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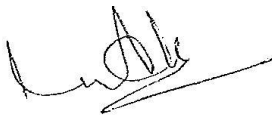
Test Dates: July 2,3,4,5 of 2019

EMC testing of the Levven Electronics Ltd. LC-Q2

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

FCC ID: 2AA9N-LCQ2

Prepared for: Levven Electronics Ltd
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REVISION RECORD

ISSUE	DATE	AUTHOR	REVISIONS
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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, ANSI C63.4-2014 and ANSI C63.10-2013 to gain FCC Certification Authorization for 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:

Product Name:		Levven Controls Q2 Gateway
LoRa Radio	Frequency Band	902 – 928 MHz
	Type of Modulation	GFSK
	BW/Frequency Range	DTS 750kHz, 903 – 927 MHz, 33 Channels
	Associated Antenna	PCB trace, gain 0dBi
	Detachable/Non Detachable	Non-Detachable
Model# / Serial#		Model: LC-Q2, s/n: EMC1 (radiated), s/n EMC2 (conducted)
Power supply:		AC / DC Adaptor (120VAC / 60Hz , 0.55A), mfr: LI TONE Electronics Co. Ltd. Model: LTE18WS-S1, s/n: 184100015

Note: All three channels and axis for LC-Q2 were evaluated. Worse Channel and Axis was selected for detail analysis for radiated emission.

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.

In this report, the EUT is only tested for the DTS 500 kHz transmission.

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.

The EUT was also tested as an unintentional radiator, as reported separately.

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

Modulation mode:

GFSK radio signals are transmitted from and received on the radio IC on one of 33 channels of 750 kHz step size from 903 MHz to 927 MHz. Each device in the network uses a randomly selected channel in the set of 33 and will continue to use that channel until the user sets up a new network channel for the home. There is no frequency hopping during normal operation. The channels used for the tests are:

Low = 903 MHz

MID = 915 MHz

High = 927 MHz

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
Frequency Range = (903 - 927) MHz 500 KHz DTS Mode Max. Conducted Tx Power =20.43 dBm (0.1104Watt)						
2.1	AC Conducted Emissions (Tx)	15.207	LC-Q2 s/n EMC1	none	see § 2.1	Compliant
2.2	Occupied Bandwidth	15.247(a)(1) 15.247(2)(2)	LC-Q2 s/n EMC2	none	see § 2.2	Compliant
2.3	Max Average Output Power Conducted	15.247(b)	LC-Q2 s/n EMC2	none	see § 2.3	Compliant
2.4	Power Spectral Density	15.247(e) 15.247(f)	LC-Q2 s/n EMC2	none	see § 2.4	Compliant
2.5	Band Edge	15.247(d)	LC-Q2 s/n EMC2	none	see § 2.5	Compliant
2.6	Conducted Spurious Emission in Non-Restricted Band	15.247(d)	LC-Q2 s/n EMC2	none	see § 2.6	Compliant
2.7	EUT Position	ANSI C63.4	LC-Q2 s/n EMC1	none	see § 2.7	Assessed
2.8	Radiated Spurious Emission in Restricted Band (Tx Mode)	15.205, 15.209 15.247(d)	LC-Q2 s/n EMC1	none	see § 2.8	Compliant
2.9	RF Exposure	15.247(i)	LC-Q2 s/n EMC2	none	see § 2.9	Exempt

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: Bushra Muharram Imran Akram	Standard: FCC Part 15.207
Date: 2019-07-03 (23.5°C, 33 % RH)	Basic Standard: ANSI C63.10: 2013
EUT status: Compliant	

Specification: Part 15.207

Frequency (MHz)	Quasi-Peak Limit (dBµV)	Average Limit (dBµV)
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: ANSI C63.4-2014, Clause 7.3.1

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:

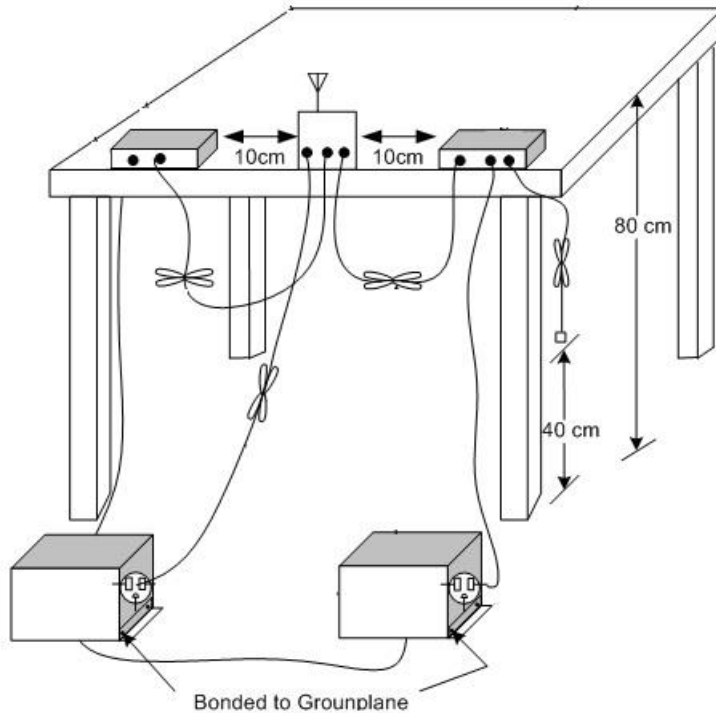
Equipment	Manufacturer	Model #	Asset #	Cal. Date (yyyy-mm-dd)	Cal. Due (yyyy-mm-dd)
EMC Software	UL	Ver. 9.5	ETC-SW-EMC 2.1	N/A	N/A
EMI receiver	Agilent	N9038A (FW A.23.07)	6130	2019-05-10	2020-05-10
LISN	Com-Power	LI-215A	6180	2018-06-06	2020-06-06
Temp/RH logger	Extech	42270	5892	2019-04-05	2020-04-05
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 was set to selected channels with test-specific software. The output was modulated as in normal operation. Configuration in Tx mode radios are transmitting at MID channel.

The EUT met the requirements without modification.

Test setup diagram:



2.1.5 Conducted Emissions Data:

The EUT was evaluated in all channels. No channel showed emission worst then another. The plots are from the DTS mode using MID-Channel.

Freq. Marker	Freq. [MHz]	Meter reading [dBμv]	Det	LISN Factor [dB]	Pre amp Gain [dB]	Corrected Reading [dBμv]	FCC 15.207 Limit [dBμv]	Delta [dB]	L/N
1	0.4338	34.36	Av	0	.1	34.46	47.18	-12.72	L
2	1.04829	40.18	Av	0	.1	40.28	46	-5.72	L
3	21.6629	40.29	Av	-.1	1	41.19	50	-8.81	L
1	0.43291	34.22	Av	0	.1	34.32	47.2	-12.88	N
2	1.04642	40.3	Av	0	.1	40.4	46	-5.6	N
3	21.6629	40.54	Av	.1	1	41.64	50	-8.36	N

Av = average detector

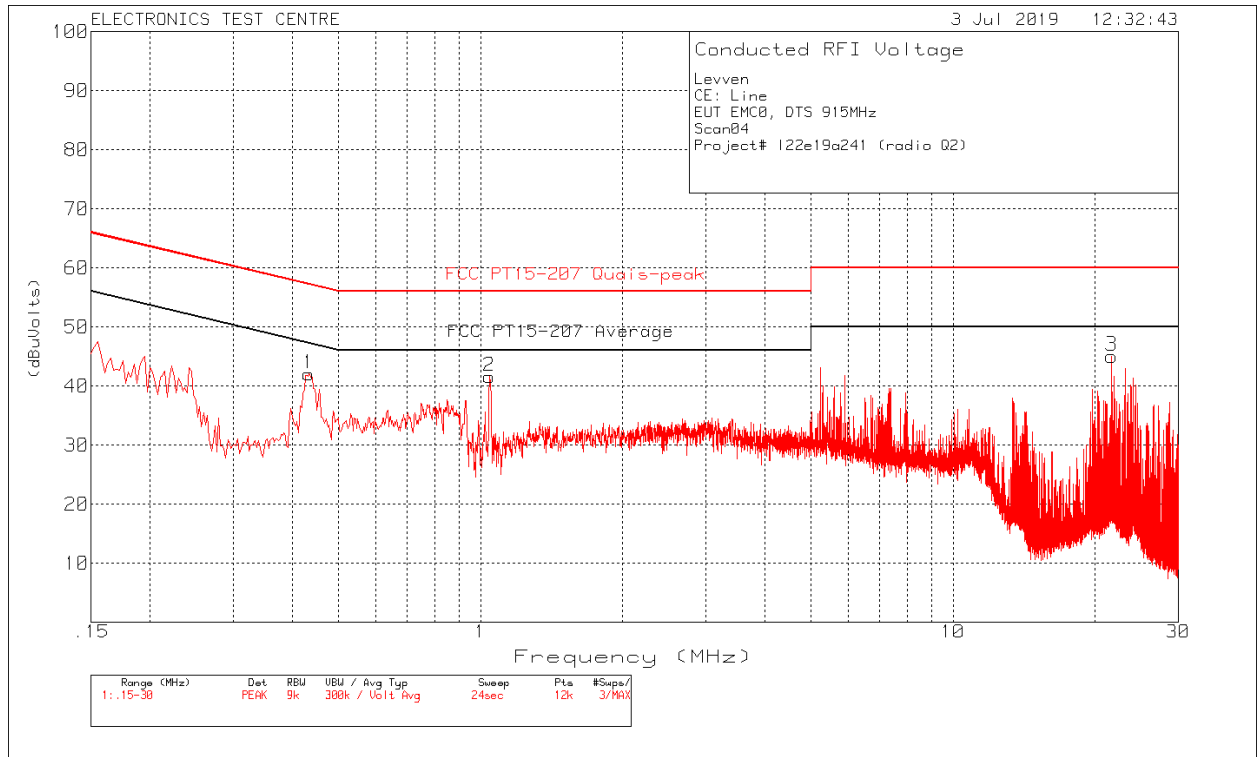
Negative values for Delta indicate compliance.

Meter Reading in dBμV + LISN Factor dB + Loss Factor in dB = Corrected Field Strength in dBμV.

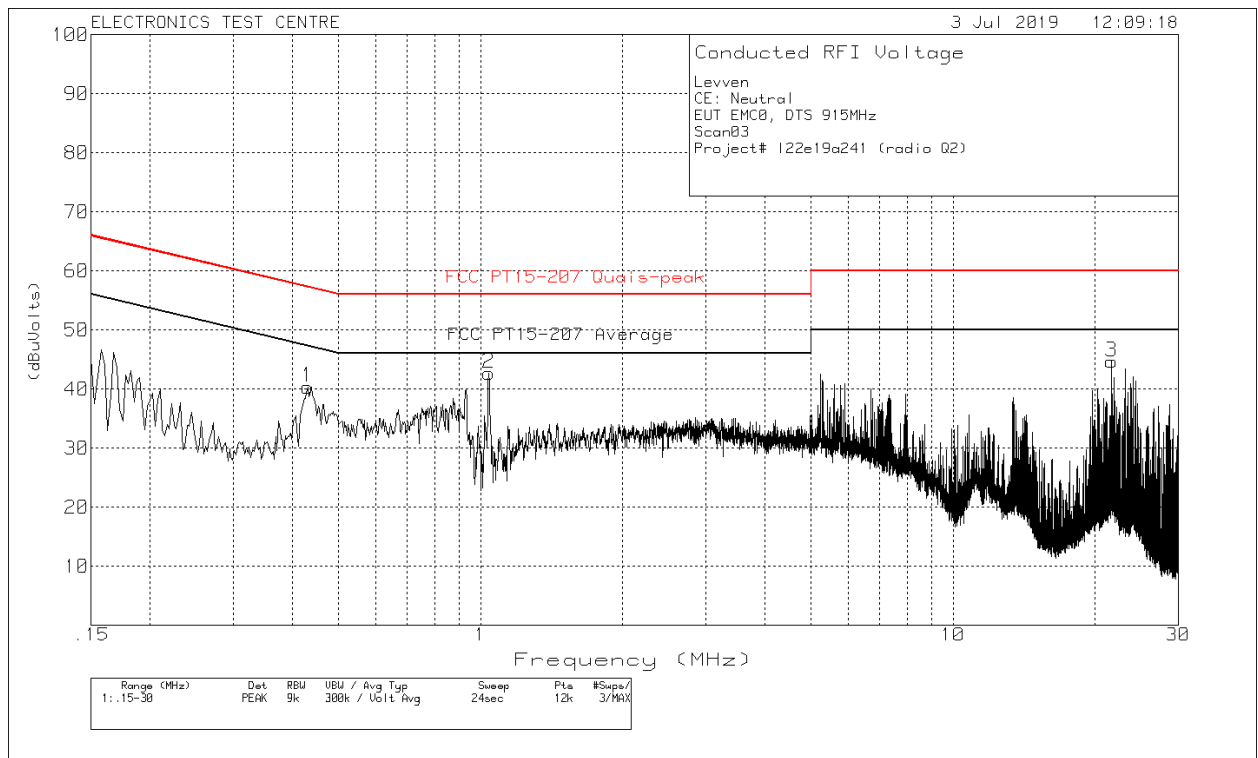
Delta = Field Strength - Limit

The Ground Bond was measured and found to be 1.25 mΩ.

