MET Laboratories, Inc. *Safety Certification - EMI - Telecom Environmental Simulation*
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October 28, 2016

Intelligent Automation, Inc.
15400 Calhoun Place Suite 400
Rockville, MD 20855

Dear Eric van Doorn,

Enclosed is the EMC Wireless test report for compliance testing of the Intelligent Automation, Inc., ARGUS as tested to the requirements of Title 47 of the CFR, Ch. 1 (10-1-06 ed.), Part 15 Subpart C for Intentional Radiators.

Thank you for using the services of MET Laboratories, Inc. If you have any questions regarding these results or if MET can be of further service to you, please feel free to contact me.

Sincerely yours,
MET LABORATORIES, INC.

Jennifer Warnell
Documentation Department

Reference: (\Intelligent Automation, Inc.\EMC91497-FCC247 REV 1)

Electromagnetic Compatibility Criteria
Test Report

for the

Intelligent Automation, Inc.
ARGUS

Tested under
the FCC Certification Rules contained in
Title 47 of the CFR, Part 15.247 Subpart C
for Intentional Radiators

MET Report: EMC91497-FCC247 REV 1

October 28, 2016

Prepared For:

Intelligent Automation, Inc.
15400 Calhoun Place Suite 400
Rockville, MD 20855

Prepared By:
MET Laboratories, Inc.
914 W. Patapsco Ave.
Baltimore, MD 21230

Electromagnetic Compatibility Criteria
Test Report

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ARGUS

Tested under
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Title 47 of the CFR, Part 15.247 Subpart C
for Intentional Radiators

Deepak Giri, Project Engineer
Electromagnetic Compatibility Lab

Jennifer Warnell
Documentation Department

Engineering Statement: The measurements shown in this report were made in accordance with the procedures indicated, and the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them. It is further stated that upon the basis of the measurements made, the equipment tested is capable of operation in accordance with the requirements of the FCC Rule Part 15.247 under normal use and maintenance.

Asad Bajwa,
Director, Electromagnetic Compatibility Lab

Report Status Sheet

Revision	Report Date	Reason for Revision
∅	October 7, 2016	Initial Issue.
1	October 28, 2016	Revisions Made During TCB Review

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List of Terms and Abbreviations

AC	**A**lternating **C**urrent
ACF	**A**ntenna **C**orrection **F**actor
Cal	**Cal**ibration
D	**M**easurement **D**istance
dB	**D**eci**b**els
dBµA	**D**eci**b**els above one **micro**amp
dBµV	**D**eci**b**els above one **micro**volt
dBµA/m	**D**eci**b**els above one **micro**amp **per m**eter
dBµV/m	**D**eci**b**els above one **micro**volt **per m**eter
DC	**D**irect **C**urrent
E	**E**lectric Field
DSL	**D**igital **S**ubscriber **L**ine
ESD	**E**lectro**s**tatic **D**ischarge
EUT	**E**quipment **U**nder **T**est
F	**F**requency
FCC	**F**ederal **C**ommunications **C**ommission
GRP	**G**round **R**eference **P**lane
H	Magnetic Field
HCP	**H**orizontal **C**oupling **P**lane
Hz	**H**ert**z**
IEC	**I**nternational **E**lectrotechnical **C**ommission
kHz	**k**ilo**h**ert**z**
kPa	**k**ilo**pa**scal
kV	**k**ilo**v**olt
LISN	**L**ine **I**mpedance **S**tabilization **N**etwork
MHz	**M**ega**h**ertz
µH	**microh**enry
µ	**microf**arad
µs	**micros**econds
NEBS	**N**etwork **E**quipment-**B**uilding **S**ystem
PRF	**P**ulse **R**epetition **F**requency
RF	**R**adio **F**requency
RMS	**R**oot-**M**ean-**S**quare
TWT	**T**raveling **W**ave **T**ube
V/m	**V**olts **per m**eter
VCP	**V**ertical **C**oupling **P**lane

I. Executive Summary

A. Purpose of Test

An EMC evaluation was performed to determine compliance of the Intelligent Automation, Inc. ARGUS, with the requirements of Part 15, §15.247. All references are to the most current version of Title 47 of the Code of Federal Regulations in effect. In accordance with §2.1033, the following data is presented in support of the Certification of the ARGUS. Intelligent Automation, Inc. should retain a copy of this document which should be kept on file for at least two years after the manufacturing of the ARGUS, has been **permanently** discontinued.

B. Executive Summary

The following tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with Part 15, §15.247, in accordance with Intelligent Automation, Inc., purchase order number 3004-16-07-20-001. All tests were conducted using measurement procedure ANSI C63.4-2014.

FCC Reference 47 CFR Part 15.247:2005	Description	Compliance
Title 47 of the CFR, Part 15 §15.203	Antenna Requirement	Compliant
Title 47 of the CFR, Part 15 §15.207(a)	Conducted Emission Limits	Not Applicable
Title 47 of the CFR, Part 15 §15.247(a)(1)	20 dB Occupied Bandwidth	Compliant
Title 47 of the CFR, Part 15 §15.247(a)(1)	Average Time of Occupancy (Dwell Time)	Compliant
Title 47 of the CFR, Part 15 §15.247(a)(1)	Number of RF Channels	Compliant
Title 47 of the CFR, Part 15 §15.247(a)(1)	RF Channel Separation	Compliant
Title 47 of the CFR, Part 15 §15.247(b)	Peak Power Output	Compliant
Title 47 of the CFR, Part 15 §15.247(d); §15.209; §15.205	Radiated Spurious Emissions	Compliant
Title 47 of the CFR, Part 15 §15.247(d)	Spurious Conducted Emissions	Compliant
Title 47 of the CFR, Part 15 §15.247(g) & (h)	Declaration Statements for FHSS	Compliant
Title 47 of the CFR, Part 15 §15.247(i)	Maximum Permissible Exposure (MPE)	Compliant

Table 1. Executive Summary of EMC Part 15.247 ComplianceTesting

II. Equipment Configuration

A. Overview

MET Laboratories, Inc. was contracted by Intelligent Automation, Inc. to perform testing on the ARGUS, under Intelligent Automation, Inc.'s purchase order number 3004-16-07-20-001.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the Intelligent Automation, Inc., ARGUS.

The results obtained relate only to the item(s) tested.

Model(s) Tested:	ARGUS	
Model(s) Covered:	ARGUS	
EUT Specifications:	Primary Power: 3.60V DC	
	FCC ID: 2AI6Y-ARGUSBP	
	Type of Modulations:	GFSK
	Equipment Code:	DSS
	Peak RF Output Power:	9.06 dBm
	EUT Frequency Ranges:	2400-2483.5 MHz
Analysis:	The results obtained relate only to the item(s) tested.	
Environmental Test Conditions:	Temperature: 15-35º C	
	Relative Humidity: 30-60%	
	Barometric Pressure: 860-1060 mbar	
Evaluated by:	Deepak Giri	
Report Date(s):	October 28, 2016	

Table 2. EUT Summary Table

B. References

CFR 47, Part 15, Subpart C	Federal Communication Commission, Code of Federal Regulations, Title 47, Part 15: General Rules and Regulations, Allocation, Assignment, and Use of Radio Frequencies
ANSI C63.4:2014	Methods and Measurements of Radio-Noise Emissions from Low-Voltage Electrical And Electronic Equipment in the Range of 9 kHz to 40 GHz
ISO/IEC 17025:2005	General Requirements for the Competence of Testing and Calibration Laboratories
ANSI C63.10-2013	American National Standard for Testing Unlicensed Wireless Devices
KDB 447498 D01	General RF Exposure Guidance v05r01

Table 3. References

C. Test Site

All testing was performed at MET Laboratories, Inc., 914 W. Patapsco Ave., Baltimore, MD 21230. All equipment used in making physical determinations is accurate and bears recent traceability to the National Institute of Standards and Technology.

Radiated Emissions measurements were performed in a 3 meter semi-anechoic chamber (equivalent to an Open Area Test Site). In accordance with §2.948(a)(3), a complete site description is contained at MET Laboratories.

D. Description of Test Sample

The Intelligent Automation, Inc. ARGUS, Equipment Under Test (EUT), is a system of unattended ground sensors used for the purpose of perimeter intrusion detection, typically in outdoor wooded or open settings surrounding a building or other high valued asset needed protection. Each individual ARGUS sensor is comprised of two radio transceivers – one 2.4GHz transceiver for the purpose of networking and communications, and one 900MHz transceiver for the purpose of sending/receiving the transmissions that are actually used to detect the intruders.

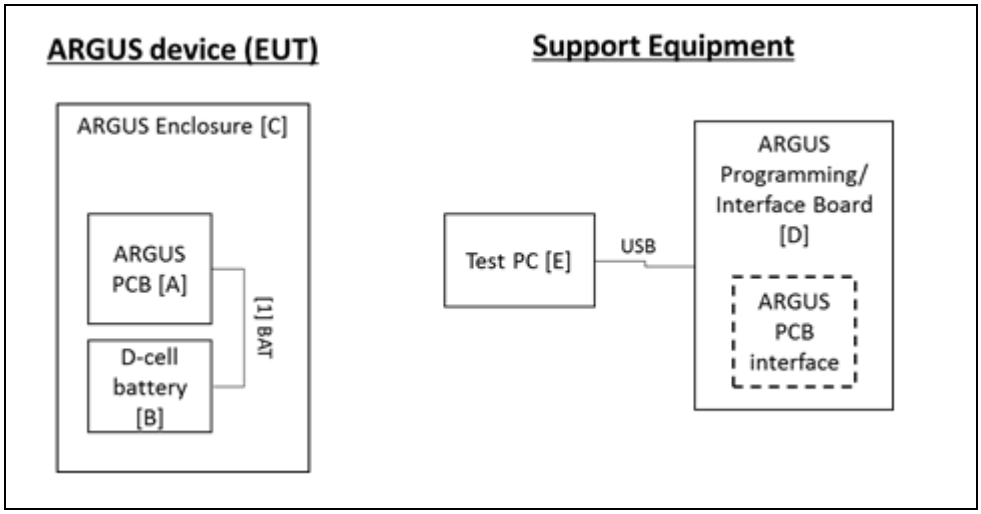


Figure 1. Block Diagram of Test Configuration

E. Equipment Configuration

The EUT was set up as outlined in Figure 1, Block Diagram of Test Setup. All cards, racks, etc., incorporated as part of the EUT is included in the following list.

Ref. ID	Name / Description	Model Number	Rev. #
A	ARGUS PCB	IAI15001_ARGUSHS_X4	X4
B	D-cell battery	ER34615	--
C	ARGUS enclosure	180-001-0000	--

Table 4. Equipment Configuration

F. Support Equipment

Support equipment necessary for the operation and testing of the EUT is included in the following list.

Ref. ID	Name / Description	Manufacturer	Model Number
D	ARGUS Programming/Interface Board	Intelligent Automation, Inc.	IAI15001_DEV_X2
E	Test/Configuration PC	Panasonic	Toughbook CF-31

Table 5. Support Equipment

G. Ports and Cabling Information

Ref. ID	Port name on EUT	Cable Description or reason for no cable	Qty.	Length as tested (m)	Shielded? (Y/N)	Termination Box ID & Port Name
1	BAT	2 conductor, 26 awg	1	0.2	No	--

Table 6. Ports and Cabling Information

H. Mode of Operation

For testing purposes, we expect to operate either/both transceivers in a continuous modulation (CM) mode on a particular channel to represent a "worst-case" configuration for the device.

I. Method of Monitoring EUT Operation

1. The EUT will blink its onboard LED green three times indicating that it has started up. After startup, no LED indication is present.
2. If directly connected to a PC USB port (via the separate configuration interface board), the EUT will print out statements indicating the test mode being used upon startup. This would be done only to confirm a configuration, but would not be used during actual testing.
3. The 2.4GHz and/or 900MHz transmissions can be observed on a spectrum analyzer.

J. Modifications

a) Modifications to EUT
No modifications were made to the EUT.

b) Modifications to Test Standard
No modifications were made to the test standard.

K. Disposition of EUT

The test sample including all support equipment submitted to the Electro-Magnetic Compatibility Lab for testing was returned to Intelligent Automation, Inc. upon completion of testing.

III. Electromagnetic Compatibility Criteria for Intentional Radiators

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.203 Antenna Requirement

Test Requirement: **§ 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.

The structure and application of the EUT were analyzed to determine compliance with Section 15.203 of the Rules. Section 15.203 states that the subject device must meet at least one of the following criteria:

a.) Antenna must be permanently attached to the unit.

b.) Antenna must use a unique type of connector to attach to the EUT.

c.) Unit must be professionally installed. Installer shall be responsible for verifying that the correct antenna is employed with the unit.

Results: The EUT as tested is compliant the criteria of §15.203. The EUT employ integral antennas.

Test Engineer(s): Deepak Giri

Test Date(s): 09/16/16

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.207(a) Conducted Emissions Limits

Test Requirement(s): **§ 15.207 (a):** 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 30MHz, shall not exceed the limits in the following table, as measured using a 50 μH/50 Σ 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 range (MHz)	§ 15.207(a), Conducted Limit (dBμV)	
	Quasi-Peak	Average
* 0.15- 0.45	66 - 56	56 - 46
0.45 - 0.5	56	46
0.5 - 30	60	50

Table 7. Conducted Limits for Intentional Radiators from FCC Part 15 § 15.207(a)

Test Results: The EUT was not applicable with this requirement. The EUT is battery powered device. So conducted emission is not applicable.

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(a)(1) 20 dB Occupied Bandwidth

Test Requirements: **§ 15.247(a):** Operation under the provisions of this section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:

For systems using digital modulation techniques, the EUT may operate in the 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz bands. For DTS, the minimum 6 dB bandwidth shall be at least 500 kHz. For frequency hopping systems, the EUT shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

Test Procedure: The bandwidth of the fundamental frequency was measured radiated. The 20 dB bandwidth was measured and recorded.

Test Results The EUT was compliant with § 15.247 (a)(2).

Test Engineer(s): Deepak Giri

Test Date(s): 09/15/16

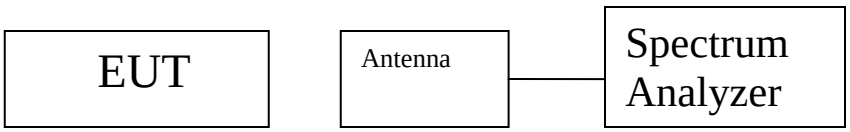
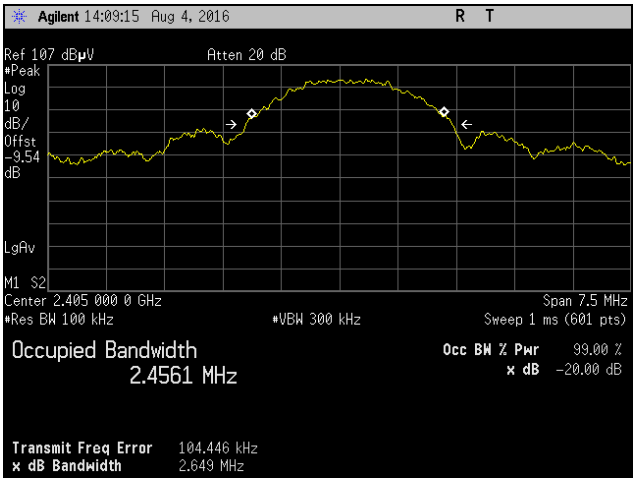
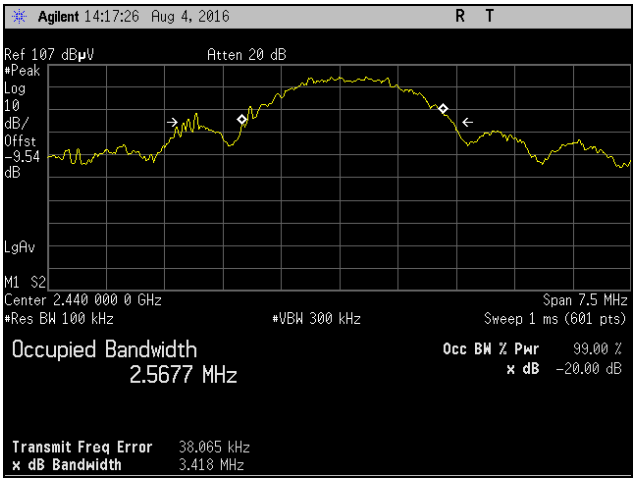


Figure 2. Block Diagram, Occupied Bandwidth Test Setup

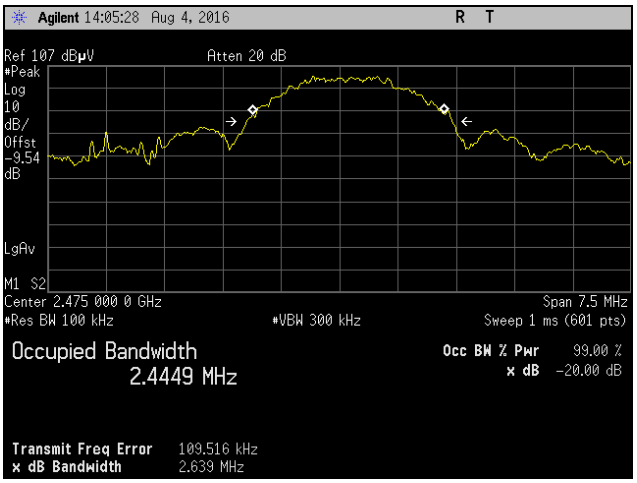
20 dB Occupied Bandwidth Test Results



Plot 1. 20 dB Occupied Bandwidth, Low Channel



Plot 2. 20 dB Occupied Bandwidth, Mid Channel



Plot 3. 20 dB Occupied Bandwidth, High Channel

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(a)(1) Average Time of Occupancy (Dwell Time)

Remarks: The average time of occupancy on any frequency shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. .

