LS RESEARCH, LLC
Wireless Product Development

W66 N220 Commerce Court ● Cedarburg, WI 53012 USA ● Phone: 262.375.4400 ● Fax: 262.375.4248 ● www.lsr.com

ENGINEERING TEST REPORT # 313033 A
LSR Job #: C-1694

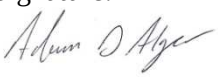
Compliance Testing of:
TiWi5

Test Date(s):
February 7, 8, 16, March 26-28, and April 1-2 2013

Prepared For:
LS Research
W66 N220 Commerce Court
Cedarburg, WI 53012

This Test Report is issued under the Authority of: Adam Alger, EMC Engineer

Signature: Date: 5-16-13



Test Report Reviewed by:
Khairul Aidi Zainal, Senior EMC Engineer

Signature: Date: 5-13-13

Report by:
Adam Alger, EMC Engineer

Signature: Date: 5-13-13

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LS Research, LLC in Review

As an EMC Testing Laboratory, our Accreditation and Assessments are recognized through the following:

TESTING CERT #1255.01

A2LA – American Association for Laboratory Accreditation

Accreditation based on ISO/IEC 17025: 2005 with Electrical (EMC) Scope of Accreditation
A2LA Certificate Number: 1255.01

Federal Communications Commission (FCC) – USA

Listing of 3 Meter Semi-Anechoic Chamber based on Title 47 CFR – Part 2.948
FCC Registration Number: 90756

Industrie Canada Industry Canada

Canada

Industry Canada

On file, 3 Meter Semi-Anechoic Chamber based on RSS-212 – Issue 1
File Number: IC 3088-A
On file, 3 and 10 Meter OATS based on RSS-212 – Issue 1
File Number: IC 3088

U. S. Conformity Assessment Body (CAB) Validation

Validated by the European Commission as a U. S. Competent Body operating under the U. S./EU, Mutual Recognition Agreement (MRA) operating under the European Union Electromagnetic Compatibility –Council Directive 2004/108/EC (formerly 89/336/EEC, Article 10.2).
Date of Validation: January 16, 2001

Validated by the European Commission as a U.S. Notified Body operating under the U.S. /EU, Mutual Recognition Agreement (MRA) operating under the European Union Telecommunication Equipment – Council Directive 99/5/EC, Annex V.
Date of Validation: November 20, 2002
Notified Body Identification Number: 1243

1.0 Summary of Test Report

The purpose of these tests is to request a Class II permissive change to FCC ID: TFB-TIWI501 and IC: 5969A-TIWI501, to add an antenna. See permissive change request letter for full description of changes.

In 2013 the EUT TiWi5 was tested and MEETS the following requirements:

FCC Rule Part	RSS Rule Part	Test Description	Test Result
15.407 (a)(1)	210 A9.2 (1)	Power Limits	Pass
15.407 (a)(1)	210 A9.2 (1)	Peak Power Spectral Density	Pass
15.407 (a)(1)	210 A9.2 (1)	26dB Bandwidth	Pass
15.407 (a)(6)	N/A	Peak Excursion Ratio	Pass
15.407 (b)(1)	210 A9.2 (1)	Undesirable emissions Limit	Pass
15.407 (b)(6) & (7),	210 A9.2 (1) GEN	Spurious Emissions below 1GHz AC Mains emissions	Pass
15.407 (e)	210 A.9.2 (1)	Indoor Operation	Pass
15.407 (f)	102 (4)	RF Exposure requirements	Pass
15.407 (g)	N/A	Frequency Stability	Pass

2.0 Test Facilities

All testing was performed at:

LS Research, LLC
W66 N220 Commerce Court
Cedarburg, Wisconsin, 53012 USA

LS Research, LLC is accredited by A2LA (American Association for Laboratory Accreditation) to the requirements of ISO/IEC 17025, 2005 “General Requirements for the Competence of Calibration and Testing Laboratories”.
LS Research, LLC’s scope of accreditation includes all test methods listed herein, unless otherwise noted.

3.0 Client Information

Manufacturer Name:	LS Research
Address:	W66 N220 Commerce Court Cedarburg, WI 53012
Contact Person:	Josh Bablitch

3.1 Equipment Under Test (EUT) Information

The following information has been supplied by the applicant.

Product Name:	TIWI5
Model Number:	TIWI5
Serial Number:	Synapse XBRV4
FCC ID	TFB-TIWI501
IC Number	5969A-TIWI501

3.2 Product Description

The TIWI5 module is a multi-standard module with support for WLAN (802.11 a/b/g/n), Bluetooth 2.1+EDR and Bluetooth 4.0 (LE).

3.3 Modifications Incorporated In the EUT for Compliance Purposes

None noted at time of test.

3.4 Deviations & Exclusions from Test Specifications

None noted at time of test.

4.0 Conditions of Test

Environmental:

Temperature: 20-25º C
Relative Humidity: 30-60%
Atmospheric Pressure: 86-106 kPa

Mains Voltage: 120VAC 60 Hz

5.0 Additional Information

The EUT was programmed from a laptop computer with a HyperTerminal type program sending commands via Ethernet cable connected to PoE injector. EUT powered via PoE.

6.0 Test Equipment

All test equipment is calibrated by a calibration laboratory accredited by A2LA to the requirements of ISO 17025. For a complete list of test equipment and calibration dates, see Appendix A. Unless otherwise noted, resolution bandwidth of measuring instrument used during testing for given frequency range, see below.

Frequency Range	Resolution Bandwidth
9 kHz – 150 kHz	200 Hz
150 kHz – 30 MHz	9 kHz
30 MHz – 1000 MHz	120 kHz
Above 1000 MHz	1 MHz

7.0 Conformance Summary

The EUT was found to MEET the requirements as described within the specification of FCC Title 47, CFR Part 15.407, and Industry Canada RSS-210, Issue 8 (2010), Annex 9.

If some emissions are seen to be within 3 dB of their respective limits:
As these levels are within the tolerances of the test equipment and site employed, there is a possibility that this unit, or a similar unit selected out of production may not meet the required limit specification if tested by another agency.

LS Research, LLC certifies that the data contained herein was taken under conditions that meet or exceed the requirements of the test specifications. The results in this Test Report apply only to the item(s) tested on the above-specified dates. Any modifications made to the EUT subsequent to the indicated test date(s) will invalidate the data herein, and void this certification.

Appendix A – Test Equipment

LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date : 26-Mar-2013 Type Test : Radiated Measurments Job # : C-1694

Prepared By: Adam Customer : LSR Quote #: 313033

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960073	Spectrum Analyzer	Agilent	E4446A	US45300564	5/9/2012	5/9/2013	Active Calibration
2	EE 960147	Pre-Amp	Adv. Micro	WLA612	123101	2/1/2013	2/1/2014	Active Calibration
3	EE 960146	Std. Gain Horn Ant. w/preamp	Adv. Micro / EMC	WLA622-4 / 3160-09	123001	9/26/2012	9/26/2013	Active Calibration
4	EE 960156	100kHz-1GHz Analog Signal Generator	Agilent	N5181A	MY49060062	6/30/2012	6/30/2013	Active Calibration
5	EE 960157	3Hz-13.2GHz Spectrum Analyzer	Agilent	E4445A	MY48250225	6/29/2012	6/29/2013	Active Calibration
6	EE 960158	RF Preselecter	Agilent	N9039A	MY46520110	6/29/2012	6/29/2013	Active Calibration
7	EE 960161	26.5-40GHz LNA	Ducommun Tech	ALN-33144030	1103717-01	9/17/2012	9/17/2013	Active Calibration
8	AA 960144	Phaseflex	Gore	EKD01D010720	5800373	6/1/2011	6/1/2013	Active Calibration
9	AA 960005	Biconical Antenna	EMCO	93110B	9601-2280	6/26/2012	6/26/2013	Active Calibration
10	AA 960078	Log Periodic Antenna	EMCO	93146	9701-4855	12/10/2012	12/10/2013	Active Calibration
11	AA 960081	Double Ridge Horn Antenna	EMCO	3115	6907	1/29/2013	1/29/2014	Active Calibration
12	AA 960137	Standard Gain Horn Ant.	EMCO	3160-10	69259	10/4/2011	10/4/2014	Active Calibration
13	AA 960160	UTiFLEX Cable	Micro-Coax	UFC142A-0-0720-200	218652-001	9/13/2012	9/13/2013	Active Calibration

Project Engineer: Quality Assurance:

LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date : 26-Mar-2013 Type Test : RF Conducted Job # : C-1694

Prepared By: Adam Customer : LSR Quote #: 313033

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	AA 960143	Phaseflex	Gore	EKD01D01048.0	5546519	6/1/2011	6/1/2013	Active Calibration
2	EE 960073	Spectrum Analyzer	Agilent	E4446A	US45300564	5/9/2012	5/9/2013	Active Calibration

Project Engineer: Quality Assurance:

LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date : 20-Dec-2011 Type Test : AC mains Job # : C-1371

Prepared By: Aidi Customer : LSR Quote #: 311362

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960013	EMI Receiver	HP	8546A System	3617A00320;3448A	11/22/2011	11/22/2012	Active Calibration
2	EE 960014	EMI Receiver-filter section	HP	85460A	3448A00296	11/22/2011	11/22/2012	Active Calibration
3	AA 960072	Transient Limiter	HP	11947A	3107A02515	11/2/2011	11/2/2012	Active Calibration
4	AA 960075	LISN	EMCO	3810/2NM	9612-1710	9/19/2011	9/19/2012	Active Calibration

Project Engineer: Aidi Quality Assurance: Mike Hintzke

Appendix B – Test Data
B.1 – RF Conducted Emissions

Manufacturer	LS Research
Test Location	LS Research, LLC – Bench Measurements
Rule Part	FCC Part 15 Subpart E / RSS-210 Annex 9
General Measurement Procedure	FCC KDB 789033 D01 General UNII Test Procedures v01r02 ANSI C63.10-2009 Section 6.7
General Description of Measurement	A direct measurement of the transmitted signal was performed at the antenna port of the EUT via a cable connection to a spectrum analyzer. An attenuator was placed in series with the cable to protect the spectrum analyzer. The loss from the cable and the attenuator were added on the analyzer as gain offset settings there by allowing direct measurements, without the need for any further corrections. The EUT was configured to run in a continuous transmit mode, while being supplied with typical data as a modulation source.

B.1.1 – Duty Cycle

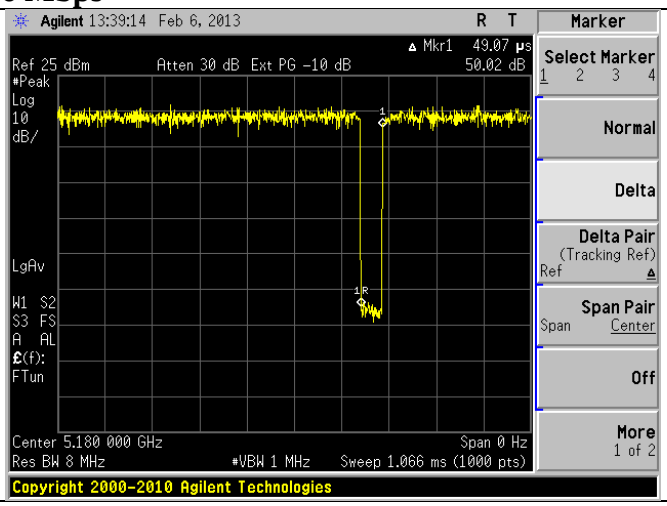
Manufacturer	LS Research
Date	2-16-13
Operator	Adam A
Temp. / R.H.	20 - 25º C / 30-60% R.H.
Rule Part	N/A
Specific Measurement Procedure	FCC KDB 789033 D01 General UNII Test Procedures v01r02
Additional Description of Measurement	The EUT must transmit at 100 percent duty cycle (no less than 98 percent) during testing. FCC KDB 789033 Section (B)
Additional Notes	1) Sample Calculation Duty Cycle = Tx On /(Tx On + Tx Off) Duty Cycle Correction = 10 log(1/x) x= duty cycle

Duty Cycle Table

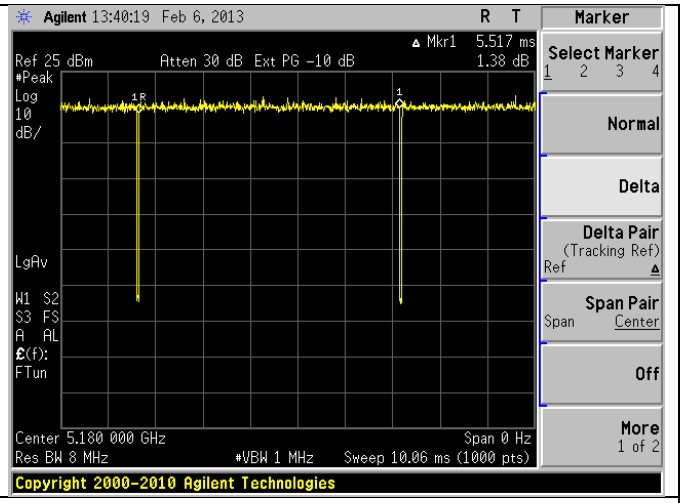
Mode	Duty Cycle (percent)	Correction (dB)
6 Mbps	99.1	none
12 Mbps	98.2	none
24 Mbps	96.6	0.15
MCS7	91.5	0.38

Duty Cycle Plots

6 Mbps



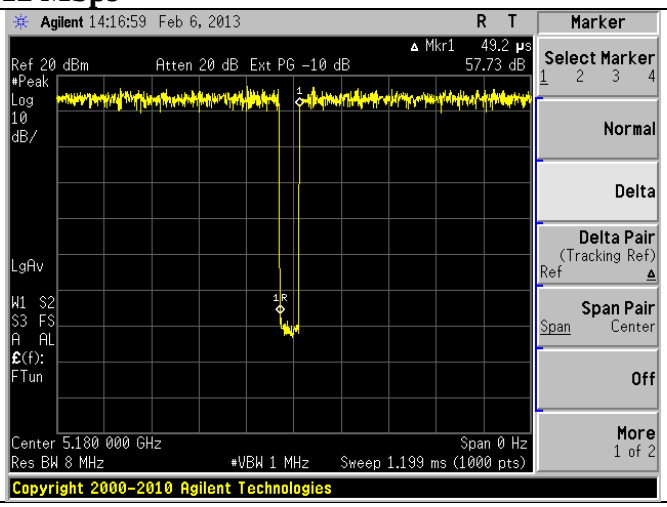
Off Time 49.07 µs



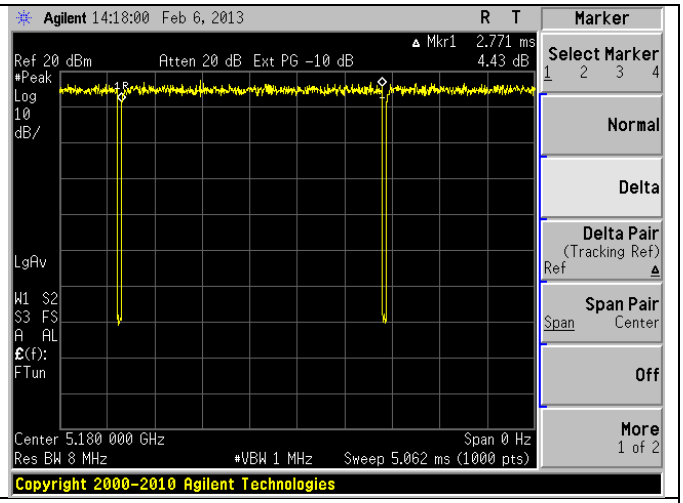
On Time 5.517 ms

Duty cycle = 5.517 / (5.517 + .0491) = .991 = 99.1%
No correction necessary

12 Mbps



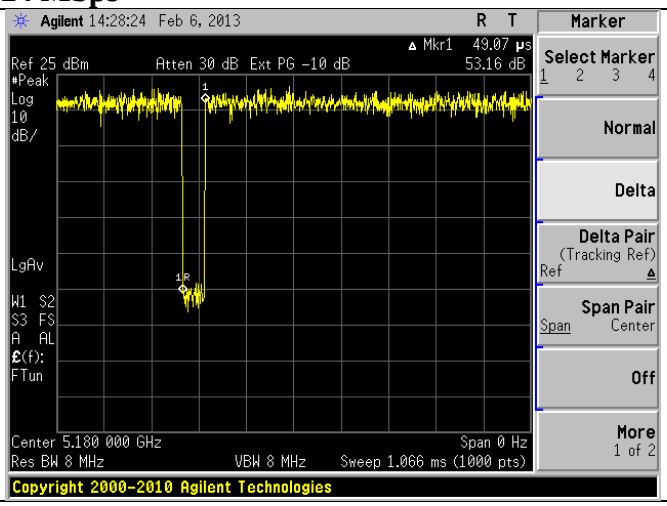
Off Time 49.2 µs



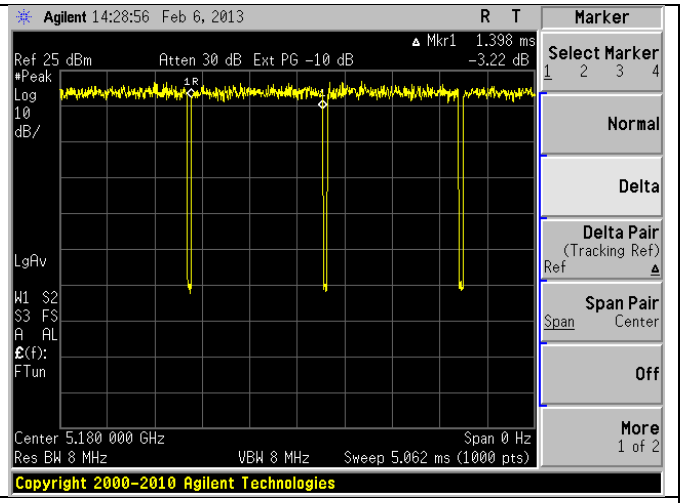
On Time 2.771 ms

Duty cycle = 2.771 / (2.771 + .0492) = .982 = 98.2%
No correction necessary

24 Mbps



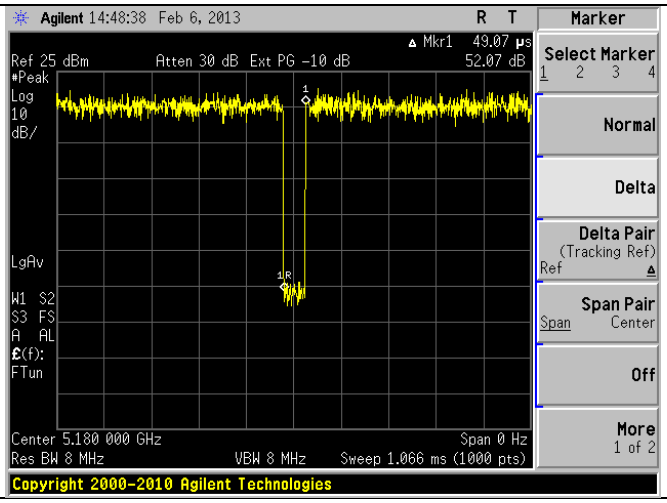
Off Time 49.07 µs



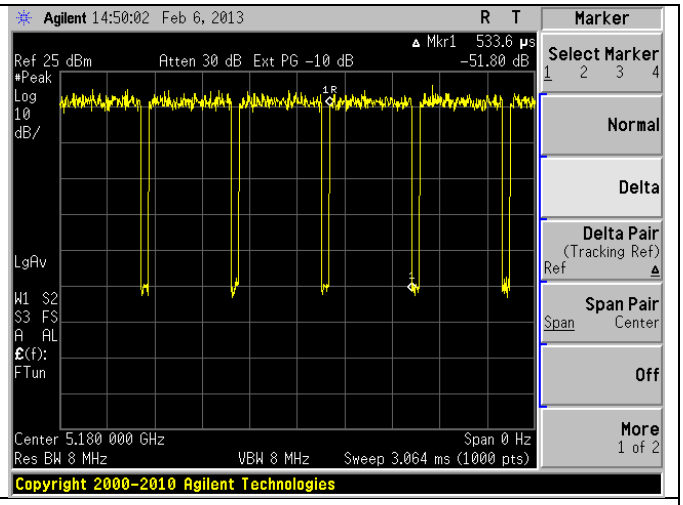
On Time 1.398 ms

Duty cycle = 1.398 / (1.398 + .0491) = .966
Duty Cycle Correction = 10 log (1/.966) = .15 dB

MCS7



Off Time 49.07 µs



On Time 533.6 µs

Duty cycle = 533.6 / (533.6 + 49.07) = .915
Duty Cycle Correction = 10 log (1/.915) = .38 dB

B.1.2 – Operation in the 5.15 – 5.25 GHz Band

Manufacturer	LS Research
Date	3-26 to 3-27 2013
Operator	Adam A
Temp. / R.H.	20 - 25º C / 30-60% R.H.
Rule Part	FCC Part 15.407 (a)(1) / RSS-210 A9.2 (1)
Specific Measurement Procedure	FCC KDB 789033 Section C) Method SA-1 and SA-2 – Output Power FCC KDB 789033 Section D) – Emission bandwidth FCC KDB 789033 Section C) – Peak power spectral density (PPSD)
Additional Description of Measurement	Output Power Method SA-1 used for modes 6 and 12 Mbps Method SA-2 used for modes 24 Mbps and MCS7
Additional Notes	1) Channel 52 lies in 5.25-5.35 GHz band however per 15.407(b) (2) must meet all applicable requirements of 5.15-5.25 GHz band therefore reported in this section. 2) Duty cycle added to 24 Mbps and MCS7 measurements. 3) Per Industry Canada email to TCB date 3-6-2012 FCC KDB 789033 can be used for measurements (26 dB EBW used for output power calculation)

Duty Cycle Calculations

Sample Calculation:
Analyzer data Power (dBm) + duty cycle (dB) = Power (dBm)
Analyzer data PPSD (dBm/MHz) + duty cycle (dB) = PPSD (dBm/MHz)
Power = 13.48 (dBm) analyzer + 0.15 (dB for 24 Mbps) = 13.63 (dBm) reported

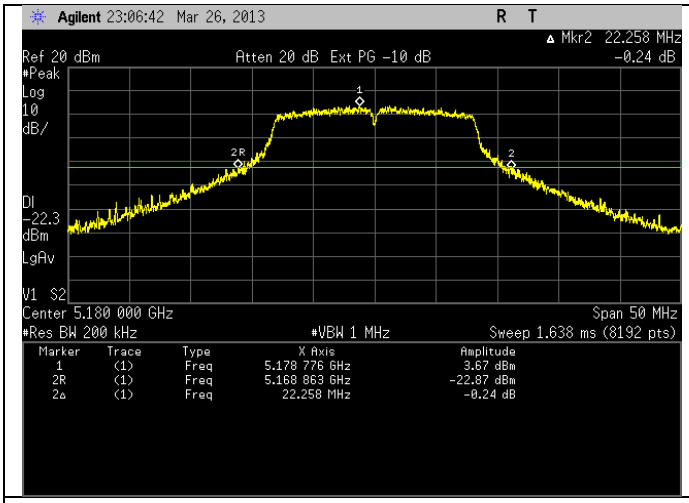
Mode	Duty Cycle (percent)	Correction (dB)
6 Mbps	99.1	none
12 Mbps	98.2	none
24 Mbps	96.6	0.15
MCS7	91.5	0.38

Operation in the Band 5.15 – 5.25 GHz

Data Rate	Channel	Frequency (MHz)	EBW 26dB (MHz)	Power (dBm)	Power Limit (dBm)	Power Margin (dB)	PPSD dBm/MHz	PPSD Limit dBm/MHz	PPSD Margin (dB)
6 Mbps	36	5180	22.26	13.60	17	3.40	3.54	4	0.46
	40	5200	22.02	13.54	17	3.46	3.47	4	0.53
	48	5240	22.35	13.38	17	3.62	3.35	4	0.65
	52	5260	21.76	13.60	17	3.40	3.29	4	0.71
12 Mbps	36	5180	21.66	13.39	17	3.61	3.67	4	0.33
	40	5200	21.40	13.69	17	3.31	3.66	4	0.34
	48	5240	22.00	13.80	17	3.20	3.80	4	0.20
	52	5260	21.40	13.47	17	3.53	3.37	4	0.63
24 Mbps	36	5180	21.23	13.63	17	3.37	3.87	4	0.13
	40	5200	21.10	13.59	17	3.41	3.46	4	0.54
	48	5240	20.80	13.65	17	3.35	3.53	4	0.47
	52	5260	21.50	13.48	17	3.52	3.33	4	0.67
MCS7	36	5180	22.19	11.96	17	5.04	1.39	4	2.61
	40	5200	21.44	12.01	17	4.99	1.43	4	2.57
	48	5240	22.00	12.09	17	4.91	1.52	4	2.48
	52	5260	22.13	12.32	17	4.68	1.51	4	2.49

Plots – 6 Mbps

Channel 36 – 5180 MHz



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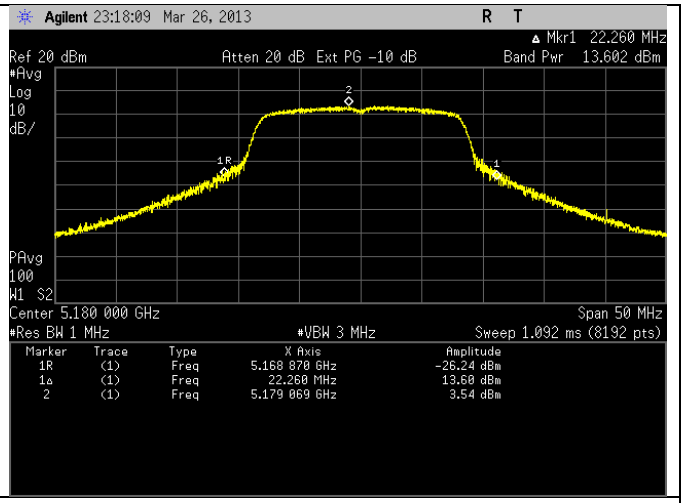
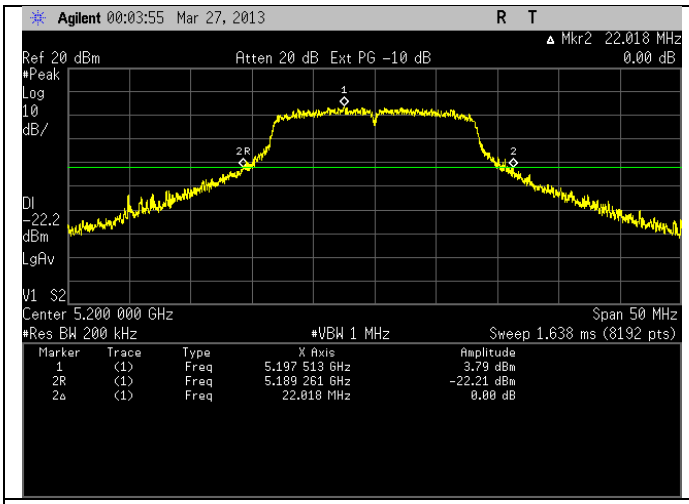


