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ETC Report #: m4316a251-1 Release2 Date: 2016-12-20

EMC testing of the mcThings Inc. PECO Sigfox wireless devices in accordance with:

FCC Part 15.247, ANSI C63.4: 2014 and ANSI C63.10: 2013

as referenced by FCC Public Notice DA 00-705 Measurement Guidelines

FCC ID: 2AGBO-PECO

Test Personnel: David Raynes

Prepared for: mcThings Inc.

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REVISION RECORD

ISSUE	DATE	AUTHOR	REVISIONS
DRAFT 1	2016-11-29	D. Raynes	Initial draft submitted for review.
Release 1	2016-12-07	D. Raynes	Released for distribution.
Release 2	2016-12-20	D. Raynes	Revised to reflect single product. Revised to accord with DA 00-705.

TABLE OF CONTENTS

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. All test procedures, limits, criteria, and results described in this report apply only to the mcThings Inc. PECO test samples, referred to herein as the EUT (Equipment Under Test).

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

1.2.1 Applicant

This test report has been prepared for mcThings Inc., located in Calgary, Alberta, Canada.

1.3 Test Sample Description

As provided to ETC (Airdrie) by McThings Inc.:

Product Name:	PECO
Model #	PECO
Serial #	N/A
Power:	Internal replaceable battery pack

Note: This device contains an approved transmitter (mcMod120) certified under FCC ID # 2AGBO-MCMOD120. The transmitters can not operate simultaneously.

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.

Where relevant, the EUT was only tested using the monitoring methods and test criteria defined in this report.

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 and ANSI C63.10-2013.

1.5.1 Test Methodology

Test methods are documented 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.

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**. If testing was not performed at this time, the appropriate field is marked **n/t**. **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	Mods	Config.	Result
2.1	AC Conducted Emissions (Tx)	15.109	PECO	none	see § 2.1	**N/A**
2.2	Channel Separation	15.247(a)	PECO	none	see § 2.2	**Compliant**
2.3	Number of Hopping Channels	15.247(a)	PECO	none	see § 2.3	**Compliant**
2.4	Occupied Bandwidth	15.247(a)	PECO	none	see § 2.4	**Compliant**
2.5	Time of Occupancy	15.247(a)	PECO	none	see § 2.5	**Compliant**
2.6	Peak Output	15.247(d)	PECO	none	see § 2.6	**Compliant**
2.7	Band Edge	15.247(d)	PECO	none	see § 2.7	**Compliant**
2.8	Conducted Spurious	15.247(d)	PECO	none	see § 2.8	**Compliant**
2.9	EUT Position	ANSI C63.4	PECO	none	see § 2.9	see § 2.9
2.10	Radiated Spurious	15.205, 15.209 15.247(d)	PECO	none	see § 2.10	**Compliant**
2.11	Antenna Requirements	15.203	PECO	none	see § 2.11	**Compliant**
2.12	RF Exposure	15.247(i)	PECO	none	~	**Compliant**

Refer to the test data for applicable test conditions.

2.1 AC Power Line Conducted Emissions

Test Lab: Electronics Test Centre, Airdrie	**EUT: PECO**
Test Personnel: David Raynes	**Standard: FCC Part 15.207**
Date:	**Basic Standard: ANSI C63.4: 2014**
EUT status: Not Applicable	

The EUT is powered by a replaceable internal battery pack.

There is no connection to the AC mains.

2.2 Channel Separation

Test Lab: Electronics Test Centre, Airdrie	**EUT: PECO**
Test Personnel: David Raynes	**Standard: FCC Part 15.247**
Date: 2016-11-15 (195° C, 23.9% RH)	**Basic Standard: ANSI C63.10: 2013**

EUT status: Compliant

Specification: FCC Part 15.247(a)(1)

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

2.2.1 Test Guidance:

This measurement is performed with the EUT transmitter frequency hopping function active.

The RF output of EUT with an antenna connector is fed to the input of the spectrum analyzer through appropriate attenuation. If the EUT antenna is integral to the device, an antenna is placed to capture the transmitted signals.

The spectrum analyzer is set for a frequency span wide enough to capture at least two adjacent channels. The RBW is set to at least 1% of the span. The Peak detector is used, with the trace set to Max Hold. Channel Separation is displayed with the Marker Delta function.

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

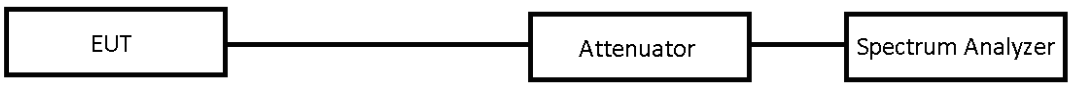
Testing was performed with the following equipment:

Equipment	Manufacturer	Model #	Asset #	Calibration Date	Calibration Due
EMI receiver	Agilent	N9038A	6130	2016-06-23	2017-06-23

2.2.4 Test Sample Verification, Configuration & Modifications

The EUT was operating normally. The EUT met the requirements without modification.

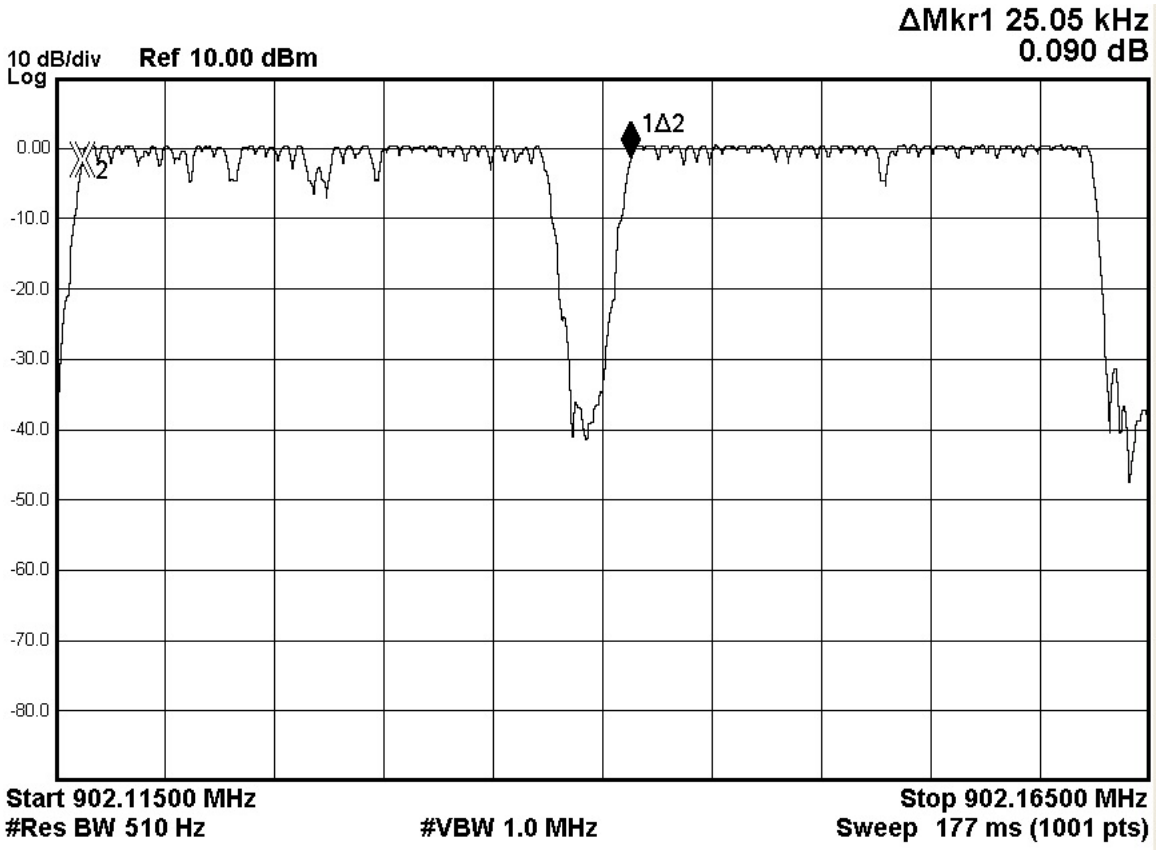
EUT configuration for Channel Separation testing:



2.2.5 Channel Separation Data:

Compliant: The channels are 25.05 kHz apart.

Screen Captures from the spectrum analyzer:



2.3 Number of Hopping Channels

Test Lab: Electronics Test Centre, Airdrie	**EUT: PECO**
Test Personnel: David Raynes	**Standard: FCC Part 15.247**
Date: 2016-11-15 (195° C, 23.9% RH)	**Basic Standard: ANSI C63.10: 2013**
	Number of Channels: 54

EUT status: Compliant

Specification: FCC Part 15.247(a)(1)(i)

For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period.

2.3.1 Test Guidance:

This measurement is performed with the EUT transmitter frequency hopping function active.

The RF output of EUT with an antenna connector is fed to the input of the spectrum analyzer through appropriate attenuation. If the EUT antenna is integral to the device, an antenna is placed to capture the transmitted signals.

The spectrum analyzer is set for a frequency span selected to clearly display the hopping channels. The RBW is set ≥ 1% of the span. The Peak detector is used, with the trace set to Max Hold.

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

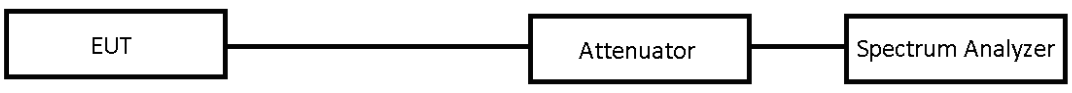
Testing was performed with the following equipment:

Equipment	Manufacturer	Model #	Asset #	Calibration Date	Calibration Due
EMI receiver	Agilent	N9038A	6130	2016-06-23	2017-06-23

2.3.4 Test Sample Verification, Configuration & Modifications

The EUT was operating normally. The EUT met the requirements without modification.

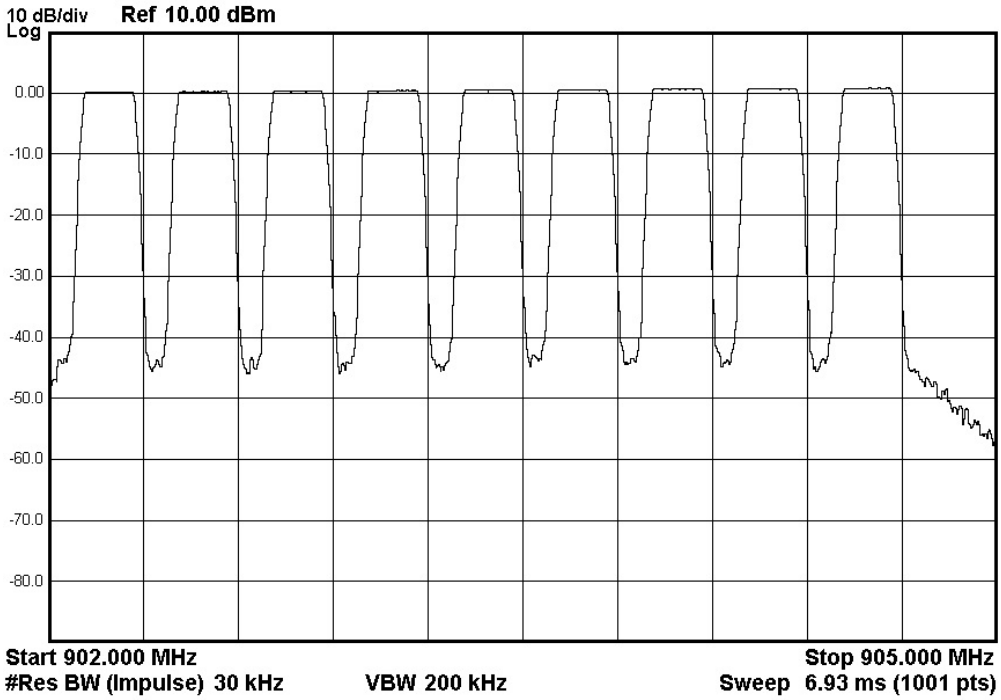
EUT configuration for Radiated Emissions testing:



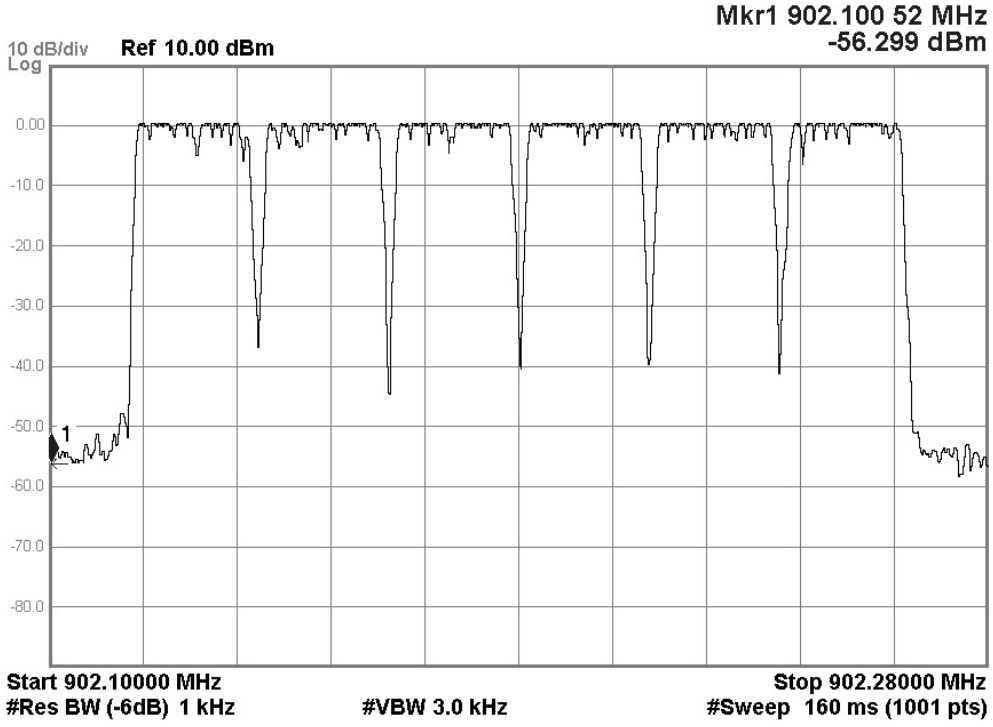
2.3.5 Hopping Channel Data:

Compliant: There are 54 hopping channels

Screen Capture from the spectrum analyzer: 9 Channel groups



Screen Capture from the spectrum analyzer: 6 Channels within each group



2.4 Channel Occupied Bandwidth

Test Lab: Electronics Test Centre, Airdrie	**EUT: PECO**
Test Personnel: David Raynes	**Standard: FCC PART 15.247**
Date: 2016-11-15 (19.5° C, 23.9% RH)	**Basic Standard: ANSI C63.10: 2013**

EUT status: Compliant

Specification: FCC Part 15.247(a)(1)(i)

For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies…

… The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

2.4.1 Test Guidance:

This measurement is performed with modulation.

The RF output of EUT with an antenna connector is fed to the input of the spectrum analyzer through appropriate attenuation. If the EUT antenna is integral to the device, an antenna is placed to capture the transmitted signals.

The spectrum analyzer is set for a frequency span selected to clearly display the channel. The RBW is set ≥ 1% of the 20 dB BW. The Peak detector is used, with the trace set to Max Hold.

OBW is measured manually using the Marker Delta function, or the automated 99% BW function of the spectrum analyzer is engaged, and the 6 dB OBW and/or the 20 dB OBW is measured with the x dB function.

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

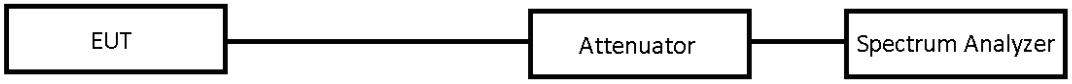
Testing was performed with the following equipment:

Equipment	Manufacturer	Model #	Asset #	Calibration Date	Calibration Due
EMI receiver	Agilent	N9038A	6130	2016-06-23	2017-06-23

2.4.4 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.

