MET Laboratories, Inc. *Safety Certification - EMI - Telecom Environmental Simulation*
914 WEST PATAPSCO AVENUE • BALTIMORE, MARYLAND 21230-3432 • PHONE (410) 354-3300 • FAX (410) 354-3313
33439 WESTERN AVENUE • UNION CITY, CALIFORNIA 94587 • PHONE (510) 489-6300 • FAX (510) 489-6372
3162 BELICK STREET • SANTA CLARA, CA 95054 • PHONE (408) 748-3585 • FAX (510) 489-6372
13501 MCCALLEN PASS • AUSTIN, TEXAS 78753 • PHONE (512) 287-2500 • FAX (512) 287-2513

December 18, 2017

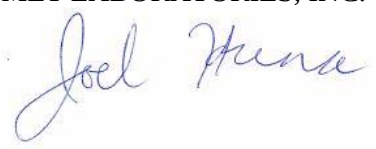
Weir Group Management Services
1 West Regent Street
Glasgow, Scotland G2 1RW

Dear Wayne Cooke,

Enclosed is the EMC Wireless test report for compliance testing of the Weir Group Management Services, Weir Industrial Gateway as tested to the requirements of Title 47 of the CFR, Ch. 1, 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.



Joel Huna
Documentation Department

Reference: (\Weir Group Management Services\EMCA92659A-FCC247 WiFi Rev. 1)

ACCREDITED
TESTING CERT #0591.06

Electromagnetic Compatibility Criteria
Test Report

for the

Weir Group Management Services
Weir Industrial Gateway

Tested under
the FCC Certification Rules
contained in
15.247 Subpart C for Intentional Radiators

MET Report: EMCA92659A-FCC247 Rev. 1

December 18, 2017

Prepared For:

Weir Group Management Services
1 West Regent Street
Glasgow, Scotland G2 1RW

Prepared By:
MET Laboratories, Inc.
13501 McCallen Pass,
Austin, TX 78753

Electromagnetic Compatibility Criteria
Test Report

for the

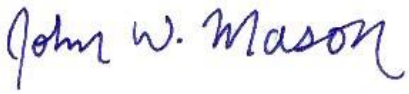
Weir Group Management Services
Weir Industrial Gateway

Tested under
the FCC Certification Rules
contained in
15.247 Subpart C for Intentional Radiators

Giuliano Messina, Project Engineer
Electromagnetic Compatibility Lab

Joel Huna
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 Rules Part 15.247 under normal use and maintenance.



John Mason,
Director, Electromagnetic Compatibility Lab

Report Status Sheet

Revision	Report Date	Reason for Revision
∅	November 29, 2017	Initial Issue.
1	December 18, 2017	Engineer corrections.

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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 Weir Group Management Services Weir Industrial Gateway, 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 Weir Industrial Gateway. Weir Group Management Services should retain a copy of this document which should be kept on file for at least two years after the manufacturing of the Weir Industrial Gateway, 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 Weir Group Management Services, purchase order number T10536863. All tests were conducted using measurement procedures ANSI C63.4-2014 and ANSI C63.10-2013.

FCC Reference 47 CFR Part 15.247	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	Compliant
Title 47 of the CFR, Part 15 §15.247(a)(2)	6dB Occupied Bandwidth	Compliant
Title 47 of the CFR, Part 15 §15.247(b)(3)	Peak Power Output	Compliant
Title 47 of the CFR, Part 15 §15.247(d); §15.209; §15.205	Radiated Spurious Emissions Requirements	Compliant
Title 47 of the CFR, Part 15 §15.247(d)	RF Conducted Spurious Emissions Requirements	Compliant
Title 47 of the CFR, Part 15 §15.247(d)	RF Conducted Band Edge	Compliant
Title 47 of the CFR, Part 15; §15.247(e)	Peak Power Spectral Density	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 Weir Group Management Services to perform testing on the Weir Industrial Gateway, under Weir Group Management Services's purchase order number T10536863.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the Weir Group Management Services, Weir Industrial Gateway.

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

Model(s) Tested:	Weir Industrial Gateway	
Model(s) Covered:	Weir Industrial Gateway	
EUT Specifications:	Primary Power: 120/240 VAC 50/60 Hz	
	FCC ID: 2ANXR-STXMPM	
	Type of Modulations:	CCK, OFDM
	Equipment Code:	DTS
	Peak RF Output Power:	20.37 dBm, 0.109 W
	EUT Frequency Ranges:	2412-2462 MHz
	Duty Cycle:	≥ 98%
	Data Rates:	1M **(worst case)**, 2M, 5.5M, 11M, 22M, 6M, 9M, 12M, 18M, 24M, 36M, 48M, 54M, 72M, MCS0, MCS1, MCS2, MCS3, MCS4, MCS5, MCS6, MCS7, MCS8, MCS9, MCS10, MCS11, MCS12, MCS13, MCS14, MCS15, VHT_SS1_MCS0, VHT_SS1_MCS1, VHT_SS1_MCS2, VHT_SS1_MCS3, VHT_SS1_MCS4, VHT_SS1_MCS5, VHT_SS1_MCS6, VHT_SS1_MCS7, VHT_SS1_MCS8, VHT_SS1_MCS9, VHT_SS2_MCS0, VHT_SS2_MCS1, VHT_SS2_MCS2, VHT_SS2_MCS3, VHT_SS2_MCS4, VHT_SS2_MCS5, VHT_SS2_MCS6, VHT_SS2_MCS7, VHT_SS2_MCS8, VHT_SS2_MCS9
Analysis:	The results obtained relate only to the item(s) tested.	
Environmental Test Conditions:	Temperature: 15-35° C	
	Relative Humidity: 30-60%	
	Barometric Pressure: 860-1060 mbar	
Evaluated by:	Giuliano Messina	
Report Date(s):	December 18, 2017	

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 558074 v04 (April 5th, 2017)	Guidance for performing compliance measurements on digital transmission systems (DTS) operating under section 15.247

Table 3. References

C. Test Site

All testing was performed at MET Laboratories, Inc., 13501 McCallen Pass, Austin, TX 78753. 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 10 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 Weir Group Management Services Weir Industrial Gateway, Equipment Under Test (EUT), is used to monitor the operation of the components of a drilling rig, in particular the sound and vibration from the bearings in the system. This is monitored through digital signal processing to determine if the bearing is nearing the end of its life and needs to be replaced.

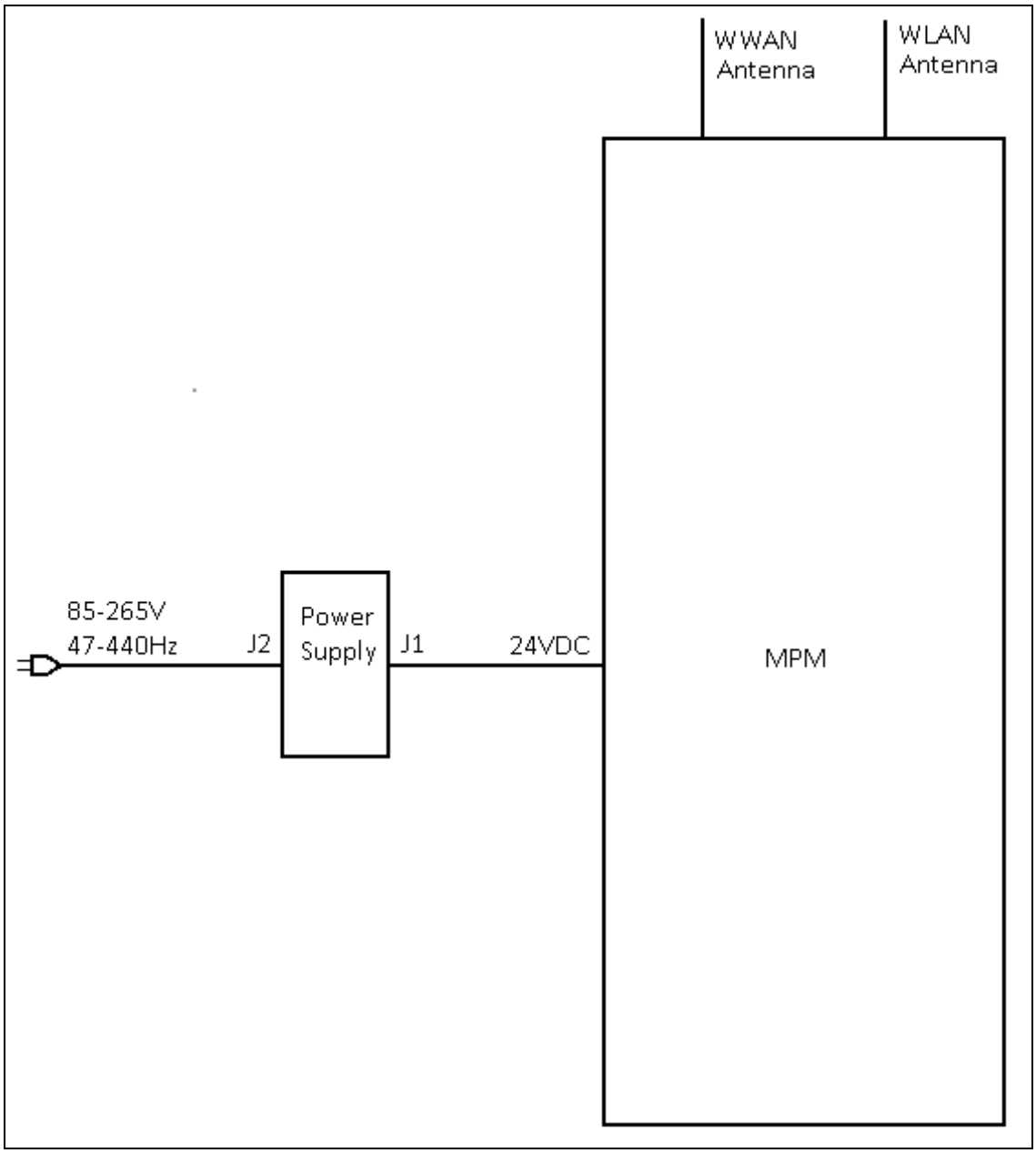


Figure 1. Block Diagram of Test Configuration

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	Serial Number	Rev. #
A	Power Supply	CH-SAN500AC-24	161103	01
B	MPM	North America: STX-000004	006	01
P	Antenna	SCR12-2400-WHT	N/A	N/A
P	Antenna	OD6-2400-BLK	N/A	N/A

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	*Customer Supplied Calibration Data
E	Ethernet Switch	Netgear	N300	N/A
F	External Laptop	Dell	Latitude E5570	N/A
The 'Customer Supplied Calibration Data' column will be marked as either not applicable, not available, or will contain the calibration date supplied by the customer.				

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)	Max Length (m)	Shielded? (Y/N)	Termination Box ID & Port Name
1	AC Input	3 conductor, bare wires at AC Mains end, 14 AWG	1	10	50	No	Power Box.J2
2	24VDC	4 conductor, 14 AWG	1	2	50	No	Power Box.J1
9	LAN	8 conductor, 20 AWG	1	5	50	Yes	Ethernet switch
33	MPM	Antenna cable, 1 conductor, coax, CA120/195-XC	1	10	10	Yes	Antenna

Table 6. Ports and Cabling Information

H. Mode of Operation

Custom software (Labtool) will exercise the transmitter and display the system performance via ethernet link to be monitored by an external laptop.

I. Method of Monitoring EUT Operation

An external laptop with an ethernet link will monitor the system and display the system performance.

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 Weir Group Management Services 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. EUT is professionally installed only.

Test Engineer(s): Kristine Song

Test Date(s): April 25, 2017

Gain	Type	Model	Manufacturer
12dBi	Wifi	SCR12-2400-WHT	Mobile-Mark
6dBi	Wifi	OD6-2400-BLK	Mobile-Mark

Table 7. Antenna List

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

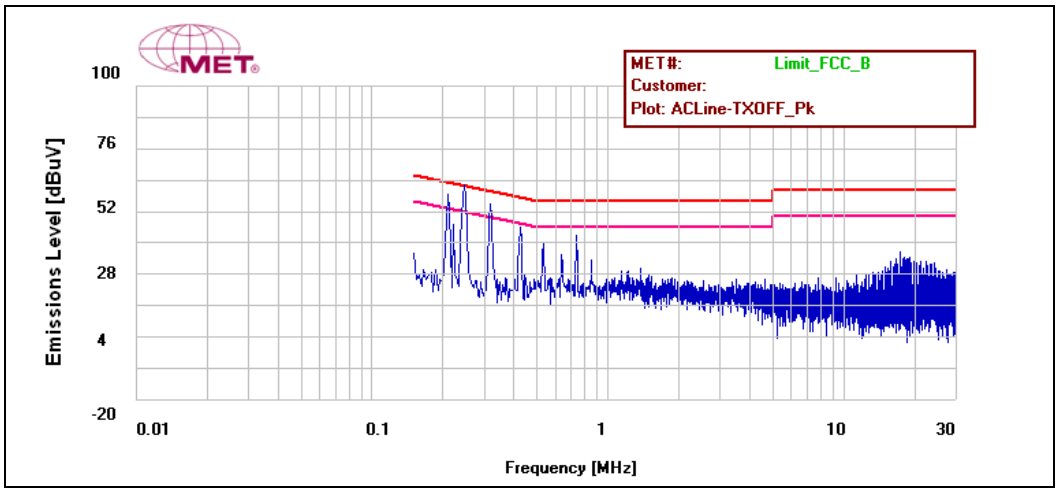
Test Procedure: The EUT was placed on a 0.8 m-high wooden table above a ground plane. The EUT was situated such that the back of the EUT was 0.4 m from one wall of the vertical ground plane, and the remaining sides of the EUT were no closer than 0.8 m from any other conductive surface. The EUT was powered from a 50 Ω/50 μH Line Impedance Stabilization Network (LISN). The EMC receiver scanned the frequency range from 150 kHz to 30 MHz. Conducted Emissions measurements were made in accordance with *ANSI C63.4-2014 "Methods and Measurements of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9kHz to 40 GHz"*. The measurements were performed over the frequency range of 0.15 MHz to 30 MHz using a 50 Ω/50 μH LISN as the input transducer to an EMC/field intensity meter. For the purpose of this testing, the transmitter was turned on. Scans were performed with the transmitter on. Measurements were taken with the transmitter off to ensure that any frequencies over the limit were not caused by the transmitter.

Test Results: The EUT was compliant with this requirement. Measured emissions were within applicable limits. Emissions above the limit were present with the transmitter off and are likely to not be caused by the transmitter.

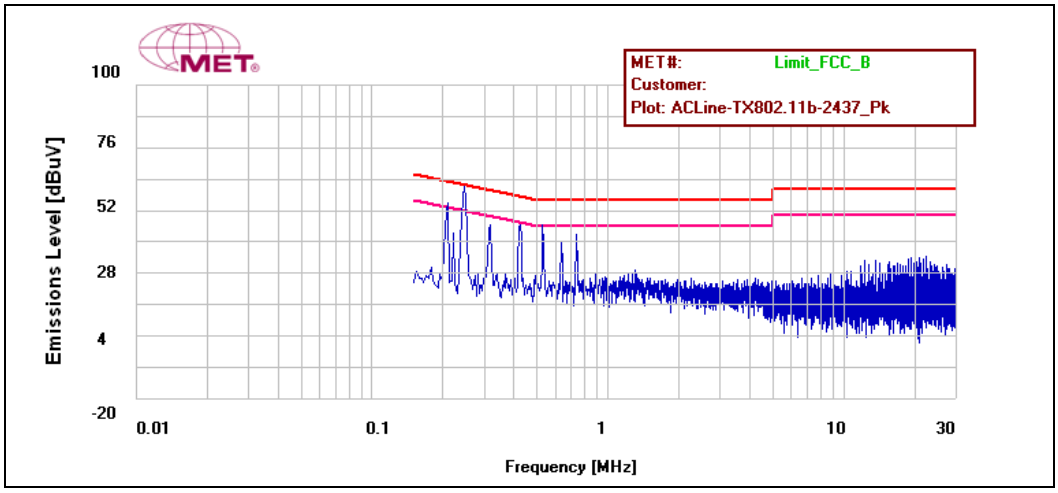
Test Engineer(s): Giuliano Messina

Test Date(s): May 9, 2017

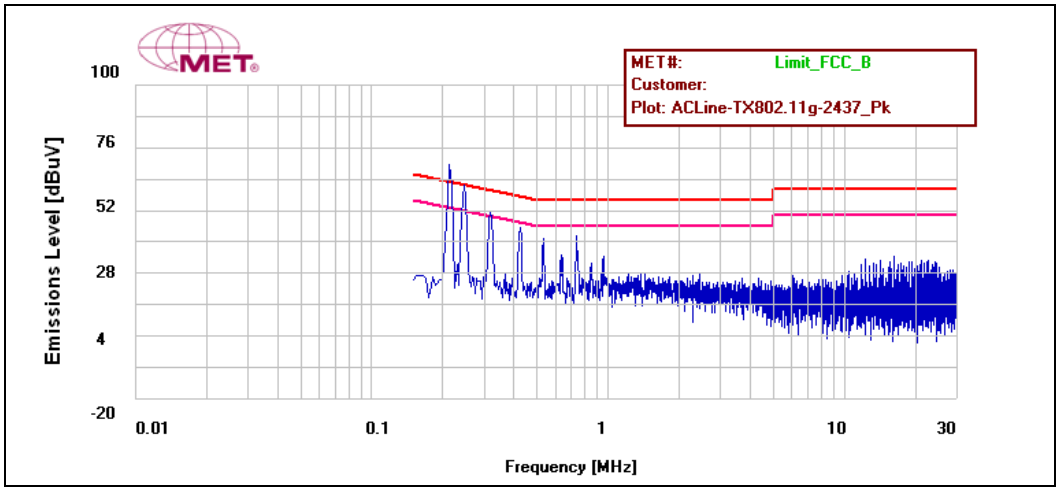
15.207(a) Conducted Emissions Test Results



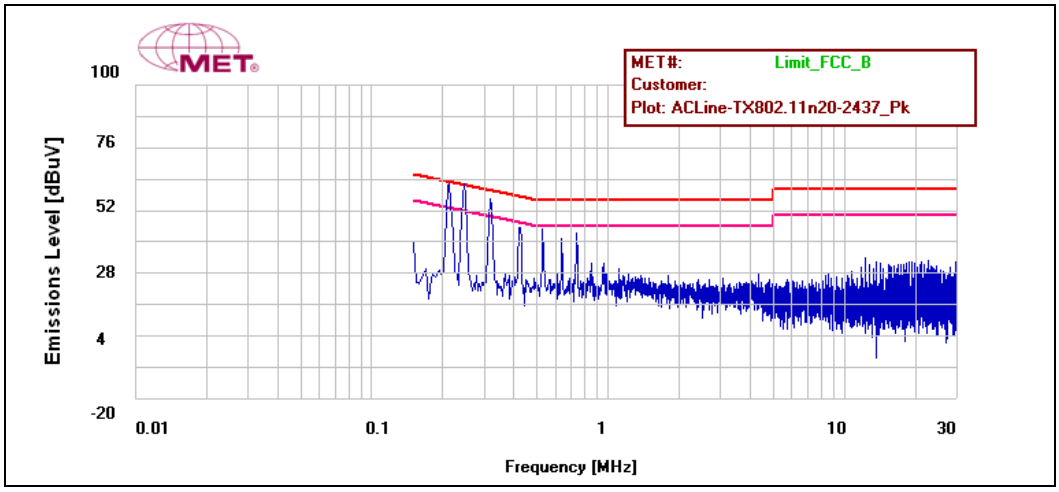
Plot 1. Conducted Emissions, 15.207(a), Transmit Off, Phase Line



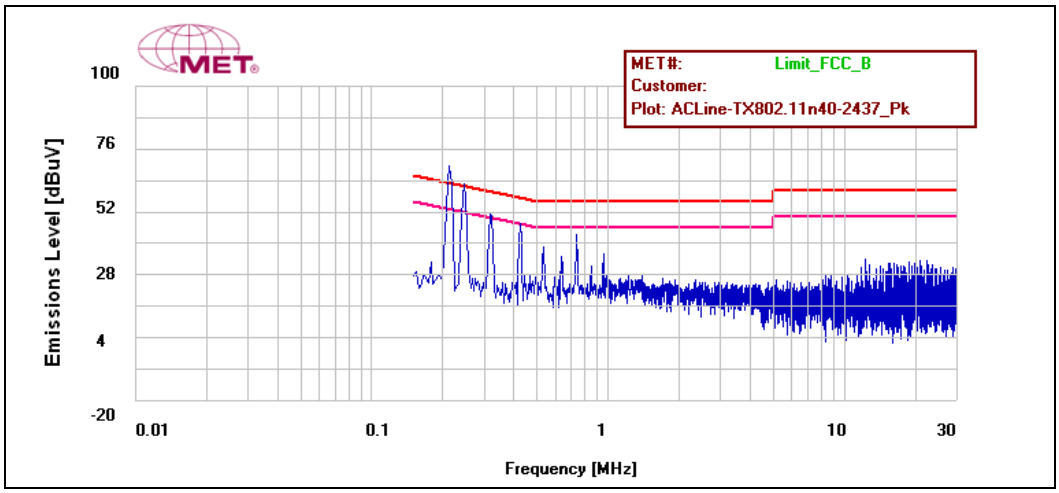
Plot 2. Conducted Emissions, 15.207(a), 2.4 GHz WiFi, 802.11b, Phase Line



Plot 3. Conducted Emissions, 15.207(a), 2.4 GHz WiFi, 802.11g, Phase Line

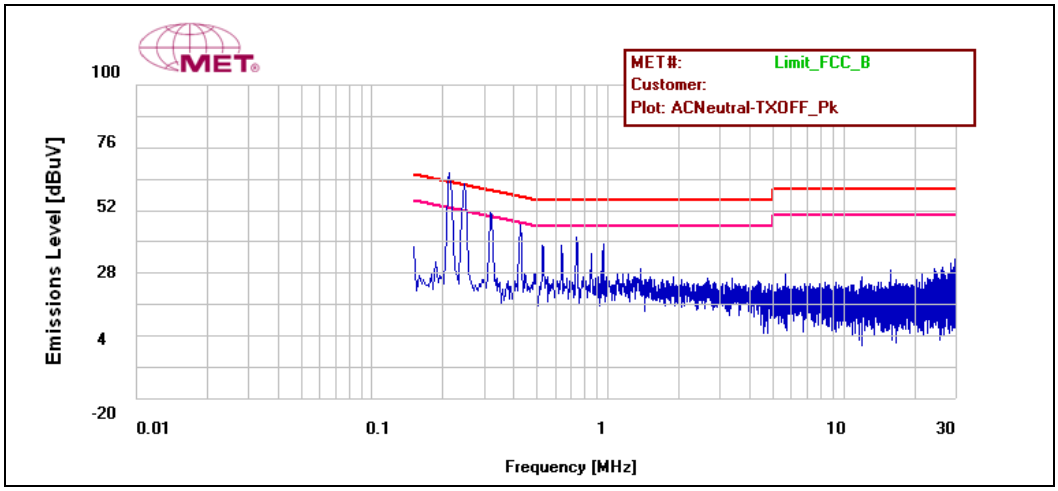


Plot 4. Conducted Emissions, 15.207(a), 2.4 GHz WiFi, 802.11n, 20 MHz, Phase Line

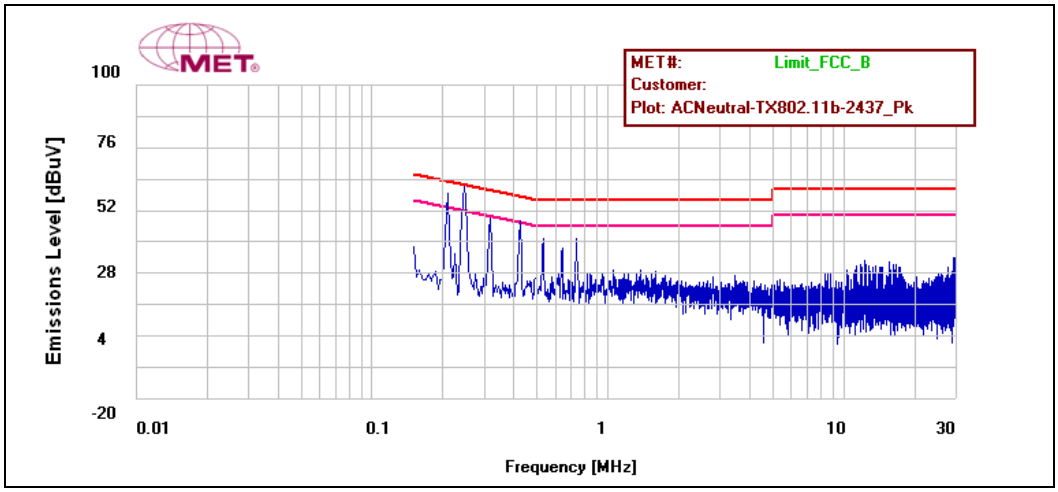


Plot 5. Conducted Emissions, 15.207(a), 2.4 GHz WiFi, 802.11n, 40 MHz, Phase Line

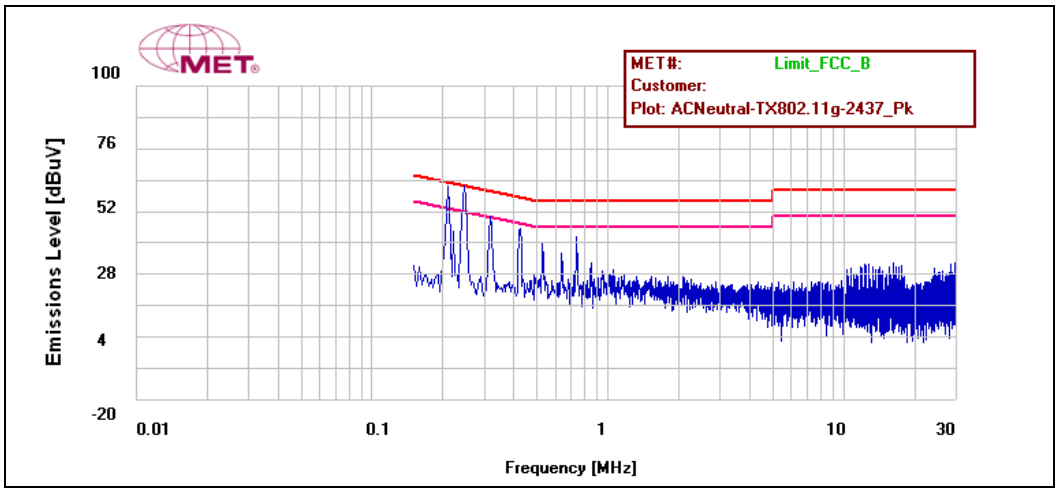
15.207(a) Conducted Emissions Test Results



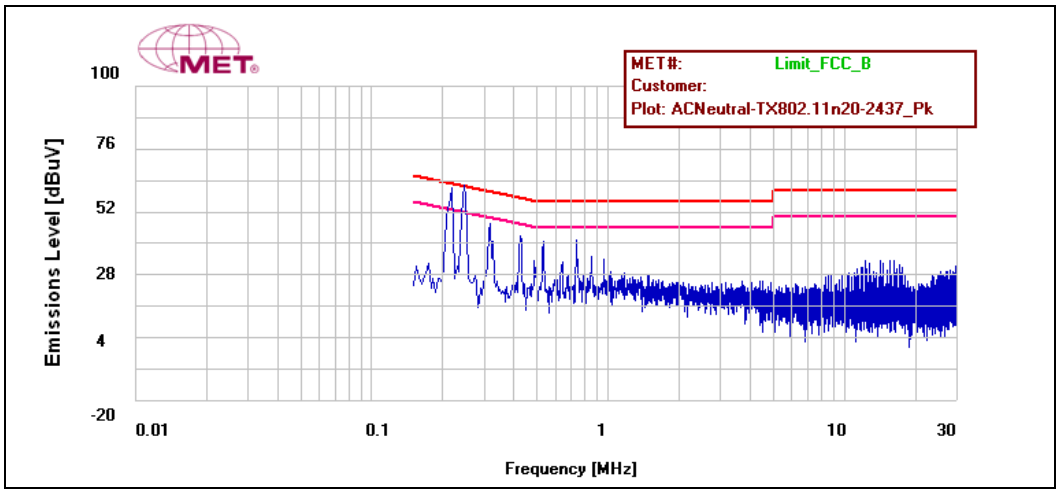
Plot 6. Conducted Emissions, 15.207(a), Transmit Off, Neutral Line