Power and PPSD

Channel 40 – 5200 MHz



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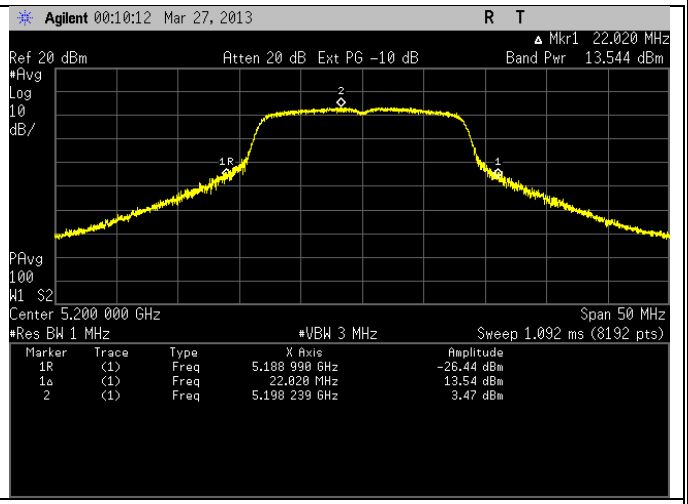
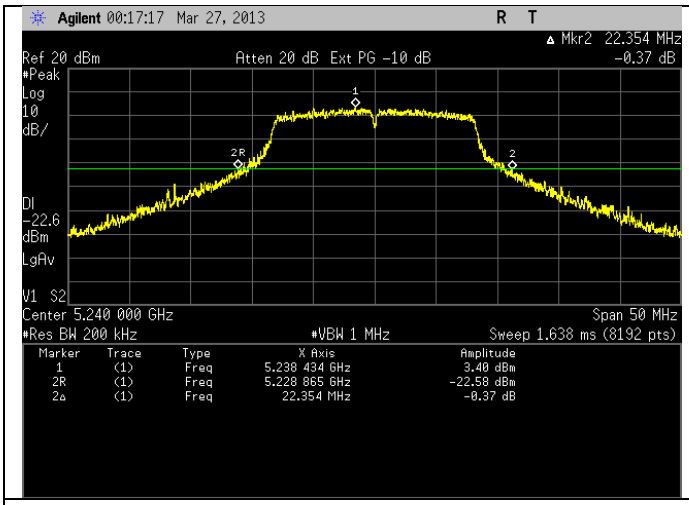


Power and PPSD

Channel 48 – 5240 MHz



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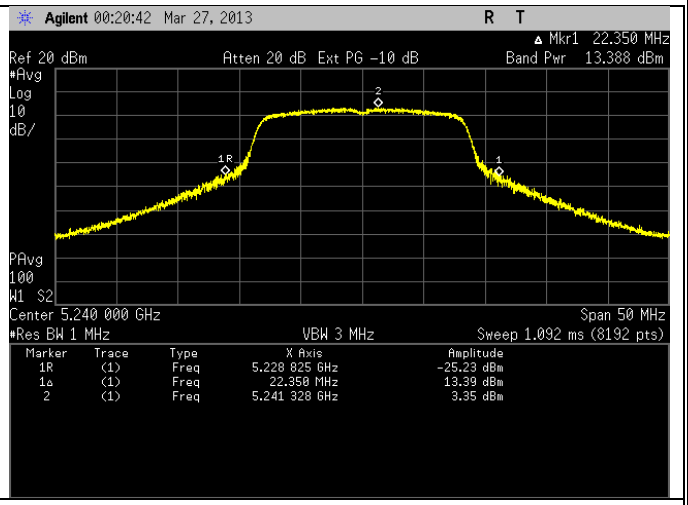
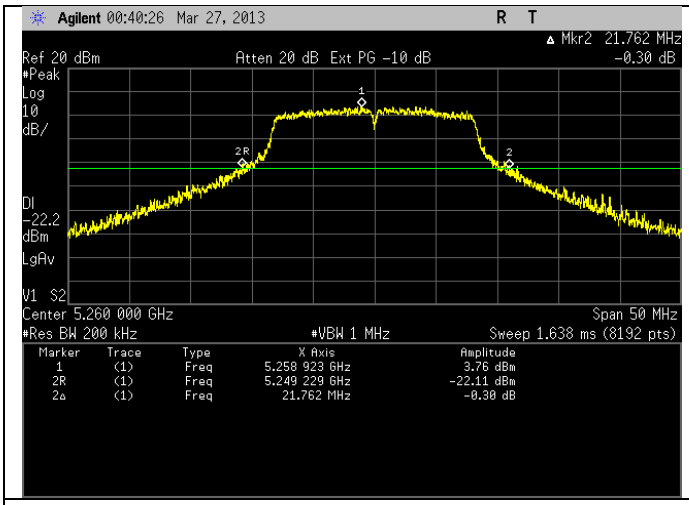


Power and PPSD

Channel 52 – 5260 MHz



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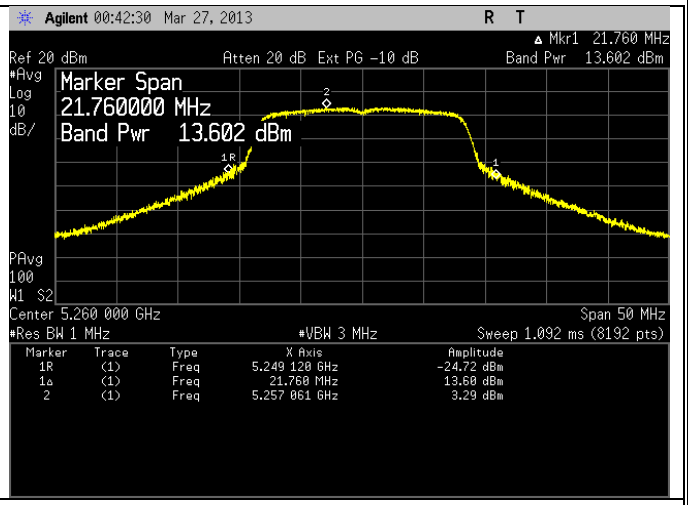
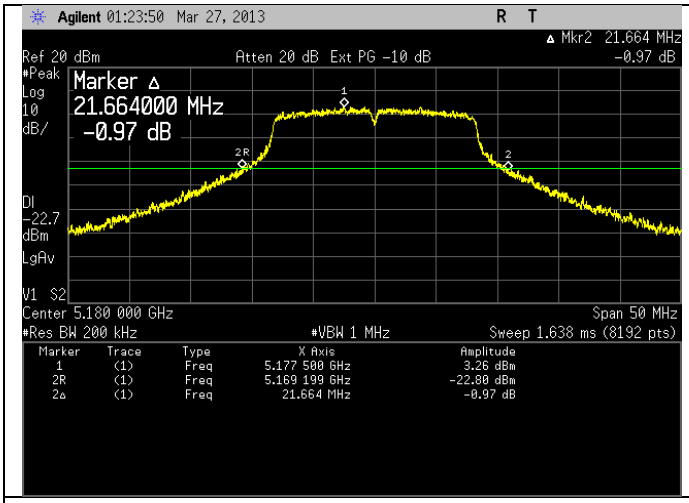


Power and PPSD

Plots – 12 Mbps

Channel 36 – 5180 MHz



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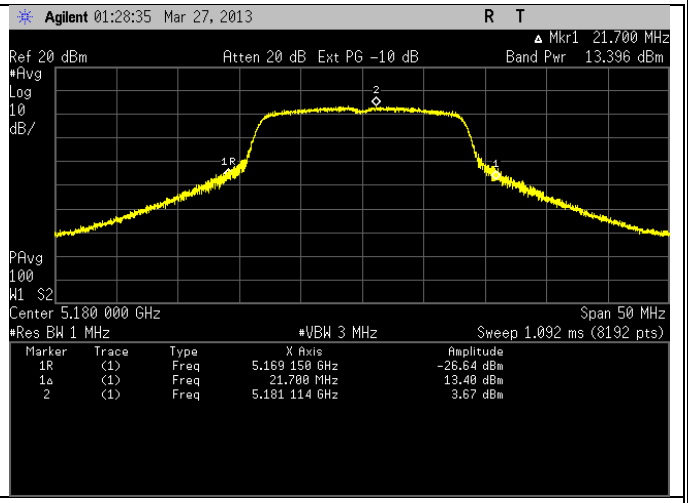
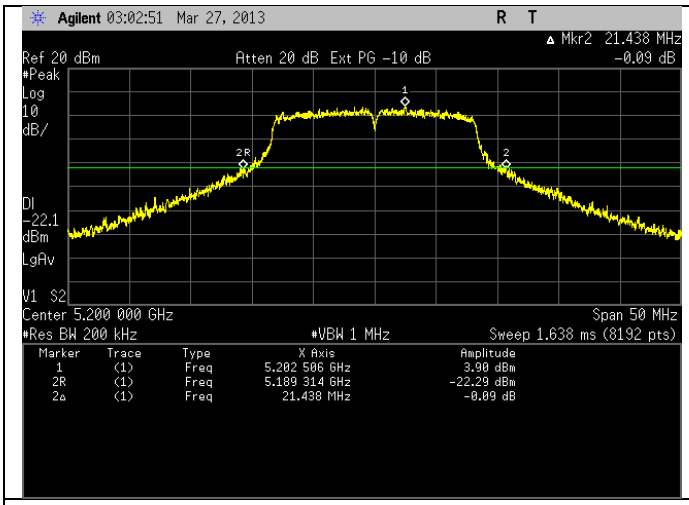


Power and PPSD

Channel 40 – 5200 MHz



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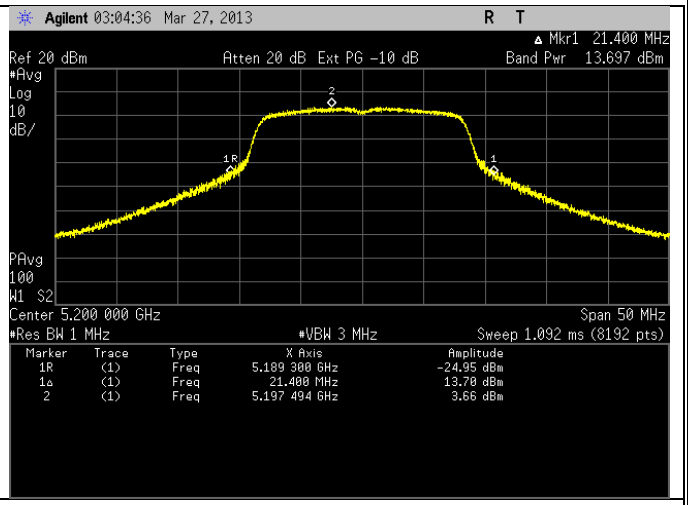
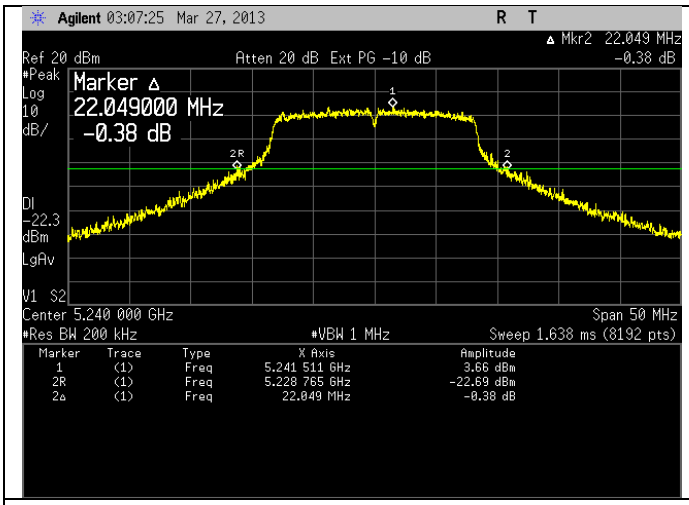


Power and PPSD

Channel 48 – 5240 MHz



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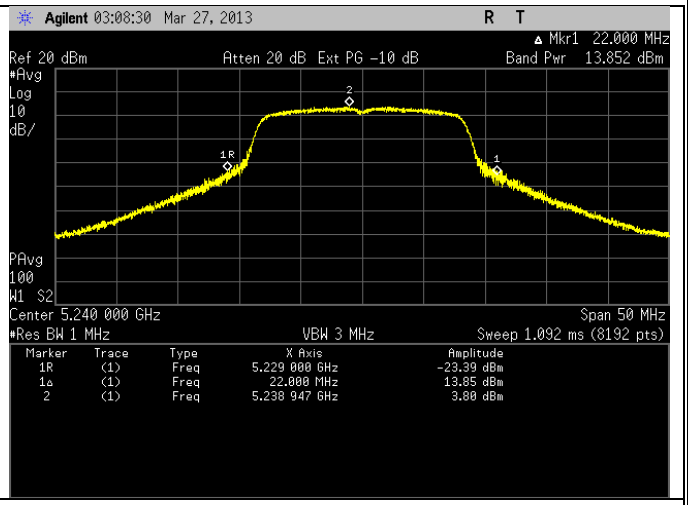
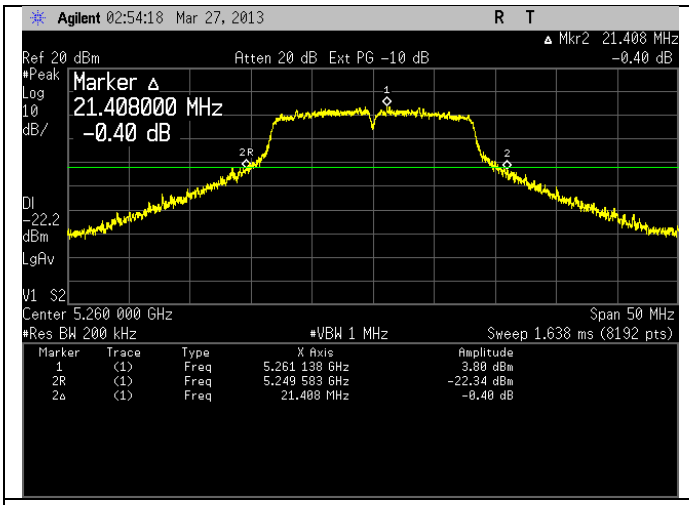


Power and PPSD

Channel 52 – 5260 MHz



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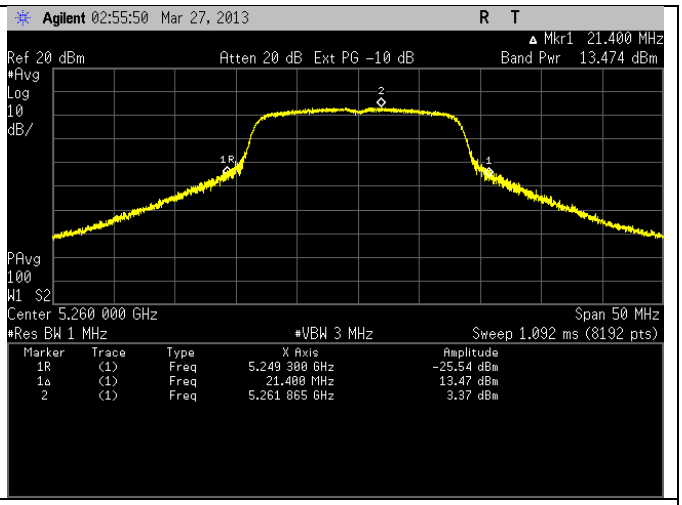
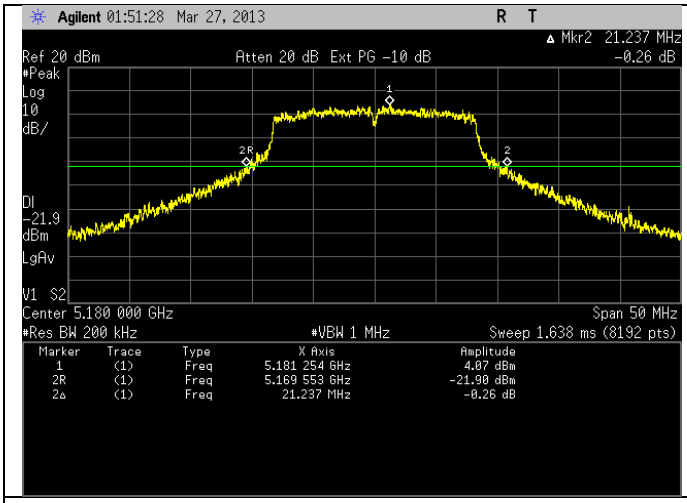


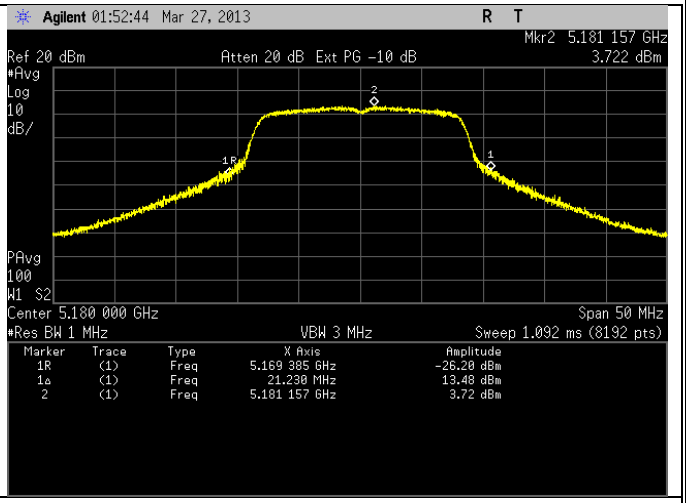
Power and PPSD

Plots – 24 Mbps

Channel 36 – 5180 MHz

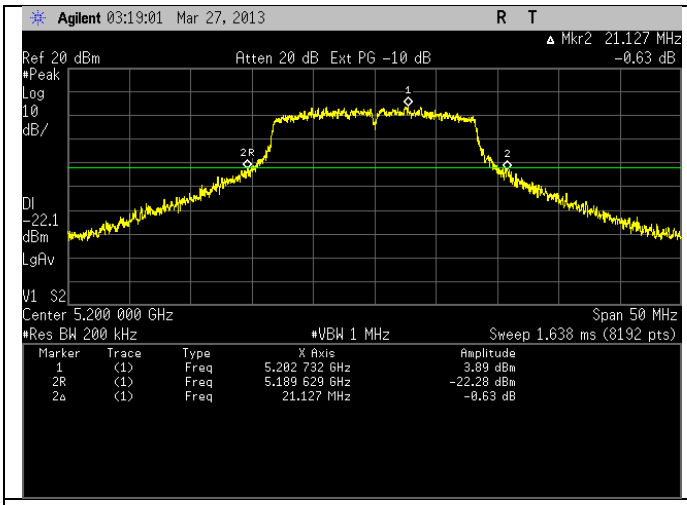


EBW



Power and PPSD

Channel 40 – 5200 MHz



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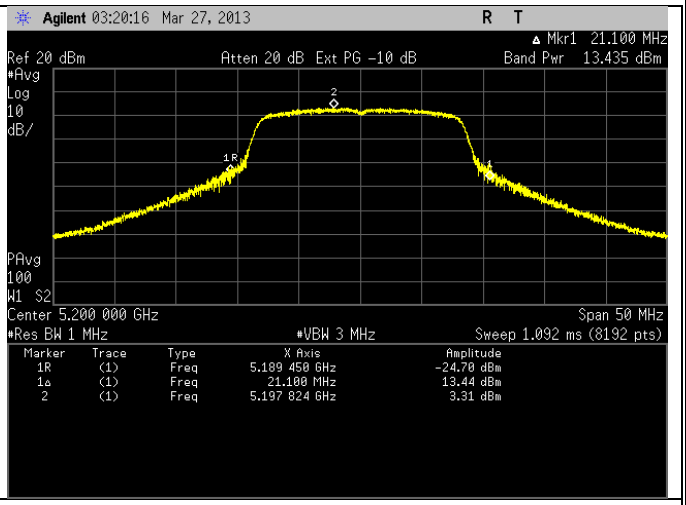
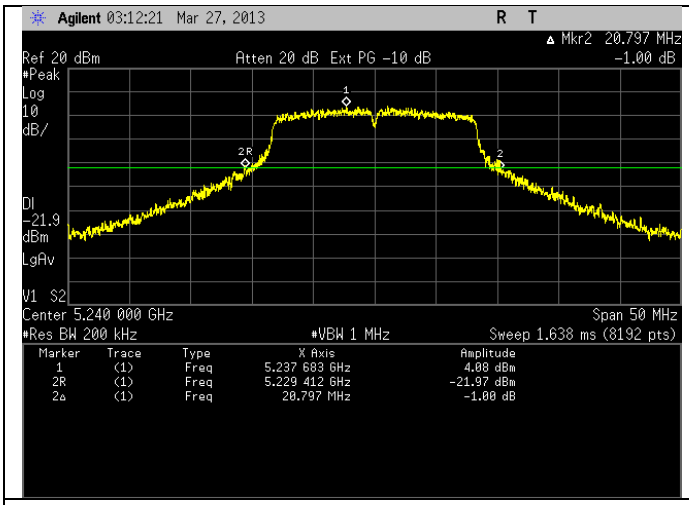


Power and PPSD

Channel 48 – 5240 MHz



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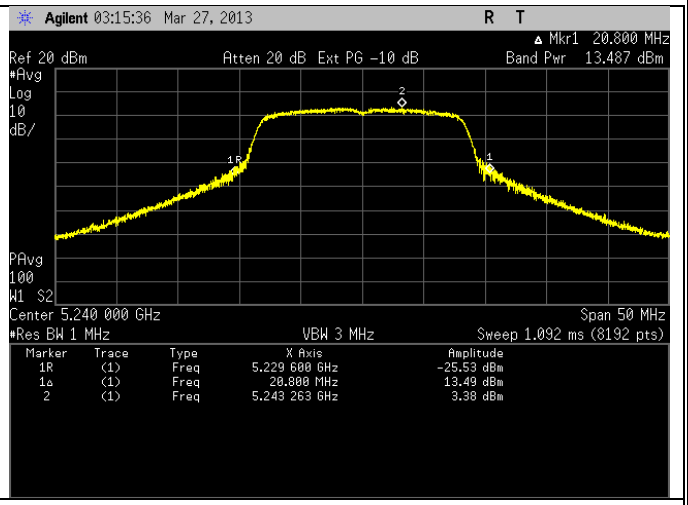
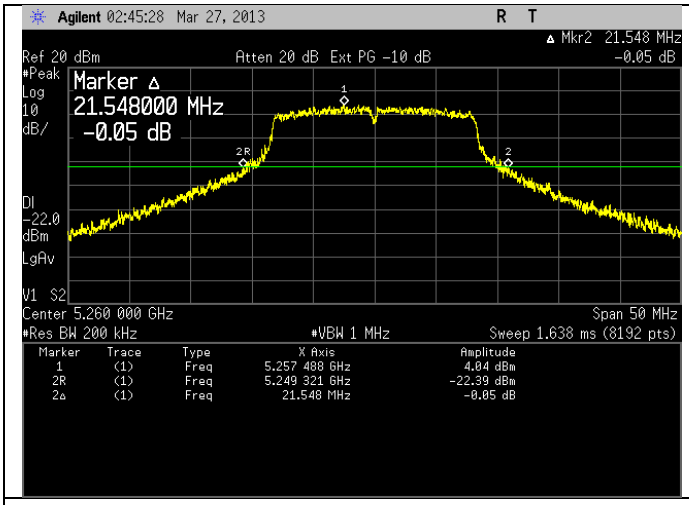
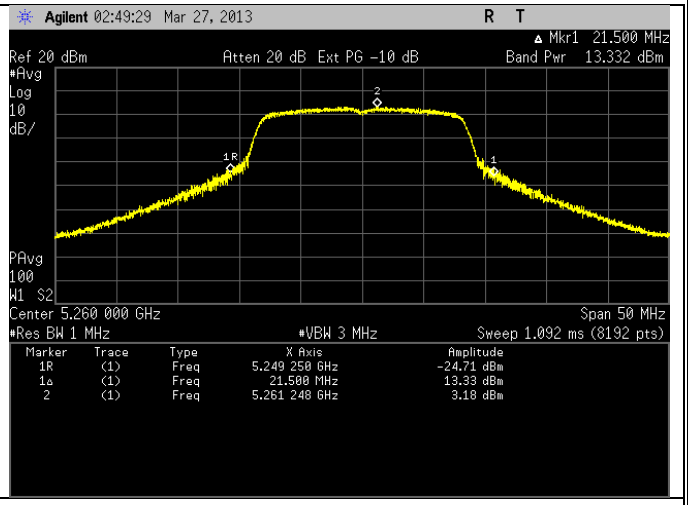


