731 Enterprise Drive
Lexington, KY 40510

Telephone: 859-226-1000
Facsimile: 859-226-1040
www.intertek-etlsemko.com

TEST REPORT

Report Number: **102289380LEX-001**
Project Number: **G102289380**

Report Issue Date: **10/30/2015**

Product Name: **Bluetooth Low Energy Module**
Model Number: **LEX-M06-001**

Standards: **CFR Title 47 Part 15 Subpart B and C**
RSS-247 Issue 1 and ICES-003 Issue 5

Tested by:
Intertek Testing Services NA, Inc.
731 Enterprise Drive
Lexington, KY 40510

Client:
Lexmark International, Inc.
740 New Circle Road, NW
Lexington, KY 40511

Report prepared by

Bryan Taylor, Team Leader

Report reviewed by

James Sudduth, Senior Staff engineer

TABLE OF CONTENTS

1 Introduction and Conclusion

The tests indicated in section 2 were performed on the product constructed as described in section 3. The remaining test sections are the verbatim text from the actual data sheets used during the investigation. These test sections include the test name, the specified test method, a list of the actual test equipment used, documentation photos, results and raw data. No additions, deviations, or exclusions have been made from the standard(s) unless specifically noted.

Based on the results of our investigation, we have concluded the product tested complied with the requirements of the standard(s) indicated. The results obtained in this test report pertain only to the item(s) tested.

The INTERTEK-Lexington is located at 731 Enterprise Drive, Lexington Kentucky, 40510. The radiated emission test site is a 10-meter semi-anechoic chamber. The chamber meets the characteristics of CISPR 16-1 and ANSI C63.4. For measurements, a remotely controlled flush-mount metal-top turntable is used to rotate the EUT a full 360 degrees. A remote controlled non-conductive antenna mast is used to scan the antenna height from one to four meters. The test site is listed with the FCC under registration number 485103. The test site is listed with Industry Canada under site number IC 2042M-1.

2 Test Summary

Page	Test full name	FCC Reference	IC Reference	Result
5	Peak Conducted Power	§ 15.247(b)(3)(4)	RSS-247 (5.4)	Pass
9	Occupied Bandwidth	§ 15.247(a)(2)	RSS-247 (5.2) RSS-GEN (4.6.1)	Pass
14	Conducted Spurious Emissions	§ 15.247(d)	RSS-247 (5.5)	Pass
16	Power Spectral Density	§ 15.247(e)	RSS-247 (5.2)	Pass
19	Radiated Spurious Emissions (Transmitter)	§ 15.247(d), § 15.209, and § 15.205	RSS-247 (5.5)	Pass
31	Radiated Spurious Emissions (Receiver)	§ 15.109	ICES-003	Pass
38	Conducted Voltage Emissions on the AC Mains Terminals	§ 15.107, § 15.207	ICES-003	Pass
45	Antenna Requirement per FCC Part 15.203	§ 15.203	RSS-Gen (7.1.2)	Pass

3 Description of Equipment Under Test

Equipment Under Test	
Manufacturer	Lexmark International, Inc.
Model Number	LEX-M06-001
Serial Number	Test Sample 1 and 2
Receive Date	10/13/2015
Test Start Date	10/13/2015
Test End Date	10/16/2015
Device Received Condition	Good
Test Sample Type	Production
Frequency Band	2402MHz – 2480MHz
Mode(s) of Operation	BTLE
Modulation Type	GFSK
Number of Hopping Channels	40
Transmission Control	Test Commands
Test Channels	0, 19, 39 (2402, 2440, 2480 MHz)
Antenna Type (15.203)	Chip antenna and external PCB Antenna
Power Supply	5-12Vdc

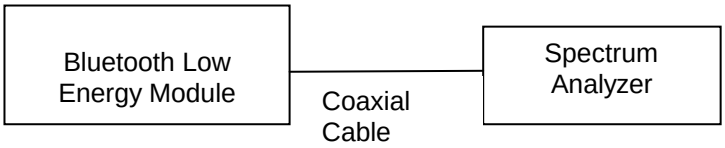
Description of Equipment Under Test			
The product under test was a Bluetooth "Low Energy" module. Two antennas were evaluated with this module as described below			
Antenna Manufacturer	**Antenna Model**	**Antenna Type**	**Max Efficiency**
Yaiyo Yuden	AF216M245001	Chip Antenna	71% at 2.5GHz
SkyCross	CBL-EMWQU-A	External PCB Antenna with Cable Assembly	60% across 2.4GHz – 2.5GHz band

Operating modes of the EUT:

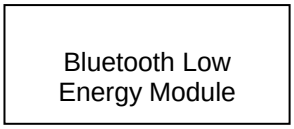
No.	**Descriptions of EUT Exercising**
1	Transmiting Bluetooth Low Energy on Low, Mid and High Channels
2	Receive mode / Idle Mode

3.1 System setup including cable interconnection details, support equipment and simplified block diagram

3.2 EUT Block Diagram:



Conducted Output Measurements



Radiated Measurements

3.3 Cables:

Cables					
Description	Length	Shielding	Ferrites	Connection	
				From	To
USB Power / Communication Cable	5ft	No	No	EUT	Laptop

4 Peak Conducted Power

4.1 Test Limits

§ 15.247(b)(3): For systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the *maximum conducted output power* is the highest total transmit power occurring in any mode.

§ 15.247(b)(4): The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

4.2 Test Procedure

ANSI C63.10: 2013 and KDB Publication No. 558074: Guidance on Measurements for Digital Transmission Systems (47 CFR 15.247). The peak output power was measured using the channel power function of the spectrum analyzer.

4.3 Test Equipment Used:

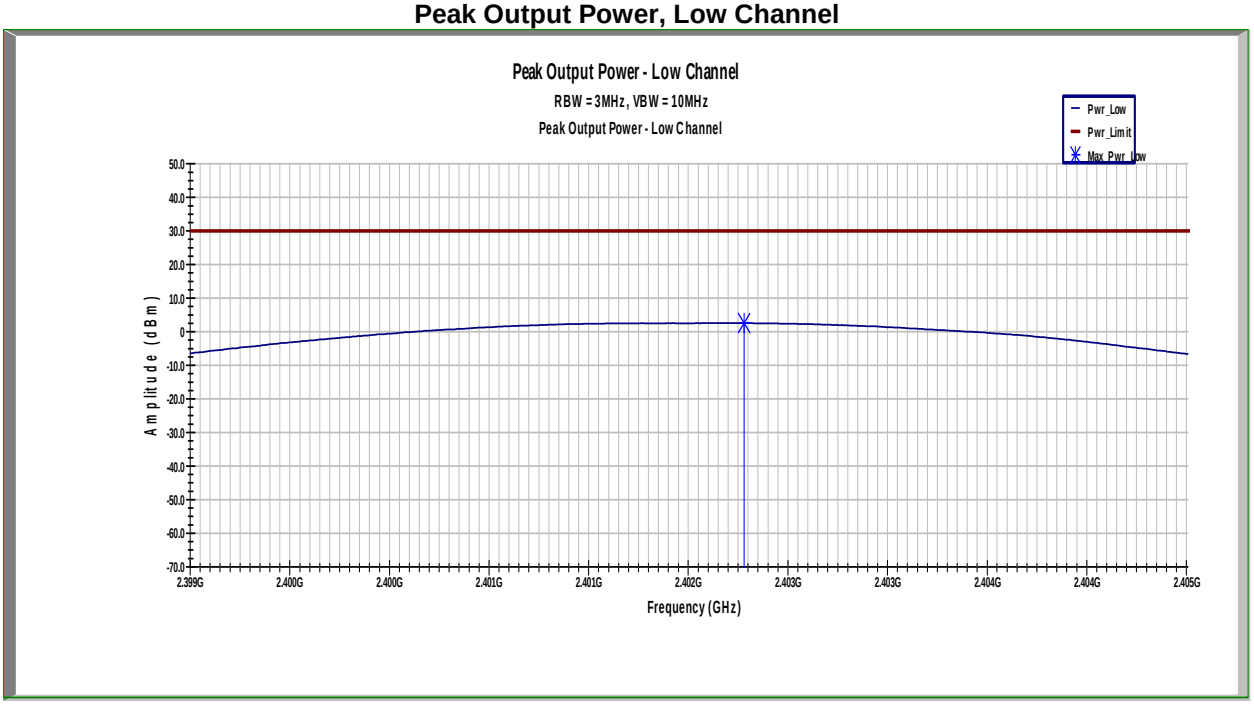
Description	Serial Number	Manufacturer	Model	Cal. Date	Cal. Due
Spectrum Analyzer	3720	Rohde & Schwarz	FSEK30	9/20/2015	9/20/2016

4.4 Results:

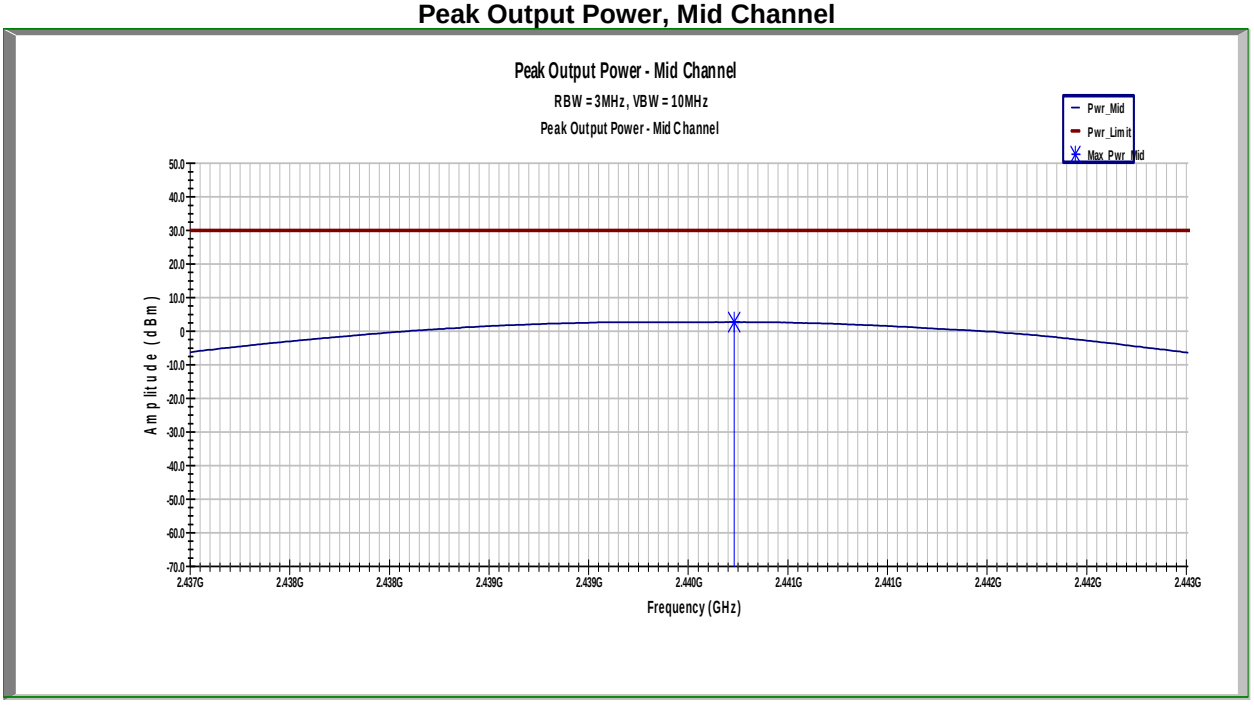
The peak output power measurements were all below the 30dBm limit.

Mode	Channel Number	Frequency (MHz)	Peak Output Power (dBm)	Limit (dBm)	Result
BTLE	0	2402	2.524	30	Pass
BTLE	19	2440	2.700	30	Pass
BTLE	39	2480	2.829	30	Pass

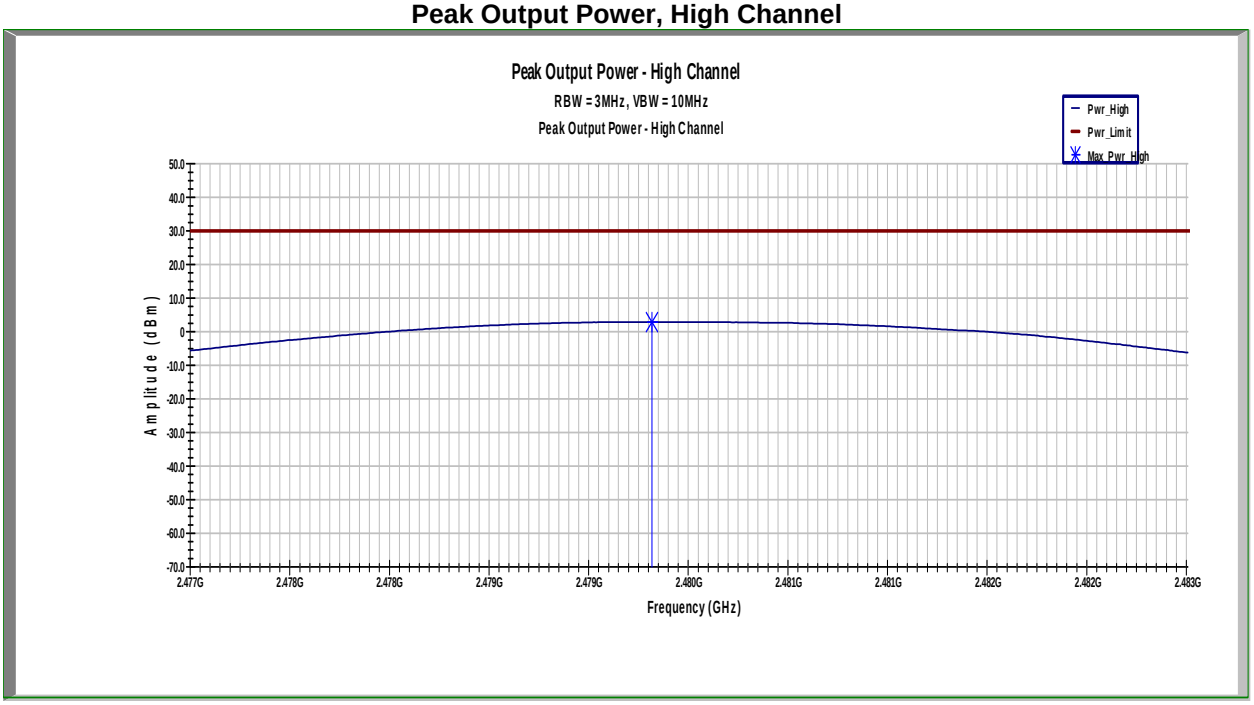
Peak Output Power, Low Channel



Peak Output Power, Mid Channel



Peak Output Power, High Channel



5 Occupied Bandwidth

5.1 Test Limits

§ 15.247(a)(2): For digital modulation systems, the minimum 6dB bandwidth shall be at least 500kHz.

