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May 21, 2018

Caterpillar Inc.
100 NE Adams St.
Peoria, IL 61629

Dear David Mitchell,

Enclosed is the EMC Wireless test report for compliance testing of the Caterpillar Inc., PL671 as tested to the requirements of Title 47 of the CFR, Ch. 1 (10-1-06 ed.), Title 47 of the CFR, Part 15.407, Subpart E (UNII 2).

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: (\Caterpillar Inc.\EMC95659-FCC407 UNII 2 Rev. 2)

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Electromagnetic Compatibility Criteria
Test Report

for the

Caterpillar Inc.
Model PL671

Tested under
The FCC Certification Rules
contained in
Title 47 of the CFR
15.407 Subpart E

MET Report: EMC95659-FCC407 UNII 2 Rev. 2

May 21, 2018

Prepared For:

Caterpillar Inc.
100 NE Adams St.
Peoria, IL 61629

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

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Title 47 of the CFR
15.407 Subpart E

Deepak Giri, 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 15.407 of the FCC Rules under normal use and maintenance.

John Mason,
Director, Electromagnetic Compatibility Lab

Report Status Sheet

Revision	Report Date	Reason for Revision
∅	January 23, 2018	Initial Issue.
1	March 1, 2018	Updated FCC ID.
2	May 21, 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
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 Caterpillar Inc. PL671, with the requirements of Part 15, §15.407. 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 PL671. Caterpillar Inc. should retain a copy of this document which should be kept on file for at least two years after the manufacturing of the PL671, 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, §15.407, in accordance with Caterpillar Inc., purchase order number PO9516. All tests were conducted using measurement procedure ANSI C63.4-2014.

FCC Reference	Description	Results
§15.203	Antenna Requirement	Compliant
§15.403(i)	26 dB Occupied Bandwidth	Compliant
§15.407 (a)(2)	Maximum Conducted Output Power	Compliant
§15.407 (a)(2)	Maximum Power Spectral Density	Compliant
§15.407 (b)(2 – 3)& (6 - 7)	Undesirable Emissions	Compliant
§15.407(b)(6)	Conducted Emission	Not Applicable
§15.407(f)	RF Exposure	Compliant
§15.407(g)	Frequency Stability	Compliant

Table 1. Executive Summary of EMC Part 15.407 ComplianceTesting

II. Equipment Configuration

A. Overview

MET Laboratories, Inc. was contracted by Caterpillar Inc. to perform testing on the PL671, under Caterpillar Inc.'s purchase order number PO9516.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the Caterpillar Inc. PL671.

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

Model(s) Tested:	PL671	
Model(s) Covered:	PL671	
EUT Specifications:	Primary Power: 9 - 32 VDC	
	FCC ID: PQMPL671	
	Type of Modulations:	BPSK, QPSK, 16QAM
	Equipment Code:	NII
	Peak RF Output Power:	16.82 dBm
	EUT Frequency Ranges:	5260 – 5320 MHz, 5500 -5700 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	
Type of Filing:	Original	
Evaluated by:	Deepak Giri	
Report Date(s):	May 21, 2018	

Table 2. EUT Summary

B. References

CFR 47, Part 15, Subpart E	Unlicensed National Information Infrastructure Devices (UNII)
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
789033 D02 General UNII Test Procedures New Rules v01	Guidelines for Compliance Testing of Unlicensed National Information Infrastructure (U-NII) Devices Part 15, Subpart E
905462 DO2 UNII DFS Compliance Procedures New Rules v01r02	Compliance Measurement Procedures for Unlicensed-National Information Infrastructure Devices Operating in the 5250-5350 MHz and 5470-5725 MHz Bands Incorporating Dynamic Frequency Selection

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. Measurement Uncertainty

E. Description of Test Sample

The Caterpillar Inc. PL671, Equipment Under Test (EUT), is a dedicated short range communication (DSRC) device. Units are mounted on heavy machinery on both sides of the vehicle to minimize blind spots. It is intended to provide proximity information vehicle to vehicle. A dedicated radio module in the EUT is used to do provide this link. EUT can also communicate to a stationary device or device on a smaller vehicle by Wi-Fi or BT. A GNSS module inside the EUT provides positioning information to the EUT. The two EUTs communicate with each other and the vehicle using Ethernet. An audio module in the EUT can send audible warnings in case of collision possibilities.

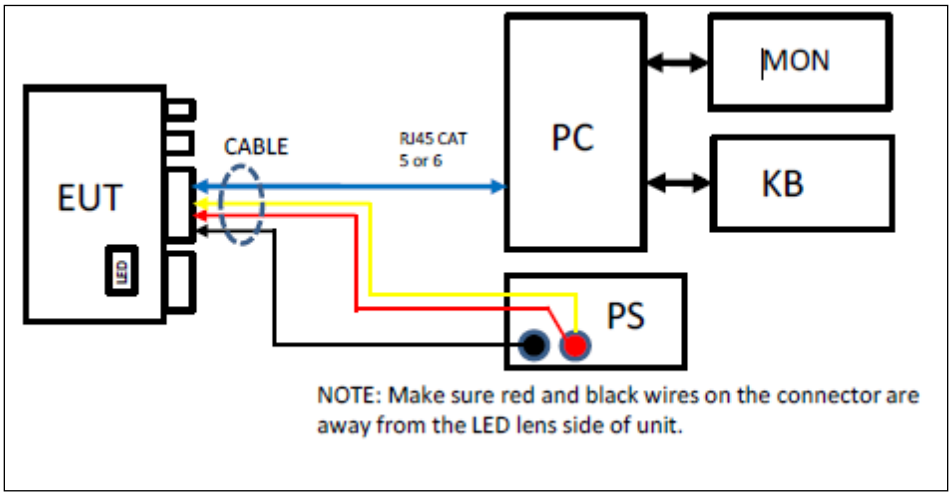
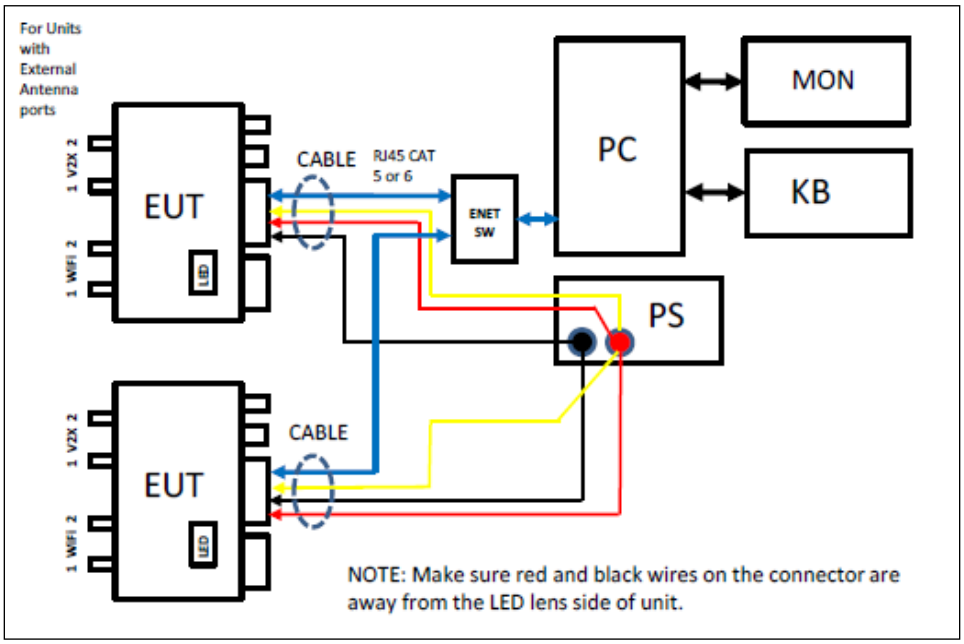


Figure 1. Block Diagram of Test Configuration 1.1



Note: EUT modified with antenna terminal only for test purposes. Otherwise, EUT will have permanent antenna.

Figure 2. Block Diagram of Test Configuration 1.2

F. Equipment Configuration

The EUT was set up as outlined in Figure 2, 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	Revision
EUT	N/A	DSRC Radio	PL671			A

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
PS	Power Supply	BK Precision	1697 or Equiv.	N/A
KB	Standard PC Keyboard	Dell	Any	N/A
PC	Computer	Dell	VOSTRO or Equiv.	N/A
MON	Monitor	Dell	Any	N/A
ENET SW	Ethernet Switch 10/100/1000	Linksys	EG005 or equiv.	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	Qty.	Length (m)	Max Length	Shielded (Y/N)	Termination Point
1	Data Cable	RJ45 CAT 5 or 6 on Quake Cable	2	TBD		No	12 PIN Conn.
2	Power Supply Leads	On Quake Conn. Red, Black, and Yellow		TBD		No	9-32V

Table 7. Ports and Cabling Information

I. Mode of Operation

Mode 1: The DSRC module in the EUT is put in a continuous transmit mode using the test script. It will broadcast at full power till turned off.
Mode 2: The Wi-Fi module in the EUT is put into continuous transmit mode using the test script. It will broadcast at full power till turned off.
Mode 3: The GNSS module in the EUT is activated using the test script and sends out NMEA data to the CPU. It will receive and send data till turned off. The EUT must be connected to an active antenna and have a clear sky view
Mode 4: The Ethernet is used to set up the test modes. The Ethernet is set to full duplex and set to communicate with the computer in a continuous mode.

J. Method of Monitoring EUT Operation

Mode 1: The DSRC is activated for the test menu using “d”. It will down load firmware to the DSRC module. A secondary menu will appear. Select “b” (TX with no GPS). Current will increase and a rolling script will appear in the terminal window continuously. Please refer to Quake document 1153-3011 for instructions.
Mode 2: The Wi-Fi is activated by opening another terminal. Use the test script to select “w”. Select TX mode. A continuous script will scroll in the terminal as the module transmits.
Mode 3: Open another terminal and select “g” to activate the GNSS module. The NMEA data stream from the module will scroll continuously.
Mode 4: Open another terminal and set up a ping on the ENET. Continuous acknowledgement will be sent.

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 Caterpillar Inc. upon completion of testing.

III. Electromagnetic Compatibility Criteria for Intentional Radiators

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.203 Antenna Requirement

Test Requirement: **§ 15.203:** An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

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

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

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

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

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

Antennas are permanently attached.

Test Engineer(s): Deepak Giri

Test Date(s): November 13, 2017

Antenna Type	Gain dBi	Manufacturer
Balance Flex Antenna	4.5 dBi	N/A

Table 8. Antenna List

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15. 403(i) 26dB Bandwidth

Test Requirements: **§ 15.403(i):** For purposes of this subpart the emission bandwidth shall be determined by measuring the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, that are 26 dB down relative to the maximum level of the modulated carrier. Determination of the emissions bandwidth is based on the use of measurement instrumentation employing a peak detector function with an instrument resolution bandwidth approximately equal to 1.0 to 5.0 percent of the emission bandwidth of the device under measurement.

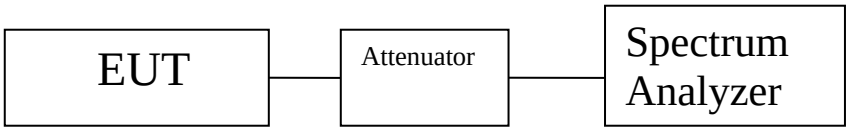
Test Procedure: The transmitter was set to low, mid, and high operating frequencies at the highest output power and connected to the spectrum analyzer through an attenuator. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using a RBW approximately equal to 1% - 5 % of the total emission bandwidth, VBW > RBW. The 26 dB Bandwidth was measured and recorded.

Test Results The 26 dB Bandwidth was compliant with the requirements of this section.

No anomalies detected.

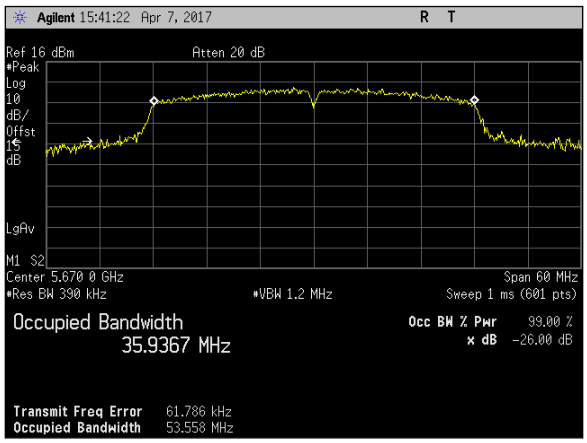
Test Engineer(s): Deepak Giri

Test Date(s): November 16, 2017

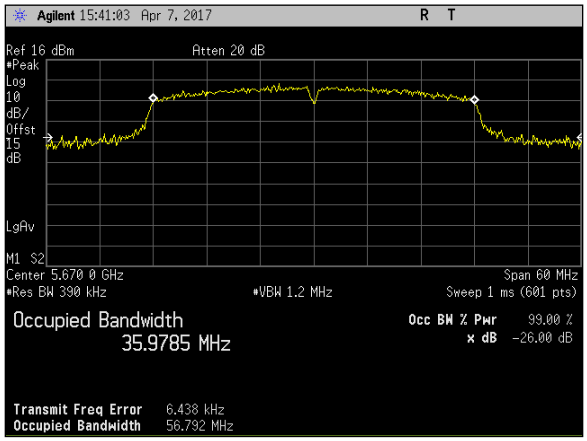


Frequency MHz	Mode	Bandwidth MHz	26 dB Bandwidth MHz port 1	26 dB Bandwidth MHz port 2
5260	a	20	29.29	29.36
5280			28.41	28.60
5320			29.32	30.00
5500			29.87	30.00
5580			29.73	28.58
5700			29.87	29.62
5260	n		29.80	29.54
5280			29.77	29.69
5320			29.95	30.00
5500			28.79	29.57
5580			29.72	28.59
5700			30.00	30.00
5270		40	49.32	49.92
5310			54.57	54.83
5510			55.47	53.31
5550			54.18	52.35
5670			56.79	53.55

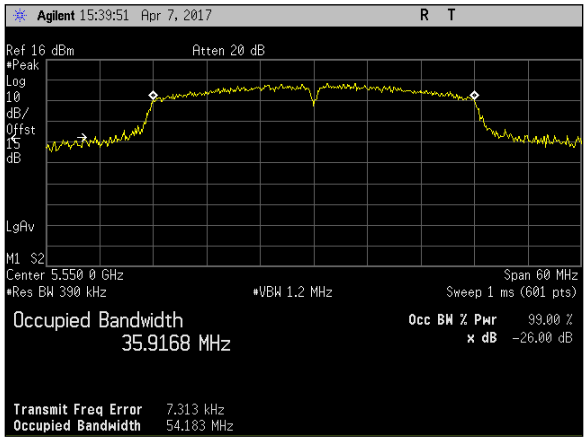
Table 9. 26 dB Occupied Bandwidth, Test Results



