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**EMC testing of the Levven Electronics Ltd. LC-Q2 in accordance with FCC  
Part 15.247, and ANSI C63.10: 2013 for Co-Location Analysis.**

**FCC ID: 2AA9N-LCQ2**

Prepared for: Levven Electronics Ltd

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## REVISION RECORD

ISSUE	DATE	AUTHOR	REVISIONS
DRAFT 1	2019-11-07	I. Akram	Initial draft submitted for review.
Release 1	2019-11-28	M. Rousseau	Sign off

## TABLE OF CONTENTS

1.0	INTRODUCTION	4
1.1	Scope .....	4
1.2	Applicant .....	4
1.3	Test Sample Description.....	4
1.4	General Test Conditions and Assumptions .....	4
1.5	Scope of Testing .....	5
1.5.1	Test Methodology.....	5
1.5.2	Variations in Test Methodology.....	5
1.5.3	Test Sample Verification, Configuration & Modifications .....	5
1.5.4	Uncertainty of Measurement:.....	5
2.0	TEST CONCLUSION	6
2.1	AC Power Line Conducted Emissions: Transmit Mode .....	7
2.1.1	Test Guidance:.....	7
2.1.2	Deviations From The Standard:.....	7
2.1.3	Test Equipment.....	7
2.1.4	Test Sample Verification, Configuration & Modifications .....	8
2.1.5	Conducted Emissions Data:.....	9
2.2	Radiated Spurious Emissions in restricted frequency bands Co-Location (TX Mode) 12	
2.2.1	Test Guidance: ANSI C63.10-2013, Clause 11.12 / KDB 558074 D01 15.247 Measurement Guidance v05r02 Clause 8.6 .....	12
2.2.2	Deviations From The Standard:.....	12
2.2.4	Test Equipment.....	13
2.2.5	Test Sample Verification, Configuration & Modifications .....	13
2.2.6	Radiated Emissions Data:.....	16
2.3	RF Exposure .....	25
3.0	TEST FACILITY	26
3.1	Location.....	26
3.2	Grounding Plan .....	26
3.3	Power Supply .....	26
	End of Document	27

## **1.0 INTRODUCTION**

### **1.1 Scope**

The purpose of this report is to present the results of compliance testing performed in accordance with FCC Part 15.247, and ANSI C63.10-2013 to gain permissive change for pre-certified Low-Power License-Exempt transmitters. All test procedures, limits, criteria, and results described in this report apply only to the Levven Electronics Ltd. LC-Q2 test sample, referred to herein as the EUT (Equipment Under Test).

The sample has been provided by the customer.

This report does not imply product endorsement by the Electronics Test Centre, A2LA, nor any Canadian Government agency.

### **1.2 Applicant**

This test report has been prepared for Levven Electronics Ltd, located in Calgary, Alberta, Canada.

### **1.3 Test Sample Description**

As provided to ETC (Airdrie) by Levven Electronics Ltd:

<b>Product Name:</b>		Leven Controls Q2 Gateway
<b>Leven Radio</b>	<b>Frequency Band</b>	902 – 928 MHz
	<b>Type of Modulation</b>	GFSK
	<b>BW/Frequency Range</b>	DTS 750kHz, 903 – 927 MHz, 33 Channels
	<b>Associated Antenna</b>	PCB trace, gain 0dBi
	<b>Detachable/Non Detachable</b>	Non-Detachable
<b>Wi-Fi &amp; Bluetooth Pre-Certified Module</b>	<b>Frequency Band (BT)</b>	2402 – 2480 MHz
	<b>Frequency Band (Wi-Fi)</b>	2412 – 2462 MHz
	<b>FCC ID</b>	2AC7Z-ESP32WROVERB
	<b>Associated Antenna</b>	PCB trace, gain 3.74 dBi
<b>Model# / Serial#</b>		Model: LC-Q2, s/n: EMC1 (radiated)
<b>Power supply:</b>		AC / DC Adaptor (120VAC / 60Hz, 0.55A), mfr: LI TONE Electronics Co. Ltd. Model: LTE18WS-S1, s/n: 184100015

**Note:** All mode and channels were evaluated for pre-certified module using customer provided program. Worst case channel and axis (see test setup photo exhibit for final axis selected) was selected for detail analysis for radiated spurious emission and co-location analysis.

### **1.4 General Test Conditions and Assumptions**

The EUT was set up and exercised using the configurations, modes of operation and arrangements defined in this report only. All inputs and outputs to and from other equipment associated with the EUT were adequately simulated.

The environmental conditions are recorded during each test and are reported in the relevant sections of this document.

## 1.5 Scope of Testing

Tests were performed in accordance with FCC Part 15.247, ANSI C63.4: 2014, ANSI C63.10: 2013 as referenced in FCC OET KDB 558074 D01 15.247 Measurement Guidance v05r02.

### 1.5.1 Test Methodology

Test methods are specified in the Basic Standard as referenced and/or modified by the Product Standard in the part of Section 2 of this report associated with each particular test case.

### 1.5.2 Variations in Test Methodology

Any variance in methodology or deviation from the reference Standard is documented in the part of Section 2 of this report associated with each particular Test Case.

### 1.5.3 Test Sample Verification, Configuration & Modifications

EUT setup, configuration, protocols for operation and monitoring of EUT functions, and any modifications performed in order to meet the requirements, are detailed in each Test Case of Section 2 of this report.

### 1.5.4 Uncertainty of Measurement:

The factors contributing to uncertainty of measurement are identified and calculated in accordance with UKAS (United Kingdom Accreditation Service) document “Lab 34, The Expression of Uncertainty in EMC Testing, Aug 2002.” as based on the “ISO Guide to the Expression of Uncertainty in Measurement, 1995.”

This uncertainty estimate represents an expended uncertainty expressed at approximately 95% confidence using a coverage factor of  $k = 2$ .

Test Method	Uncertainty
Radiated Emissions Level (9 KHz – 1 GHz)	$\pm 4.6$ dB
Radiated Emissions Level (1 GHz – 26.5 GHz)	$\pm 5.31$ dB
Conducted Emissions Level (150 KHz – 30 MHz)	$\pm 2.7$ dB
Uncertainty Conducted Power level	$\pm 0.5$ dB
Uncertainty Conducted Spurious emission level	$\pm 0.6$ dB
Uncertainty for Bandwidth test	$\pm 1.5$ %

## **2.0 TEST CONCLUSION**

### **STATEMENT OF COMPLIANCE**

**The customer equipment referred to in this report was found to comply with the requirements, as summarized below.**

The EUT was subjected to the following tests. Compliance status is reported as **Compliant** or **Non-compliant**. **N/A** indicates the test was Not Applicable to the EUT.

**Note:** Maintenance of compliance is the responsibility of the Manufacturer. Any modifications to the product should be assessed to determine their potential impact on the compliance status of the EUT with respect to the standards detailed in this test report.

The following table summarizes the tests performed in terms of the specification, class or performance criterion applied, and the EUT modification state.

Test Case	Test Type	Specification	Test Sample	Modifications	Config.	Result
2.1	AC Conducted Emissions (Tx)	15.207	LC-Q2 s/n EMC1	none	see § 2.1	<b>Compliant</b>
2.2	Radiated Spurious Emission in Restricted Band (Tx Mode)	15.205, 15.209 15.247(d)	LC-Q2 s/n EMC1	none	see § 2.2	<b>Compliant</b>
2.3	RF Exposure	15.247(i)	LC-Q2 s/n EMC2	none	see § 2.3	<b>Exempt</b>

Refer to the test data for applicable test conditions.

## 2.1 AC Power Line Conducted Emissions: Transmit Mode

Test Lab: Electronics Test Centre, Airdrie	EUT: LC-Q2 s/n EMC1
Test Personnel: Imran Akram	Standard: FCC Part 15.207
Date: 2019-11-06 (20.8°C, 13.9 % RH)	Basic Standard: ANSI C63.10: 2013
<b>EUT status: Compliant</b>	

Specification: Part 15.207

Frequency (MHz)	Quasi-Peak Limit (dB $\mu$ V)	Average Limit (dB $\mu$ V)
0.15 – 0.5	66 – 56	56 – 46
0.5 – 5	56	46
5 – 30	60	50
Criteria: The conducted emissions produced by a device shall not exceed the limits as specified.		

### 2.1.1 Test Guidance:

Before any testing is performed, the Ambient (measurement noise floor) is recorded, and a QC check is performed to show that the system is functioning correctly.

Testing starts with a scan, performed under software control. After this is complete, the list of frequencies of interest is generated. These frequencies are then investigated for quasi-peak and average amplitude, as applicable. Emissions measured with a QP detector that fall below the Average limit are deemed to meet both requirements.

### 2.1.2 Deviations From The Standard:

There were no deviations from the EUT setup or methodology specified in the standard.

### 2.1.3 Test Equipment

Testing was performed with the following equipment:

Equipment	Manufacturer	Model #	Asset #	Cal. Date (yyyy-mm-dd)	Cal. Due (yyyy-mm-dd)
EMC Software	UL	Ver. 9.5	ETC-SW-EMC 2.1	N/A	N/A
EMI receiver	Agilent	N9038A (FW A.23.07)	6130	2019-05-10	2020-05-10
LISN	Com-Power	LI-215A	6180	2018-06-06	2020-06-06
Temp/RH logger	Extech	42270	5892	2019-04-05	2020-04-05
RE Cable below 30MHz	Insulated Wire Inc.	KPS-1501A-3600-KPA-01102006	4436	2019-01-03	2020-01-03

### 2.1.4 Test Sample Verification, Configuration & Modifications

The EUT PCB is embedded pre-certified radio module which can be configured in either Wi-Fi or Bluetooth mode. Conducted Emission test is performed to analyze the effect of the pre-certified module in the following configurations,

#### 1<sup>st</sup> Configuration:

Leven radio is configured to transmit at channel 903 MHz and pre-certified module is configured in Wi-Fi mode and worse transmitting channel frequency is 2442 MHz. Both are transmitting in continuous mode.