5.2 Test Procedure

ANSI C63.10: 2013 and KDB Publication No. 558074: Guidance on Measurements for Digital Transmission Systems (47 CFR 15.247)

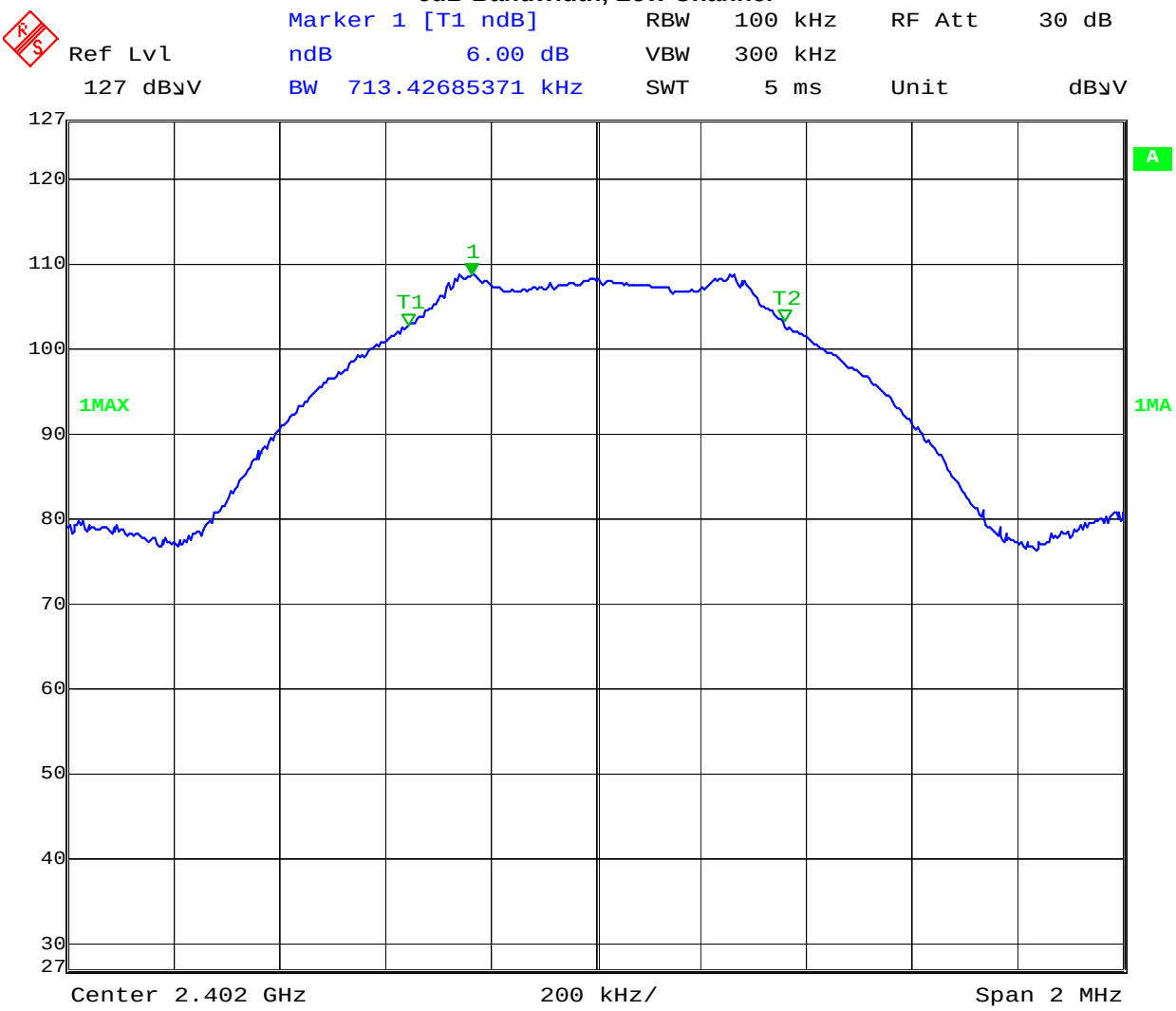
5.3 Test Equipment Used:

Description	Serial Number	Manufacturer	Model	Cal. Date	Cal. Due
Spectrum Analyzer	3720	Rohde&Schwarz	FSEK30	9/20/2015	9/20/2016

5.4 Results:

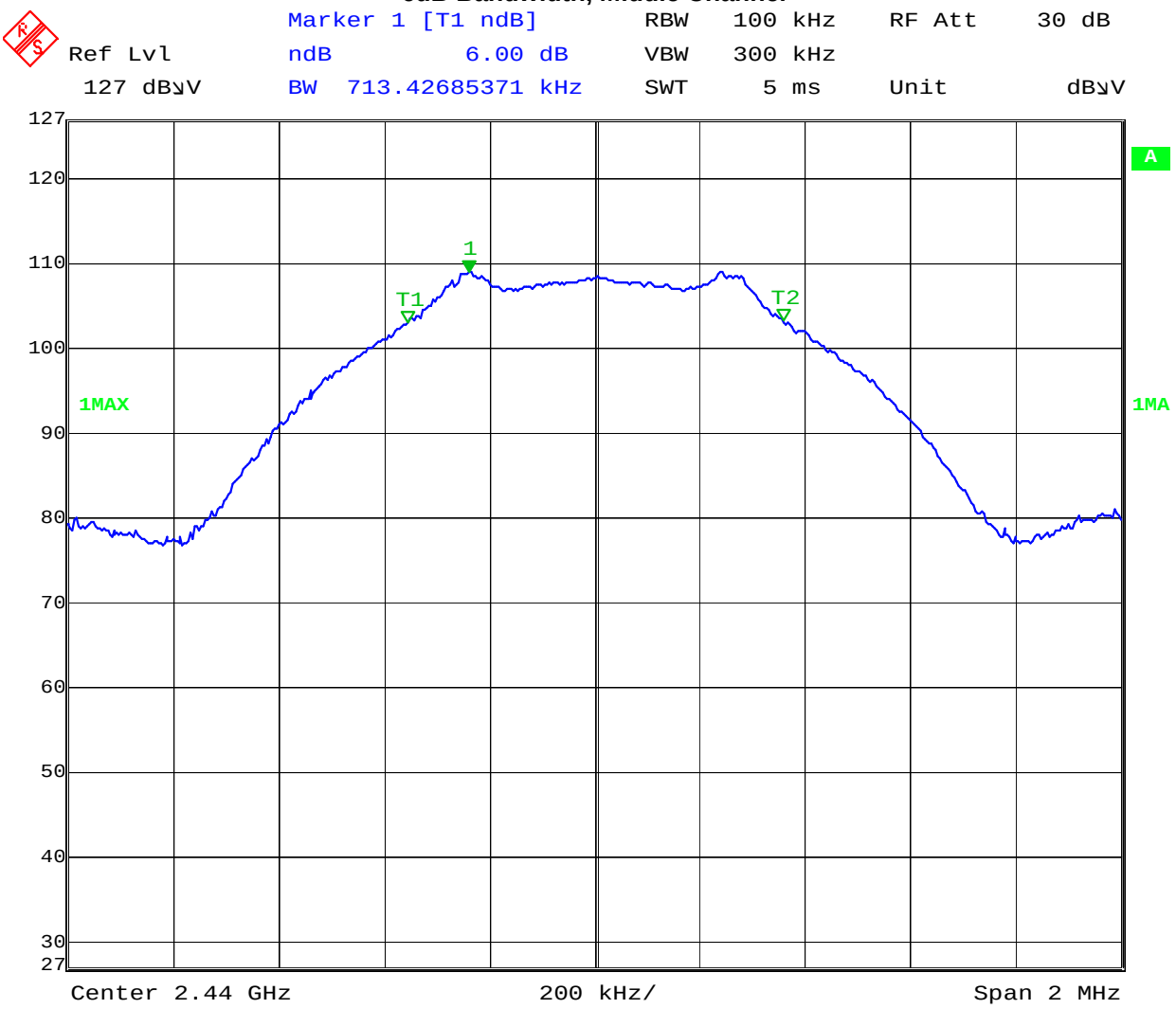
Mode	Channel Number	Frequency (MHz)	6dB Bandwidth	99% Power Bandwidth	Result
BTLE	0	2402	713.4kHz	---	Pass
BTLE	19	2440	713.4kHz	1.07MHz	Pass
BTLE	39	2480	725.45kHz	---	Pass

6dB Bandwidth, Low Channel



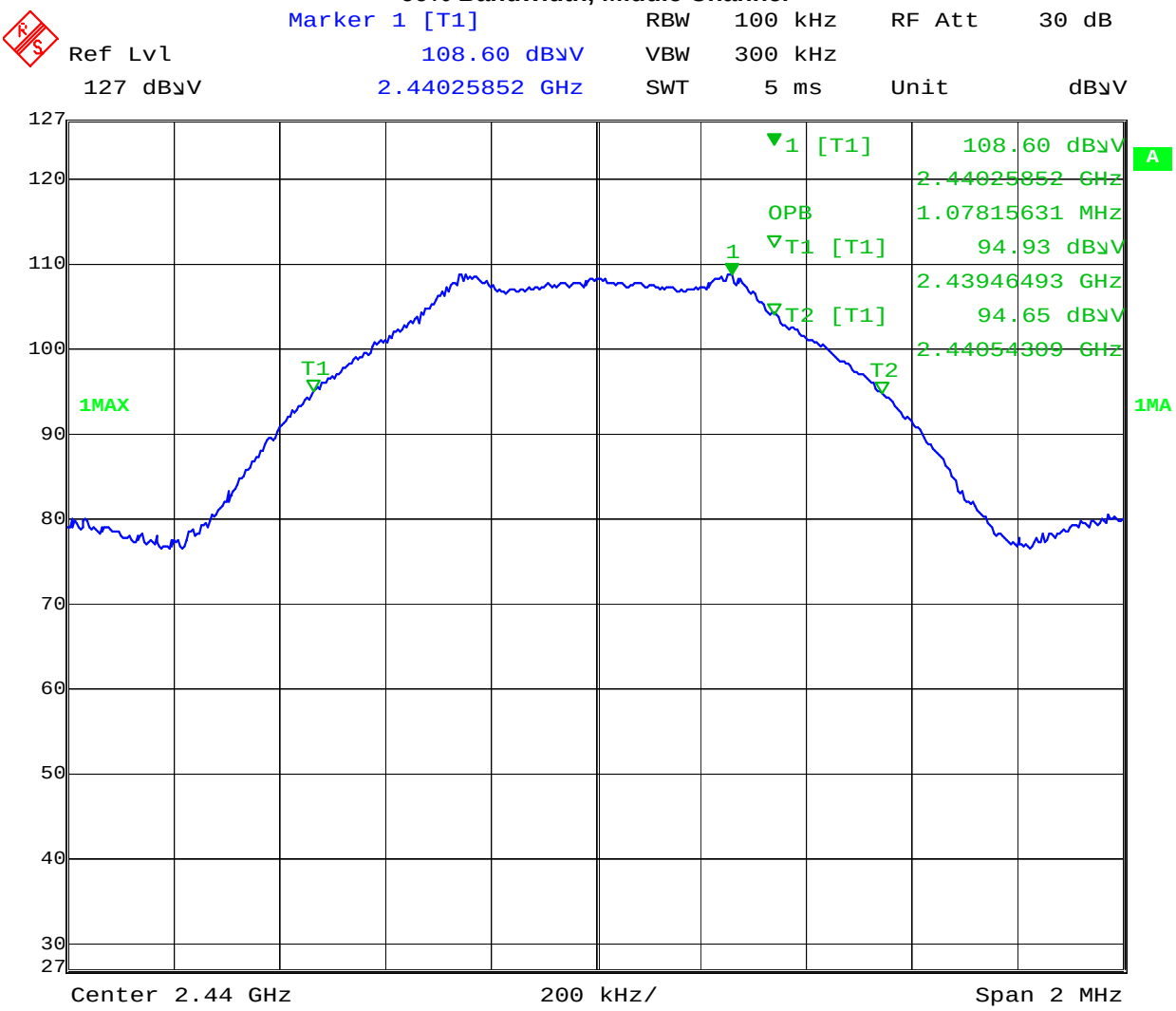
Date: 13.OCT.2015 16:37:49

6dB Bandwidth, Middle Channel



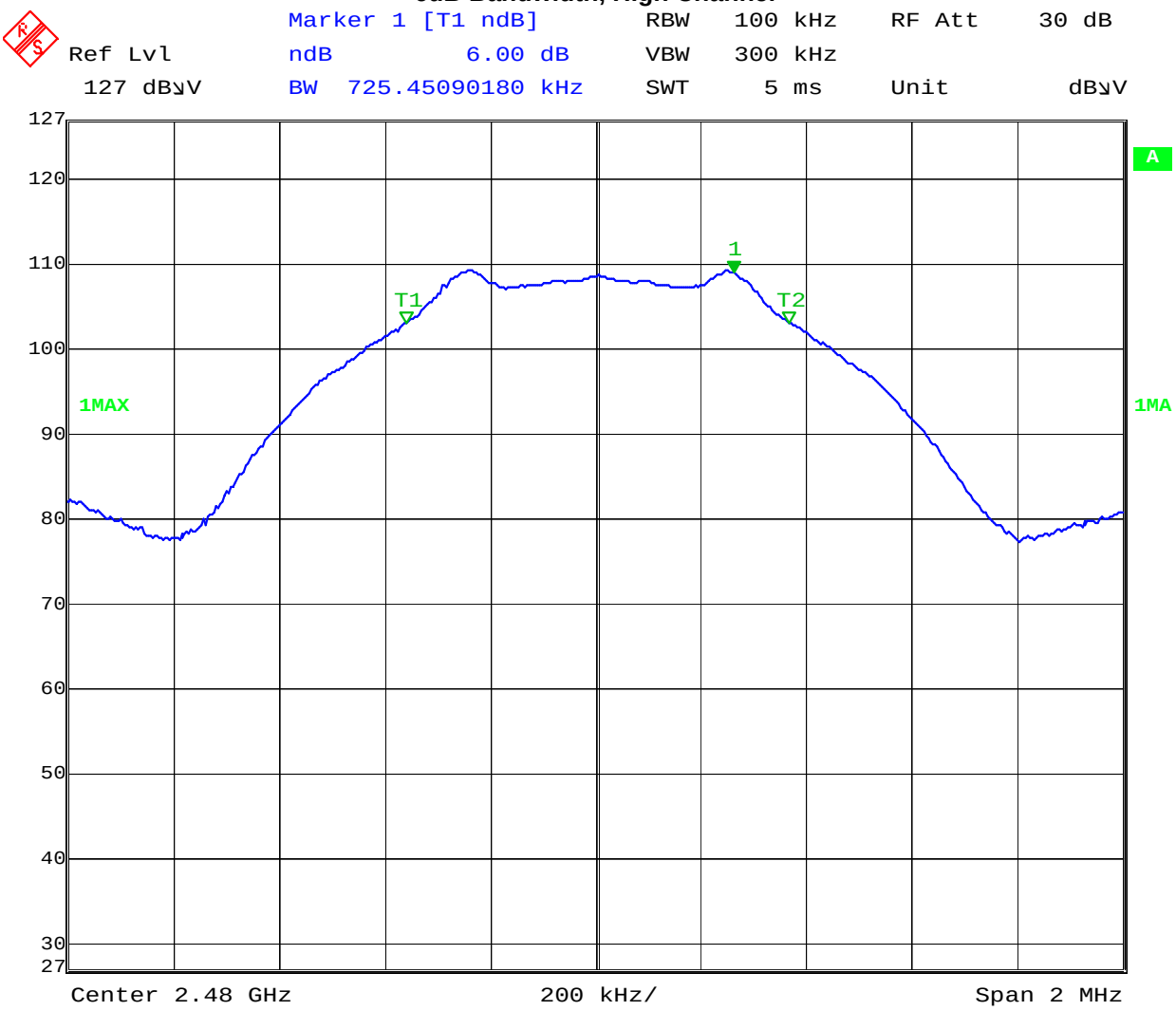
Date: 13.OCT.2015 16:37:07

99% Bandwidth, Middle Channel



Date: 13.OCT.2015 16:43:55

6dB Bandwidth, High Channel



6 Conducted Spurious Emissions

6.1 Test Limits

§ 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.

