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ELECTROMAGNETIC COMPATIBILITY TEST REPORT

PREPARED FOR SYSCOR CONTROLS AND AUTOMATION INC.
BY QAI LABORATORIES

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Laboratory Accreditations (per ISO/IEC 17025:2005):

American Association for Laboratory Accreditation Certificate Number: 3657.02

EMC Client:	Syscor Controls and Automation Inc.
Address:	Suite 201 - 60 Bastion Square, Victoria BC, V8W 1J2 Canada
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Applicable Test Standards:	FCC Title 47 CFR Part 15: Subpart C RSS-247 Issue 2 RSS-Gen Issue 5 FCC Title 47 CFR Part 15: Subpart B ICES-003 Issue 6
Equipment Tested **Model Number:**	PCU (Power & Communication Unit)+HCD (Sensor)+HCDW (Sensor) PCU-2-1-1-1-0 (000697+Omni-directional Antenna) PCU-2-1-1-2-0 (000697+Patch Antenna) HCD (000802 – Hydrocarbon Liquid & Gas Detector) HCDW (000878–Hydrocarbon Liquid & Gas Detector w/Water Level Sensor
FCC ID:	**2AAZE-000697**
IC Certification Number:	**11413A-000697**
Manufacturer:	Syscor Controls and Automation Inc.

REVISION HISTORY

Date	Report Number	Rev #	Details	Author's Initials
May 27, 2019	E11020-1801_Syscor-PCU	1.0	Initial Release	JQ
June 27, 2019	E11020-1801_Syscor-PCU	2.0	Add MPE	JQ
All previous versions of this report have been superseded by the latest dated revision as listed in the above table. Please dispose of all previous electronic and paper printed revisions accordingly.				

REPORT AUTHORIZATION

The data documented in this report is for the test equipment provided by Syscor Controls and Automation Inc. The tests were conducted on the sample equipment as requested by Syscor Controls and Automation Inc. for the purpose of demonstrating compliance with FCC Title 47 CFR Part 15: Subpart B, ICES-003 Issue 6, FCC Title 47 CFR Part 15: Subpart C, RSS-247 Issue 2, and RSS-Gen Issue 5 as agreed upon by Syscor Controls and Automation Inc. as per Quote 18SH05091R3.

Syscor Controls and Automation 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 or IC Declaration of Conformity and can only be produced by the manufacturer.

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

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QAI 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	9543A	3657.02

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Section I: EXECUTIVE SUMMARY

1.1 Purpose

The purpose of this report is to demonstrate and document the compliance of "PL02 PCU + HCD + HCDW Power and" as per Sections 1.2 & 1.3.

1.2 Scope

The information documented in this report is based on the test methods and levels as per Quote 18SH05091R3:

- **CFR Title 47 FCC Part 15** – Radio Frequency Devices, Subpart C – Intentional Radiators
- 15.247: Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5875 MHz
- **CFR Title 47 FCC Part 15** - Radio Frequency Devices, Subpart B – Unintentional Radiators
- **RSS-247 Issue 2** – Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices
- **RSS-Gen Issue 5** – General Requirements and Information for the Certification of Radio Apparatus
- **ICES-003 Issue 6** – Information Technology Equipment (Including Digital Apparatus) – Limits and Methods of Measurement

The tests documented in this report were performed in accordance with ANSI C63.4-2014, ANSI C63.10-2013, RSS-Gen Issue 5and FCC KDB 558074 D01 DTS Meas Guidance v05r02.

1.3 Summary of Results

The following tests demonstrate the testimony to "FCC and IC" Mark Electromagnetic compatibility testing for "PL02 PCU + HCD + HCDW Power and" manufactured by Syscor Controls and Automation Inc.

The following testing was performed pursuant to the FCC and IC Radio and RF Emissions Standards:

Test or Measurement	Applicable FCC and IC Standard	Clause	Result
RF Peak Power Output	FCC Title 47 CFR Part 15: Subpart C	§15.247 (b)(3)	Complies
	RSS-247 Issue 2	5.4 (4)	
6dB Occupied Bandwidth	FCC Title 47 CFR Part 15: Subpart C	§15.247 (a)(2)	Complies
	RSS-247 Issue 2	5.2 (1)	
99% Occupied Bandwidth	RSS-Gen Issue 4	6.6	Complies
Power Spectral Density	FCC Title 47 CFR Part 15: Subpart C	§15.247 (e)	Complies
	RSS-247 Issue 2	5.2 (2)	
Out-of-Band Emissions & Band Edge	FCC Title 47 CFR Part 15: Subpart C	§15.247 (d)	Complies
	RSS-247 Issue 2	5.5	
Radiated Spurious Emissions – Transmit Mode	FCC Title 47 CFR Part 15: Subpart C	§15.209 §15.205	Complies
	RSS-Gen Issue 4	8.9, 8.10	
Radiated Emissions – Receive Mode	FCC Title 47 CFR Part 15: Subpart B	§15.109	Complies
	ICES-003 Issue 6 RSS-Gen Issue 4	6.2 7.1	
Frequency Stability	FCC Title 47 CFR Part 15: Subpart C	§15.215 (c)	Complies
	RSS-Gen Issue 4	8.8	

Section II: GENERAL INFORMATION

2.1 Product Description

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

Equipment Under Test (EUT) Information

Model Names / Model No.	PCU-2-1-1-1-0 (000697+Omni-directional Antenna) PCU-2-1-1-2-0 (000697+Patch Antenna) HCD / 000802 – Hydrocarbon Liquid & Gas Detector HCDW / 000878 –Hydrocarbon Liquid & Gas Detector w/Water Level Sensor
Manufacturer	Syscor Controls and Automation Inc.
Description	EUT monitors its sensors including temperature, chemical, water, acceleration and inclination readings. PCU has three ports: one to antenna and two to gas sensors. Antenna communicates sensor readings with wireless HART gateway at 2.4 GHz. Gas sensors have no radio but an oscillator. PCU is encased in cylindrical SS316 body and gets installed in potentially explosive gas atmospheres. Designed to be ultra-low power and survive on 19.0Ah for 5+ years.
Operating Frequency	2.405 GHz to 2.475 GHz
Transmit Power	8 dBm per channel
Modulation Type	DSSS
Test Channels	2405, 2440 and 2480 MHz
Data Rate	250kb/s maximum
Antenna Type and Gain	1: N Type(M) straight, 4dBi peak gain Omni MFG: Taoglas MFG P/N: FW.24.NTY.M 2. Patch Antenna, 4.9dBi peak gain RH circular MFG: Taoglas MFG P/N: WTSP.2400.25.4.40
Input Power	Li-SOC12 battery pack, 7.2 VDC, 19 Ah, < 160mA (fused) PN: 000842
FCC ID:	2AAZE-000697
IC ID:	11413A-000697

Equipment Under Test (EUT) – PL02 PCU + HCD + HCDW

HCD and HCDW sensors

4.9 dBi Hemispherical Patch antenna.

12 dBi Omni-directional antenna

2.2 Environmental Conditions

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

Parameter	Conditions
Location	Indoors
Temperature	22-28ºC
Relative Humidity	39.7 – 54.4%

2.3 Measurement Uncertainty

Parameter	Uncertainty
Radiated Emissions, 30MHz-1GHz	± 2.40 dB
Radiated Emissions, 1GHz-40GHz	± 2.48 dB
Radio Frequency	±1,5 x 10-5 MHz
Total RF Power Conducted	±1.36 dB
Spurious Emissions, Conducted	±1.36 dB
RF Power Density, Conducted	±1.36 dB
Temperature	±1ºC
Humidity	±5 %
DC and low frequency voltages	±3 %

2.4 Worst Test Case

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

2.5 Sample Calculations of Emissions Data

Radiated and conducted emissions were performed using EMC32 software developed by 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)	Quasi-Peak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Antenna height (cm)	Polarity	Turntable position (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
42.663900	33.0	1000.000	120.000	100.0	H	70.0	13.2	7.5	40.5

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:

Corr.(dB) = Antenna factor + Cable loss

Or

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

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

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

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

Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.150	44.3	1000.000	9.000	0.6	21.7	66.0

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

Note: *Data shown above are sample data and are not relevant to the EUT's actual data.*

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

Corr.(dB) = Antenna factor + Cable loss

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

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

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

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

2.6 Test Equipment List

The tables below contain all the equipment used by QAI Laboratories in conducting all tests on the Equipment Under Test (EUT) as per Section 1.3.

Emissions Test Equipment

Manufacturer	Model	Description	Serial No.	Last Calibration Date	Calibration Due Date
ETS Lindgren	S201	5-meter Semi-Anechoic Chamber	1030	N/A	N/A
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 – 3GHz	A120106	2017-Sep-24	2020-Sep-24
Sunol Sciences	DRH-118	Horn Antenna 1GHz-18GHz	A050905	2016-Mar-10	2020-Mar-10
Rohde & Schwarz	ESU40	EMI Receiver	100011	2017-Nov-20	2020-Nov-20
Fischer	FCC-LISN-50-25-2-08	LISN (150kHz-30MHz)	2041	2015-Nov-19	2020-Nov-19
EMCO	6502	Loop Antenna	6502	11/13/2017	2020-Nov-13
EMCO	3160-09	Horn Antenna 18-26.5GHz	9701-1071	13-Sep-17	2020-Sep-13

The following components and equipment are calibrated as a complete signal path.

Manufacturer	Model	Description	Serial No.	Last Calibration Date	Calibration Due Date
AH Systems	PAM118	Amplifier 10KHz-18GHz	189	January 1, 2019	January 1, 2020
Insulated Wire Inc.	SPS-1753-1140-SPS	Yellow cable, 3m	102395		
Insulated Wire Inc.	SPS-1753-2400-SPS	Yellow cable, 6m	091096		
WEINSCHEL ENGINEERING	44	6db attenuator	665		
A.H.Systems	PAM-1840VH	Preamplifier 18-40GHz	152	January 1, 2019	January 1, 2020
A.H.Systems	2649-03	Green short input cable	395		
A.H.Systems	2649-225	Green short output cable	396		

Measurement Software List

Manufacturer	Model	Version	Description
Rohde & Schwarz	EMC 32	6.20.0	Emissions Test Software

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

3.1 RF Peak Output Power

Date Performed:

May 10, 2019

Test Standard:

- FCC Title 47 CFR Part 15: Subpart C §15.247 (b)(3)
- RSS-247 Issue 2: Clause 5.4 (4)

Test Method:

- FCC KDB 558074 D01 DTS Meas Guidance v05r02

Test Requirement:

For DTSs employing digital modulation techniques operating in the bands 902-928 MHz and 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1W (30 dBm). The e.i.r.p. shall not exceed 4 W (36dBm), except as provided in section 5.4(e).

Fixed point-to-point systems in the bands 2400-2483.5 MHz and 5725-5850 MHz are permitted to have an e.i.r.p. higher than 4 W provided that the higher e.i.r.p. is achieved by employing higher gain directional antennas and not higher transmitter output powers. Point-to-multipoint systems,2 omnidirectional applications and multiple co-located transmitters transmitting the same information are prohibited from exceeding an e.i.r.p. of 4 W.

Result:

The EUT complies with the applicable standard.

Measurement Data and Plot:

Data of Conducted Peak Power

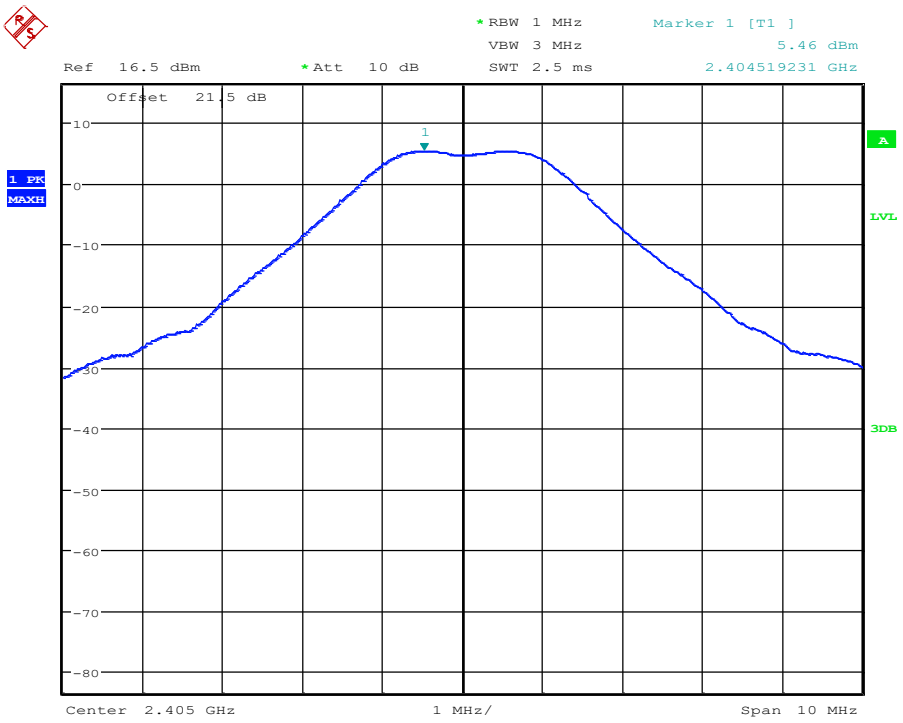
Channel	Frequency	Conducted Peak Power	Limit	Margin	Result
	MHz	dBm	dBm	dB	
Low	2405	5.46	30	24.54	Pass
Mid	2440	5.42	30	24.58	Pass
High	2480	5.19	30	24.81	Pass