Plot of Conducted Emissions: Line1



Plot of Conducted Emissions: Line2



2.2 Channel Occupied Bandwidth (DTS Mode)

Test Lab: Electronics Test Centre, Airdrie	EUT: LC-Q2 s/n EMC2
Test Personnel: Bushra Muharram Imran Akram	Standard: FCC PART 15.247
Date: 2019-07-04 (23.7°C, 37.4 % RH)	Basic Standard: ANSI C63.10-2013 KDB 558074 D01 15.247
	Measurement Guidance v05r02
EUT status: Compliant	

Specification: FCC Part 15.247 (a, 2), FCC 15.215 (c)

Criteria: Systems using digital modulation techniques may operate in the 902-928 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

2.2.1 Test Guidance: FCC KDB 558074 D01 15.247 Measurement Guidance v05r02/ ANSI C63.10 clause 11.8

This measurement is performed at low, mid and high frequencies, with modulation.

The RF output of EUT with an antenna connector is fed to the input of the spectrum analyzer through appropriate attenuation. The loss from the cable and the attenuator were added on the analyzer as gain offset setting there by allowing direct measurements, without the need for any further corrections.

Use the following spectrum analyzer settings:	
Span	between two times and five times the channel center frequency OBW
RBW	100 KHz
VBW	Set the VBW $\geq [3 \times \text{RBW}]$.
Sweep	Auto Couple
Detector function	peak
Trace mode	max hold
Allow the trace to stabilize. The automatic bandwidth measurement capability of an instrument employed using the X dB bandwidth mode with X set to 6 dB	

2.2.2 Deviations From The Standard:

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

2.2.3 Test Equipment

Testing was performed with the following equipment:

Equipment	Manufacturer	Model #	Asset #	Cal. Date (yyyy-mm-dd)	Cal. Due (yyyy-mm-dd)
Signal Analyzer	Agilent	N9010A (FW A.14.16)	6678	2018-07-16	2019-07-16
Temp/Humidity	Extech	42270	5892	2019-04-05	2020-04-05
Attenuator	FairView Microwave	SA18N5WA-10	6886	2018-11-23	2019-11-23
DC Blocker	MCL	BLK-89-S+	-	2019-01-15	2020-01-15
CE Cable (50cm length)	Huber+Suhner	Enviroflex 400	-	2019-01-15	2020-01-15

2.2.4 Test Sample Verification, Configuration & Modifications

The EUT was set to transmit continuously on a selected channel with test-specific software. The output was modulated as in normal operation. The EUT modified to provide the direct access to antenna trace for conducted measurements.

For compliance purposes EUT met requirements without any modification

There is no Deviation and exclusions from test specifications.

Test setup diagrams for Occupied Bandwidth testing:

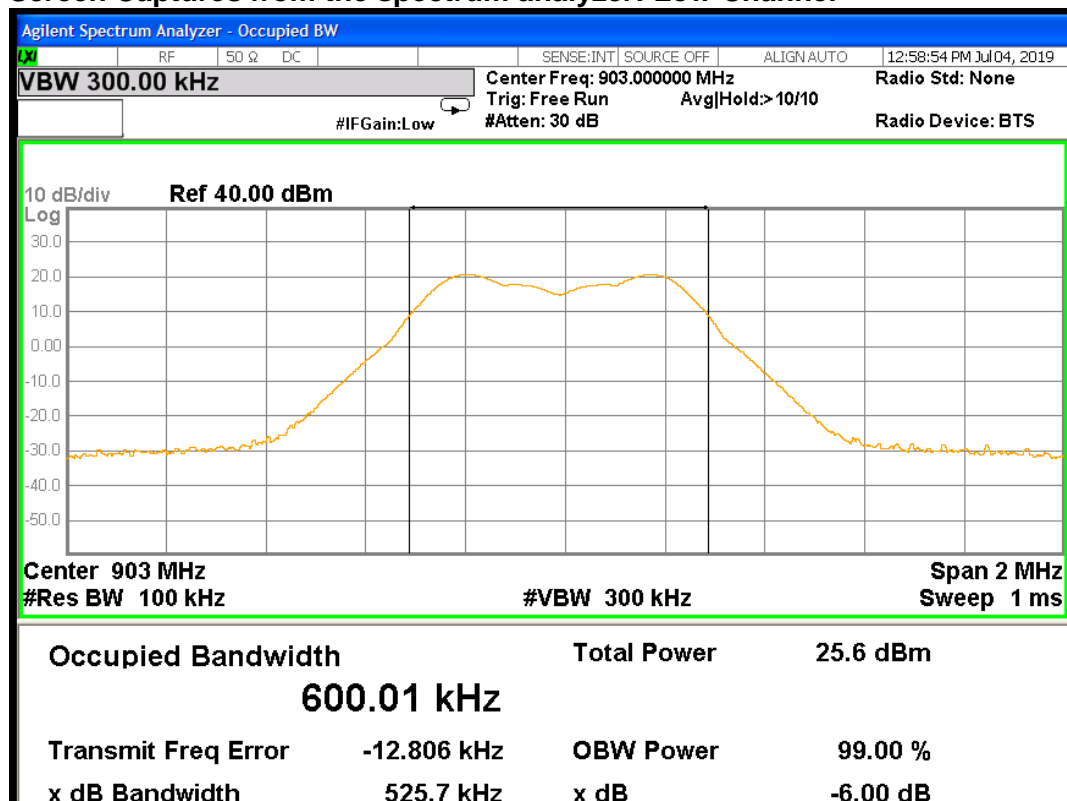
Conducted:



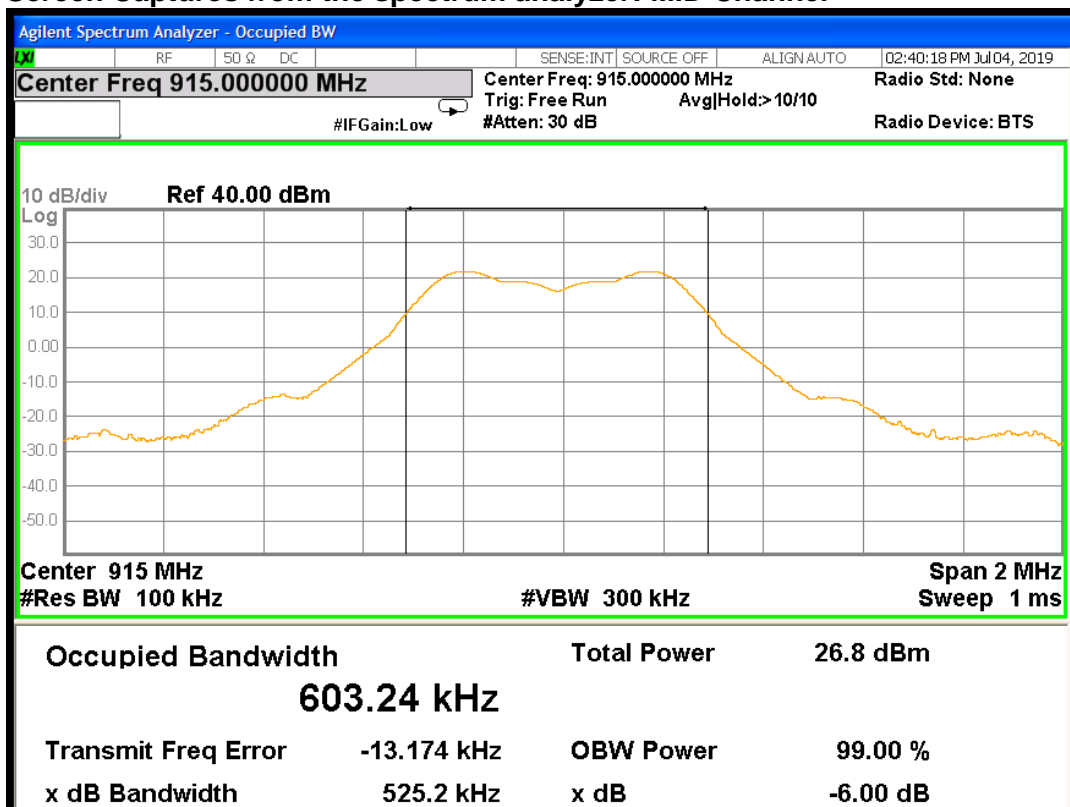
2.2.5 Channel Occupied Bandwidth Data: (DTS Mode)

Channel	Freq. [MHz]	6 dB OBW [kHz]	Limit 6 dB OBW
Low	903	525.7	≥ 500 KHz
Mid	915	525.2	≥ 500 KHz
High	927	524.9	≥ 500 KHz

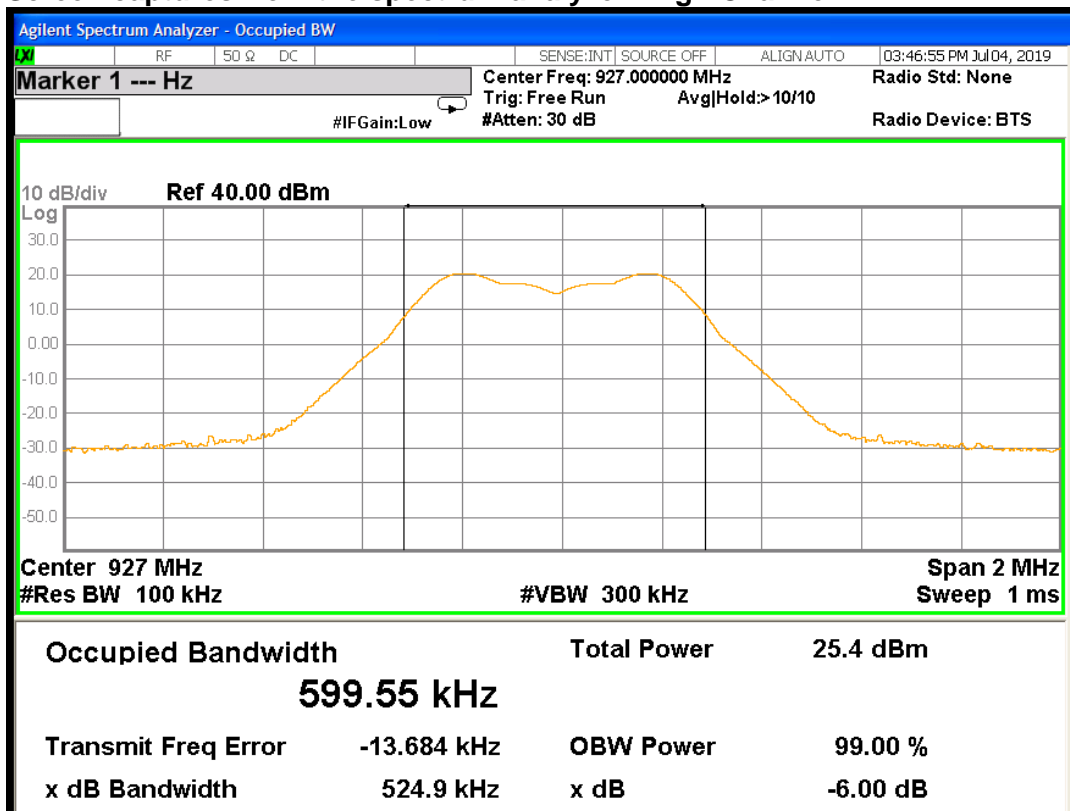
Screen Captures from the spectrum analyzer: Low Channel



Screen Captures from the spectrum analyzer: MID Channel



Screen captures from the spectrum analyzer: High Channel



2.3 Maximum conducted (average) output power

Test Lab: Electronics Test Centre, Airdrie	EUT: LC-Q2 s/n EMC2
Test Personnel: Bushra Muharram Imran Akram	Standard: FCC PART 15.247
Date: 2019-07-04 (23.7°C, 37.4 % RH)	Basic Standard: ANSI C63.10: 2013 FCC OET KDB 558074
EUT status: Compliant	

Specification: FCC Part 15.247(b, 3)

Criteria For systems using digital modulation in the 902-928 MHz bands: 1 Watt.

2.3.1 Test Guidance: FCC KDB 558074 D01 15.247 Measurement Guidance v05r02/ ANSI C63.10 Sub clause 11.9.2.2

This measurement is performed at low, mid and high frequencies, with modulation.

The RF output of EUT with an antenna connector is fed to the input of the spectrum analyzer through appropriate attenuation. The loss from the cable and the attenuator were added on the analyzer as gain offset setting there by allowing direct measurements, without the need for any further corrections.

Output Power Method AVGSA-1	
Span	≥ 1.5 times the OBW
RBW	1 – 5 % of the OBW, ≤ 1 MHz
VBW	≥ 3 x RBW
Number of Points in sweep	≥ 2 x Span / RBW
Sweep time	Auto
Detector	RMS (Power Averaging)
Sweep trigger	Free Run (If Duty Cycle ≥ 98%)
Trace Average	At least 100 traces in power Averaging (RMS)
Power measured	Integrated the spectrum across the OBW of the signal using the S/A band power measurement function, with band limit set equal to the OBW band edge.

2.3.2 Deviations From The Standard:

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

2.3.3 Test Equipment

Testing was performed with the following equipment:

Equipment	Manufacturer	Model #	Asset #	Cal. Date (yyyy-mm-dd)	Cal. Due (yyyy-mm-dd)
Signal Analyzer	Agilent	N9010A (FW A.14.16)	6678	2018-07-16	2019-07-16
Temp/Humidity	Extech	42270	5892	2019-04-05	2020-04-05
Attenuator	FairView Microwave	SA18N5WA-10	6886	2018-11-23	2019-11-23
DC Blocker	MCL	BLK-89-S+	-	2019-01-15	2020-01-15
CE Cable (50cm length)	Huber+Suhner	Enviroflex 400	-	2019-01-15	2020-01-15

2.3.4 Test Sample Verification, Configuration & Modifications

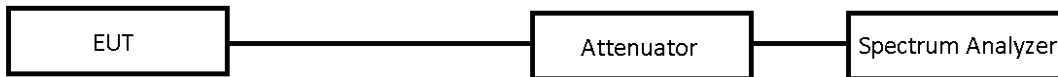
The EUT was set to a selected channel with test-specific software. The output was modulated as in normal operation.

