MET Laboratories, Inc. *Safety Certification - EMI - Telecom Environmental Simulation*
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June 8, 2018

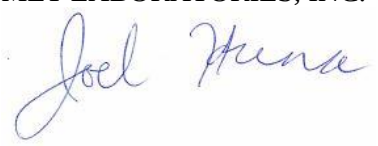
Viavi Solutions - Germantown
20250 Century Blvd.
Germantown, MD 20874

Dear Jaryk Kuzel,

Enclosed is the EMC Wireless test report for compliance testing of the Viavi Solutions - Germantown, TB/MTS-5882, with Expansion Module as tested to the requirements of Title 47 of the CFR, Ch. 1 (10-1-06 ed.), Part 15 Subpart C for Intentional Radiators.

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

Sincerely yours,
MET LABORATORIES, INC.



Joel Huna
Documentation Department

Reference: (\Viavi Solutions - Germantown\EMC97842B-FCC247 WIFI Rev. 6)

Electromagnetic Compatibility Criteria
Test Report

for the

Viavi Solutions - Germantown
TB/MTS-5882, with Expansion Module

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

MET Report: EMC97842B-FCC247 WIFI Rev. 6

June 8, 2018

Prepared For:

Viavi Solutions - Germantown
20250 Century Blvd.
Germantown, MD 20874

Prepared By:
MET Laboratories, Inc.
914 West Patapsco Avenue,
Baltimore, MD 21230

Electromagnetic Compatibility Criteria
Test Report

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the FCC Certification Rules
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15.247 Subpart C for Intentional Radiators

Bradley Jones, 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
∅	May 10, 2018	Initial Issue.
1	May 17, 2018	Revision of CEV Data
2	May 22, 2018	TCB Corrections.
3	May 29, 2018	TCB Corrections.
4	June 1, 2018	Addition of Power Section.
5	June 7, 2018	Corrections to Power Section.
6	June 8, 2018	TCB 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 Viavi Solutions - Germantown TB/MTS-5882, with Expansion Module, 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 TB/MTS-5882, with Expansion Module. Viavi Solutions - Germantown should retain a copy of this document which should be kept on file for at least two years after the manufacturing of the TB/MTS-5882, with Expansion Module, 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 Viavi Solutions - Germantown, purchase order number 294123309. All tests were conducted using measurement procedure ANSI C63.4-2014.

FCC Reference 47 CFR Part 15.247:2005	Description	Compliance
Title 47 of the CFR, Part 15 §15.207(a)	Conducted Emission Limits	Compliant
Title 47 of the CFR, Part 15 §15.247(b)	Peak Power Output	Compliant
Title 47 of the CFR, Part 15 §15.247(d); §15.209; §15.205	Radiated Spurious Emissions Requirements	Compliant

Table 1. Executive Summary of EMC Part 15.247 ComplianceTesting

This device contains the radio modular (FCC ID: TFB-TIWI1-01/IC: 5969A-TIWI101). For all conducted signal tests (such as DTS Bandwidth and PSD), please refer to the original reports of the modular.

II. Equipment Configuration

A. Overview

MET Laboratories, Inc. was contracted by Viavi Solutions - Germantown to perform testing on the TB/MTS-5882, with Expansion Module, under Viavi Solutions - Germantown's purchase order number 294123309.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the Viavi Solutions - Germantown, TB/MTS-5882, with Expansion Module.

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

Model(s) Tested:	TB/MTS-5882, with Expansion Module	
Model(s) Covered:	TB/MTS-5882, with Expansion Module	
EUT Specifications:	Primary Power: 100-240 VAC 50/60 Hz	
	FCC ID: WUW-5882TWB	
	Type of Modulations:	802.11 b/g/n DSSS, OFDM
	Equipment Code:	DTS
	EUT Frequency Ranges:	2412-2462 MHz
Analysis:	The results obtained relate only to the item(s) tested.	
Environmental Test Conditions:	Temperature: 15-35º C	
	Relative Humidity: 30-60%	
	Barometric Pressure: 860-1060 mbar	
Evaluated by:	Bradley Jones	
Report Date(s):	June 8, 2018	

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

Table 3. References

C. Test Site

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

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

D. Measurement Uncertainty

Test Method	Typical Expanded Uncertainty	K	Confidence Level
RF Frequencies	±4.52 Hz	2	95%
RF Power Conducted Emissions	±2.32 dB	2	95%
RF Power Conducted Spurious Emissions	±2.25 dB	2	95%
RF Power Radiated Emissions	±3.01 dB	2	95%

Table 4. Uncertainty Calculations Summary

E. Description of Test Sample

The Viavi Solutions - Germantown TB/MTS-5882, with Expansion Module, Equipment Under Test (EUT), is a multi-rate handheld network tester used to evaluate telecommunications circuits. These circuits include but are not limited to Ethernet (10Mbps – 10Gbps), SONET/SDH (STS-1, OC3 - OC192), OTN (up to 11.1 Gbps), Fibre Channel (1Gig – 16Gig), CIPRI (up to 10137.6 Mbps), OBSAI (up to 6144 Mbps) and PDH (DS1, DS3, STM-1e, E1, E3, E4).
All interfaces are intended for indoor use, connected to equipment that is isolated from the outside plant. Power is supplied by an external AC/DC converter or by the internal battery. GPS synchronized timing is provided by an optionally-attached C5TEM-R module.
The unit is intended to be used by telecommunications network provisioning and maintenance technicians located in network operations centers, central offices, and customer premises (not residential).

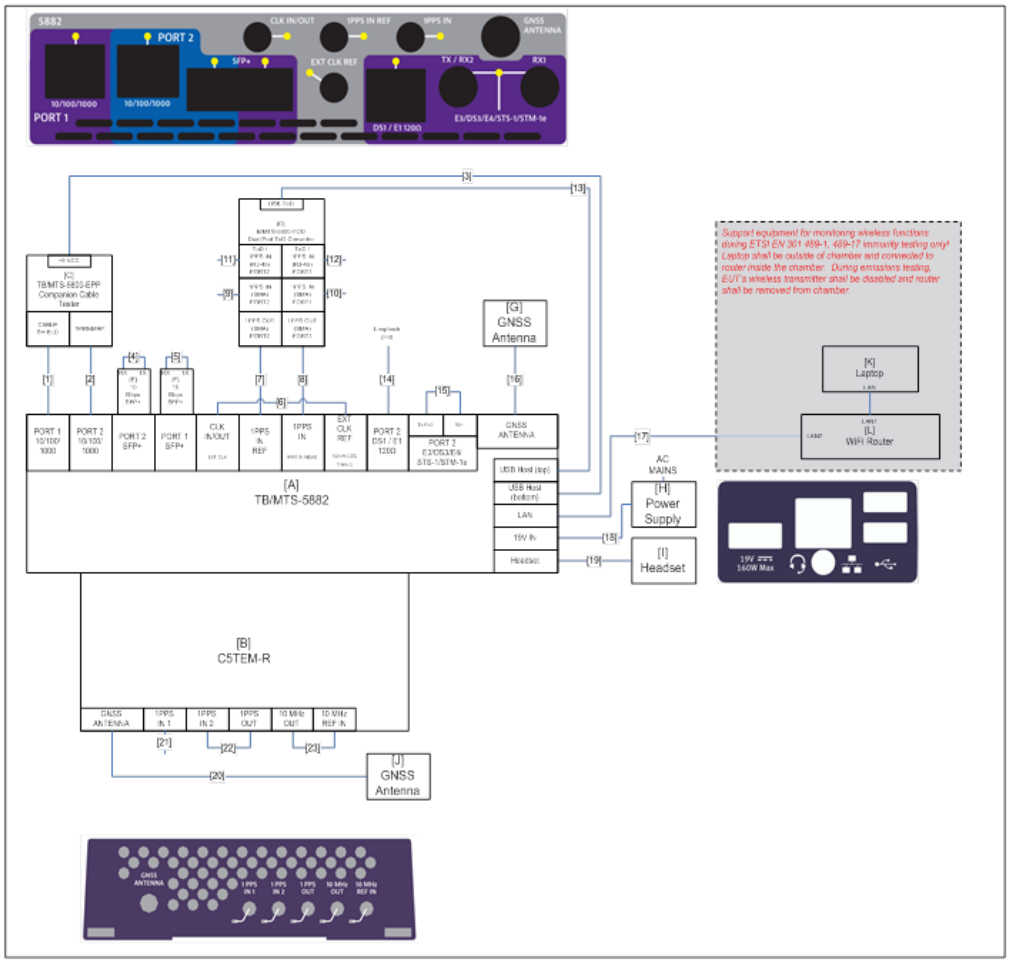


Figure 1. Block Diagram of Test Configuration

F. 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	Slot #	Name / Description	Model Number	Part Number	Serial Number	Rev. #
A	NA	Base Unit	TB/MTS-5882	22123563	WMNK 0025170020	N/A
B	Expansion	Expansion Module	C5TEM-R	22108483	WMRU 0020160015	N/A
C	Ports 1 & 2 10/100/1000	Companion Cable Tester	TB/MTS-5800-EPP	22123564	WMNH 0025170009	N/A
D	NA	Dual Port ToD Converter	TB/MTS-5800-TOD	22123565	N/A	N/A
E	Port2 SFP+	16Gbps SFP+ (850nm)	Finisar FTLF8529P3BCV	22103786	USM17U7	N/A
F	Port1 SFP+	16Gbps SFP+ (1310nm)	Finisar FTLF1429P3BNV	22103787	USM0ATG	N/A
G	NA	GNSS Antenna	Taoglas AA.162.301111	22110717	162CT15360101	NA
H	NA	Power Supply	Adapter Tech ATS160TP190Q15201	22115862	NA	N/A
I	NA	Headset	Plantronics M110	10-017673	NA	001
J	NA	GNSS Antenna	Taoglas AA.162.301111	22110717	162CT15360110	NA

Table 5. Equipment Configuration

G. 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
K	Laptop	Dell	Lattitude D610	N/A
L	WiFi Router	Netgear	AC1200 Model R6220 s/n A063910223F8	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 6. Support Equipment

H. 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	[A] PORT 1 10/100/1000	CAT5/5e/6, STP	1	3m	100m	Y	[C] CABLE SHIELD
2	[A] PORT 2 10/100/1000	CAT5/5e/6, UTP	1	7.6m	100m	N	[C] WIREMAP
3	[C] +5 VDC	USB to Micro USB A/B, STP	1	1.2m	2m	Y	[A] USB Host (bottom)
4	[E] TX	Fiber optic, MM (orange)	1	N/A	N/A	N/A	[E] RX
5	[F] TX	Fiber optic, SM (yellow)	1	N/A	N/A	N/A	[F] RX
6	[A] CLK IN/OUT (EXT CLK)	50Ω coaxial, RG-174/U, SMB-SMB	1	3m	7.6m	Y	[A] EXT CLK REF (ADVANCED TIMING)
7	[A] 1PPS IN REF	50Ω coaxial, RG-174/U, SMB-SMA	1	1.5	7.6m	Y	[D] 1PPS OUT PORT 2
8	[A] 1PPS IN	50Ω coaxial, RG-174/U, SMB-SMA	1	1.5	7.6m	Y	[D] 1PPS OUT PORT 1
9	[D] 1PPS IN PORT 2	50Ω coaxial, RG-174/U, SMA-SMA	1	1.5	7.6m	Y	Unterminated
10	[D] 1PPS IN PORT 1	50Ω coaxial, RG-174/U, SMA-SMA	1	1.5	7.6m	Y	Unterminated
11	[D] ToD/1PPS IN PORT 2	CAT5/5e/6, UTP	1	3m	7.6m	Y	Unterminated
12	[D] ToD/1PPS IN PORT 1	CAT5/5e/6, UTP	1	7.6m	7.6m	Y	Unterminated
13	[D] USB TOD	USB to Mini USB A/B, STP	1	1m	2m	Y	[A] USB Host (top)
14	[A] PORT 2 DS1/E1	RJ-48 to split 2x Bantam	1	3m	20m	N	[A] PORT 2 DS1/E1 (via Loopback Plug)
15	[A] PORT 2 E3/DS3/E4/STS-1/STM-1e TX/RX2	75Ω coaxial, Belden 1855A, sub-miniature 59/U, HDBNC	1	3m	20m	Y	[A] PORT 2 E3/DS3/E4/STS-1/STM-1e RX1
16	[A] Antenna	Antenna integrated cable: 50Ω coaxial, RG-174/U, SMA	1	3m	3m	Y	[G] GNSS Antenna
17	[A] LAN	CAT5/5e/6, UTP	1	4.6m	100m	N	[O] LAN2
18	[A] 19V IN	AC/DC adapter, UL1185	1	1.1m	1.1m (to adapter)	Y	[H] Power Supply
19	[A] Headset	Headset	1	1.2m	1.2m (to headset)	Y	[I] Headset
20	[B] GNSS Antenna	Antenna integrated cable: 50Ω coaxial, RG-174/U, SMA	1	3m	3m	Y	[J] GNSS Antenna
21	[B] 1PPS IN1	50Ω coaxial, RG-174/U, SMB	1	3m	7.5m	Y	Unterminated
22	[B] 1PPS OUT	50Ω coaxial, RG-174/U, SMB	1	3m	7.5m	Y	[B] 1PPS IN2
23	[B] 10MHz OUT	50Ω coaxial, RG-174/U, SMB	1	3m	7.5m	Y	[B] 10MHz REF IN