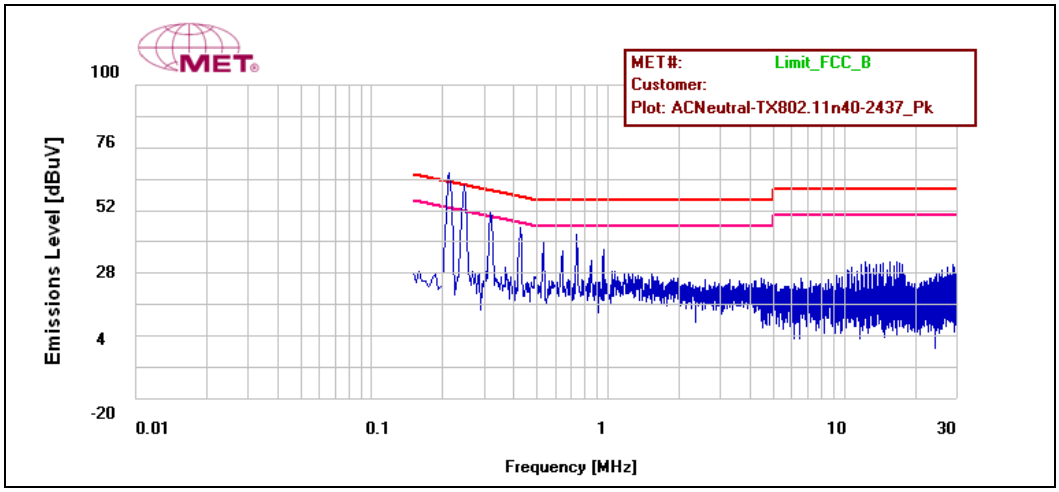
Plot 7. Conducted Emissions, 15.207(a), 2.4 GHz WiFi, 802.11b, Neutral Line



Plot 8. Conducted Emissions, 15.207(a), 2.4 GHz WiFi, 802.11g, Neutral Line

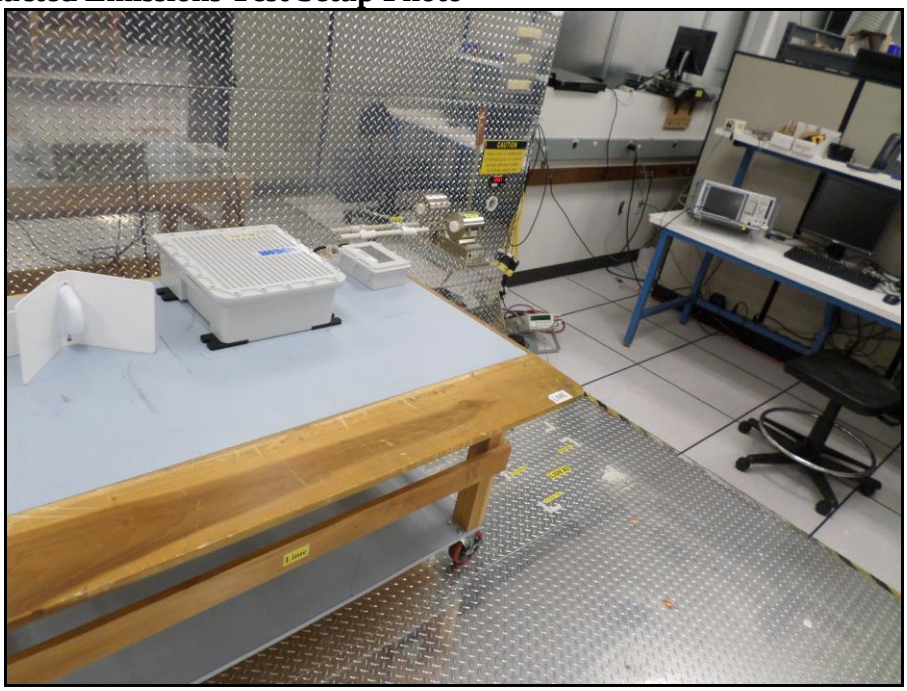


Plot 9. Conducted Emissions, 15.207(a), 2.4 GHz WiFi, 802.11n, 20 MHz, Neutral Line

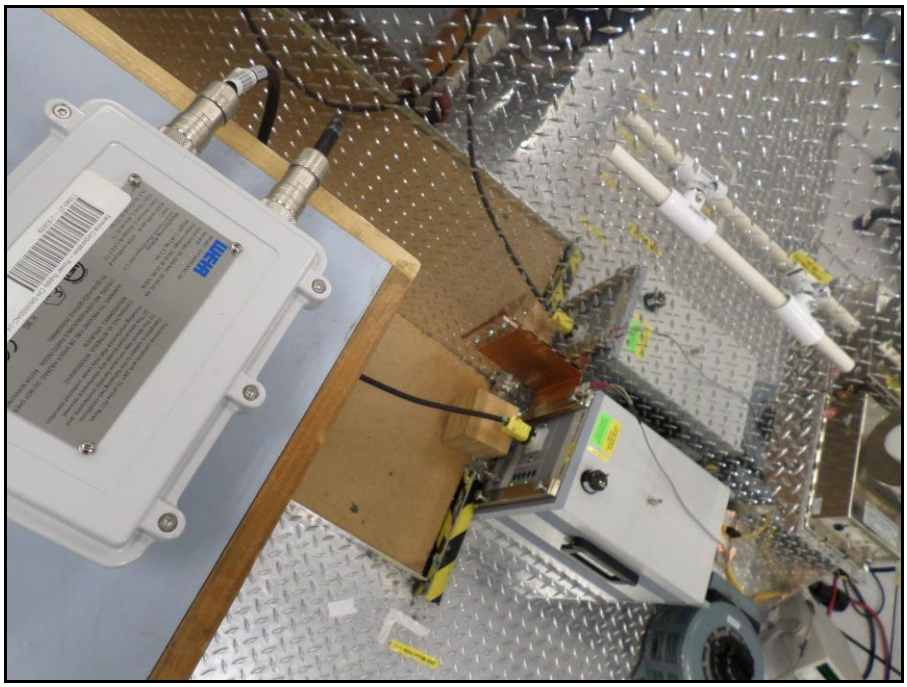


Plot 10. Conducted Emissions, 15.207(a), 2.4 GHz WiFi, 802.11n, 40 MHz, Neutral Line

15.207(a) Conducted Emissions Test Setup Photo



Photograph 1. Conducted Emissions, 15.207(a), CEV Station Setup



Photograph 2. Conducted Emissions, 15.207(a), LISN Connection

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(a)(2) 6 dB Bandwidth

Test Requirements: **§ 15.247(a)(2):** 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. The minimum 6dB bandwidth shall be at least 500 kHz.

Test Procedure: The transmitter was on and transmitting at the highest output power. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using a RBW approximately 1% of the total emission bandwidth, VBW > RBW. The 6 dB Bandwidth was measured and recorded. The measurements were performed on the low, mid and high channels.

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

The 6 dB Bandwidth was determined from the plots on the following pages.

Test Engineer(s): Giuliano Messina

Test Date(s): April 14, 2017

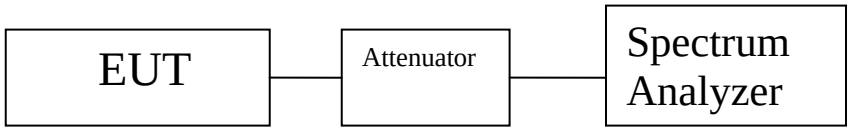


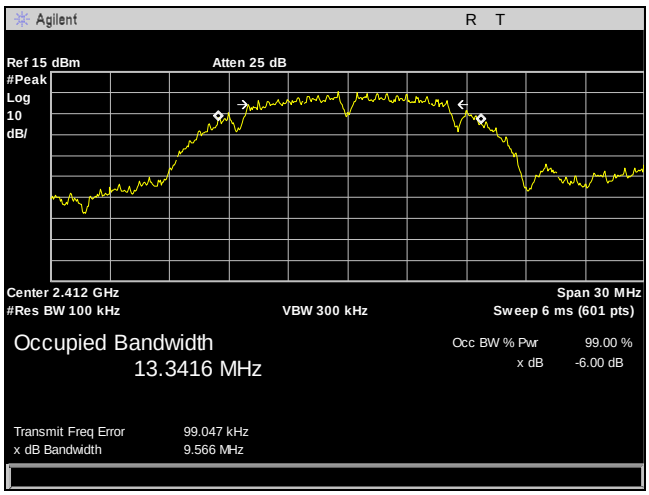
Figure 2. Block Diagram, Occupied Bandwidth Test Setup

Occupied Bandwidth Test Results

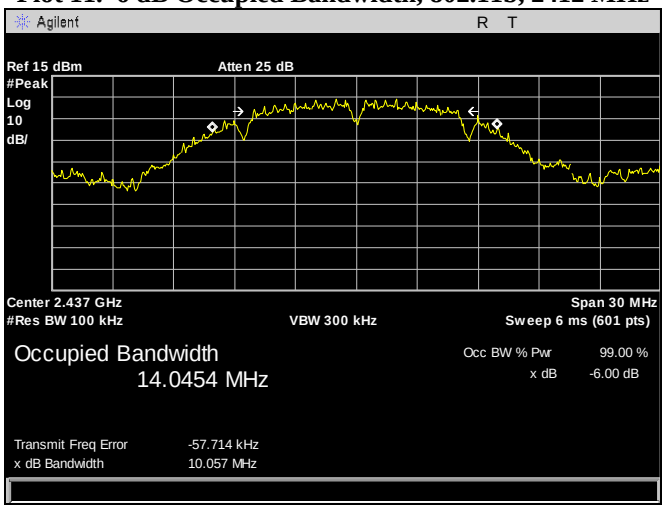
Mode	Freq (MHz)	99% BW (MHz)	-6dB BW (MHz)
b	2412	13.3416	9.566
b	2437	14.0454	10.057
b	2462	14.5521	10.089
g	2412	16.471	16.117
g	2437	16.6501	16.324
g	2462	16.872	16.129
n HT20	2412	17.5647	17.392
n HT20	2437	17.5821	17.366
n HT20	2462	17.5575	17.384
n HT40	2422	35.9788	35.193
n HT40	2437	36.049	35.462
n HT40	2452	35.9834	35.628

Table 9. 6 dB Occupied Bandwidth, WiFi, Test Results

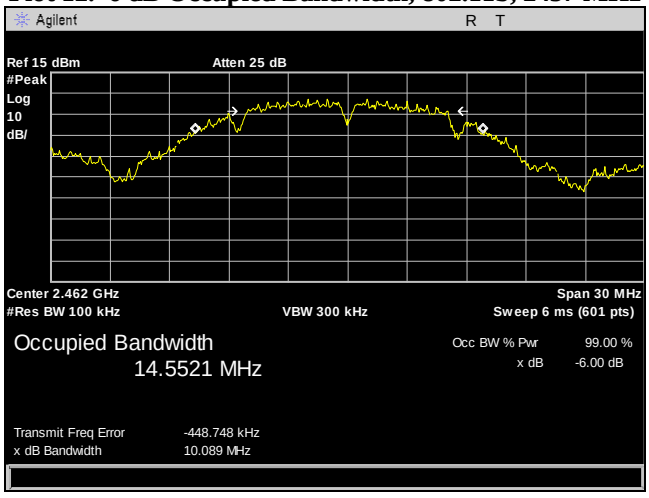
6 dB Occupied Bandwidth Test Results



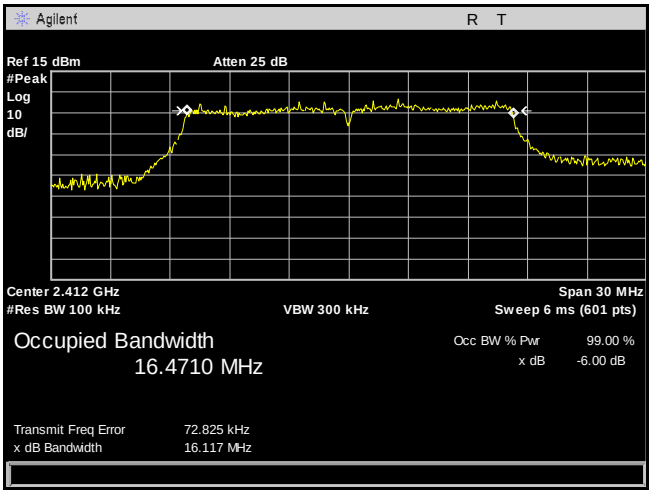
Plot 11. 6 dB Occupied Bandwidth, 802.11b, 2412 MHz



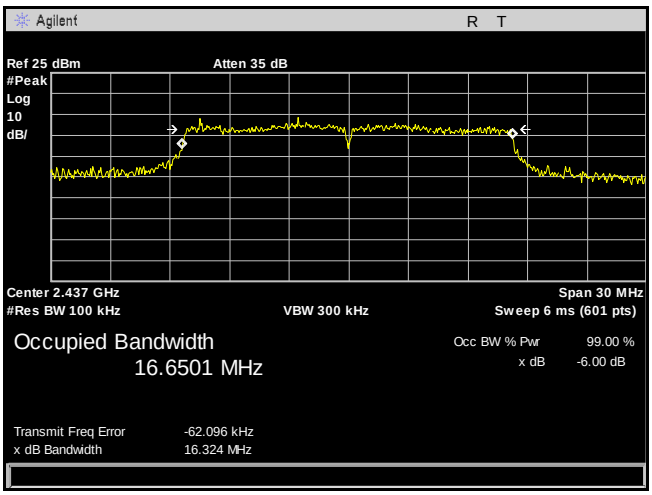
Plot 12. 6 dB Occupied Bandwidth, 802.11b, 2437 MHz



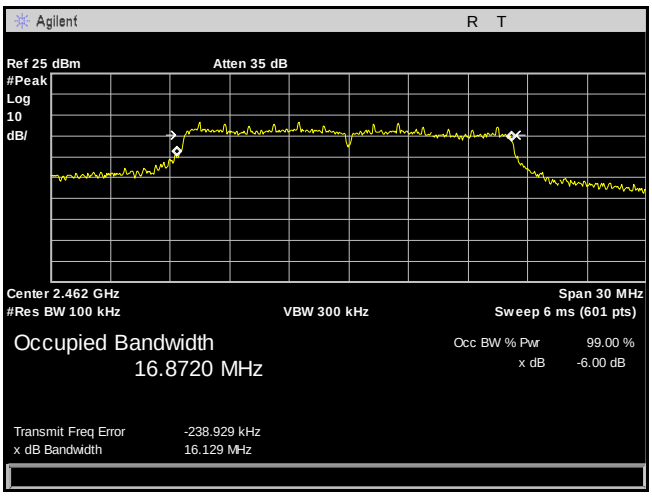
Plot 13. 6 dB Occupied Bandwidth, 802.11b, 2462 MHz



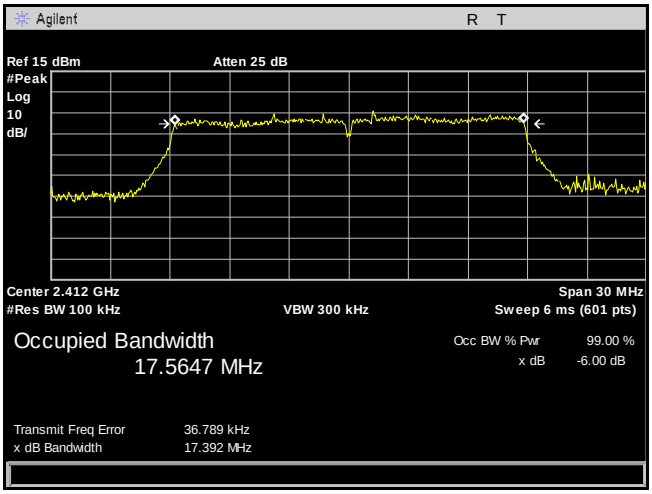
Plot 14. 6 dB Occupied Bandwidth, 802.11g, 2412 MHz



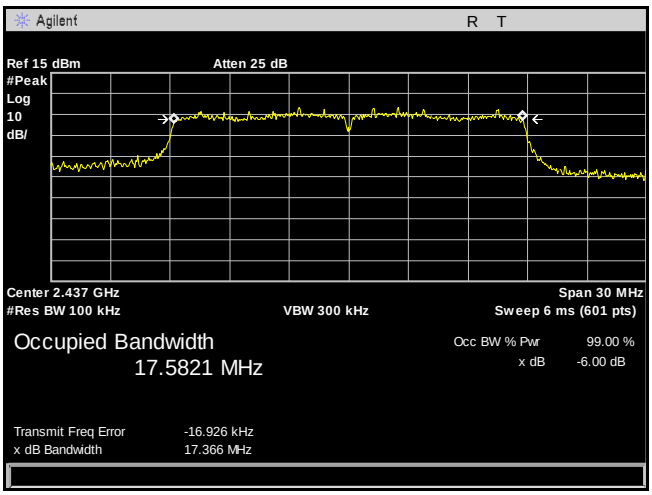
Plot 15. 6 dB Occupied Bandwidth, 802.11g, 2437 MHz



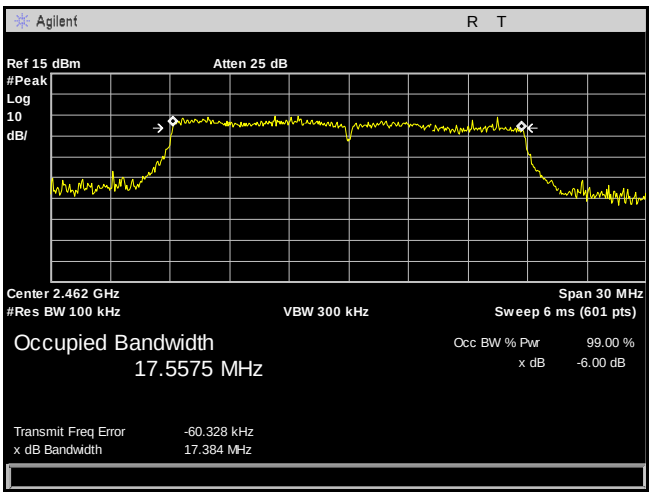
Plot 16. 6 dB Occupied Bandwidth, 802.11g, 2462 MHz



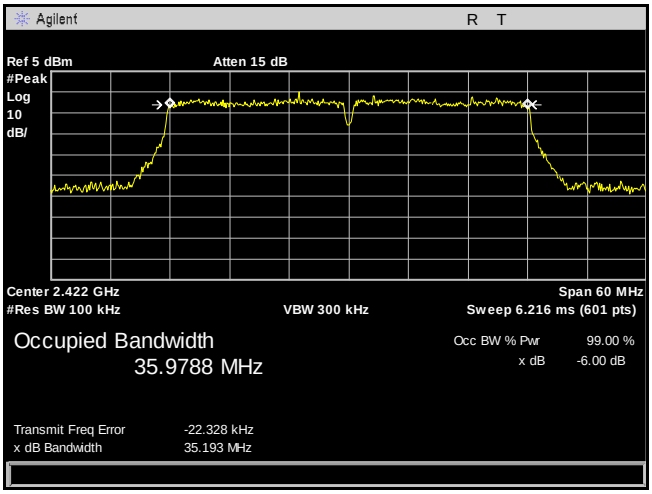
Plot 17. 6 dB Occupied Bandwidth, 802.11n HT20, 2412 MHz



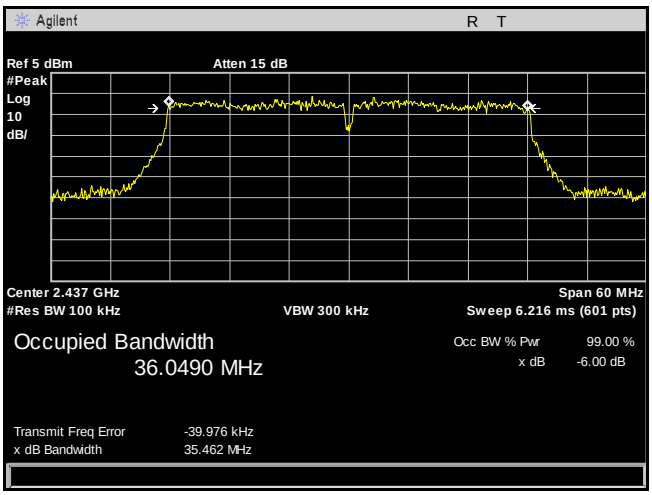
Plot 18. 6 dB Occupied Bandwidth, 802.11n HT20, 2437 MHz



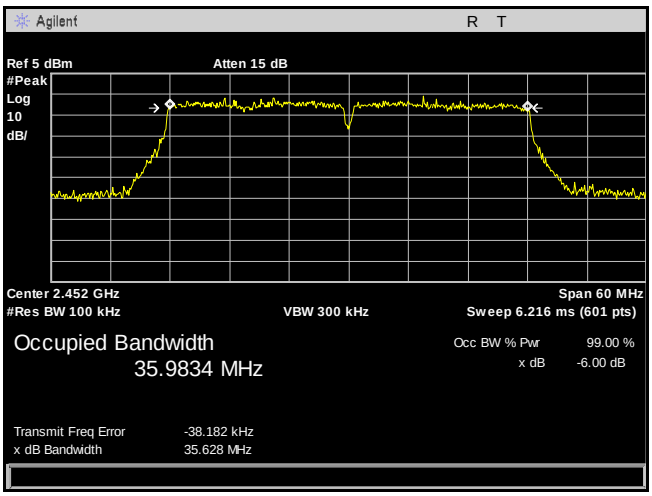
Plot 19. 6 dB Occupied Bandwidth, 802.11n HT20, 2462 MHz



Plot 20. 6 dB Occupied Bandwidth, 802.11n HT40, 2422 MHz



Plot 21. 6 dB Occupied Bandwidth, 802.11n HT40, 2437 MHz



Plot 22. 6 dB Occupied Bandwidth, 802.11n HT40, 2452 MHz

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(b) Peak Power Output

Test Requirements: **§15.247(b):** The maximum peak output power of the intentional radiator shall not exceed the following:

Digital Transmission Systems (MHz)	Output Limit (Watts)
902-928	1.000
2400–2483.5	1.000
5725– 5850	1.000

Table 10. Output Power Requirements from §15.247(b)

§15.247(c): If transmitting antennas of directional gain greater than 6 dBi are used the peak output power from the intentional radiator shall be reduced below the stated values in the Table 10, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Systems operating in the 2400 – 2483.5 MHz band and using a point to point application may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum peak output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

Systems operating in the 5725 – 5850 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter peak output power.

Fixed, point-to-point operation excludes the use of point-to-multipoint systems, Omni-directional applications, and multiple co-located intentional radiators transmitting the same information. The operator of the spread spectrum intentional radiator or, if the equipment is professionally installed, the installer is responsible for ensuring that the system is used exclusively for fixed, point-to-point operations. The instruction manual furnished with the intentional radiator shall contain language in the installation instructions informing the operator and the installer of this responsibility.

Test Procedure: The transmitter was connected to a calibrated spectrum analyzer. The EUT was measured at the low, mid, and high channels of each band at the maximum power level.

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

Test Engineer(s): Giuliano Messina

Test Date(s): April 20, 2017

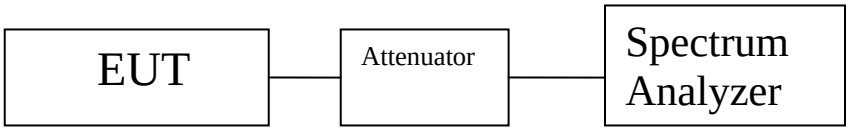


Figure 3. Peak Power Output Test Setup

Peak Power Output Test Results

Note: The limit was lowered to 24 dBm per KDB 558074 section 7.0. Antenna gain 12 dBi.

Peak Conducted Output Power				
Carrier Channel	**Frequency (MHz)**	**Measured PCOP (dBm)**	**Limit (dBm)**	**Margin (dB)**
Low	2412	17.12	24	-6.88
Mid	2437	20.37	24	-3.63
High	2462	16.91	24	-7.09

Table 11. Peak Power Output, WiFi, 802.11b, Test Results

Peak Conducted Output Power				
Carrier Channel	**Frequency (MHz)**	**Measured PCOP (dBm)**	**Limit (dBm)**	**Margin (dB)**
Low	2412	10.3	24	-13.7
Mid	2437	20.27	24	-3.73
High	2462	12.69	24	-11.31

Table 12. Peak Power Output, WiFi, 802.11g, Test Results

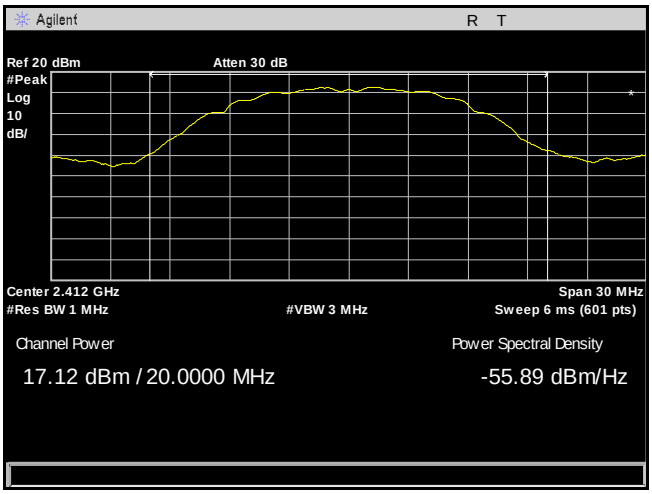
Peak Conducted Output Power				
Carrier Channel	**Frequency (MHz)**	**Measured PCOP (dBm)**	**Limit (dBm)**	**Margin (dB)**
Low	2412	9.85	24	-14.15
Mid	2437	19.84	24	-4.16
High	2462	12.23	24	-11.77

Table 13. Peak Power Output, WiFi, 802.11n HT20, Test Results

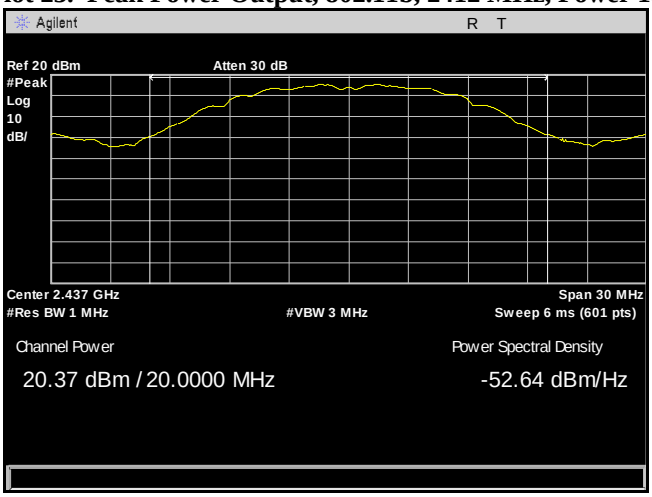
Peak Conducted Output Power				
Carrier Channel	**Frequency (MHz)**	**Measured PCOP (dBm)**	**Limit (dBm)**	**Margin (dB)**
Low	2422	5.8	24	-18.2
Mid	2437	15.32	24	-8.68
High	2452	6.14	24	-17.86

Table 14. Peak Power Output, WiFi, 802.11n HT40, Test Results

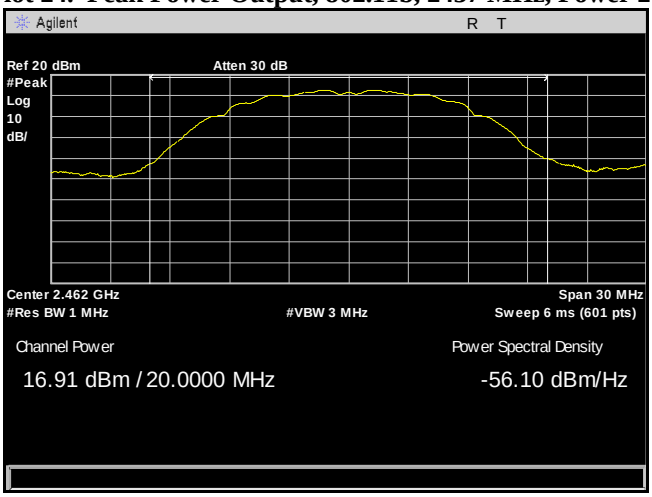
Peak Power Output Test Results



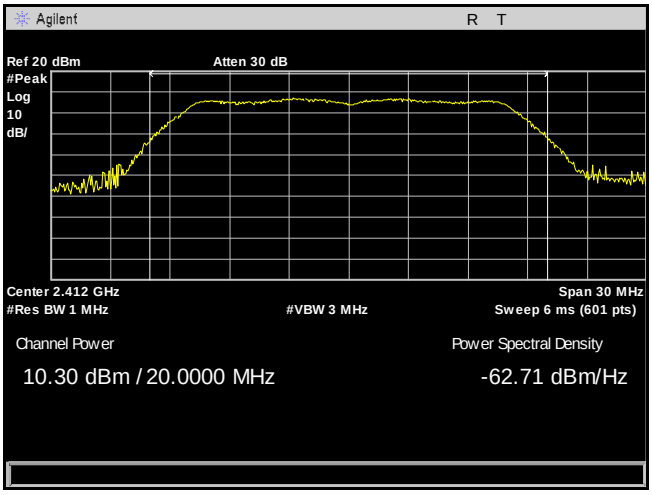
Plot 23. Peak Power Output, 802.11b, 2412 MHz, Power 18