EUT configuration for Occupied Bandwidth testing:

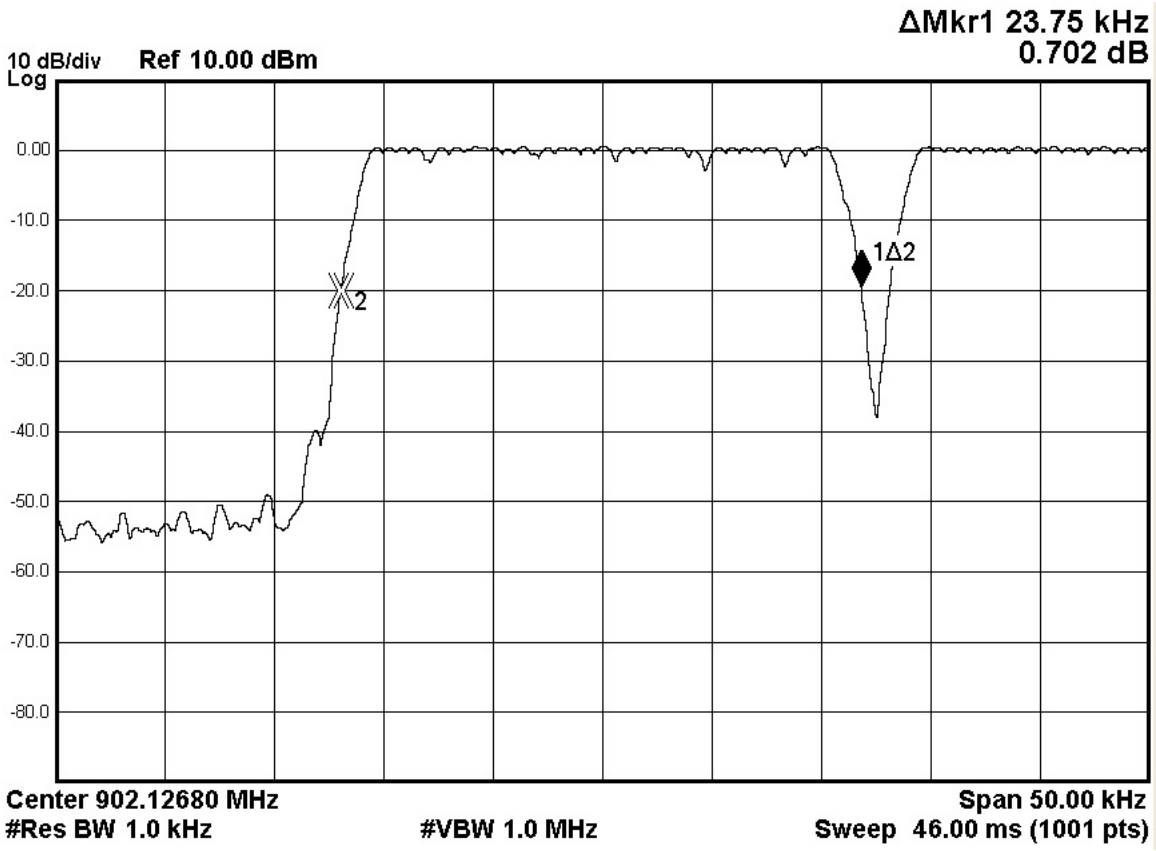


2.4.5 Channel Occupied Bandwidth Data:

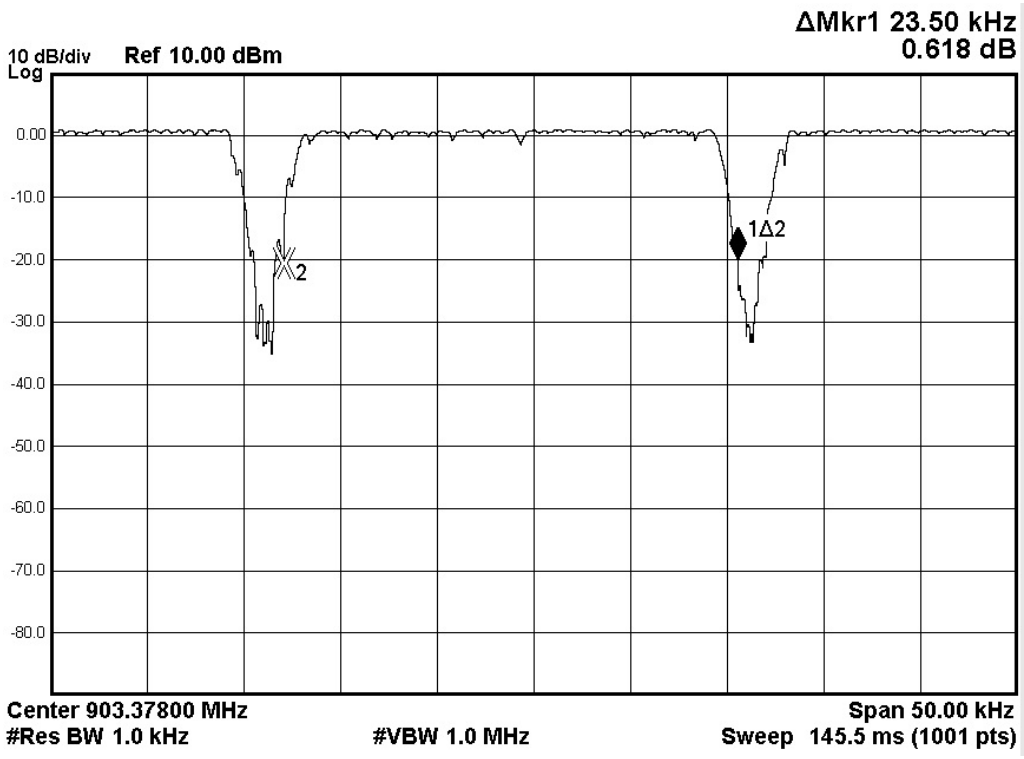
Freq. (MHz)	20 dB OBW (kHz)
902.1375	23.75
903.3875	23.50
904.6625	23.45

Screen Captures from the spectrum analyzer:

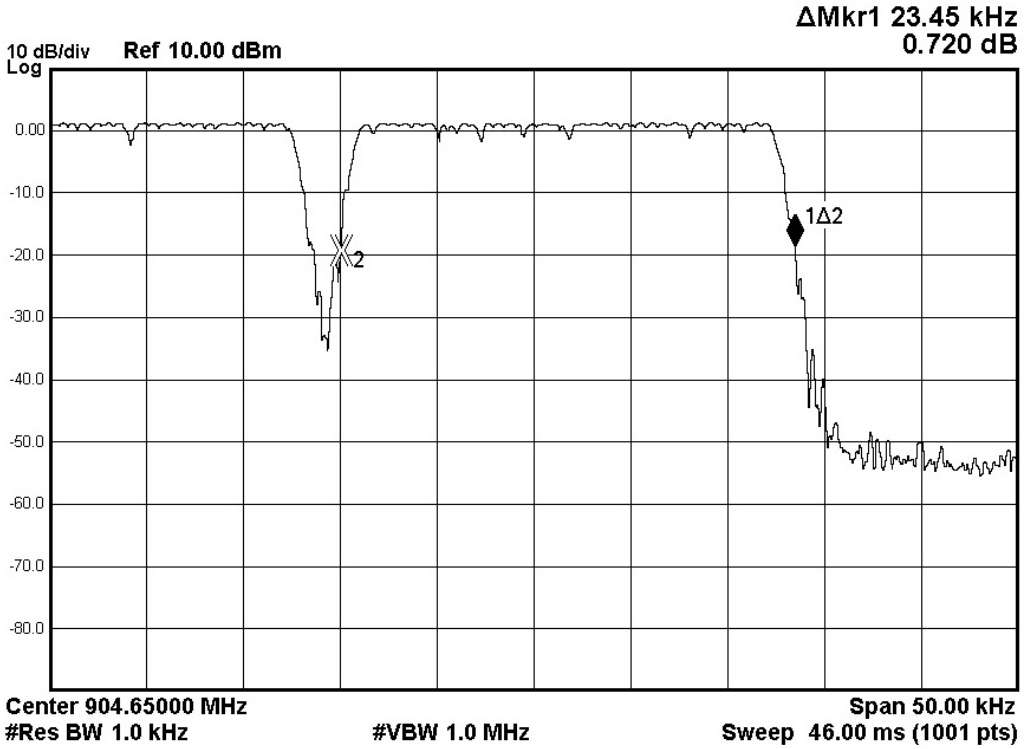
20 dB OBW, lowest channel:



20 dB OBW, mid-band channel:



20 dB OBW, highest channel:



2.5 Time of Occupancy

Test Lab: Electronics Test Centre, Airdrie	**EUT: PECO**
Test Personnel: David Raynes	**Standard: FCC PART 15.247**
Date: 2016-11-15 (19.5° C, 23.9% RH)	**Basic Standard: ANSI C63.10: 20013**

EUT status: Compliant

Specification: FCC Part 15.247 (a)(1)(i)

For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period.

2.5.1 Test Guidance:

This measurement is performed with the EUT frequency hopping function active.

The RF output of EUT with an antenna connector is fed to the input of the spectrum analyzer through appropriate attenuation. If the EUT antenna is integral to the device, an antenna is placed to capture the transmitted signals.

The spectrum analyzer is set for Peak detection over a 0 Hz frequency span (time domain) centered on a channel. The RBW is set to ≥ Channel OBW. VBW ≥ RBW.

The sweep time is adjusted to clearly capture one transmission. The Dwell time is measured with the Marker Delta function.

Another sweep is set to capture enough transmission events to calculate the number of events within the specified period of time.

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

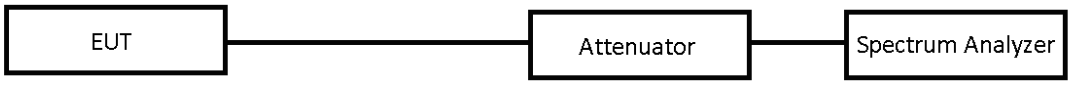
Testing was performed with the following equipment:

Equipment	Manufacturer	Model #	Asset #	Calibration Date	Calibration Due
EMI receiver	Agilent	N9038A	6130	2016-06-23	2017-06-23

2.5.4 Test Sample Verification, Configuration & Modifications

The EUT was operating normally, in communication with an iPod. The EUT met the requirements without modification.

EUT configuration for Dwell Time testing:



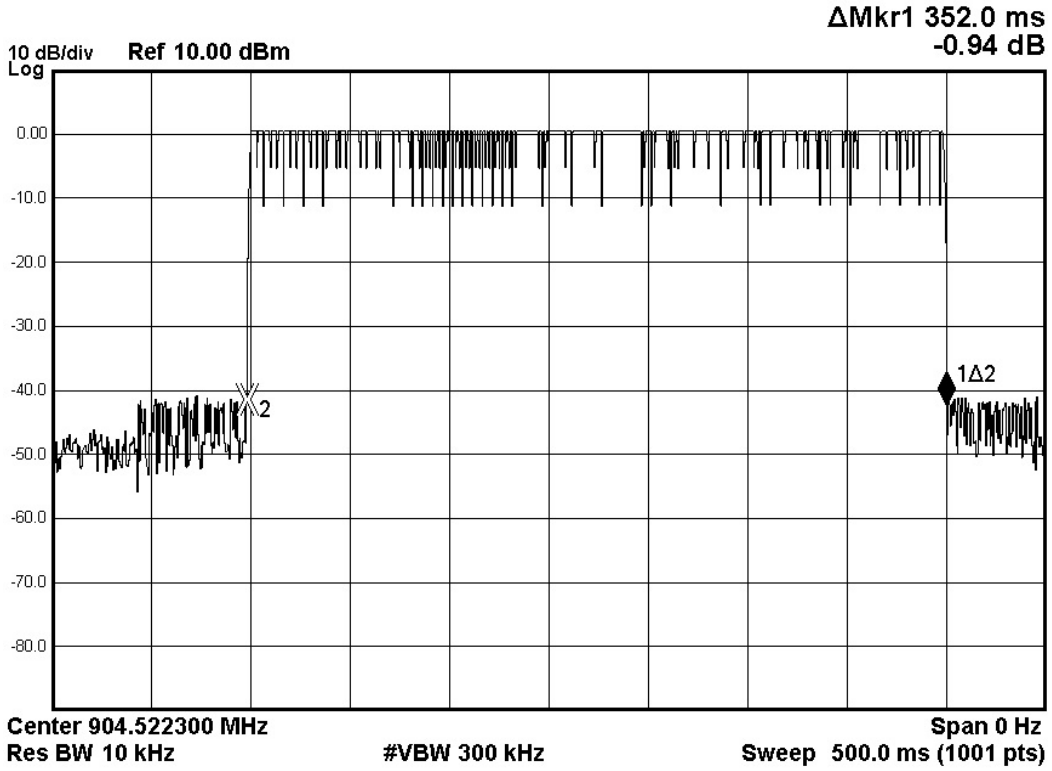
2.5.5 Dwell Time Data:

Measured Dwell time = 352 ms

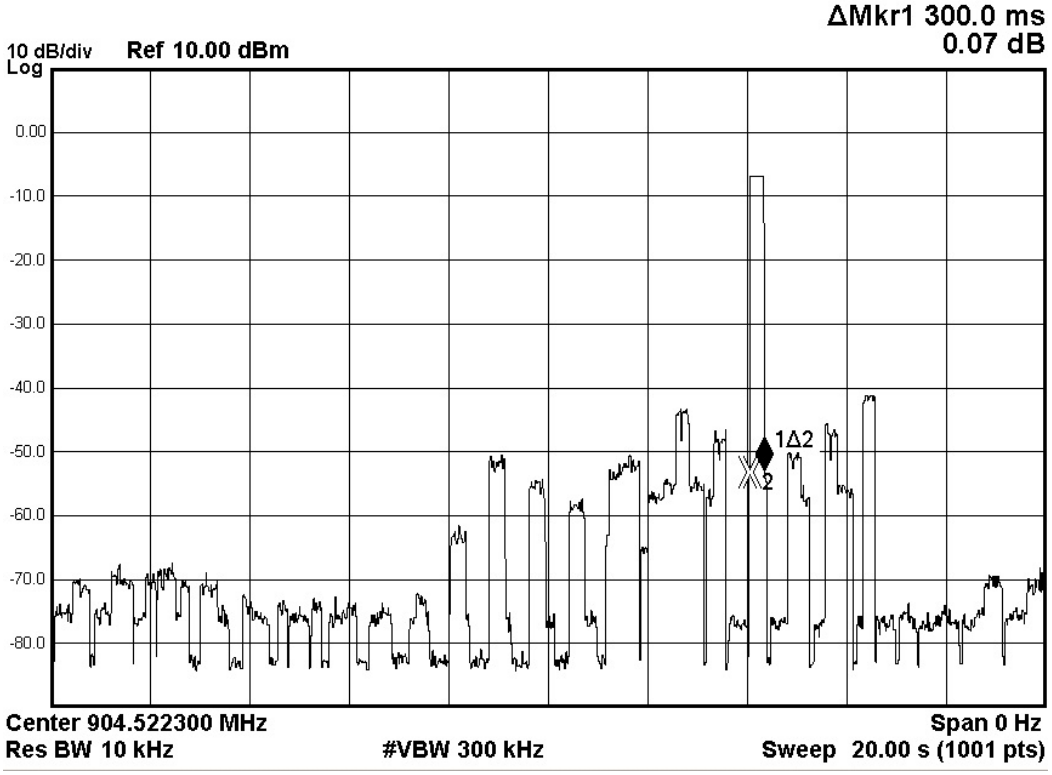
Number of events in 20 s = 1

Margin = 400 – 352 = **48 ms**

Screen Capture from the spectrum analyzer: Dwell time



Screen Capture from the spectrum analyzer: Number of events (disregard any signals below -40 dBm)



2.6 Peak Conducted Output Power

Test Lab: Electronics Test Centre, Airdrie	**EUT: PECO**
Test Personnel: David Raynes	**Standard: RSS-247 Issue 1**
Date: 2016-11-14 (20.0° C, 24.6% RH)	

EUT status: Compliant

Specification: FCC Part 15.247 (b)(2)

For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.

2.6.1 Test Guidance:

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 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

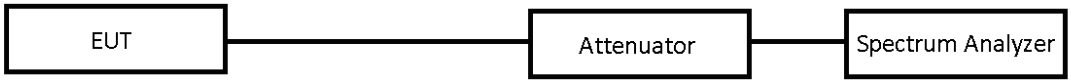
Testing was performed with the following equipment:

Equipment	Manufacturer	Model #	Asset #	Calibration Date	Calibration Due
EMI receiver	Agilent	N9038A	6130	2016-06-23	2017-06-23

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.

