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WLAN TEST REPORT

Report Number: 103236250LEX-004
Project Number: G103236250

Report Issue Date: 11/10/2017

Product Name: GEA Single Board Computer

FCC Standards: FCC Title 47 CFR Part 15.247
Industry Canada Standards: RSS-247 Issue 2 & RSS-GEN Issue 4

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

Client:
GE Digital Energy
AP6-1NW
Appliance Park
Louisville, KY 40225-001

Report prepared by


Brian Lackey, Project Engineer

Report reviewed by


Bryan Taylor, Team Leader



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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
6	Peak Conducted Power	§ 15.247(b)(3)(4)	RSS-247 (5.4)	Pass
8	Occupied Bandwidth	§ 15.247(a)(2)	RSS-247 (5.2(A)) RSS-GEN (4.6.1)	Pass
14	Conducted Spurious Emissions	§ 15.247(d)	RSS-247 (5.5)	Pass
23	Power Spectral Density	§ 15.247(e)	RSS-247 (5.2(B))	Pass
29	Radiated Spurious Emissions (Transmitter)	§ 15.247(d), § 15.209, and § 15.205	RSS-247 (5.5)	Pass
37	Radiated Spurious Emissions (Receiver)	§ 15.109	RSS-Gen (6.1)	Pass
39	AC Powerline Conducted Emissions	§ 15.107, § 15.207	RSS-Gen (7.2.4)	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	GE Digital Energy
Model Number	SBCA001
Serial Number	201727DC0114
Receive Date	10/10/2017
Test Start Date	10/10/2017
Test End Date	11/8/2017
Device Received Condition	Good
Test Sample Type	Production
Frequency Band	2412MHz – 2462MHz
Mode(s) of Operation	802.11b,g,n
Modulation Type	BPSK, QPSK, CCK, OFDM
Duty Cycle	100%
Transmission Control	Test Commands
Maximum Output Power	20.23dBm
Maximum Antenna Gain¹	2dBi
Test Channels	1,6,11
Antenna Type (15.203)	PCB Antenna
Operating Voltage	120Vac 60Hz

Description of Equipment Under Test
<p>The host appliance shall supply 5Vdc to the SBC and communication will be facilitated through an internal GEA3 serial bus (high-speed, full duplex UART). The SBC shall also possess two additional UARTs for potential interface to other peripheral boards in the system.</p> <p>The SBC shall provide a 24-bit Format 1 LVDS (low-voltage differential signaling) interface to the graphic LCD and a boost converter to drive the LCD panel backlight. The SBC micro shall be capable of supporting user input from a projected capacitive touch panel via an I2C interface. An audio drive circuit shall also be included to facilitate a 1W off board speaker.</p> <p>Wireless communication capability shall be provided by an on board transceiver and a 2.4GHz antenna with matching network. Wi-Fi WLAN protocol shall be supported. An SDIO interface shall link the transceiver and Cortex-A8, and the wireless stack(s) shall run on the main MPU. An MFi chip may be populated to support direct interface to the Apple eco-system of products.</p> <p>A USB-A host interface will be available to allow for file upload and application firmware and OS updates, and a micro-SD card slot will be available as a host for an alternate boot device for development purposes.</p>

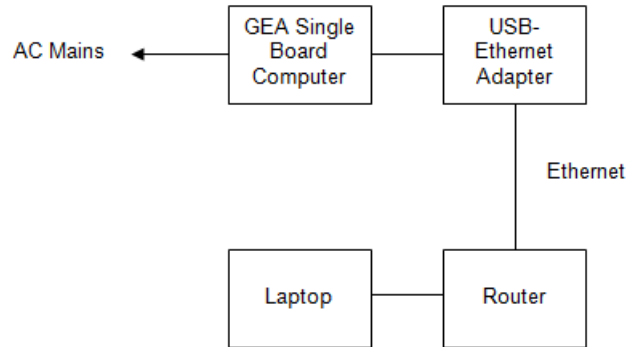
Operating modes of the EUT:

No.	Descriptions of EUT Exercising
1	Transmitting 802.11 b, g or n on low, mid or high channels
2	Receive mode / idle mode

¹ From antenna datasheet

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

4.1 EUT Block Diagram:



4.2 Cables:

Cables					
Description	Length	Shielding	Ferrites	Connection	
				From	To
Power Cable	1m	No	No	EUT	AC Mains
Ethernet	10m	No	No	EUT	Router

4.3 Support Equipment:

Support Equipment			
Description	Manufacturer	Model Number	Serial Number
Laptop	HP	-	-
Router	Cisco	-	-
USB-Ethernet Adapter	Tripp-Lite	U236-000-R	2711ACECU87B10070 7

5 Peak Conducted Power

5.1 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.

5.2 Test Procedure:

ANSI C63.10:2013 § 11.9.1.3 and KDB Publication No. 558074: Guidance on Measurements for Digital Transmission Systems (47 CFR 15.247). The peak and average output power were measured using a wideband power sensor.

5.3 Test Equipment Used:

Description	Serial Number	Manufacturer	Model	Cal. Date	Cal. Due
Wideband Power Sensor	100155	Rohde&Schwarz	NRP-Z81	9/20/2017	9/20/2018

5.4 Test Results:

The device was found to be **compliant**.

5.5 Test Conditions:

Test Personnel: Brian Lackey
 Supervising/Reviewing
 Engineer:
 (Where Applicable) NA
 Input Voltage: 120V, 60Hz

Test Date: 10/26/2017
 Ambient Temperature: 20.7C
 Relative Humidity: 29.1%
 Atmospheric Pressure: 988.8mbar

5.6 Test Data:

Mode	Frequency (MHz)	Channel Number	Peak Power (dBm)	Average Power (dBm)	PAPR (dB)
802.11b	2412	1	17.66	15.36	2.30
	2437	6	17.83	15.53	2.30
	2462	11	17.73	15.48	2.25
802.11g	2412	1	20.23	15.35	4.88
	2437	6	20.21	15.18	5.03
	2462	11	20.14	15.10	5.04
802.11n (20MHz)	2412	1	20.19	14.36	5.83
	2437	6	20.08	14.36	5.72
	2462	11	19.96	14.25	5.71
802.11n (40MHz)	2422	3	19.86	12.74	7.12
	2442	7	19.74	12.64	7.10
	2462	11	19.65	12.53	7.12

6 Occupied Bandwidth

6.1 Test Limits:

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

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
EMI Test Receiver	10887490.26	Rohde & Schwarz	ESI26	9/20/2017	9/20/2018

6.4 Test Results:

The device was found to be **compliant**. All occupied bandwidth measurements were greater than 500kHz.

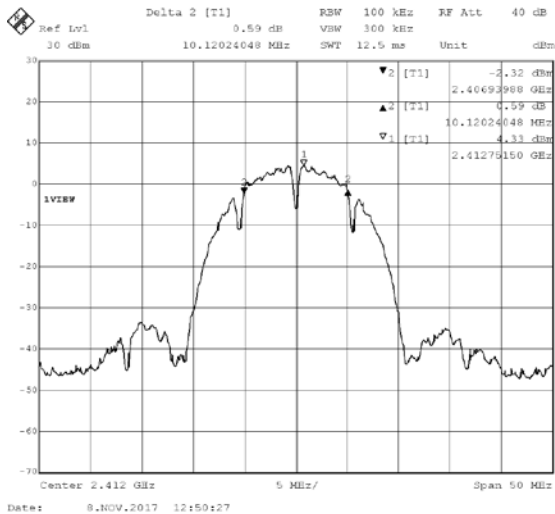
6.5 Test Conditions

Test Personnel: Brian Lackey
 Supervising/Reviewing Engineer:
 (Where Applicable) NA
 Input Voltage: 120V, 60Hz

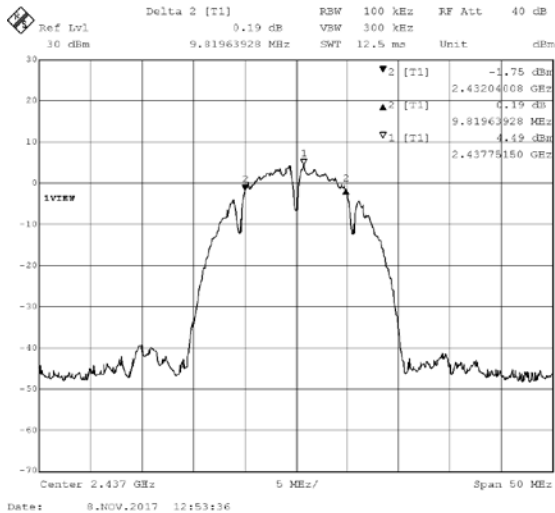
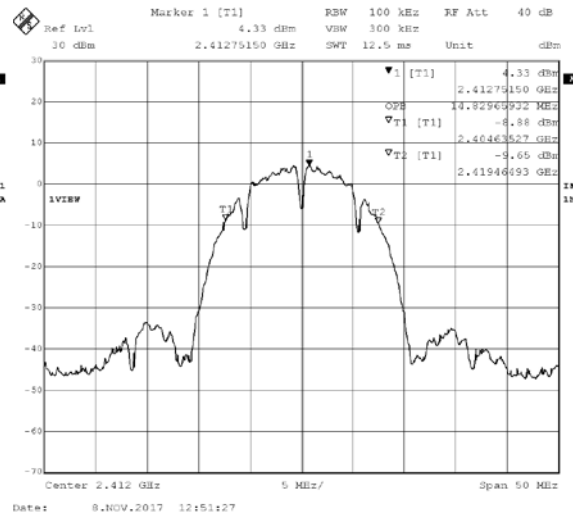
Test Date: 11/8/2017
 Ambient Temperature: 22.1C
 Relative Humidity: 35.2%
 Atmospheric Pressure: 992.0mbar

6.6 Test Data:

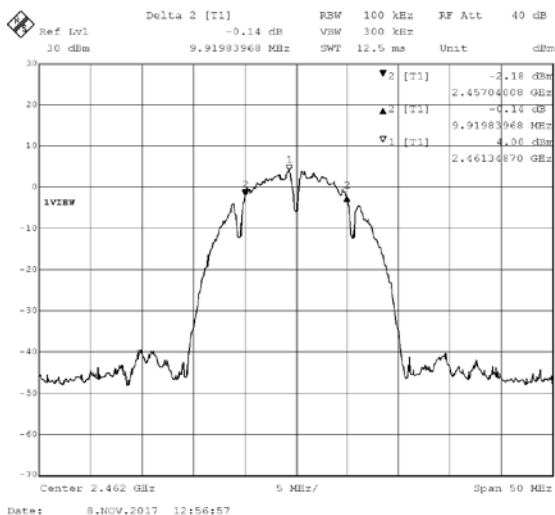
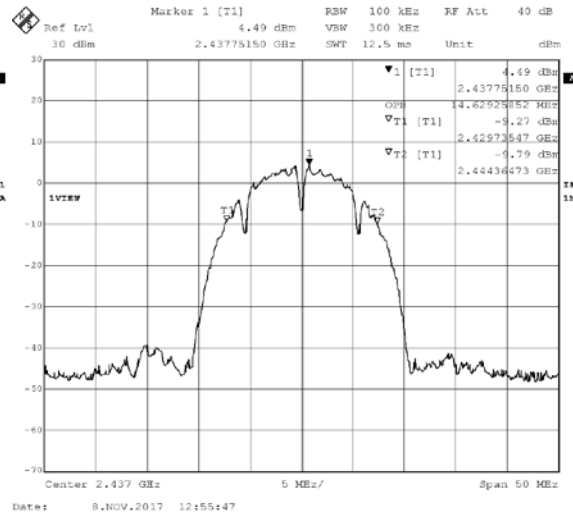
Mode	Channel Number	Frequency (MHz)	6dB Bandwidth (MHz)	99% Power Bandwidth (MHz)	Result
802.11b	1	2412	10.120	14.830	Pass
802.11b	6	2437	9.820	14.629	Pass
802.11b	11	2462	9.920	14.629	Pass
802.11g	1	2412	15.331	18.537	Pass
802.11g	6	2437	15.331	18.036	Pass
802.11g	11	2462	15.331	17.735	Pass
802.11n (20MHz)	1	2412	16.132	17.635	Pass
802.11n (20MHz)	6	2437	15.631	17.535	Pass
802.11n (20MHz)	11	2462	16.232	17.535	Pass
802.11n (40MHz)	3	2422	35.471	35.872	Pass
802.11n (40MHz)	7	2442	35.471	35.872	Pass
802.11n (40MHz)	11	2462	35.471	35.872	Pass



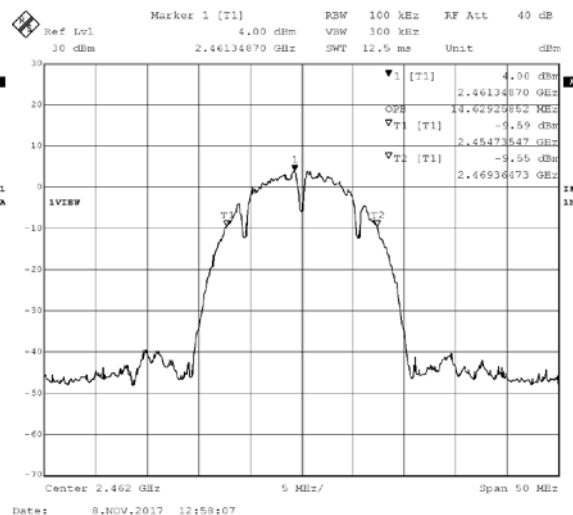
6dB and 99% Power Bandwidth Plot (Channel 1) – 802.11b mode

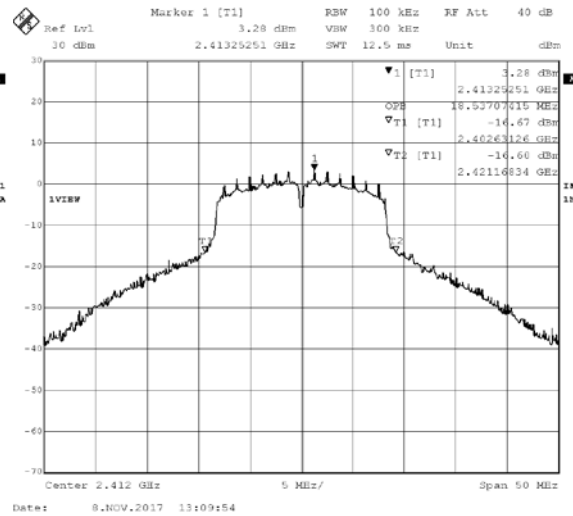
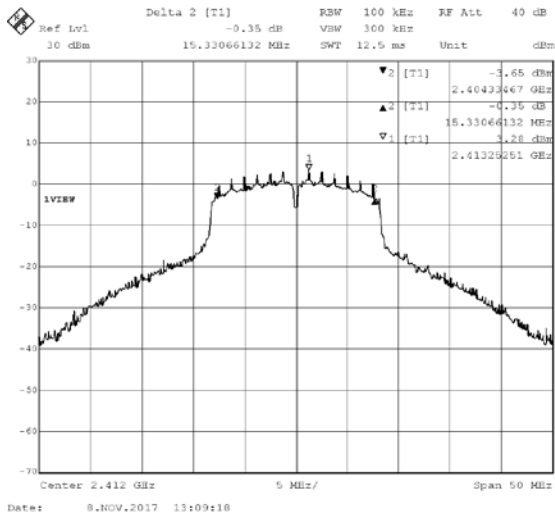


6dB and 99% Power Bandwidth Plot (Channel 6) – 802.11b mode

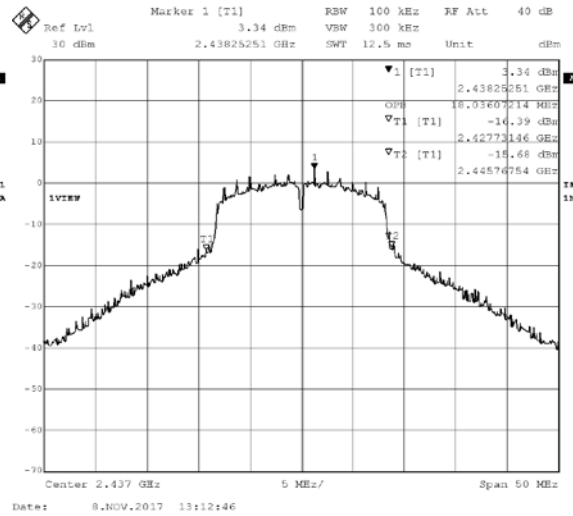
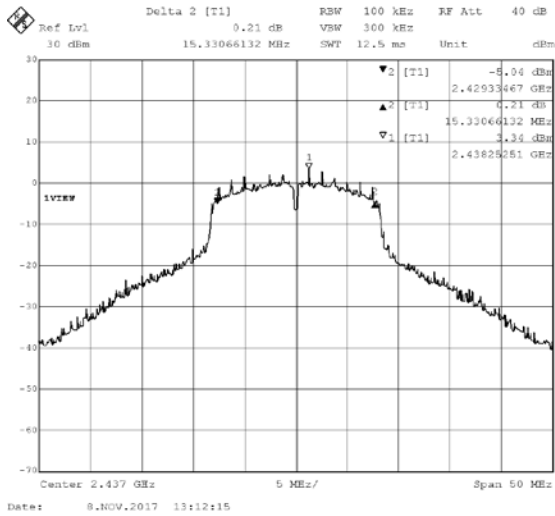


6dB and 99% Power Bandwidth Plot (Channel 11) – 802.11b mode

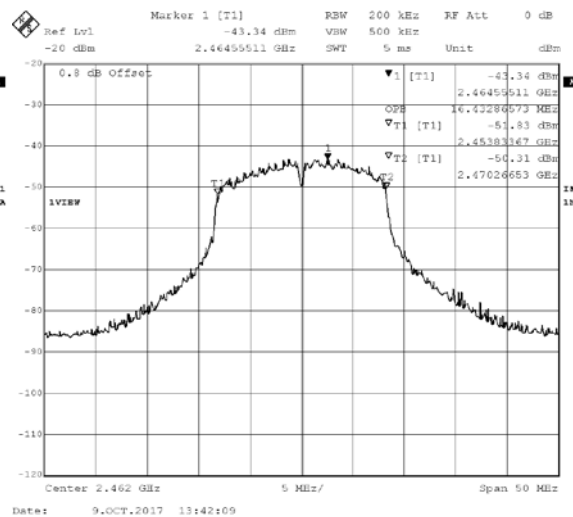
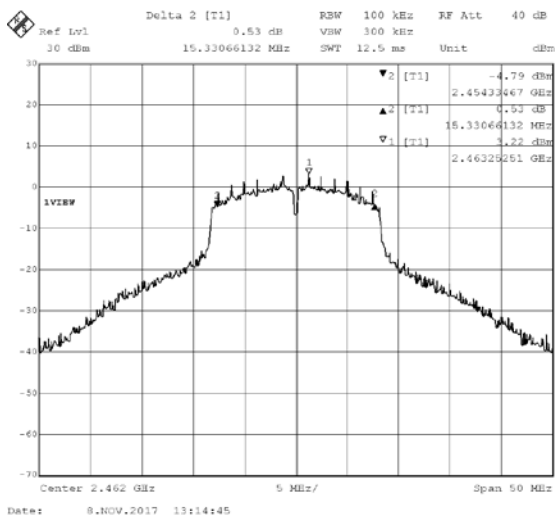