Power and PPSD

Channel 52 – 5260 MHz



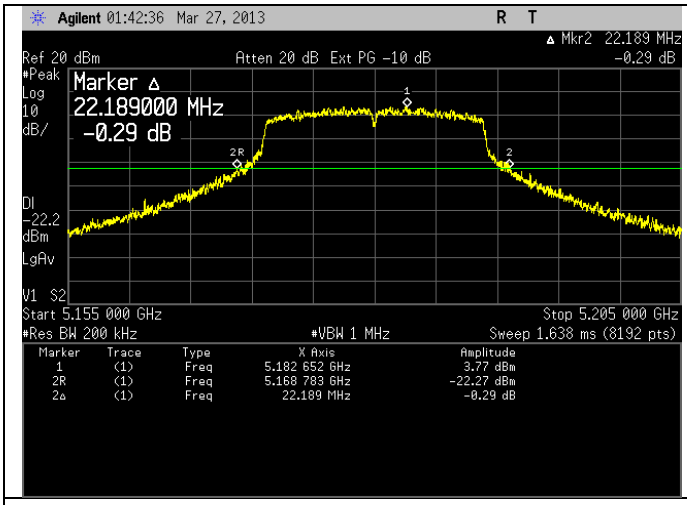
EBW



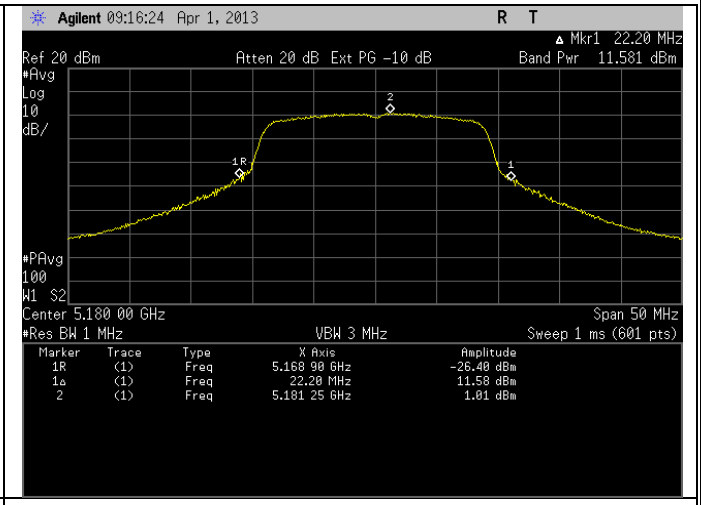
Power and PPSD

Plots – MCS7

Channel 36 – 5180 MHz

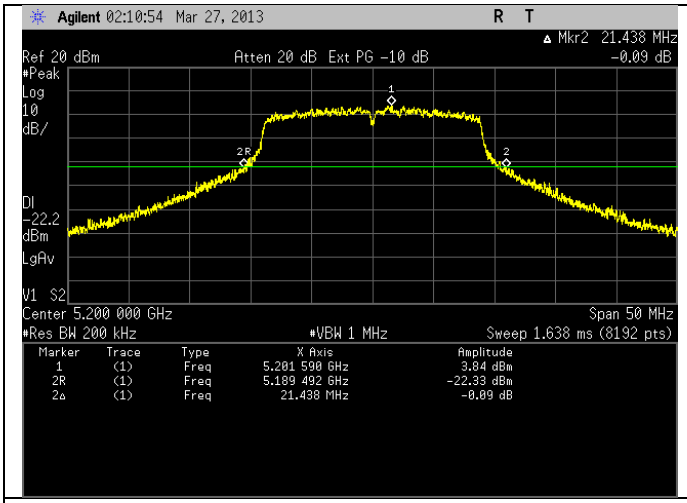


EBW

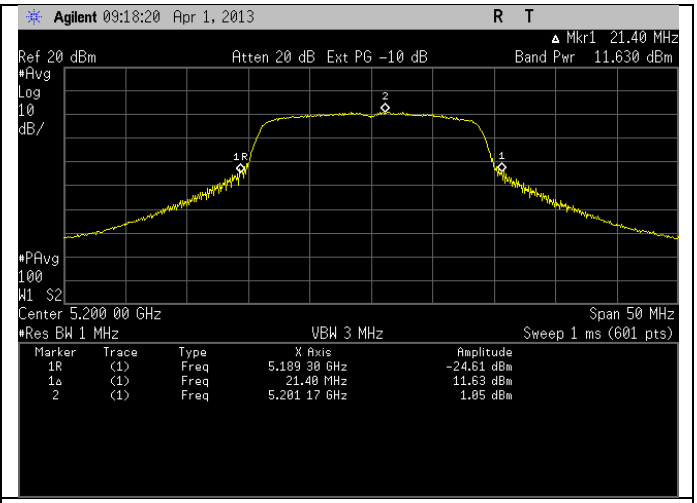


Power and PPSD

Channel 40 – 5200 MHz

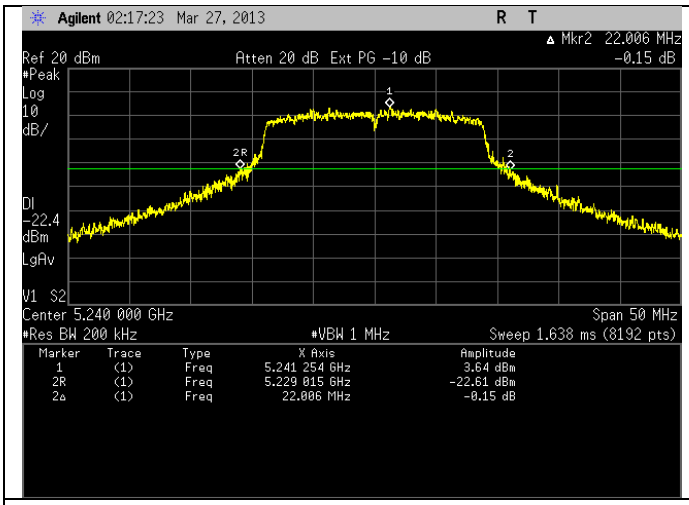


EBW

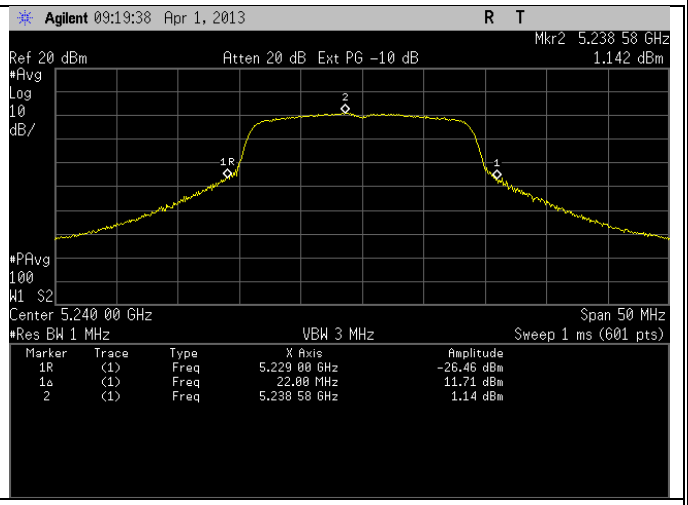


Power and PPSD

Channel 48 – 5240 MHz

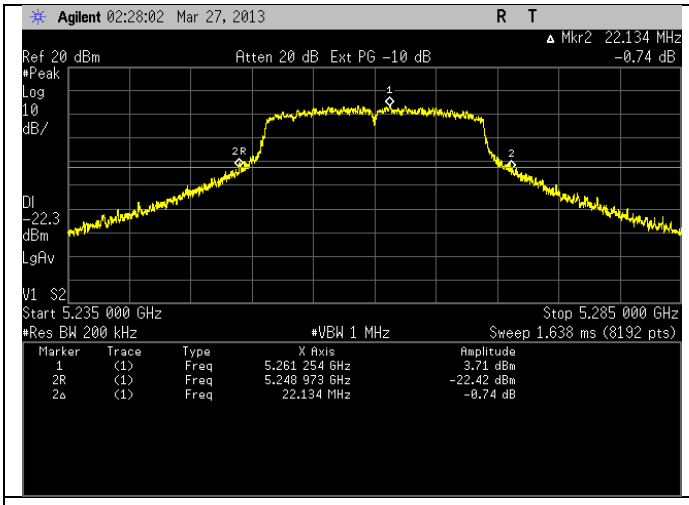


EBW

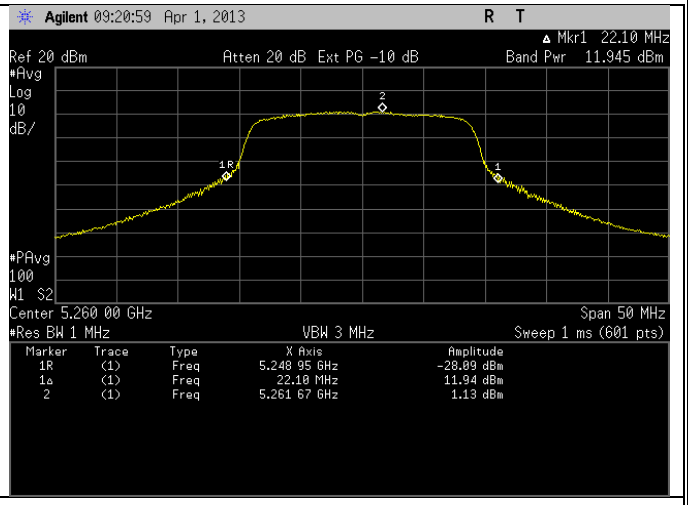


Power and PPSD

Channel 52 – 5260 MHz



EBW



Power and PPSD

B.1.2.1 – Operation in the 5.15 – 5.25 GHz Band (Undesirable Emissions)

Manufacturer	LS Research
Date	3-26, 3-27, 4-1 2013
Operator	Adam A
Temp. / R.H.	20 - 25º C / 30-60% R.H.
Rule Part	15.407 (b) (1) / RSS-210 A9.2 (1)
Specific Measurement Procedure	FCC KDB 789033 Section G) 5) – Peak measurements above 1000 MHz FCC KDB 789033 Section G) 6) – Method AD - Average measurements above 1000 MHz
Additional Description of Measurement	Per 15.407(b) and KDB 789033 Section G) 2) c), RF Conducted measurements of out-of-band emissions that comply with average (-41.2 dBm/MHz) and peak (-21.2 dBm/MHz) limits of 15.209 are satisfactory for showing compliance with 15.407(b) limit of -27 dBm/MHz. Data reported shows peak measurements with max antenna gain and duty cycle correction (if applicable) meeting more stringent peak limit of -27 dBm/MHz as well as average limit (-41.2 dBm/MHz)
Additional Notes	1) Channel 52 lies in 5.25-5.35 GHz band however per 15.407(b) (2) must meet all applicable requirements of 5.15-5.25 GHz band therefore reported in this section. 2) Duty cycle added to 25 Mbps and MCS7 measurements. 3) Band-edge measurements at 6, 12, 24 and MCS7 modes. 4) Worst-case out-of-band spurious reported with 6 Mbps mode. 5) Worst-case antenna gain used per KDB 789033 Section G) 3) b) (iii)

Sample Calculations:

Band-edge (dBm) + Antenna Gain (dBi) + Duty Cycle = Total (dBm)

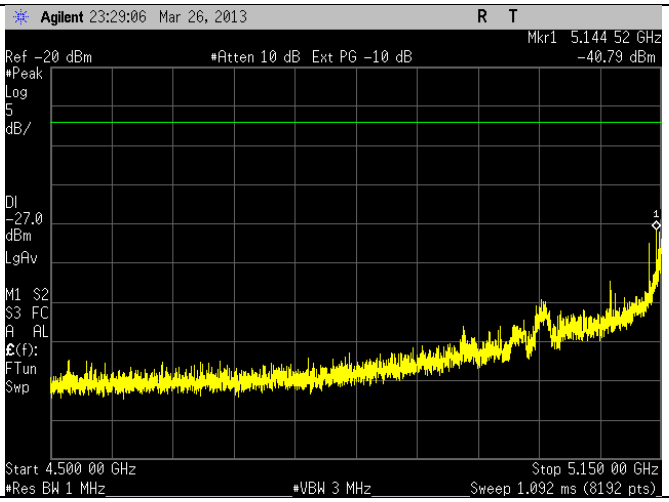
Margin (dB) = Limit (dBm/MHz) – Total (dBm/MHz)

Lower Band-edge Data Table (5.15 GHz)

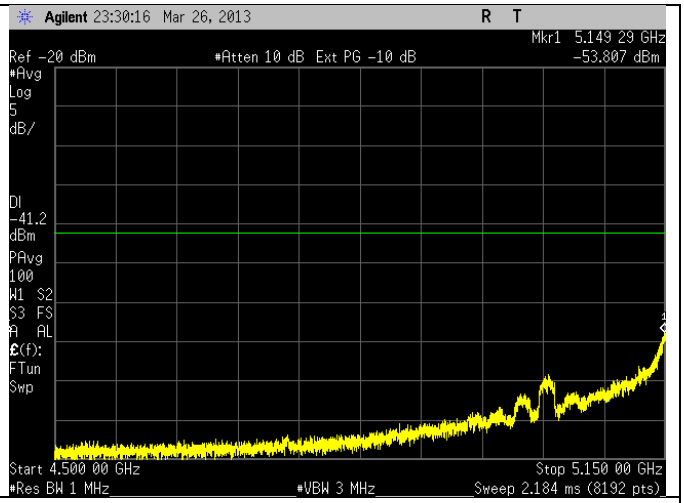
Data Rate	Band-edge (dBm)	Antenna Gain(dBi)	Duty Cycle (dB)	Total (dBm/MHz)	Limit (dBm/MHz)	Margin (dB)
6 Mbps	-40.79	2	0	-38.79	-27	11.79
12 Mbps	-41.51	2	0	-39.51	-27	12.51
24 Mbps	-40.16	2	0.15	-38.01	-27	11.01
MCS7	-44.01	2	0.38	-41.63	-27	14.63

Plots – Band Edge

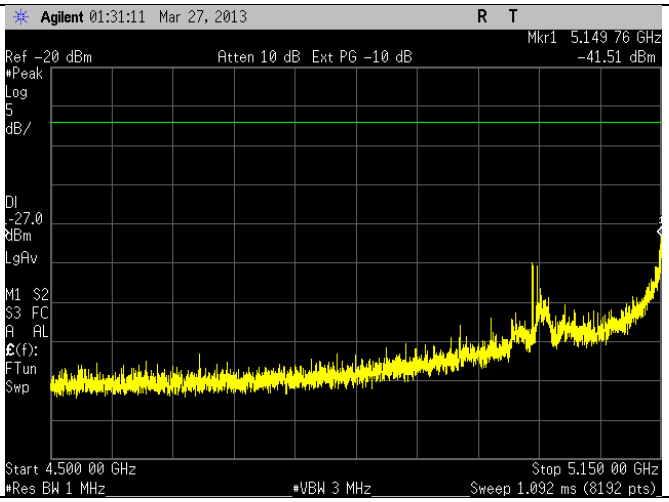
Channel 36



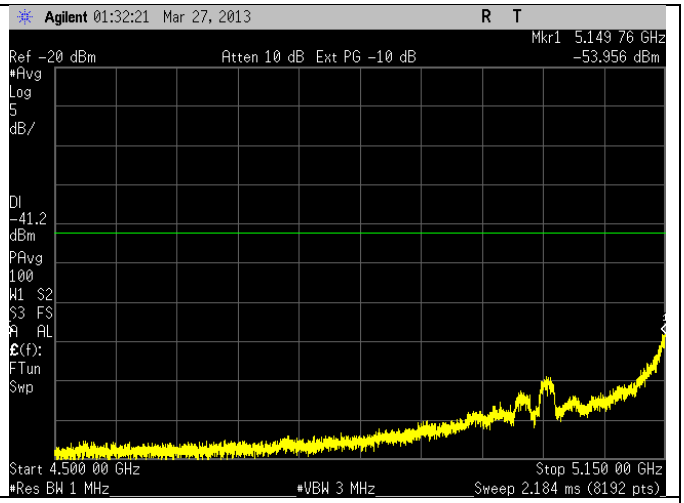
6 Mbps Peak



6 Mbps Average



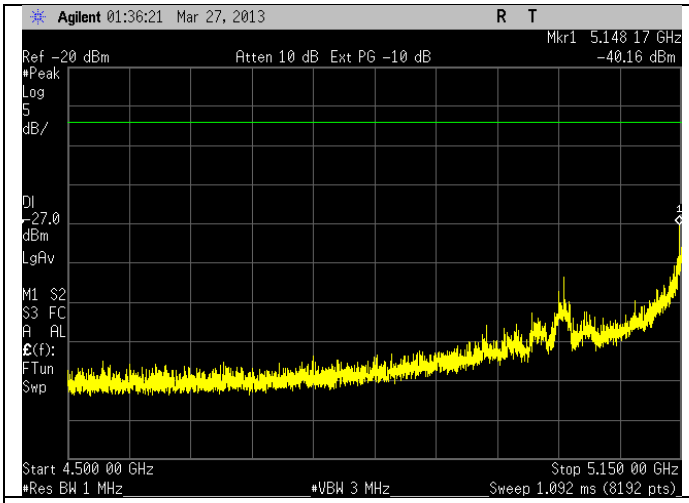
12 Mbps Peak



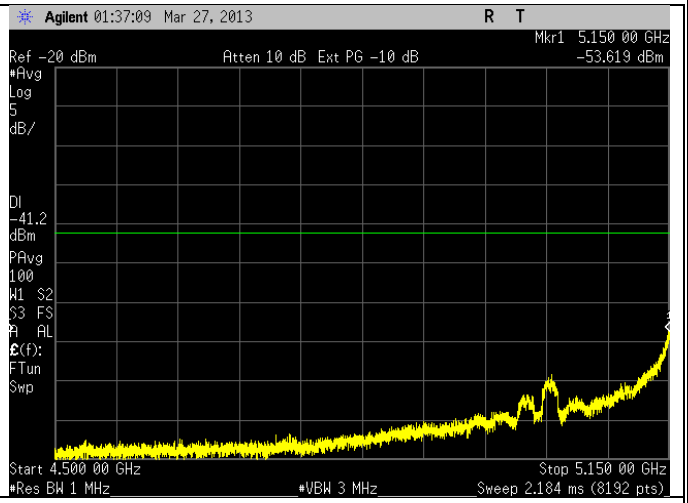
12 Mbps Average

Plots – Band Edge

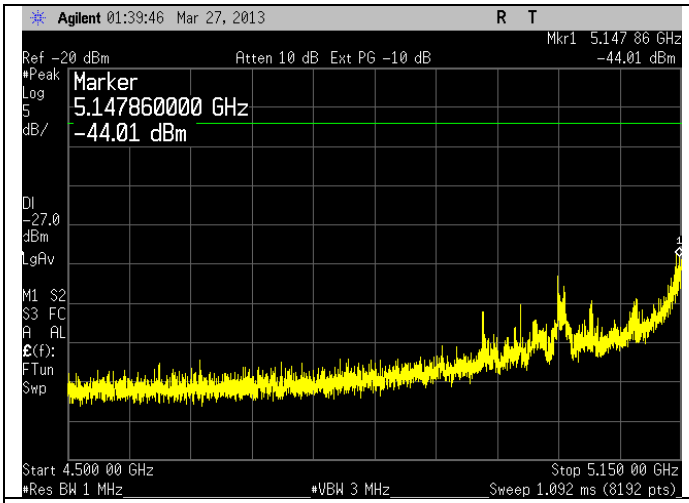
Channel 36



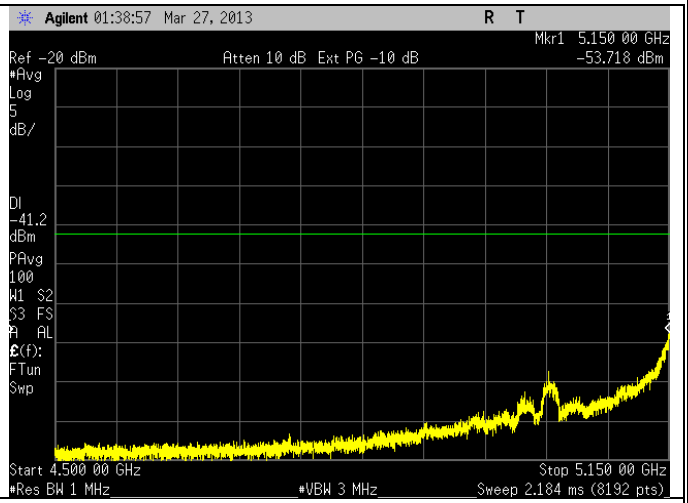
24 Mbps Peak



24 Mbps Average



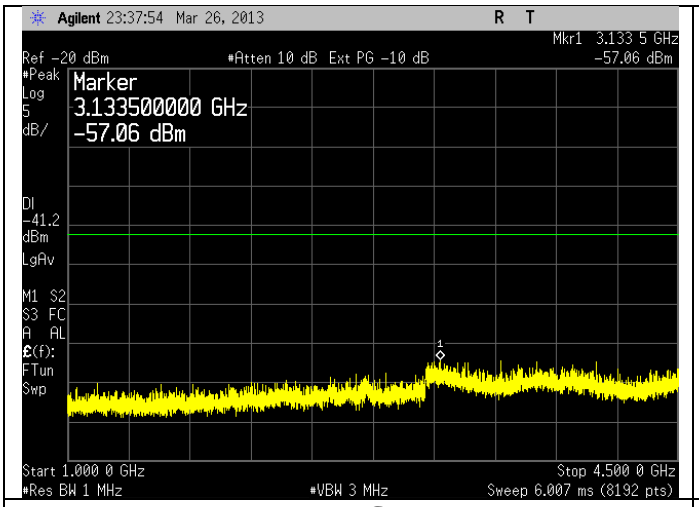
MCS7 Peak



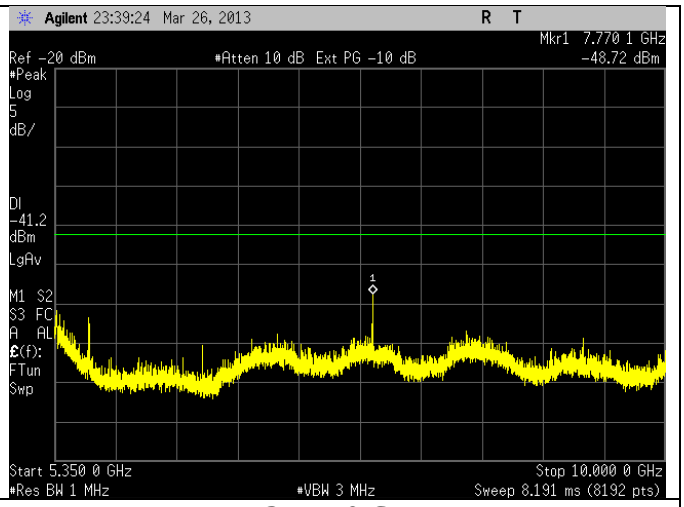
MCS7 Average

Plots – Spurious

Channel 36

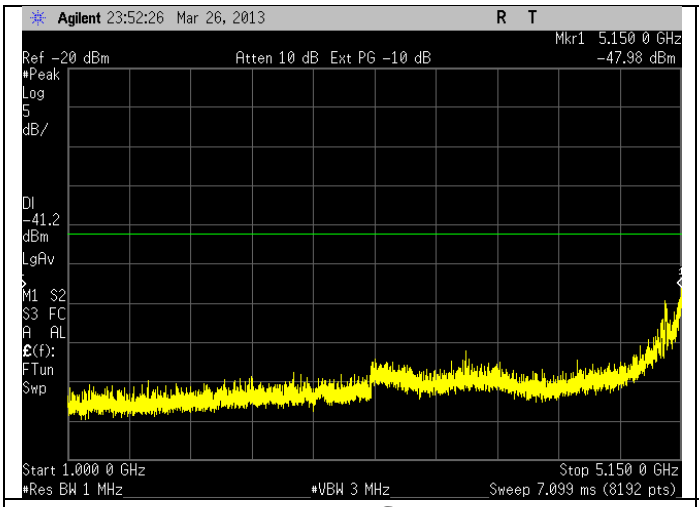


1 – 4.5 GHz

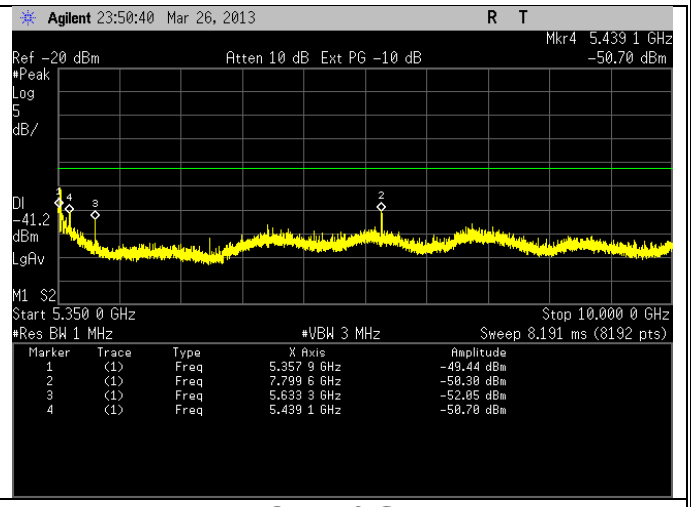


5.35 – 10 GHz

Channel 40

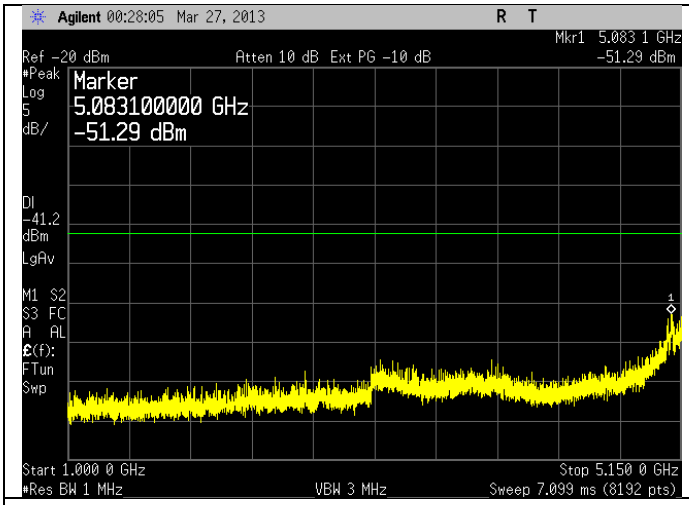


1 – 5.15 GHz

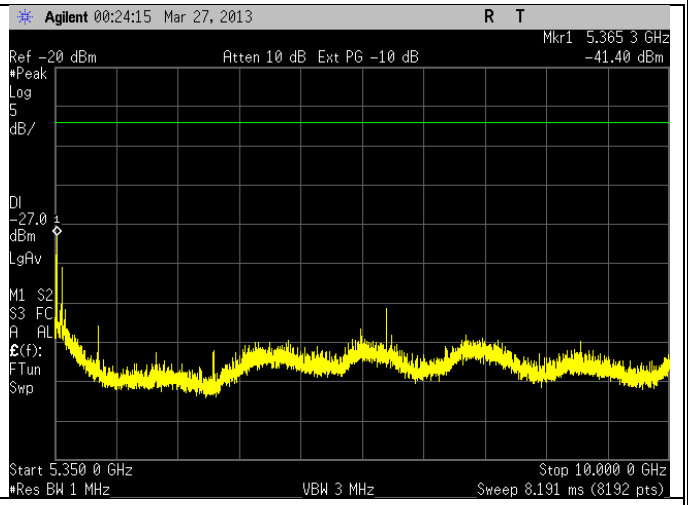


5.35 – 10 GHz

Channel 48

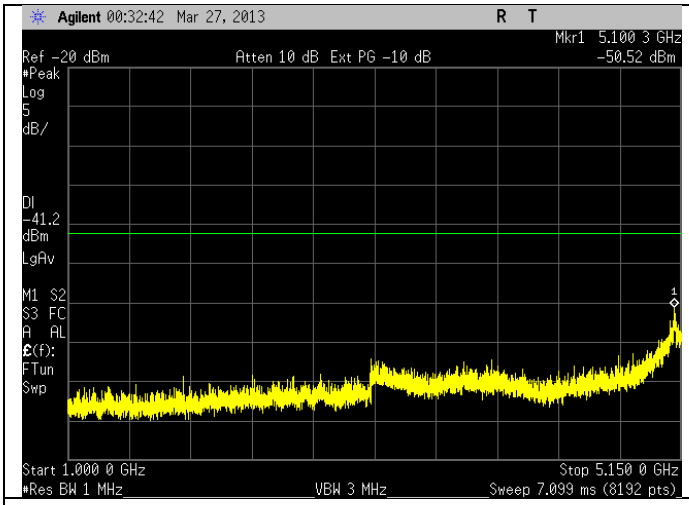


1 – 5.15 GHz

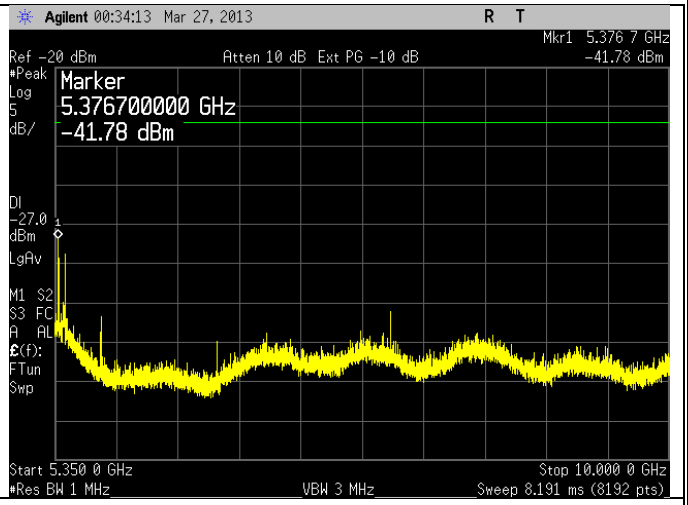


5.35 – 10 GHz

Channel 52

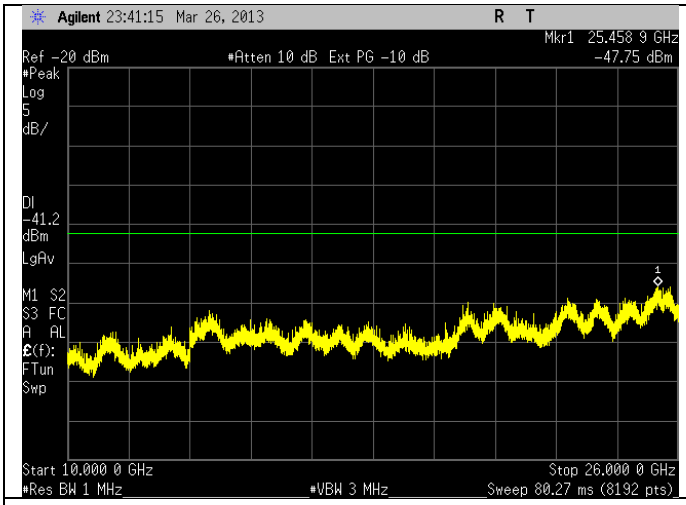


1 – 5.15 GHz

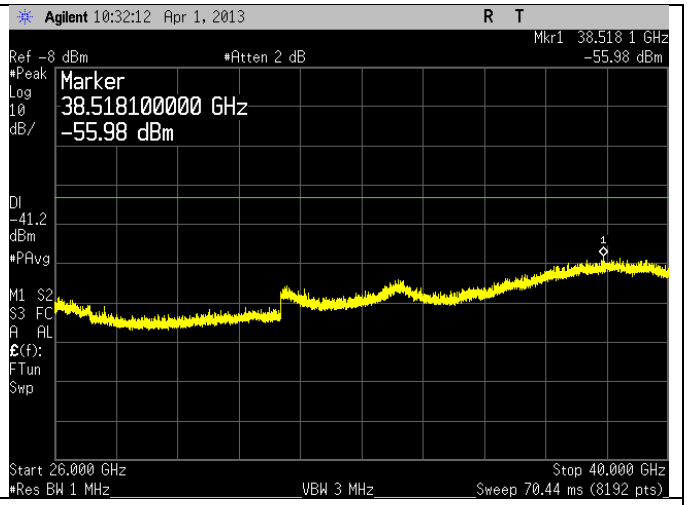


5.35 – 10 GHz

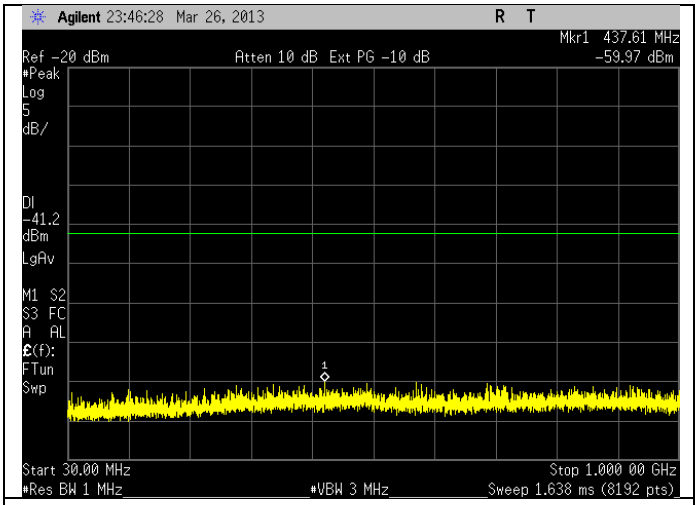
Plots – Spurious



10 – 26 GHz



26 – 44 GHz



30-1000 MHz

B.1.3 – Operation in the 5.25 – 5.35 GHz Band

Manufacturer	LS Research
Date	3-27, 4-1 2013
Operator	Adam A
Temp. / R.H.	20 - 25º C / 30-60% R.H.
Rule Part	FCC Part 15.407 (a)(2) / RSS-210 A9.2 (2)
Specific Measurement Procedure	FCC KDB 789033 Section C) Method SA-1 and SA-2 – Output Power FCC KDB 789033 Section D) – Emission bandwidth FCC KDB 789033 Section C) – Peak power spectral density (PPSD)
Additional Description of Measurement	Output Power Method SA-1 used for modes 6 and 12 Mbps Method SA-2 used for modes 24 Mbps and MCS7
Additional Notes	1) Channel 52 lies in 5.25-5.35 GHz band however per 15.407(b) (2) must meet all applicable requirements of 5.15-5.25 GHz band therefore reported previous section. 2) Duty cycle added to 25 Mbps and MCS7 measurements. 3) Per Industry Canada email to TCB date 3-6-2012 FCC KDB 789033 can be used for measurements (26 dB EBW used for output power calculation)