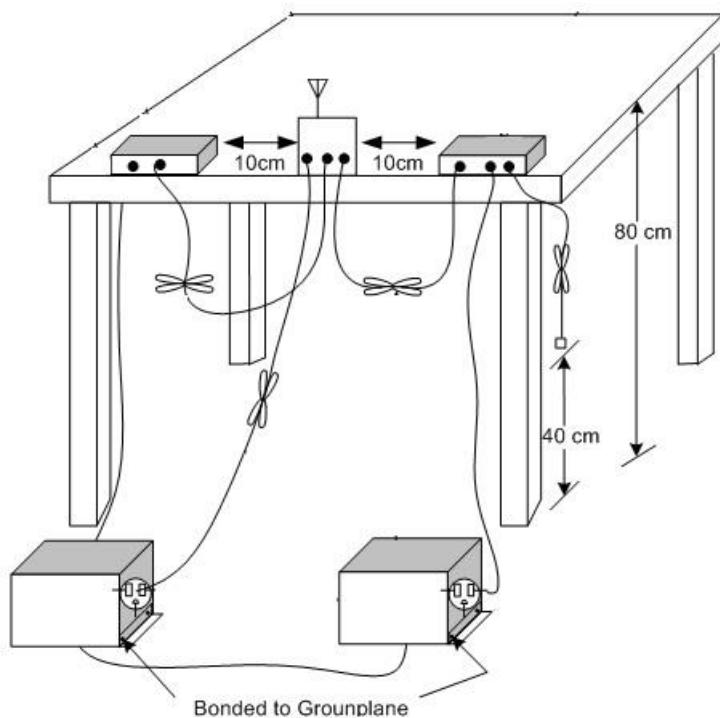
#### 2<sup>nd</sup> Configuration:

Leven radio is configured to transmit at channel 903 MHz and pre-certified module is configured in BT mode and worse transmitting channel frequency is 2480 MHz. Both are transmitting in continuous mode.

All transmitting channels are selected as worst-case scenario after performing the preliminary analysis on all modes of Wi-Fi and Bluetooth. The output was modulated as in normal operation.

The EUT met the requirements without modification.

#### Test setup diagram:



**2.1.5 Conducted Emissions Data:**

Freq. Marker	Freq. [MHz]	Meter reading [dB $\mu$ V]	Det	LISN Factor [dB]	Pre amp Gain [dB]	Corrected Reading [dB $\mu$ V]	FCC 15.207 Limit [dB $\mu$ V]	Delta [dB]	L/N
<b>1<sup>st</sup> Configuration</b>									
1	0.4039	39.97	Av	0	.1	40.07	47.77	-7.7	L
2	2.11302	36.21	Av	0	.2	36.41	46	-8.59	L
3	5.59974	34.28	Av	0	.4	34.68	50	-15.32	L
1	0.40434	39.5	Av	0	.1	39.6	47.76	-8.16	N
2	2.11305	36.09	Av	0	.2	36.29	46	-9.71	N
3	5.54413	33.44	Av	0	.4	33.84	50	-16.16	N
<b>2<sup>nd</sup> Configuration</b>									
1	0.40314	35.52	Av	0	.1	36.62	47.79	-12.17	L
2	2.10937	35.2	Av	0	.2	35.4	46	-10.6	L
3	5.54386	33.75	Av	0	.4	34.15	50	-15.85	L
1	0.40299	35.26	Av	0	.1	35.36	47.79	-12.43	N
2	2.11043	35.28	Av	0	.2	35.48	46	-10.52	N
3	5.54389	34.31	Av	0	.4	34.71	50	-15.29	N

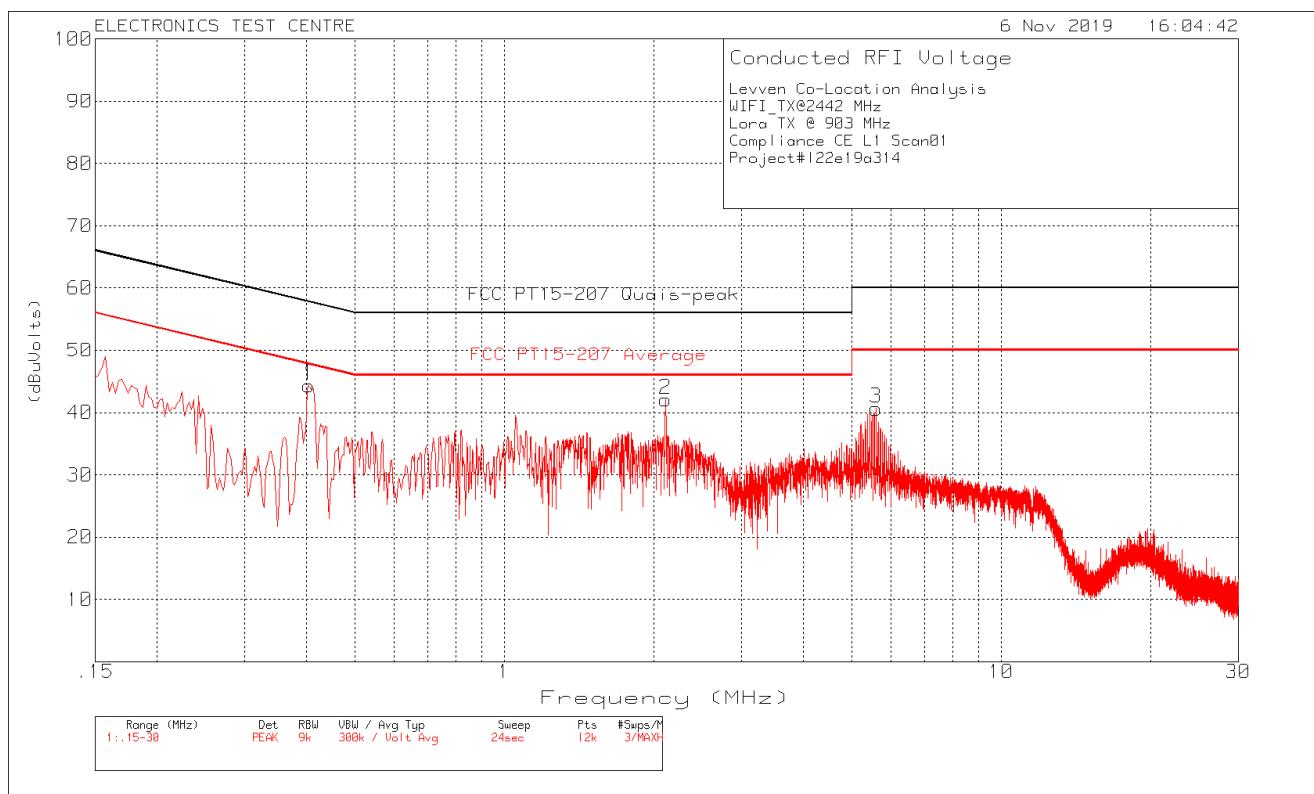
Av = average detector

NOTE: " - " Indicates an emission level below the applicable limit (s).

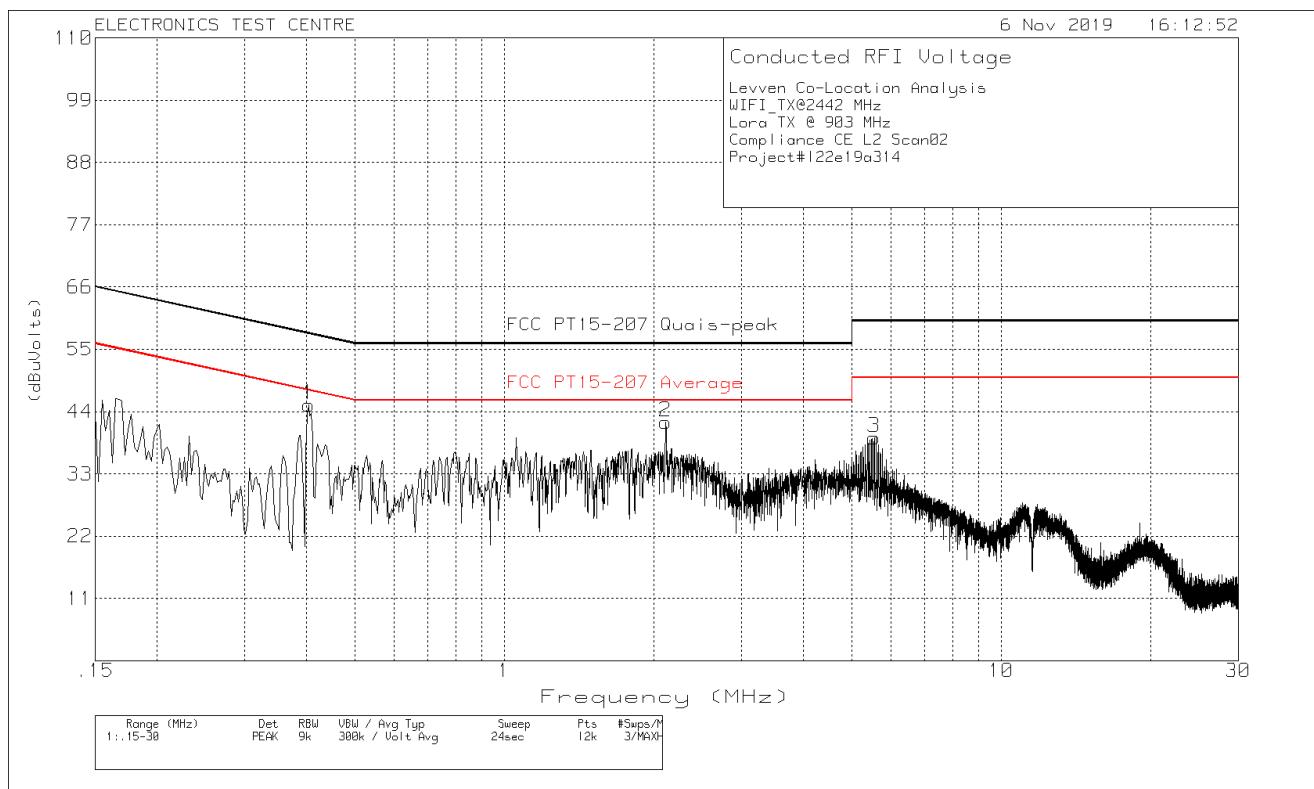
**Meter Reading in dB $\mu$ V + LISN Factor dB + Loss Factor in dB = Corrected Field Strength in dB $\mu$ V.****Delta = Field Strength - Limit****The Ground Bond was measured and found to be 1.25 m $\Omega$ .**