Table 7. Ports and Cabling Information

I. Mode of Operation

The UUT will thus be running three simultaneous applications as denoted by the three separate tabs near the top of the display:

For all tests

"16Gig Fibre Channel Layer 2 Traffic Term" test application running on Port 1 (SFP)

"10/100/1000 Eth Layer 2 Traffic Term" test application running on Port 2 (RJ45)

"Timing Module" timing application running on the attached C5TEM-R Expansion Module
For the purposes of simulating the EUT's normal function of testing telecommunication circuits, the transmitted signals are looped back to the receivers using appropriate external, optical and/or electrical loopback cables/accessories.

J. Method of Monitoring EUT Operation

For test applications running on Port 1 and Port 2:
Each running test has its own full-screen test view that can be accessed by selecting the application tab for that particular test near the top of the screen. In full-screen mode, it is necessary to switch back and forth between the tabs in order to monitor each running test.
1. In normal error-free operation, the tab for the associated test is GREEN or YELLOW and, when selected:
- the circular Signal Present indicator is GREEN
- the circular Frame Sync and/or Sync Acquired indicator is GREEN
- the circular Pattern Sync indicator is GREEN
- the oval Summary indicator is GREEN or YELLOW
- the text in both "Summary" results category windows states "ALL SUMMARY RESULTS OK"
- the text below the test tabs states "Running" and test minutes and seconds are incrementing

2. In Continuously Errored / Broken state you would see one or more of the following:
- one or more of the referenced circular indicators is not continuously GREEN
- the text in either "Summary" results category windows is not GREEN or YELLOW, does not state "ALL SUMMARY RESULTS OK" and instead continuously displays one or more errors that do not have "History" in the error name and if the errors includes a count, is continuously incrementing.

The above are to be monitored from outside the test chamber using the laptop VNC client.

Note regarding immunity testing pass/fail criteria:
RED indicators alone do not necessarily constitute a failure per performance criteria B. For example, the Summary results box turns and remains RED after the first error is encountered, even if normal operation subsequently resumes. Also, if any of the square indicators turn RED, or an error is displayed that includes "History" in the error name, it means that at least one historical error of that type was registered. Provided that none of the conditions noted for Continuously Errored / Broken state are true, these historical-only errors are considered transient and signify that the equipment has resumed operating normally without user intervention. Proof that the EUT is still performing its function as a network tester can be had by manually inserting bit errors on the Errors tab. Errors can be cleared by selecting "Restart".
Monitoring and required performance criteria of wireless functionality (during ETSI EN 301 489-1, 489-17 immunity testing only):
Place the wireless router in the chamber.
Power on the EUT, laptop, and wireless router
On the EUT, press System Network WiFi to access the network configuration settings screen
Check the "Enable wireless adapter" checkbox.
Select the wireless router (see SSID and KEY on router). Note the assigned IP address.
Log into the laptop (see username and password on laptop).
Open a command prompt using on the laptop using the Command Prompt icon on the desktop.
Continuously ping the EUT from the laptop (substituting the IP address obtained above).
ping -t xxx.xxx.xxx.xxx
Press Ctrl + Fn + Pause(Insert) on the laptop to see lost packet statistics
Lost packets greater than 10% for a single given test shall constitute a failure.
Press Ctrl + C on the laptop to stop pinging.
Reissue the ping command when starting a new test in order to reset the lost packet statistics.

K. 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.

L. Disposition of EUT

The test sample including all support equipment submitted to the Electro-Magnetic Compatibility Lab for testing was returned to Viavi Solutions - Germantown upon completion of testing.

III. Electromagnetic Compatibility Criteria for Intentional Radiators

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 inside a screen room. 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.

Test Results: The EUT was compliant with this requirement. Measured emissions were within applicable limits.

Test Engineer(s): Deepak Giri

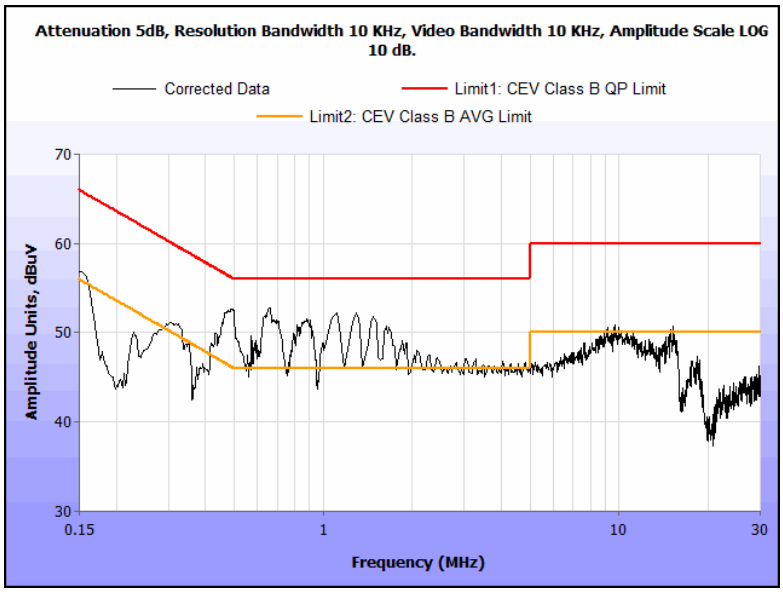
Test Date(s): February 27, 2018

15.207(a) Conducted Emissions Test Results

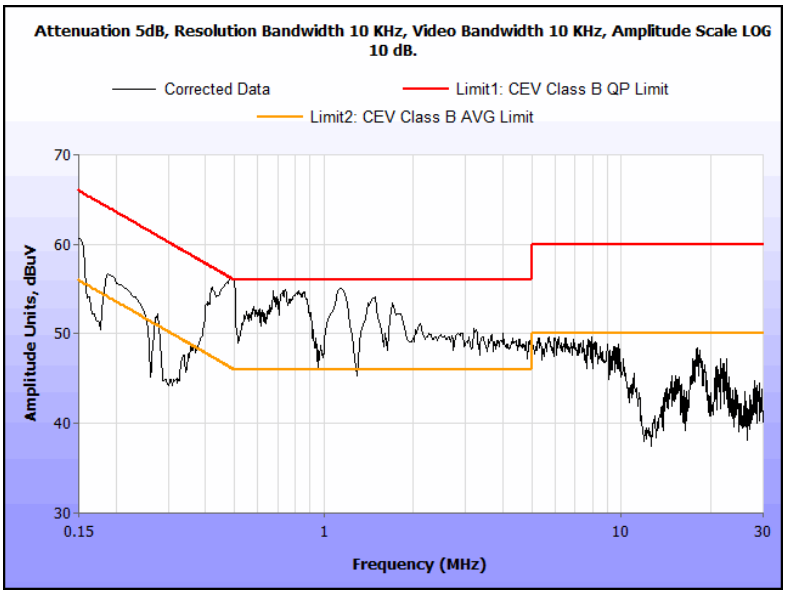
Frequency (MHz)	Uncorrected Meter Reading (dBuV) QP	Cable Loss (dB)	Corrected Measurement (dBuV) QP	Limit (dBuV) QP	Margin (dB) QP	Uncorrected Meter Reading (dBuV) Avg.	Cable Loss (dB)	Corrected Measurement (dBuV) AVG	Limit (dBuV) AVG	Margin (dB) AVG
*0.458	54.88	0	54.88	56.73	-1.85	38.19	0	38.19	46.73	-8.54
*0.5605	57.61	0	57.61	56	1.61	42.76	0	42.76	46	-3.24
1.079	43.55	0	43.55	56	-12.45	32.07	0	32.07	46	-13.93
9.911	45.67	0.08	45.75	60	-14.25	36.12	0.08	36.2	50	-13.8
10.3	46.37	0.08	46.45	60	-13.55	37.04	0.08	37.12	50	-12.88
17.84	37.78	0.15	37.93	60	-22.07	31.95	0.15	32.1	50	-17.9

Table 9. Conducted Emissions, 15.207(a), Phase Line, Test Results

Note: * - As per FCC 15.207, conducted emissions as a results of the intentional radio are only accounted for. Emission level in digital emission case and transmitter ON case throughout the span of 150 KHz to 30 MHz are very closely similar. Hence, it is concluded that emissions above the FCC 15.207 limit are not the result of the transmitter emissions, but due to the digital emissions.



Plot 1. Conducted Emissions, 15.207(a), Phase Line Transmitter OFF



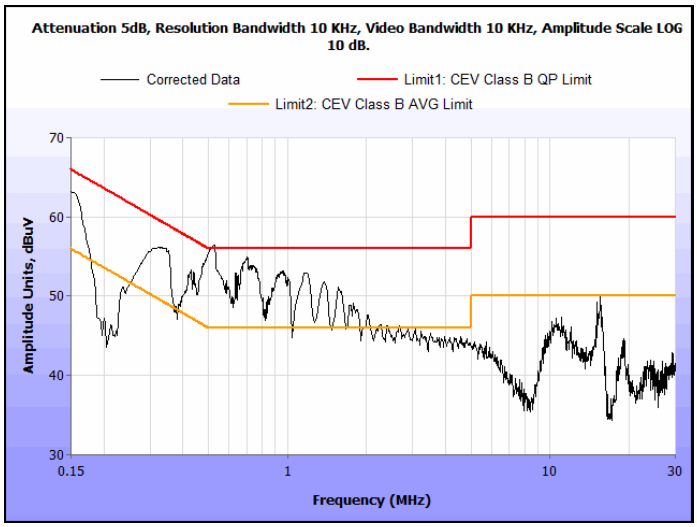
Plot 2. Conducted Emissions, 15.207(a), Phase Line Transmitter ON