EUT configuration for Peak Output Power testing:

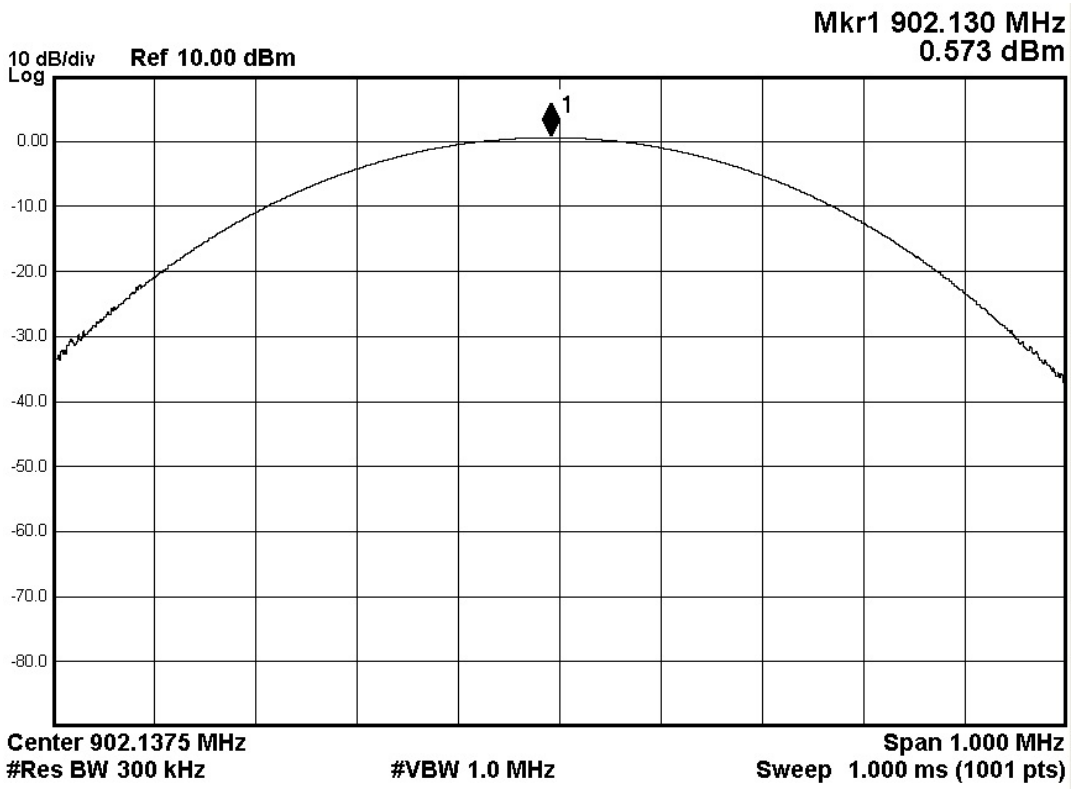


2.6.5 Peak Output Power Data

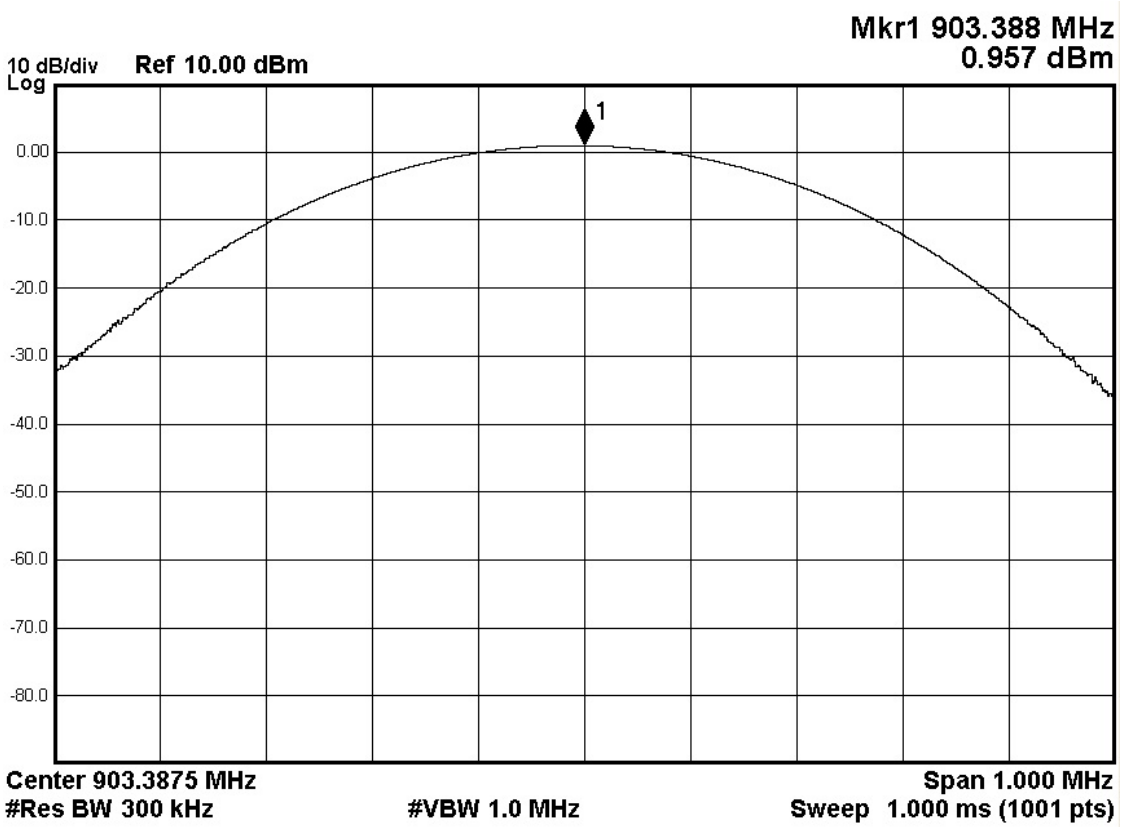
Conducted measurements were performed at low, mid and high channel frequencies.

Frequency (MHz)	EUT Peak Reading (dBm)	Attenuation (dBm)	Peak RF Output (dBm)	Peak RF Output (mW)	Limit (W)	Margin (W) (Output - Limit)
902.1375	0.573	20.115	20.688	117.2	1	-0.88
903.3875	0.957	20.116	21.073	128.0	1	-0.87
904.6540	1.240	20.118	21.358	136.7	1	-0.86

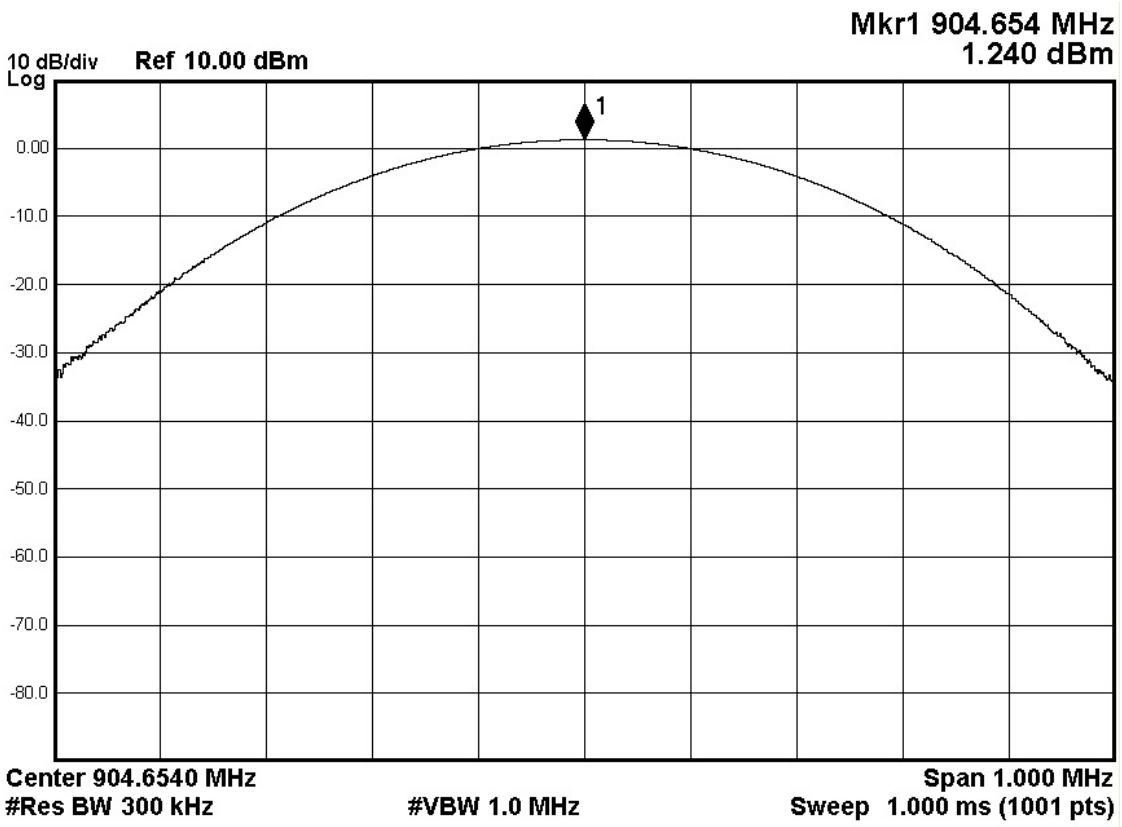
Screen Capture from the spectrum analyzer: 902.1375 MHz



Screen Capture from the spectrum analyzer: 903.3875 MHz



Screen Capture from the spectrum analyzer: 904.6540 MHz



2.7 Band Edge Attenuation

Test Lab: Electronics Test Centre, Airdrie	**EUT: PECO**
Test Personnel: David Raynes	**Standard: RSS-247 Issue 1**
Date: 2016-11-14 (20.0° C, 24.6% 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 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.

2.7.1 Test Guidance

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. If the EUT antenna is integral to the device, the radiated output is measured.

The spectrum analyzer is set for a frequency span to show the band edge and the nearest channel. The RBW is set to ≥ 100 kHz. The VBW is set to ≥ RBW * 3. The Peak detector is used, with the trace set to Max Hold.

2.7.2 Deviations From The Standard:

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

2.7.3 Test Equipment

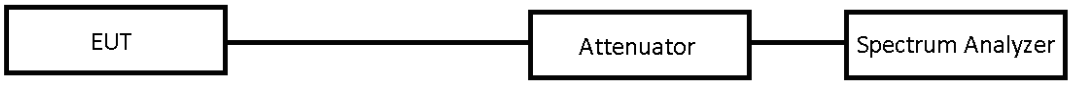
Testing was performed with the following equipment:

Equipment	Manufacturer	Model #	Asset #	Calibration Date	Calibration Due
EMI receiver	Agilent	N9038A	6130	2016-06-23	2017-06-23

2.7.4 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.

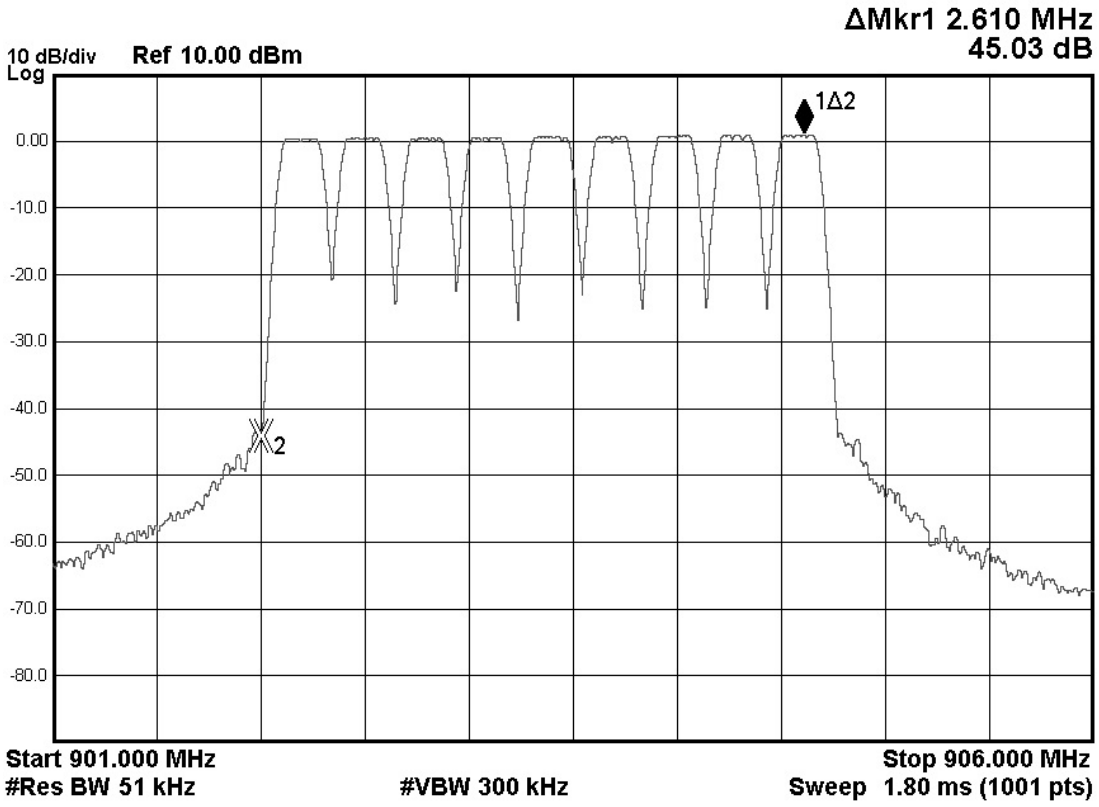
EUT configuration for Band Edge testing:



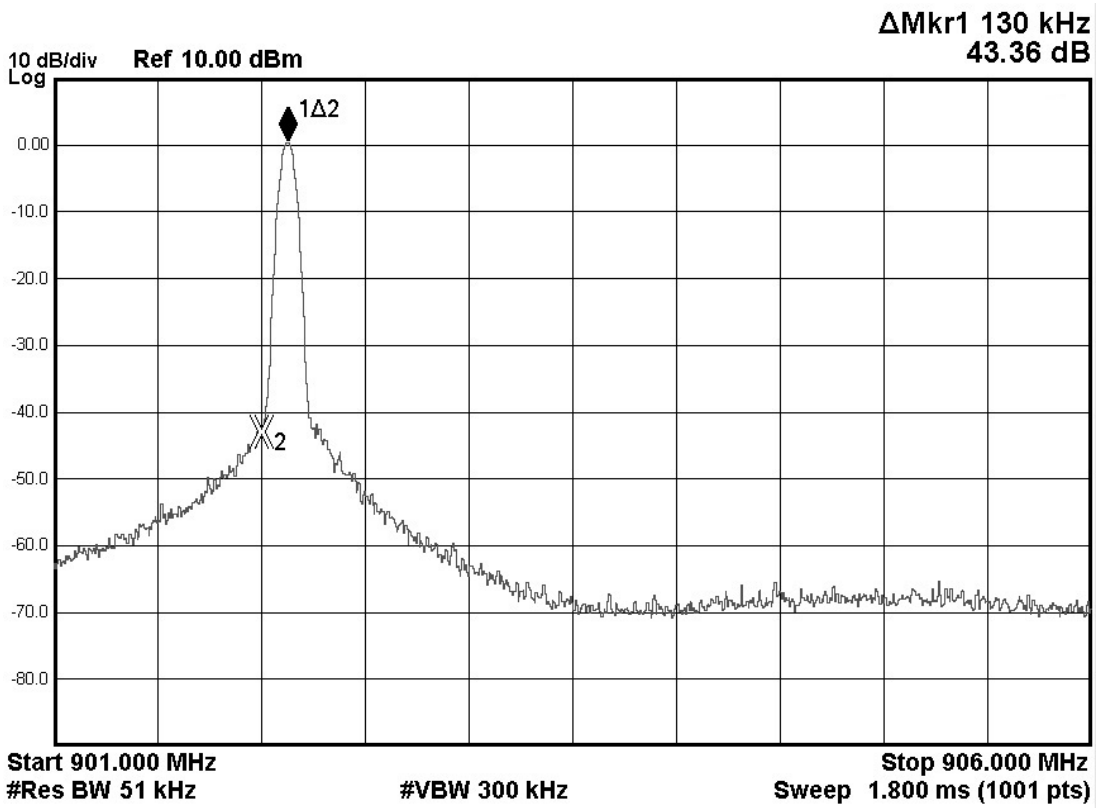
2.7.5 Band Edge Data

Band Edge Frequency	Attenuation
902 MHz	> 40 dB
928 MHz	> 50 dB

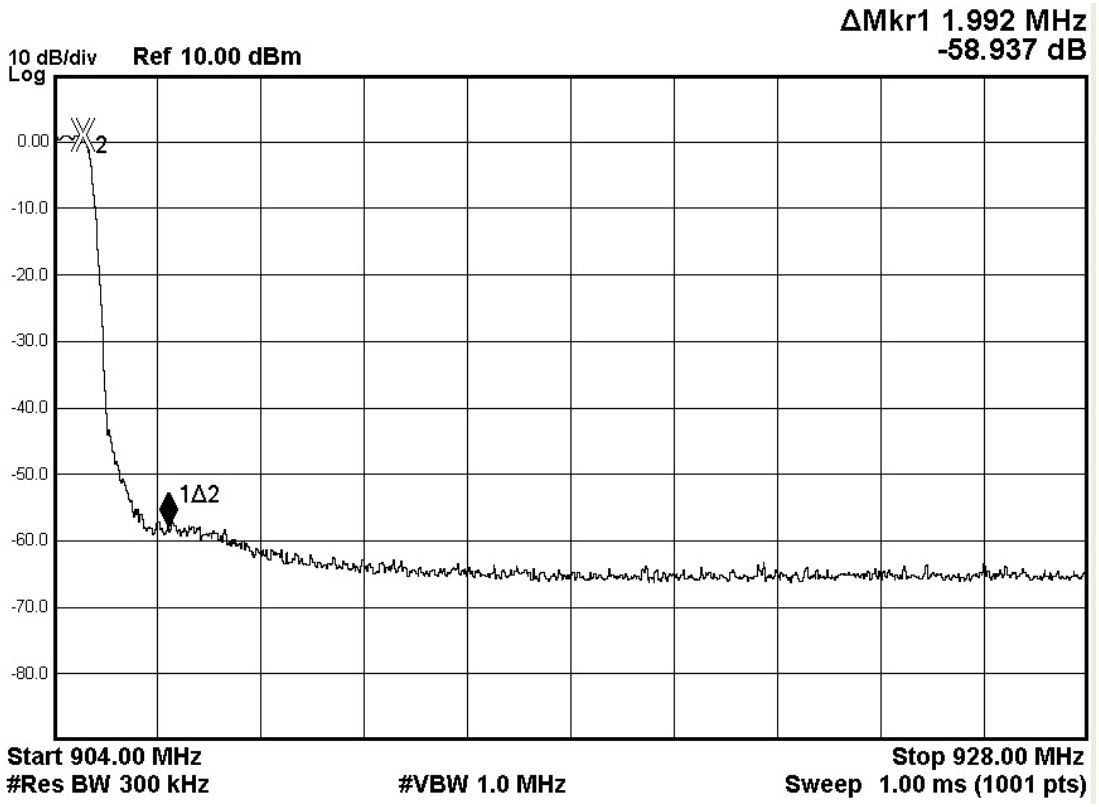
Screen Capture from the spectrum analyzer: Lower Band Edge, hopping



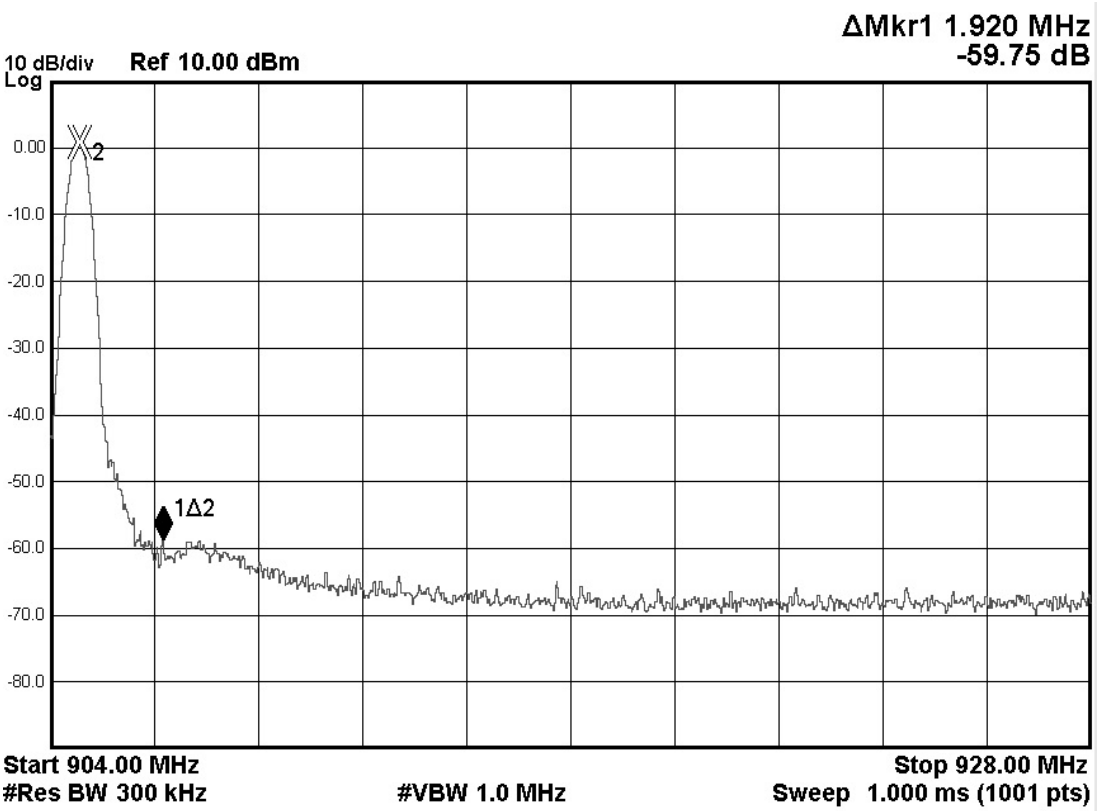
Screen Capture from the spectrum analyzer: Lower Band Edge, non-hopping



Screen Capture from the spectrum analyzer: Upper Band Edge, hopping



Screen Capture from the spectrum analyzer: Upper Band Edge, non-hopping



2.8 Conducted Spurious Emissions

Test Lab: Electronics Test Centre, Airdrie	**EUT: PECO**
Test Personnel: David Raynes	**Standard: RSS-247 Issue 1**
Date: 2016-11-15 (195° C, 23.9% RH)	**Basic Standard: ANSI C63.10-2013**

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.

2.8.1 Test Guidance: ANSI C63.10-2013, Clause 6.7

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. If the EUT antenna is integral to the device, the radiated output is measured.

The spectrum analyzer is stepped through the spectrum in frequency spans selected to ensure acceptable frequency resolution. The Peak detector is used, with the trace set to Max Hold.

2.8.2 Deviations From The Standard:

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

2.8.3 Test Equipment

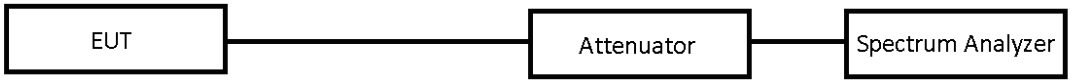
Testing was performed with the following equipment:

Equipment	Manufacturer	Model #	Asset #	Calibration Date	Calibration Due
EMI receiver	Agilent	N9038A	6130	2016-06-23	2017-06-23

2.8.4 Test Sample Verification, Configuration & Modifications

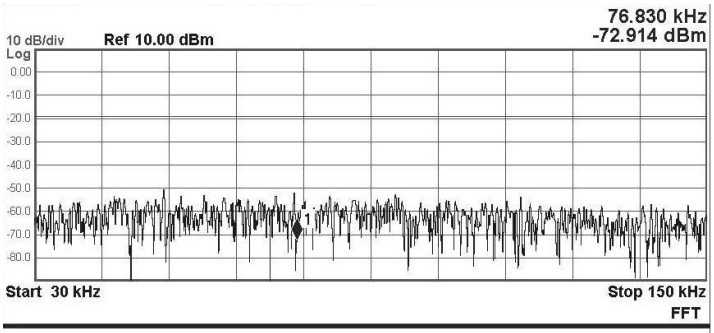
The EUT was set to a selected channel with test-specific software. The output was modulated as in normal operation. The EUT met the requirements without modification.

Test setup diagram for Conducted Spurious Emissions testing:

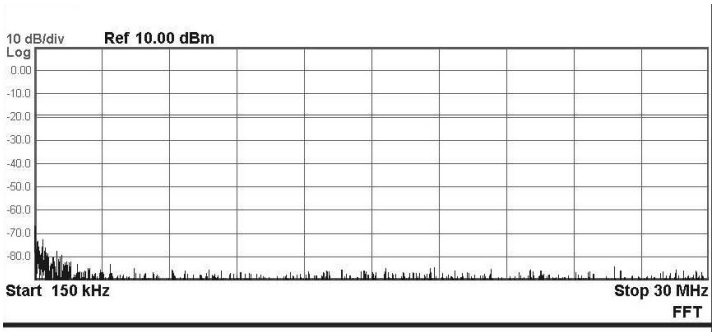


2.8.5 Conducted Emissions Data:

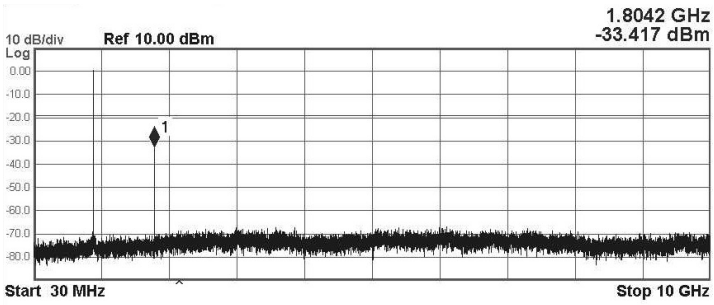
Screen Captures from the spectrum analyzer: Low f_c



Spur	Range	Frequency	Amplitude	Limit	Δ Limit
1	2	76.83 kHz	-51.27 dBm	-19.08 dBm	-32.19 dB
2	2	65.87 kHz	-52.33 dBm	-19.08 dBm	-33.25 dB
3	2	94.32 kHz	-52.44 dBm	-19.08 dBm	-33.36 dB
4	2	37.61 kHz	-52.81 dBm	-19.08 dBm	-33.73 dB
5	2	53.27 kHz	-53.14 dBm	-19.08 dBm	-34.06 dB
6	2	53.98 kHz	-53.15 dBm	-19.08 dBm	-34.07 dB
7	2	73.54 kHz	-53.38 dBm	-19.08 dBm	-34.30 dB
8	2	44.20 kHz	-53.65 dBm	-19.08 dBm	-34.57 dB

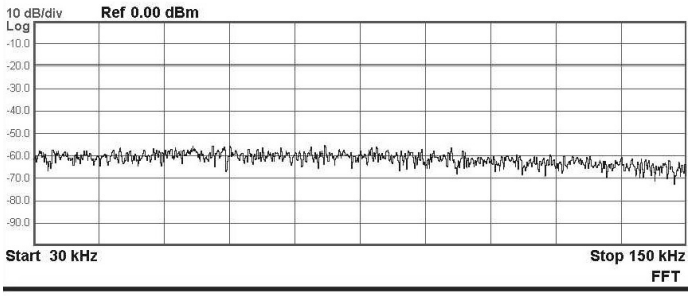


Spur	Range	Frequency	Amplitude	Limit	Δ Limit
1	2	166.4 kHz	-70.65 dBm	-19.08 dBm	-51.57 dB
2	2	214.2 kHz	-72.25 dBm	-19.08 dBm	-53.17 dB
3	2	261.9 kHz	-73.02 dBm	-19.08 dBm	-53.94 dB
4	2	469.4 kHz	-75.43 dBm	-19.08 dBm	-56.35 dB
5	2	414.2 kHz	-76.53 dBm	-19.08 dBm	-57.45 dB
6	2	332.1 kHz	-76.79 dBm	-19.08 dBm	-57.71 dB
7	2	487.3 kHz	-77.12 dBm	-19.08 dBm	-58.04 dB
8	2	660.4 kHz	-77.57 dBm	-19.08 dBm	-58.49 dB

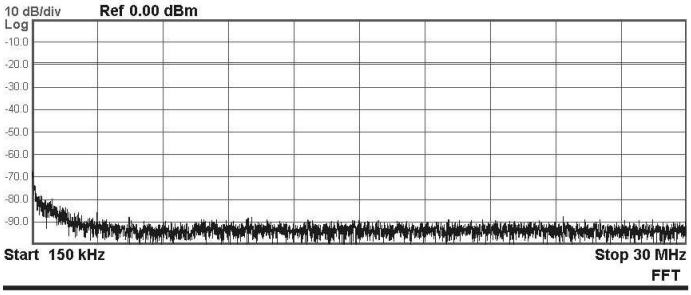


Spur	Range	Frequency	Amplitude		Limit	Δ Limit
1	2	902.4 MHz	0.432 dBm	F	-19.08 dBm	19.51 dB
2	2	1.804 GHz	-34.03 dBm		-19.08 dBm	-14.95 dB
3	2	905.4 MHz	-63.71 dBm		-19.08 dBm	-44.63 dB
4	2	6.066 GHz	-66.70 dBm		-19.08 dBm	-47.62 dB
5	2	6.234 GHz	-66.86 dBm		-19.08 dBm	-47.78 dB
6	2	3.026 GHz	-66.90 dBm		-19.08 dBm	-47.82 dB
7	2	6.080 GHz	-66.95 dBm		-19.08 dBm	-47.87 dB
8	2	5.503 GHz	-67.20 dBm		-19.08 dBm	-48.12 dB

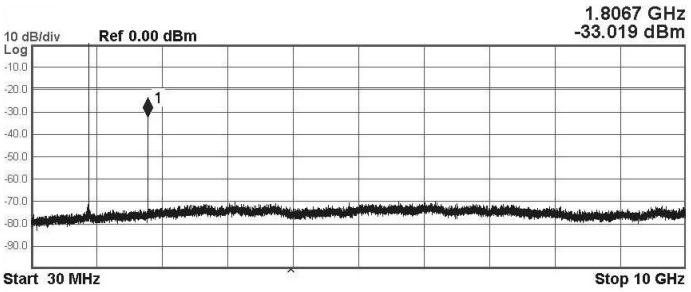
Screen Capture from the spectrum analyzer: Mid f_c



Spur	Range	Frequency	Amplitude	Limit	Δ Limit
1	1	72.94 kHz	-55.54 dBm	-19.08 dBm	-36.46 dB
2	1	90.15 kHz	-55.54 dBm	-19.08 dBm	-36.46 dB
3	1	78.24 kHz	-55.63 dBm	-19.08 dBm	-36.55 dB
4	1	69.73 kHz	-55.73 dBm	-19.08 dBm	-36.65 dB
5	1	53.12 kHz	-55.89 dBm	-19.08 dBm	-36.81 dB
6	1	55.92 kHz	-55.91 dBm	-19.08 dBm	-36.83 dB
7	1	56.52 kHz	-56.17 dBm	-19.08 dBm	-37.09 dB
8	1	46.51 kHz	-56.24 dBm	-19.08 dBm	-37.16 dB

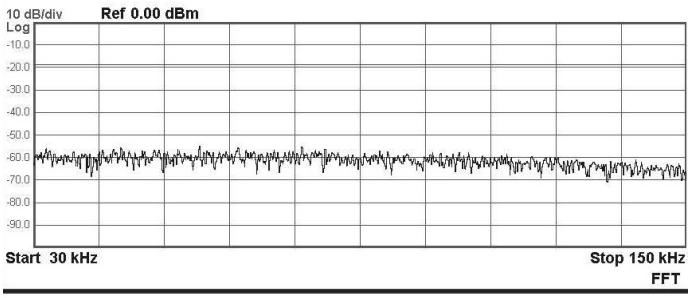


Spur	Range	Frequency	Amplitude	Limit	Δ Limit
1	1	313.8 kHz	-76.21 dBm	-19.08 dBm	-57.13 dB
2	1	696.1 kHz	-77.80 dBm	-19.08 dBm	-58.72 dB
3	1	969.2 kHz	-79.57 dBm	-19.08 dBm	-60.49 dB
4	1	841.8 kHz	-81.10 dBm	-19.08 dBm	-62.02 dB
5	1	1.106 MHz	-81.64 dBm	-19.08 dBm	-62.56 dB
6	1	1.174 MHz	-82.70 dBm	-19.08 dBm	-63.62 dB
7	1	1.442 MHz	-82.99 dBm	-19.08 dBm	-63.91 dB
8	1	1.292 MHz	-83.22 dBm	-19.08 dBm	-64.14 dB