## 1<sup>st</sup> Configuration:

### Plot of Conducted Emissions: Line1

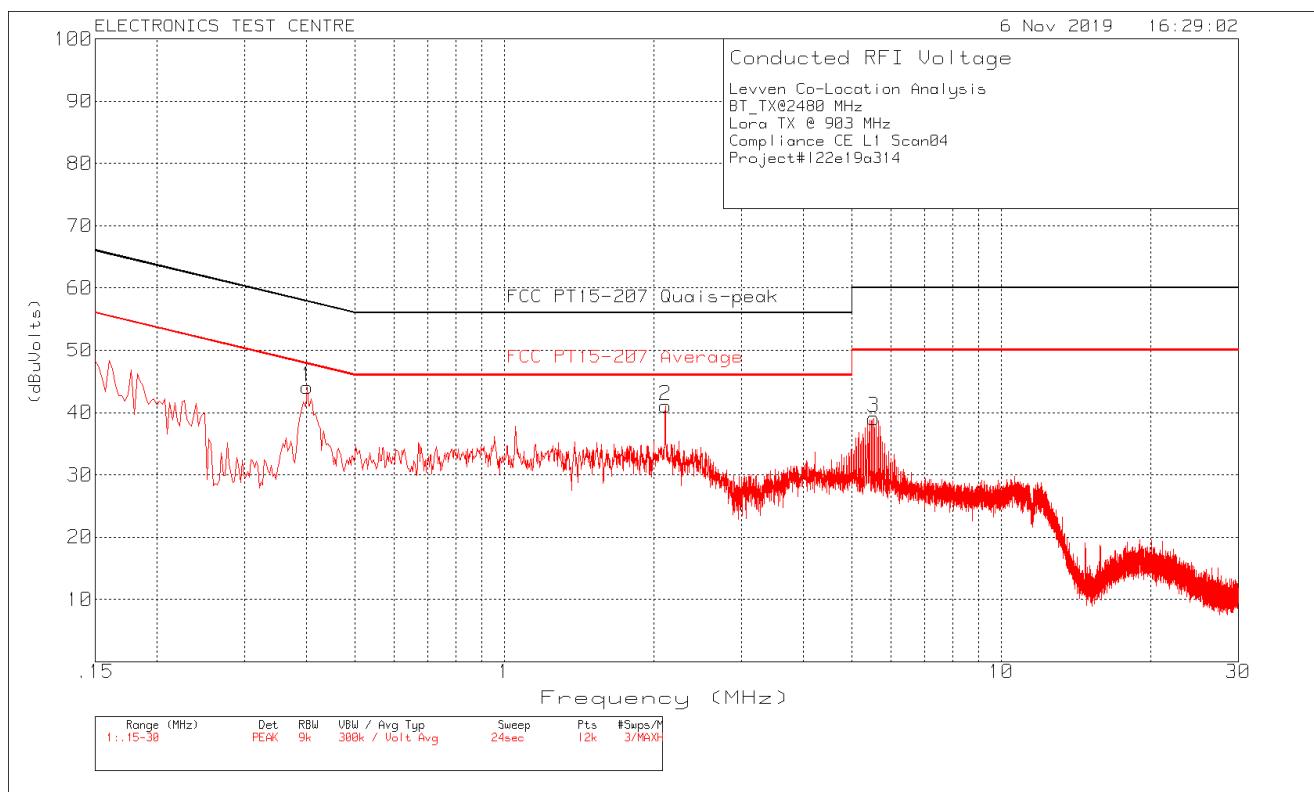


### Plot of Conducted Emissions: Line2

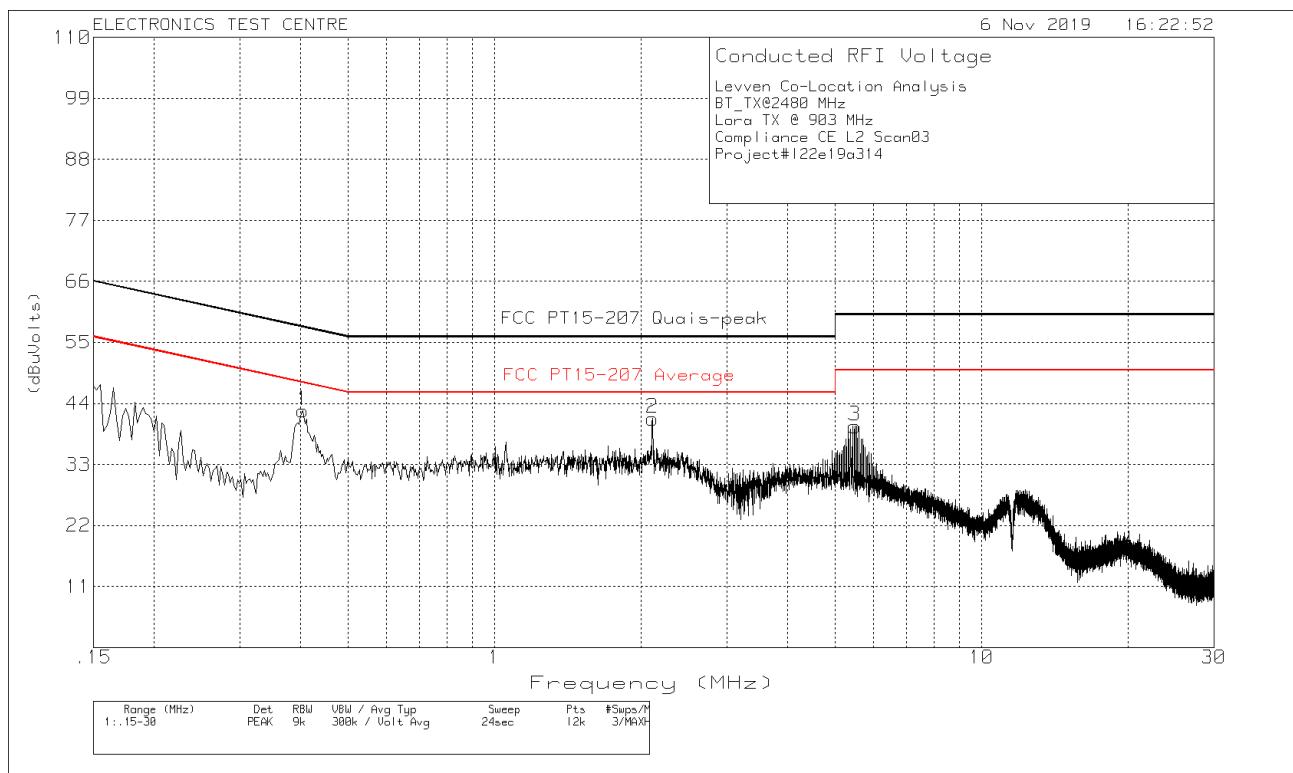


## 2<sup>nd</sup> Configuration:

### Plot of Conducted Emissions: Line1



### Plot of Conducted Emissions: Line2



## 2.2 Radiated Spurious Emissions in restricted frequency bands Co-Location (TX Mode)

Test Lab: Electronics Test Centre, Airdrie	EUT: LC-Q2 s/n EMC1
Test Personnel: Imran Akram	Standard: FCC PART 15.247
Date: 2019-11-05/06 (19.2°C,21.5% RH)	Basic Standard: ANSI C63.10-2013
<b>EUT status: Compliant</b>	

### Specification: FCC PART 15.247(d)

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator which fall in the restricted bands, as defined in §15.205(a), must comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

#### 2.2.1 Test Guidance: ANSI C63.10-2013, Clause 11.12 / KDB 558074 D01 15.247 Measurement Guidance v05r02 Clause 8.6

From 9 kHz to 150 kHz (resolution bandwidth of 200 Hz) and from 150 kHz to 30 MHz (resolution bandwidth 9 kHz) measurements are performed with a loop antenna (as per KDB 460108).

From 30 MHz to 1000 MHz, measurements are performed with a broadband biconilog antenna and a resolution bandwidth of 120 kHz.

Above 1000 MHz, measurements are performed with a DRG Horn antenna or a Standard Gain horn, and a resolution bandwidth of 1 MHz. The EUT is raised to 150 cm above the ground plane, and the area between the EUT and the antenna mast is covered with RF absorbent material.

The scan is performed at discrete increments of turntable azimuth and antenna height, which are selected in accordance with the applicable standard in order to assure capture of frequencies of interest. Optimization is performed based on the scan data.

Frequencies having peak emissions within 10dB of the limits are optimized. The EUT is rotated in azimuth over 360 degrees and the direction of maximum emission is noted.

Antenna height is varied from 1 – 4 meters at this azimuth to obtain the maximum emission. Then the maximum level is measured with the appropriate detector and recorded. Up to 1 GHz, measurements are performed with a Quasi-Peak detector. Above 1 GHz, measurements are recorded with Peak and/or Average detectors, as applicable.

Emission fall in restricted Band = limit is 74 dBuv/m (Peak) / 54dBuv/m (Average)

Emission fall in Non restricted Band = Limit is 20dBc (Peak) / 30dBc (Average) [attenuation below carrier]

#### 2.2.2 Deviations From The Standard:

There were no deviations from the EUT setup or methodology specified in the standard.

## 2.2.4 Test Equipment

Testing was performed with the following equipment:

Equipment	Manufacturer	Model #	Asset #	Cal. Date (yyyy-mm-dd)	Cal. Due (yyyy-mm-dd)
EMC Software	UL	Ver. 9.5	ETC-SW-EMC 2.1	N/A	
EMI receiver	Agilent	N9038A (FW A.23.07)	6130	2019-05-10	2020-05-10
Loop Antenna	EMCO	6502	10868	2019-04-11	2020-04-11
Biconilog Antenna	ARA	LPB-2520/A	4318	2018-09-19	2020-09-19
DRG Horn	EMCO	3115	19357	2018-09-12	2020-09-12
Humidity/Temp Logger	Extech Ins. Corp.	42270	5892	2019-04-05	2020-04-05
Low Noise Amplifier (1 – 18 GHz)	MITEQ	JS43-01001800-21-5P	4354	2019-01-03	2020-01-03
Pre-Amplifier (30 – 1300 MHz)	HP	8447D	9291	2019-01-03	2020-01-03
RE Cable below 1GHz	Insulated Wire Inc.	KPS-1501A-3600-KPA-01102006	4419	2019-01-03	2020-01-03
Re Cable Above 1 GHz	A.H. System Inc.	SAC-26G-8.23	6187	2019-01-03	2020-01-03

## 2.2.5 Test Sample Verification, Configuration & Modifications

The EUT PCB is embedded pre-certified radio module which can be configured in either Wi-Fi or Bluetooth mode. Conducted Emission test is performed to analyze the effect of the pre-certified module in the following configurations,

### 1<sup>st</sup> Configuration:

Leven radio is configured to transmit at channel 903 MHz and pre-certified module is configured in Wi-Fi mode and transmitting channel frequency is 2442 MHz. Both are transmitting in continuous mode.

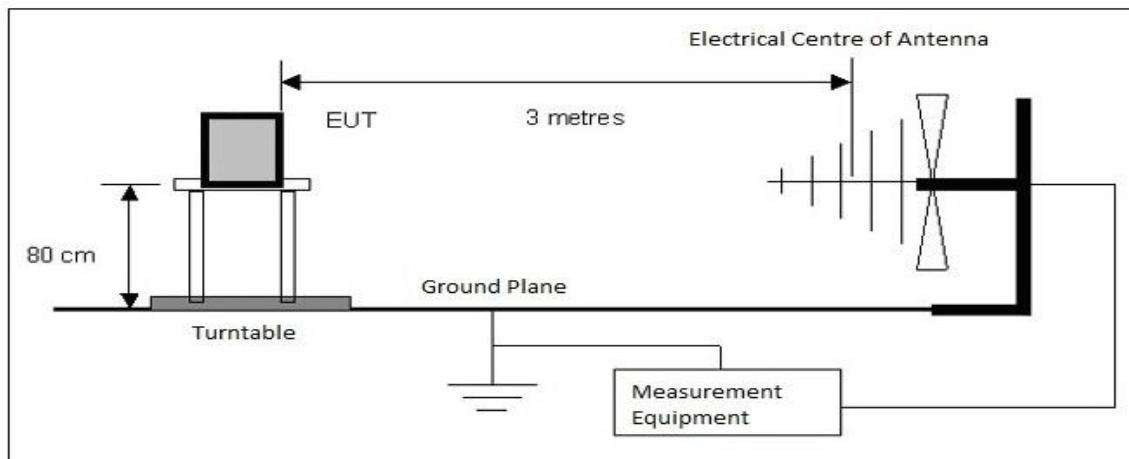
### 2<sup>nd</sup> Configuration:

Leven radio is configured to transmit at channel 903 MHz and pre-certified module is configured in BT mode and transmitting channel frequency is 2480 MHz. Both are transmitting in continuous mode.