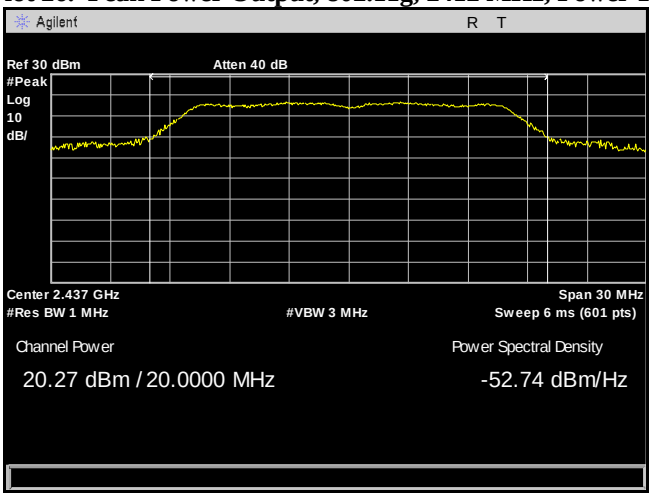
Plot 24. Peak Power Output, 802.11b, 2437 MHz, Power 20



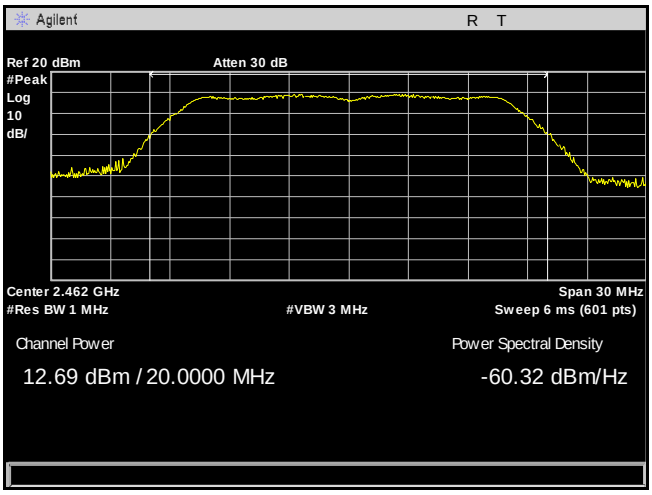
Plot 25. Peak Power Output, 802.11b, 2462 MHz, Power 17



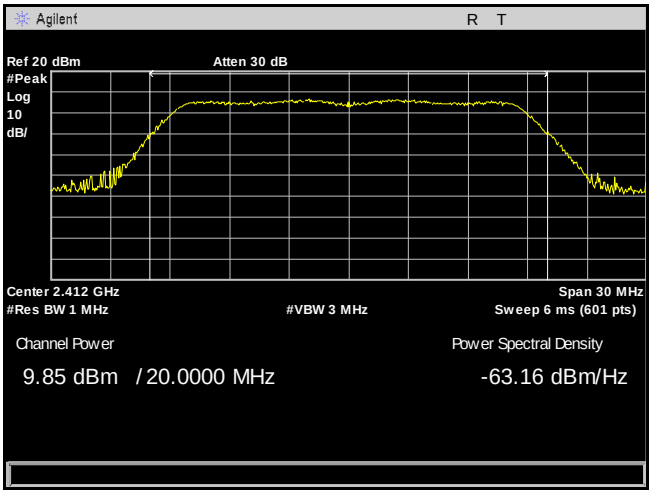
Plot 26. Peak Power Output, 802.11g, 2412 MHz, Power 10



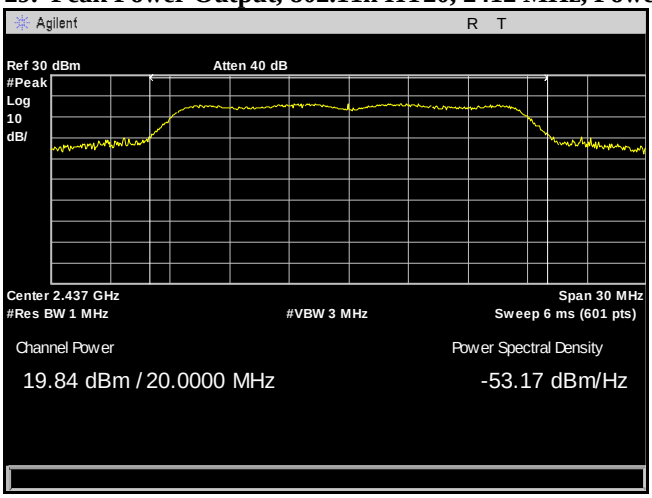
Plot 27. Peak Power Output, 802.11g, 2437 MHz, Power 20



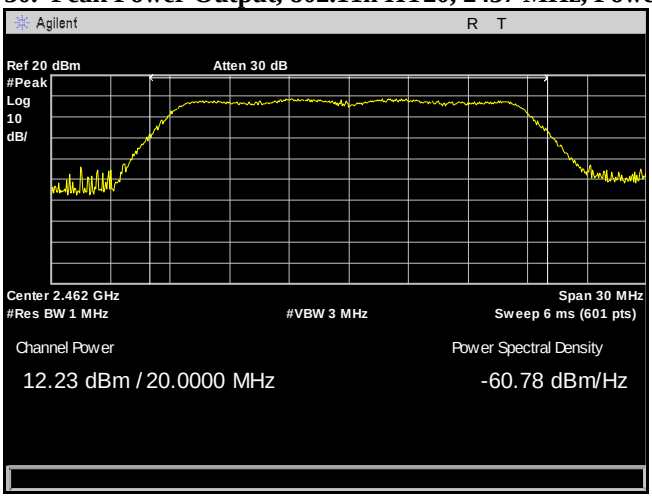
Plot 28. Peak Power Output, 802.11g, 2462 MHz, Power 12



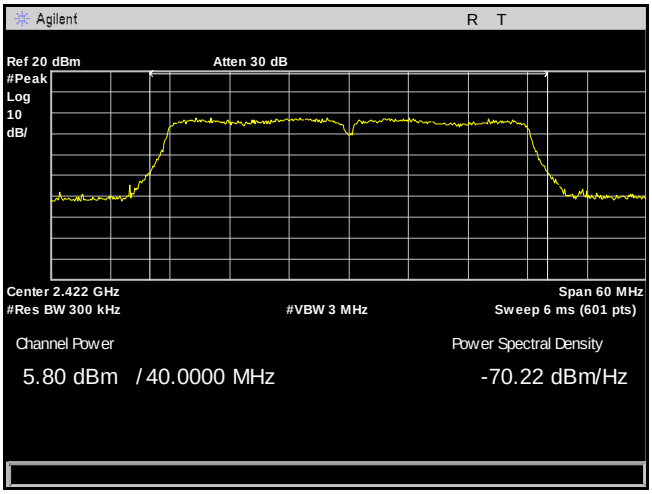
Plot 29. Peak Power Output, 802.11n HT20, 2412 MHz, Power 10



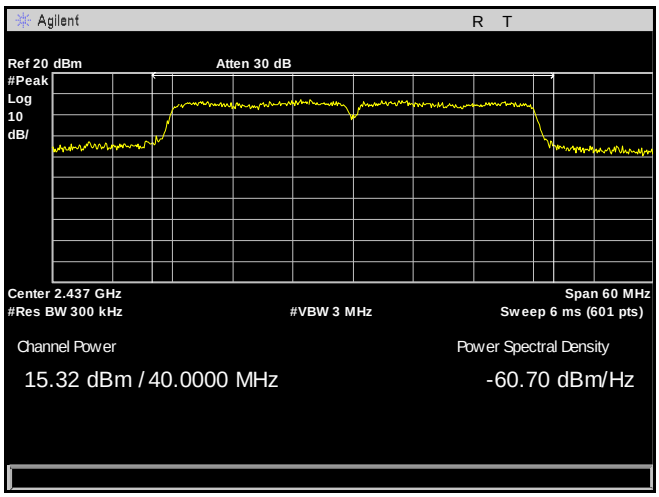
Plot 30. Peak Power Output, 802.11n HT20, 2437 MHz, Power 20



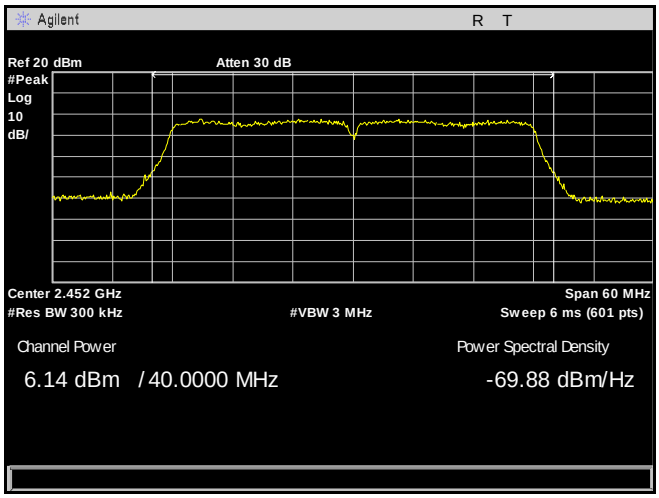
Plot 31. Peak Power Output, 802.11n HT20, 2462 MHz, Power 12



Plot 32. Peak Power Output, 802.11n HT40, 2422 MHz, Power 10



Plot 33. Peak Power Output, 802.11n HT40, 2437 MHz, Power 20



Plot 34. Peak Power Output, 802.11n HT40, 2452 MHz, Power 10

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 15. 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 16.

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

Test Procedures: 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. Measurements were taken with the transmitter off to ensure that measurable spurious emissions were not caused by the transmitter.

For measurements above 1 GHz (spurious emissions only), a bandpass filter was used in between the horn antenna and the preamp in order to block the fundamental frequency.

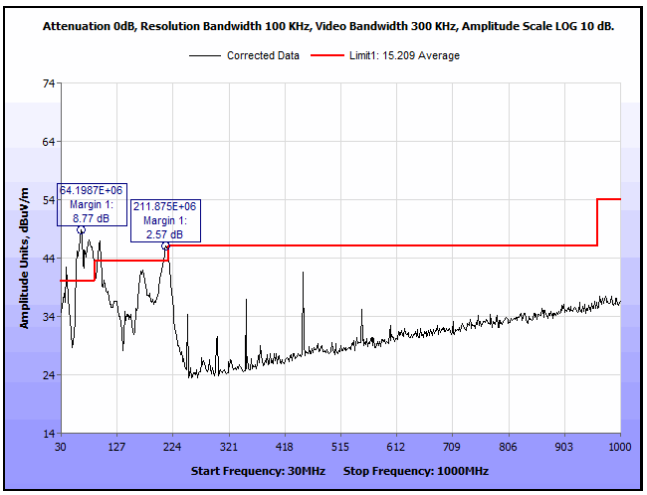
Test Results: The EUT was compliant with the Radiated Spurious Emission limits of **§ 15.247(d)**. Measured emissions were within applicable limits. Only noise floor was measured above 18 GHz. Emissions above the limit (Below 1 GHz) were present with the transmitter off and are likely to not be caused by the transmitter.

Emissions were evaluated with both the 12dBi Corner Reflector and the 6dBi Omni-directional antenna. Worst case plots are presented below.

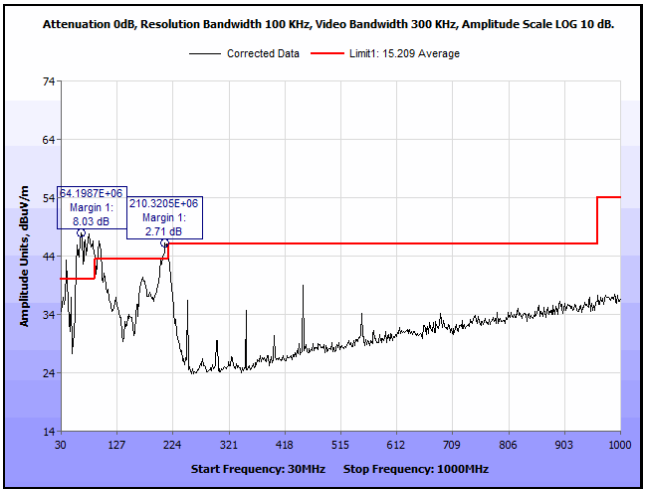
Test Engineer(s): Giuliano Messina

Test Date(s): May 25, 2017

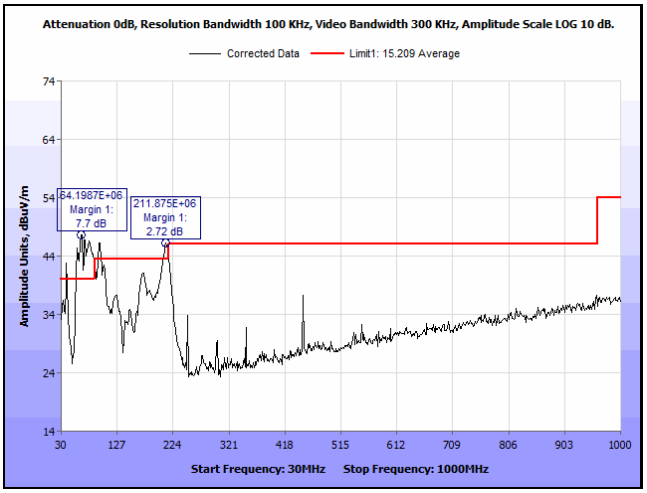
Radiated Spurious Emissions Test Results



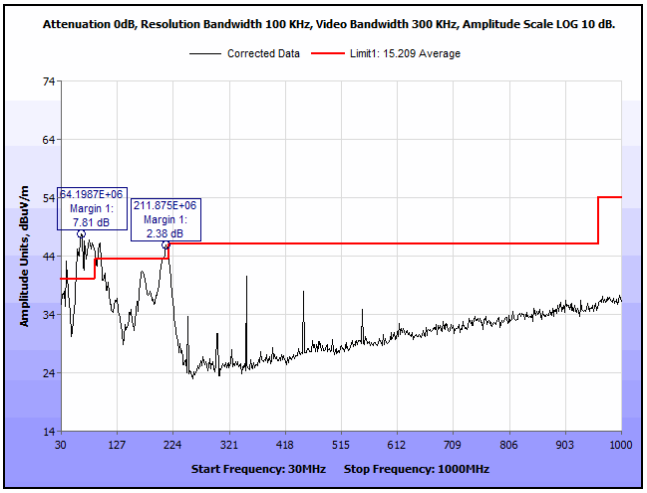
Plot 35. Radiated Spurious Emissions, - TX OFF - 30M-1GHz - QP



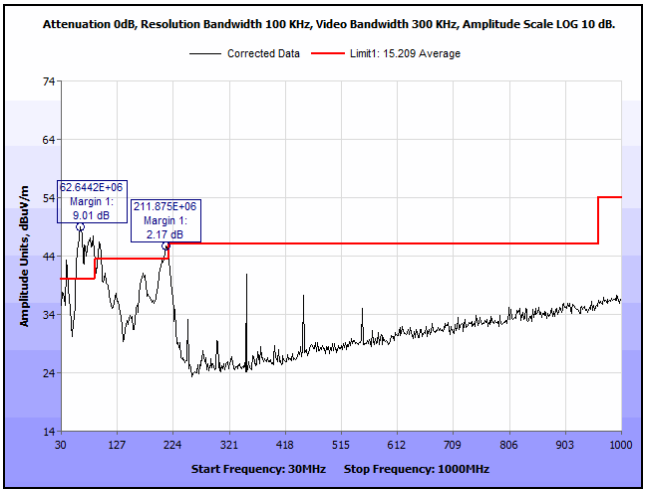
Plot 36. Radiated Spurious Emissions, 802.11b - 2412 - 30M-1GHz - QP



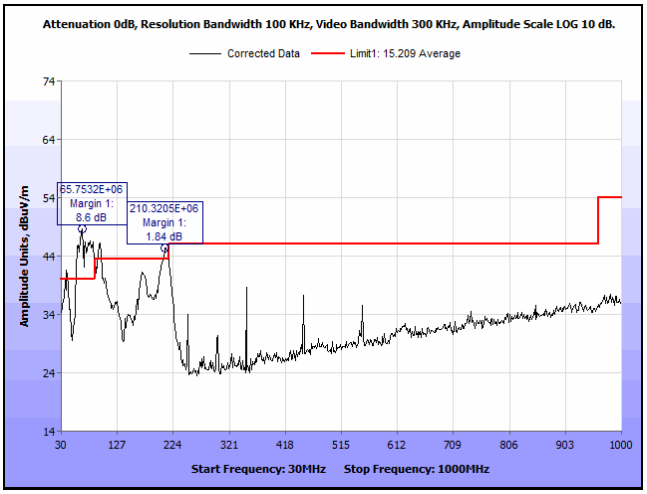
Plot 37. Radiated Spurious Emissions, 802.11b - 2437 - 30M-1GHz – QP



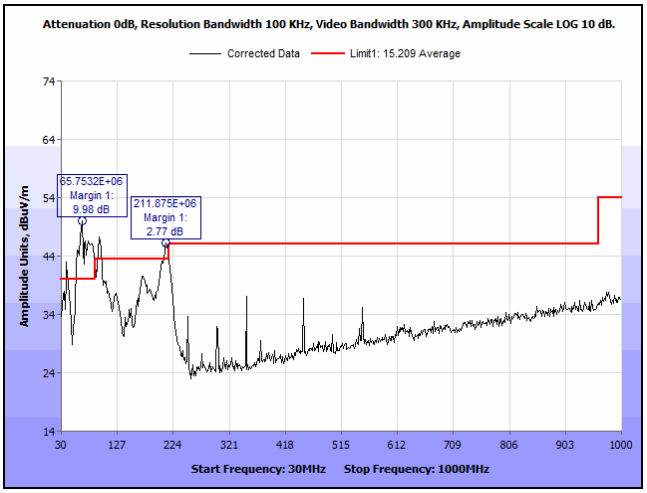
Plot 38. Radiated Spurious Emissions, 802.11b - 2462 - 30M-1GHz - QP



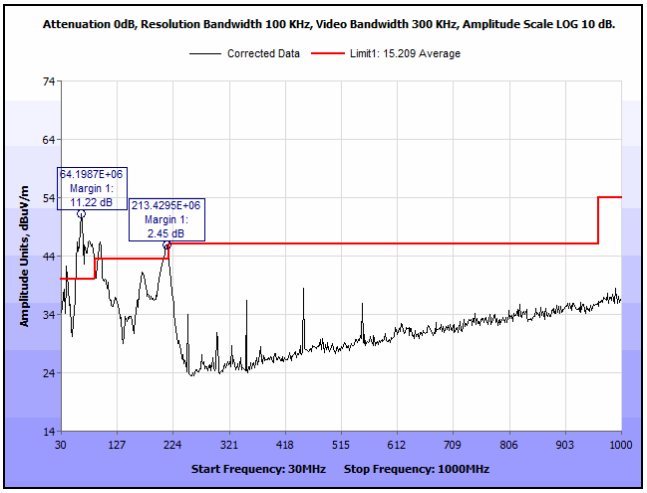
Plot 39. Radiated Spurious Emissions, 802.11g - 2412 - 30M-1GHz - QP



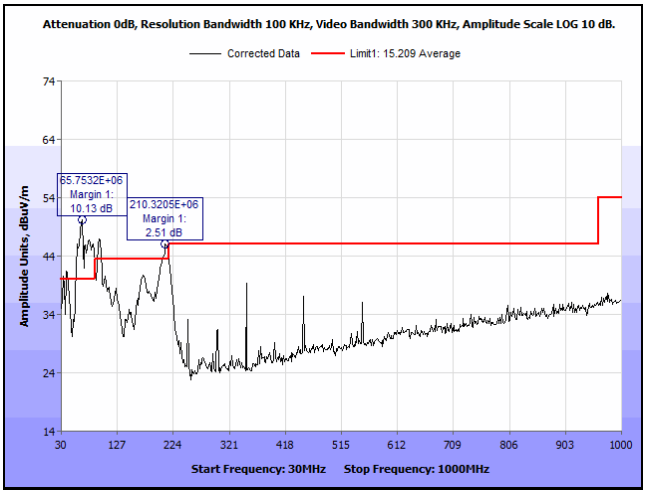
Plot 40. Radiated Spurious Emissions, 802.11g - 2437 - 30M-1GHz – QP



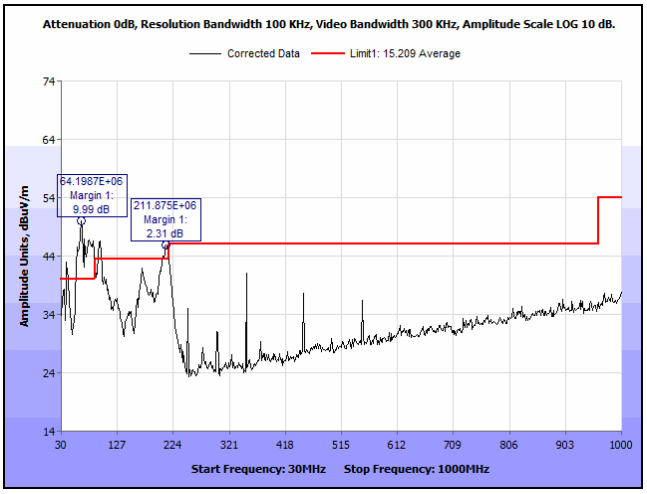
Plot 41. Radiated Spurious Emissions, 802.11g - 2462 - 30M-1GHz - QP



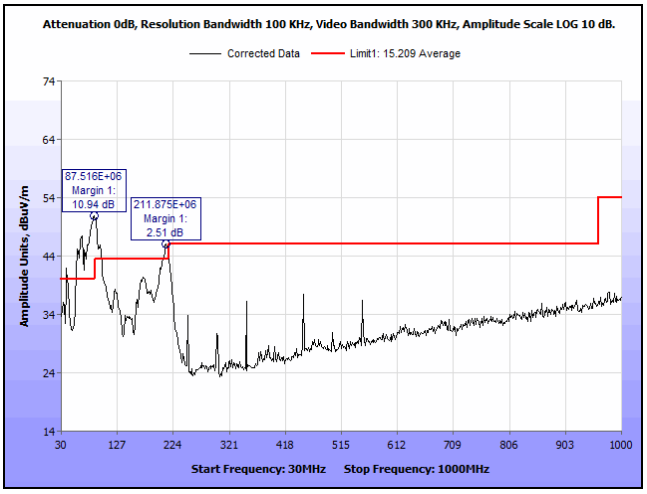
Plot 42. Radiated Spurious Emissions, 802.11n HT20 - 2412 - 30M-1GHz - QP



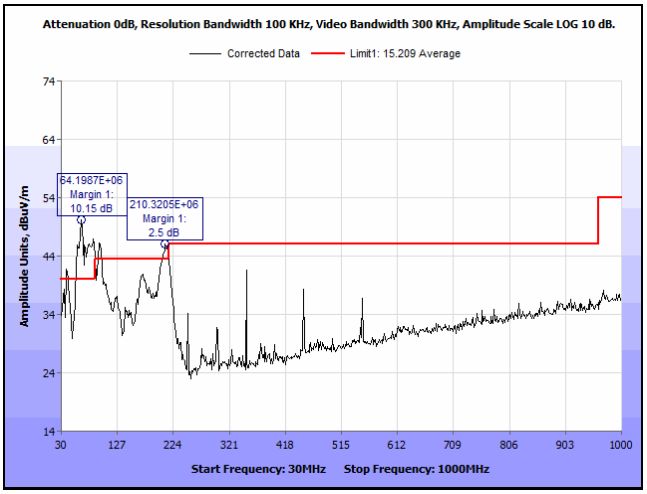
Plot 43. Radiated Spurious Emissions, 802.11n HT20 - 2437 - 30M-1GHz – QP



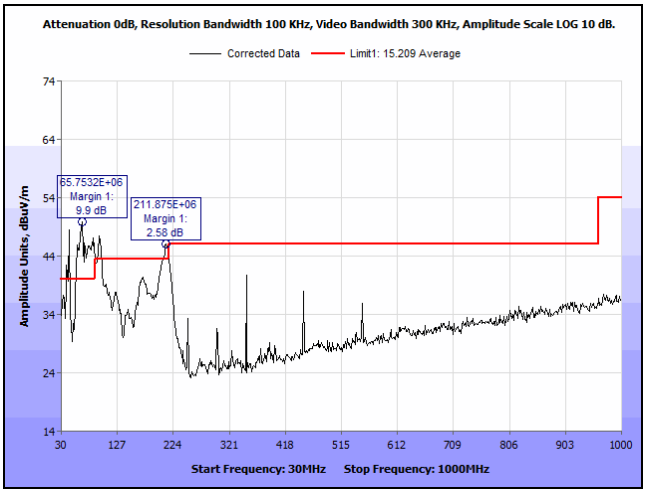
Plot 44. Radiated Spurious Emissions, 802.11n HT20 - 2462 - 30M-1GHz - QP



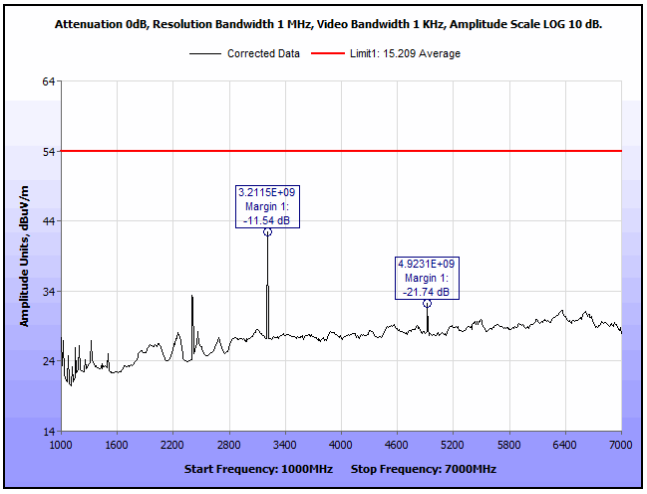
Plot 45. Radiated Spurious Emissions, 802.11n HT40 - 2422 - 30M-1GHz - QP



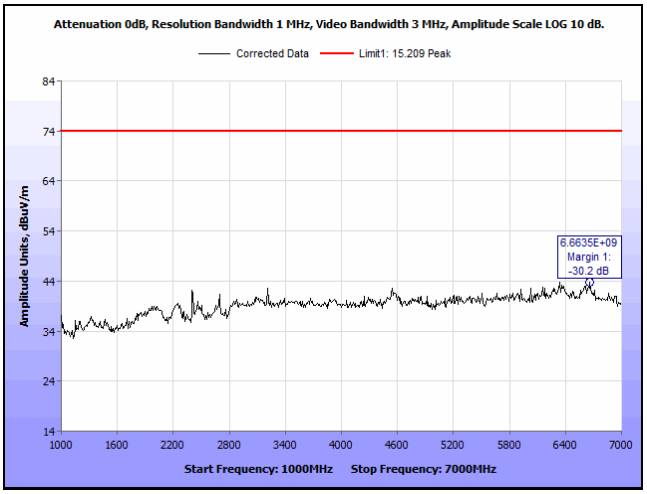
Plot 46. Radiated Spurious Emissions, 802.11n HT40 - 2437 - 30M-1GHz – QP



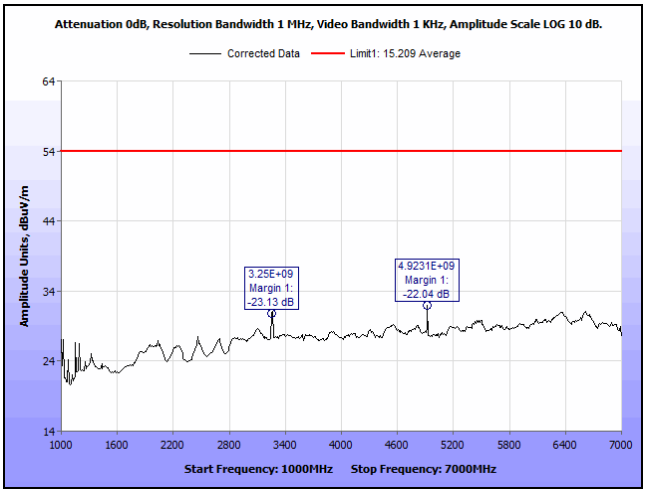
Plot 47. Radiated Spurious Emissions, 802.11n HT40 - 2452 - 30M-1GHz - QP