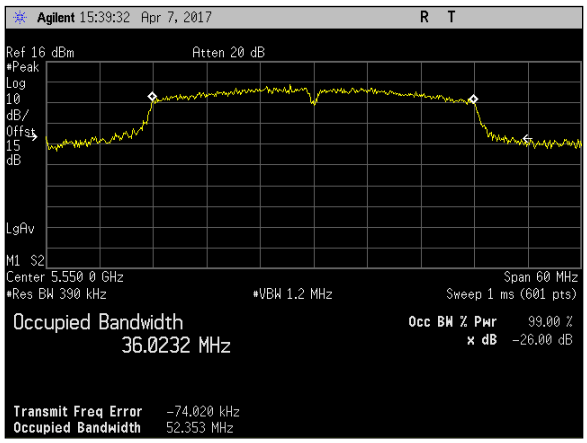
Plot 1. 26 dB Occupied Bandwidth, BW 40M, Ch 5670M, N Mode Port 2



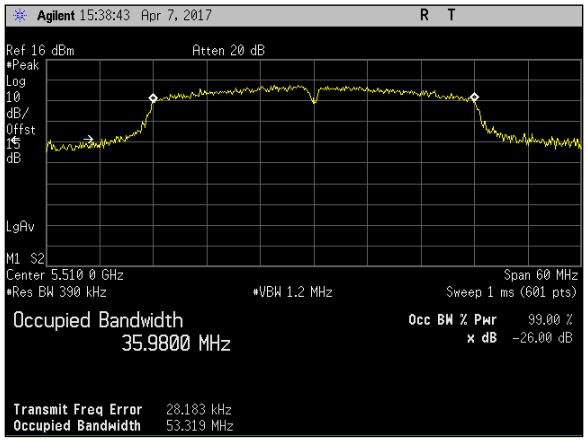
Plot 2. 26 dB Occupied Bandwidth, BW 40M, Ch 5670M, N Mode Port 1



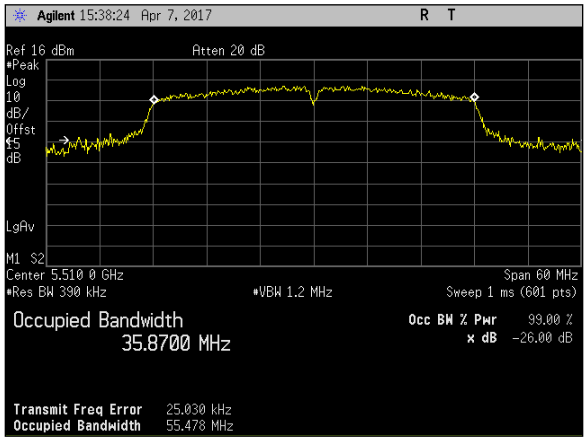
Plot 3. 26 dB Occupied Bandwidth, BW 40M, Ch 5550M, N Mode Port 1



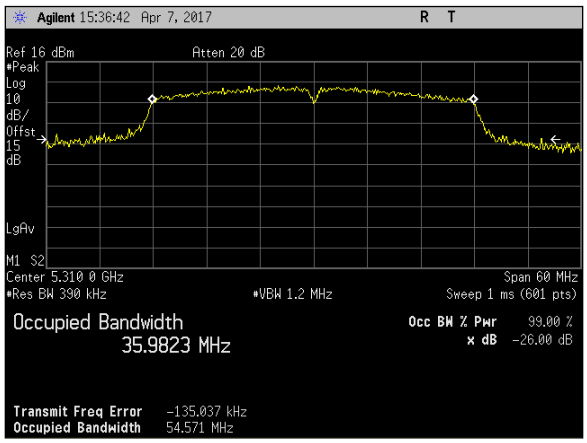
Plot 4. 26 dB Occupied Bandwidth, BW 40M, Ch 5550M, N Mode Port 2



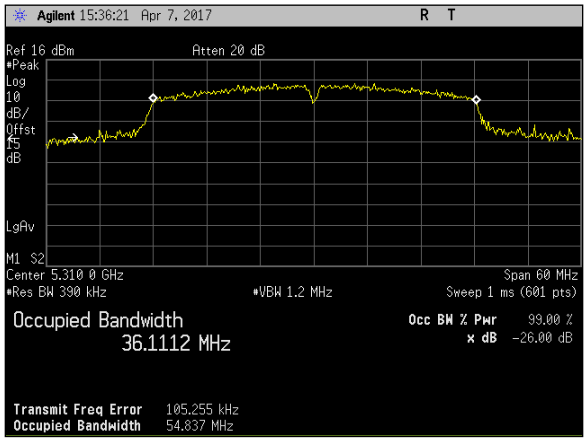
Plot 5. 26 dB Occupied Bandwidth, BW 40M, Ch 5510M, N Mode Port 2



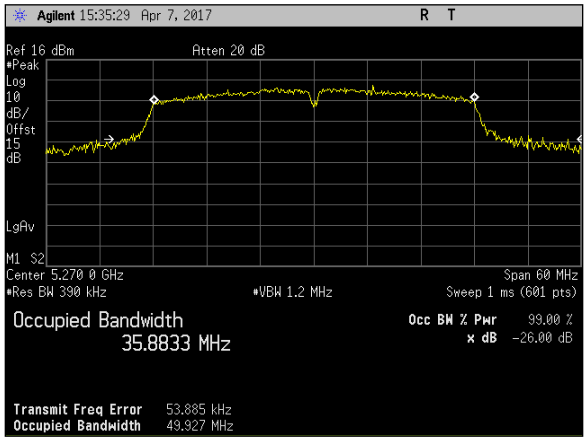
Plot 6. 26 dB Occupied Bandwidth, BW 40M, Ch 5510M, N Mode Port 1



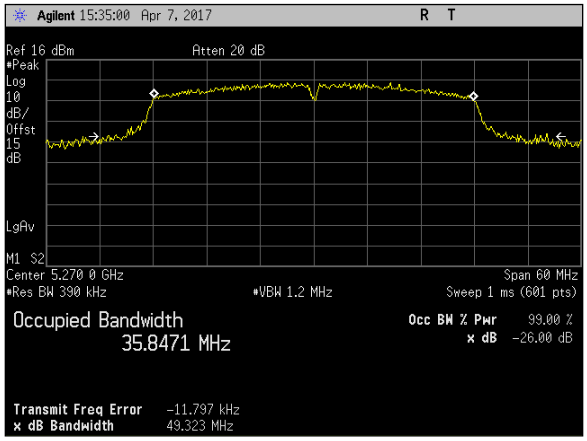
Plot 7. 26 dB Occupied Bandwidth, BW 40M, Ch 5310M, N Mode Port 1



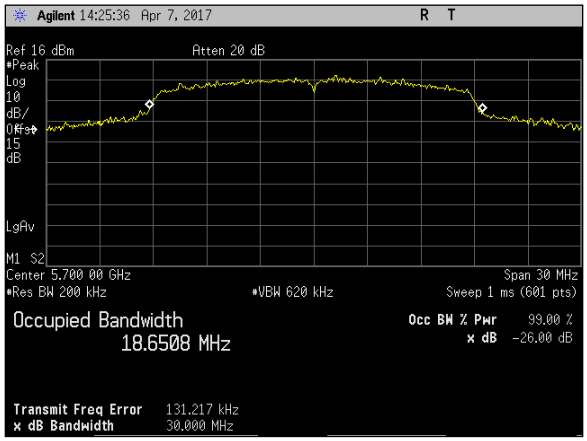
Plot 8. 26 dB Occupied Bandwidth, BW 40M, Ch 5310M, N Mode Port 2



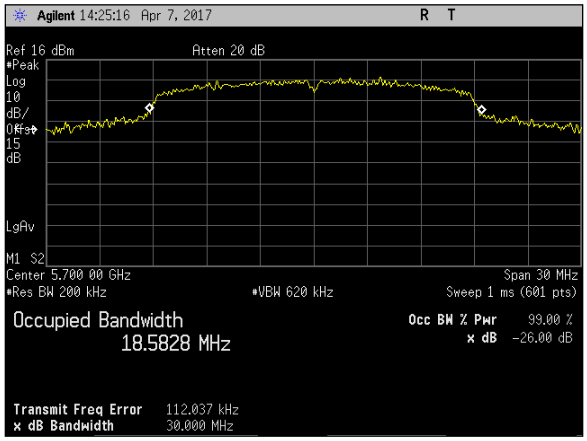
Plot 9. 26 dB Occupied Bandwidth, BW 40M, Ch 5270M, N Mode Port 2



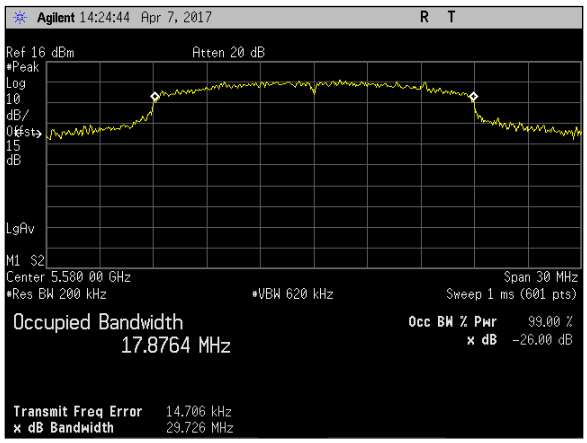
Plot 10. 26 dB Occupied Bandwidth, BW 40M, Ch 5270M, N Mode Port 1



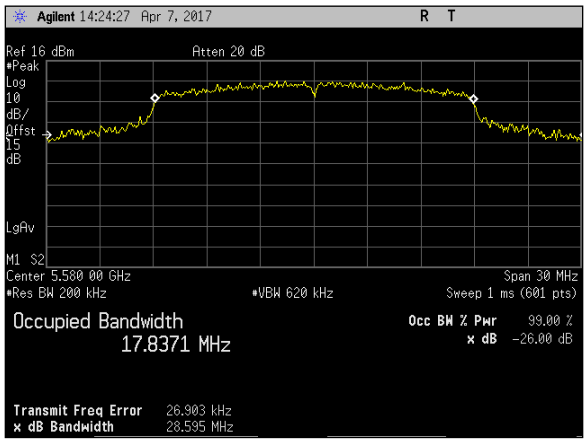
Plot 11. 26 dB Occupied Bandwidth, BW 20M, Ch 5700M, N Mode Port 2



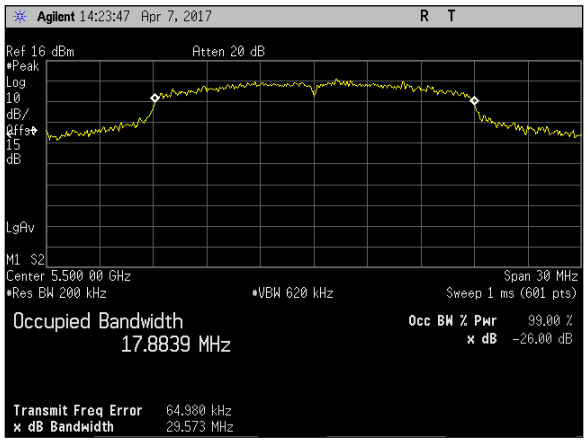
Plot 12. 26 dB Occupied Bandwidth, BW 20M, Ch 5700M, N Mode Port 1



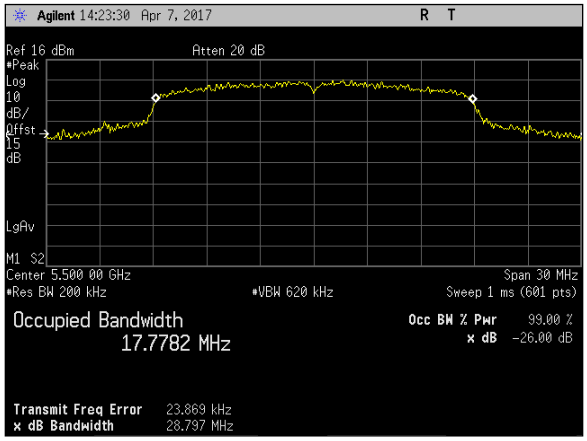
Plot 13. 26 dB Occupied Bandwidth, BW 20M, Ch 5580M, N Mode Port 1



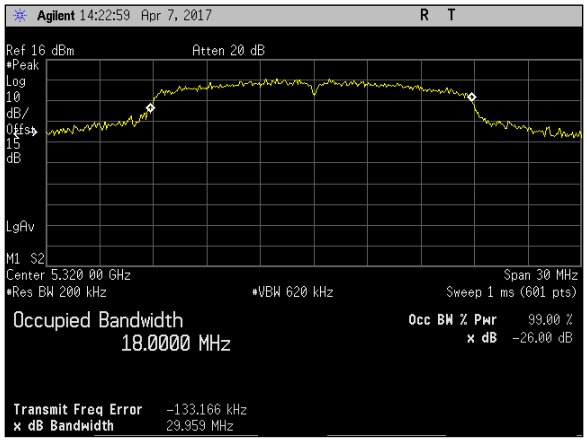
Plot 14. 26 dB Occupied Bandwidth, BW 20M, Ch 5580M, N Mode Port 2



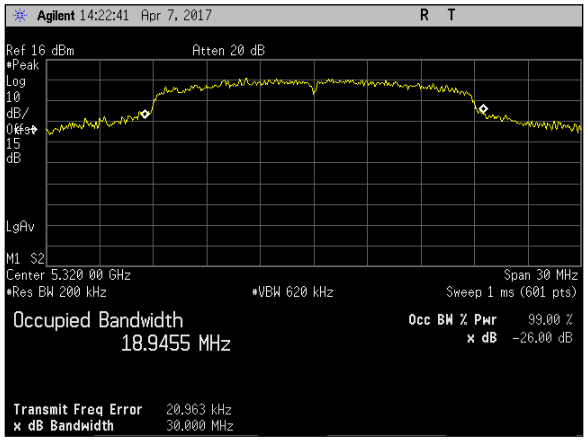
Plot 15. 26 dB Occupied Bandwidth, BW 20M, Ch 5500M, N Mode Port 2



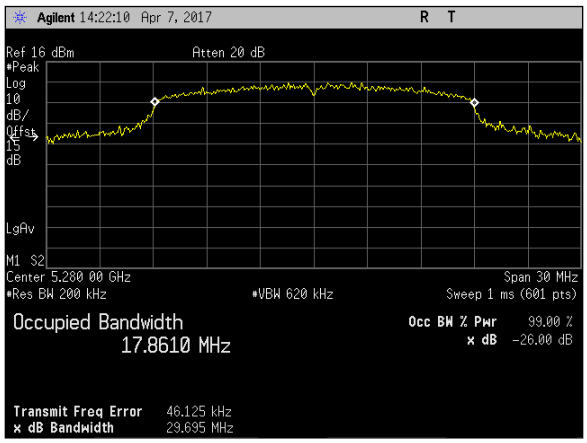
Plot 16. 26 dB Occupied Bandwidth, BW 20M, Ch 5500M, N Mode Port 1