All transmitting channels are selected as worst-case scenario after performing the preliminary analysis on all modes of Wi-Fi and Bluetooth. The output was modulated as in normal operation.

The EUT met the requirements without modification.

**Test setup diagram for Radiated Spurious Emissions testing (below 1GHz):**



Above 1GHz, the EUT is raised using a low permittivity material (polystyrene) to a height of 1.5m.

**FCC Part 15.205 Restricted Bands of Operation:**

MHz	MHz	MHz	GHz
0.090 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
<sup>1</sup> 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	( <sup>2</sup> )
13.36 - 13.41			

<sup>1</sup> Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz, <sup>2</sup> Above 38.6

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.

**Specification: FCC15.209 Radiated emission limits.**

Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

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

**2.2.6 Radiated Emissions Data:**

The emissions data are presented in tabular form, showing turntable azimuth, antenna height and polarization, the uncorrected spectrum analyzer reading, the correction factors applied, the net result, the value of the limit at the frequency investigated, and the Delta between the result and the limit.

**Meter Reading in dB $\mu$ V + Antenna Factor in dB/m + Gain/Loss Factor in dB = Corrected Field Strength in dB $\mu$ V/m.**

**Delta = Field Strength - Limit**

**Notes:** When a preamp is used, the resulting gain is compensated, producing a negative value for the Cable Loss.

- Measurements reported are the result of adjusting the turntable azimuth and antenna height to obtain the maximum EUT emission. This may produce a different reading than the plot trace. The plot is a Peak Hold function obtained at discrete increments of height and azimuth, while the reported measurement is obtained with the appropriate Quasi Peak or Average detector after the height and azimuth have been adjusted for maximum emission.
- Preliminary scans were performed for all channels in Transmit modes. The worst-case channels were selected for detailed examination for all radios.
- In Transmit mode, the EUT was assessed up to 25.0 GHz.
- No emission found above 18 GHz to report.

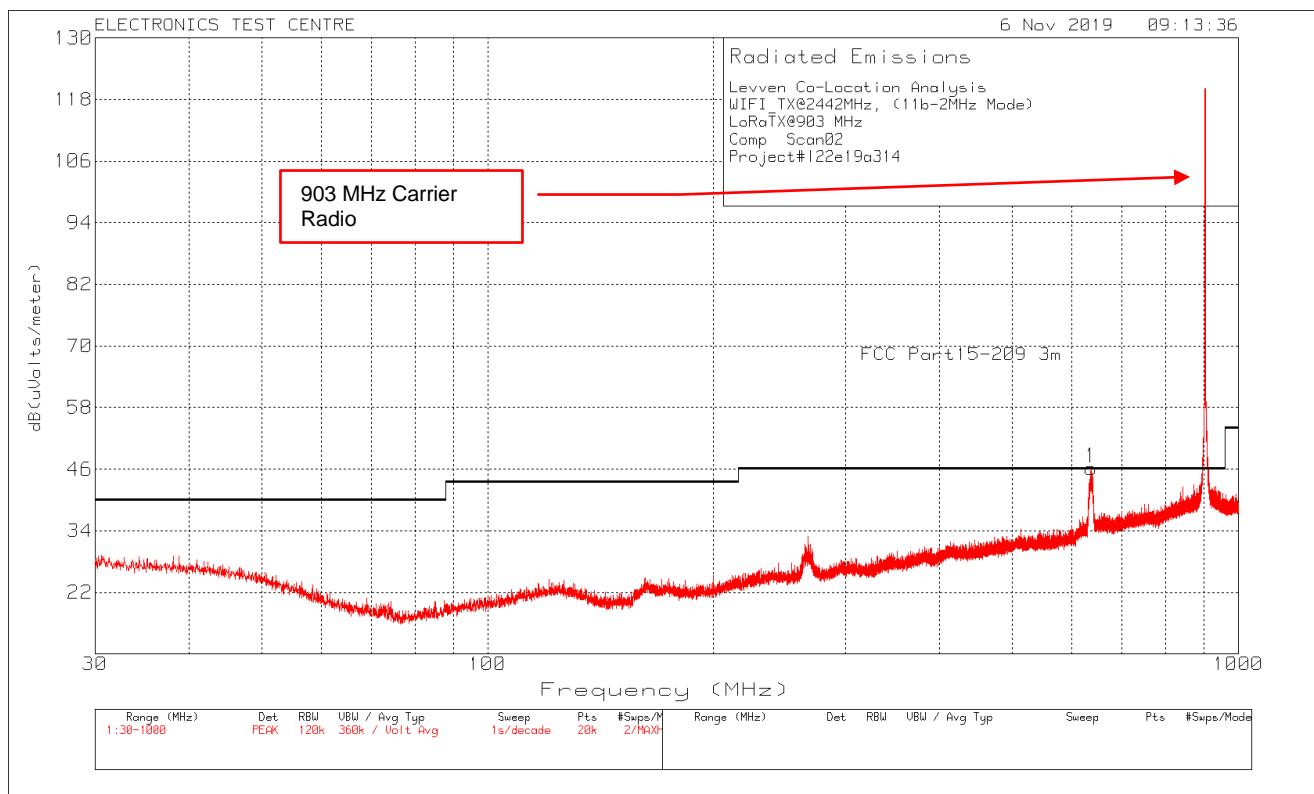
Freq. Marker	Freq. [MHz]	Raw reading [dB $\mu$ V]	Det	Antenna Factor [dB/m]	Pre amp Gain [dB]	Corrected Reading [dB $\mu$ V/m]	FCC 15.209 Limit [dB $\mu$ V/m]	Delta [dB]	Azimuth [Deg]	Height [cm]	Polarization
(1 <sup>st</sup> Configuration)											
1	636.7842	22.81	QP	23.1	-20	25.91	46.02	-20.11	0	110	Horizontal
1	4884.0	42.82	PK	33.4	-32.1	44.12	54	-9.88	26	251	Horizontal
2	4884.0	43.71	PK	33.4	-32.1	45.01	54	-8.99	45	251	Vertical
(2 <sup>nd</sup> Configuration)											
1	37.73	37.73	QP	23.5	-19.8	41.43	46.02	-4.59	0	105	Horizontal
2	33.42	33.42	QP	25.1	-18.6	39.92	46.02	-6.1	330	106	Horizontal
3	31.93	31.93	QP	25.6	-18.8	38.73	46.02	-7.29	71	111	Horizontal
4	31.1	31.16	QP	26.3	-18.6	38.86	46.02	-7.16	1	102	Horizontal
5	32.81	32.81	QP	12.2	-23.8	21.21	43.5	-22.29	354	117	Vertical