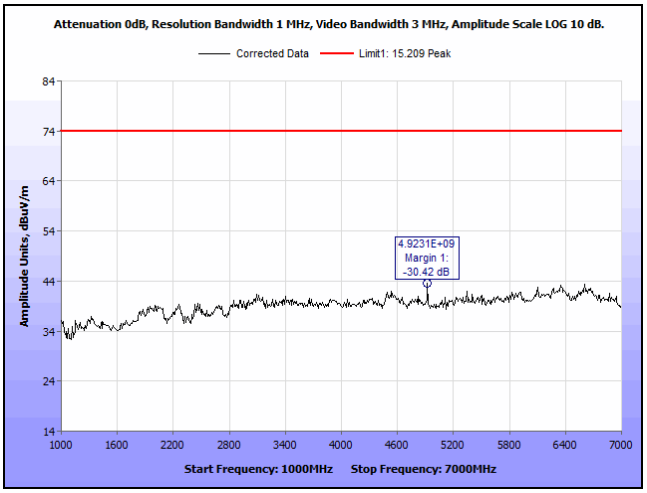
Plot 48. Radiated Spurious Emissions, 802.11b 2412MHz 1-7GHz Avg



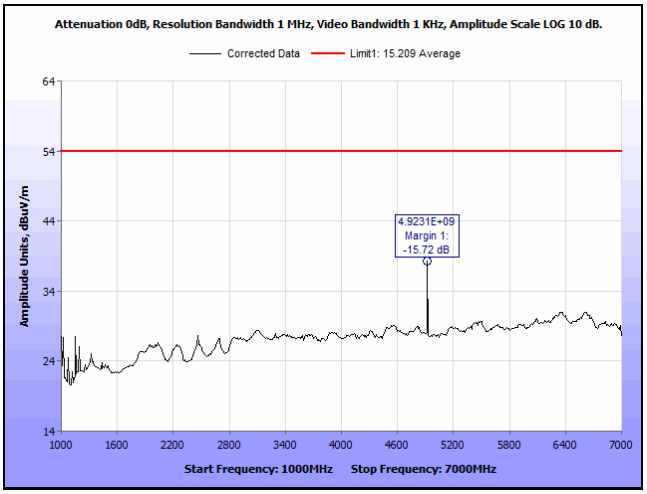
Plot 49. Radiated Spurious Emissions, 802.11b 2412MHz 1-7GHz Peak



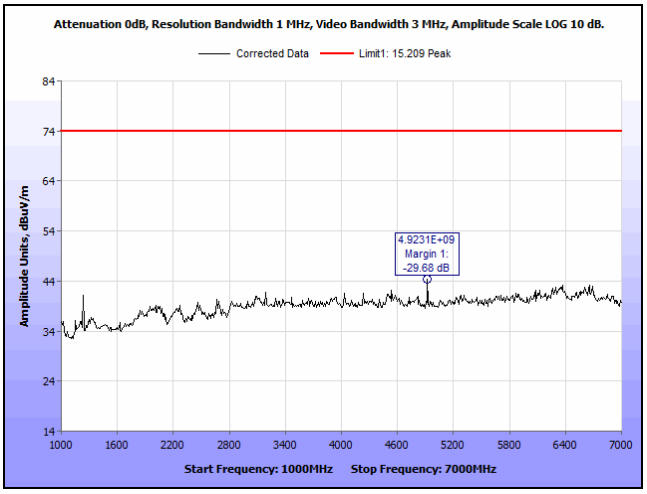
Plot 50. Radiated Spurious Emissions, 802.11b 2437MHz 1-7GHz Avg



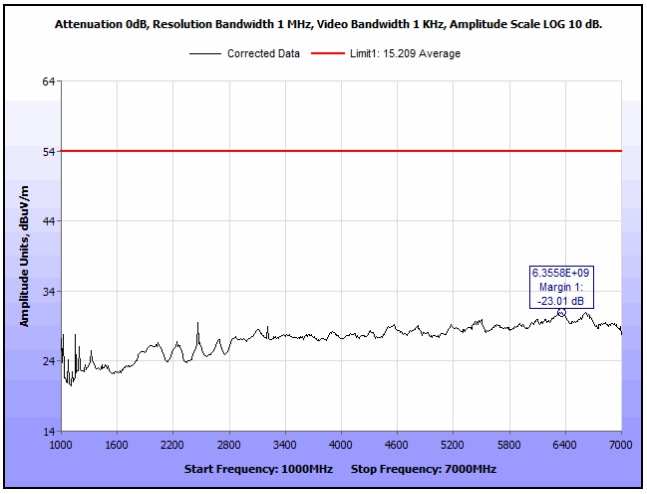
Plot 51. Radiated Spurious Emissions, 802.11b 2437MHz 1-7GHz Peak



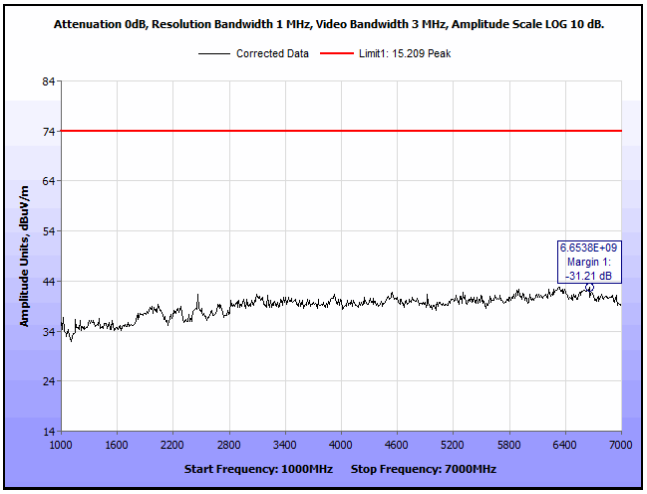
Plot 52. Radiated Spurious Emissions, 802.11b 2462MHz 1-7GHz Avg



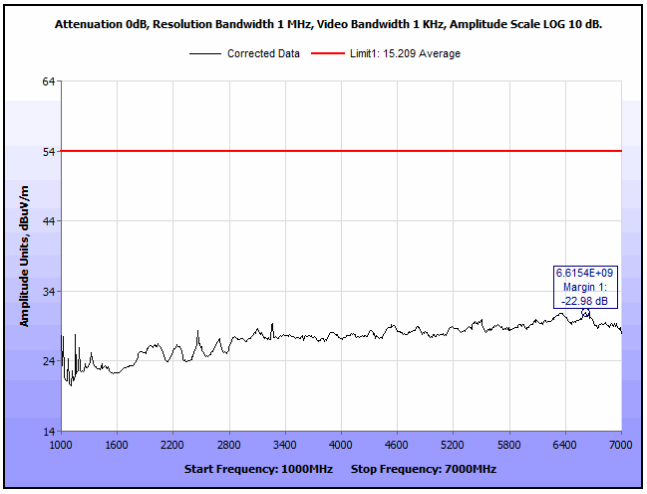
Plot 53. Radiated Spurious Emissions, 802.11b 2462MHz 1-7GHz Peak



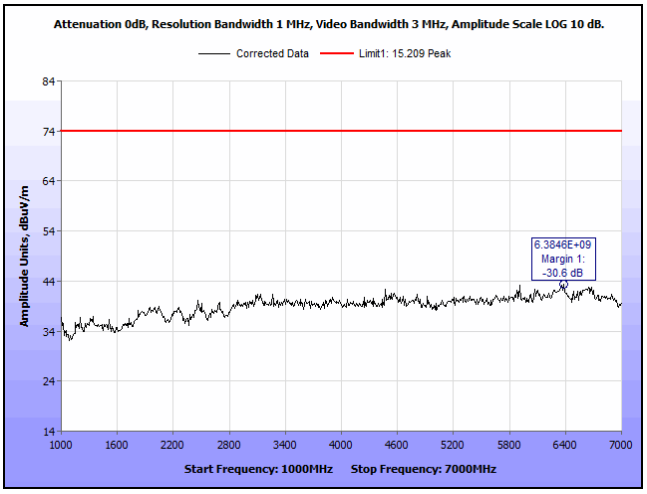
Plot 54. Radiated Spurious Emissions, 802.11g 2412MHz 1-7GHz Avg



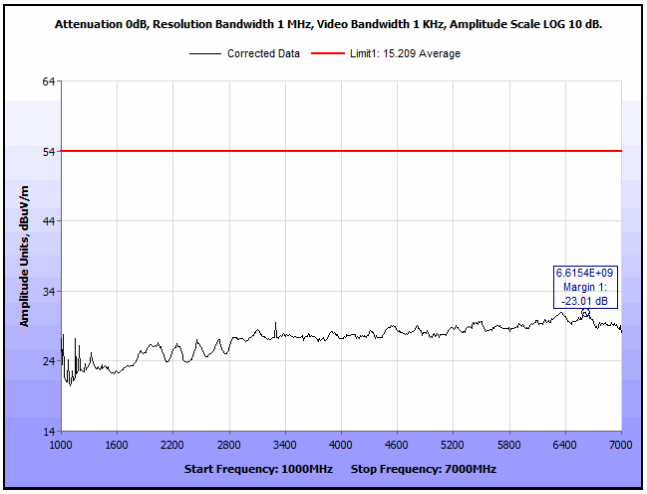
Plot 55. Radiated Spurious Emissions, 802.11g 2412MHz 1-7GHz Peak



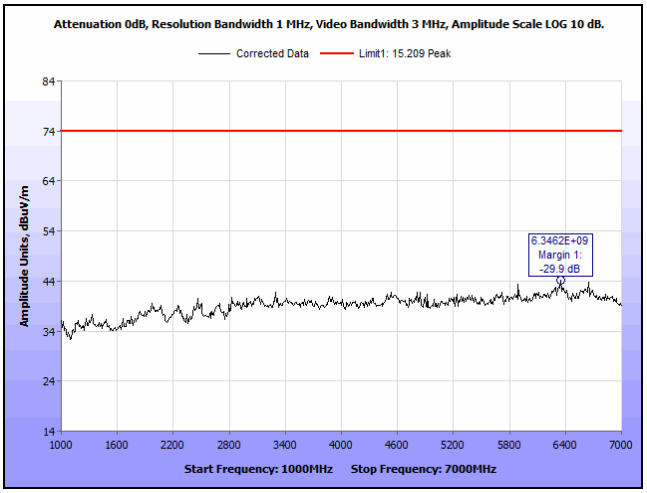
Plot 56. Radiated Spurious Emissions, 802.11g 2437MHz 1-7GHz Avg



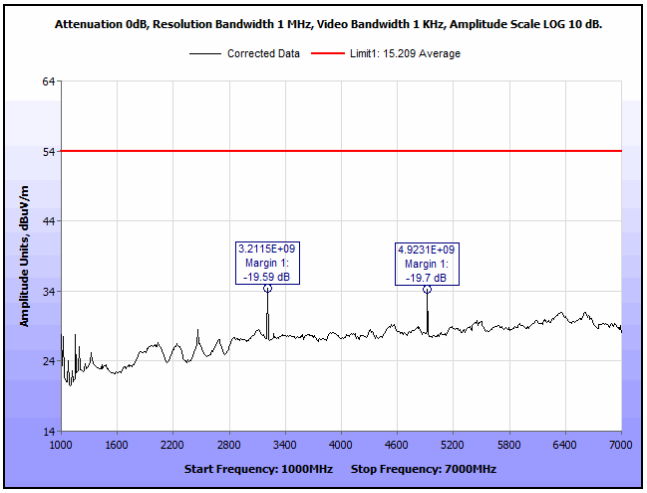
Plot 57. Radiated Spurious Emissions, 802.11g 2437MHz 1-7GHz Peak



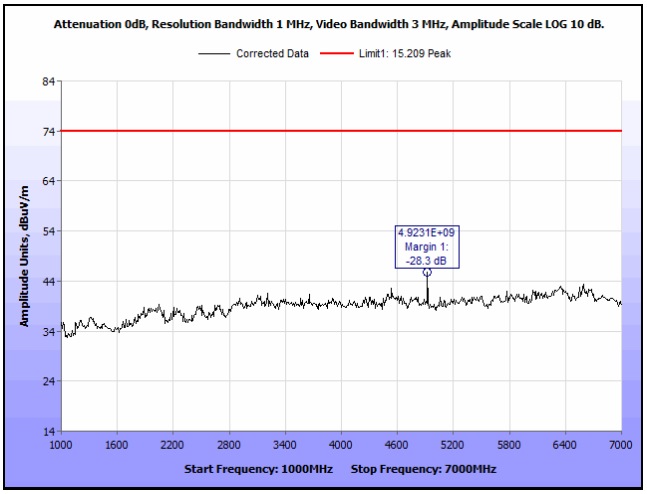
Plot 58. Radiated Spurious Emissions, 802.11g 2462MHz 1-7GHz Avg



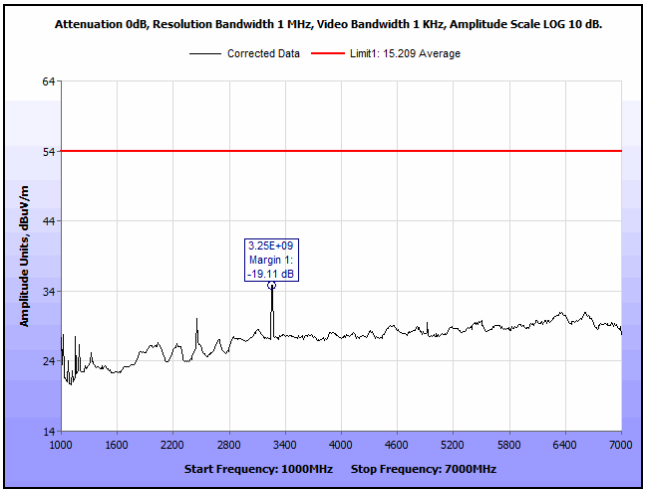
Plot 59. Radiated Spurious Emissions, 802.11g 2462MHz 1-7GHz Peak



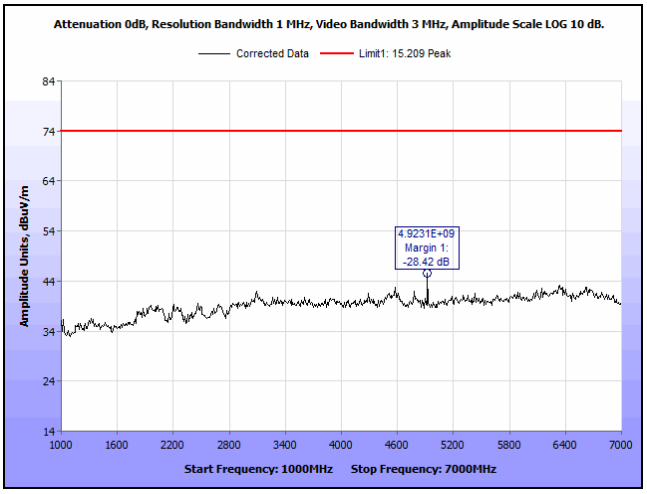
Plot 60. Radiated Spurious Emissions, 802.11n HT20 2412MHz 1-7GHz Avg



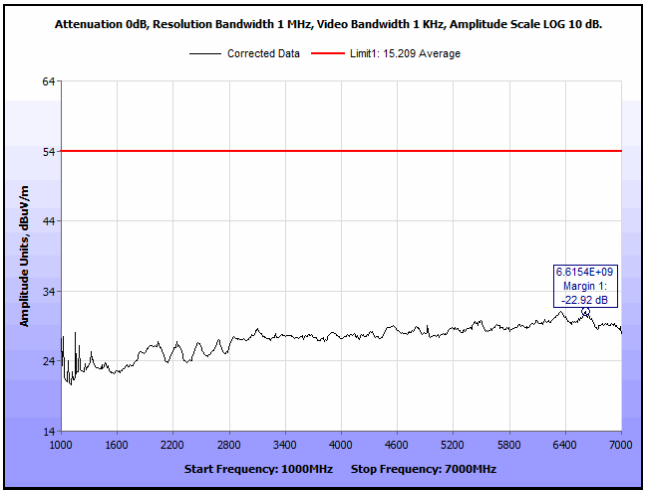
Plot 61. Radiated Spurious Emissions, 802.11n HT20 2412MHz 1-7GHz Peak



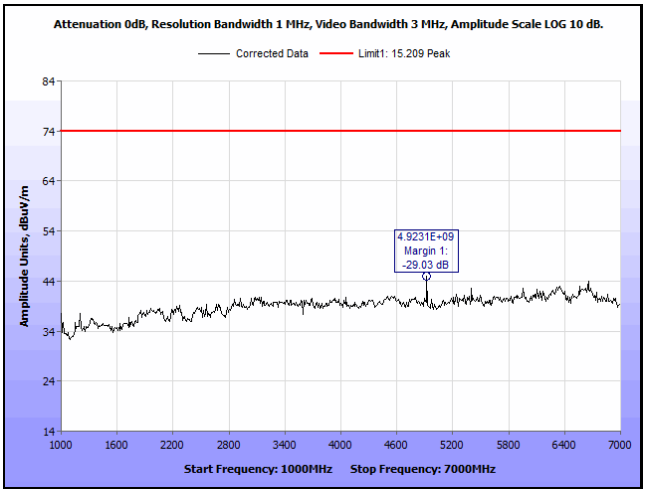
Plot 62. Radiated Spurious Emissions, 802.11n HT20 2437MHz 1-7GHz Avg



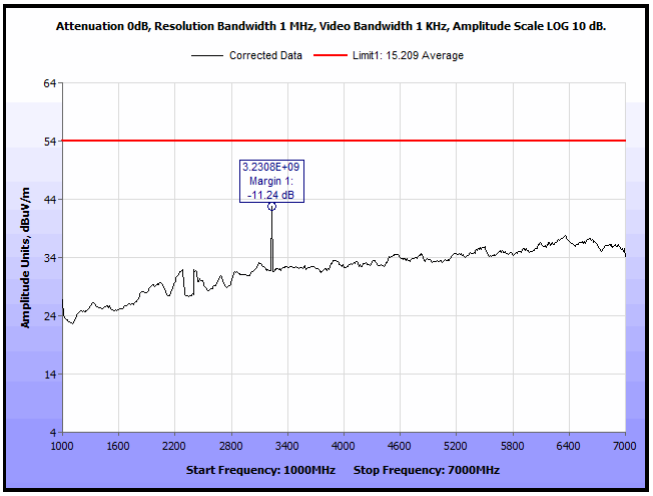
Plot 63. Radiated Spurious Emissions, 802.11n HT20 2437MHz 1-7GHz Peak



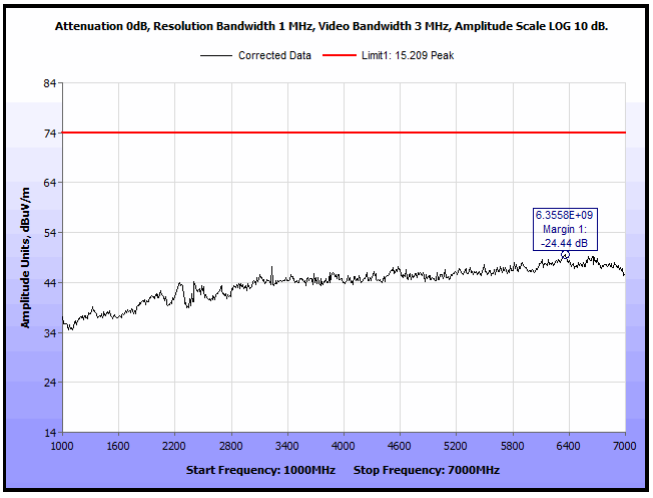
Plot 64. Radiated Spurious Emissions, 802.11n HT20 2462MHz 1-7GHz Avg



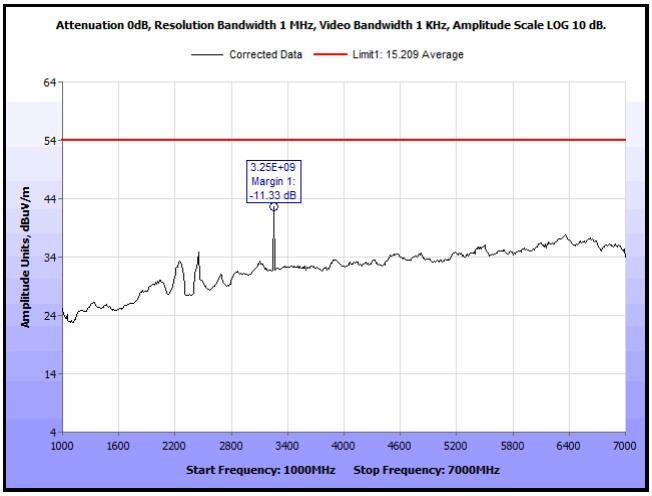
Plot 65. **Radiated Spurious Emissions, 802.11n HT20 2462MHz 1-7GHz Peak**



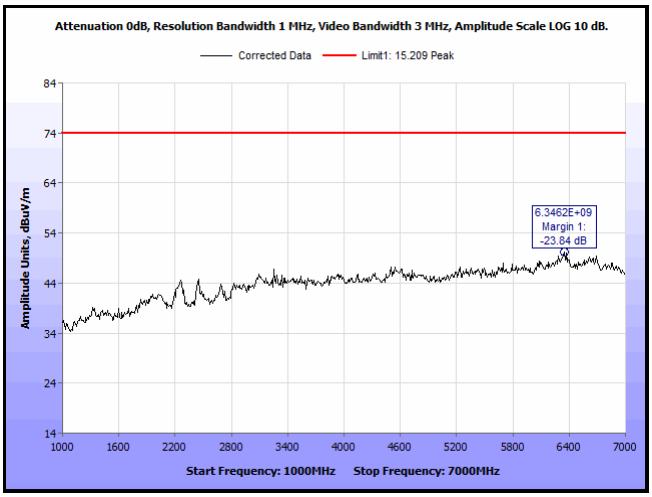
Plot 66. Radiated Spurious Emissions, 802.11n HT40 2422 1-7GHz Avg



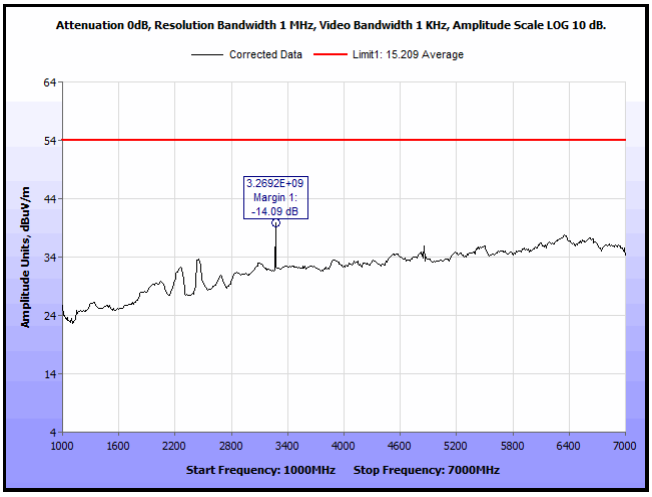
Plot 67. Radiated Spurious Emissions, 802.11n HT40 2422 1-7GHz Peak



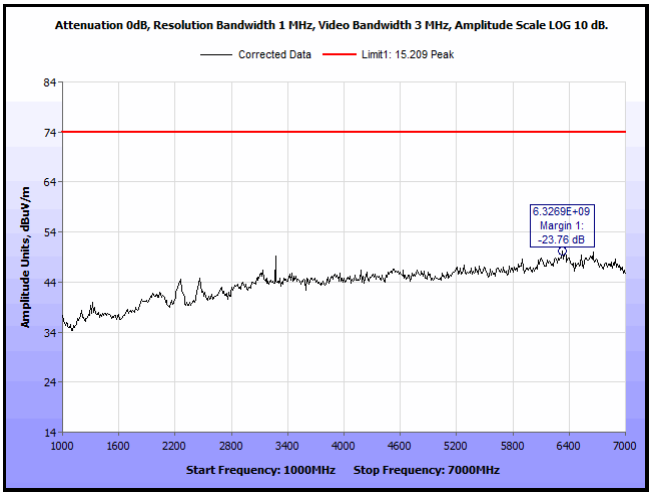
Plot 68. Radiated Spurious Emissions, 802.11n HT40 2437 1-7GHz Avg



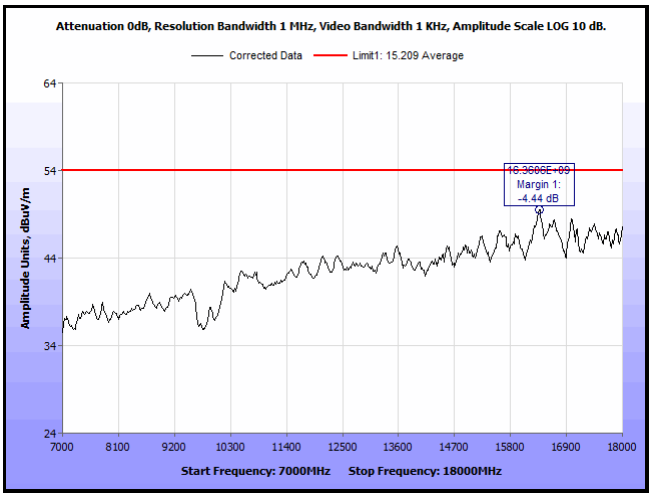
Plot 69. Radiated Spurious Emissions, 802.11n HT40 2437 1-7GHz Peak



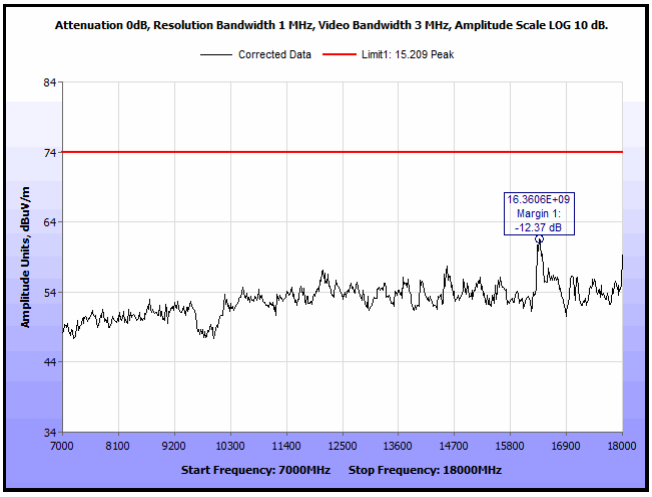
Plot 70. Radiated Spurious Emissions, 802.11n HT40 2452 1-7GHz Avg



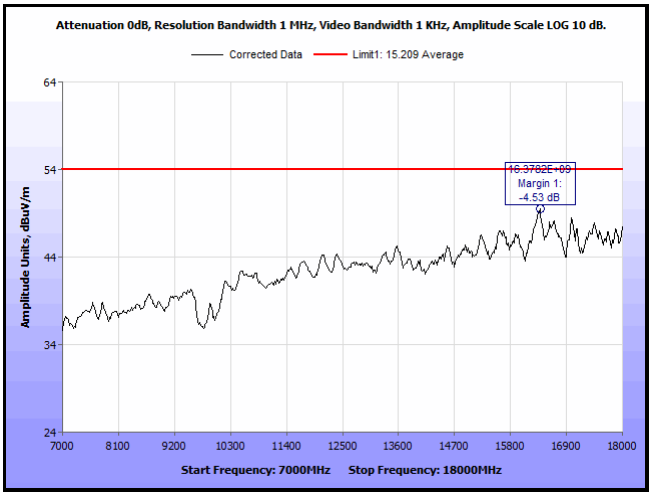
Plot 71. Radiated Spurious Emissions, 802.11n HT40 2452 1-7GHz Peak



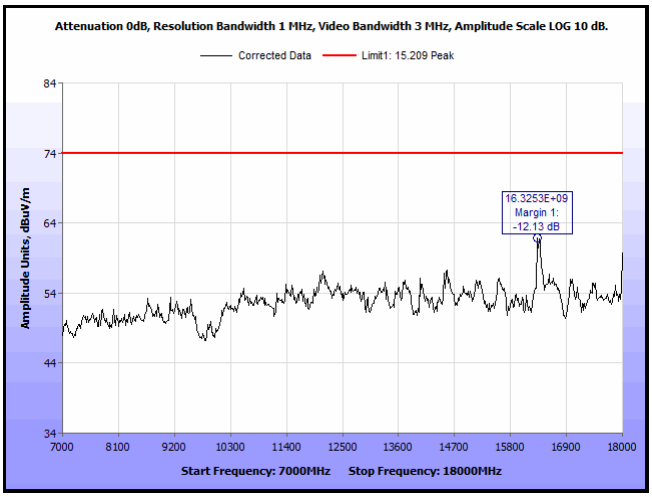
Plot 72. Radiated Spurious Emissions, 802.11b 2412 7-18GHz Avg



