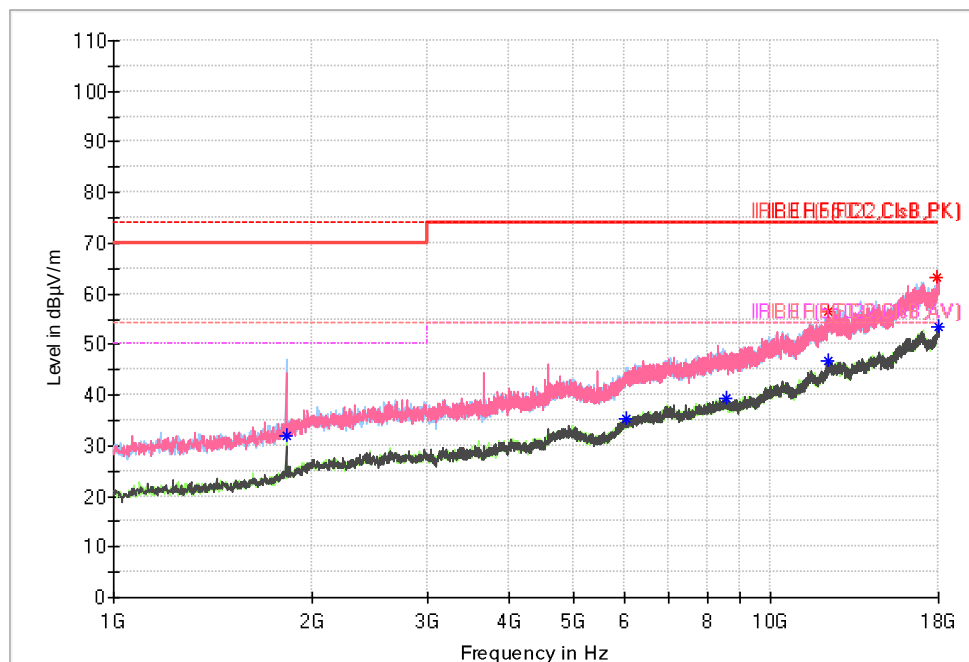
Frequency	Raw Average	Raw Maxpeak	Antenna factor	sys gain	Average	Average Limit	Maxpeak	Maxpeak limit
MHz	dBuV	dBuV	dB/m	dB	dBuV/m	dBuV/m	dBuV/m	dBuV/m
1805	51	54	30	32	49	54	52	74
2707.5	44	49	32	30	46	54	51	74
3610	43	48	33	29	47	54	52	74
4512.5	44	49	34	28	50	54	55	74
5415	44	50	35	27	52	54	58	74
6317.5	42	49	36	26	52	54	59	74
7220	BG Noise	BG Noise	36	23		54		74
8122.5	BG Noise	BG Noise	36	23		54		74

Data of Radiated Emissions: 30MHz-1GHz

Frequency (MHz)	QuasiPeak (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
30.0721	39.6	40.0	0.4	1000	120.000	106.0	V	205	26.1
30.0860	38.4	40.0	1.6	1000	120.000	99.0	V	202	26.0
39.6182	29.3	40.0	10.7	1000	120.000	100.0	V	187	19.4
55.0110	31.8	40.0	8.2	1000	120.000	111.0	V	248	13.1
64.6117	32.3	40.0	7.7	1000	120.000	104.0	V	140	13.6
902.5181	92.9	46.0	-46.9	1000	120.000	99.0	H	299	32.7



Radiated Emissions: 30MHz-1GHz



TX Mode (Low Channel)- Radiated Emissions: 1GHz-18GHz

Note: The data was 20dB or greater below the limit line and were not included in this report.

3.3 20dB Occupied Bandwidth

Date Performed:

July 28, 2020

Test Standard:

- RSS-Gen Issue 5

Test Method:

- ANSI C63.10-2013

Test Requirement:

The emission bandwidth (20dB) is defined as the frequency range between two points, one above and one below the carrier frequency, at which the spectral density of the emission is attenuated 20dB below the maximum in-band spectral density of the modulated signal. Spectral density (power per unit bandwidth) is to be measured with a detector of resolution bandwidth in the range of 1% to 5% of the anticipated emission bandwidth, and a video bandwidth at least 3× the resolution bandwidth.

Test Setup:

The EUT was tested in our 3 m SAC and was positioned on the center of the turntable. The transmitter was set for continuous transmission.