15.207(a) Conducted Emissions Test Results

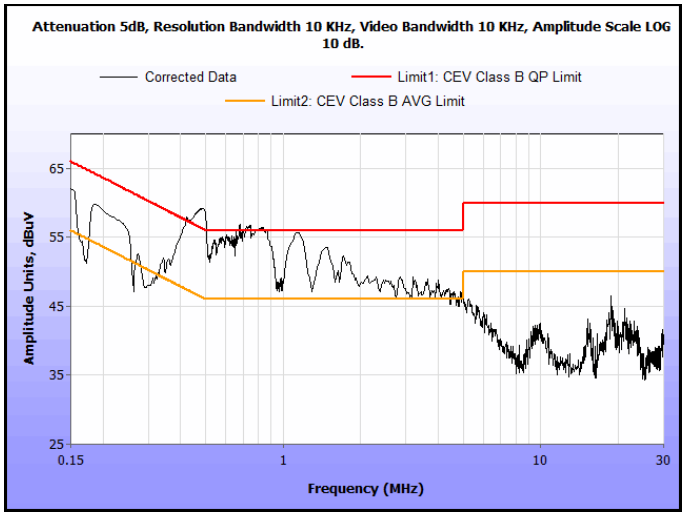
Frequency (MHz)	Uncorrected Meter Reading (dBuV) QP	Cable Loss (dB)	Corrected Measurement (dBuV) QP	Limit (dBuV) QP	Margin (dB) QP	Uncorrected Meter Reading (dBuV) Avg.	Cable Loss (dB)	Corrected Measurement (dBuV) AVG	Limit (dBuV) AVG	Margin (dB) AVG
0.4553	52.67	0	52.67	56.78	-4.11	37.88	0	37.88	46.78	-8.9
*0.5705	56.34	0	56.34	56	0.34	43.21	0	43.21	46	-2.79
1.0883	44.21	0	44.21	56	-11.79	33.12	0	33.12	46	-12.88
9.901	43.26	0.08	43.34	60	-16.66	35.42	0.08	35.5	50	-14.5
10.235	47.11	0.08	47.19	60	-12.81	37.11	0.08	37.19	50	-12.81
17.796	36.91	0.15	37.06	60	-22.94	30.87	0.15	31.02	50	-18.98

Table 10. Conducted Emissions, 15.207(a), Neutral Line, Test Results

Note: * - As per FCC 15.207, conducted emissions as a results of the intentional radio are only accounted for. Emission level in digital emission case and transmitter ON case throughout the span of 150 KHz to 30 MHz are very closely similar. Hence, it is concluded that emissions above the FCC 15.207 limit are not the result of the transmitter emissions, but due to the digital emissions.

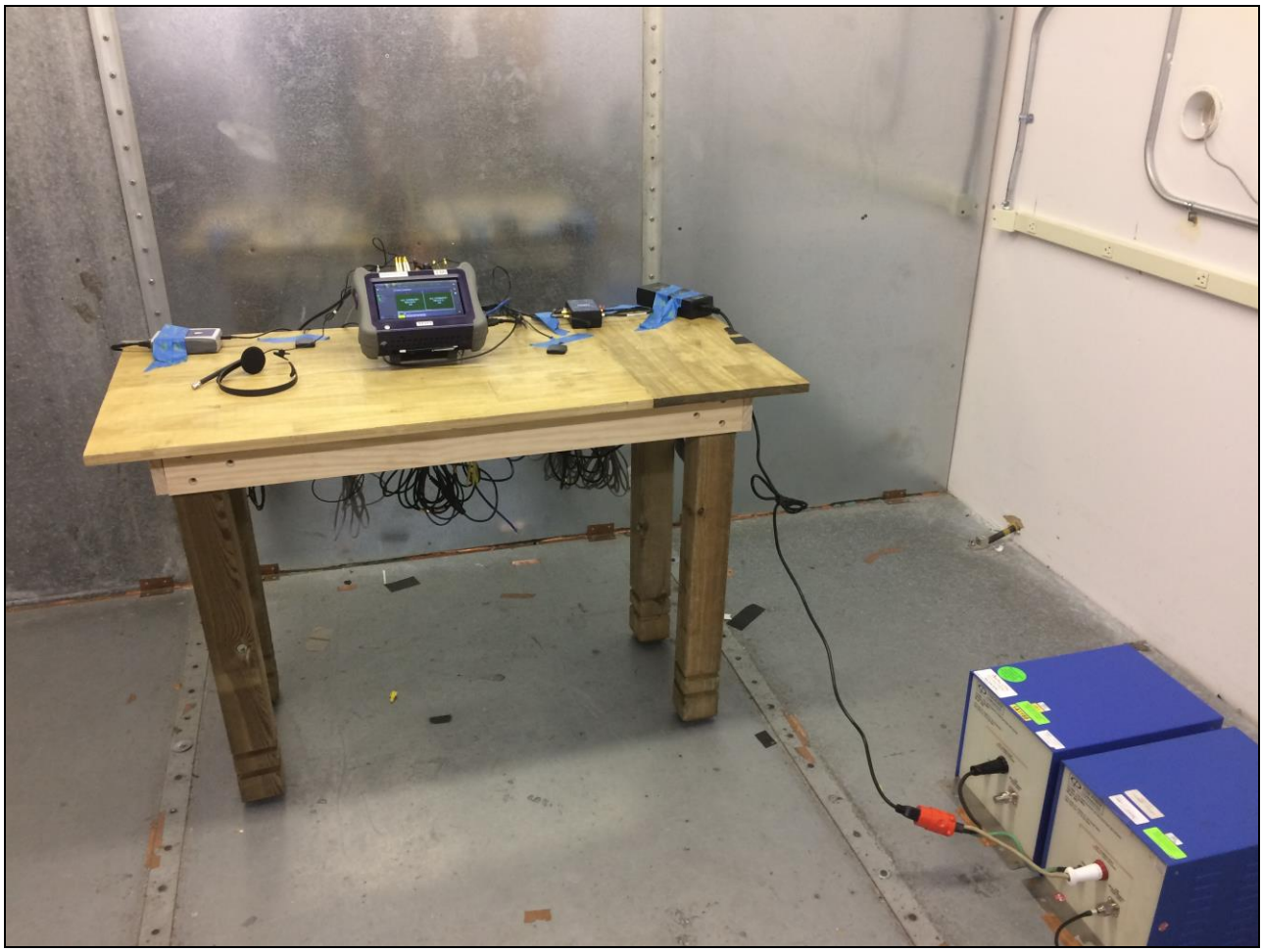


Plot 3. Conducted Emissions, 15.207(a), Neutral Line Transmitter OFF



Plot 4. Conducted Emissions, 15.207(a), Neutral Line Transmitter ON

15.207(a) Conducted Emissions Test Setup Photo



Photograph 1. Conducted Emissions, 15.207(a), Test Setup

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 11. 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 11, 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)**. No anomalies detected.

Test Engineer(s): Benjamin Taylor

Test Date(s): May 31, 2018

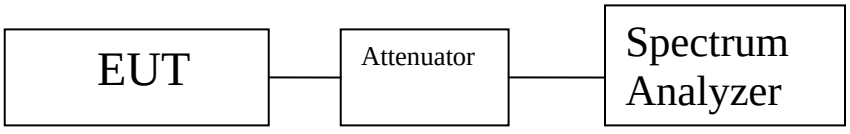
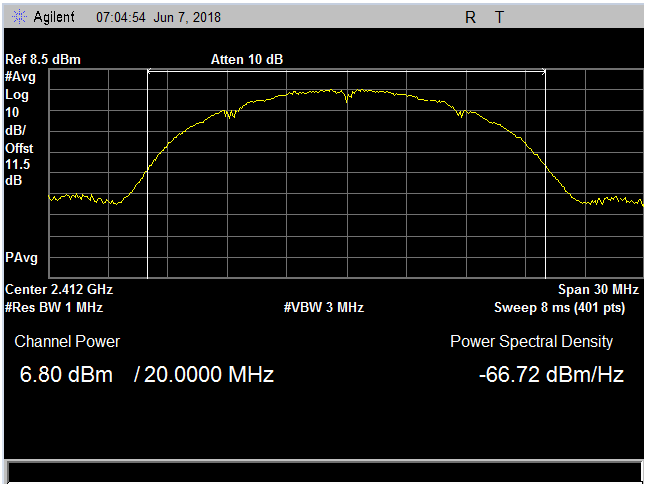


Figure 2. Peak Power Output Test Setup

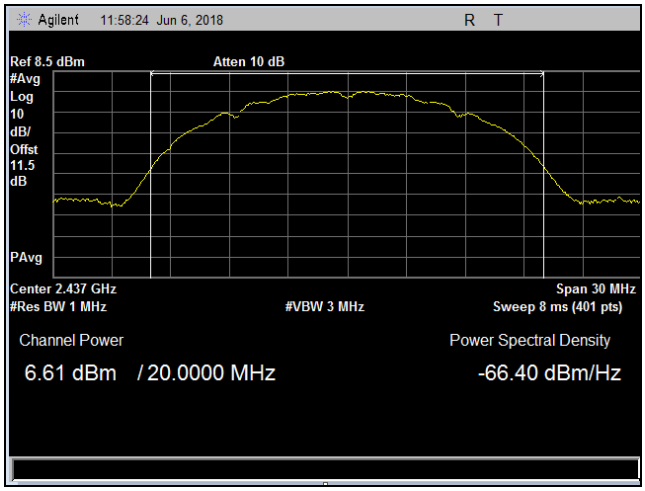
Peak Power Output Test Results

Band (GHz)	Mode	Data Rate	Channel Number	Frequency (MHz)	Measured Avg. Pwr. (dBm)
2.4	802.11b	1 Mbps	1	2412	6.80
			6	2437	6.61
			11	2462	6.71
	802.11g	6 Mbps	1	2412	6.21
			6	2437	6.53
			11	2462	6.44
	802.11n (HT20)	6.5 Mbps	1	2412	6.05
			6	2437	5.80
			11	2462	6.55

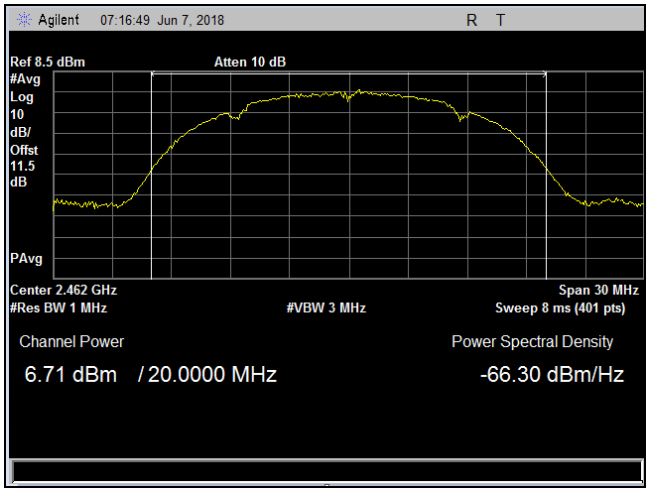
Table 12. Peak Power Output, Test Results



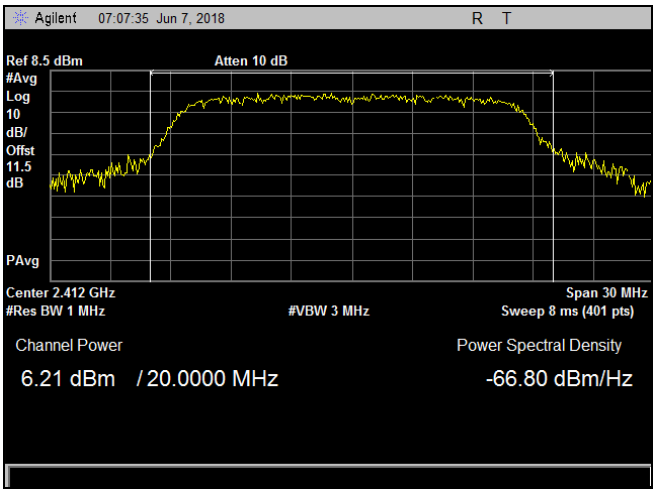
Plot 5. Peak Power Output, 802.11b, 2412 MHz