Data of EIRP with 4.9dBi RH circular antenna

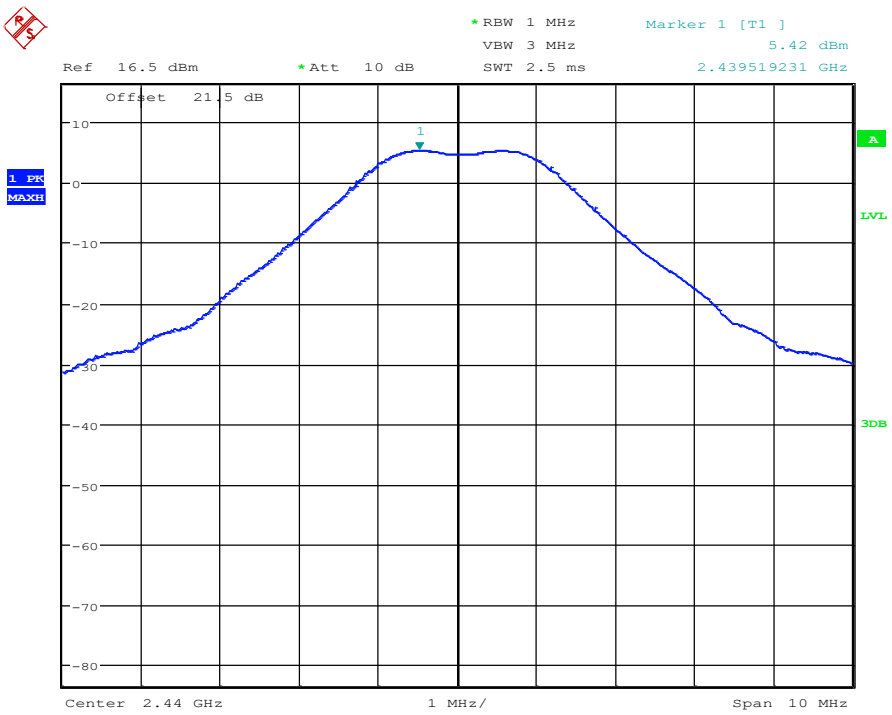
Channel	Frequency	Conducted Peak Power	Antenna Gain	EIRP	Limit	Margin	Result
	MHz	dBm	dBi	dBm	dBm	dB	
Low	2405	5.46	4.9	10.36	36	25.64	Pass
Mid	2440	5.42	4.9	10.32	36	25.68	Pass
High	2480	5.19	4.9	10.09	36	25.91	Pass

Data of EIRP with 12dBi Omni-directional antenna

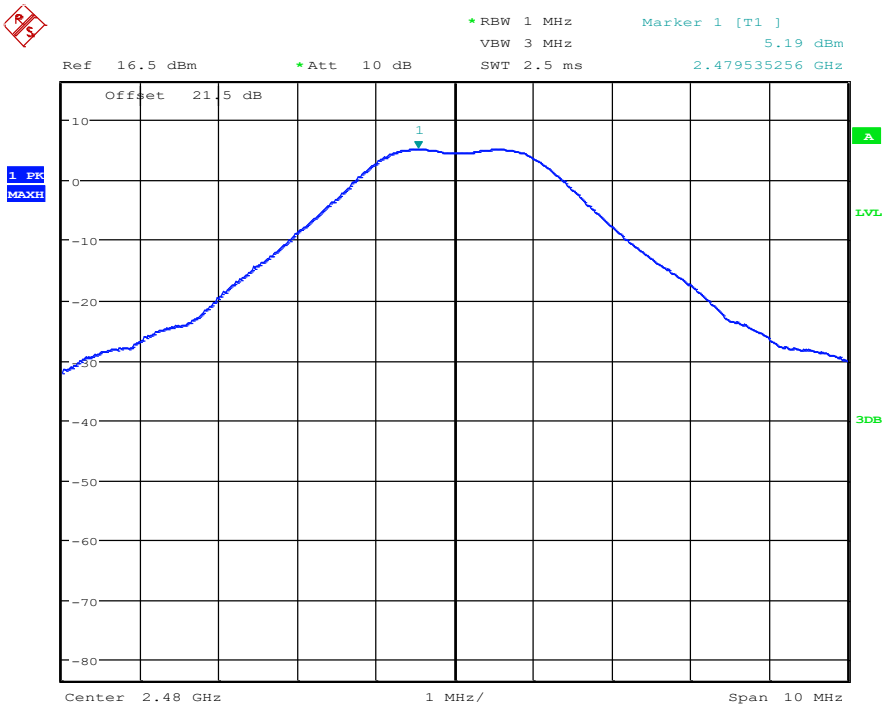
Channel	Frequency	Conducted Peak Power	Antenna Gain	EIRP	Limit	Margin	Result
	MHz	dBm	dBi	dBm	dBm	dB	
Low	2405	5.46	12	17.46	36	18.54	Pass
Mid	2440	5.42	12	17.42	36	18.58	Pass
High	2480	5.19	12	17.19	36	18.81	Pass



Plot of Conducted Peak Power, Low Channel



Plot of Conducted Peak Power, Mid Channel



Plot of Conducted Peak Power, High Channel

3.2 6dB Occupied Bandwidth

Date Performed:

May 2, 2019

Test Standard:

- FCC Title 47 CFR Part 15: Subpart C §15.247 (a)(2)
- RSS-247 Issue 2: Clause 5.2 (1)

Test Method:

- ANSI C63.10:2013

Test Requirement:

The minimum 6dB bandwidth shall be at least 500kHz.

Test Setup:

The antenna port of EUT was directly connected to a spectrum analyzer.

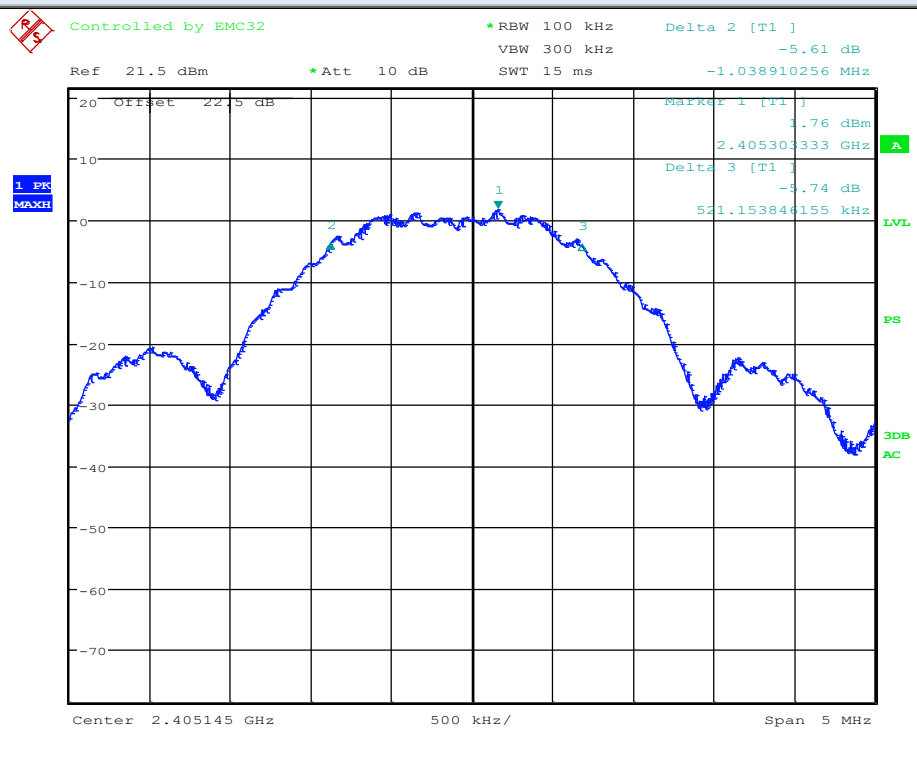
Modifications:

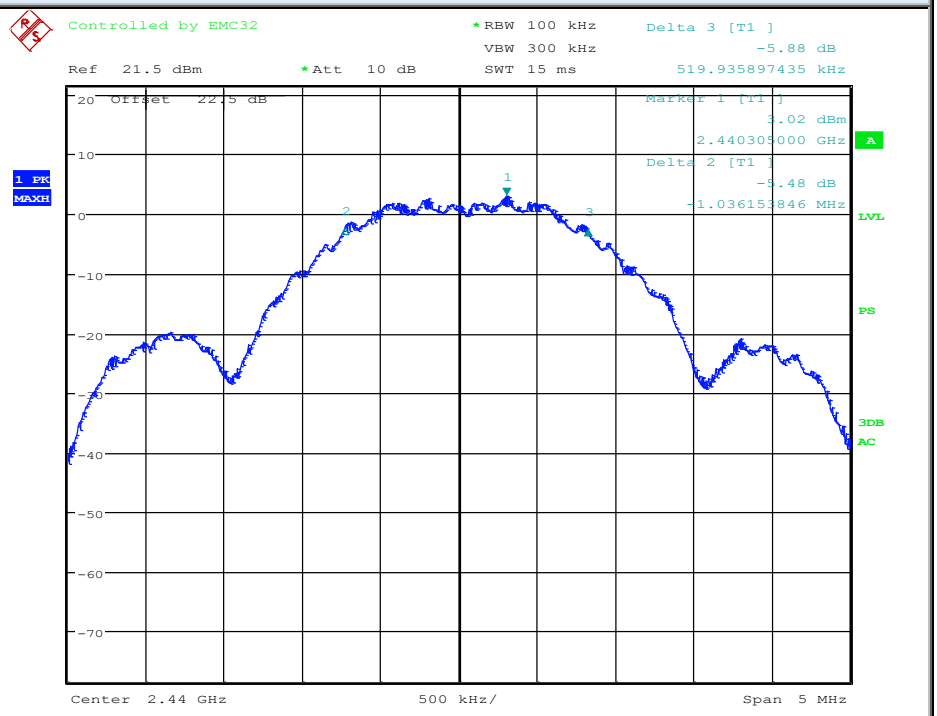
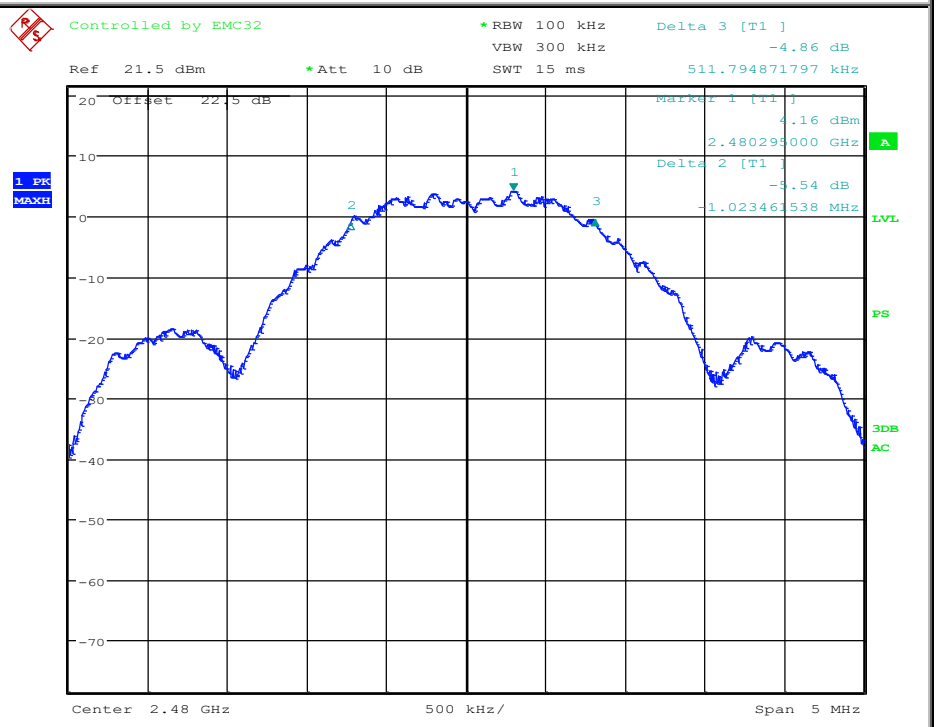
No modification was required to comply for this test.

Result:

The EUT complies with the applicable standard.