6.2 Test Procedure

ANSI C63.10: 2013 and KDB Publication No. 558074: Guidance on Measurements for Digital Transmission Systems (47 CFR 15.247)

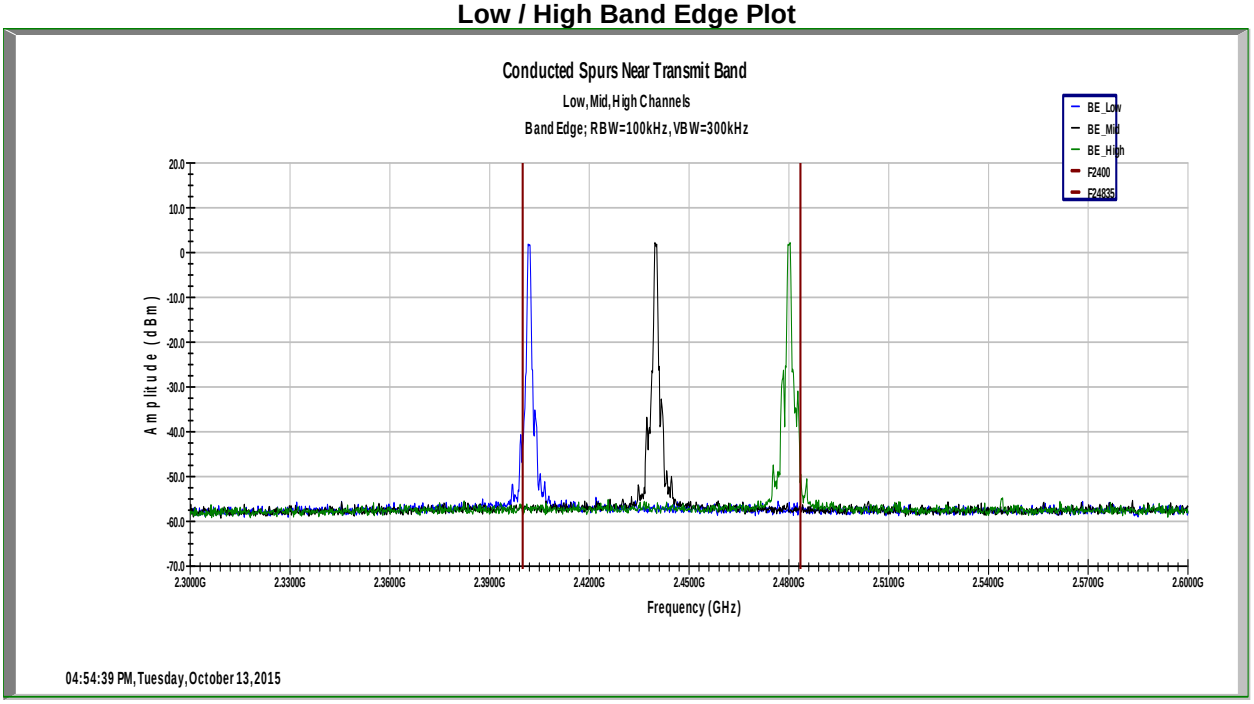
6.3 Test Equipment Used:

Description	Serial Number	Manufacturer	Model	Cal. Date	Cal. Due
Spectrum Analyzer	3720	Rohde&Schwarz	FSEK30	9/20/2015	9/20/2016

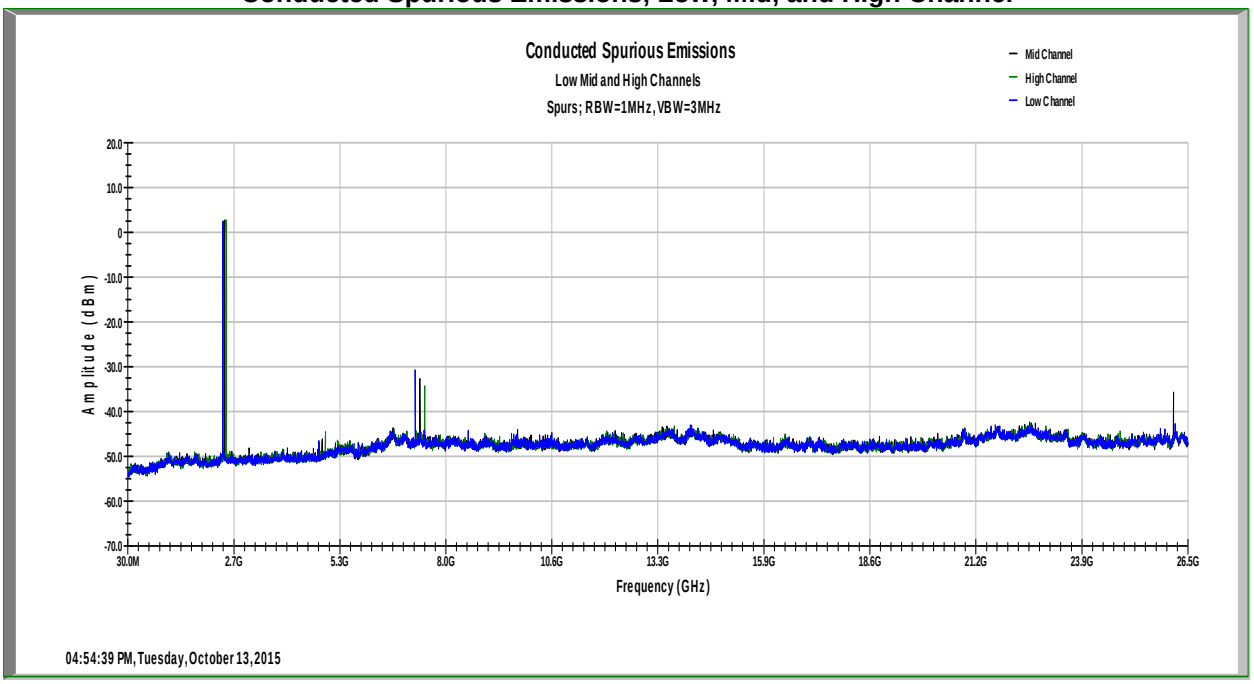
6.4 Results:

The following plots show that there are no conducted spurious emissions exceeding the 20dB down criteria.

Low / High Band Edge Plot



Conducted Spurious Emissions, Low, Mid, and High Channel



7 Power Spectral Density

7.1 Test Limits

§ 15.247(e): For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

7.2 Test Procedure

ANSI C63.10: 2013 and KDB Publication No. 558074: Guidance on Measurements for Digital Transmission Systems (47 CFR 15.247)

7.3 Test Equipment Used:

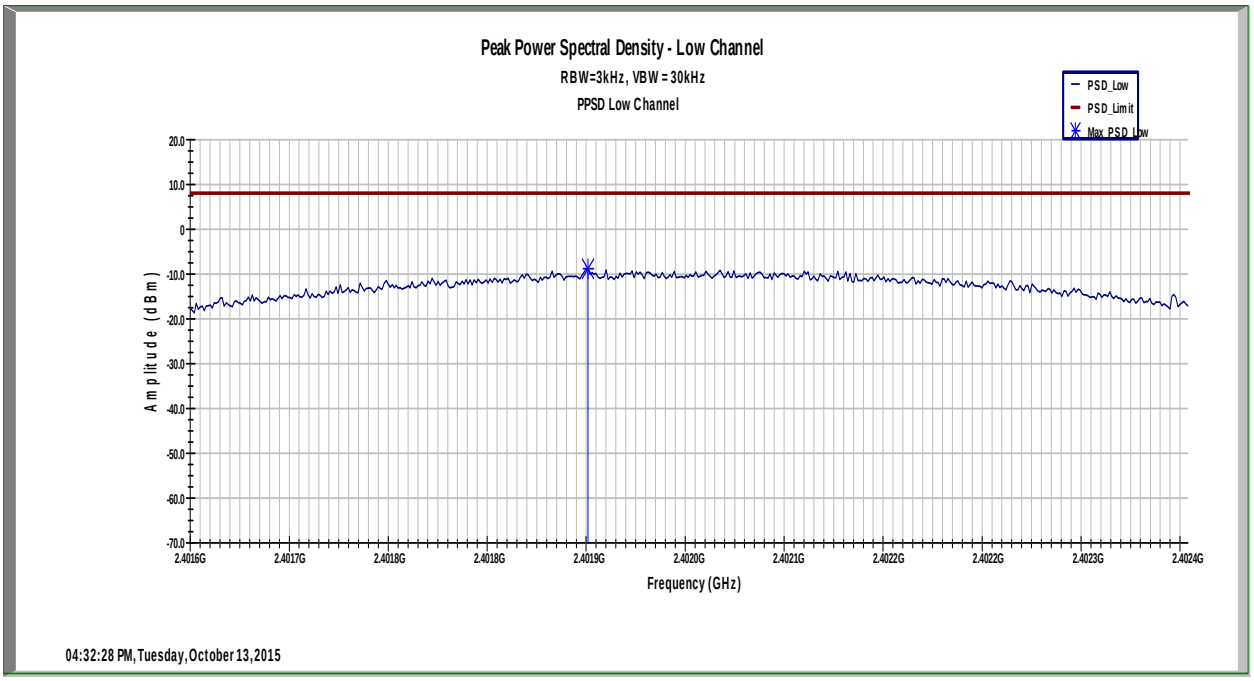
Description	Serial Number	Manufacturer	Model	Cal. Date	Cal. Due
Spectrum Analyzer	3720	Rohde&Schwarz	FSEK30	9/20/2015	9/20/2016

7.4 Results:

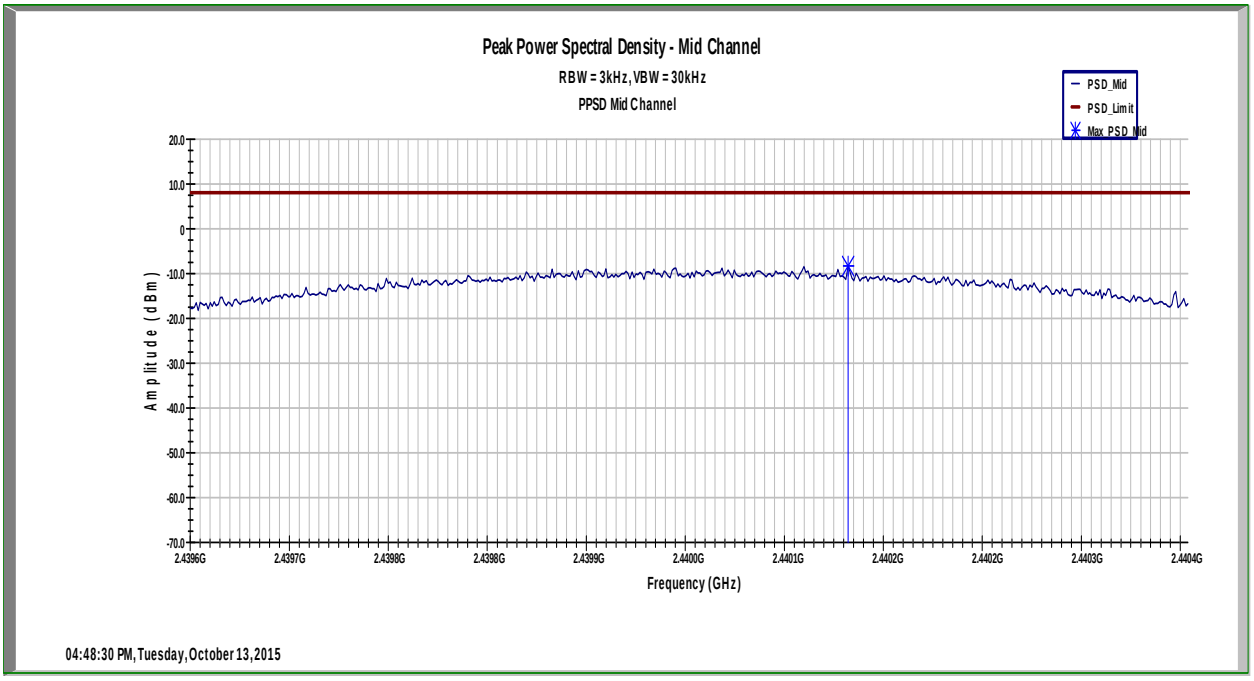
*PSD Option 1 Method

Mode	Channel Number	Frequency (MHz)	PSD in 3kHz BW (dBm)	Limit (dBm)	Result
BTLE	0	2402	-8.845	8.0	Pass
BTLE	19	2440	-8.350	8.0	Pass
BTLE	39	2480	-8.322	8.0	Pass

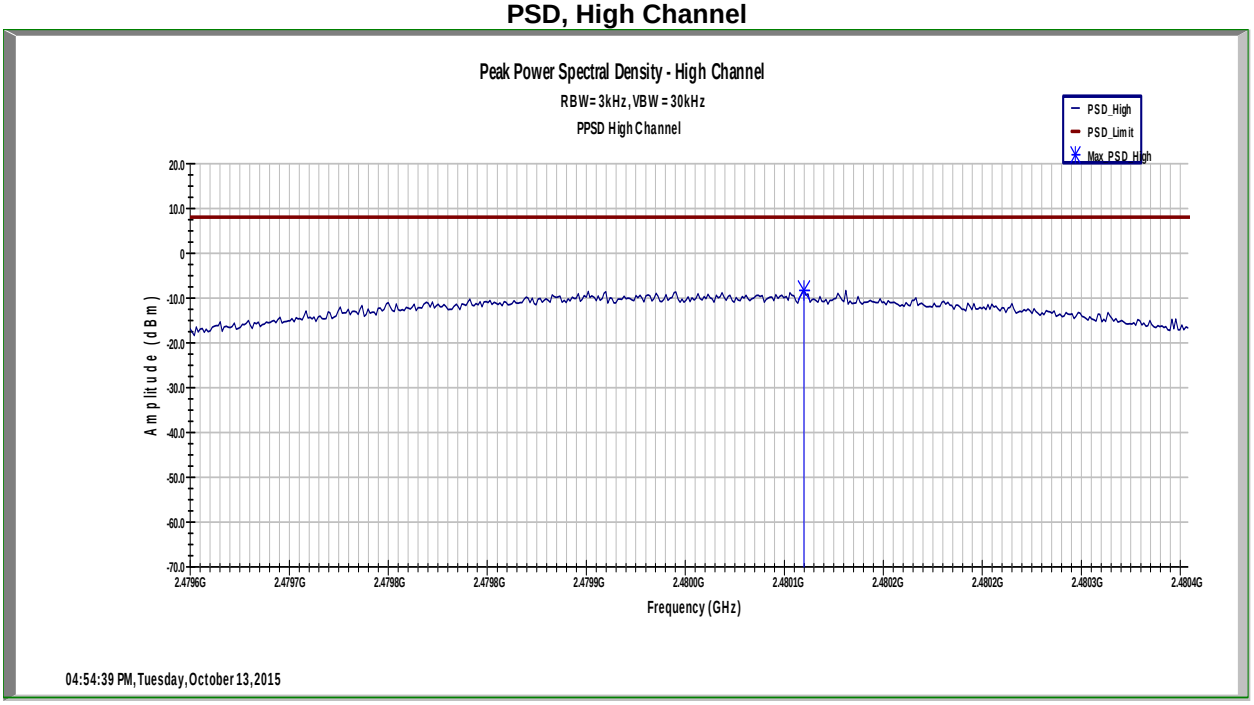
PSD Low Channel



PSD Middle Channel



PSD, High Channel



8 Radiated Spurious Emissions (Transmitter)

8.1 Test Limits

§ 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)).

Part 15.205(a): Restricted Bands of Operations

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	2655–2900	22.01–23.12
8.41425–8.41475	162.0125–167.17	3260–3267	23.6–24.0
12.29–12.293	167.72–173.2	3332–3339	31.2–31.8
12.51975–12.52025	240–285	3345.8–3358	36.43–36.5
12.57675–12.57725	322–335.4	3600–4400	[2]
13.36–13.41.			

