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, CALIFORNIA 95054 ● PHONE (408 748-3585 ● FAX (510) 489-6372

February 22, 2017

Firetide, Inc.
2105 South Bascom Avenue
Suite 220
Campbell, CA 95008

Dear Sudhir Hirudayaraj,

Enclosed is the EMC Wireless test report for compliance testing of the Firetide, Inc., 7010(W), tested to the requirements of Title 47 of the Code of Federal Regulations (CFR), Part 90 Subpart M for Intelligent Transportation Systems Radio Service.

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: (\Firetide, Inc.\EMCS92597-FCC90M Rev. 1)

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Electromagnetic Compatibility Criteria Test Report

For the

Firetide, Inc.
Model 7010(W)

Tested under

The FCC Verification Rules
Contained in Title 47 of the CFR, Part 90, Subpart M
for Private Intelligent Transportation Systems Radio Service

MET Report: EMCS92597-FCC90M Rev. 1

February 22, 2017

Prepared For:
Firetide, Inc.
2105 South Bascom Avenue
Suite 220
Campbell, CA 95008

Prepared By:
MET Laboratories, Inc.
3162 Belick St.
Santa Clara, CA 95054

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MET Report: EMCS92597-FCC90M Rev. 1

Jun Qi, 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 Part 90, Subpart M of the FCC Rules and under normal use and maintenance

Asad Bajwa,
EMC Director, Electromagnetic Compatibility Lab

Report Status Sheet

Revision	Report Date	Reason for Revision
∅	February 9, 2017	Initial Issue.
1	February 22, 2017	Engineer corrections.

Table of Contents

All references to section numbers are taken directly from the standard/specification used. Only sections requiring testing or evaluation are included.

List of Tables

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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

1. Testing Summary

These tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with Part 90, Subpart M and ASTM E2213-03(2010). All tests were conducted using measurement procedure ANSI TIA/EIA-603-D-2010.

Title 47 of the CFR, Part 90, Subpart M, and FCC 04-265 Reference and Test Description	Compliance
2.1046; 90.1215(a) Peak Power Output	Compliant
2.1047(a) Modulation Characteristics	Not Applicable
2.1049; 90.210 Occupied Bandwidth (Emission Mask)	Compliant
2.1051; 90.210 Spurious Emissions at Antenna Terminals	Compliant
2.1053; 90.210 Radiated Spurious Emissions	Compliant
2.1055(a) (1); 90.213 Frequency Stability over Temperature Variations	Compliant
2.1055(d) (2) Frequency Stability over Voltage Variations	Compliant
90.1217 RF Hazards	Compliant

ASTM E2213-03(2010)	Compliance
8.9.1 *Transmit Power Levels*	Compliant
8.9.2 *Transmit Spectrum Mask*	Compliant
8.9.3 *Spurious Transmissions*	Compliant
8.9.4 *Transmit Center Frequency Tolerance*	Compliant

II. Equipment Configuration

2. Equipment Configuration

2.1. Overview

MET Laboratories, Inc. was contracted by Firetide, Inc. to perform testing on the 7010(W) under purchase order number PO-3987.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the Firetide, Inc., 7010(W).

An EMC evaluation to determine compliance of the TB 4.9 with the requirements of Part 90, Subpart M, was conducted. (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 TB4.9. Firetide, Inc. should retain a copy of this document and it should be kept on file for at least five years after the manufacturing of the EUT has been **permanently** discontinued. The results obtained relate only to the item(s) tested.

Model(s) Tested:	7010(W)	
Model(s) Covered:	7010(W)	
EUT Specifications:	Primary Power Source: 115VAC	
	FCC ID: REP-7100-W IC: 4988A-7100W	
	Type of Modulations:	BPSK, DQPSK, CCK & QAM
	Emission Designators:	12M6D7D for 10MHz
		20M4D7D for 20MHz
	Peak Output Power:	16.55dBm for 10MHz, 6.77 dBm for 20MHz
	Equipment Code:	TNB
	EUT Frequency Ranges:	5860-5920MHz for 10MHz, 5875-5905MHz for 20MHz
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:	Jun Qi	
Report Date(s):	February 22, 2017	

2.2. Test Site

All testing was performed at MET Laboratories, Inc., 3162 Belick St., Santa Clara, CA 95054. 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 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.

2.3. Description of Test Sample

The Firetide, Inc. 7010(W), Equipment Under Test (EUT), is a Firetide Mesh Network, which is composed of two or more Mesh Nodes, gives you the convenience of a wired- Ethernet switch combined with the deployment flexibility of wireless technology. Each Mesh Node in the network can accept a wired Ethernet connection. That connection's Ethernet data is sent wirelessly to another Mesh Node. If the receiving Mesh Node is connected to the wired destination for the data packet, the Node routes that packet to its Ethernet connection. If it is not the final destination, the packet is forwarded wirelessly to the next Mesh Node and ultimately to its final destination.
Depending on the network topology, a Mesh Node can be set up to operate as a point to point device (in which directional antennas would be used) or as a point to multipoint device (in which a combination of omnidirectional and directional antennas would be used). The Radio technology incorporated into the Mesh Node is based on the 802.11a/b/g/n standard. The Radio can be configured to operate in standard 802.11g mode or 802.11n mode, referred to as MIMO.
The HotPort Node is housed in a weatherized, cast aluminum enclosure. External antennas connect to the four type N connectors (two per radio 2x2), two on each side of the enclosure.

2.4. 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. #
1		HOTPORT Out Door Mesh Node	7010(W)	7010(W)		1.0

Table 1. Equipment Configuration

2.5. Support Equipment

Firetide, Inc. supplied support equipment necessary for the operation and testing of the 7010(W). All support equipment supplied is listed in the following Support Equipment List.

Ref. ID	Name / Description	Manufacturer	Model Number	*Customer Supplied Calibration Data
1	5.125 to 6.1G,3xN,19dBi Panel Antenna	Firetide	AP-20-050-MIMO-19	N/A
2	4.9 to 6.1 GHZ3xN,16dBi Sector	Firetide	AS90-050-MIMO-16T	N/A
3	4.9 to 5.85G,3 Port,9dBi Omini	Firetide	AO-050-MIMO-9	N/A
4	2.3 to 2.7G,2xN,13dBi Panel	Firetide	AS90-024-MIMO-13	N/A
5	2.4 to 2.5G,3 Port,9dBi,Omini	Firetide	AO-024-MIMO-8	N/A
6	5G,5dBi Omini (used for DFS)	WHA Yu	C812510010-A	N/A
7	5G,5dBi Omini(used for DFS)	WHA Yu	C812510012-A	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 2. Support Equipment

2.6. Ports and Cabling Information

Ref. ID	Port name on EUT	Cable Description or reason for no cable	Qty	Length as tested (m)	Shielded? (Y/N)	Termination Box ID & Port Name
1	Antenna Ports,Radio1: Ant1,Ant2 Radio2: Ant1,Ant2	CB-C-015-N(LMR400)	4	1.5Meter	Yes	Antenna Ports
2	Power Input Port: AC	Power cord, 3 conductor, 18 awg	1		Yes	AC: Power Input Port (115v/60hz)
3	Port1 … Port4 (P1...P4)	CAT 5E Ethernet cable	1	2 Meter	N	Port1 … Port4

Table 3. Ports and Cabling Information

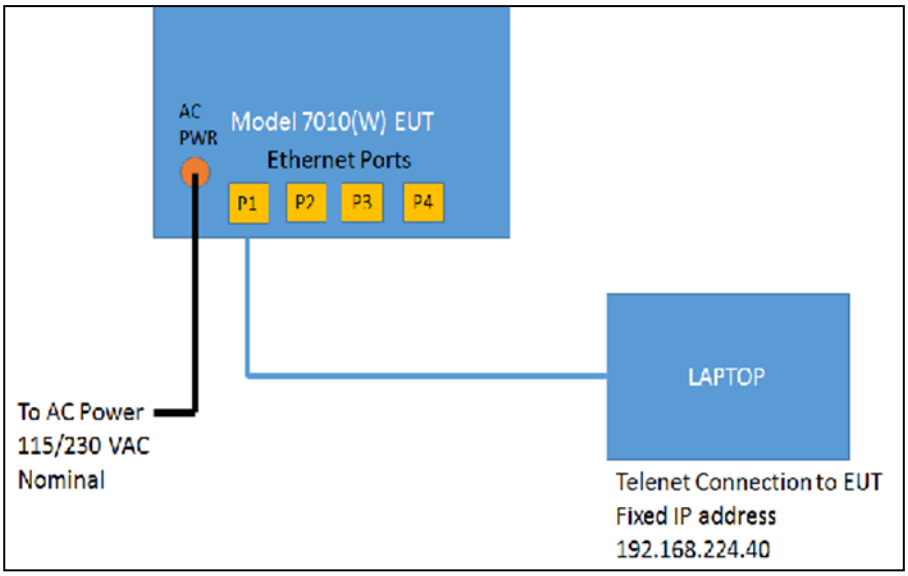


Figure 1. Block Diagram of Test Configuration

2.7. Method of Monitoring EUT Operation

HotPort 7010(W)
Mechanical Dimension: Dimensions: 13.4” X 9.3” X 4.7”Outdoor

Electrical Indication: Power and Status LED’s on the front panel To verify whether the EUT is power ON , if the EUT is ON the Power LED will glow Green
Status LED Glows when the firmware is up. When the unit meshes with another unit using single radio configuration Radio1 LED will glow and when the unit meshes with another unit with dual radio configuration both Radio 1 and Radio 2 LED will glow.
With the Ethernet cable connected to PC or Laptop Ping the EUT with the IP address 192.168.224.xxx (150) for 7010(W)

2.8. Modifications

2.8.1. Modifications to EUT

No modifications were made to the EUT.