Measurement Data and Plot:

Data	Plot
Channel: Low Frequency: 2405MHz 6dB BW: 1560 kHz	

Data	Plot
Channel: Mid Frequency: 2440MHz 6dB BW: 1556 kHz	
Channel: High Frequency: 2480MHz 6dB BW: 1535 kHz	

3.3 99% Occupied Bandwidth

Date Performed:

May 2, 2019

Test Standard:

- RSS-Gen Issue 4: Clause 6.6

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 and RSS-Gen Issue 4

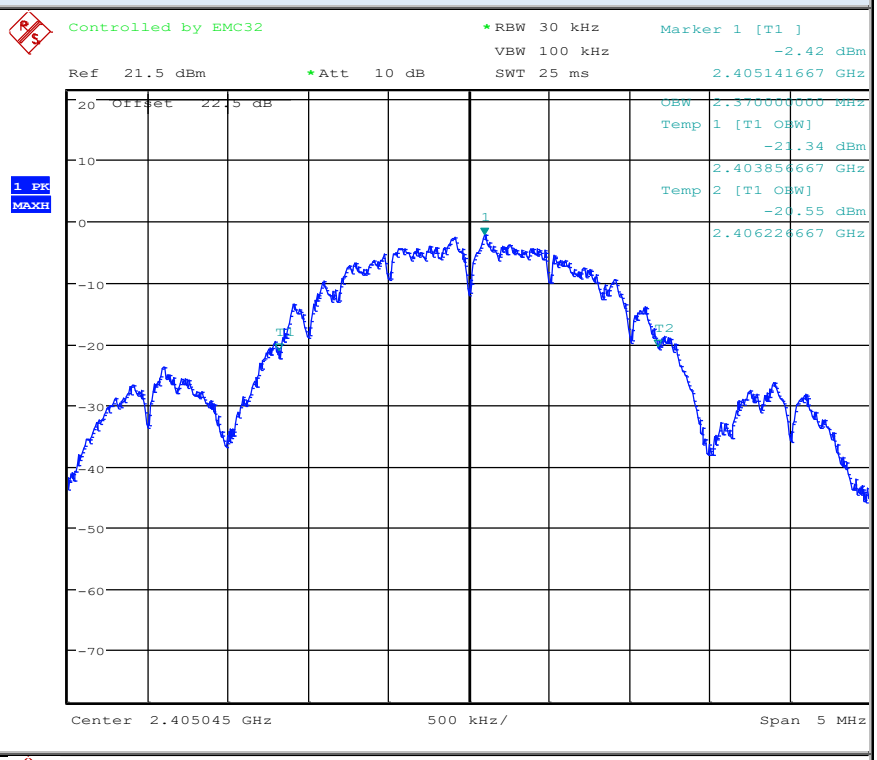
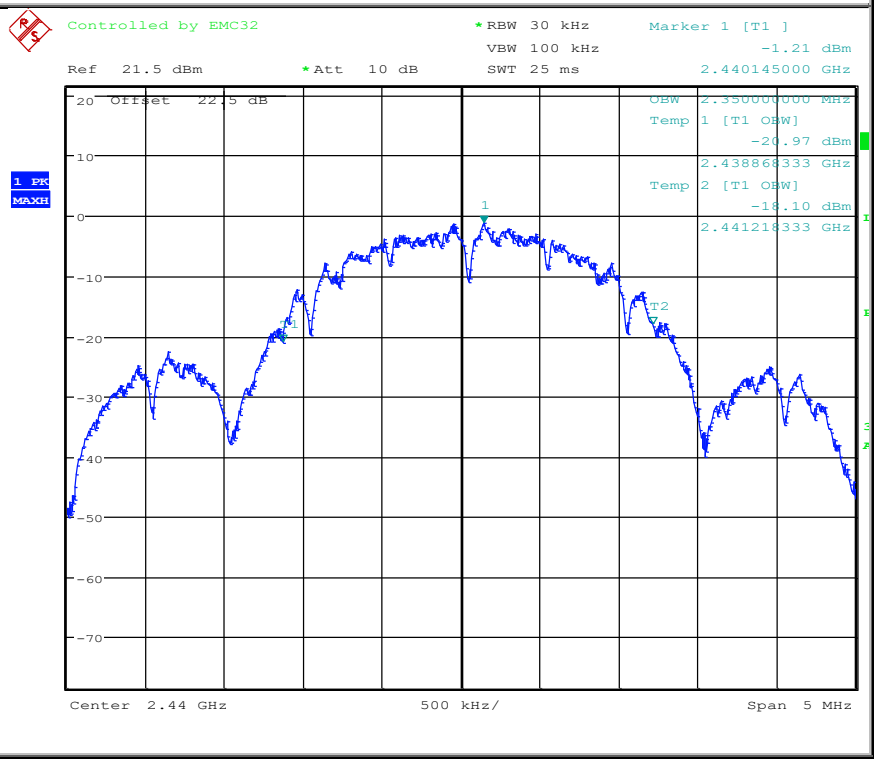
Modifications:

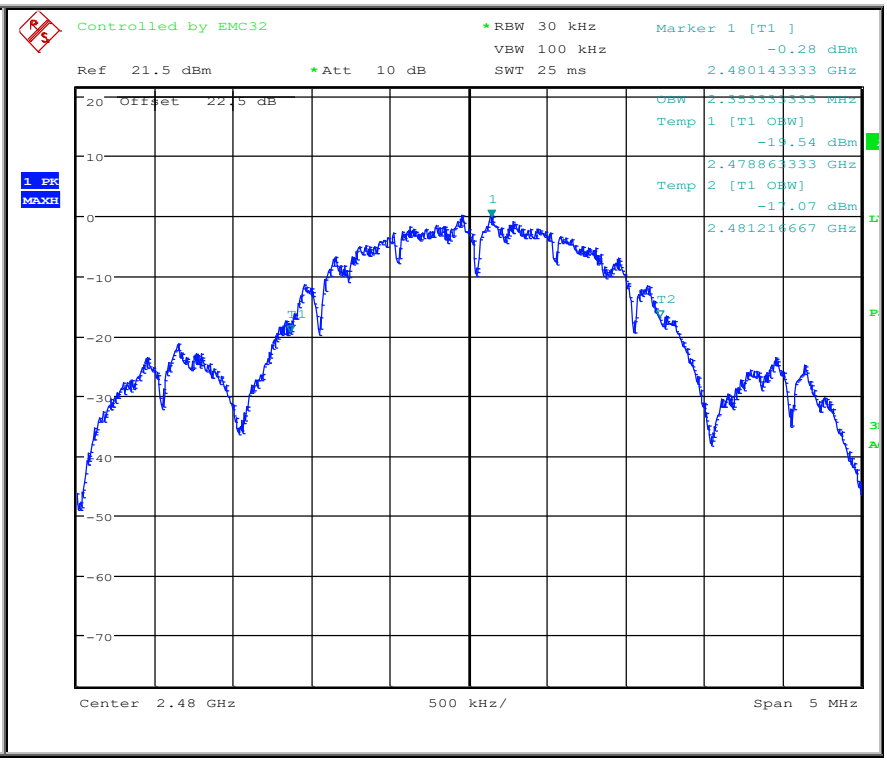
No modification was required to comply for this test.

Result:

The EUT complies with the applicable standard.

Measurement Data and Plot:

Data	Plot
Channel: Low Frequency: 2405MHz 99% BW: 2370 kHz	
Channel: Mid Frequency: 2440MHz 99% BW: 2350 kHz	

Channel: High Frequency: 2480MHz 99% BW: 2353 kHz	

3.4 Power Spectral Density

Date Performed:

May 2, 2019

Test Standard:

- FCC Title 47 CFR Part 15: Subpart C §15.247 (e)
- RSS-247 Issue 2: 5.2 (2)

Test Method:

- FCC KDB 558074 D01 DTS Meas Guidance v05r02

Test Requirement:

The transmitter power spectral density conducted from the transmitter to the antenna shall not be greater than 8dBm in any 3kHz band during any time interval of continuous transmission. The power spectral density was determined using the same method as is used to determine the conducted output power).

Test Setup:

The antenna port of EUT was directly connected to a spectrum analyzer.

Modifications:

No modification was required to comply for this test.

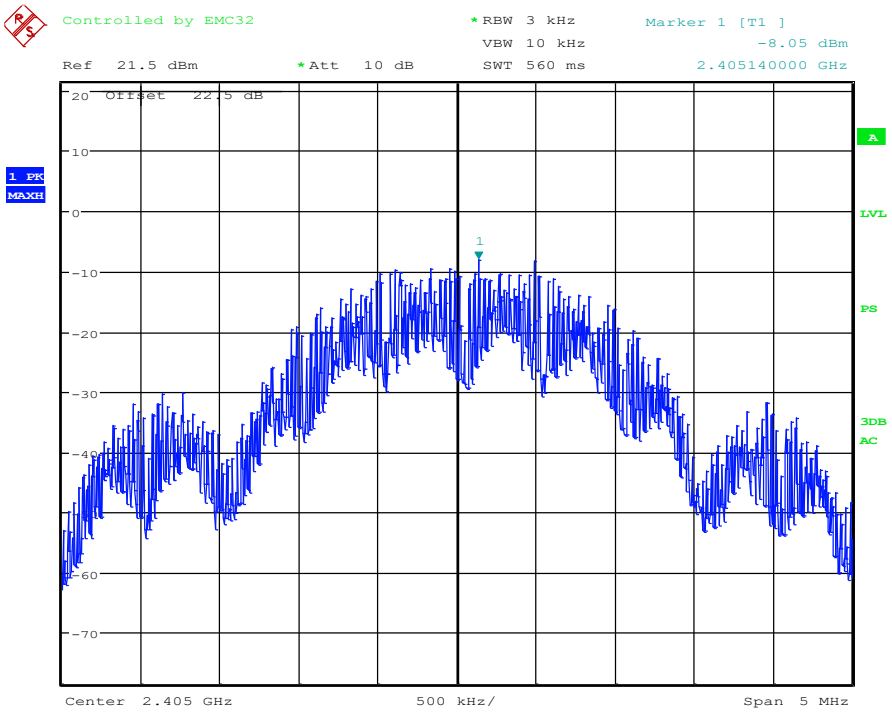
Result:

The EUT complies with the applicable standard.

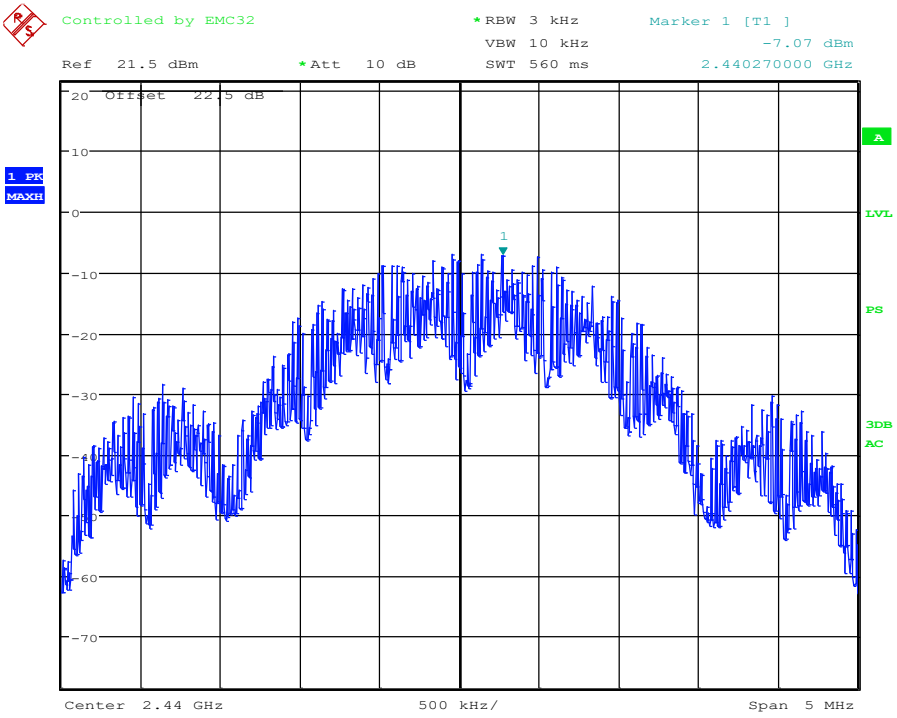
Measurement Data and Plot:

Data of Power Spectral Density

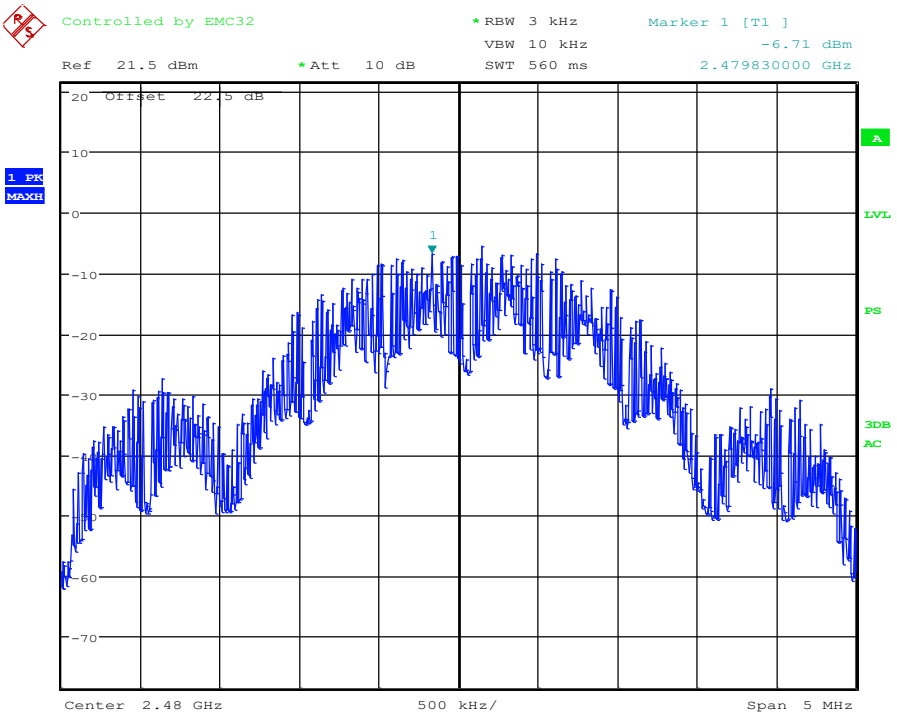
Channel	Frequency	Conducted Peak Power	Limit	Margin	Result
	MHz	dBm	dBm	dB	
Low	2405	-8.05	8	16.05	Pass
Mid	2440	-7.07	8	15.07	Pass
High	2480	-6.71	8	14.71	Pass



Plot of Power Spectral Density, Low Channel



Plot of Power Spectral Density, Mid Channel



Plot of Power Spectral Density, High Channel

3.5 Band Edge & Out of Band Emissions

Date Performed: May 13, 2019

Test Standard:

- FCC Title 47 CFR Part 15: Subpart C §15.247 (d)
- RSS-247 Issue 2: Clause 5.5

Test Method:

- ANSI C63.10:2013

Test Requirement:

In any 100kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section A8.4 (4), the attenuation required shall be 30 dB instead of 20dB. Attenuation below the general field strength limits specified in RSS-Gen Issue 5is not required.