[1] Until February 1, 1999, this restricted band shall be 0.490–0.510 MHz.
[2] Above 38.6

Part 15.209(a): Field Strength Limits for Restricted Bands of Operation

Frequency (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
0.009 - 0.490	2,400 / F (kHz)	300
0.490 - 1.705	24,000 / F (kHz)	30
1.705 - 30.0	30	30
30 – 88	100	3
88 – 216	150	3
216 – 960	200	3
Above 960	500	3

8.2 Test Procedure

ANSI C63.10: 2013 and KDB Publication No. 558074: Guidance on Measurements for Digital Transmission Systems (47 CFR 15.247)

8.3 Example of Field Strength Calculation Method:

The measured field strength was calculated by summing the readings taken from the spectrum analyzer with the appropriate correction factors associated with the antenna losses and cable losses. The calculation formula and sample calculations are listed below:

Formula:
FS = RA + AF + CF

FS = Field Strength in dBµV/m
RA = Receiver Amplitude in dBµV
AF = Antenna Factor in dB
CF = Cable Attenuation Factor in dB (Including preamplifier and filter attenuation)

Example Calculation:

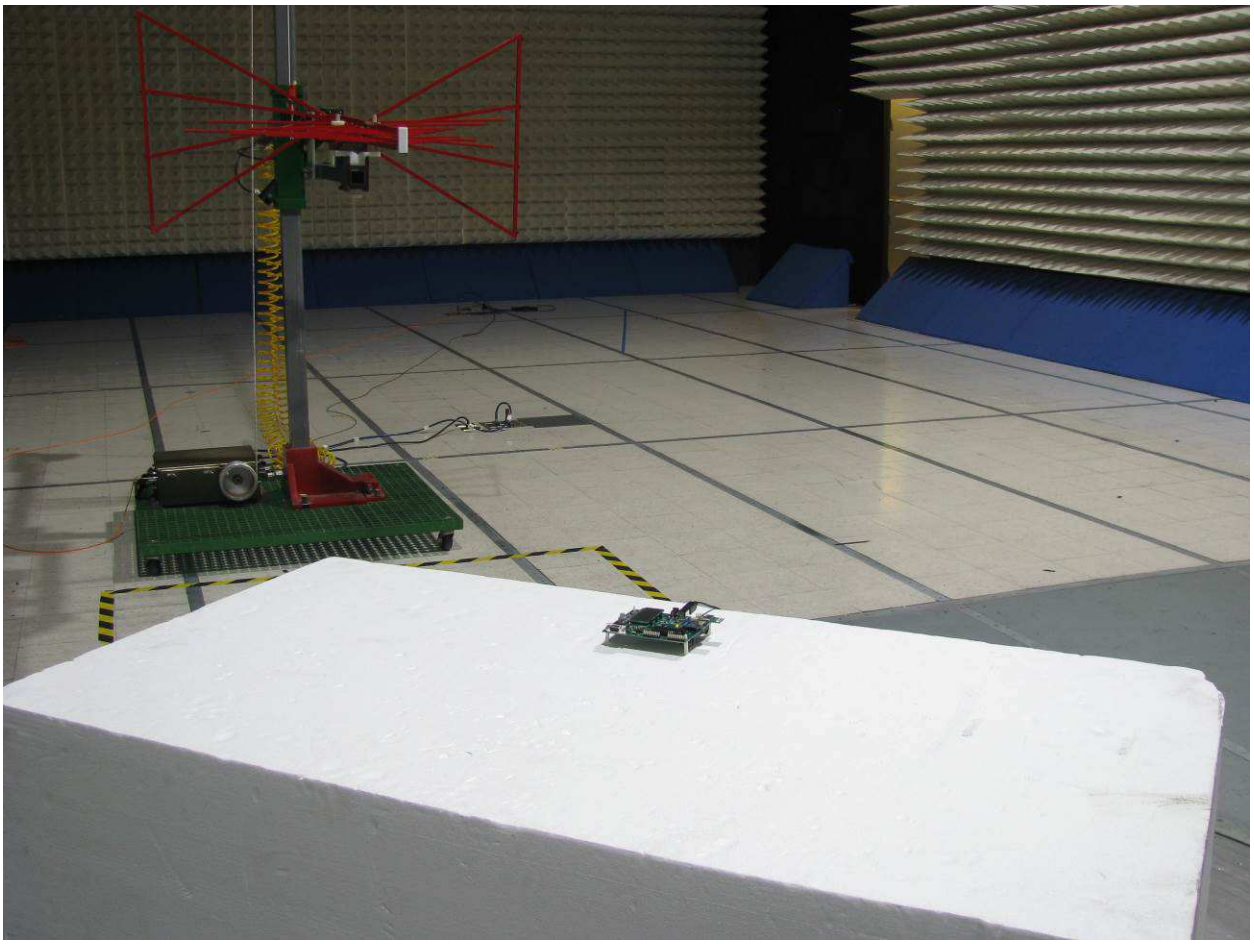
RA = 19.48 dBµV
AF = 18.52 dB
CF = 0.78 dB

FS = 19.48 + 18.52 + 0.78 = 38.78 dBµV/m
Level in µV/m = Common Antilogarithm [(38.78 dBµV/m)/20] = 86.89 µV/m

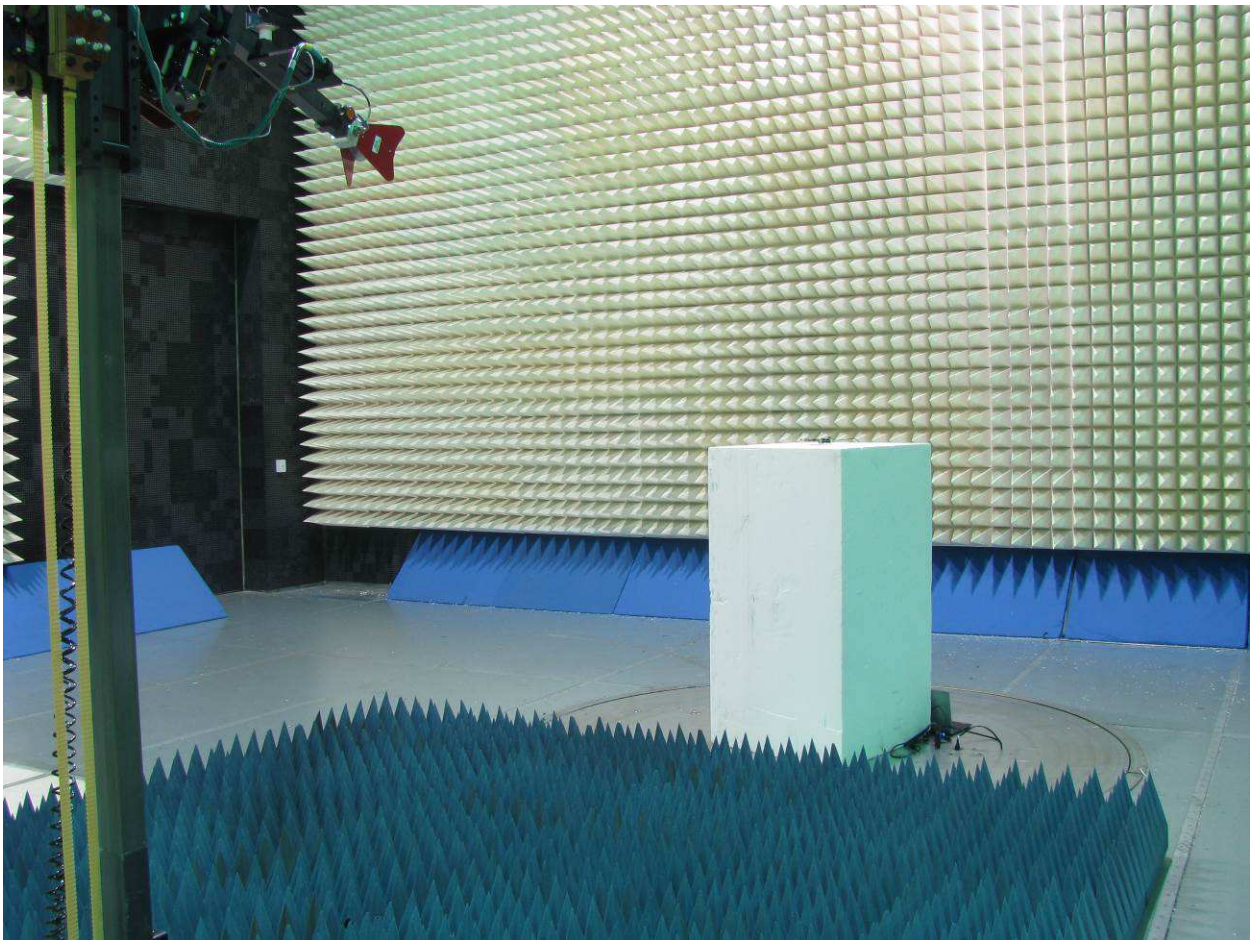
8.4 Test Equipment Used:

Description	Serial Number	Manufacturer	Model	Cal. Date	Cal. Due
EMI Test Receiver	1302.6005.40	Rohde&Schwarz	ESU40	9/19/2015	9/19/2016
Preamplifier	122005	Rohde&Schwarz	TS-PR18	11/26/2015	11/26/2016
Preamplifier	100050	Rohde&Schwarz	TS-PR26	11/26/2015	11/26/2016
Horn Antenna (18 – 40GHz)	00117798	ETS	3116c	4/22/2015	4/22/2016
Horn Antenna	00156319	ETS	3117	5/15/2015	5/15/2016
Bilog Antenna	00051864	ETS	3142C	1/20/2015	1/20/2016
System Controller	121701-1	Sunol Sciences	SC99V	Time of Use	Time of Use
Band Reject Filter	155	Micro-Tronics	BRM50702	Time of Use	Time of Use
EMC Software	Version 9.15.02	Rohde&Schwarz	EMC32	Time of Use	Time of Use

8.5 Test Photos:



Radiated Spurious Emissions (Bilog)



Radiated Spurious Emissions (Horn)

8.6 Results:

The radiated spurious testing was conducted up to 10 times the fundamental frequency. All spurious emissions were attenuated by at least 20dB below the level of the fundamental as required by Part 15.247(d). Additionally, all emissions falling within restricted bands of operation and at the band edges were found to be below the limit specified in Part 15.209(a). The spurious emissions listed in the following tables are the worst case emissions. Emissions not reported were at or below the measurement noise floor. The test sample was evaluated on three orthogonal axes since it could be used in any orientation.

Worst Case Spurious Emissions (Below 1GHz, External Antenna)

EUT Name:	Lexmark BTLE Module
Manufacturer:	Lexmark
Test Engineer:	Bryan Taylor
Date:	10/16/2015
Temp/Humidity/Pressure:	21.5C/47.7%/981.2mbar
Comment:	External Antenna, Channel 2440

Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
52.244000	22.78	40.00	17.22	120.000	108.9	V	149.0	10.3
100.340000	30.50	43.52	13.02	120.000	108.6	V	321.0	10.6
219.120000	30.56	46.02	15.46	120.000	108.0	V	46.0	14.3
268.640000	26.54	46.02	19.48	120.000	109.1	V	0.0	16.5
669.610000	34.12	46.02	11.90	120.000	295.5	V	218.0	26.3
702.180000	35.00	46.02	11.02	120.000	265.7	H	349.0	27.1
738.400000	36.20	46.02	9.82	120.000	134.6	H	283.0	27.2
795.010000	36.15	46.02	9.87	120.000	138.4	V	218.0	28.1
923.840000	38.51	46.02	7.51	120.000	135.4	H	94.0	30.0
963.980000	39.36	54.00	14.64	120.000	322.5	H	321.0	30.4

Worst Case Spurious Emissions (Below 1GHz, Chip Antenna)

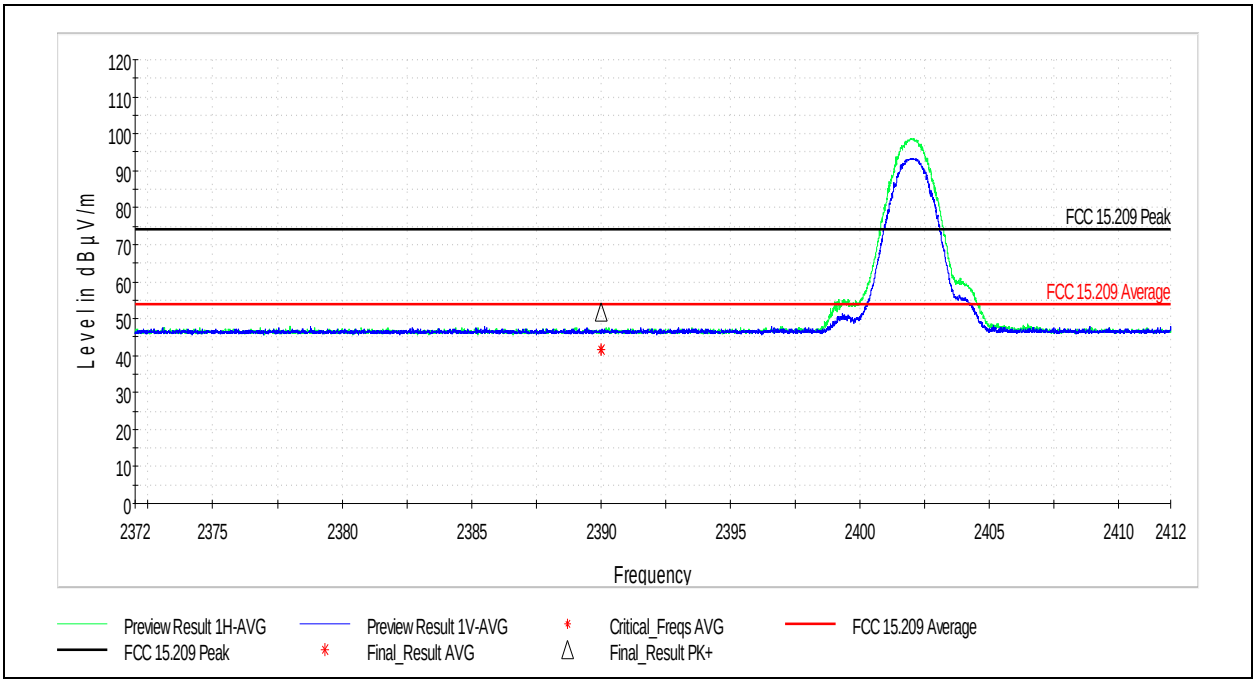
EUT Name:	Lexmark BTLE Module
Manufacturer:	Lexmark
Test Engineer:	Bryan Taylor
Date:	10/17/2015
Temp/Humidity/Pressure:	24.2C/54.5%/984.2mbar
Comment:	Chip Antenna, Channel 2440

Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
52.253000	24.60	40.00	15.40	120.000	105.4	V	44.0	10.3
52.550000	23.71	40.00	16.29	120.000	104.8	V	20.0	10.2
96.264000	30.44	43.52	13.08	120.000	109.7	V	319.0	10.4
206.640000	25.34	43.52	18.18	120.000	114.9	V	46.0	13.9
268.480000	29.76	46.02	16.26	120.000	105.0	V	0.0	16.5
731.620000	35.20	46.02	10.82	120.000	153.9	H	294.0	27.3

Worst Case Spurious Emissions (Channel 2402, Low Band Edge)

EUT Name:	Lexmark BTLE Module
Manufacturer:	Lexmark
Test Engineer:	Bryan Taylor
Date:	10/15/2015
Temp/Humidity/Pressure:	22.6C, 39.2%, 989.6mBar
Comment:	External Antenna, Low Band Edge

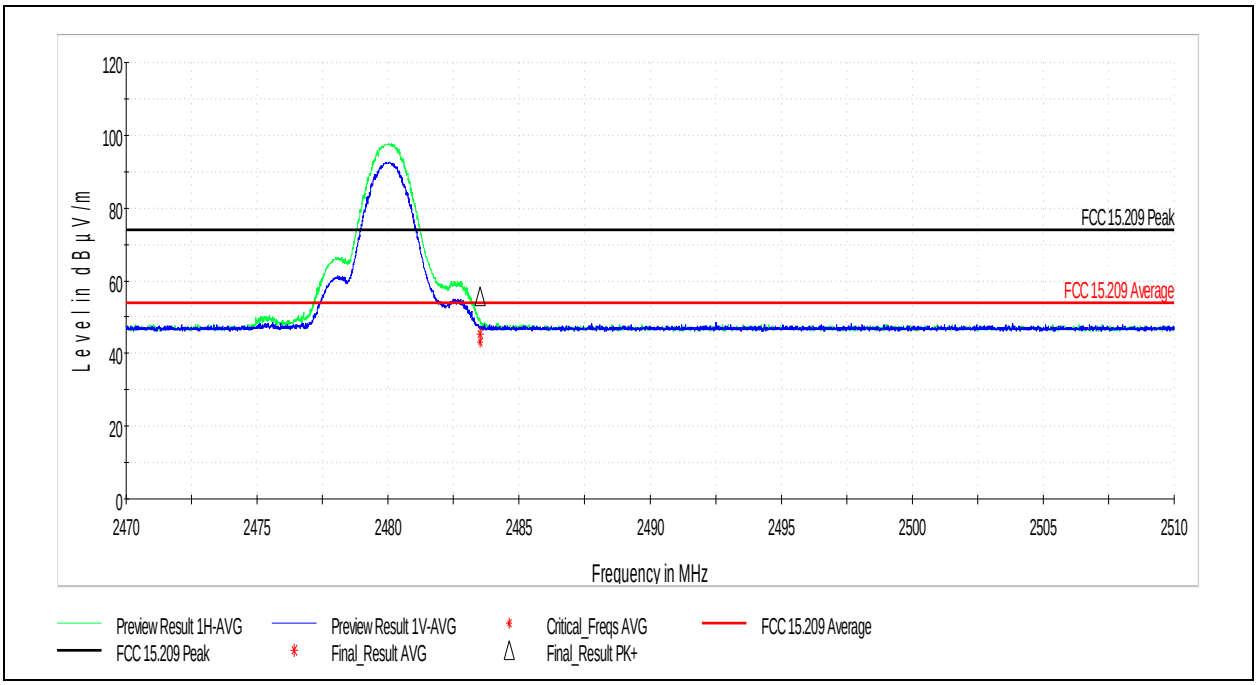


Final_Result

Frequency (MHz)	Average (dBµV/m)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
2390.000000	---	51.63	74.00	22.37	1000.000	222.0	V	152.0	37.7
2390.000000	41.66	---	54.00	12.34	1000.000	222.0	V	152.0	37.7