The EUT modified to provide the direct access to antenna trace for conducted measurements.

For compliance purposes EUT met requirements without any modification

Test setup diagrams for Peak Power testing:

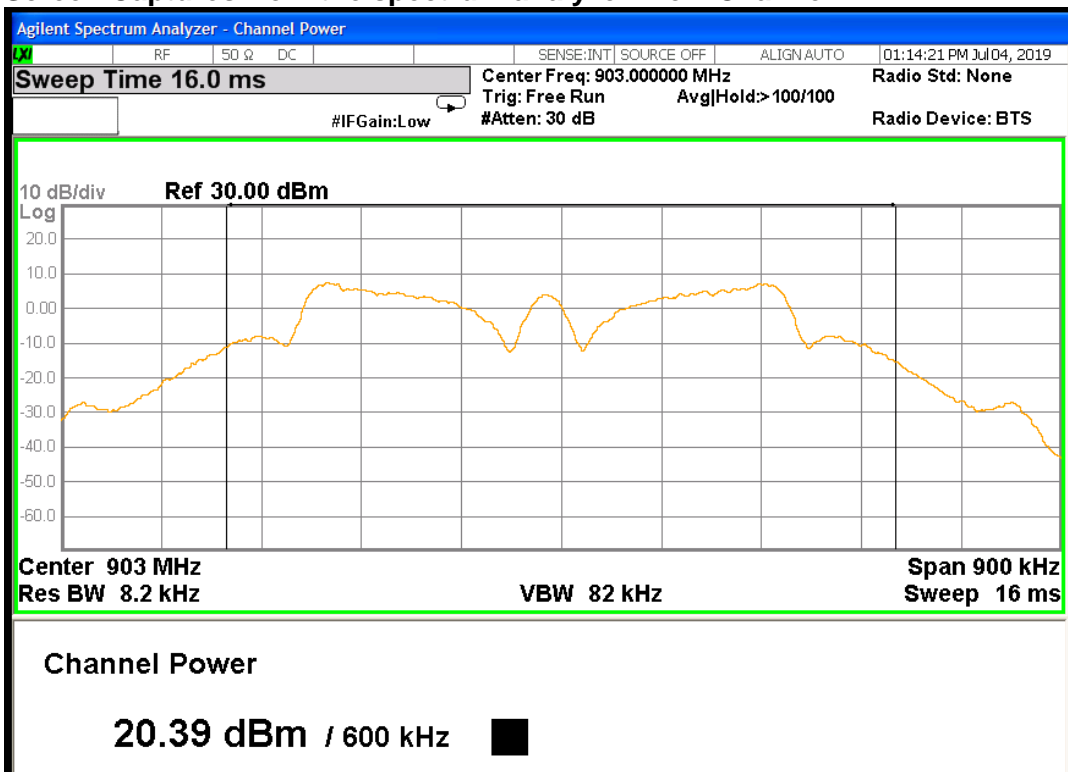
Conducted:



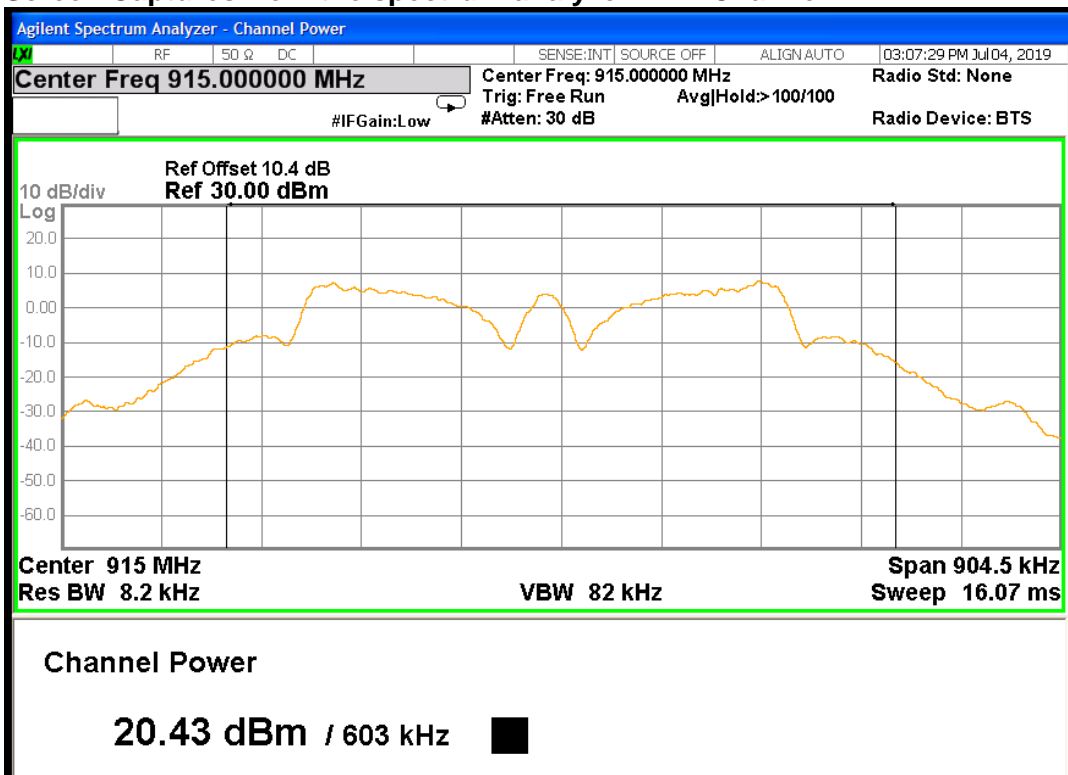
2.3.5 Average Output Power Data

Channel	Freq. [MHz]	Out Put Power (dBm)	Out Put Power Limit (dBm)	Margin (dB)
Low	903	20.39	30	9.61
Mid	915	20.43	30	9.57
High	927	20.40	30	9.60

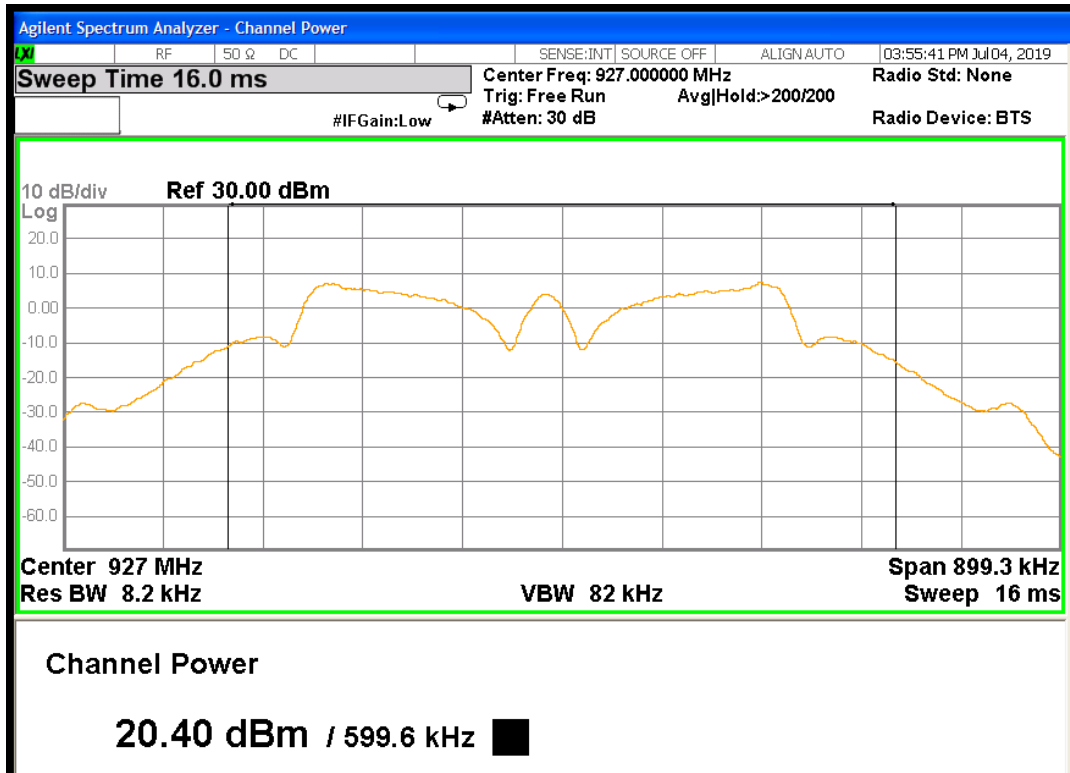
Screen Captures from the spectrum analyzer: Low Channel



Screen Captures from the spectrum analyzer: MID Channel



Screen Captures from the spectrum analyzer: High Channel



2.4 Power Spectral Density

Test Lab: Electronics Test Centre, Airdrie	EUT: LC-Q2 s/n EMC2
Test Personnel: Bushra Muharram Imran Akram	Standard: FCC PART 15.247
Date: 2019-07-04 (27.3°C, 37.4 % RH)	Basic Standard: ANSI C63.10: 2013 FCC OET KDB 558074
EUT status: Compliant	

Specification: FCC Part 15.247(e)

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

2.4.1 Test Guidance: FCC KDB 558074 D01 15.247 Measurement Guidance v05r02/ Sub clause 11.10 of ANSI C63.10

This measurement is performed at low, mid and high frequencies, in continuous transmission, with modulation.

The RF output of EUT with an antenna connector is fed to the input of the spectrum analyzer through appropriate attenuation. The loss from the cable and the attenuator were added on the analyzer as gain offset setting there by allowing direct measurements, without the need for any further corrections.

Use the following spectrum analyzer settings:	
Span	At least 1.5 times the OBW.
RBW	3 KHz
VBW	Set the VBW $\geq [3 \times \text{RBW}]$.
Sweep	Auto Couple
Detector function	Power averaging (RMS) or sample detector (when RMS not available).
Trace mode	Employ trace averaging (RMS) mode over a minimum of 100 traces.
Allow the trace to stabilize. Use the peak marker function to determine the maximum amplitude level.	

2.4.2 Deviations From The Standard:

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

2.4.3 Test Equipment

Testing was performed with this equipment:

Equipment	Manufacturer	Model #	Asset #	Cal. Date (yyyy-mm-dd)	Cal. Due (yyyy-mm-dd)
Signal Analyzer	Agilent	N9010A (FW A.14.16)	6678	2018-07-16	2019-07-16
Temp/Humidity	Extech	42270	5892	2017-04-06	2018-04-06
Attenuator	JFW	50FH-020-10	-	2018-01-15	2019-01-15
DC Blocker	MCL	BLK-89-S+	-	2018-01-15	2019-01-15
CE Cable (50cm length)	Huber+Suhner	Enviroflex 400	-	2018-01-15	2019-01-15

2.4.4 Test Sample Verification, Configuration & Modifications

The EUT was set to transmit continuously on a selected channel with test-specific software. The output was modulated as in normal operation.

The EUT met the requirements without modification.

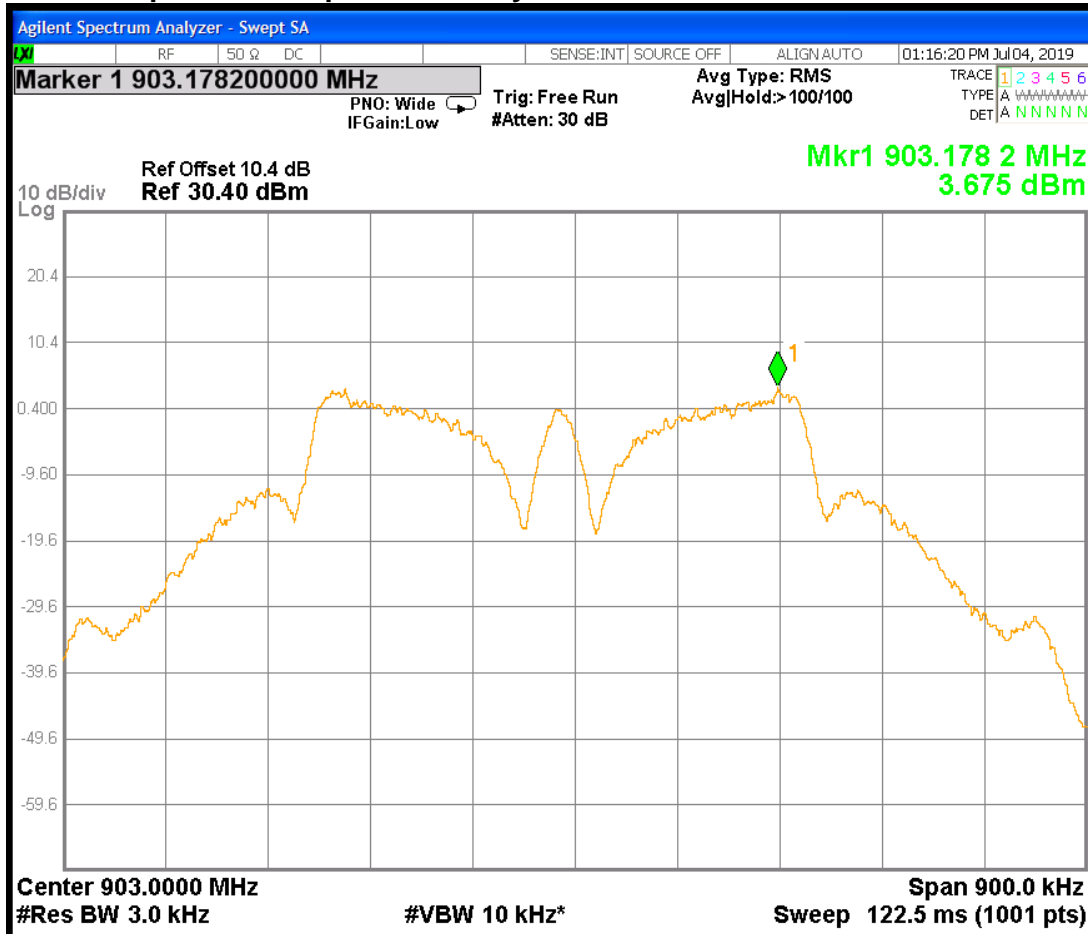
**Test setup diagrams for Peak Power Spectral Density testing:
Conducted:**