Test Setup:

The antenna port of EUT was directly connected to a spectrum analyzer.

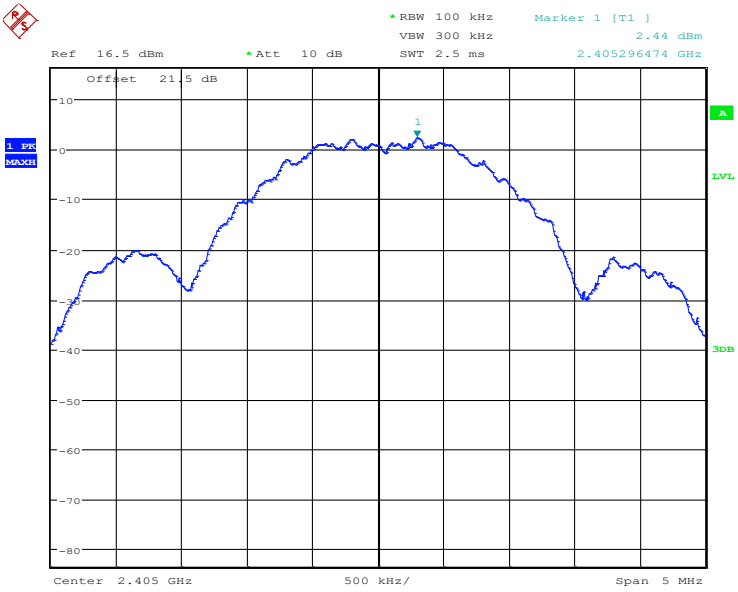
Modifications:

No modification was required to comply for this test.

Result:

The EUT complies with the applicable standard.

Measurement Data and Plot:



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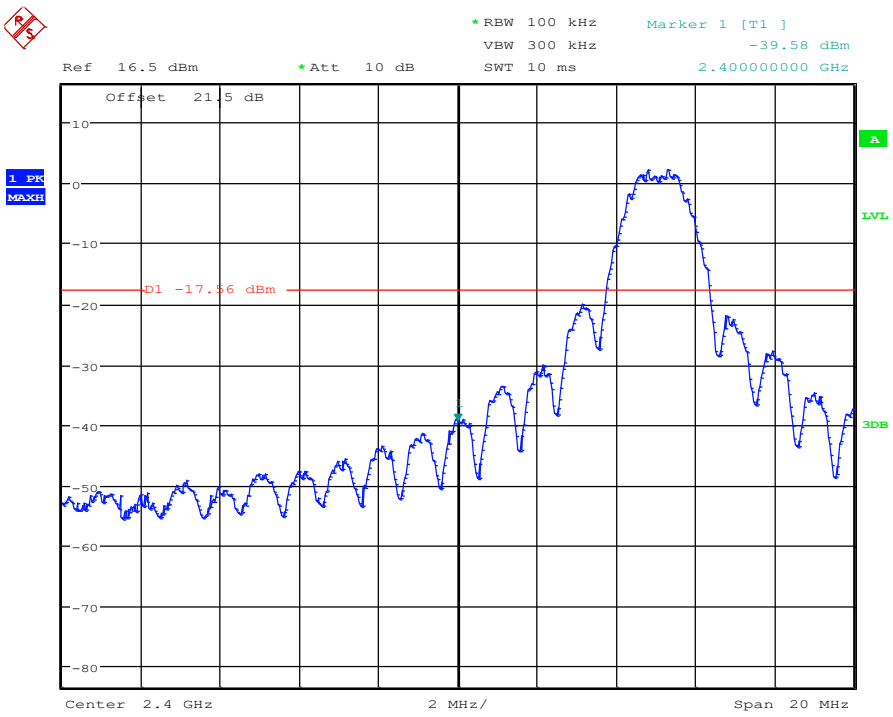
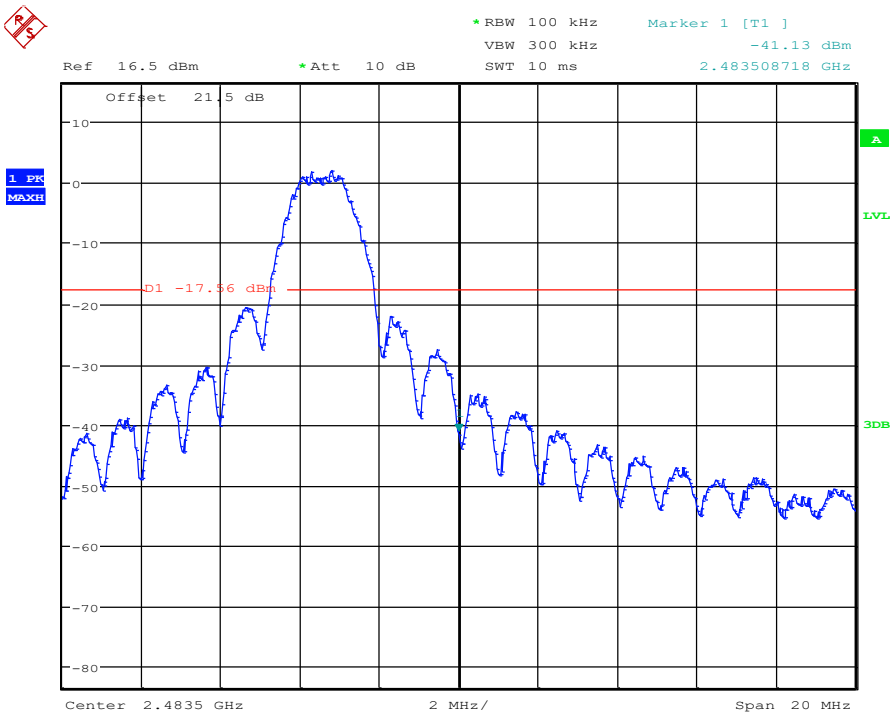
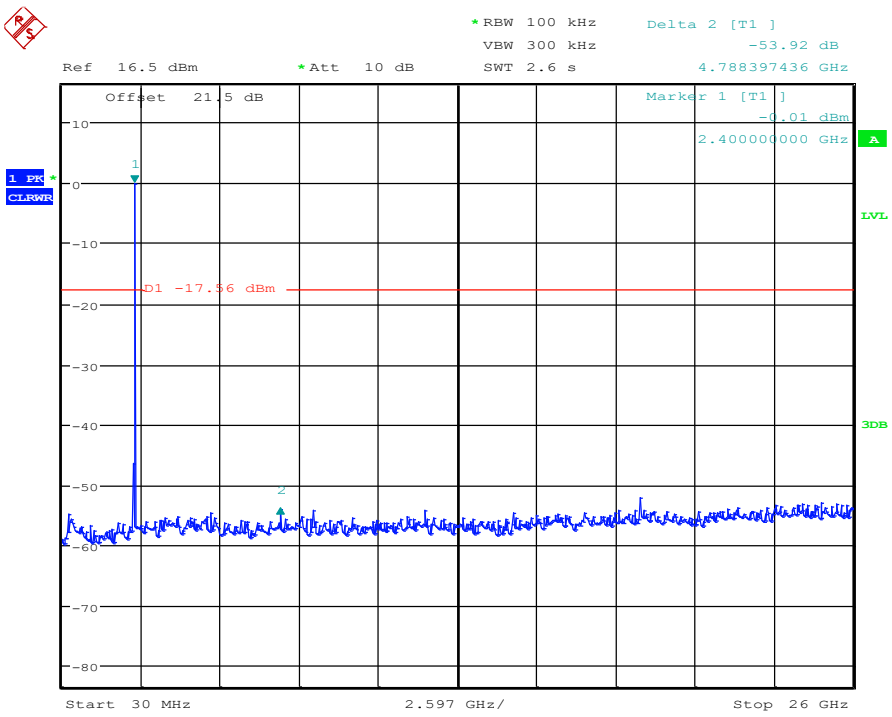


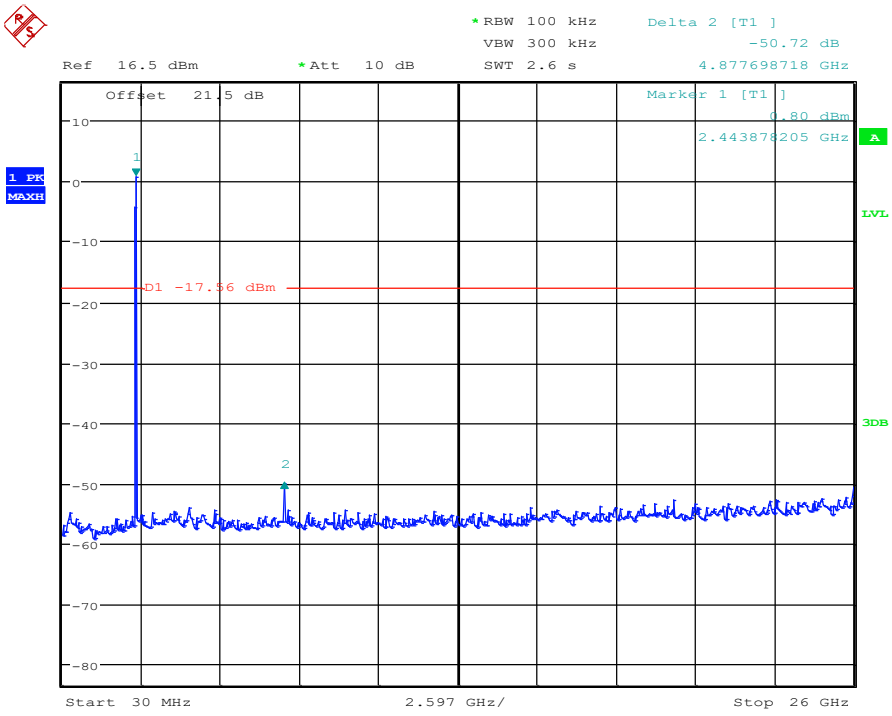
Low Channel Band Edge



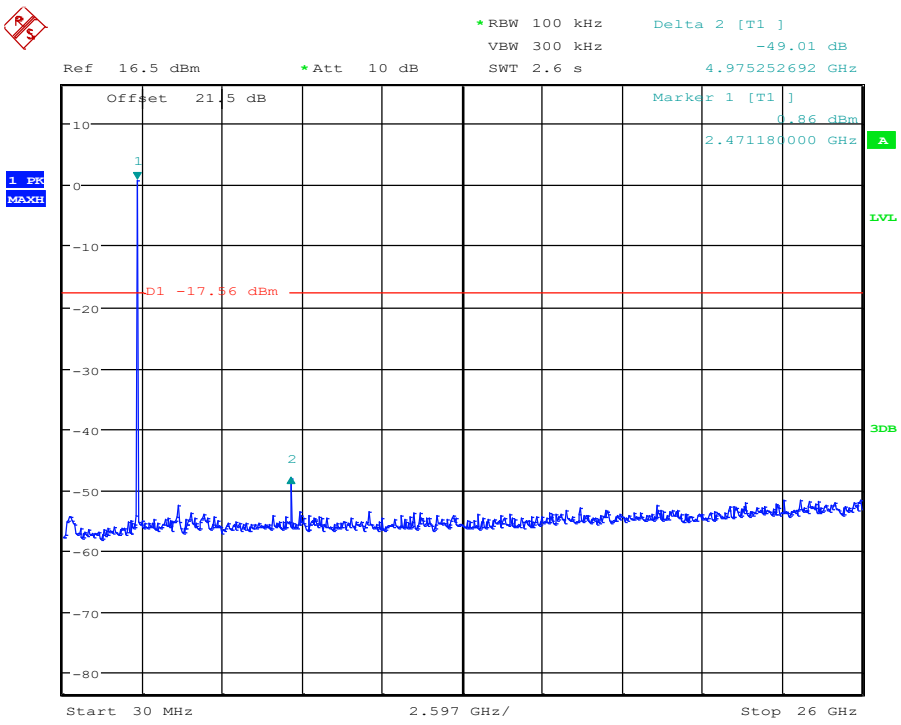
High Channel Band Edge



Out of band emissions, Low Channel



Out of band emissions, Mid Channel



Out of band emissions, High Channel

3.6 Radiated Spurious Emissions ~ Transmit Mode

Date Performed:

March 9, 2017

Test Standard:

- FCC Title 47 CFR Part 15: Subpart C §15.209
- FCC Title 47 CFR Part 15: Subpart C §15.205
- RSS-Gen Issue 4: Clause 8.9 and 8.10

Test Method:

- ANSI C63.10:2013

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 (dBµV/m) at 3m
0.009 – 0.490	128.5 – 93.8
0.490 – 1.705	73.8 – 63.0
1.705 – 30.0	69.5

Frequency (MHz)	Field Strength Quasi Peak dBµV/m @ 3m
30 – 88	40.0
88 – 216	43.5
216 – 960	46.0
Above 960	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			

*** - note FCC-specific .**

Canada-specific frequency ranges in MHz – 3.020-3.026, 5.677–5.683, 121.94-123.0. 149.9-150.05, 162.0125-167.17, 167.72-173.2, 1300-1427, 2483.5-2500, 3500-3600,

(2) Above 38,6 GHz

(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
0.090-0.110
2.1735-2.1905
3.020-3.026
4.125-4.128
4.17725-4.17775
4.20725-4.20775
5.677-5.683
6.215-6.218
6.26775-6.26825
6.31175-6.31225
8.291-8.294
8.362-8.366
8.37625-8.38675
8.41425-8.41475
12.29-12.293
12.51975-12.52025
12.57675-12.57725
13.36-13.41
16.42-16.423
16.69475-16.69525
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

MHz
240-285
322-335.4
399.9-410
608-614
960-1427
1435-1626.5
1645.5-1646.5
1660-1710
1718.8-1722.2
2200-2300
2310-2390
2655-2900
3260-3267
3332-3339
3345.8-3358
3500-4400
4500-5150
5350-5460
7250-7750
8025-8500

GHz
9.0-9.2
9.3-9.5
10.6-12.7
13.25-13.4
14.47-14.5
15.35-16.2
17.7-21.4
22.01-23.12
23.6-24.0
31.2-31.8
36.43-36.5
Above 38.6

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 lowest, middle and highest channels in the 902-928 MHz bands 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:

ANSI C63.4:2014 radiated emissions procedure was followed to demonstrate the compliance of EUT.

Modifications:

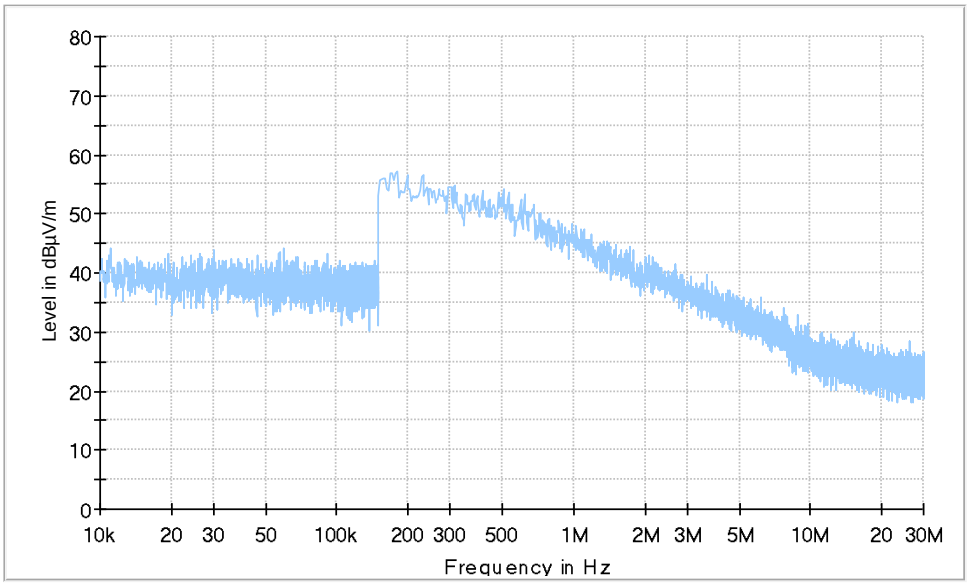
No modification was required to comply for this test.

Result:

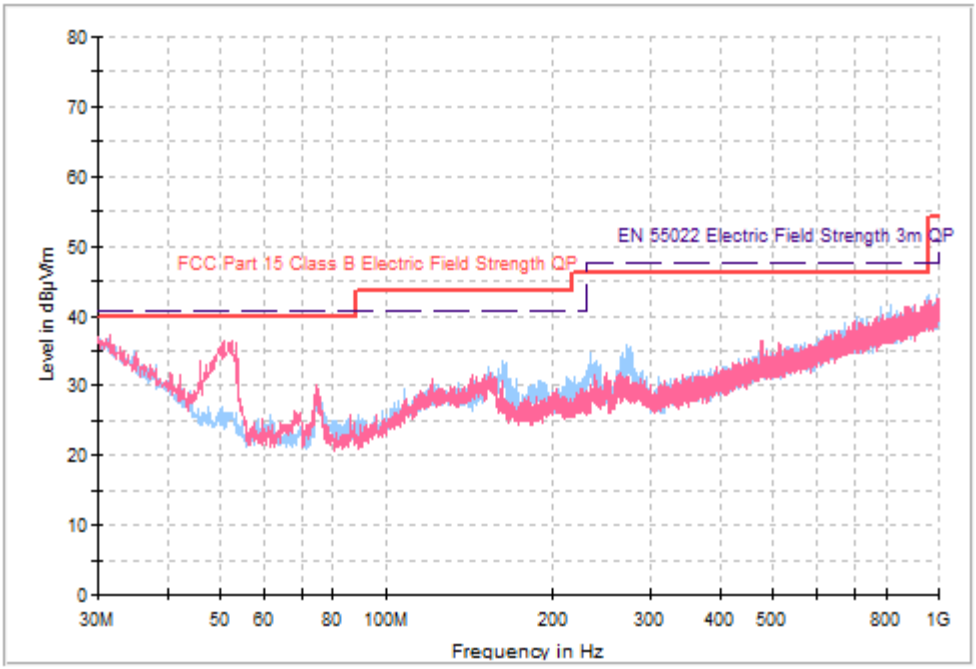
The EUT complies with the applicable standard.

Measurement Data and Plot:

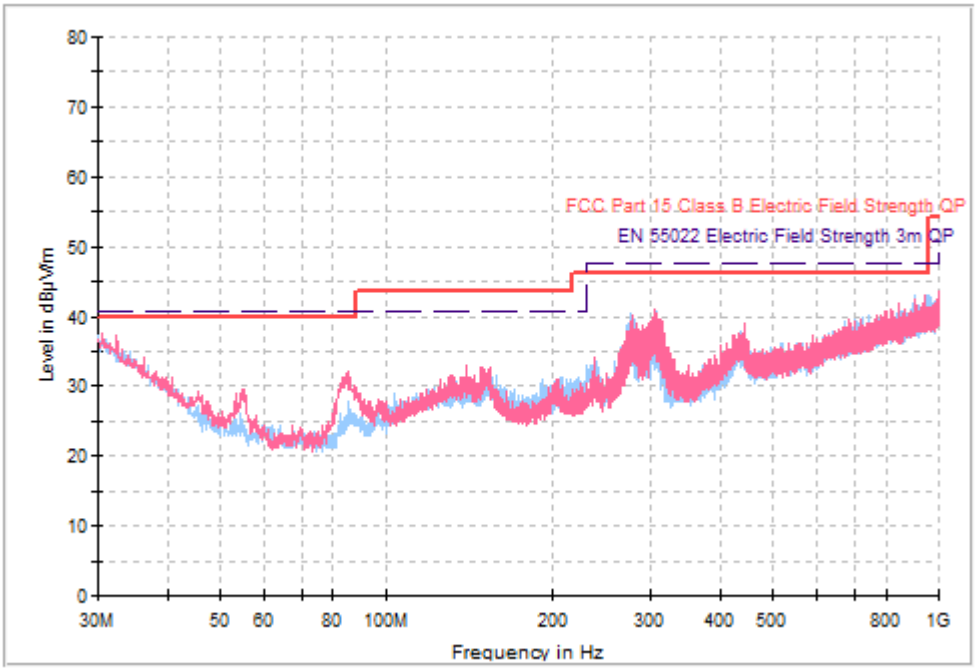
Remark: Data were 20dB and greater below the limit line and need not to be reported.



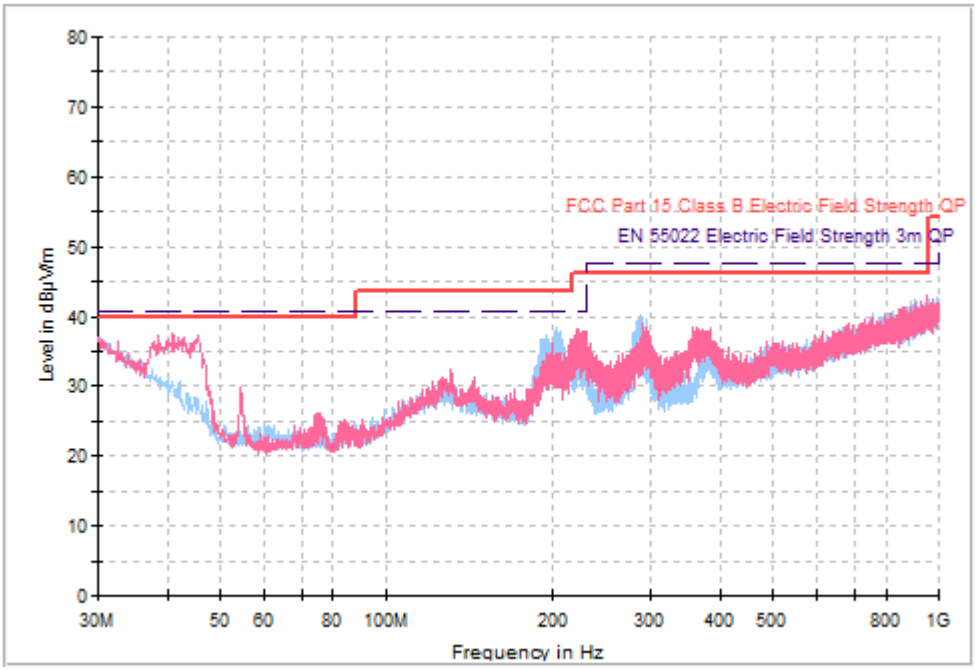
Plot of Radiated Emissions scanned at 3m SAC, 10kHz - 30MHz



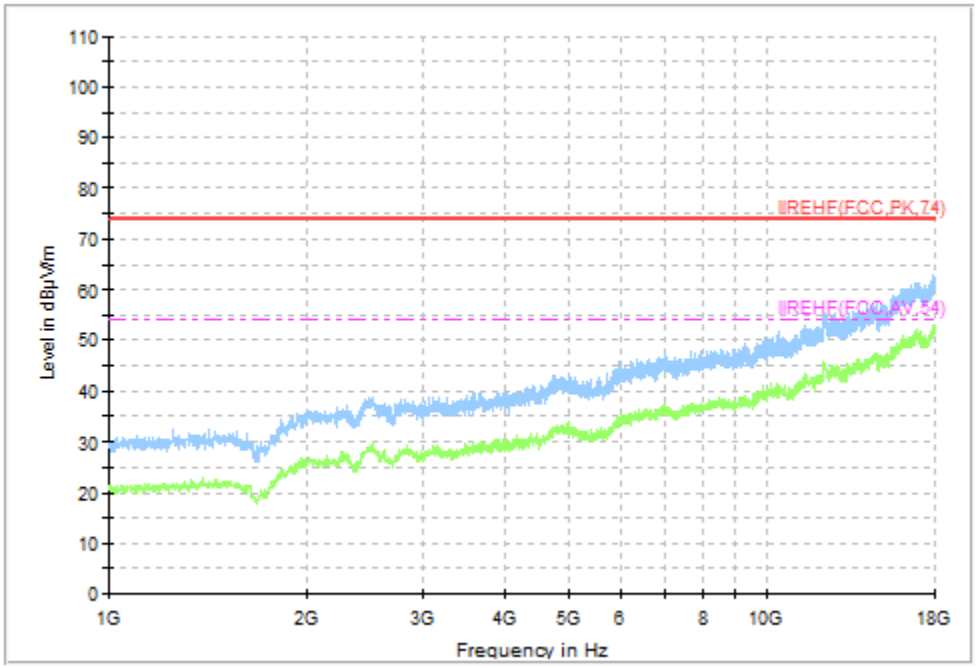
Plot of Radiated Emissions scanned at 3m SAC, 30MHz - 1GHz, RH circular antenna