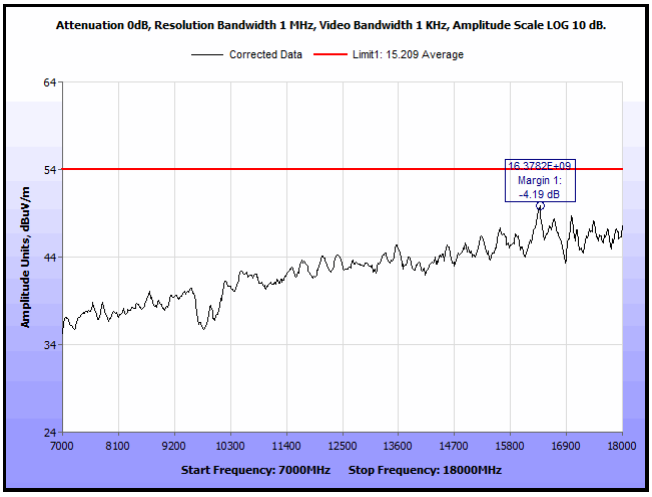
Plot 73. Radiated Spurious Emissions, 802.11b 2412 7-18GHz Peak



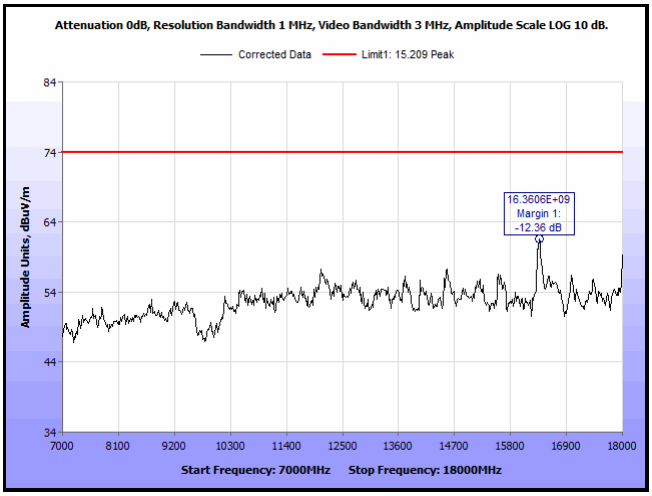
Plot 74. Radiated Spurious Emissions, 802.11b 2437 7-18GHz Avg



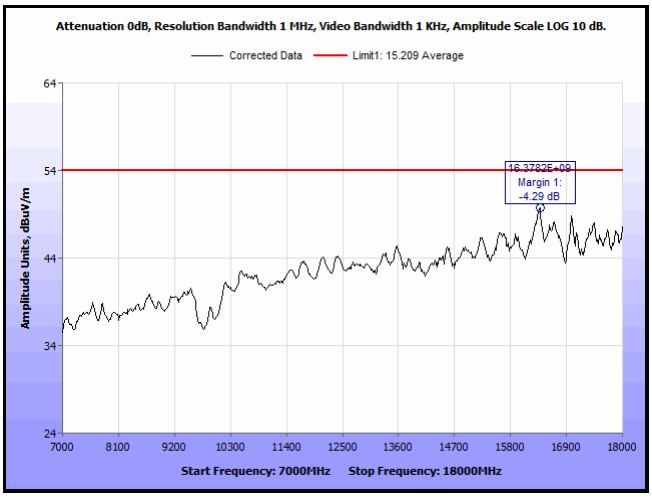
Plot 75. Radiated Spurious Emissions, 802.11b 2437 7-18GHz Peak



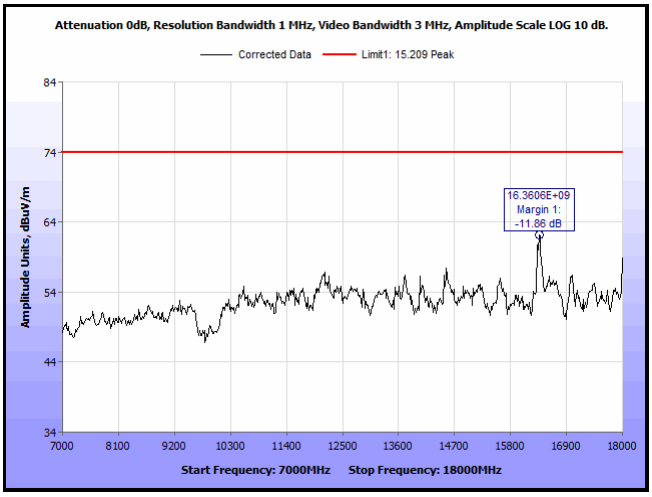
Plot 76. Radiated Spurious Emissions, 802.11b 2462 7-18GHz Avg



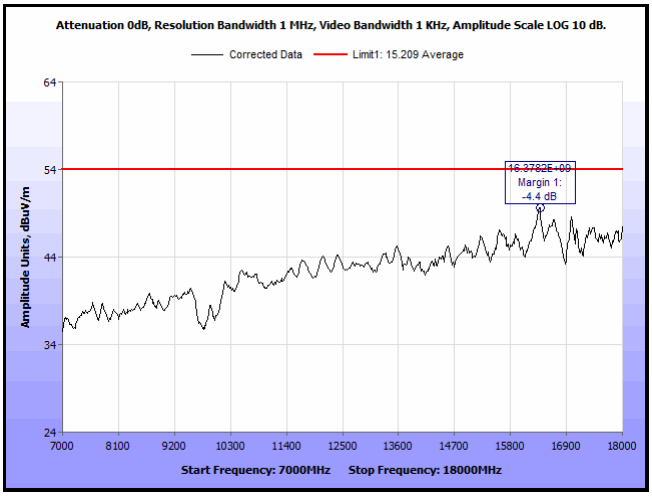
Plot 77. Radiated Spurious Emissions, 802.11b 2462 7-18GHz Peak



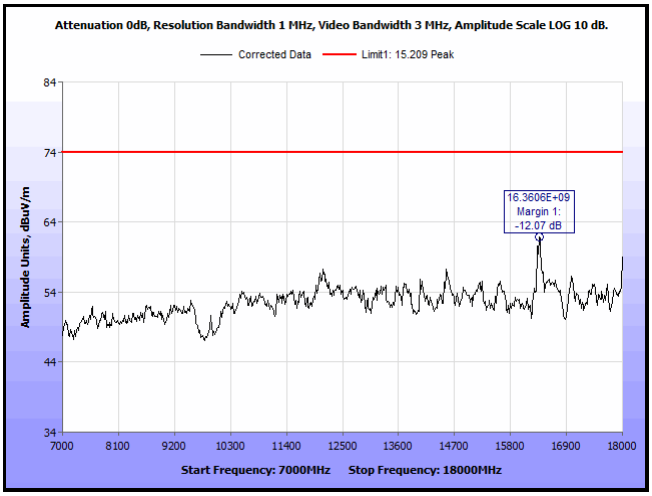
Plot 78. Radiated Spurious Emissions, 802.11g 2412 7-18GHz Avg



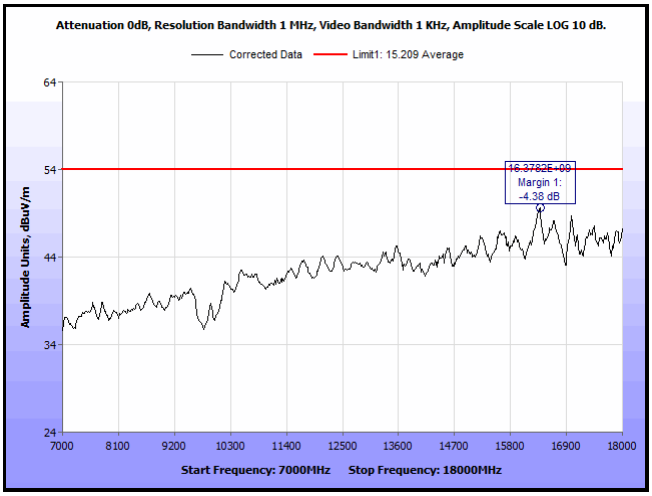
Plot 79. Radiated Spurious Emissions, 802.11g 2412 7-18GHz Peak



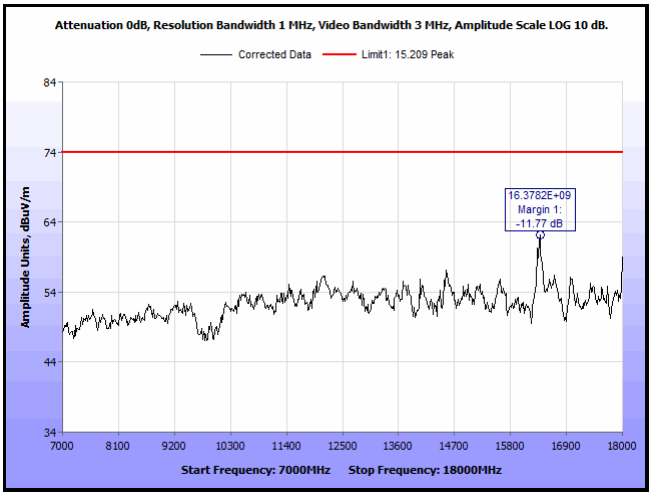
Plot 80. Radiated Spurious Emissions, 802.11g 2437 7-18GHz Avg



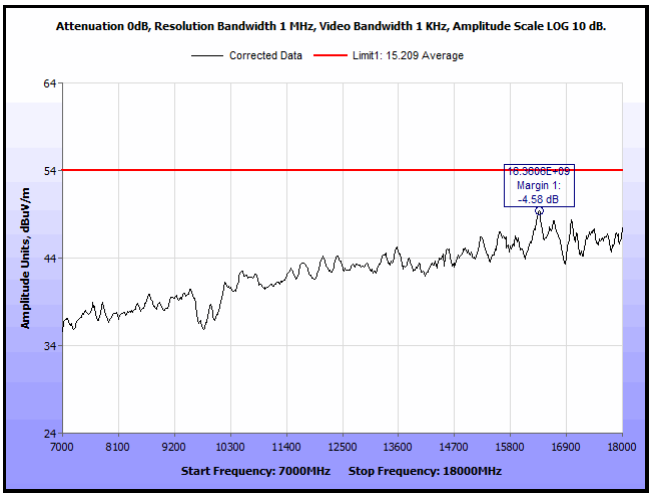
Plot 81. Radiated Spurious Emissions, 802.11g 2437 7-18GHz Peak



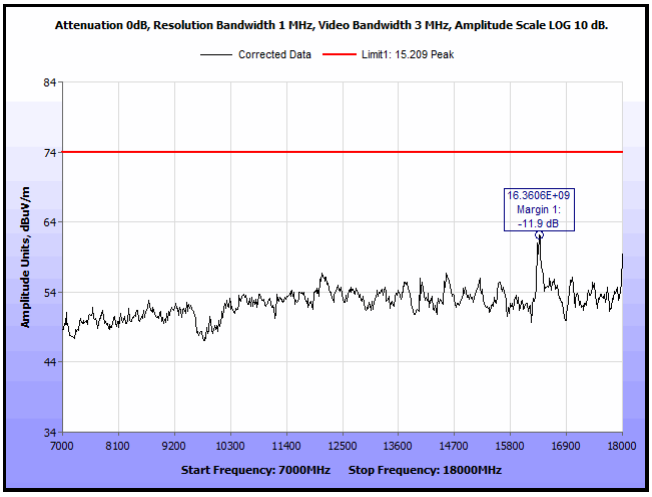
Plot 82. Radiated Spurious Emissions, 802.11g 2462 7-18GHz Avg



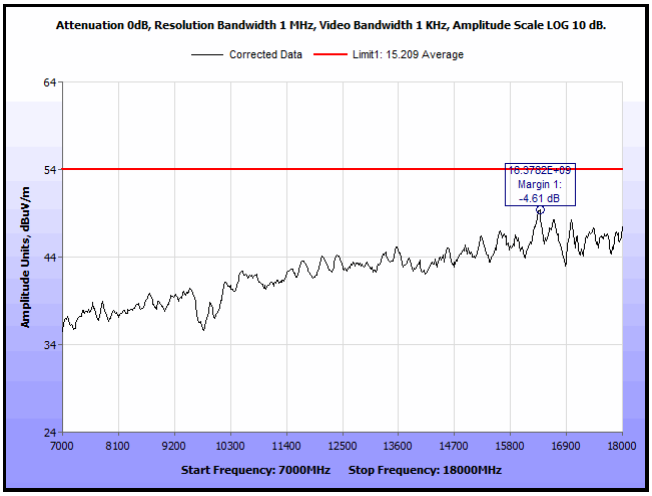
Plot 83. Radiated Spurious Emissions, 802.11g 2462 7-18GHz Peak



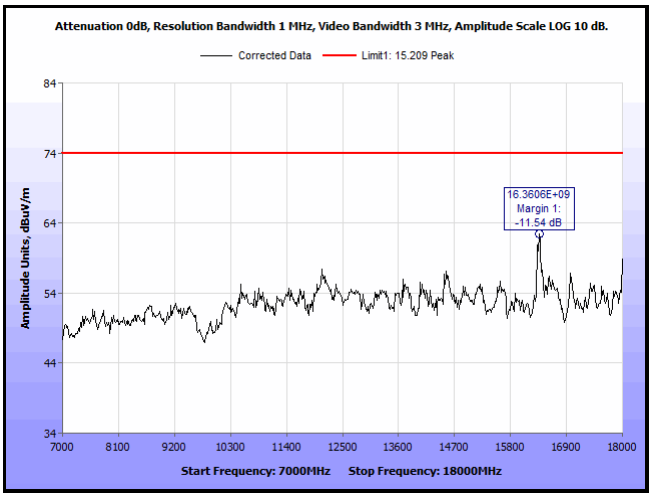
Plot 84. Radiated Spurious Emissions, 802.11n HT20 2412 7-18GHz Avg



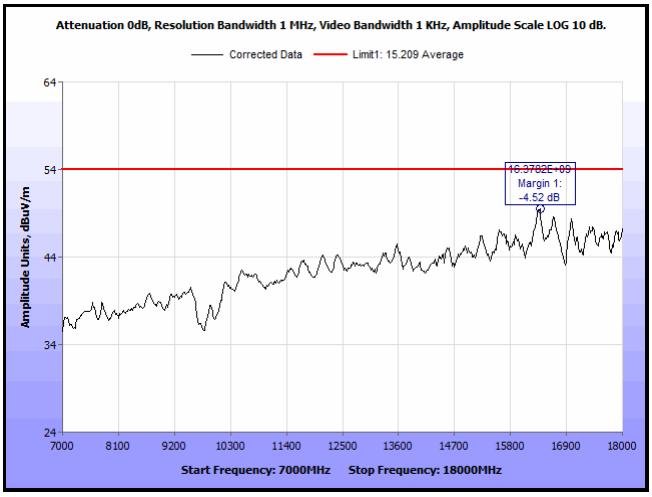
Plot 85. Radiated Spurious Emissions, 802.11n HT20 2412 7-18GHz Peak



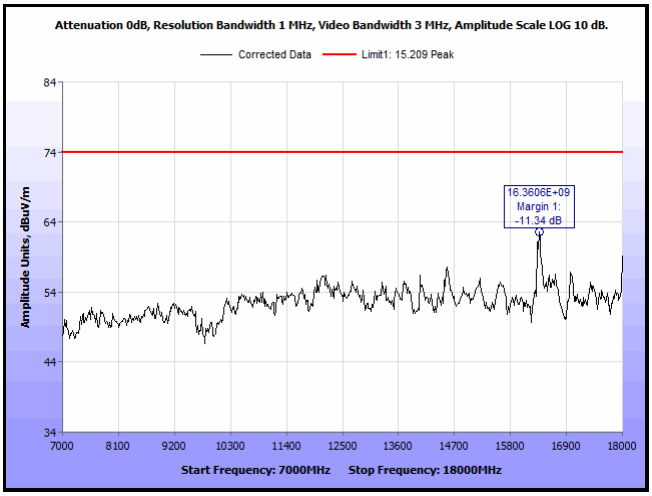
Plot 86. Radiated Spurious Emissions, 802.11n HT20 2437 7-18GHz Avg



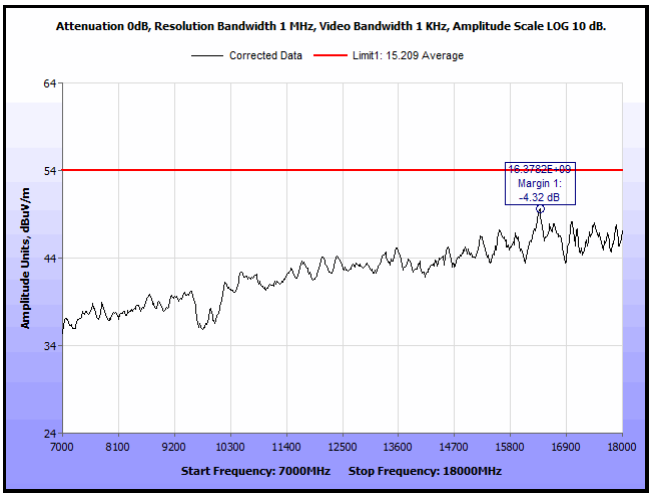
Plot 87. Radiated Spurious Emissions, 802.11n HT20 2437 7-18GHz Peak



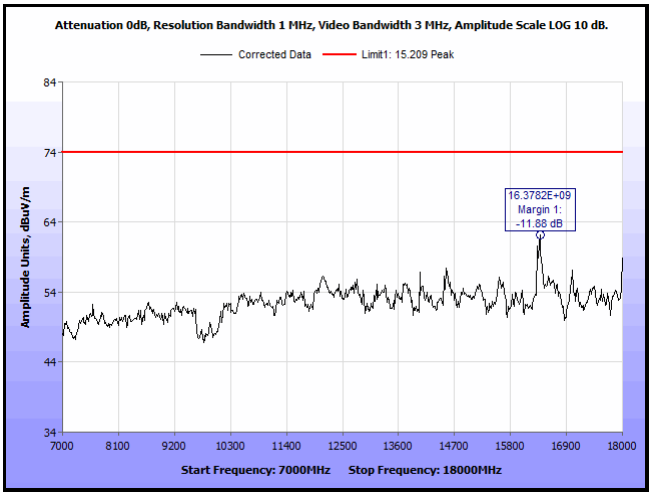
Plot 88. Radiated Spurious Emissions, 802.11n HT20 2462 7-18GHz Avg



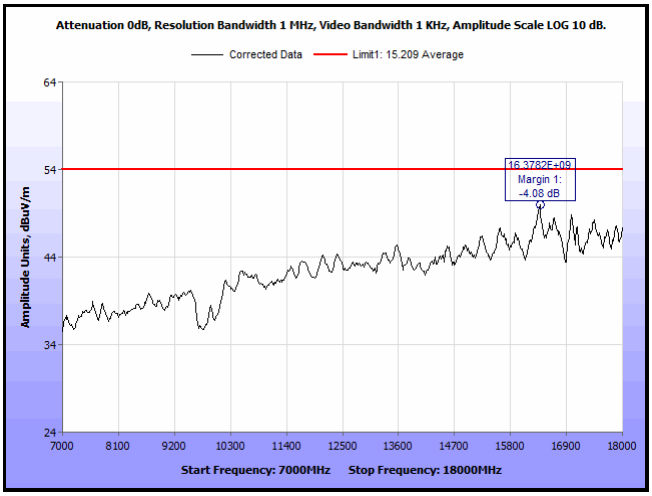
Plot 89. Radiated Spurious Emissions, 802.11n HT20 2462 7-18GHz Peak



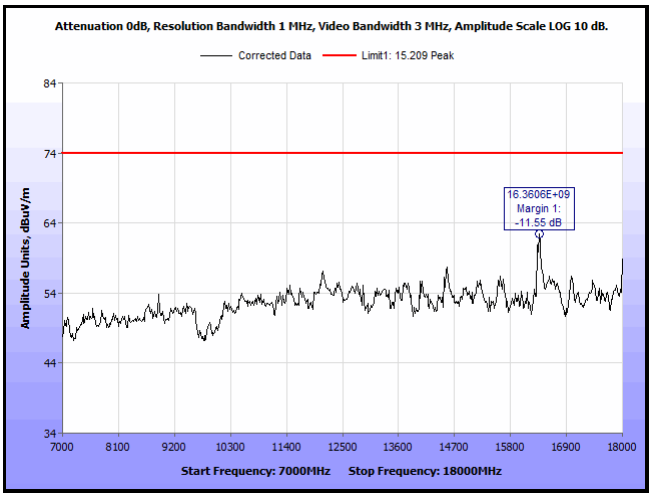
Plot 90. Radiated Spurious Emissions, 802.11n HT40 2422 7-18GHz Avg



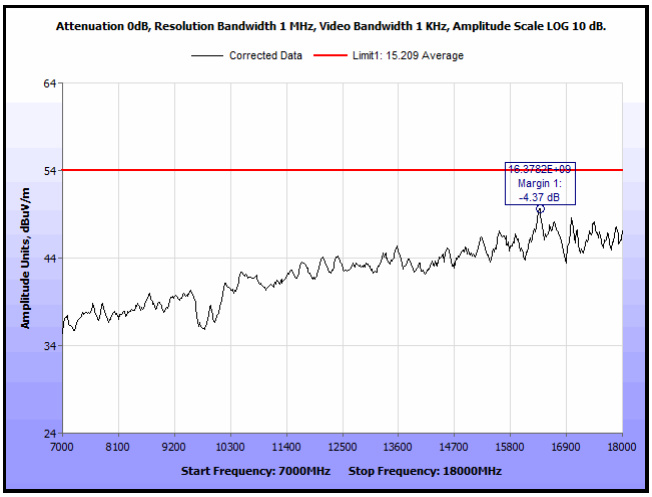
Plot 91. Radiated Spurious Emissions, 802.11n HT40 2422 7-18GHz Peak



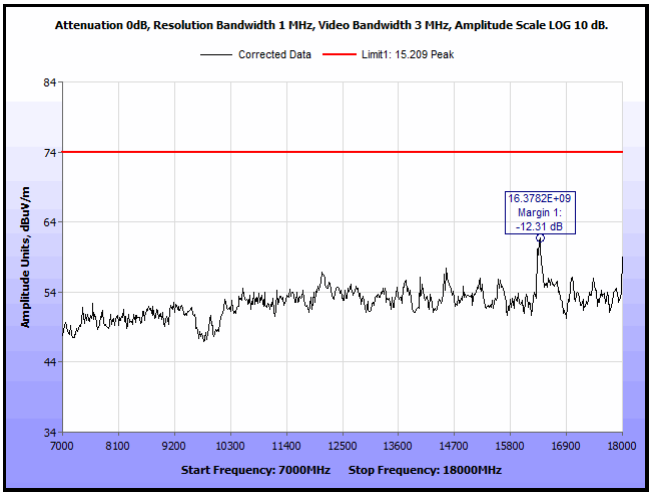
Plot 92. Radiated Spurious Emissions, 802.11n HT40 2437 7-18GHz Avg



Plot 93. Radiated Spurious Emissions, 802.11n HT40 2437 7-18GHz Peak



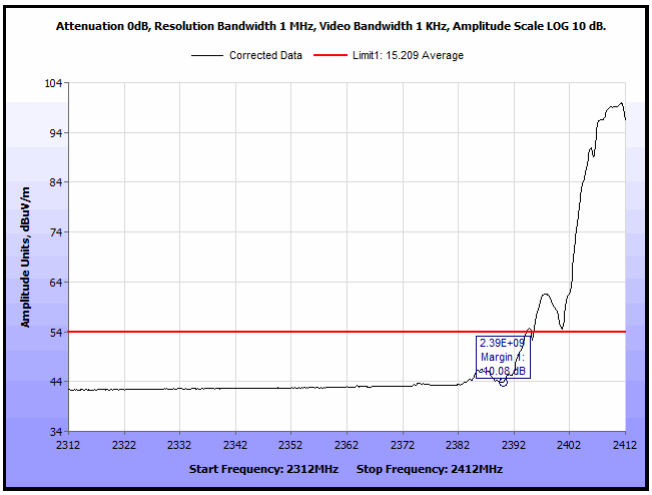
Plot 94. Radiated Spurious Emissions, 802.11n HT40 2452 7-18GHz Avg



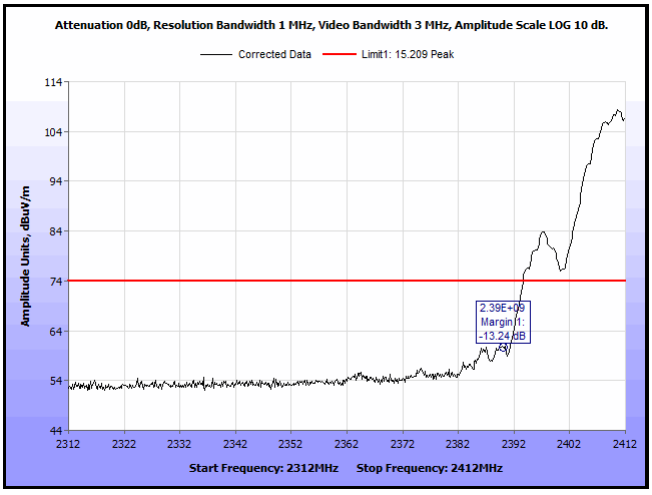
Plot 95. Radiated Spurious Emissions, 802.11n HT40 2452 7-18GHz Peak

Radiated Band Edge Measurements

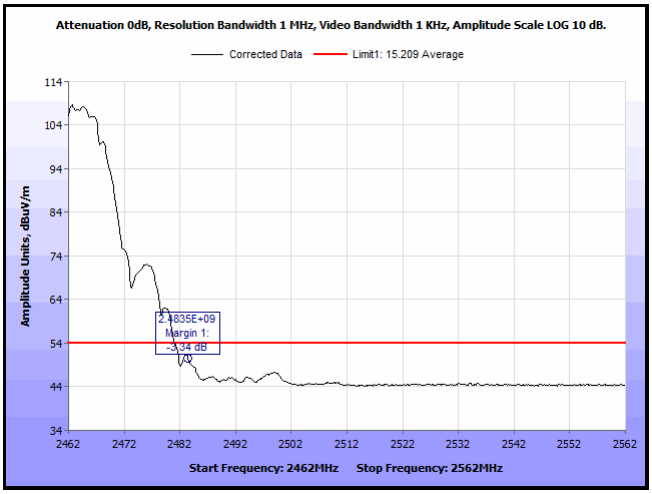
Test Procedures: The transmitter was turned on. Measurements were performed of the low and high Channels. The EUT was rotated orthogonally through all three axes. Plots shown are corrected for both antenna correction factor and distance and compared to a 3 m limit line.