**Negative values for Delta indicate compliance.**

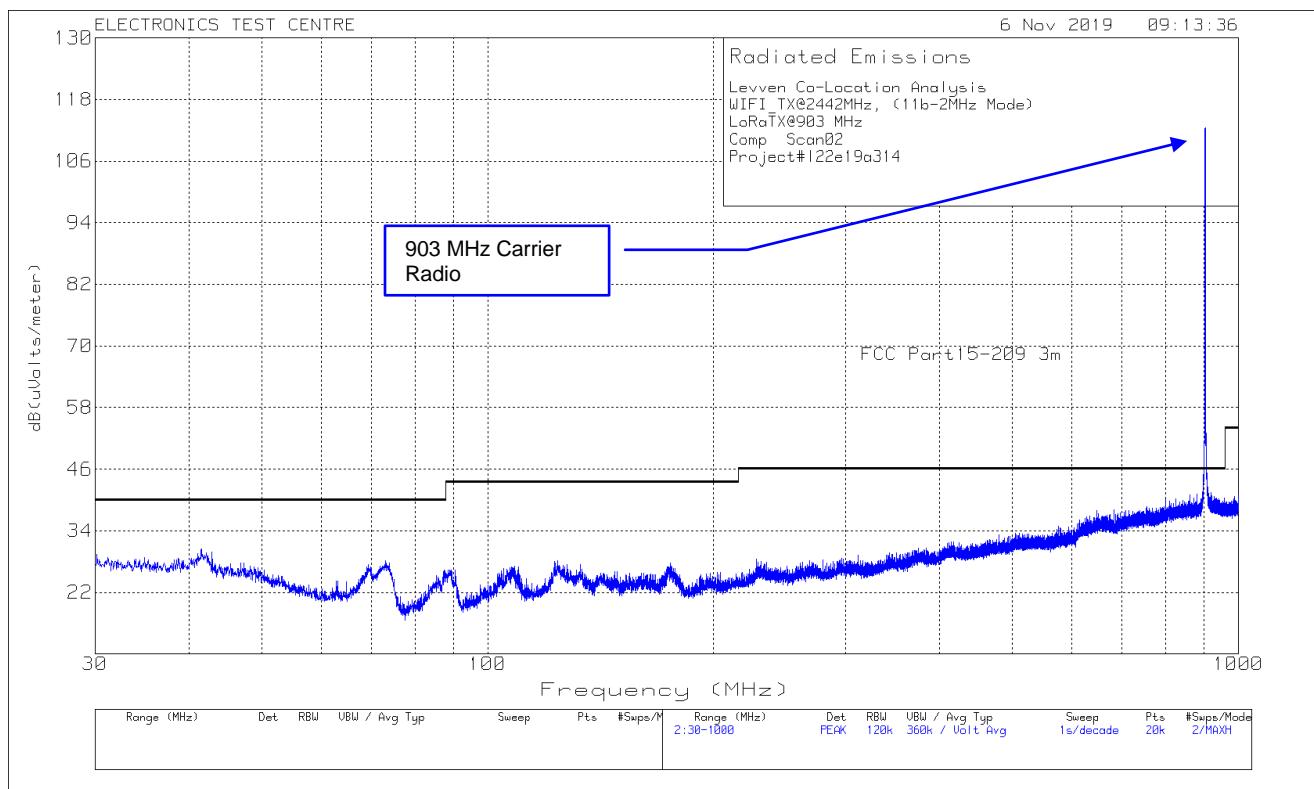
\* Restricted Band

## 1<sup>st</sup> Configuration Plots

### Plot of Radiated Emissions: Horizontal polarization



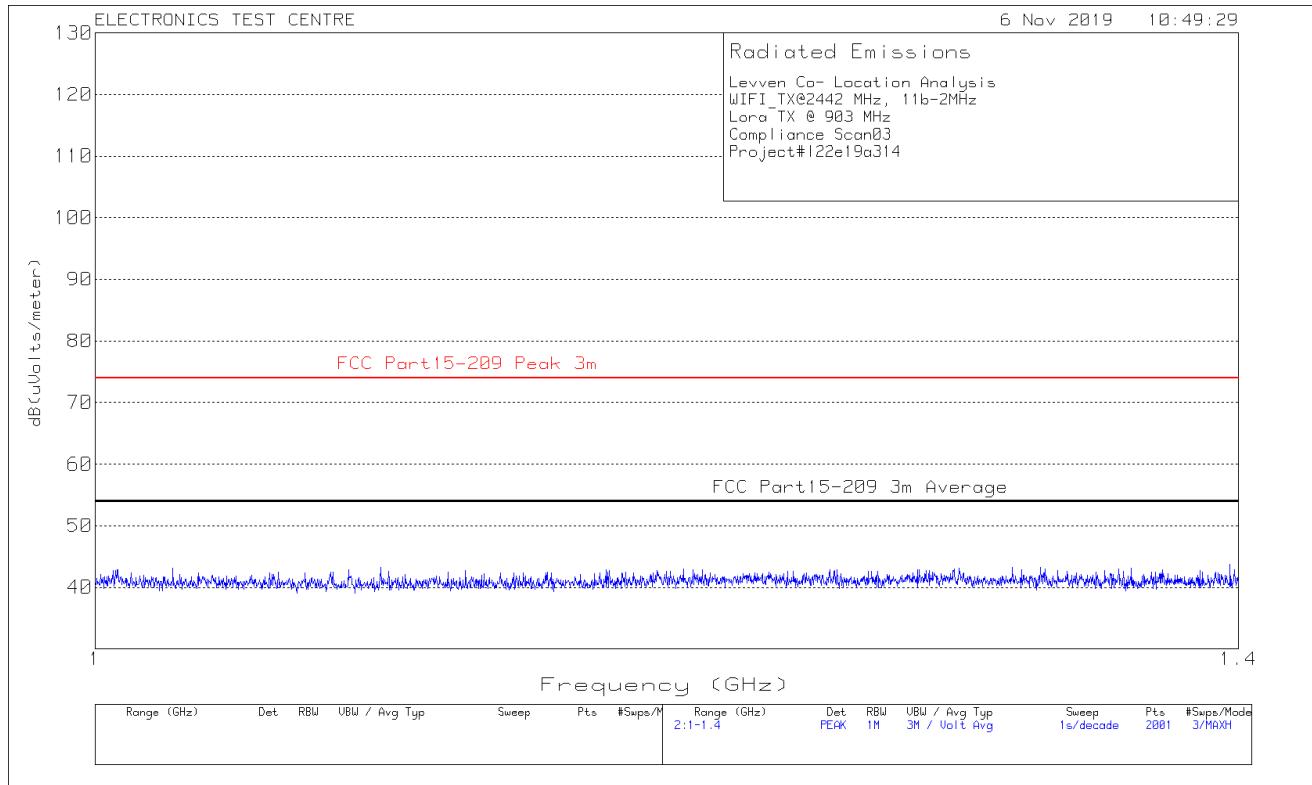
### Plot of Radiated Emissions: Vertical polarization



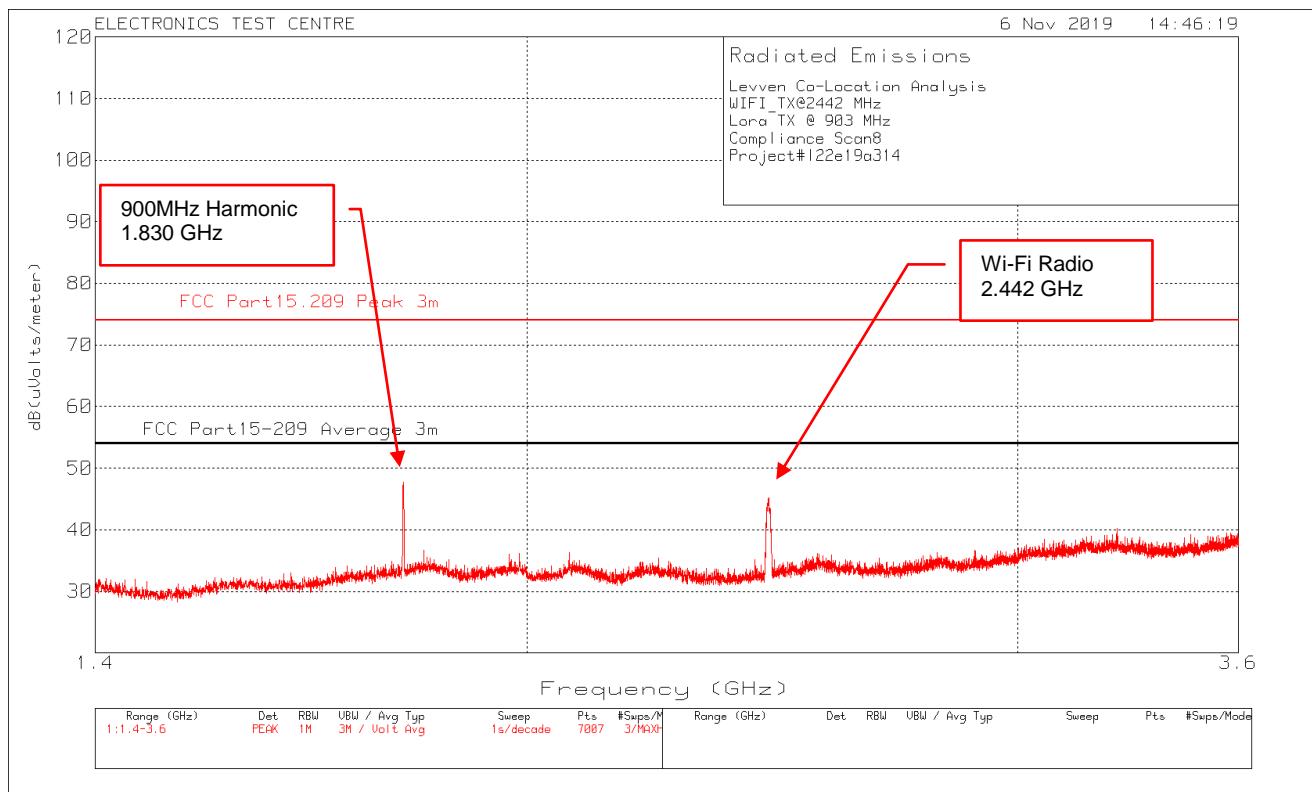
## Plot of Radiated Emissions: Horizontal polarization



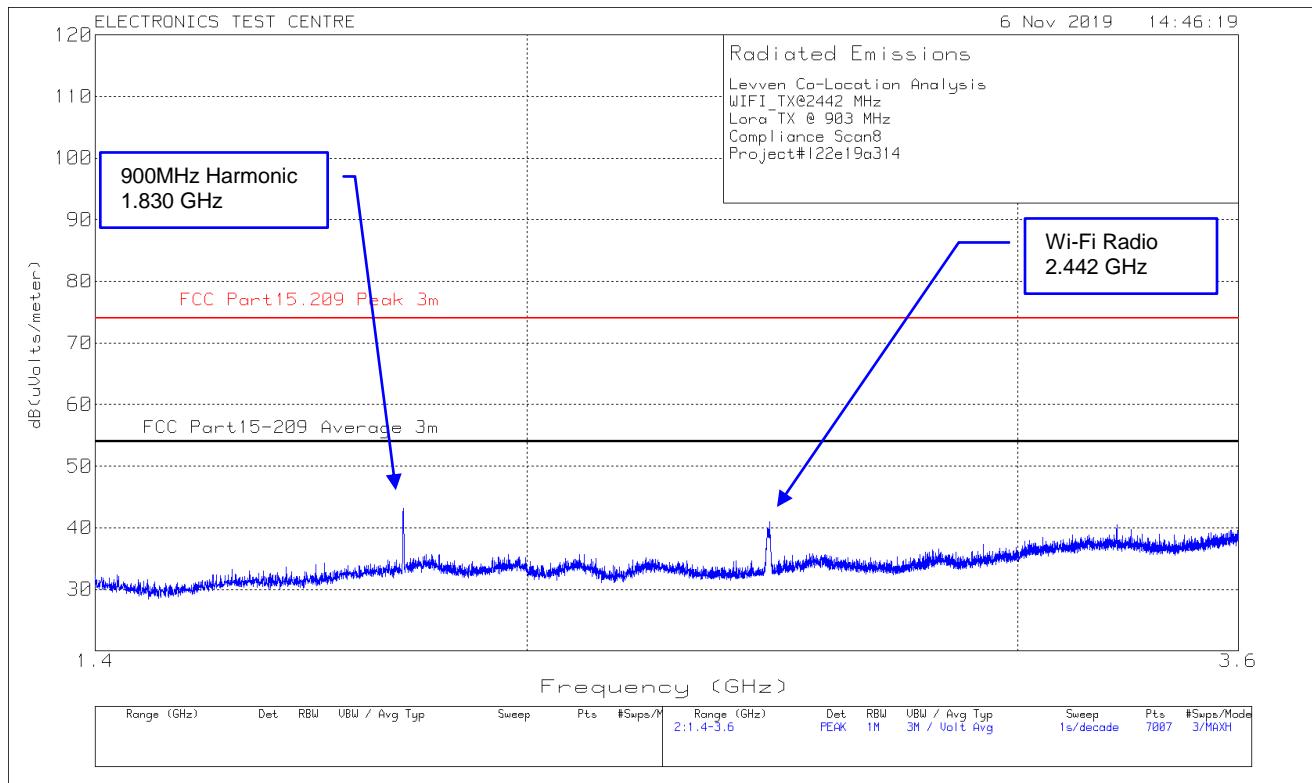
## Plot of Radiated Emissions: Vertical polarization