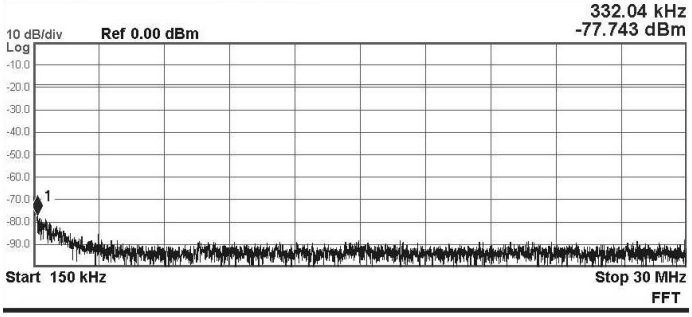


Spur	Range	Frequency	Amplitude	Limit	Δ Limit
1	1	1.807 GHz	-33.04 dBm	-19.08 dBm	-13.96 dB
2	1	2.710 GHz	-66.85 dBm	-19.08 dBm	-47.77 dB
3	1	9.034 GHz	-68.93 dBm	-19.08 dBm	-49.85 dB
4	1	3.008 GHz	-69.45 dBm	-19.08 dBm	-50.37 dB
5	1	6.100 GHz	-70.49 dBm	-19.08 dBm	-51.41 dB
6	1	6.629 GHz	-70.54 dBm	-19.08 dBm	-51.46 dB
7	1	5.563 GHz	-70.68 dBm	-19.08 dBm	-51.60 dB
8	1	3.648 GHz	-70.86 dBm	-19.08 dBm	-51.78 dB

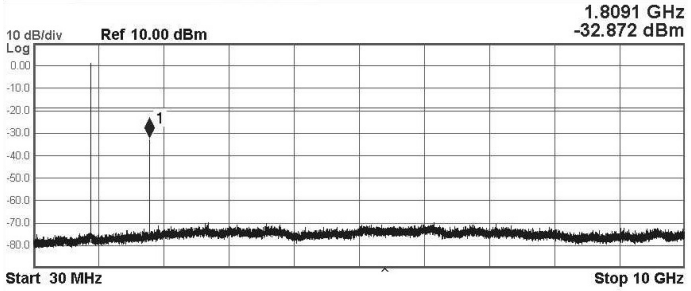
Screen Capture from the spectrum analyzer: High f_c



Spur	Range	Frequency	Amplitude	Limit	Δ Limit
1	1	102.6 kHz	-55.45 dBm	-18.72 dBm	-36.73 dB
2	1	98.76 kHz	-55.73 dBm	-18.72 dBm	-37.01 dB
3	1	45.61 kHz	-56.10 dBm	-18.72 dBm	-37.38 dB
4	1	83.64 kHz	-56.63 dBm	-18.72 dBm	-37.91 dB
5	1	64.83 kHz	-56.63 dBm	-18.72 dBm	-37.91 dB
6	1	48.32 kHz	-56.67 dBm	-18.72 dBm	-37.95 dB
7	1	71.23 kHz	-56.71 dBm	-18.72 dBm	-37.99 dB
8	1	77.44 kHz	-56.75 dBm	-18.72 dBm	-38.03 dB



Spur	Range	Frequency	Amplitude	Limit	Δ Limit
1	1	332.0 kHz	-76.13 dBm	-18.72 dBm	-57.41 dB
2	1	500.4 kHz	-78.14 dBm	-18.72 dBm	-59.42 dB
3	1	582.3 kHz	-78.59 dBm	-18.72 dBm	-59.87 dB
4	1	773.5 kHz	-80.28 dBm	-18.72 dBm	-61.56 dB
5	1	964.6 kHz	-80.34 dBm	-18.72 dBm	-61.62 dB
6	1	668.8 kHz	-81.39 dBm	-18.72 dBm	-62.67 dB
7	1	1.183 MHz	-82.60 dBm	-18.72 dBm	-63.88 dB
8	1	1.370 MHz	-82.96 dBm	-18.72 dBm	-64.24 dB



Spur	Range	Frequency	Amplitude	Limit	Δ Limit
1	1	1.809 GHz	-32.89 dBm	-18.72 dBm	-14.17 dB
2	1	6.055 GHz	-70.02 dBm	-18.72 dBm	-51.30 dB
3	1	5.398 GHz	-70.03 dBm	-18.72 dBm	-51.31 dB
4	1	5.114 GHz	-70.39 dBm	-18.72 dBm	-51.67 dB
5	1	2.681 GHz	-70.57 dBm	-18.72 dBm	-51.85 dB
6	1	3.224 GHz	-70.90 dBm	-18.72 dBm	-52.18 dB
7	1	6.670 GHz	-71.09 dBm	-18.72 dBm	-52.37 dB
8	1	9.497 GHz	-71.23 dBm	-18.72 dBm	-52.51 dB

2.9 EUT Positioning Assessment

Test Lab: Electronics Test Centre, Airdrie	**EUT: PECO**
Test Personnel: David Raynes	**Standard: FCC Part 15.247**
Date: 2016-11-09 (20.4° C, 33.5% RH)	**Basic Standard: ANSI C63.4-2014**

EUT status: Positioned on edge selected

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 nonconducting 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.

2.9.1 Test Guidance:

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

The EUT is rotated in azimuth over 360 degrees to find the direction of maximum emission. Antenna height is varied from 1 – 4 meters at this azimuth to obtain the maximum emission. Then the maximum level is measured with the Peak detector and recorded.

This process is repeated for all three orthogonal axes of the EUT, in both polarizations.

2.9.2 Deviations From The Standard:

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

2.9.3 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	Frequency	Uncertainty
Radiated Emissions Level	30 MHz – 1 GHz	±4.6 dB
Radiated Emissions Level	1 GHz – 26.5 GHz	±5.3 dB

2.9.4 Test Equipment

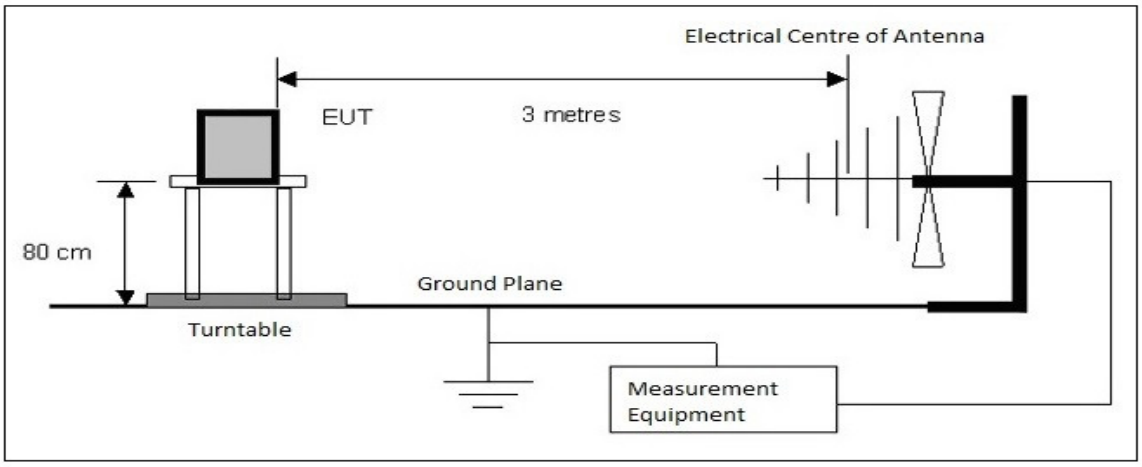
Testing was performed with the following equipment:

Equipment	Manufacturer	Model #	Asset #	Calibration Date	Calibration Due
EMC Software	UL	Ver. 9.5	ETC-SW-EMC 2.1	N/A	
EMI receiver	Agilent	N9038A	6130	2016-06-23	2017-06-23
Biconilog Antenna	ARA	LPB-2520/A	4318	2016-05-18	2018-05-18

2.9.5 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 was not modified.

EUT configuration for EUT Positioning:



2.9.6 Peak Radiated Emissions Data:

The emissions data are presented in tabular form, showing antenna polarization, and the uncorrected spectrum analyzer reading. Assessment was performed at the strongest carrier frequency.

EUT Position	f [MHz]	SA Reading (dBuV)	Polarization
Upright	904.654	52.184	Horizontal
Upright	904.654	68.582	Vertical
Flat	904.654	68.176	Horizontal
Flat	904.654	58.682	Vertical
On Edge	904.654	**69.229**	Horizontal
On Edge	904.654	60.031	Vertical

2.10 Radiated Spurious Emissions

Test Lab: Electronics Test Centre, Airdrie	**EUT: PECO**
Test Personnel: David Raynes	**Standard: FCC PART 15.247**
Date: 2016-11-10 (20.4° C, 33.5% RH) **2016-11-13 (19.5° C, 27.9% RH)**	**Basic Standard: ANSI C63.10: 2013**

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. 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)).

Restricted Bands of Operation:

MHz	MHz	MHz	MHz	MHz	GHz	GHz
0.0900000 – 0.1100000	8.2910000 - 8.2940000	16.804250 - 16.804750	162.01250 - 167.17000 *	1660.0000 – 1710.0000	3.6000000 – 4.4000000	14.470000 – 14.500000
0.4950000 - 0.5050000 *	8.3620000 - 8.3660000	25.500000 - 25.670000	167.72000 - 173.20000 *	1718.8000 – 1722.2000	4.5000000 – 5.1500000	15.350000 – 16.200000
2.1735000 - 2.1905000	8.3762500 - 8.3867500	37.500000 - 38.250000	240.00000 – 285.00000	2200.0000 – 2300.0000	5.3500000 – 5.4600000	17.700000 – 21.400000
4.1250000 - 4.1280000	8.4142500 - 8.4147500	73.000000 - 74.600000	322.00000 - 335.40000	2310.0000 – 2390.0000	7.2500000 – 7.7500000	22.010000 – 23.120000
4.1772500 - 4.1777500	12.290000 - 12.293000	74.800000 - 75.200000	399.90000 – 410.00000	2483.5000 – 2500.0000 *	8.0250000 – 8.5000000	23.600000 – 24.000000
4.2072500 - 4.2077500	12.519750 - 12.520250	108.00000 - 121.94000 **	608.00000 – 614.00000	2655.0000 – 2900.0000	9.0000000 – 9.2000000	31.200000 – 31.800000
5.6770000 - 5.6830000	12.576750 - 12.577250	123.00000 - 138.00000 **	960.00000 – 1240.0000 ***	3260..0000 – 3267.0000	9.3000000 – 9.5000000	36.430000 – 36.500000
6.2150000 - 6.2180000	13.360000 - 13.410000	149.90000 - 150.05000 *	1300.0000 – 1427.0000 ***	3332.0000 – 3339.0000	10.600000 – 12.700000	Above 38.600000
6.2677500 - 6.2682500	16.420000 - 16.423000	156.52475- 156.52525	1435.0000 – 1626.5000	3345.8000 – 3358.0000	13.250000 – 13.400000	
6.3117500 - 6.3122500	16.694750 - 16.695250	156.70000 - 156.90000	1645.5000 – 1646.5000	3500.0000 – 3600.0000 ****		

* US only ** Canada 108 – 138 MHz *** Canada 960 – 1427 MHz **** Canada only

2.10.1 Test Guidance:

Below 30 MHz, measurements are performed with an active loop antenna. From 9 kHz to 150 kHz, the resolution bandwidth is 200 Hz. From 150 kHz to 30 MHz, the resolution bandwidth is 9 kHz.

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 scan is performed at discreet 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.

Note: The EUT was assessed for worst-case orientation. All radiated testing was performed with this orientation, as shown in the test setup photos.

2.10.2 Deviations From The Standard:

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

2.10.3 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	Frequency	Uncertainty
Radiated Emissions Level	30 MHz – 1 GHz	±4.6 dB
Radiated Emissions Level	1 GHz – 26.5 GHz	±5.3 dB

2.10.4 Test Equipment

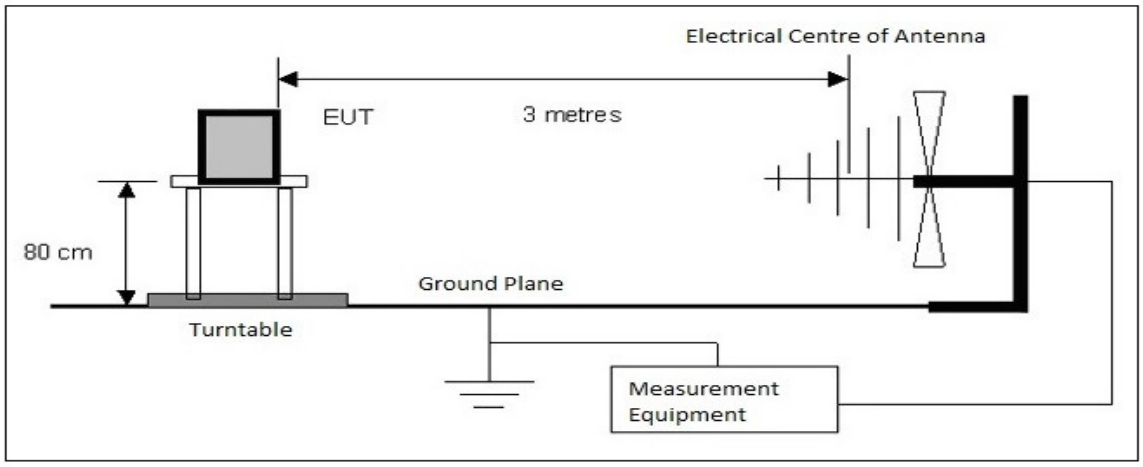
Testing was performed with the following equipment:

Equipment	Manufacturer	Model #	Asset #	Calibration Date	Calibration Due
EMC Software	UL	Ver. 9.5	ETC-SW-EMC 2.1	N/A	
EMI receiver	Agilent	N9038A	6130	2016-06-23	2017-06-23
Loop Antenna	EMCO	6502	10868	2015-04-10	2017-04-10
Biconilog Antenna	ARA	LPB-2520/A	4318	2016-05-18	2018-05-18
DRG Horn	EMCO (Tensor)	3115	19357	2016-08-24	2018-08-24
Low Noise Amplifier (1 – 18 GHz)	MITEQ	JS43-01001800-21-5P	4354	Monitored	

2.10.5 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.

EUT configuration for Radiated Spurious Emissions testing:



2.10.6 Radiated Emissions Data:

There were no emissions other than carrier and harmonics.

Freq. Marker	Freq. (GHz)	Raw reading (dBµv)	Det	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Reading (dBµv/m)	-20 dBc Limit (dBµv/m)	Delta (dB)	Azimuth (Deg)	Height (cm)	Polarization
1	0.9021	113.94	Pk	26.6	-20.0	120.54	Carrier	N/A	74	158	Horizontal
1	1.8042	80.29	Pk	27.4	-21.7	85.99	100.54	-14.55	291	192	Horizontal

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.

