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

July 6, 2015

Airvana
250 Apollo Drive
Chelmsford, MA 01824

Dear Gary Falk,

Enclosed is the EMC Wireless test report for compliance testing of the Airvana, Small Cell Type as tested to the requirements of the FCC Certification rules under Title 47 of the CFR Part 27 Subpart L and RSS-139, Issue 2, February 2009 for Broadband Radio Service (BRS) Devices.

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 contact me.

Sincerely yours,
MET LABORATORIES, INC.

Jennifer Warnell
Documentation Department

Reference: (\Airvana\EMC85374-FCC27 Rev. 1)

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Electromagnetic Compatibility Criteria
Test Report

for the

Airvana
Model Small Cell Type

Tested under
FCC Certification Rules
Title 47 of the CFR, Part 27 Subpart L
& RSS-139, Issue 2, February 2009

MET Report: EMC85374-FCC27 Rev. 1

July 6, 2015

Prepared For:

Airvana
250 Apollo Drive
Chelmsford, MA 01824

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

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& RSS-139, Issue 2, February 2009

Benjamin Taylor, Project Engineer
Electromagnetic Compatibility Lab

Jennifer Warnell
Documentation Department

Engineering Statement: The measurements shown in this report were made in accordance with the procedures indicated, and the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them. It is further stated that upon the basis of the measurements made, the equipment tested is capable of operation in accordance with the requirements of Part 27 M of the FCC Rules and Industry Canada standard RSS-139, Issue 2, February 2009 under normal use and maintenance.

Asad Bajwa,
Director, Electromagnetic Compatibility Lab

Report Status Sheet

Revision	Report Date	Reason for Revision
∅	July 2, 2015	Initial Issue.
1	July 6, 2015	Corrections to Equipment Specifications.

Table of Contents

List of Tables

List of Figures

List of Plots

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**er**z**
IEC	**I**nternational **E**lectrotechnical **C**ommission
kHz	**k**ilo**h**er**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 Airvana Small Cell Type, with the requirements of Part 27. 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 Small Cell Type. Airvana should retain a copy of this document which should be kept on file for at least two years after the manufacturing of the Small Cell Type, 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 27, in accordance with Airvana, quote number 1AIR2001.

Reference	IC Reference	Description	Compliance
§2.1046; §27.50(h)	RSS-139; Section 6.4	RF Power Output	Compliant
§2.1047	RSS-139; Section 6.2	Modulation Characteristics	Not Applicable
§2.1049	RSS-GEN	Occupied Bandwidth	Compliant
§27.53	RSS-139; Section 6.5	Emissions in GPS Bands	Not Applicable – EUT does not operate in the 700-800 MHz bands.
§2.1051; §27.53(l)	RSS-139; Section 6.5	Spurious Emissions at Antenna Terminals	Compliant
§2.1053	RSS-139; Section 6.5	Radiated Spurious Emissions	Compliant
§2.1055	RSS-139; Section 6.3	Frequency Stability over Temperature Variations	Compliant

Table 1. Executive Summary of EMC ComplianceTesting

II. Equipment Configuration

A. Overview

MET Laboratories, Inc. was contracted by Airvana to perform testing on the Small Cell Type, under Airvana's quote number 1AIR2001.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the Airvana, Small Cell Type.

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

Model(s) Tested	Small Cell Type	
Model(s) Covered:	Small Cell Type	
EUT Specifications:	Primary Power: 120 VAC, 60 Hz	
	Equipment Code:	PCB
	RF Output Power:	21.26dBm
	EUT Frequency Range:	2506-2680 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:	Benjamin Taylor	
Date(s):	July 6, 2015	

Table 2. EUT Summary Table

B. References

CFR 47, Part 27	Federal Communication Commission, Code of Federal Regulations, Title 47, Part 27: Rules and Regulations for Advanced Wireless Services
RSS-139, Issue 2, February 2009	Advanced Wireless Services Equipment Operating in the Bands 1710-1755 MHz and 2110-2155 MHz
ANSI C63.4:2003	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
EIA/TIA-603-A-2001	Land Mobile FM or PM Communication Equipment Measurement and Performance Standards

Table 3. Standard References

C. Test Site

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

Radiated Emissions measurements were performed in a 3 meter semi-anechoic chamber (equivalent to an Open Area Test Site).

D. Description of Test Sample

The Airvana Small Cell Type, Equipment Under Test (EUT), is a small cell intended for small to medium size business and residential application.

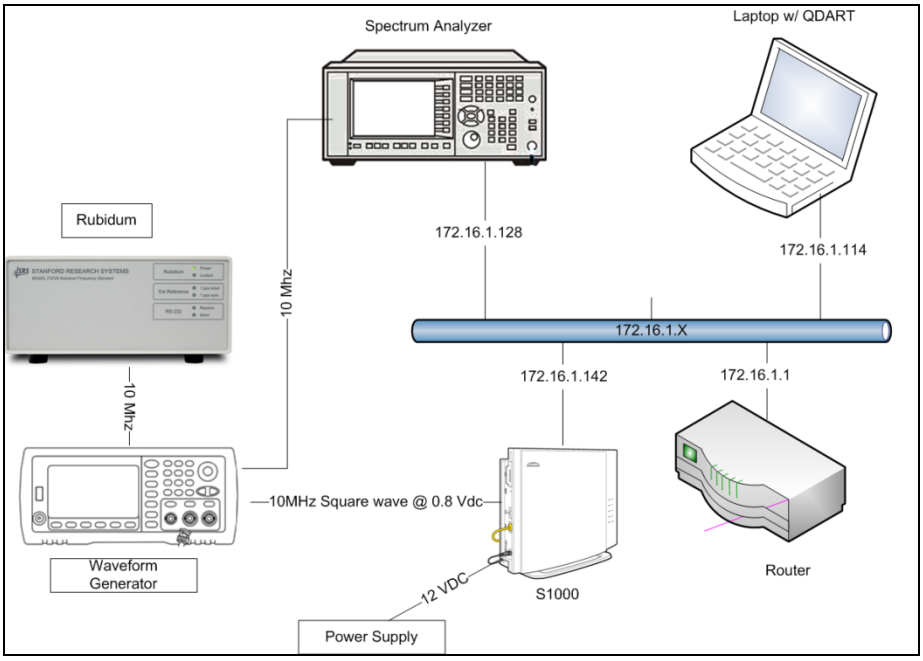


Figure 1. Block Diagram of Test Configuration

E. Equipment Configuration

Ref. ID	Name / Description	Model Number	Part Number	Serial Number	Revision
5	NSC	--	800238	1520600023	--
5	MLF AC Adapter	--	(MLF -A0030120250000051)	--	--

Table 4. Equipment Configuration

F. Support Equipment

Ref. ID	Name / Description	Manufacturer	Model Number	*Customer Supplied Calibration Data
1	MXA Analyzer	Agilent	N9020A	04-09-2015
2	Rubidum	Stanford Research Systems	SRSF725	N/A
3	Waveform Generator	Keysight	33500B	N/A
4	Laptop (9JL2FX)	Dell	Vostro 1510	N/A
4	AC Adapter for Laptop	Dell	DA90PM130	N/A
6	WiFi Router	Linksys	EA2700	N/A
7	Wireless Mouse	Logitech	M310	N/A
8	USB Keyboard	Dell	--	N/A
9	USB Optical Mouse	Dell	--	--
10	Miscellaneous Cables	--	--	--

Table 5. Support Equipment

* - 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.

G. Ports and Cabling Information

Ref. ID	Port Name on EUT	Cable Description	Qty.	Length (m)	Shielded (Y/N)	Termination Point
8	Power Port (J10)	--	1	--	--	--
9	Ethernet Port (J1204/5)	--	2	--	--	--
10	Console Port (J1323)	--	1	--	--	--

Table 6. Ports and Cabling Information

H. Mode of Operation

Band 41 LTE -TDD - transmitter modes of operation supported:
1. FCC Part 27 (BAND 41-20 MHz BW – QPSK modulation)
2. FCC Part 27 (BAND 41-20 MHz BW – 16QAM modulation)
3. FCC Part 27 (BAND 41-20 MHz BW – 64QAM modulation)

I. Method of Monitoring EUT Operation

1. QDART software will support all operating modes and will configure EVM measurement on the on the spectrum analyzer. This measurement will show the modulation type as well as the transmit channel power. A console port will also be available to verify that the system is active.
2. Same as above.

J. Modifications

a) Modifications to EUT

No modifications were made to the EUT.

b) Modifications to Test Standard

No modifications were made to the test standard.

K. Disposition of EUT

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

III. Electromagnetic Compatibility Criteria for Intentional Radiators

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 2.1046 RF Power Output

Test Requirement(s): §2.1046 and §27.50(h)

RSS-139, Section 6.4 Transmitter Output Power

The average equivalent isotropically radiated power (e.i.r.p.) for fixed, mobile and portable transmitters in the 1710-1755 MHz shall not exceed 1 watt.

Consult SRSP-513 for e.i.r.p. limits on fixed and base stations operating in the 2110-2155 MHz band.

Test Procedures: *RF power output measurement* was made at the RF output terminal using a spectrum analyzer for downlink.

Test Results: Equipment complies with 47CFR 2.1046 and 27.50(h).