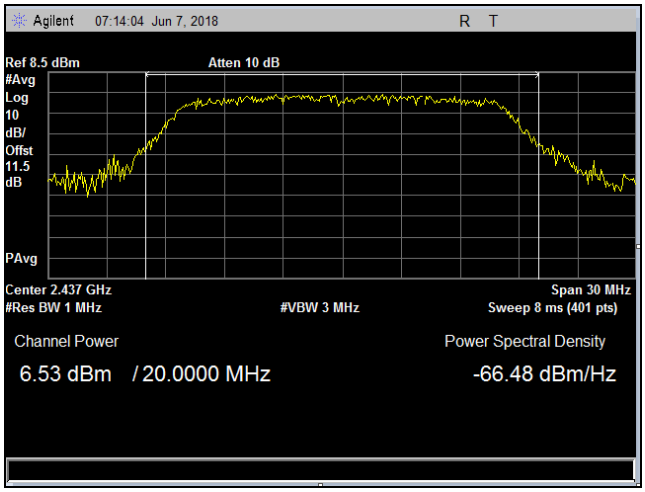
Plot 6. Peak Power Output, 802.11b, 2437 MHz



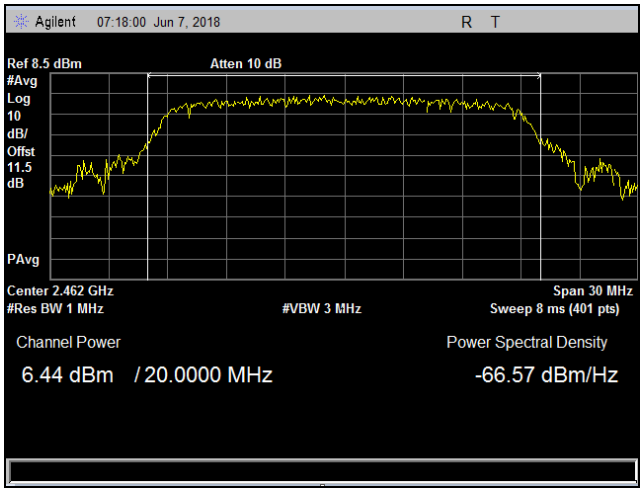
Plot 7. Peak Power Output, 802.11b, 2462 MHz



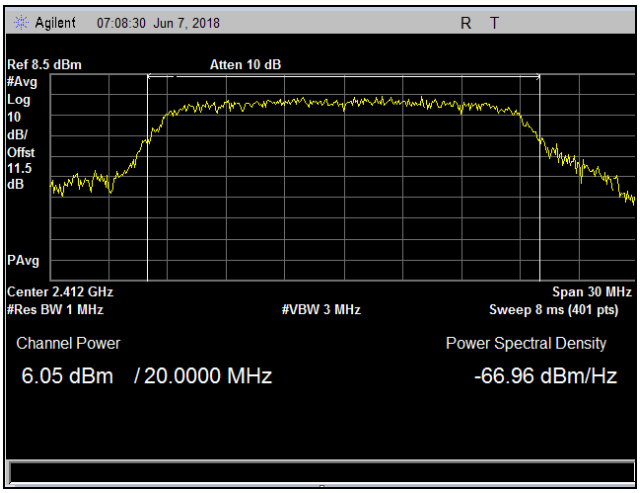
Plot 8. Peak Power Output, 802.11g, 2412 MHz



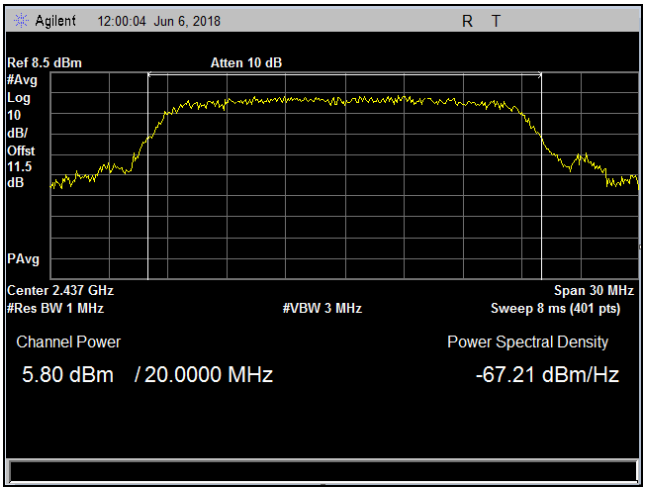
Plot 9. Peak Power Output, 802.11g, 2437 MHz



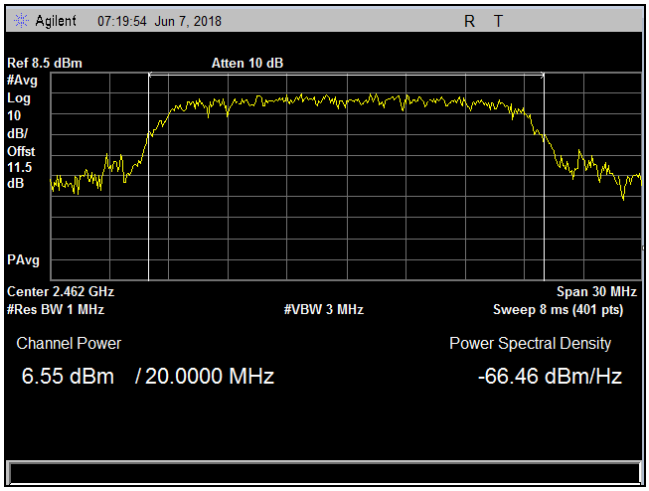
Plot 10. Peak Power Output, 802.11g, 2462 MHz



Plot 11. Peak Power Output, 802.11n, HT20, 2412 MHz



Plot 12. Peak Power Output, 802.11n, HT20, 2437 MHz



Plot 13. Peak Power Output, 802.11n, HT20, 2462 MHz

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 13. 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 14.

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

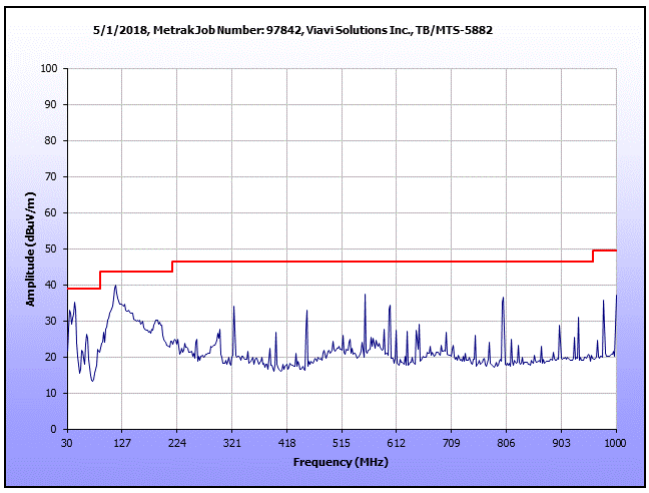
Test Procedures: The transmitter was turned on. Measurements were performed of the low, mid and high Channels. The EUT was rotated orthogonally through all three axes. Plots shown are corrected for both antenna correction factor and distance and compared to a 3 m limit line. Only noise floor was measured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

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

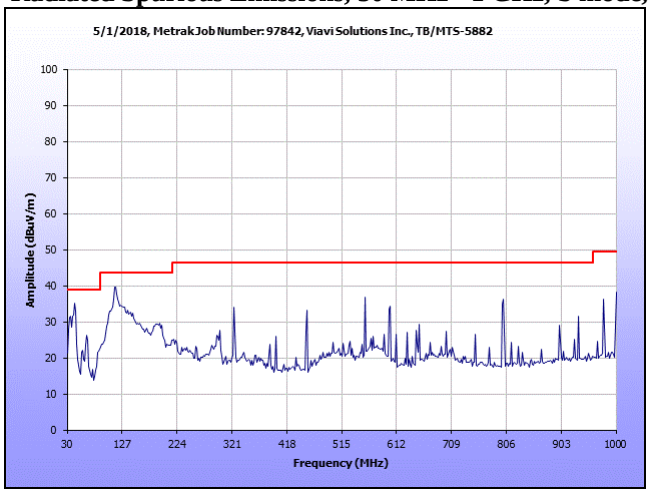
Test Engineer(s): Bradley Jones

Test Date(s): May 2, 2018

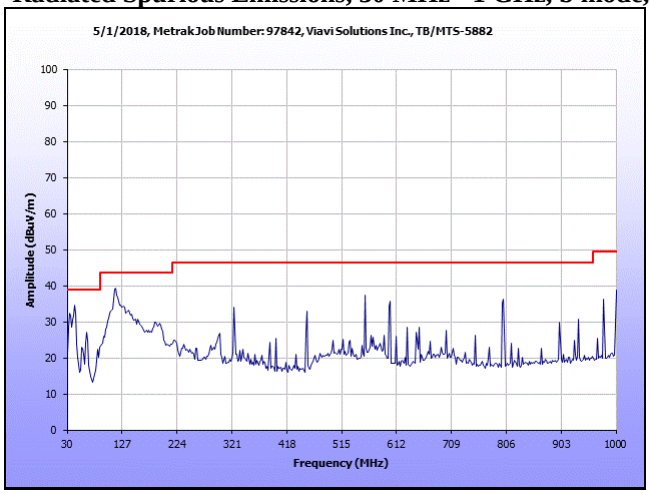
Radiated Spurious Emissions Test Results



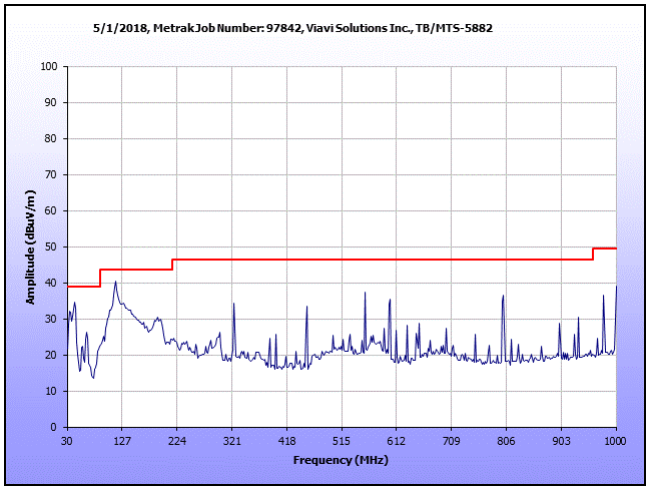
Plot 14. Radiated Spurious Emissions, 30 MHz - 1 GHz, b mode, 19 Low



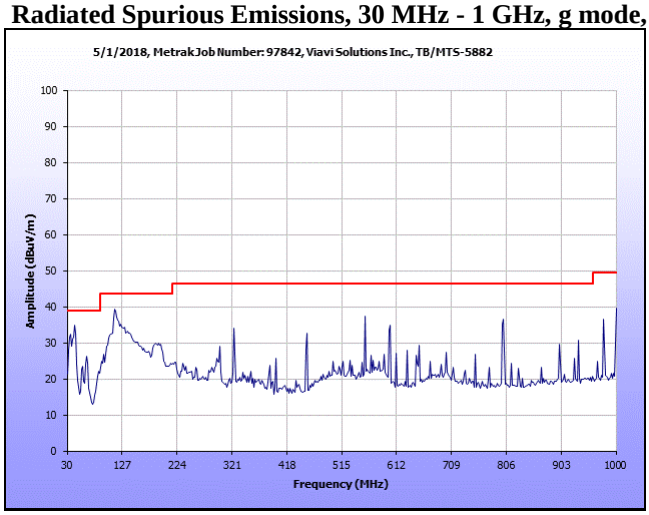
Plot 15. Radiated Spurious Emissions, 30 MHz - 1 GHz, b mode, 19 Mid