The EUT meets the requirement for Average Time of Occupancy or Dwell time. The calculated result is shown in table below:

Dwell Time							
Frequency Range	**No. of Channels**	**Hopping Period (s)**	**No. of Burst per Period**	**Burst duration (s)**	**Dwell Time (s)**	**Limit (s)**	**Margin**
2400-2483.5	15	6	1	0.00326	0.00326	0.4	-0.39044

Table 8. Average Time of Occupancy (Dwell Time), Test Results

Dwell Time Calculation;

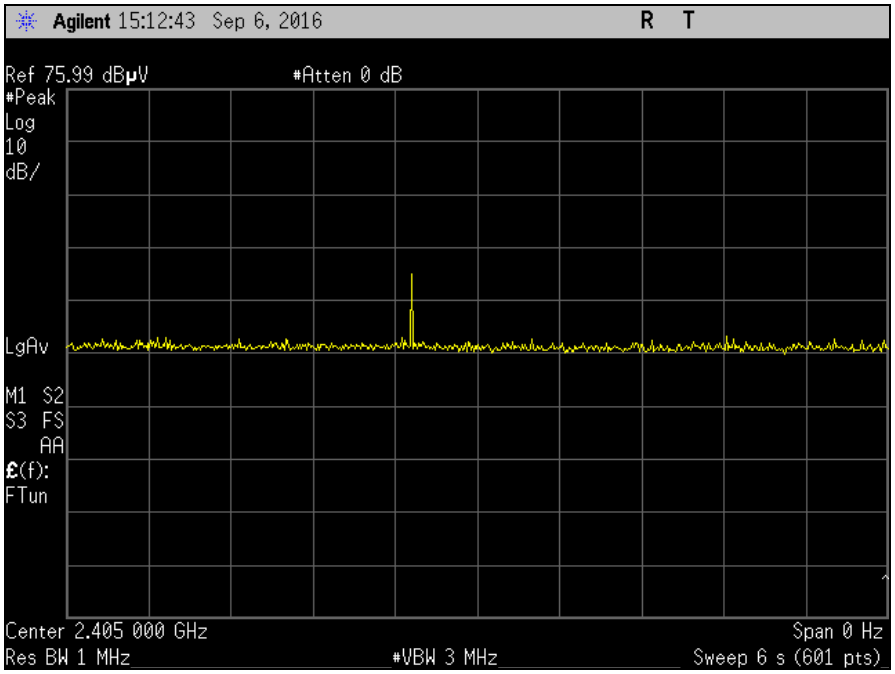
Hopping period = Number of channel * 0.4 = 15* 0.4 = 6 seconds

Number of Burst = Burst per hopping period = 1

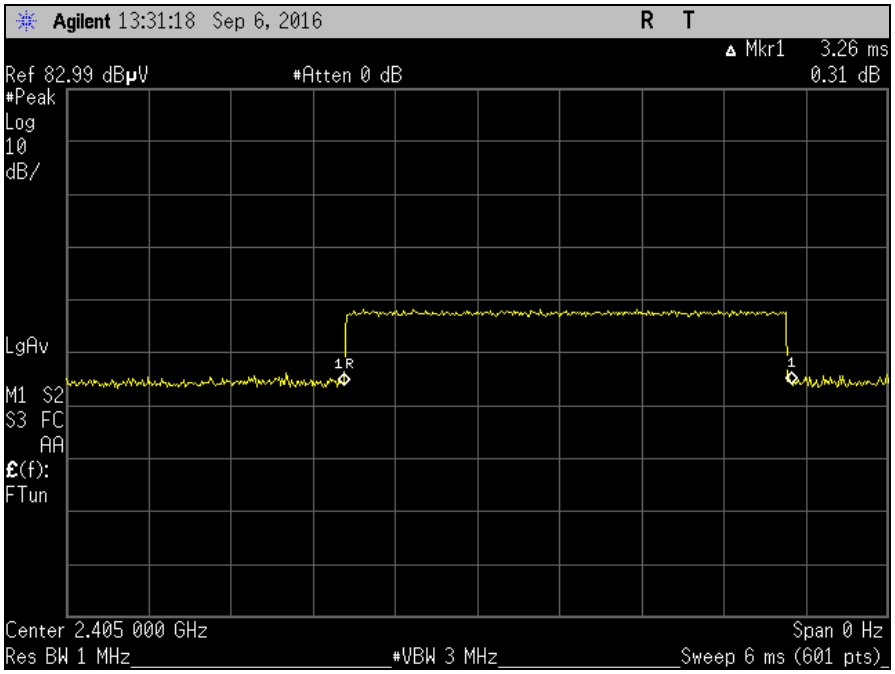
Burst Duration = time of sinlge burst = 0.00326 seconds

Dwell time = Number of Burst * Burst duration = 1 * 0.00326 = 0.00326 seconds

Dwell Time



Plot 4. Dwell Time, Number of Bursts per Period



Plot 5. Dwell Time per Channel

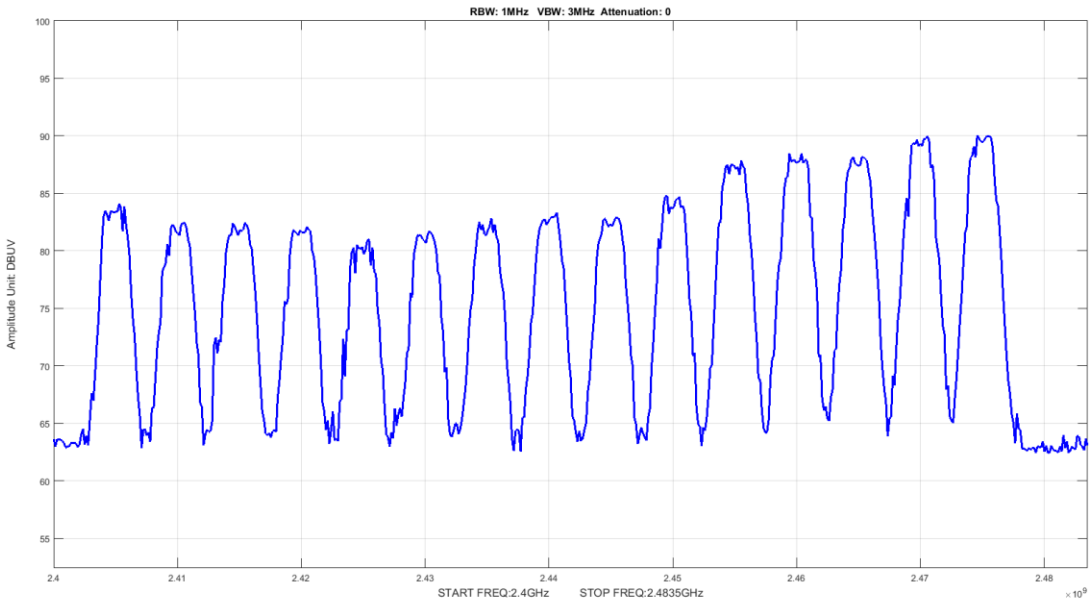
Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(a)(1) Number of RF Channels

Frequency hopping systems in the 2400- 2483.5 MHz band shall use at least 15 channels.

The average time of occupancy on any frequency shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

Result: The number of channels is 15 which meets the requirement for the EUT to be considered frequency hopping system.



Plot 6. Number of Channels

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(a)(1) RF Channel Separation

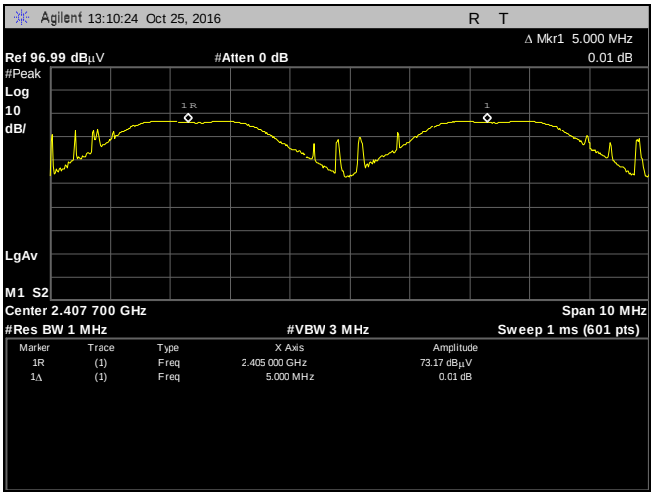
Requirement: Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25KHz or two-thirds of the 20dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125mW.

20dB bandwidth ranges from 2.3-2.6MHz.

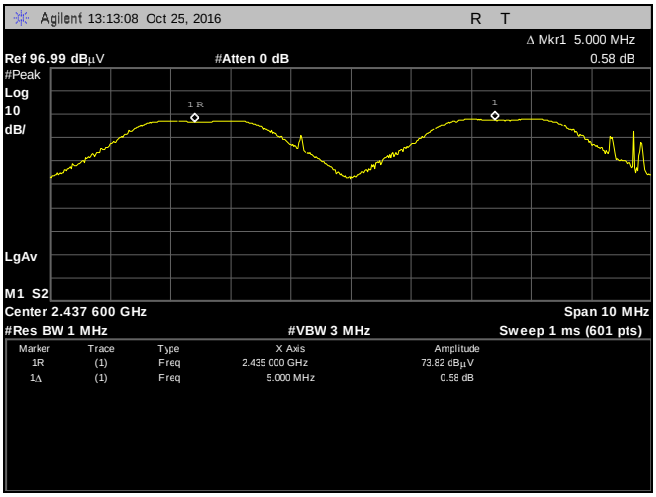
Result: Channel separation results are shown in table below.

Frequency Band	Channel	Channel-1 MHz	Channel -2 MHz	Separation MHz
2400-2483.5 MHz	Low Channel	2405	2410	5
	Mid Channel	2435.00	2440.00	5
	High Channel	2470	2475.00	5

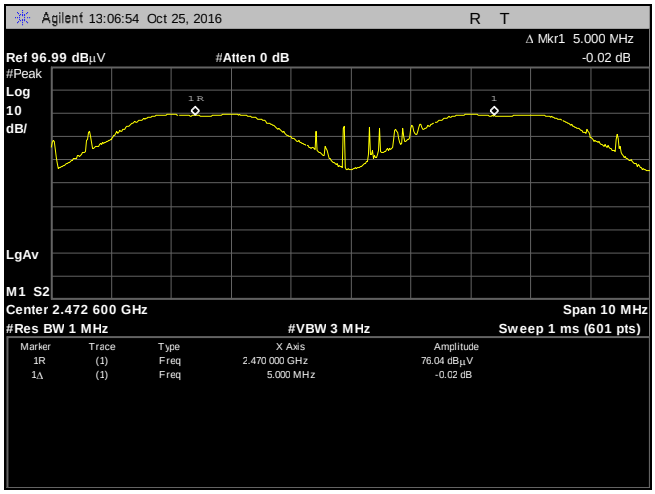
Table 9. Channel Separation, Test Results



Plot 7. Channel Separation, Low Channel



Plot 8. Channel Separation, Mid Channel



Plot 9. Channel Separation, High Channel

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(b) Peak Power Output

Test Requirements: **15.247 (d)** For frequency hopping system operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

Test Procedure: The peak output power was measured radiated. The EUT was measured at the low, mid and high channels. The EUT utilizes a 3dBi Omni Antenna, so the maximum power allowed is 21dBm for frequency hopper employing 15 channels.

Test Results: The EUT was compliant with the Peak Power Output limits of **§15.247(b)**.

Test Engineer(s): Deepak Giri

Test Date(s): 09/15/16

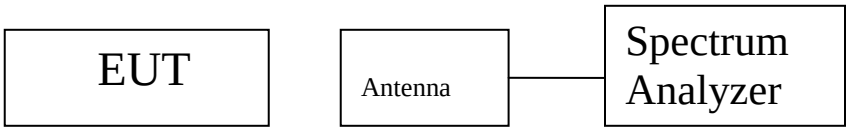
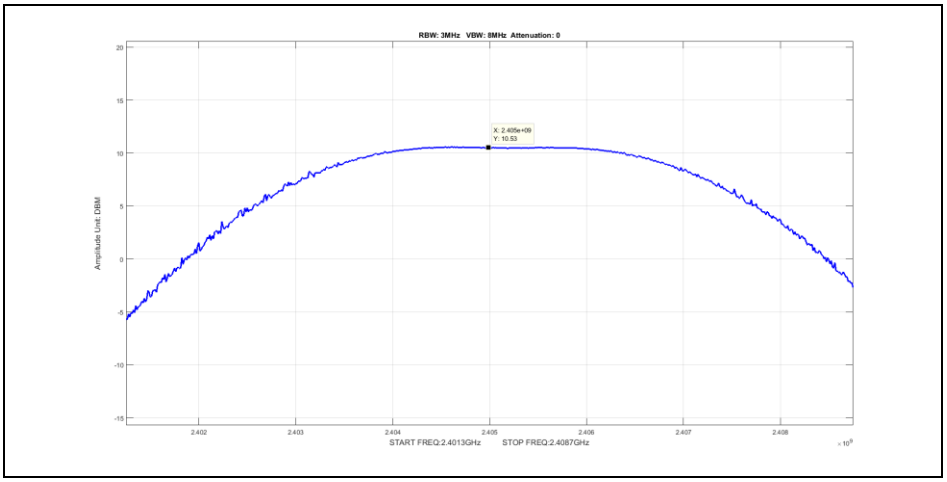


Figure 3. Peak Power Output Test Setup

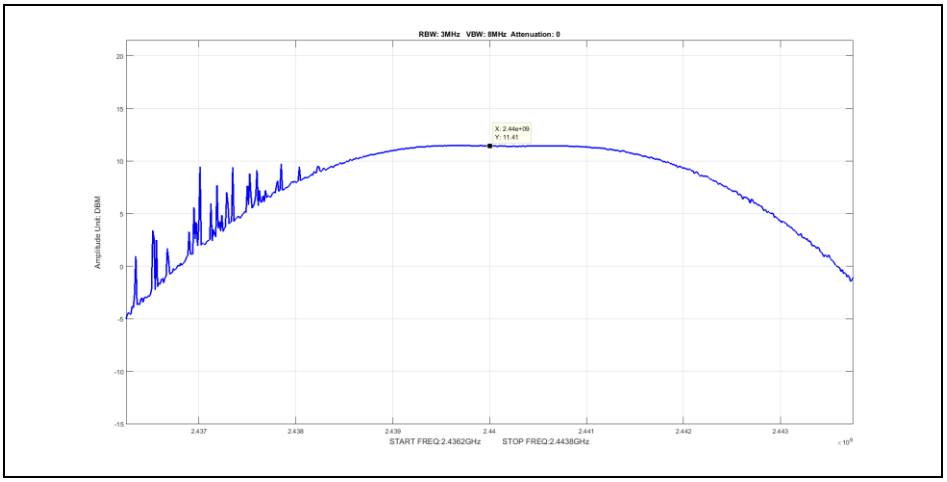
FCC-15.247 Conducted Power						
Frequency MHz	**EIRP dBm**	**Antenna Gain dBi**	**Conducted Power dBm**	**Limit dBm**	**Margin dBm**	**Result**
2405	10.53	3	7.53	21	-13.47	Pass
2440	11.41	3	8.41	21	-12.59	Pass
2474	12.06	3	9.06	21	-11.94	Pass

Table 10. Peak Power Output, Test Results

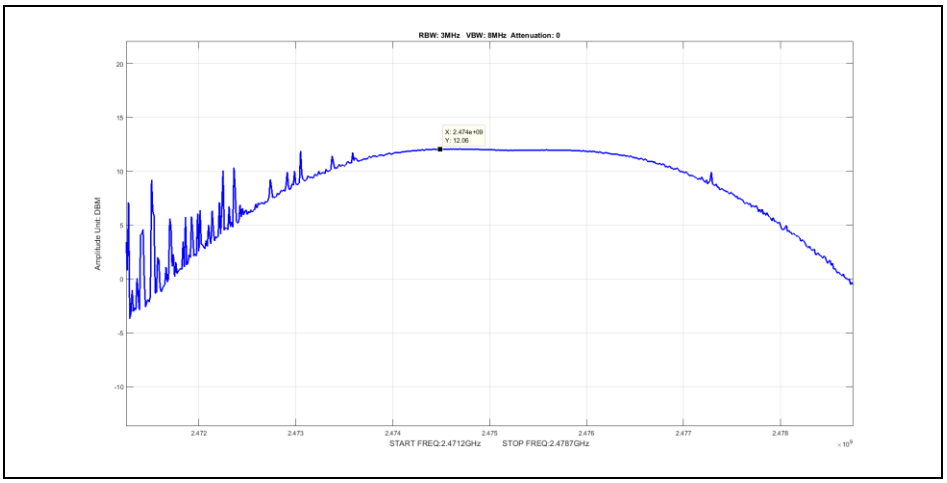
Peak Power Output Test Results



Plot 10. Peak Power Output, Low Channel



Plot 11. Peak Power Output, Mid Channel



Plot 12. Peak Power Output, High Channel

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(d) Radiated Spurious Emissions Requirements and Band Edge

Test Requirements: **§15.247(d); §15.205:** Emissions outside the frequency band.

§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. 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).

§15.205(a): Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090–0.110----------	16.42–16.423	399.9–410	4.5–5.15
[1] 0.495–0.505----------	16.69475–16.69525	608–614	5.35–5.46
2.1735–2.1905----------	16.80425–16.80475	960–1240	7.25–7.75
4.125–4.128----------	25.5–25.67	1300–1427	8.025–8.5
4.17725–4.17775----------	37.5–38.25	1435–1626.5	9.0–9.2
4.20725–4.20775----------	73–74.6	1645.5–1646.5	9.3–9.5
6.215–6.218----------	74.8–75.2	1660–1710	10.6–12.7
6.26775–6.26825----------	108–121.94	1718.8–1722.2	13.25–13.4
6.31175–6.31225----------	123–138	2200–2300	14.47–14.5
8.291–8.294----------	149.9–150.05	2310–2390	15.35–16.2
8.362–8.366----------	156.52475–156.52525	2483.5–2500	17.7–21.4
8.37625–8.38675----------	156.7–156.9	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])

Table 11. Restricted Bands of Operation

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

Test Requirement(s): **§ 15.209 (a):** Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in Table 12.

Frequency (MHz)	§ 15.209(a),Radiated Emission Limits (dBµV) @ 3m
30 - 88	40.00
88 - 216	43.50
216 - 960	46.00
Above 960	54.00

Table 12. Radiated Emissions Limits Calculated from FCC Part 15, § 15.209 (a)

Test Procedure: The transmitter was turned on. Measurements were performed of the low, mid and high Channels. The EUT was rotated orthogonally through all three axes. Plots shown are corrected for both antenna correction factor and distance and compared to a 3 m limit line. Only noise floor was measured above 18 GHz.

For frequencies from 30 MHz to 1 GHz, measurements were made using a quasi-peak detector.