Measurement Method:

As called in ANSI C63.10-2013.

Modifications:

No modification was required to comply for this test.

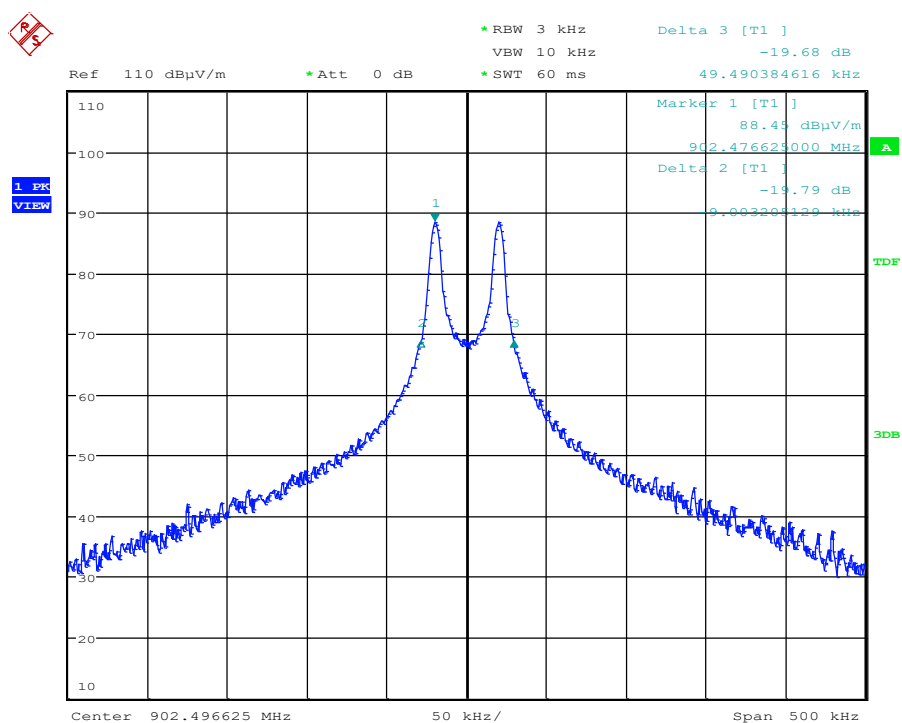
Final Result:

The EUT complies with the applicable standard.

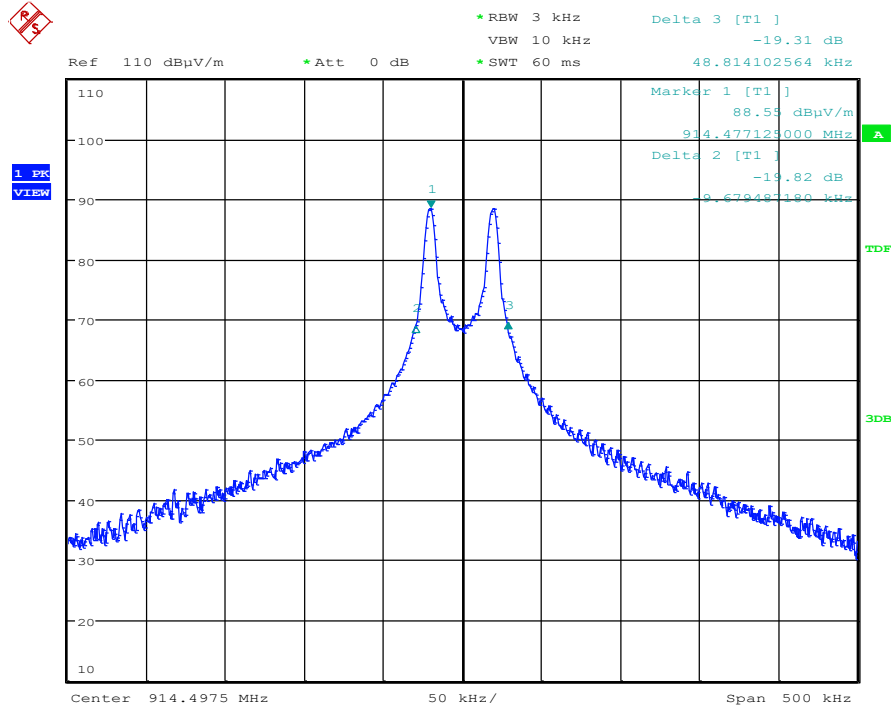
Measurement Data and Plot:

Data: 20dB Occupied Bandwidth

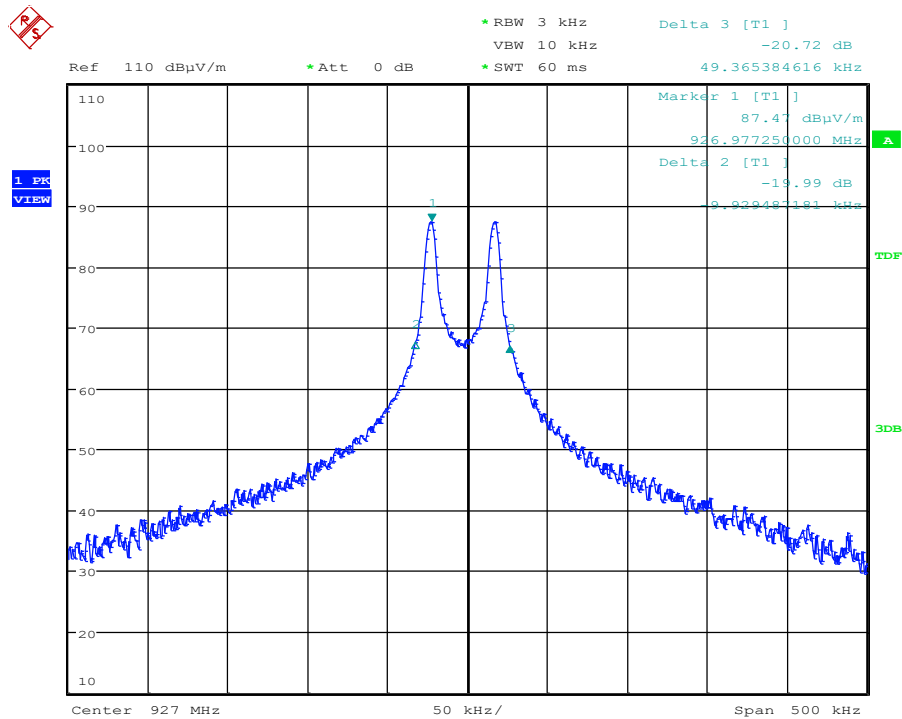
Channel	Frequency (MHz)	20dB Bandwidth (kHz)
Low	902.5	58.5
Middle	914.5	58.9
High	927	59.4



Plot: 20dB Occupied Bandwidth of Low Channel



Plot: 20dB Occupied Bandwidth of Mid Channel



Plot: 20dB Occupied Bandwidth of High Channel

3.4 99% Occupied Bandwidth

Date Performed:

July 28, 2020

Test Standard:

- RSS-Gen Issue 5

Test Method:

- ANSI C63.10-2013

Test Setup:

RSS-Gen Issue 4: Section 6.6 – A peak, or peak hold, may be used in place of the sampling detector as this may produce a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold may be necessary to determine the occupied bandwidth if the device is not transmitting continuously.

The trace data points are recovered and are directly summed in linear power level terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached and that frequency recorded. The process is repeated for the highest frequency data points (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded.

Measurement Method:

As called in ANSI C63.10-2013.

Modifications:

No modification was required to comply for this test.

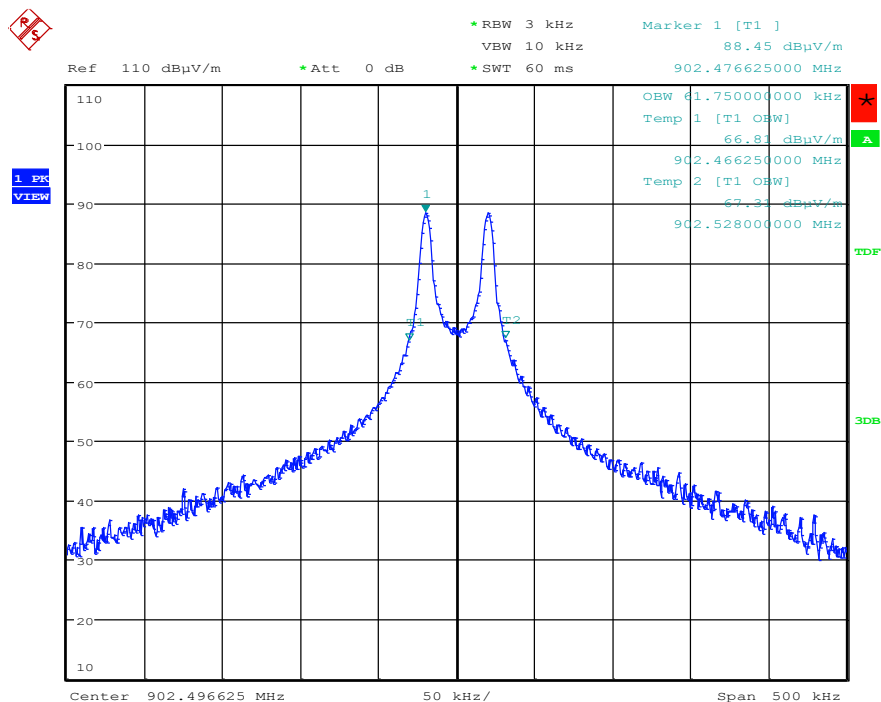
Final Result:

The EUT complies with the applicable standard.

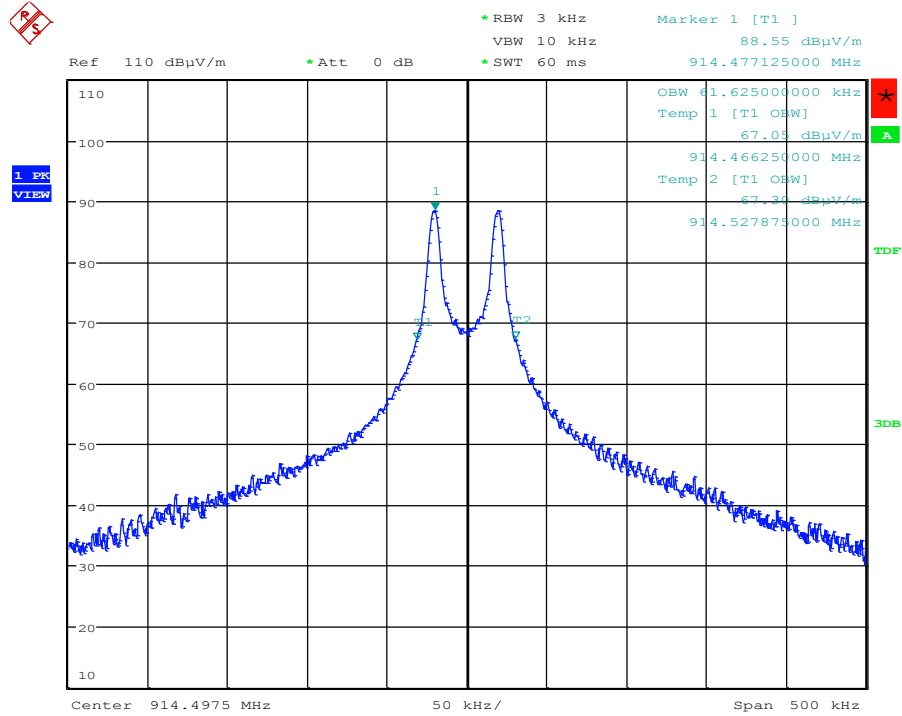
Measurement Data and Plot:

Data: 99% Occupied Bandwidth

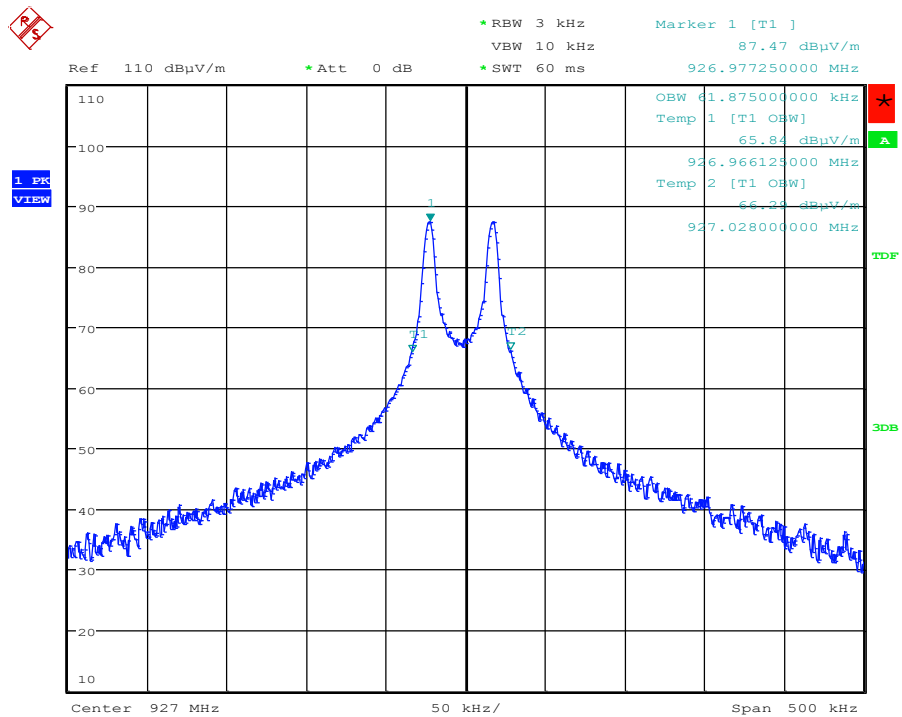
Channel	Frequency (MHz)	99% Bandwidth (kHz)
Low	902.5	61.8
Middle	914.5	61.6
High	927	61.9