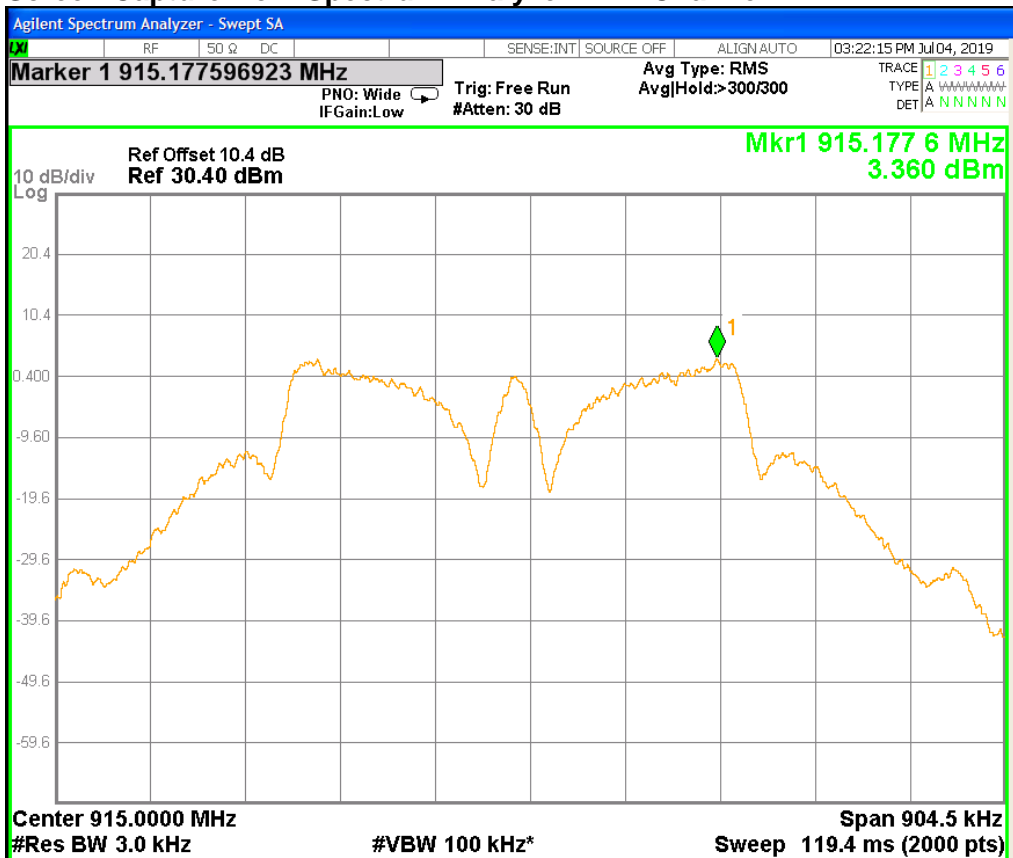
2.4.5 Peak PSD Data

Channel	Freq. [MHz]	PSD (dBm/3KHz)	PSD Limit (dBm/3KHz)
Low	903	3.675	8
Mid	915	3.360	8
High	927	3.179	8

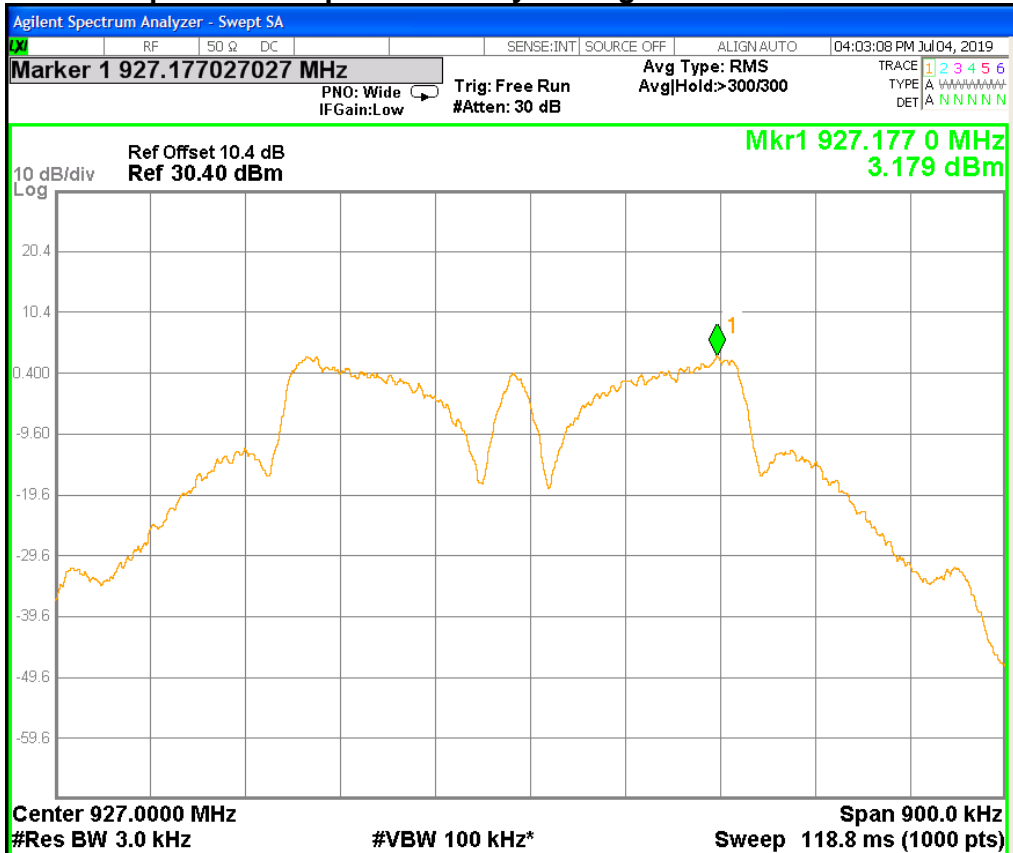
Screen Capture from Spectrum Analyzer: LOW Channel



Screen Capture from Spectrum Analyzer: MID Channel



Screen Capture from Spectrum Analyzer: High Channel



2.5 Band Edge Attenuation (DTS Mode)

Test Lab: Electronics Test Centre, Airdrie	EUT: LC-Q2 s/n EMC2
Test Personnel: Bushra Muharram Imran Akram	Standard: FCC PART 15.247
Date: 2019-07-04 (23.7°C, 37.4 % RH)	Basic Standard: ANSI C63.10: 2013
EUT status: Compliant	

Specification: FCC Part 15.247(d)

Criteria: 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 shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

2.5.1 Test Guidance: ANSI C63.10-2013 Clause 11.11, 11.13.2 / FCC KDB 558074 D01 15.247 Measurement Guidance v05r02 Clause 8.7

This measurement is performed at the low and high frequencies, with modulation.

The RF output of EUT with an antenna connector is fed to the input of the spectrum analyzer through appropriate attenuation. The loss from the cable and the attenuator were added on the analyzer as gain offset setting there by allowing direct measurements, without the need for any further corrections.

Use the following spectrum analyzer settings:	
Span	That encompasses both the peak of the fundamental emission and the band-edge emission under investigation.
RBW	1% of the total span
VBW	Set the VBW $\geq [3 \times \text{RBW}]$.
Sweep	Auto Couple
Detector function	Peak
Trace mode	Max Hold.
Allow the trace to stabilize. Use the peak marker function to determine the maximum amplitude level.	

2.5.2 Deviations From The Standard:

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

2.5.3 Test Equipment

Testing was performed with the following equipment:

Equipment	Manufacturer	Model #	Asset #	Cal. Date (yyyy-mm-dd)	Cal. Due (yyyy-mm-dd)
Signal Analyzer	Agilent	N9010A (FW A.14.16)	6678	2018-07-16	2019-07-16
Temp/Humidity	Extech	42270	5892	2019-04-05	2020-04-05
Attenuator	Fairview MW	SA18N5WA-10	6886	2018-11-23	2019-11-23
DC Blocker	MCL	BLK-89-S+	-	2019-01-15	2020-01-15
CE Cable (50cm length)	Huber+Suhner	Enviroflex 400	-	2019-01-15	2020-01-15

2.5.4 Test Sample Verification, Configuration & Modifications

The EUT was set to transmit continuously on a selected channel with test-specific software. The output was modulated as in normal operation. The EUT met the requirements without modification.

Test setup diagrams for Band Edge Attenuation testing:

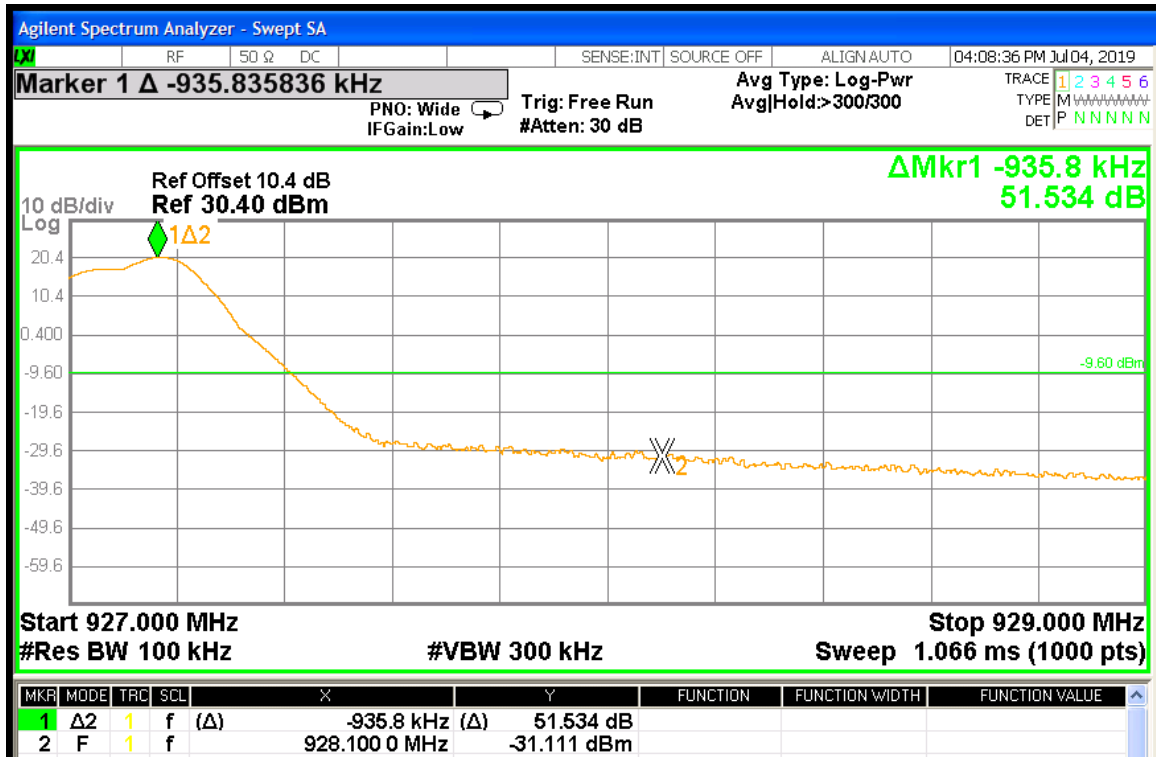
Conducted:



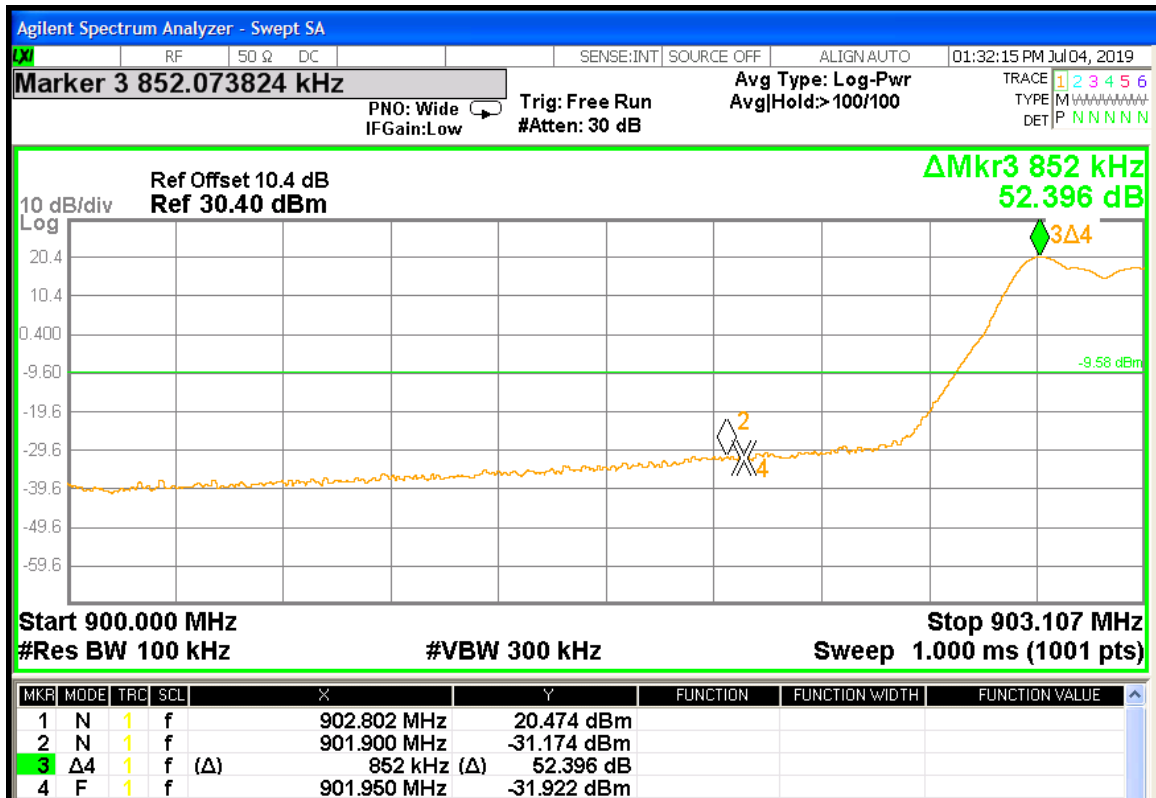
2.5.5 Band Edge Data

Modulation	Channel	Attenuation at Band Edge	Attenuation Limit at Band Edge
GFSK (DTS)	903	51.534dBc	30 dBc
	927	52.396dBc	30 dBc

Screen Capture from the spectrum analyzer: Lower Band Edge



Screen Capture from the spectrum analyzer: Upper Band Edge



2.6 Conducted Spurious Emissions in non-restricted frequency bands

Test Lab: Electronics Test Centre, Airdrie
Test Personnel: Bushra Muharram
Imran Akram
Date: 2019-07-04 (23.7°C, 37.4 % RH)

EUT: LC-Q2 s/n EMC2
Standard: FCC PART 15.247
Basic Standard: ANSI C63.10-2013
FCC KDB 558074 D01 v05r02

EUT status: Compliant

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 shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required.

2.6.1 Test Guidance: ANSI C63.10-2013, Clause 11.11, FCC KDB 558074 D01 15.247 Measurement Guidance v05r02 Clause 8.5

This measurement is performed at the low, mid and high frequencies, with modulation. The RF output of EUT with an antenna connector is fed to the input of the spectrum analyzer through appropriate attenuation. The loss from the cable and the attenuator were added on the analyzer as gain offset setting there by allowing direct measurements, without the need for any further corrections. The spectrum analyzer is stepped through the spectrum in frequency spans selected to ensure acceptable frequency resolution. The RBW is set to 100 kHz. The VBW is set to ≥ 300 kHz. The Peak detector is used, with the trace set to Max Hold.

2.6.2 Deviations From The Standard:

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

2.6.3 Test Equipment

Testing was performed with the following equipment:

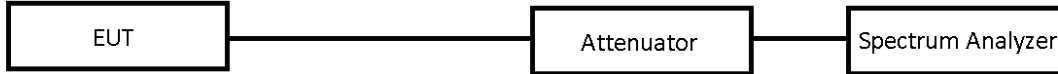
Equipment	Manufacturer	Model #	Asset #	Cal. Date (yyyy-mm-dd)	Cal. Due (yyyy-mm-dd)
Signal Analyzer	Agilent	N9010A (FW A.14.16)	6678	2018-07-16	2019-07-16
Temp/Humidity	Extech	42270	5892	2019-04-05	2020-04-05
Attenuator	Fairview MW	SA18N5WA-10	6886	2018-11-23	2019-11-23
DC Blocker	MCL	BLK-89-S+	-	2019-01-15	2020-01-15
CE Cable (50cm length)	Huber+Suhner	Enviroflex 400	-	2019-01-15	2020-01-15

2.6.4 Test Sample Verification, Configuration & Modifications

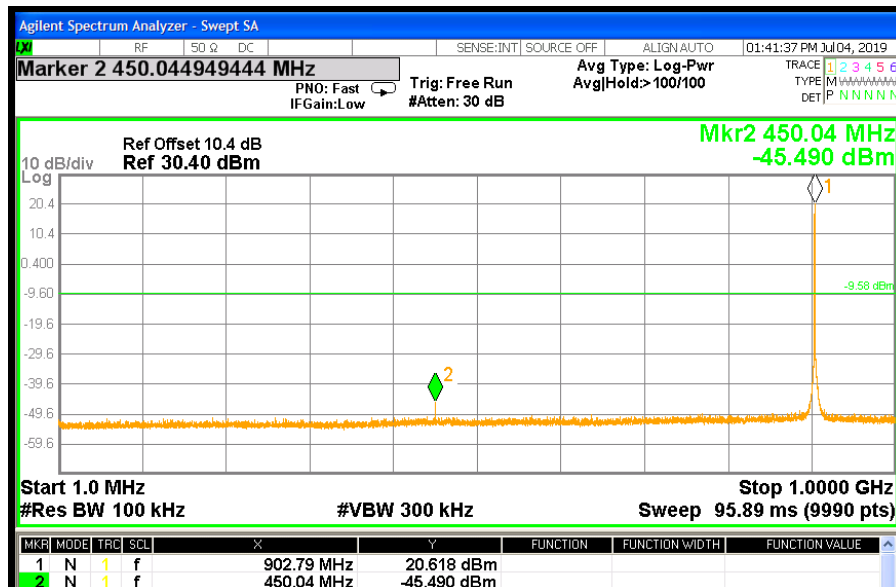
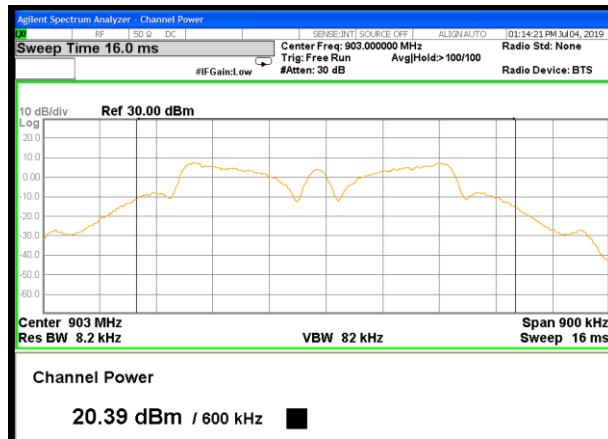
The EUT was set to a selected channel with test-specific software. The output was modulated as in normal operation. The EUT met the requirements without modification.

The EUT modified to provide the direct access to antenna trace for conducted measurements.

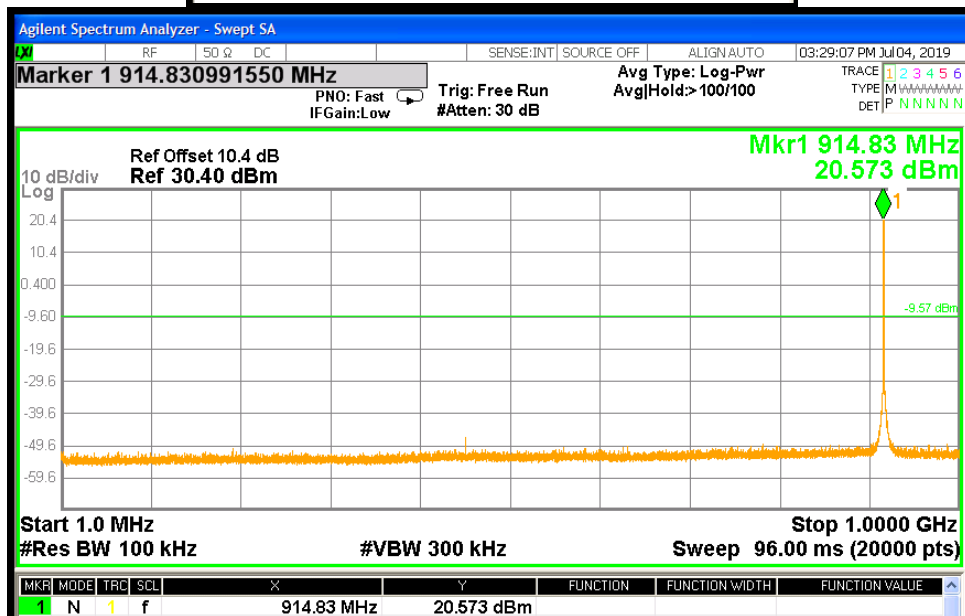
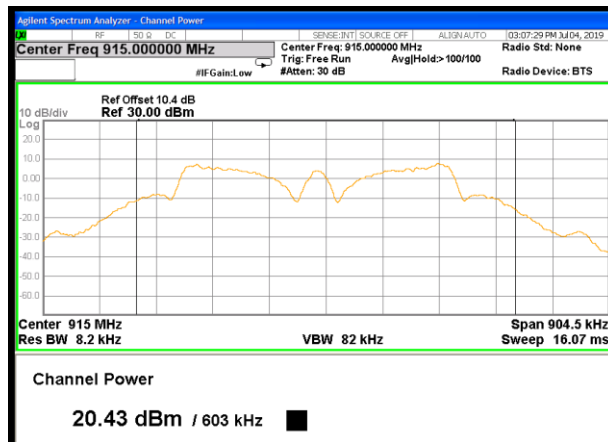
Test setup diagram for Conducted Spurious Emissions testing:



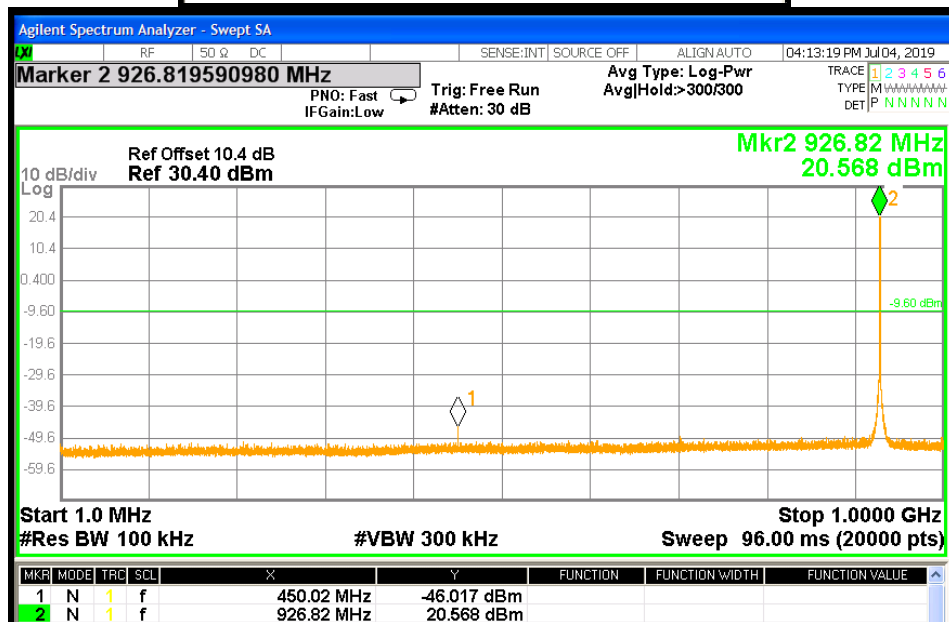
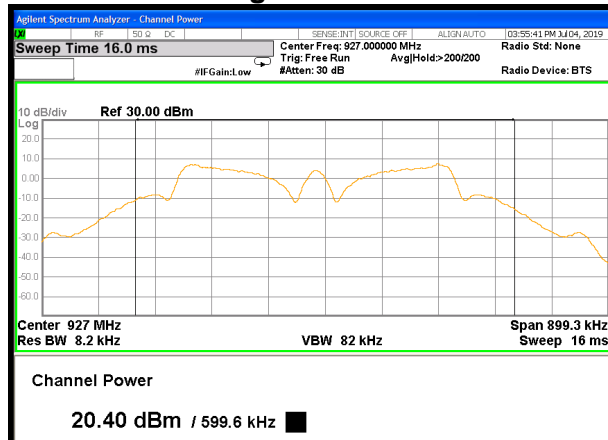
2.6.5 Conducted Emissions Data: Low Channel