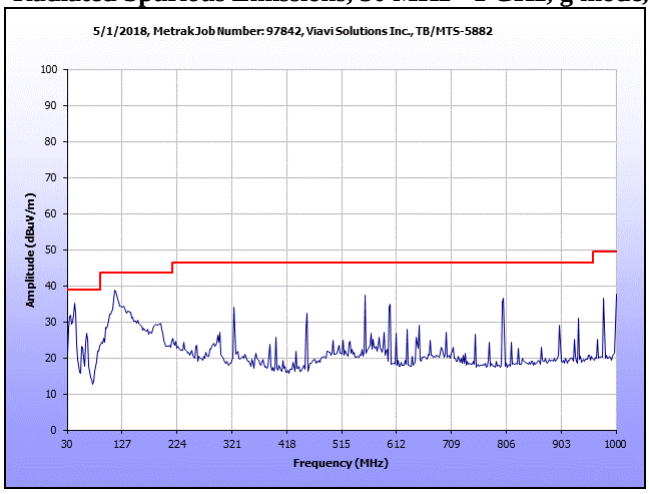
Plot 16. Radiated Spurious Emissions, 30 MHz - 1 GHz, b mode, 19 High



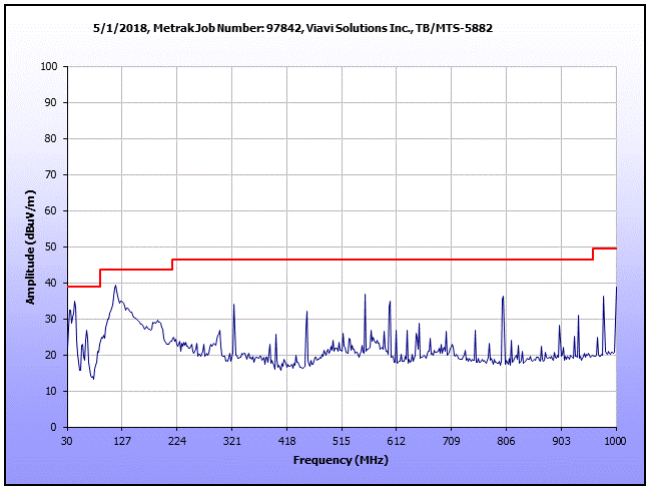
Plot 17. Radiated Spurious Emissions, 30 MHz - 1 GHz, g mode, 19 Low



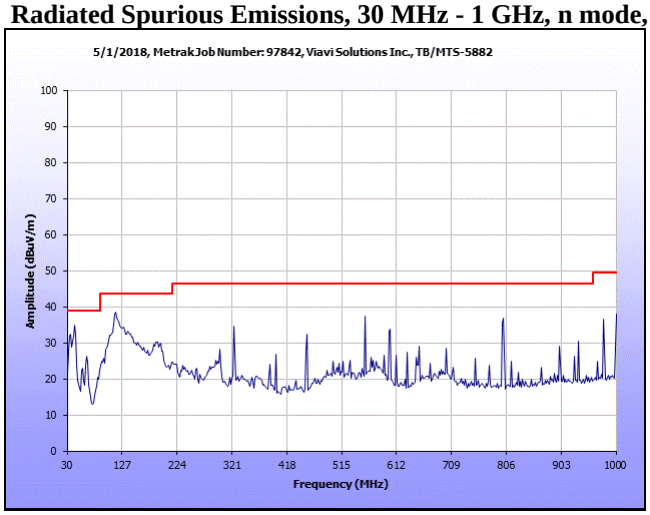
Plot 18. Radiated Spurious Emissions, 30 MHz - 1 GHz, g mode, 19 Mid



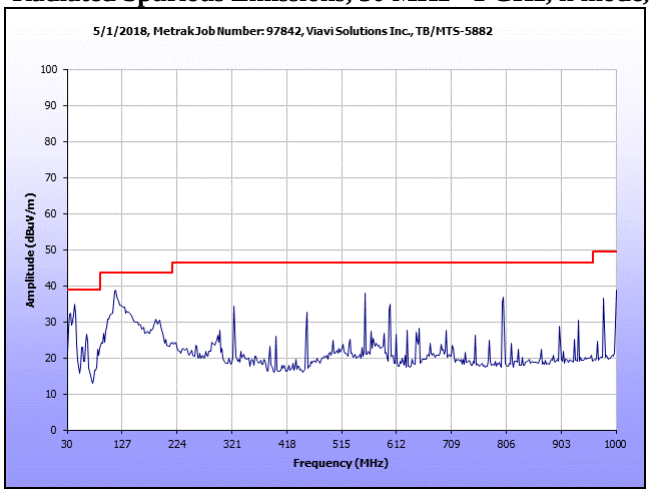
Plot 19. Radiated Spurious Emissions, 30 MHz - 1 GHz, g mode, 19 High



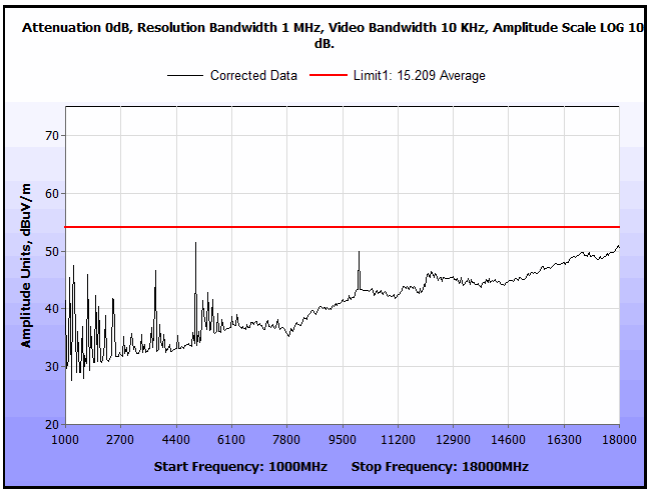
Plot 20. Radiated Spurious Emissions, 30 MHz - 1 GHz, n mode, 19 Low



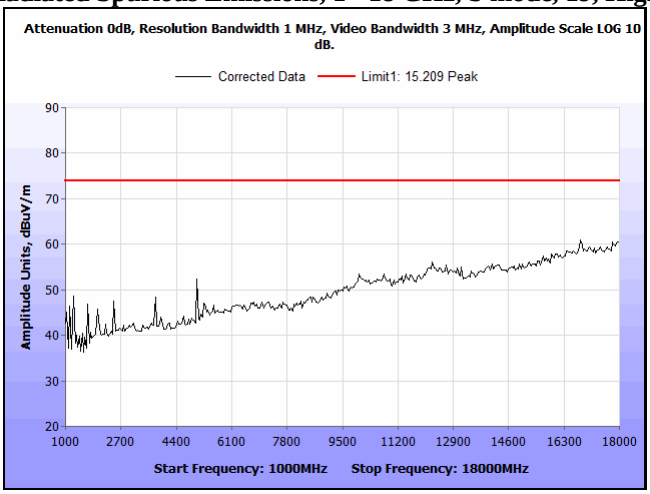
Plot 21. Radiated Spurious Emissions, 30 MHz - 1 GHz, n mode, 19 Mid



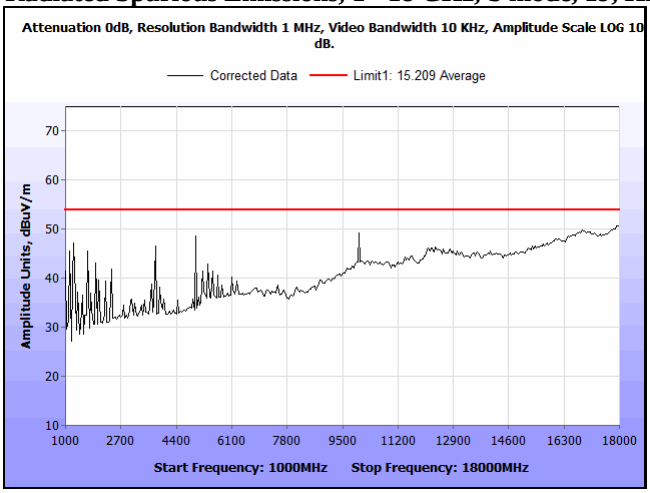
Plot 22. Radiated Spurious Emissions, 30 MHz - 1 GHz, n mode, 19 High



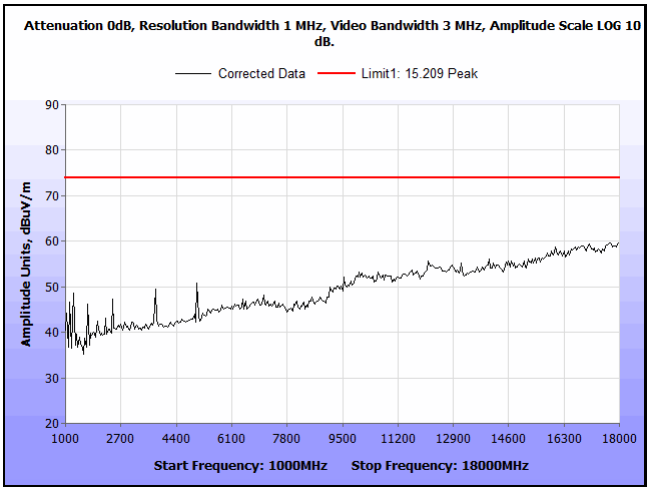
Plot 23. Radiated Spurious Emissions, 1 - 18 GHz, b mode, 19, High Average



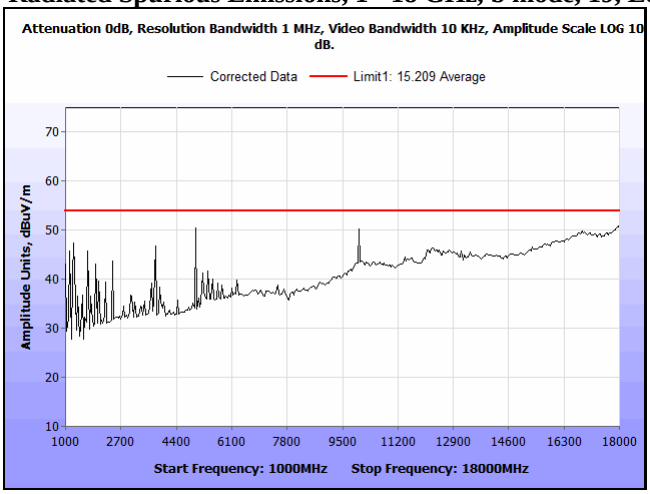
Plot 24. Radiated Spurious Emissions, 1 - 18 GHz, b mode, 19, High Peak



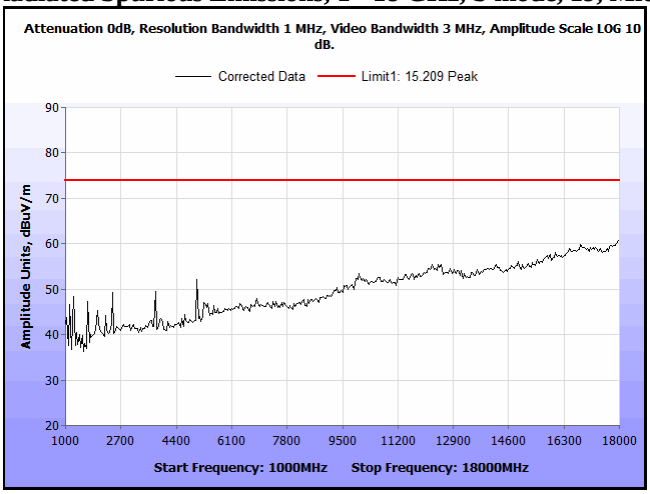
Plot 25. Radiated Spurious Emissions, 1 - 18 GHz, b mode, 19,Low Average