Duty Cycle Calculations

Sample Calculation:
Analyzer data Power (dBm) + duty cycle (dB) = Power (dBm)
Analyzer data PPSD (dBm/MHz) + duty cycle (dB) = PPSD (dBm/MHz)
Power = 13.48 (dBm) analyzer + 0.15 (dB for 24 Mbps) = 13.63 (dBm) reported

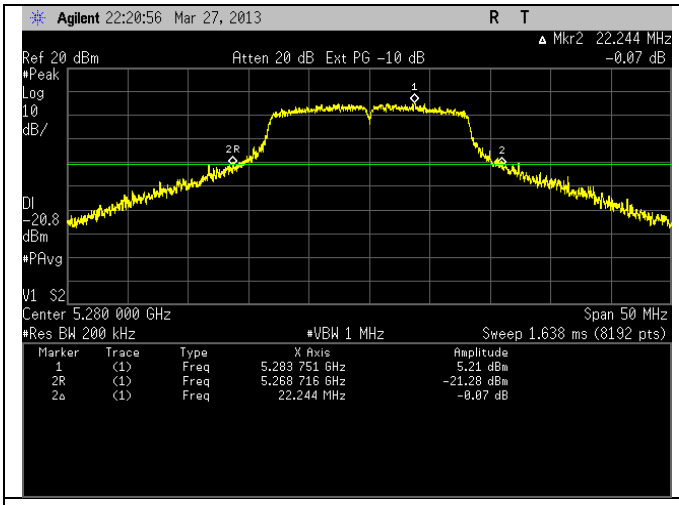
Mode	Duty Cycle (percent)	Correction (dB)
6 Mbps	99.1	none
12 Mbps	98.2	none
24 Mbps	96.6	0.15
MCS7	91.5	0.38

Operation in the Band 5.25 – 5.35 GHz

Data Rate	Channel	Frequency (MHz)	EBW 26dB (MHz)	Power (dBm)	Power Limit (dBm)	Power Margin (dB)	PPSD (dBm)	PPSD Limit (dBm)	PPSD Margin (dB)
6 Mbps	56	5280	22.20	15.31	24	8.69	5.09	11	5.91
	60	5300	22.30	15.44	24	8.56	5.52	11	5.48
	64	5320	22.40	15.38	24	8.62	5.21	11	5.79
12 Mbps	56	5280	21.86	15.36	24	8.64	5.12	11	5.88
	60	5300	21.60	15.39	24	8.61	5.24	11	5.76
	64	5320	22.30	15.40	24	8.60	5.30	11	5.70
24 Mbps	56	5280	21.90	15.45	24	8.55	5.37	11	5.63
	60	5300	21.49	15.41	24	8.59	5.32	11	5.68
	64	5320	22.20	15.48	24	8.52	5.49	11	5.51
MCS7	56	5280	21.50	12.53	24	11.47	1.81	11	9.19
	60	5300	21.80	12.26	24	11.74	1.08	11	9.92
	64	5320	21.80	12.46	24	11.54	1.42	11	9.58

Plots – 6 Mbps

Channel 56 – 5280 MHz



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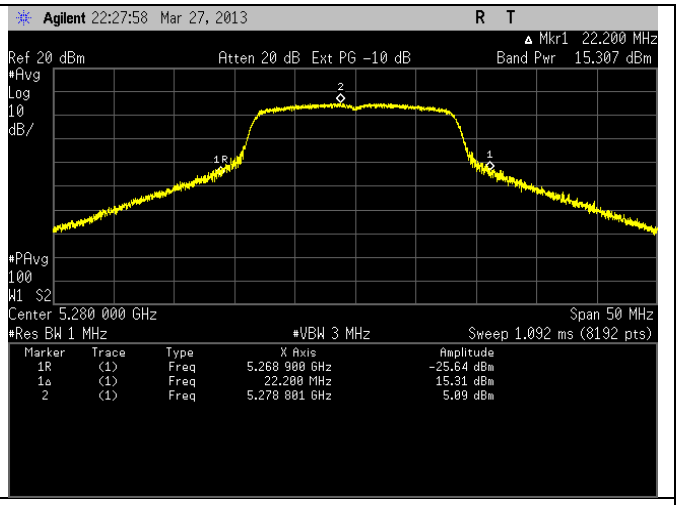
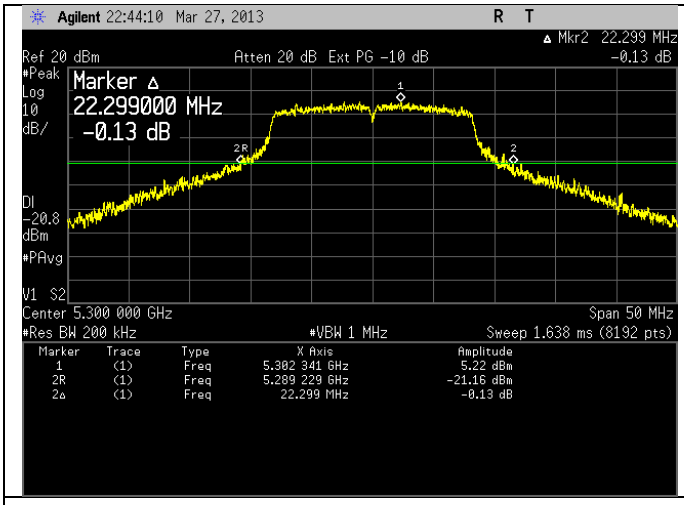
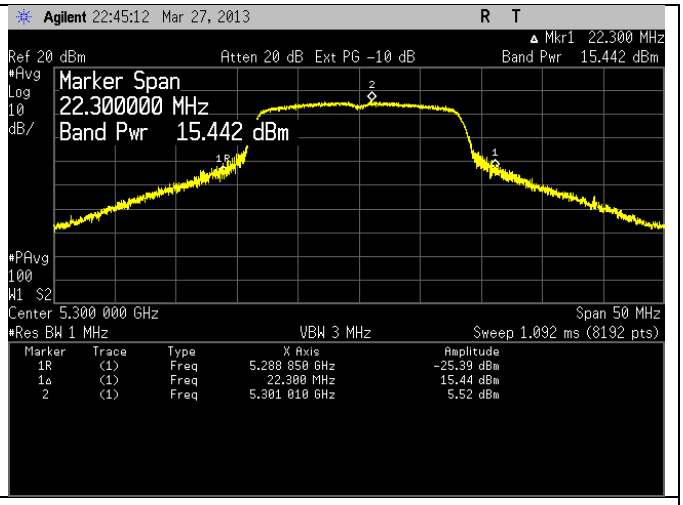


Power and PPSD

Channel 60 – 5300 MHz

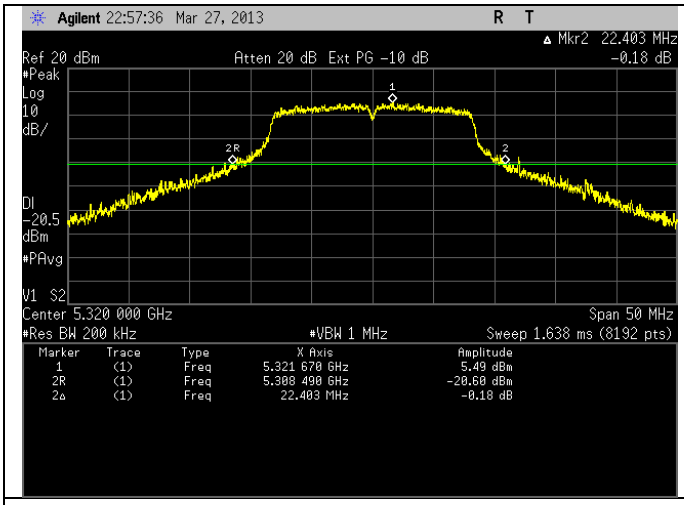


EBW



Power and PPSD

Channel 64 – 5320 MHz



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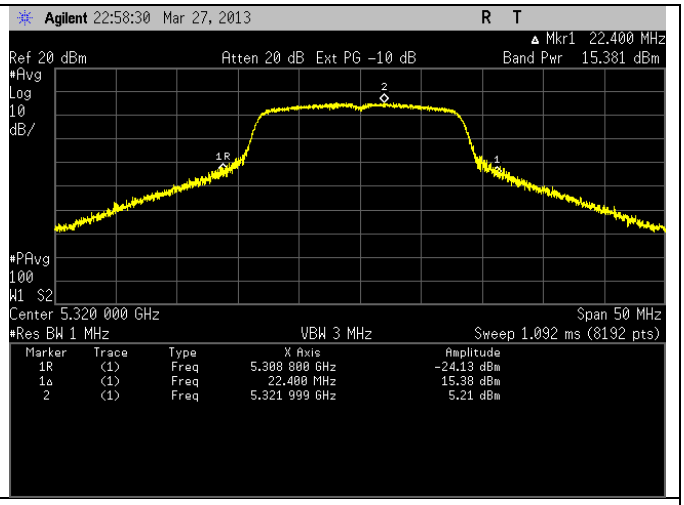
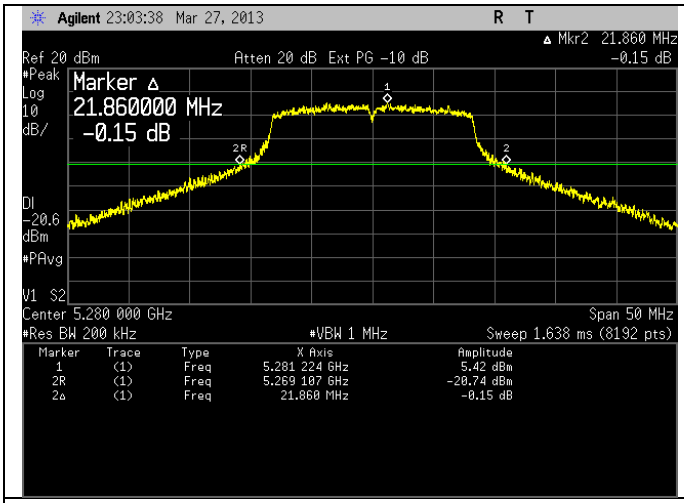


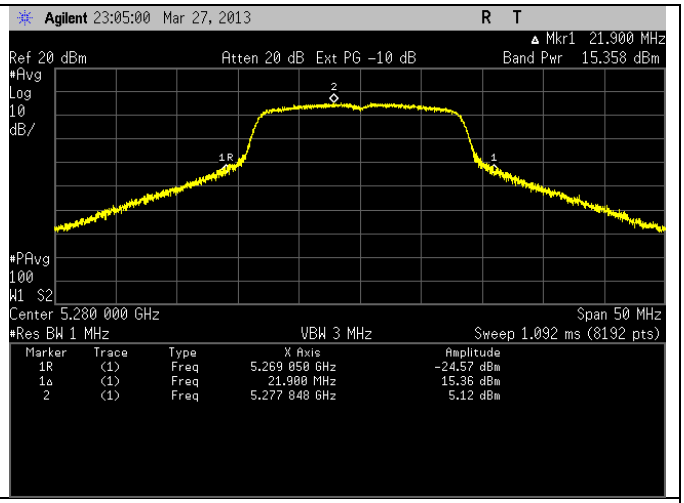
Power and PPSD

Plots – 12 Mbps

Channel 56 – 5280 MHz

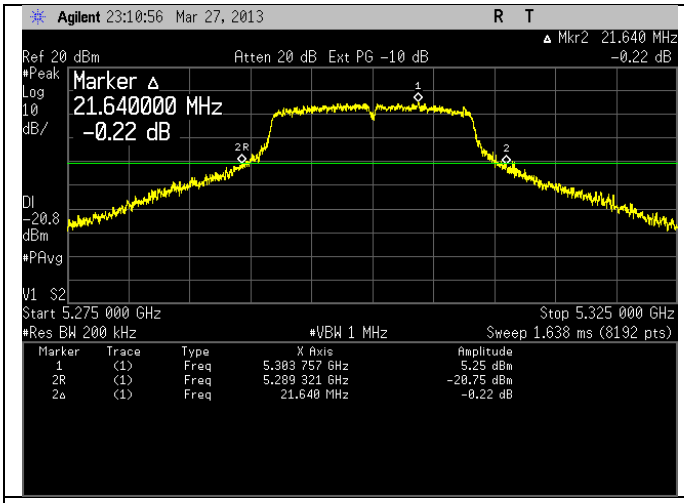


EBW



Power and PPSD

Channel 60 – 5300 MHz



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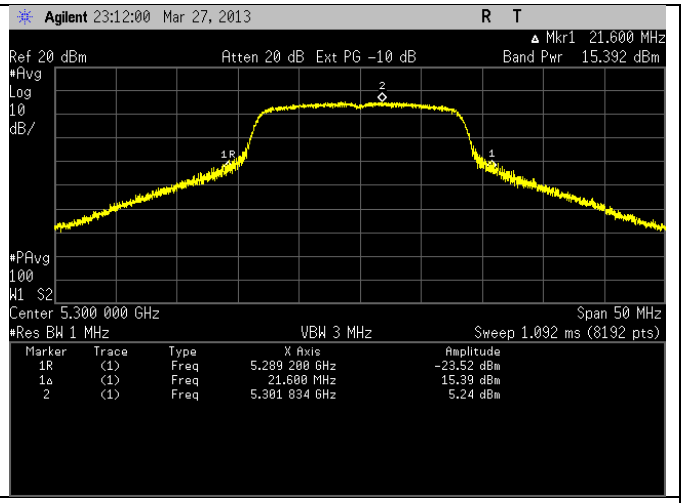
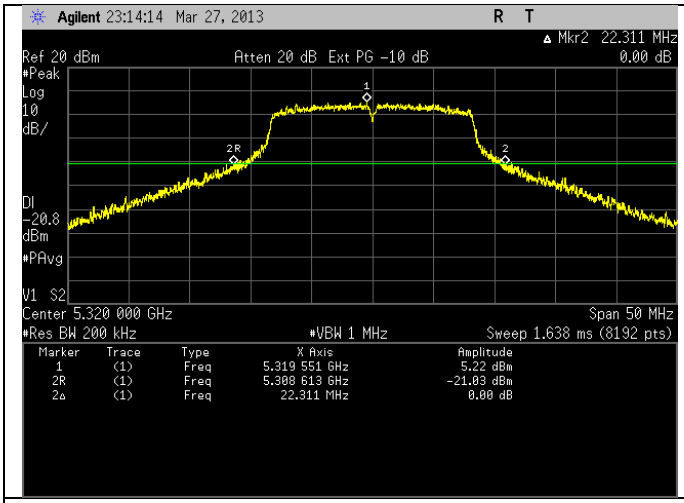
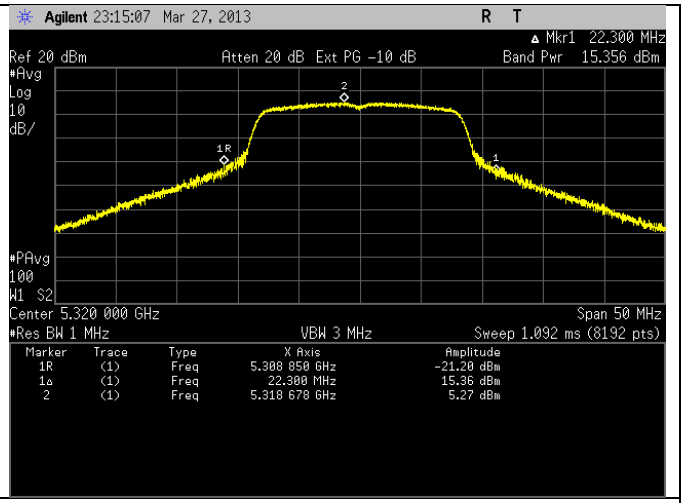