Plot: 99% Occupied Bandwidth of Low Channel



Plot: 99% Occupied Bandwidth of Mid Channel



Plot: 99% Occupied Bandwidth of High Channel

3.5 Band Edge

Date Performed:

July 28, 2020

Test Standard:

- FCC CFR 47 Part 15.249
- RSS-210 Issue 9

Test Method:

- ANSI C63.10-2013

Test Requirement:

As per §15.249(d):

Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in § 15.209, whichever is the lesser attenuation.

As per RSS-210 F.1(e):

Emissions radiated outside of the specified frequency bands, except for harmonic emissions, shall be attenuated by at least 50 dB below the level of the fundamental emissions or to the general field strength limits specified in RSS-Gen, whichever is less stringent.

Measurement Method:

The measurement method used was Section 6.10.6.2 Marker-delta Method of ANSI C63.10-2013 standard.

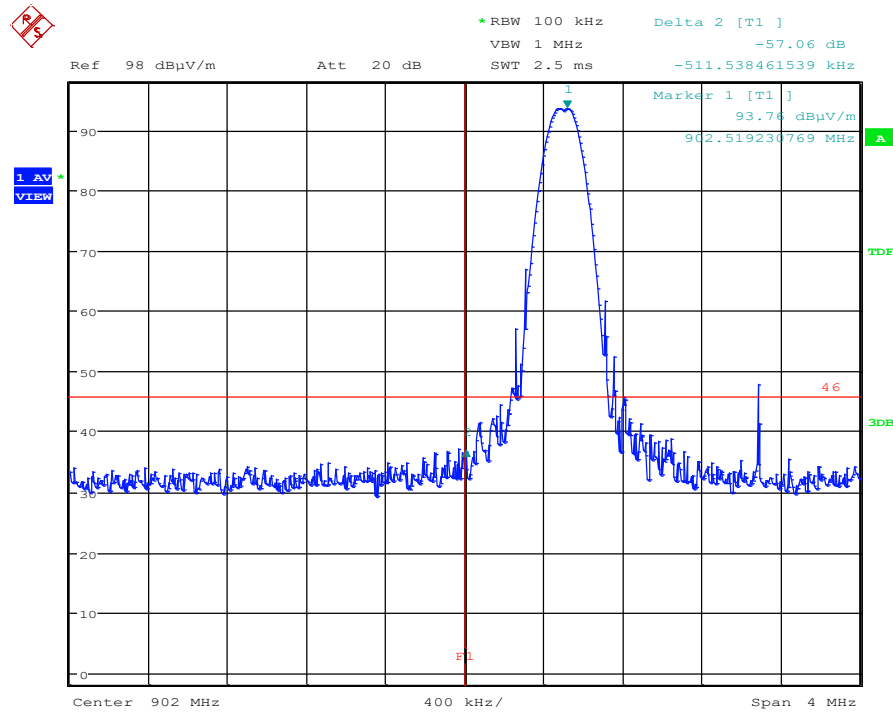
Modifications:

No modification was required to comply for this test.