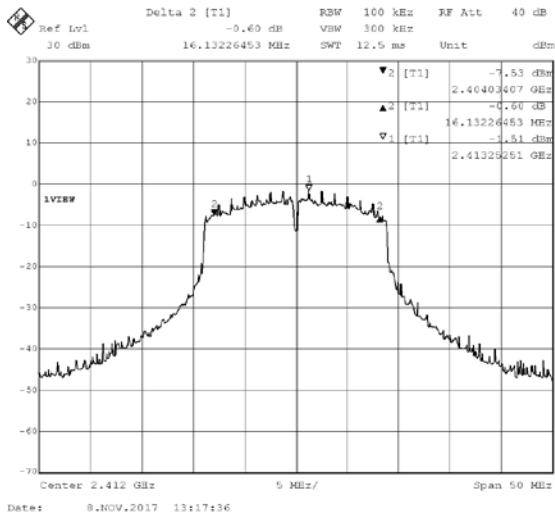
6dB and 99% Power Bandwidth Plot (Channel 1) – 802.11g mode



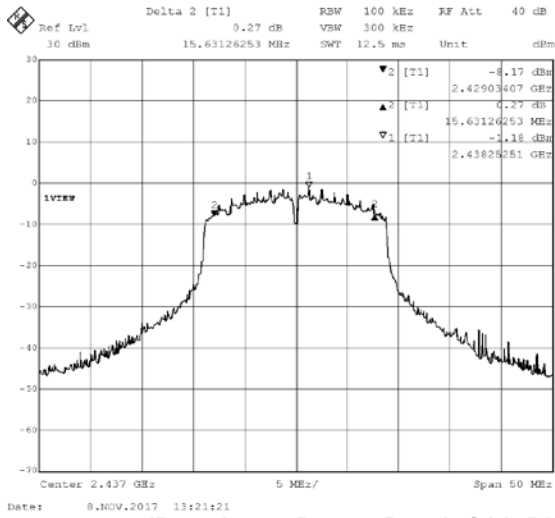
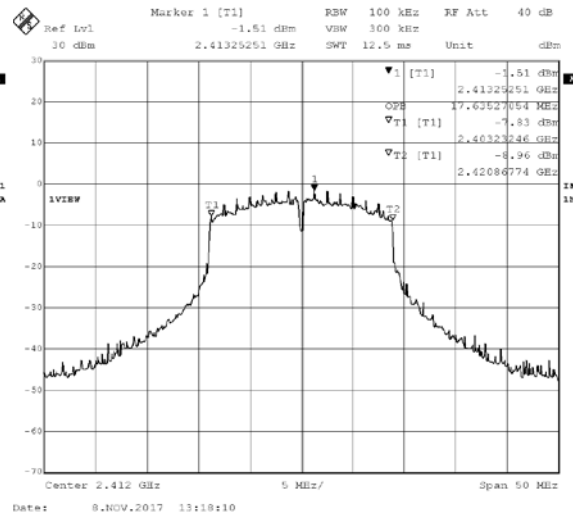
6dB and 99% Power Bandwidth Plot (Channel 6) – 802.11g mode



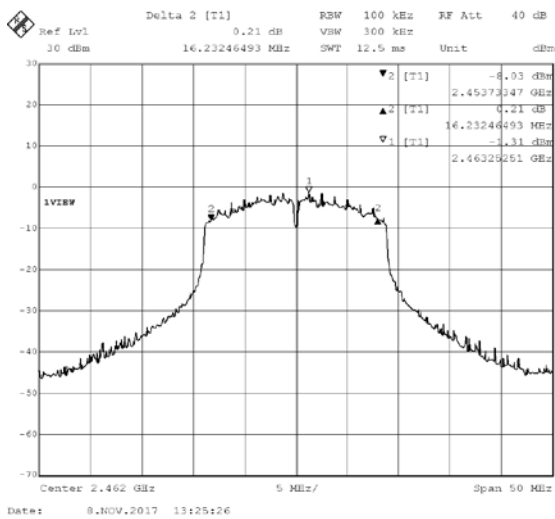
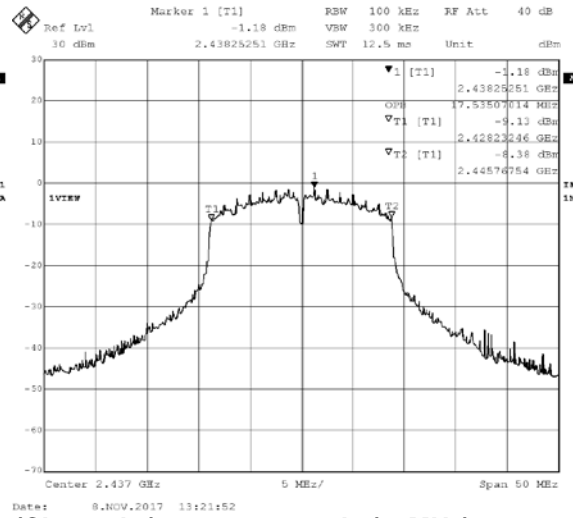
6dB and 99% Power Bandwidth Plot (Channel 11) – 802.11g mode



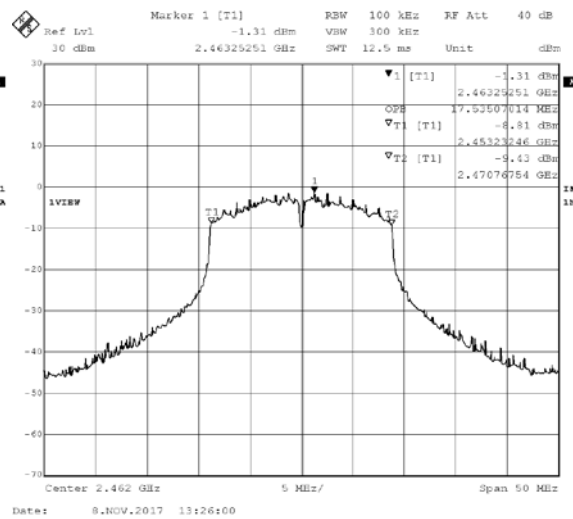
6dB and 99% Power Bandwidth Plot (Channel 1) – 802.11n mode (20MHz)

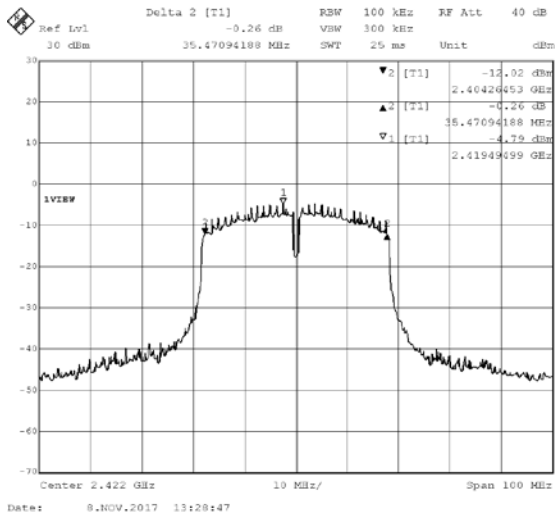


6dB and 99% Power Bandwidth Plot (Channel 6) – 802.11n mode (20MHz)

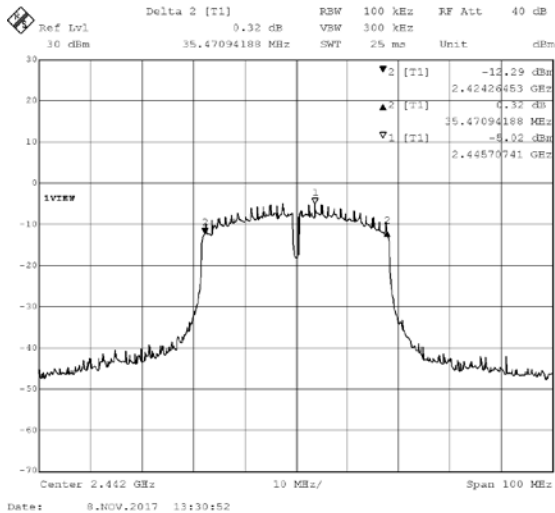
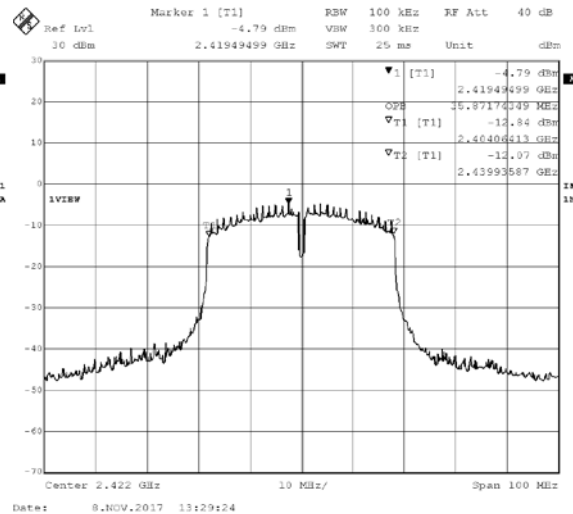


6dB and 99% Power Bandwidth Plot (Channel 11) – 802.11n mode (20MHz)

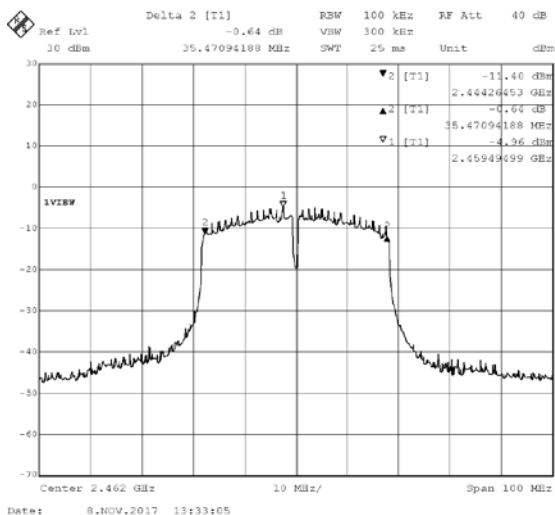
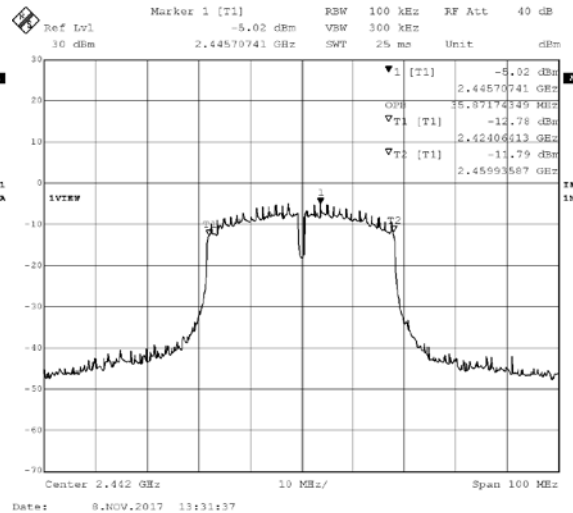




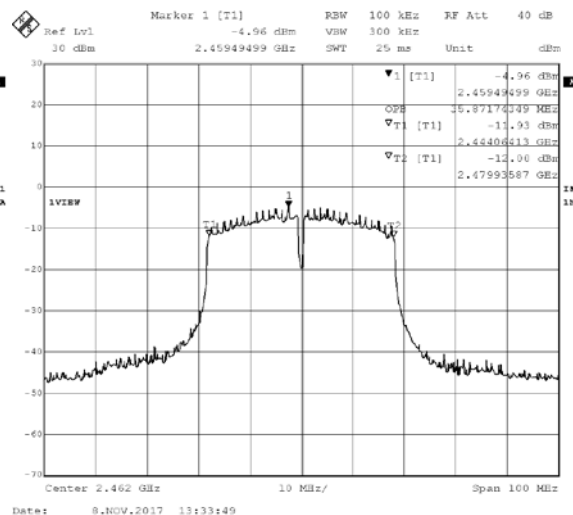
6dB and 99% Power Bandwidth Plot (Channel 3) – 802.11n mode (40MHz)



6dB and 99% Power Bandwidth Plot (Channel 7) – 802.11n mode (40MHz)



6dB and 99% Power Bandwidth Plot (Channel 11) – 802.11n mode (40MHz)



7 Conducted Spurious Emissions

7.1 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.

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
EMI Test Receiver	10887490.26	Rohde & Schwarz	ESI26	9/20/2017	9/20/2018

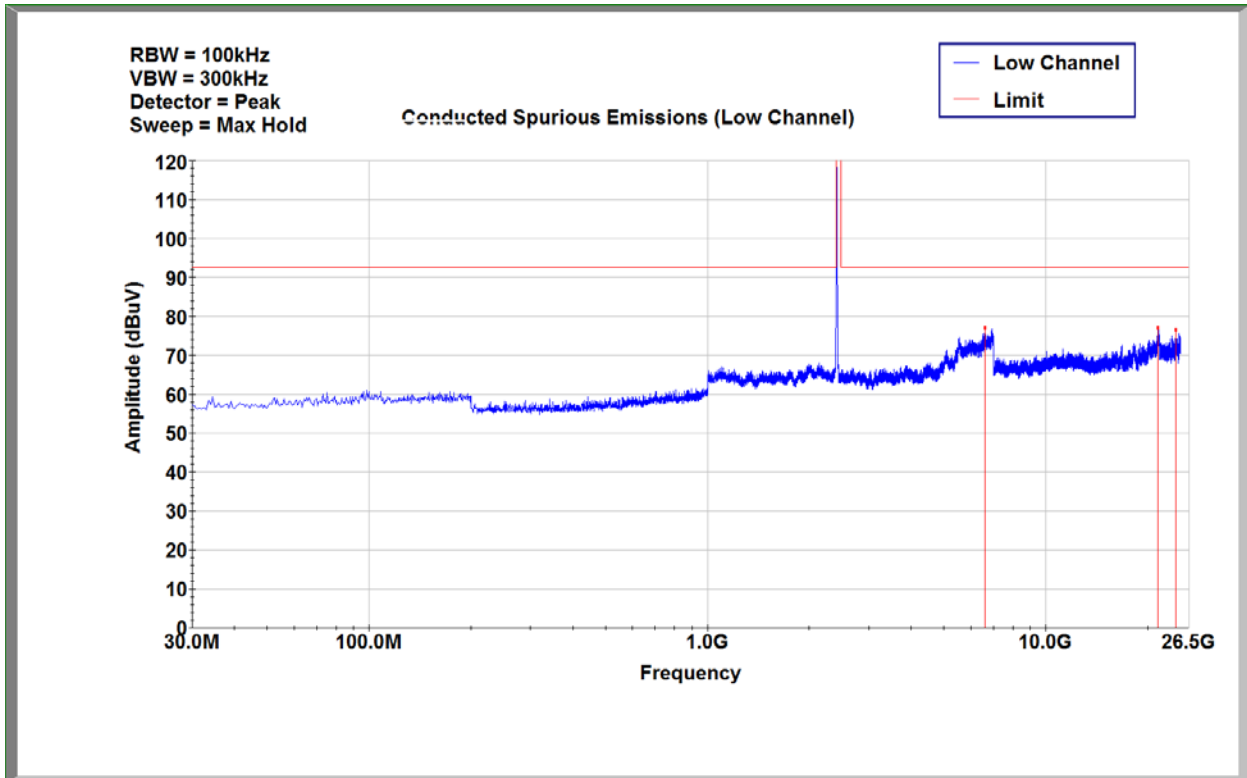
7.4 Test Results:

The device was found to be **compliant**. The following plots show that there are no conducted spurious emissions exceeding the 20dB down criteria.