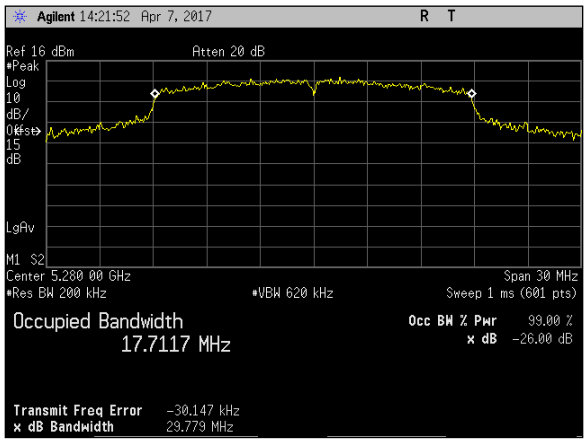
Plot 17. 26 dB Occupied Bandwidth, BW 20M, Ch 5320M, N Mode Port 1



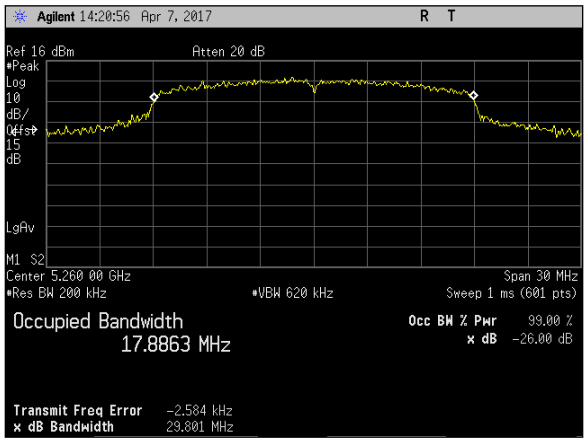
Plot 18. 26 dB Occupied Bandwidth, BW 20M, Ch 5320M, N Mode Port 2



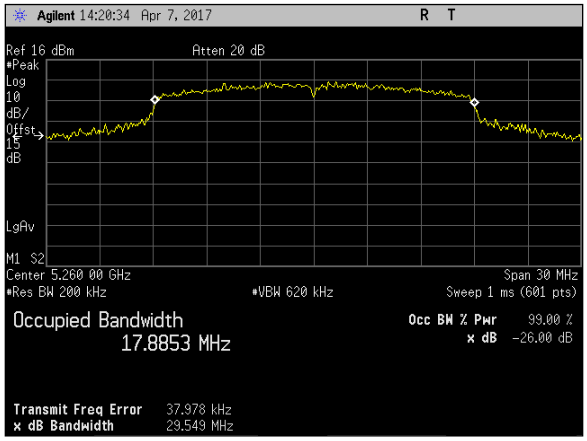
Plot 19. 26 dB Occupied Bandwidth, BW 20M, Ch 5280M, N Mode Port 2



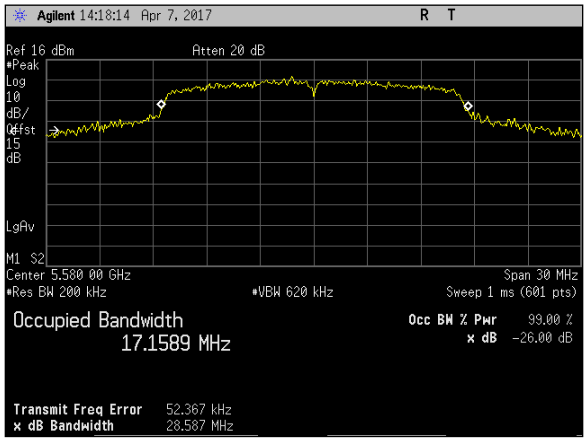
Plot 20. 26 dB Occupied Bandwidth, BW 20M, Ch 5280M, N Mode Port 1



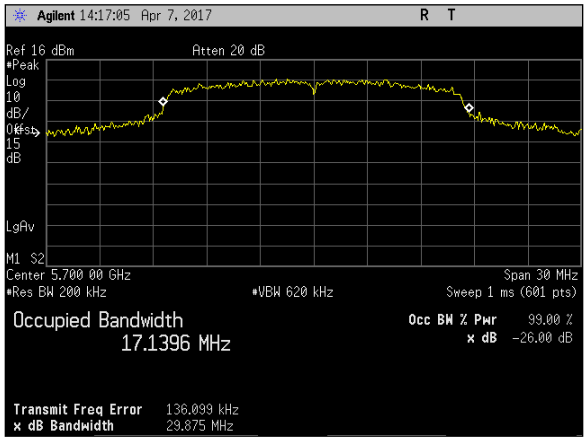
Plot 21. 26 dB Occupied Bandwidth, BW 20M, Ch 5260M, N Mode Port 1



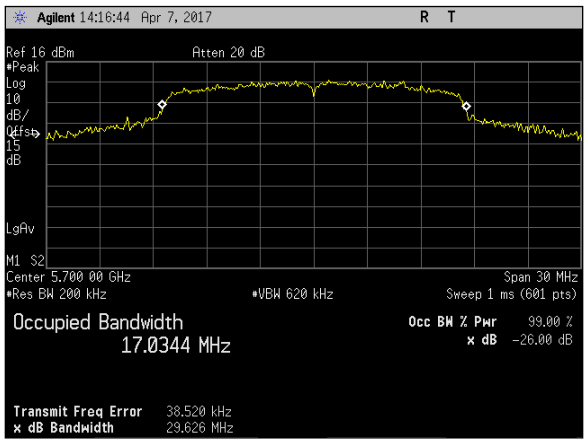
Plot 22. 26 dB Occupied Bandwidth, BW 20M, Ch 5260M, N Mode Port 2



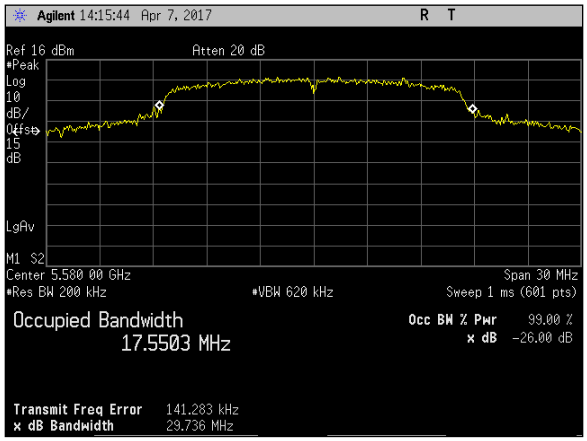
Plot 23. 26 dB Occupied Bandwidth, BW 20M, Ch 5580M, A Mode Port 2



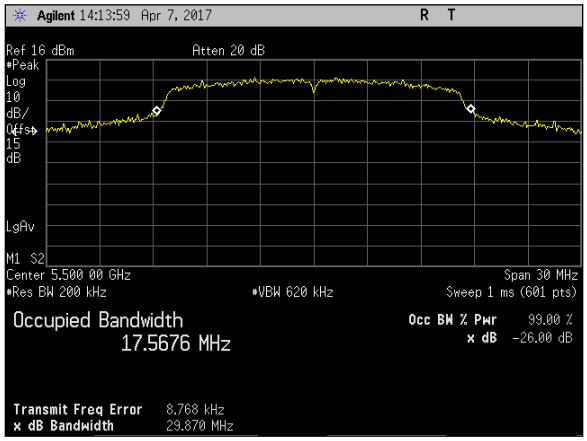
Plot 24. 26 dB Occupied Bandwidth, BW 20M, Ch 5700M, A Mode Port 1



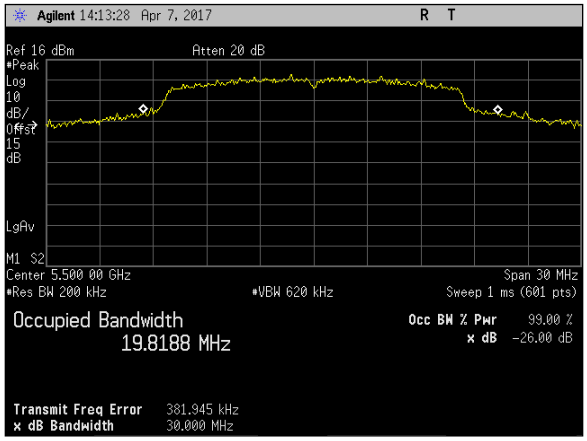
Plot 25. 26 dB Occupied Bandwidth, BW 20M, Ch 5700M, A Mode Port 2



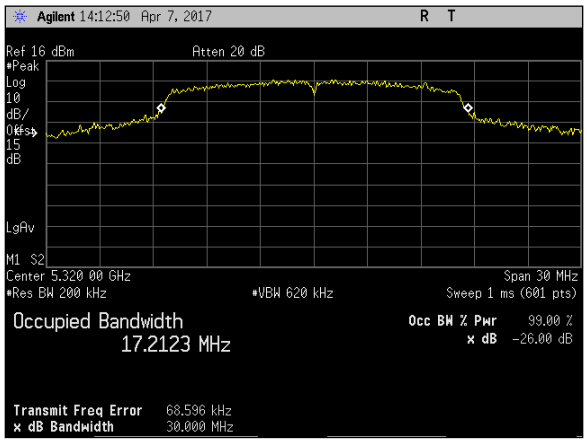
Plot 26. 26 dB Occupied Bandwidth, BW 20M, Ch 5580M, A Mode Port 1



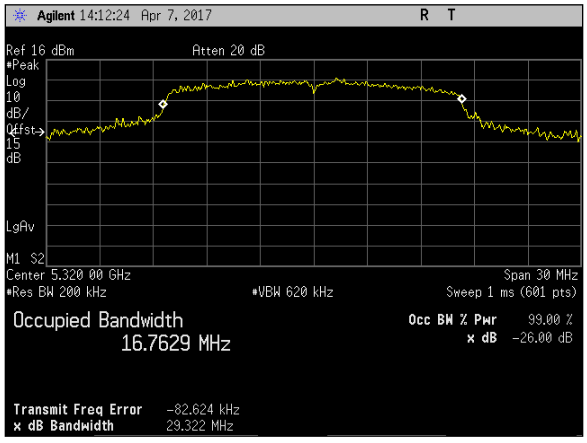
Plot 27. 26 dB Occupied Bandwidth, BW 20M, Ch 5500M, A Mode Port 1



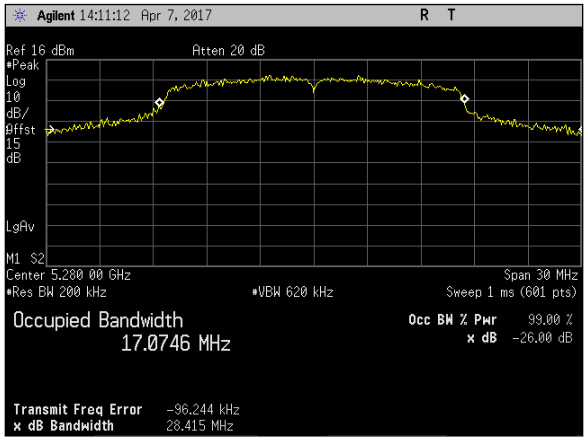
Plot 28. 26 dB Occupied Bandwidth, BW 20M, Ch 5500M, A Mode Port 2



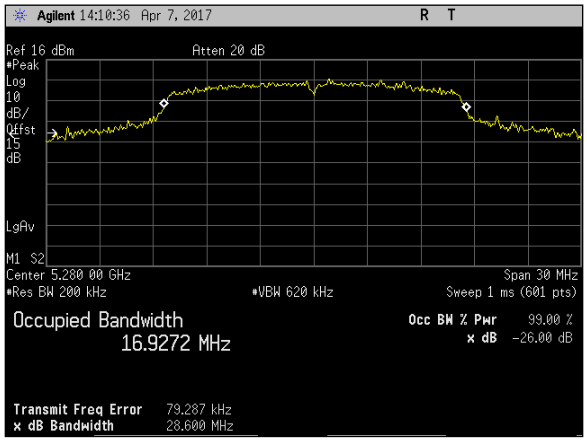
Plot 29. 26 dB Occupied Bandwidth, BW 20M, Ch 5320M, A Mode Port 2



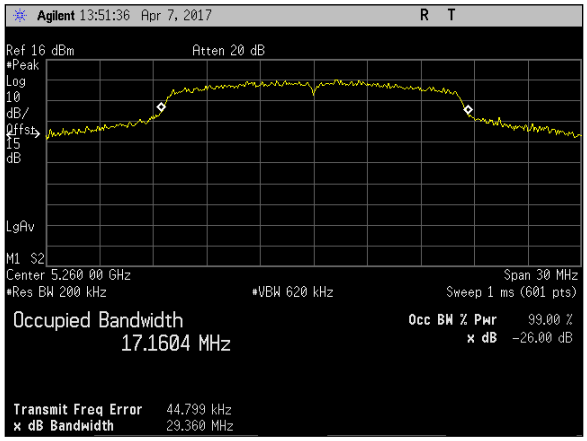
Plot 30. 26 dB Occupied Bandwidth, BW 20M, Ch 5320M, A Mode Port 1



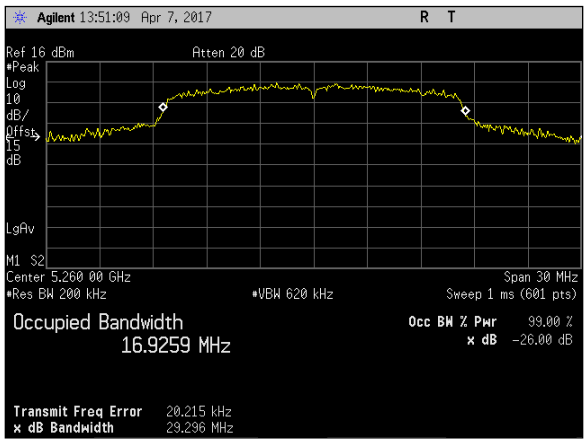
Plot 31. 26 dB Occupied Bandwidth, BW 20M, Ch 5280M, A Mode Port 1



Plot 32. 26 dB Occupied Bandwidth, BW 20M, Ch 5280M, A Mode Port 2



Plot 33. 26 dB Occupied Bandwidth, BW 20M, Ch 5260M, A Mode Port 2



Plot 34. 26 dB Occupied Bandwidth, BW 20M, Ch 5260M, A Mode Port 1

Electromagnetic Compatibility Criteria for Intentional Radiators

§15. 407(a)(2) Maximum Conducted Output Power

Test Requirements: **§15.407(a)(2):** For the 5.25-5.35 GHz and 5.47-5.725 GHz bands, the maximum conducted output power over the frequency bands of operation shall not exceed the lesser of 250 mW or 11 dBm + 10 log B, where B is the 26 dB emission bandwidth in megahertz.

If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

§15.407(h)(1): Transmit power control (TPC). U-NII devices operating in the 5.25-5.35 GHz band and the 5.47-5.725 GHz band shall employ a TPC mechanism. The U-NII device is required to have the capability to operate at least 6 dB below the mean EIRP value of 30 dBm. A TPC mechanism is not required for systems with an e.i.r.p. of less than 500 mW.