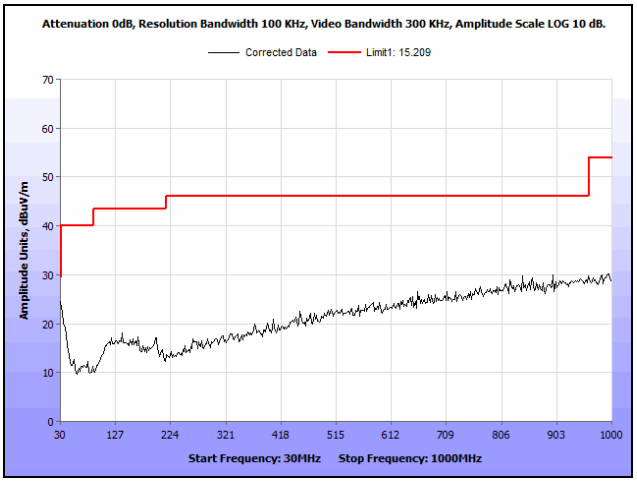
In accordance with §15.35(b) the limit on the radio frequency emissions as measured using instrumentation with a peak detector function shall be 20 dB above the maximum permitted average limit for the frequency being investigated unless a different peak emission limit is otherwise specified in the rules.

Test Results: The EUT was compliant with the Radiated Spurious Emission limits of **§15.247(d)**. The measurement plot shown below ranges from 30 Mhz- 18 Ghz. Above 18 GHz any noise floor was observed.

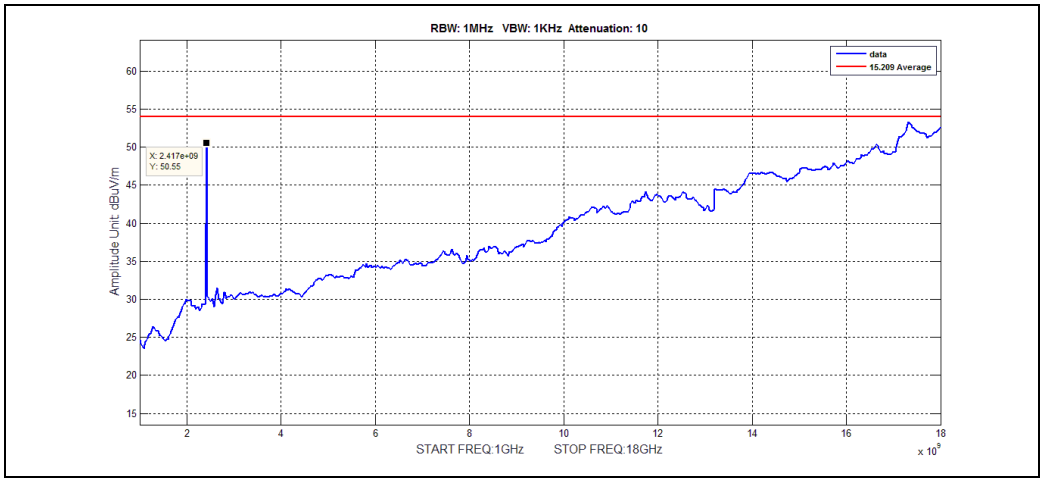
Test Engineer(s): Deepak Giri

Test Date(s): 09/16/16

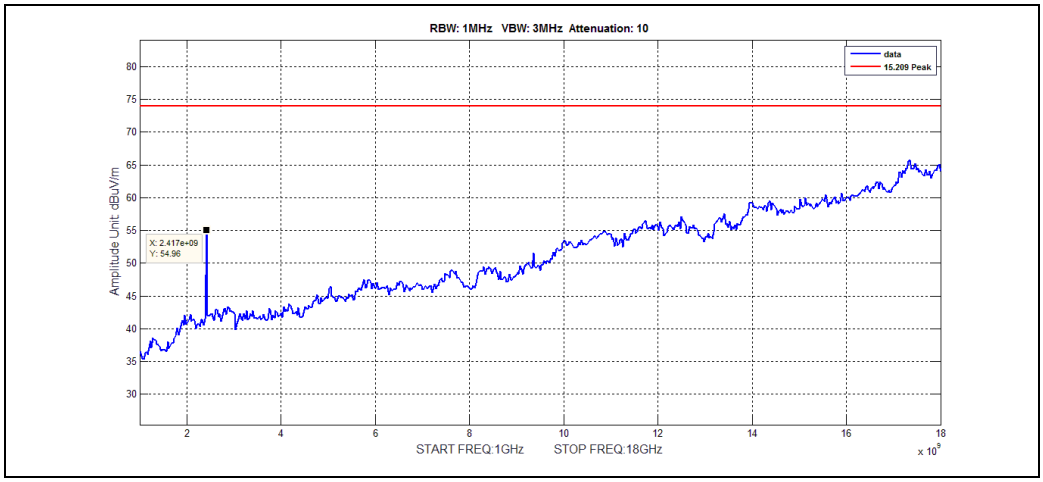
Radiated Spurious Emissions Test Results



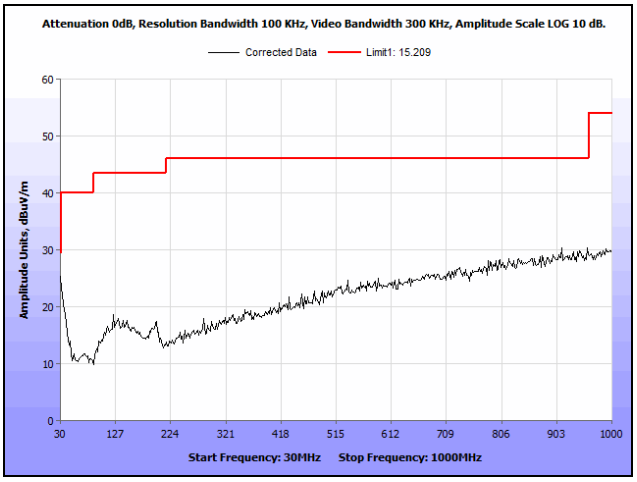
Plot 13. Radiated Spurious Emissions, 30 MHz – 1 GHz, Low Channel



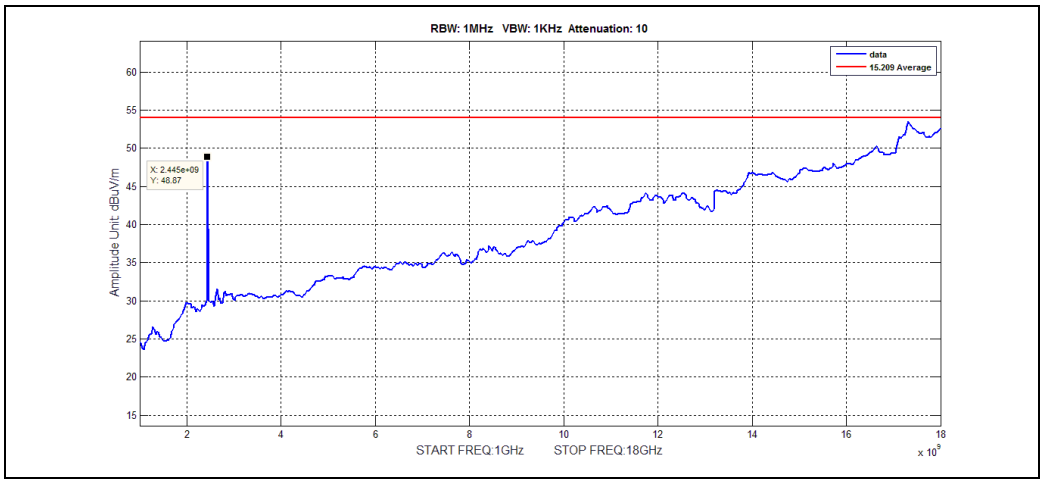
Plot 14. Radiated Spurious Emissions, 1 GHz – 18 GHz, Low Channel, Average



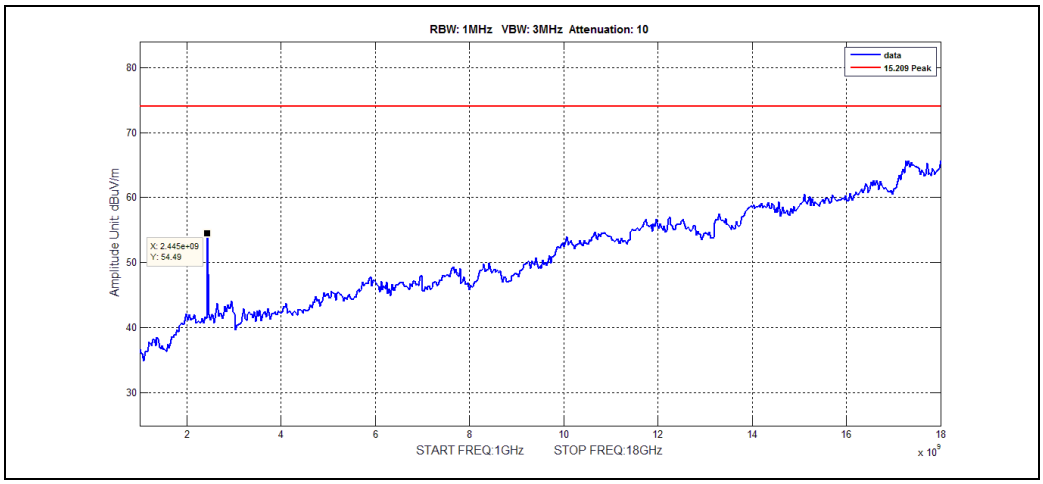
Plot 15. Radiated Spurious Emissions, 1 GHz – 18 GHz, Low Channel, Peak



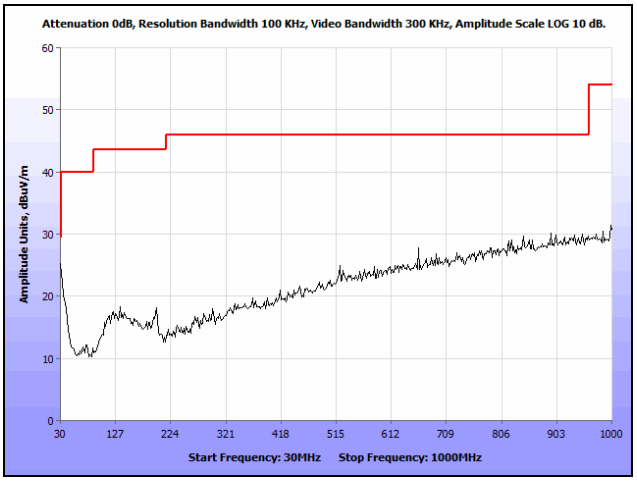
Plot 16. Radiated Spurious Emissions, 30 MHz – 1 GHz, Mid Channel



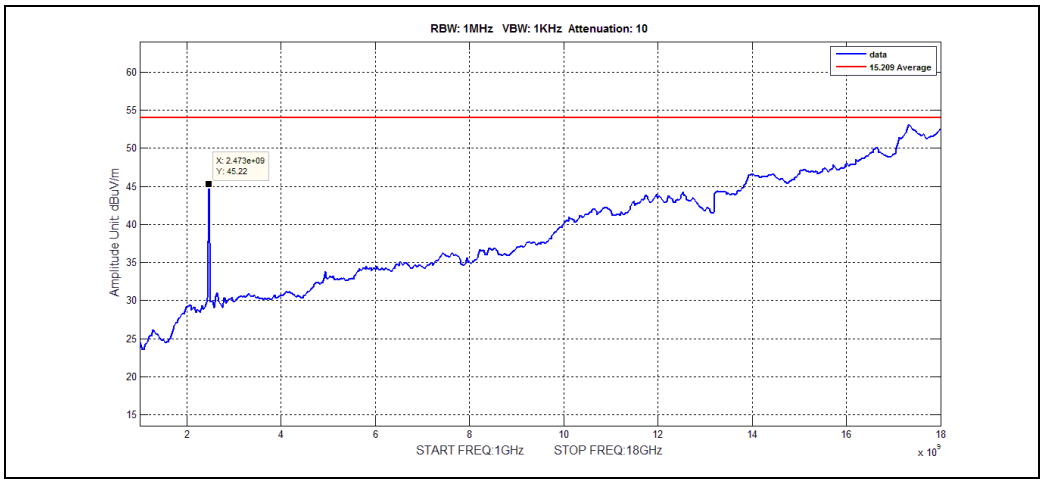
Plot 17. Radiated Spurious Emissions, 1 GHz – 18 GHz, Mid Channel, Average



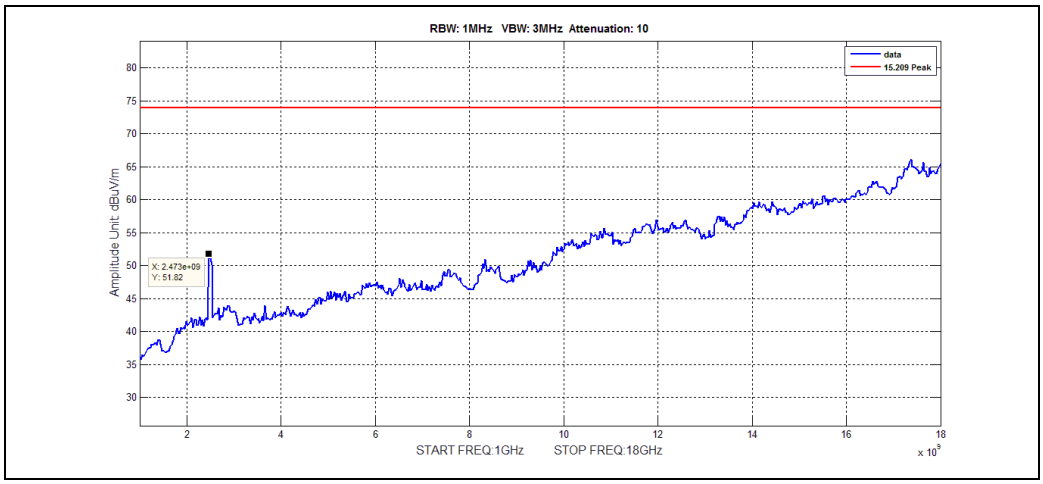
Plot 18. Radiated Spurious Emissions, 1 GHz – 18 GHz, Mid Channel, Peak



Plot 19. Radiated Spurious Emissions, 30 MHz – 1 GHz, High Channel



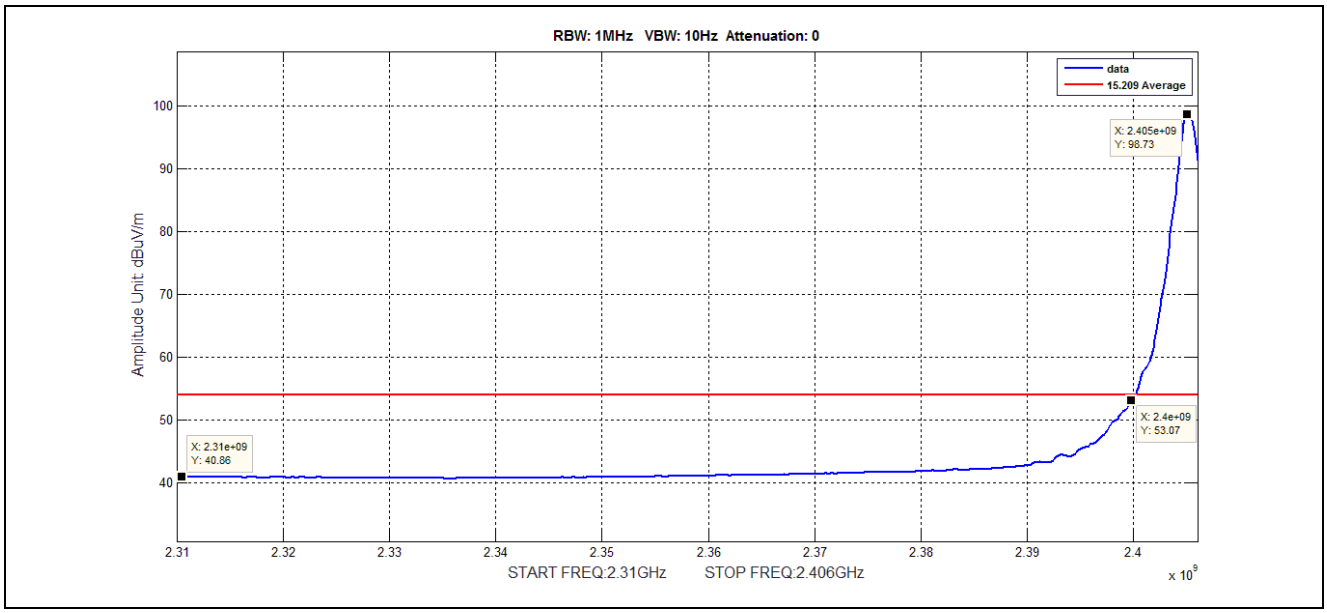
Plot 20. Radiated Spurious Emissions, 1 GHz – 18 GHz, High Channel, Average