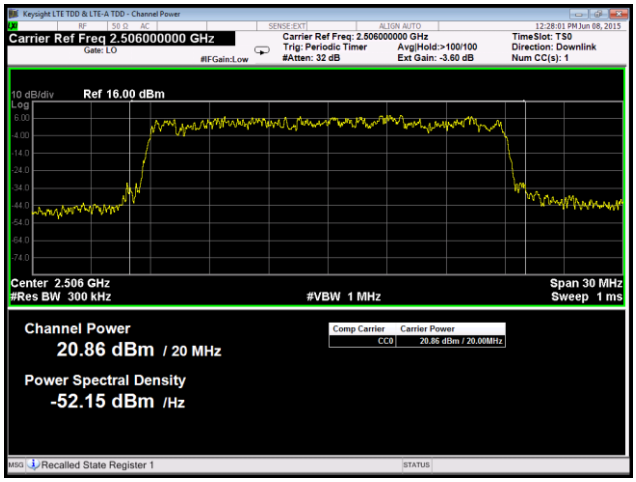
The following page show measurements of RF Power output which is recorded below:

Test Engineer(s): Benjamin Taylor

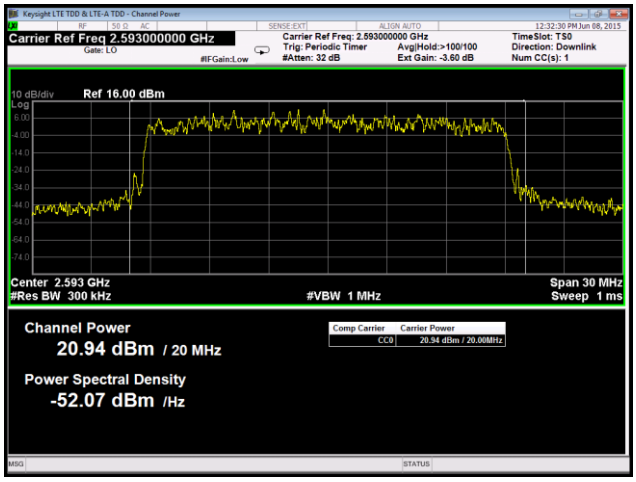
Test Date(s): 06/08/15

Transmit Chain	Modulation/Frequency	Output Power (dBm)
Port 1	16QAM, 2506 MHz	20.86
	16QAM, 2593 MHz	20.94
	16QAM, 2680 MHz	21.23
Port2	16QAM, 2506 MHz	20.53
	16QAM, 2593 MHz	20.46
	16QAM, 2680 MHz	21.08
Port 1	64QAM, 2506 MHz	20.62
	64QAM, 2593 MHz	20.86
	64QAM, 2680 MHz	21.26
Port 2	64QAM, 2506 MHz	20.79
	64QAM, 2593 MHz	20.73
	64QAM, 2680 MHz	21.07
Port 1	QPSK, 2506 MHz	20.45
	QPSK, 2593 MHz	20.61
	QPSK, 2680 MHz	21.02
Port 2	QPSK, 2506 MHz	20.59
	QPSK, 2593 MHz	20.52
	QPSK, 2680 MHz	20.88

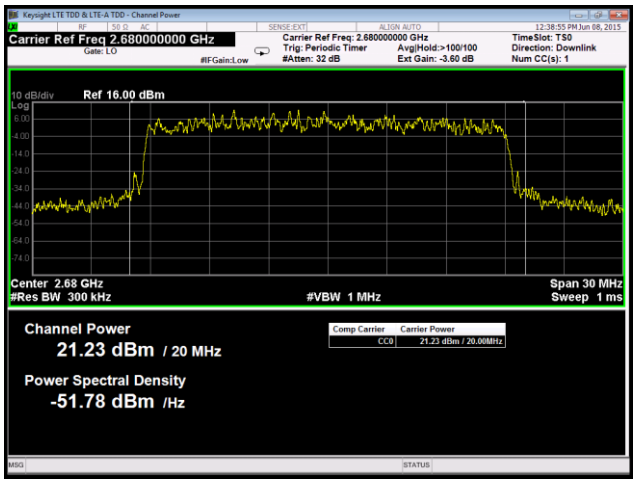
Table 7. RF Output Power, Test Results



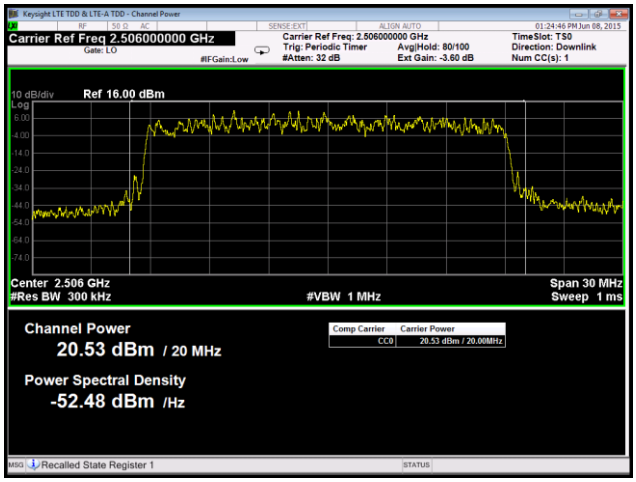
Plot 1. RF Output Power, 16QAM, Low Channel, Port 1



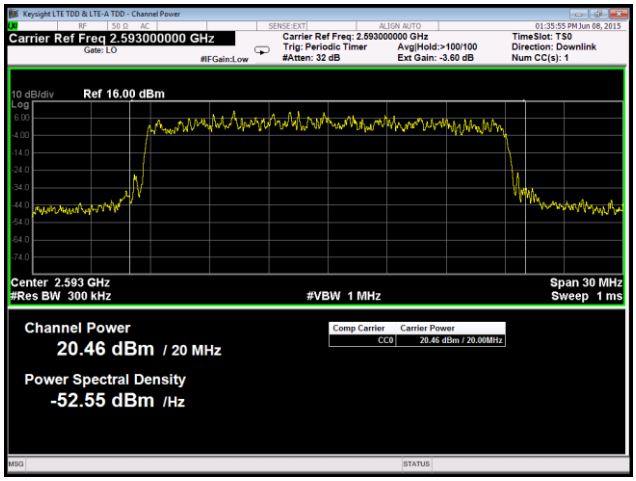
Plot 2. RF Output Power, 16QAM, Mid Channel, Port 1



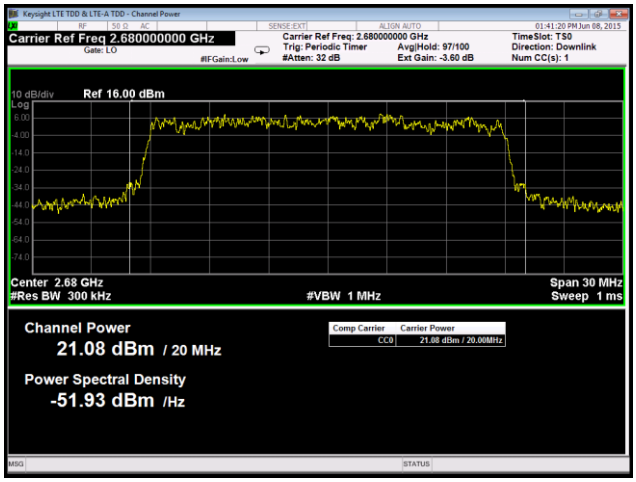
Plot 3. RF Output Power, 16QAM, High Channel, Port 1



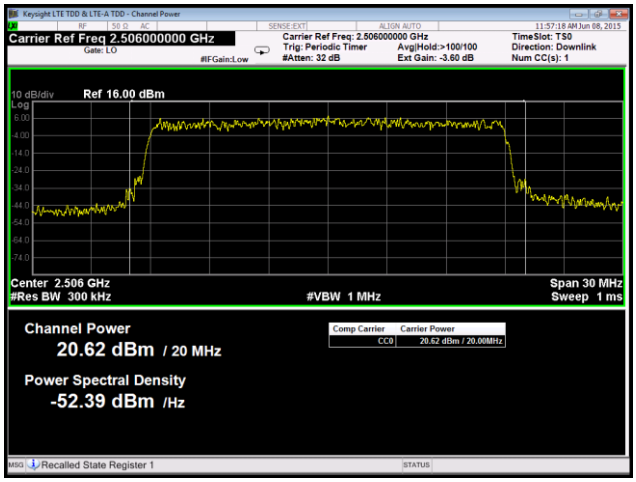
Plot 4. RF Output Power, 16QAM, Low Channel, Port 2



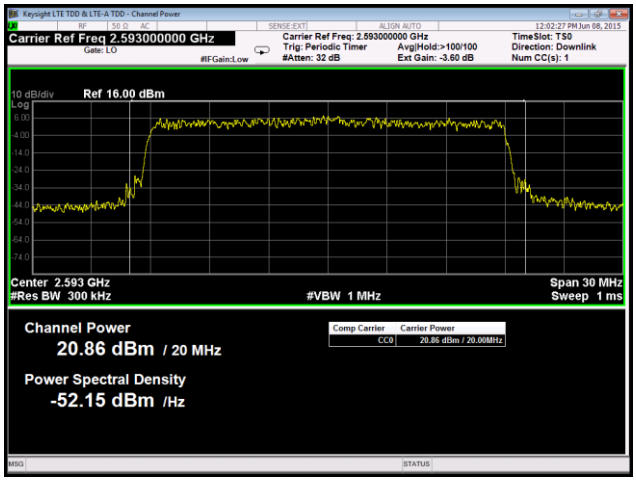
Plot 5. RF Output Power, 16QAM, Mid Channel, Port 2



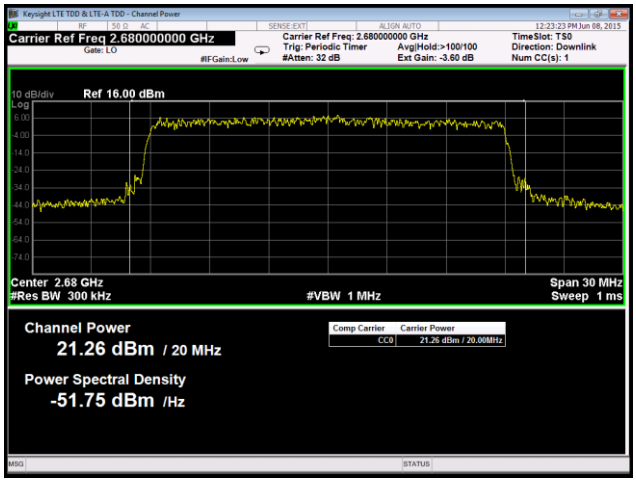
Plot 6. RF Output Power, 16QAM, High Channel, Port 2



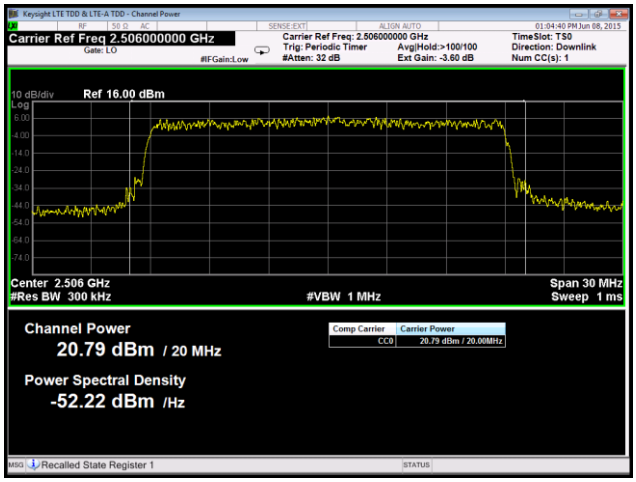
Plot 7. RF Output Power, 64QAM, Low Channel, Port 1