2.8.2. Modifications to Test Standard

No modifications were made to the test standard.

2.9. Disposition of EUT

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

III. Electromagnetic Compatibility Criteria for Intentional Radiators

3. Electromagnetic Compatibility RF Power Output Requirements

3.1. RF Power Output

Test Requirement(s): **§2.1046 and §90.1215(a) with FCC 04-265**

Test Procedures: As required by 47 CFR 2.1046, *RF power output measurements* were made at the RF output terminals using a Spectrum Analyzer.

A laptop was connected to EUT to control the RF power output and frequency channel. The EUT was connected to a Spectrum Analyzer via an attenuator to measure the Avg. power. The EUT power was adjusted enough to produce maximum output power as specified in the owner's manual. The output power was then recorded with Avg. reading. Measurements were made at the low & high channels. EUT only uses channel 175 and 181. Reference table below for 20MHz Channels

Test Results: Equipment complies with 47CFR 2.1046 and 90.1215(a) with FCC 04-265.

All RF Power output measurements were direct connection to RF output Terminal of EUT from a Spectrum Analyzer.

Test Engineer(s): Jun Qi

Test Date(s): December 16, 2016

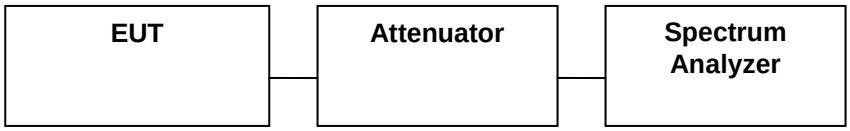


Figure 2. RF Power Output Test Setup

10MHz										
Center Frequency	**Bandwidth**	**Port R11 Data**	**Port R12 Data**	**Port R21 Data**	**Port R22 Data**	**Sum of 4 Ports**	**ERIP Limit**	**Antenna Gain**	**Final limit**	**Margin dB**
Ch 5860M	BW 10M	7.74	6.81	7.97	7.48	13.55	33	19	14	-0.45
Ch 5890M	BW 10M	7.78	7.17	8.01	7.23	13.59	33	19	14	-0.41
Ch 5920M	BW 10M	7.01	1.84	8.25	6.62	12.52	33	19	14	-1.48
20MHz										
Center Frequency	**Bandwidth**	**Port R11 Data**	**Port R12 Data**	**Port R21 Data**	**Port R22 Data**	**Sum of 4 Ports**	**ERIP Limit**	**Antenna Gain**	**Final limit**	**Margin dB**
Ch 5875M	BW 20M	-3.88	-0.62	-5.67	-6.26	2.52	23	19	4	-1.48
Ch 5905M	BW 20M	-4.42	-1.19	-5.91	-7.89	1.88	23	19	4	-2.12

Table 4. RF Power Output, 90M Power 19 dBi, Test Results

10MHz										
Center Frequency	**Bandwidth**	**Port R11 Data**	**Port R12 Data**	**Port R21 Data**	**Port R22 Data**	**Sum of 4 Ports**	**ERIP Limit**	**Antenna Gain**	**Final limit**	**Margin dB**
Ch 5860M	BW 10M	10.48	10.84	10.51	10.25	16.55	33	16	17	-0.45
Ch 5890M	BW 10M	10.97	9.12	10.24	10.12	16.19	33	16	17	-0.81
Ch 5920M	BW 10M	9.96	8.24	10.05	8.82	15.36	33	16	17	-1.64
20MHz										
Center Frequency	**Bandwidth**	**Port R11 Data**	**Port R12 Data**	**Port R21 Data**	**Port R22 Data**	**Sum of 4 Ports**	**ERIP Limit**	**Antenna Gain**	**Final limit**	**Margin dB**
Ch 5875M	BW 20M	0.77	0.81	0.51	0.74	6.73	23	16	7	-0.27
Ch 5905M	BW 20M	0.97	1.27	0.54	0.11	6.77	23	16	7	-0.23

Table 5. RF Power Output, 90M Power 16 dBi, Test Results

Electromagnetic Compatibility Occupied Bandwidth Requirements

3.2. Occupied Bandwidth (Emission Mask)

Test Requirement(s): **§2.1049 and §90.210 with FCC 04-265 (Emissions Mask)**

Test Procedures: As required by 47 CFR 2.1049, *occupied bandwidth measurements* were made at the RF output terminals using a Spectrum Analyzer.

A laptop was connected to EUT to control the RF power output and frequency channel. The EUT was connected to a Spectrum Analyzer via attenuator. The measured highest Average Power was set relative to zero dB reference. The RBW of the Spectrum Analyzer was set to at least 1% of the channel bandwidth. The EUT power was adjusted at the maximum output power level. Measurements were carried out at Channel 175 and 181.

The Mask was generated from ASTM E2213-03(2010). Standard Specification for Telecommunications and Information Exchange Between Roadside and Vehicle Systems - 5 GHz Band Dedicated Short Range Communications (DSRC) Medium Access Control (MAC) and Physical Layer (PHY) Specifications.

Device Class	Maximum Device Output Power, dBm
A	0
B	10
C	20
D	28.8 or more

Figure 3. DSRC Device Classes and Transmit Power Levels

Class	± 4.5-MHz Offset	± 5.0-MHz Offset	± 5.5-MHz Offset	± 10-MHz Offset	± 15-MHz Offset
Class A	0	-10	-20	-28	-40
Class B	0	-16	-20	-28	-40
Class C	0	-26	-32	-40	-50
Class D	0	-35	-45	-55	-65

Figure 4. DSRC Spectrum Mask Table

Test Results: Equipment falls under Class C and complies with Section 8.92 of ASTM E2213-03(2010). The EUT does not exceed the Emission Masks limit.

The following pages show measurements of Occupied Bandwidth and Emission Mask plots.

Test Engineer(s): Jun Qi

Test Date(s): December 16, 2016

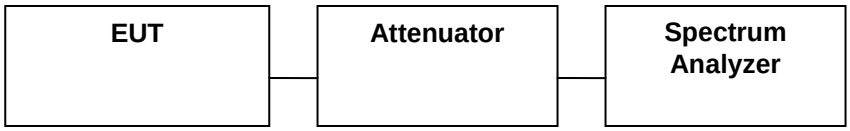


Figure 5. Occupied Bandwidth/Mask Test Setup

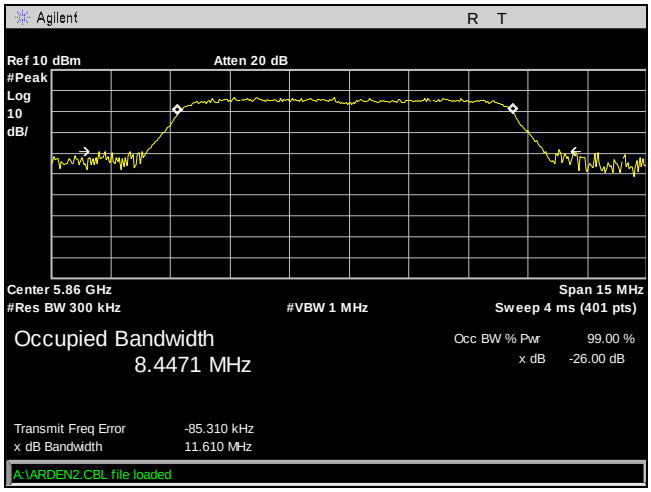
10MHz		
Center Frequency	**Bandwidth**	**99% Bandwidth(MHz)**
Ch 5860M	BW 10M	8.4471
Ch 5890M	BW 10M	8.5368
Ch 5920M	BW 10M	8.4807

Table 6. Occupied Bandwidth, 90M Bandwidth, 10MHz, Test Results

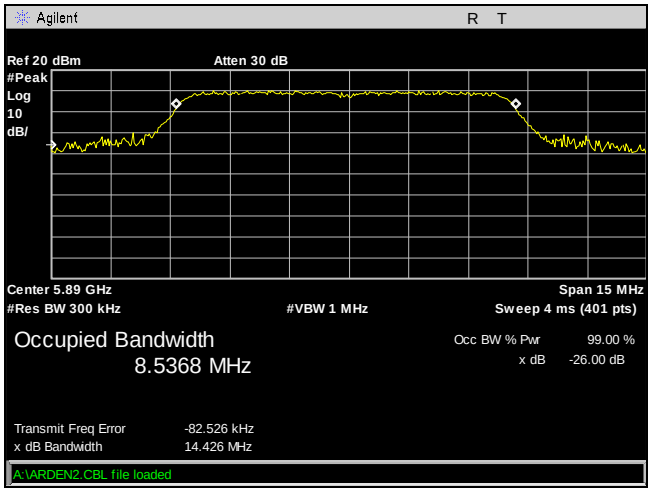
20MHz		
Center Frequency	**Bandwidth**	**99% Bandwidth(MHz)**
Ch 5875M	BW 20M	17.1436
Ch 5905M	BW 20M	17.0231