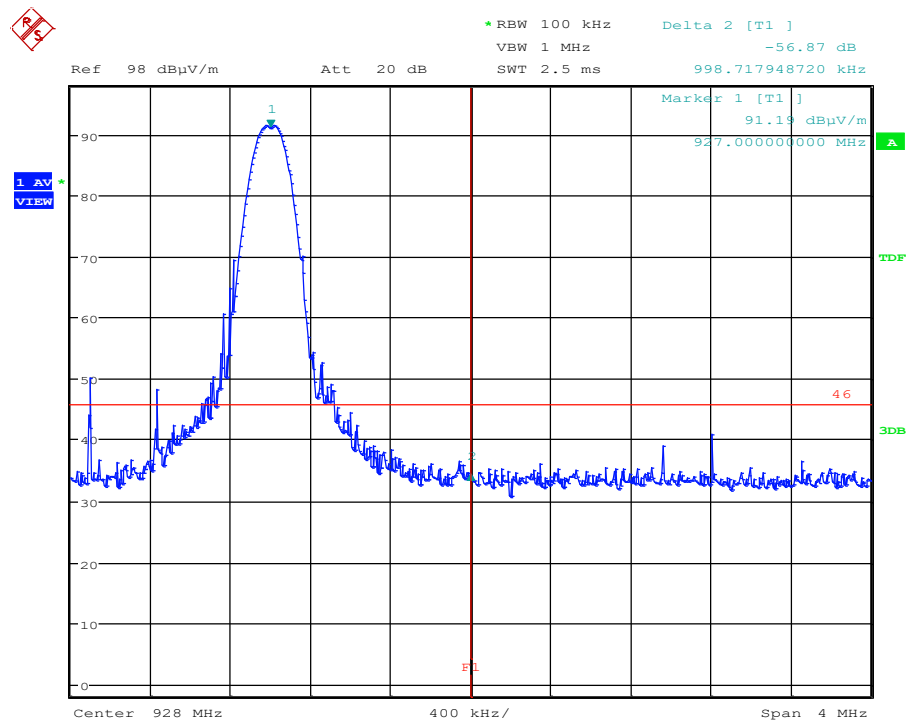
Final Result:

The EUT complies with the applicable standard.

Measurement Data and Plot:



Band edge, low side



Band edge, high side

3.6 Unintentional Radiated Emissions

Date Performed:

July 24, 2020

Test Standard:

- FCC CFR 47 Part 15.209
- CFR Title 47 FCC Part 15 - Radio Frequency Devices, Subpart B
- ICES-003 Issue 6
- RSS-Gen Issue 4

Test Method:

- ANSI C63.4-2014

Test Requirement:

Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 20 dB below the level of the fundamental or to the general field strength limits listed in Rss-Gen Issue 4, whichever is less stringent.

In measuring unwanted emissions, the spectrum shall be investigated from 30 MHz or the lowest radio frequency signal generated in the equipment, whichever is lower, without going below 9 kHz, up to at least the frequency if the equipment operates below 10 GHz: to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

Unwanted emissions falling into restricted bands of shall comply with the limits specified below

Frequency (MHz)	Field Strength	
	uV/m @ 3-m	Calculated dBµV/m at 3m
30 – 88	100	40.0
88 - 216	150	43.5
216 - 960	200	46.0
960 - 1000	500	54.0

Test Setup:

The EUT was tested in our 3 m SAC and was positioned on the center of the turntable. The transmitter was set for continuous transmission. The lowest, middle and highest channels in the 2400-2483.5 MHz band were measured for all radiated emissions 10kHz to 18 GHz. The EUT was pre-scanned in 3 different orthogonal orientations and was found to radiate highest when placed flat on the table top as indicated in the test photos.

Measurement Method:

Measurements were made using spectrum analyser and receiver, 200Hz RBW average detector for the frequency range 9-150KHz; 9kHz RBW average detector for the Frequency range 150kHz to 30MHz; 120kHz RBW quasi-peak detector using the appropriate antennas, amplifiers and filters.

The measurement results are obtained as described below:

$$E \text{ [dB}\mu\text{V/m]} = \text{Un-Corrected Value} + \text{ATOT}$$

Where ATOT is total correction factor including cable loss, antenna factor and preamplifier gain
(ATOT = LCABLES + AF - AMP).