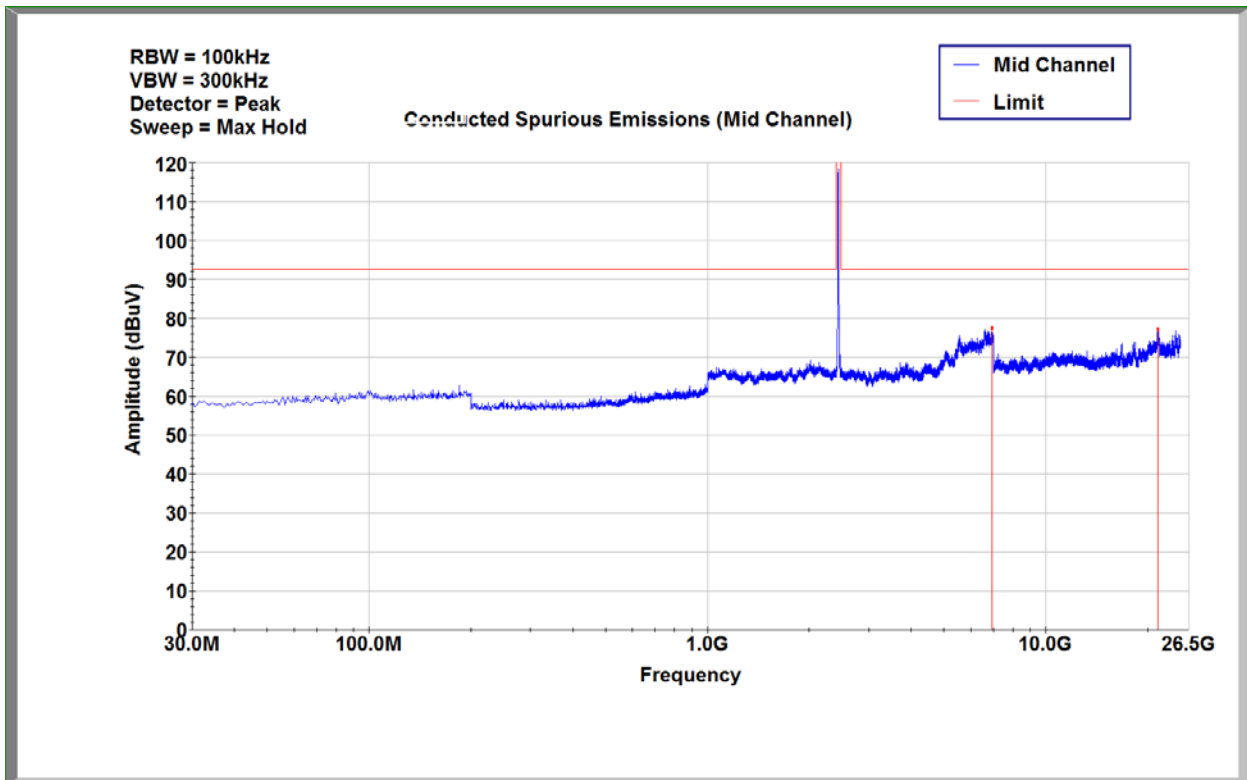
7.5 Test Conditions:

Test Personnel: <u>Brian Lackey</u>	Test Date: <u>11/10/2017</u>
Supervising/Reviewing Engineer: _____	
(Where Applicable) <u>NA</u>	Ambient Temperature: <u>22.0C</u>
Input Voltage: <u>120V, 60Hz</u>	Relative Humidity: <u>33.0%</u>
	Atmospheric Pressure: <u>999.0mbar</u>

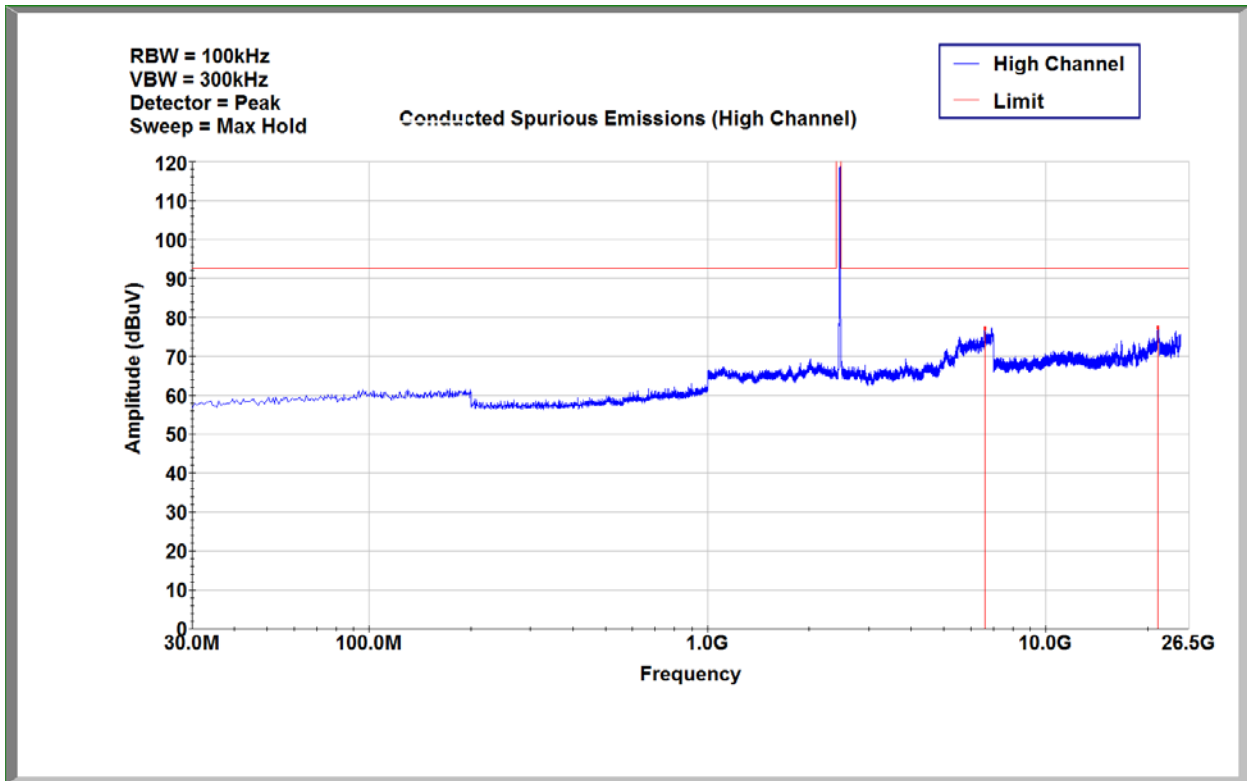
7.6 Test Data:



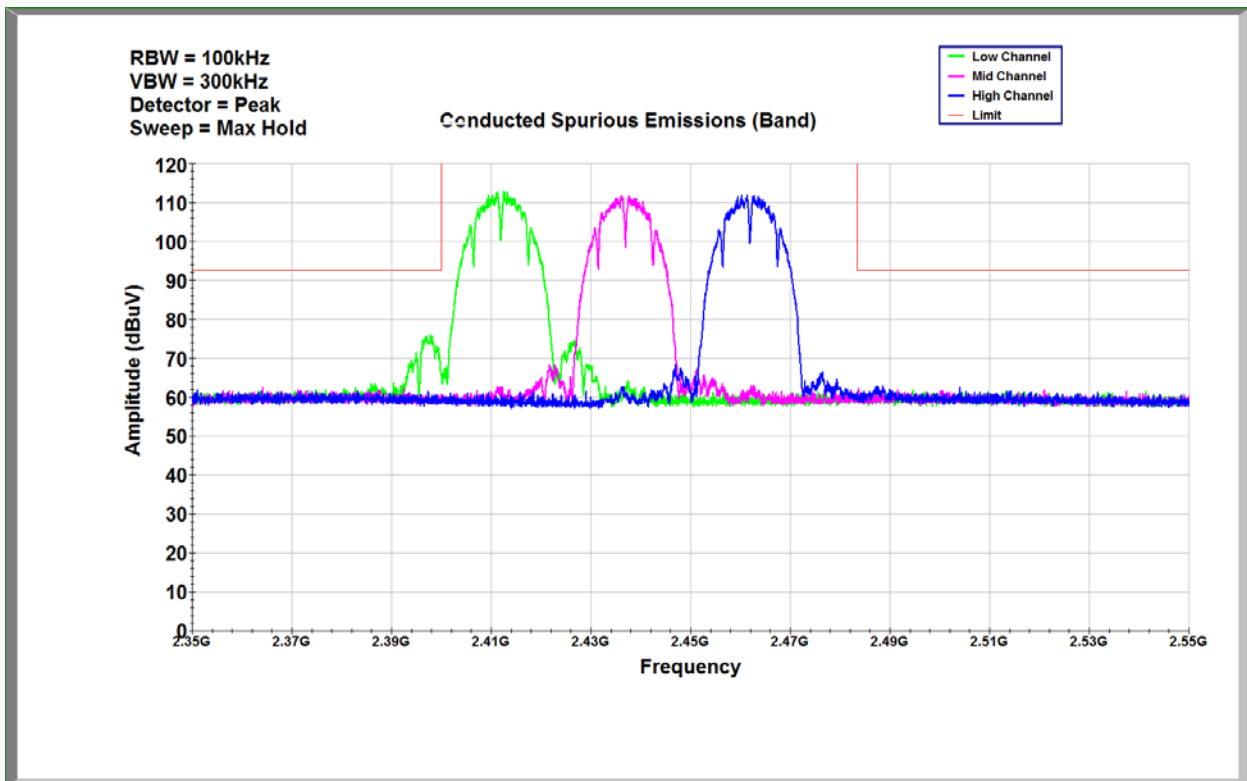
Low Channel Conducted Spurious Emissions - 802.11b Mode



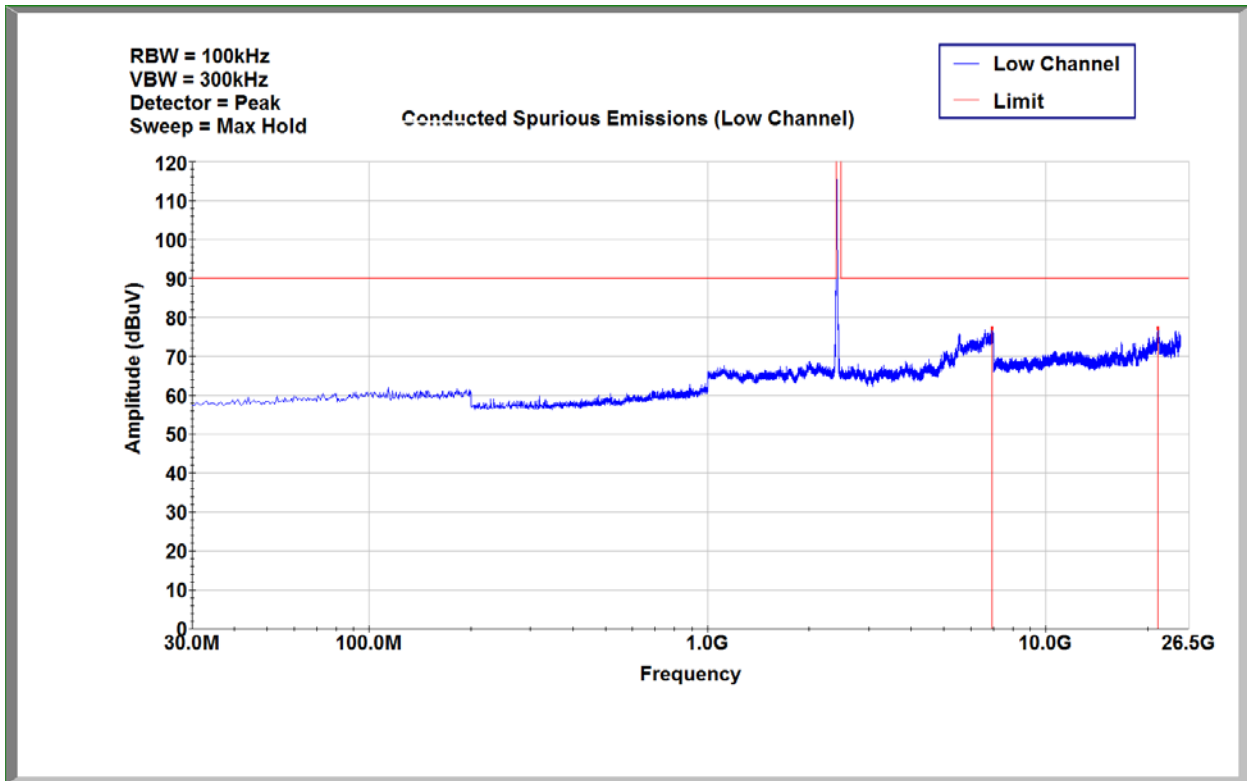
Mid Channel Conducted Spurious Emissions - 802.11b Mode



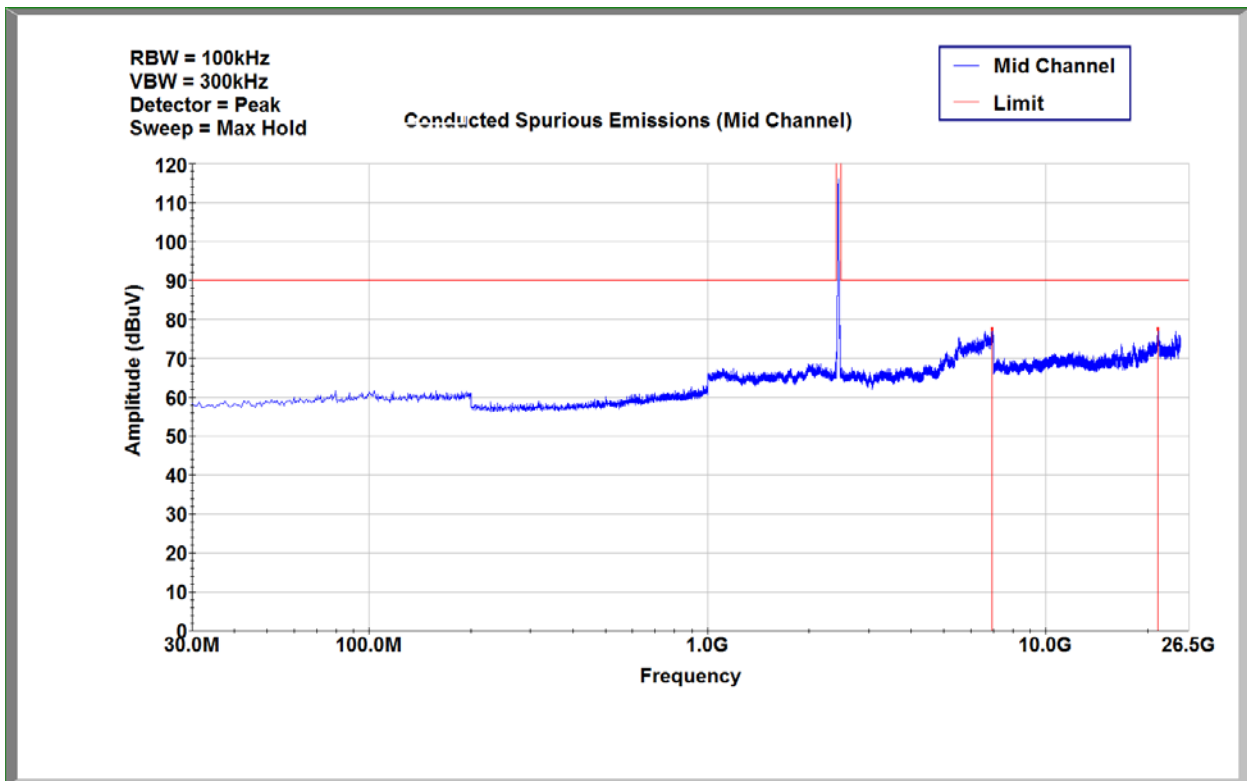
High Channel Conducted Spurious Emissions - 802.11b Mode



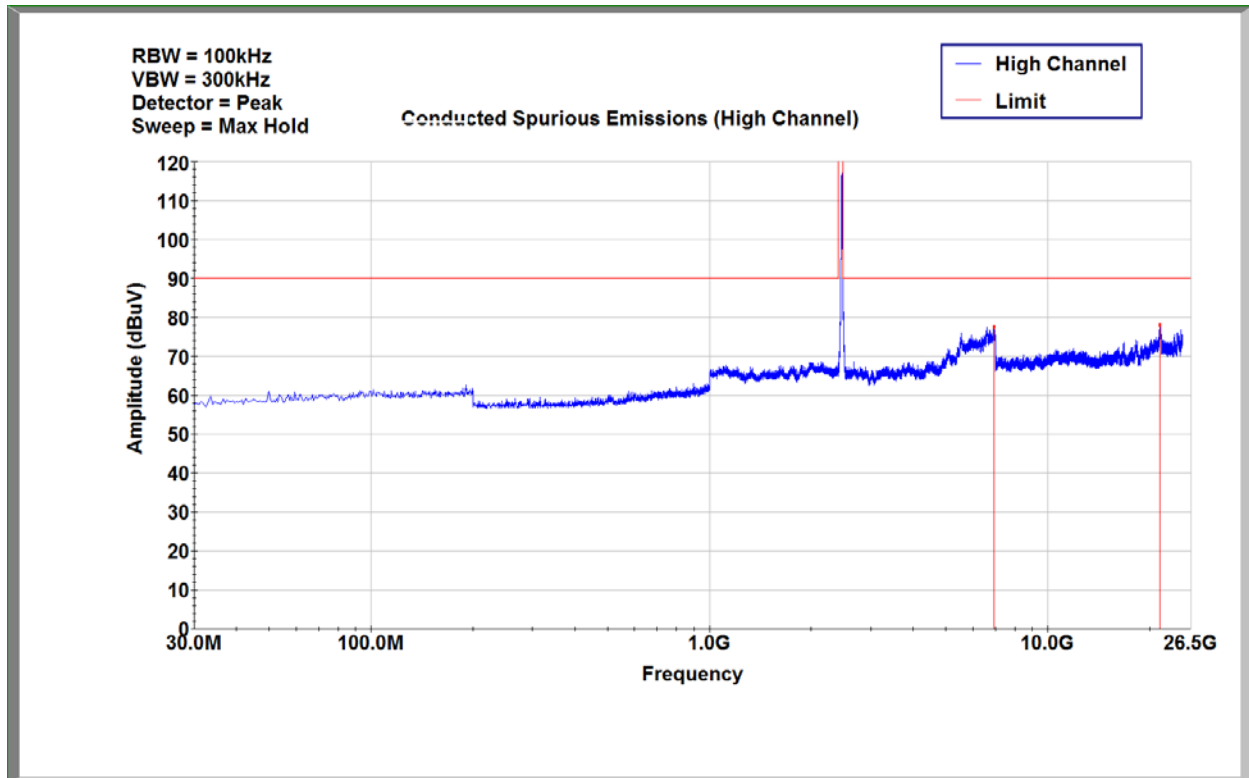
Emissions Close to Band Edge - 802.11b Mode