Worst Case Spurious Emissions (Channel 2480 High Band Edge)

Manufacturer:	Lexmark
Test Engineer:	Bryan Taylor
Date:	10/15/2015
Temp/Humidity/Pressure:	22.6C, 39.2%, 989.6mBar
Comment:	External Antenna, High Band Edge

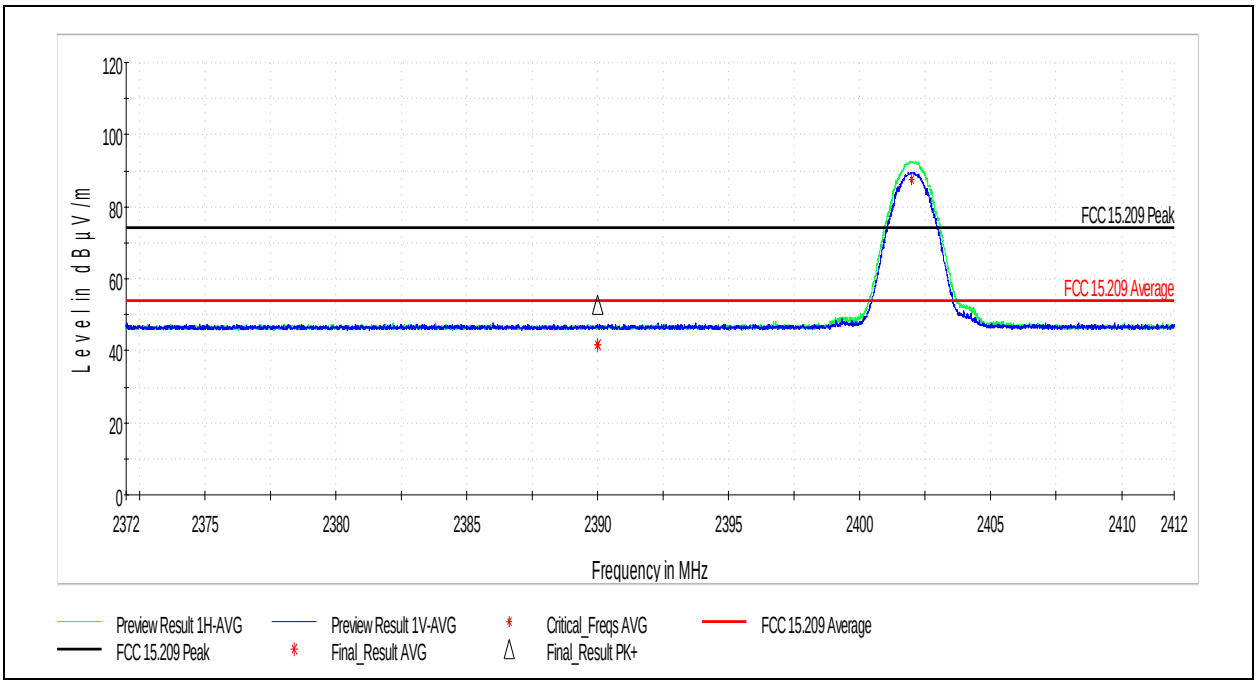


Final_Result

Frequency (MHz)	Average (dBµV/m)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
2483.500000	---	55.59	74.00	18.41	1000.000	363.0	H	183.0	37.8
2483.500000	45.21	---	54.00	8.79	1000.000	363.0	H	183.0	37.8

Worst Case Spurious Emissions (Channel 2402, Low Band Edge)

EUT Name:	Lexmark BTLE Module
Manufacturer:	Lexmark
Test Engineer:	Bryan Taylor
Date:	10/15/2015
Temp/Humidity/Pressure:	22.6C, 39.2%, 989.6mBar
Comment:	Chip Antenna, Low Band Edge

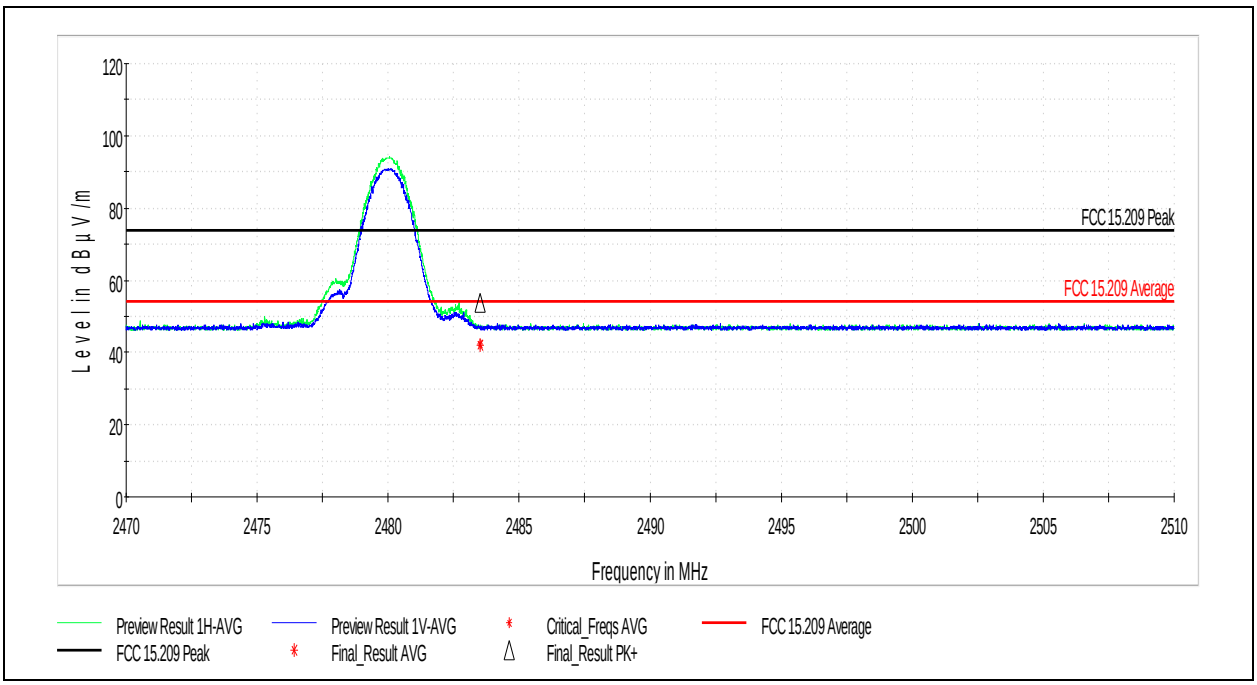


Final_Result

Frequency (MHz)	Average (dBµV/m)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
2390.000000	---	52.68	74.00	21.32	1000.000	212.0	H	274.0	37.7
2390.000000	41.53	---	54.00	12.47	1000.000	212.0	H	274.0	37.7

Worst Case Spurious Emissions (Channel 2480, High Band Edge)

EUT Name:	Lexmark BTLE Module
Manufacturer:	Lexmark
Test Engineer:	Bryan Taylor
Date:	10/15/2015
Temp/Humidity/Pressure:	22.6C, 39.2%, 989.6mBar
Comment:	Chip Antenna, High Band Edge



Final_Result

Frequency (MHz)	Average (dBµV/m)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
2483.500000	---	53.58	74.00	20.42	1000.000	245.0	V	131.0	37.8
2483.500000	42.15	---	54.00	11.85	1000.000	245.0	V	131.0	37.8

Worst Case Spurious Emissions (Channel 2402, Chip Antenna)

EUT Name: Lexmark BTLE Module
Manufacturer: Lexmark
Test Engineer: Bryan Taylor
Date: 10/15/2015
Temp/Humidity/Pressure: 22.6C, 39.2%, 989.6mBar
Comment: Chip Antenna, Channel 2402

Final_Result

Frequency (MHz)	Average (dBµV/m)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
4804.200000	---	48.41	74.00	25.59	1000.000	100.0	V	0.0	7.5
4804.200000	41.15	---	54.00	12.85	1000.000	100.0	V	0.0	7.5
7205.400000	---	46.85	74.00	27.15	1000.000	410.0	V	220.0	10.4
7205.400000	35.78	---	54.00	18.22	1000.000	410.0	V	220.0	10.4
9609.000000	---	45.93	74.00	28.07	1000.000	410.0	V	138.0	13.6
9609.000000	33.33	---	54.00	20.67	1000.000	410.0	V	138.0	13.6
12009.400000	---	49.80	74.00	24.20	1000.000	373.0	V	259.0	17.5
12009.400000	36.82	---	54.00	17.18	1000.000	373.0	V	259.0	17.5
14412.600000	---	48.43	74.00	25.57	1000.000	238.0	V	252.0	17.0
14412.600000	35.54	---	54.00	18.46	1000.000	238.0	V	252.0	17.0
16813.400000	---	53.34	74.00	20.66	1000.000	410.0	V	234.0	21.5
16813.400000	40.56	---	54.00	13.44	1000.000	410.0	V	234.0	21.5

Worst Case Spurious Emissions (Channel 2440, Chip Antenna)

EUT Name: Lexmark BTLE Module
Manufacturer: Lexmark
Test Engineer: Bryan Taylor
Date: 10/15/2015
Temp/Humidity/Pressure: 22.6C, 39.2%, 989.6mBar
Comment: Chip Antenna, Channel 2440

Final_Result

Frequency (MHz)	Average (dBµV/m)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
4880.200000	---	44.87	74.00	29.13	1000.000	330.0	V	124.0	7.4
4880.200000	34.41	---	54.00	19.59	1000.000	330.0	V	124.0	7.4
7319.400000	---	46.72	74.00	27.28	1000.000	410.0	V	218.0	10.5
7319.400000	35.02	---	54.00	18.98	1000.000	410.0	V	218.0	10.5
9761.000000	---	47.46	74.00	26.54	1000.000	388.0	V	265.0	13.7
9761.000000	34.42	---	54.00	19.58	1000.000	388.0	V	265.0	13.7
12200.600000	---	49.60	74.00	24.40	1000.000	410.0	V	254.0	17.2
12200.600000	36.67	---	54.00	17.33	1000.000	410.0	V	254.0	17.2
14640.200000	---	48.75	74.00	25.25	1000.000	309.0	V	305.0	17.3
14640.200000	36.05	---	54.00	17.95	1000.000	309.0	V	305.0	17.3
17080.200000	---	53.50	74.00	20.50	1000.000	410.0	V	180.0	21.3
17080.200000	39.97	---	54.00	14.03	1000.000	410.0	V	180.0	21.3

Worst Case Spurious Emissions (Channel 2480, Chip Antenna)

EUT Name:	Lexmark BTLE Module
Manufacturer:	Lexmark
Test Engineer:	Bryan Taylor
Date:	10/15/2015
Temp/Humidity/Pressure:	22.6C, 39.2%, 989.6mBar
Comment:	Chip Antenna, Channel 2480

Final_Result

Frequency (MHz)	Average (dBµV/m)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
4959.800000	35.10	---	54.00	18.90	1000.000	299.0	V	123.0	7.2
4959.800000	---	44.89	74.00	29.11	1000.000	299.0	V	123.0	7.2
7440.600000	41.66	---	54.00	12.34	1000.000	410.0	V	215.0	10.9
7440.600000	---	50.76	74.00	23.24	1000.000	410.0	V	215.0	10.9
9919.400000	34.80	---	54.00	19.20	1000.000	286.0	H	288.0	14.0
9919.400000	---	46.79	74.00	27.21	1000.000	286.0	H	288.0	14.0
12399.000000	36.35	---	54.00	17.65	1000.000	352.0	V	317.0	16.9
12399.000000	---	49.33	74.00	24.67	1000.000	352.0	V	317.0	16.9
14881.000000	---	50.86	74.00	23.14	1000.000	287.0	H	329.0	18.2
14881.000000	37.48	---	54.00	16.52	1000.000	287.0	H	329.0	18.2
17359.800000	---	51.98	74.00	22.02	1000.000	314.0	V	0.0	20.6
17359.800000	38.80	---	54.00	15.20	1000.000	314.0	V	0.0	20.6

Worst Case Spurious Emissions (Channel 2402, External Antenna)

EUT Name:	Lexmark BTLE Module
Manufacturer:	Lexmark
Test Engineer:	Bryan Taylor
Date:	10/16/2015
Temp/Humidity/Pressure:	21.5C/47.7%/981.2mbar
Comment:	External Antenna, Channel 2402

Final_Result

Frequency (MHz)	Average (dBµV/m)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
4804.200000	---	45.48	74.00	28.52	1000.000	370.0	V	170.0	7.5
4804.200000	36.14	---	54.00	17.86	1000.000	370.0	V	170.0	7.5
7205.400000	51.09	---	54.00	2.91	1000.000	380.0	V	276.0	10.4
7205.400000	---	57.99	74.00	16.01	1000.000	380.0	V	276.0	10.4
9609.000000	35.79	---	54.00	18.21	1000.000	372.0	H	287.0	13.6
9609.000000	---	48.43	74.00	25.57	1000.000	372.0	H	287.0	13.6
12011.000000	---	49.78	74.00	24.22	1000.000	410.0	V	213.0	17.4
12011.000000	37.61	---	54.00	16.39	1000.000	410.0	V	213.0	17.4
14413.000000	35.27	---	54.00	18.73	1000.000	377.0	H	210.0	17.0
14413.000000	---	47.91	74.00	26.09	1000.000	377.0	H	210.0	17.0
16813.400000	40.40	---	54.00	13.60	1000.000	252.0	H	292.0	21.5
16813.400000	---	53.06	74.00	20.94	1000.000	252.0	H	292.0	21.5

Worst Case Spurious Emissions (Channel 2440, External Antenna)

EUT Name: Lexmark BTLE Module
Manufacturer: Lexmark
Test Engineer: Bryan Taylor
Date: 10/16/2015
Temp/Humidity/Pressure: 21.5C/47.7%/981.2mbar
Comment: External Antenna, Channel 2440

Final_Result

Frequency (MHz)	Average (dBµV/m)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
4880.200000	39.49	---	54.00	14.51	1000.000	388.0	V	260.0	7.4
4880.200000	---	47.34	74.00	26.66	1000.000	388.0	V	260.0	7.4
7320.600000	---	50.30	74.00	23.70	1000.000	240.0	V	233.0	10.5
7320.600000	41.32	---	54.00	12.68	1000.000	240.0	V	233.0	10.5
9761.000000	---	47.50	74.00	26.50	1000.000	266.0	H	280.0	13.7
9761.000000	34.53	---	54.00	19.47	1000.000	266.0	H	280.0	13.7
12199.000000	38.92	---	54.00	15.08	1000.000	339.0	H	297.0	17.2
12199.000000	---	51.41	74.00	22.59	1000.000	339.0	H	297.0	17.2
14640.200000	---	48.60	74.00	25.40	1000.000	274.0	H	176.0	17.3
14640.200000	35.98	---	54.00	18.02	1000.000	274.0	H	176.0	17.3
17080.200000	---	52.83	74.00	21.17	1000.000	375.0	H	118.0	21.3
17080.200000	39.93	---	54.00	14.07	1000.000	375.0	H	118.0	21.3