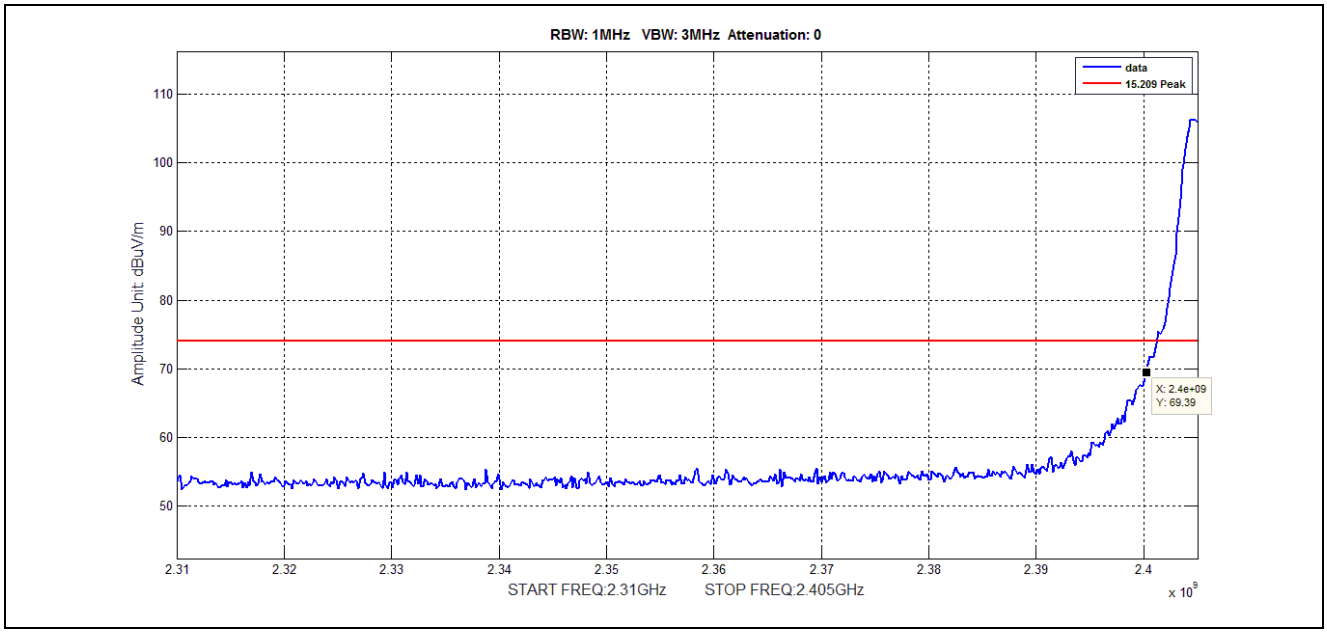
Plot 21. Radiated Spurious Emissions, 1 GHz – 18 GHz, High Channel, Peak

Radiated Band Edge Measurements

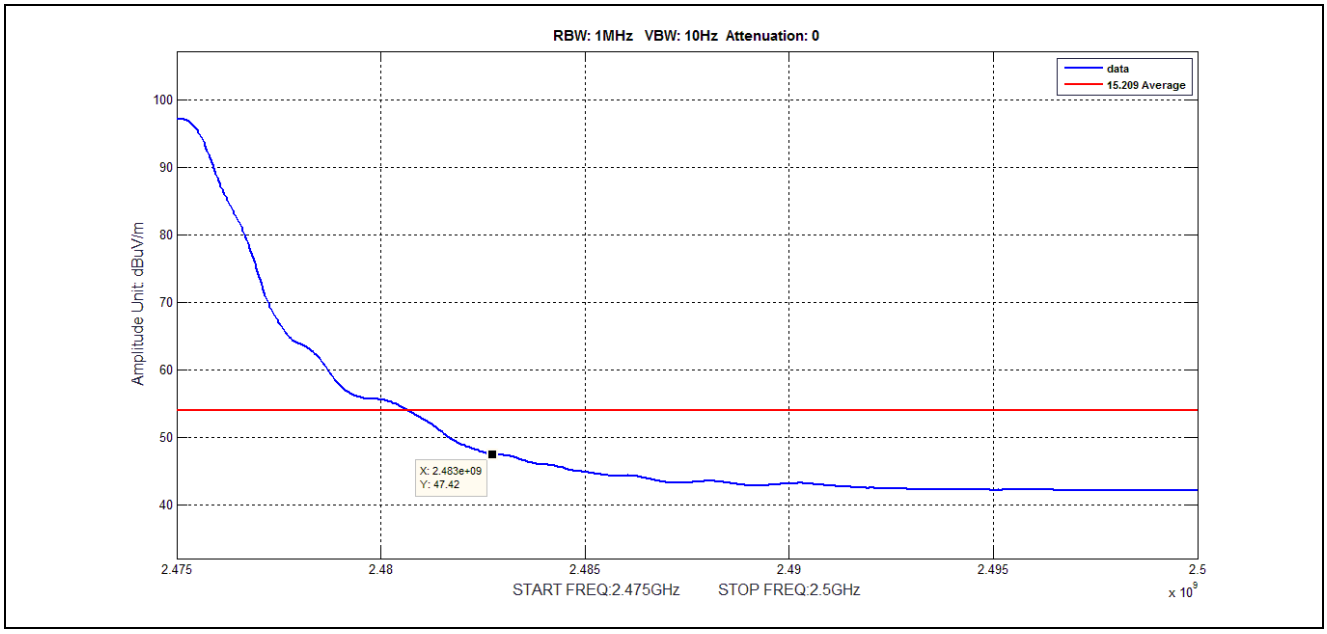
Test Procedures: The transmitter was turned. Measurements were performed of the low and high Channels. The EUT was rotated orthogonally through all three axes. Plots shown are corrected for both antenna correction factor and distance.



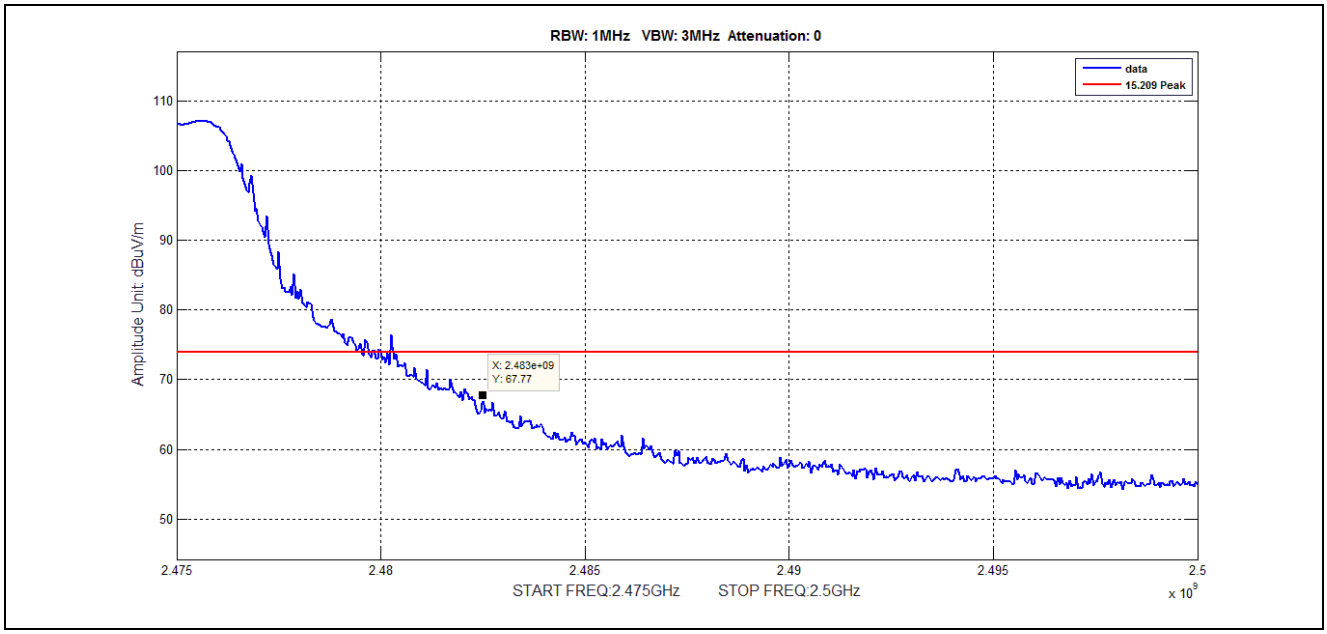
Plot 22. Radiated Restricted Band Edge, Low Channel, Average



Plot 23. Radiated Restricted Band Edge, Low Channel, Peak



Plot 24. Radiated Restricted Band Edge, High Channel, Average

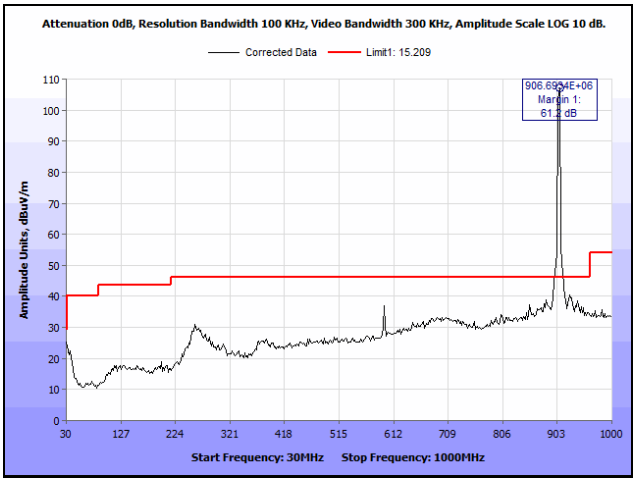


Plot 25. Radiated Restricted Band Edge, High Channel, Peak

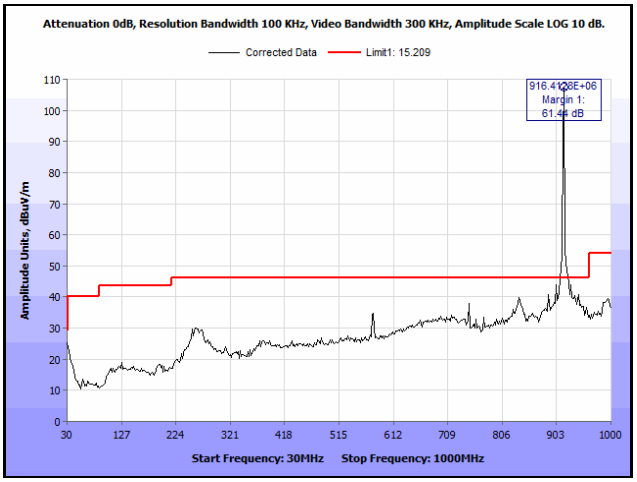
Spurious Emission for Simultaneous Operation:

This EUT has another radio operating at 900 MHz and has its own integrated antenna, which is being tested under 15.247. 900 Mhz and 2.4 ghz can operate simultaneously. Plots below shows the simultaneous spurious emission from both radios.

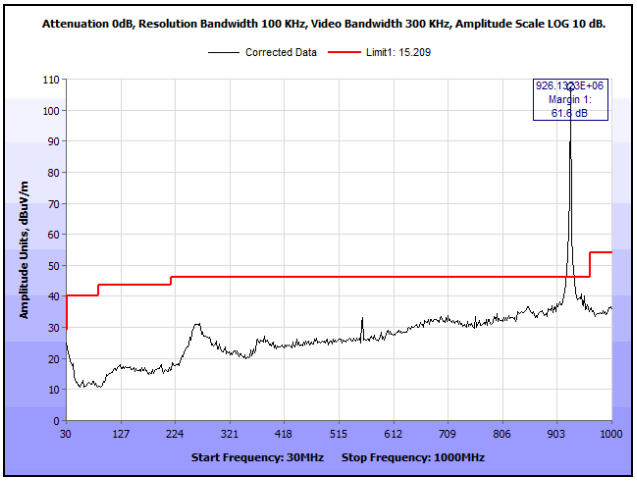
Spurious Emission for 30MHz-1GHZ:



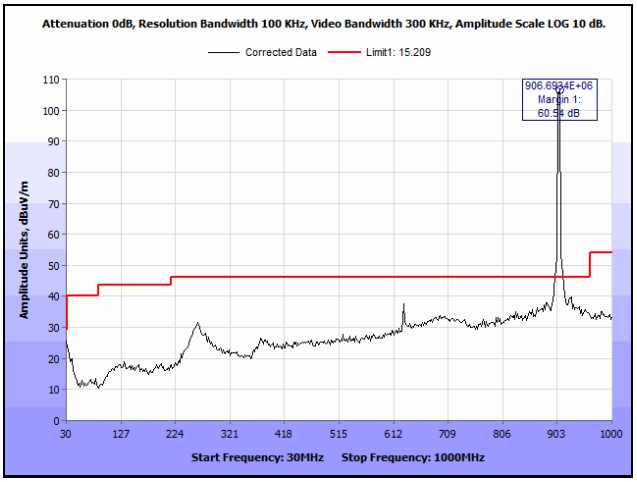
Plot 26. Spurious Emissions, 2.4 GHz, Low 900 MHz, Low Channel, 30 MHz – 1 GHz



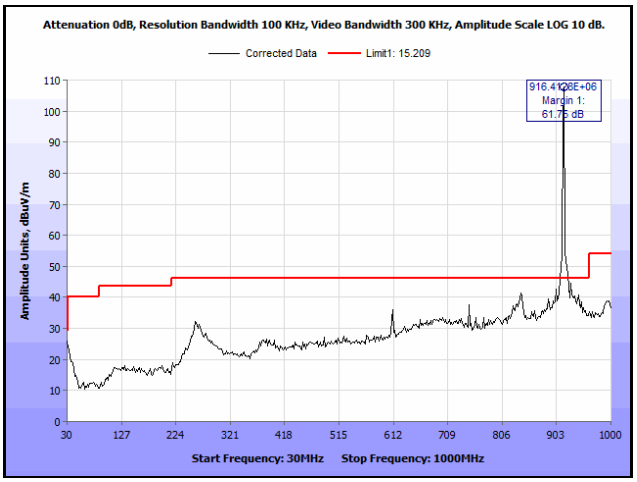
Plot 27. Spurious Emissions, 2.4 GHz, Low 900 MHz, Mid Channel, 30 MHz – 1 GHz



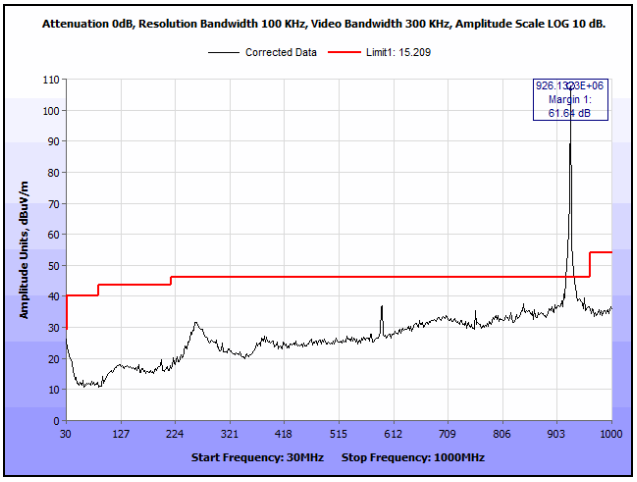
Plot 28. Spurious Emissions, 2.4 GHz, Low 900 MHz, High Channel, 30 MHz – 1 GHz



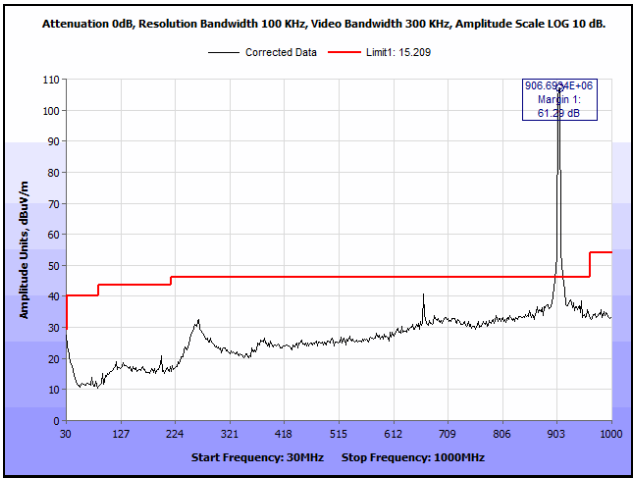
Plot 29. Spurious Emissions, 2.4 GHz, Mid 900 MHz, Low Channel, 30 MHz – 1 GHz



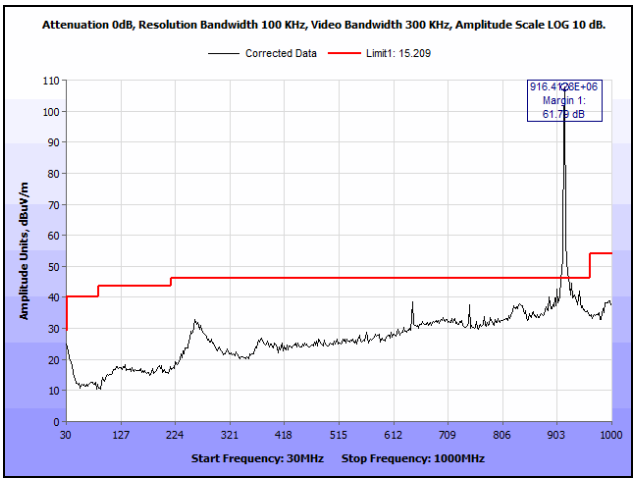
Plot 30. Spurious Emissions, 2.4 GHz, Mid 900 MHz, Mid Channel, 30 MHz – 1 GHz



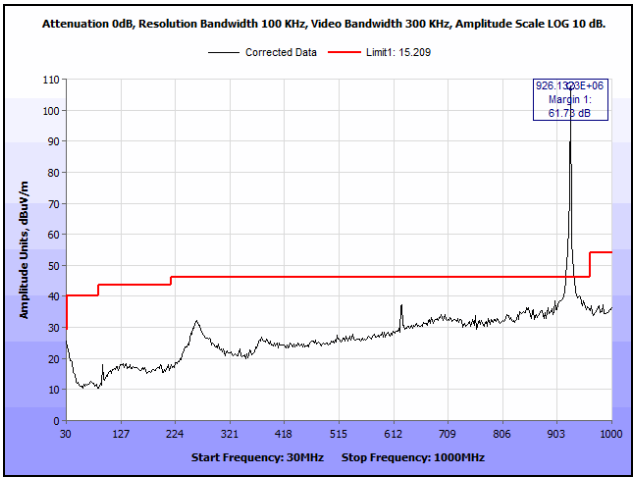
Plot 31. Spurious Emissions, 2.4 GHz, Mid 900 MHz, High Channel, 30 MHz – 1 GHz