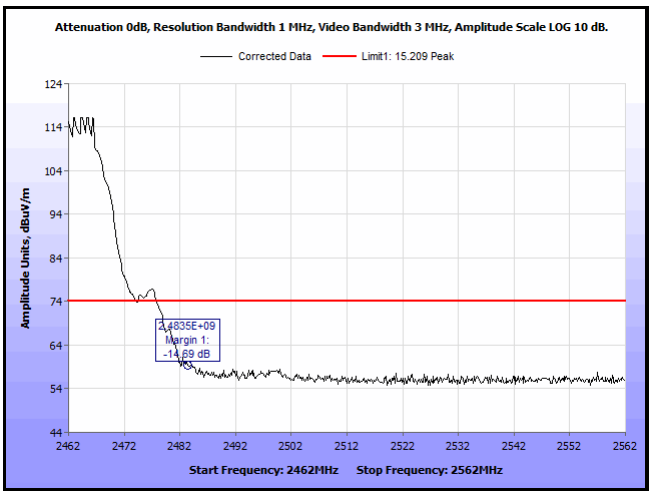
Plot 96. Radiated Restricted Band Edge, 802.11b, 2412 MHz, Pwr 18, Average



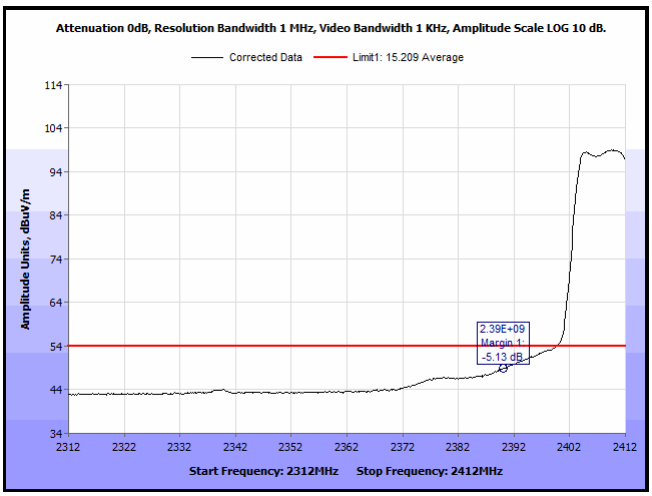
Plot 97. Radiated Restricted Band Edge, 802.11b, 2412 MHz, Pwr 18, Peak



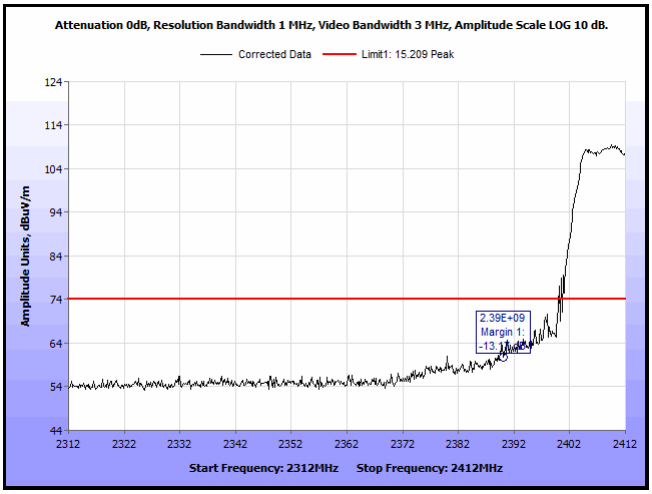
Plot 98. Radiated Restricted Band Edge, 802.11b, 2462 MHz, Pwr 17, Average



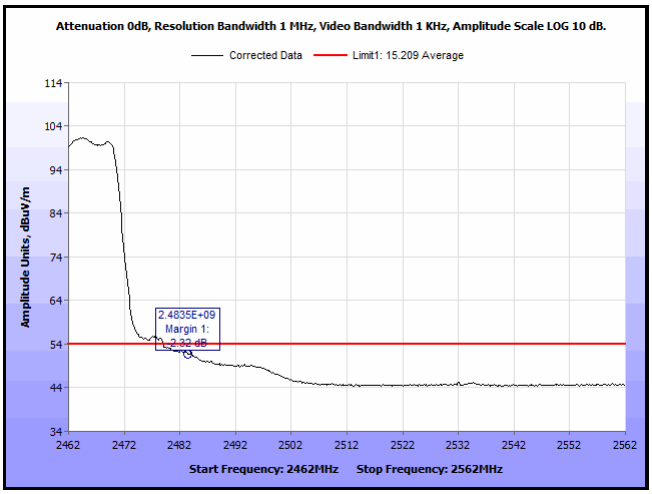
Plot 99. Radiated Restricted Band Edge, 802.11b, 2462 MHz, Pwr 17, Peak



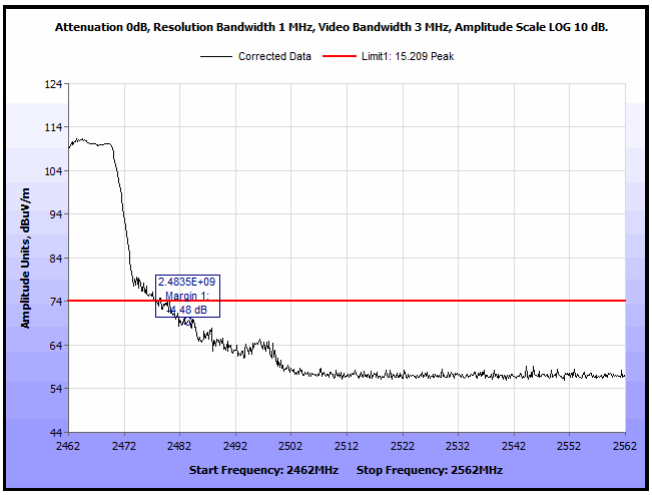
Plot 100. Radiated Restricted Band Edge, 802.11g, 2412 MHz, Pwr 10, Average



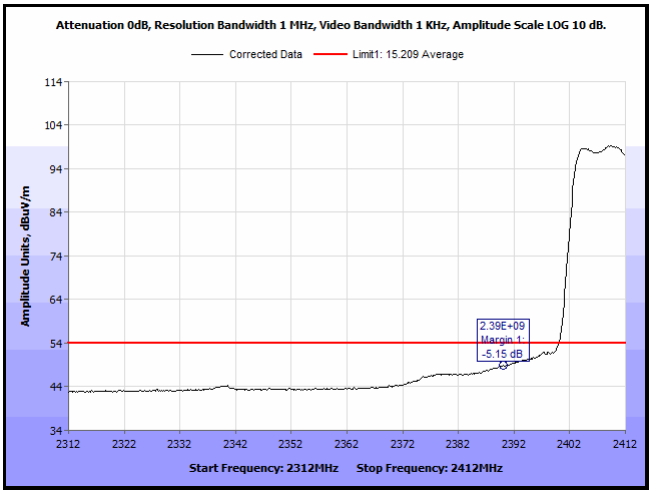
Plot 101. Radiated Restricted Band Edge, 802.11g, 2412 MHz, 10 Pwr, Peak



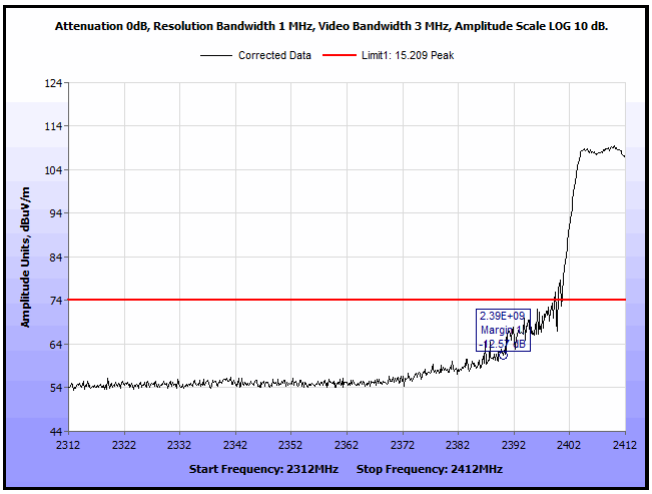
Plot 102. Radiated Restricted Band Edge, 802.11g, 2462 MHz, 12 Pwr, Average



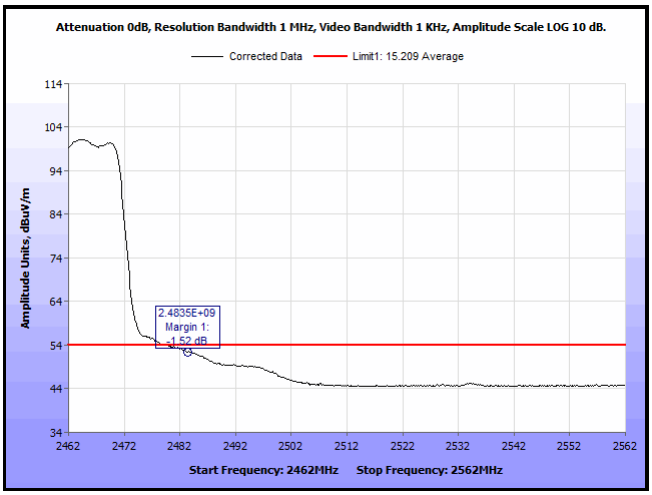
Plot 103. Radiated Restricted Band Edge, 802.11g, 2462 MHz, 12 Pwr, Peak



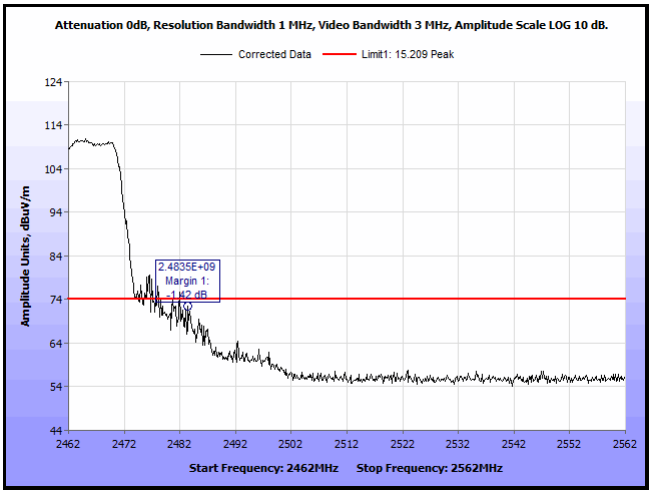
Plot 104. Radiated Restricted Band Edge, 802.11n HT20, 2412 MHz, Pwr 10, Average



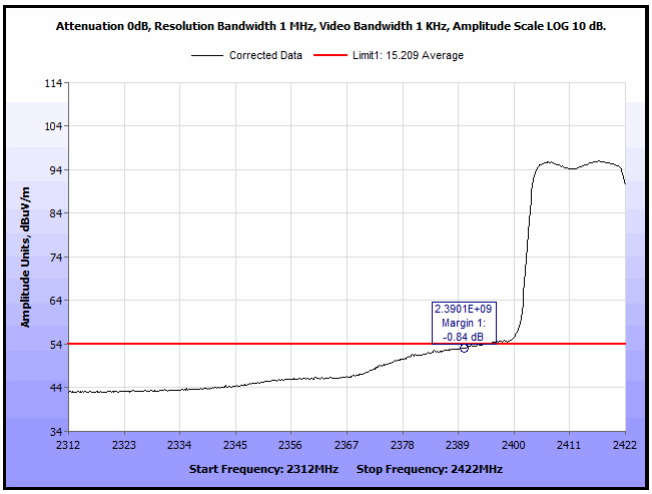
Plot 105. Radiated Restricted Band Edge, 802.11n HT20, 2412 MHz, Pwr 10, Peak



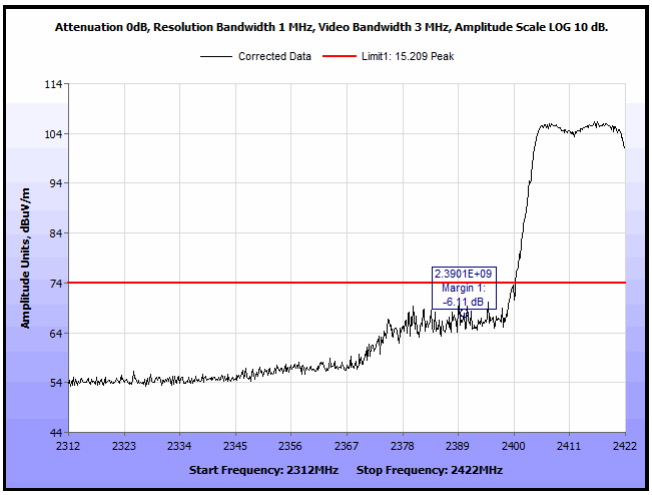
Plot 106. Radiated Restricted Band Edge, 802.11n HT20, 2462 MHz, Pwr 12, Average



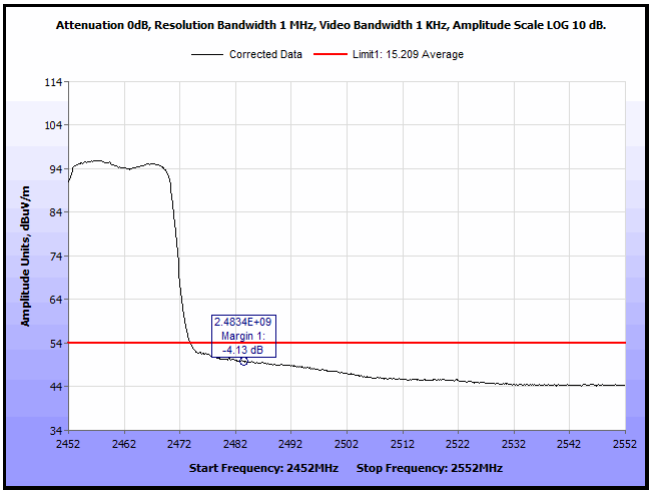
Plot 107. Radiated Restricted Band Edge, 802.11n HT20, 2462 MHz, Pwr 12, Peak



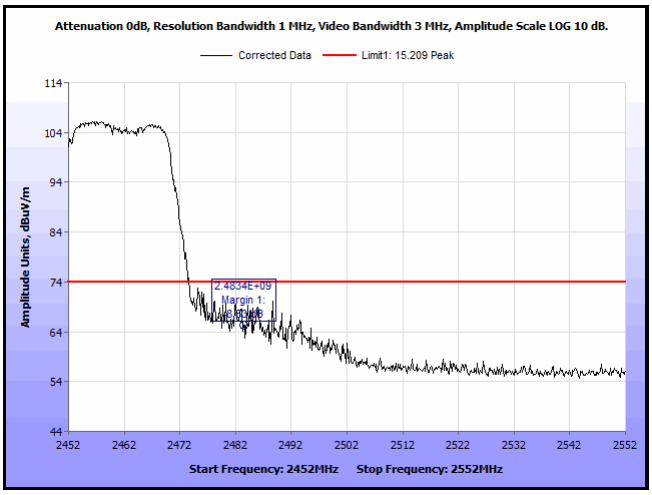
Plot 108. Radiated Restricted Band Edge, 802.11n HT40, 2422 MHz, Pwr 10, Average



Plot 109. Radiated Restricted Band Edge, 802.11n HT40, 2422 MHz, Pwr 10, Peak

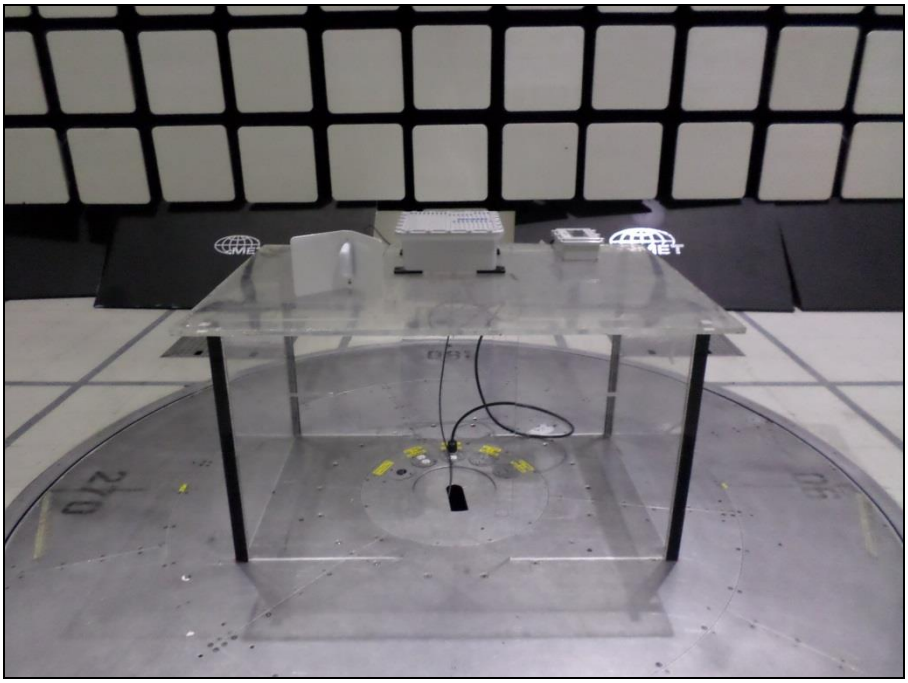


Plot 110. Radiated Restricted Band Edge, 802.11n HT40, 2452 MHz, Pwr 10, Average

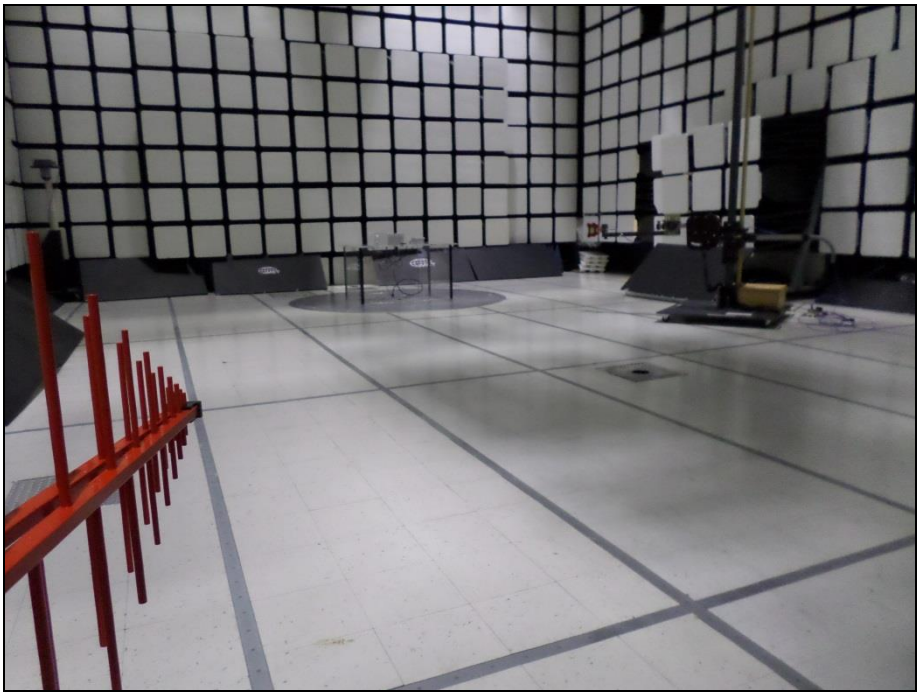


Plot 111. Radiated Restricted Band Edge, 802.11n HT40, 2452 MHz, Pwr 10, Peak

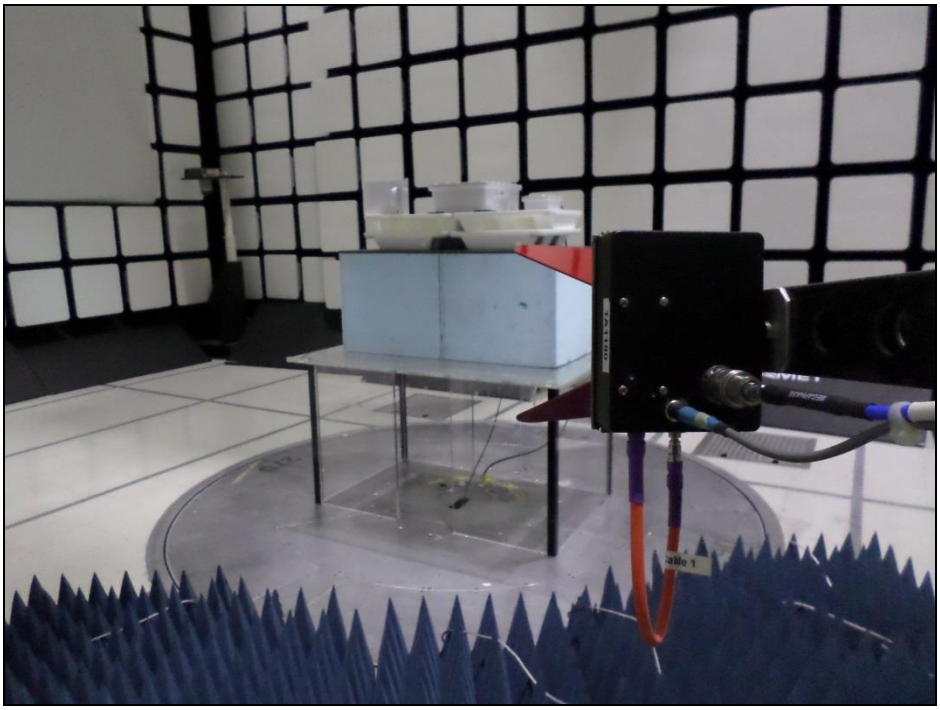
Radiated Spurious Emissions Test Setup



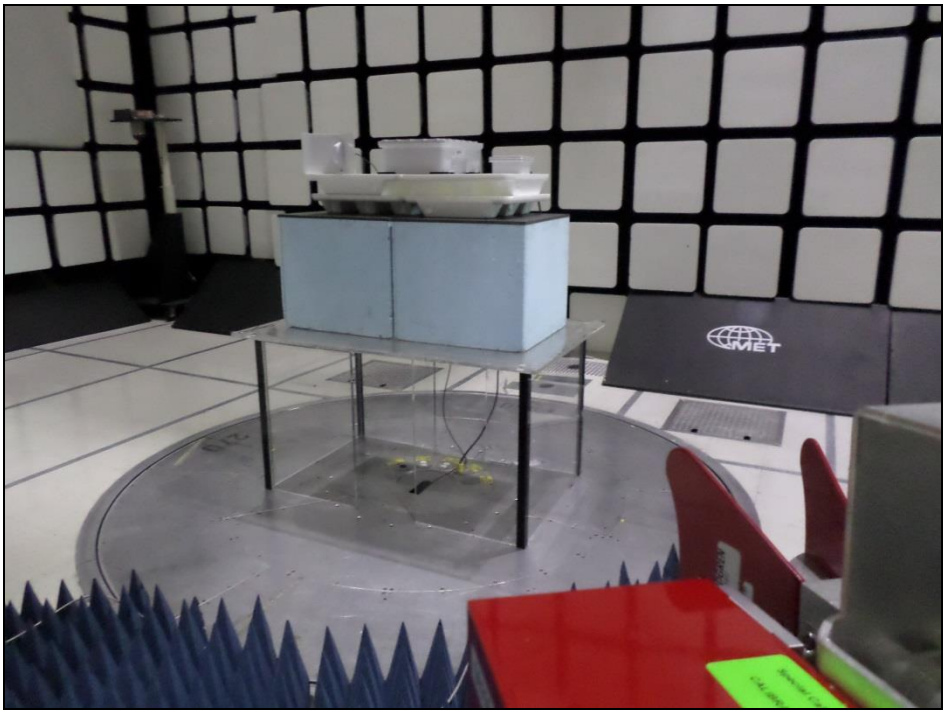
Photograph 3. Radiated Spurious Emissions, 12 dBi, 30 MHz – 1 GHz, Test Setup, Front



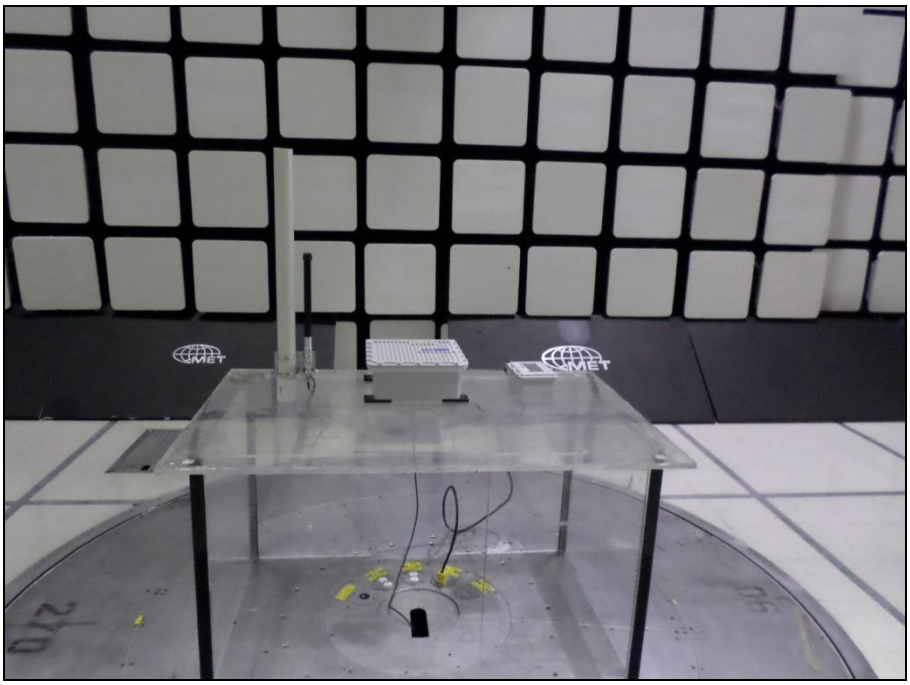
Photograph 4. Radiated Spurious Emissions, 12 dBi, 30 MHz – 1 GHz, Test Setup, Antenna



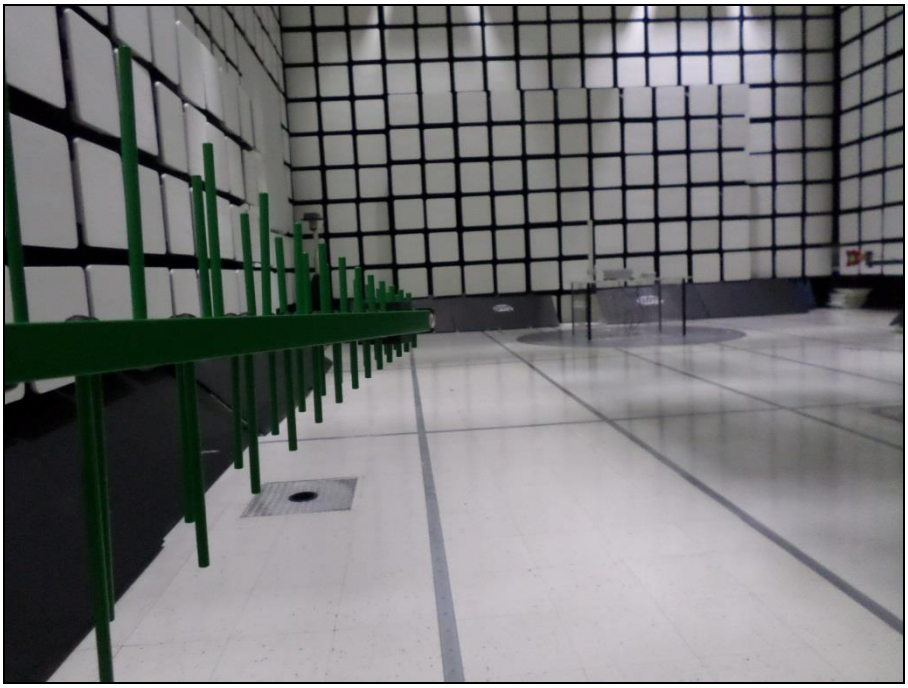
Photograph 5. Radiated Spurious Emissions, 12dBi, 1 – 18 GHz, Test Setup, Antenna



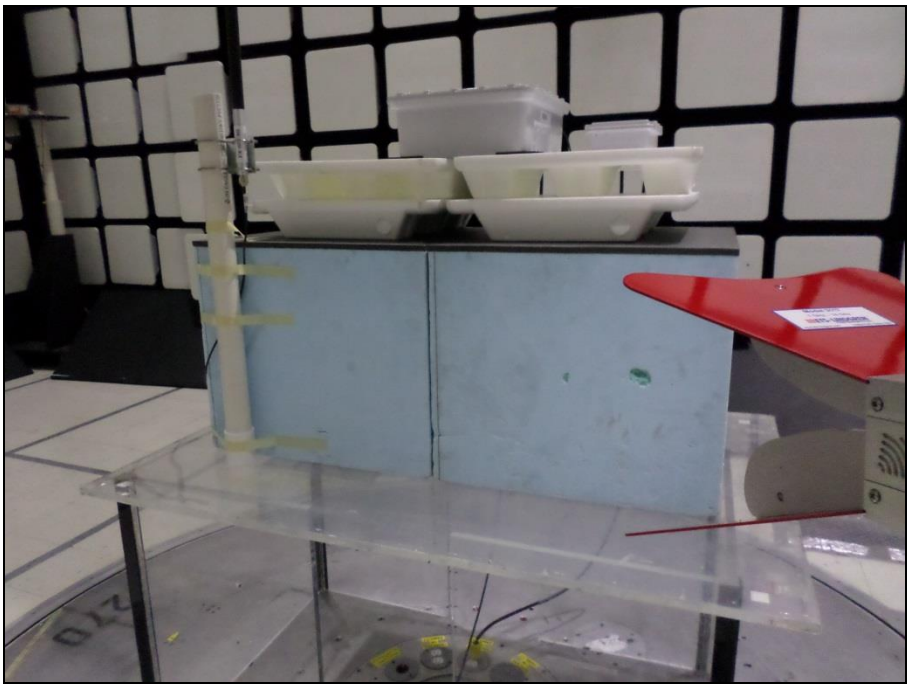
Photograph 6. Radiated Spurious Emissions, 12dBi, 18 - 40 GHz, Test Setup, Antenna



Photograph 7. Radiated Spurious Emissions, 6dBi, 30 MHz - 1 GHz, Test Setup, Front



Photograph 8. Radiated Spurious Emissions, 6dBi, 30 MHz - 1 GHz, Test Setup, Antenna



Photograph 9. Radiated Spurious Emissions, 6dBi, 1 – 18 GHz, Test Setup, Antenna

Photograph 10. Radiated Spurious Emissions, 6dBi, 18 - 40 GHz, Test Setup, Antenna

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: For intentional radiators with a digital device portion which operates below 10 GHz, the spectrum was investigated as per §15.33(a)(1) and §15.33(a)(4); i.e., the lowest RF signal generated or used in the device up to the 10th harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

See following pages for detailed test results with RF Conducted Spurious Emissions.