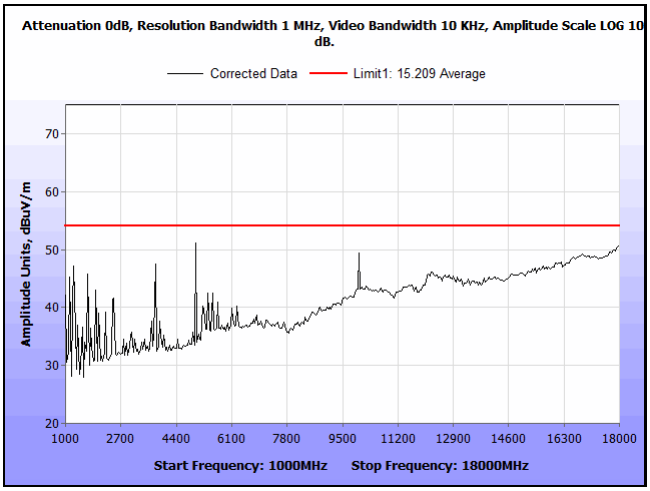
Plot 26. Radiated Spurious Emissions, 1 - 18 GHz, b mode, 19, Low Peak



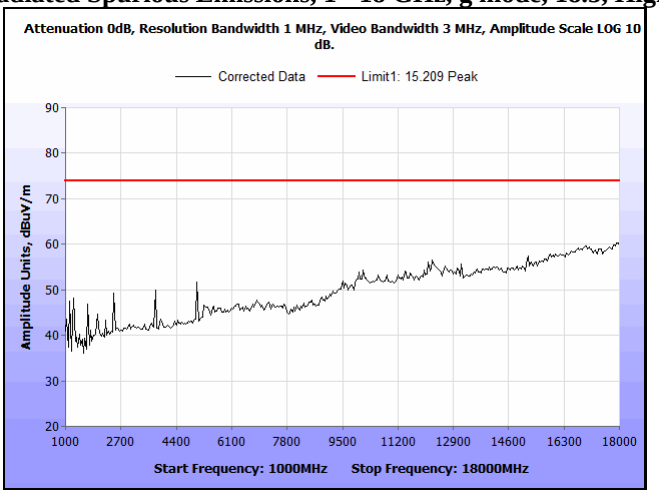
Plot 27. Radiated Spurious Emissions, 1 - 18 GHz, b mode, 19, Mid Average



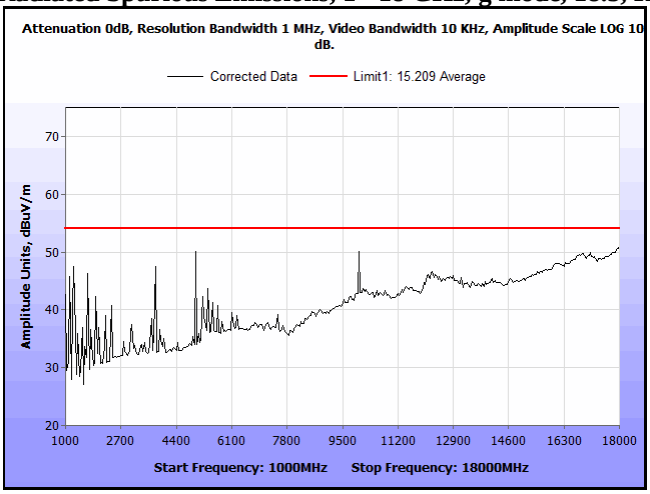
Plot 28. Radiated Spurious Emissions, 1 - 18 GHz, b mode, 19, Mid Peak



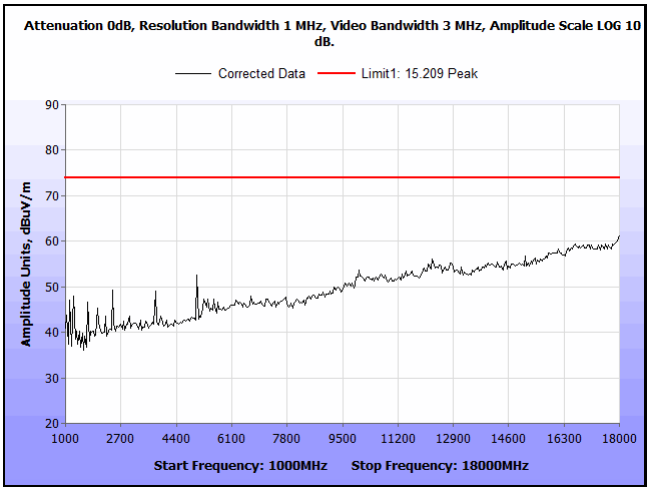
Plot 29. Radiated Spurious Emissions, 1 - 18 GHz, g mode, 18.5, High Average



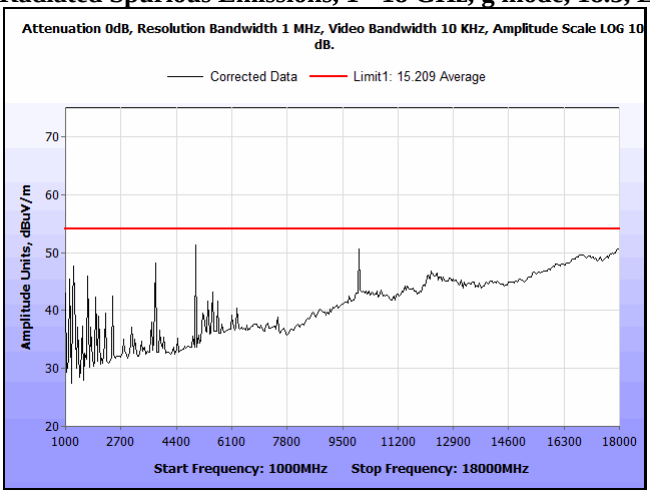
Plot 30. Radiated Spurious Emissions, 1 - 18 GHz, g mode, 18.5, High Peak



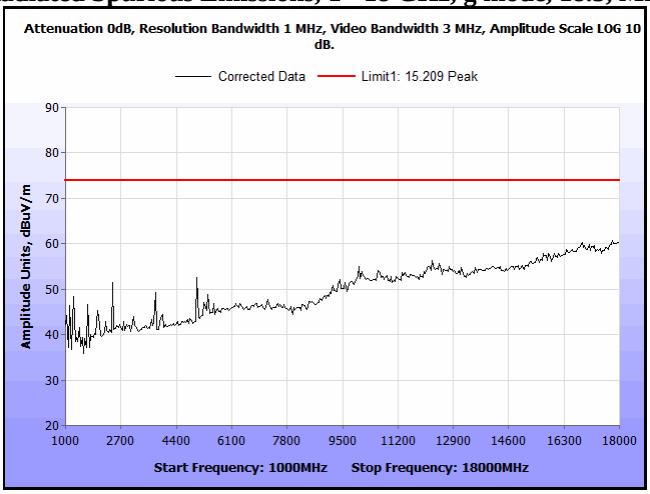
Plot 31. Radiated Spurious Emissions, 1 - 18 GHz, g mode, 18.5, Low Average



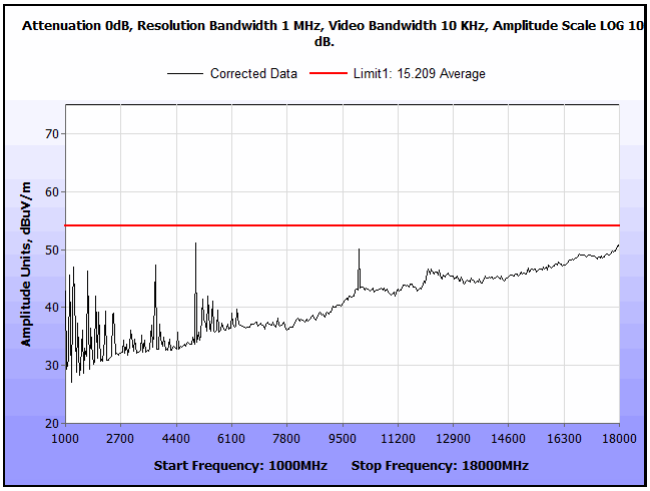
Plot 32. Radiated Spurious Emissions, 1 - 18 GHz, g mode, 18.5, Low Peak



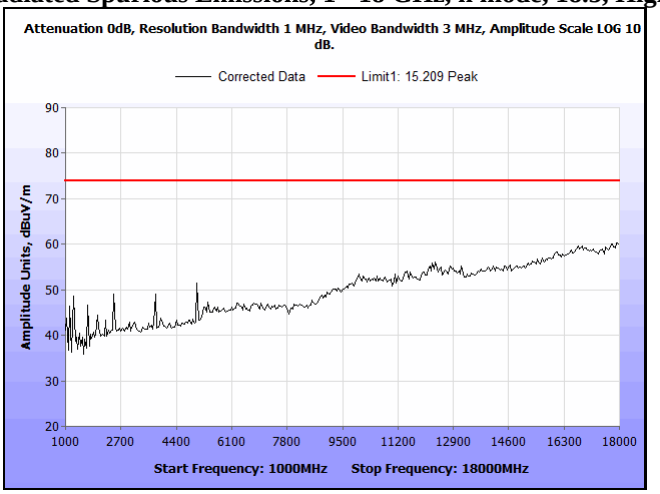
Plot 33. Radiated Spurious Emissions, 1 - 18 GHz, g mode, 18.5, Mid Average



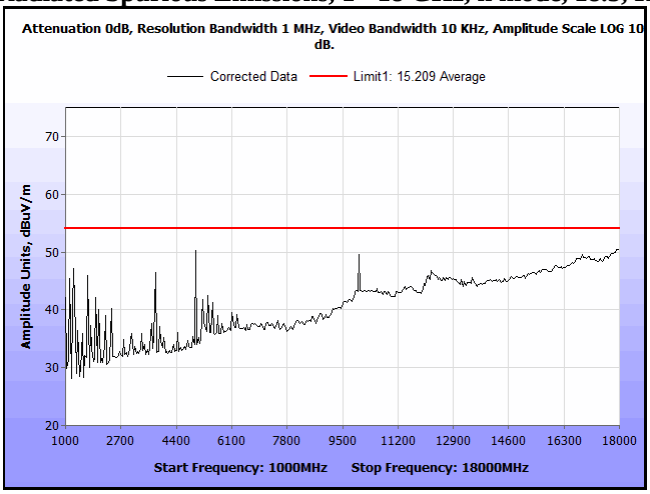
Plot 34. Radiated Spurious Emissions, 1 - 18 GHz, g mode, 18.5, Mid Peak



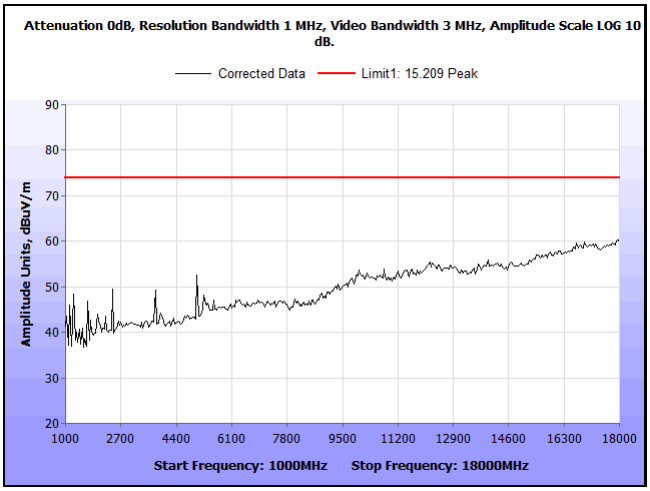
Plot 35. Radiated Spurious Emissions, 1 - 18 GHz, n mode, 18.5, High Average