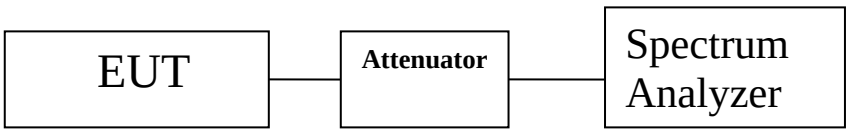
Test Procedure: The EUT was connected to a spectrum analyzer through a cable and attenuator. Measurements were taken with the EUT set to transmit on its low, mid, and high channels. Its power was measured according to measurement method SA-2, as described in 789033 D02 General UNII Test Procedures v02.

Test Results: The EUT as tested is compliant with the requirements of this section.

No anomalies detected.

Test Engineer(s): Deepak Giri

Test Date(s): November 16, 2017



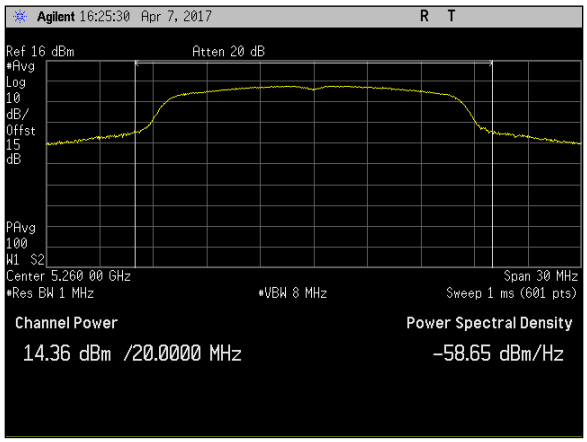
Frequency MHz	Mode	Bandwidth MHz	26 dB Bandwidth MHz	Conducted Power dBm port 1	Conducted Power dBm port 2	Directional Gain dBi	Conducted Limit dBm	EIRP Limit dBm
5260	a	20	29.29	16.15	14.36	4.5	23.98	30.00
5280			28.41	16.82	15.12	4.5	23.98	30.00
5320			29.32	15.4	15.96	4.5	23.98	30.00
5500			29.87	16.11	16.53	4.5	23.98	30.00
5580			29.73	15.57	15.54	4.5	23.98	30.00
5700			29.87	15.21	15.33	4.5	23.98	30.00
5260	n		29.80	16.54	13.64	4.5	23.98	30.00
5280			29.77	16.43	14.67	4.5	23.98	30.00
5320			29.95	15.12	15.64	4.5	23.98	30.00
5500			28.79	16.07	15.29	4.5	23.98	30.00
5580			29.72	15.62	15.67	4.5	23.98	30.00
5700			30.00	15.53	15.16	4.5	23.98	30.00
5270		40	49.32	15.06	12.68	4.5	23.98	30.00
5310			54.57	14.51	14.08	4.5	23.98	30.00
5510			55.47	13.67	13.65	4.5	23.98	30.00
5550			54.18	14.02	13.71	4.5	23.98	30.00
5670			56.79	14.01	14.1	4.5	23.98	30.00

Table 10. Maximum Conducted Output Power, Test Results

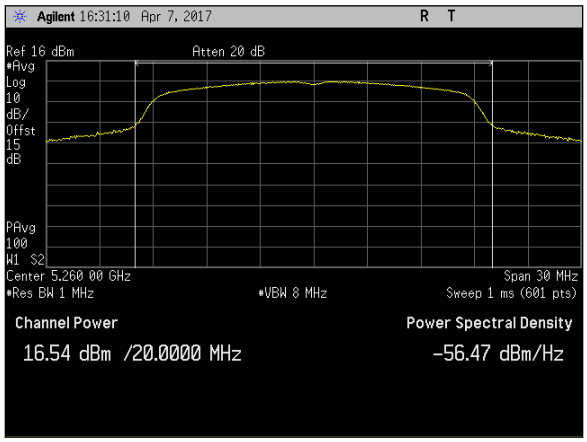
Frequency MHz	Mode and Bandwidth	On Time ms	Period ms	Duty Cycle
5500	a mode 20 MHz	4.075	4.501	0.91
5500	4 mode 20 MHz	3.784	4.21	0.90
5510	n mode 40 MHz	1.83	2.24	0.82

Table 11. Duty Cycle, Test Results

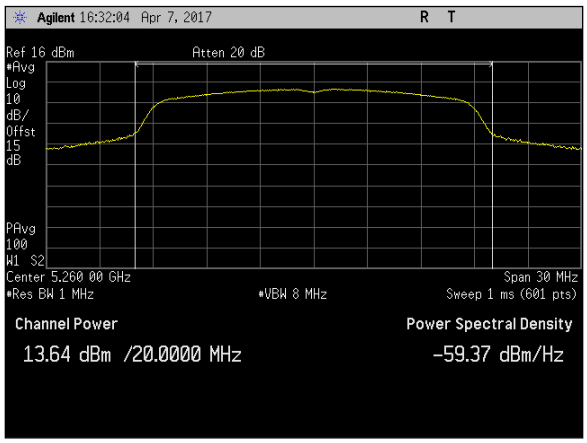
Plot 35. Maximum Conducted Transmitter Output Power, BW 20M, Ch 5260M, A Mode Port 1



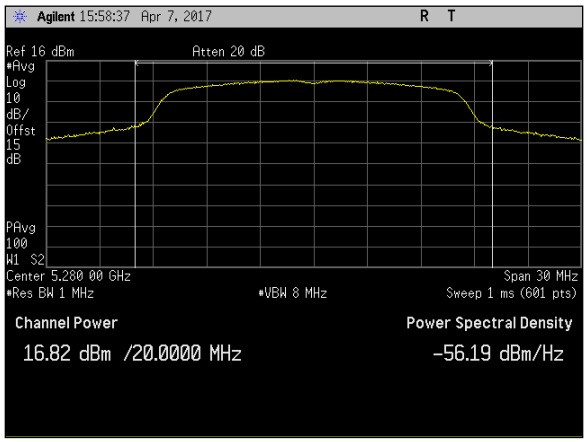
Plot 36. Maximum Conducted Transmitter Output Power, BW 20M, Ch 5260M, A Mode Port 2



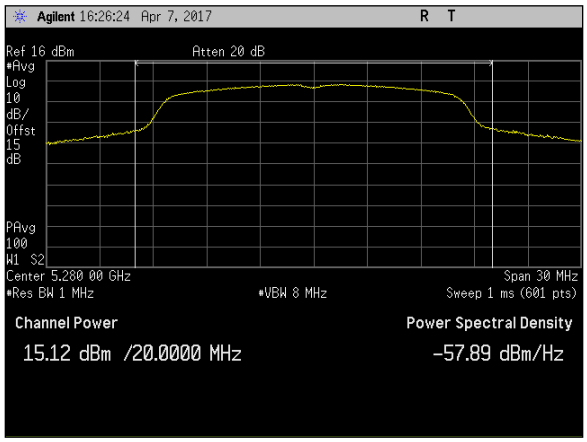
Plot 37. Maximum Conducted Transmitter Output Power, BW 20M, Ch 5260M, N Mode Port 1



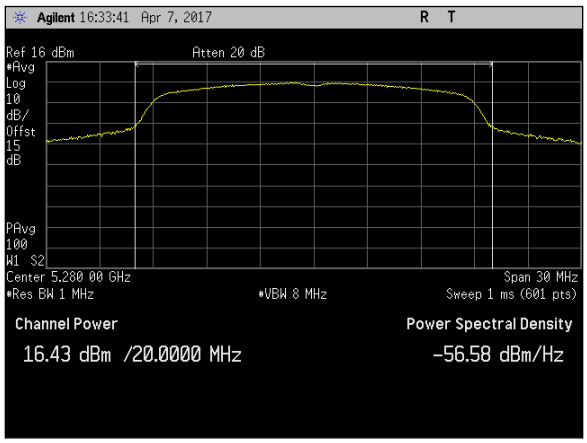
Plot 38. Maximum Conducted Transmitter Output Power, BW 20M, Ch 5260M, N Mode Port 2



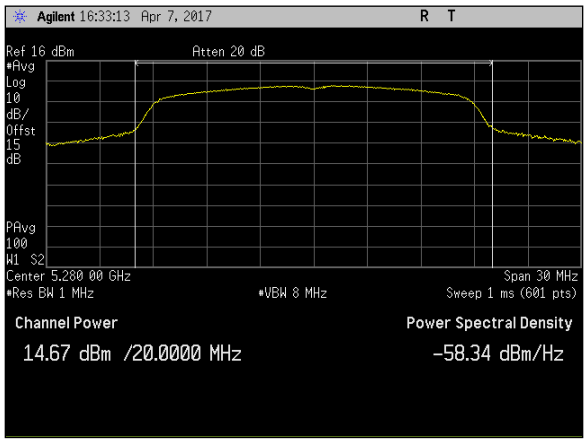
Plot 39. Maximum Conducted Transmitter Output Power, BW 20M, Ch 5280M, A Mode Port 1



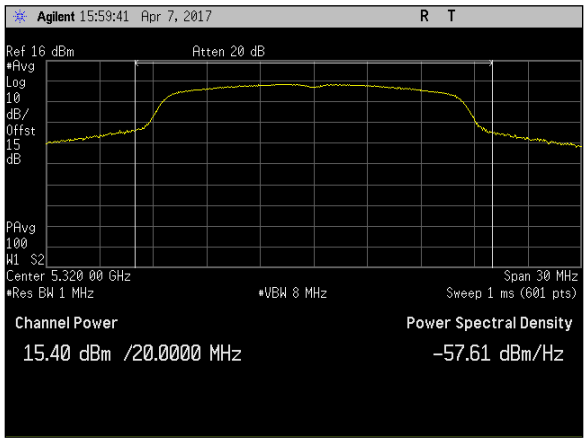
Plot 40. Maximum Conducted Transmitter Output Power, BW 20M, Ch 5280M, A Mode Port 2



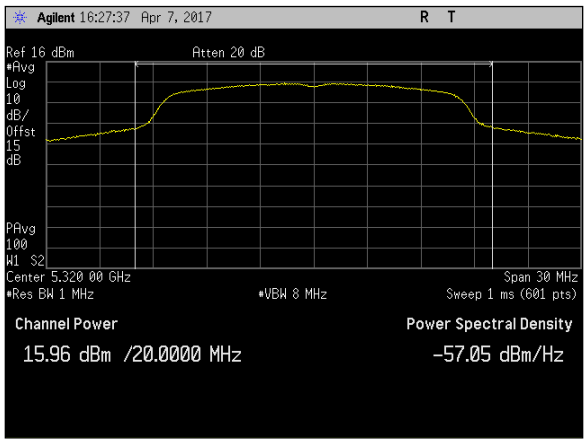
Plot 41. Maximum Conducted Transmitter Output Power, BW 20M, Ch 5280M, N Mode Port 1



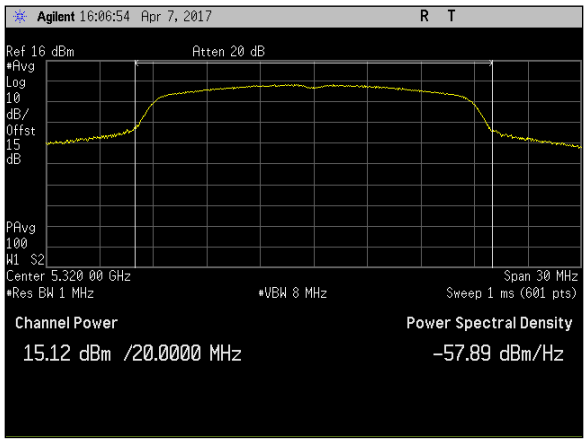
Plot 42. Maximum Conducted Transmitter Output Power, BW 20M, Ch 5280M, N Mode Port 2



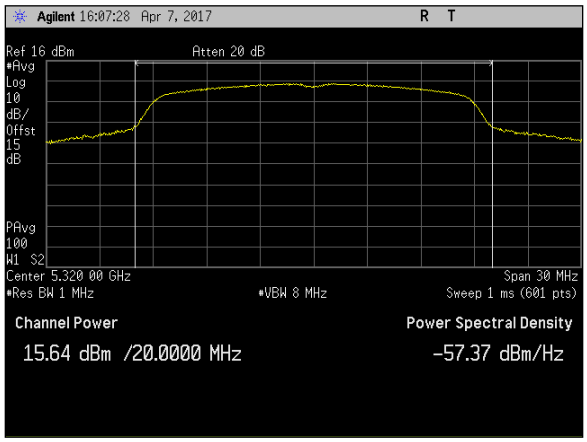
Plot 43. Maximum Conducted Transmitter Output Power, BW 20M, Ch 5320M, A Mode Port 1



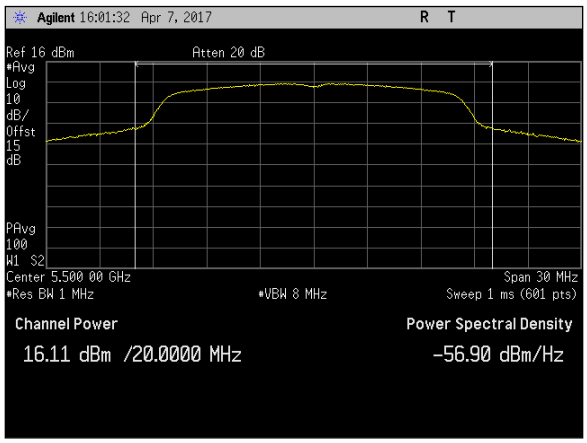
Plot 44. Maximum Conducted Transmitter Output Power, BW 20M, Ch 5320M, A Mode Port 2



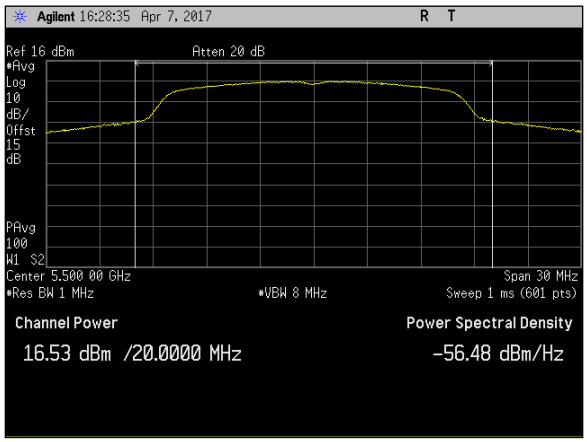
Plot 45. Maximum Conducted Transmitter Output Power, BW 20M, Ch 5320M, N Mode Port 1



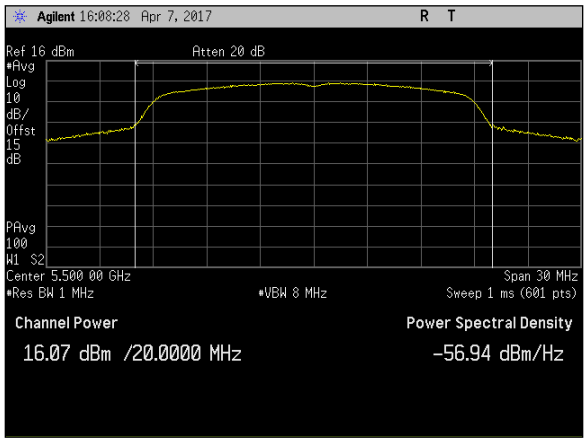
Plot 46. Maximum Conducted Transmitter Output Power, BW 20M, Ch 5320M, N Mode Port 2