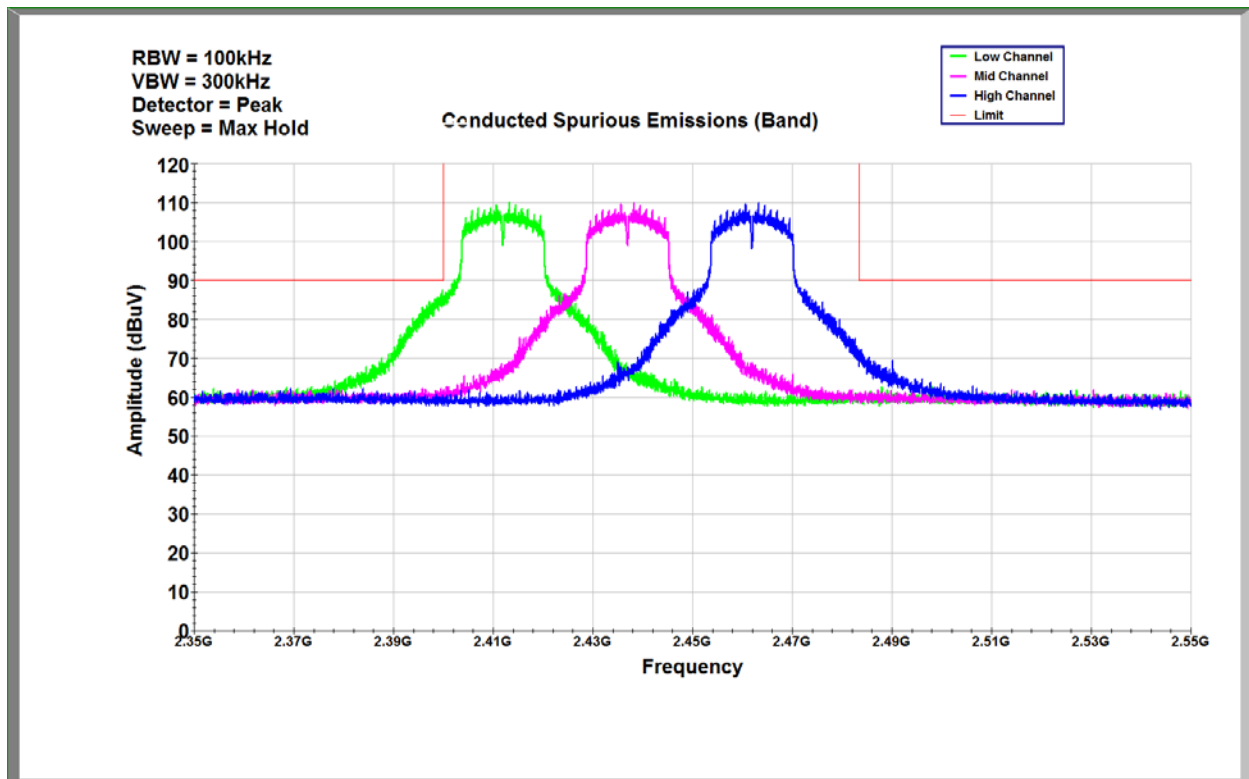
Low Channel Conducted Spurious Emissions - 802.11g Mode



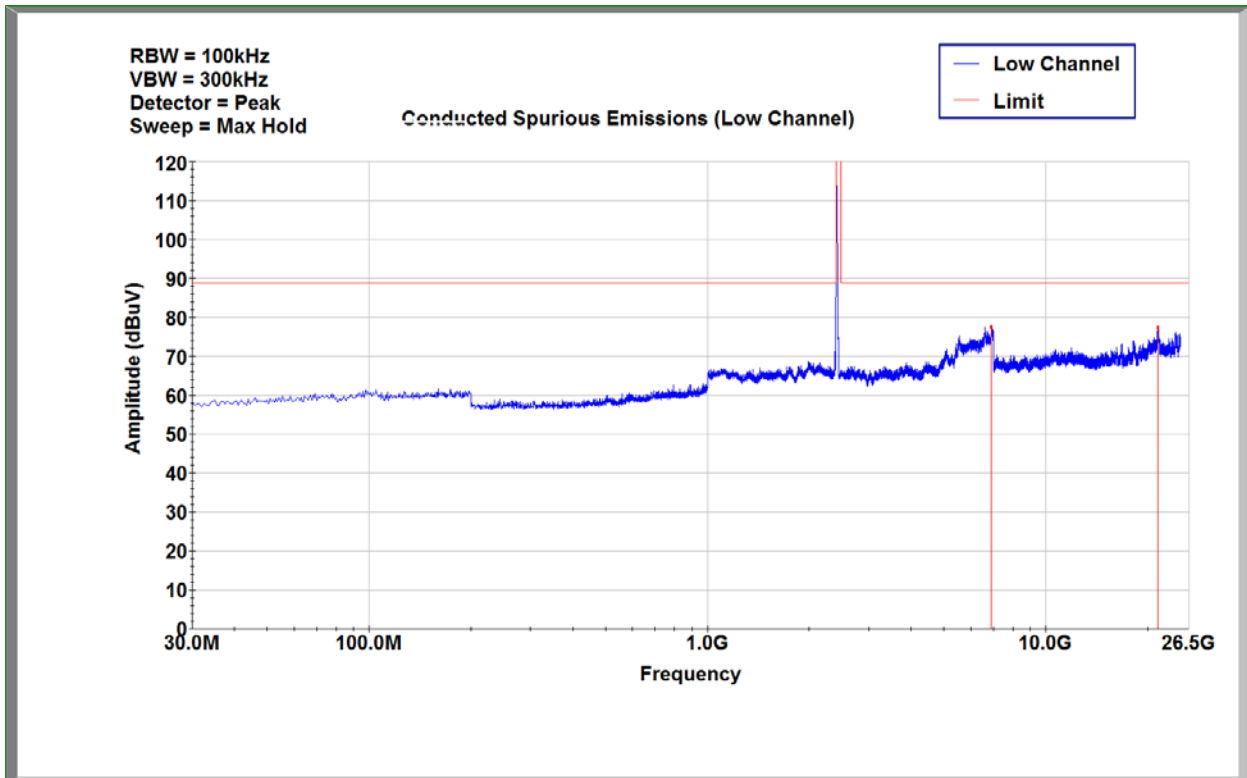
Mid Channel Conducted Spurious Emissions - 802.11g Mode



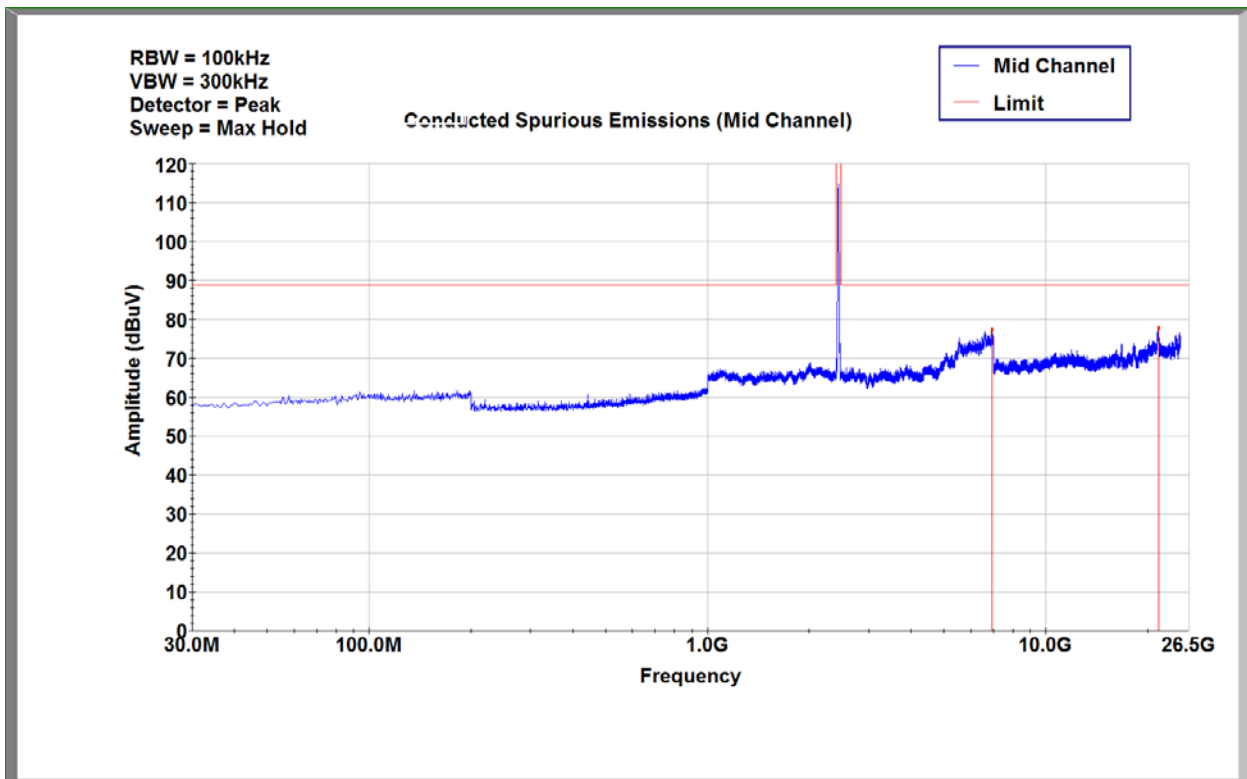
High Channel Conducted Spurious Emissions - 802.11g Mode



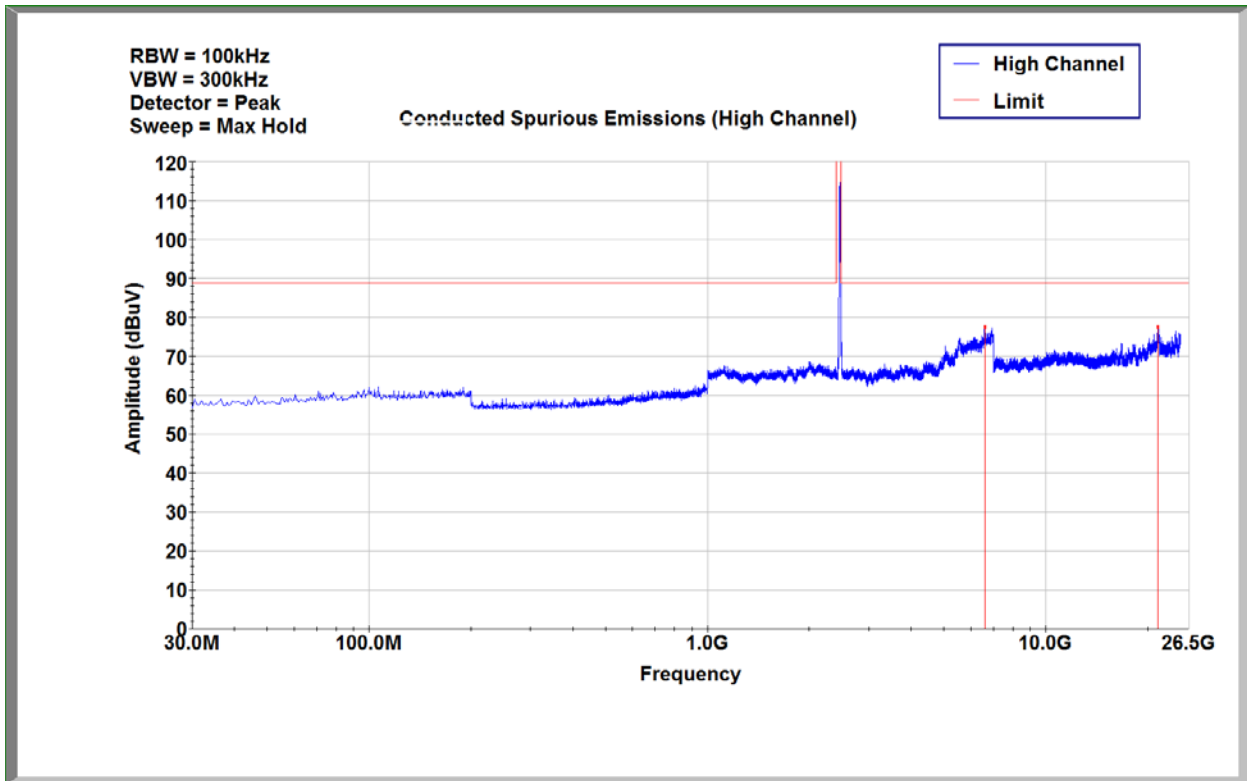
Emissions Close to Band Edge - 802.11g Mode



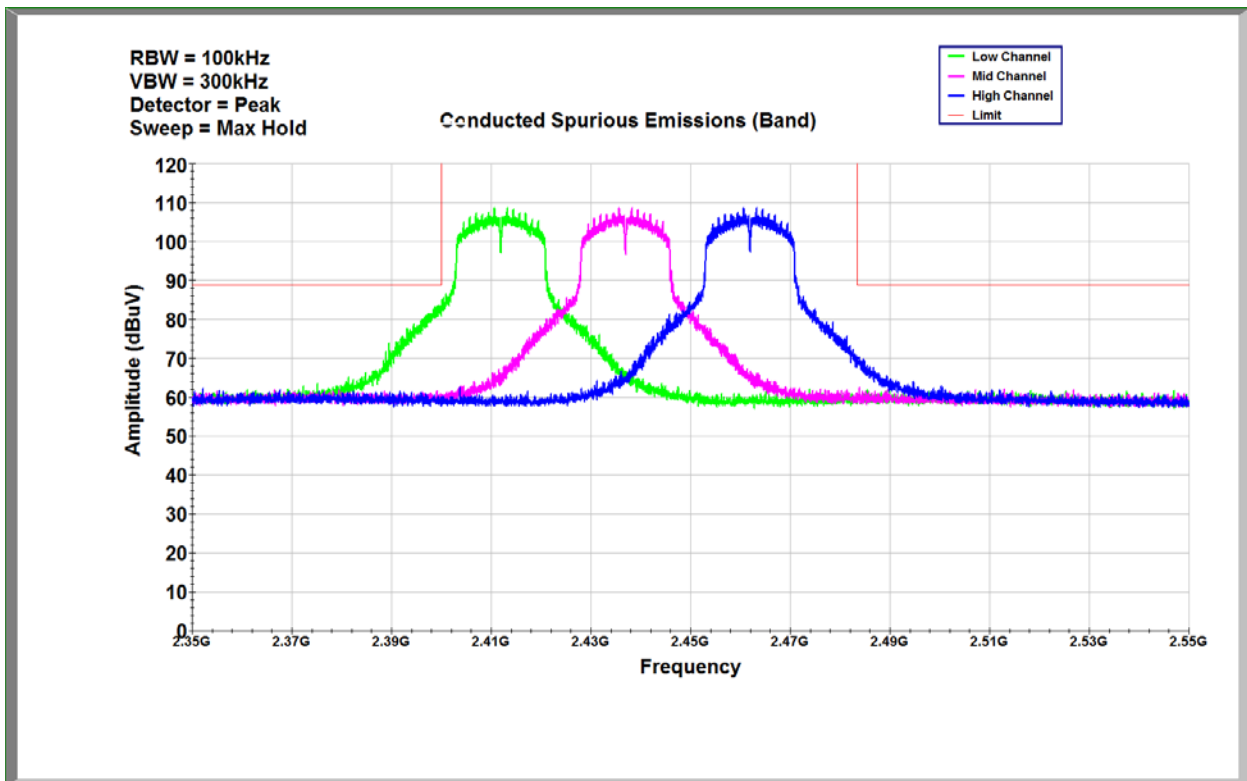
Low Channel Conducted Spurious Emissions - 802.11n Mode (20MHz)



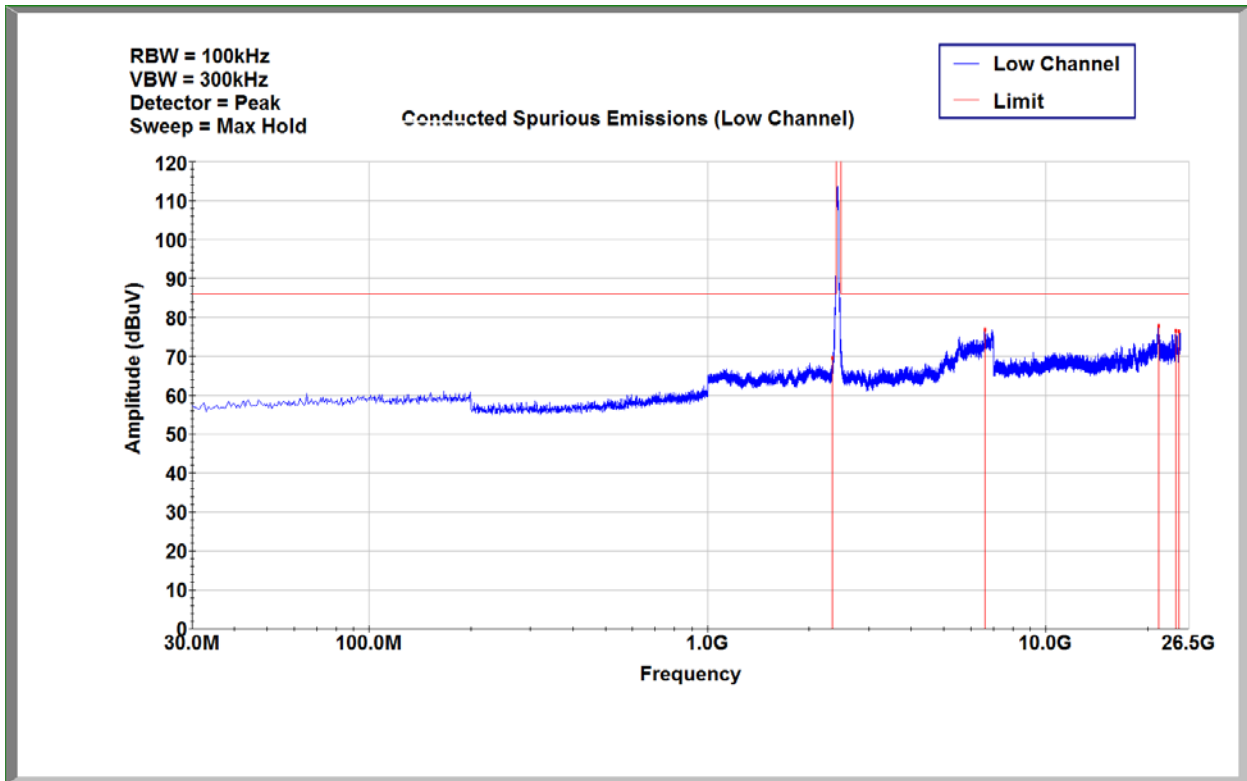
Mid Channel Conducted Spurious Emissions - 802.11n Mode (20MHz)