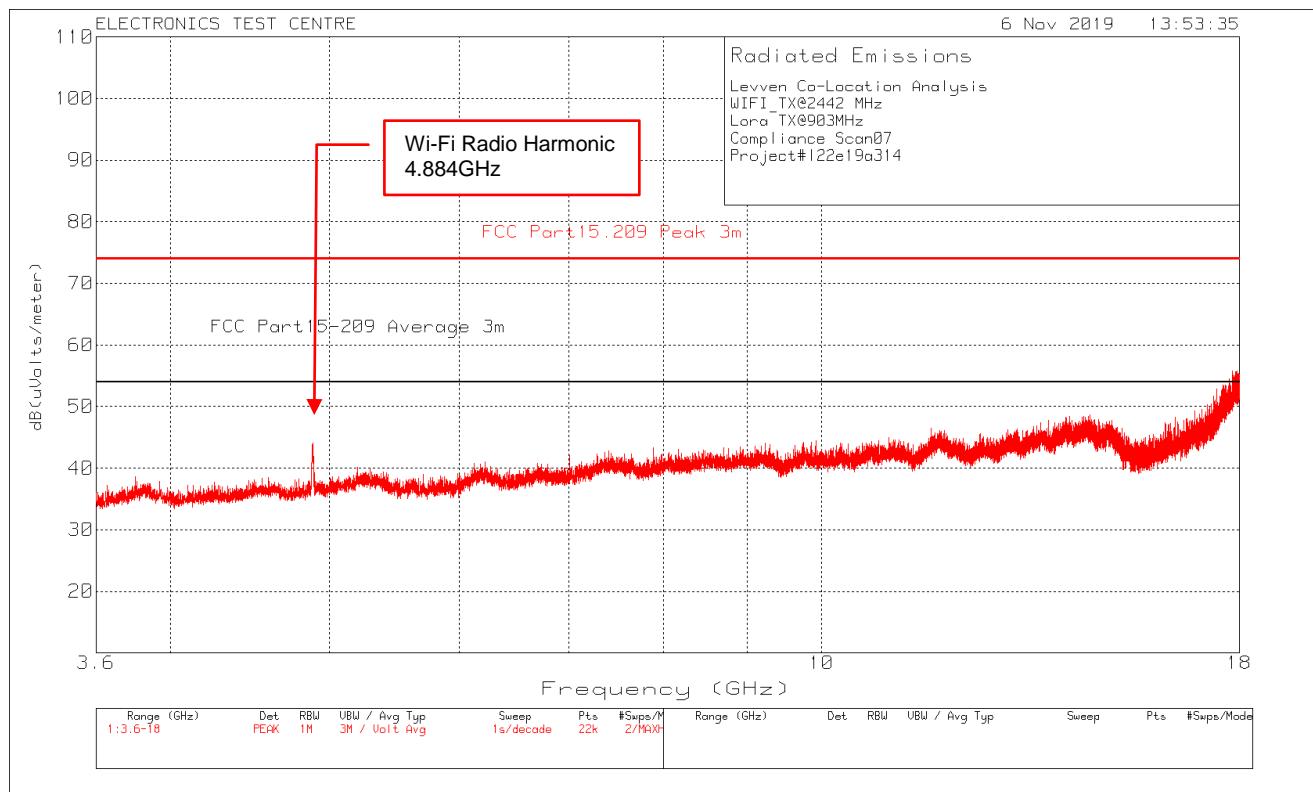
## Plot of Radiated Emissions: Horizontal polarization



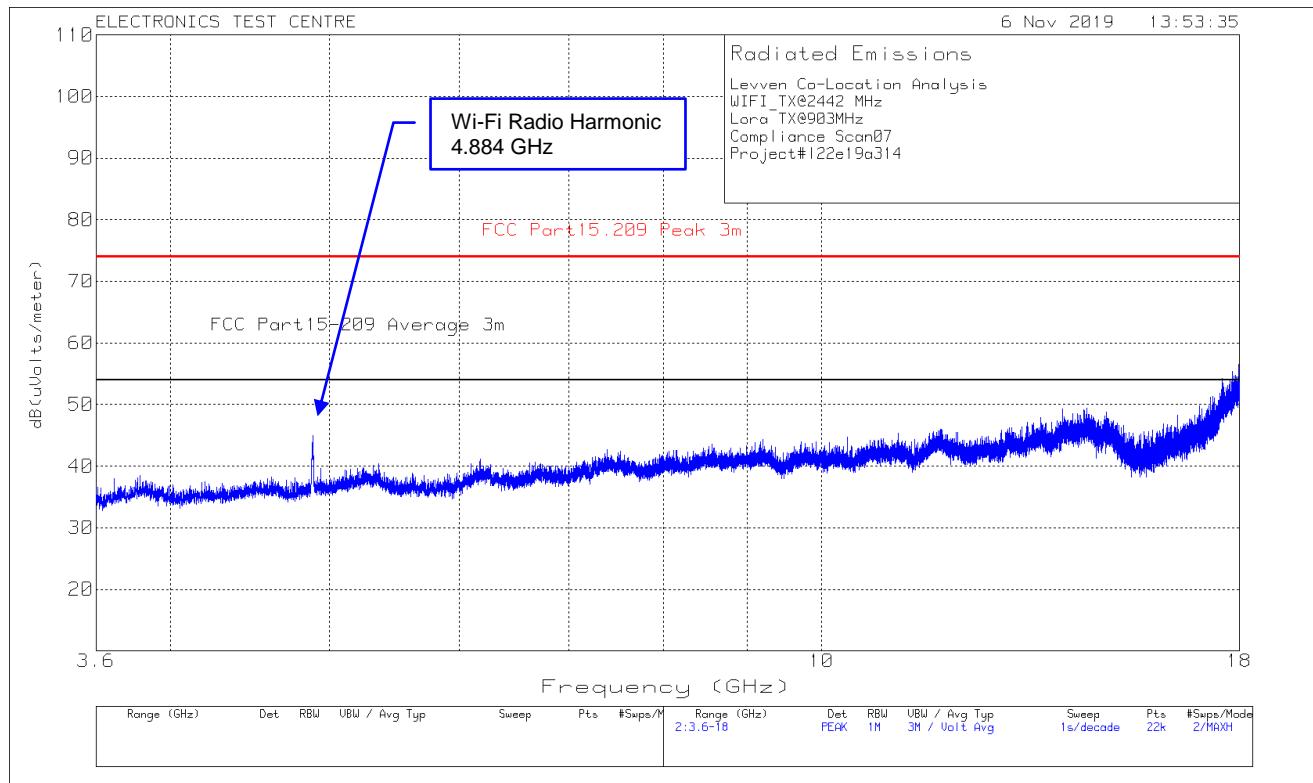
## Plot of Radiated Emissions: Vertical polarization



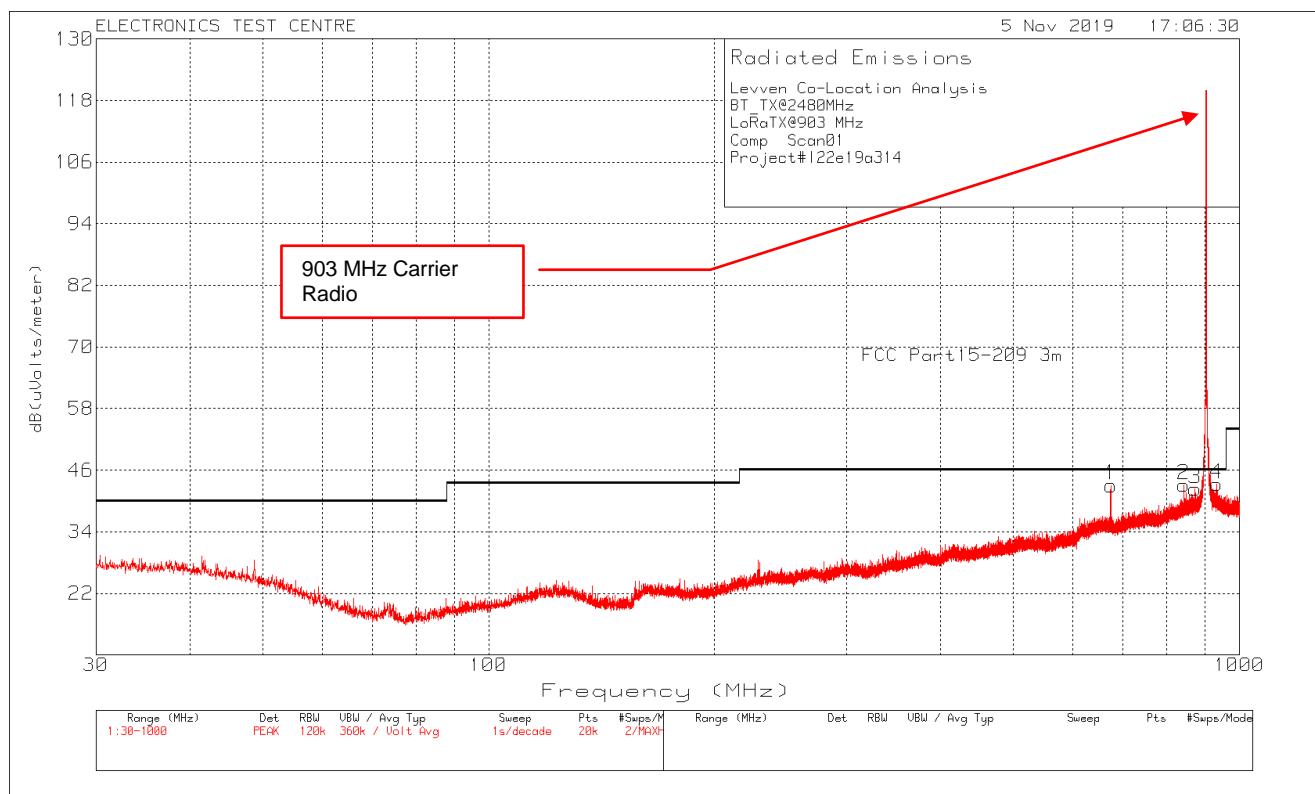
## Plot of Radiated Emissions: Horizontal polarization