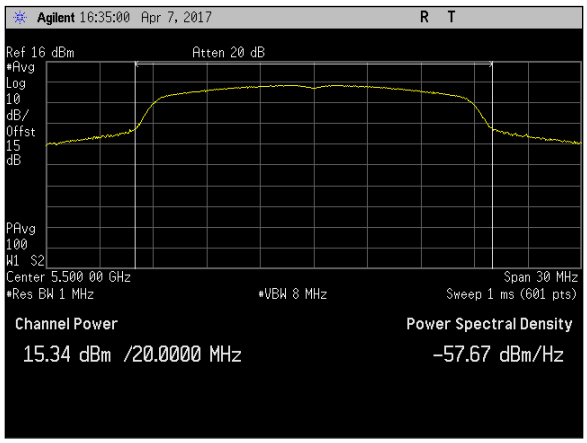
Plot 47. Maximum Conducted Transmitter Output Power, BW 20M, Ch 5500M, A Mode Port 1



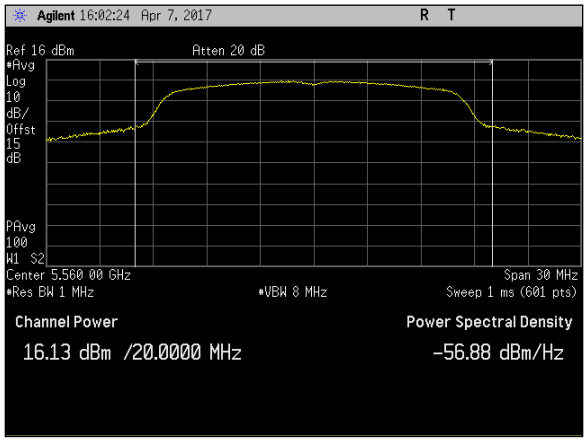
Plot 48. Maximum Conducted Transmitter Output Power, BW 20M, Ch 5500M, A Mode Port 2



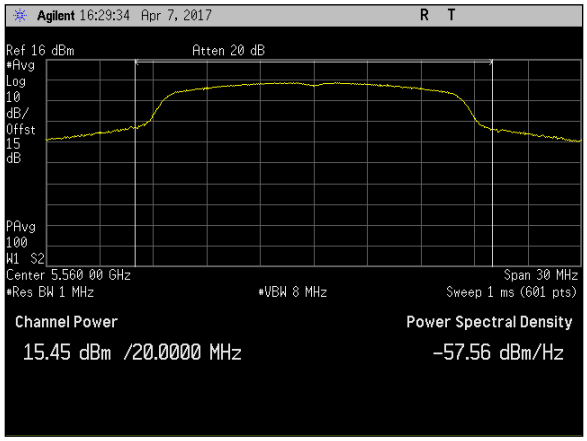
Plot 49. Maximum Conducted Transmitter Output Power, BW 20M, Ch 5500M, N Mode Port 1



Plot 50. Maximum Conducted Transmitter Output Power, BW 20M, Ch 5500M, N Mode Port 2

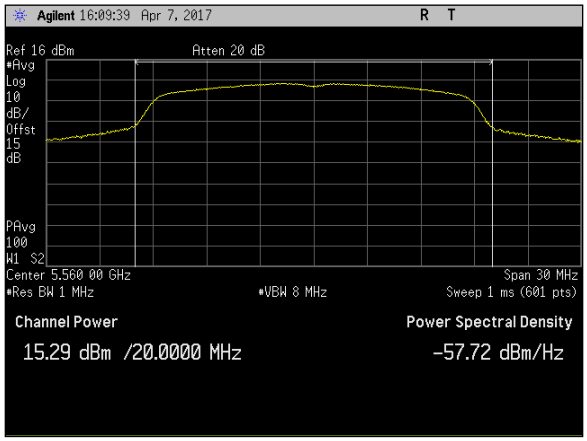


Plot 51. Maximum Conducted Transmitter Output Power, BW 20M, Ch 5560M, A Mode Port 1

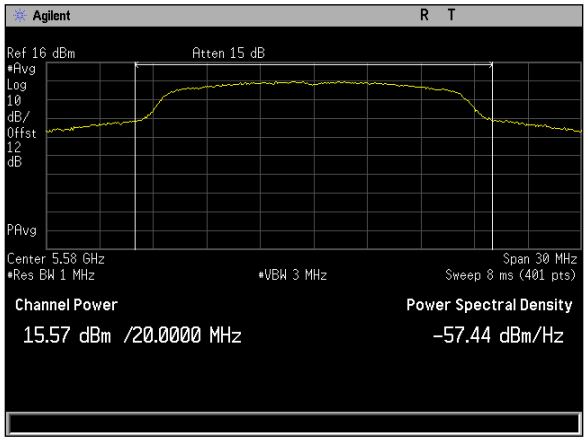


Plot 52. Maximum Conducted Transmitter Output Power, BW 20M, Ch 5560M, A Mode Port 2

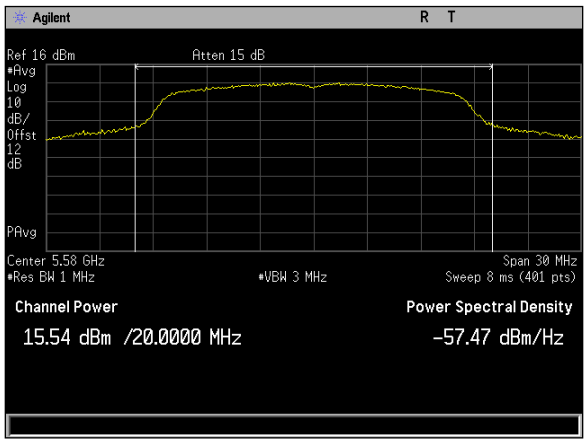
Plot 53. Maximum Conducted Transmitter Output Power, BW 20M, Ch 5560M, N Mode Port 1



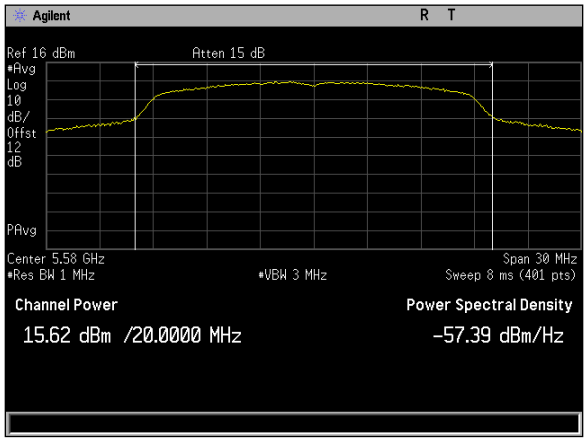
Plot 54. Maximum Conducted Transmitter Output Power, BW 20M, Ch 5560M, N Mode Port 2



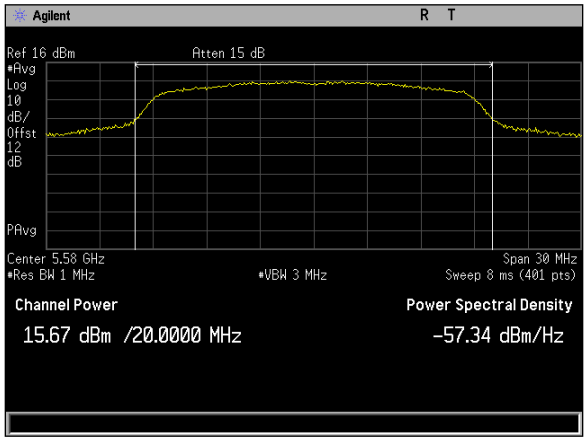
Plot 55. Maximum Conducted Transmitter Output Power, BW 20M, Ch 5580M, A Mode Port 1



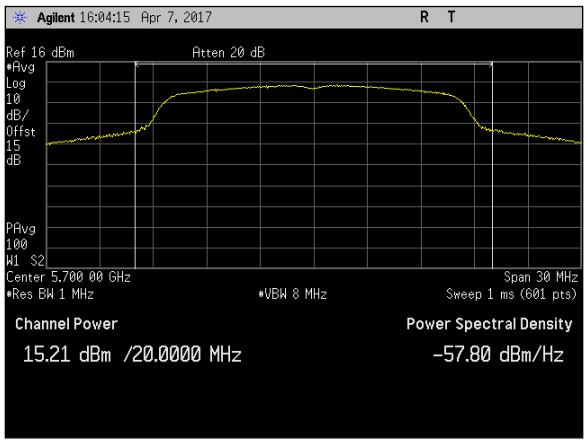
Plot 56. Maximum Conducted Transmitter Output Power, BW 20M, Ch 5580M, A Mode Port 2



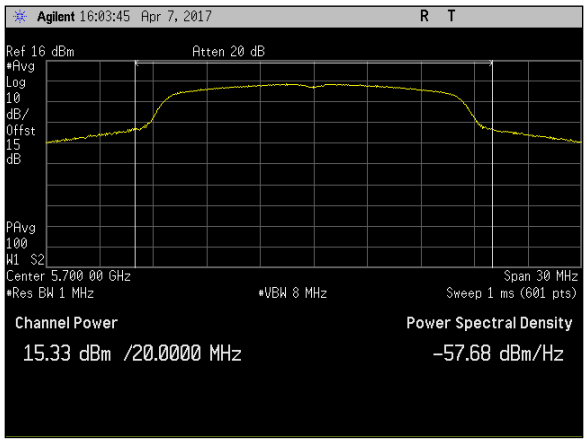
Plot 57. Maximum Conducted Transmitter Output Power, BW 20M, Ch 5580M, N Mode Port 1



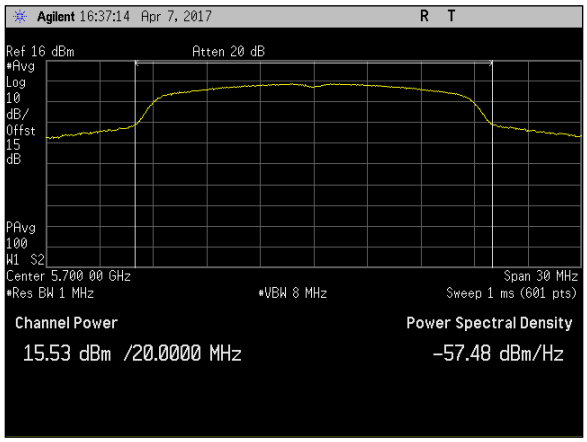
Plot 58. Maximum Conducted Transmitter Output Power, BW 20M, Ch 5580M, N Mode Port 2



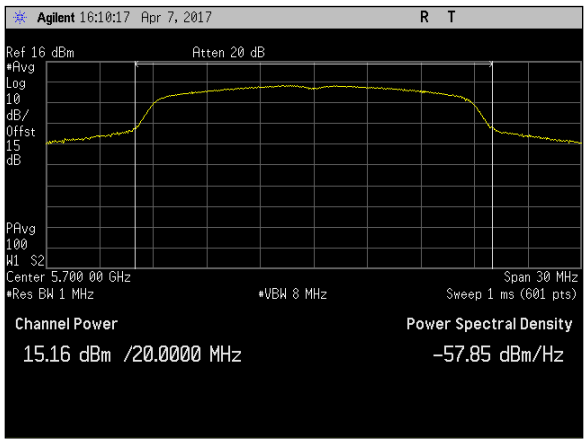
Plot 59. Maximum Conducted Transmitter Output Power, BW 20M, Ch 5700M, A Mode Port 1



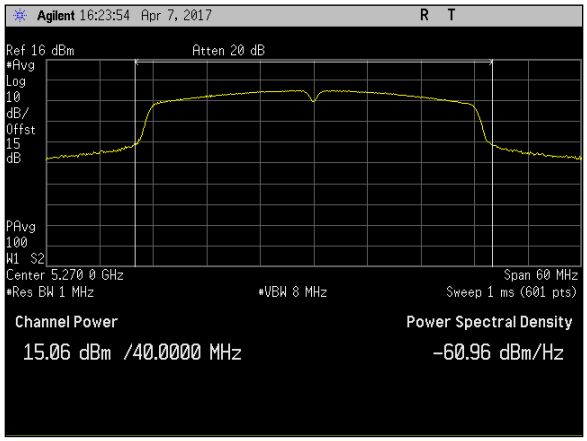
Plot 60. Maximum Conducted Transmitter Output Power, BW 20M, Ch 5700M, A Mode Port 2



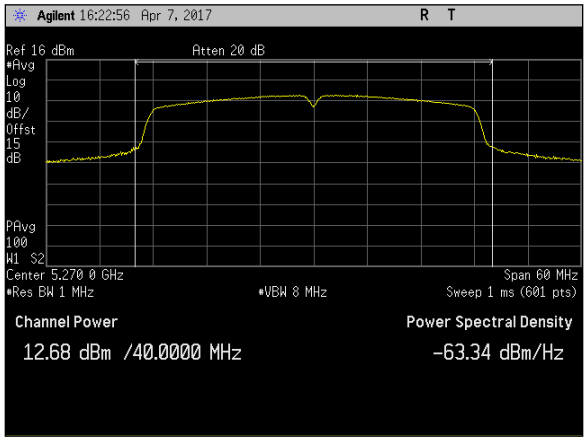
Plot 61. Maximum Conducted Transmitter Output Power, BW 20M, Ch 5700M, N Mode Port 1



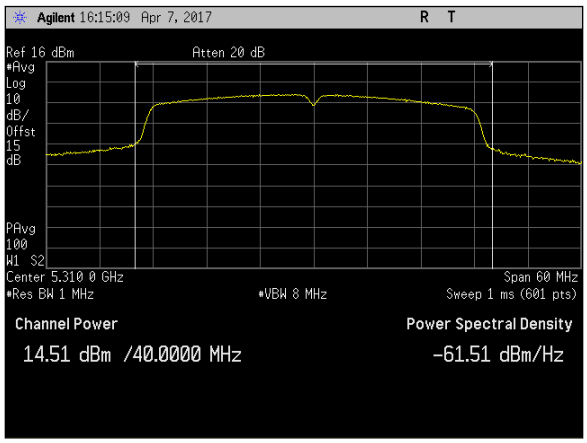
Plot 62. Maximum Conducted Transmitter Output Power, BW 20M, Ch 5700M, N Mode Port 2



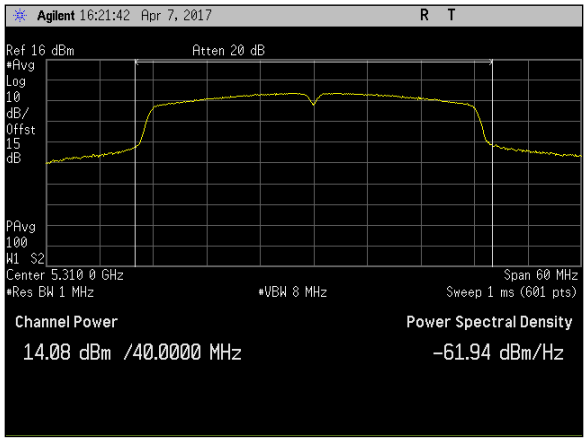
Plot 63. Maximum Conducted Transmitter Output Power, BW 40M, Ch 5270M, N Mode Port 1