MID Channel



High Channel

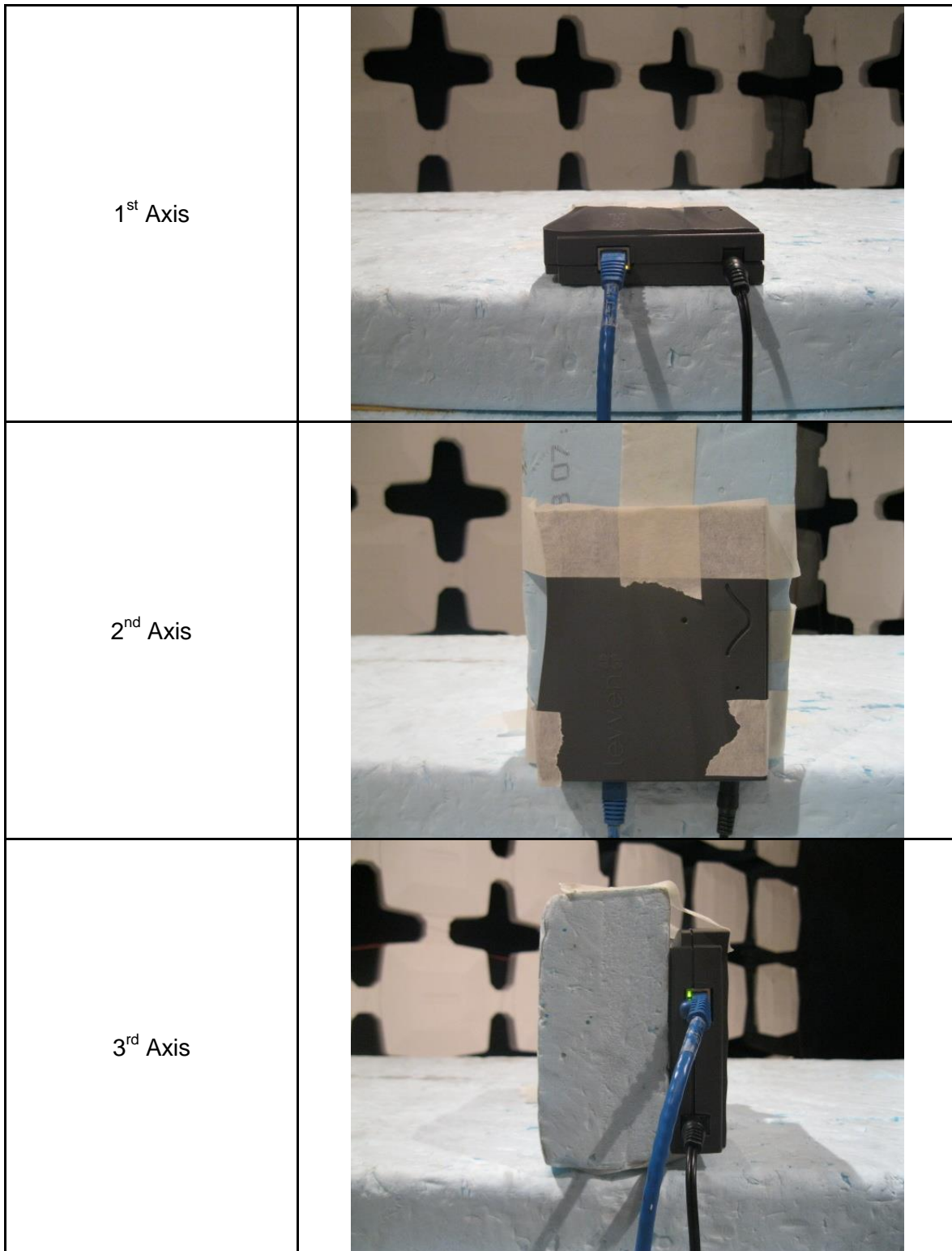


2.7 EUT Positioning Assessment

Test Lab: Electronics Test Centre, Airdrie	EUT: LC-Q2 s/n EMC1
Test Personnel: Test Personnel: Bushra Muharram	Standard: FCC PART 15.247
Imran Akram	Basic Standard: ANSI C63.4-2014
Date: 2019-07-02 (23.7°C, 37.4 % RH)	
1st Axis Found worse	
Comments: EUT oriented in three axis's and 1 st axis found to be worse emission axis.	

Specification: ANSI C63.4-2014, Clause 6.3.2.1

Portable, small, lightweight, or modular devices that may be handheld, worn on the body, or placed on a table during operation shall be positioned on a non-conducting platform, the top of which is 80 cm above the reference ground plane. The preferred area occupied by the EUT arrangement is 1 m by 1.5 m, but it may be larger or smaller to accommodate various sized EUTs (see Figure 6, Figure 7, and Figure 9). For testing purposes, ceiling- and wall-mounted devices also shall be positioned on a tabletop (see also 6.3.4 and 6.3.5). In making any tests involving handheld, body-worn, or ceiling-mounted equipment, it is essential to recognize that the measured levels may be dependent on the orientation (attitude) of the three orthogonal axes of the EUT. Thus, exploratory tests as specified in 8.3.1 shall be carried out for various axes orientations to determine the attitude having maximum or near-maximum emission level.



2.8 Radiated Spurious Emissions in restricted frequency bands (TX Mode)

Test Lab: Electronics Test Centre, Airdrie

EUT: LC-Q2 s/n EMC1

Test Personnel: Bushra Muharram
Imran Akram

Standard: FCC PART 15.247

Basic Standard: ANSI C63.10-2013

Date: 2019-07-02/04/05 (23.7°C, 37.4 % RH)

EUT status: Compliant

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)).

2.8.1 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]

2.8.2 Deviations From The Standard:

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

2.8.4 Test Equipment

Testing was performed with the following equipment:

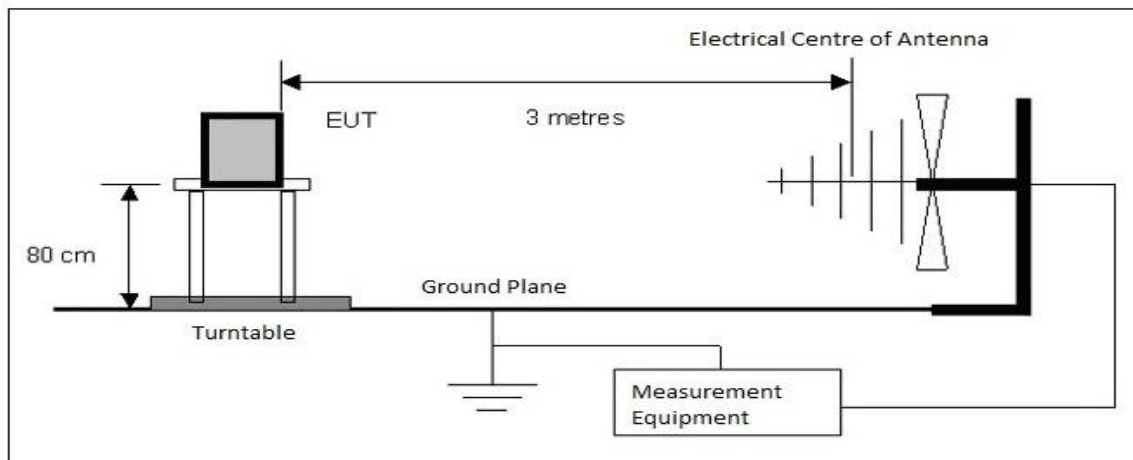
Equipment	Manufacturer	Model #	Asset #	Cal. Date (yyyy-mm-dd)	Cal. Due (yyyy-mm-dd)
EMC Software	UL	Ver. 9.5	ETC-SW-EMC 2.1	N/A	
EMI receiver	Agilent	N9038A (FW A.23.07)	6130	2019-05-10	2020-05-10
Loop Antenna	EMCO	6502	10868	2019-04-11	2020-04-11
Biconilog Antenna	ARA	LPB-2520/A	4318	2018-09-19	2020-09-19
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

2.8.5 Test Sample Verification, Configuration & Modifications

The EUT was set to a selected channel with test-specific software. 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
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			

¹ Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz, ² 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

2.8.6 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 dBμV + Antenna Factor in dB/m + Gain/Loss Factor in dB = Corrected Field Strength in dBμV/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 MID channel 915 MHz was selected as the worst-case condition for detailed examination.
- In Transmit mode, the EUT was assessed up to 10.0 GHz.

Freq. Marker	Freq. [MHz]	Raw reading [dBμV]	Det	Antenna Factor [dB/m]	Pre amp Gain [dB]	Corrected Reading [dBμV/m]	FCC 15.209 Limit [dBμV/m]	Delta [dB]	Azimuth [Deg]	Height [cm]	Polarization
Frequency Range 30 – 1000 MHz											
1	*250.0056	19.42	QP	16	3.9	39.32	46.02	-6.7	127	115	Horizontal
2	449.9832	17.28	QP	20.5	5.2	42.98	46.02	-3.04	301	223	Horizontal
3	865.1503	12.85	QP	25.5	7	45.35	46.02	-0.67	91	116	Horizontal
4	885.1595	12.88	QP	25.5	7.1	45.48	46.02	-0.54	83	107	Horizontal
5	932.114	3.71	QP	26.4	7.3	37.41	46.02	-8.61	72	106	Horizontal
6	*964.8001	9.4	QP	26.2	7.4	43	54	-11.0	72	102	Horizontal
7	41.6048	11.68	QP	20.3	1.7	33.68	40	-6.32	263	105	Vertical
8	129.4913	8.43	QP	15.1	2.9	26.43	43.5	-17.07	175	106	Vertical
9	*250.0022	19.48	QP	16	3.9	39.38	46.02	-6.64	214	188	Vertical
10	450.0009	17.99	QP	20.5	5.2	43.69	46.02	-2.33	288	103	Vertical
11	765.1477	0.41	QP	24.2	6.7	31.31	46.02	-14.71	173	228	Vertical
12	820.7205	1.12	QP	25.1	6.9	33.12	46.02	-12.9	47	141	Vertical

Negative values for Delta indicate compliance.

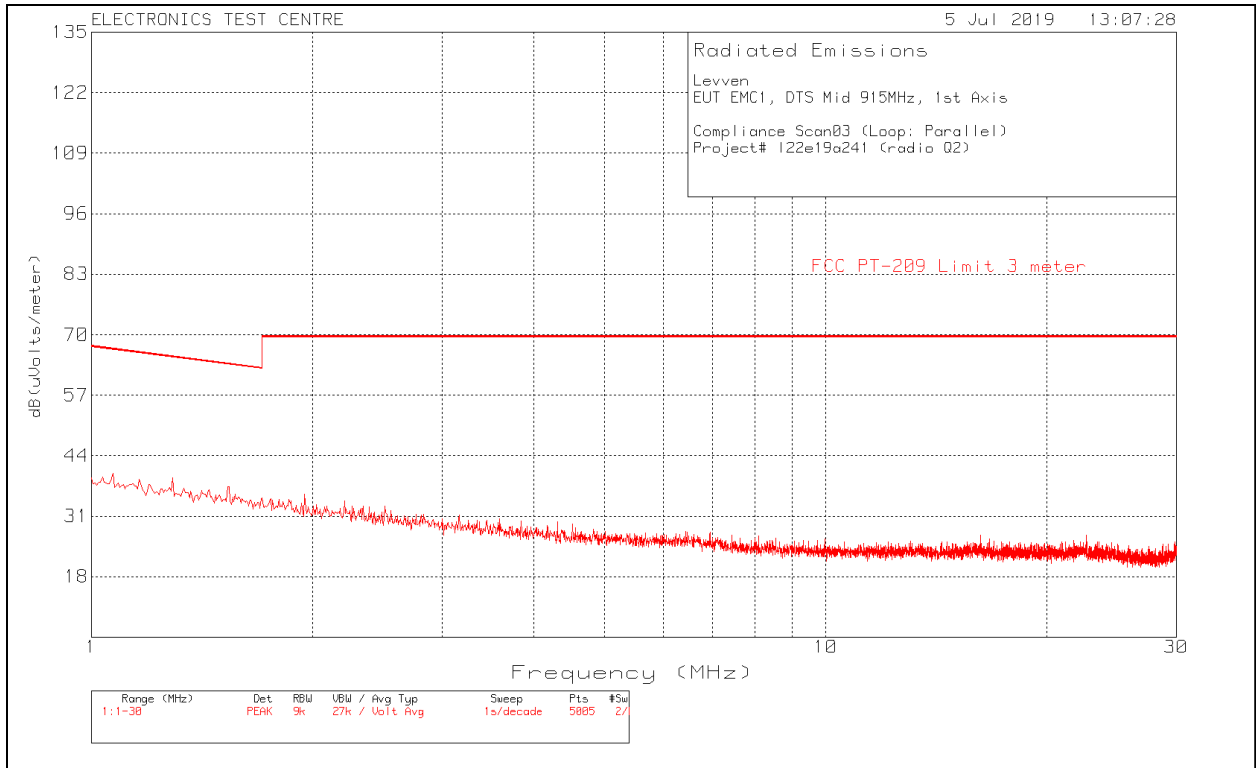
* Restricted Band

Negative values for Delta indicate compliance.