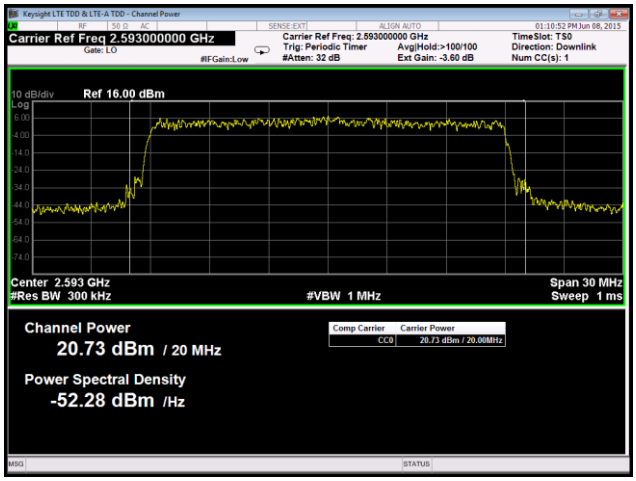
Plot 8. RF Output Power, 64QAM, Mid Channel, Port 1



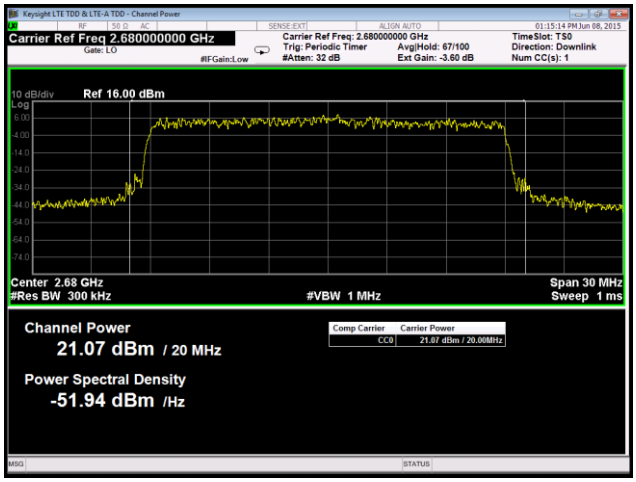
Plot 9. RF Output Power, 64QAM, High Channel, Port 1



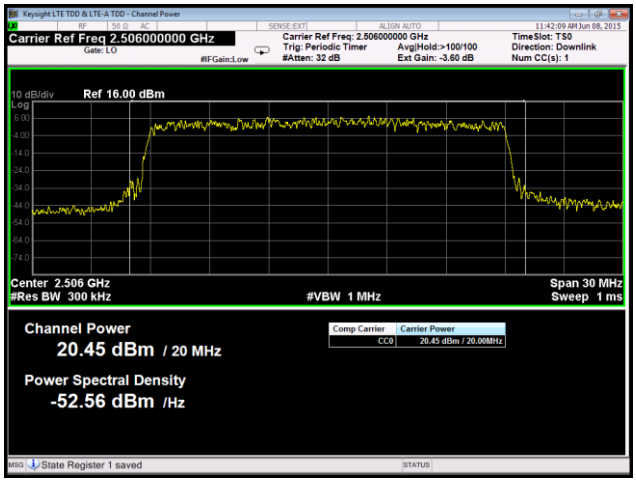
Plot 10. RF Output Power, 64QAM, Low Channel, Port 2



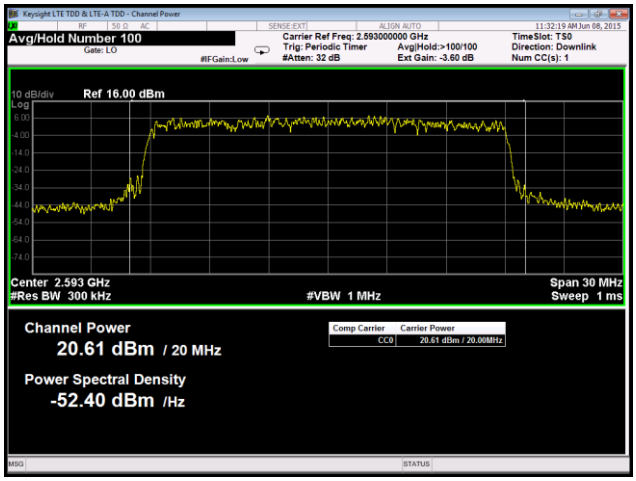
Plot 11. RF Output Power, 64QAM, Mid Channel, Port 2



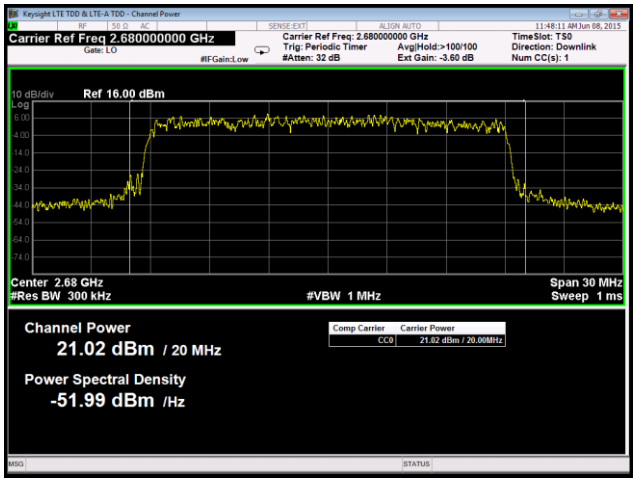
Plot 12. RF Output Power, 64QAM, High Channel, Port 2



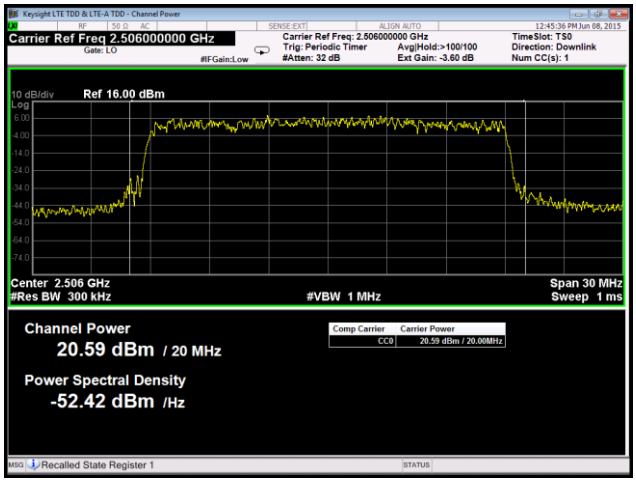
Plot 13. RF Output Power, QPSK, Low Channel, Port 1



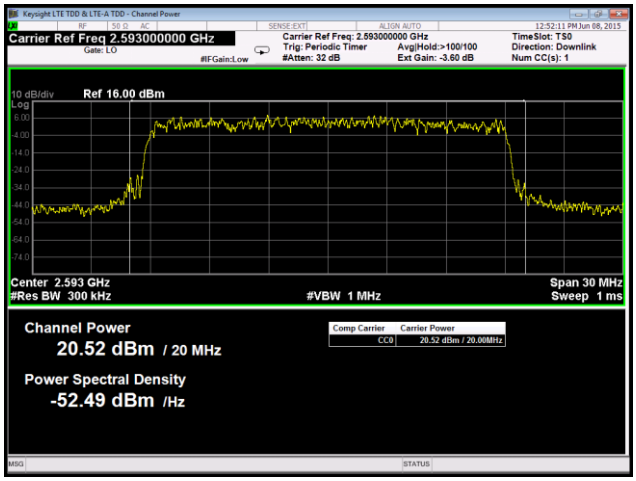
Plot 14. RF Output Power, QPSK, Mid Channel, Port 1



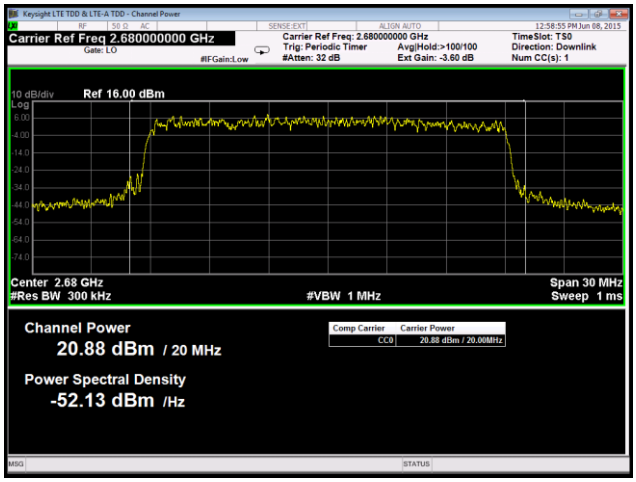
Plot 15. RF Output Power, QPSK, High Channel, Port 1



Plot 16. RF Output Power, QPSK, Low Channel, Port 2



Plot 17. RF Output Power, QPSK, Mid Channel, Port 2



Plot 18. RF Output Power, QPSK, High Channel, Port 2

§ 2.1049 Occupied Bandwidth

Test Requirement(s): **§ 2.1049 Measurements required: Occupied bandwidth:** The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission shall be measured under the specified conditions of § 2.1049 (a) through (i) as applicable.

Test Procedures: As required by 47 CFR 2.1049, *occupied bandwidth measurements* were made with a Spectrum Analyzer connected to the RF ports for both Uplink and Downlink (this only, Downlink only).

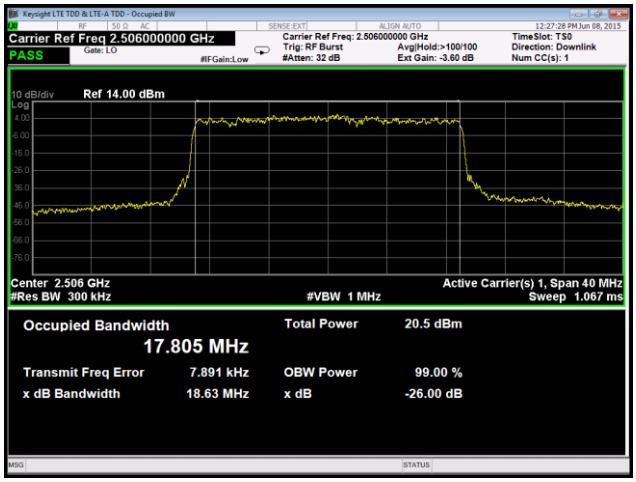
Test Results: Equipment complies with Section 2.1049. The following pages show measurements of 99% and -26 dB Occupied Bandwidth plots.