Power and PPSD

Channel 64 – 5320 MHz



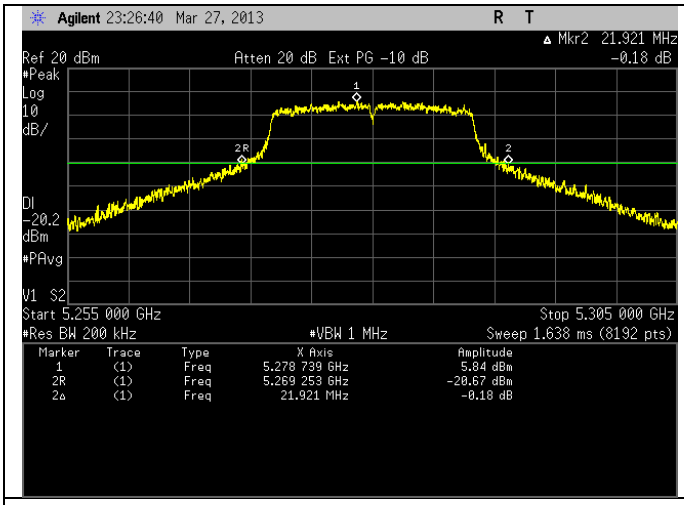
EBW

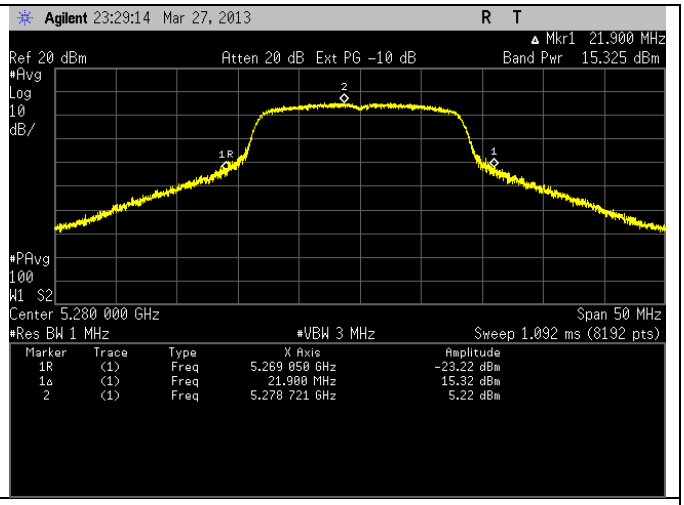


Power and PPSD

Plots – 24 Mbps

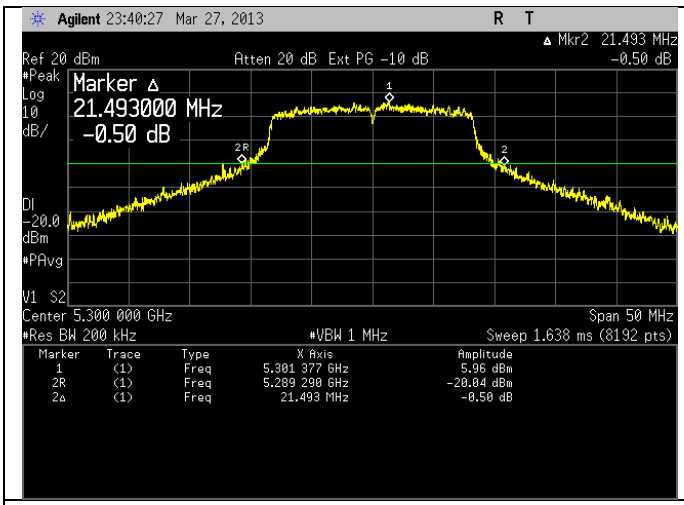
Channel 56 – 5280 MHz

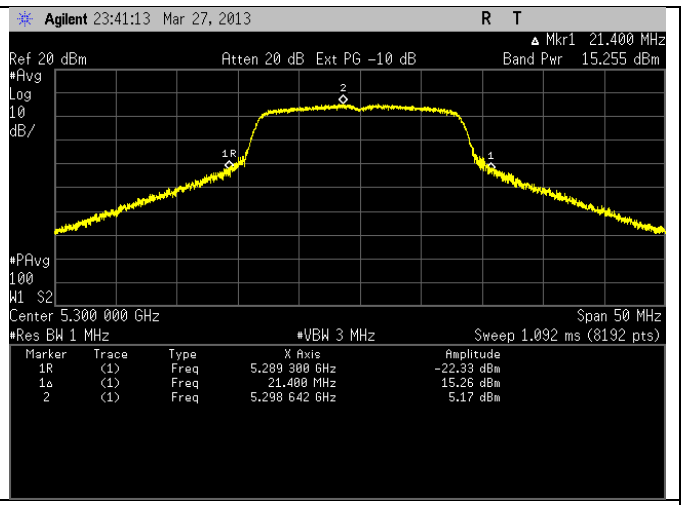




EBW	Power and PPSD

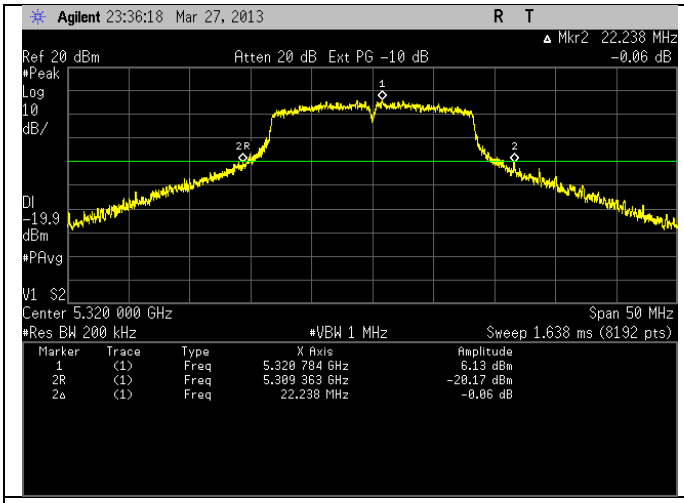
Channel 60 – 5300 MHz



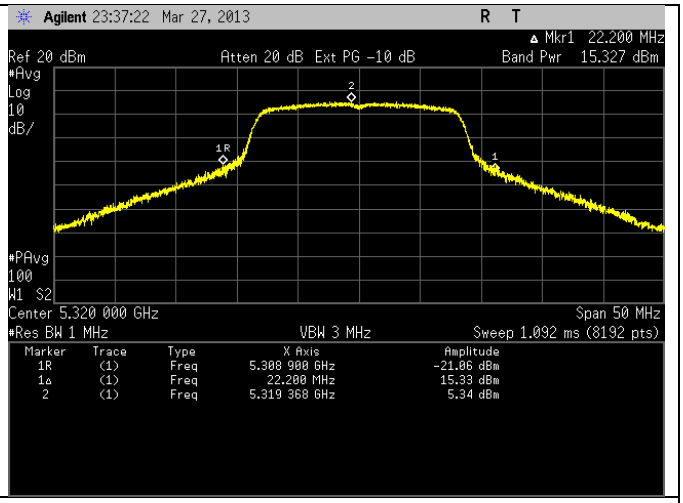


EBW	Power and PPSD

Channel 64 – 5320 MHz



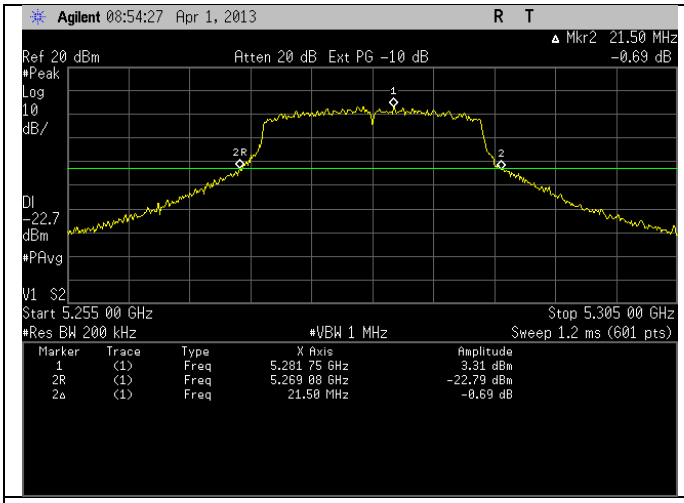
EBW



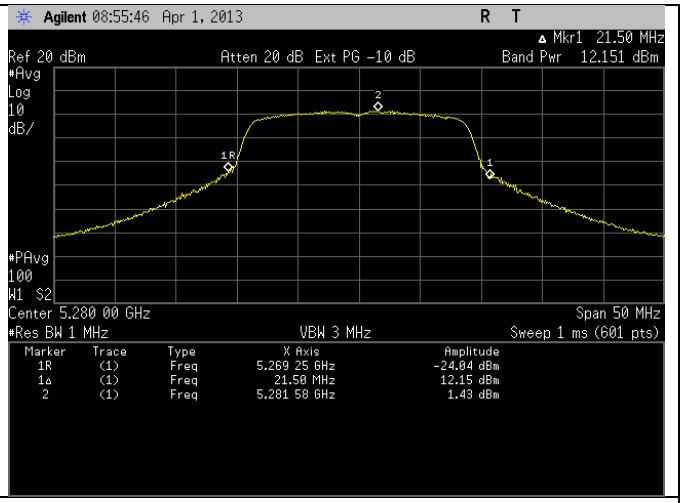
Power and PPSD

Plots – MCS7

Channel 56 – 5280 MHz

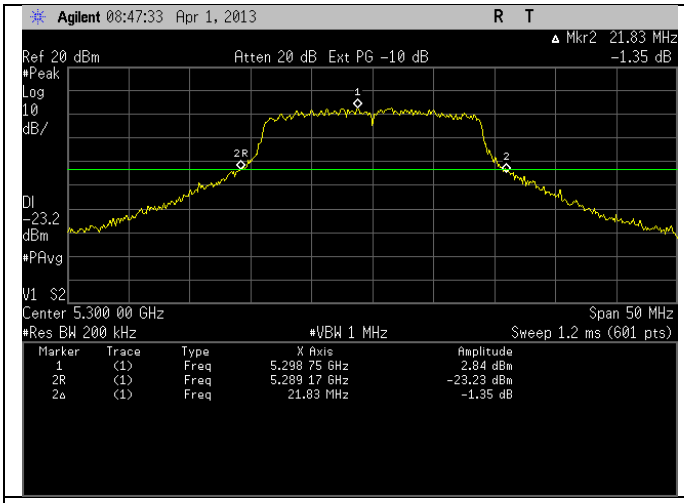


EBW

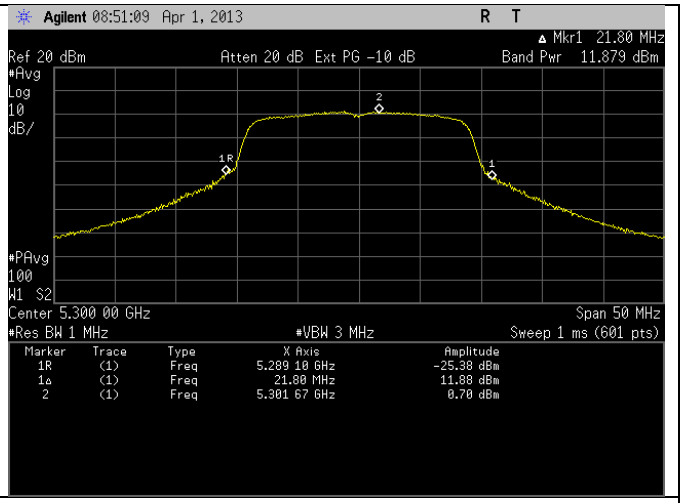


Power and PPSD

Channel 60 – 5300 MHz

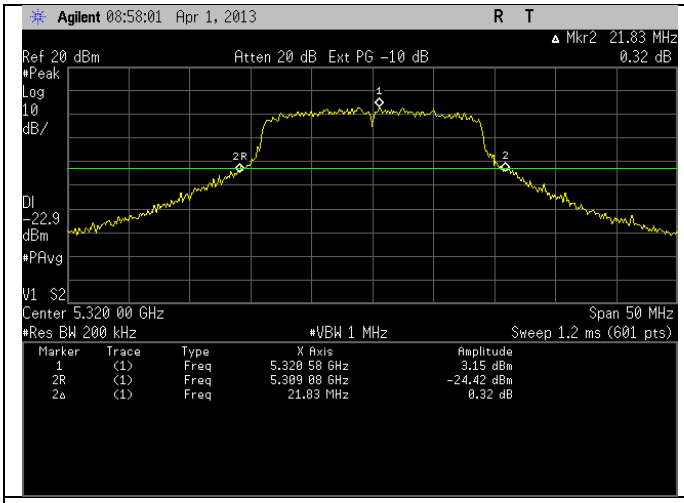


EBW

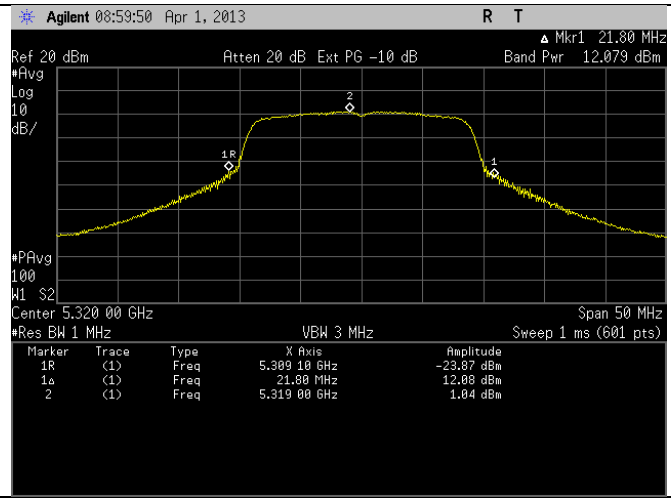


Power and PPSD

Channel 64 – 5320 MHz



EBW



Power and PPSD

B.1.3.1 – Operation in the 5.25 – 5.35 GHz Band (Undesirable Emissions)

Manufacturer	LS Research
Date	2-8, 3-27, 4-1 2013
Operator	Adam A
Temp. / R.H.	20 - 25º C / 30-60% R.H.
Rule Part	15.407 (b) (1) / RSS-210 A9.2 (1)
Specific Measurement Procedure	FCC KDB 789033 Section G) 5) – Peak measurements above 1000 MHz FCC KDB 789033 Section G) 6) – Method AD - Average measurements above 1000 MHz
Additional Description of Measurement	Per 15.407(b) and KDB 789033 Section G) 2) c), RF Conducted measurements of out-of-band emissions that comply with average (-41.2 dBm/MHz) and peak (-21.2 dBm/MHz) limits of 15.209 are satisfactory for showing compliance with 15.407(b) limit of -27 dBm/MHz. Data reported shows peak measurements with max antenna gain and duty cycle correction (if applicable) meeting more stringent peak limit of -27 dBm/MHz as well as average limit (-41.2 dBm/MHz)
Additional Notes	1) Channel 52 lies in 5.25-5.35 GHz band however per 15.407(b) (2) must meet all applicable requirements of 5.15-5.25 GHz band therefore reported in previous section. 2) Duty cycle added to 25 Mbps and MCS7 measurements. 3) Band-edge measurements at 6, 12, 24 and MCS7 modes. 4) Worst-case out-of-band spurious reported with 6 Mbps mode. 5) Worst-case antenna gain used per KDB 789033 Section G) 3) b) (iii)

Sample Calculations:
Band-edge (dBm) + Antenna Gain (dBi) + Duty Cycle = Total (dBm)
Margin (dB) = Limit (dBm/MHz) – Total (dBm/MHz)

Lower Band-Edge Data Table (5.25 GHz)

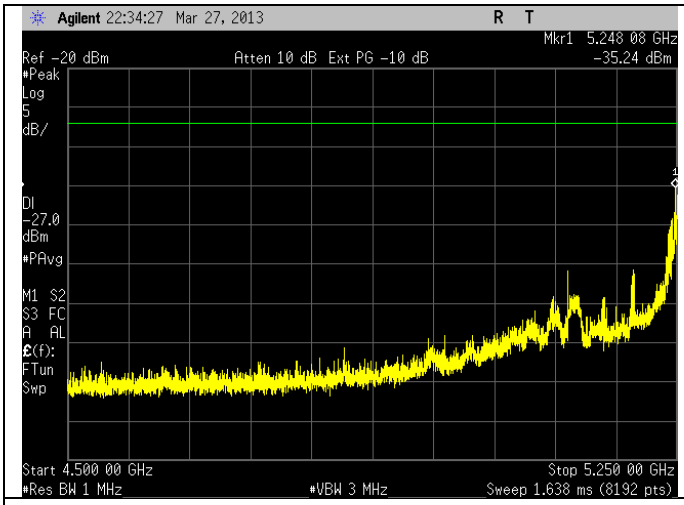
Data Rate	Band-edge (dBm)	Antenna Gain(dBi)	Duty Cycle (dB)	Total (dBm/MHz)	Limit (dBm/MHz)	Margin (dB)
6 Mbps	-35.24	2	0	-33.24	-27	6.24
12 Mbps	-33.25	2	0	-31.25	-27	4.25
24 Mbps	-35.99	2	0.15	-33.84	-27	6.84
MCS7	-37.84	2	0.38	-35.46	-27	8.46

Upper Band-Edge Data Table (5.35 GHz)

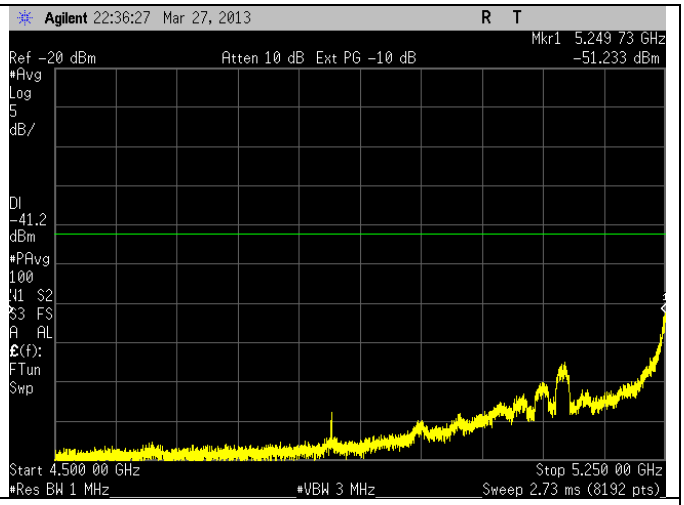
Data Rate	Band-edge (dBm)	Antenna Gain(dBi)	Duty Cycle (dB)	Total (dBm/MHz	Limit (dBm/MHz)	Margin (dB)
6 Mbps	-35.70	2	0	-33.7	-27	6.7
12 Mbps	-39.04	2	0	-37.04	-27	10.04
24 Mbps	-36.81	2	0.15	-34.66	-27	7.66
MCS7	-35.79	2	0.38	-33.41	-27	6.41