Table 7. Occupied Bandwidth, 90M Bandwidth, 20MHz, Test Results

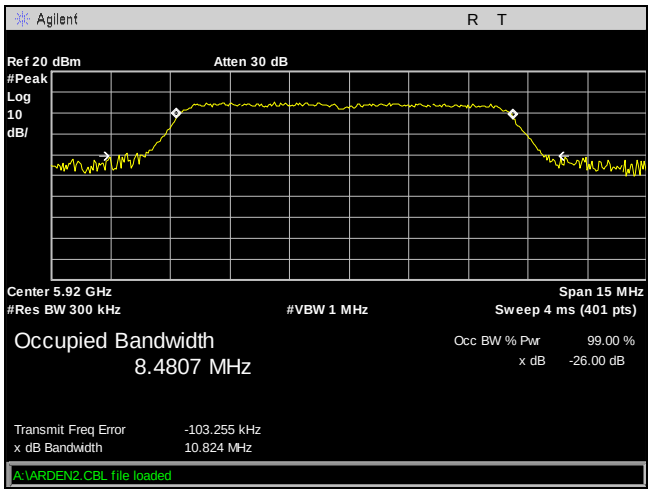
Occupied Bandwidth



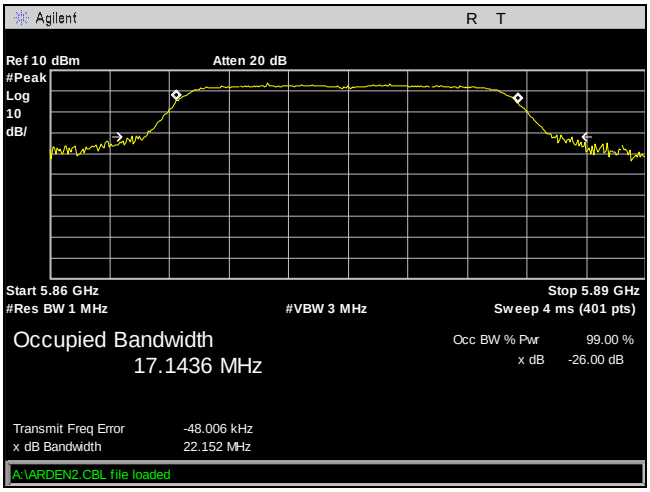
Plot 1. Occupied Bandwidth, 10 MHz, Ch. 5860M, 16 dBi, TP16



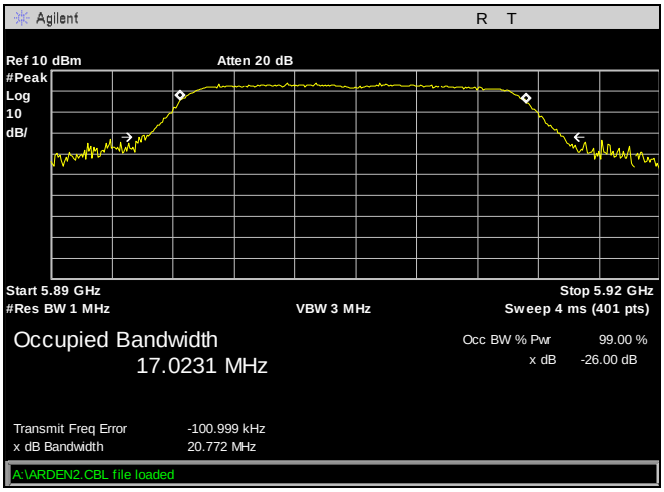
Plot 2. Occupied Bandwidth, 10 MHz, Ch. 5890M, 16 dBi, Tp15.5



Plot 3. Occupied Bandwidth, 10 MHz, Ch. 5900M, 16 dBi, TP12

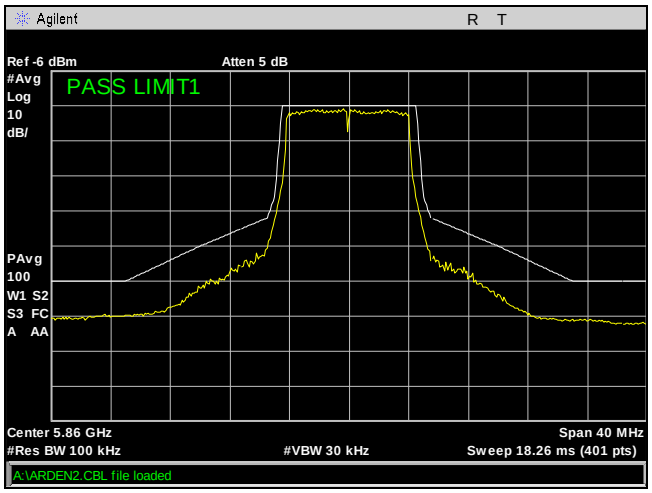


Plot 4. Occupied Bandwidth, 20 MHz, Ch. 5875M, 16 dBi, TP6

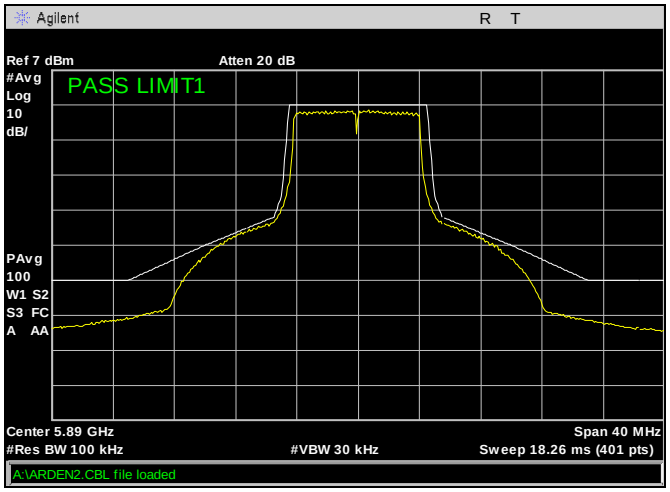


Plot 5. Occupied Bandwidth, 20 MHz, Ch. 5905M, 16 dBi, TP6

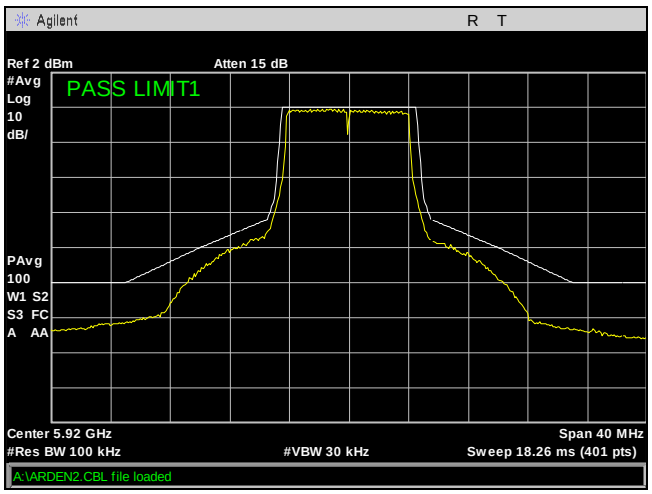
Emission Mask C



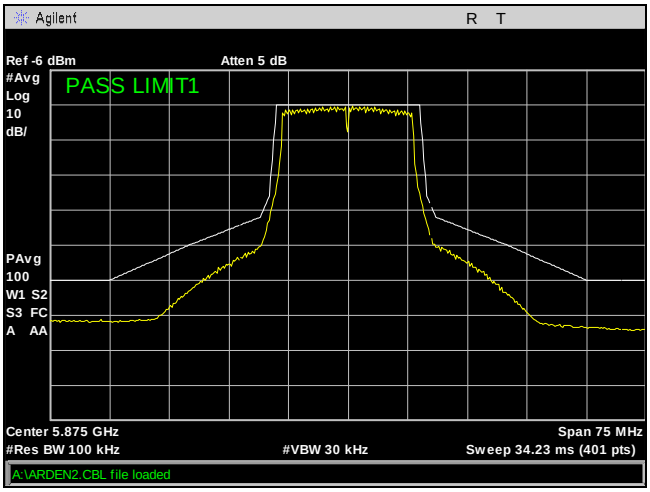
Plot 6. Emission Mask C, 10 MHz, Ch. 5860M, 16 dBi, TP16



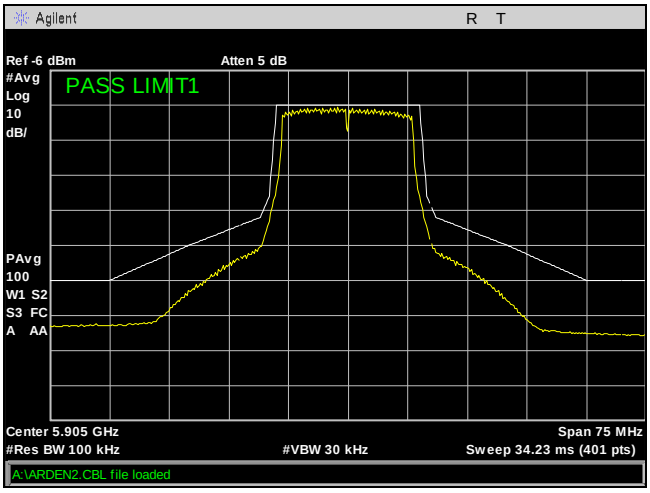
Plot 7. Emission Mask C, 10 MHz, Ch. 5890M, 16 dBi, TP15.5



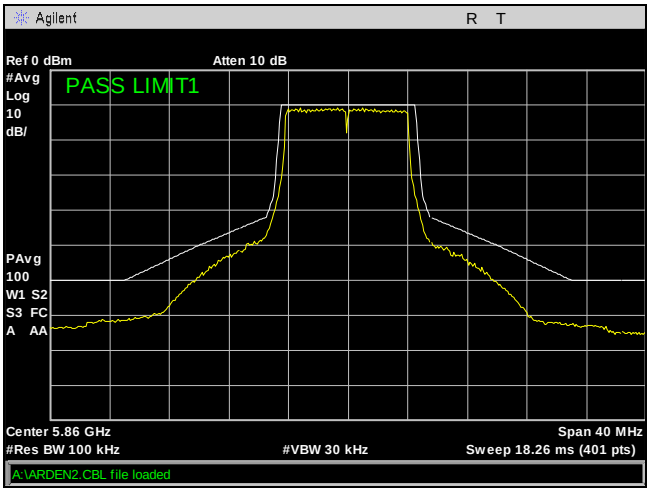
Plot 8. Emission Mask C, 10 MHz, 5920M, 16 dBi, TP12