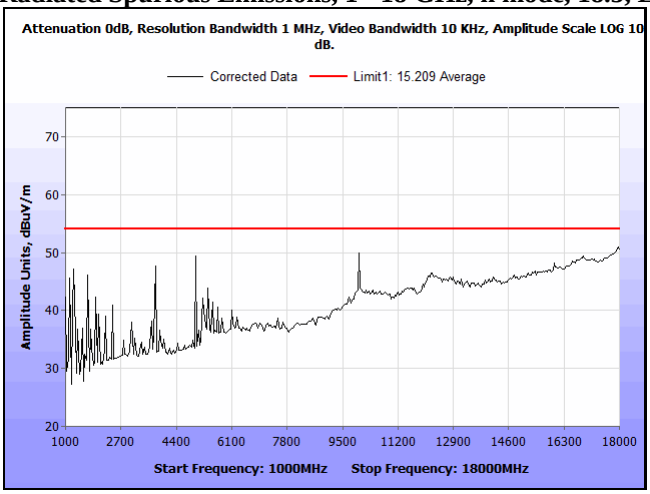
Plot 36. Radiated Spurious Emissions, 1 - 18 GHz, n mode, 18.5, High Peak



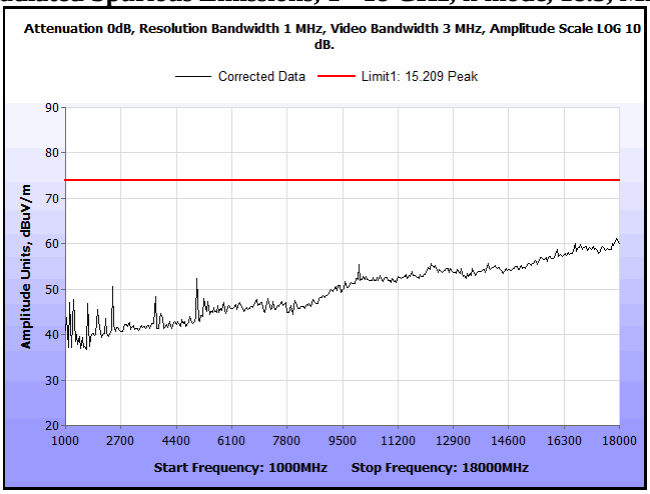
Plot 37. Radiated Spurious Emissions, 1 - 18 GHz, n mode, 18.5, Low Average



Plot 38. Radiated Spurious Emissions, 1 - 18 GHz, n mode, 18.5, Low Peak



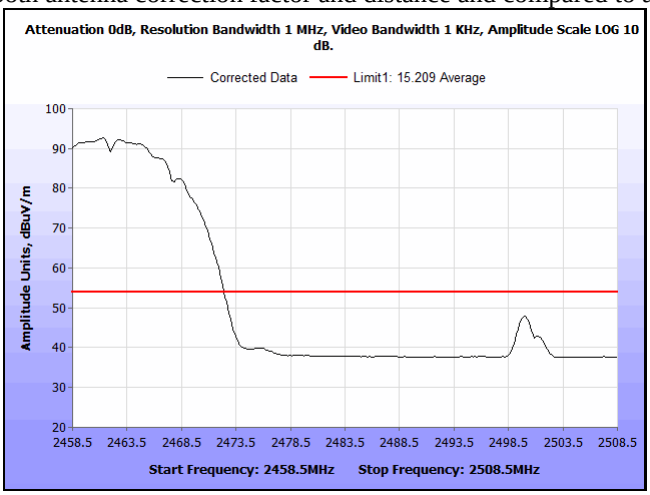
Plot 39. Radiated Spurious Emissions, 1 - 18 GHz, n mode, 18.5, Mid Average



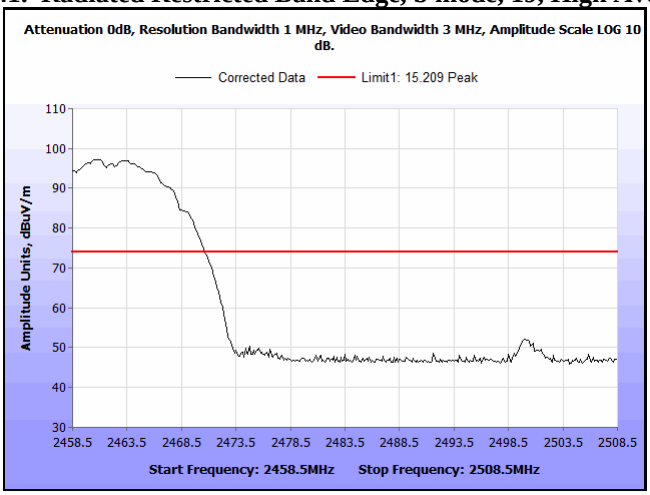
Plot 40. Radiated Spurious Emissions, 1 - 18 GHz, n mode, 18.5, Mid Peak

Radiated Band Edge Measurements

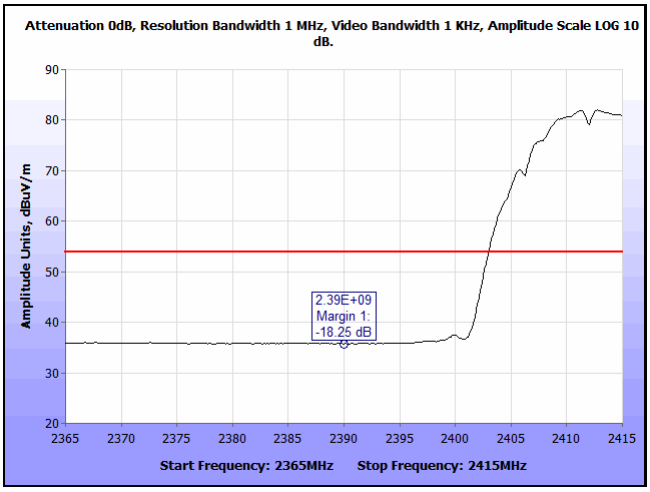
Test Procedures: The transmitter was turned on. Measurements were performed of the low, mid and high Channels. The EUT was rotated orthogonally through all three axes. Plots shown are corrected for both antenna correction factor and distance and compared to a 3 m limit line.



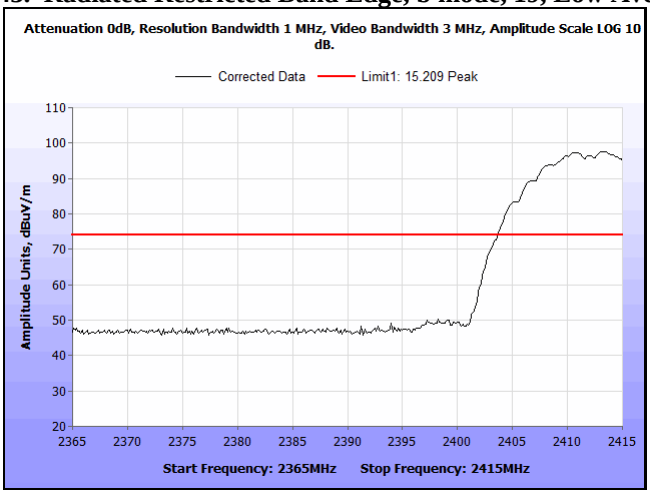
Plot 41. Radiated Restricted Band Edge, b mode, 19, High Average



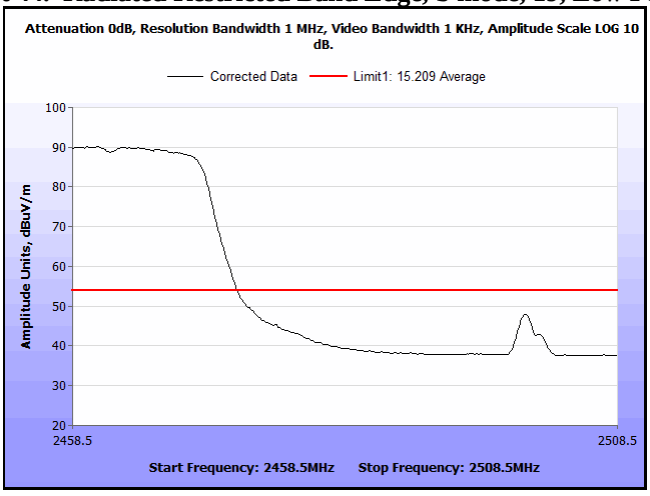
Plot 42. Radiated Restricted Band Edge, b mode, 19, High Peak



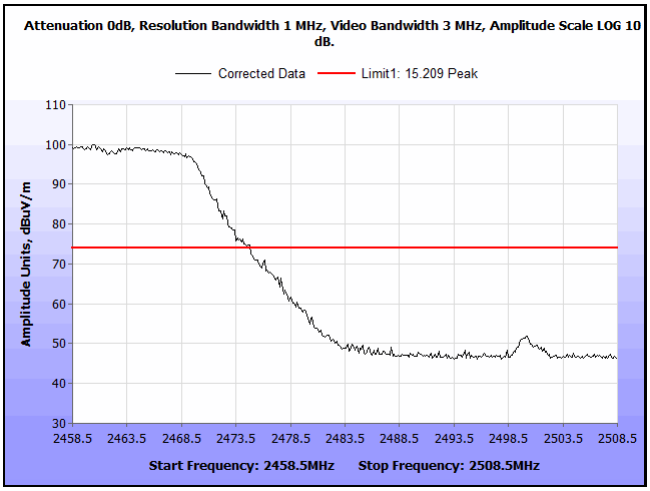
Plot 43. Radiated Restricted Band Edge, b mode, 19, Low Average



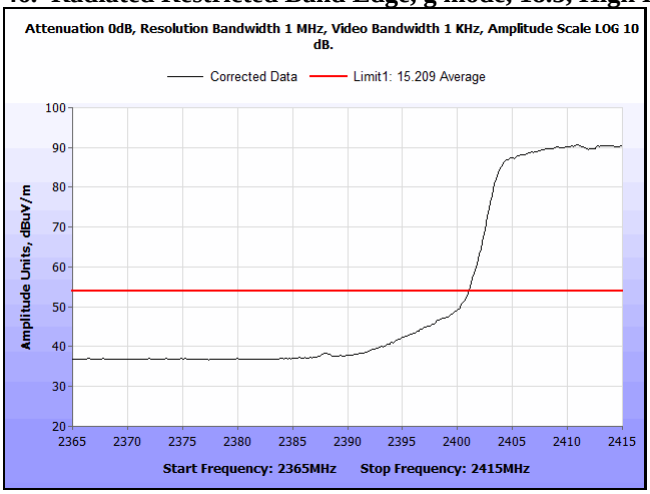
Plot 44. Radiated Restricted Band Edge, b mode, 19, Low Peak



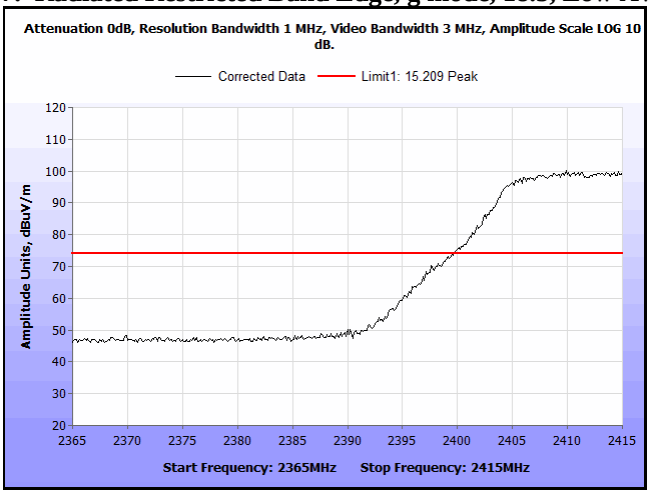
Plot 45. Radiated Restricted Band Edge, g mode, 18.5, High Average