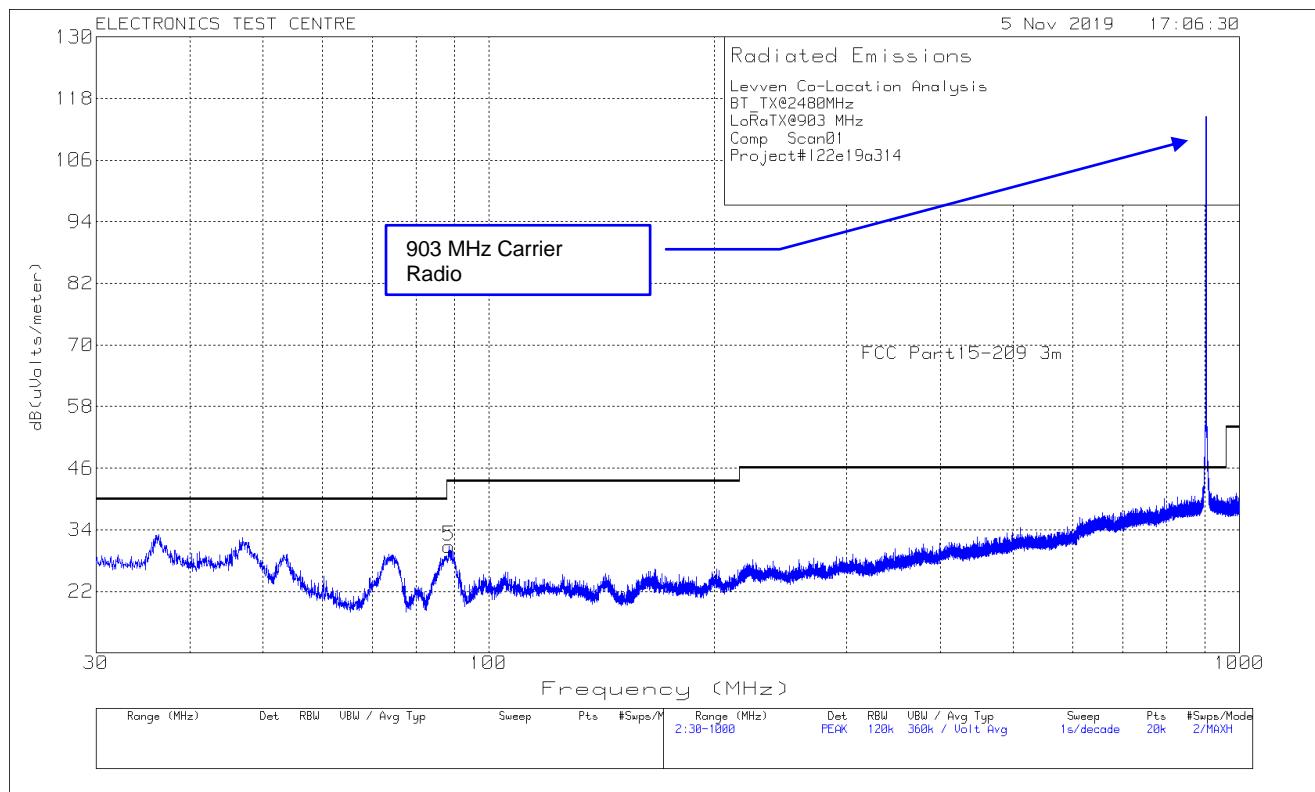
## Plot of Radiated Emissions: Vertical polarization



**2<sup>nd</sup> Configuration Plots:**  
**Plot of Radiated Emissions: Horizontal polarization**



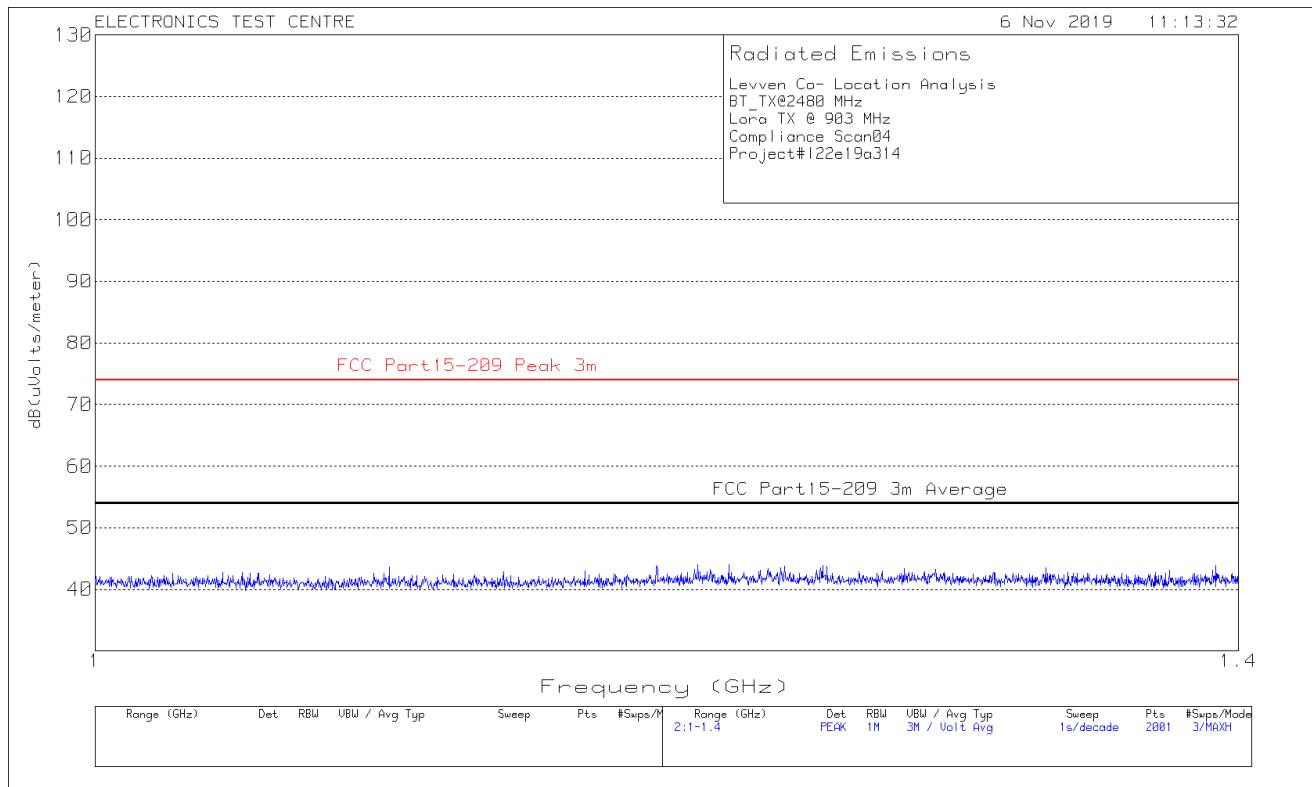
**Plot of Radiated Emissions: Vertical polarization**



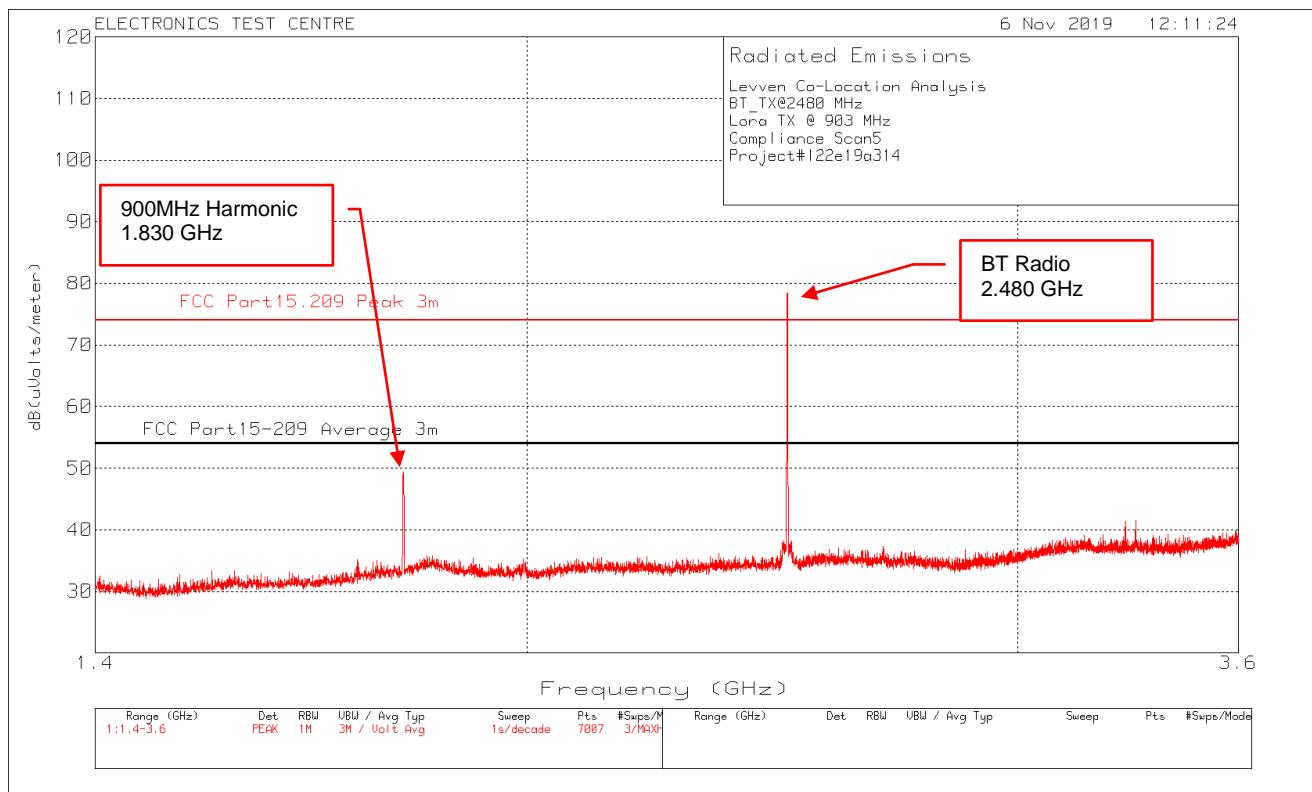
## Plot of Radiated Emissions: Horizontal polarization



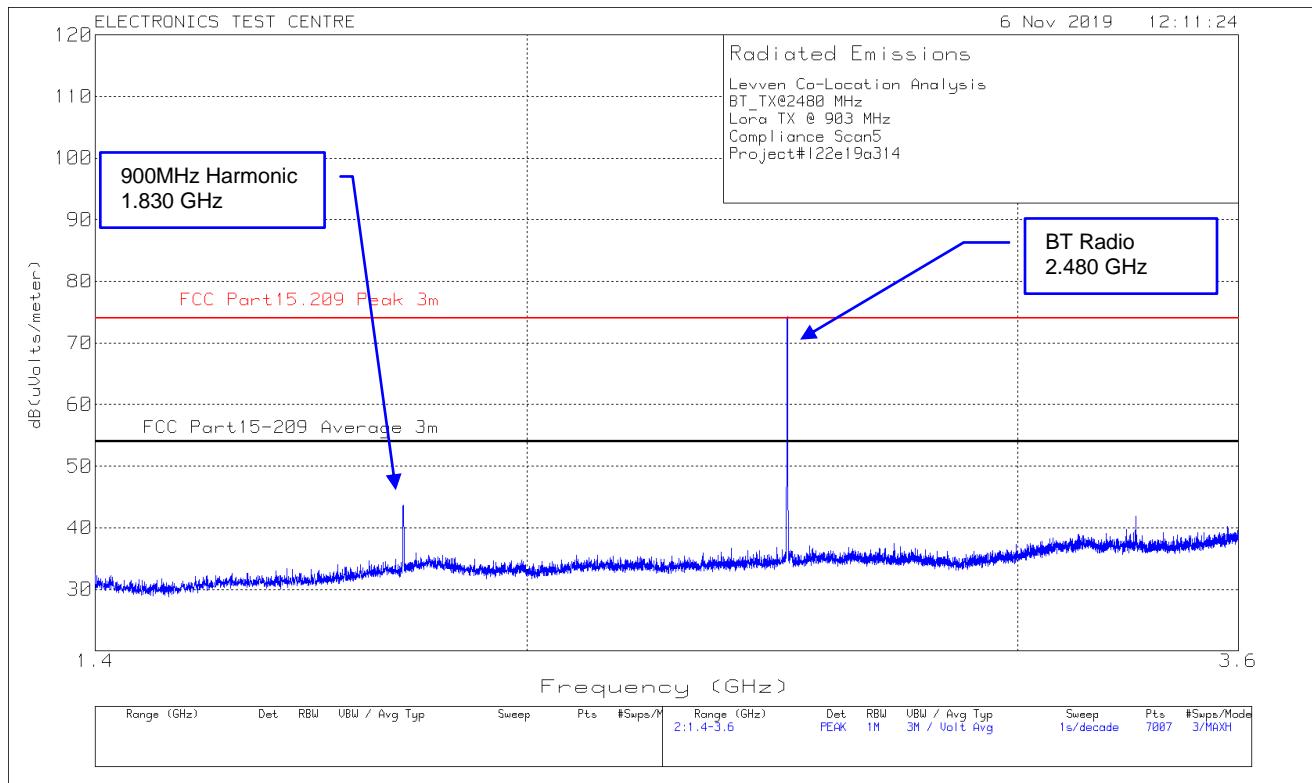
## Plot of Radiated Emissions: Vertical polarization