Test Engineer(s): Benjamin Taylor

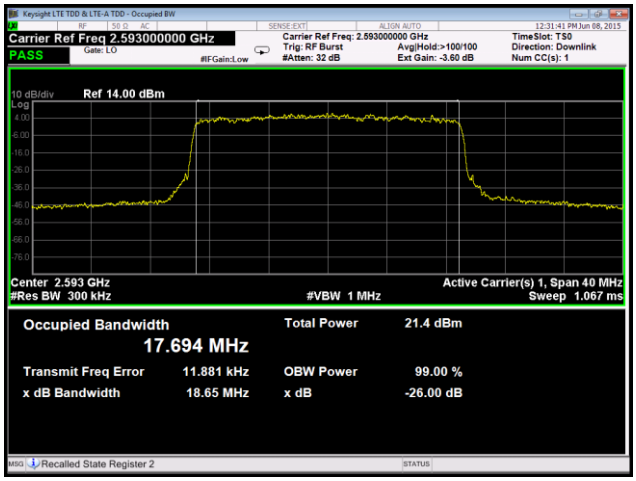
Test Date(s): 06/08/15

Transmit Chain	Modulation/Frequency	-26 dB Occupied Bandwidth (MHz)	99% Occupied Bandwidth (MHz)
Port 1	16QAM, 2506 MHz	18.63	17.805
	16QAM, 2593 MHz	18.65	17.694
	16QAM, 2680 MHz	18.61	17.692
Port2	16QAM, 2506 MHz	18.60	17.748
	16QAM, 2593 MHz	18.64	17.687
	16QAM, 2680 MHz	18.63	17.683
Port 1	64QAM, 2506 MHz	18.64	17.744
	64QAM, 2593 MHz	18.88	17.740
	64QAM, 2680 MHz	18.67	17.765
Port 2	64QAM, 2506 MHz	18.63	17.759
	64QAM, 2593 MHz	18.67	17.764
	64QAM, 2680 MHz	18.67	17.759
Port 1	QPSK, 2506 MHz	18.65	17.739
	QPSK, 2593 MHz	18.71	17.751
	QPSK, 2680 MHz	18.68	17.742
Port 2	QPSK, 2506 MHz	18.73	17.694
	QPSK, 2593 MHz	18.72	17.755
	QPSK, 2680 MHz	18.68	17.704

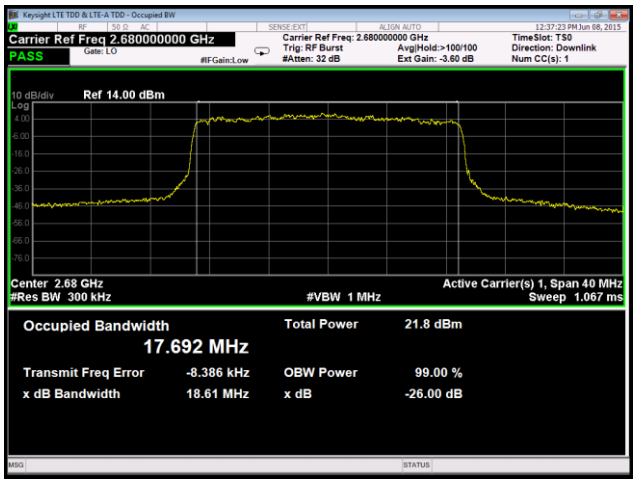
Table 8. Occupied Bandwidth, Test Results



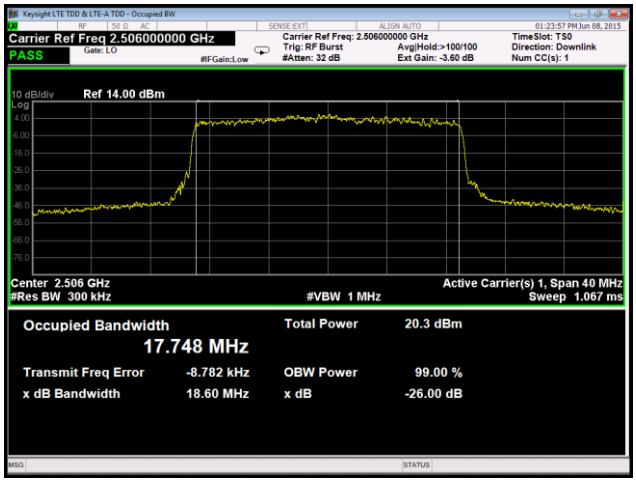
Plot 19. Occupied Bandwidth, 16QAM, Low Channel, Port 1



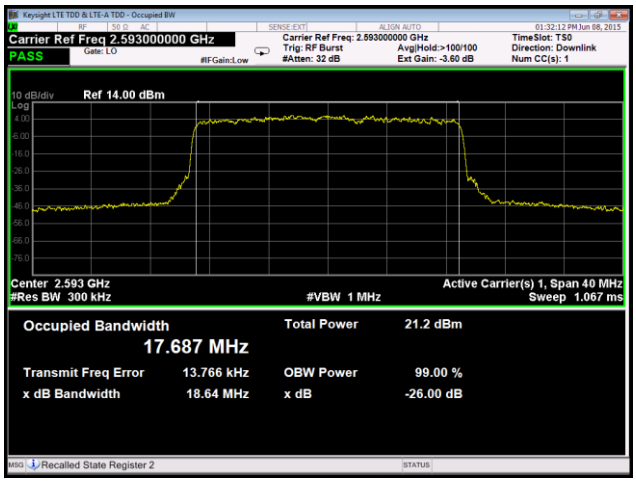
Plot 20. Occupied Bandwidth, 16QAM, Mid Channel, Port 1



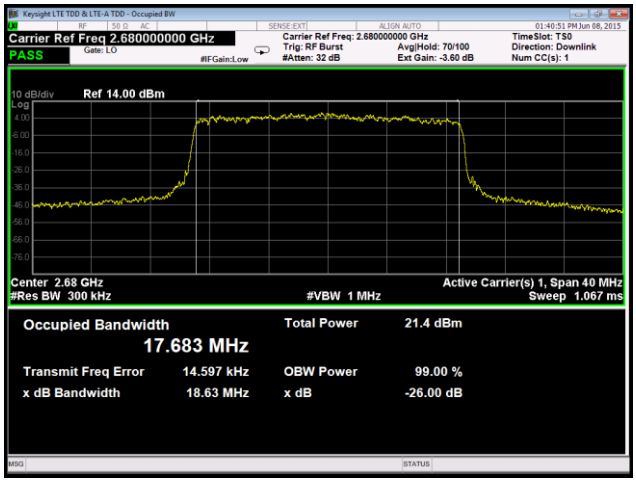
Plot 21. Occupied Bandwidth, 16QAM, High Channel, Port 1



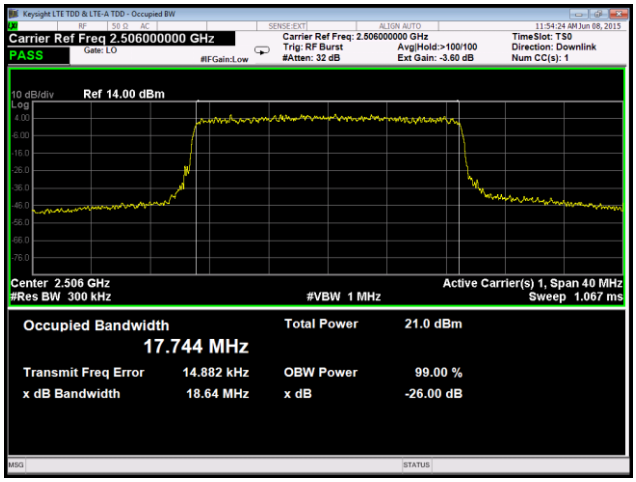
Plot 22. Occupied Bandwidth, 16QAM, Low Channel, Port 2



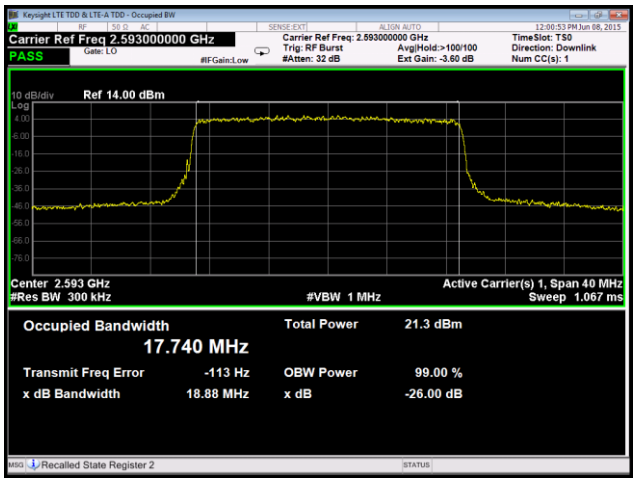
Plot 23. Occupied Bandwidth, 16QAM, Mid Channel, Port 2



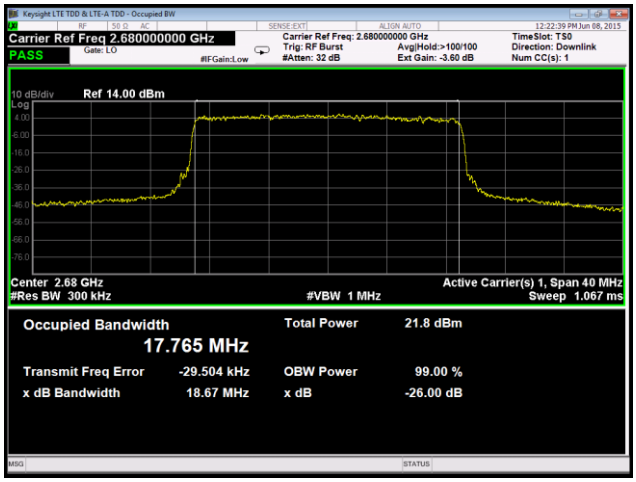
Plot 24. Occupied Bandwidth, 16QAM, High Channel, Port 2



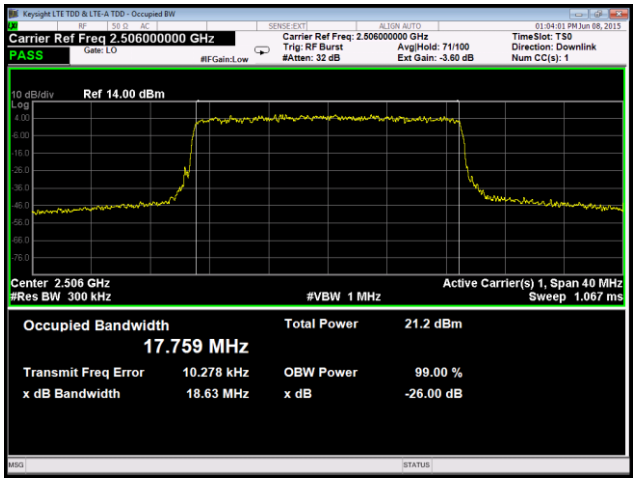
Plot 25. Occupied Bandwidth, 64QAM, Low Channel, Port 1