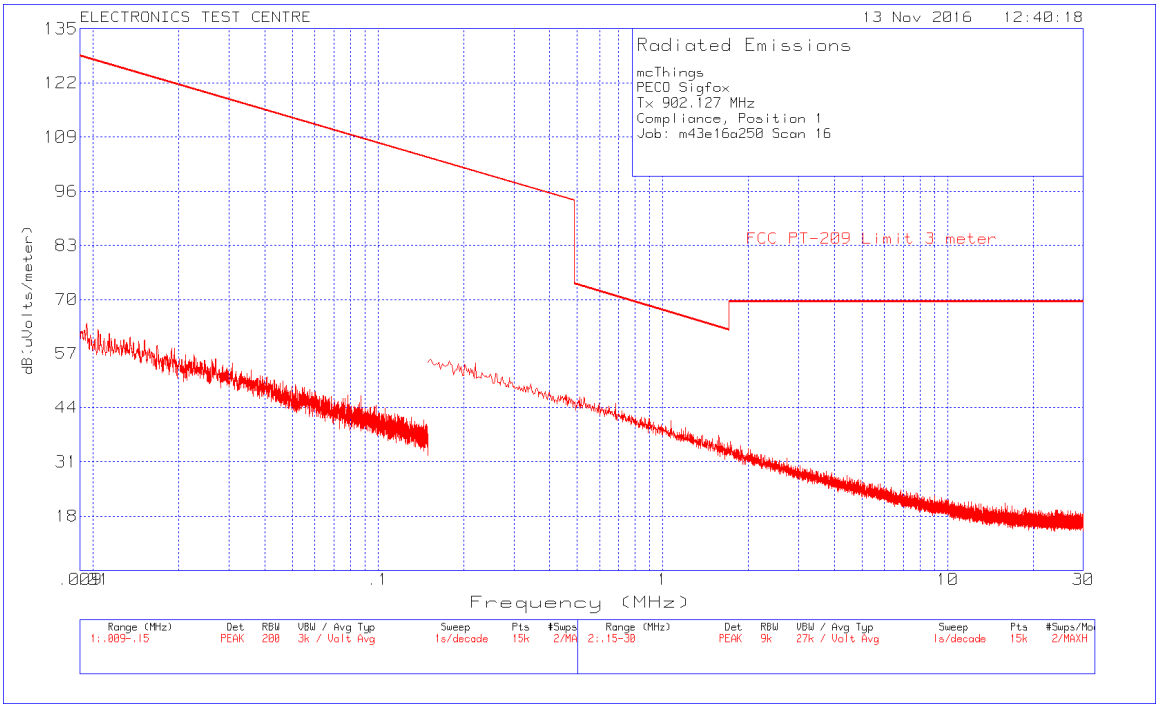
Delta = Field Strength - Limit

Notes:

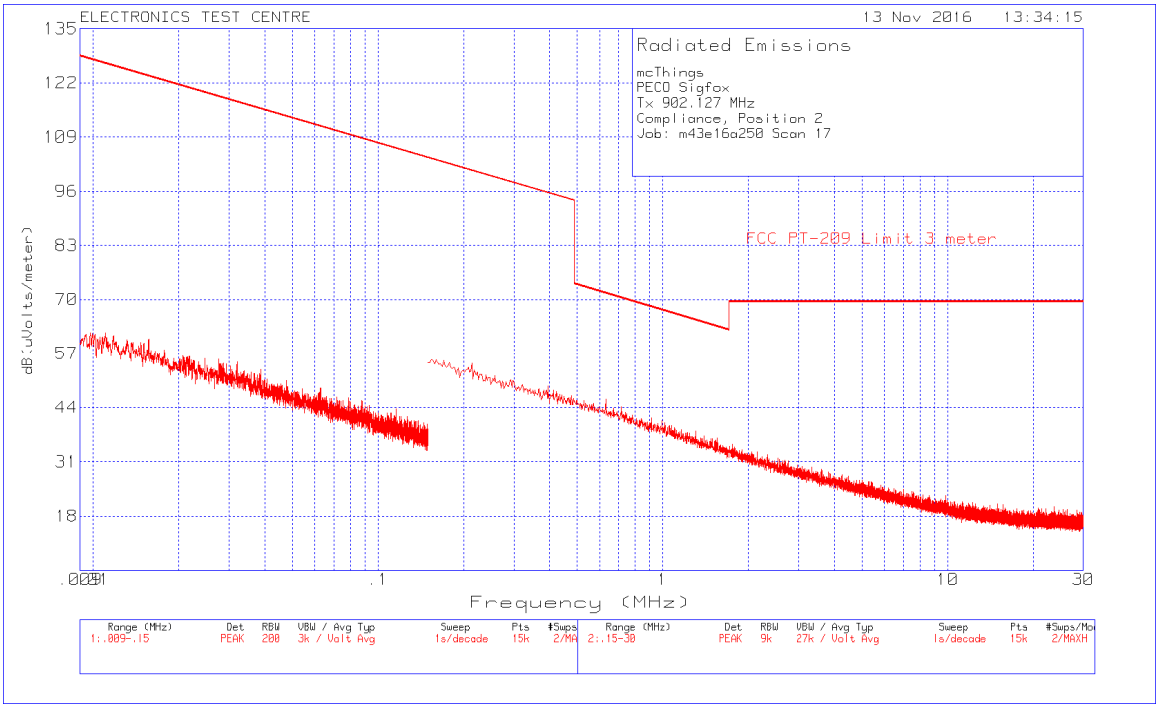
- When a preamp is used, the resulting gain is compensated, producing a negative value for the Cable Loss.
- Measurements reported are the result of adjusting the turntable azimuth and antenna height to obtain the maximum EUT emission. This may produce a different reading than the plot trace. The plot is a Peak Hold function obtained at discreet increments of height and azimuth, while the reported measurement is obtained with the appropriate Peak, Quasi Peak or Average detector after the height and azimuth have been adjusted for maximum emission.
- Preliminary scans were performed for all channels in both Receive and Transmit modes. The low channel (902 MHz) was selected as the worst-case condition for detailed examination.
- Above 1 GHz, high-pass filters blocked the carrier frequency to prevent saturation of the LNA.
- In Transmit mode, the EUT was assessed up to 10 GHz. There were no emissions other than carrier and harmonics.

Negative values for Delta indicate compliance.

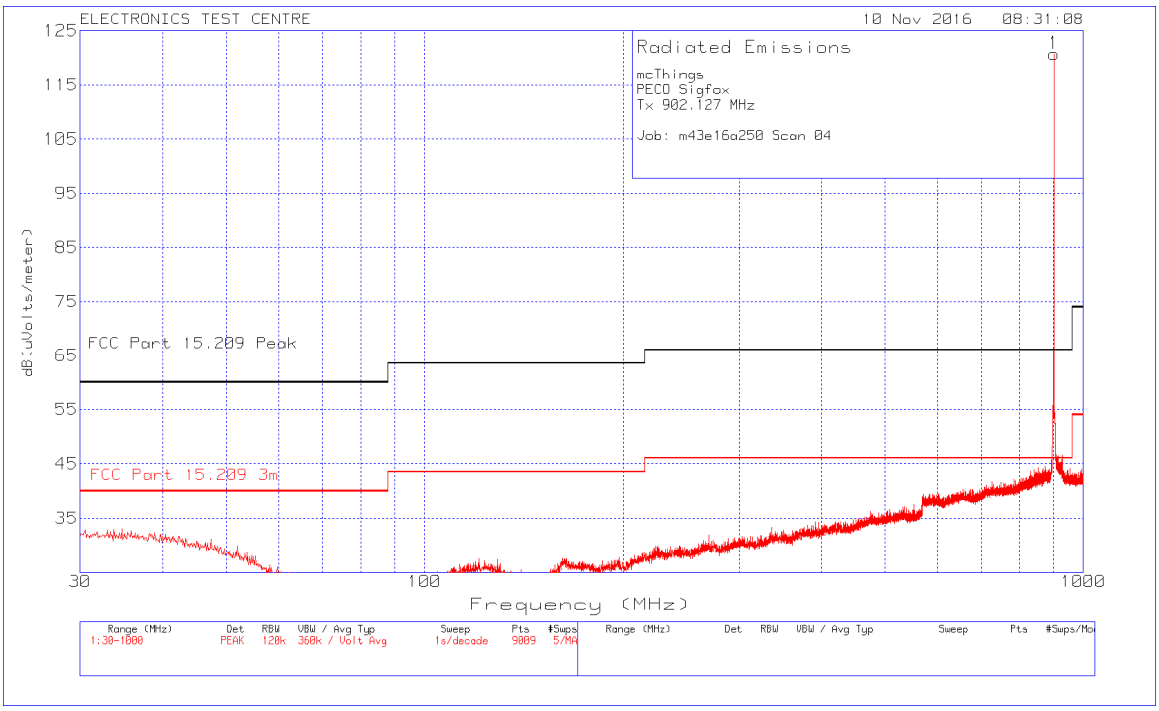
Plot of Radiated Emissions: Measuring Antenna 1st Orientation



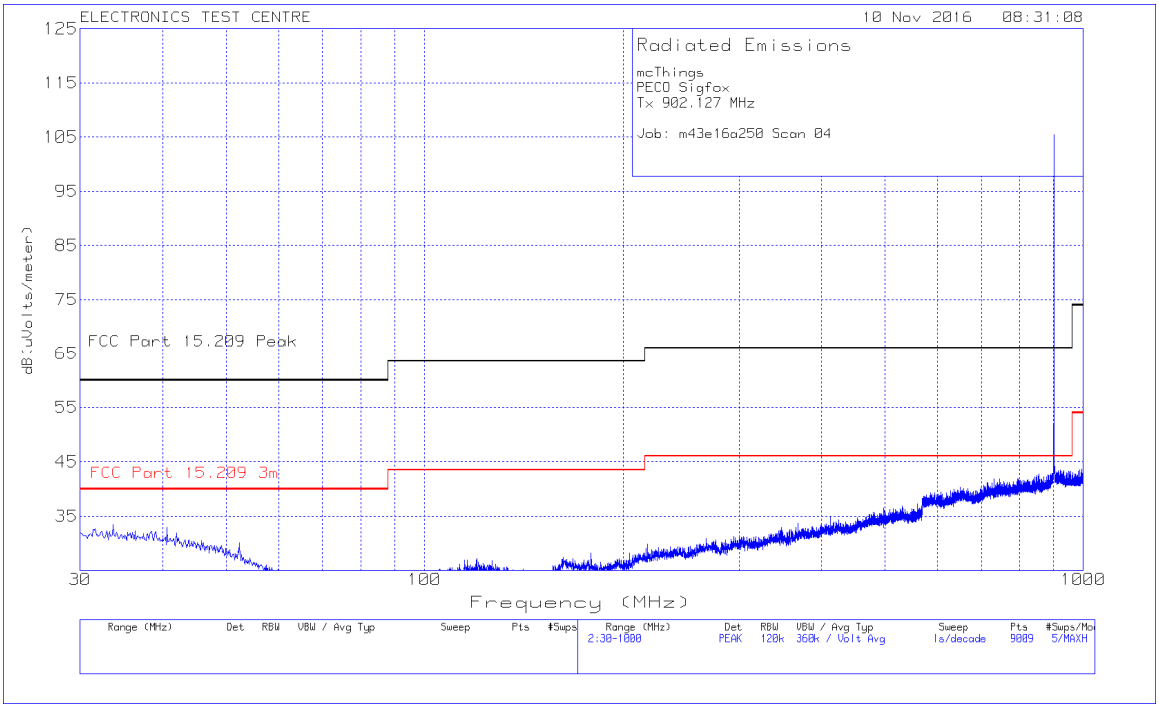
Plot of Radiated Emissions: Measuring Antenna 2nd Orientation



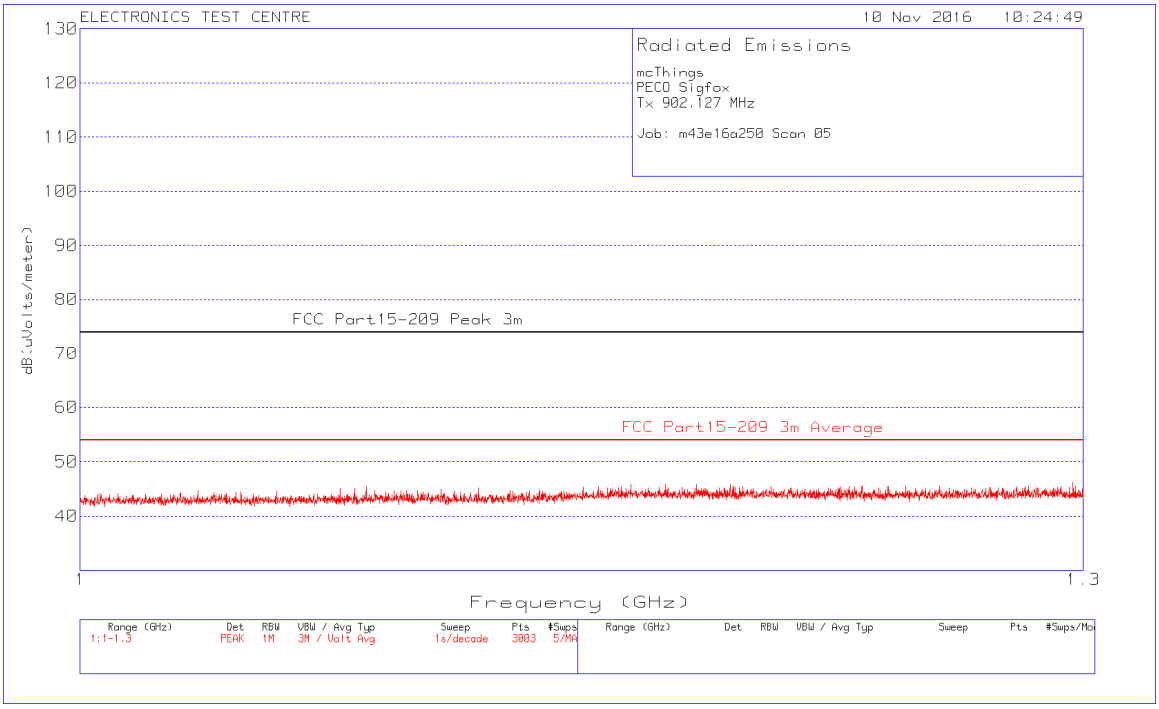
Plot of Radiated Emissions: Horizontal polarization



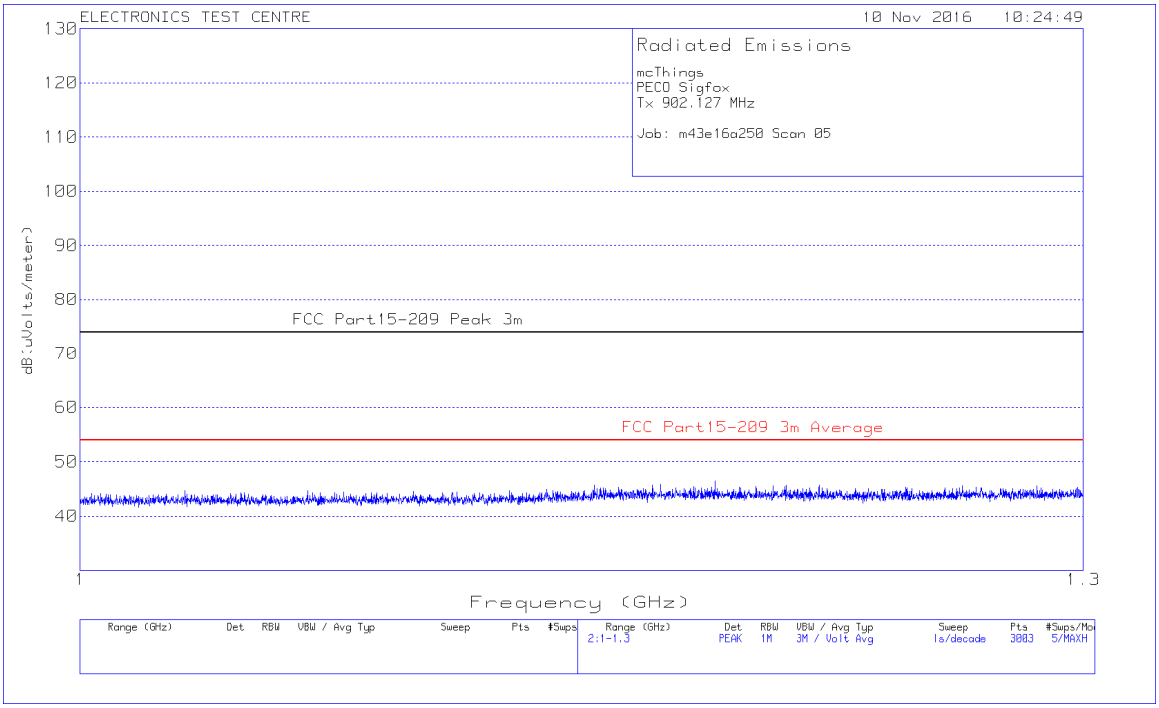
Plot of Radiated Emissions: Vertical polarization