Worst Case Spurious Emissions (Channel 2480, External Antenna)

EUT Name: Lexmark BTLE Module
Manufacturer: Lexmark
Test Engineer: Bryan Taylor
Date: 10/16/2015
Temp/Humidity/Pressure: 21.5C/47.7%/981.2mbar
Comment: External Antenna, Channel 2480

Final_Result

Frequency (MHz)	Average (dBµV/m)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
4959.800000	---	44.85	74.00	29.15	1000.000	335.0	V	254.0	7.2
4959.800000	34.95	---	54.00	19.05	1000.000	335.0	V	254.0	7.2
7440.600000	41.28	---	54.00	12.72	1000.000	397.0	V	227.0	10.9
7440.600000	---	50.68	74.00	23.32	1000.000	397.0	V	227.0	10.9
9919.800000	34.20	---	54.00	19.80	1000.000	268.0	H	277.0	14.0
9919.800000	---	47.08	74.00	26.92	1000.000	268.0	H	277.0	14.0
12399.000000	---	48.68	74.00	25.32	1000.000	240.0	V	198.0	16.9
12399.000000	36.09	---	54.00	17.91	1000.000	240.0	V	198.0	16.9
14881.000000	37.42	---	54.00	16.58	1000.000	410.0	H	171.0	18.2
14881.000000	---	49.75	74.00	24.25	1000.000	410.0	H	171.0	18.2
17359.800000	38.62	---	54.00	15.38	1000.000	323.0	H	0.0	20.6
17359.800000	---	52.32	74.00	21.68	1000.000	323.0	H	0.0	20.6
1595.800000	22.25	---	54.00	31.75	1000.000	306.0	V	181.0	-1.3
1595.800000	---	44.12	74.00	29.88	1000.000	306.0	V	181.0	-1.3

9 Radiated Spurious Emissions (Receiver)

9.1 Test Limits

§ 15.109: Except for Class A digital devices, the field strength of radiated emissions from unintentional radiators at a distance of 3 meters shall not exceed the following values:

Frequency of emission (MHz)	Field strength (microvolts/meter)	Field strength (dBuV/m)
30–88	100	40
88–216	150	43.5
216–960	200	46
Above 960	500	54

These limits are identical to those in RSS-GEN

9.2 Test Procedure

ANSI C63.4: 2014

9.3 Example of Field Strength Calculation Method:

The measured field strength was calculated by summing the readings taken from the spectrum analyzer with the appropriate correction factors associated with the antenna losses and cable losses. The calculation formula and sample calculations are listed below:

Formula:
FS = RA + AF + CF

FS = Field Strength in dBµV/m
RA = Receiver Amplitude in dBµV
AF = Antenna Factor in dB
CF = Cable Attenuation Factor in dB (Including preamplifier and filter attenuation)

Example Calculation:

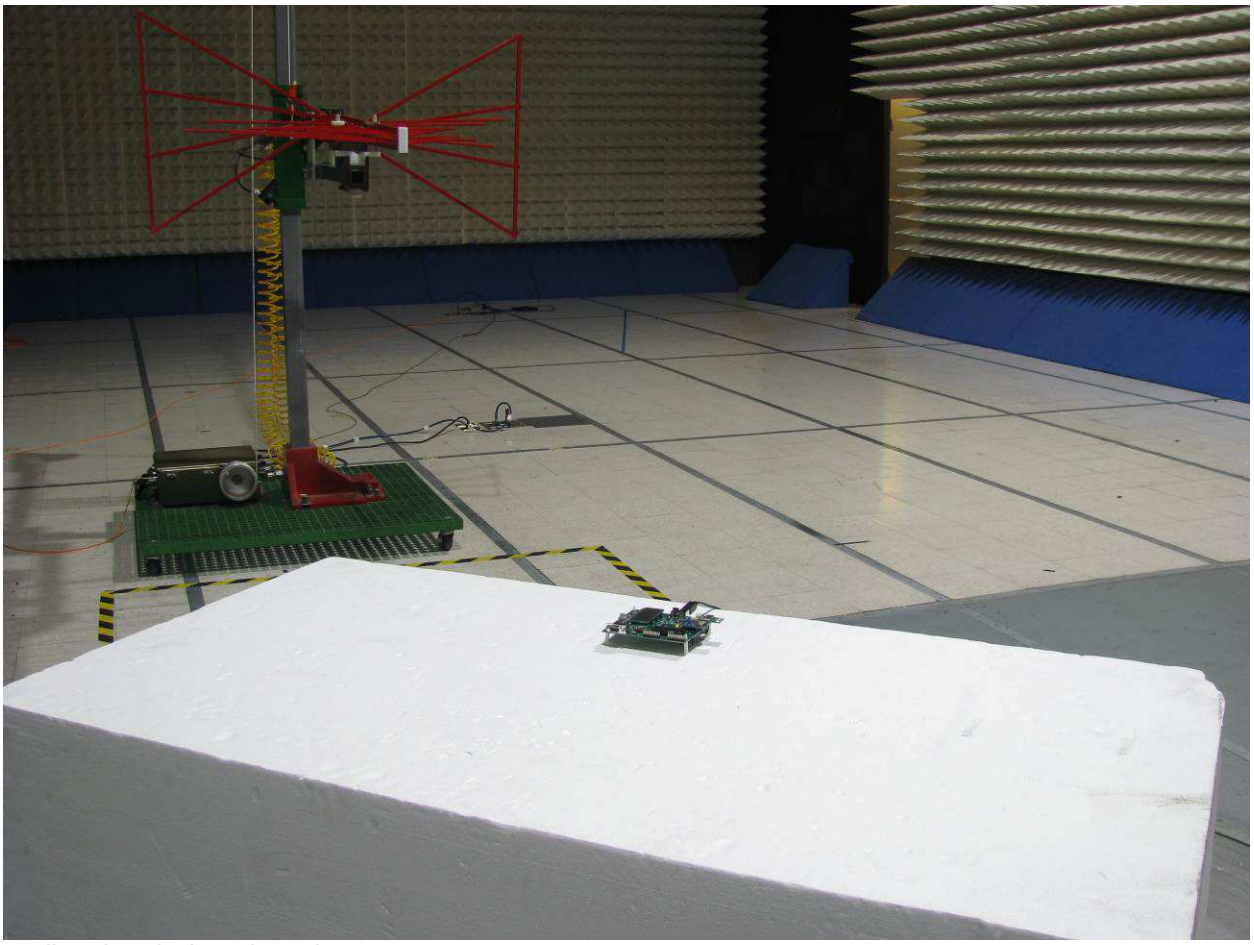
RA = 19.48 dBµV
AF = 18.52 dB
CF = 0.78 dB

FS = 19.48 + 18.52 + 0.78 = 38.78 dBµV/m
Level in µV/m = Common Antilogarithm [(38.78 dBµV/m)/20] = 86.89 µV/m

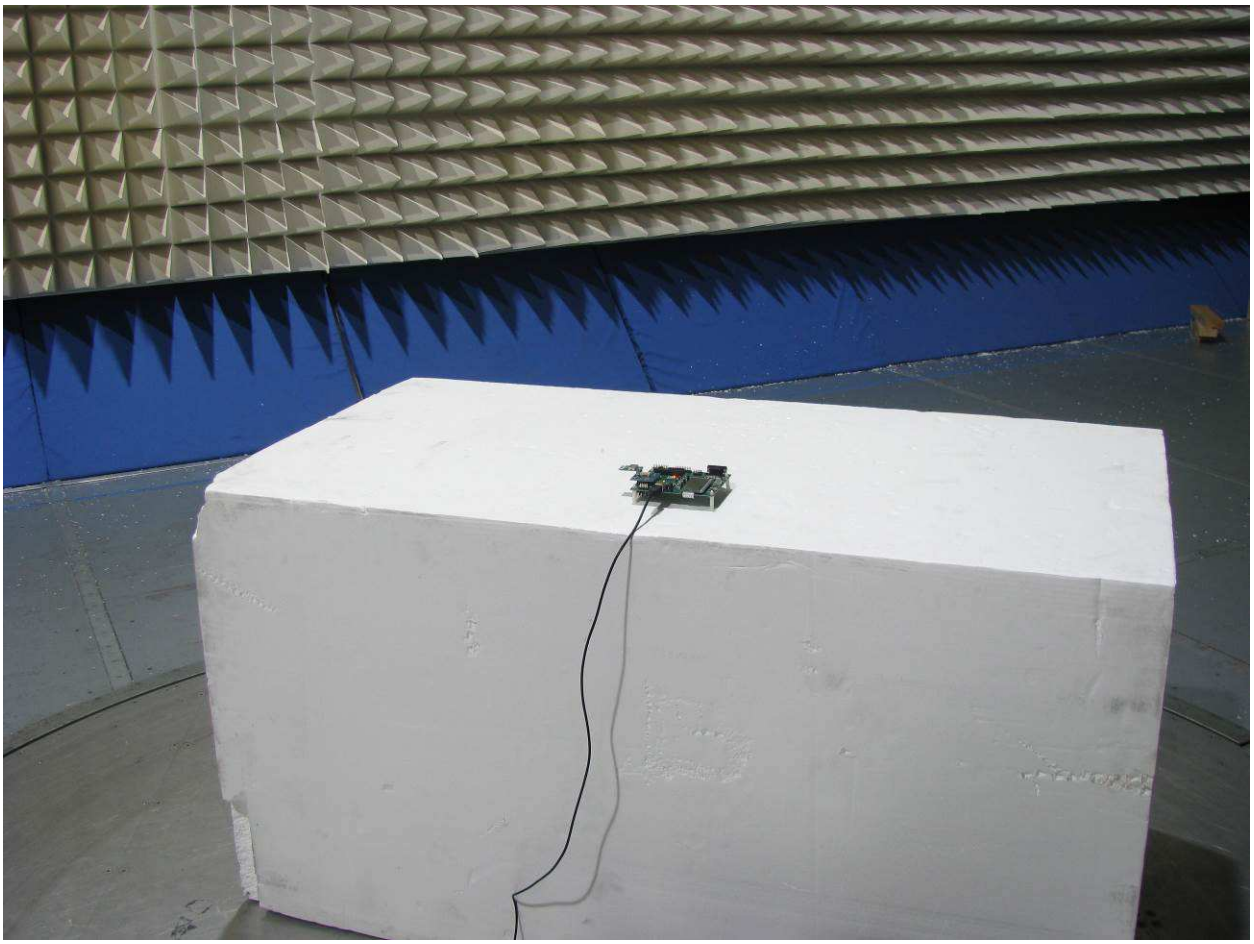
9.4 Test Equipment Used:

Description	Serial Number	Manufacturer	Model	Cal. Date	Cal. Due
EMI Test Receiver	1302.6005.40	Rohde&Schwarz	ESU40	9/19/2015	9/19/2016
Preamplifier	122005	Rohde&Schwarz	TS-PR18	11/26/2015	11/26/2016
Horn Antenna	00156319	ETS	3117	5/15/2015	5/15/2016
Bilog Antenna	00051864	ETS	3142C	1/20/2015	1/20/2016
System Controller	121701-1	Sunol Sciences	SC99V	Time of Use	Time of Use
EMC Software	Version 9.15.02	Rohde&Schwarz	EMC32	Time of Use	Time of Use

9.5 Test Photos:



Radiated Emissions (Front)



Radiated Emissions (Back)

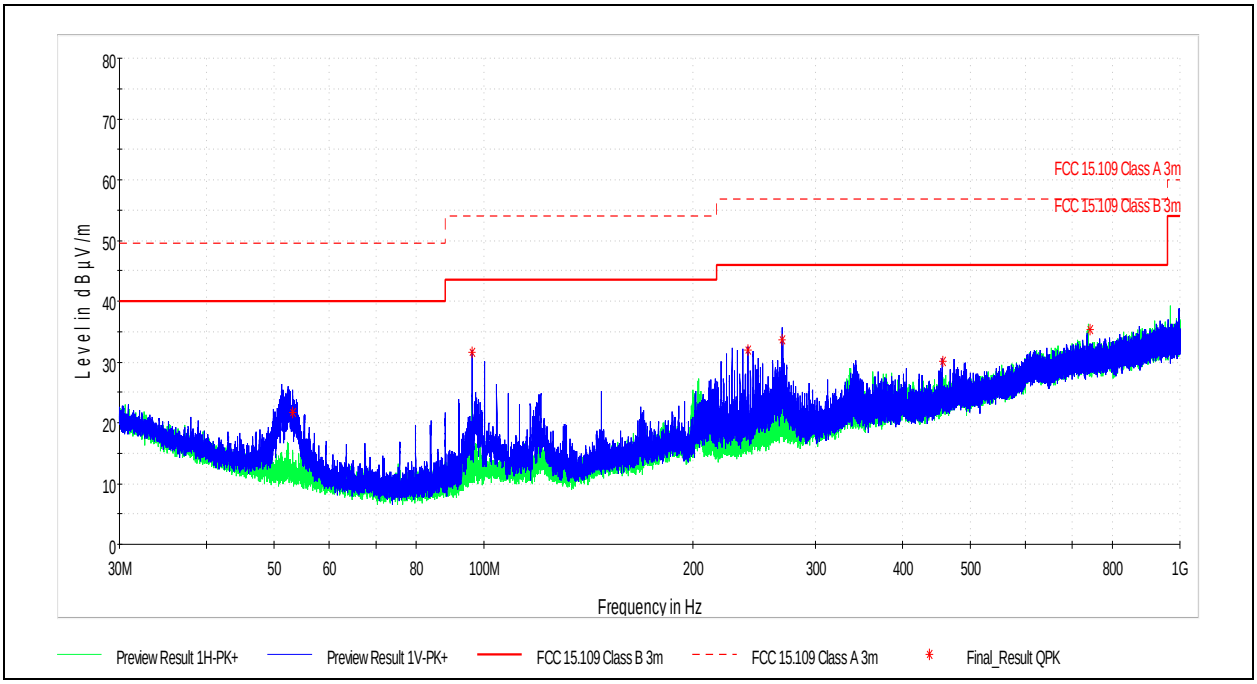
9.6 Results:

All spurious emissions with the test sample in receive mode were below the limits specified in Part 15.109 for a class B digital device ICES-003 and RSS-GEN Section 6.1.