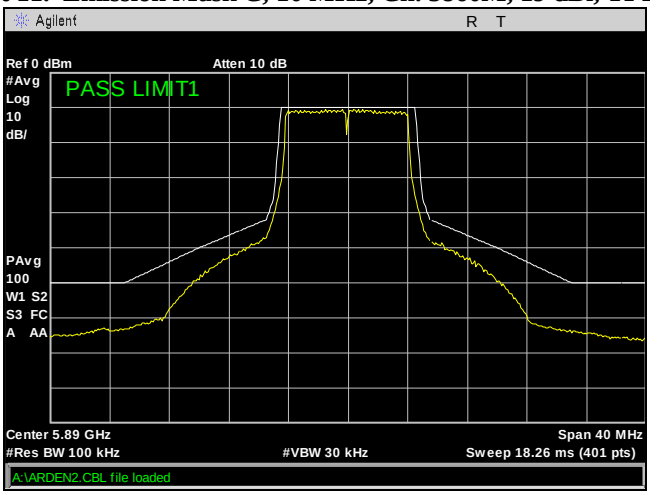
Plot 9. Emission Mask C, 20 MHz, Ch. 5875M, 16 dBi, TP6



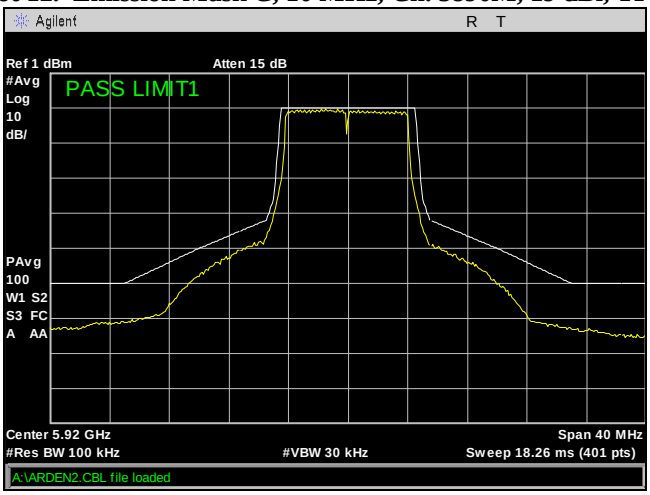
Plot 10. Emission Mask C, 20 MHz, Ch. 5905M, 16 dBi, TP6



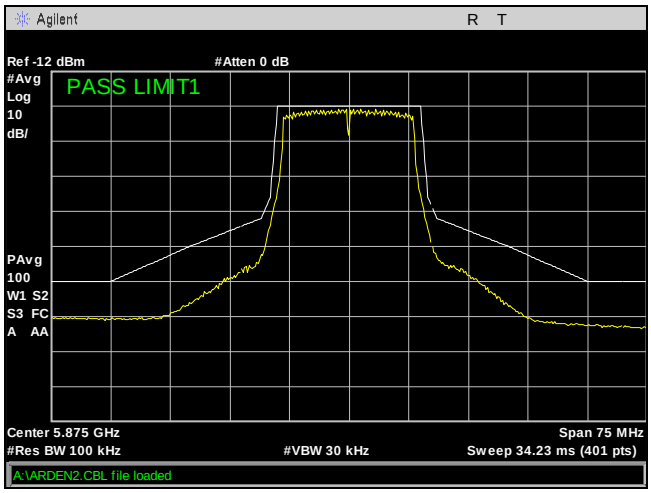
Plot 11. Emission Mask C, 10 MHz, Ch. 5860M, 19 dBi, TP11.5



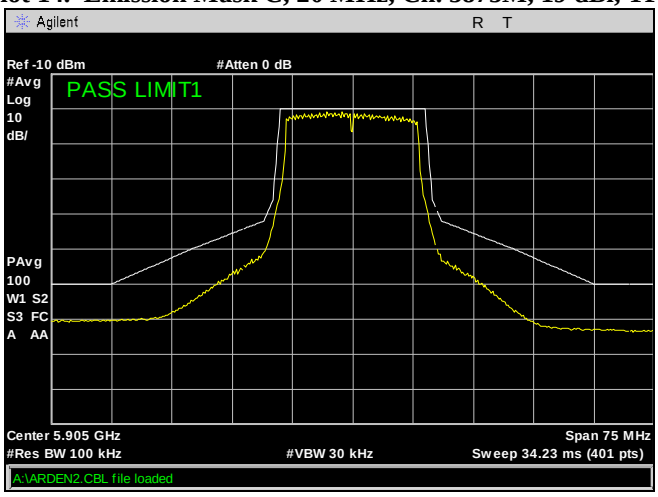
Plot 12. Emission Mask C, 10 MHz, Ch. 5890M, 19 dBi, TP10



Plot 13. Emission Mask C, 10 MHz, Ch. 5920M, 19 dBi, TP11



Plot 14. Emission Mask C, 20 MHz, Ch. 5875M, 19 dBi, TP1



Plot 15. Emission Mask C, 20 MHz, Ch. 5905M, 19 dBi, TP1

Electromagnetic Compatibility Spurious Emissions at Antenna Terminal Requirements

3.3. Spurious Emissions at Antenna Terminals

Test Requirement(s): **§2.1051 and §90.210 with FCC 04-265**

Test Procedures: As required by 47 CFR 2.1051, *spurious emissions at antenna terminal measurements* were made at the RF output terminals using a Spectrum Analyzer.

A laptop was connected to EUT to control the RF power output and frequency channel. The EUT was connected to a Spectrum Analyzer to monitor the output power level. The Spectrum Analyzer was set to sweep 30 MHz and up to 10th harmonic of the fundamental or 40GHz whichever is the lesser.

Test Results: Equipment complies with Section 2.1051 and 90.210 with FCC 04-265 & ASTM E2213-03(2010).

Test Engineer(s): Jun Qi

Test Date(s): December 16, 2016

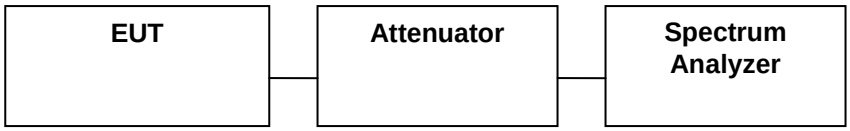
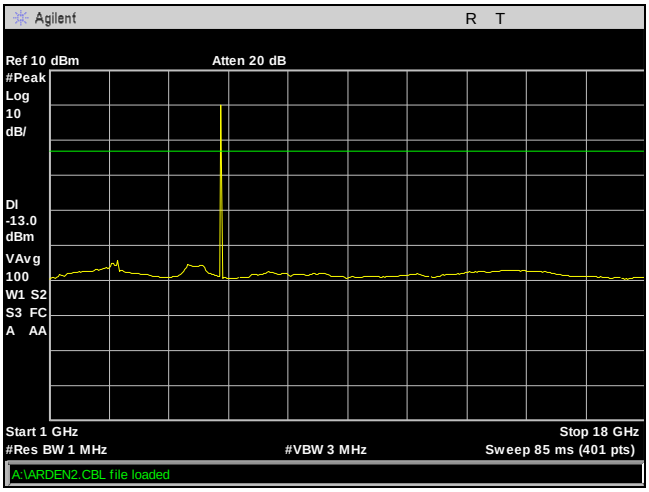
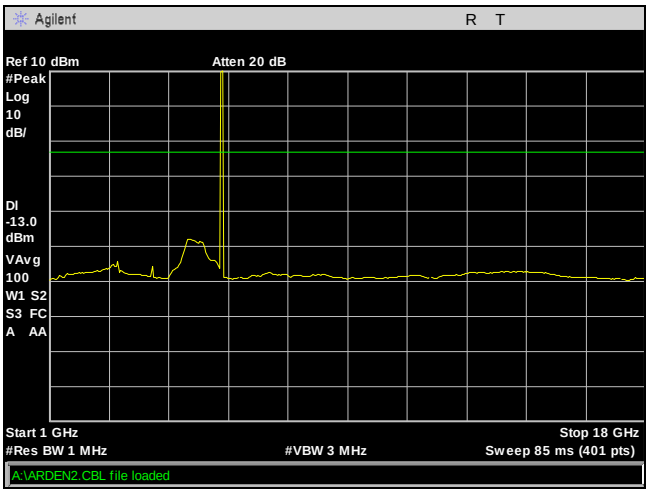


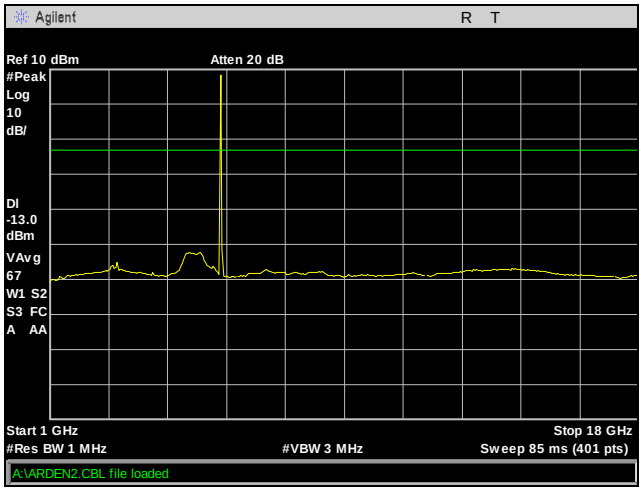
Figure 6. Spurious Emissions at Antenna Terminals Test Setup