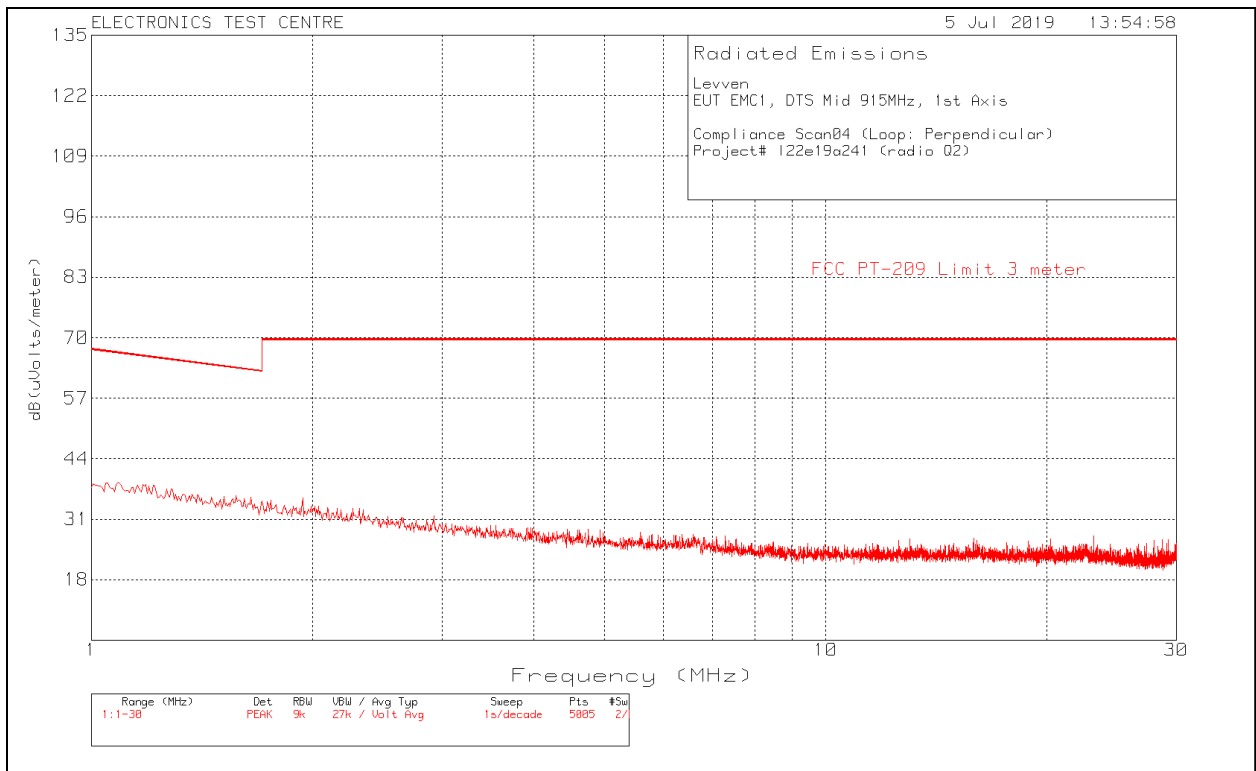
Freq. Marker	Freq. [MHz]	Raw reading [dBµv]	Det	Antenna Factor [dB/m]	Pre amp Gain [dB]	Corrected Reading [dBµv/m]	FCC 15.209 Limit [dBµv/m]	Delta [dB]	Azimuth [Deg]	Height [cm]	Polarization
Frequency Range 1 – 3.6 GHz											
1	*1400.2	48.33	PK	25.6	-34.4	39.53	54	-14.47	270	101	Horizontal
2	*1449.8	48.04	PK	25.3	-34.4	38.94	54	-15.06	271	251	Horizontal
3	1499.9	47.19	PK	25.3	-34.3	38.19	54	-15.81	271	251	Horizontal
4	1599.7	45.85	PK	25.5	-34.3	37.05	54	-16.95	270	101	Horizontal
5	1830.4	52.84	PK	28	-34.3	46.44	54	-7.56	180	101	Horizontal
6	2099.8	44.62	PK	28.1	-33.9	38.82	54	-15.18	360	251	Horizontal
7	2300.2	44.02	PK	28.1	-33.5	38.62	54	-15.38	271	101	Horizontal
8	1399.7	56.7	PK	25.6	-34.4	37.9	54	-16.1	270	102	Vertical
9	1830.0	46.32	PK	28	-34.4	39.92	54	-14.08	91	102	Vertical
10	2099.8	46.01	PK	28.1	-33.9	40.21	54	-13.79	360	102	Vertical
11	2200.0	45.39	PK	28.1	-33.7	39.79	54	-14.21	271	102	Vertical
Frequency Range 3.6 – 10 GHz											
1	*7318.9	31.17	AV	36.5	-27.2	40.47	54	-13.53	319	337	Horizontal
1	*7318.9	42.61	PK	36.5	-27.2	51.91	74	-22.09	319	337	Horizontal
2	*8236.7	29.56	AV	36.6	-26.9	39.26	54	-14.74	316	383	Horizontal
2	*8236.7	40.94	PK	36.6	-26.9	50.64	74	-23.36	316	383	Horizontal
3	*7321.4	39.91	AV	36.5	-27.2	49.21	54	-4.79	4	348	Vertical
3	*7321.4	49.22	PK	36.5	-27.2	58.52	74	-15.48	4	348	Vertical
4	*8236.7	34.76	AV	36.6	-26.9	44.46	54	-9.54	358	350	Vertical
4	*8236.7	45.51	PK	36.6	-26.9	55.21	74	-18.79	358	350	Vertical

* Restricted Band

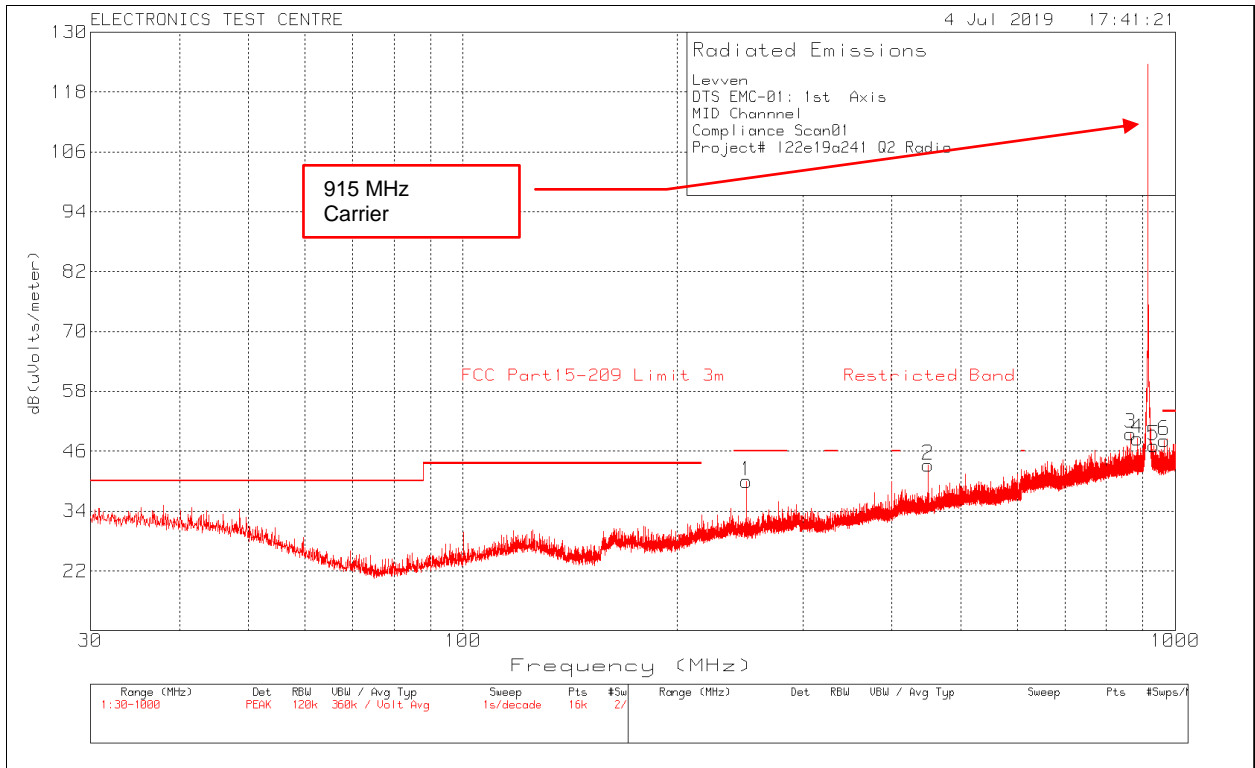
Plot of Radiated Emissions: Measuring Antenna Parallel



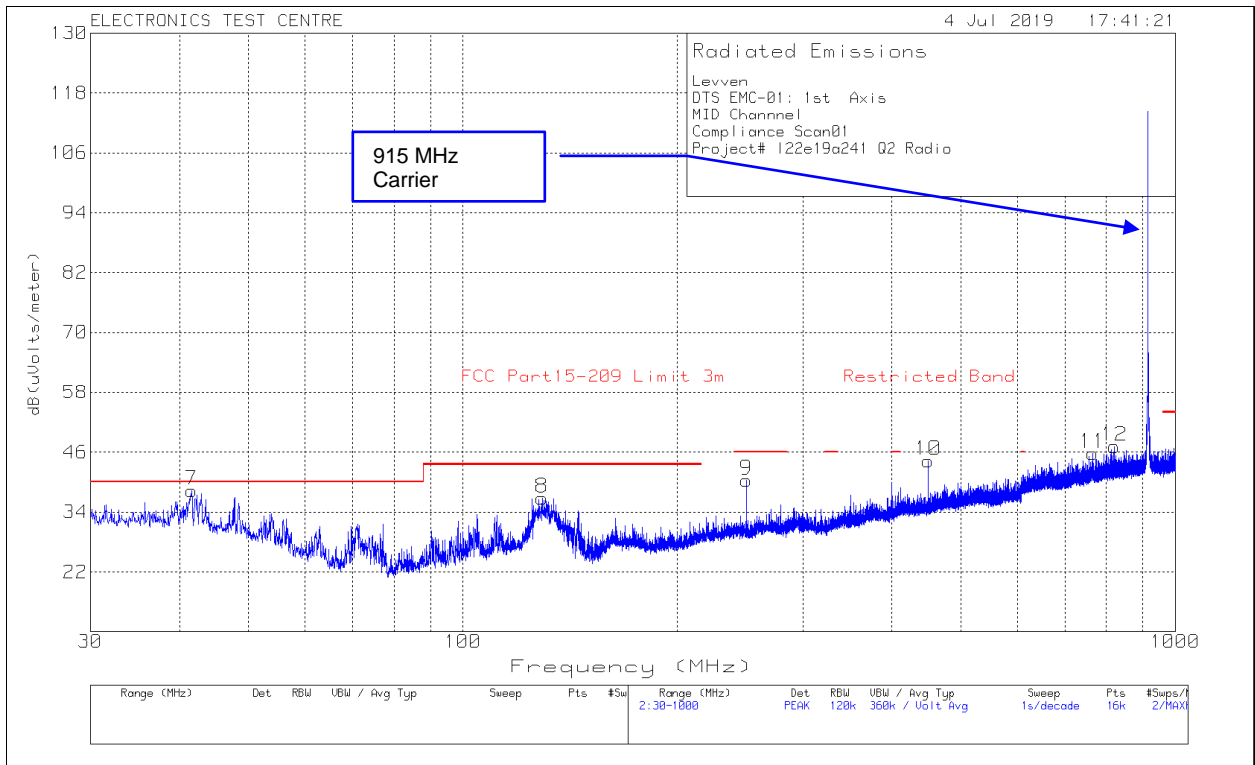
Plot of Radiated Emissions: Measuring Antenna Perpendicular



Plot of Radiated Emissions: Horizontal polarization



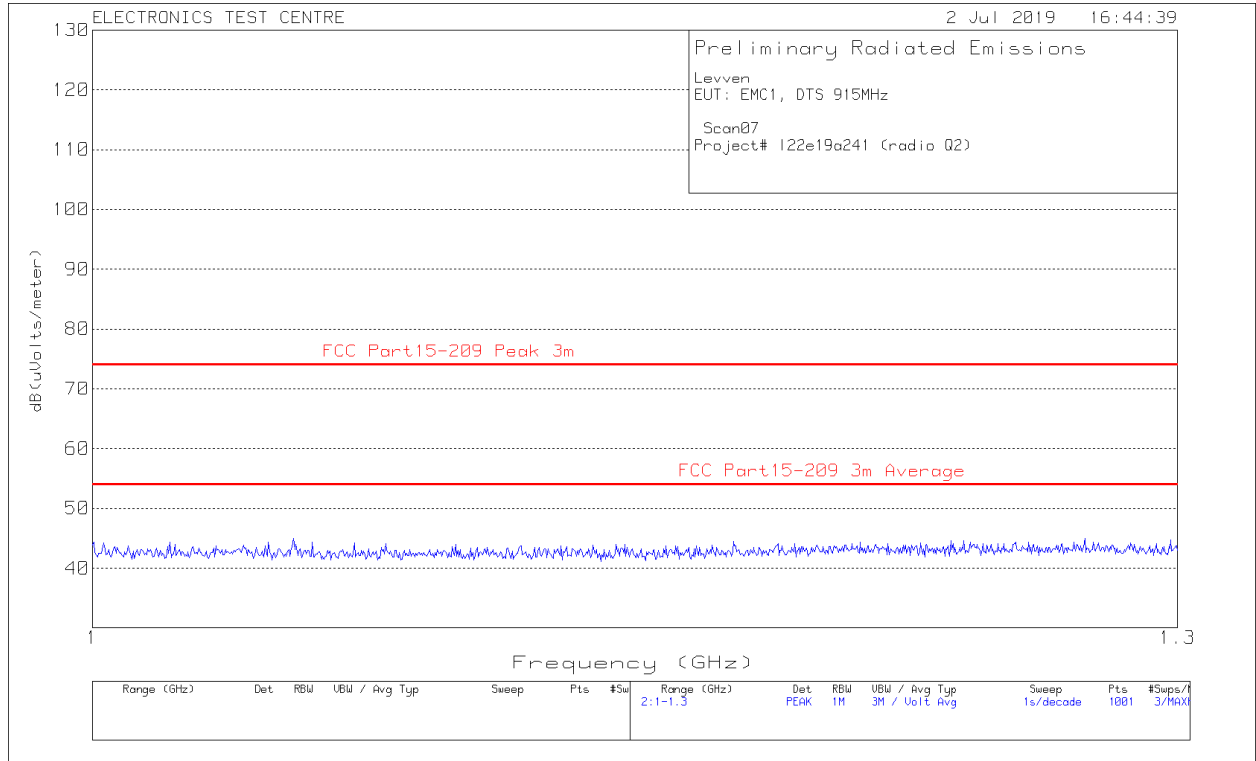
Plot of Radiated Emissions: Vertical polarization