Plots – Lower Band Edge

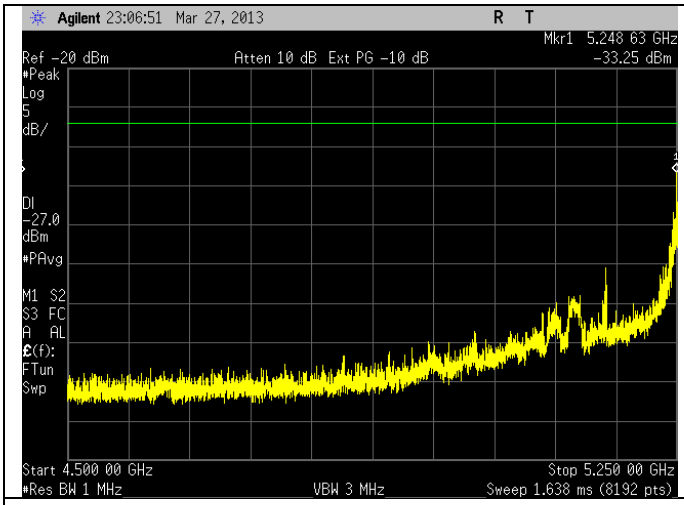
Channel 56



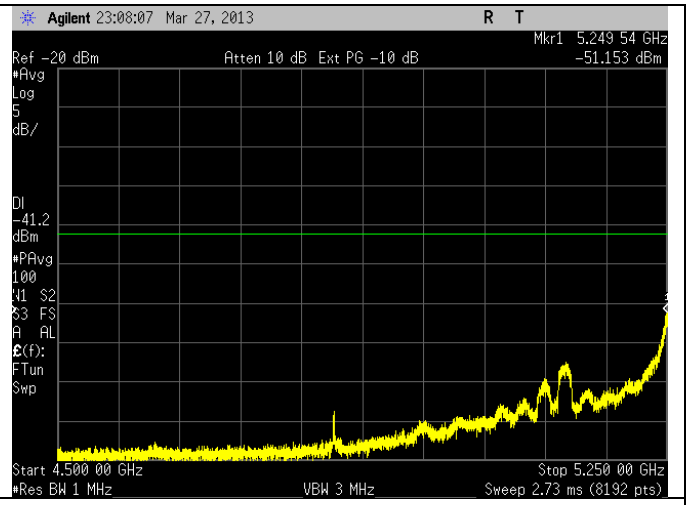
6 Mbps Peak



6 Mbps Average

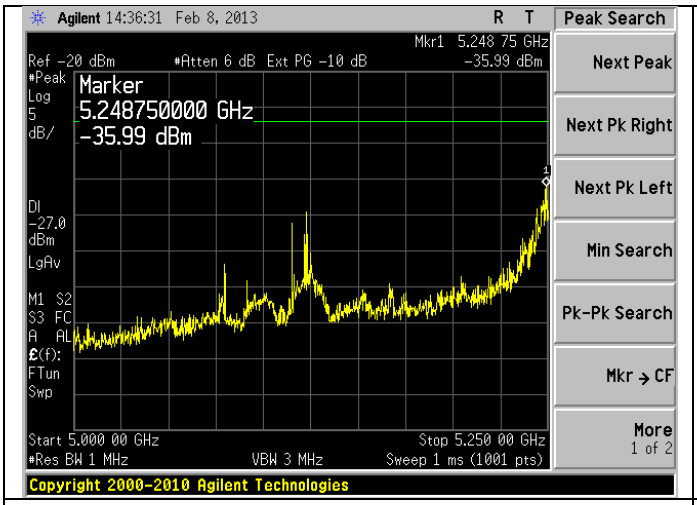


12 Mbps Peak

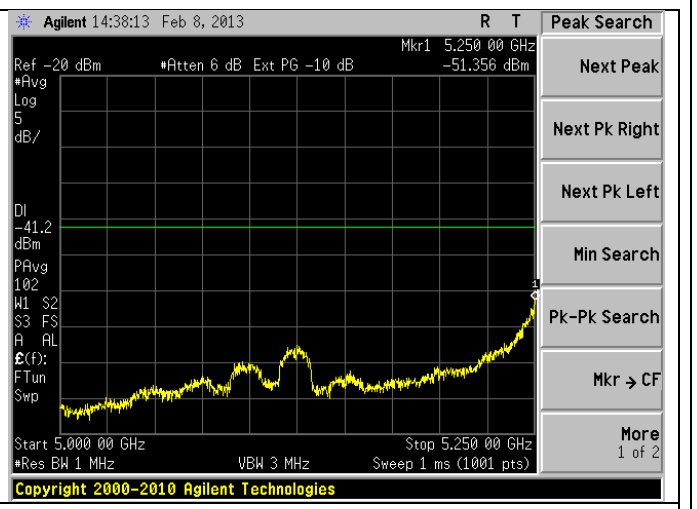


12 Mbps Average

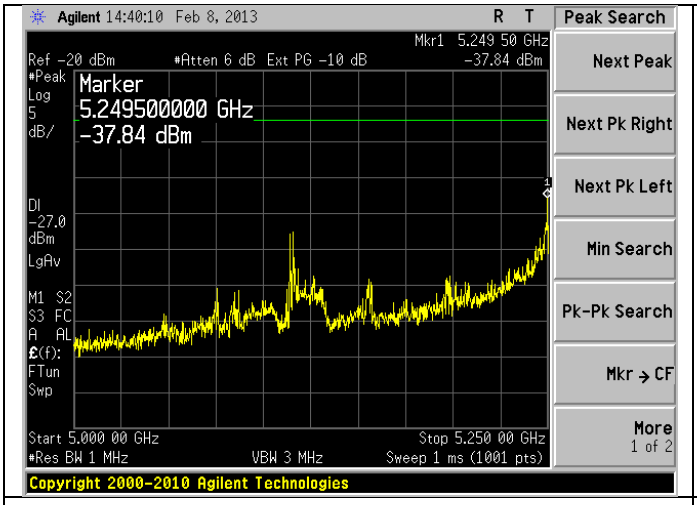
Channel 56



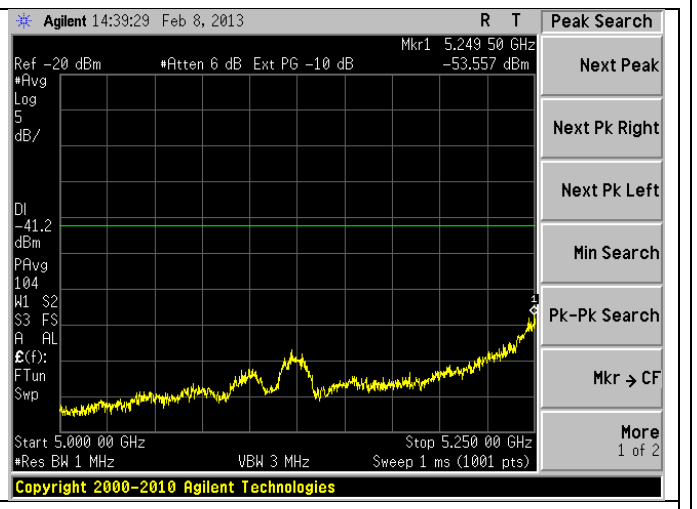
24 Mbps Peak



24 Mbps Average



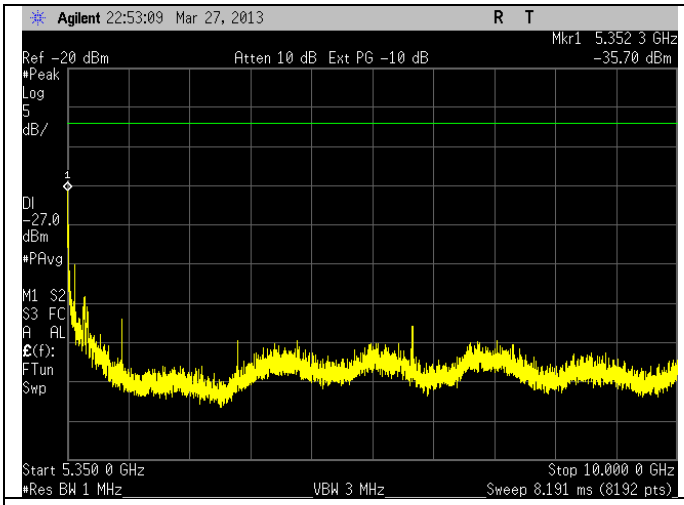
MCS7 Peak



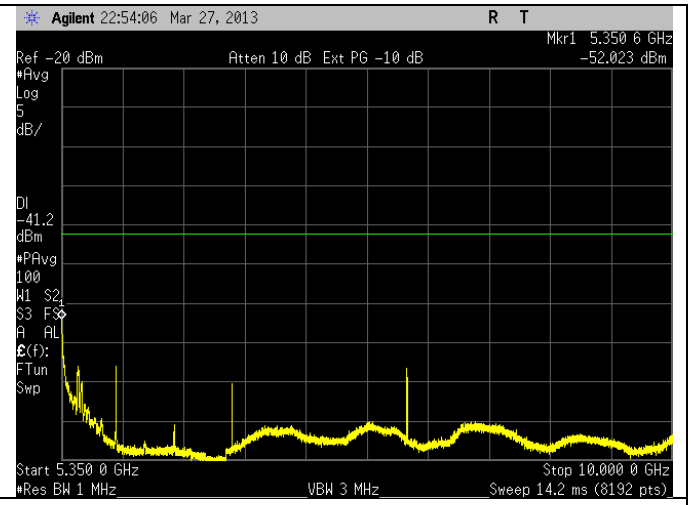
MCS7 Average

Plots – Upper Band Edge

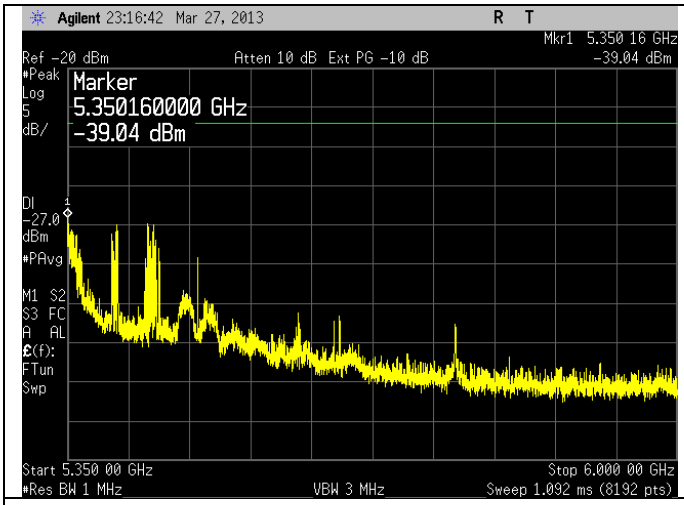
Channel 64



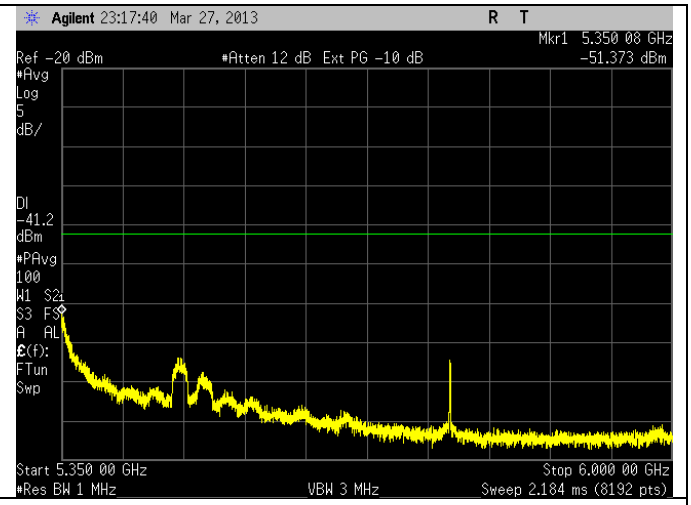
6 Mbps Peak



6 Mbps Average

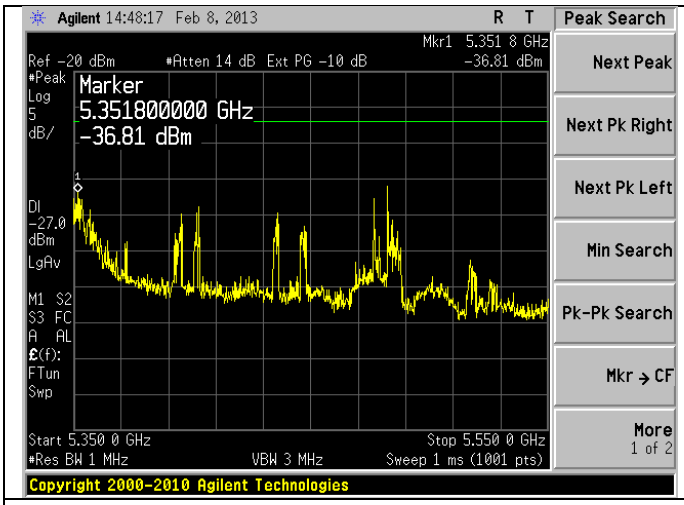


12 Mbps Peak

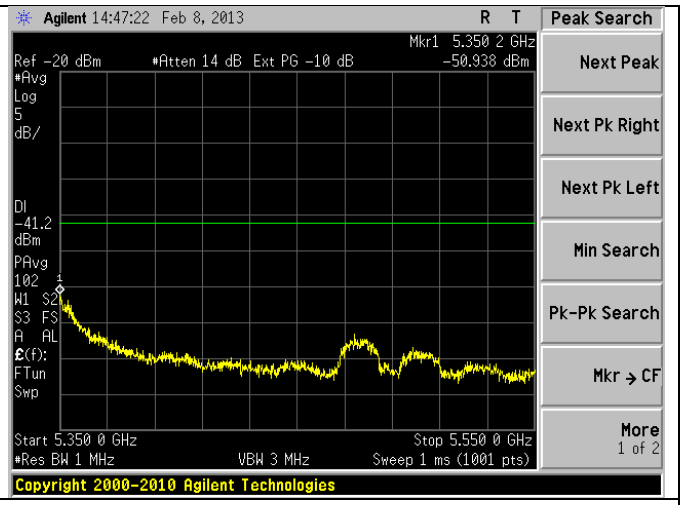


12 Mbps Average

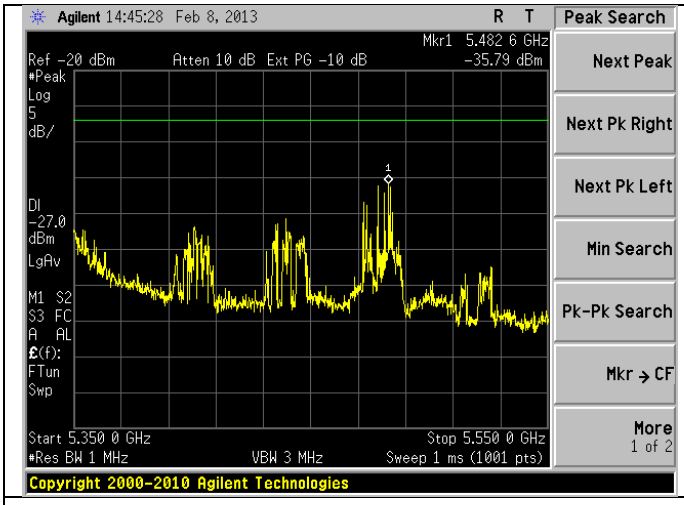
Channel 64



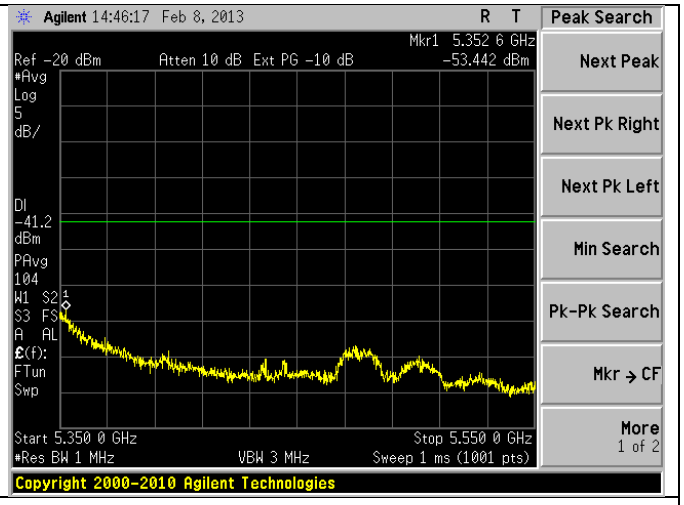
24 Mbps Peak



24 Mbps Average



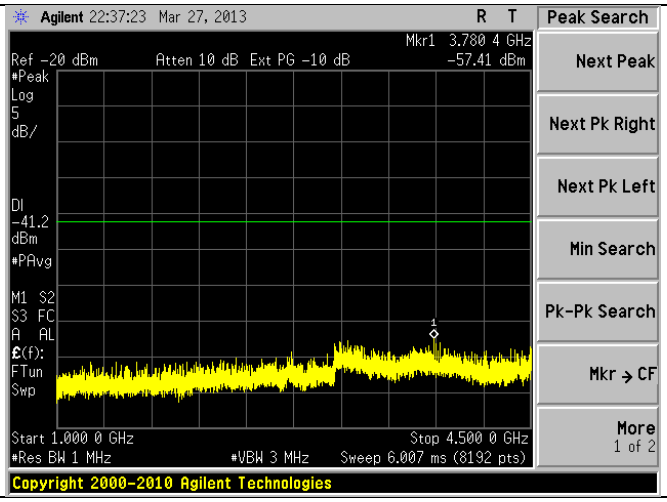
MCS7 Peak



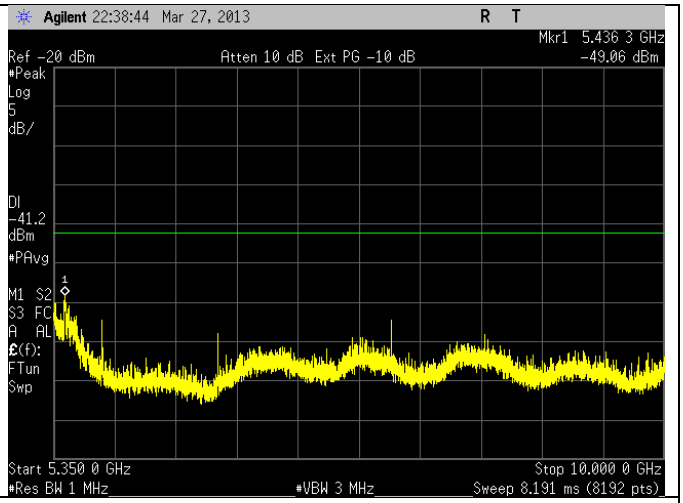
MCS7 Average

Plots – Spurious

Channel 56

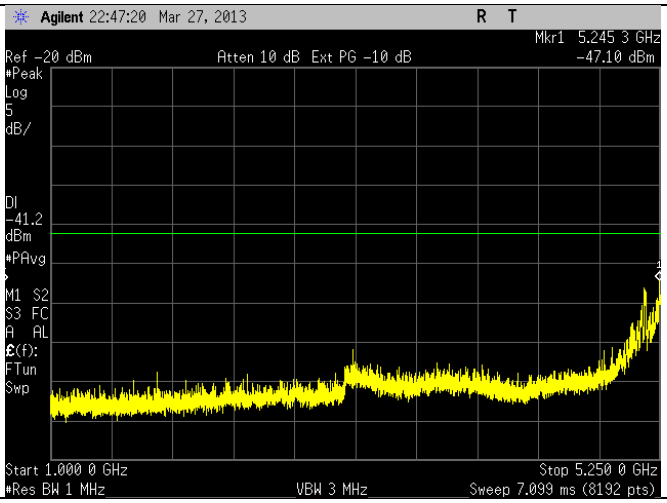


1 – 4.5 GHz

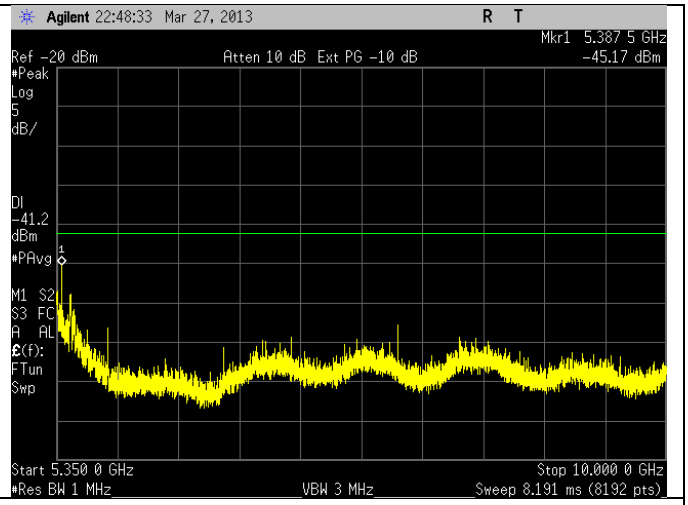


5.35 – 10 GHz

Channel 60

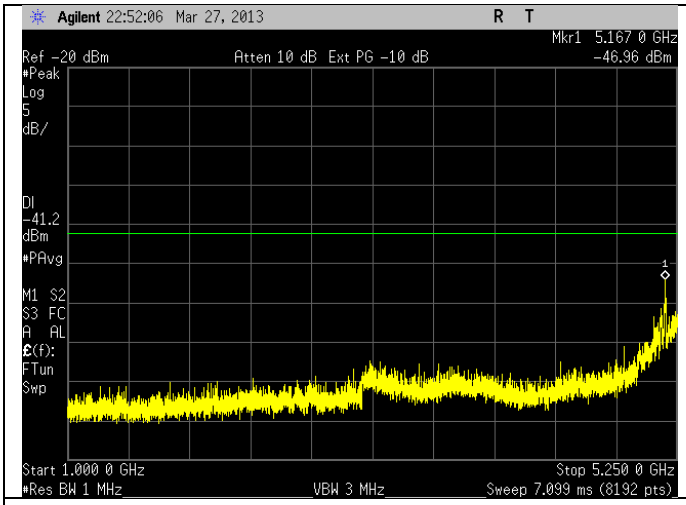


1 –5.25 GHz

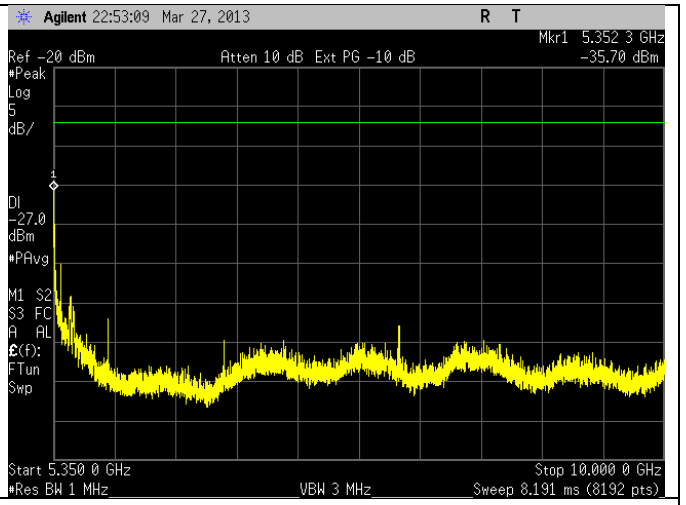


5.35 – 10 GHz

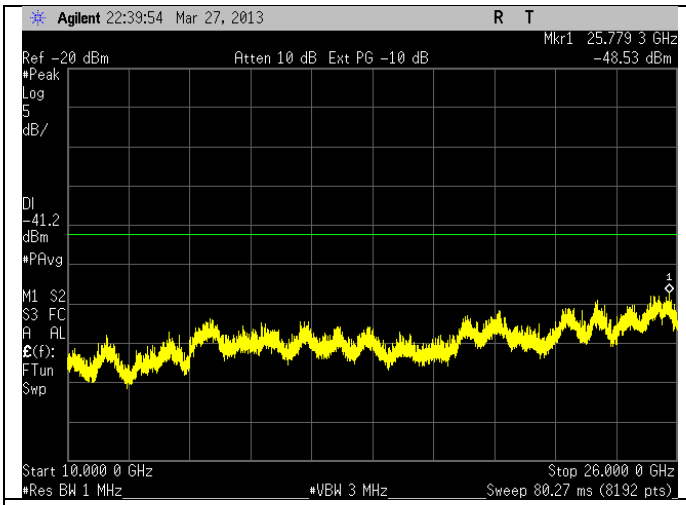
Channel 64



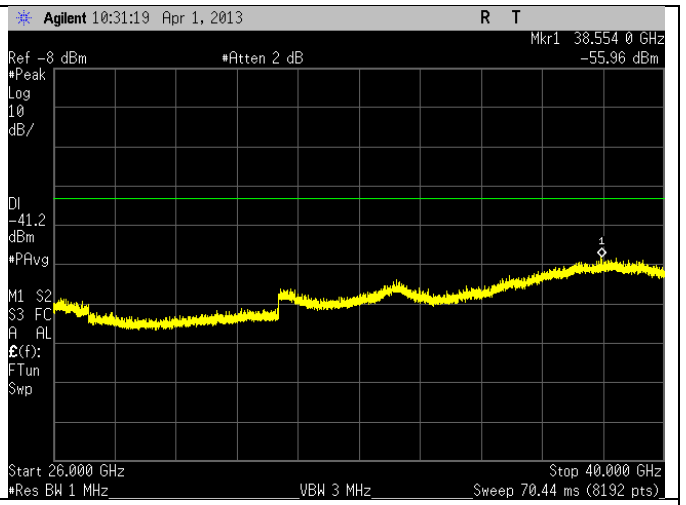
1 – 5.25 GHz



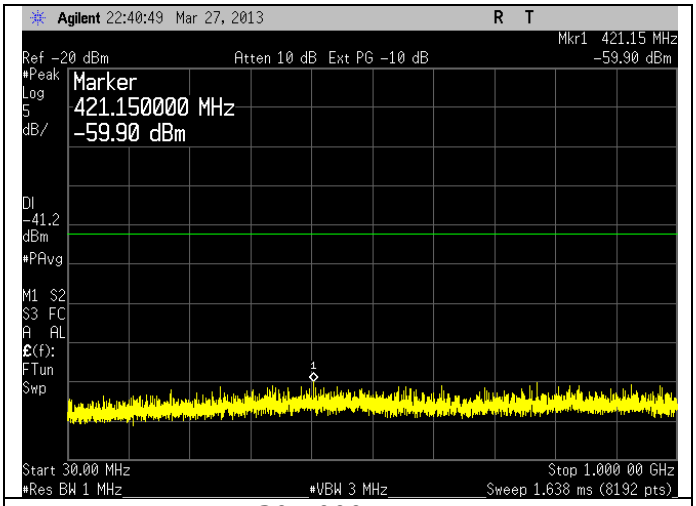
5.35 – 10 GHz



10 – 26 GHz



26 – 44 GHz



30-1000 MHz

B.1.4 – Operation in the 5.47 – 5.725 GHz Band

Manufacturer	LS Research
Date	3-28, 4-1 2013
Operator	Adam A
Temp. / R.H.	20 - 25º C / 30-60% R.H.
Rule Part	FCC Part 15.407 (a)(2) / RSS-210 A9.2 (2)
Specific Measurement Procedure	FCC KDB 789033 Section C) Method SA-1 and SA-2 – Output Power FCC KDB 789033 Section D) – Emission bandwidth FCC KDB 789033 Section C) – Peak power spectral density (PPSD)
Additional Description of Measurement	Output Power Method SA-1 used for modes 6 and 12 Mbps Method SA-2 used for modes 24 Mbps and MCS7
Additional Notes	1) Duty cycle added to 25 Mbps and MCS7 measurements. 2) Per Industry Canada email to TCB date 3-6-2012 FCC KDB 789033 can be used for measurements (26 dB EBW used for output power calculation)

Duty Cycle Calculations

Sample Calculation:
Analyzer data Power (dBm) + duty cycle (dB) = Power (dBm)
Analyzer data PPSD (dBm/MHz) + duty cycle (dB) = PPSD (dBm/MHz)
Power = 13.48 (dBm) analyzer + 0.15 (dB for 24 Mbps) = 13.63 (dBm) reported

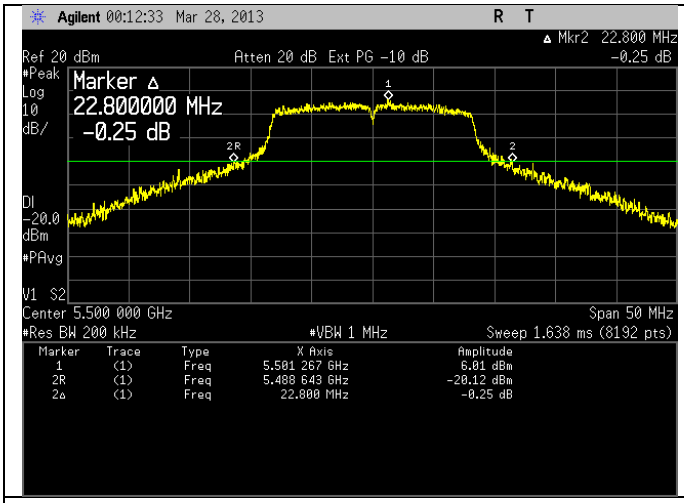
Mode	Duty Cycle (percent)	Correction (dB)
6 Mbps	99.1	none
12 Mbps	98.2	none
24 Mbps	96.6	0.15
MCS7	91.5	0.38

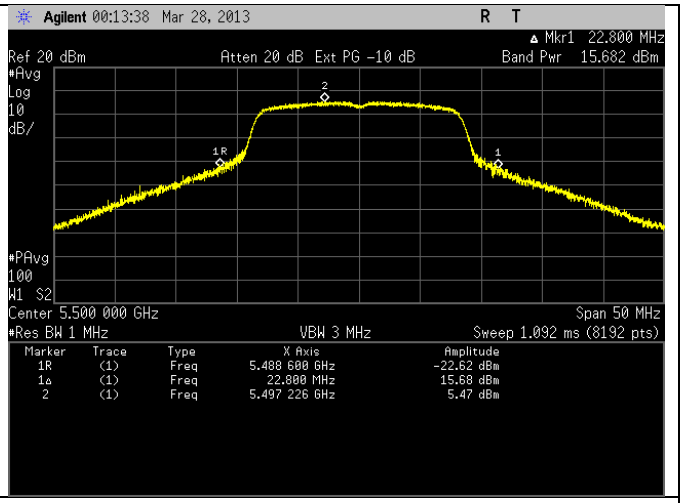
Operation in the Band 5.47 – 5.725 GHz

Data Rate	Channel	Frequency (MHz)	EBW 26dB (MHz)	Power (dBm)	Power Limit (dBm)	Power Margin (dB)	PPSD (dBm)	PPSD Limit (dBm)	PPSD Margin (dB)
6 Mbps	100	5500	22.80	15.68	24	8.32	5.47	11	5.53
	116	5580	21.30	15.60	24	8.40	5.83	11	5.17
	140	5700	22.70	15.60	24	8.40	5.33	11	5.67
12 Mbps	100	5500	22.00	15.70	24	8.30	5.68	11	5.32
	116	5580	21.80	15.64	24	8.36	5.66	11	5.34
	140	5700	23.30	15.56	24	8.44	5.74	11	5.26
24 Mbps	100	5500	22.20	15.74	24	8.26	6.24	11	4.76
	116	5580	21.20	15.54	24	8.46	5.49	11	5.51
	140	5700	21.00	15.76	24	8.24	5.77	11	5.23
MCS7	100	5500	22.30	12.89	24	11.11	2.10	11	8.90
	116	5580	22.30	12.79	24	11.21	1.94	11	9.06
	140	5700	22.30	12.44	24	11.56	1.53	11	9.47