Plot 32. Spurious Emissions, 2.4 GHz, High 900 MHz, Low Channel, 30 MHz – 1 GHz



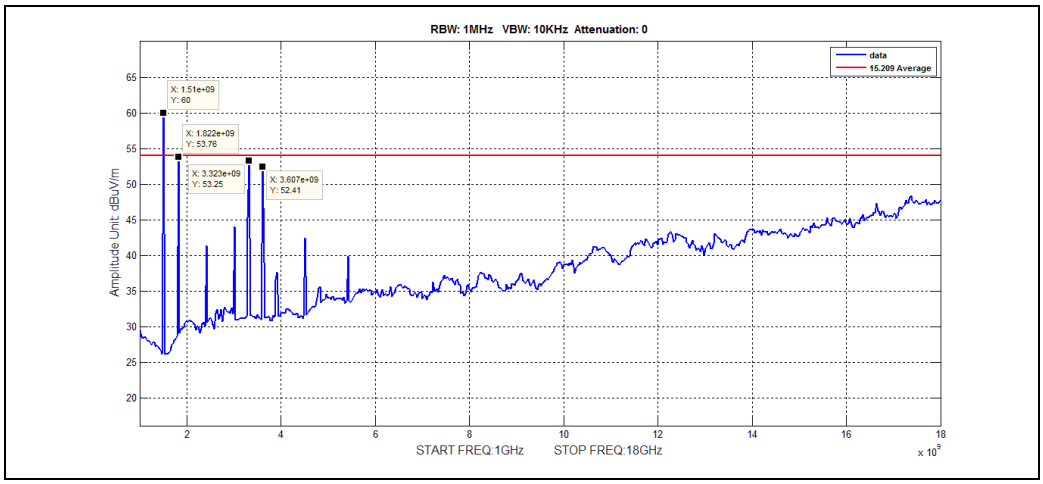
Plot 33. Spurious Emissions, 2.4 GHz, High 900 MHz, Mid Channel, 30 MHz – 1 GHz



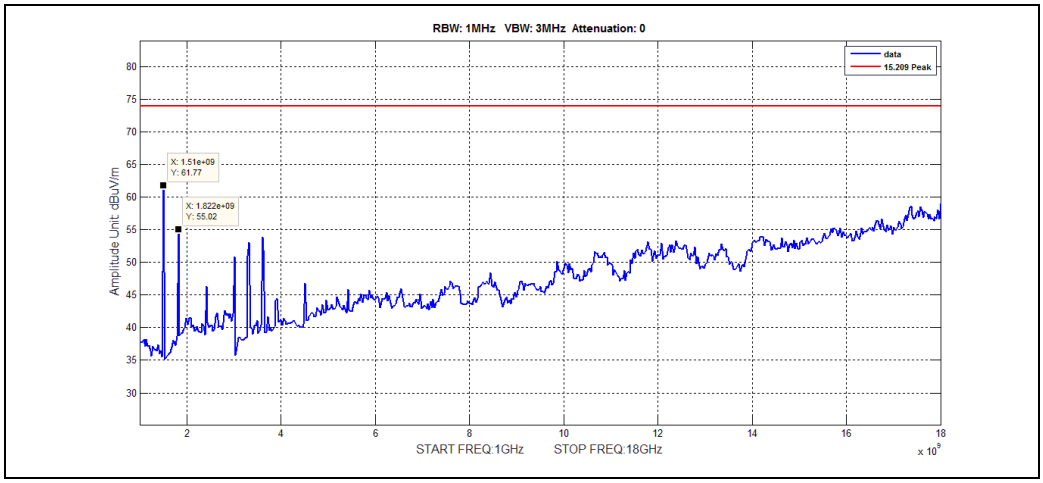
Plot 34. Spurious Emissions, 2.4 GHz, High 900 MHz, High Channel, 30 MHz – 1 GHz

Spurious Emission of 1GHz- 18GHz

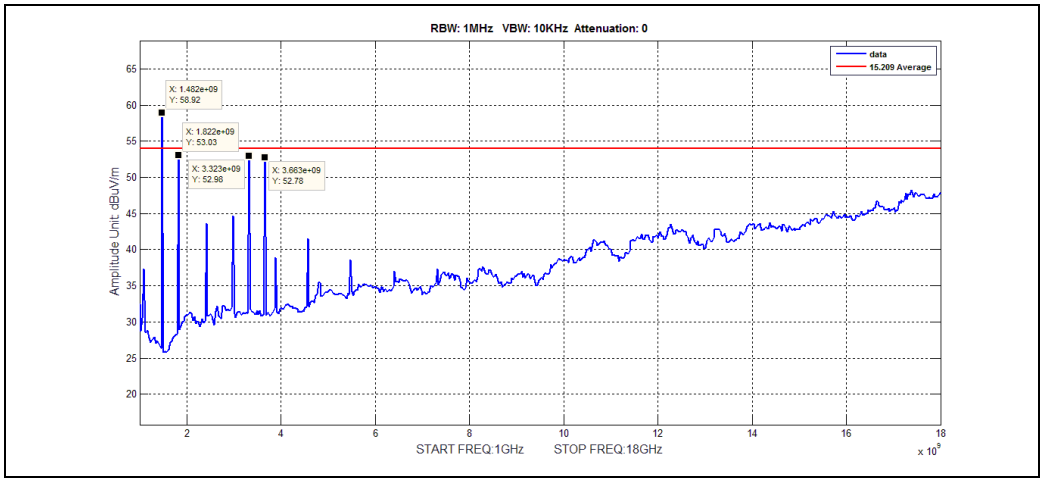
Note: Spurs above the limit are marked and identified and data is presented in the table at the end of this section. Table shows the applicable duty cycle correction to the spurs and the final measurement were recorded in the table.



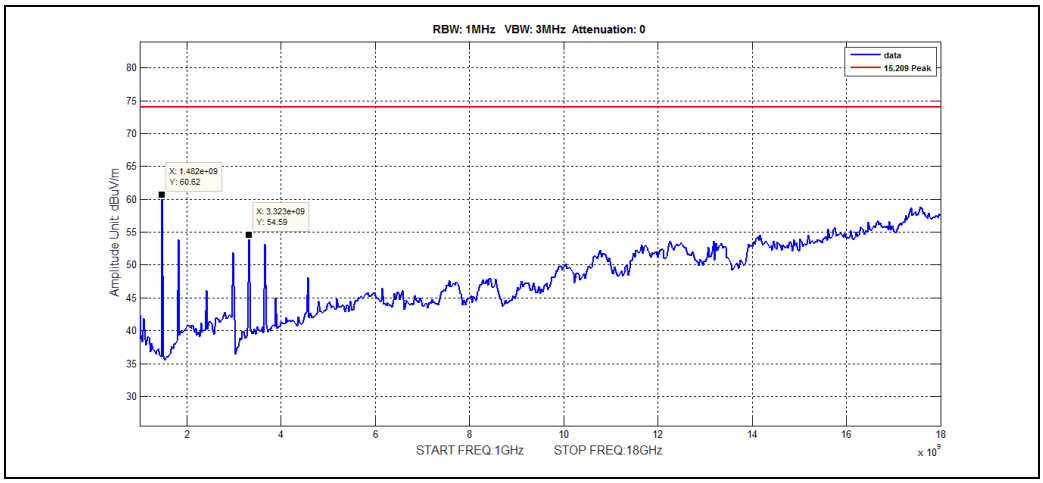
Plot 35. Spurious Emissions, 2.4 GHz, Low 900 MHz, Low Channel, 1 GHz – 18 GHz, Average



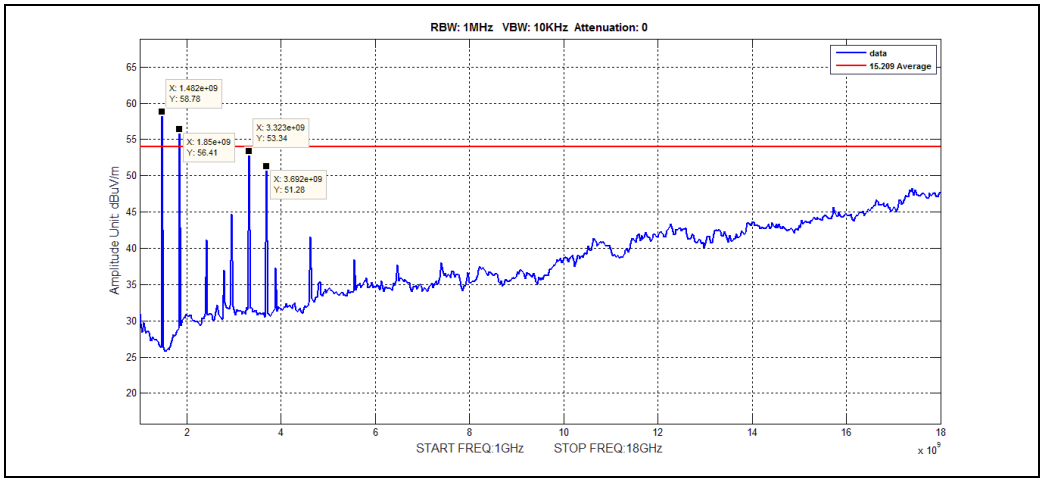
Plot 36. Spurious Emissions, 2.4 GHz, Low 900 MHz, Low Channel, 1 GHz – 18 GHz, Peak



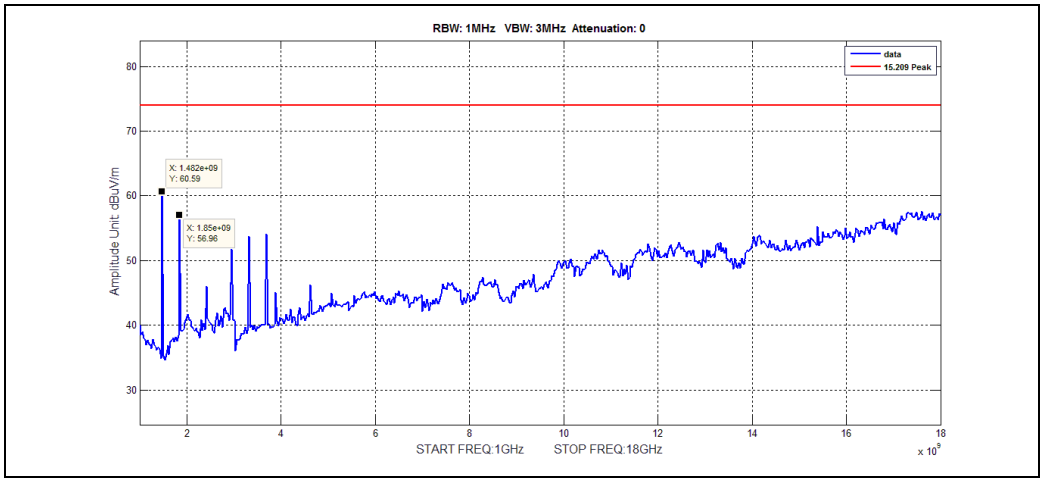
Plot 37. Spurious Emissions, 2.4 GHz, Low 900 MHz, Mid Channel, 1 GHz – 18 GHz, Average



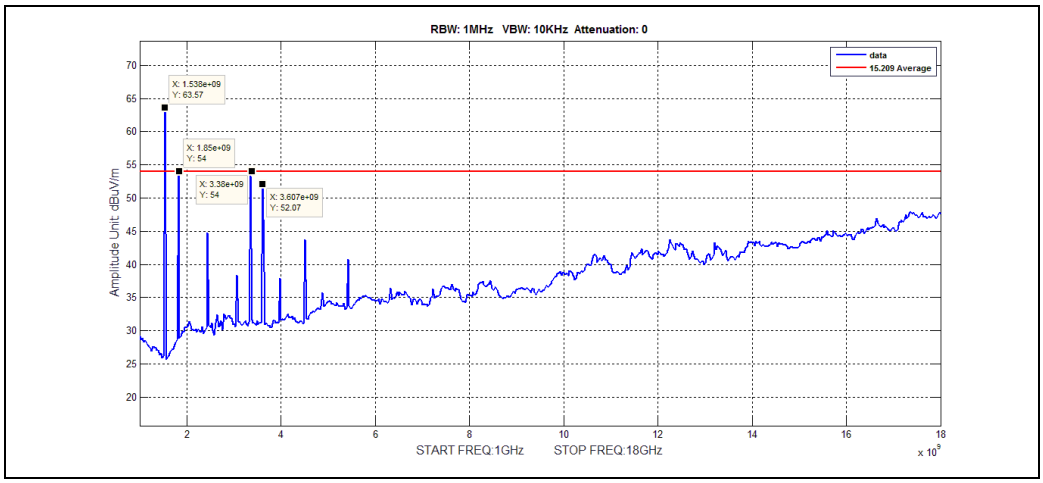
Plot 38. Spurious Emissions, 2.4 GHz, Low 900 MHz, Mid Channel, 1 GHz – 18 GHz, Peak



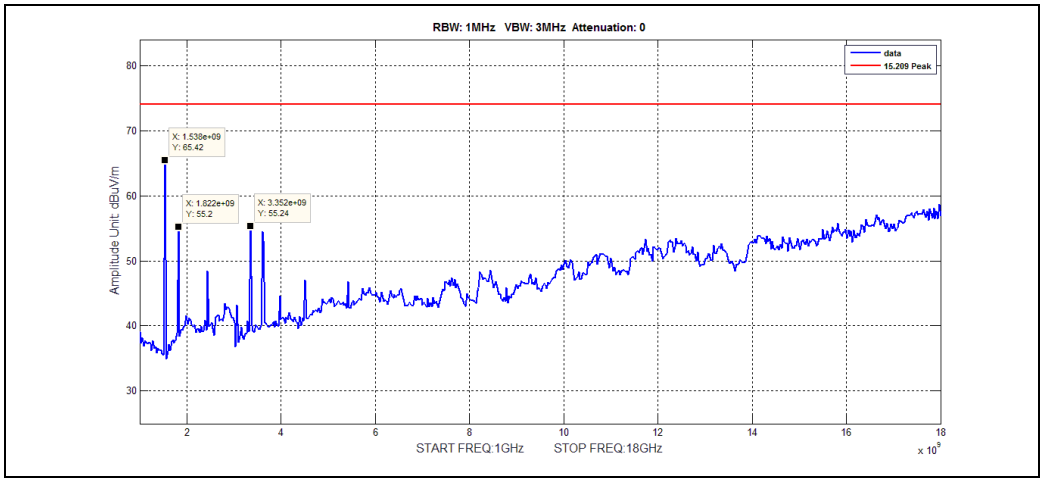
Plot 39. Spurious Emissions, 2.4 GHz, Low 900 MHz, High Channel, 1 GHz – 18 GHz, Average



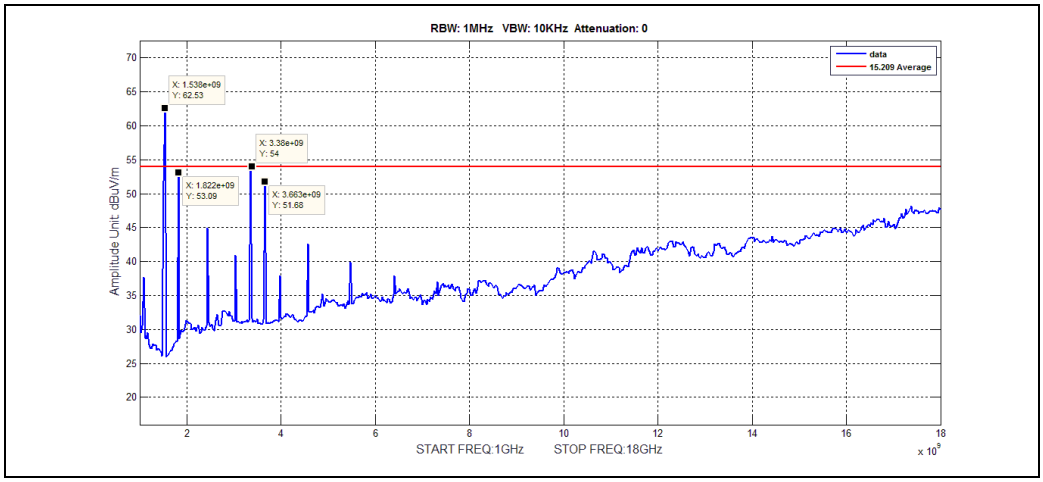
Plot 40. Spurious Emissions, 2.4 GHz, Low 900 MHz, High Channel, 1 GHz – 18 GHz, Peak



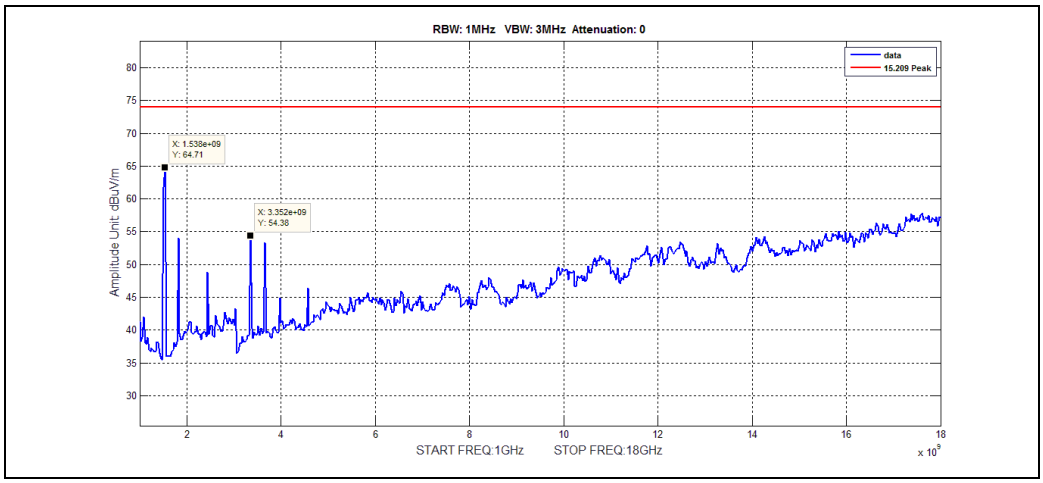
Plot 41. Spurious Emissions, 2.4 GHz, Mid 900 MHz, Low Channel, 1 GHz – 18 GHz, Average