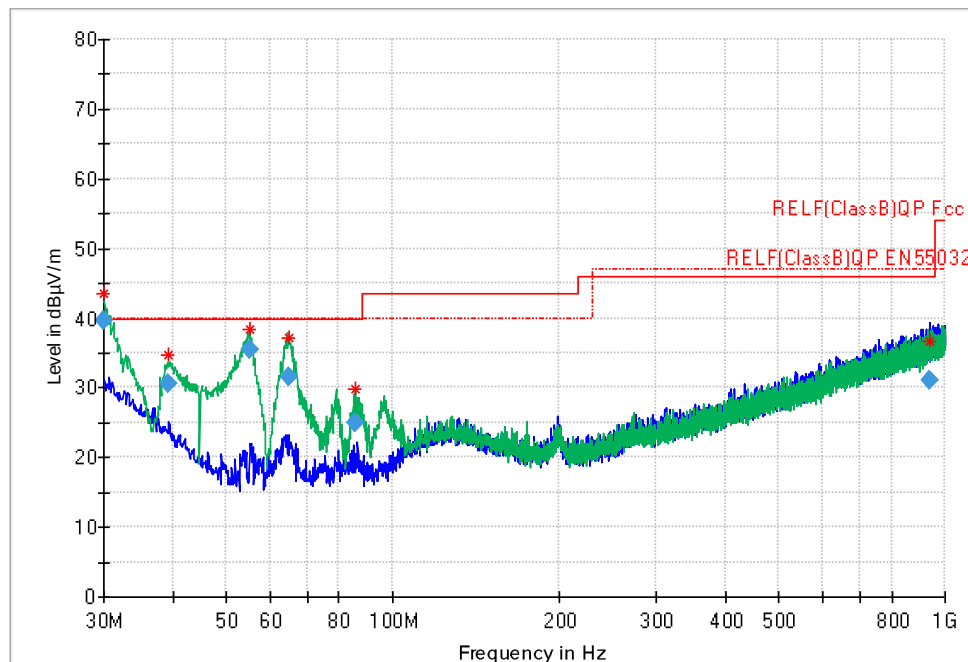
Modifications:

No modification was required to comply for this test.

Final Result:

The EUT complies with the applicable standard.

Measurement Data and Plot:



Unintentional Radiated Emissions: 30-1000MHz

Frequency (MHz)	QuasiPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
30.0666	39.7	40.0	0.3	1000	120.000	126.0	V	190	26.1
39.1817	30.6	40.0	9.4	1000	120.000	104.0	V	176	19.7
55.0634	35.4	40.0	4.6	1000	120.000	105.0	V	209	13.1
64.9265	31.5	40.0	8.5	1000	120.000	106.0	V	172	13.7
85.3570	25.0	40.0	15.0	1000	120.000	130.0	V	344	14.4
939.9709	31.1	46.0	14.9	1000	120.000	192.0	H	345	33.5

Note: Quasi-peaks were 20dB or greater below the limit line and were not included in this report.

3.7 Frequency Stability

Date Performed:

July 27, 2020

Test Standard:

- FCC CFR 47 Part 15.215
- RSS-Gen Issue 5

Test Method:

- ANSI C63.10-2013

Test Setup:

FCC (15.215(c)): The 20dB bandwidth must remain within the designated frequency band over the expected variations in temperature and voltage range.

Rss-Gen Issue 5 (8.8): Transmitter frequency stability for licence-exempt radio apparatus shall be measured in accordance with Section 6.11. For licence-exempt radio apparatus, the frequency stability shall be measured at temperatures of -20°C (-4°F), +20°C (+68°F) and +50°C (+122°F) instead of at the temperatures specified in Section 6.11. If the frequency stability of the licence-exempt radio apparatus is not specified in the applicable standard (RSS), measurement of the frequency stability is not required provided that the occupied bandwidth of the licence-exempt radio apparatus lies entirely outside the restricted bands and the prohibited TV bands of 54-72 MHz, 76-88 MHz, 174-216 MHz, 470-608 MHz and 614-806 MHz.

Modifications:

No modification was required to comply for this test.

Performance:

Complies with the applicable standard.

Measurement Data and Plot:

Temperature °C	Frequency MHz
75	902.49575
50	902.49725
20	902.49825
0	902.49925
-40	902.50850

3.8 RF Exposure MPE

Date Performed:

July 27, 2020

Test Standard: FCC 47 CFR §1.1310: RSS-102 Section 2.5.2:

MPE Requirement:

CC CFR 47 §1.1310:

“Radiofrequency radiation exposure limits for General Population/Uncontrolled Exposure at Frequency range 1500 - 100000 MHz: 1.0 mW/cm²”

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm ²)	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposures				
0.3–3.0	614	1.63	*(100)	6
3.0–30	1842/f	4.89/f	*(900/f ²)	6
30–300	61.4	0.163	1.0	6
300–1500			f/300	6
1500–100,000			5	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3–1.34	614	1.63	*(100)	30
1.34–30	824/f	2.19/f	*(180/f ²)	30
30–300	27.5	0.073	0.2	30
300–1500			f/1500	30
1500–100,000			1.0	30

f = frequency in MHz

* = Plane-wave equivalent power density

NOTE 1 TO TABLE 1: Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.