Plots – 6 Mbps

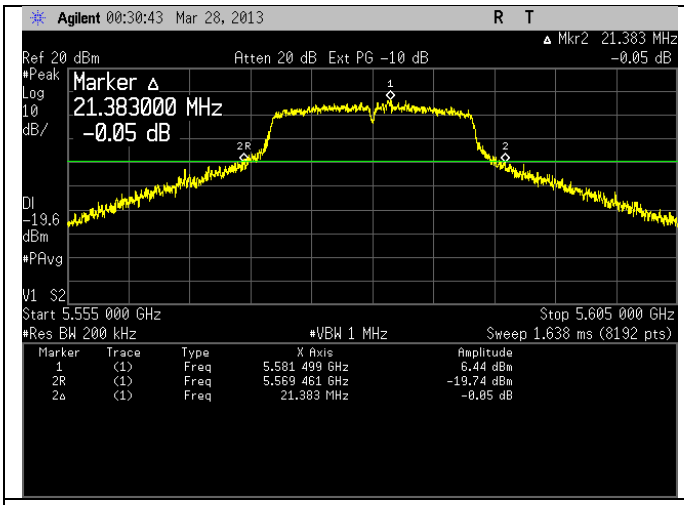
Channel 100

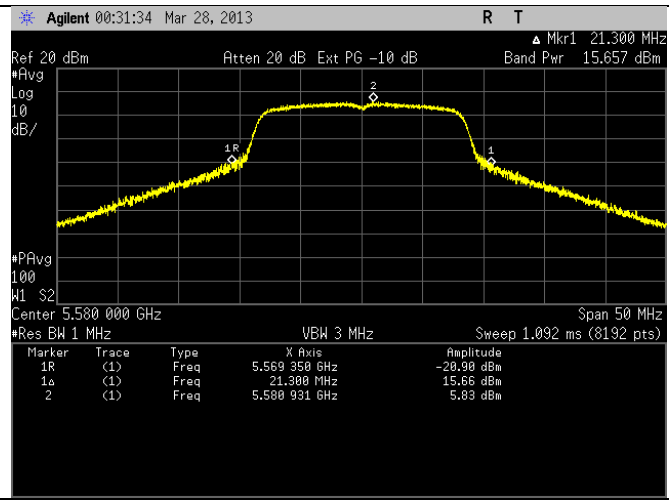




EBW	Power and PPSD

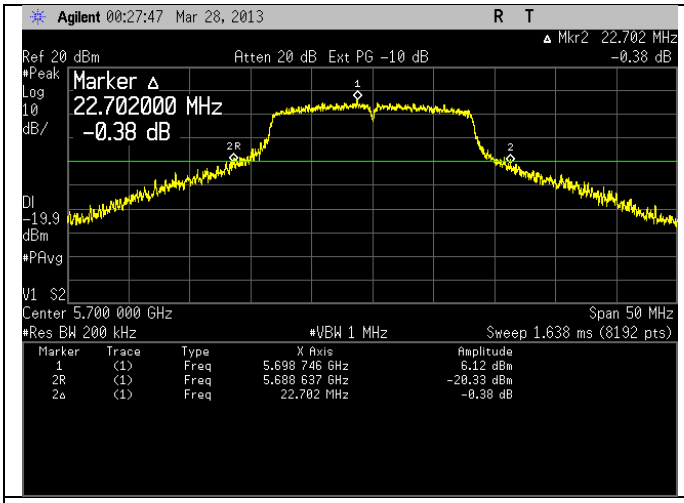
Channel 116



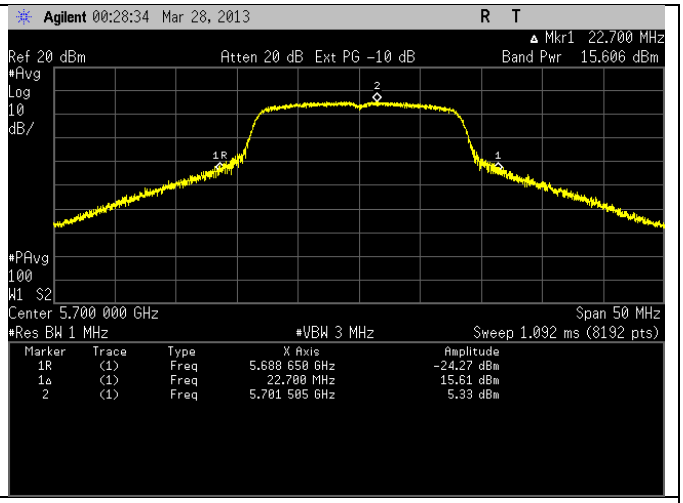


EBW	Power and PPSD

Channel 140



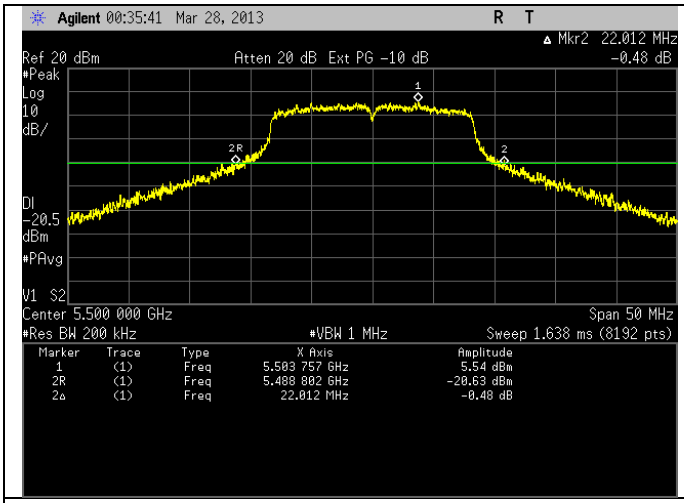
EBW



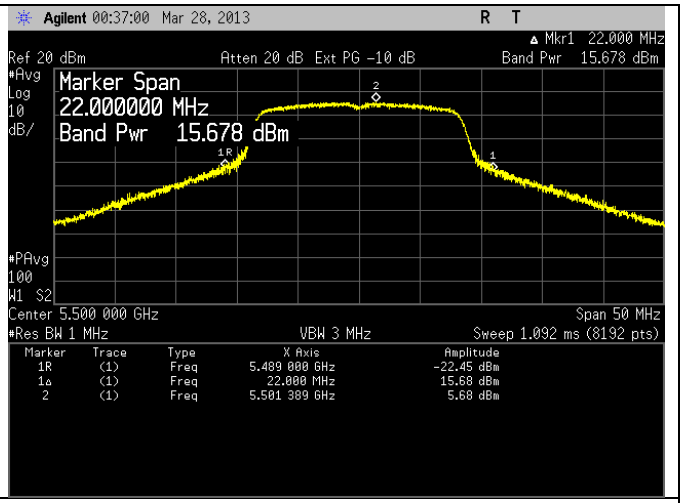
Power and PPSD

Plots – 12 Mbps

Channel 100

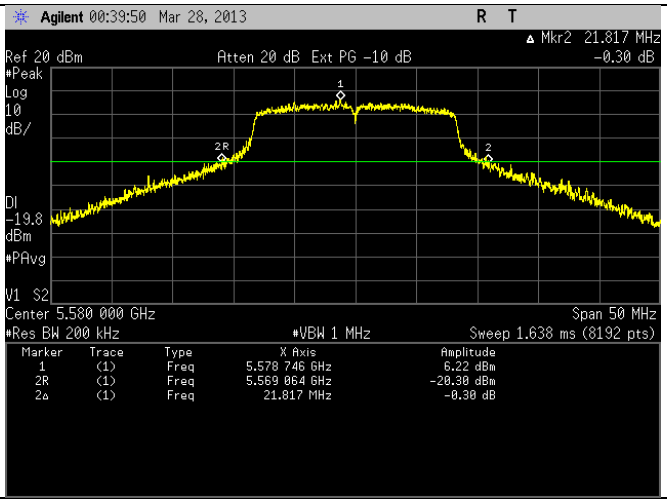


EBW

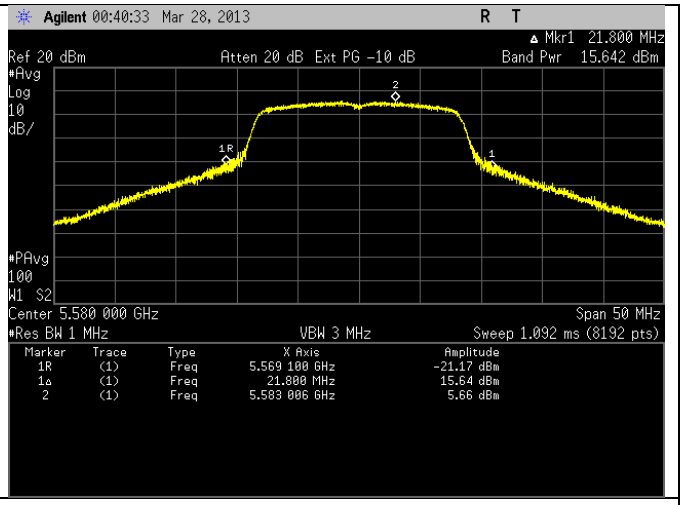


Power and PPSD

Channel 116

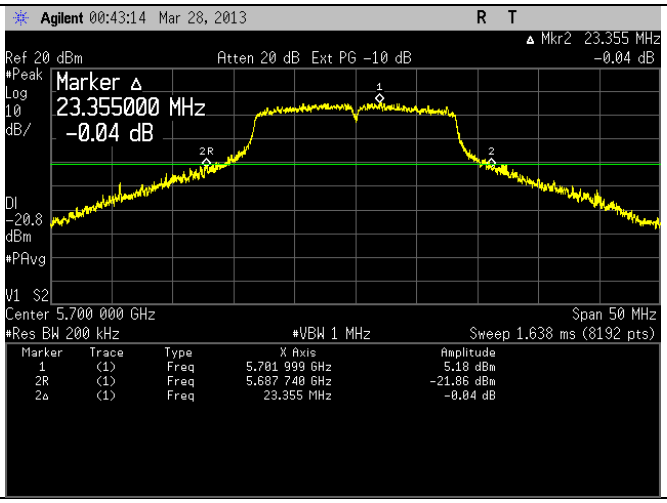


EBW

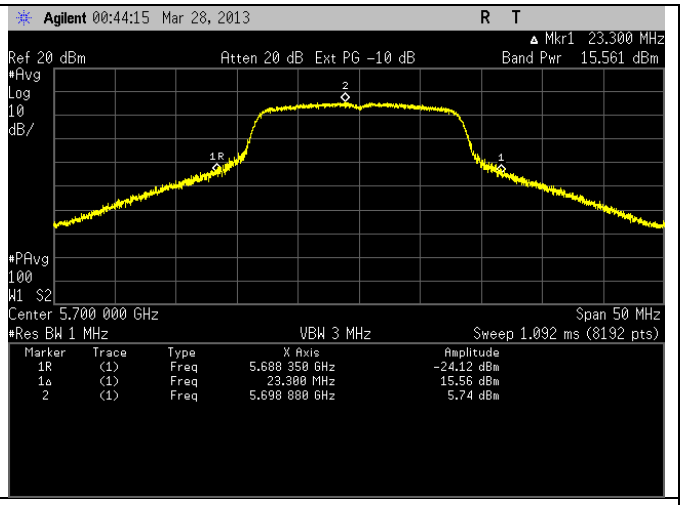


Power and PPSD

Channel 140



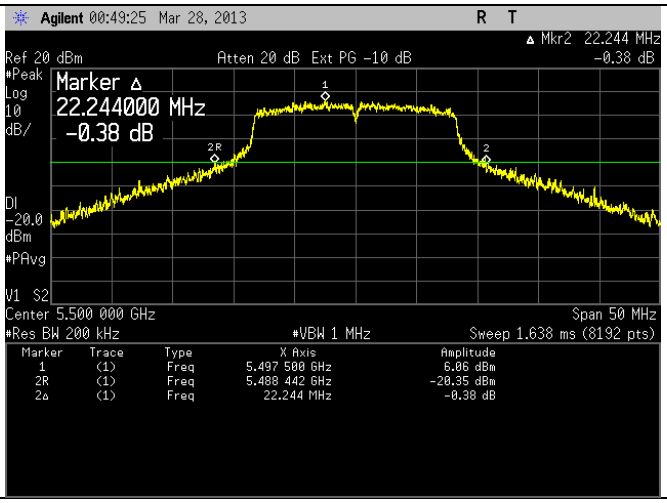
EBW

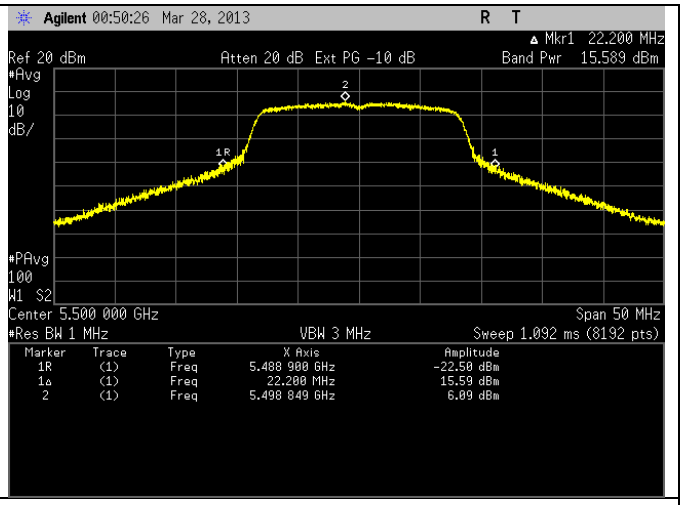


Power and PPSD

Plots – 24 Mbps

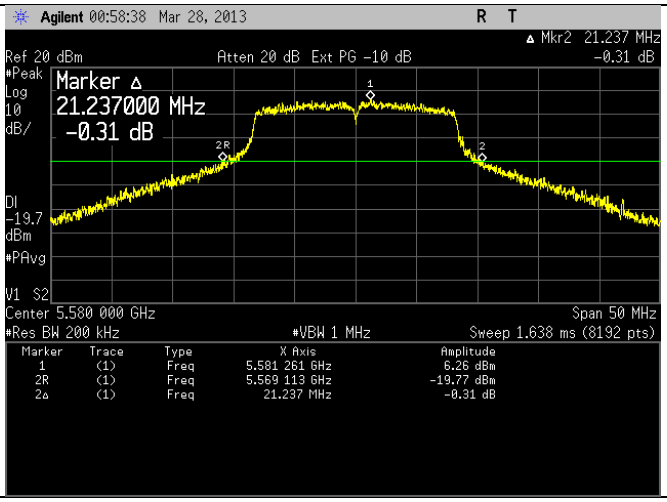
Channel 100

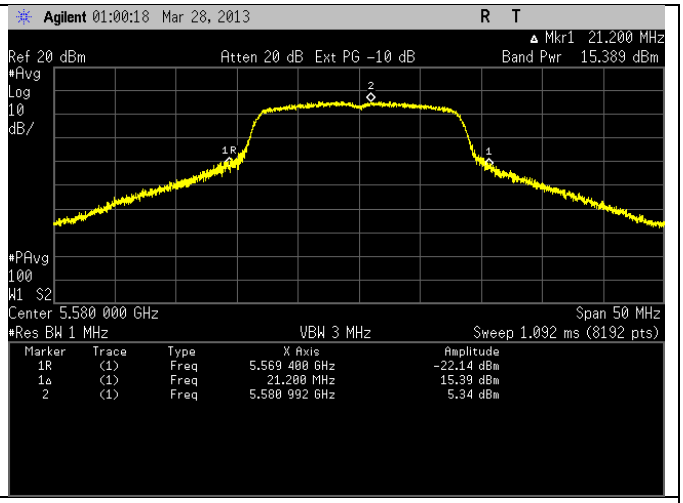




EBW	Power and PPSD

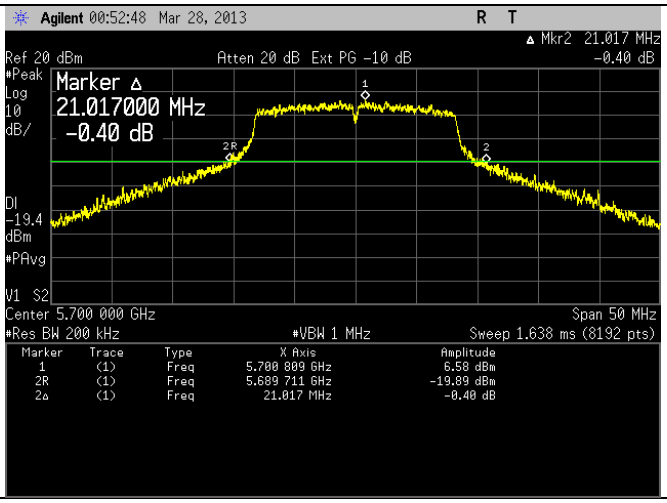
Channel 116

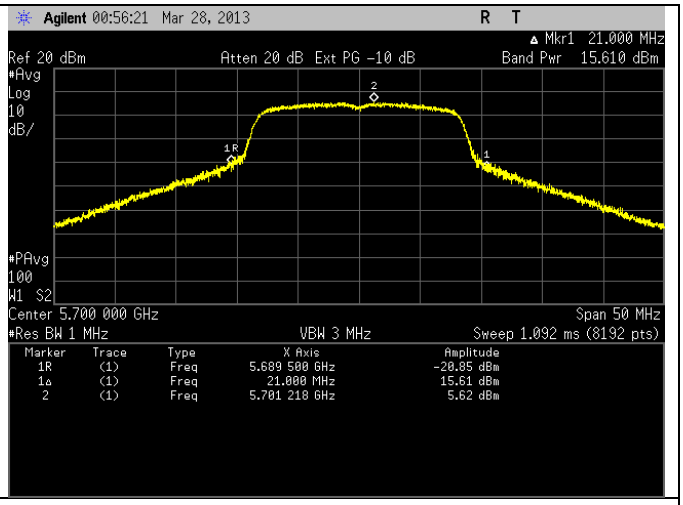




EBW	Power and PPSD

Channel 140

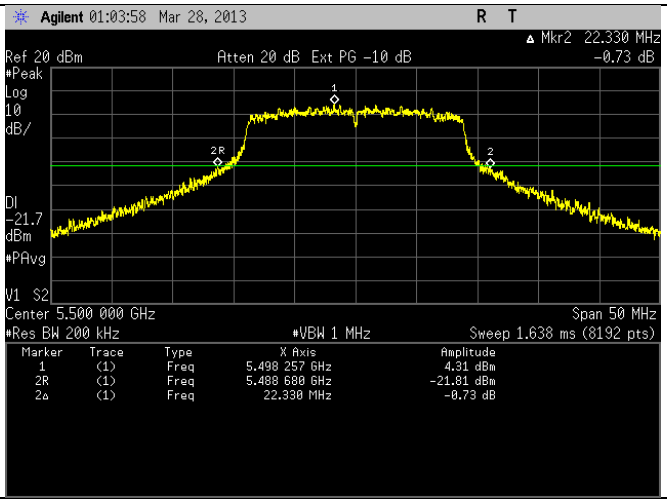


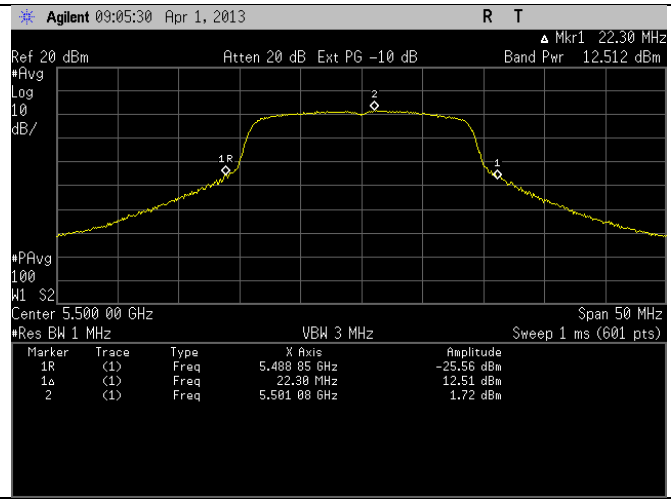


EBW	Power and PPSD

Plots – MCS7

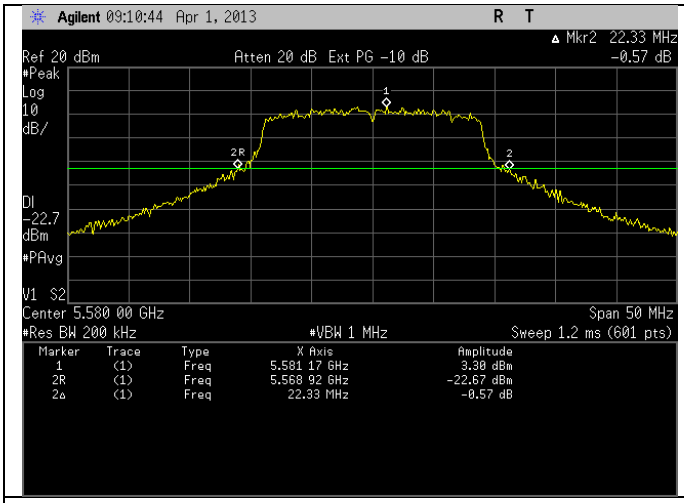
Channel 100



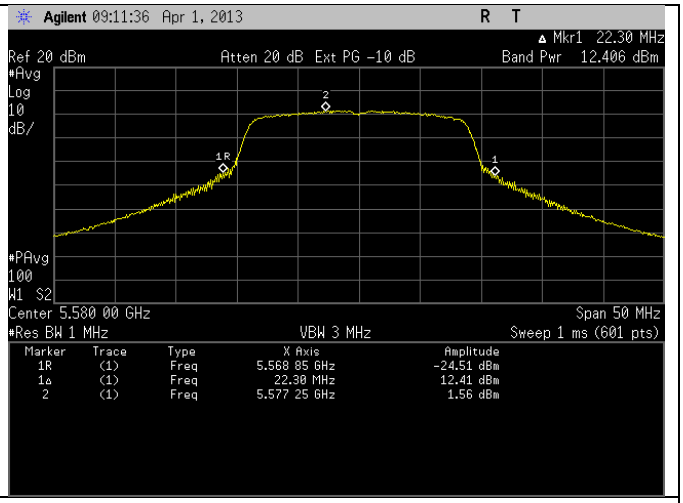


EBW	Power and PPSD

Channel 116

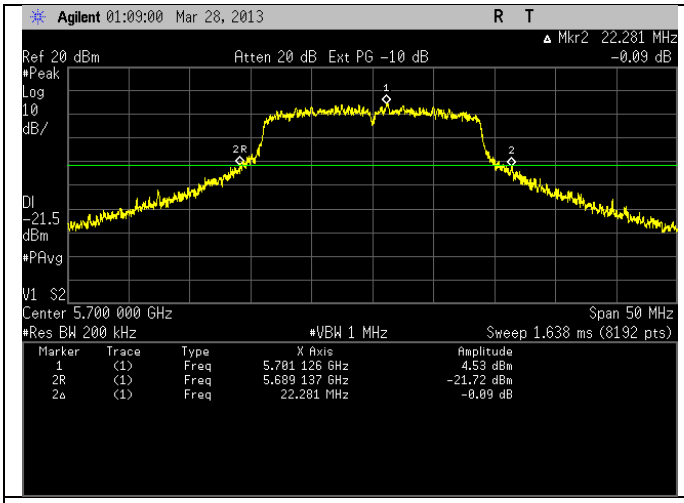


EBW

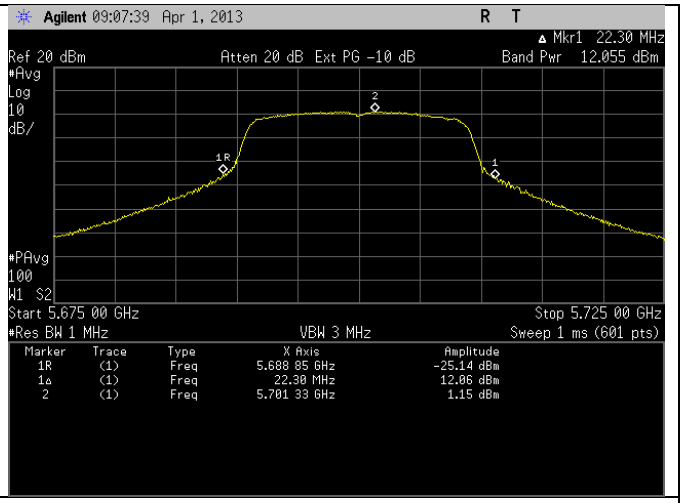


Power and PPSD

Channel 140



EBW



Power and PPSD

B.1.4.1 – Operation in the 5.47 – 5.725 GHz Band (Undesirable Emissions)

Manufacturer	LS Research
Date	2-8, 3-27, 4-1 2013
Operator	Adam A
Temp. / R.H.	20 - 25º C / 30-60% R.H.
Rule Part	15.407 (b) (1) / RSS-210 A9.2 (1)
Specific Measurement Procedure	FCC KDB 789033 Section G) 5) – Peak measurements above 1000 MHz FCC KDB 789033 Section G) 6) – Method AD - Average measurements above 1000 MHz
Additional Description of Measurement	Per 15.407(b) and KDB 789033 Section G) 2) c), RF Conducted measurements of out-of-band emissions that comply with average (-41.2 dBm/MHz) and peak (-21.2 dBm/MHz) limits of 15.209 are satisfactory for showing compliance with 15.407(b) limit of -27 dBm/MHz. Data reported shows peak measurements with max antenna gain and duty cycle correction (if applicable) meeting more stringent peak limit of -27 dBm/MHz as well as average limit (-41.2 dBm/MHz)
Additional Notes	1) Duty cycle added to 25 Mbps and MCS7 measurements. 2) Band-edge measurements at 6, 12, 24 and MCS7 modes. 3) Worst-case out-of-band spurious reported with 6 Mbps mode. 4) Worst-case antenna gain used per KDB 789033 Section G) 3) b) (iii)

Sample Calculations:
Band-edge (dBm) + Antenna Gain (dBi) + Duty Cycle = Total (dBm)
Margin (dB) = Limit (dBm/MHz) – Total (dBm/MHz)

Lower Band-Edge (5.47 GHz)

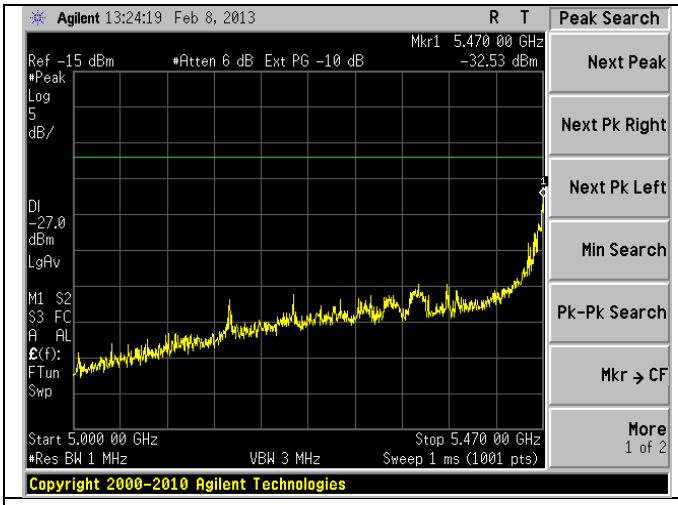
Data Rate	Band-edge (dBm)	Antenna Gain(dBi)	Duty Cycle (dB)	Total dBm/MHz	Limit (dBm/MHz)	Margin (dB)
6 Mbps	-32.53	2	0	-30.53	-27	3.53
12 Mbps	-34.51	2	0	-32.51	-27	5.51
24 Mbps	-34.40	2	0.15	-32.25	-27	5.25
MCS7	-40.36	2	0.38	-37.98	-27	10.98

Upper Band-Edge (5.725 GHz)

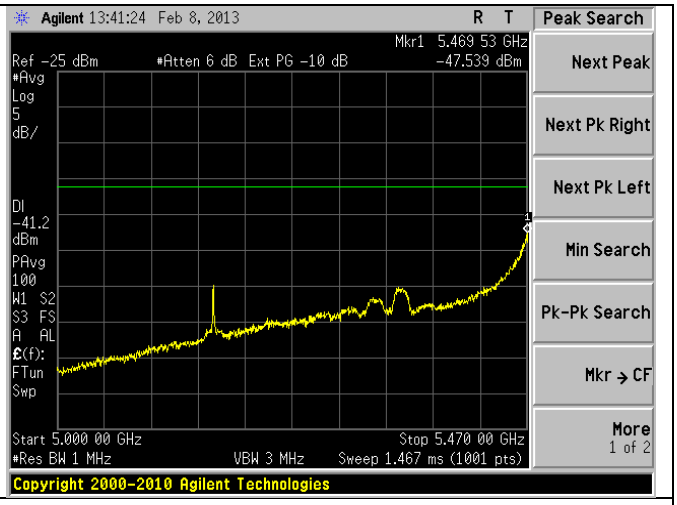
Data Rate	Band-edge (dBm)	Antenna Gain(dBi)	Duty Cycle (dB)	Total dBm/MHz	Limit (dBm/MHz)	Margin (dB)
6 Mbps	-33.63	2	0	-31.63	-27	4.63
12 Mbps	-30.7	2	0	-28.7	-27	1.7
24 Mbps	-33.61	2	0.15	-31.46	-27	4.46
MCS7	-37.13	2	0.38	-34.75	-27	7.75