Test Results: The EUT was compliant with the Conducted Spurious Emission limits of **§15.247(d)**. Measured emissions were within applicable limits.

Test Engineer(s): Giuliano Messina

Test Date(s): May 1, 2017

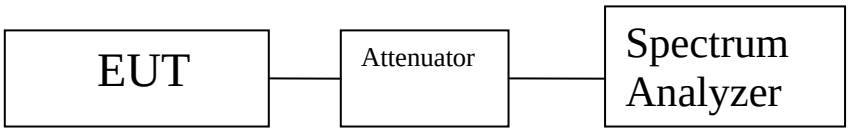
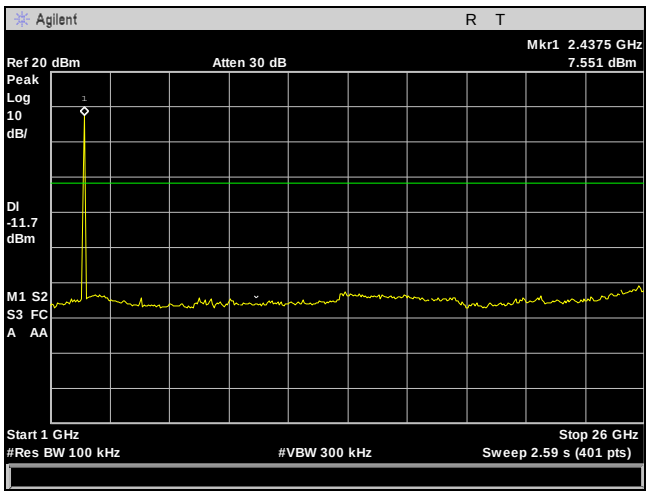
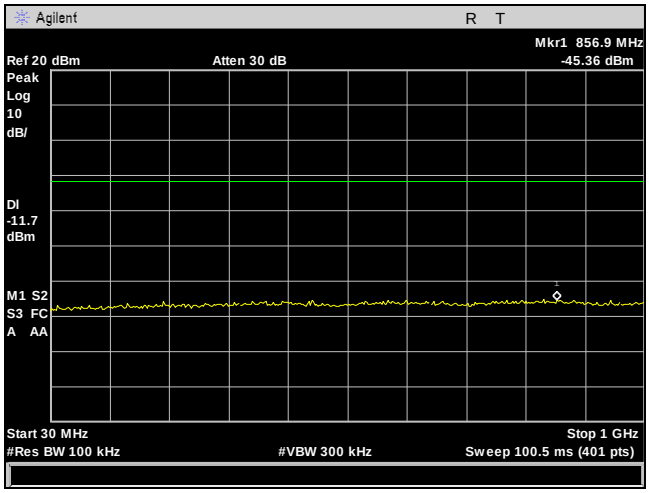


Figure 4. Block Diagram, Conducted Spurious Emissions Test Setup

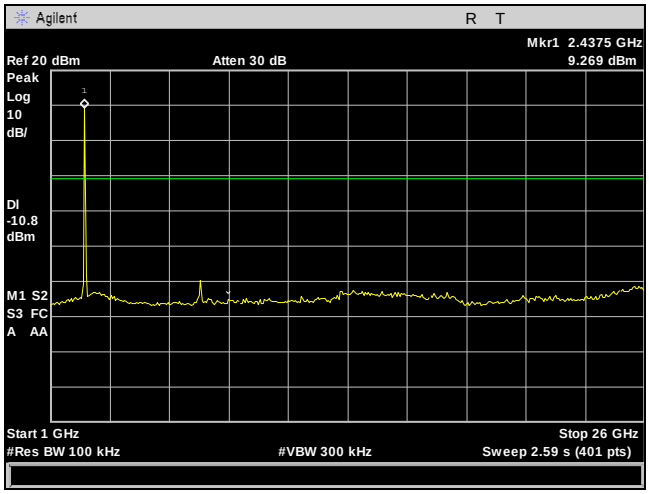
Conducted Spurious Emissions Test Results



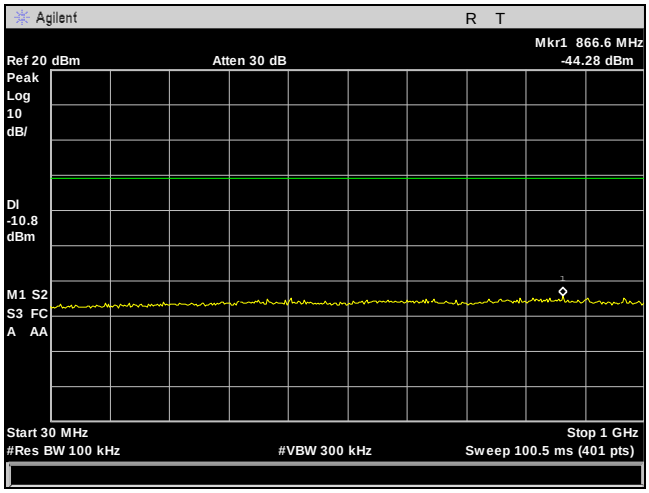
Plot 112. Spurious RF Conducted Emissions, 802.11b - 2412 - Pwr 18 - 1-26GHz



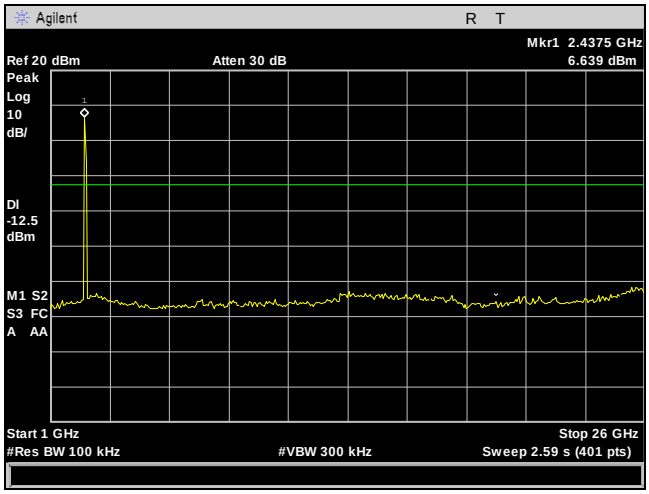
Plot 113. Spurious RF Conducted Emissions, 802.11b - 2412 - Pwr 18 - 30M-1GHz



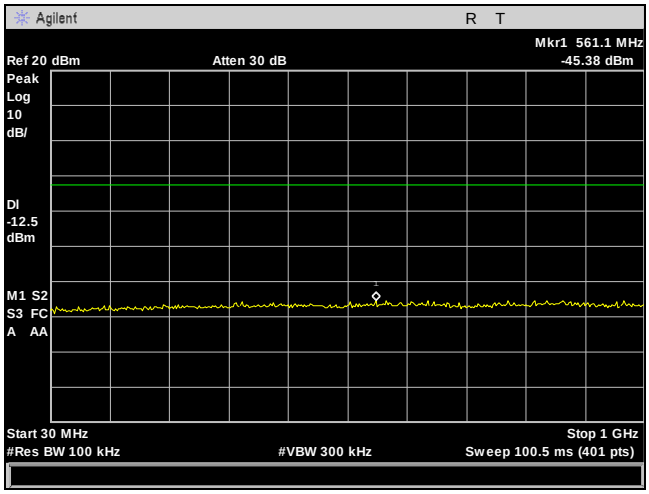
Plot 114. Spurious RF Conducted Emissions, 802.11b - 2437 - Pwr 20 - 1-26GHz



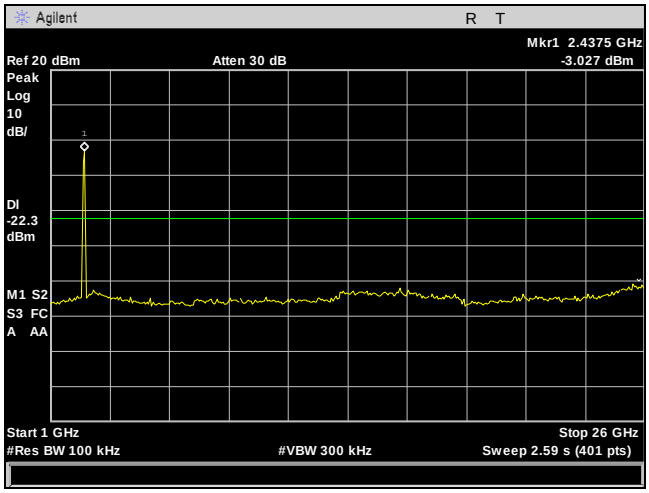
Plot 115. Spurious RF Conducted Emissions, 802.11b - 2437 - Pwr 20 - 30M-1GHz



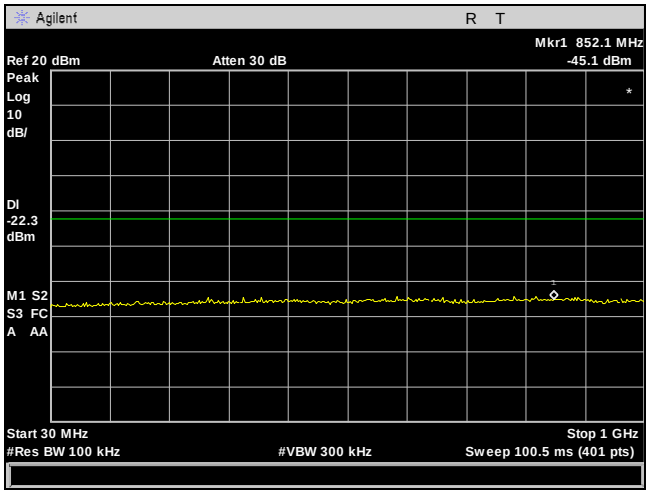
Plot 116. Spurious RF Conducted Emissions, 802.11b - 2462 - Pwr 17 - 1-26GHz



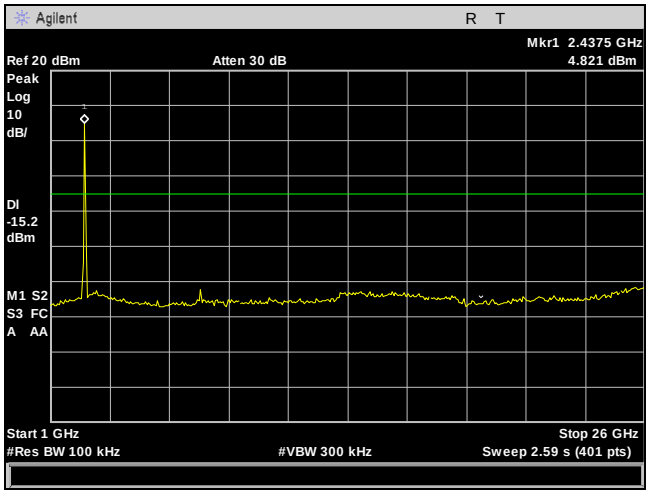
Plot 117. Spurious RF Conducted Emissions, 802.11b - 2462 - Pwr 17 - 30M-1GHz



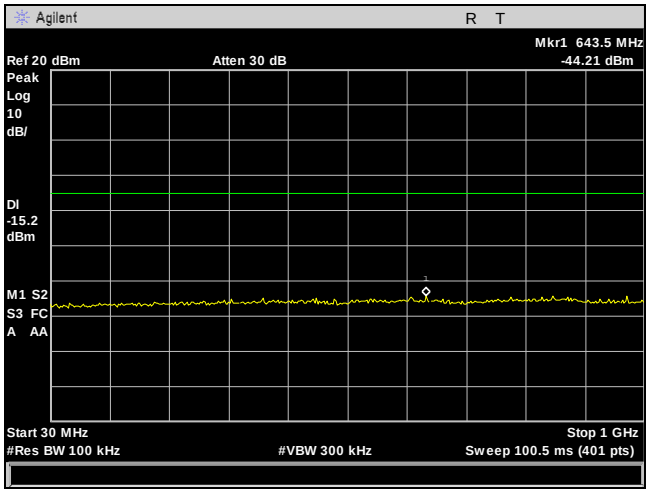
Plot 118. Spurious RF Conducted Emissions, 802.11g - 2412 - Pwr 10 - 1-26GHz



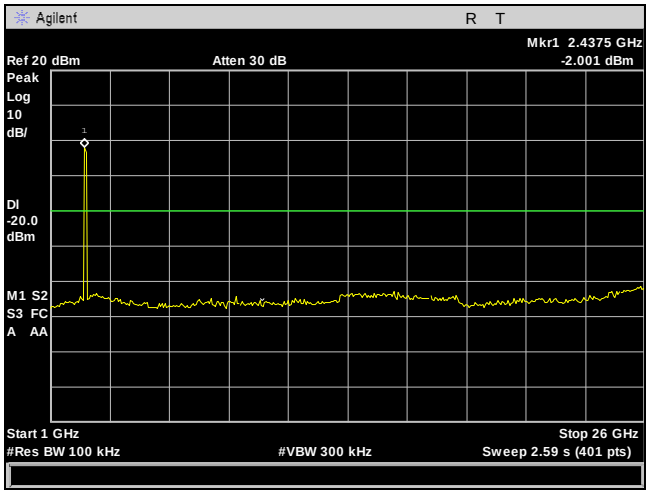
Plot 119. Spurious RF Conducted Emissions, 802.11g - 2412 - Pwr 10 - 30M-1GHz



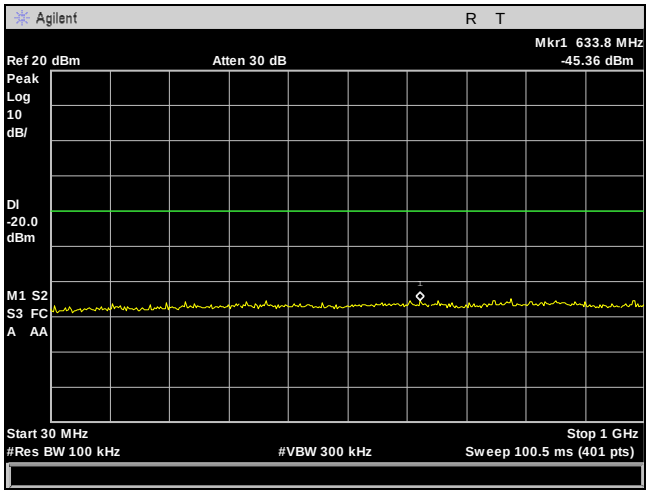
Plot 120. Spurious RF Conducted Emissions, 802.11g - 2437 - Pwr 20 - 1-26GHz



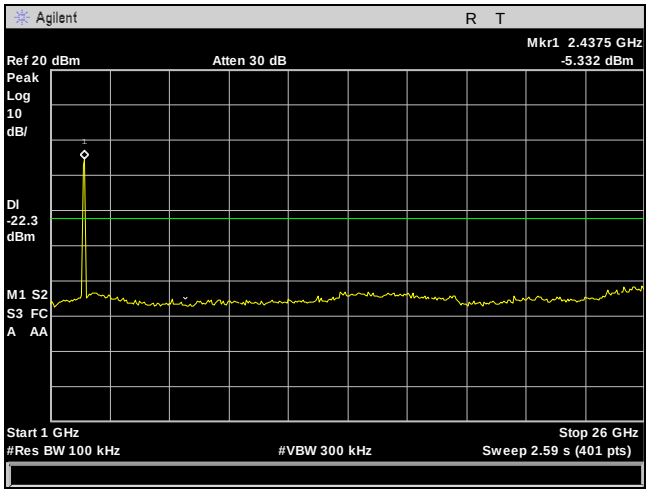
Plot 121. Spurious RF Conducted Emissions, 802.11g - 2437 - Pwr 20 - 30M-1GHz



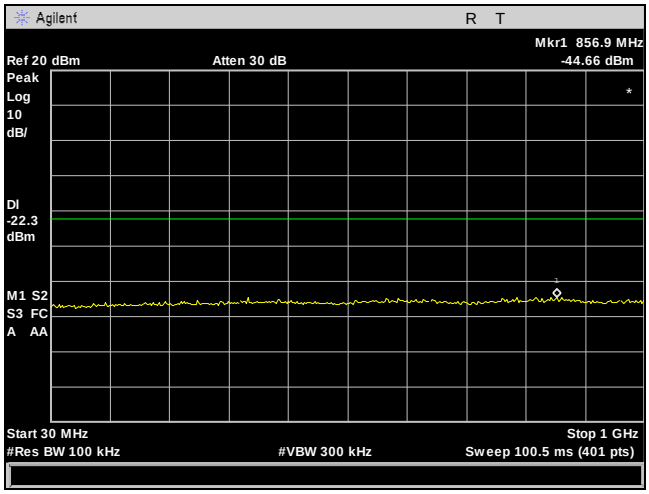
Plot 122. Spurious RF Conducted Emissions, 802.11g - 2462 - Pwr 12 - 1-26GHz



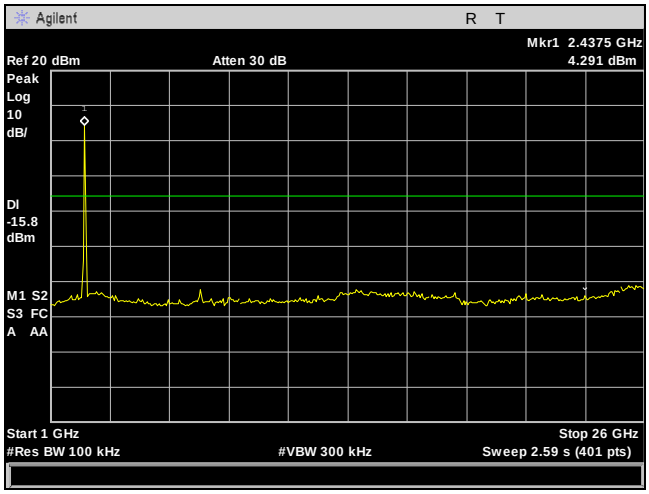
Plot 123. Spurious RF Conducted Emissions, 802.11g - 2462 - Pwr 12 - 30M-1GHz



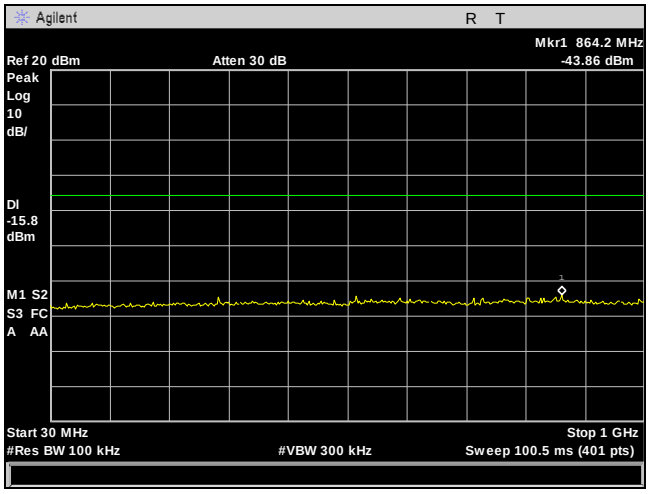
Plot 124. Spurious RF Conducted Emissions, 802.11n HT20 - 2412 - Pwr 10 - 1-26GHz



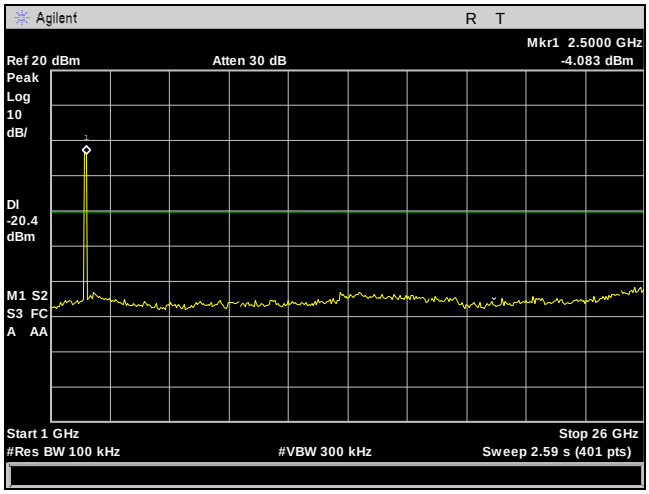
Plot 125. Spurious RF Conducted Emissions, 802.11n HT20 - 2412 - Pwr 10 - 30M-1GHz



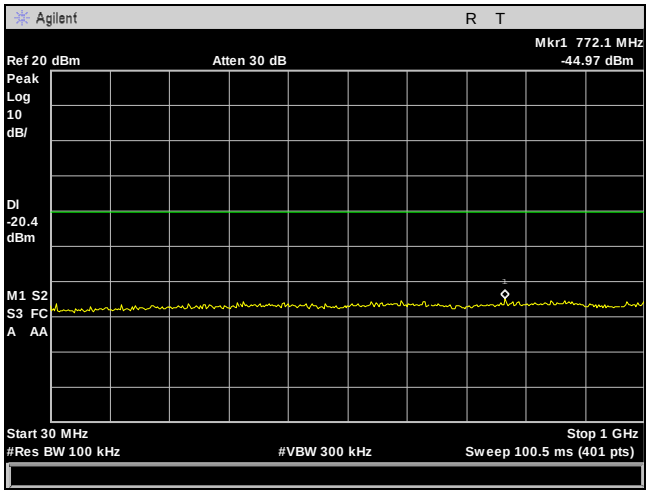
Plot 126. Spurious RF Conducted Emissions, 802.11n HT20 - 2437 - Pwr 20 - 1-26GHz



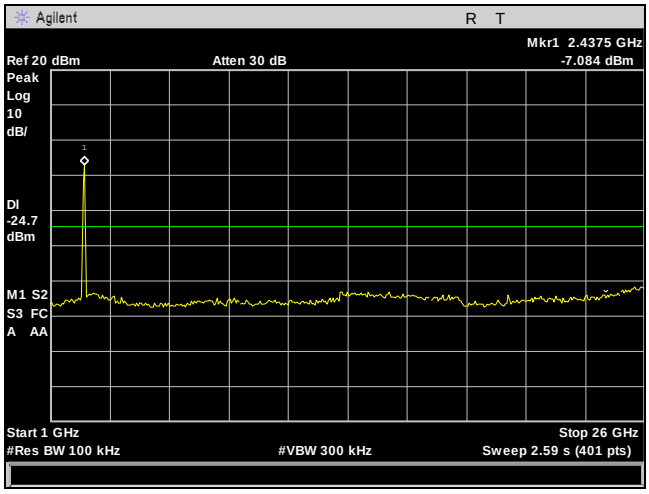
Plot 127. Spurious RF Conducted Emissions, 802.11n HT20 - 2437 - Pwr 20 - 30M-1GHz



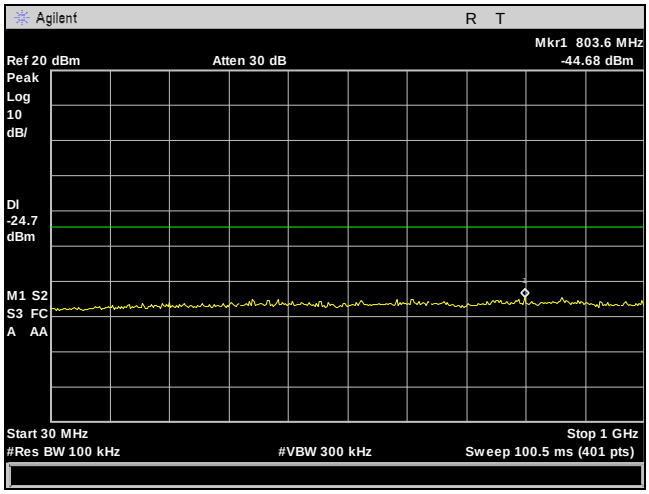
Plot 128. Spurious RF Conducted Emissions, 802.11n HT20 - 2462 - Pwr 12 - 1-26GHz



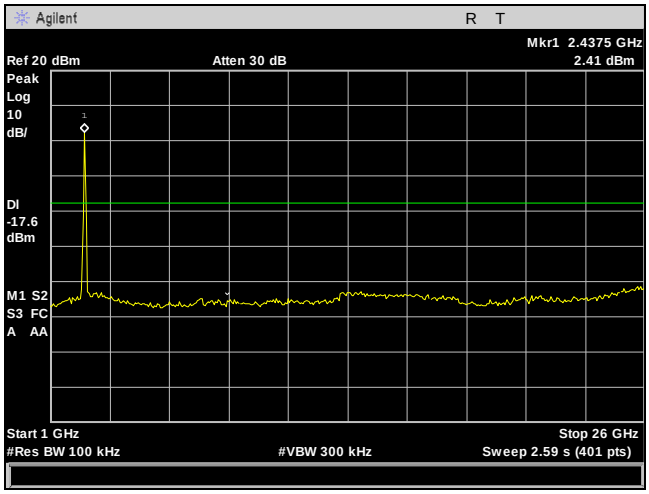
Plot 129. Spurious RF Conducted Emissions, 802.11n HT20 - 2462 - Pwr 12 - 30M-1GHz



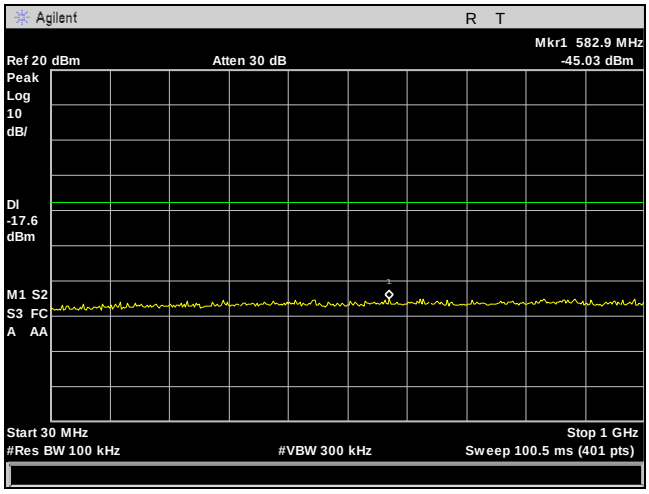
Plot 130. Spurious RF Conducted Emissions, 802.11n HT40 - 2422 - Pwr 10 - 1-26GHz



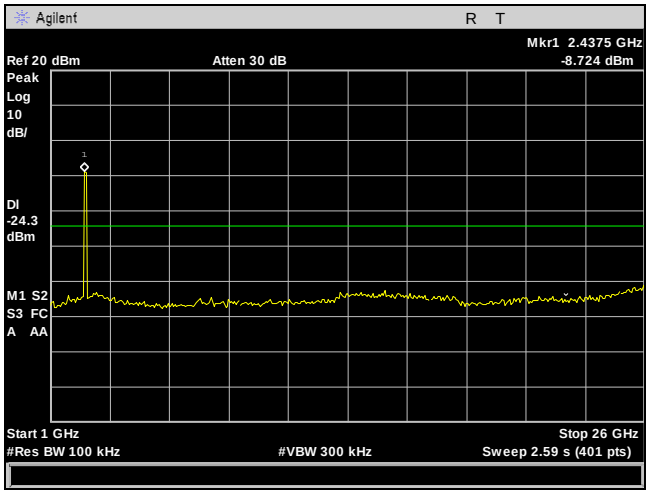
Plot 131. Spurious RF Conducted Emissions, 802.11n HT40 - 2422 - Pwr 10 - 30M-1GHz



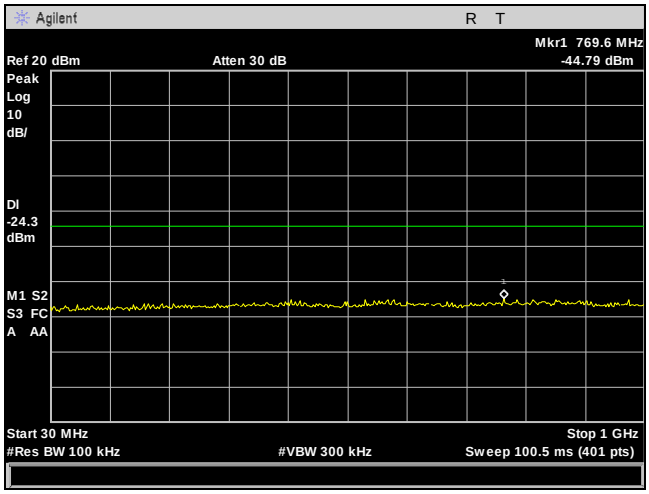
Plot 132. Spurious RF Conducted Emissions, 802.11n HT40 - 2437 - Pwr 20 - 1-26GHz