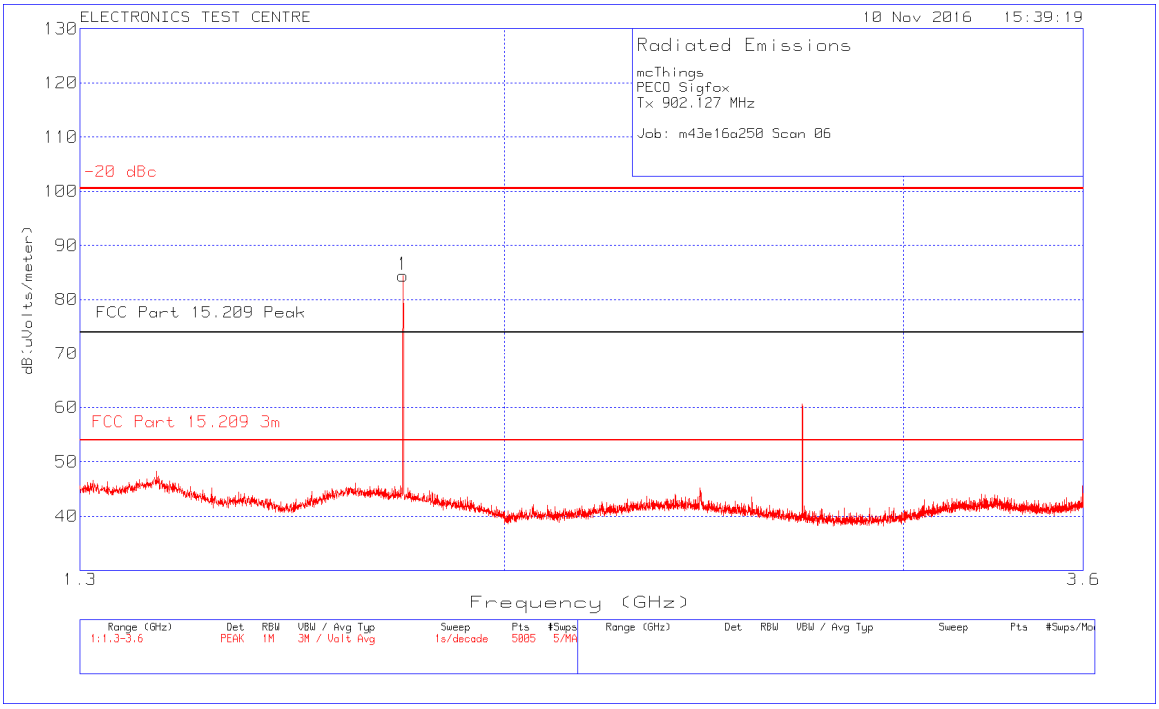
Plot of Radiated Emissions: Horizontal polarization



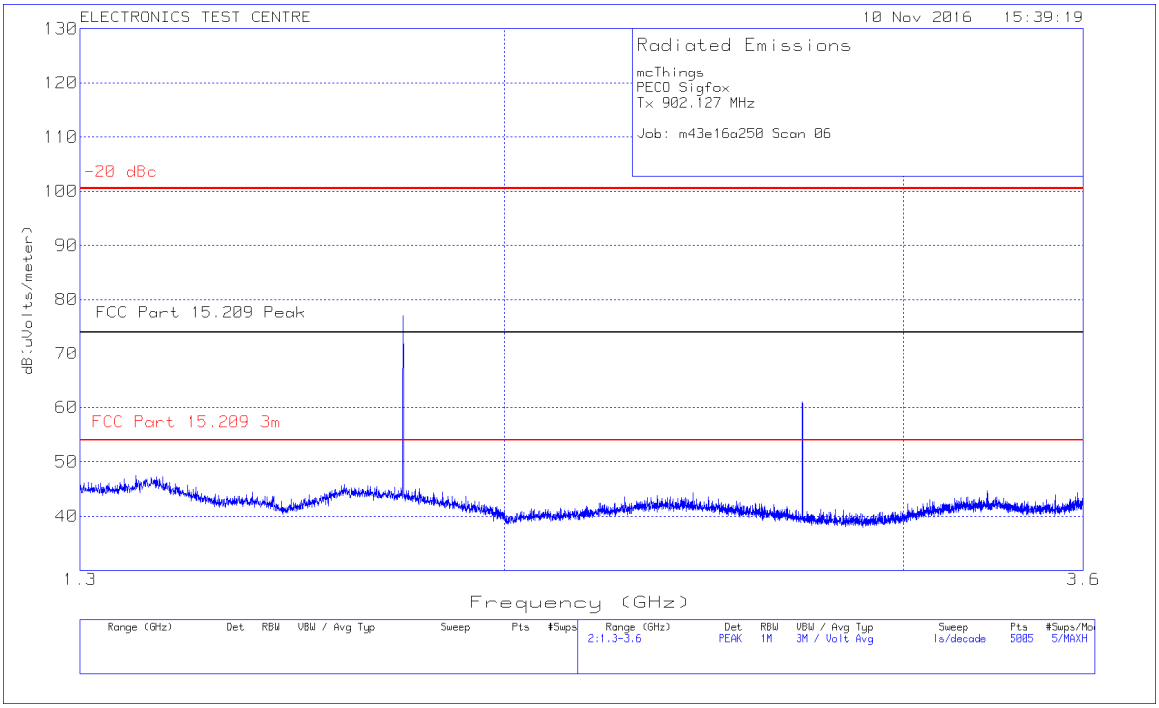
Plot of Radiated Emissions: Vertical polarization



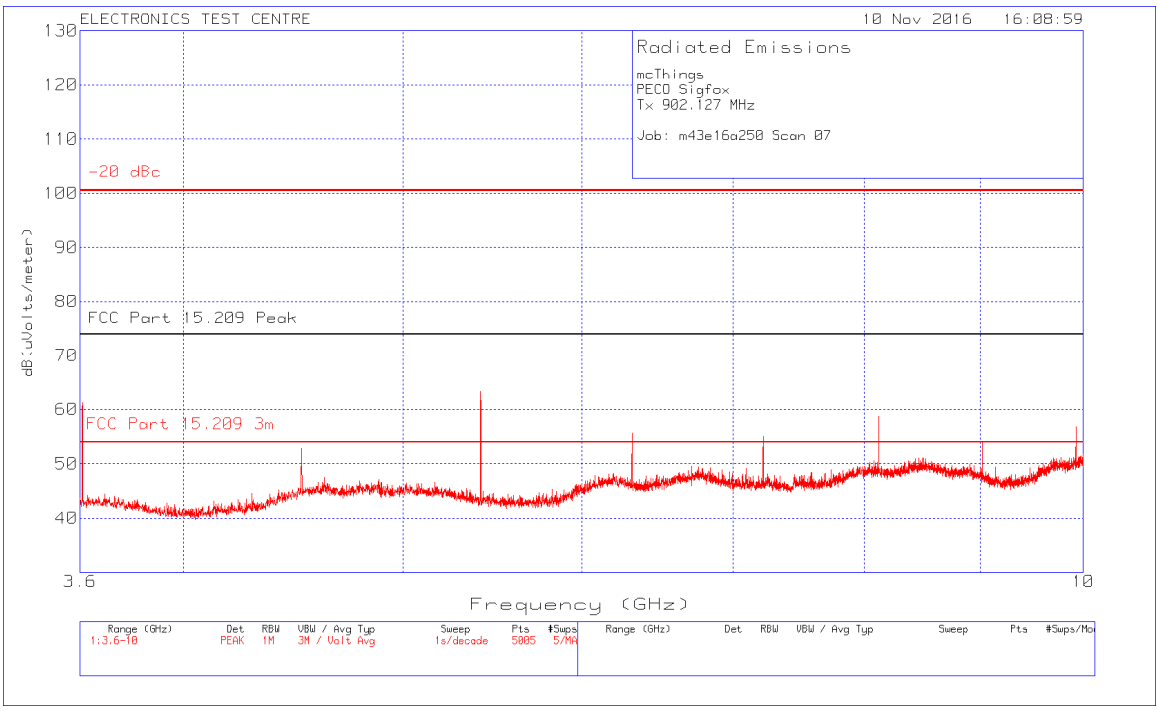
Plot of Radiated Emissions: Horizontal polarization



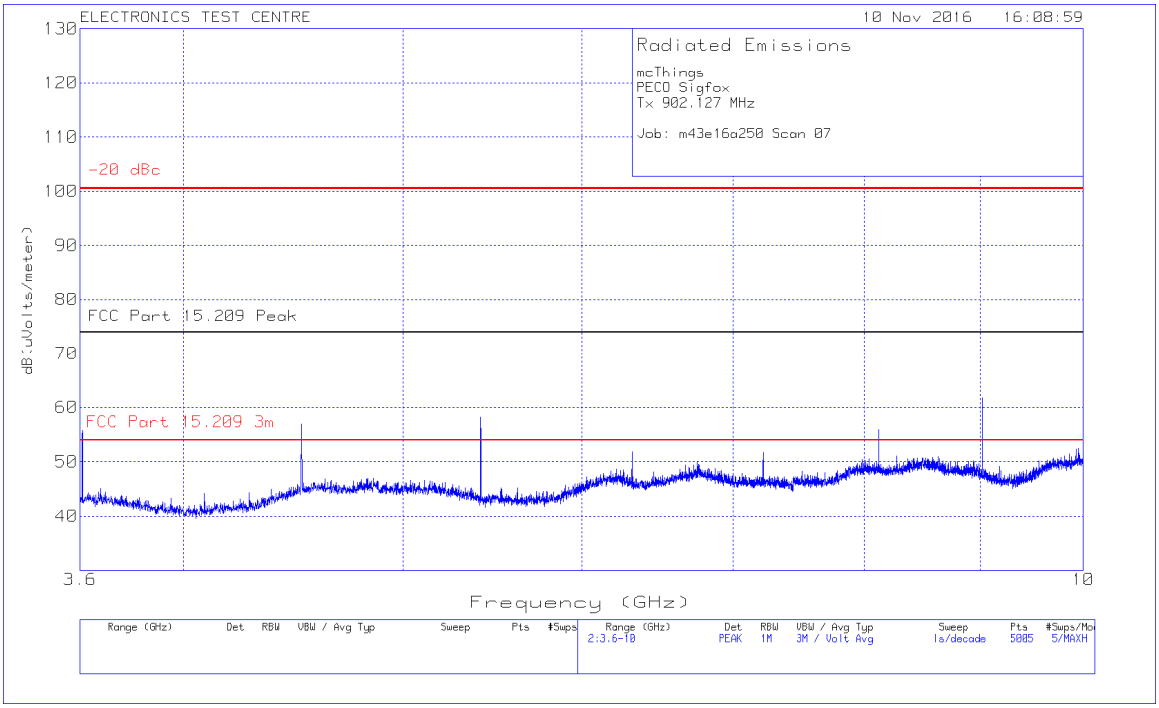
Plot of Radiated Emissions: Vertical polarization



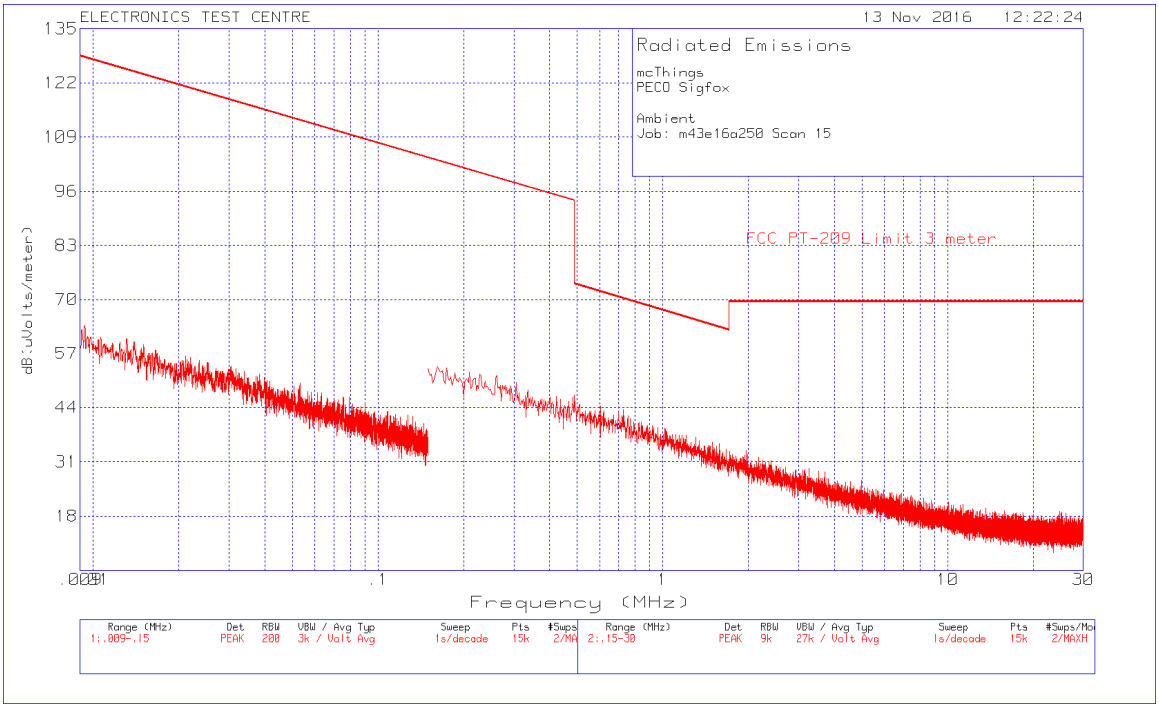
Plot of Radiated Emissions: Horizontal polarization



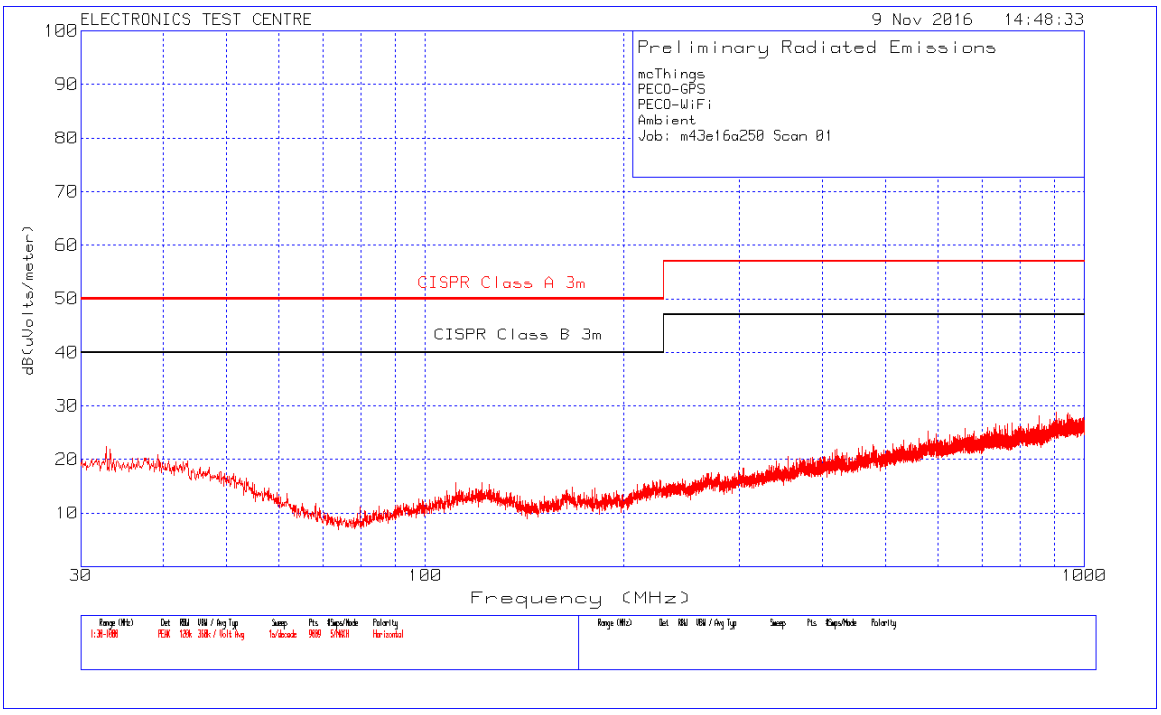
Plot of Radiated Emissions: Vertical polarization