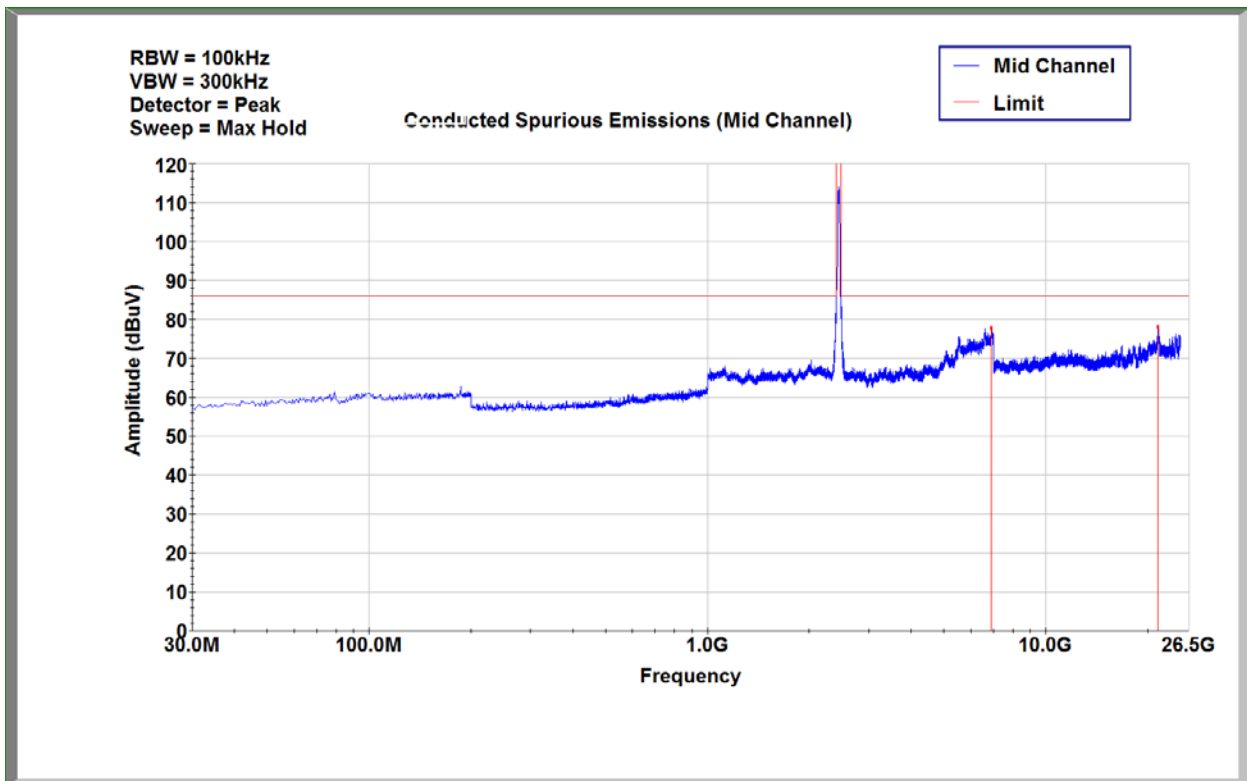
High Channel Conducted Spurious Emissions - 802.11n Mode (20MHz)



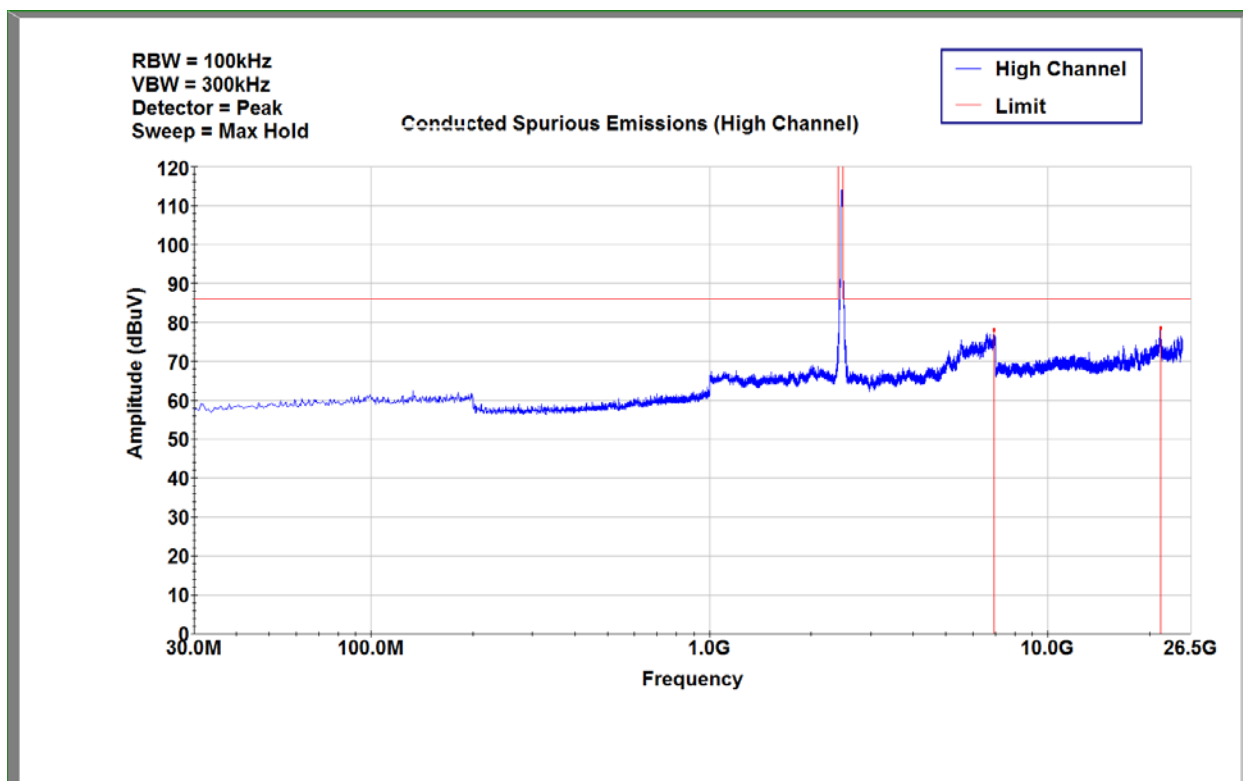
Emissions Close to Band Edge – 802.11n Mode (20MHz)



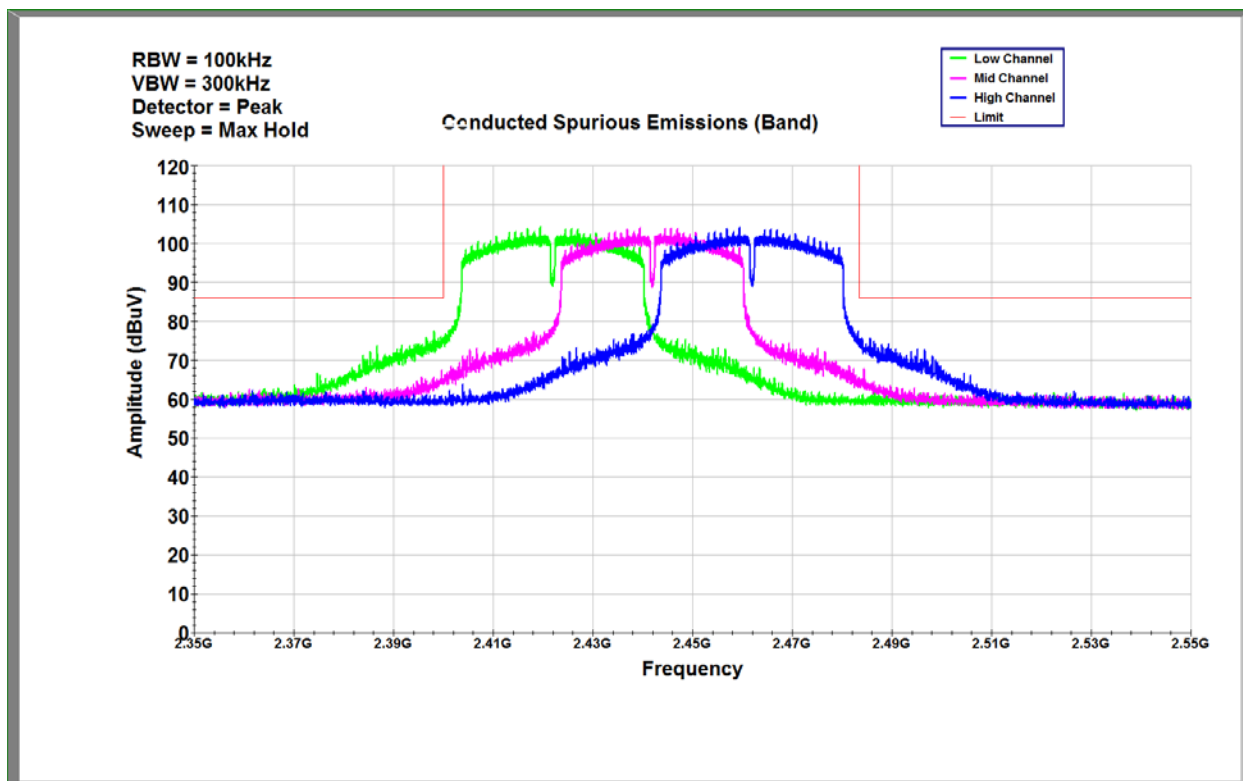
Low Channel Conducted Spurious Emissions - 802.11n Mode (40MHz)



Mid Channel Conducted Spurious Emissions - 802.11n Mode (40MHz)



High Channel Conducted Spurious Emissions - 802.11n Mode (40MHz)



Emissions Close to Band Edge – 802.11n Mode (40MHz)

8 Power Spectral Density

8.1 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.

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 Test Equipment Used:

Description	Serial Number	Manufacturer	Model	Cal. Date	Cal. Due
EMI Test Receiver	10887490.26	Rohde & Schwarz	ESI26	9/20/2017	9/20/2018

8.4 Test Results:

The device was found to be **compliant**. The peak power spectral density did not exceed 8dBm in any 3kHz bandwidth on any operating channel using the PKPSD method.

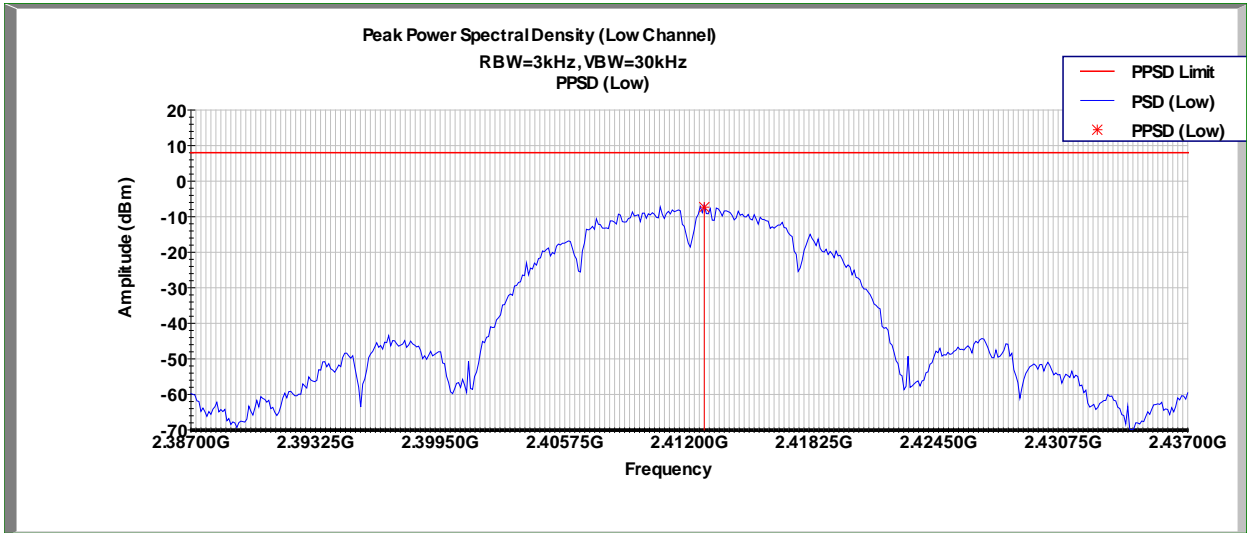
8.5 Test Conditions:

Test Personnel: Brian Lackey
 Supervising/Reviewing Engineer:
 (Where Applicable) NA
 Input Voltage: 120V, 60Hz

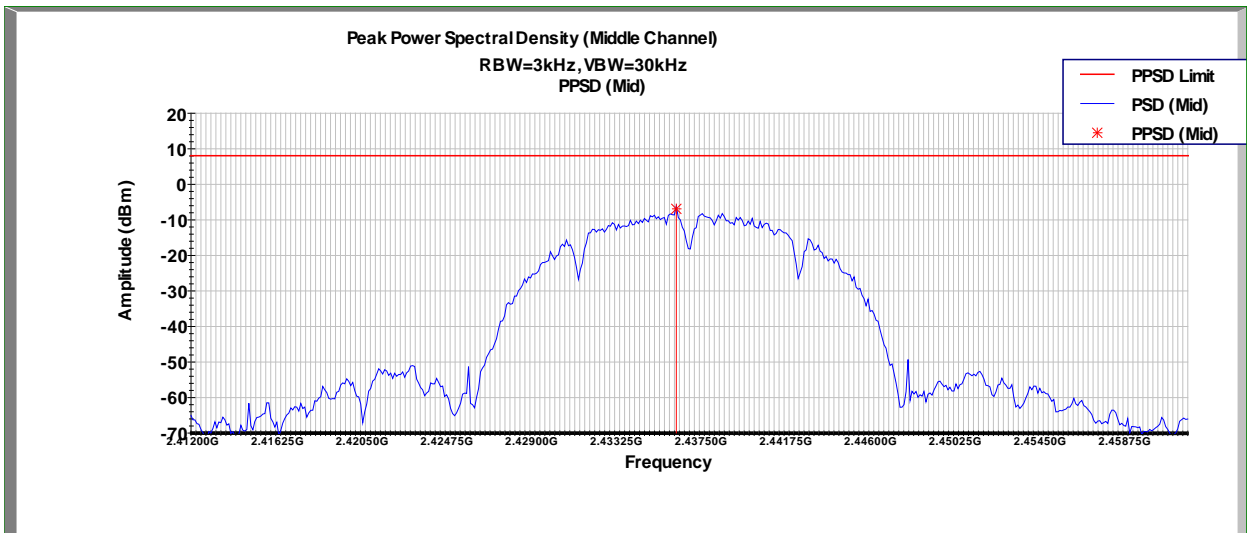
Test Date: 10/26/2017
 Ambient Temperature: 20.7C
 Relative Humidity: 29.1%
 Atmospheric Pressure: 988.8mbar

8.6 Test Data:

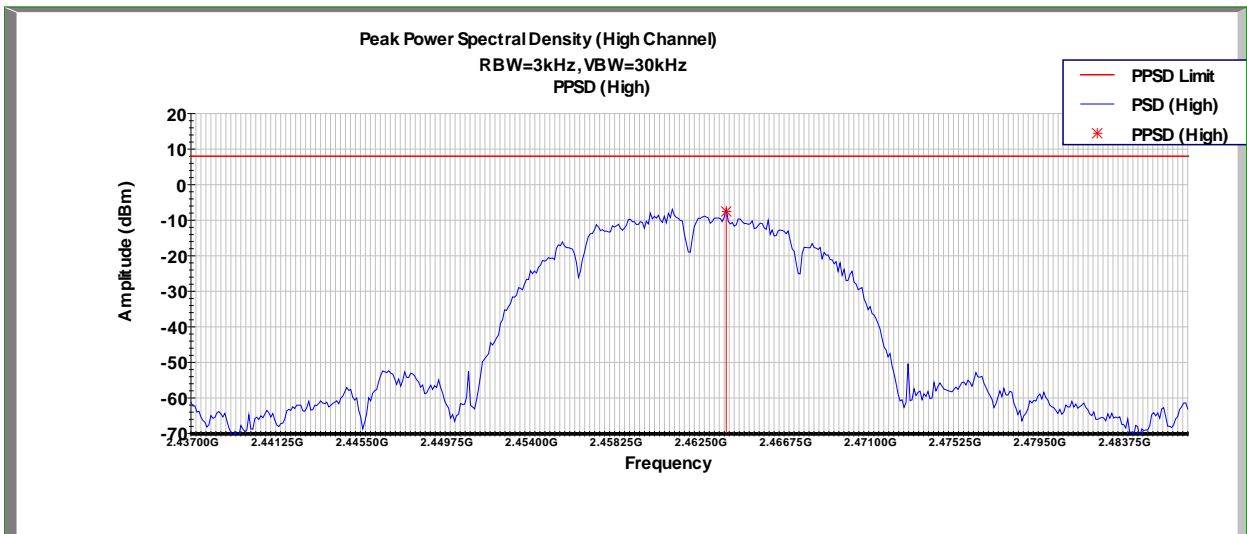
Mode	Channel Number	Frequency (MHz)	PKPSD in 3kHz BW (dBm)	Limit (dBm)	Margin (dB)	Result
802.11b	1	2412	-7.338	8	15.338	Pass
802.11b	6	2437	-6.959	8	14.959	Pass
802.11b	11	2462	-7.561	8	15.561	Pass
802.11g	1	2412	-9.215	8	17.215	Pass
802.11g	6	2437	-8.857	8	16.857	Pass
802.11g	11	2462	-10.313	8	18.313	Pass
802.11n (20MHz)	1	2412	-11.438	8	19.438	Pass
802.11n (20MHz)	6	2437	-11.190	8	19.190	Pass
802.11n (20MHz)	11	2462	-10.791	8	18.791	Pass
802.11n (20MHz)	3	2422	-16.487	8	24.487	Pass
802.11n (40MHz)	7	2442	-14.297	8	22.297	Pass
802.11n (40MHz)	11	2462	-15.151	8	23.151	Pass