Plot 133. Spurious RF Conducted Emissions, 802.11n HT40 - 2437 - Pwr 20 - 30M-1GHz

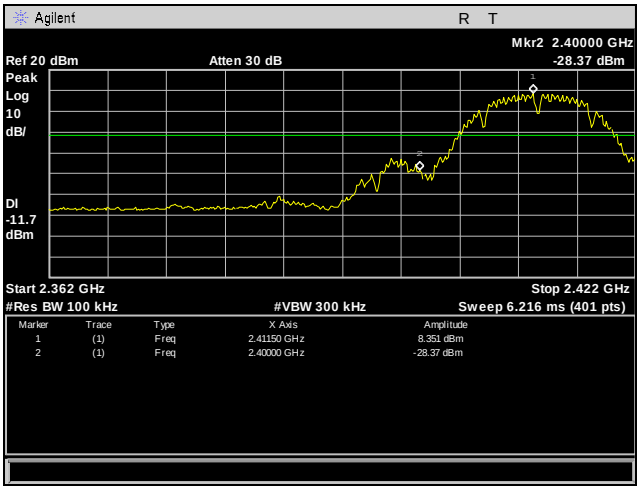


Plot 134. Spurious RF Conducted Emissions, 802.11n HT40 - 2452 - Pwr 10 - 1-26GHz

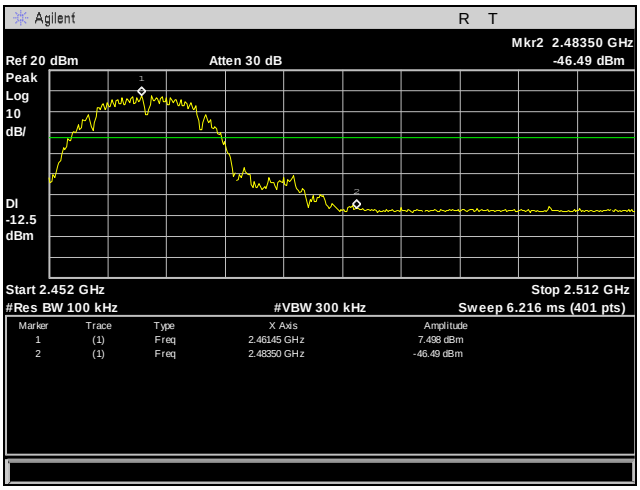


Plot 135. Spurious RF Conducted Emissions, 802.11n HT40 - 2452 - Pwr 10 - 30M-1GHz

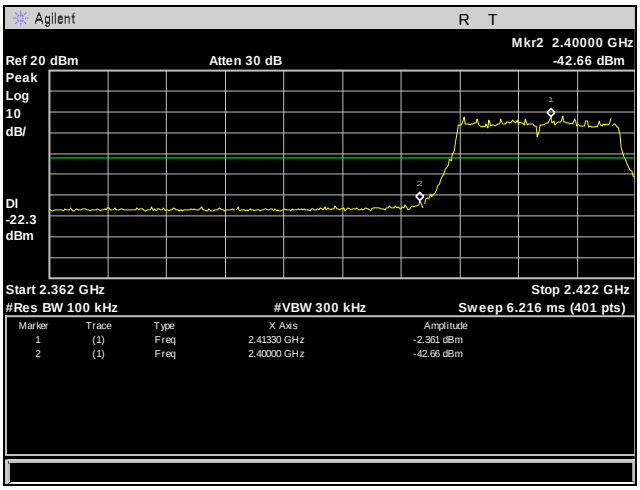
Conducted Band Edge Test Results



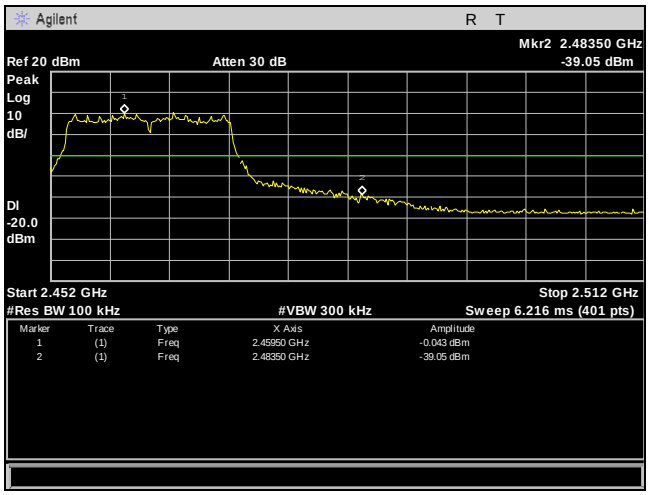
Plot 136. Conducted Band Edge, 802.11b - 2412 - Pwr 18



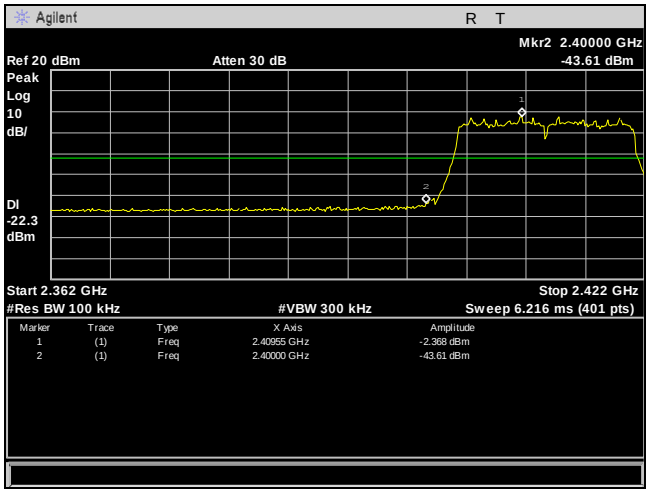
Plot 137. Conducted Band Edge, 802.11b - 2462 - Pwr 17



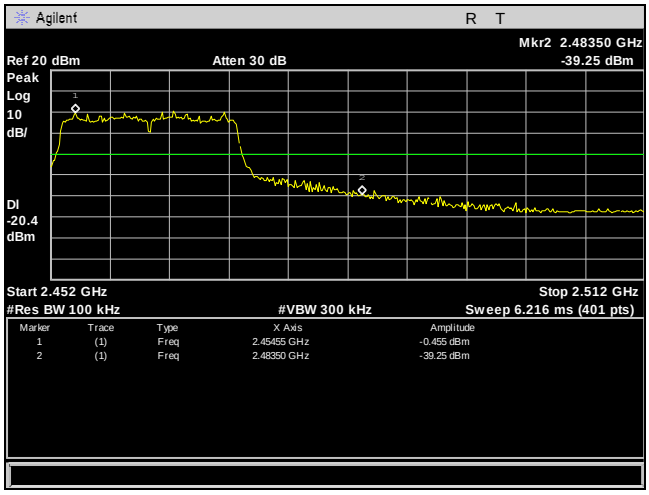
Plot 138. Conducted Band Edge, 802.11g - 2412 - Pwr 10



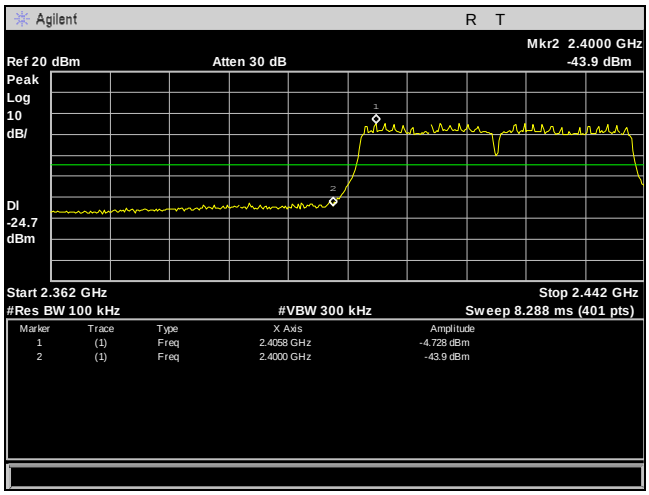
Plot 139. Conducted Band Edge, 802.11g - 2462 - Pwr 12



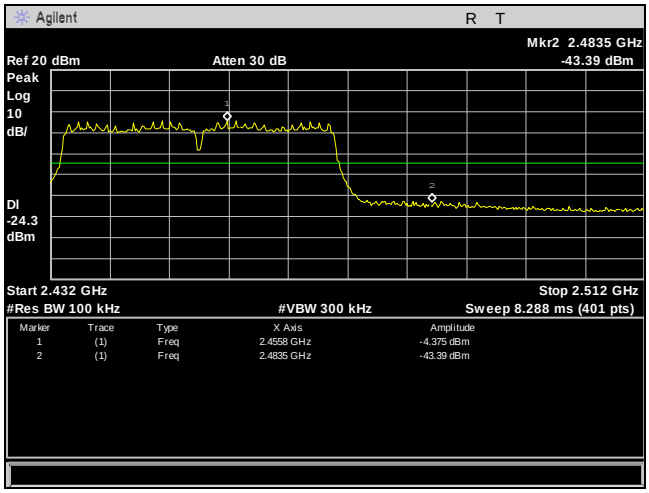
Plot 140. Conducted Band Edge, 802.11n HT20 - 2412 - Pwr 10



Plot 141. Conducted Band Edge, 802.11n HT20 - 2462 - Pwr 12



Plot 142. Conducted Band Edge, 802.11n HT40 - 2422 - Pwr 10



Plot 143. Conducted Band Edge, 802.11n HT40 - 2452 - Pwr 10

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(e) Peak Power Spectral Density

Test Requirements: **§15.247(e):** For digitally modulated systems, the peak power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8dBm in any 3 kHz band during any time interval of continuous transmission.

Test Procedure: The transmitter was connected directly to a Spectrum Analyzer through an attenuator. The power level was set to the maximum level throughout each of the 100 sweeps of power averaging. The RBW was set to 10-30 kHz and the VBW set to 30-100 kHz. The spectrum analyzer was set to an auto sweep time and a peak detector was used. Measurements were carried out at the low, mid and high channels.

Test Results: The EUT was compliant with the peak power spectral density limits of **§ 15.247 (e)**. No anomalies detected.

The peak power spectral density was determined from plots on the following page(s).

Test Engineer: Giuliano Messina

Test Date: May 1, 2017

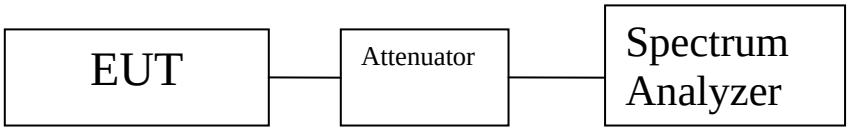


Figure 5. Block Diagram, Peak Power Spectral Density Test Setup

Peak Power Spectral Density Test Results

Note: The limit was lowered to 2 dBm per KDB 558074 section 7.0. Antenna gain 12 dBi.

Peak Power Spectral Density				
Carrier Channel	**Frequency (MHz)**	**Measured PPSD (dBm)**	**Limit (dBm)**	**Margin (dB)**
Low	2412	-0.164	2	-2.164
Mid	2437	1.629	2	-0.371
High	2462	-0.973	2	-2.973

Table 17. Peak Power Spectral Density, WiFi, 802.11b Mode, Test Results

Peak Power Spectral Density				
Carrier Channel	**Frequency (MHz)**	**Measured PPSD (dBm)**	**Limit (dBm)**	**Margin (dB)**
Low	2412	-6.309	2	-8.309
Mid	2437	-0.85	2	-2.85
High	2462	-5.621	2	-7.621

Table 18. Peak Power Spectral Density, WiFi, 802.11g Mode, Test Results

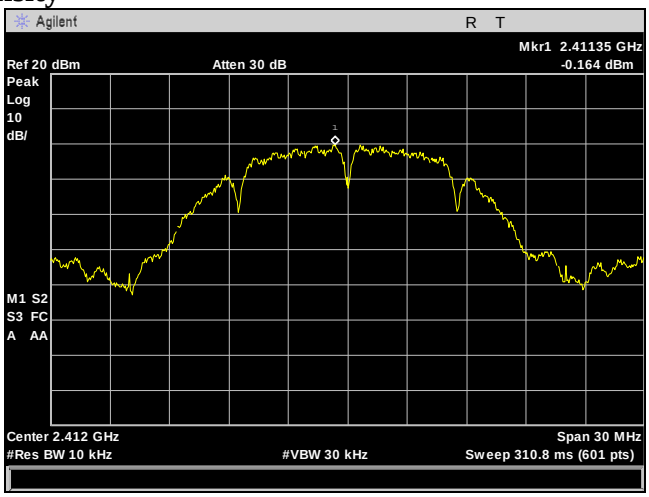
Peak Power Spectral Density				
Carrier Channel	**Frequency (MHz)**	**Measured PPSD (dBm)**	**Limit (dBm)**	**Margin (dB)**
Low	2412	-7.31	2	-9.31
Mid	2437	-0.307	2	-2.307
High	2462	-4.032	2	-6.032

Table 19. Peak Power Spectral Density, WiFi, 802.11n HT20 Mode, Test Results

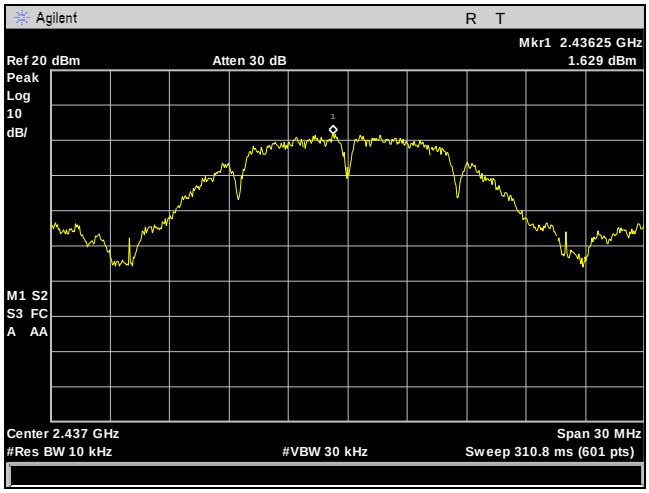
Peak Power Spectral Density				
Carrier Channel	**Frequency (MHz)**	**Measured PPSD (dBm)**	**Limit (dBm)**	**Margin (dB)**
Low	2422	-9.468	2	-11.468
Mid	2437	0.217	2	-1.783
High	2452	-9.436	2	-11.436

Table 20. Peak Power Spectral Density, WiFi, 802.11n HT40 Mode, Test Results

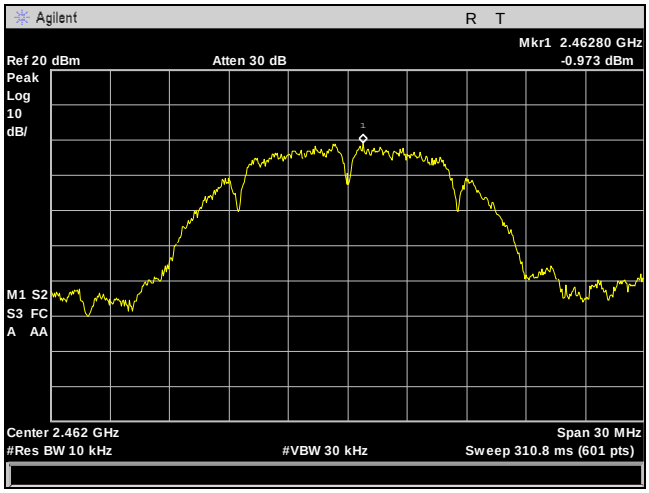
Peak Power Spectral Density



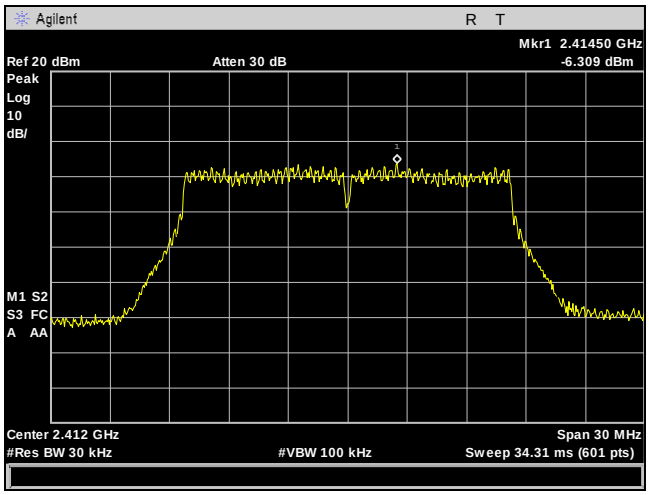
Plot 144. Power Spectral Density, 802.11b - 2412 - Pwr 18



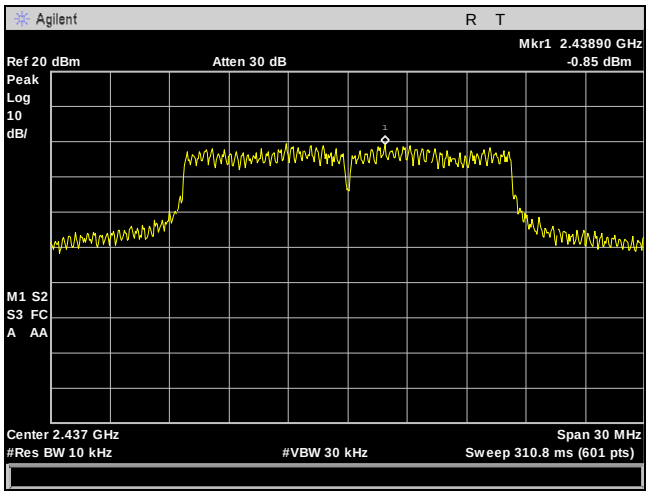
Plot 145. Power Spectral Density, 802.11b - 2437 - Pwr 20



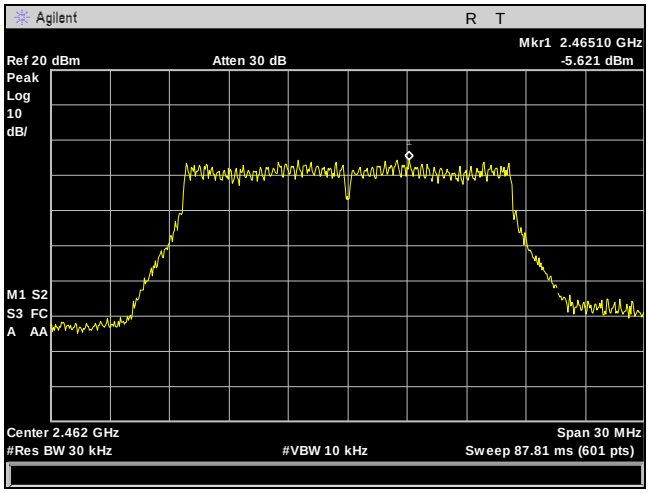
Plot 146. Power Spectral Density, 802.11b - 2462 - Pwr 17



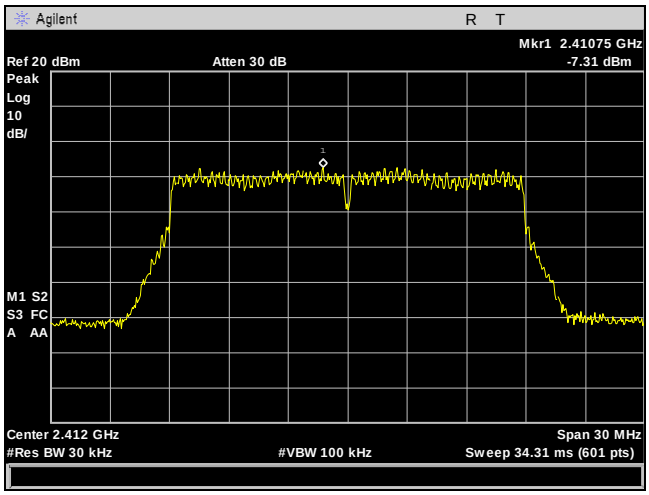
Plot 147. Power Spectral Density, 802.11g - 2412 - Pwr 10



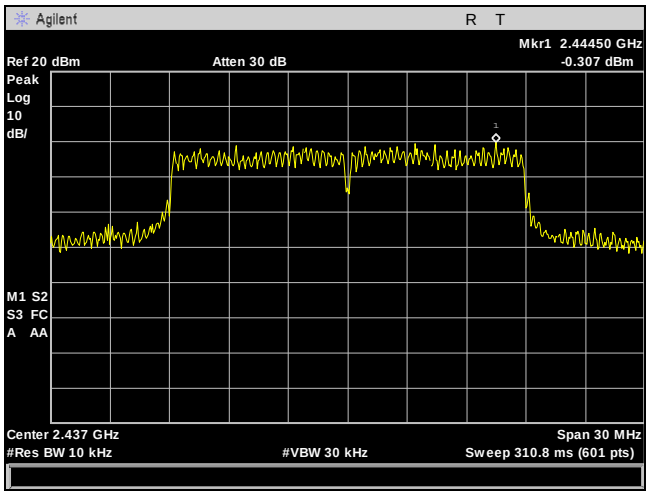
Plot 148. Power Spectral Density, 802.11g - 2437 - Pwr 20



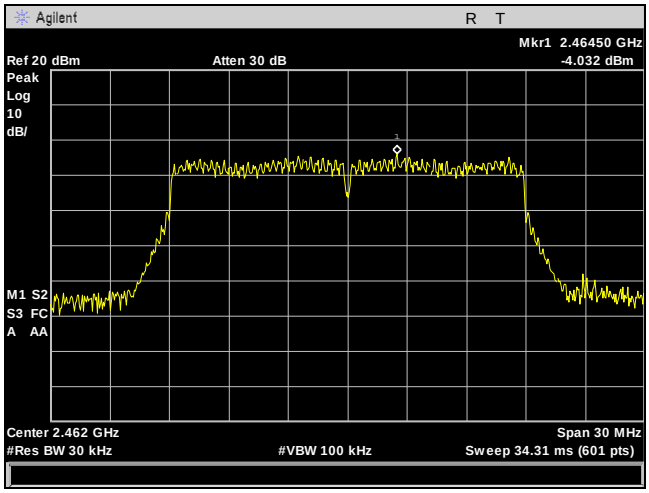
Plot 149. Power Spectral Density, 802.11g - 2462 - Pwr 12



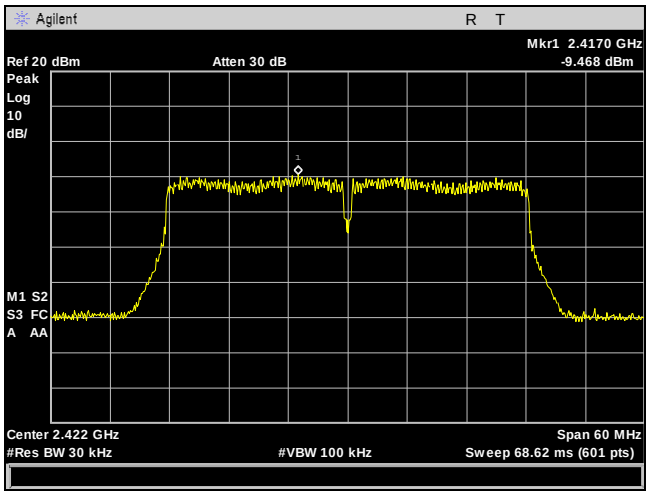
Plot 150. Power Spectral Density, 802.11n HT20 - 2412 - Pwr 10



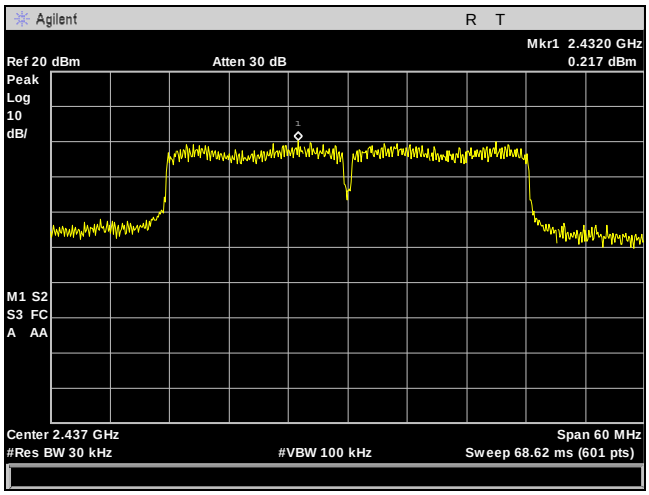
Plot 151. Power Spectral Density, 802.11n HT20 - 2437 - Pwr 20



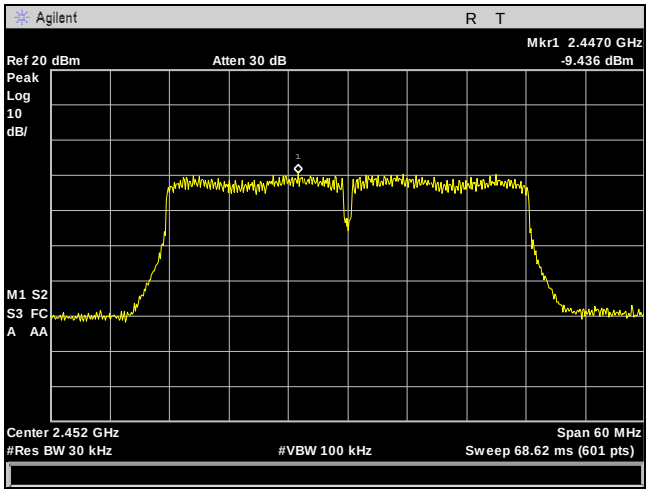
Plot 152. Power Spectral Density, 802.11n HT20 - 2462 - Pwr 12



Plot 153. Power Spectral Density, 802.11n HT40 - 2422 - Pwr 10



Plot 154. Power Spectral Density, 802.11n HT40 - 2437 - Pwr 20



Plot 155. Power Spectral Density, 802.11n HT40 - 2452 - Pwr 10

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.

MPE Limit: EUT's operating frequencies @ 2400-2483.5 MHz; **Limit for Uncontrolled exposure: 1 mW/cm^2 or 10 W/m^2**

Equation from page 18 of OET 65, Edition 97-01

$$S = PG / 4\pi R^2 \quad \text{or} \quad R = \sqrt{(PG / 4\pi S)}$$

where, S = Power Density (mW/cm^2)
P = Power Input to antenna (mW)
G = Antenna Gain (numeric value)
R = Distance (cm)

Test Results:

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**
2437	20.37	108.893	12	15.849	0.34334	1	0.65666	20	Pass
2437	20.37	108.893	6	3.981	0.08624	1	0.91376	20	Pass

Table 21. Maximum Permissible Exposure, 2.4 WiFi

The safe distance where Power Density is less than the MPE Limit listed above was found to be 20 cm.

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
1A1083	EMI Test Receiver	Rohde & Schwarz	ESU40	8/2/2016	8/2/2017
1A1106A	10m Chamber (FCC)	ETS	Semi-Anechoic	12/1/2016	12/1/2017
1A1147	Bilog Antenna (30MHz to 1GHz)	Sunol Sciences Corp	JB3	3/9/2017	3/9/2018
1A1047	Horn Antenna	ETS	3117	2/23/2017	8/23/2018
1A1161	DRG Horn Antenna	ETS	3116C-PA	3/6/2017	9/6/2018
1A1099	Generator	COM-Power Corp	CGO-51000	See Note	
1A1088	Pre-Amp	Rohde & Schwarz	TS-PR1	See Note	
1A1044	Generator	COM-Power Corp	CG-520	See Note	
1A1073	Multi Device Controller	ETS EMCO	2090	See Note	
1A1074	System Controller	Panasonic	WV-CU101	See Note	
1A1075	System Controller	Panasonic	WV-CU101	See Note	
1A1080	Multi Device Controller	ETS EMCO	2090	See Note	
1A1180	Pre-Amp	Miteq	AMF-7D-01001800-22-10P	See Note	
1A1065	EMI Receiver	Rohde & Schwarz	ESCI	3/14/2017	3/14/2018
1A1177	Pulse Limiter	Rohde & Schwarz	ESH3Z2	2/21/2017	8/21/2018
1A1119	Test Area	Custom Made	N/A	8/14/2015	8/14/2017
1A1122	LISN	Teseq	NNB 51	5/26/2016	5/26/2017
1A1149	Milliohm Meter	GW Instek	GOM-802	4/27/2017	4/27/2018
1A1141	Spectrum Analyzer	Agilent	E4407B	4/10/2017	4/10/2018

Table 22. 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 user's 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