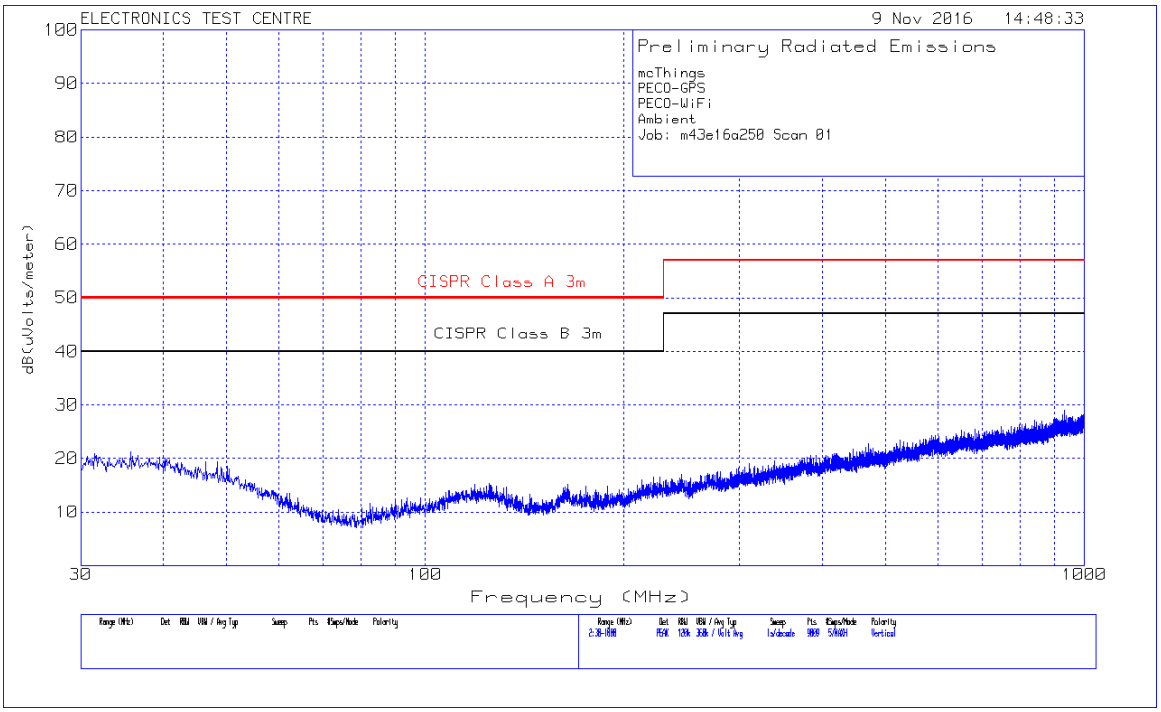
Plot of Test Chamber Ambient: (measurement noise floor):



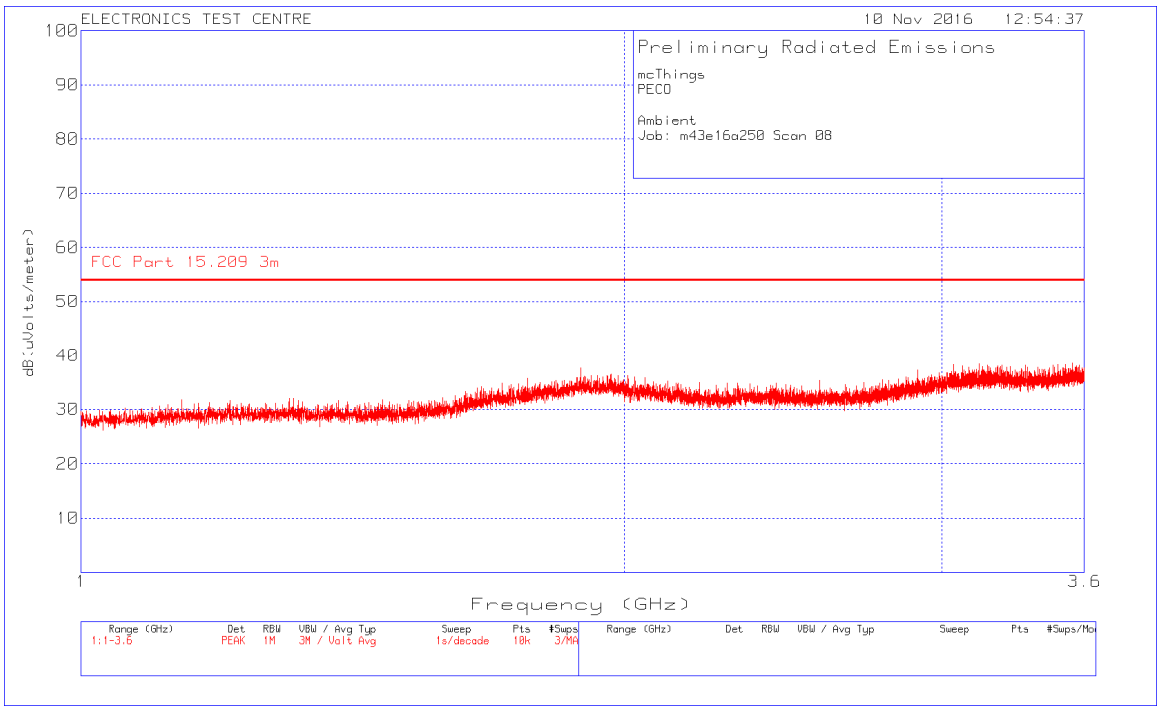
Plot of Test Chamber Ambient: (measurement noise floor):



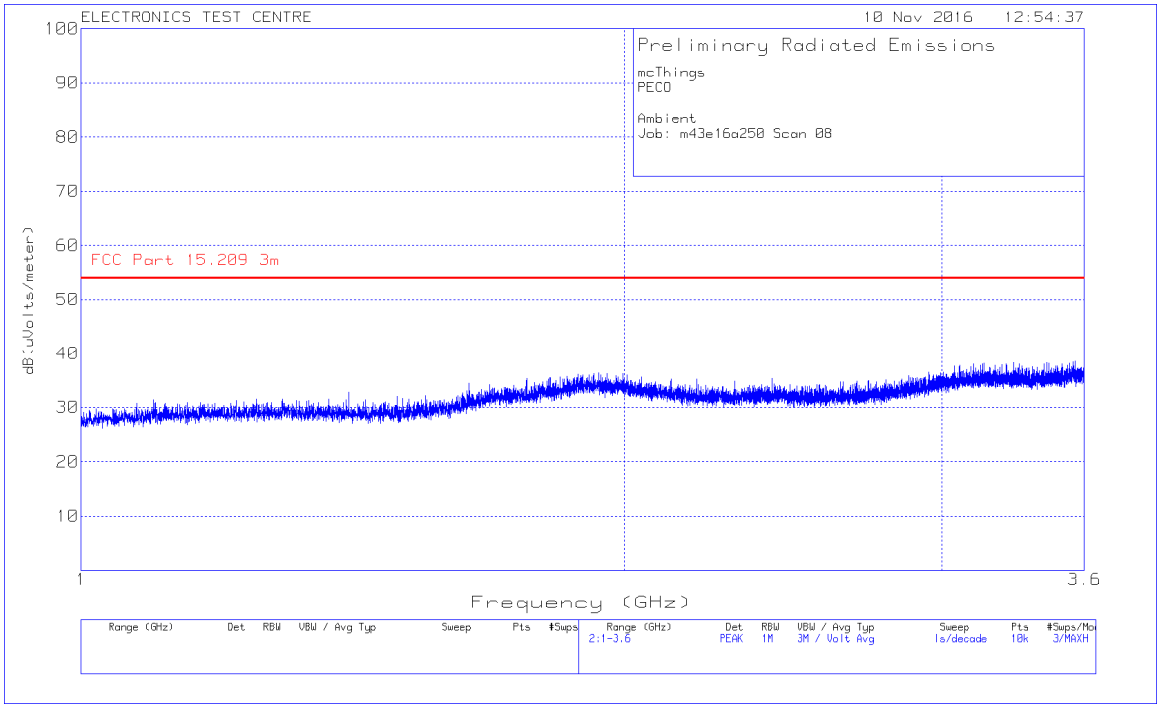
Plot of Test Chamber Ambient: (measurement noise floor):



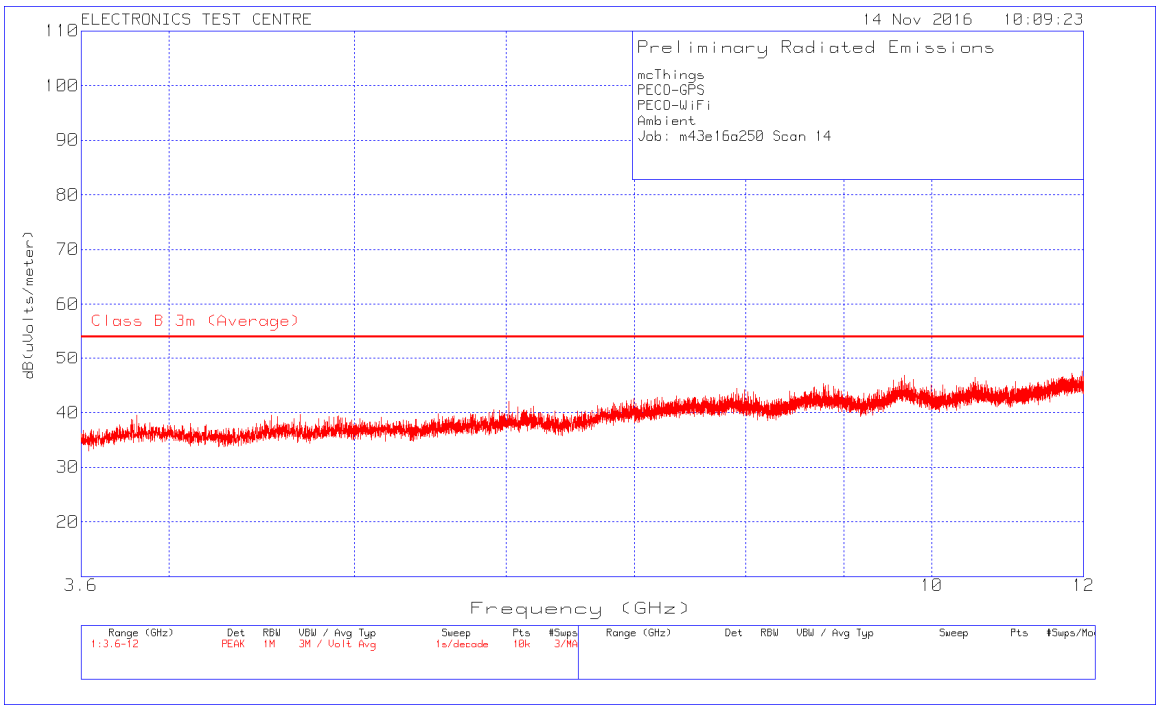
Plot of Test Chamber Ambient: (measurement noise floor):



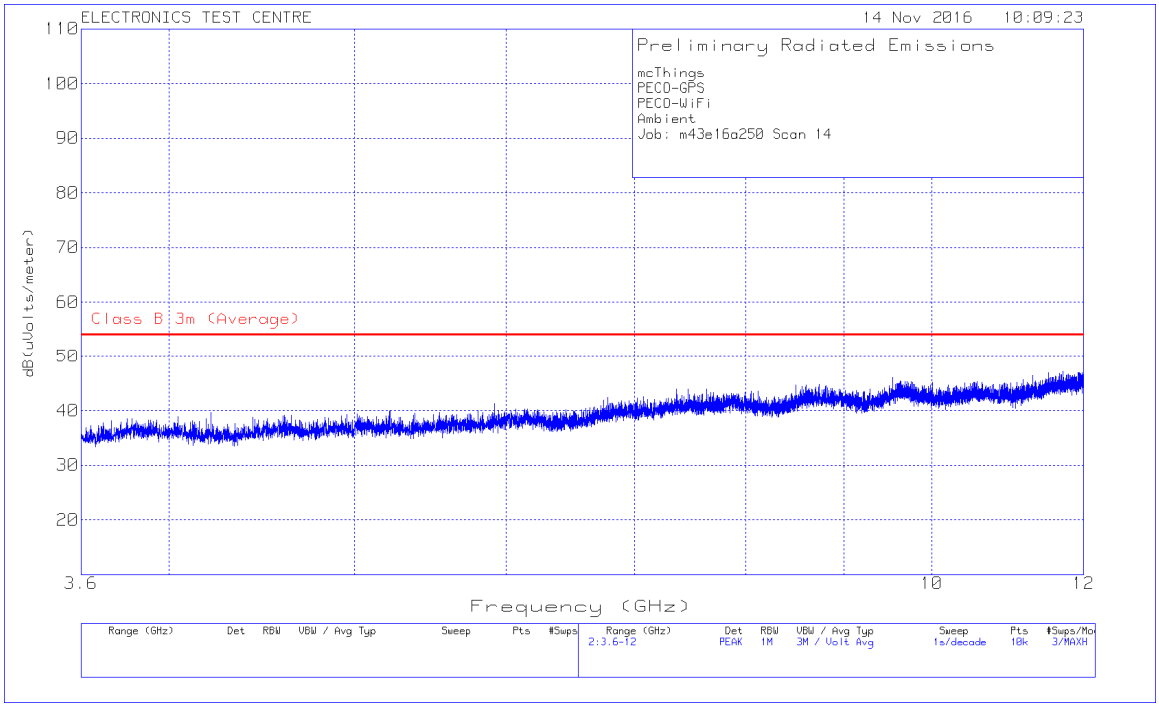
Plot of Test Chamber Ambient: (measurement noise floor):



Plot of Test Chamber Ambient: (measurement noise floor):



Plot of Test Chamber Ambient: (measurement noise floor):



2.11 Antenna Requirements

Test Lab: Electronics Test Centre, Airdrie	**EUT: PECO**
Test Personnel: David Raynes	**Standard: FCC PART 15.203**
Date: 2016-11-09 (20.4° C, 33.5% RH)	

EUT status: Compliant

Specification: FCC Part 15.203

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

2.2.1 Test Methodology

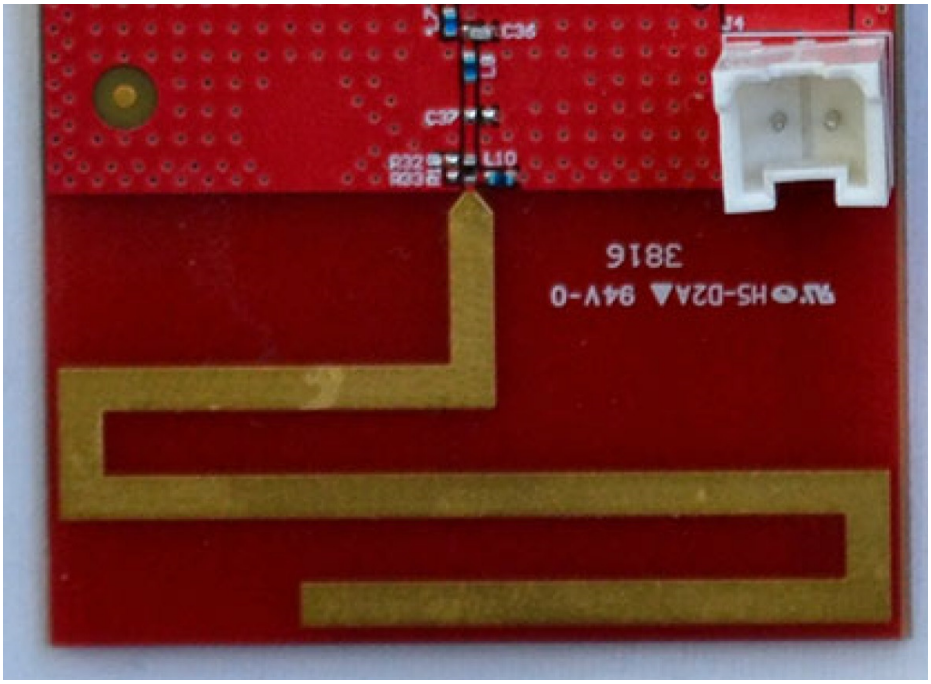
The EUT is visually inspected to assess compliance.

2.2.2 Deviations From The Standard:

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

2.2.3 Assessment

The antenna is integral to the printed circuit board of the device, preventing any replacement or substitution by the end user.



2.12 RF Exposure

Test Lab: Electronics Test Centre, Airdrie	**EUT: PECO** **Standard: FCC PART 1.1307(b)(1)**
EUT status: Compliant	

Exempt: See SAR assessment submitted separately.

3.0 TEST FACILITY

3.1 Location

The PECO 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 number 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 PECO-GPS and PECO-WIFI was placed at the centre of the test chamber turntable on top of an 80-cm high polystyrene foam table. The EUT was not grounded, according to mcThings Inc. specifications.

3.3 Power Supply

All EUT power was supplied by an internal replaceable battery pack.

3.4 Emissions Profile

Ambient emission profiles were generated throughout the tests and are included in the test data.

End of Document