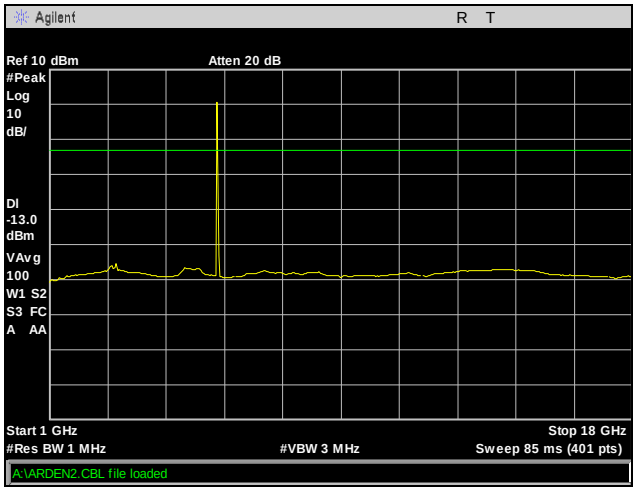
Plot 16. Conducted Spurious Emissions, 1 GHz – 18 GHz – 13 dBm, 10 MHz, Ch. 5860M, 16 dBi



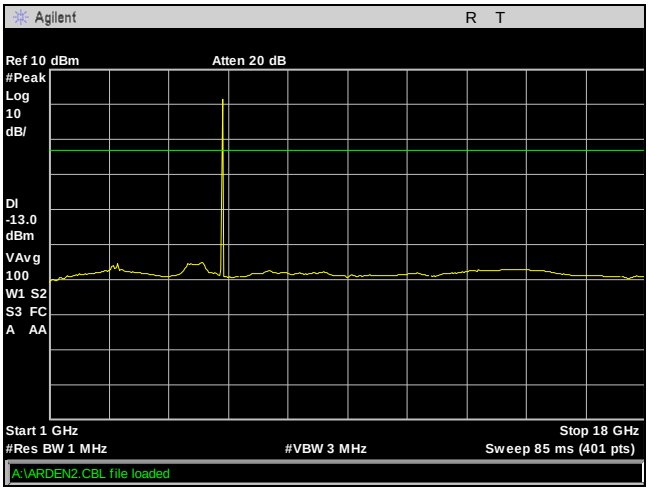
Plot 17. Conducted Spurious Emissions, 1 GHz – 18 GHz – 13 dBm, 10 MHz, Ch. 5890M, 16 dBi



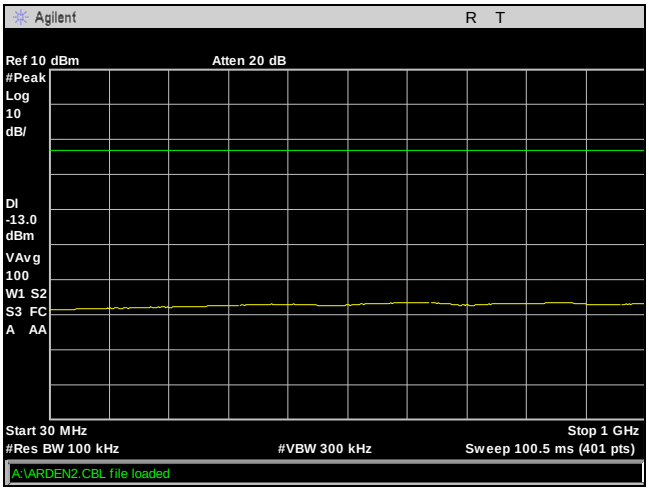
Plot 18. Conducted Spurious Emissions, 1 GHz – 18 GHz – 13 dBm, 10 MHz, Ch. 5920M, 16 dBi



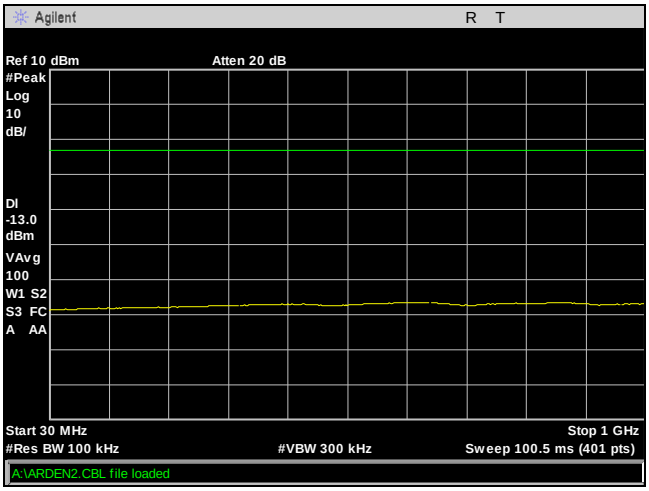
Plot 19. Conducted Spurious Emissions, 1 GHz – 18 GHz – 13 dBm, 20 MHz, Ch. 5875M, 16 dBi



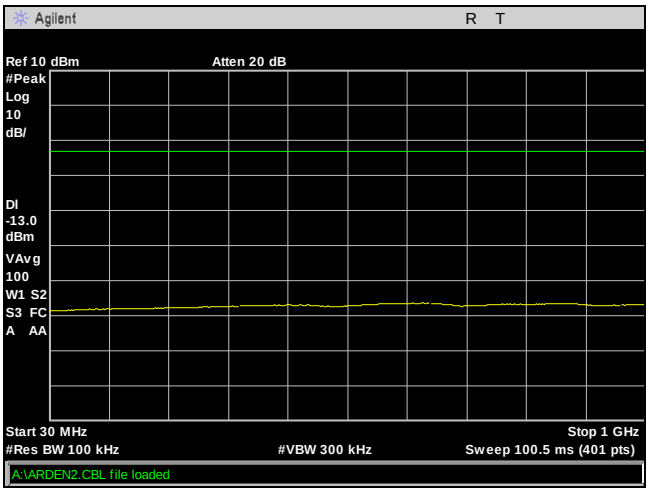
Plot 20. Conducted Spurious Emissions, 1 GHz – 18 GHz – 13 dBm, 20 MHz, Ch. 5905M, 16 dBi



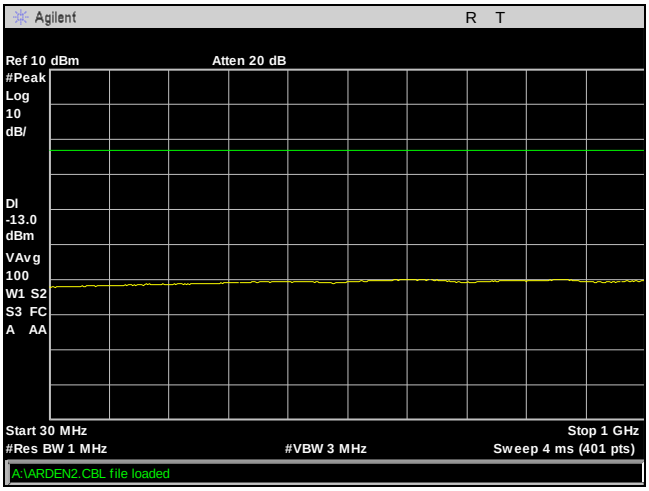
Plot 21. Conducted Spurious Emissions, 30 MHz – 1 GHz – 13 dBm, 10 MHz, Ch. 5860M, 16 dBi



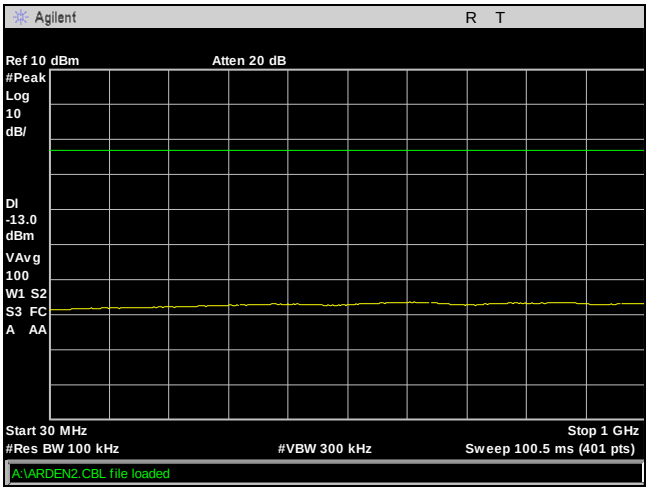
Plot 22. Conducted Spurious Emissions, 30 MHz – 1 GHz – 13 dBm, 10 MHz, Ch. 5890M, 16 dBi



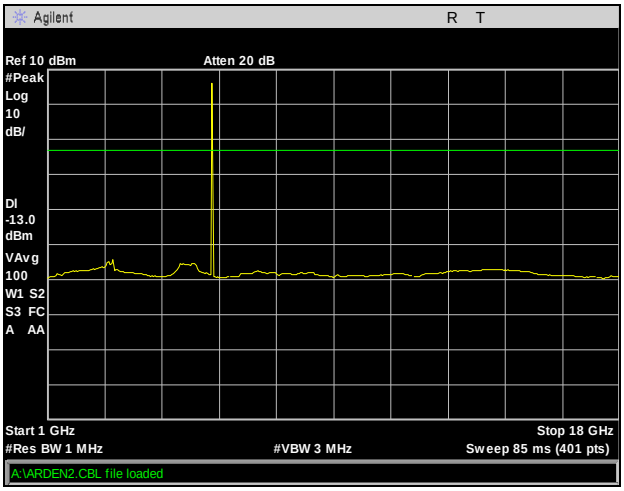
Plot 23. Conducted Spurious Emissions, 30 MHz – 1 GHz – 13 dBm, 10 MHz, Ch. 5920M, 16 dBi