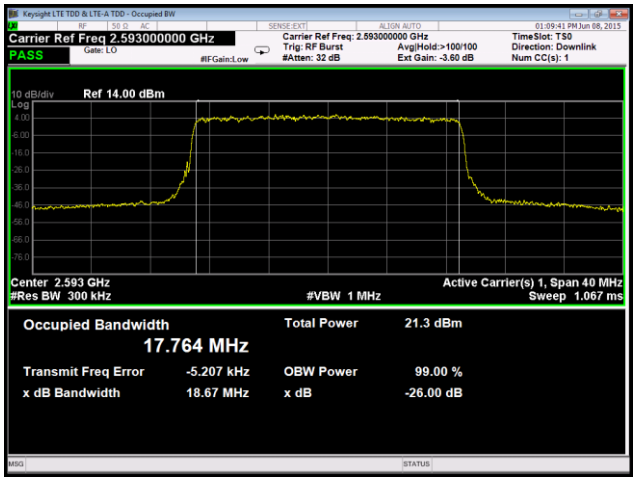
Plot 26. Occupied Bandwidth, 64QAM, Mid Channel, Port 1



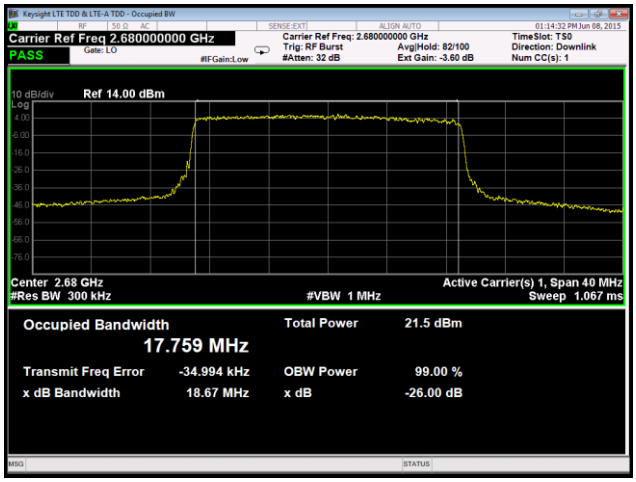
Plot 27. Occupied Bandwidth, 64QAM, High Channel, Port 1



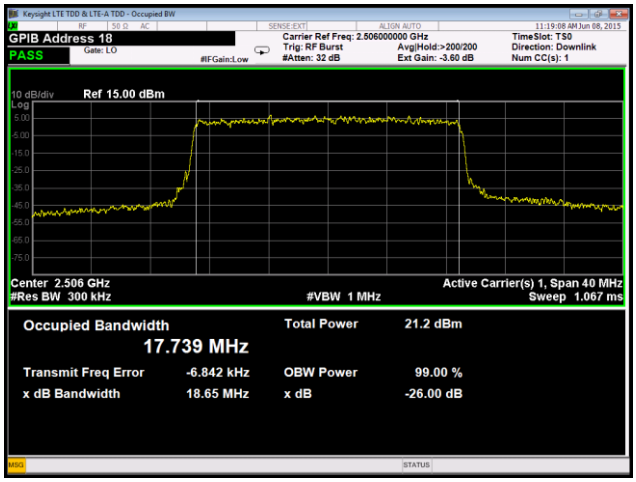
Plot 28. Occupied Bandwidth, 64QAM, Low Channel, Port 2



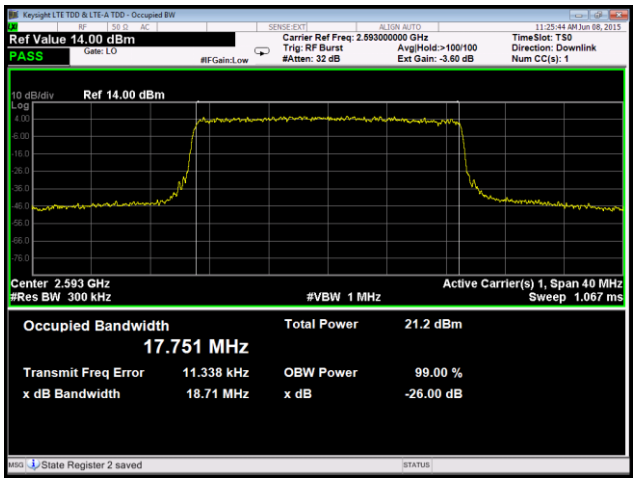
Plot 29. Occupied Bandwidth, 64QAM, Mid Channel, Port 2



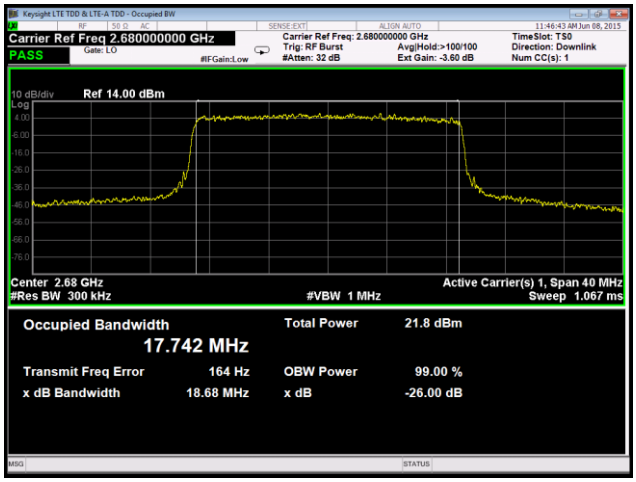
Plot 30. Occupied Bandwidth, 64QAM, High Channel, Port 2



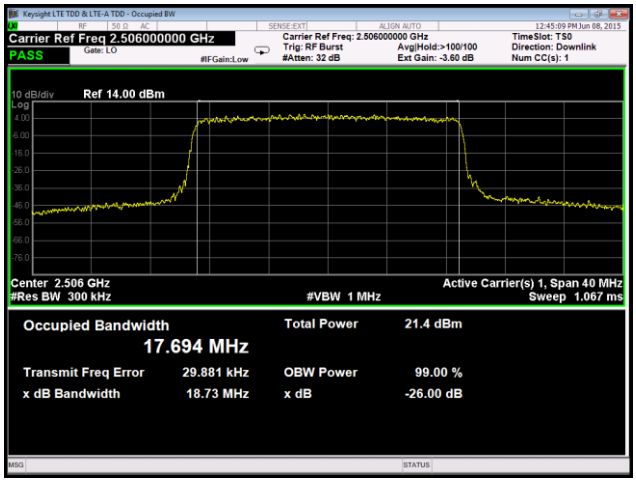
Plot 31. Occupied Bandwidth, QPSK, Low Channel, Port 1



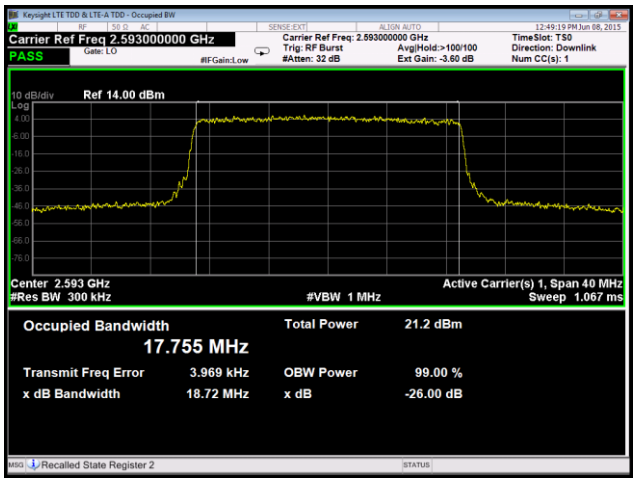
Plot 32. Occupied Bandwidth, QPSK, Mid Channel, Port 1



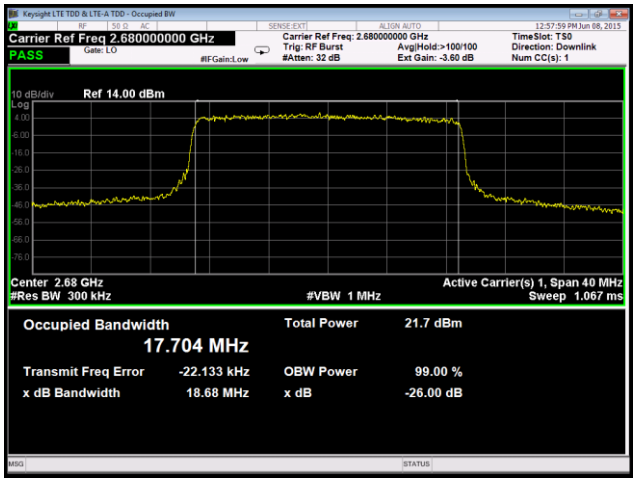
Plot 33. Occupied Bandwidth, QPSK, High Channel, Port 1



Plot 34. Occupied Bandwidth, QPSK, Low Channel, Port 2



Plot 35. Occupied Bandwidth, QPSK, Mid Channel, Port 2



Plot 36. Occupied Bandwidth, QPSK, High Channel, Port 2

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 2.1053 Radiated Spurious Emissions

Test Requirement(s): **§ 2.1053 Measurements required: Field strength of spurious radiation.**

§ 2.1053 (a) Measurements shall be made to detect spurious emissions that may be radiated directly from the cabinet, control circuits, power leads, or intermediate circuit elements under normal conditions of installation and operation. Curves or equivalent data shall be supplied showing the magnitude of each harmonic and other spurious emission. For this test, single sideband, independent sideband, and controlled carrier transmitters shall be modulated under the conditions specified in paragraph (c) of § 2.1049, as appropriate. For equipment operating on frequencies below 890 MHz, an open field test is normally required with the measuring instrument antenna located in the far-field at all test frequencies. In the event it is either impractical or impossible to make open field measurements (e.g. a broadcast transmitter installed in a building) measurements will be accepted of the equipment as installed. Such measurements must be accompanied by a description of the site where the measurements were made showing the location of any possible source of reflections which might distort the field strength measurements. Information submitted shall include the relative radiated power of each spurious emission with reference to the rated power output of the transmitter, assuming all emissions are radiated from half-wave dipole antennas.

§ 2.1053 (b): The measurements specified in paragraph (a) of this section shall be made for the following equipment:

(1) Those in which the spurious emissions are required to be 60 dB or more below the mean power of the transmitter.

(2) All equipment operating on frequencies higher than 25 MHz.

(3) All equipment where the antenna is an integral part of, and attached directly to the transmitter.

(4) Other types of equipment as required, when deemed necessary by the Commission.