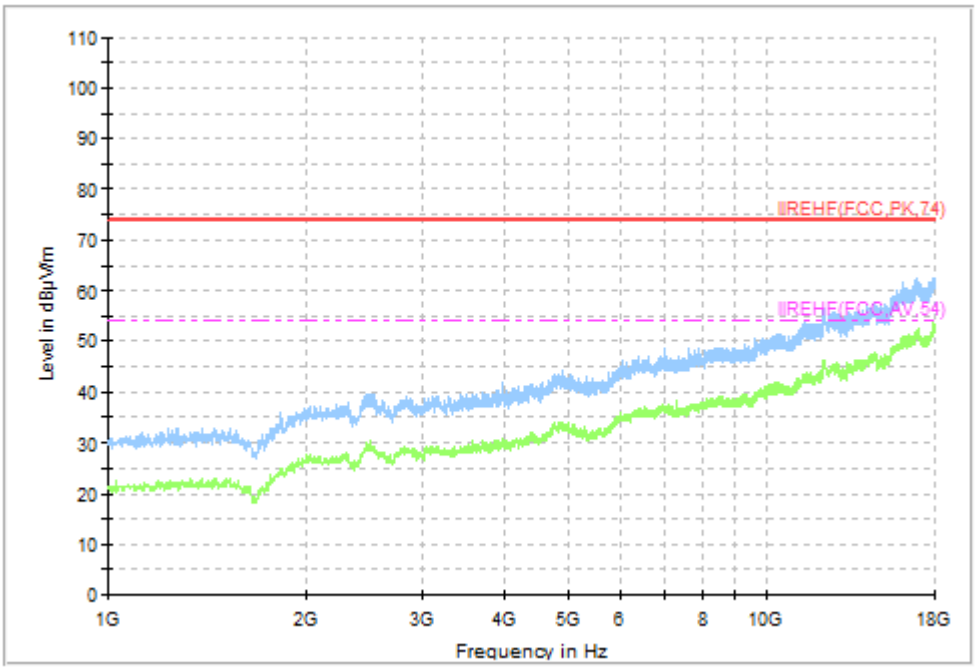
Plot of Radiated Emissions scanned at 3m SAC, 30MHz - 1GHz, Omni-directional antenna



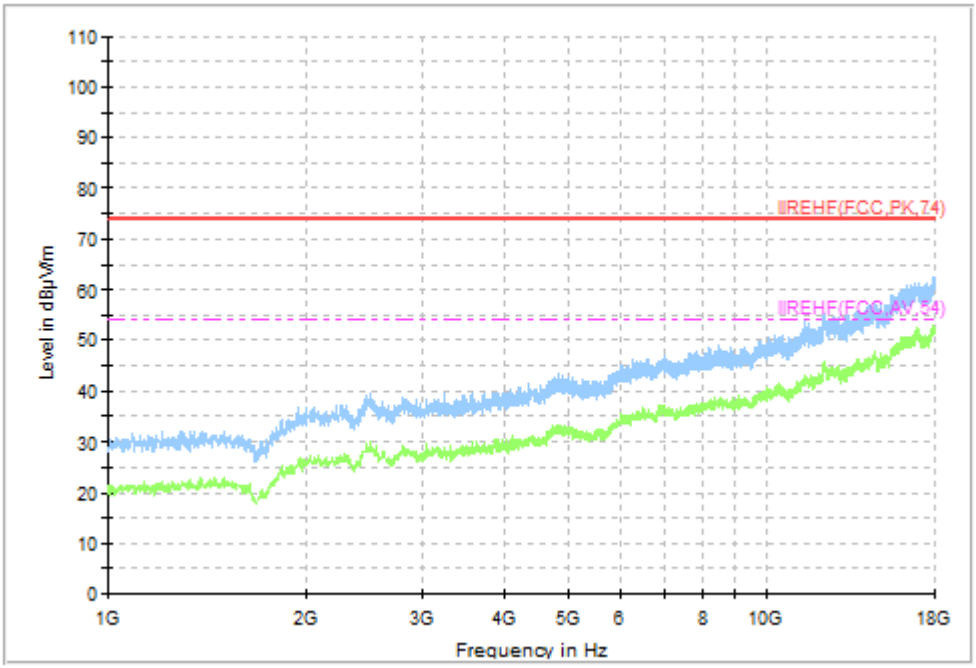
Plot of Radiated Emissions scanned at 3m SAC, 30MHz - 1GHz, Omni-directional antenna, 32ft HCD



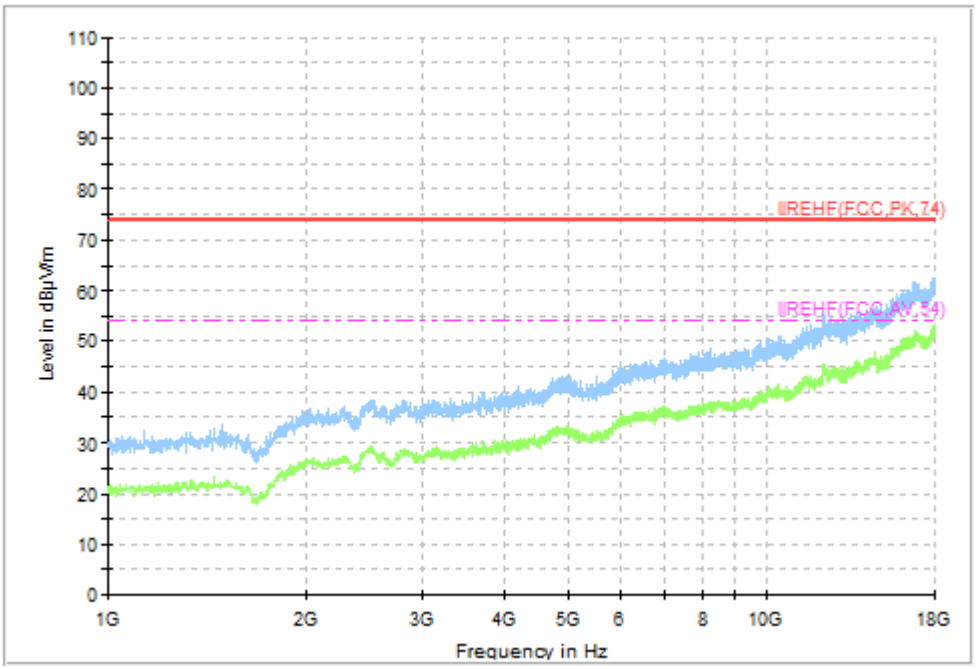
Plot of Radiated Emissions scanned at 3m SAC, 1GHz – 18GHz, Low Channel, RH circular antenna



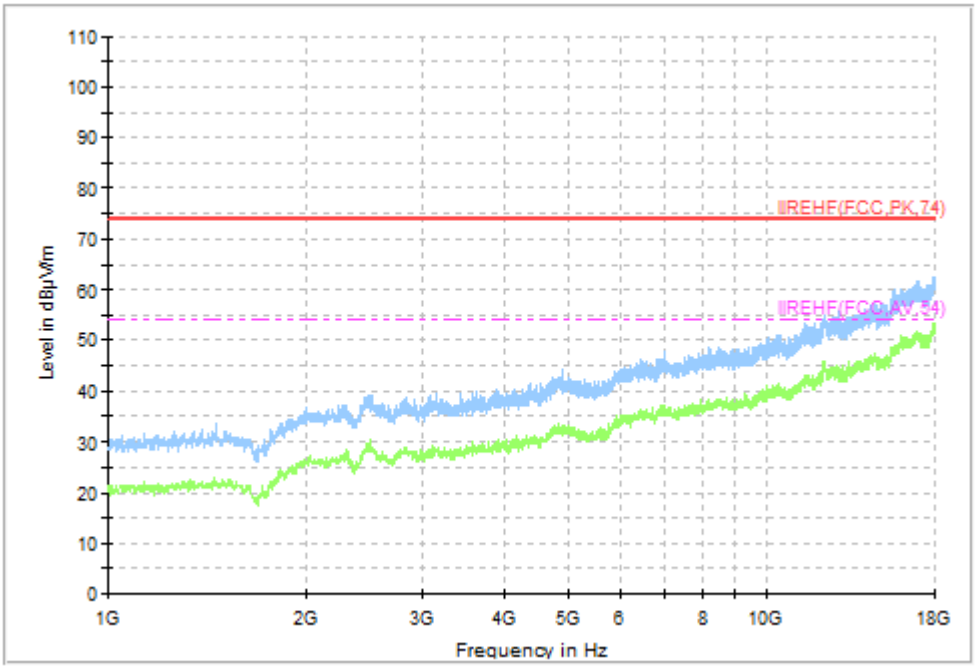
Plot of Radiated Emissions scanned at 3m SAC, 1GHz – 18GHz, Mid Channel, RH circular antenna



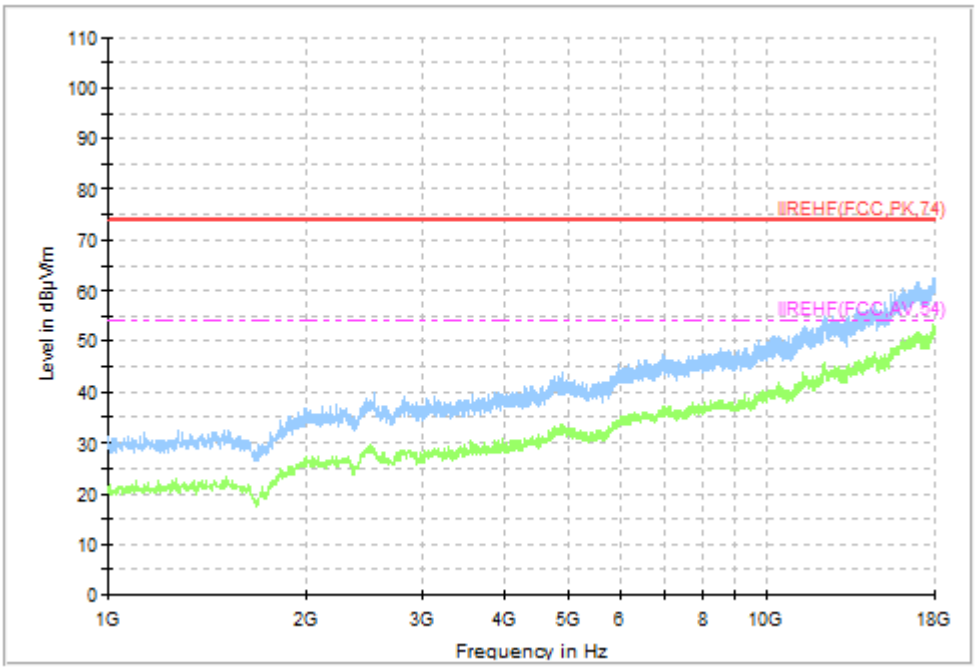
Plot of Radiated Emissions scanned at 3m SAC, 1GHz – 18GHz, High Channel, RH circular antenna



Plot of Radiated Emissions scanned at 3m SAC, 1GHz – 18GHz, Low Channel, Omni-directional antenna



Plot of Radiated Emissions scanned at 3m SAC, 1GHz – 18GHz, Mid Channel, Omni-directional antenna



Plot of Radiated Emissions scanned at 3m SAC, 1GHz – 18GHz, High Channel, Omni-directional antenna

3.7 Radiated Emissions ~ Receive Mode

Date Performed:

May 20, 2019

Test Standard:

- FCC Title 47 CFR Part 15: Subpart B §15.109
- ICES-003 Issue 6: Clause 6.2
- RSS-Gen Issue 4: Clause 7.1

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 Quasi Peak dBµV/m @ 3m
30 – 88	40.0
88 – 216	43.5
216 – 960	46.0
Above 960	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:

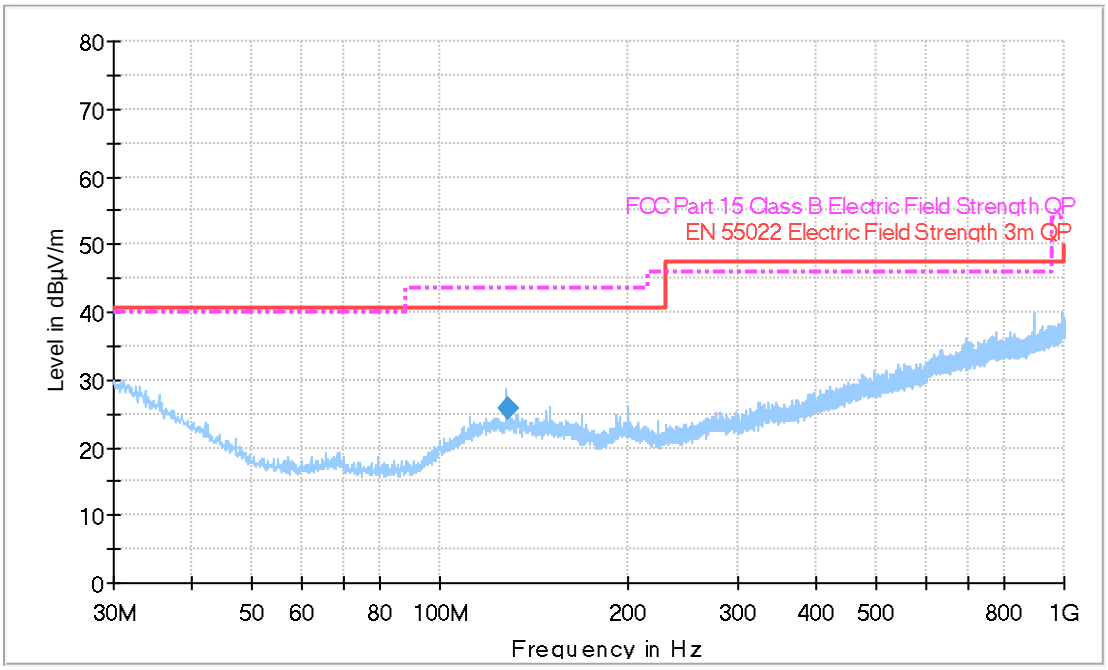
E [dBµV/m] = Un-Corrected Value + ATOT

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

Result:

The EUT complies with the applicable standard.