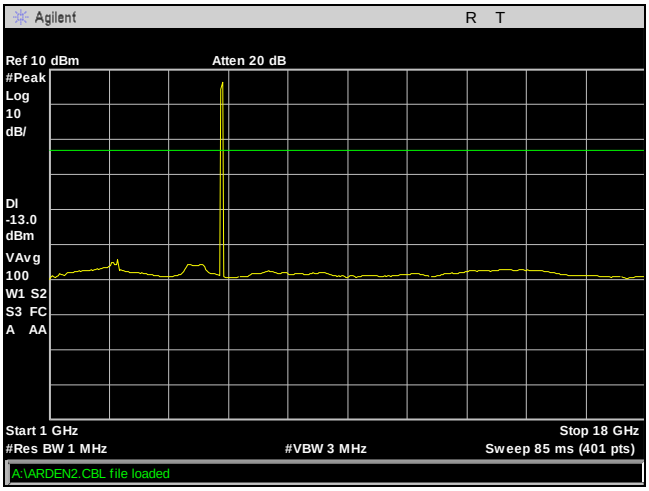
Plot 24. Conducted Spurious Emissions, 30 MHz – 1 GHz – 13 dBm, 20 MHz, Ch. 5875M, 16 dBi



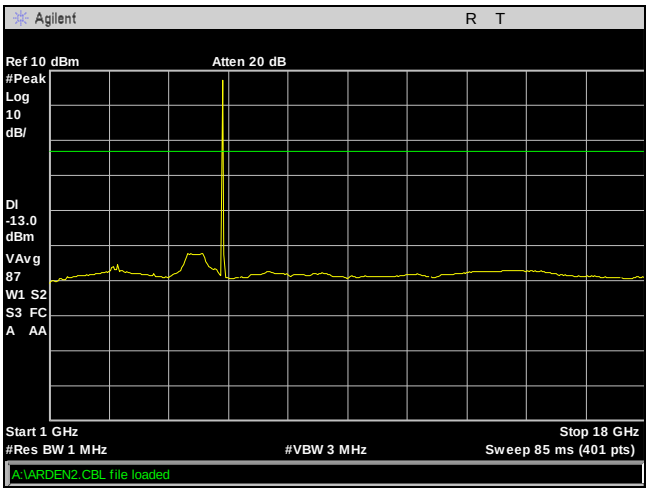
Plot 25. Conducted Spurious Emissions, 30 MHz – 1 GHz – 13 dBm, 20 MHz, Ch. 5905M, 16 dBi



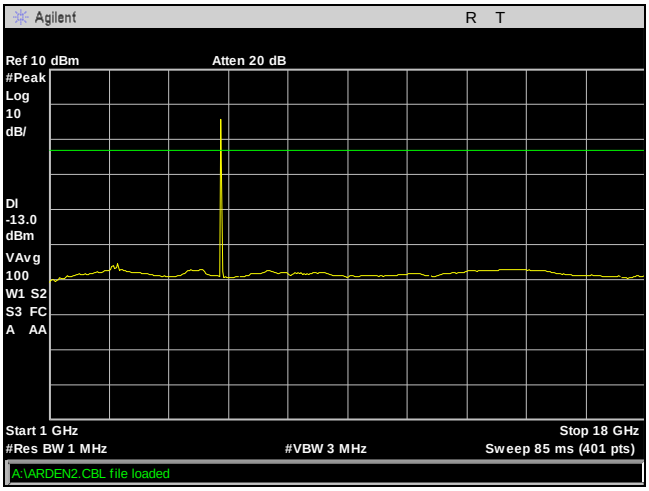
Plot 26. Conducted Spurious Emissions, 1 GHz – 18 GHz – 13 dBm, 10 MHz, Ch. 5860M, 19 dBi



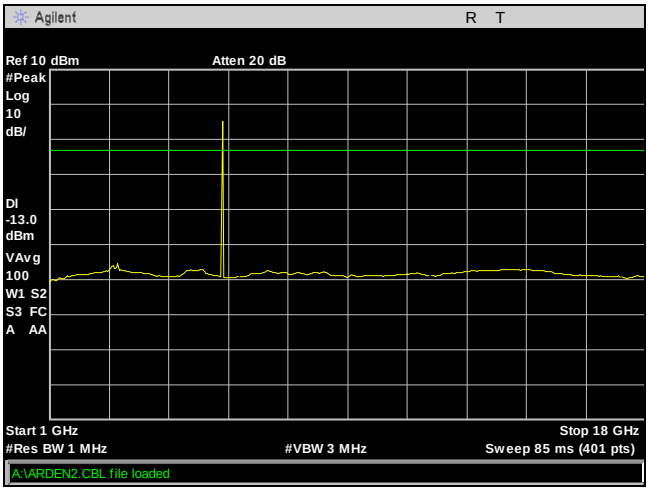
Plot 27. Conducted Spurious Emissions, 1 GHz – 18 GHz – 13 dBm, 10 MHz, Ch. 5890M, 19 dBi



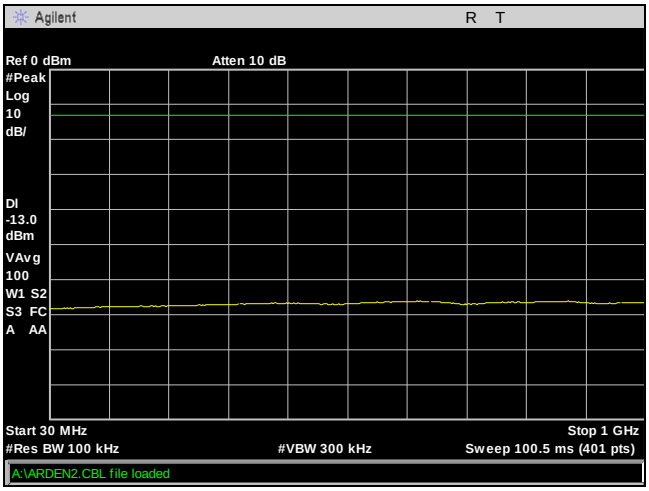
Plot 28. Conducted Spurious Emissions, 1 GHz – 18 GHz – 13 dBm, 10 MHz, Ch. 5920M, 19 dBi



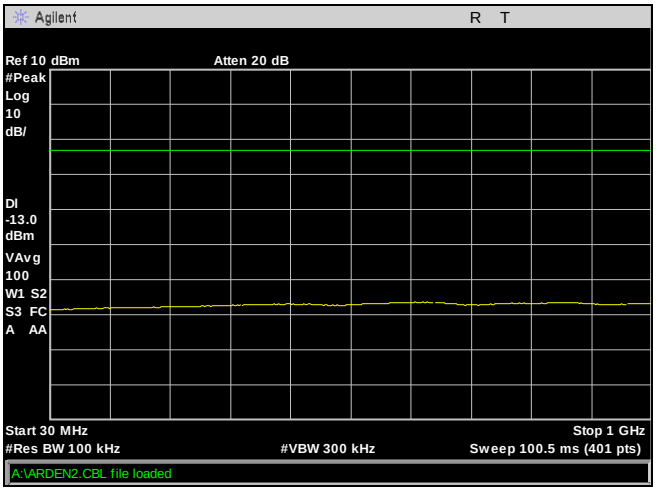
Plot 29. Conducted Spurious Emissions, 1 GHz – 18 GHz – 13 dBm, 20 MHz, Ch. 5875M, 19 dBi



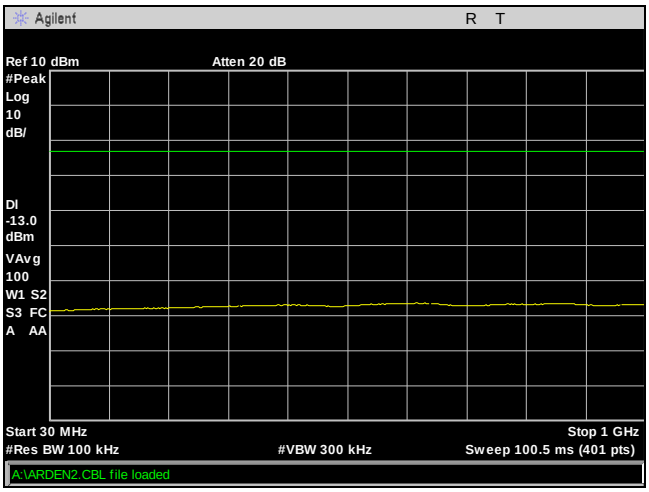
Plot 30. Conducted Spurious Emissions, 1 GHz – 18 GHz – 13 dBm, 20 MHz, Ch. 5905M, 19 dBi



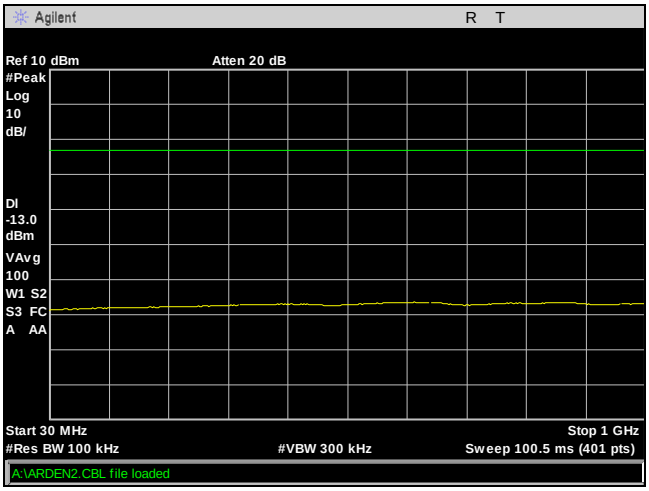
Plot 31. Conducted Spurious Emissions, 30 MHz – 1 GHz – 13 dBm, 10 MHz, Ch. 5860M, 19 dBi