9.1 Test Data

Worst Case Spurious Emissions (Chip Antenna, Constant Receive)

EUT Name:	Lexmark BTLE Module
Manufacturer:	Lexmark
Test Engineer:	Bryan Taylor
Date:	10/17/2015
Temp/Humidity/Pressure:	24.2C/54.5%/984.2mbar
Comment:	Chip Antenna, Constant Receive

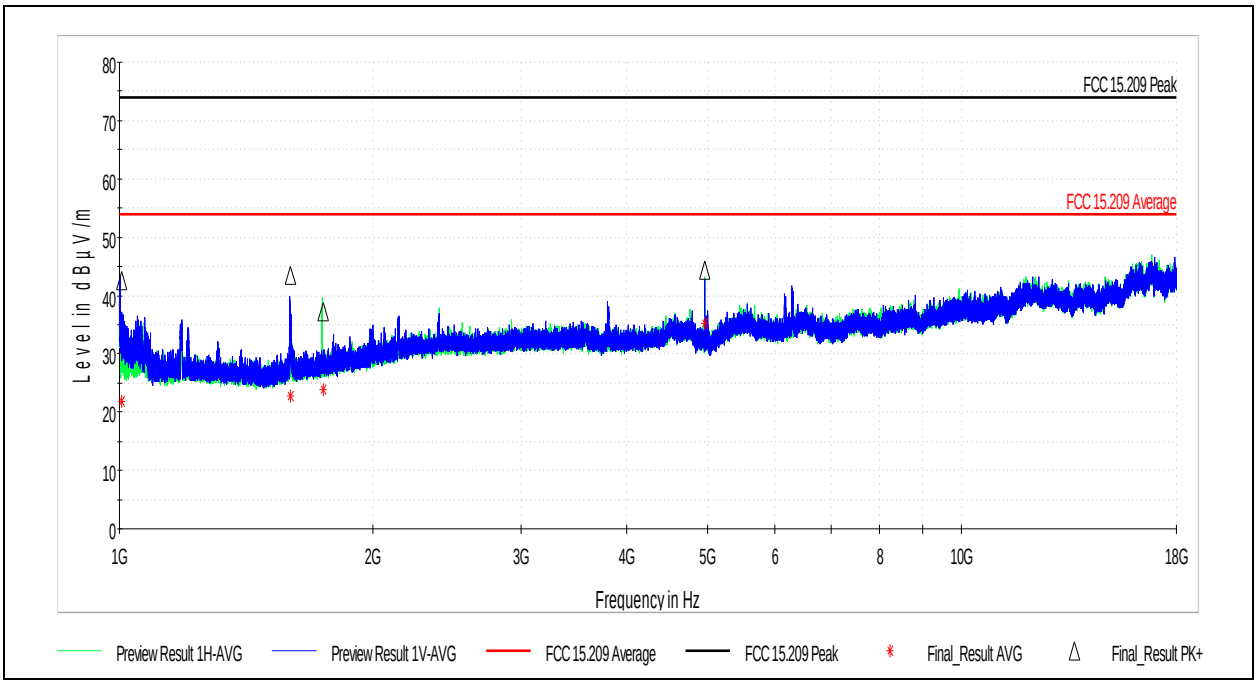


Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
53.205000	21.76	40.00	18.24	120.000	110.1	V	0.0	10.0
96.248000	31.56	43.52	11.96	120.000	109.6	V	311.0	10.4
239.600000	31.89	46.02	14.13	120.000	104.1	V	74.0	15.4
268.280000	33.61	46.02	12.41	120.000	109.2	V	257.0	16.5
456.720000	30.07	46.02	15.95	120.000	109.2	V	257.0	22.2
742.160000	35.34	46.02	10.68	120.000	115.5	H	11.0	27.3

Worst Case Spurious Emissions (Chip Antenna, Constant Receive)

EUT Name:	Lexmark BTLE Module
Manufacturer:	Lexmark
Test Engineer:	Bryan Taylor
Date:	10/15/2015
Temp/Humidity/Pressure:	22.6C, 39.2%, 989.6mBar
Comment:	Chip Antenna, Constant Receive

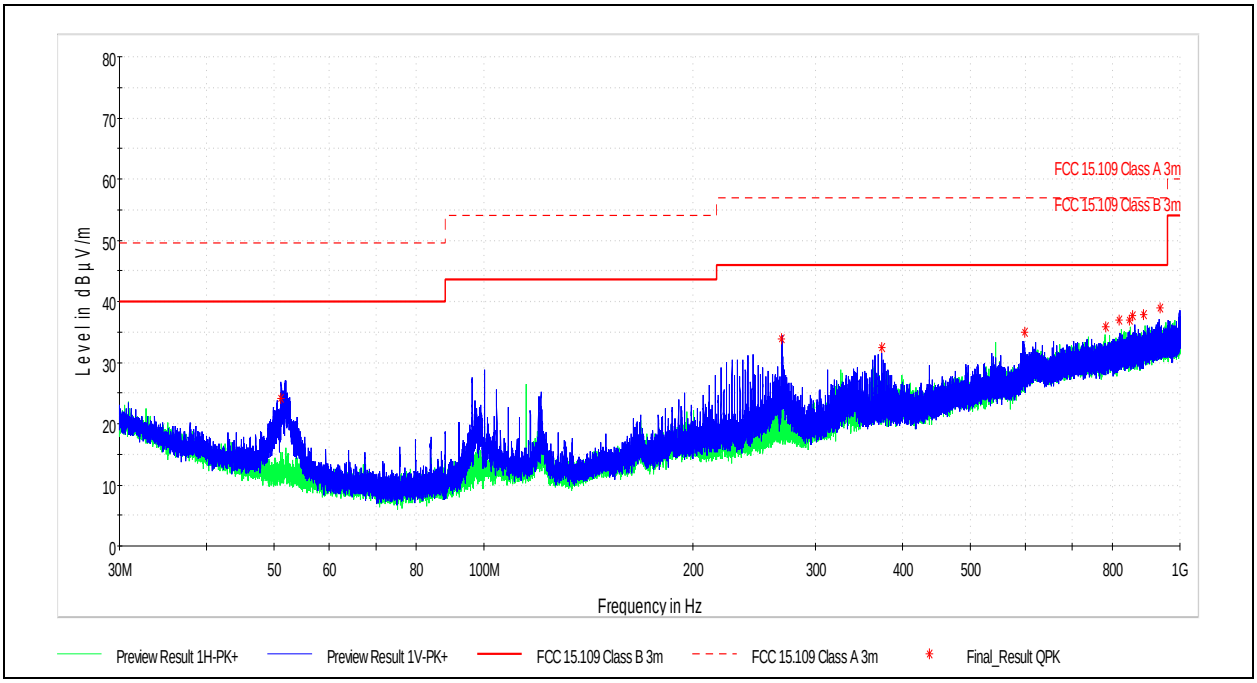


Final_Result

Frequency (MHz)	Average (dBµV/m)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
1005.400000	---	42.64	74.00	31.36	1000.000	297.0	V	204.0	-2.8
1005.400000	21.73	---	54.00	32.27	1000.000	297.0	V	204.0	-2.8
1596.500000	---	43.49	74.00	30.51	1000.000	410.0	V	196.0	-1.3
1596.500000	22.64	---	54.00	31.36	1000.000	410.0	V	196.0	-1.3
1746.900000	---	37.30	74.00	36.70	1000.000	344.0	V	178.0	0.0
1746.900000	23.81	---	54.00	30.19	1000.000	344.0	V	178.0	0.0
4958.000000	---	44.36	74.00	29.64	1000.000	410.0	V	158.0	7.2
4958.000000	35.28	---	54.00	18.72	1000.000	410.0	V	158.0	7.2

Worst Case Spurious Emissions (External Antenna, Constant Receive)

EUT Name:	Lexmark BTLE Module
Manufacturer:	Lexmark
Test Engineer:	Bryan Taylor
Date:	10/16/2015
Temp/Humidity/Pressure:	21.5C/47.7%/981.2mbar
Comment:	External Antenna, Constant Receive

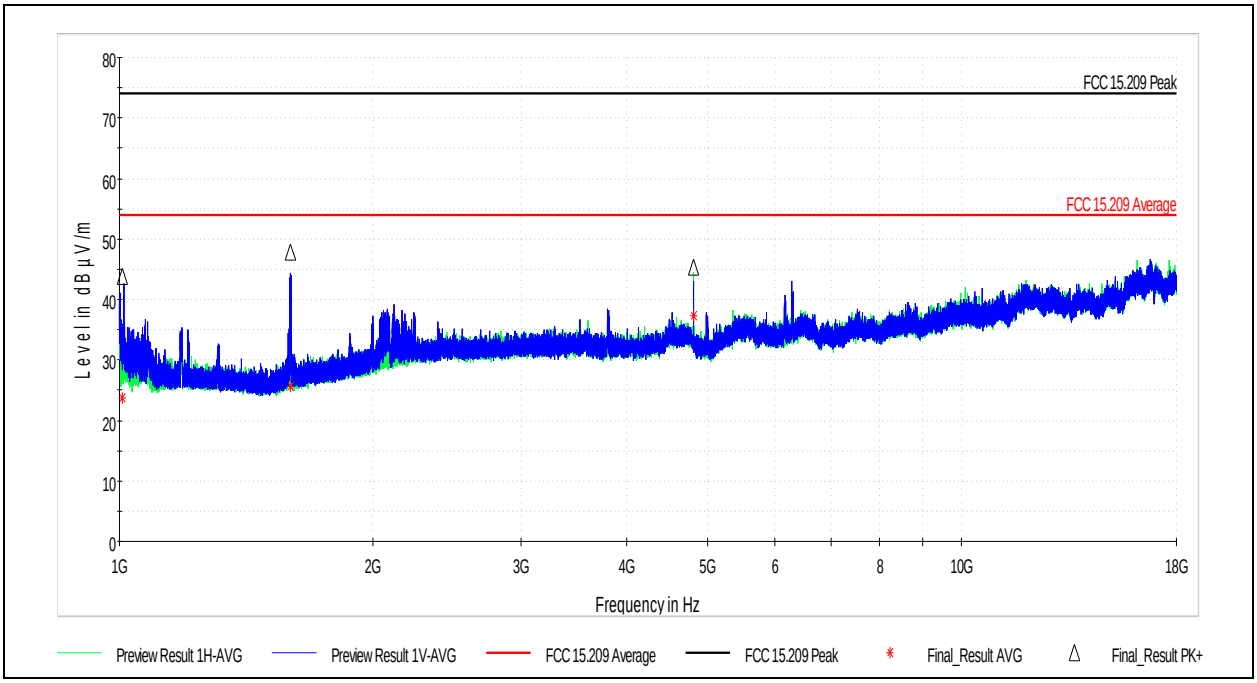


Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
51.206000	24.12	40.00	15.88	120.000	105.3	V	332.0	10.4
267.860000	33.90	46.02	12.12	120.000	109.7	V	85.0	16.4
372.720000	32.51	46.02	13.51	120.000	114.7	V	273.0	20.2
598.010000	34.87	46.02	11.15	120.000	105.0	V	264.0	25.4
781.700000	35.89	46.02	10.13	120.000	229.9	H	0.0	27.8
818.000000	36.88	46.02	9.14	120.000	118.2	H	90.0	28.7
845.620000	36.92	46.02	9.10	120.000	381.9	H	9.0	28.7
855.340000	37.70	46.02	8.32	120.000	130.3	V	336.0	29.1
886.580000	37.76	46.02	8.26	120.000	390.6	H	117.0	29.4
936.320000	38.93	46.02	7.09	120.000	388.9	V	158.0	30.1

Worst Case Spurious Emissions (External Antenna, Constant Receive)

EUT Name:	Lexmark BTLE Module
Manufacturer:	Lexmark
Test Engineer:	Bryan Taylor
Date:	10/16/2015
Temp/Humidity/Pressure:	21.5C/47.7%/981.2mbar
Comment:	External Antenna, Constant Receive



Final_Result

Frequency (MHz)	Average (dBµV/m)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
1007.900000	---	43.92	74.00	30.08	1000.000	254.0	V	202.0	-2.7
1007.900000	23.74	---	54.00	30.26	1000.000	254.0	V	202.0	-2.7
1596.900000	---	47.77	74.00	26.23	1000.000	295.0	V	181.0	-1.3
1596.900000	25.68	---	54.00	28.32	1000.000	295.0	V	181.0	-1.3
4806.000000	---	45.41	74.00	28.59	1000.000	203.0	V	218.0	7.5
4806.000000	37.34	---	54.00	16.66	1000.000	203.0	V	218.0	7.5

10 AC Powerline Conducted Emissions

10.1 Test Limits

§ 15.107(e): Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 µH/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Frequency of emission (MHz)	Conducted limit (dBµV)	
	Quasi-peak	Average
0.15–0.5	66 to 56*	56 to 46*
0.5–5	56	46
5–30	60	50

*Decreases with the logarithm of the frequency.

10.2 Test Procedure

ANSI C63.4: 2014

10.3 Test Equipment Used:

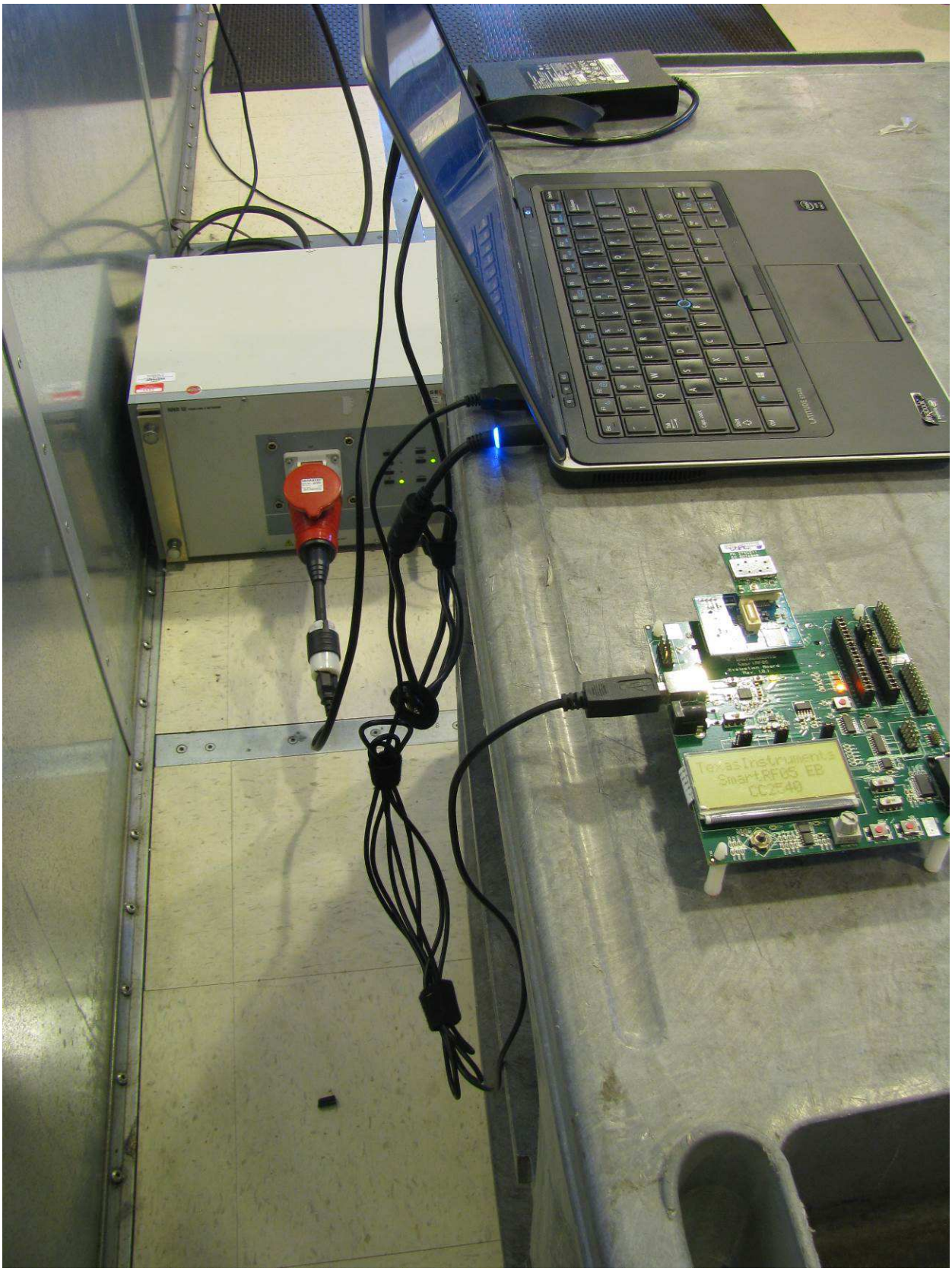
Description	Serial Number	Manufacturer	Model	Cal. Date	Cal. Due
EMI Test Receiver	10887490.26	Rohde & Schwarz	ESI26	9/20/2015	9/20/2016
LISN	3333	Teseq	NNB52	3/12/2015	3/12/2016

10.4 Results:

All spurious emissions with the test sample in receive mode were below the limits specified in Part 15.107 for a class B digital device ICES-003 and RSS-GEN Section 6.1.