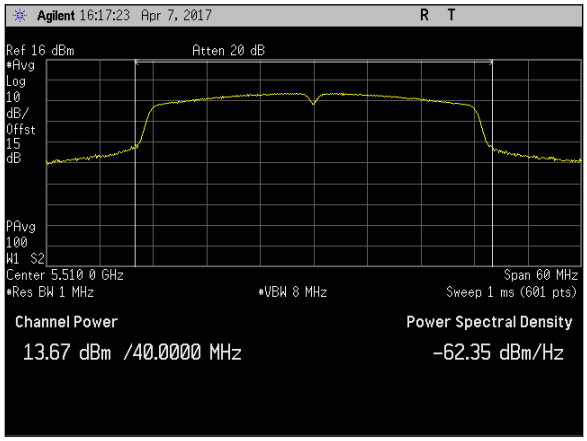
Plot 64. Maximum Conducted Transmitter Output Power, BW 40M, Ch 5270M, N Mode Port 2



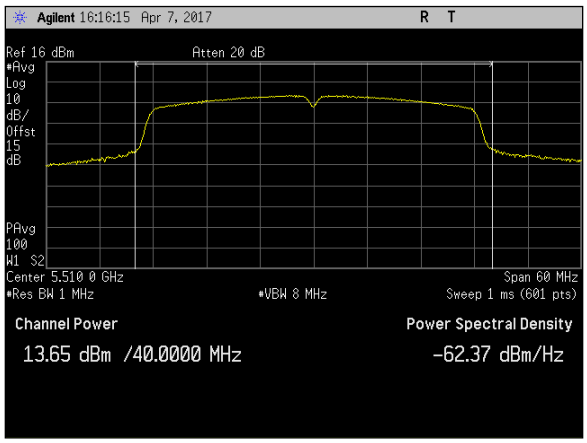
Plot 65. Maximum Conducted Transmitter Output Power, BW 40M, Ch 5310M, N Mode Port 1



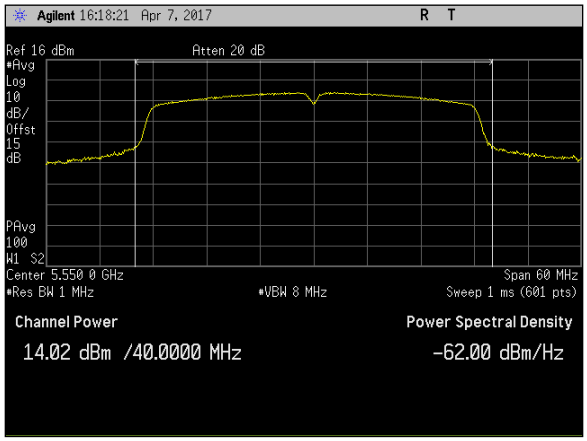
Plot 66. Maximum Conducted Transmitter Output Power, BW 40M, Ch 5310M, N Mode Port 2



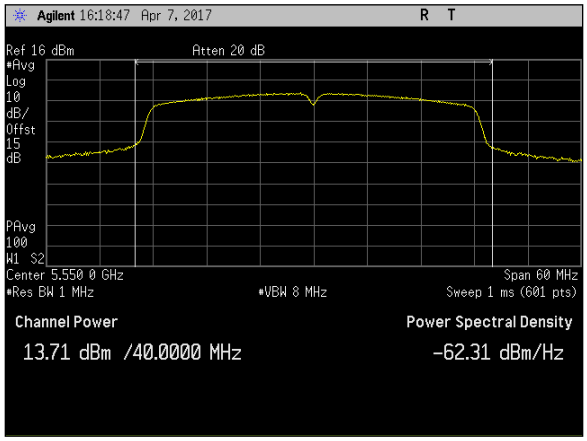
Plot 67. Maximum Conducted Transmitter Output Power, BW 40M, Ch 5510M, N Mode Port 1



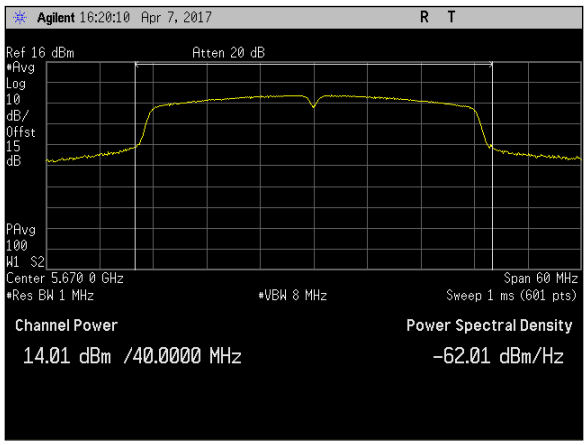
Plot 68. Maximum Conducted Transmitter Output Power, BW 40M, Ch 5510M, N Mode Port 2



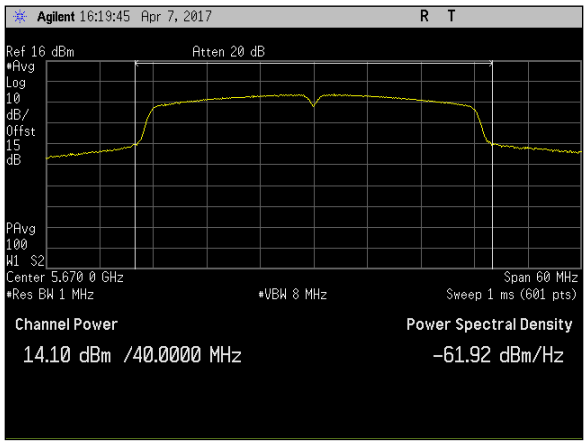
Plot 69. Maximum Conducted Transmitter Output Power, BW 40M, Ch 5550M, N Mode Port 1



Plot 70. Maximum Conducted Transmitter Output Power, BW 40M, Ch 5550M, N Mode Port 2



Plot 71. Maximum Conducted Transmitter Output Power, BW 40M, Ch 5670M, N Mode Port 1



Plot 72. Maximum Conducted Transmitter Output Power, BW 40M, Ch 5670M, N Mode Port 2

Electromagnetic Compatibility Criteria for Intentional Radiators

§15.407(a)(2) Maximum Power Spectral Density

Test Requirements: **§15.407(a)(2):** In addition, the maximum power spectral density shall not exceed 11 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

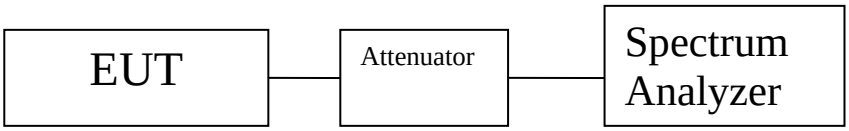
Test Procedure: The EUT was connected to a spectrum analyzer through a cable and attenuator. Measurements were taken with the EUT set to transmit on its low, mid, and high channels. Its power was measured according KDB 789033 D02 General UNII Test Procedures v02.

Test Results: The EUT as tested is compliant with the requirements of this section.

No anomalies detected.

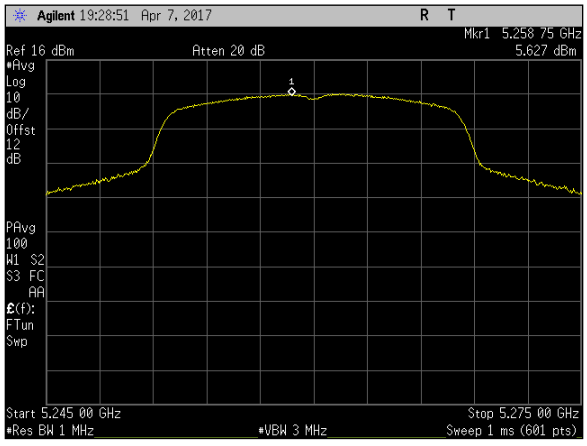
Test Engineer(s): Deepak Giri

Test Date(s): November 16, 2017

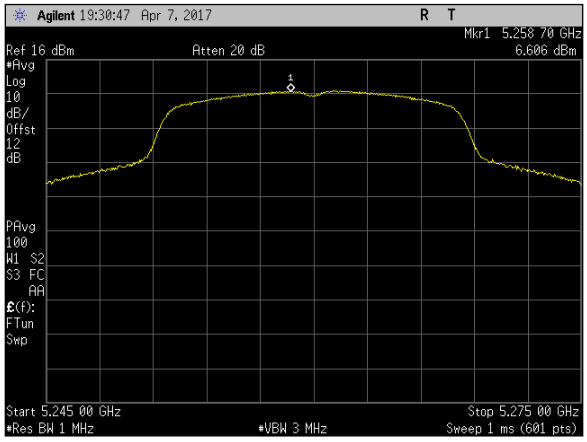


Frequency MHz	Mode	Bandwidth MHz	Power Spectral Density dBm port 1	Power Spectral Density dBm port 2	Limit dBm
5260	a	20	5.627	6.606	11.00
5280			6.396	7.635	11.00
5320			6.945	7.416	11.00
5500			5.865	6.462	11.00
5580			6.182	6.631	11.00
5700			5.73	5.503	11.00
5260	n		4.511	5.303	11.00
5280			4.138	6.838	11.00
5320			5.155	5.719	11.00
5500			6.199	5.124	11.00
5580			5.256	6.385	11.00
5700			5.347	4.57	11.00
5270		40	1.499	1.103	11.00
5310			0.009	0.261	11.00
5510			1.892	0.239	11.00
5550			1.206	1.844	11.00
5670			0.878	0.153	11.00

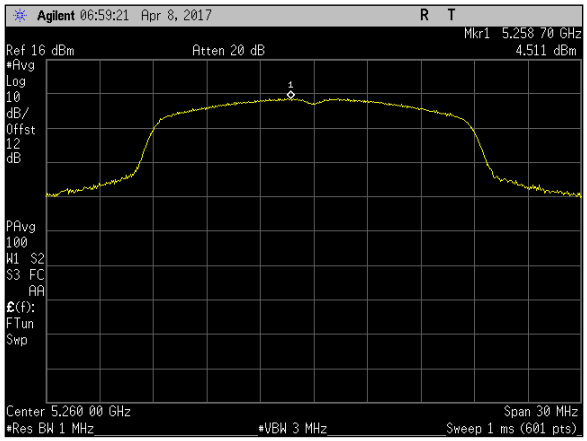
Table 12. Power Spectral Density, Test Results



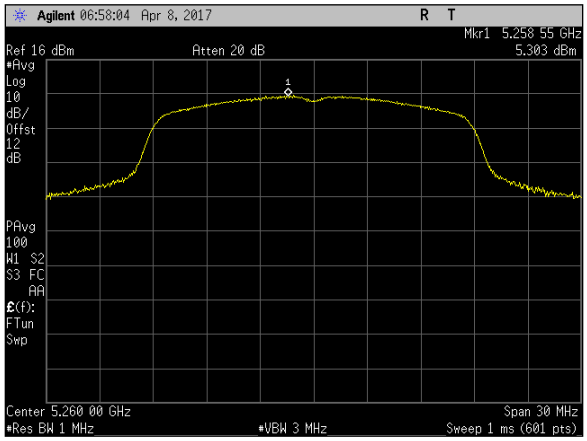
Plot 73. Power Spectral Density, BW 20M, Ch 5260M, A Mode Port 1



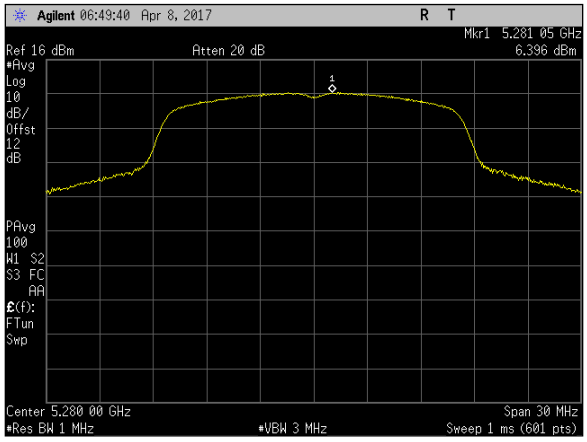
Plot 74. Power Spectral Density, BW 20M, Ch 5260M, A Mode Port 2



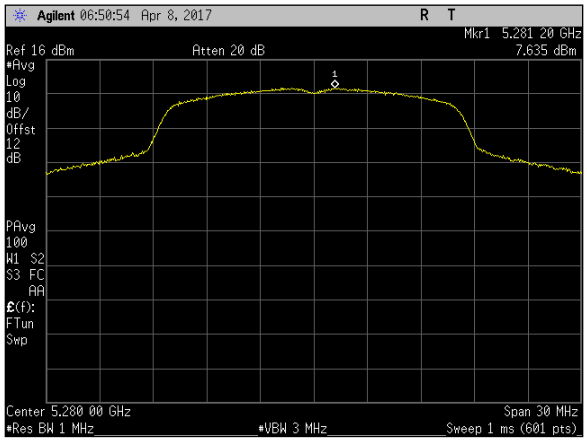
Plot 75. Power Spectral Density, BW 20M, Ch 5260M, N Mode Port 1



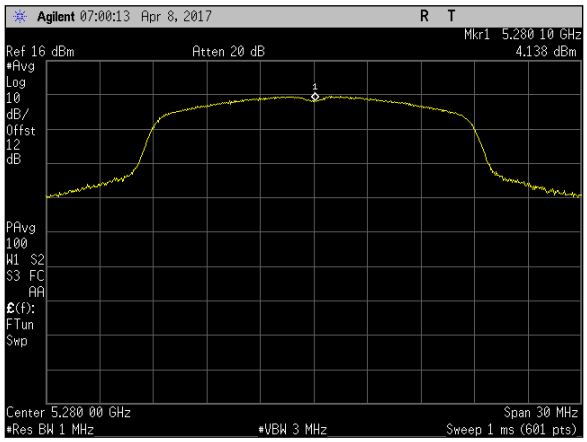
Plot 76. Power Spectral Density, BW 20M, Ch 5260M, N Mode Port 2



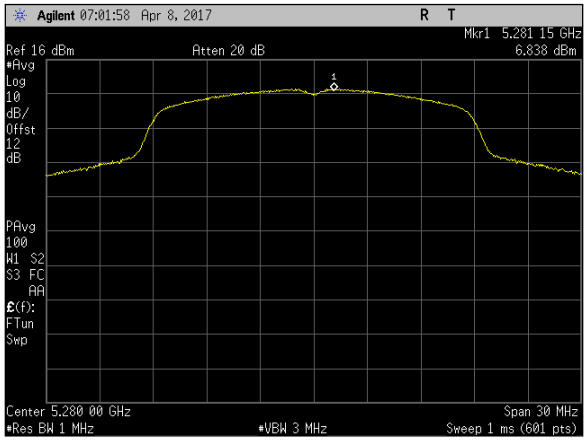
Plot 77. Power Spectral Density, BW 20M, Ch 5280M, A Mode Port 1