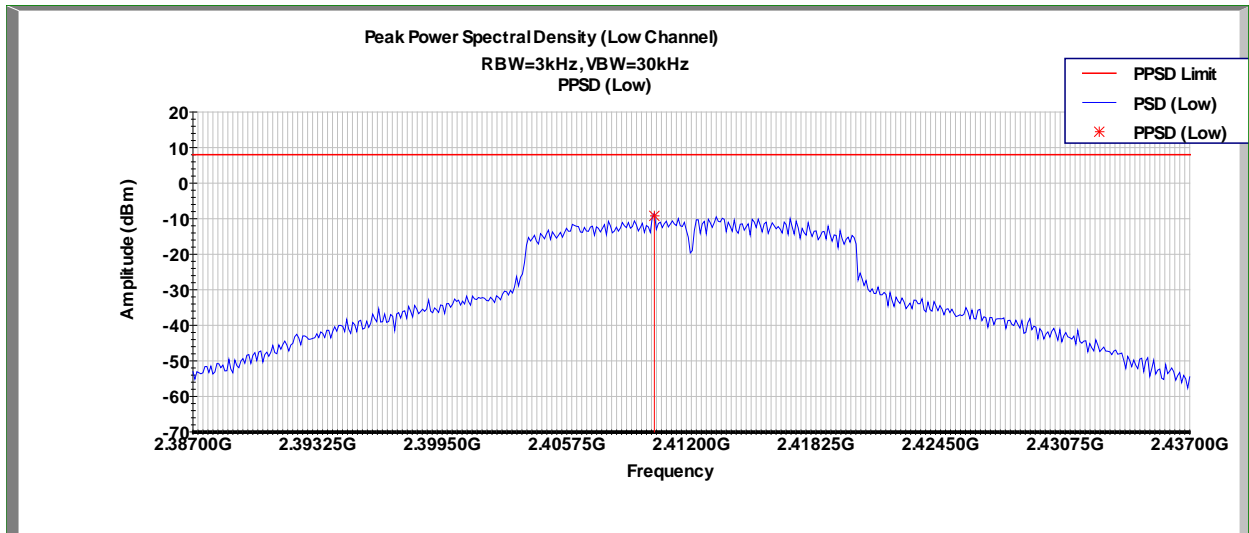
Power Spectral Density – Channel 1 802.11b mode



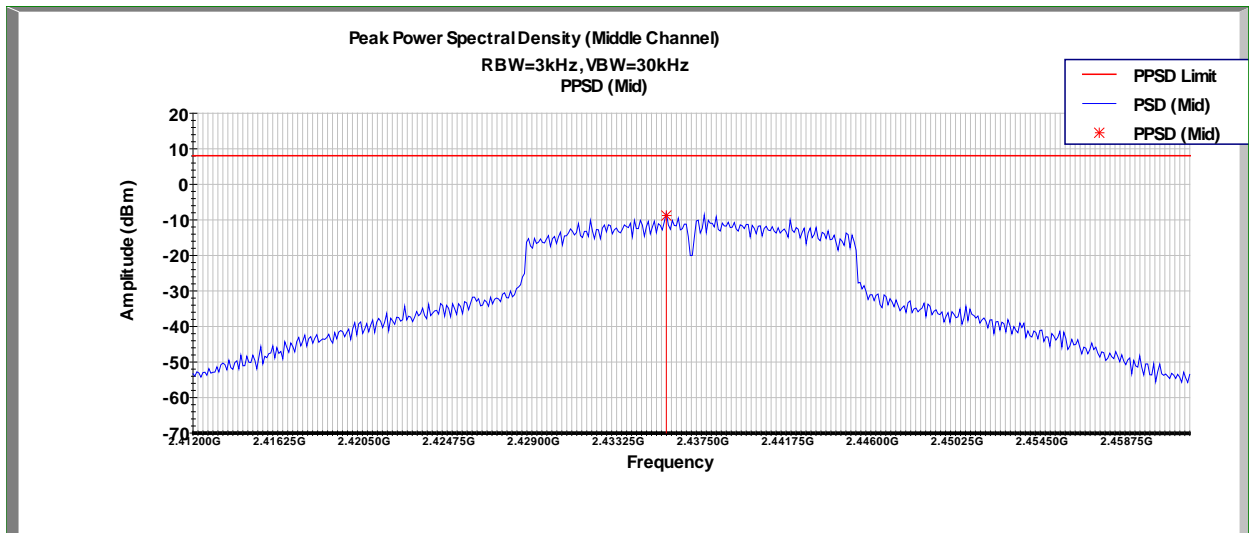
Power Spectral Density – Channel 6 802.11b mode



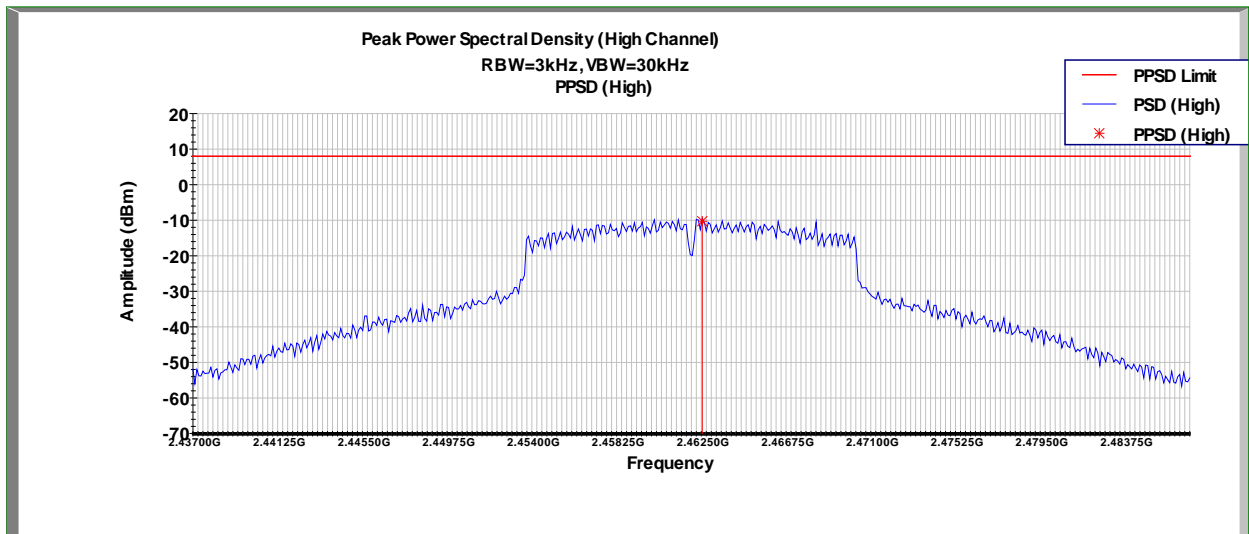
Power Spectral Density – Channel 11 802.11b mode



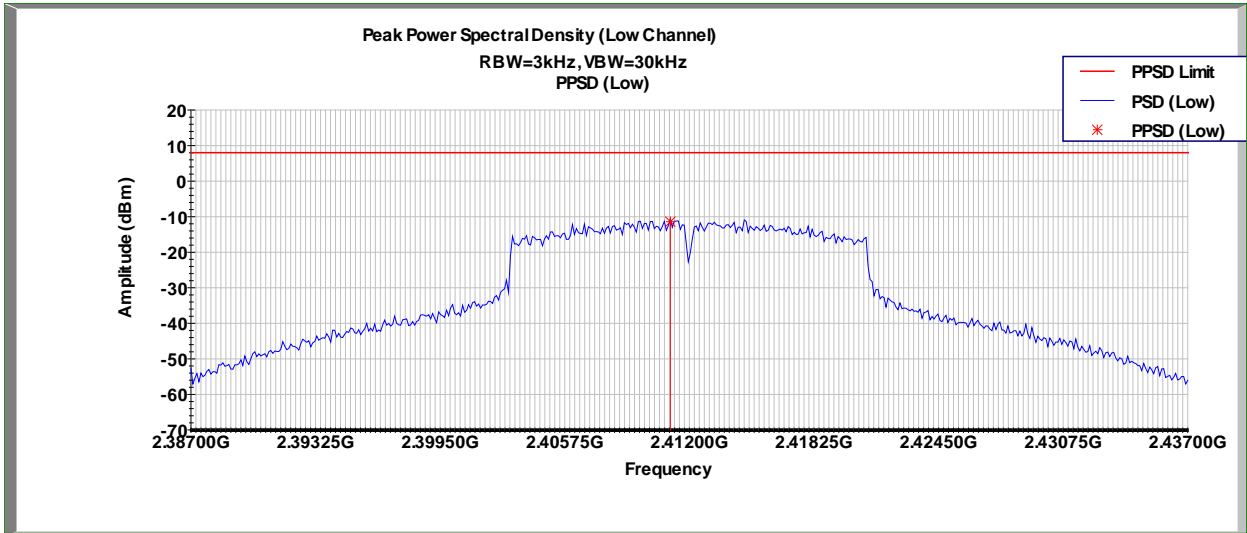
Power Spectral Density – Channel 1 802.11g mode



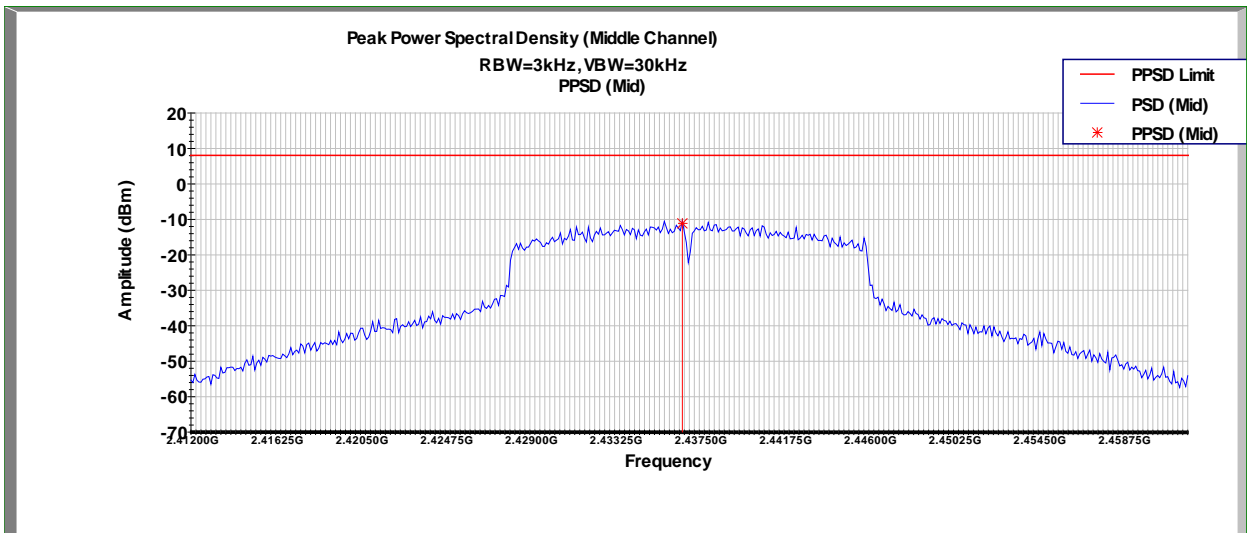
Power Spectral Density – Channel 6 802.11g mode



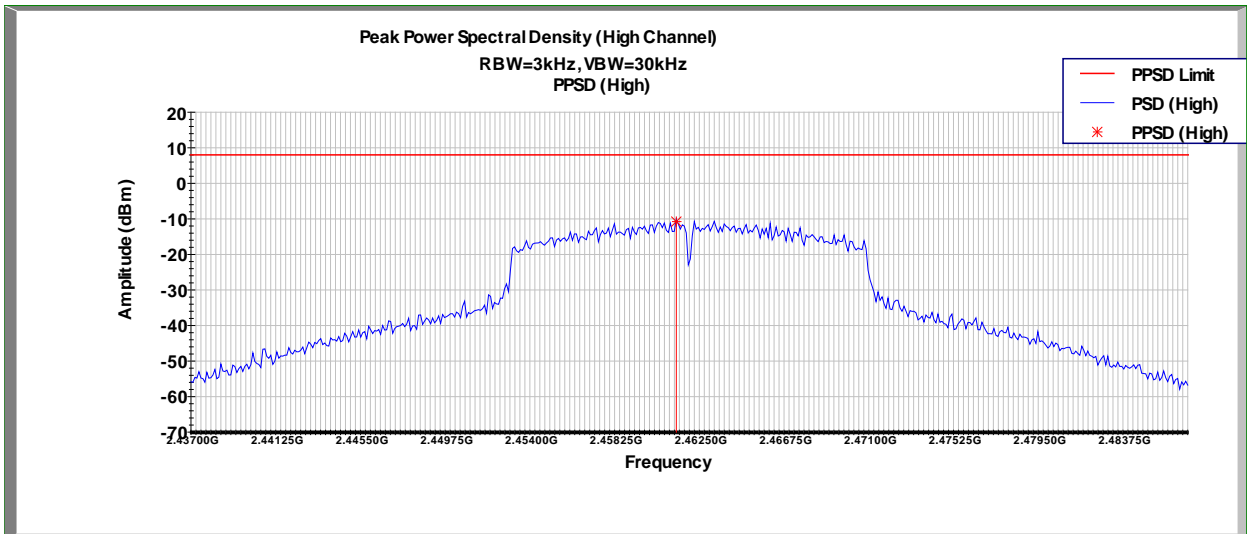
Power Spectral Density – Channel 11 802.11g mode



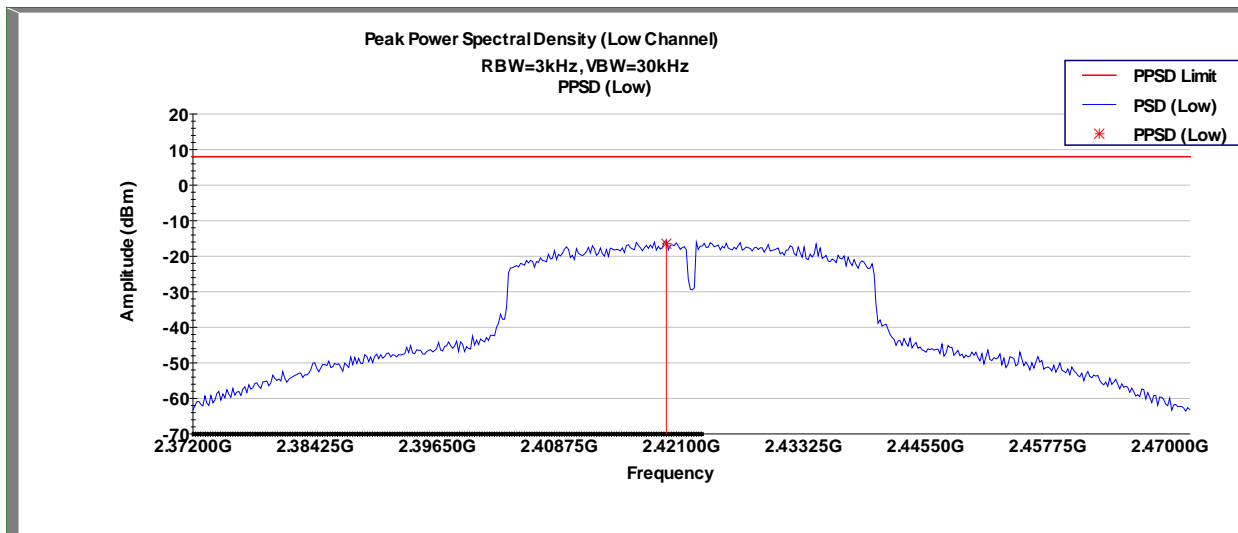
Power Spectral Density – Channel 1 802.11n mode (20MHz)



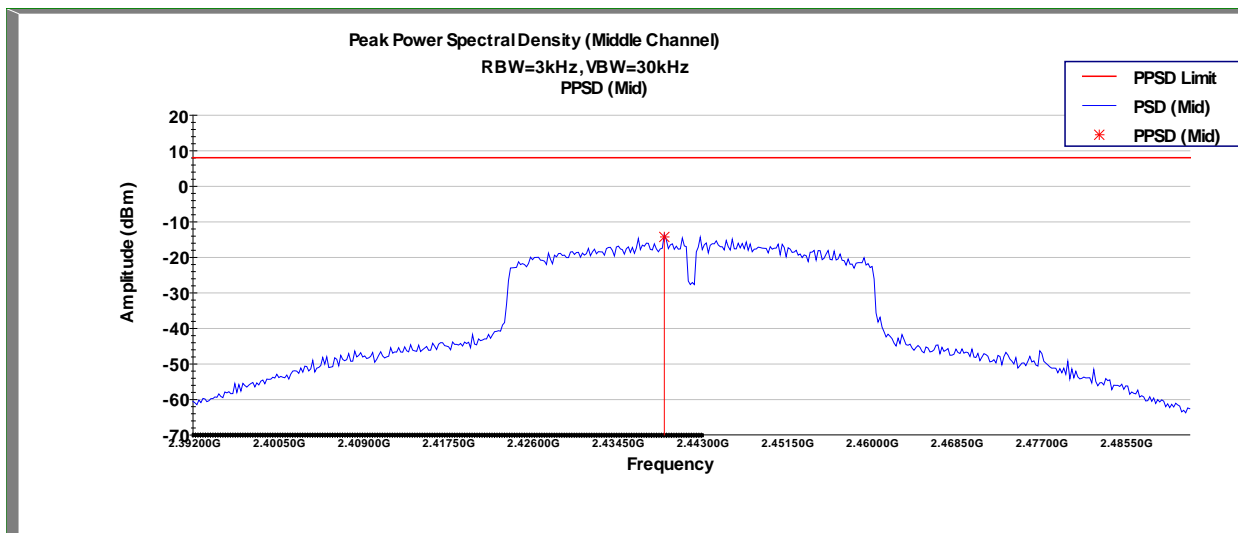
Power Spectral Density – Channel 6 802.11n mode (20MHz)



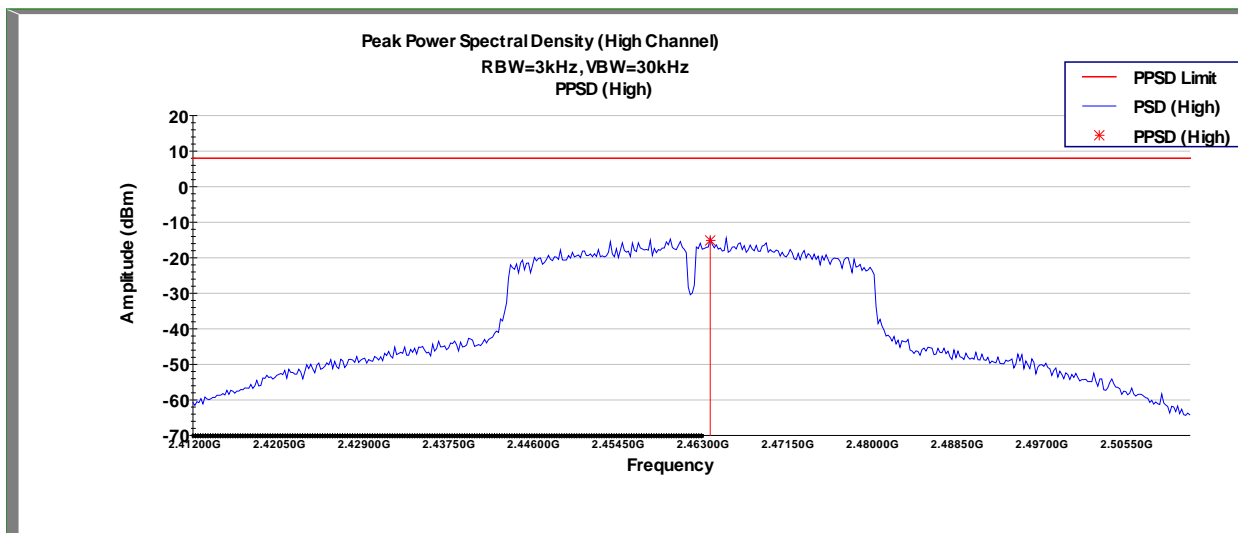
Power Spectral Density – Channel 11 802.11n mode (20MHz)