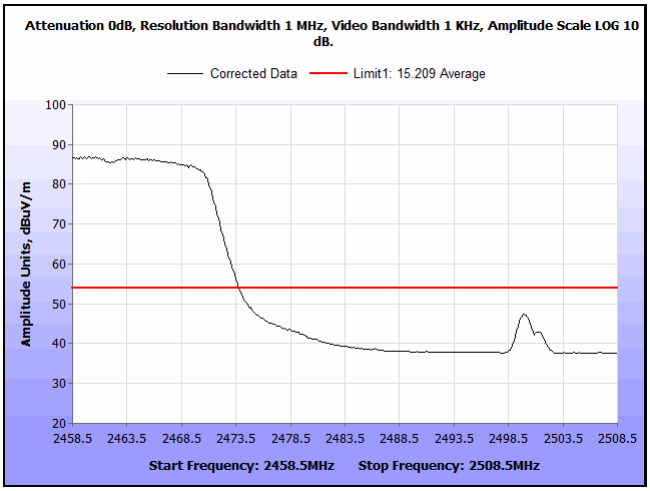
Plot 46. Radiated Restricted Band Edge, g mode, 18.5, High Peak



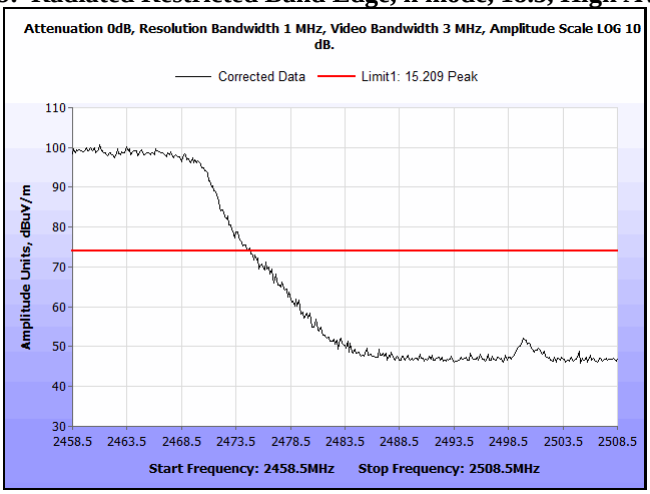
Plot 47. Radiated Restricted Band Edge, g mode, 18.5, Low Average



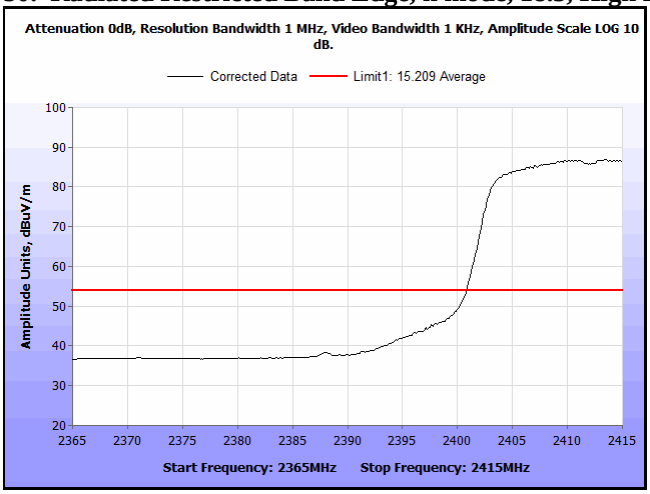
Plot 48. Radiated Restricted Band Edge, g mode, 18.5, Low Peak



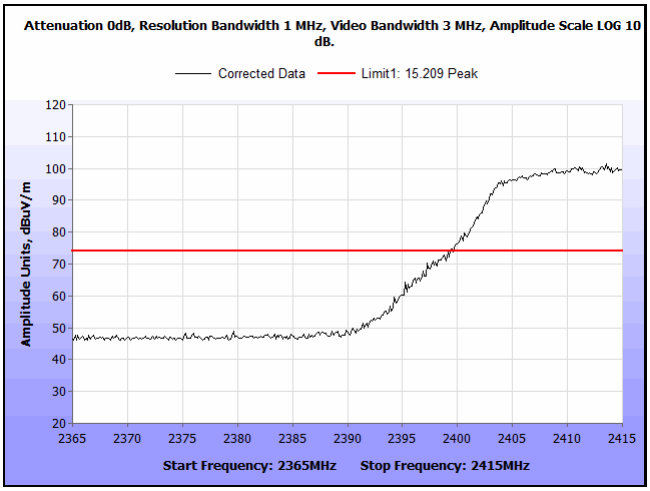
Plot 49. Radiated Restricted Band Edge, n mode, 18.5, High Average



Plot 50. Radiated Restricted Band Edge, n mode, 18.5, High Peak

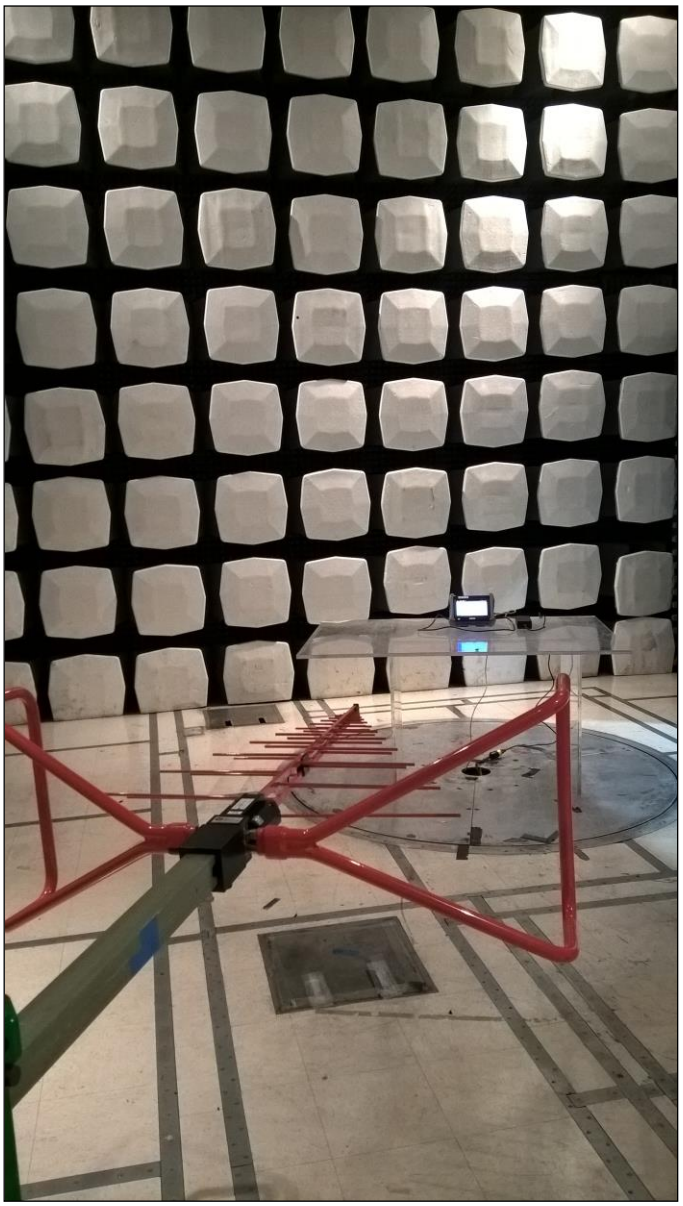


Plot 51. Radiated Restricted Band Edge, n mode, 18.5, Low Average

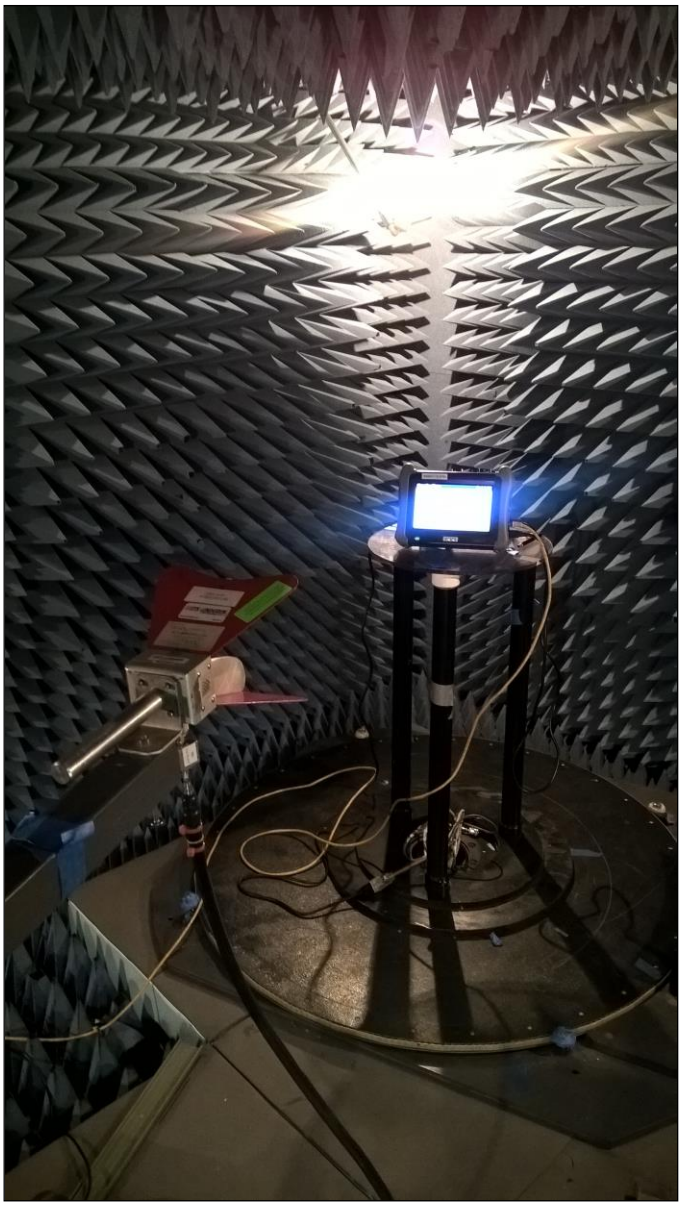


Plot 52. Radiated Restricted Band Edge, n mode, 18.5, Low Peak

Radiated Spurious Emissions Test Setup



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



Photograph 3. Radiated Spurious Emissions, Above 1 GHz, Test Setup

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
1T4709	Highpass Filter, 150 kHz	Rohde & Schwarz	EZ-25	10/24/2016	4/24/2018
1T8266	Spectrum Analyzer	Keysight technologies, Inc	E4407B	1/29/2018	1/29/2019
1A1188	LISN	Com-Power	CP-L1-150A	6/13/2017	6/13/2018
1T4796	LISN	Com-Power	LI-150A	2/6/2018	2/6/2019
1T4907	Digital Barometer, Hygrometer, Thermometer	Control Company	06-662-4	1/11/2016	1/11/2018
1T4300A	SEMI-ANECHOIC CHAMBER # 1 (FCC)	EMC TEST SYSTEMS	NONE	01/31/2016	01/31/2019
1T4751	Antenna - Bilog	Sunol Sciences	JB6	02/28/2017	08/28/2018
1T4149	High-Frequency Anechoic Chamber	Ray Proof	81	Not Required	
1T4442	Pre-amplifier, Microwave	Miteq	AFS42-01001800-30-10P	See Note	
1T4612	Spectrum Analyzer	Agilent Technologies	E4407B	03/30/2017	09/30/2018
1T4409	EMI Receiver	Rohde & Schwarz	ESIB7	12/07/2016	12/07/2018

Table 15. 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