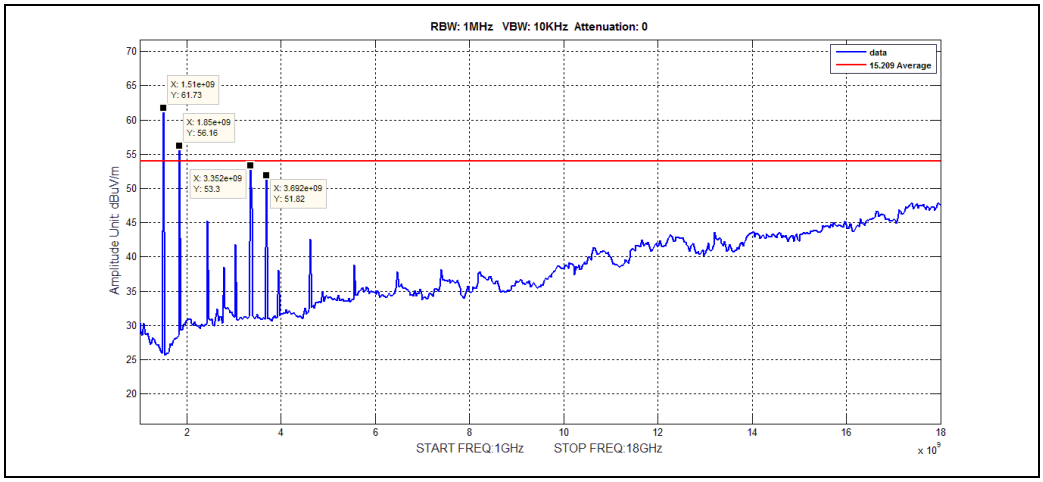
Plot 42. Spurious Emissions, 2.4 GHz, Mid 900 MHz, Low Channel, 1 GHz – 18 GHz, Peak



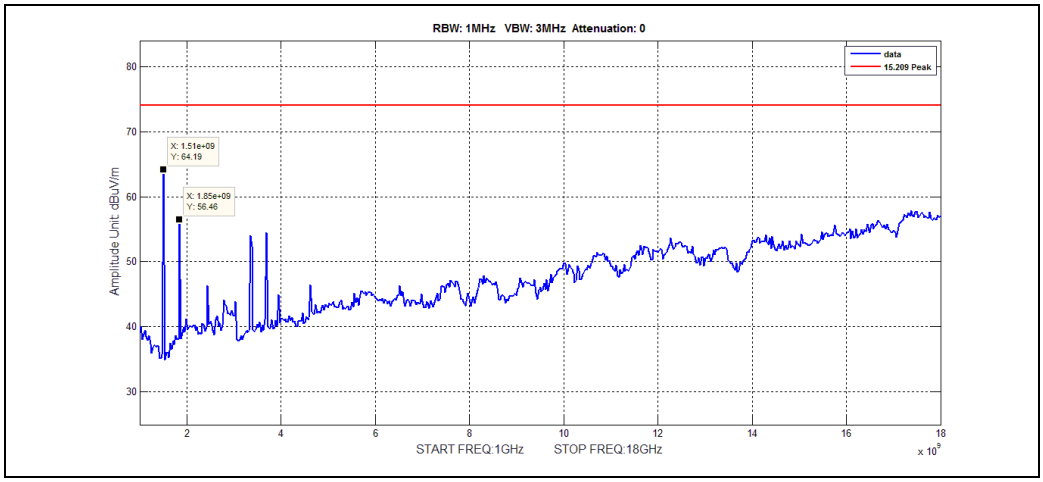
Plot 43. Spurious Emissions, 2.4 GHz, Mid 900 MHz, Mid Channel, 1 GHz – 18 GHz, Average



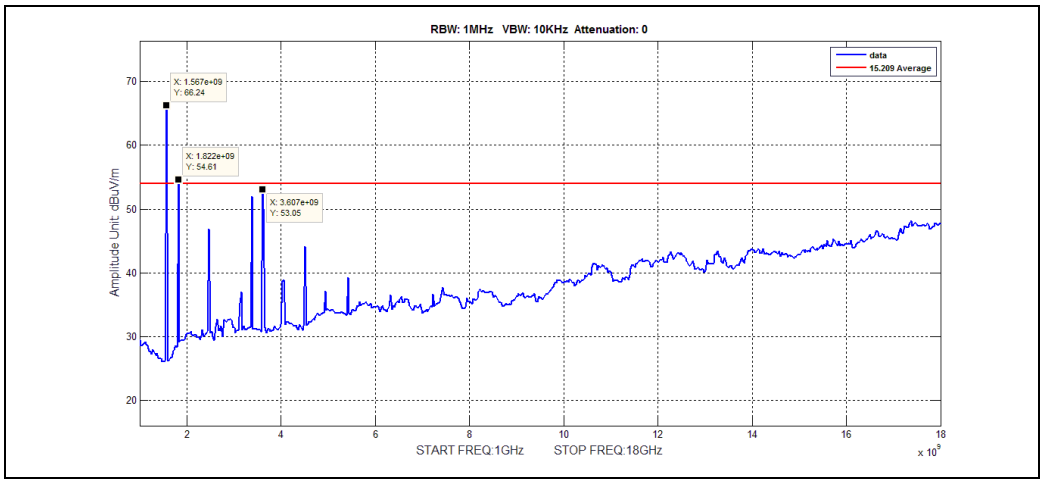
Plot 44. Spurious Emissions, 2.4 GHz, Mid 900 MHz, Mid Channel, 1 GHz – 18 GHz, Peak



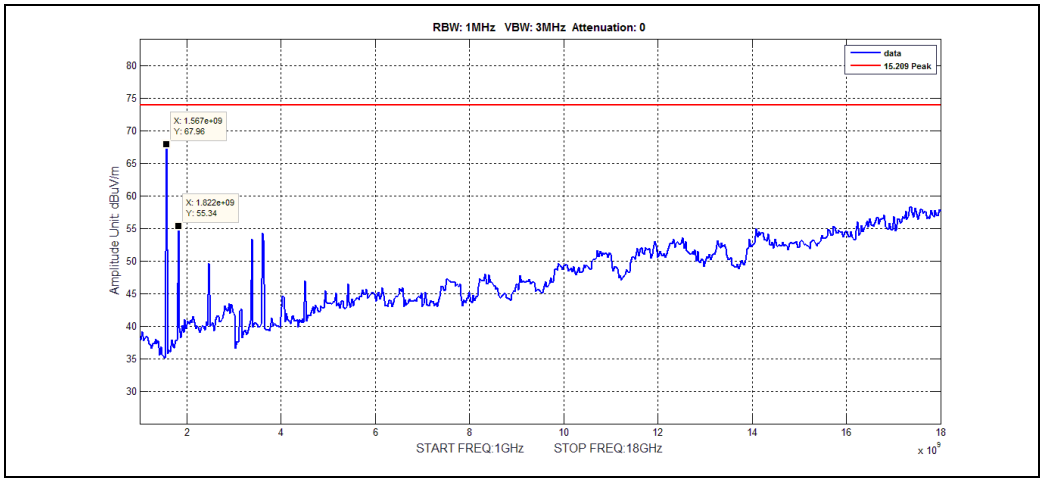
Plot 45. Spurious Emissions, 2.4 GHz, Mid 900 MHz, High Channel, 1 GHz – 18 GHz, Average



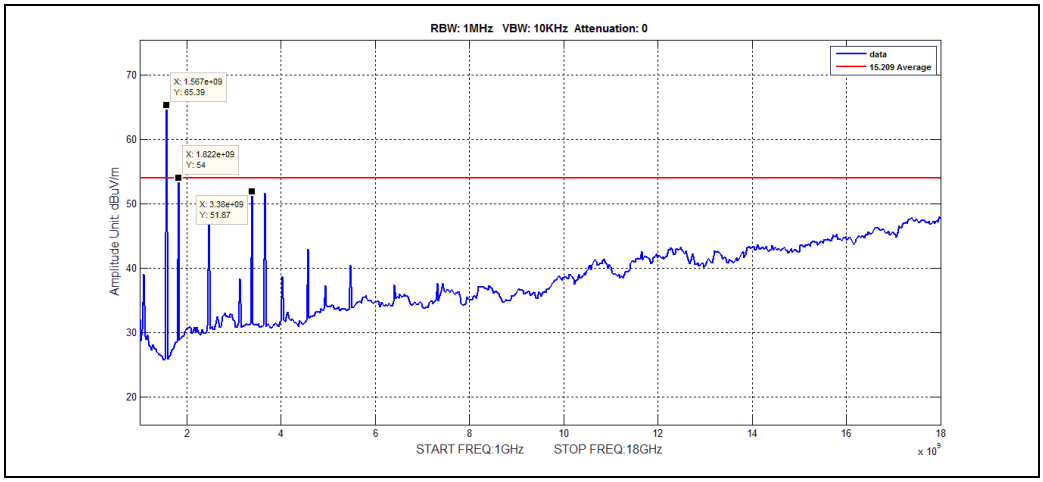
Plot 46. Spurious Emissions, 2.4 GHz, Mid 900 MHz, High Channel, 1 GHz – 18 GHz, Peak



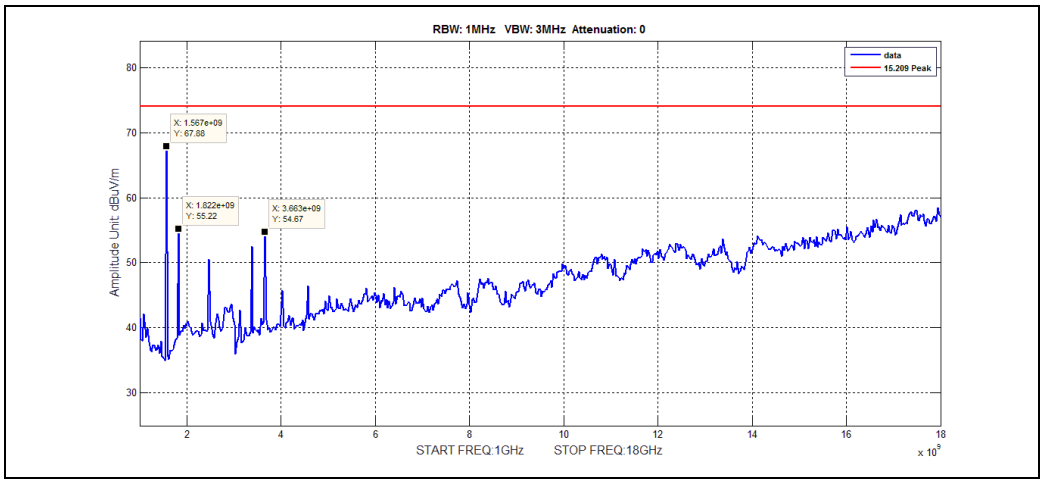
Plot 47. Spurious Emissions, 2.4 GHz, High 900 MHz, Low Channel, 1 GHz – 18 GHz, Average



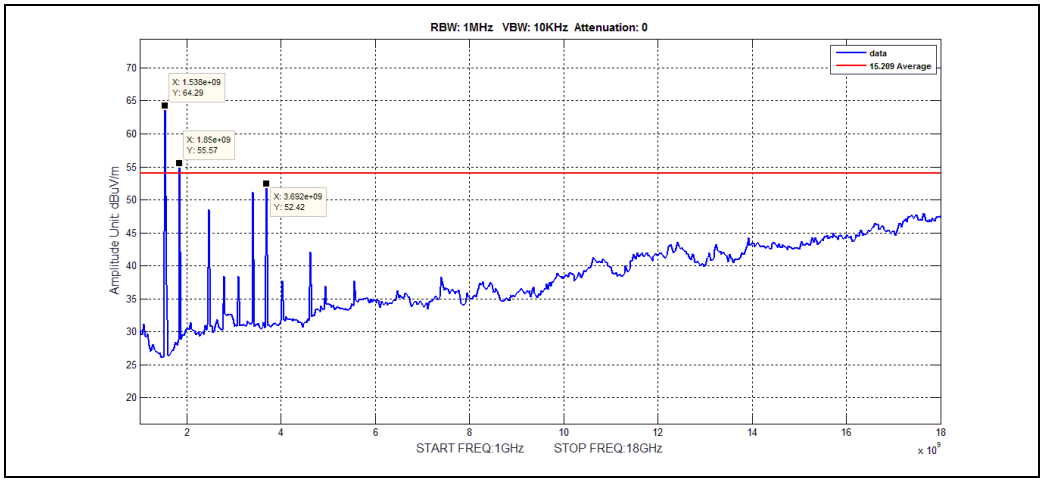
Plot 48. Spurious Emissions, 2.4 GHz, High 900 MHz, Low Channel, 1 GHz – 18 GHz, Peak



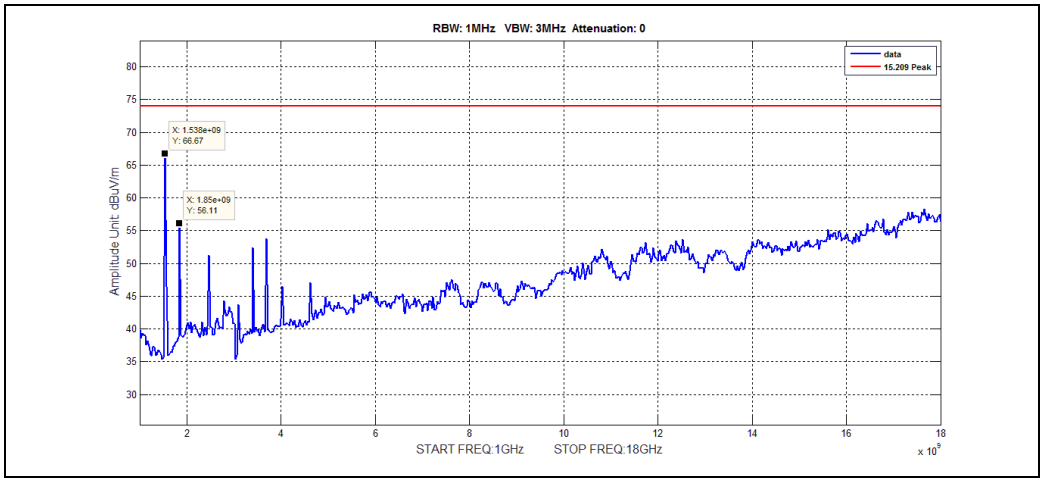
Plot 49. Spurious Emissions, 2.4 GHz, High 900 MHz, Mid Channel, 1 GHz – 18 GHz, Average



Plot 50. Spurious Emissions, 2.4 GHz, High 900 MHz, Mid Channel, 1 GHz – 18 GHz, Peak



Plot 51. Spurious Emissions, 2.4 GHz, High 900 MHz, High Channel, 1 GHz – 18 GHz, Average



Plot 52. Spurious Emissions, 2.4 GHz, High 900 MHz, High Channel, 1 GHz – 18 GHz, Peak

2.4ghz high 900mhx high channel 1-18ghz peak

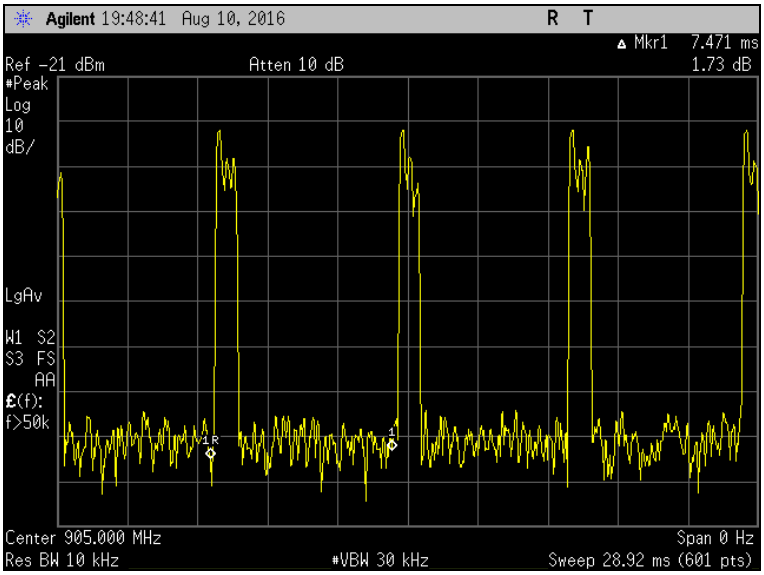
Frequencies Above Average Rad Spurious Emission Above 1GHz						
2.4GHz Channel	**900MHz Channel**	**Frequency**	**Strength dBuV/m**	**Duty Cycle**	**Final Reading dBuV/m**	**Limit dBuV/m**
low	low	1.151GHz	61.73	17	44.73	54
		1.85GHz	56.16	17	39.16	54
		3.352GHz	53.3	17	36.3	54
low	mid	1.482GHz	58.92	17	41.92	54
		1.822GHz	53.03	17	36.03	54
low	high	1.482GHz	58.78	17	41.78	54
		1.85GHz	56.41	17	39.41	54
		3.323GHz	53.34	17	36.34	54
mid	low	1.538GHz	63.57	17	46.57	54
		1.85GHz	54	17	37	54
		3.38GHz	54	17	37	54
mid	mid	1.538GHz	62.53	17	45.53	54
		1.822GHz	53.09	17	36.09	54
		3.38GHz	54	17	37	54
mid	high	1.51GHz	61.73	17	44.73	54
		1.85GHz	56.16	17	39.16	54
		3.352GHz	53.3	17	36.3	54
high	low	1.567GHz	66.24	17	49.24	54
		1.822	54.61	17	37.61	54
		3.607GHz	53.05	17	36.05	54
high	mid	1.567GHz	65.36	17	48.36	54
		1.822GHz	54	17	37	54
high	high	1.538GHz	64.29	17	47.29	54
		1.85GHz	55.57	17	38.57	54

Table 13. Frequencies Above Average Rad Spurious Emission Above 1GHz

Note: Duty Cycle Correction factor for co-located 900Mhz radio which was tested under 15.249 has been included below:

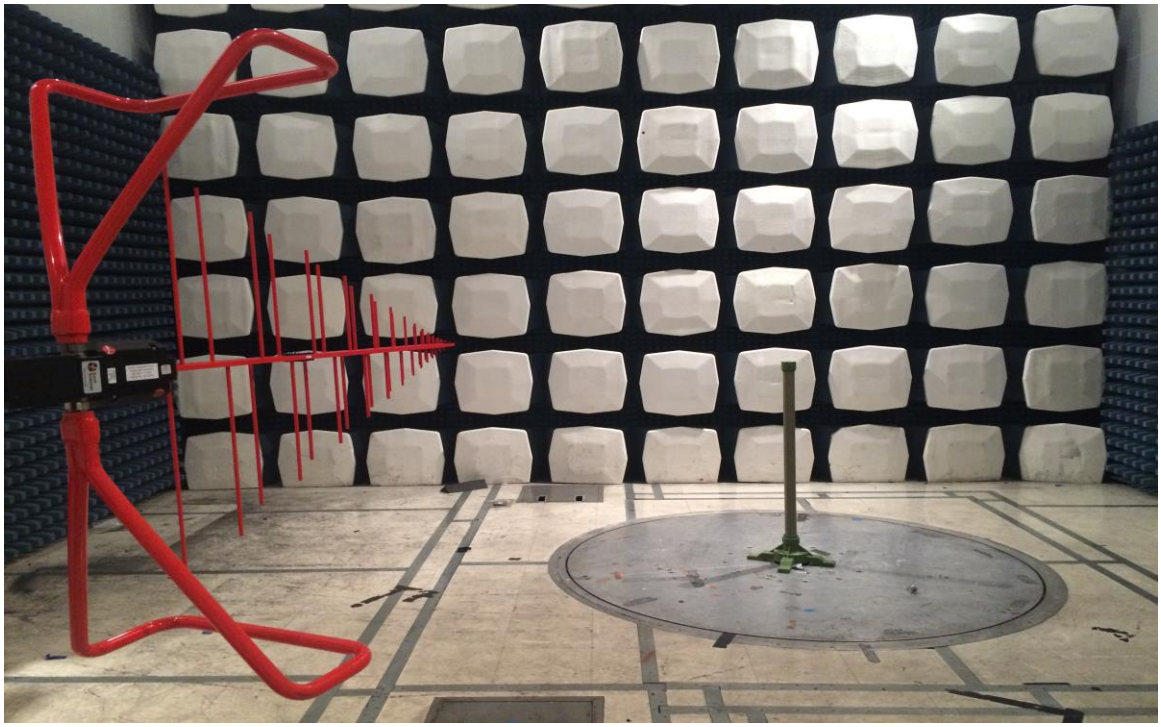
Frequency Band	Period mS	On Time mS	Duty Cycle
902-928 MHz	7.2	0.9676	-17.43273273

Duty cycle:

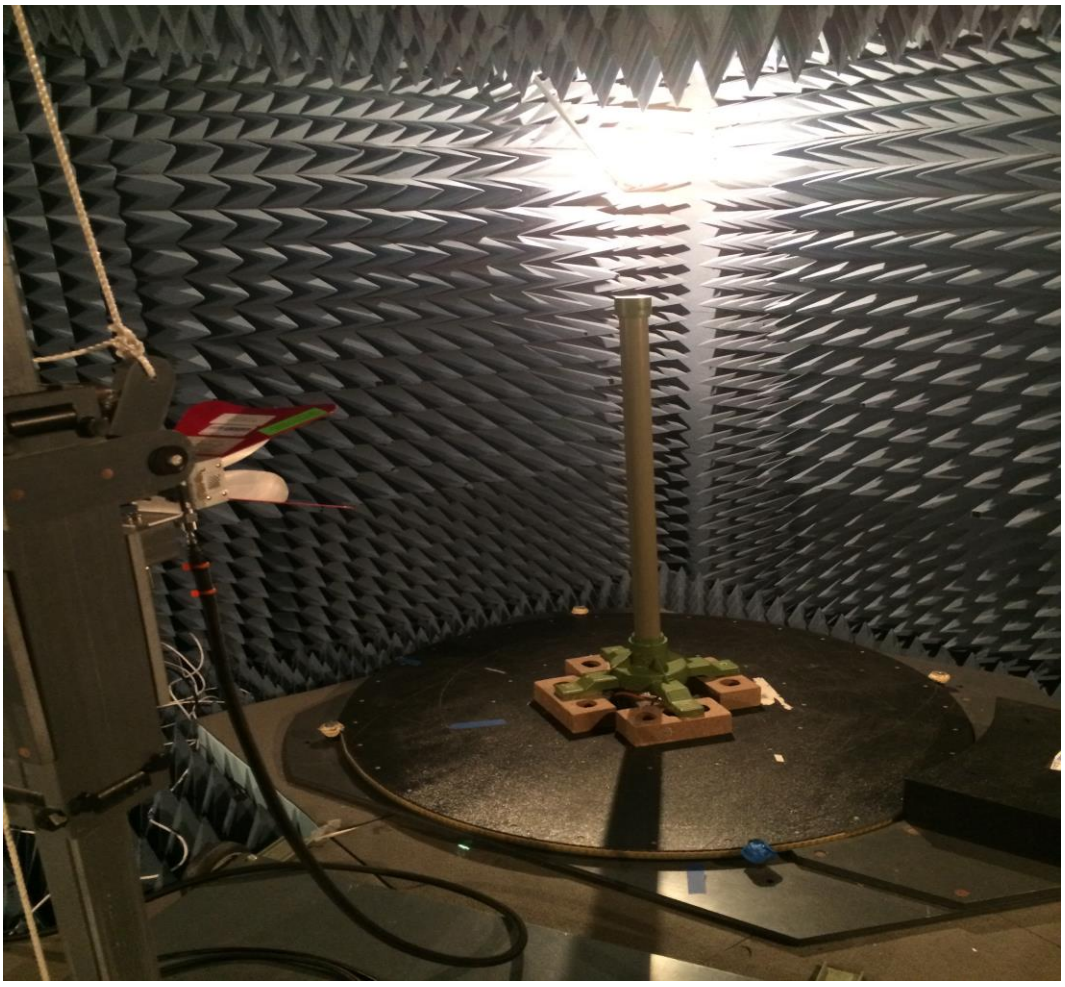


Plot 53. Duty Cycle, Period_10 kHz with sweep time of 28.92 ms

Radiated Spurious Emissions Test Setup



Photograph 1. Radiated Spurious Emissions, Test Setup, 30 MHz – 1 GHz



Photograph 2. Radiated Spurious Emissions, Test Setup, Above 1 GHz

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(d) RF Conducted Spurious Emissions Requirements and Band Edge

Test Requirement: **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.

Test Procedure: The transmitter was turned on. Measurements were performed of the low, mid and high Channels. The EUT was rotated orthogonally through all three axes. Plots shown are corrected for both antenna correction factor and distance and compared to a 3 m limit line. Only noise floor was measured above 18 GHz.

Test Results: Conducted sample was not available. Measurements were done radiated and are compliant with 15.247(d)

Test Engineer(s): Deepak Giri

Test Date(s): 09/16/16

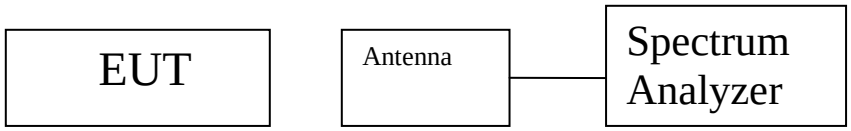
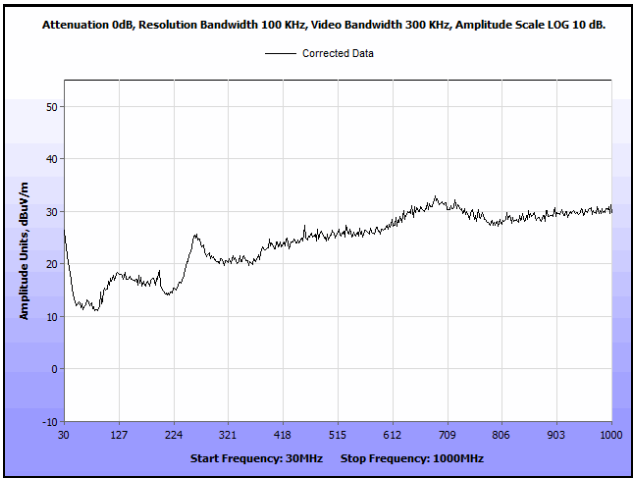
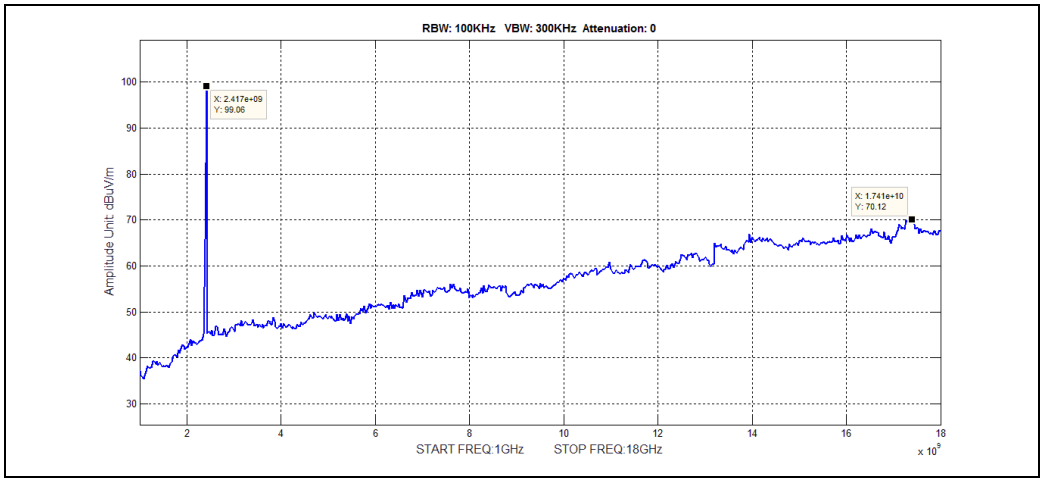


Figure 4. Block Diagram, Conducted Spurious Emissions Test Setup

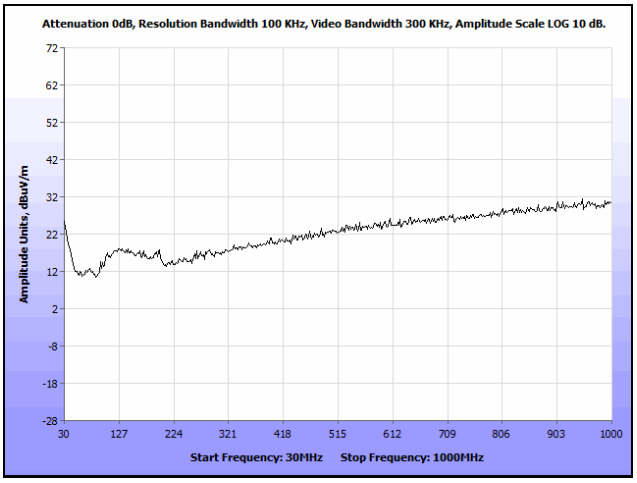
Conducted Spurious Emissions Test Results



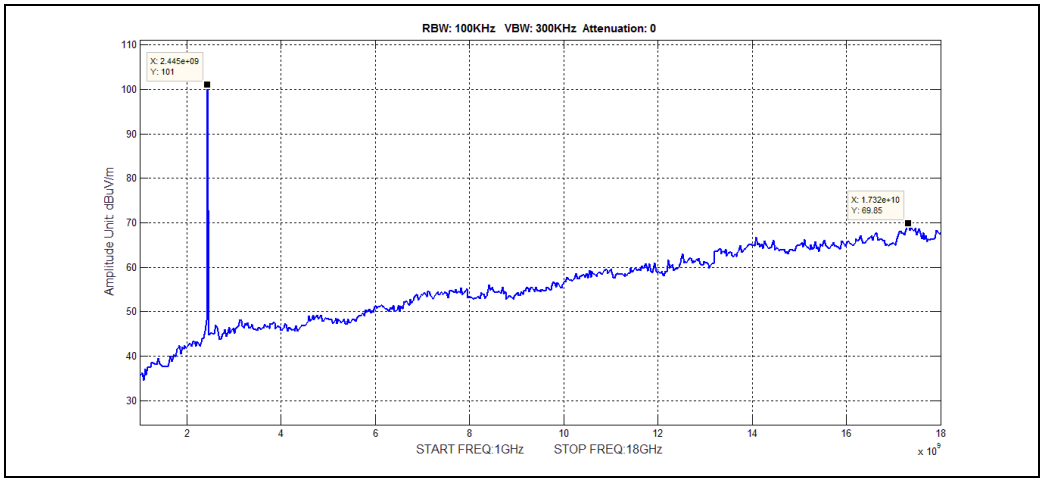
Plot 54. Conducted Spurious Emissions, Low Channel, 30 MHz – 1 GHz



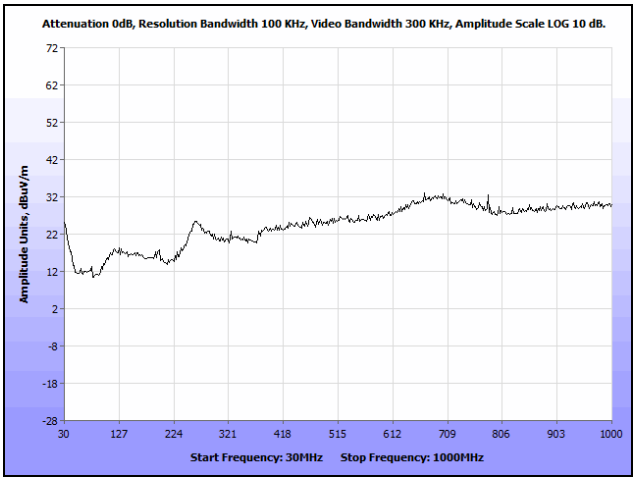
Plot 55. Conducted Spurious Emissions, Low Channel, 1 GHz – 18 GHz



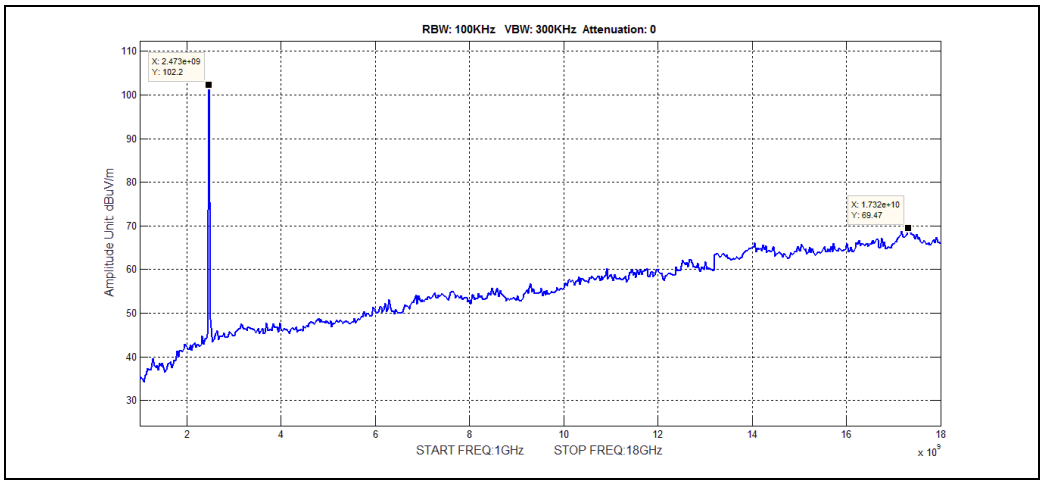
Plot 56. Conducted Spurious Emissions, Mid Channel, 30 MHz – 1 GHz