Power Spectral Density – Channel 3 802.11n mode (40MHz)



Power Spectral Density – Channel 7 802.11n mode (40MHz)



Power Spectral Density – Channel 11 802.11n mode (40MHz)

9 Radiated Spurious Emissions (Transmitter)

9.1 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
10.495–0.505	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

9.2 Test Procedure:

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

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 dB μ V/m

RA = Receiver Amplitude in dB μ V

AF = Antenna Factor in dB

CF = Cable Attenuation Factor in dB (Including preamplifier and filter attenuation)

Example Calculation:

$$RA = 19.48 \text{ dB}\mu\text{V}$$

$$AF = 18.52 \text{ dB}$$

$$CF = 0.78 \text{ dB}$$

$$FS = 19.48 + 18.52 + 0.78 = 38.78 \text{ dB}\mu\text{V/m}$$

$$\text{Level in } \mu\text{V/m} = \text{Common Antilogarithm} [(38.78 \text{ dB}\mu\text{V/m})/20] = 86.89 \mu\text{V/m}$$

9.4 Test Equipment Used:

Description	Serial Number	Manufacturer	Model	Cal. Date	Cal. Due
EMI Test Receiver	1302.6005.40	Rohde & Schwarz	ESU40	10/12/2017	10/12/2018
Preamplifier	122005	Rohde & Schwarz	TS-PR18	11/17/2016	11/17/2017
Biconnilog Antenna	00051864	ETS	3142C	4/6/2017	4/6/2018
Horn Antenna	154521	ETS	3117	11/14/2016	11/14/2017
System Controller	121701-1	Sunol Sciences	SC99V	Verify at Time of Use	Verify at Time of Use
Horn Antenna (18 - 40GHz)	117798	ETS	3116c	6/5/2017	6/5/2018
40GHz Preamplifier	3921	Rohde & Schwarz	TS-PR40	11/17/2016	11/17/2017
Highpass Filter	SN1	Wainwright	WHKX12-2533.85-2710-18000-40ss	Verify at Time of Use	Verify at Time of Use
3m Cable Antenna→Preamp	3074			11/17/2016	11/17/2017
3m Cable Preamp→Chamber	2588			11/17/2016	11/17/2017
3m Cable Chamber→Control Room	2593			11/17/2016	11/17/2017
3m Cable Control Room→Receiver	2592			11/17/2016	11/17/2017
10m Cable Antenna→Preamp	3339			11/17/2016	11/17/2017
10m Cable Preamp→Chamber	3172			11/17/2016	11/17/2017
10m Cable Chamber→Control Room	2590			11/17/2016	11/17/2017
10m Cable Control Room→Receiver	2589			11/17/2016	11/17/2017

9.5 Test Conditions:

Test Personnel: Brian Lackey
 Supervising/Reviewing Engineer:
 (Where Applicable) NA
 Input Voltage: 120V, 60Hz

Test Date: 10/17/2017
 Ambient Temperature: 22.4C
 Relative Humidity: 44.9%
 Atmospheric Pressure: 995.6mbar

9.6 Test Results:

The device was found to be **compliant**. 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 were investigated with the test sample positioned in 3 orthogonal axis and the worst case reported.

9.7 Test Data:

Worst Case Spurious Measurements (802.11b Mode)

802.11b Channel 1 Radiated Spurs:

Frequency (MHz)	MaxPeak (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
4823.941000	52.09	74.00	21.91	1000.000	179.0	H	22.0	7.5
7236.572000	46.74	74.00	27.26	1000.000	156.0	H	22.0	10.4
9643.697500	47.42	74.00	26.58	1000.000	163.0	V	50.0	13.6
12053.386000	50.64	74.00	23.36	1000.000	183.0	V	50.0	17.4

Frequency (MHz)	Average (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
4823.941000	48.47	54.00	5.53	1000.000	179.0	H	22.0	7.5
7236.572000	35.71	54.00	18.29	1000.000	156.0	H	22.0	10.4
9643.697500	34.83	54.00	19.17	1000.000	163.0	V	50.0	13.6
12053.386000	37.55	54.00	16.45	1000.000	183.0	V	50.0	17.4

802.11b Channel 6 Radiated Spurs:

Frequency (MHz)	MaxPeak (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
4873.898500	51.55	74.00	22.45	1000.000	188.0	H	22.0	7.4
7311.567500	47.16	74.00	26.84	1000.000	152.0	H	21.0	10.5
12176.379000	50.41	74.00	23.59	1000.000	165.0	V	32.0	17.2

Frequency (MHz)	Average (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
4873.898500	47.90	54.00	6.10	1000.000	188.0	H	22.0	7.4
7311.567500	36.21	54.00	17.79	1000.000	152.0	H	21.0	10.5
12176.379000	37.77	54.00	16.23	1000.000	165.0	V	32.0	17.2

802.11b Channel 11 Radiated Spurs:

Frequency (MHz)	MaxPeak (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
4923.903000	51.74	74.00	22.26	1000.000	175.0	H	24.0	7.3
7386.885000	47.73	74.00	26.27	1000.000	200.0	H	0.0	10.7
15969.050500	53.36	74.00	20.64	1000.000	152.0	V	50.0	20.6

Frequency (MHz)	Average (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
4923.903000	47.78	54.00	6.22	1000.000	175.0	H	24.0	7.3
7386.885000	36.90	54.00	17.10	1000.000	200.0	H	0.0	10.7
15969.050500	41.14	54.00	12.86	1000.000	152.0	V	50.0	20.6

Worst Case Spurious Measurements (802.11g Mode)

802.11g Channel 1 Radiated Spurs:

Frequency (MHz)	MaxPeak (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
4825.060000	48.15	74.00	25.85	1000.000	180.0	H	23.0	7.5
7240.799000	46.76	74.00	27.24	1000.000	141.0	H	21.0	10.4
16208.200500	54.01	74.00	19.99	1000.000	166.0	V	36.0	20.6

Frequency (MHz)	Average (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
4825.060000	35.05	54.00	18.95	1000.000	180.0	H	23.0	7.5
7240.799000	34.04	54.00	19.96	1000.000	141.0	H	21.0	10.4
16208.200500	40.98	54.00	13.02	1000.000	166.0	V	36.0	20.6

802.11g Channel 6 Radiated Spurs:

Frequency (MHz)	MaxPeak (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
4875.955500	48.48	74.00	25.52	1000.000	188.0	H	23.0	7.4
7310.646500	47.73	74.00	26.27	1000.000	200.0	H	18.0	10.5
9653.050000	47.63	74.00	26.37	1000.000	160.0	V	38.0	13.6
16011.364000	53.93	74.00	20.07	1000.000	154.0	H	36.0	20.9

Frequency (MHz)	Average (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
4875.955500	35.36	54.00	18.64	1000.000	188.0	H	23.0	7.4
7310.646500	34.68	54.00	19.32	1000.000	200.0	H	18.0	10.5
9653.050000	34.76	54.00	19.24	1000.000	160.0	V	38.0	13.6
16011.364000	41.26	54.00	12.74	1000.000	154.0	H	36.0	20.9

802.11g Channel 11 Radiated Spurs:

Frequency (MHz)	MaxPeak (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
4928.417000	47.11	74.00	26.89	1000.000	200.0	H	22.0	7.3
7348.715000	46.92	74.00	27.08	1000.000	134.0	V	50.0	10.5
12293.088500	50.63	74.00	23.37	1000.000	184.0	V	50.0	17.1
16234.131000	53.91	74.00	20.09	1000.000	134.0	V	38.0	20.7

Frequency (MHz)	Average (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
4928.417000	34.01	54.00	19.99	1000.000	200.0	H	22.0	7.3
7348.715000	32.67	54.00	21.33	1000.000	134.0	V	50.0	10.5
12293.088500	37.98	54.00	16.02	1000.000	184.0	V	50.0	17.1
16234.131000	40.97	54.00	13.03	1000.000	134.0	V	38.0	20.7

Worst Case Spurious Measurements (802.11n Mode, 20MHz)**802.11n (20MHz) Channel 1 Radiated Spurs:**

Frequency (MHz)	MaxPeak (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
4825.207000	46.66	74.00	27.34	1000.000	200.0	H	20.0	7.5
5508.384500	44.76	74.00	29.24	1000.000	173.0	V	50.0	9.4
7239.627500	46.36	74.00	27.64	1000.000	125.0	H	27.0	10.4
9620.502500	47.41	74.00	26.59	1000.000	170.0	V	39.0	13.6

Frequency (MHz)	Average (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
4825.207000	34.42	54.00	19.58	1000.000	200.0	H	20.0	7.5
5508.384500	31.84	54.00	22.16	1000.000	173.0	V	50.0	9.4
7239.627500	33.64	54.00	20.36	1000.000	125.0	H	27.0	10.4
9620.502500	34.75	54.00	19.25	1000.000	170.0	V	39.0	13.6

802.11n (20MHz) Channel 6 Radiated Spurs:

Frequency (MHz)	MaxPeak (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
4877.989500	47.02	74.00	26.98	1000.000	189.0	H	24.0	7.4
7481.210500	47.44	74.00	26.56	1000.000	200.0	H	18.0	10.9
11521.873500	49.66	74.00	24.34	1000.000	164.0	V	50.0	15.9
16000.134500	54.05	74.00	19.95	1000.000	200.0	H	36.0	20.8

Frequency (MHz)	Average (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
4877.989500	34.52	54.00	19.48	1000.000	189.0	H	24.0	7.4
7481.210500	33.51	54.00	20.49	1000.000	200.0	H	18.0	10.9
11521.873500	37.15	54.00	16.85	1000.000	164.0	V	50.0	15.9
16000.134500	41.25	54.00	12.75	1000.000	200.0	H	36.0	20.8

802.11n (20MHz) Channel 11 Radiated Spurs:

Frequency (MHz)	MaxPeak (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
4925.083500	46.71	74.00	27.29	1000.000	200.0	H	22.0	7.3
7462.283000	46.45	74.00	27.55	1000.000	100.0	H	28.0	10.9
12157.235000	50.36	74.00	23.64	1000.000	165.0	V	50.0	17.2

Frequency (MHz)	Average (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
4925.083500	34.12	54.00	19.88	1000.000	200.0	H	22.0	7.3
7462.283000	33.45	54.00	20.55	1000.000	100.0	H	28.0	10.9
12157.235000	37.90	54.00	16.10	1000.000	165.0	V	50.0	17.2

Worst Case Spurious Measurements (802.11n Mode, 40MHz)**802.11n (40MHz) Channel 3 Radiated Spurs:**

Frequency (MHz)	MaxPeak (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
4880.400000	43.35	74.00	30.65	1000.000	209.0	H	127.0	7.4
7265.200000	44.37	74.00	29.63	1000.000	341.0	H	218.0	10.4
9688.000000	47.36	74.00	26.64	1000.000	392.0	H	130.0	13.6
12135.600000	49.63	74.00	24.37	1000.000	319.0	H	130.0	17.2
14507.600000	50.05	74.00	23.95	1000.000	214.0	H	292.0	17.4
16473.200000	53.69	74.00	20.31	1000.000	379.0	H	200.0	21.0

Frequency (MHz)	Average (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
4880.400000	30.16	54.00	23.84	1000.000	209.0	H	127.0	7.4
7265.200000	31.74	54.00	22.26	1000.000	341.0	H	218.0	10.4
9688.000000	34.60	54.00	19.40	1000.000	392.0	H	130.0	13.6
12135.600000	36.95	54.00	17.05	1000.000	319.0	H	130.0	17.2
14507.600000	37.35	54.00	16.65	1000.000	214.0	H	292.0	17.4
16473.200000	40.42	54.00	13.58	1000.000	379.0	H	200.0	21.0

802.11n (40MHz) Channel 7 Radiated Spurs:

Frequency (MHz)	MaxPeak (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
4884.000000	43.04	74.00	30.96	1000.000	345.0	V	127.0	7.4
7299.200000	44.04	74.00	29.96	1000.000	410.0	H	221.0	10.5
9768.000000	47.08	74.00	26.92	1000.000	264.0	H	123.0	13.8
12242.200000	49.50	74.00	24.50	1000.000	377.0	H	280.0	17.2
14718.800000	49.47	74.00	24.53	1000.000	214.0	V	262.0	17.5
17206.200000	52.92	74.00	21.08	1000.000	385.0	H	0.0	21.0

Frequency (MHz)	Average (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
4884.000000	30.37	54.00	23.63	1000.000	345.0	V	127.0	7.4
7299.200000	31.42	54.00	22.58	1000.000	410.0	H	221.0	10.5
9768.000000	33.88	54.00	20.12	1000.000	264.0	H	123.0	13.8
12242.200000	37.04	54.00	16.96	1000.000	377.0	H	280.0	17.2
14718.800000	36.63	54.00	17.37	1000.000	214.0	V	262.0	17.5
17206.200000	40.28	54.00	13.72	1000.000	385.0	H	0.0	21.0

802.11n (40MHz) Channel 11 Radiated Spurs:

Frequency (MHz)	MaxPeak (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
4918.120000	42.59	74.00	31.41	1000.000	200.0	V	0.0	7.3
7387.021000	43.89	74.00	30.11	1000.000	150.0	H	29.0	10.7
9833.686000	46.13	74.00	27.87	1000.000	126.0	V	34.0	14.0
12298.591000	49.93	74.00	24.07	1000.000	149.0	H	28.0	17.1
14767.345000	49.25	74.00	24.75	1000.000	171.0	V	25.0	17.7
17229.552000	53.41	74.00	20.59	1000.000	132.0	H	50.0	21.0

Frequency (MHz)	Average (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
4918.120000	30.09	54.00	23.91	1000.000	200.0	V	0.0	7.3
7387.021000	31.18	54.00	22.82	1000.000	150.0	H	29.0	10.7
9833.686000	33.84	54.00	20.16	1000.000	126.0	V	34.0	14.0
12298.591000	36.91	54.00	17.09	1000.000	149.0	H	28.0	17.1
14767.345000	36.80	54.00	17.20	1000.000	171.0	V	25.0	17.7
17229.552000	40.10	54.00	13.90	1000.000	132.0	H	50.0	21.0

Low Channel Band Edge Emissions - 802.11b Mode

Frequency (MHz)	Average (dBµV/m)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
2390.000000	---	53.77	74.00	20.23	1000.000	100.0	H	318.0	37.7
2390.000000	42.35	---	54.00	11.65	1000.000	100.0	H	318.0	37.7

High Channel Band Edge - 802.11b Mode

Frequency (MHz)	Average (dBµV/m)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
2483.500000	---	53.54	74.00	20.46	1000.000	299.0	V	130.0	37.8
2483.500000	42.99	---	54.00	11.01	1000.000	299.0	V	130.0	37.8

Low Channel Band Edge Emissions - 802.11g Mode

Frequency (MHz)	Average (dBµV/m)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
2390.000000	---	60.73	74.00	13.27	1000.000	410.0	H	314.0	37.7
2390.000000	44.45	---	54.00	9.55	1000.000	410.0	H	314.0	37.7

High Channel Band Edge Emissions - 802.11g Mode

Frequency (MHz)	Average (dBµV/m)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
2483.500000	---	60.45	74.00	13.55	1000.000	374.0	V	121.0	37.8
2483.500000	43.47	---	54.00	10.53	1000.000	374.0	V	121.0	37.8

Low Channel Band Edge Emissions - 802.11n Mode (20MHz)

Frequency (MHz)	Average (dBµV/m)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
2390.000000	---	59.67	74.00	14.33	1000.000	410.0	H	328.0	37.7
2390.000000	43.70	---	54.00	10.30	1000.000	410.0	H	328.0	37.7

High Channel Band Edge Emissions - 802.11n Mode (20MHz)

Frequency (MHz)	Average (dBµV/m)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
2483.500000	---	59.38	74.00	14.62	1000.000	303.0	V	125.0	37.8
2483.500000	43.47	---	54.00	10.53	1000.000	303.0	V	125.0	37.8

Low Channel Band Edge Emissions - 802.11n Mode (40MHz)

Frequency (MHz)	Average (dBµV/m)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
2390.000000	---	55.49	74.00	18.51	1000.000	377.0	V	168.0	37.7
2390.000000	42.81	---	54.00	11.19	1000.000	377.0	V	168.0	37.7

High Channel Band Edge Emissions - 802.11n Mode (40MHz)

Frequency (MHz)	Average (dBµV/m)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
2483.500000	---	66.27	74.00	7.73	1000.000	342.0	V	170.0	37.8
2483.500000	46.93	---	54.00	7.07	1000.000	342.0	V	170.0	37.8

10 Radiated Spurious Emissions (Receiver)

10.1 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

10.2 Test Procedure:

ANSI C63.4: 2014

10.3 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 dB μ V/m

RA = Receiver Amplitude in dB μ V

AF = Antenna Factor in dB

CF = Cable Attenuation Factor in dB (Including preamplifier and filter attenuation)

Example Calculation:

$$RA = 19.48 \text{ dB}\mu\text{V}$$

$$AF = 18.52 \text{ dB}$$

$$CF = 0.78 \text{ dB}$$

$$FS = 19.48 + 18.52 + 0.78 = 38.78 \text{ dB}\mu\text{V/m}$$

$$\text{Level in } \mu\text{V/m} = \text{Common Antilogarithm } [(38.78 \text{ dB}\mu\text{V/m})/20] = 86.89 \mu\text{V/m}$$

10.4 Test Equipment Used:

Description	Serial Number	Manufacturer	Model	Cal. Date	Cal. Due
EMI Test Receiver	1302.6005.40	Rohde & Schwarz	ESU40	10/12/2017	10/12/2018
Preamplifier	122005	Rohde&Schwarz	TS-PR18	11/17/2016	11/17/2017
Biconnilog Antenna	00051864	ETS	3142C	4/6/2017	4/6/2018
Horn Antenna	154521	ETS	3117	11/14/2016	11/14/2017
System Controller	121701-1	Sunol Sciences	SC99V	Verify at Time of Use	Verify at Time of Use
3m Cable Antenna→Preamp	3074			11/17/2016	11/17/2017
3m Cable Preamp→Chamber	2588			11/17/2016	11/17/2017
3m Cable Chamber→Control Room	2593			11/17/2016	11/17/2017
3m Cable Control Room→Receiver	2592			11/17/2016	11/17/2017
10m Cable Antenna→Preamp	3339			11/17/2016	11/17/2017
10m Cable Preamp→Chamber	3172			11/17/2016	11/17/2017
10m Cable Chamber→Control Room	2590			11/17/2016	11/17/2017
10m Cable Control Room→Receiver	2589			11/17/2016	11/17/2017

10.5 Test Results:

The device was found to be **compliant**. 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 and RSS-GEN Section 6.1.