Measurement Data and Plot:



Plot of Radiated Emissions scanned at 3m SAC, Receive Mode

3.9 Frequency Stability

Date Performed:

May 24, 2019

Test Standard:

- FCC Title 47 CFR Part 15: Subpart C §15.215
- RSS-Gen Issue 4: Clause 8.8

Test Method:

- ANSI C63.4-2014

Test Requirement:

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 614-806MHz.

Measurement Data and Plot:

Temperature (°C)	Frequency (GHz)	Power Output (dBm)
-20	2.440058763	5.21
-10	2.440055327	5.21
0	2.440052287	5.19
10	2.440049523	5.18
20	2.440046488	5.18
30	2.440044125	5.20
40	2.440043104	5.17
50	2.440041888	5.16

Result:

The EUT complies with the applicable standard.

3.10 RF Exposure MPE

Date Performed:

June 27, 2019

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/cm^2"

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 x 10-2 *f*^0.6834 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: EIRP/[4*Pi*d^2], mW/cm^2
1) The Maximum EIRP is 17.46 dBm, when the EUT is connected to a 12 dBi Omni-directional antenna;
2) As an example, the distance from the antenna is set at 3 cm;

3) Power Density: Pd = 0.49 mW/cm², 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

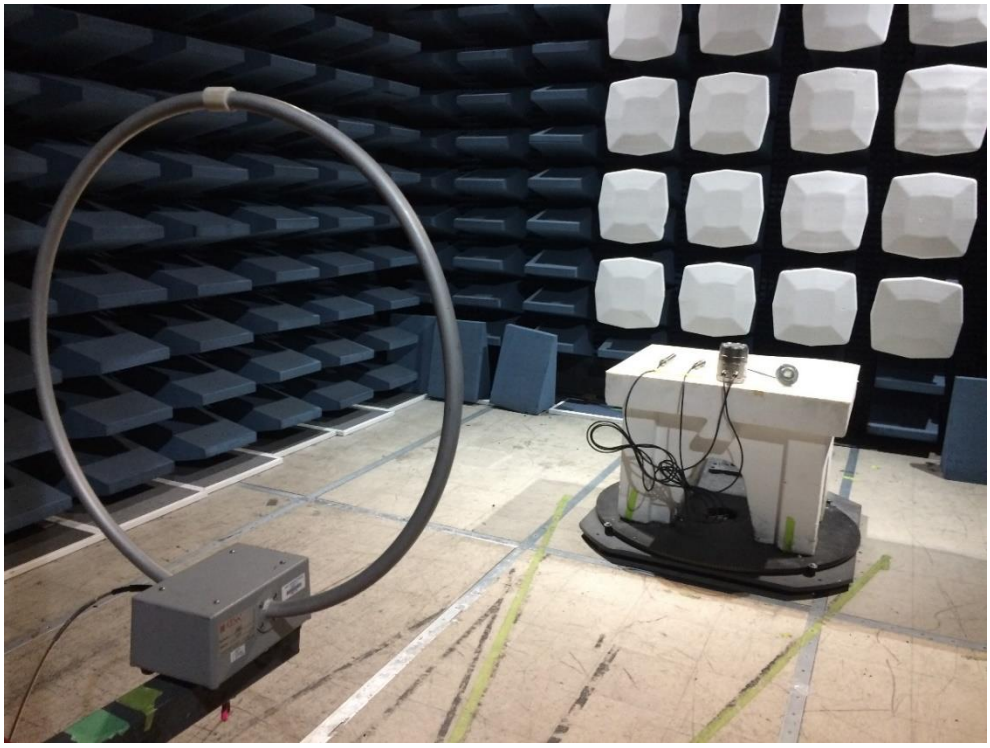
RF exposure evaluation exemption for IC:

Max EIRP measured: 17.46 dBm or 56 mW or 0.056 W

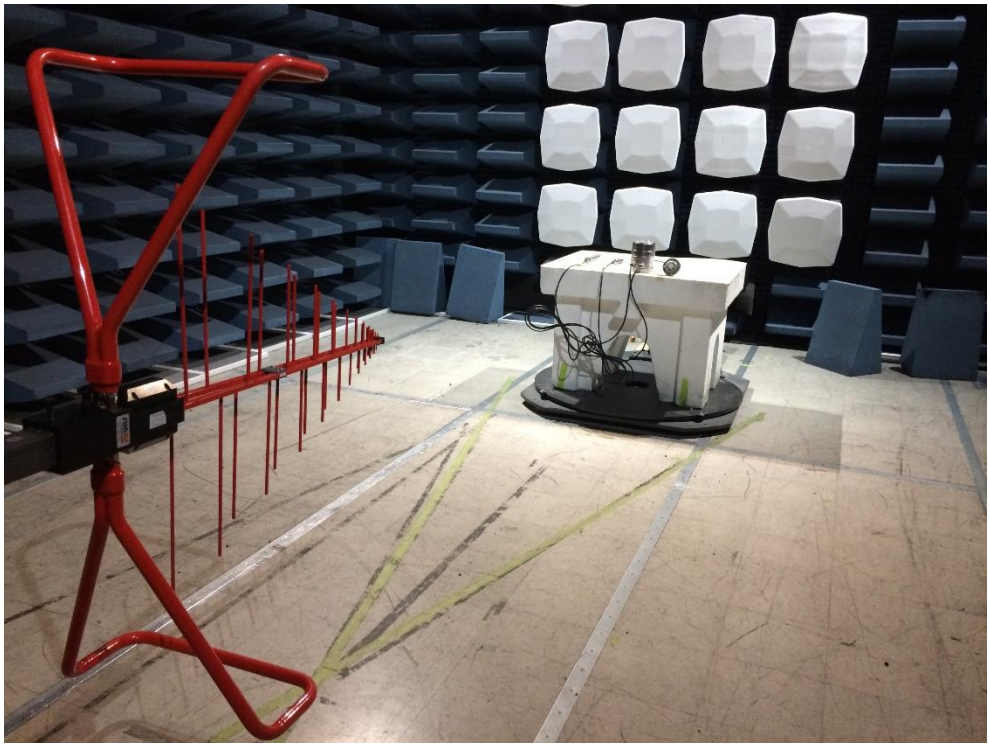
Limit: 1.31 x 10-2 f^0.6834 W =2.68 W, (f = 2426 MHz)

Therefore, RF exposure is not required.

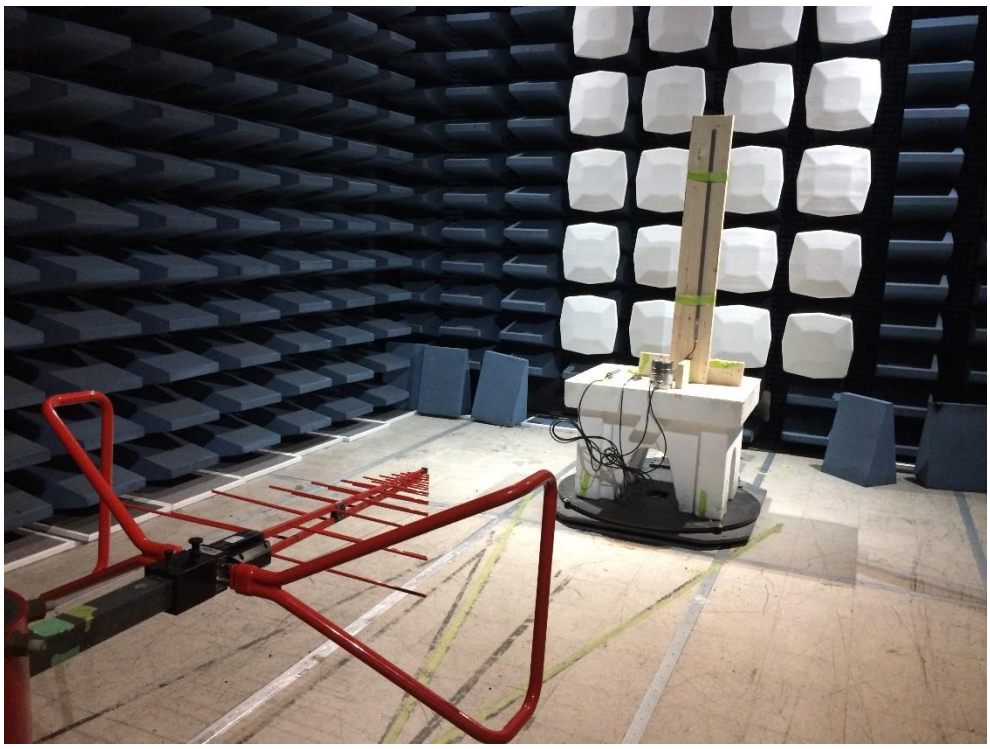
Appendix A: TEST SETUP PICTURES



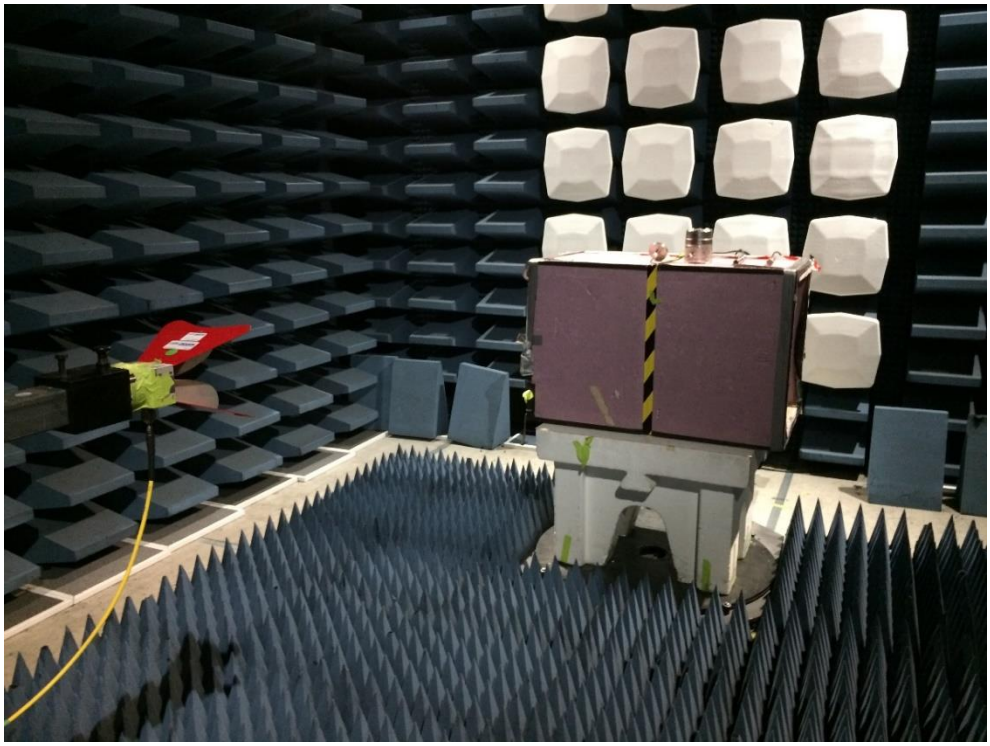
Radiated Emissions (frequency range: 10kHz ↔ 30MHz) Test Setup