Plot 57. Conducted Spurious Emissions, Mid Channel, 1 GHz – 18 GHz

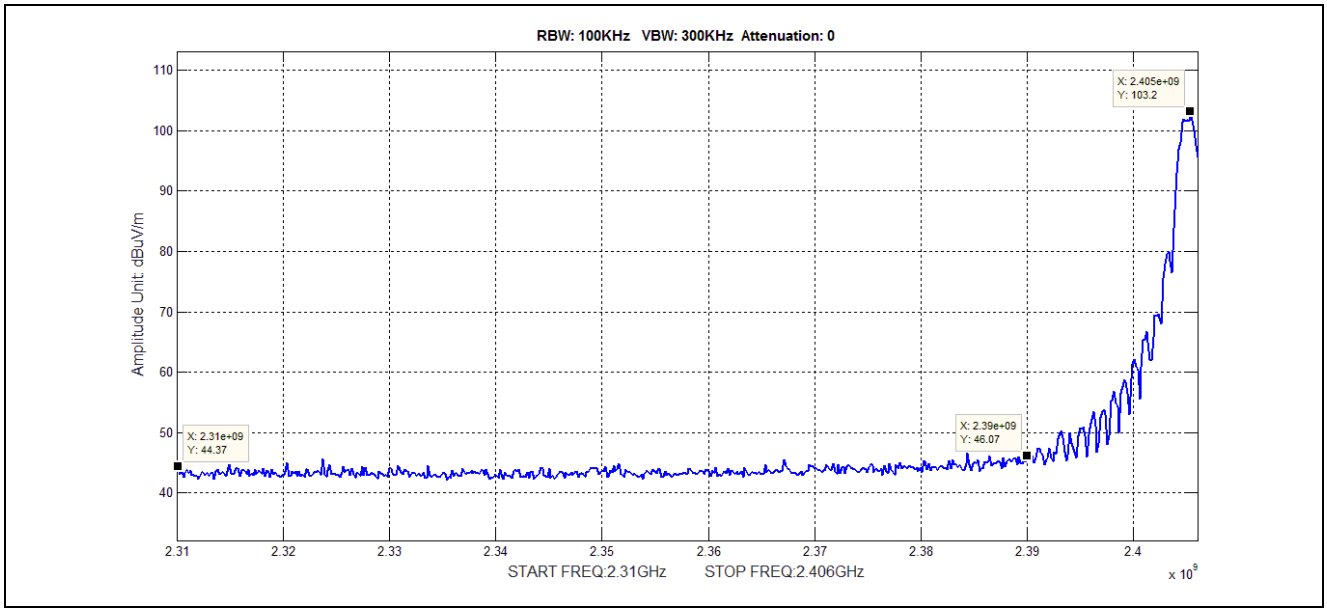


Plot 58. Conducted Spurious Emissions, High Channel, 30 MHz – 1 GHz

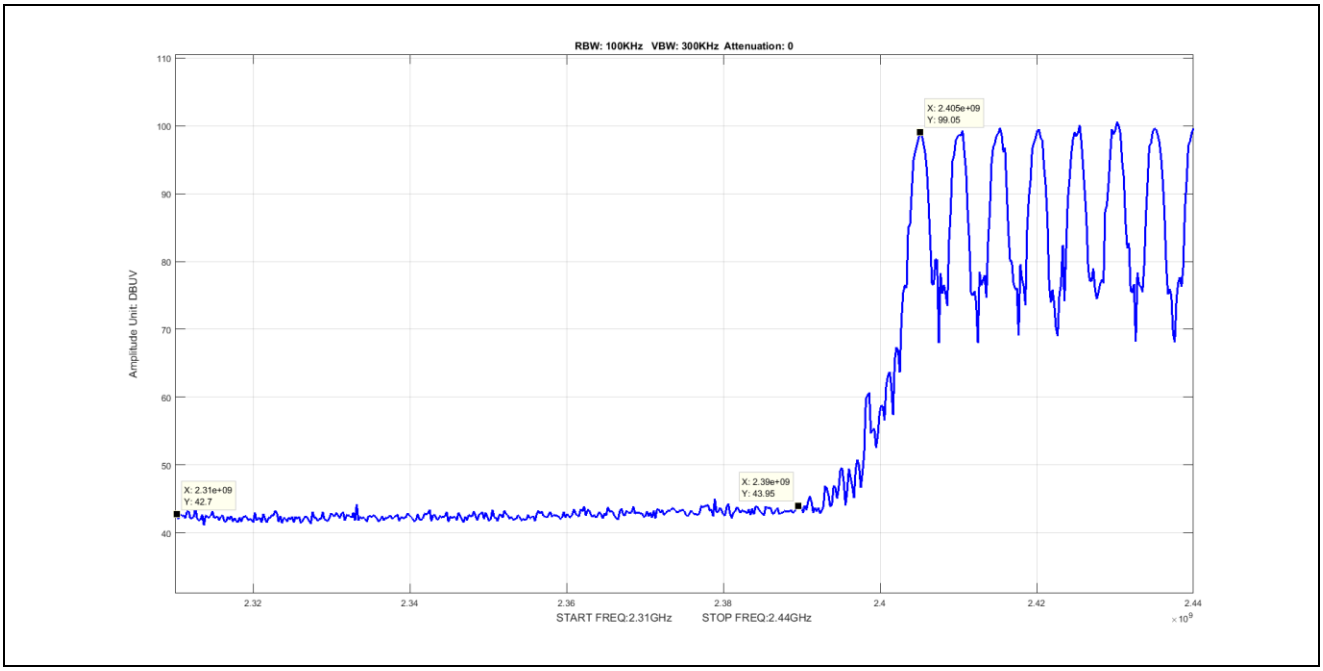


Plot 59. Conducted Spurious Emissions, High Channel, 1 GHz – 18 GHz

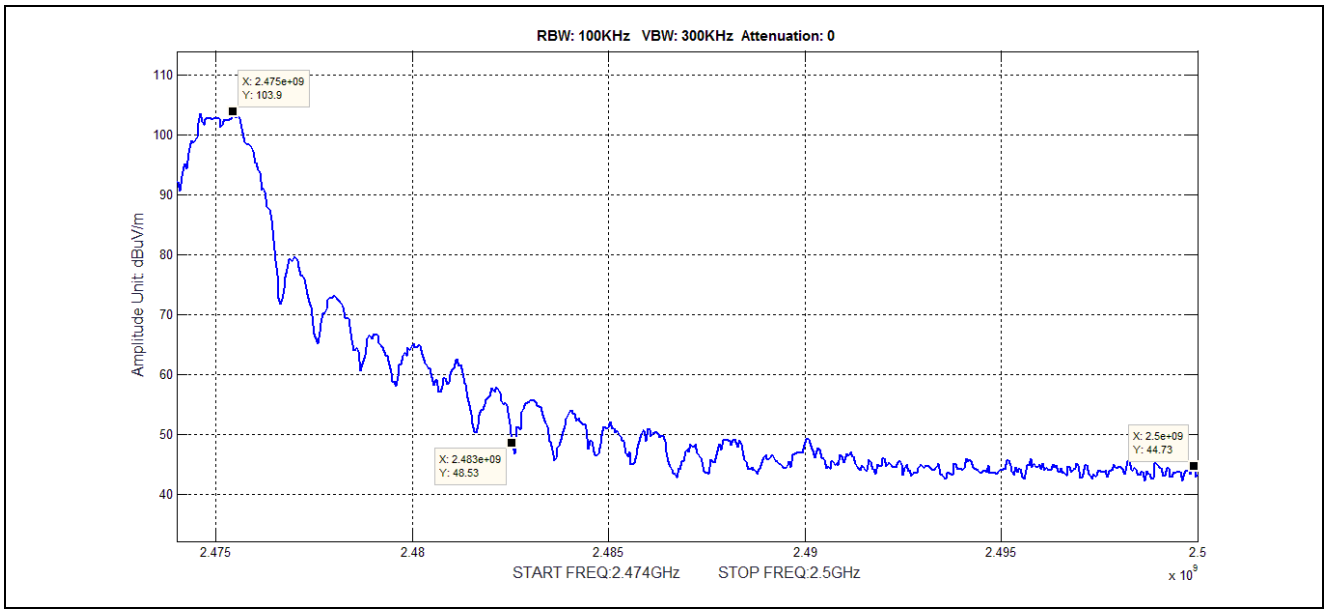
Conducted Band Edge Test Results



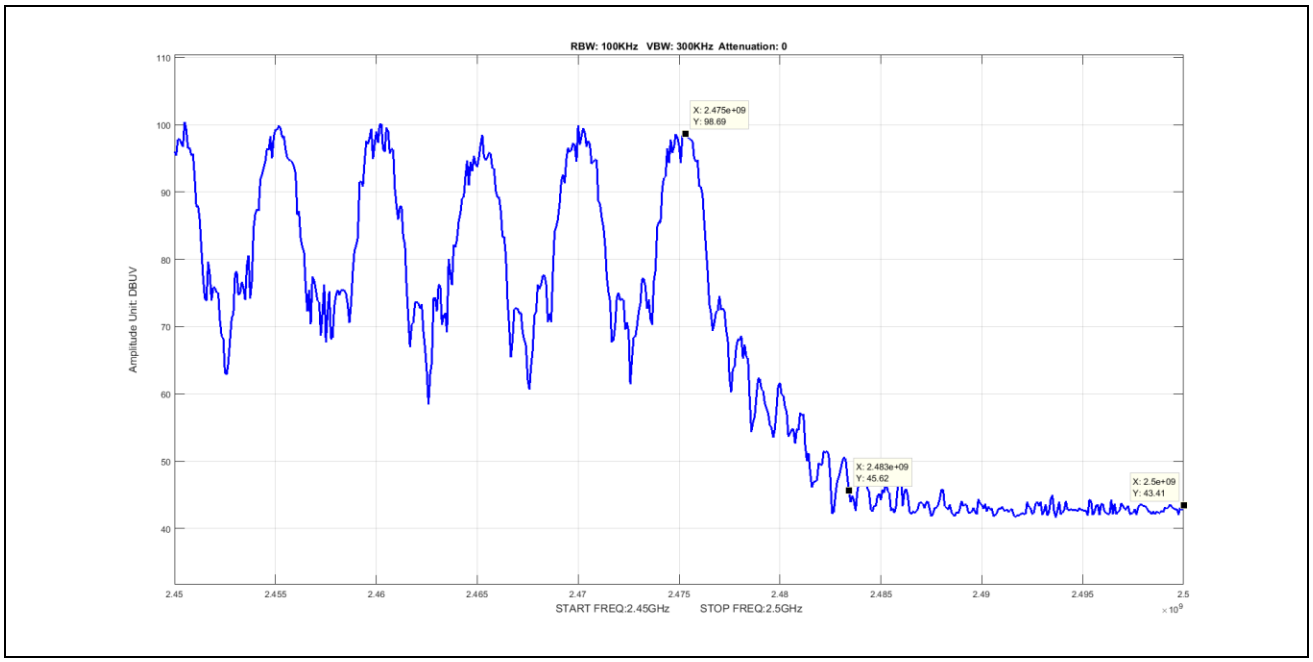
Plot 60. Conducted Band Edge, Low Channel



Plot 61. Conducted Band Edge, Lower Channels at Hopping Mode



Plot 62. Conducted Band Edge, High Channel



Plot 63. Conducted Band Edge, Higher Channel at Hopping Mode

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(g)(h) Declaration Statements for FHSS

Customer declared.

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(i) Maximum Permissible Exposure

RF Exposure Requirements: **§1.1307(b)(1) and §1.1307(b)(2):** Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines.

RF Radiation Exposure Limit: **§1.1310:** As specified in this section, the Maximum Permissible Exposure (MPE) Limit shall be used to evaluate the environmental impact of human exposure to radiofrequency (RF) radiation as specified in Sec. 1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of Sec. 2.1093 of this chapter.

FCC									
Frequency (MHz)	**Con. Pwr. (dBm)**	**Con. Pwr. (mW)**	**Ant. Gain (dBi)**	**Ant. Gain numeric**	**Pwr. Density (mW/cm^2)**	**Limit (mW/cm^2)**	**Margin**	**Distance (cm)**	**Result**
2474	9.06	8.054	3	1.995	0.0032	1	0.9968	20	Pass

Result: SAR testing is not required.

IV. Test Equipment

Test Equipment

Calibrated test equipment utilized during testing was maintained in a current state of calibration per the requirements of ISO/IEC 17025:2005.

MET Asset #	Equipment	Manufacturer	Model	Last Cal Date	Cal Due Date
1T4771	PSA SPECTRUM ANALYZER	AGILENT TECHNOLOGIES	E4446A	8/10/2016	2/10/2018
1T4483	ANTENNA; HORN	ETS-LINDGREN	3117	10/8/2015	4/8/2017
1T4859	DIGITAL BAROMETER, HYGROMETER, THERMOMETER	CONTROL COMPANY	15-078-198, FB70423, 245CD	2/10/2016	2/10/2018
1T4751	ANTENNA - BILOG	SUNOL SCIENCES	JB6	2/26/2016	8/26/2017
1T4442	PRE-AMPLIFIER, MICROWAVE	MITEQ	AFS42-01001800-30-10P	SEE NOTE	
1T4149	HIGH-FREQUENCY ANECHOIC CHAMBER	RAY PROOF	81	NOT REQUIRED	
1T4409	EMI RECEIVER	ROHDE & SCHWARZ	ESIB7	10/29/2014	10/29/2016
1T4300	SEMI-ANECHOIC CHAMBER # 1 (NSA)	EMC TEST SYSTEMS	NONE	2/6/2015	2/6/2018

Table 14. Test Equipment List

Note: Functionally tested equipment is verified using calibrated instrumentation at the time of testing.

V. Certification & User's Manual Information

Certification & User's Manual Information

A. Certification Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 2, Subpart I — Marketing of Radio frequency devices:

§ 2.801 Radio-frequency device defined.

As used in this part, a radio-frequency device is any device which in its operation is capable of Emitting radio-frequency energy by radiation, conduction, or other means. Radio- frequency devices include, but are not limited to:

(a) The various types of radio communication transmitting devices described throughout this chapter.

(b) The incidental, unintentional and intentional radiators defined in Part 15 of this chapter.

(c) The industrial, scientific, and medical equipment described in Part 18 of this chapter.

(d) Any part or component thereof which in use emits radio-frequency energy by radiation, conduction, or other means.

§ 2.803 Marketing of radio frequency devices prior to equipment authorization.

(a) Except as provided elsewhere in this chapter, no person shall sell or lease, or offer for sale or lease (including advertising for sale or lease), or import, ship or distribute for the purpose of selling or leasing or offering for sale or lease, any radio frequency device unless:

(1) In the case of a device subject to certification, such device has been authorized by the Commission in accordance with the rules in this chapter and is properly identified and labeled as required by §2.925 and other relevant sections in this chapter; or

(2) In the case of a device that is not required to have a grant of equipment authorization issued by the Commission, but which must comply with the specified technical standards prior to use, such device also complies with all applicable administrative (including verification of the equipment or authorization under a Declaration of Conformity, where required), technical, labeling and identification requirements specified in this chapter.

(d) Notwithstanding the provisions of paragraph (a) of this section, the offer for sale solely to business, commercial, industrial, scientific or medical users (but not an offer for sale to other parties or to end users located in a residential environment) of a radio frequency device that is in the conceptual, developmental, design or pre-production stage is permitted prior to equipment authorization or, for devices not subject to the equipment authorization requirements, prior to a determination of compliance with the applicable technical requirements *provided* that the prospective buyer is advised in writing at the time of the offer for sale that the equipment is subject to the FCC rules and that the equipment will comply with the appropriate rules before delivery to the buyer or to centers of distribution.

(e)(1) Notwithstanding the provisions of paragraph (a) of this section, prior to equipment authorization or determination of compliance with the applicable technical requirements any radio frequency device may be operated, but not marketed, for the following purposes and under the following conditions:

(i) Compliance testing;

(ii) Demonstrations at a trade show provided the notice contained in paragraph (c) of this section is displayed in a conspicuous location on, or immediately adjacent to, the device;

(iii) Demonstrations at an exhibition conducted at a business, commercial, industrial, scientific or medical location, but excluding locations in a residential environment, provided the notice contained in paragraphs (c) or (d) of this section, as appropriate, is displayed in a conspicuous location on, or immediately adjacent to, the device;

(iv) Evaluation of product performance and determination of customer acceptability, provided such operation takes place at the manufacturer's facilities during developmental, design or pre-production states; or

(v) Evaluation of product performance and determination of customer acceptability where customer acceptability of a radio frequency device cannot be determined at the manufacturer's facilities because of size or unique capability of the device, provided the device is operated at a business, commercial, industrial, scientific or medical user's site, but not at a residential site, during the development, design or pre-production stages.

(e)(2) For the purpose of paragraphs (e)(1)(iv) and (e)(1)(v) of this section, the term *manufacturer's facilities* includes the facilities of the party responsible for compliance with the regulations and the manufacturer's premises, as well as the facilities of other entities working under the authorization of the responsible party in connection with the development and manufacture, but not the marketing, of the equipment.

(f) For radio frequency devices subject to verification and sold solely to business, commercial, industrial, scientific and medical users (excluding products sold to other parties or for operation in a residential environment), parties responsible for verification of the devices shall have the option of ensuring compliance with the applicable technical specifications of this chapter at each end user's location after installation, provided that the purchase or lease agreement includes a proviso that such a determination of compliance be made and is the responsibility of the party responsible for verification of the equipment.

Certification & User's Manual Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 2, Subpart J — Equipment Authorization Procedures:

§ 2.901 Basis and Purpose

(a) In order to carry out its responsibilities under the Communications Act and the various treaties and international regulations, and in order to promote efficient use of the radio spectrum, the Commission has developed technical standards for radio frequency equipment and parts or components thereof. The technical standards applicable to individual types of equipment are found in that part of the rules governing the service wherein the equipment is to be operated.[1] *In addition to the technical standards provided, the rules governing the service may require that such equipment be verified by the manufacturer or importer*, be authorized under a Declaration of Conformity, or receive an equipment authorization from the Commission by one of the following procedures: certification or registration.

(b) The following sections describe the verification procedure, the procedure for a Declaration of Conformity, and the procedures to be followed in obtaining certification from the Commission and the conditions attendant to such a grant.

§ 2.907 Certification.

(a) Certification is an equipment authorization issued by the Commission, based on representation and test data submitted by the applicant.

(b) Certification attaches to all units subsequently marketed by the grantee which are identical (see Section 2.908) to the sample tested except for permissive changes or other variations authorized by the Commission pursuant to Section 2.1043.

[1] In this case, the equipment is subject to the rules of Part 15. More specifically, the equipment falls under Subpart B (of Part 15), which deals with unintentional radiators.

Certification & User's Manual Information

§ 2.948 Description of measurement facilities.

(a) Each party making measurements of equipment that is subject to an equipment authorization under Part 15 or Part 18 of this chapter, regardless of whether the measurements are filed with the Commission or kept on file by the party responsible for compliance of equipment marketed within the U.S. or its possessions, shall compile a description of the measurement facilities employed.

(1) If the measured equipment is subject to the verification procedure, the description of the measurement facilities shall be retained by the party responsible for verification of the equipment.

(i) If the equipment is verified through measurements performed by an independent laboratory, it is acceptable for the party responsible for verification of the equipment to rely upon the description of the measurement facilities retained by or placed on file with the Commission by that laboratory. In this situation, the party responsible for the verification of the equipment is not required to retain a duplicate copy of the description of the measurement facilities.

(ii) If the equipment is verified based on measurements performed at the installation site of the equipment, no specific site calibration data is required. It is acceptable to retain the description of the measurement facilities at the site at which the measurements were performed.

(2) If the equipment is to be authorized by the Commission under the certification procedure, the description of the measurement facilities shall be filed with the Commission's Laboratory in Columbia, Maryland. The data describing the measurement facilities need only be filed once but must be updated as changes are made to the measurement facilities or as otherwise described in this section. At least every three years, the organization responsible for filing the data with the Commission shall certify that the data on file is current.

Certification & User's Manual Information

1. Label and User's Manual Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 15, Subpart A — General:

§ 15.19 Labeling requirements.

(a) In addition to the requirements in Part 2 of this chapter, a device subject to certification or verification shall be labeled as follows:

(1) Receivers associated with the operation of a licensed radio service, e.g., FM broadcast under Part 73 of this chapter, land mobile operation under Part 90, etc., shall bear the following statement in a conspicuous location on the device:

This device complies with Part 15 of the FCC Rules. Operation is subject to the condition that this device does not cause harmful interference.

(2) A stand-alone cable input selector switch, shall bear the following statement in a conspicuous location on the device:

This device is verified to comply with Part 15 of the FCC Rules for use with cable television service.

(3) All other devices shall bear the following statement in a conspicuous location on the device:

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

(4) Where a device is constructed in two or more sections connected by wires and marketed together, the statement specified under paragraph (a) of this section is required to be affixed only to the main control unit.

(5) When the device is so small or for such use that it is not practicable to place the statement specified under paragraph (a) of this section on it, the information required by this paragraph shall be placed in a prominent location in the instruction manual or pamphlet supplied to the user or, alternatively, shall be placed on the container in which the device is marketed. However, the FCC identifier or the unique identifier, as appropriate, must be displayed on the device.

§ 15.21 Information to user.

The users manual or instruction manual for an intentional or unintentional radiator shall caution the user that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Verification & User's Manual Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 15, Subpart B — Unintentional Radiators:

§ 15.105 Information to the user.

(a) For a Class A digital device or peripheral, the instructions furnished the user shall include the following or similar statement, placed in a prominent location in the text of the manual:

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at own expense.

(b) For a Class B digital device or peripheral, the instructions furnished the user shall include the following or similar statement, placed in a prominent location in the text of the manual:

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a residential environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

– Reorient or relocate the receiving antenna.

– Increase the separation between the equipment and receiver.

– Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

– Consult the dealer or an experienced radio/TV technician for help.

End of Report