10.6 Test Conditions:

Test Personnel: Brian Lackey
 Supervising/Reviewing Engineer:
 (Where Applicable) NA
 Input Voltage: 120V, 60Hz

Test Date: 10/17/2017
 Ambient Temperature: 22.4C
 Relative Humidity: 44.9%
 Atmospheric Pressure: 995.6mbar

10.7 Test Data:**Quasi-Peak Measurements below 1000 MHz:**

Frequency (MHz)	QuasiPeak (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
61.047000	28.61	40.00	11.39	120.000	272.7	V	54.0	15.1
61.568000	21.41	40.00	18.59	120.000	100.7	V	6.0	15.1
63.009000	30.36	40.00	9.64	120.000	224.0	V	16.0	15.0
63.012000	30.14	40.00	9.86	120.000	234.6	V	15.0	15.0
63.437000	30.16	40.00	9.84	120.000	209.4	V	18.0	15.0
85.536000	33.06	40.00	6.94	120.000	136.6	V	270.0	16.3
85.901000	28.27	40.00	11.73	120.000	119.5	V	314.0	16.3
239.280000	39.30	46.02	6.72	120.000	202.2	V	266.0	21.3
480.020000	38.04	46.02	7.98	120.000	105.0	V	118.0	28.4
944.860000	44.19	46.02	1.83	120.000	205.0	V	3.0	36.1

Peak Measurements above 1000 MHz:

Frequency (MHz)	MaxPeak (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
1723.262000	35.56	74.00	38.44	1000.000	135.0	H	50.0	-0.2
2424.613500	38.93	74.00	35.07	1000.000	164.0	V	0.0	3.9
2429.549500	39.09	74.00	34.91	1000.000	142.0	H	50.0	3.9
2429.628000	39.53	74.00	34.47	1000.000	200.0	V	0.0	3.9
12745.746500	48.55	74.00	25.45	1000.000	200.0	V	38.0	17.0
16610.673000	52.54	74.00	21.46	1000.000	200.0	H	50.0	21.5

Average Measurements above 1000 MHz:

Frequency (MHz)	Average (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
1723.262000	22.82	54.00	31.18	1000.000	135.0	H	50.0	-0.2
2424.613500	26.43	54.00	27.57	1000.000	164.0	V	0.0	3.9
2429.549500	26.39	54.00	27.61	1000.000	142.0	H	50.0	3.9
2429.628000	26.41	54.00	27.59	1000.000	200.0	V	0.0	3.9
12745.746500	36.35	54.00	17.65	1000.000	200.0	V	38.0	17.0
16610.673000	40.51	54.00	13.49	1000.000	200.0	H	50.0	21.5

11 AC Powerline Conducted Emissions

11.1 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 μ H/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 (dB μ V)	
	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.

11.2 Test Procedure:

ANSI C63.4: 2014

11.3 Test Equipment Used:

Description	Serial Number	Manufacturer	Model	Cal. Date	Cal. Due
EMI Test Receiver	10887490.26	Rohde & Schwarz	ESI26	9/20/2017	9/20/2018
LISN	3333	Teseq	NNB52	6/15/2017	6/15/2018
Cable	Cond2			11/19/2016	11/19/2017

11.4 Test Results:

The device was found to be **compliant**.

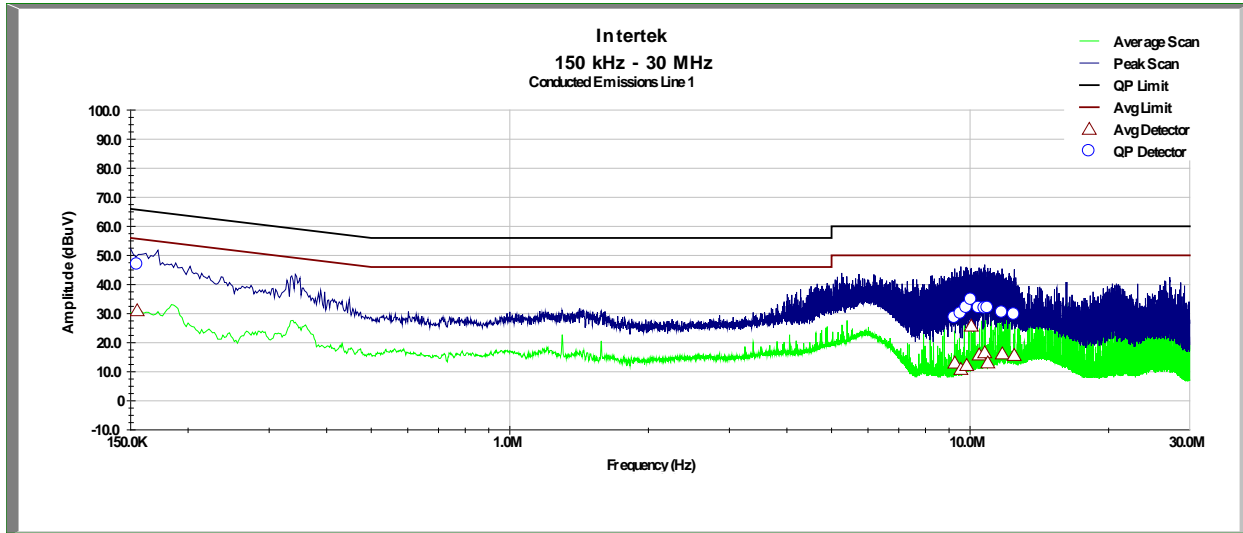
11.5 Test Conditions:

Test Personnel: Brian Lackey
 Supervising/Reviewing Engineer:
 (Where Applicable) NA
 Input Voltage: 120V, 60Hz

Test Date: 10/10/2017
 Ambient Temperature: 22.4C
 Relative Humidity: 44.9%
 Atmospheric Pressure: 995.6mbar

11.6 Test Data:

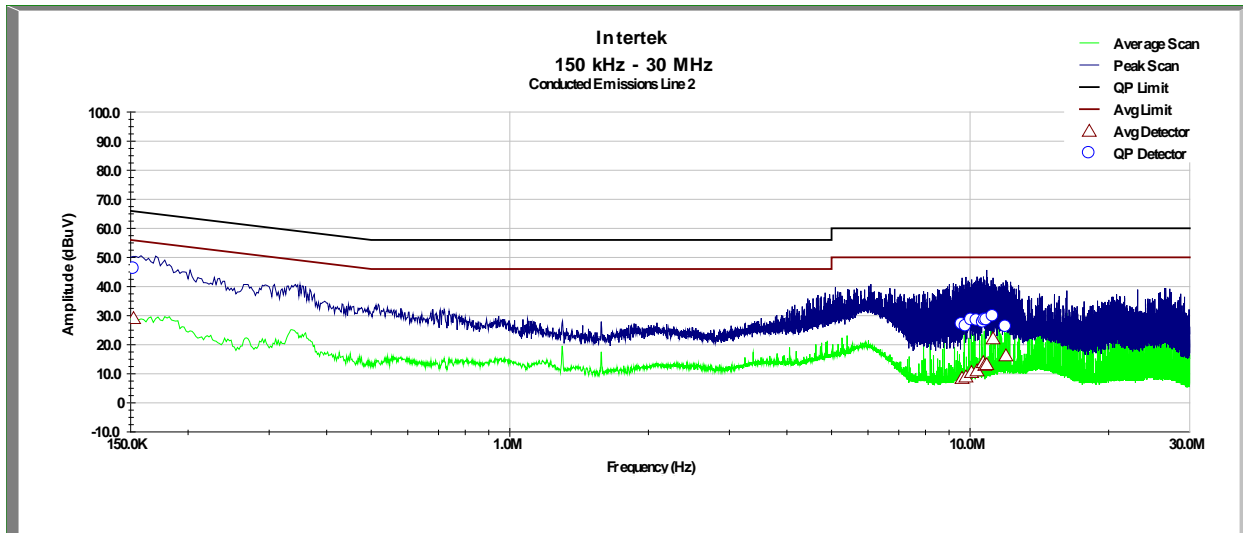
11.6.1 Quasi-Peak and Average Measurements (Transmitting):



Line

Frequency (MHz)	Quasi-Peak (dBuV)	Quasi-Peak Limit (dBuV)	Quasi-Peak Margin (dB)	Average (dBuV)	Average Limit (dBuV)	Average Margin (dB)
155.000 KHz	46.857	65.857	19.000	30.967	55.857	24.890
9.263 MHz	28.489	60.000	31.511	12.954	50.000	37.046
9.550 MHz	29.922	60.000	30.078	10.778	50.000	39.222
9.832 MHz	32.004	60.000	27.996	12.126	50.000	37.874
10.061 MHz	34.739	60.000	25.261	25.682	50.000	24.318
10.464 MHz	31.891	60.000	28.109	15.747	50.000	34.253
10.758 MHz	31.776	60.000	28.224	16.530	50.000	33.470
10.924 MHz	31.889	60.000	28.111	13.017	50.000	36.983
11.745 MHz	30.291	60.000	29.709	16.119	50.000	33.881
12.474 MHz	29.587	60.000	30.413	15.603	50.000	34.397

Line

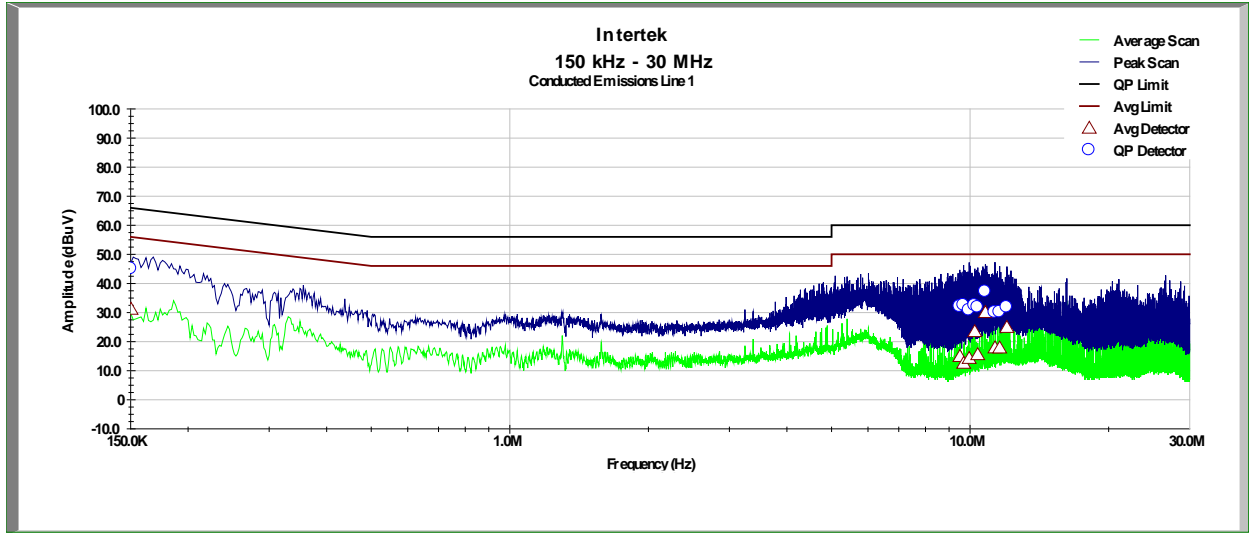


Neutral

Frequency (MHz)	Quasi-Peak (dBuV)	Quasi-Peak Limit (dBuV)	Quasi-Peak Margin (dB)	Average (dBuV)	Average Limit (dBuV)	Average Margin (dB)
152.200 KHz	46.084	65.937	19.853	28.985	55.937	26.952
9.604 MHz	26.935	60.000	33.065	8.396	50.000	41.604
9.793 MHz	26.320	60.000	33.680	8.898	50.000	41.102
10.072 MHz	28.454	60.000	31.546	10.429	50.000	39.571
10.357 MHz	28.282	60.000	31.718	10.998	50.000	39.002
10.685 MHz	27.629	60.000	32.371	13.806	50.000	36.194
10.765 MHz	28.445	60.000	31.555	12.909	50.000	37.091
10.868 MHz	28.443	60.000	31.557	13.127	50.000	36.873
11.219 MHz	29.687	60.000	30.313	21.995	50.000	28.005
11.962 MHz	26.099	60.000	33.901	16.164	50.000	33.836

Neutral

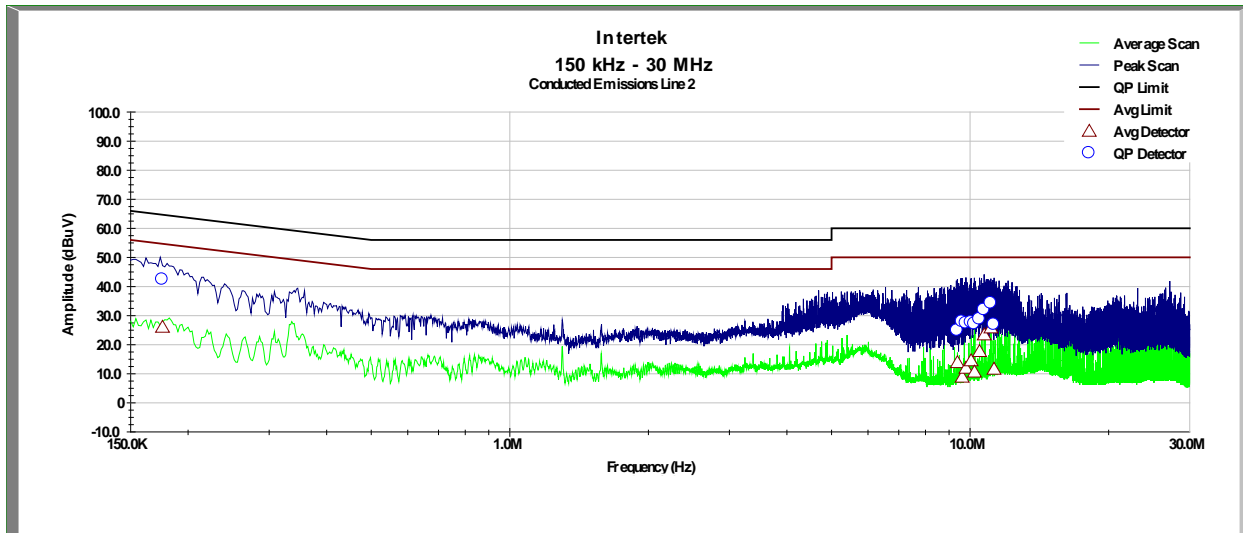
11.6.2 Quasi-Peak and Average Measurements (Receive Mode):



Line

Frequency (MHz)	Quasi-Peak (dBuV)	Quasi-Peak Limit (dBuV)	Quasi-Peak Margin (dB)	Average (dBuV)	Average Limit (dBuV)	Average Margin (dB)
150.300 KHz	44.982	65.991	21.010	31.120	55.991	24.871
9.505 MHz	31.999	60.000	28.001	14.882	50.000	35.118
9.684 MHz	32.471	60.000	27.529	12.541	50.000	37.459
9.956 MHz	30.732	60.000	29.268	14.197	50.000	35.803
10.239 MHz	32.365	60.000	27.635	23.422	50.000	26.578
10.390 MHz	31.740	60.000	28.260	15.504	50.000	34.496
10.795 MHz	37.086	60.000	22.914	29.981	50.000	20.019
11.325 MHz	29.970	60.000	30.030	17.819	50.000	32.181
11.594 MHz	30.064	60.000	29.936	17.804	50.000	32.196
12.022 MHz	31.736	60.000	28.264	24.855	50.000	25.145

Line



Neutral

Frequency (MHz)	Quasi-Peak (dBuV)	Quasi-Peak Limit (dBuV)	Quasi-Peak Margin (dB)	Average (dBuV)	Average Limit (dBuV)	Average Margin (dB)
175.900 KHz	42.315	65.260	22.945	25.986	55.260	29.274
9.384 MHz	24.756	60.000	35.244	13.832	50.000	36.168
9.614 MHz	27.817	60.000	32.183	8.807	50.000	41.193
9.793 MHz	27.327	60.000	32.673	11.890	50.000	38.110
10.054 MHz	27.637	60.000	32.363	14.442	50.000	35.558
10.220 MHz	27.067	60.000	32.933	10.574	50.000	39.426
10.484 MHz	28.668	60.000	31.332	17.634	50.000	32.366
10.734 MHz	31.892	60.000	28.108	23.340	50.000	26.660
11.103 MHz	34.151	60.000	25.849	25.756	50.000	24.244
11.272 MHz	26.794	60.000	33.206	11.561	50.000	38.439

Neutral

12 Antenna Requirement per FCC Part 15.203

12.1 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.

12.2 Test Results:

The device was found to be **compliant**. The sample tested met the antenna requirement. The antenna used was permanently attached and internal to the unit.

12.3 Test Conditions:

Test Personnel:	<u>Brian Lackey</u>	Test Date:	<u>10/10/2017</u>
Supervising/Reviewing Engineer:			
(Where Applicable)	<u>NA</u>	Ambient Temperature:	<u>22.4C</u>
Input Voltage:	<u>120V, 60Hz</u>	Relative Humidity:	<u>44.9%</u>
		Atmospheric Pressure:	<u>995.6mbar</u>

13 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	

14 Revision History

Revision Level	Date	Report Number	Notes
0	11/10/2017	103236250LEX-004	Original Issue