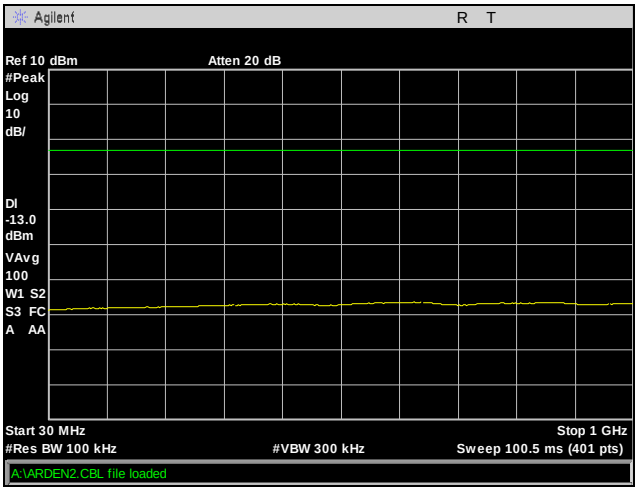
Plot 32. Conducted Spurious Emissions 30 MHz – 1 GHz – 13 dBm, 10 MHz, Ch. 5890M, 19 dBi



Plot 33. Conducted Spurious Emissions, 30 MHz – 1 GHz – 13 dBm, 10 MHz, Ch. 5920M, 19 dBi



Plot 34. Conducted Spurious Emissions, 30 MHz – 1 GHz – 13 dBm, 20 MHz, Ch. 5875M, 19 dBi



Plot 35. Conducted Spurious Emissions, 30 MHz – 1 GHz – 13 dBm, 20 MHz, Ch. 5905M, 19 dBi

Electromagnetic Compatibility Radiated Emissions Requirements

3.4. Radiated Emissions

Test Requirement(s): **§2.1053 and §90.210**

Test Procedures: As required by 47 CFR 2.1053, *field strength of radiated spurious measurements* were made in accordance with the procedures of ANSI TIA/EIA-603-D-2010 "Land Mobile FM or PM Communications Equipment Measurement and Performance Standards".

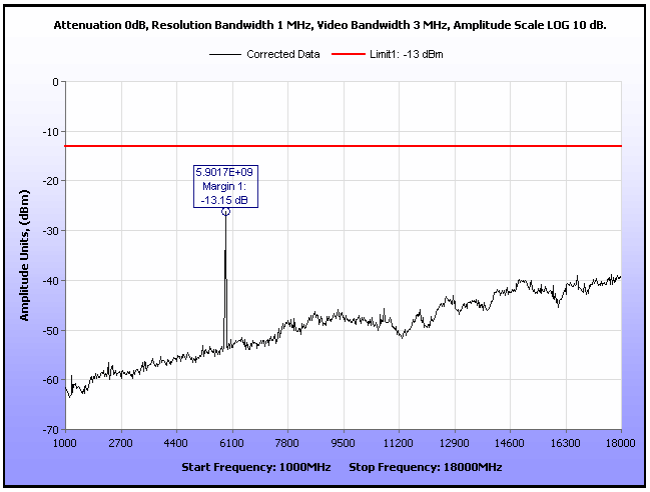
Radiated emission measurements were performed inside a 3 meter semi-anechoic chamber. The EUT was set at a distance of 3m from the receiving antenna. The EUT's RF ports were terminated to 50ohm load. The EUT was set to transmit at the low, mid and high channels of the transmitter frequency range at its maximum power level. The EUT was rotated about 360^0 and the receiving antenna scanned from 1-4m in order to capture the maximum emission. These steps were carried out with the receiving antenna in both vertical and horizontal polarization. Harmonic emissions up to the 10^{th} or 40GHz, which ever was the lesser, were investigated.

Test Results: Equipment complies with Section 2.1053, 90.210 and ASTM E2213-03(2010).

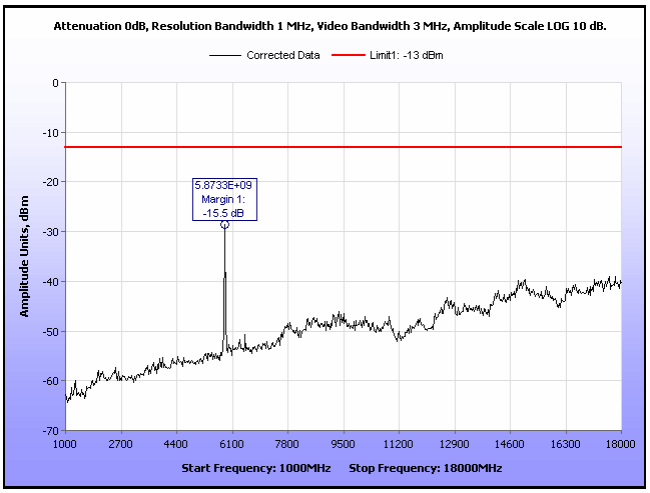
Test Engineer(s): Jun Qi

Test Date(s): December 7, 2016

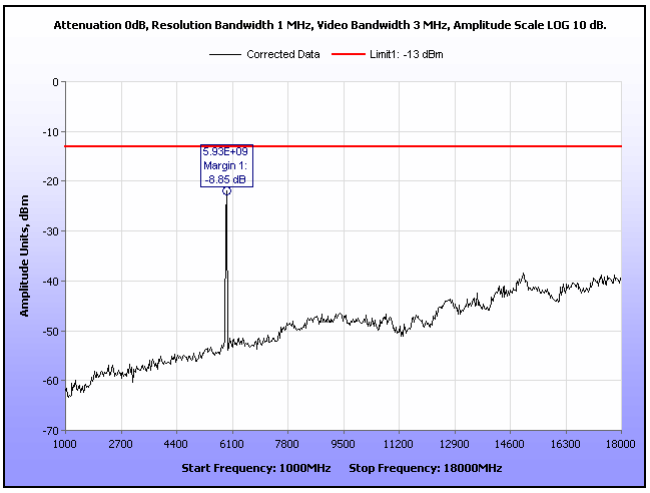
Radiated Emissions Test Results



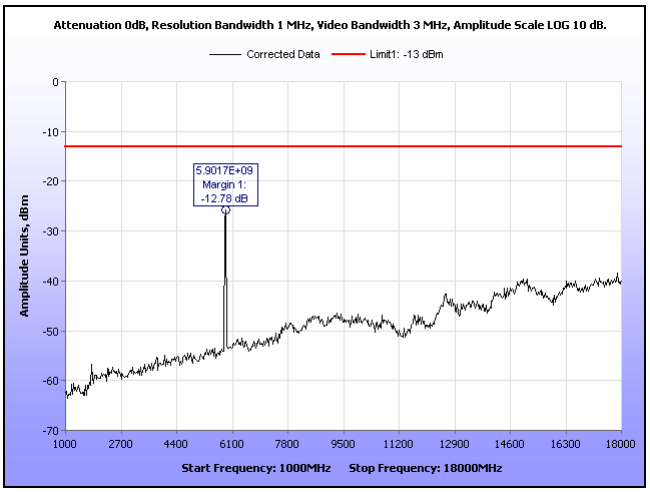
Plot 36. Radio Spurious Emissions, 1 GHz – 18 GHz – 13 dBm, 20 MHz, Ch. 5905M



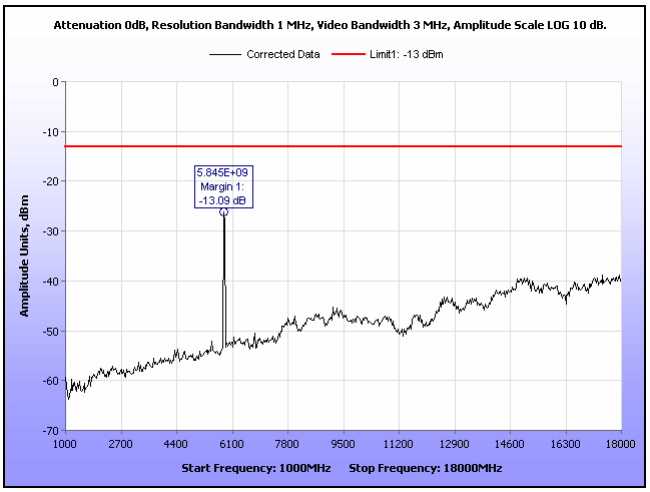
Plot 37. Radio Spurious Emissions, 1 GHz – 18 GHz – 13 dBm, 20 MHz, Ch. 5875M



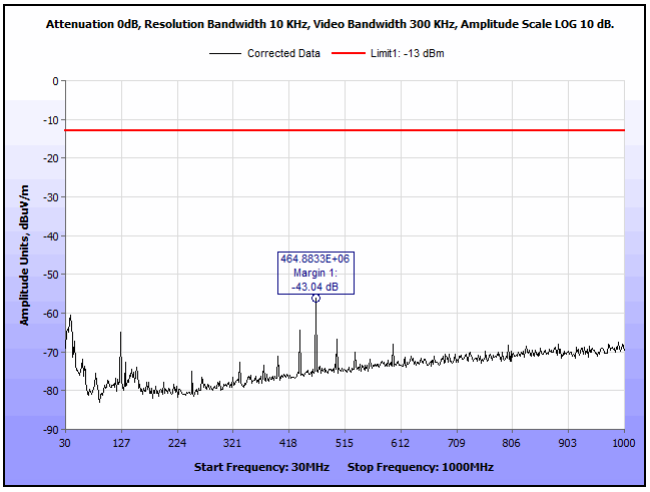
Plot 38. Radio Spurious Emissions, 1 GHz – 18 GHz – 13 dBm, 10 MHz, Ch. 5920M