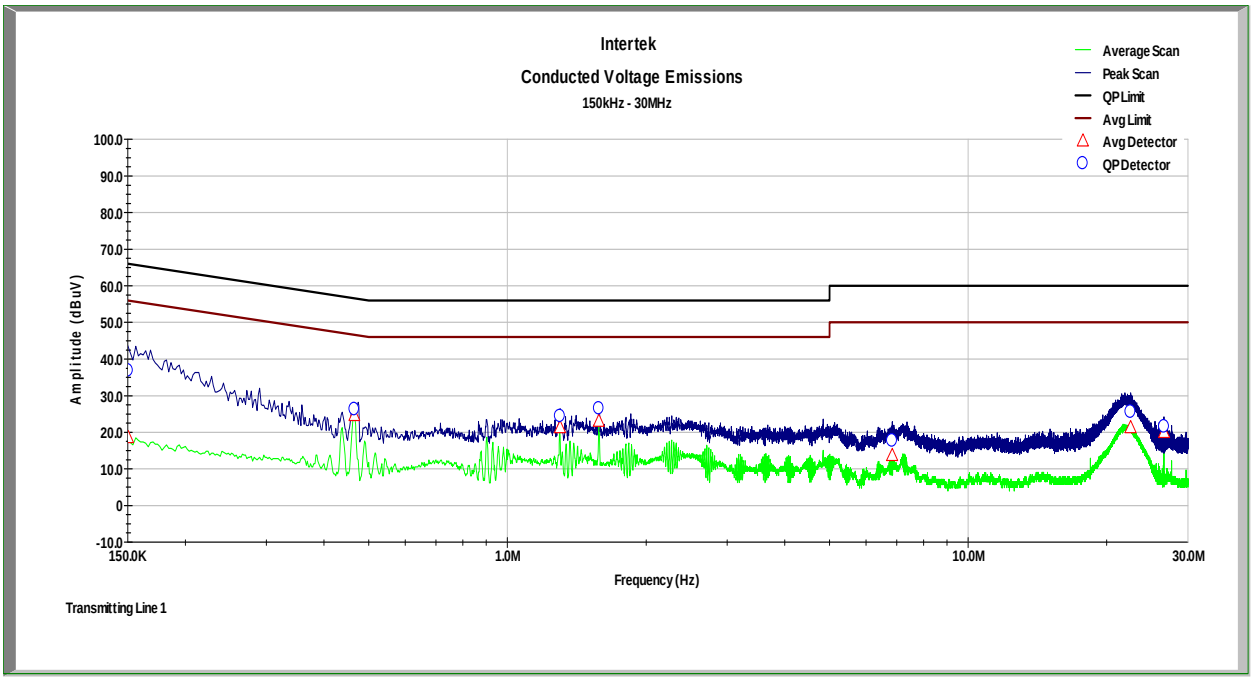
10.5 Test Photos:

Conducted Emissions (Front Side)



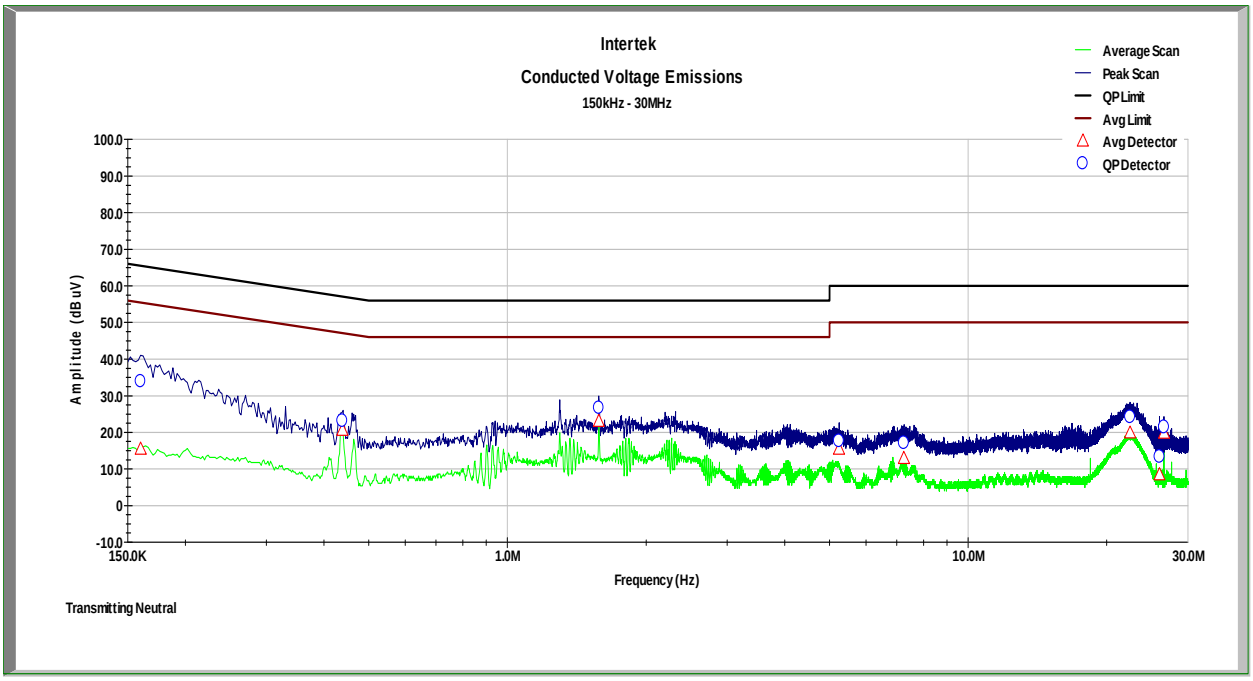
Conducted Emissions (Side View)

10.6 Results:



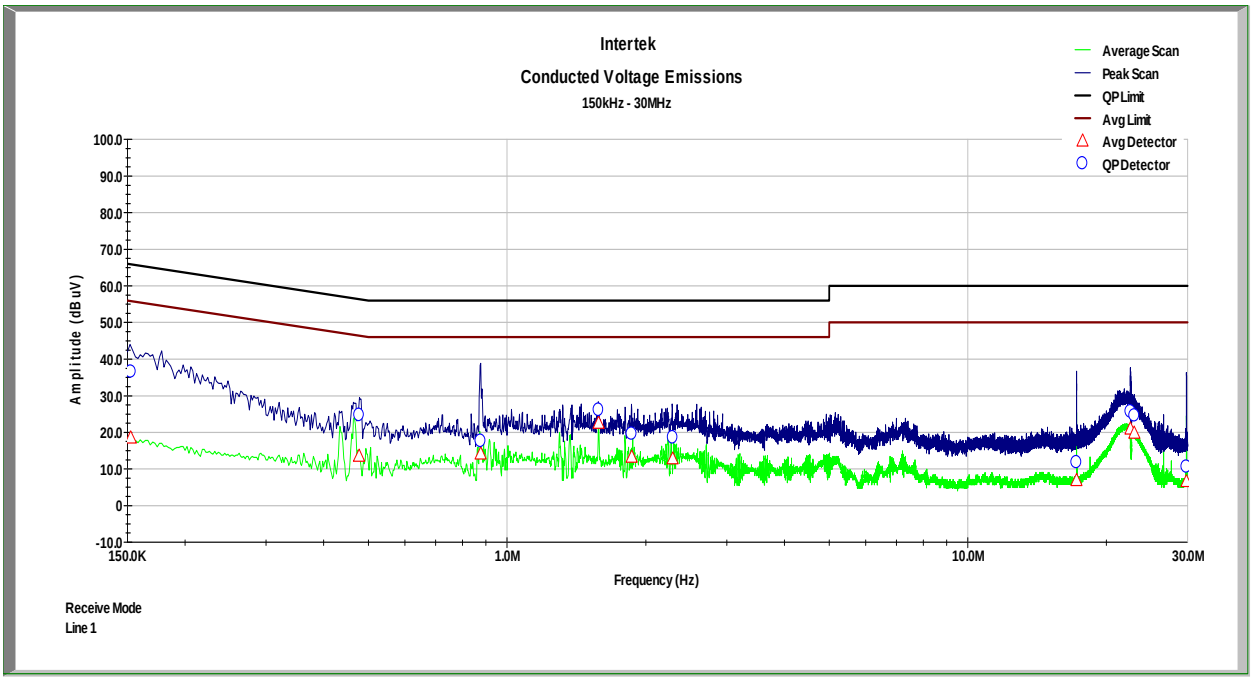
Frequency (MHz)	Quasi-Peak (dBuV)	Quasi-Peak Limit (dBuV)	Quasi-Peak Margin (dB)	Average (dBuV)	Average Limit (dBuV)	Average Margin (dB)
150.100 KHz	36.788	65.997	-29.209	18.549	55.997	-37.448
465.500 KHz	26.230	56.986	-30.756	24.560	46.986	-22.425
1.300 MHz	24.375	56.000	-31.625	21.296	46.000	-24.704
1.579 MHz	26.498	56.000	-29.502	23.028	46.000	-22.972
6.838 MHz	17.667	60.000	-42.333	13.663	50.000	-36.337
22.532 MHz	25.562	60.000	-34.438	21.266	50.000	-28.734
26.624 MHz	21.507	60.000	-38.493	19.885	50.000	-30.115

Transmitting; Line 1



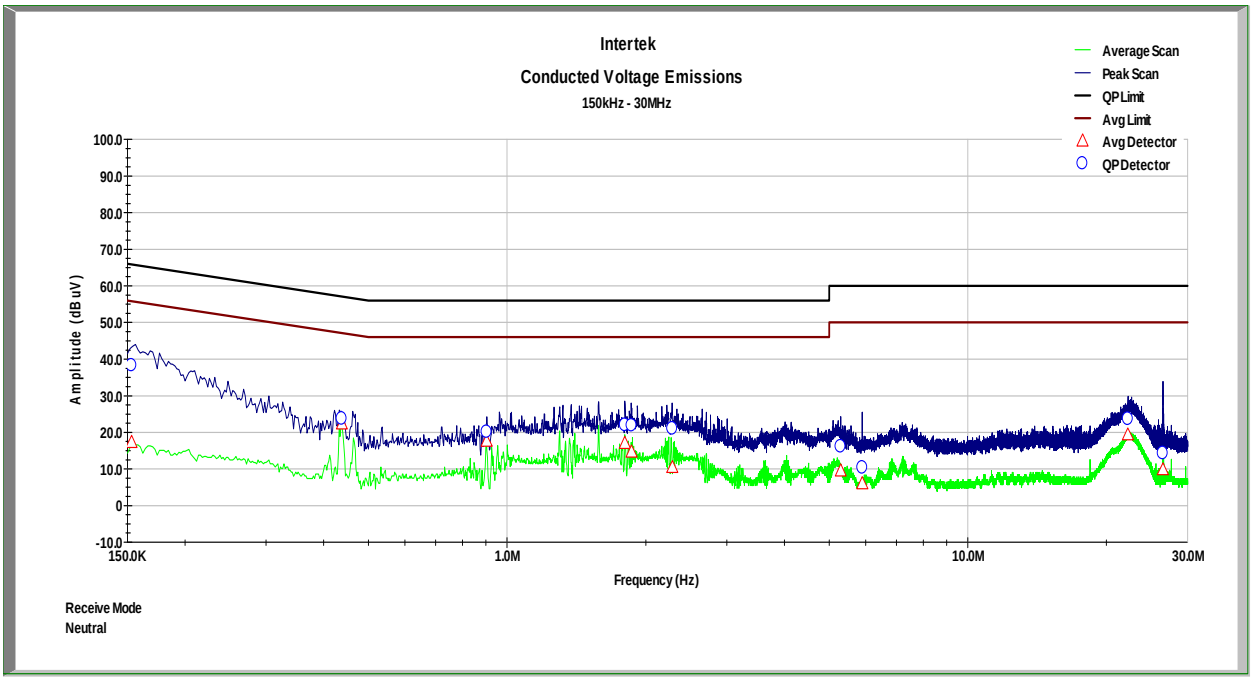
Frequency (MHz)	Quasi-Peak (dBuV)	Quasi-Peak Limit (dBuV)	Quasi-Peak Margin (dB)	Average (dBuV)	Average Limit (dBuV)	Average Margin (dB)
159.900 KHz	33.926	65.717	-31.791	15.423	55.717	-40.294
438.400 KHz	23.089	57.760	-34.671	20.545	47.760	-27.215
1.579 MHz	26.636	56.000	-29.364	23.028	46.000	-22.972
5.246 MHz	17.600	60.000	-42.400	15.424	50.000	-34.576
7.253 MHz	17.065	60.000	-42.935	12.883	50.000	-37.117
22.469 MHz	24.155	60.000	-35.845	19.834	50.000	-30.166
26.027 MHz	13.284	60.000	-46.716	8.409	50.000	-41.591
26.623 MHz	21.377	60.000	-38.623	19.727	50.000	-30.273

Transmitting; Neutral



Frequency (MHz)	Quasi-Peak (dBuV)	Quasi-Peak Limit (dBuV)	Quasi-Peak Margin (dB)	Average (dBuV)	Average Limit (dBuV)	Average Margin (dB)
152.400 KHz	36.489	65.931	-29.443	18.473	55.931	-37.458
477.100 KHz	24.676	56.654	-31.979	13.498	46.654	-33.156
876.400 KHz	17.602	56.000	-38.398	14.104	46.000	-31.896
1.580 MHz	26.071	56.000	-29.929	22.512	46.000	-23.488
1.864 MHz	19.535	56.000	-36.465	13.225	46.000	-32.775
2.288 MHz	18.567	56.000	-37.433	12.747	46.000	-33.253
17.215 MHz	11.771	60.000	-48.229	6.860	50.000	-43.140
22.541 MHz	25.643	60.000	-34.357	20.904	50.000	-29.096
22.986 MHz	24.530	60.000	-35.470	19.757	50.000	-30.243
29.826 MHz	10.570	60.000	-49.430	6.518	50.000	-43.482

Receive Mode; Line 1



Frequency (MHz)	Quasi-Peak (dBuV)	Quasi-Peak Limit (dBuV)	Quasi-Peak Margin (dB)	Average (dBuV)	Average Limit (dBuV)	Average Margin (dB)
153.100 KHz	38.256	65.911	-27.656	17.225	55.911	-38.686
437.900 KHz	23.681	57.774	-34.093	22.305	47.774	-25.469
902.900 KHz	20.101	56.000	-35.899	17.522	46.000	-28.478
1.802 MHz	21.953	56.000	-34.047	16.999	46.000	-29.001
1.863 MHz	21.837	56.000	-34.163	14.606	46.000	-31.394
2.283 MHz	20.979	56.000	-35.021	10.351	46.000	-35.649
5.301 MHz	16.098	60.000	-43.902	9.469	50.000	-40.531
5.902 MHz	10.335	60.000	-49.665	5.974	50.000	-44.026
22.259 MHz	23.663	60.000	-36.337	19.293	50.000	-30.707
26.521 MHz	14.234	60.000	-45.766	9.763	50.000	-40.237

Receive Mode; Neutral

11 Antenna Requirement per FCC Part 15.203

11.1 Test Limits

§ 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. This requirement does not apply to carrier current devices or to devices operated under the provisions of §15.211, §15.213, §15.217, §15.219, or §15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with §15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

11.2 Results:

The sample tested met the antenna requirement. There were two antennas tested with this module as detailed below:

Antenna Manufacturer	Antenna Model	Antenna Type	Max Efficiency
Yaiyo Yuden	AF216M245001	Chip Antenna	71% at 2.5GHz
SkyCross	CBL-EMWQU-A	PCB Antenna with Cable Assembly	60% across 2.4GHz – 2.5GHz band

12 Measurement Uncertainty

The measured value related to the corresponding limit will be used to decide whether the equipment meets the requirements.

The measurement uncertainty figures were calculated and correspond to a coverage factor of k = 2, providing a confidence level of respectively 95.45 % in the case where the distributions characterizing the actual measurement uncertainties are normal (Gaussian).

Measurement uncertainty Table

Parameter	Uncertainty	Notes
Radiated emissions, 30 to 1000 MHz	±3.9dB	
Radiated emissions, 1 to 18 GHz	±4.2dB	
Radiated emissions, 18 to 40 GHz	±4.3dB	
Power Port Conducted emissions, 150kHz to 30 MHz	±2.8dB	

13 Revision History

Revision Level	Date	Report Number	Notes
0	10/30/2015	102289380LEX-001	Original Issue