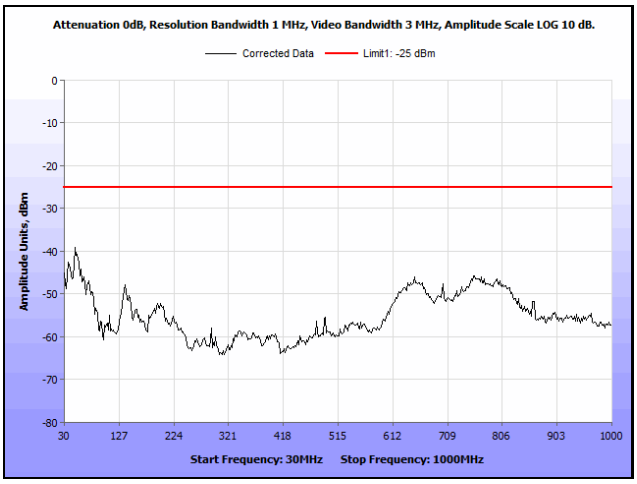
Test Procedures: As required by 47 CFR 2.1053, the *field strengths of radiated spurious emissions* were made in accordance with the procedures of TIA/EIA-603-A-2001 "Land Mobile FM or PM Communications Equipment Measurement and Performance Standards".

Radiated emission measurements were performed inside a 3 meter semi-anechoic chamber (equivalent to an Open Area Test Site). The distance between the EUT and the test antenna was 3 meters for below 1 GHz and 1m for frequencies above 1 GHz. The EUT's RF port was connected to a dummy load. The intensities of the radiated emissions were maximized by rotating the turntable 360 degrees and varying the receive antenna from 1 to 4m. Measurements were made with the receive antenna in both horizontal and vertical polarizations.

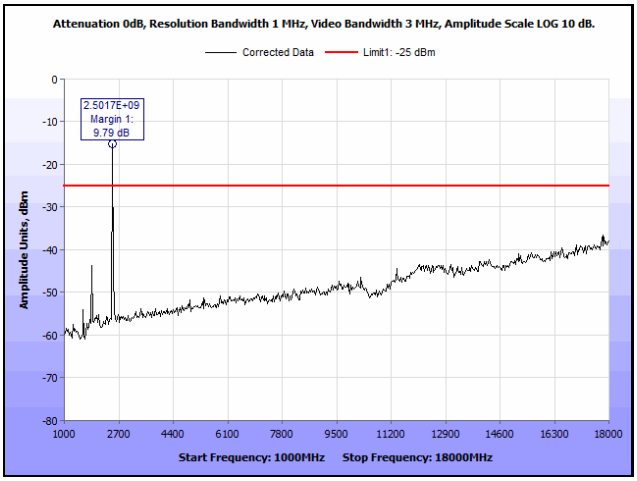
Test Results: Equipment complies with Section 2.1053. The limit for spurs is -25 dBm. Measurements revealed that no spurs came even close to this limit. Therefore, measurements using substitution method were not performed. Measurements were made with a pre-amp for above 1 GHz. Only noise floor was measured above 18 GHz.

Test Engineer: Benjamin Taylor

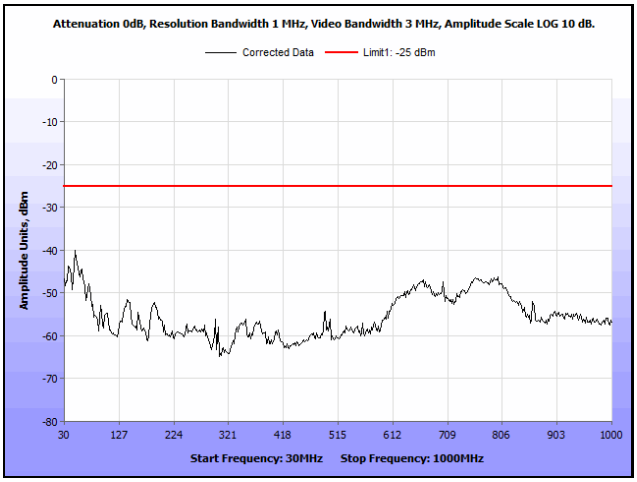
Test Date(s): 06/20/15



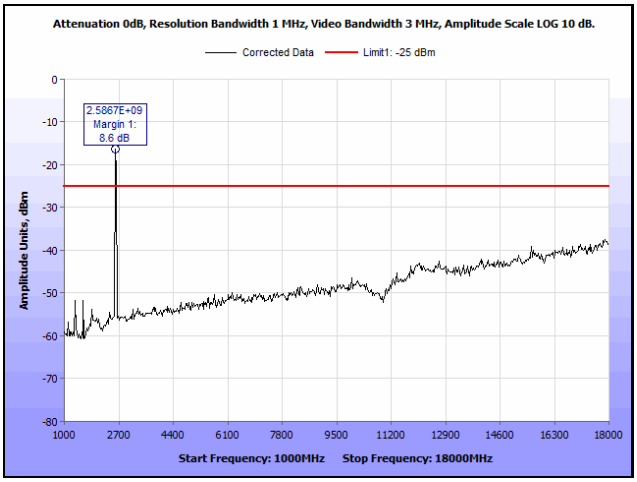
Plot 37. Radiated Spurious Emissions, 16QAM, Low Channel, Port 1, 30 MHz – 1 GHz



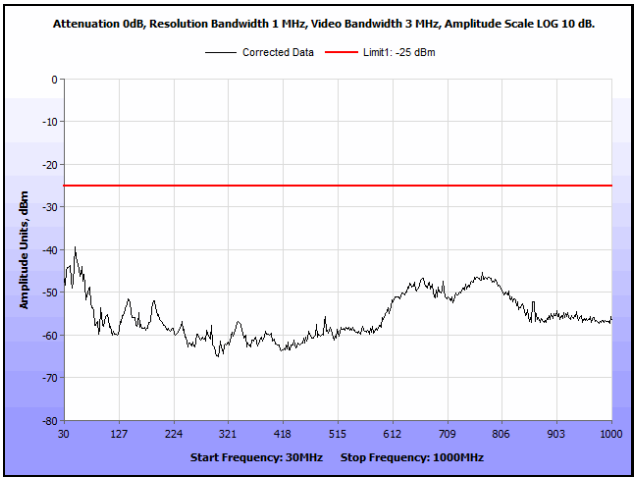
Plot 38. Radiated Spurious Emissions, 16QAM, Low Channel, Port 1, 1 GHz – 18 GHz



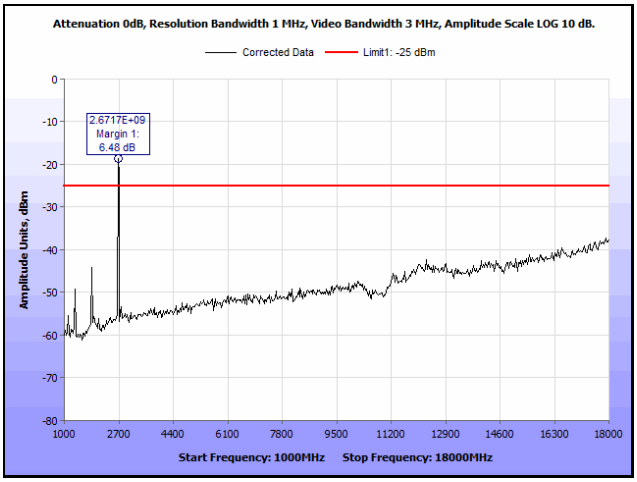
Plot 39. Radiated Spurious Emissions, 16QAM, Mid Channel, Port 1, 30 MHz – 1 GHz



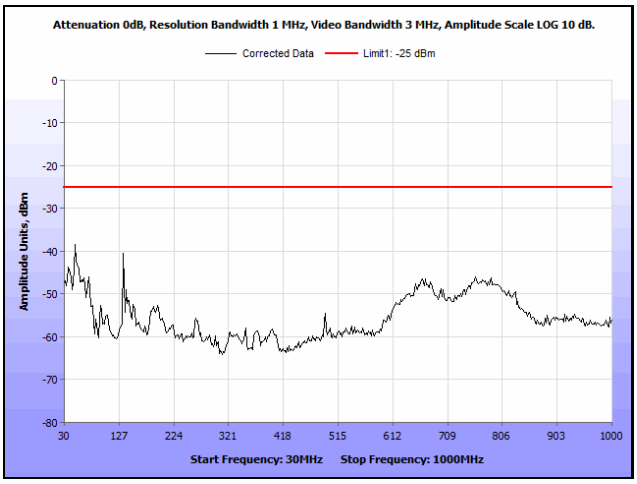
Plot 40. Radiated Spurious Emissions, 16QAM, Mid Channel, Port 1, 1 GHz – 18 GHz



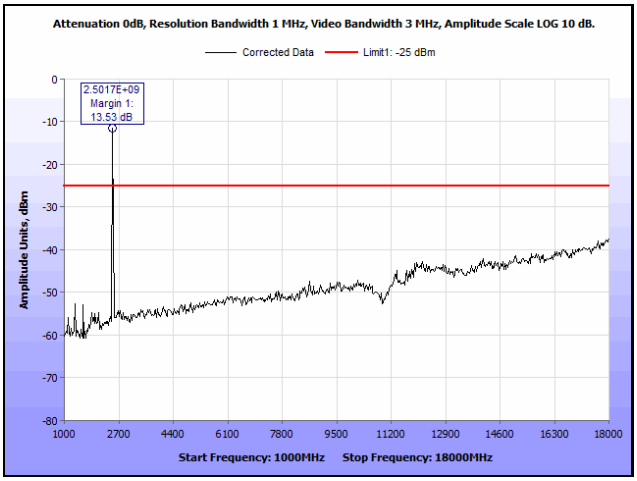
Plot 41. Radiated Spurious Emissions, 16QAM, High Channel, Port 1, 30 MHz – 1 GHz



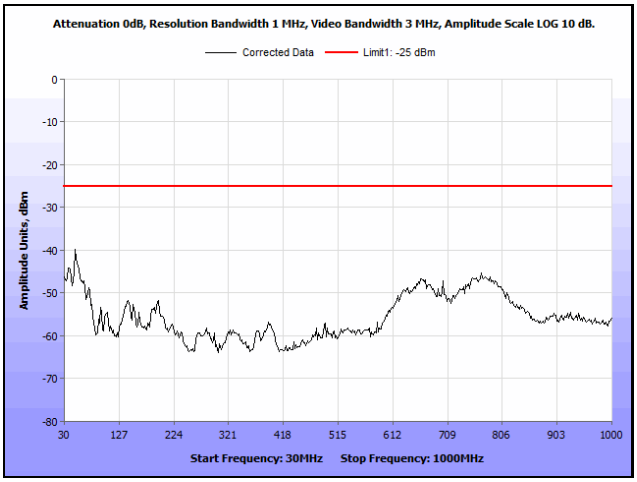
Plot 42. Radiated Spurious Emissions, 16QAM, High Channel, Port 1, 1 GHz – 18 GHz