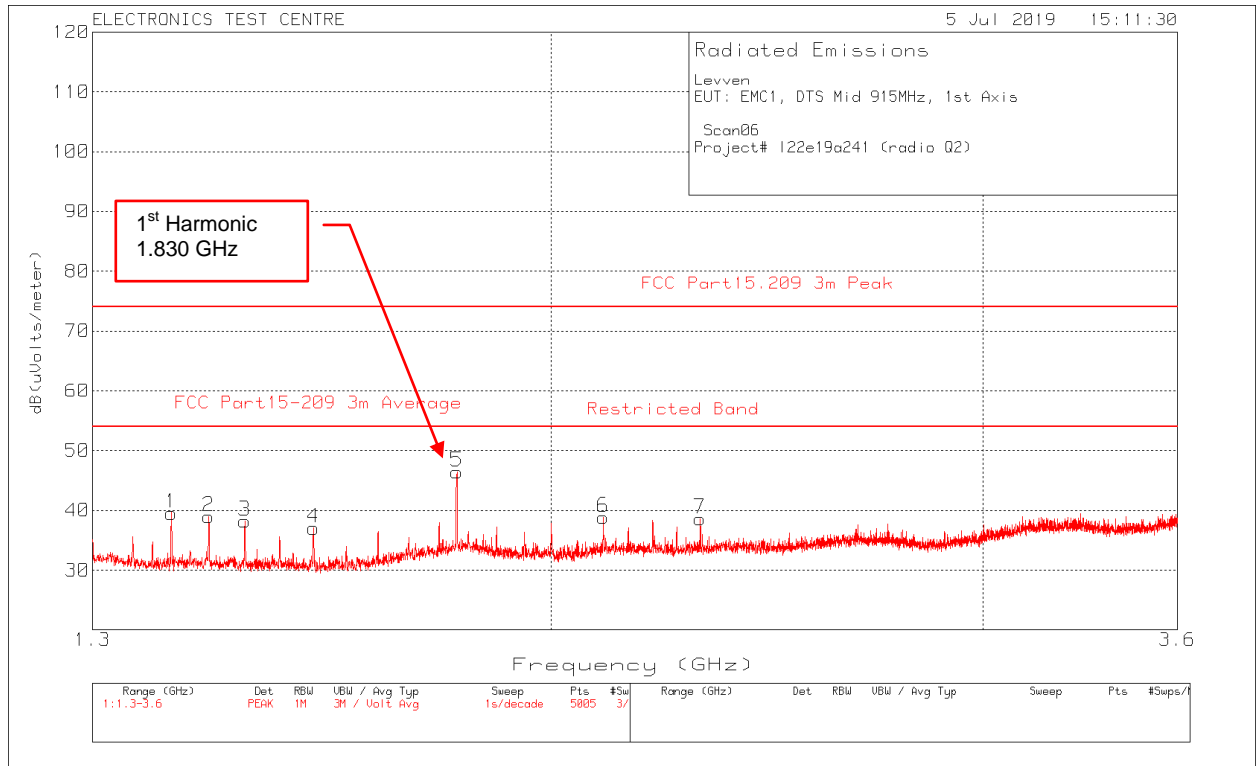
Plot of Radiated Emissions: Horizontal polarization



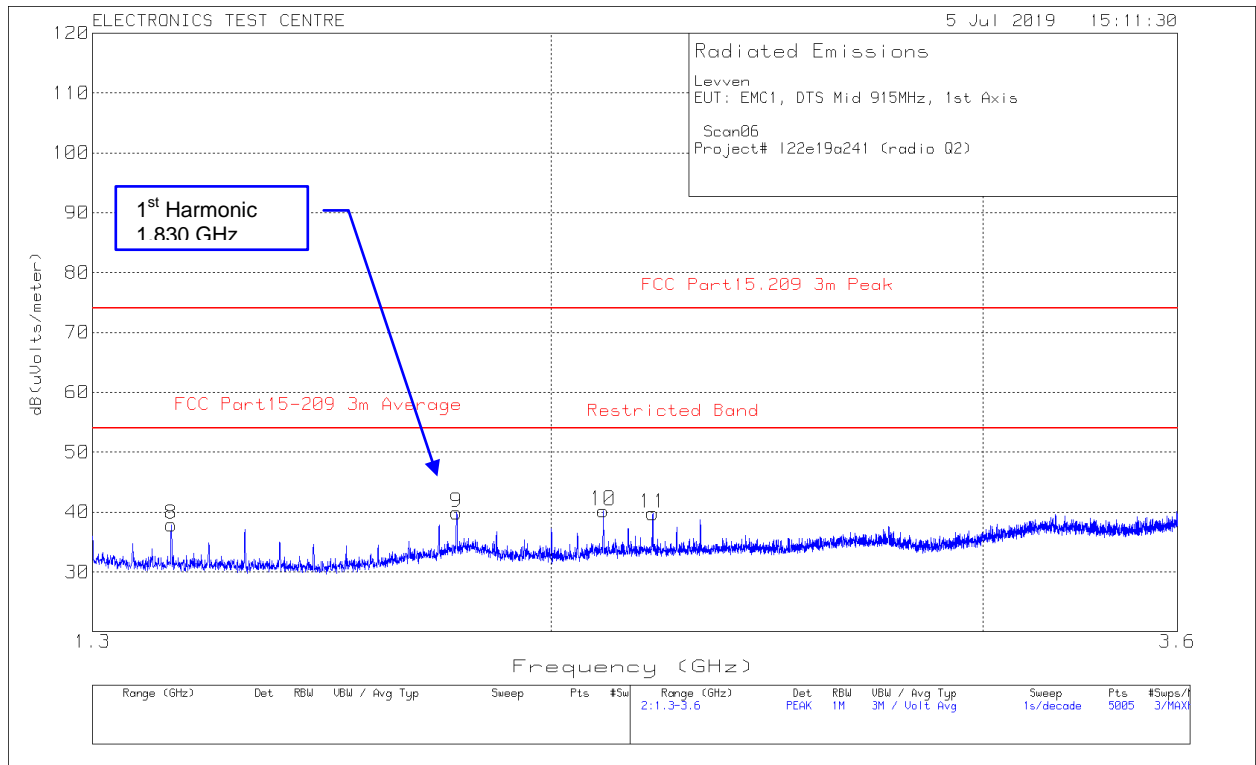
Plot of Radiated Emissions: Vertical polarization



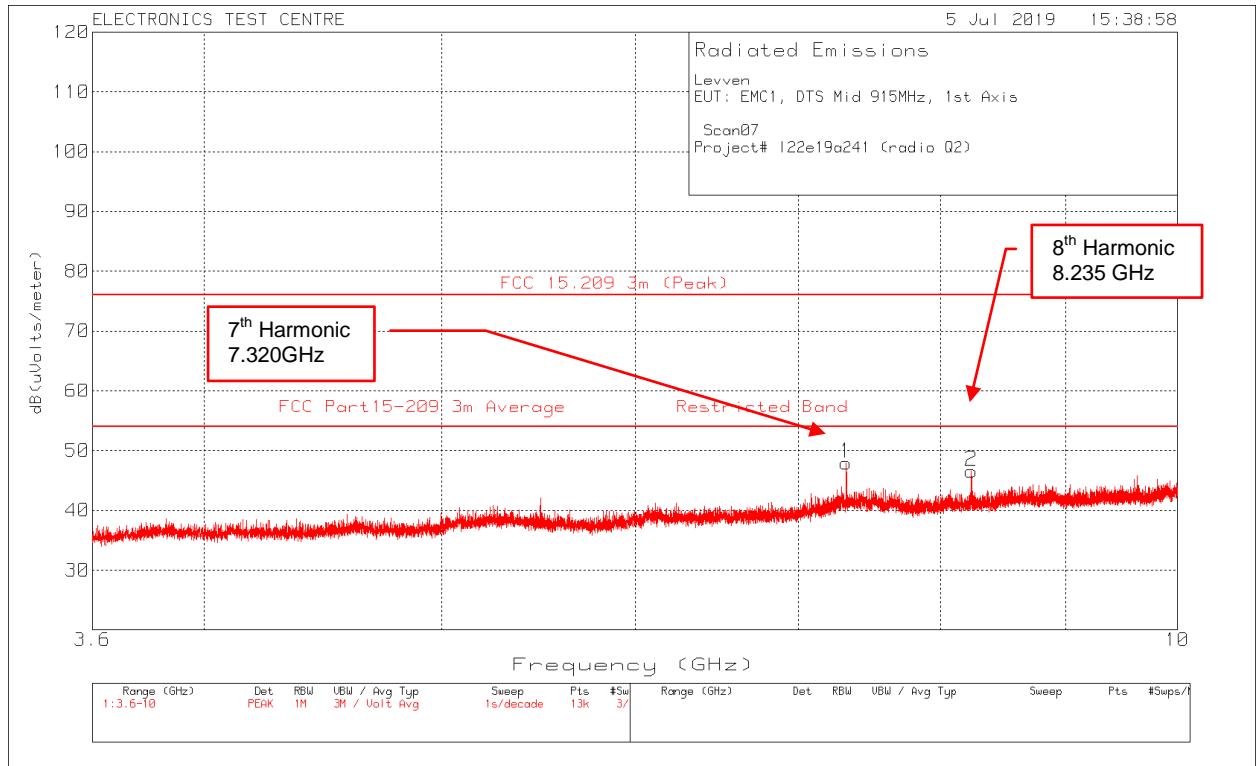
Plot of Radiated Emissions: Horizontal polarization



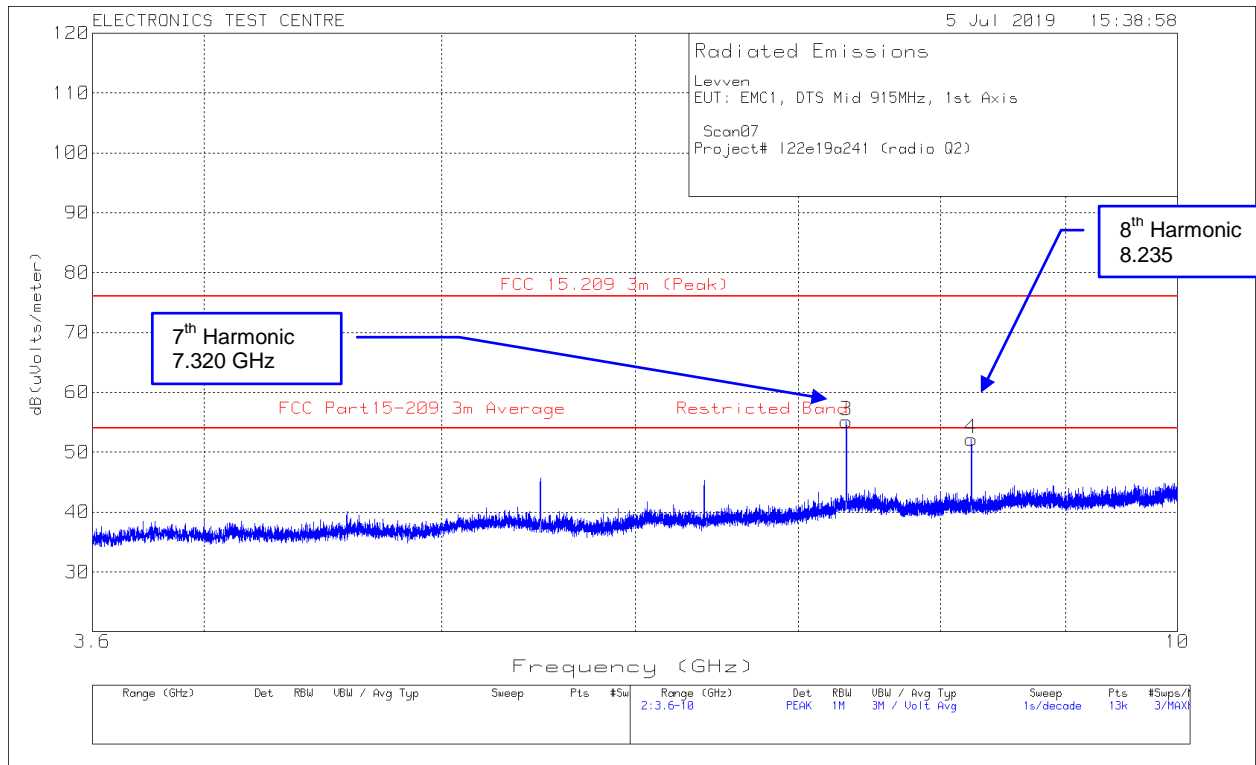
Plot of Radiated Emissions: Vertical polarization



Plot of Radiated Emissions: Horizontal polarization



Plot of Radiated Emissions: Vertical polarization



2.9 RF Exposure

Test Lab: Electronics Test Centre, Airdrie	EUT: LC-Q2 s/n EMC2
Test Personnel:	Standard: FCC PART 15.247
Date:	

EUT status: Exempt

Compliant: 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