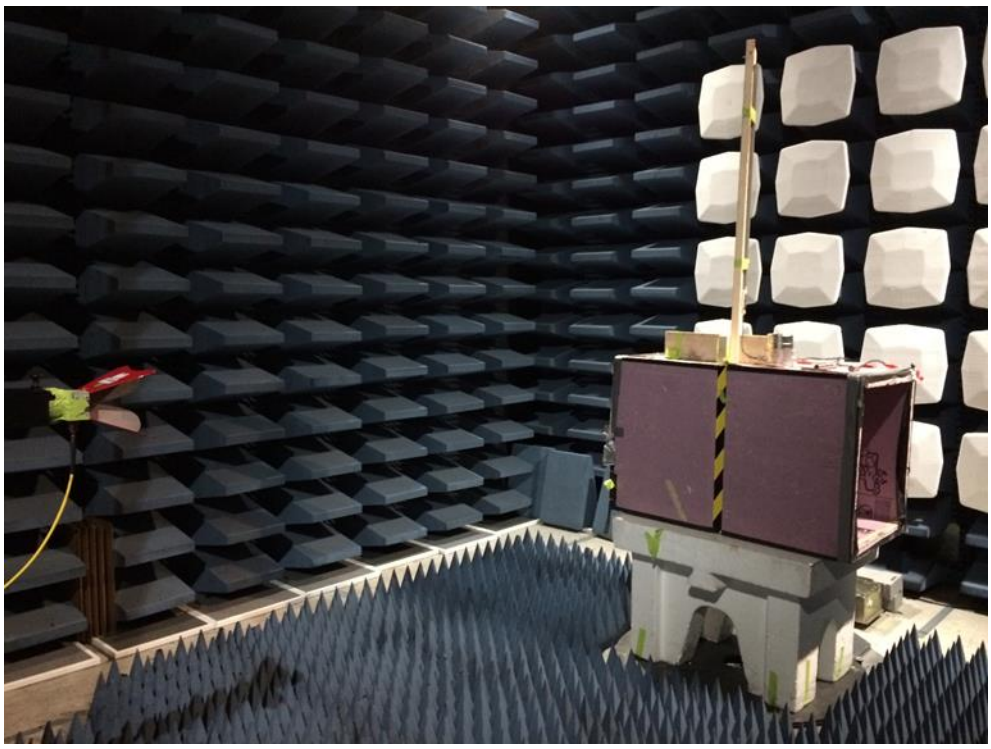
Radiated Emissions (frequency range: 30MHz ↔ 1GHz) Test Setup, the EUT with RH circular antenna



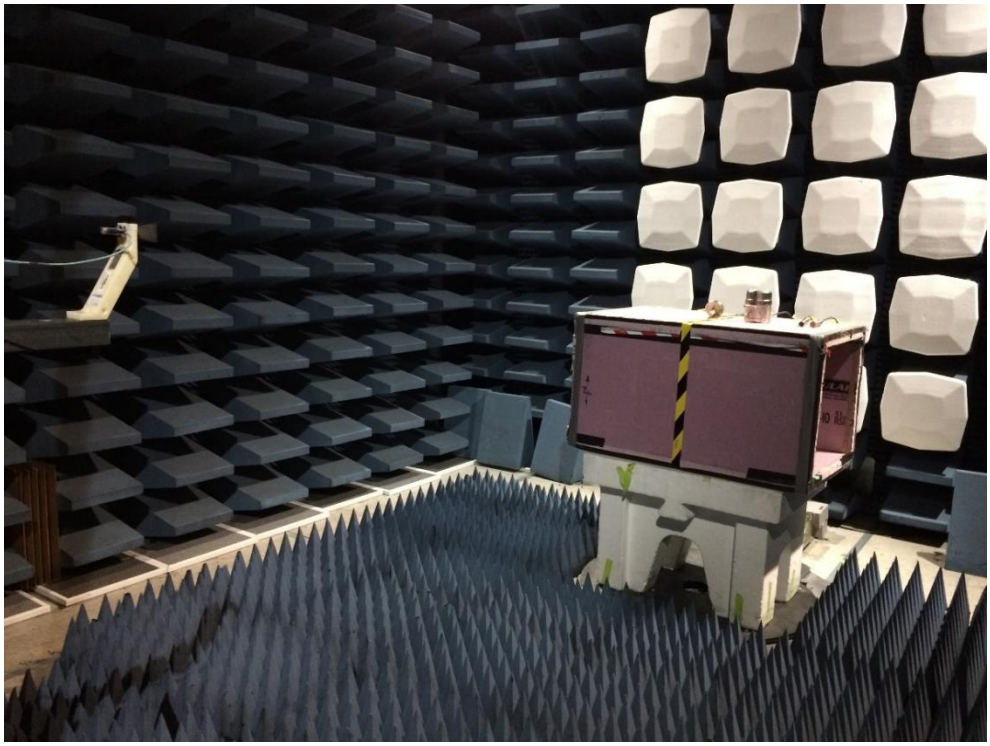
Radiated Emissions (frequency range: 30MHz ↔ 1GHz) Test Setup, the EUT with Omni-directional antenna



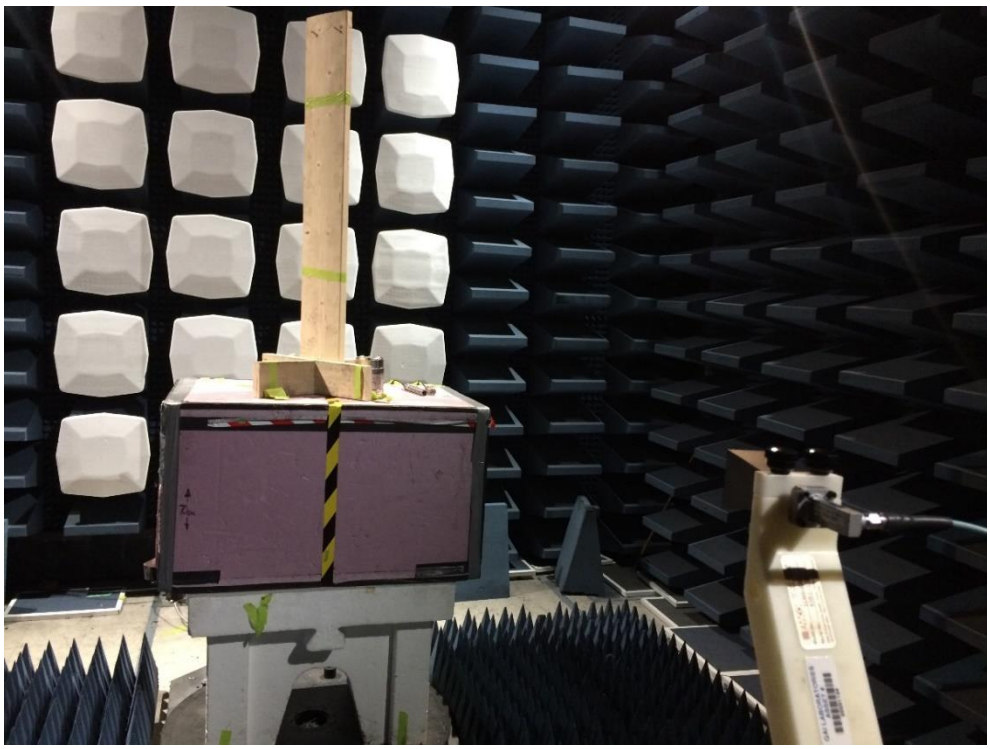
Radiated Emissions (frequency range: 1GHz ↔ 18GHz) Test Setup, the EUT with RH circular antenna



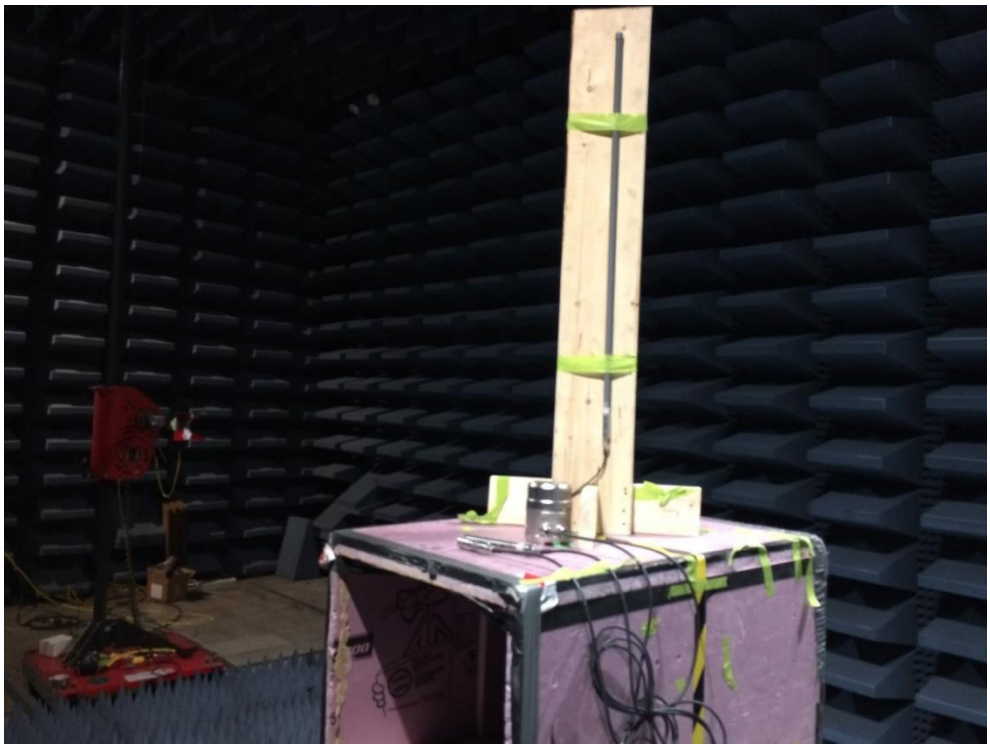
Radiated Emissions (frequency range: 1GHz ↔ 18GHz) Test Setup, the EUT with Omni-directional antenna



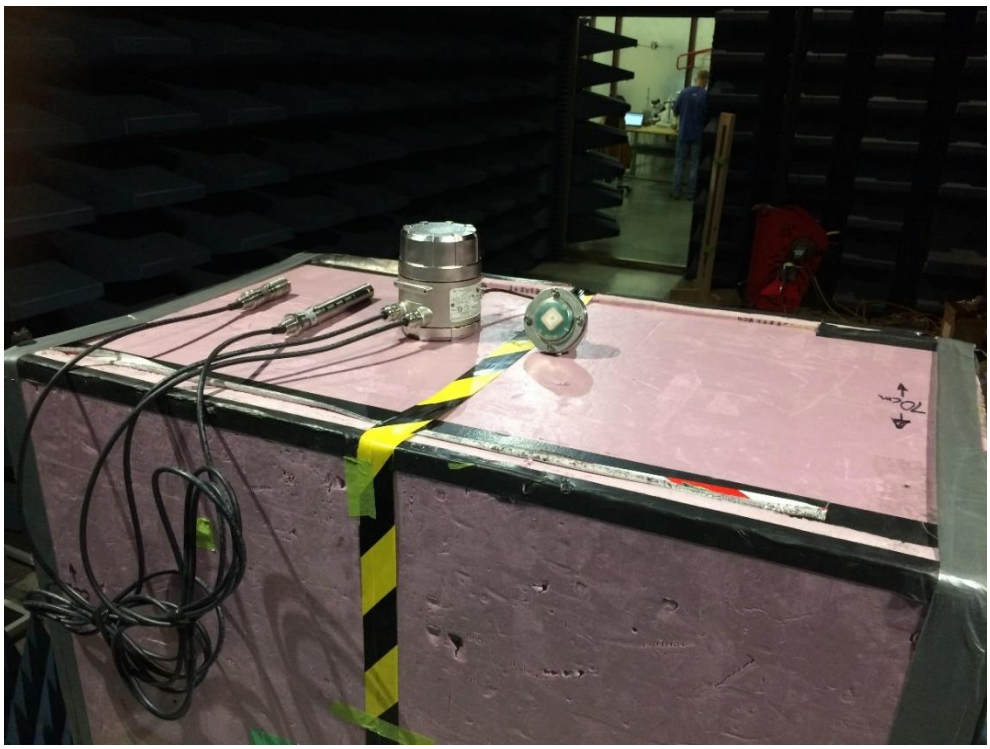
Radiated Emissions (frequency range: above 18GHz) Test Setup, the EUT with RH circular antenna



Radiated Emissions (frequency range: above 18GHz) Test Setup, the EUT with Omni-directional antenna



Test Setup, the EUT with Omni-directional antenna



Test Setup, the EUT with RH circular antenna

Appendix B: ABBREVIATIONS

Abbreviation	Definition
AC	Alternating Current
DC	Direct Current
E.I.R.P.	Equivalent Isotropically Radiated Power
EMC	ElectroMagnetic Compatibility
EMI	ElectroMagnetic Interference
EUT	Equipment Under Test
FCC	Federal Communications Commission
IC	Industry Canada
ICES	Interference-Causing Equipment Standard
LISN	Line Impedance Stabilizing Network
OATS	Open Area Test Site
RF	Radio Frequency
RMS	Root-Mean-Square
RSS	Radio Standards Specifications
SAC	Semi-Anechoic Chamber

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END OF REPORT