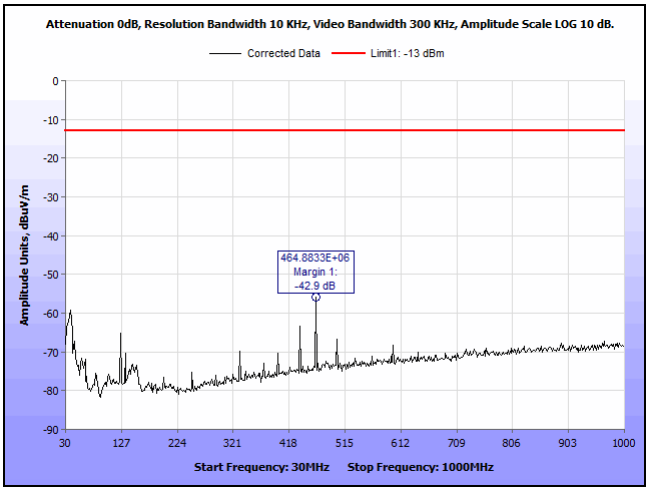
Plot 39. Radio Spurious Emissions, 1 GHz – 18 GHz – 13 dBm, 10 MHz, Ch. 5890M



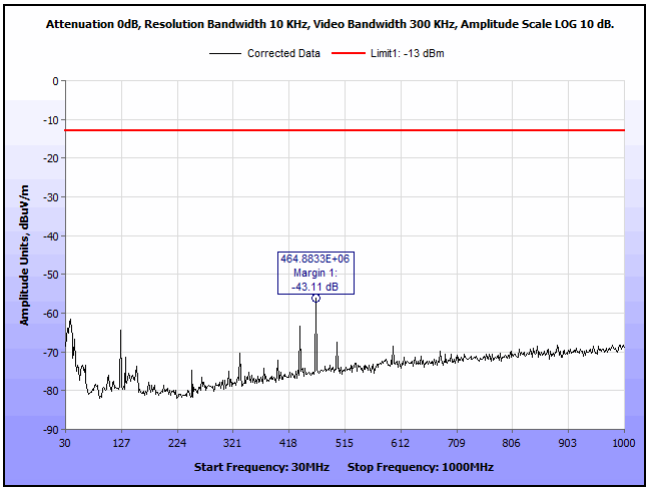
Plot 40. Radio Spurious Emissions, 1 GHz – 18 GHz – 13 dBm, 10 MHz, Ch. 5860M



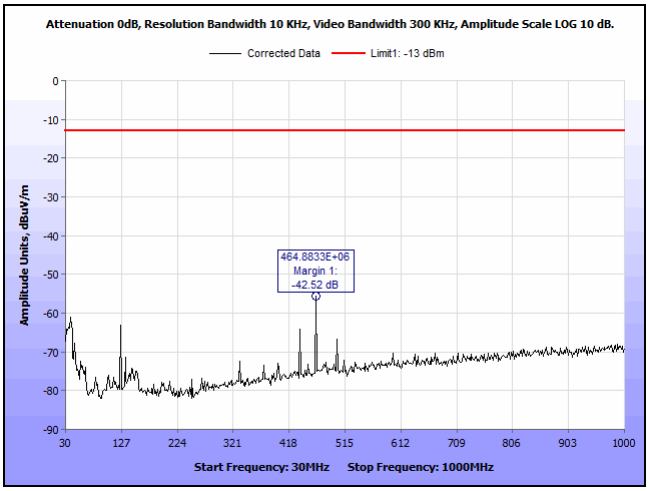
Plot 41. Radio Spurious Emissions, 30 MHz – 1 GHz – 13 dBm, 20 MHz, Ch. 5905M



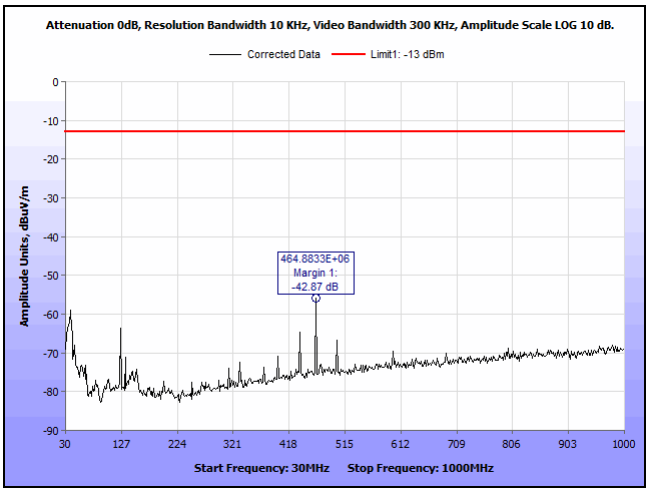
Plot 42. Radio Spurious Emissions, 30 MHz – 1 GHz – 13 dBm, 20 MHz, Ch. 5875M



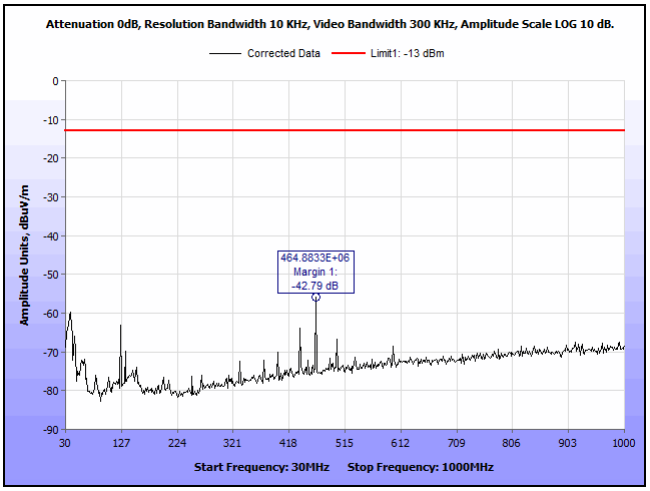
Plot 43. Radio Spurious Emissions, 30 MHz – 1 GHz – 13 dBm, 10 MHz, Ch. 5920M



Plot 44. Radio Spurious Emissions, 30 MHz – 1 GHz – 13 dBm, 10 MHz, Ch. 5890M



Plot 45. Radio Spurious Emissions, 30 MHz – 1 GHz – 13 dBm, 10 MHz, Ch. 5860M



Plot 46. Radio Spurious Emissions, 30 MHz – 1 GHz – 13 dBm, Radio Off

Electromagnetic Compatibility Frequency Stability Requirements

3.5. Frequency Stability

Test Requirement(s): **§2.1055 and §90.213**

Test Procedures: As required by 47 CFR 2.1055, *Frequency Stability measurements* were made at the RF output terminals using a Directional Coupler through a Spectrum Analyzer.

The EUT was placed in the Environmental Chamber and support equipment are outside the chamber on a table. The EUT was set to transmit a CW signal corresponding to the low, mid, and high channel of the frequency band. The frequency counter option on the Spectrum Analyzer was used to measure frequency deviations. The frequency drift was investigated for every 10^{C} increment until the unit is stabilized then recorded the reading in tabular format with the temperature range of -30 to 80°C.

Voltage supplied to EUT is 120 VAC reference temperature was done at 20 ^{C}. The voltage was varied by ± 15 % of nominal.

Test Results: Equipment complies with Section 2.1055 and 90.213.

Test Engineer(s): Jun Qi

Test Date(s): December 21, 2016

(Low Channel)				
Reference Frequency	Voltage (AC)	Temperature (C)	Frequency (MHz)	PPM
	93.5	50	5874.997498	11.921
	110.0	50	5874.932466	0.852
	126.5	50	5874.982491	9.367
	93.5	20	5874.937468	1.703
	110.0	20	5874.927463	0.000
5874.927463	126.5	20	5874.927463	0.000
	93.5	-30	5874.967483	6.812
	110.0	-30	5874.942471	2.555
	126.5	-30	5874.957478	5.109
(High Channel)				
Reference Frequency	Voltage (AC)	Temperature (C)	Frequency (MHz)	PPM
	93.5	50	5905.012506	12.708
	110.0	50	5904.957478	3.389
	126.5	50	5905.002501	11.013
	93.5	20	5904.907453	5.083
	110.0	20	5904.937468	0.000
5904.937468	126.5	20	5904.917458	3.389
	93.5	-30	5904.982491	7.625
	110.0	-30	5904.947473	1.694
	126.5	-30	5904.972486	5.930

Table 8. Frequency Stability, Exalt Frequency Stability Calculation 90M

Electromagnetic Compatibility Frequency Stability Requirements

3.6. RF Exposure Requirements

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 Calculation: EUT's operating frequencies @ 5850-5925 MHz; highest conducted power = *19.01dBm* (avg) therefore, **Limit for Uncontrolled exposure: 1 mW/cm^2 or 10 W/m^2**

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**
5860	16.55	45.186	16	39.811	0.35787	1	0.64213	20	Pass

Table 9. RF Hazards

IV. Test Equipment

4. 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
1S2746	Bilog Antenna	Sunol Science	JB3	9/29/2015	3/29/2017
1S2482	5 Meter Chamber (NSA)	Panashield	5 Meter Semi-Anechoic Chamber	See Note	
1S2603	Double Ridged Waveguide Horn	ETS-Lindgren	3117	08/09/2016	08/09/18
1S3962	Spectrum Analyzer (PSA)	Keysight/Agilent	E4448A	02/26/16	02/26/2018
1S2121	Pre-Amplifier	Hewlett Packard	8449B	See Note	
1U0258	Spectrum Analyzer	Agilent Technologies	E4407B	2/2/2016	2/2/2017
1S2229	Temperature Chamber	Tenny Engineering	T63C	17/11/2016	17/5/2018

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

V. Certification & User's Manual Information

5. Certification Label & User's Manual Information

5.1. 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 provision that such a determination of compliance be made and is the responsibility of the party responsible for verification of the equipment.

The following is extracted from Title 47 of the Code of Federal Regulations, Part 2, Subpart Y — 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, whichever is applicable.

§ 2.902 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.

§ 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.

5.2. Label and User's Manual Information

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

§ 15.19 Labeling requirements.

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

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

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

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

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

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

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

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

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

§ 15.21 Information to user.

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

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 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