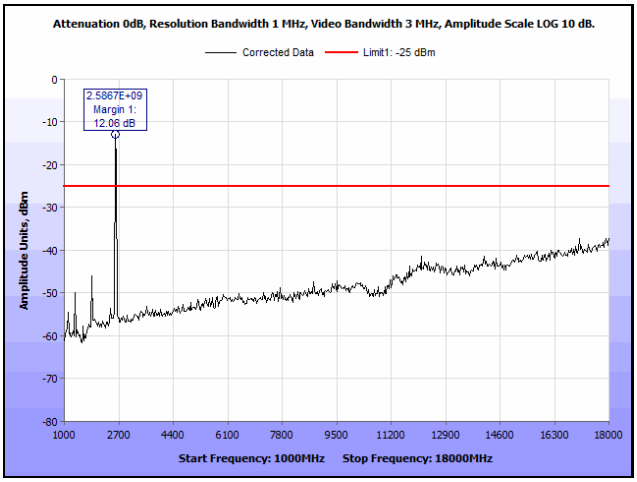
Plot 43. Radiated Spurious Emissions, 16QAM, Low Channel, Port 2, 30 MHz – 1 GHz



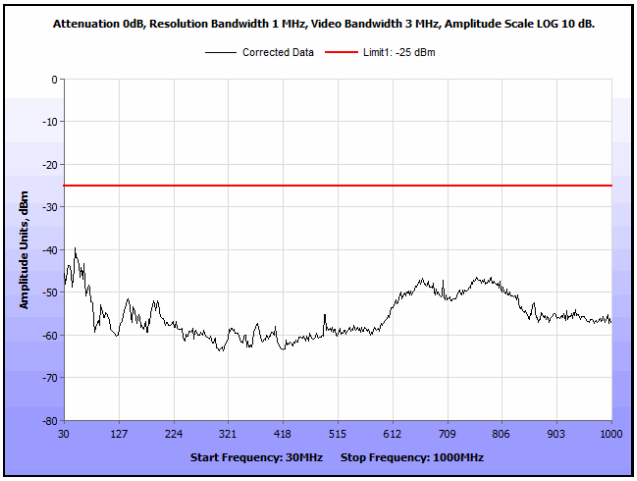
Plot 44. Radiated Spurious Emissions, 16QAM, Low Channel, Port 2, 1 GHz – 18 GHz



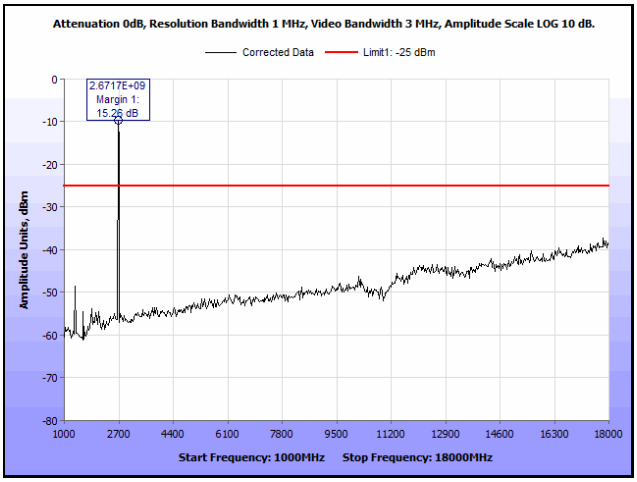
Plot 45. Radiated Spurious Emissions, 16QAM, Mid Channel, Port 2, 30 MHz – 1 GHz



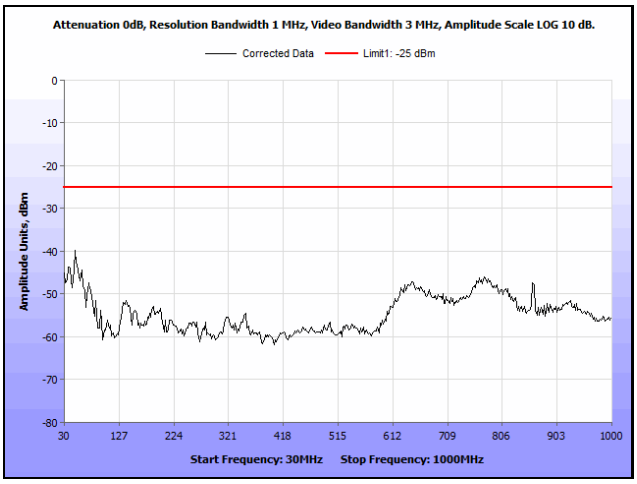
Plot 46. Radiated Spurious Emissions, 16QAM, Mid Channel, Port 2, 1 GHz – 18 GHz



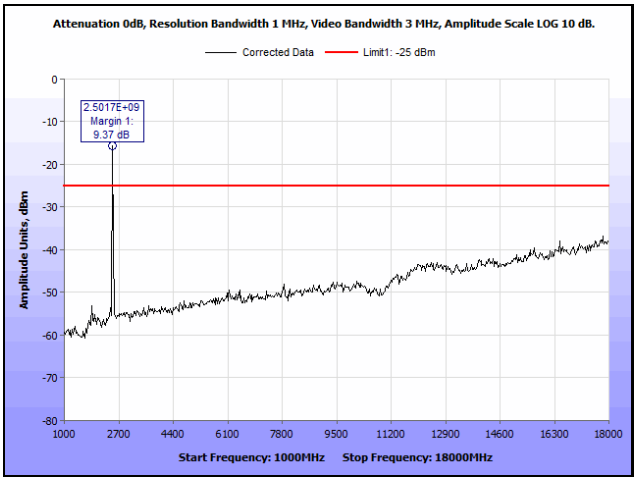
Plot 47. Radiated Spurious Emissions, 16QAM, High Channel, Port 2, 30 MHz – 1 GHz



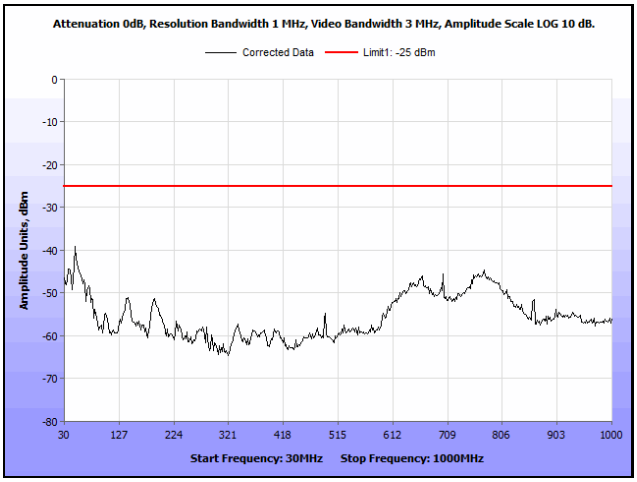
Plot 48. Radiated Spurious Emissions, 16QAM, High Channel, Port 2, 1 GHz – 18 GHz



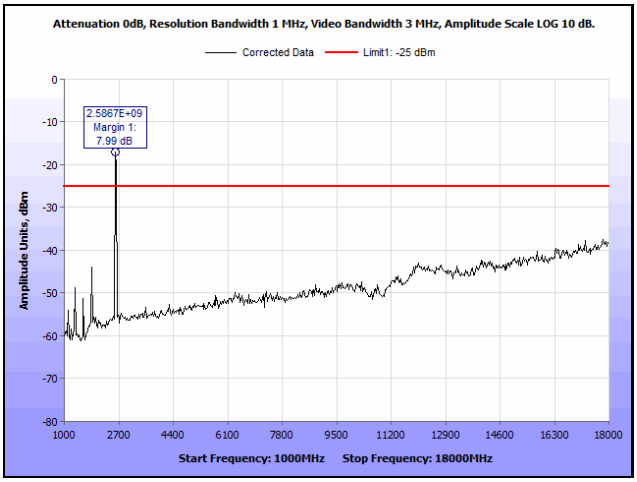
Plot 49. Radiated Spurious Emissions, 64QAM, Low Channel, Port 1, 30 MHz – 1 GHz



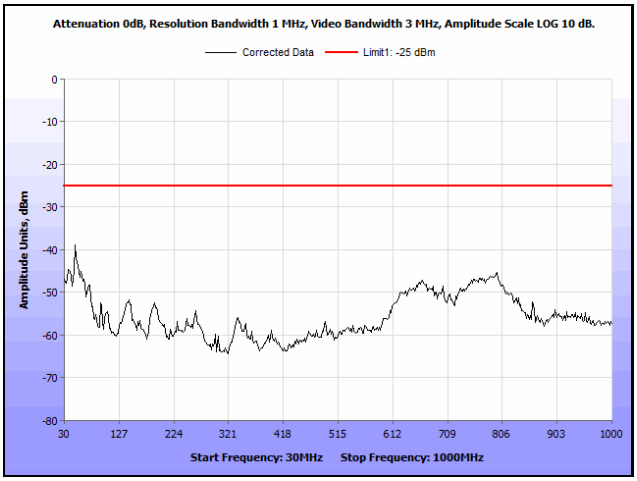
Plot 50. Radiated Spurious Emissions, 64QAM, Low Channel, Port 1, 1 GHz – 18 GHz



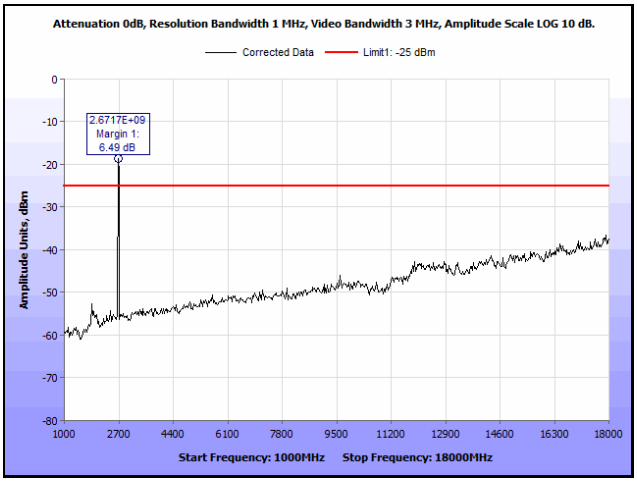
Plot 51. Radiated Spurious Emissions, 64QAM, Mid Channel, Port 1, 30 MHz – 1 GHz