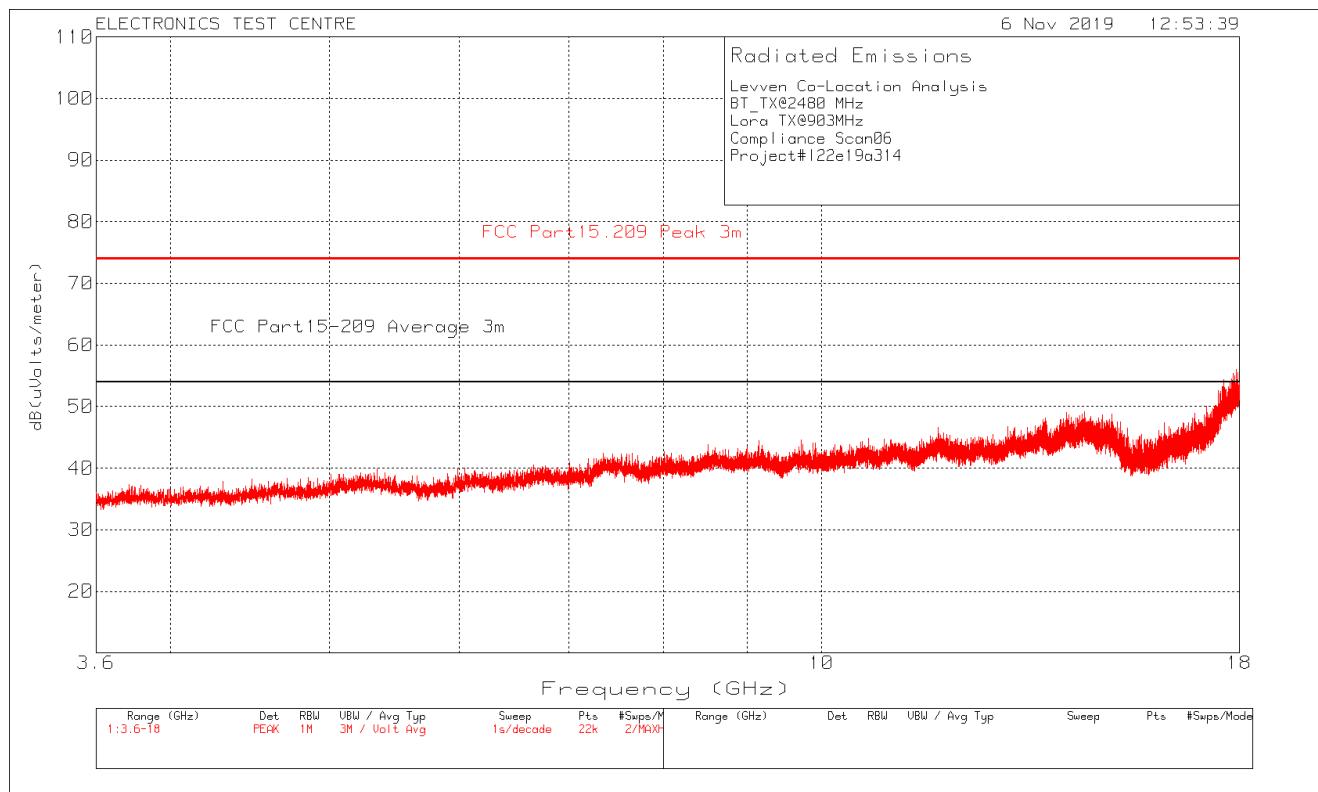
## Plot of Radiated Emissions: Horizontal polarization



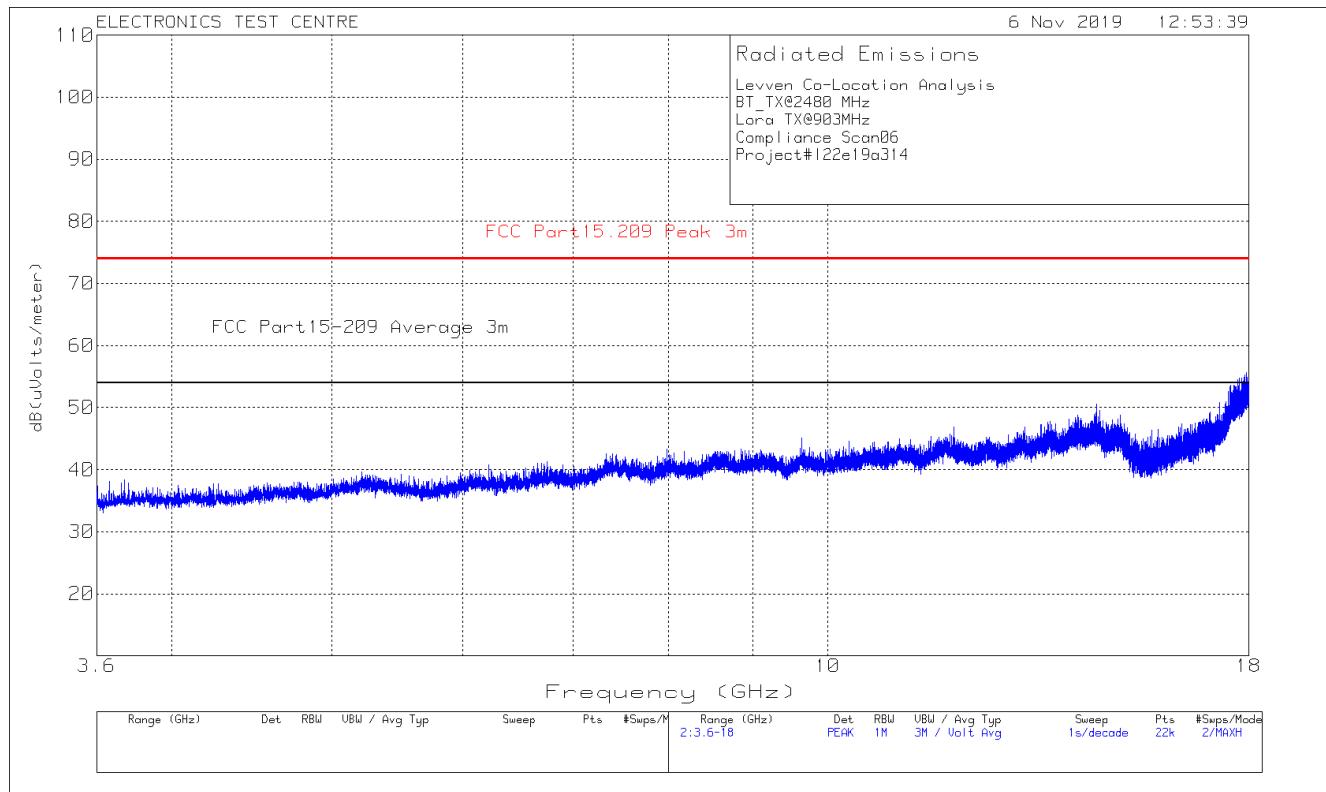
## Plot of Radiated Emissions: Vertical polarization



## Plot of Radiated Emissions: Horizontal polarization



## Plot of Radiated Emissions: Vertical polarization



### 2.3 RF Exposure

<b>Test Lab:</b> Electronics Test Centre, Airdrie	<b>EUT:</b> LC-Q2 s/n EMC2
<b>Test Personnel:</b>	<b>Standard:</b> FCC PART 15.247
<b>Date:</b>	
<b>EUT status: Exempt</b>	
<b>Compliant:</b> RF exposure assessment to be provided in a separate Exhibit.	

### **3.0 TEST FACILITY**

#### **3.1 Location**

The LC-Q2 was tested for emissions at the Electronics Test Centre laboratory located in Airdrie, Alberta, Canada. The Radio Frequency Anechoic Chamber (RFAC), identified as Chamber 1, has a usable working space measuring 10.6 m long x 7.3 m wide x 6.5 m high.

Measurements taken at this site are accepted by Industry Canada as evidence of conformity per registration file # 2046A. This site is also listed with the FCC under Registration Number CA2046.

The floor, walls and ceiling consist of annealed steel panels. The walls and ceiling are covered with ferrite tile, augmented by RF absorbant foam material on the end wall nearest the turntable, and on the adjacent walls and the ceiling. The chamber floor supports a 15 cm high internal floor, constructed of annealed steel panels, that forms the ground plane, and is bonded to the chamber walls.

The 3-m diameter turntable is flush-mounted with the floor. A sub-floor cable-way is provided to route cables between the turntable pit and EUT support equipment located in the Control Room. Cables reach the EUT through an opening in the centre of the turntable.

Test instrumentation and EUT support equipment is located in the Control Room, consisting of two shielded vestibules joined together at the side of the main room. Cables are routed through bulkhead panels between the rooms and the test chamber as required. Power feeds are routed into the main room and vestibules through line filters providing at least 100 dB of attenuation between 10 kHz and 10 GHz.

Either floor mounted or table-top equipment can be tested at this facility.

#### **3.2 Grounding Plan**

The LC-Q2 was placed at the center of the test chamber turntable on a Styrofoam table. The EUT was **NOT** grounded according to specifications.

#### **3.3 Power Supply**

All EUT power was supplied by AC/DC Adaptor connected to a filtered AC Main source for radiated emission measurement.

## End of Document