NOTE 2 TO TABLE 1: General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or can not exercise control over their exposure.

RSS-102 Section 2.5.2:

“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, except when the device operates as follows:

-at or above 300 MHz and below 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $1.31 \times 10^{-2} f^{0.6834} \text{ W}$ (adjusted for tune-up tolerance), where f is in MHz

In these cases, the information contained in the RF exposure technical brief may be limited to information that demonstrates how the e.i.r.p. was derived.”

MPE Evaluation for FCC:

Power Density: $\text{EIRP}/[4\pi d^2]$, mW/cm²;

1) The Maximum field strength measured at 3m is 93 dBuV/m, so it’s EIRP is 0.6 mW;

- 2) As an example, the distance from the antenna is set at 3 cm;
- 3) Power Density: $P_d = 0.005 \text{ mW/cm}^2$, which is less than the limit 1.0 mW/cm^2 .

When installing the antenna, the above relationship should be used to ensure the RF Maximum Permissible Exposure (MPE) Exhibit Requirements

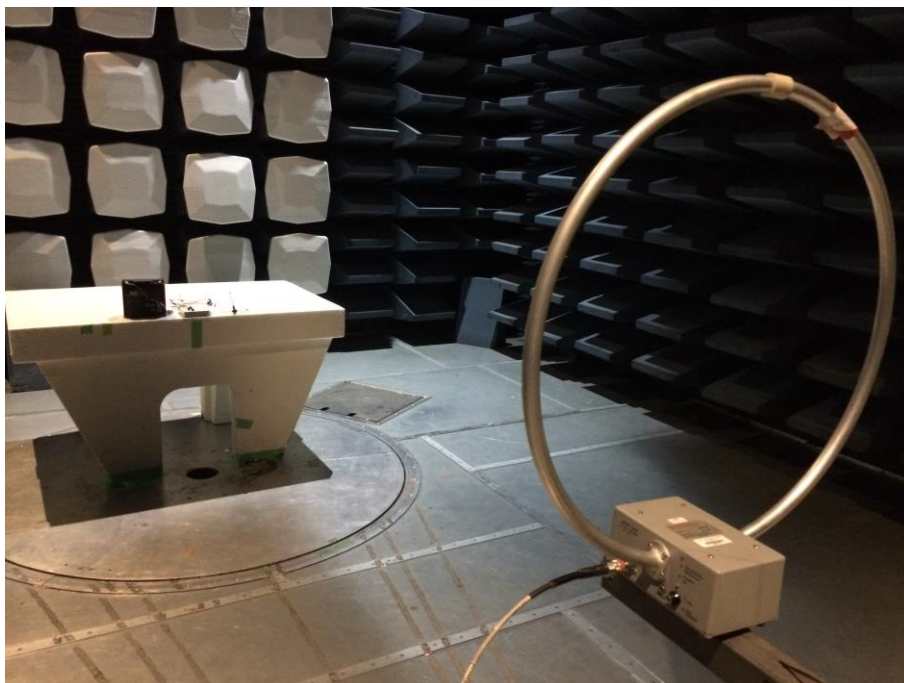
RF exposure evaluation exemption for IC:

The Maximum field strength measured at 3m is 93 dBuV/m, so it's EIRP is 0.6 mW;

Limit: $1.31 \times 10^{-2} f^{0.6834} \text{ W} = 1.4 \text{ W}$, ($f = 928 \text{ MHz}$)

Therefore, RF exposure is not required.

Appendix A: TEST SETUP PHOTOS



Radiated Emissions Below 30MHz



Radiated Emissions 30MHz – 1GHz



Radiated Emissions above 1GHz

Appendix B: ABBREVIATIONS

Abbreviation	Definition
AC	Alternating Current
AM	Amplitude Modulation
CE	European Conformity
CISPR	Comité International Spécial des Perturbations Radioélectriques
DC	Direct Current
EFT	Electrical Fast Transient
EMC	ElectroMagnetic Compatibility
EMI	ElectroMagnetic Interference
ESD	ElectroStatic Discharge
EUT	Equipment Under Test
FCC	Federal Communications Commission
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