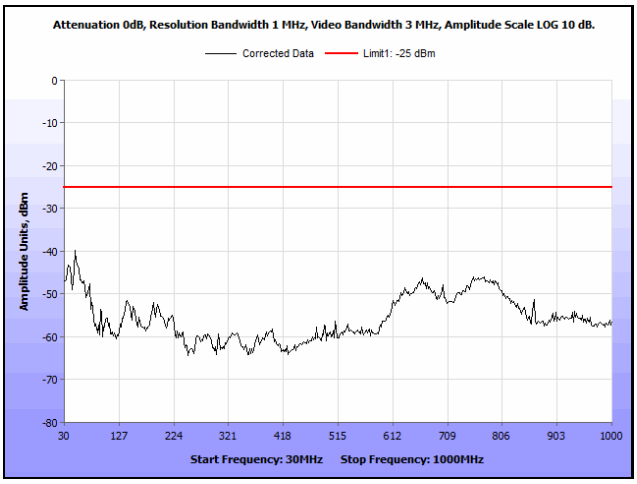
Plot 52. Radiated Spurious Emissions, 64QAM, Mid Channel, Port 1, 1 GHz – 18 GHz



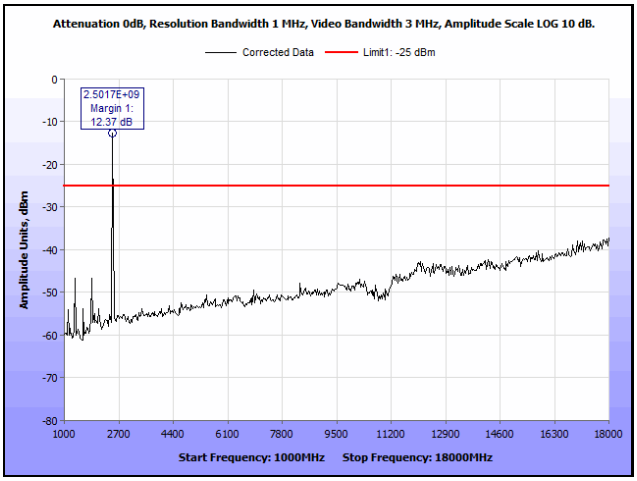
Plot 53. Radiated Spurious Emissions, 64QAM, High Channel, Port 1, 30 MHz – 1 GHz



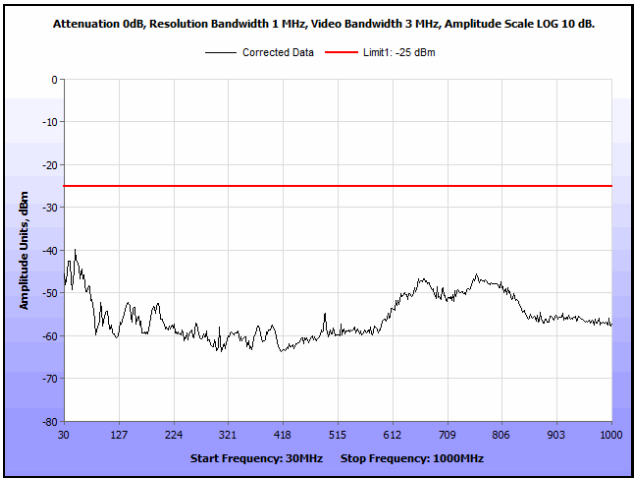
Plot 54. Radiated Spurious Emissions, 64QAM, High Channel, Port 1, 1 GHz – 18 GHz



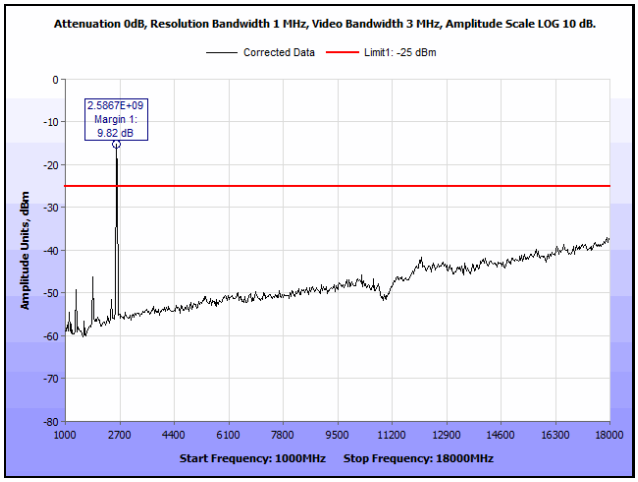
Plot 55. Radiated Spurious Emissions, 64QAM, Low Channel, Port 2, 30 MHz – 1 GHz



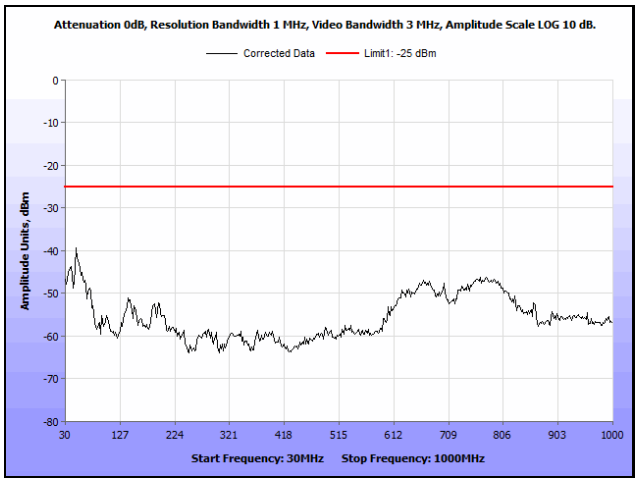
Plot 56. Radiated Spurious Emissions, 64QAM, Low Channel, Port 2, 1 GHz – 18 GHz



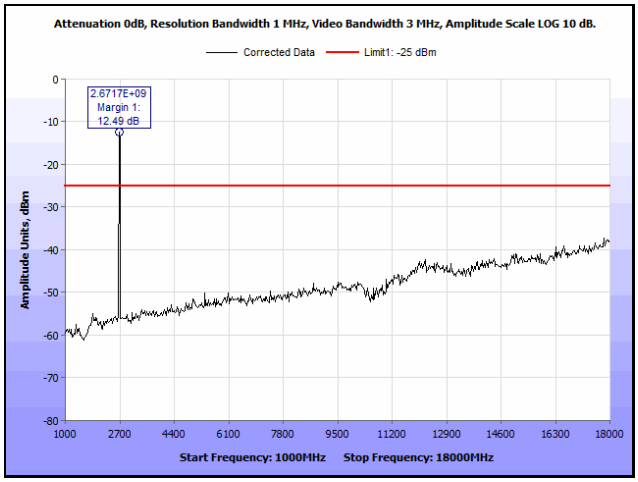
Plot 57. Radiated Spurious Emissions, 64QAM, Mid Channel, Port 2, 30 MHz – 1 GHz



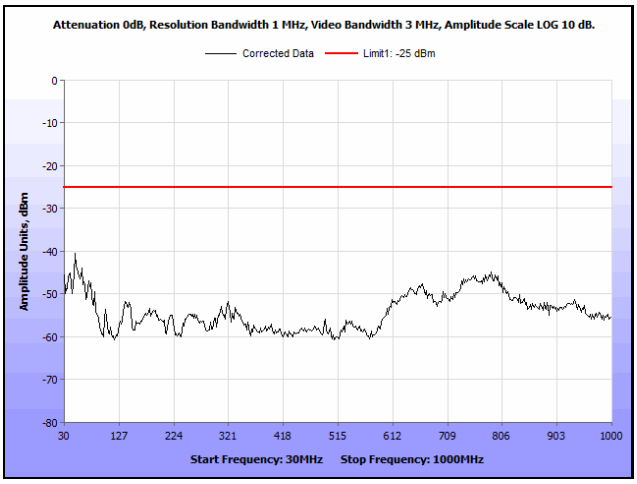
Plot 58. Radiated Spurious Emissions, 64QAM, Mid Channel, Port 2, 1 GHz – 18 GHz



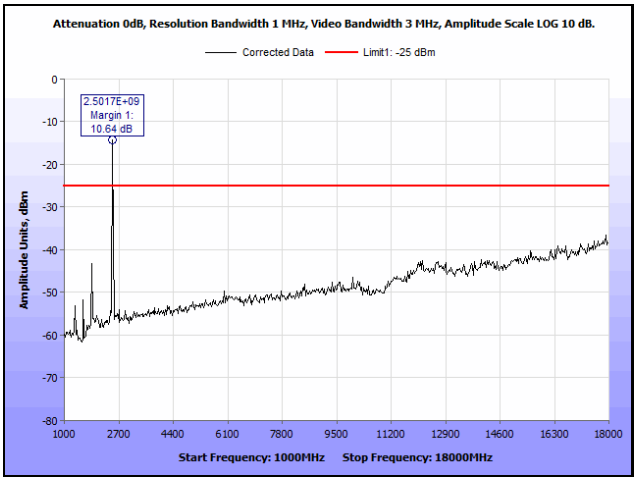
Plot 59. Radiated Spurious Emissions, 64QAM, High Channel, Port 2, 30 MHz – 1 GHz



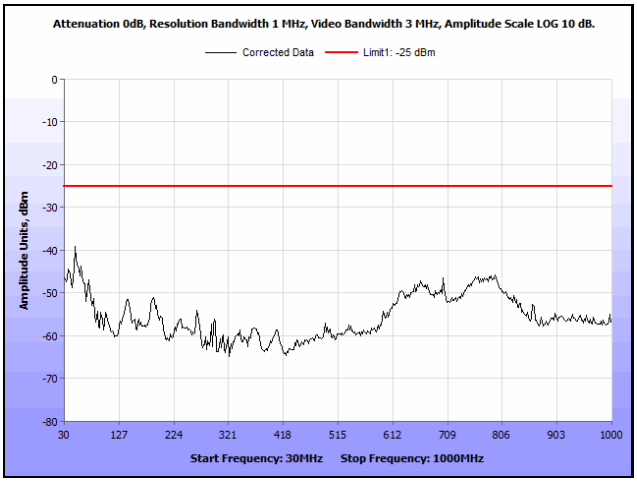
Plot 60. Radiated Spurious Emissions, 64QAM, High Channel, Port 2, 1 GHz – 18 GHz



Plot 61. Radiated Spurious Emissions, QPSK, Low Channel, Port 1, 30 MHz – 1 GHz



Plot 62. Radiated Spurious Emissions, QPSK, Low Channel, Port 1, 1 GHz – 18 GHz



Plot 63. Radiated Spurious Emissions, QPSK, Mid Channel, Port 1, 30 MHz – 1 GHz