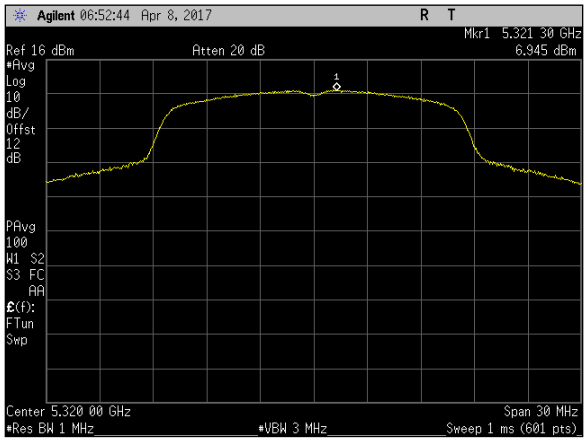
Plot 78. Power Spectral Density, BW 20M, Ch 5280M, A Mode Port 2



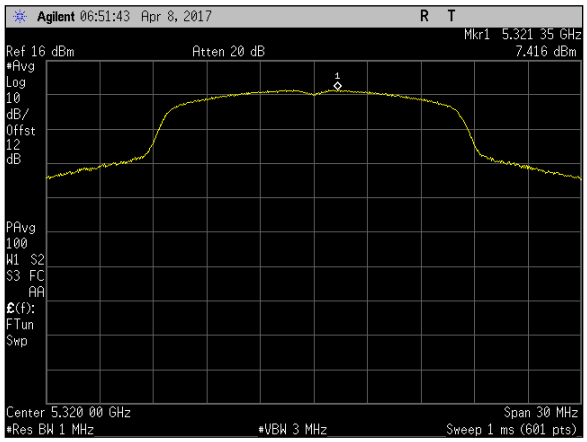
Plot 79. Power Spectral Density, BW 20M, Ch 5280M, N Mode Port 1



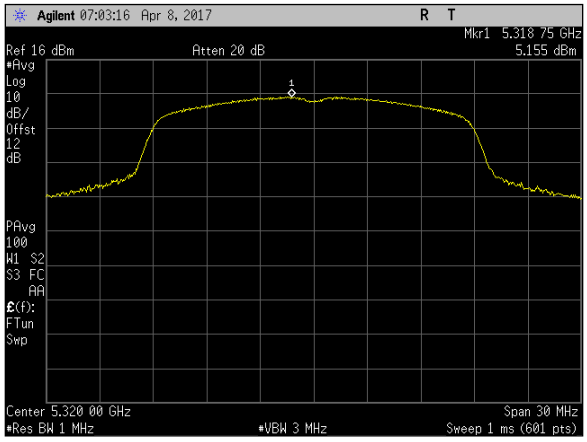
Plot 80. Power Spectral Density, BW 20M, Ch 5280M, N Mode Port 2



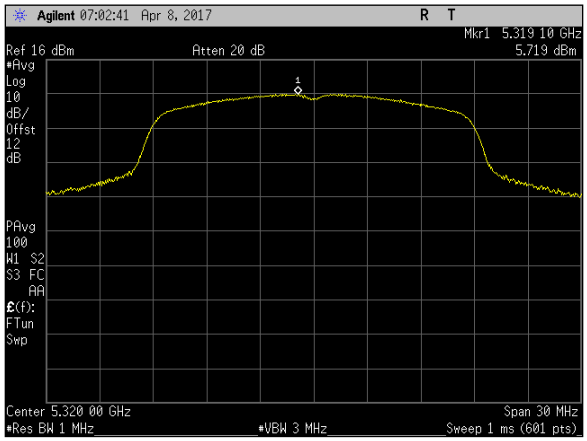
Plot 81. Power Spectral Density, BW 20M, Ch 5320M, A Mode Port 1



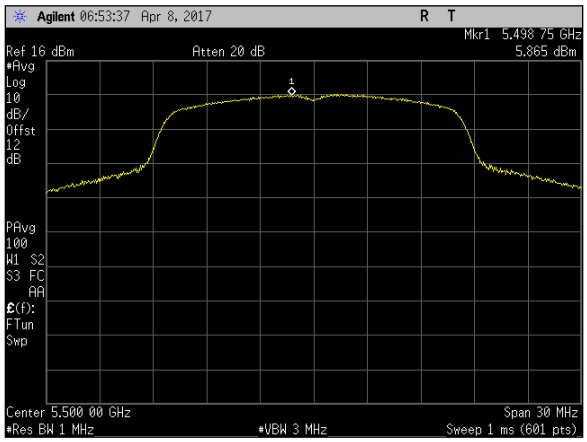
Plot 82. Power Spectral Density, BW 20M, Ch 5320M, A Mode Port 2



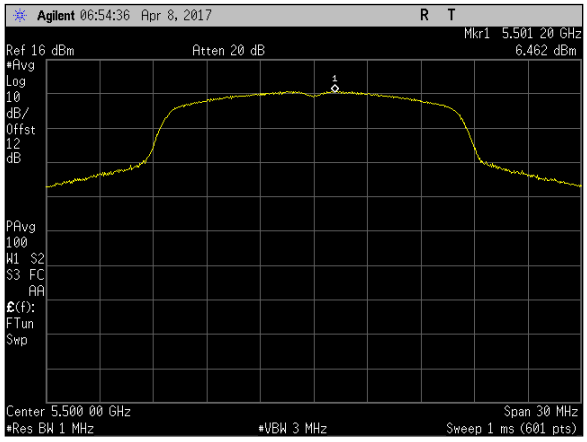
Plot 83. Power Spectral Density, BW 20M, Ch 5320M, N Mode Port 1



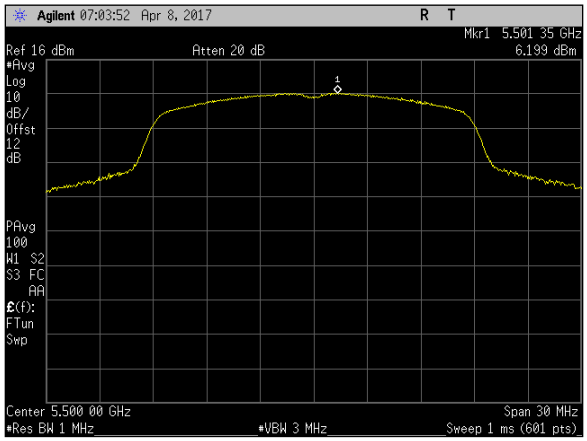
Plot 84. Power Spectral Density, BW 20M, Ch 5320M, N Mode Port 2



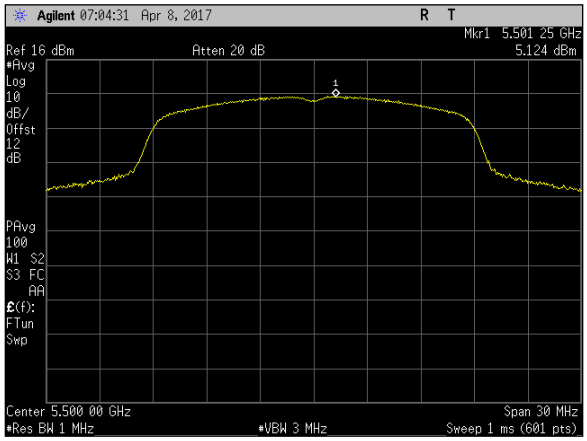
Plot 85. Power Spectral Density, BW 20M, Ch 5500M, A Mode Port 1



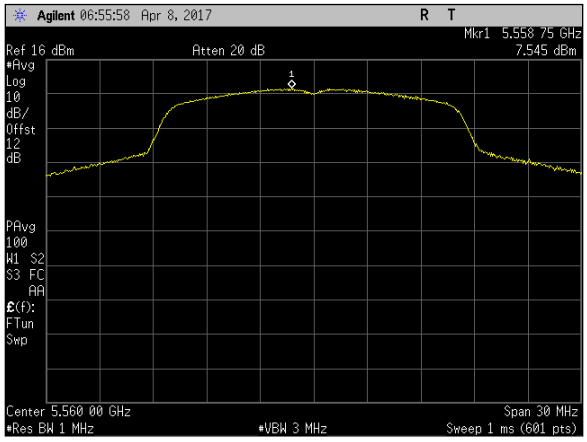
Plot 86. Power Spectral Density, BW 20M, Ch 5500M, A Mode Port 2



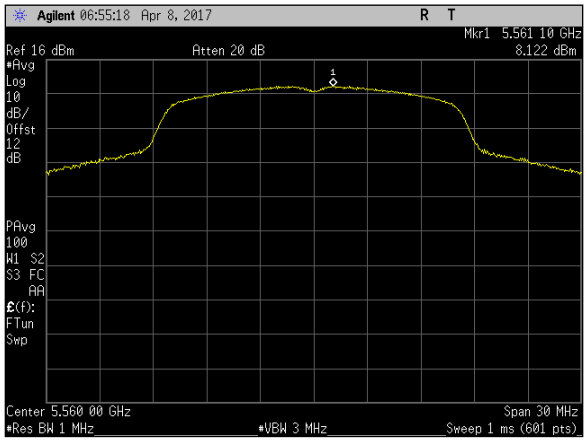
Plot 87. Power Spectral Density, BW 20M, Ch 5500M, N Mode Port 1



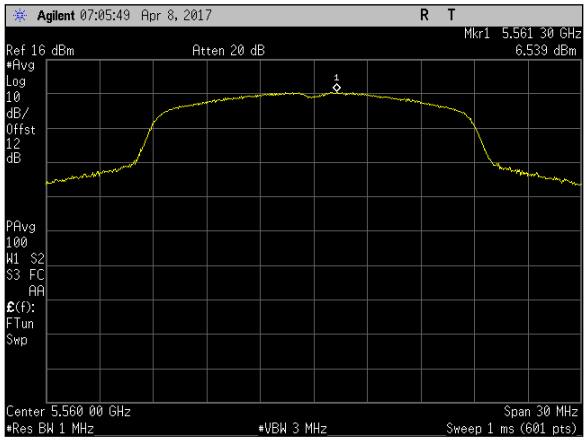
Plot 88. Power Spectral Density, BW 20M, Ch 5500M, N Mode Port 2



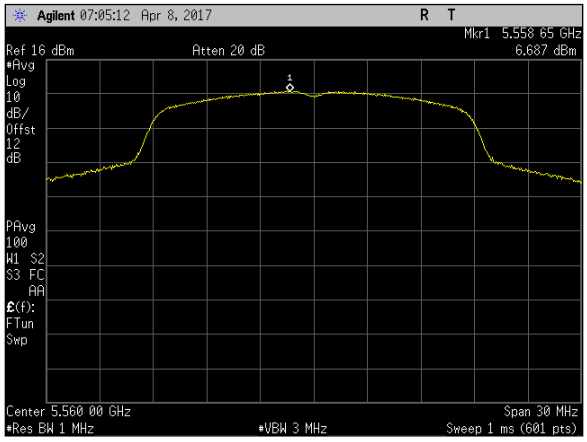
Plot 89. Power Spectral Density, BW 20M, Ch 5560M, A Mode Port 1



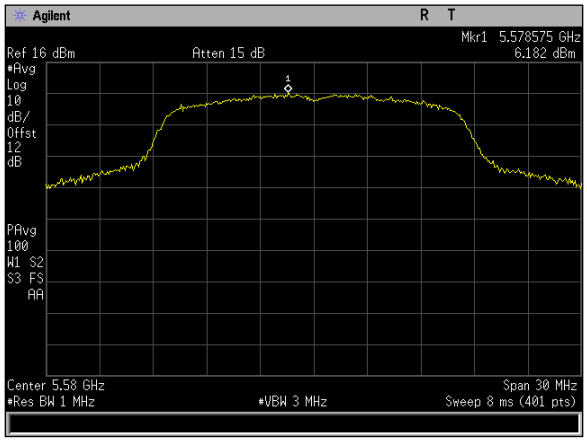
Plot 90. Power Spectral Density, BW 20M, Ch 5560M, A Mode Port 2



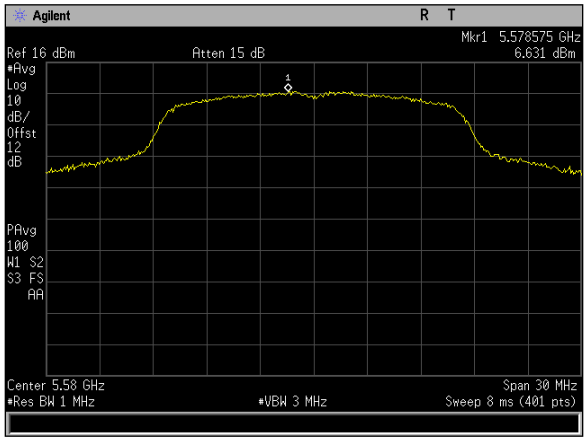
Plot 91. Power Spectral Density, BW 20M, Ch 5560M, N Mode Port 1



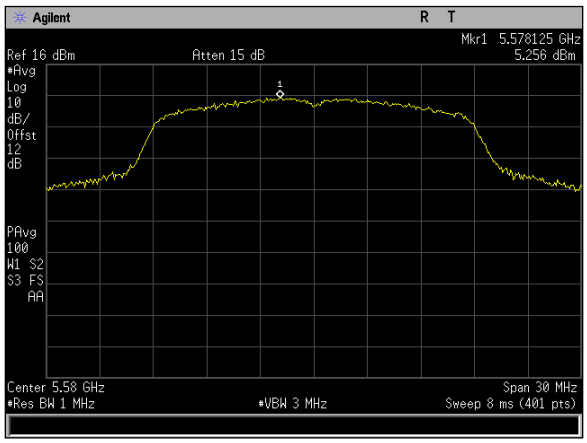
Plot 92. Power Spectral Density, BW 20M, Ch 5560M, N Mode Port 2



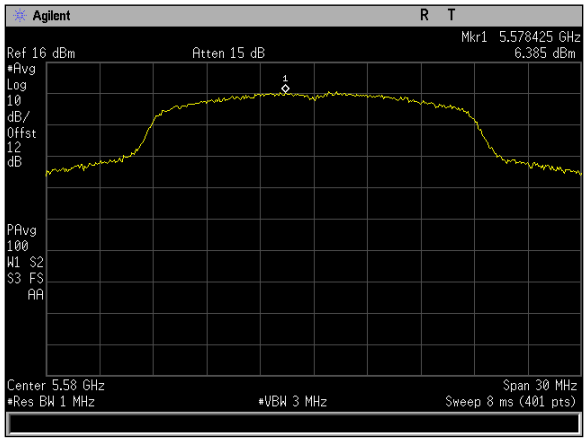
Plot 93. Power Spectral Density, BW 20M, Ch 5580M, A Mode Port 1



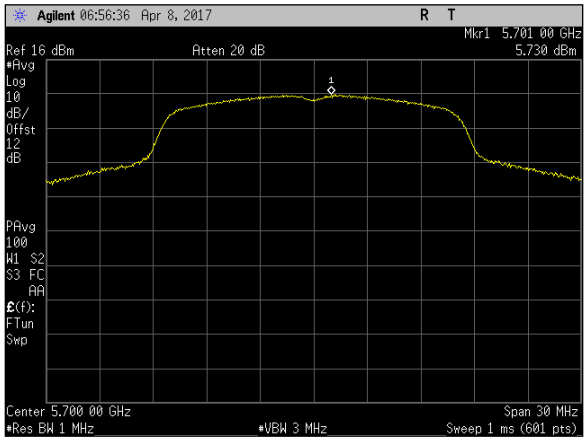
Plot 94. Power Spectral Density, BW 20M, Ch 5580M, A Mode Port 2



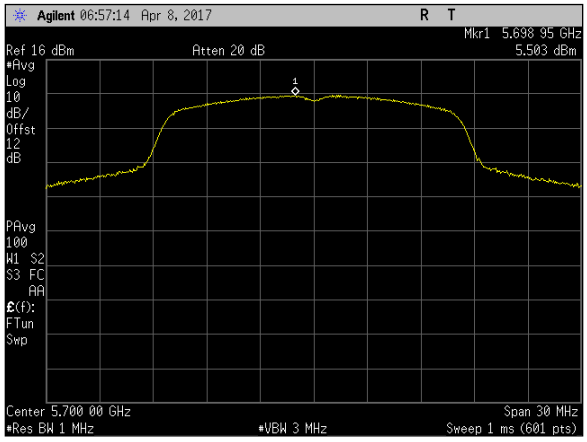
Plot 95. Power Spectral Density, BW 20M, Ch 5580M, N Mode Port 1



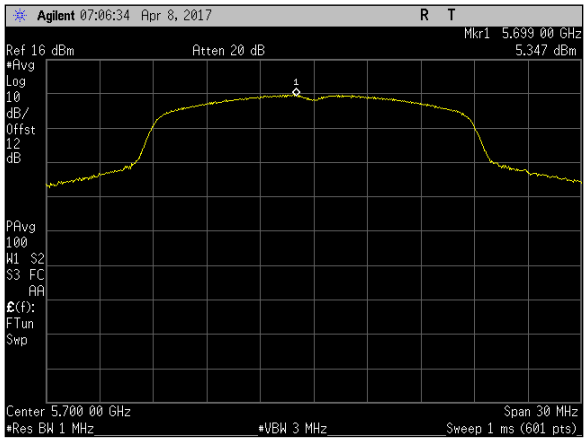
Plot 96. Power Spectral Density, BW 20M, Ch 5580M, N Mode Port 2



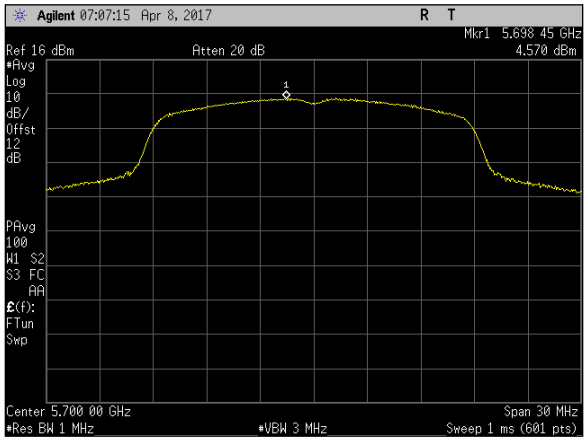
Plot 97. Power Spectral Density, BW 20M, Ch 5700M, A Mode Port 1



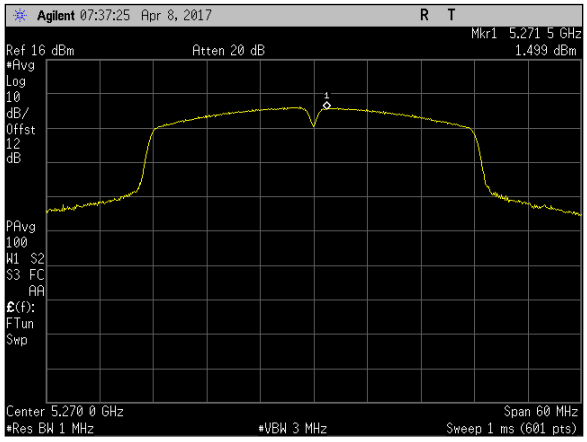
Plot 98. Power Spectral Density, BW 20M, Ch 5700M, A Mode Port 2



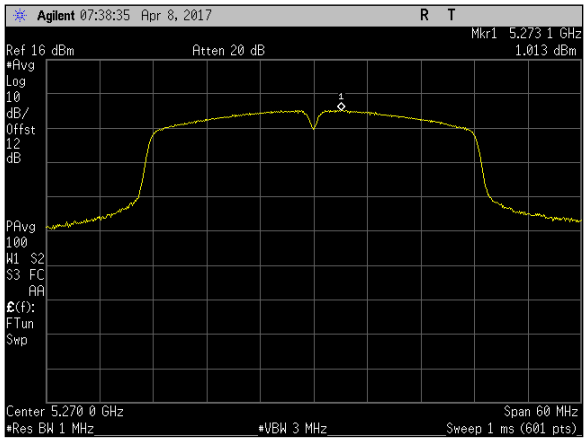
Plot 99. Power Spectral Density, BW 20M, Ch 5700M, N Mode Port 1



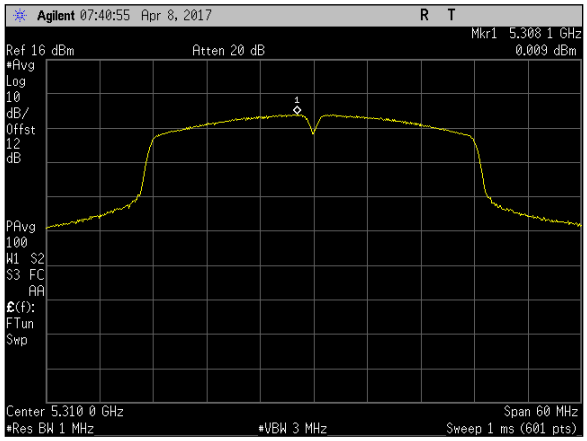
Plot 100. Power Spectral Density, BW 20M, Ch 5700M, N Mode Port 2



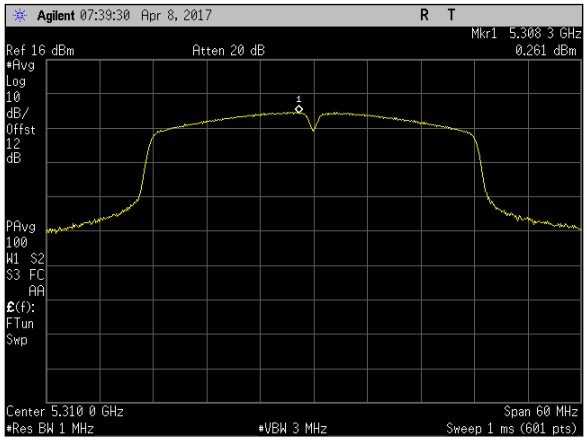
Plot 101. Power Spectral Density, BW 40M, Ch 5270M, N Mode Port 1



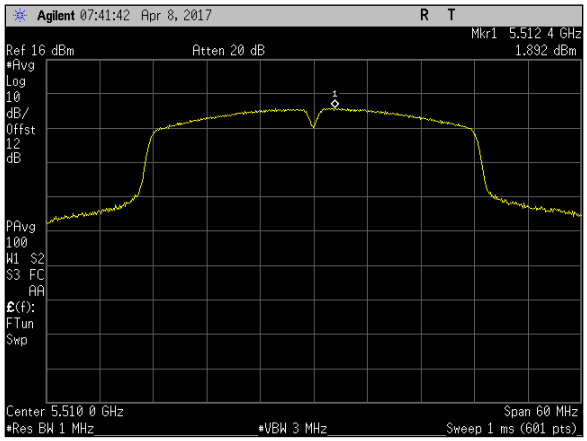
Plot 102. Power Spectral Density, BW 40M, Ch 5270M, N Mode Port 2



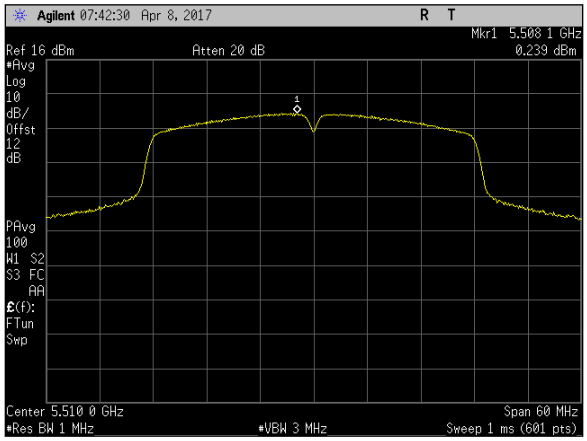
Plot 103. Power Spectral Density, BW 40M, Ch 5310M, N Mode Port 1



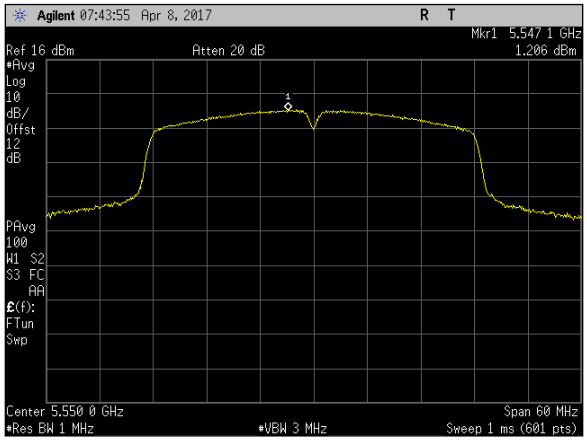
Plot 104. Power Spectral Density, BW 40M, Ch 5310M, N Mode Port 2



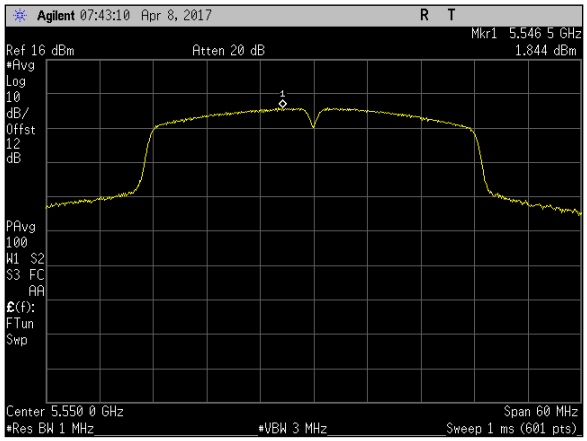
Plot 105. Power Spectral Density, BW 40M, Ch 5510M, N Mode Port 1



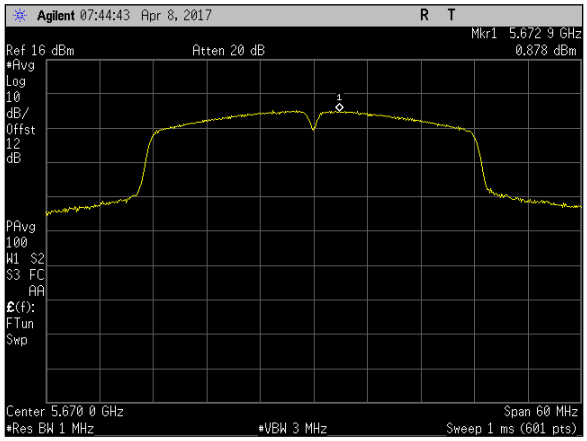
Plot 106. Power Spectral Density, BW 40M, Ch 5510M, N Mode Port 2



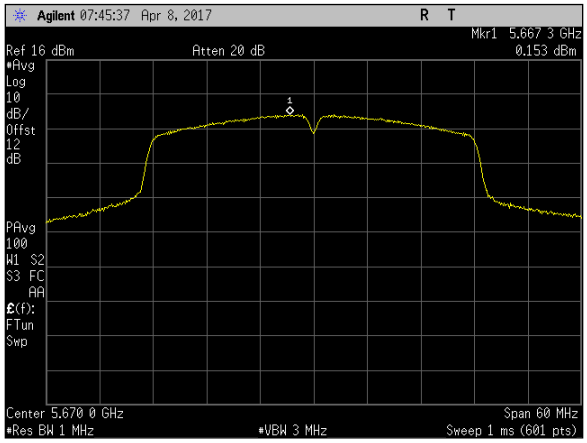
Plot 107. Power Spectral Density, BW 40M, Ch 5550M, N Mode Port 1



Plot 108.Power Spectral Density, BW 40M, Ch 5550M, N Mode Port 2



Plot 109. Power Spectral Density, BW 40M, Ch 5670M, N Mode Port 1



Plot 110. Power Spectral Density, BW 40M, Ch 5670M, N Mode Port 2

Electromagnetic Compatibility Criteria for Intentional Radiators

§15.407(b)(2 – 3) & (6 – 7) Undesirable Emissions

Test Requirements:

§ 15.407(b)(2): For transmitters operating in the 5.25-5.35 GHz band: All emissions outside of the 5.15-5.35 GHz band shall not exceed an e.i.r.p. of −27 dBm/MHz.

§ 15.407(b)(3): For transmitters operating in the 5.47-5.725 GHz band: All emissions outside of the 5.47-5.725 GHz band shall not exceed an e.i.r.p. of −27 dBm/MHz.

§ 15.407(b)(6): Unwanted emissions below 1 GHz must comply with the general field strength limits set forth in Section 15.209. Further, any U-NII devices using an AC power line are required to comply also with the conducted limits set forth in Section 15.207.

§ 15.407(b)(7): The provisions of Section 15.205 of this part apply to intentional radiators operating under this section.

Test Procedure:

The EUT was placed on a non-conducting stand on a turntable in a chamber. To find the maximum emission the EUT was set to transmit on low, mid, and high channels. Additionally, the turntable was rotated 360 degrees, the EUT was oriented through its three orthogonal axes, and the receive antenna height was varied in order to maximize emissions.

For frequencies from 30 MHz to 1 GHz, measurements were first made using a peak detector with a 100 kHz resolution bandwidth. Emissions which exceeded the limits were re-measured using a quasi-peak detector with a 120 kHz resolution bandwidth.

Above 1 GHz, measurements were made pursuant the method described in FCC KDB 789033 D02 General UNII Test Procedure New Rules v02. The equation, **EIRP= E + 20 log D – 104.8** was used to convert field strength to EIRP (**E** = field strength (dBµV/m) and **D** = Reference measurement distance**).**

For emissions above 1 GHz and in restricted bands, measurements of the field strength were made with a peak detector and an average detector and compared with the limits of 15.209.

As an alternative, according to FCC KDB 789033 D02 General UNII Test Procedure New Rules v02, all emissions above 1 GHz that comply with the peak and average limits of 15.209 satisfy the requirements of unwanted emissions in 15.407.

Test Results:

EUT was compliant with the requirements of this section. Only noise was observed above 18 GHz and below 30 MHz. Emissions were investigated up to 10th harmonics. Only worst data are presented in this report except band edges.

Measured emissions were within applicable limits.

Test Engineer(s): Deepak Giri

Test Date(s): November 28, 2017