Plots – Lower Band Edge

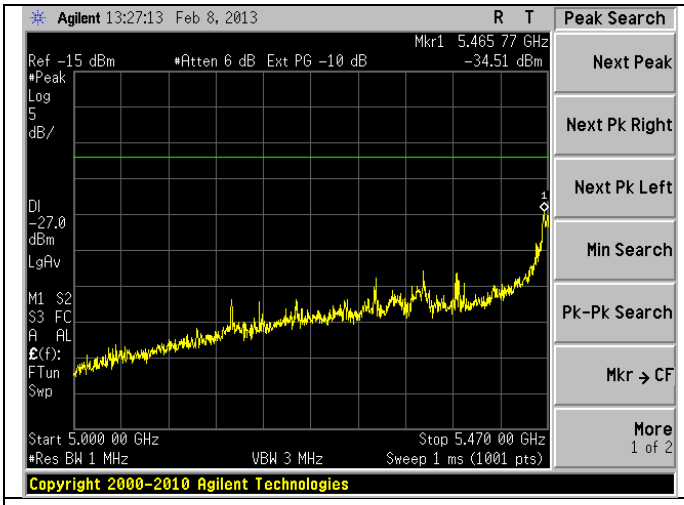
Channel 100



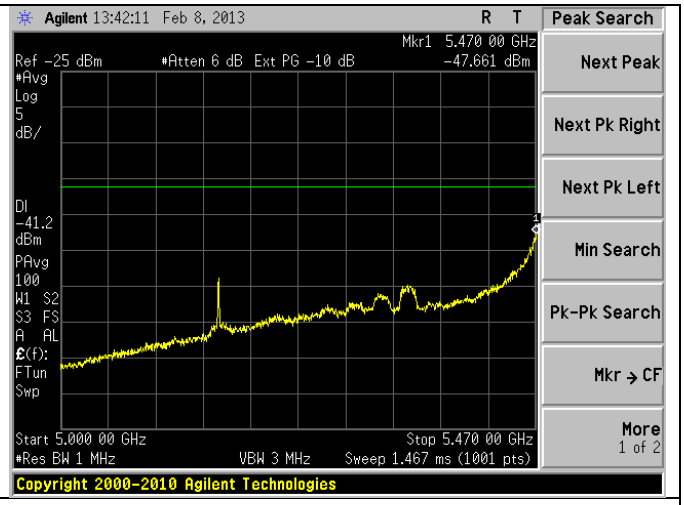
6 Mbps Peak



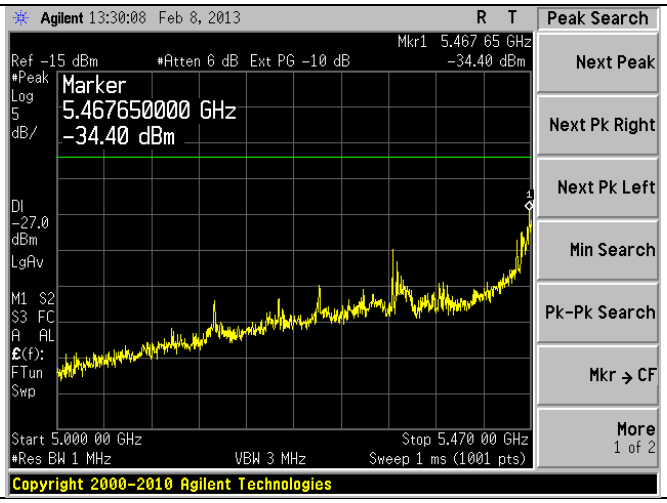
6 Mbps Average



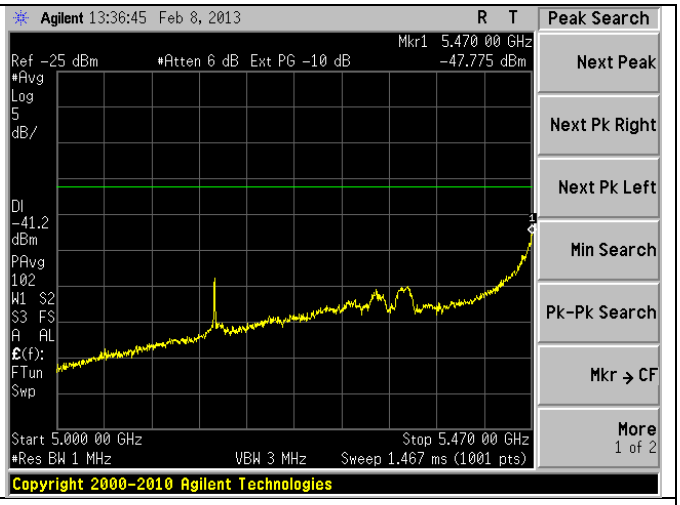
12 Mbps Peak



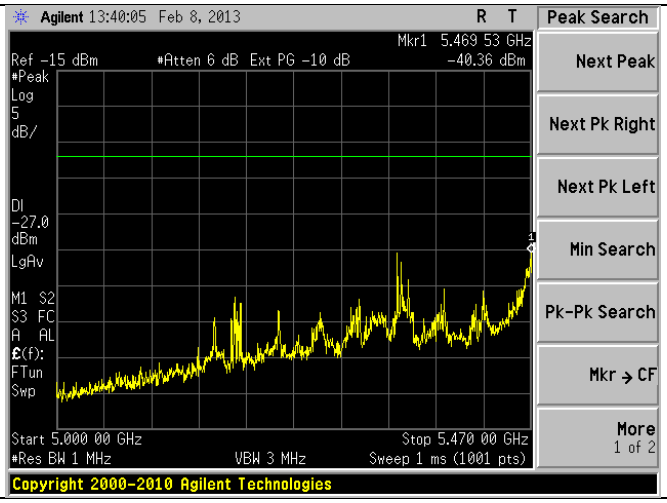
12 Mbps Average



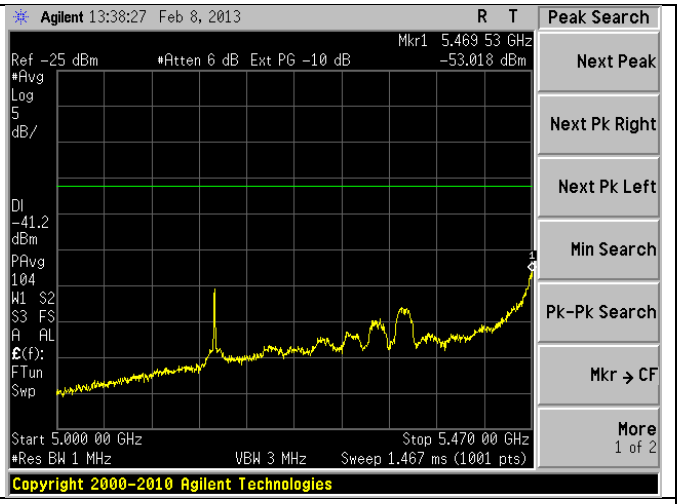
24 Mbps Peak



24 Mbps Average



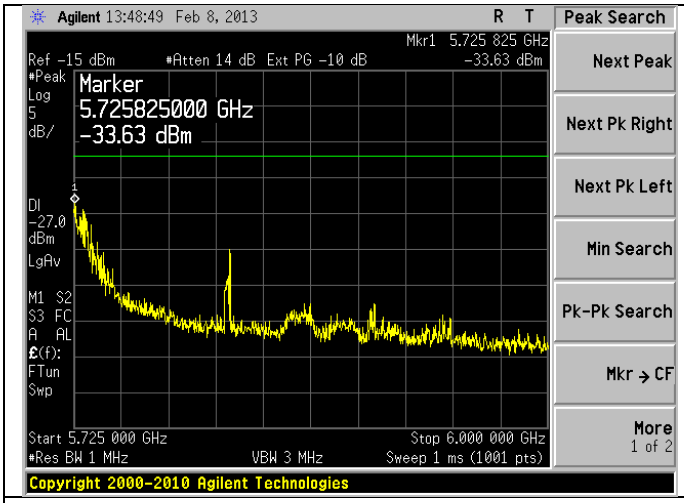
MCS7 Peak



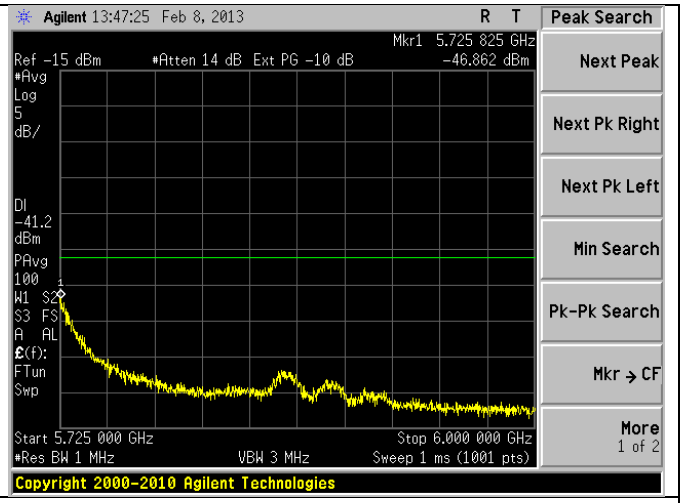
MCS7 Average

Plots – Upper Band Edge

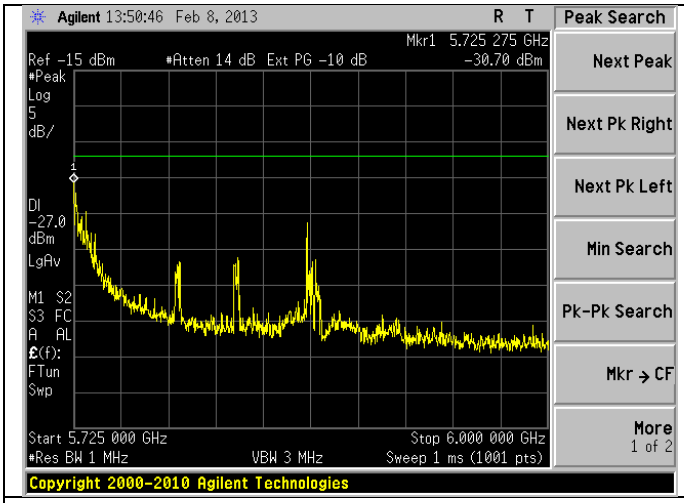
Channel 140



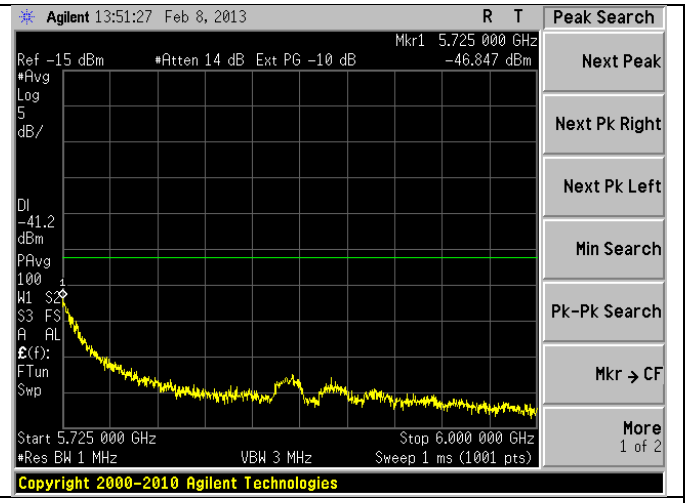
6 Mbps Peak



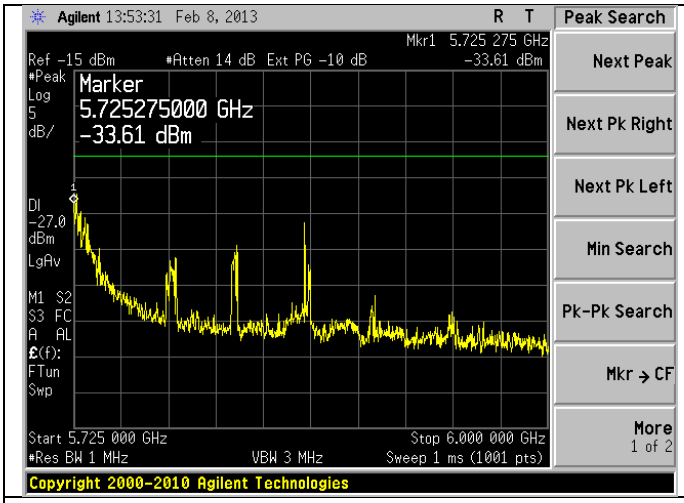
6 Mbps Average



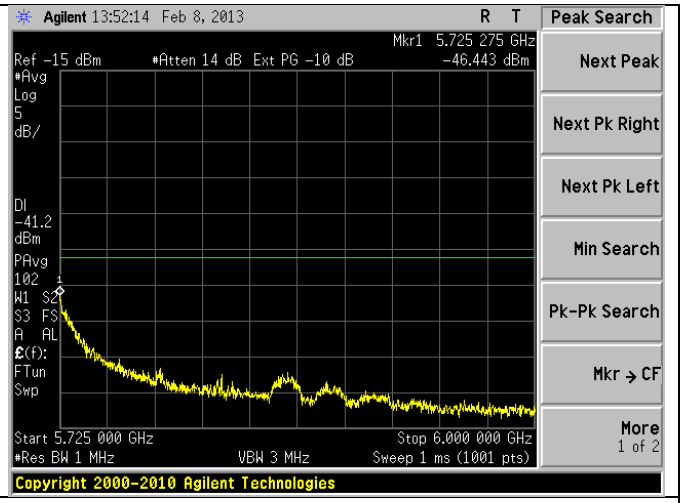
12 Mbps Peak



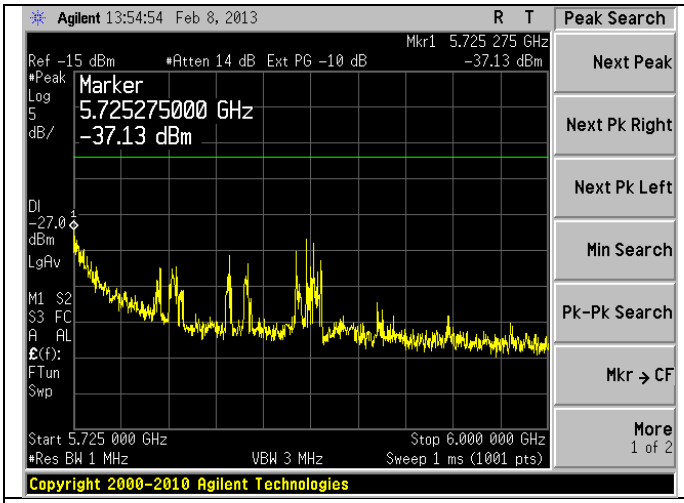
12 Mbps Average



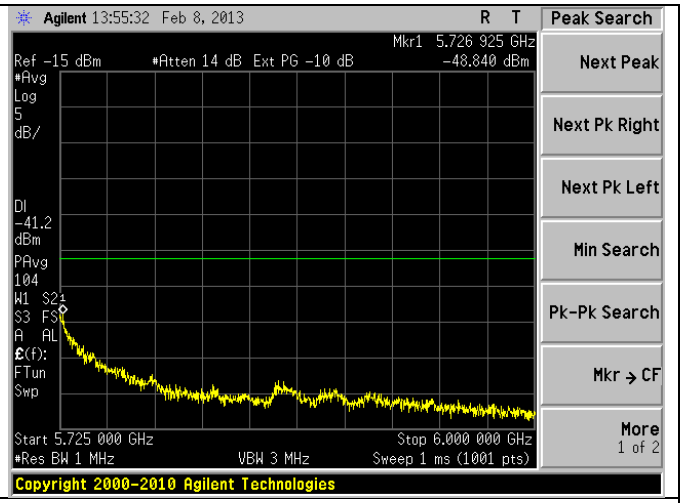
24 Mbps Peak



24 Mbps Average



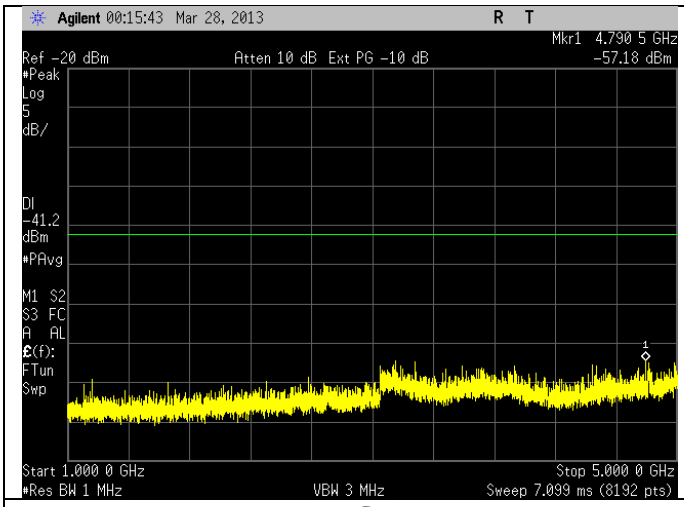
MCS7 Peak



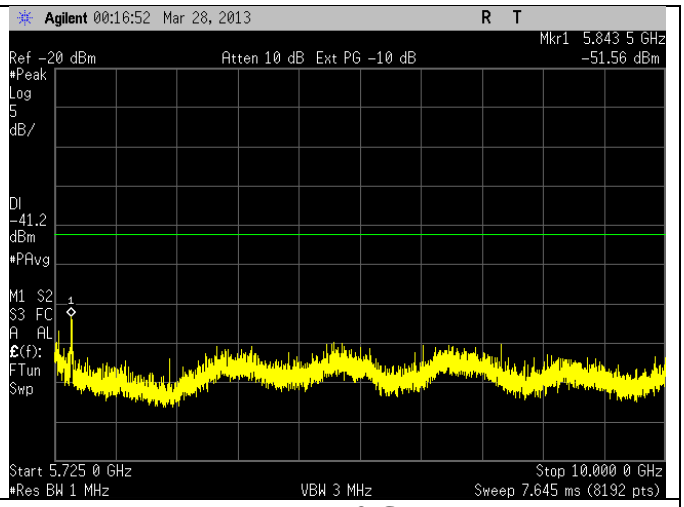
MCS7 Average

Plots – Spurious

Channel 100

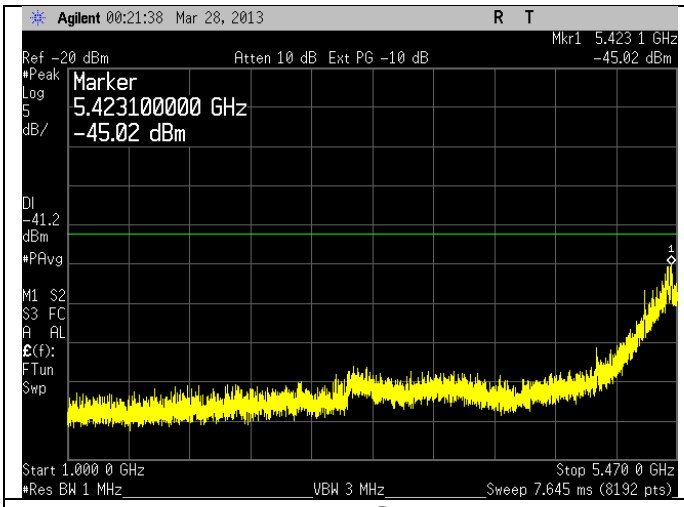


1 – 5 GHz

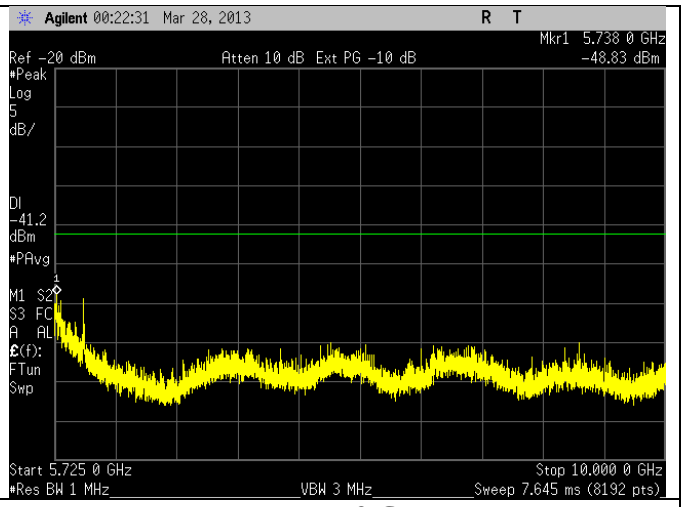


5.725 – 10 GHz

Channel 116

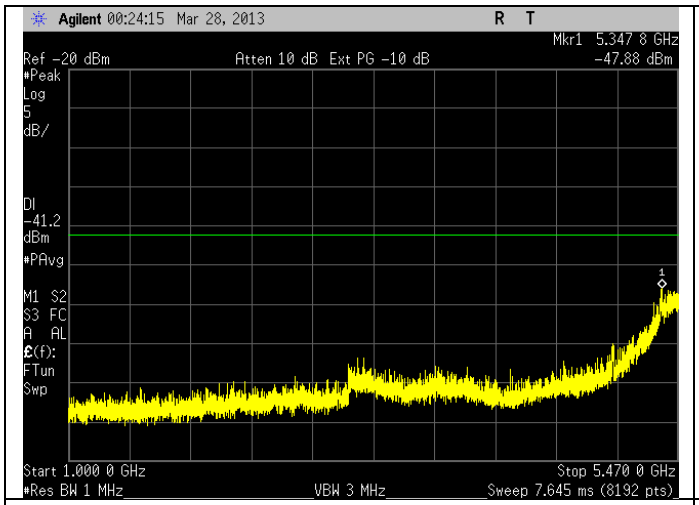


1 –5.47 GHz

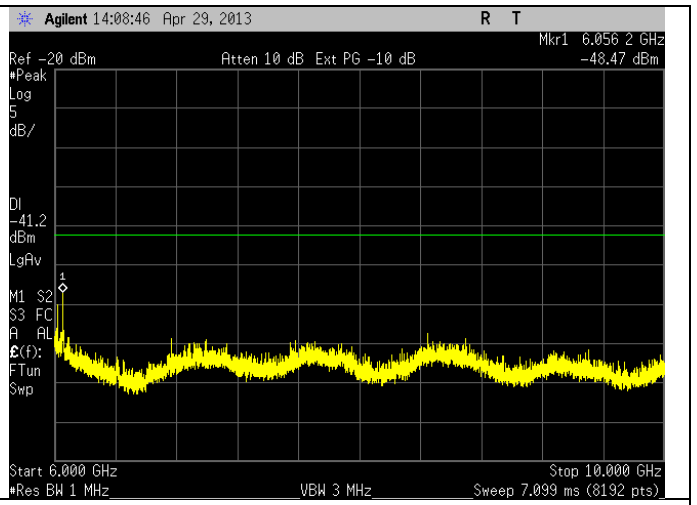


5.725 – 10 GHz

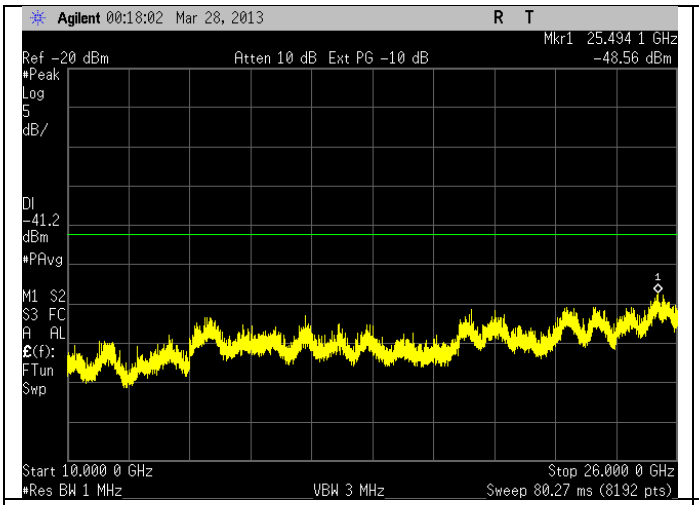
Channel 140



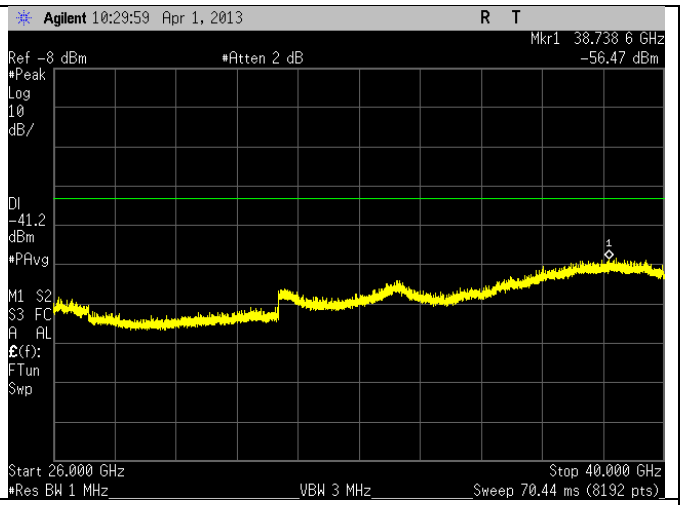
1 – 5.47 GHz



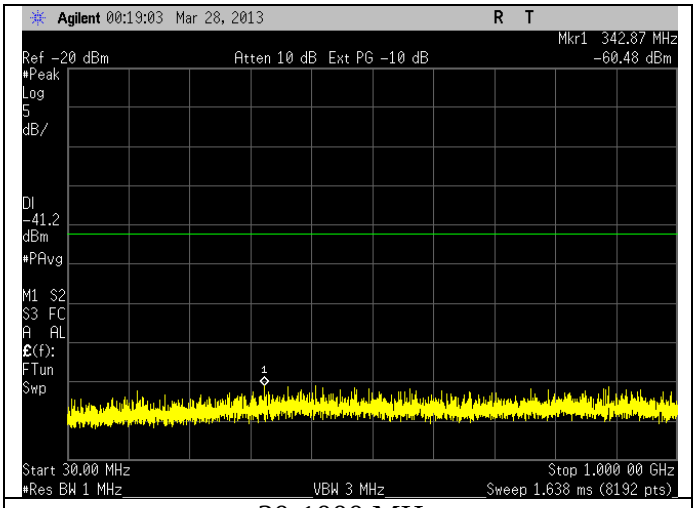
6 – 10 GHz



10 – 26 GHz



26 – 44 GHz



30-1000 MHz

Prepared For: LS Research	Name: TiWi5
Report: TR 313033 A FCCICTX A	Model: TiWi5
LSR: C-1694	Serial: Synapse XBRV4

B.1.5 – Peak Excursion

Manufacturer	LS Research
Date	3-28-2013
Operator	Adam A
Temp. / R.H.	20 - 25º C / 30-60% R.H.
Rule Part	FCC Part 15.407 (a) (6)
Specific Measurement Procedure	FCC KDB 789033 Section F) – Peak Excursion
Additional Description of Measurement	Per KDB 789033 Section F) Testing each modulation mode on a single channel is sufficient to demonstrate compliance with the peak excursion requirement.
Additional Notes	1) PPSD Average also reported earlier in report.

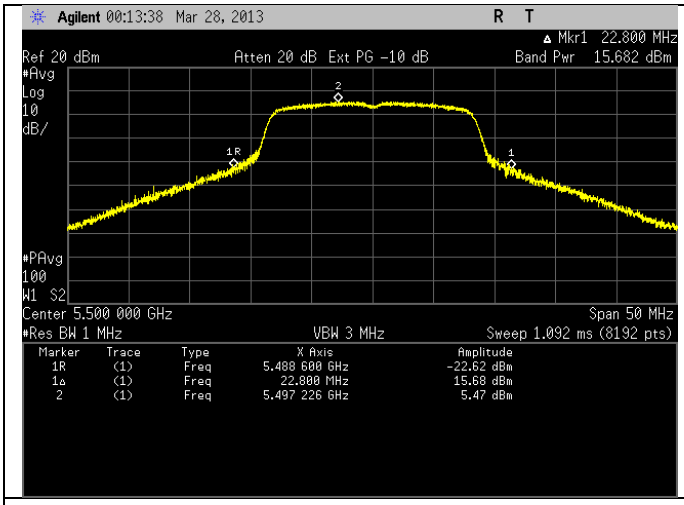
Sample Calculations:

Peak Excursion (dB) = PPSD Peak (dBm) – PPSD Average (dBm)

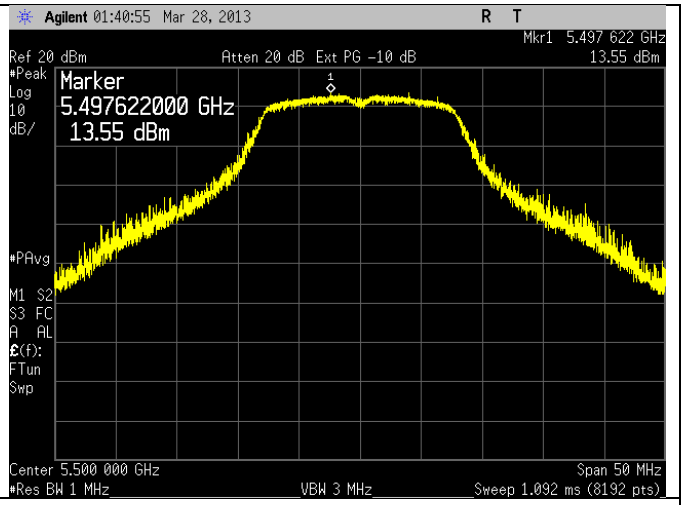
Margin (dB) = Limit (dB) – Peak Excursion (dB)

Channel	Frequency (MHz)	Data Rate	PPSD Average (dBm)	PPSD Peak (dBm)	Peak Excursion (dB)	Peak Excursion Limit (dB)	Peak Excursion Margin (dB)
100	5500	6	5.47	13.55	8.08	13	4.92
		12	5.68	14.04	8.36	13	4.64
		24	6.09	14.62	8.53	13	4.47
		MCS7	1.72	10.38	8.66	13	4.34

6 Mbps

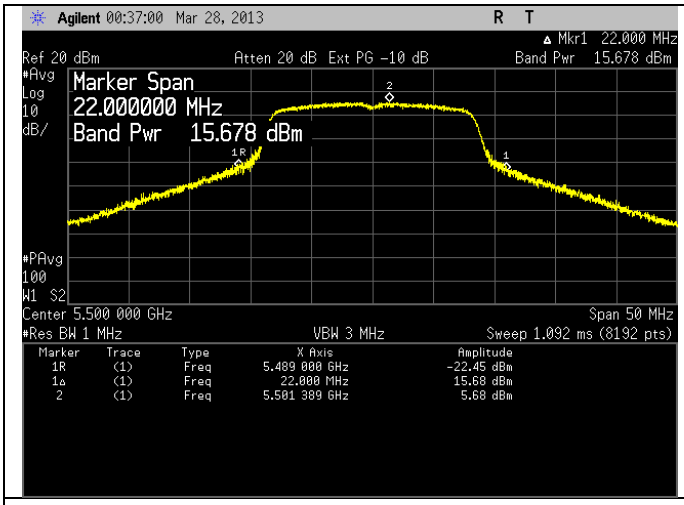


PPSD (Average)

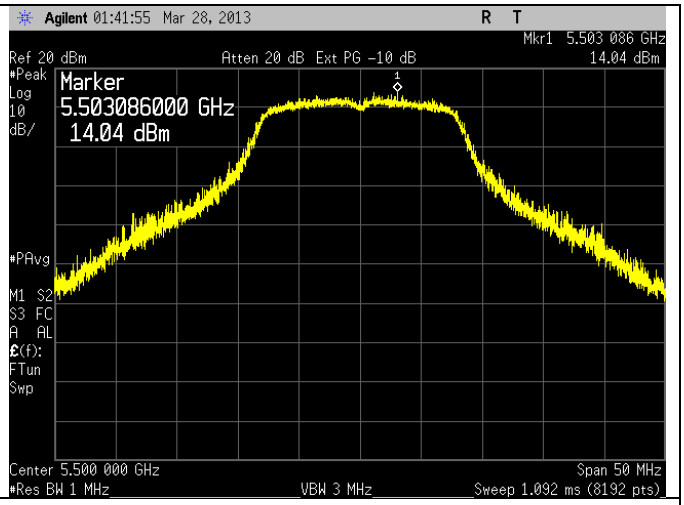


PPSD (Peak)

12 Mbps

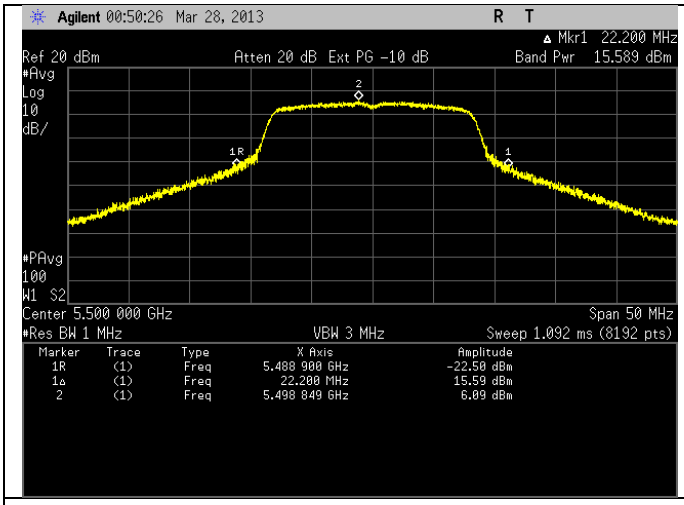


PPSD (Average)

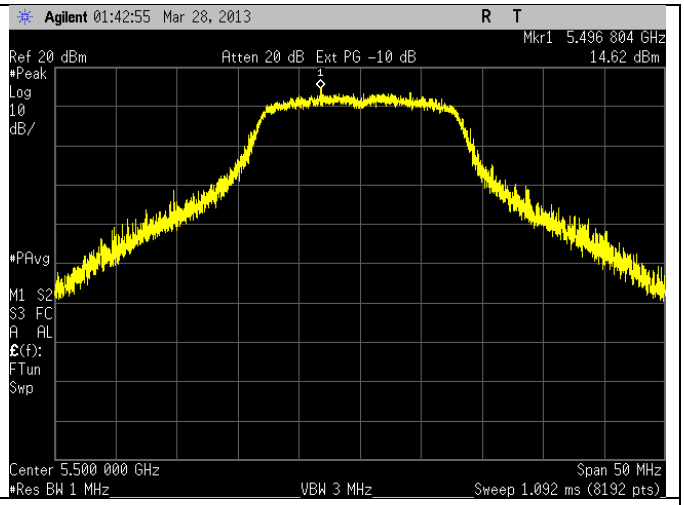


PPSD (Peak)

24 Mbps

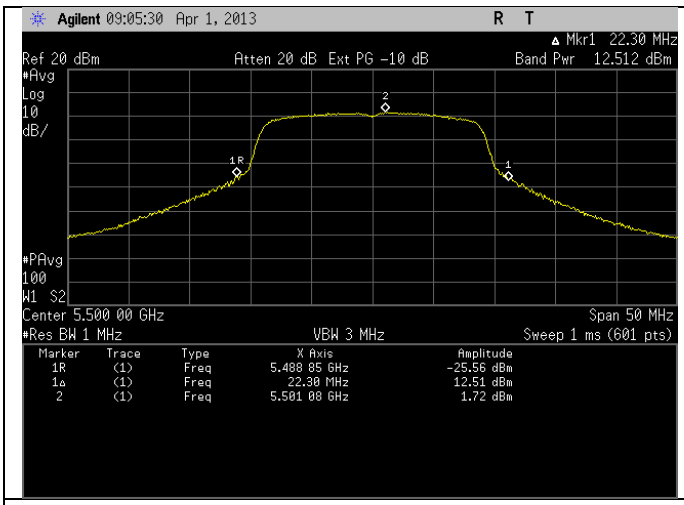


PPSD (Average)

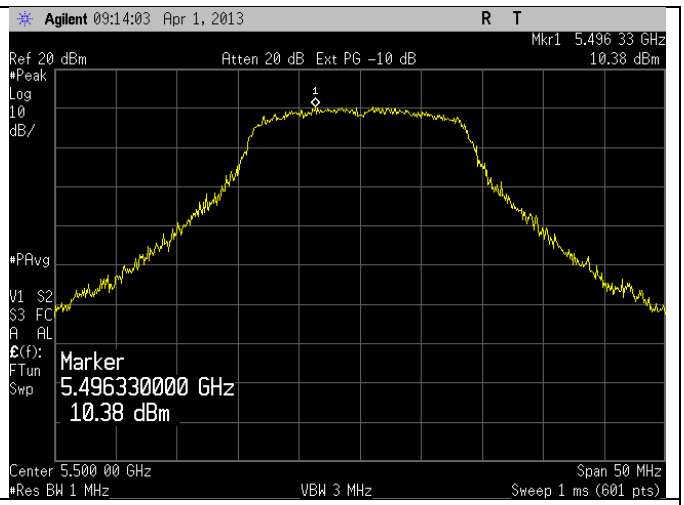


PPSD (Peak)

MCS7



PPSD (Average)



PPSD (Peak)

B.2 – Radiated Emissions

Rule Part(s)	FCC: 15.407 / 15.205 / 15.209 IC: RSS-210 A9 / RSS-210 Section 2.2			
Measurement Procedure	ANSI C63.4 - 2003 ANSI C63.10 – 2009 FCC KDB 789033 D01 General UNII Test Procedures v01r02			
Test Location	LS Research, LLC - FCC Listed 3 meter Semi-Anechoic Chamber			
Test Distance	See test data section			
EUT Placement	80 cm height non-conductive table above reference ground plane			
Frequency Range of Measurement	Biconical: 30-300 MHz	Log Periodic Dipole Array: 300-1000 MHz	Double-Ridged Waveguide Horn: 1-18 GHz	(2) Standard Gain Horn: 18-26GHz 26-40 GHz
Measurement Detectors	30-1000MHz RBW: 120 kHz VBW: As specified		1 - 40 GHz: RBW : 1MHz VBW: As specified	
Description of Measurement	1) The antenna, cable, pre-amp, and other necessary measurement system correction factors are loaded onto the EMI receiver / spectrum analyzer when the measurements are preformed. The data is gathered and reported as the corrected values. 2) The EUT is placed on a non-conductive pedestal centered on a turn-table in the test location with the antenna at the test distance from the EUT 3) Maximum radiated RF emissions are determined by rotation of azimuth and scanning the sense antenna between 1 and 4 meters in height using both horizontal and vertical antenna polarities. Maximized levels are manually noted at degree values of azimuth and at sense antenna height.			
Example Calculations	Reported Measurement data = Raw receiver measurement + Antenna Correction Factor + Cable factor (dB) - amplification factor (when applicable) + Additional factor (when applicable)			

FCC Part 15.209 / IC RSS-210 Section 2.7 Limits:

Frequency (MHz)	3 m Limit (µV/m)	3 m Limit (dBµV/m)	Type
30-88	100	40.0	Quasi-Peak
88-216	150	43.5	Quasi-Peak
216-960	200	46.0	Quasi-Peak
Above 960	500	54.0	Average (>1 GHz)

B.2.1 – Radiated Harmonics

Manufacturer	LS Research
Date	4-2-2013
Operator	Adam A
Temp. / R.H.	20 - 25º C / 30-60% R.H.
Rule Part	15.407 / 15.205 / 15.209
Measurement Procedure	ANSI C63.4 - 2003 ANSI C63.10 - 2009 FCC KDB 789033 G) 2) c) (i) AND 3) b) "Cabinet Emissions Measurements"
Test Distance	1 meter (8-40 GHz)
EUT Placement	80 cm height non-conductive table centered on turn-table
Detectors	Peak; RBW 1MHz
Additional Notes	1) Tested in the worst case of continuous transmit 6 Mbps (WLAN) modulated mode for radiated harmonics with EUT Antenna terminated in three orthogonal positions at maximum power. Maximum results reported. 2) Antenna port terminated at SMA connector 3) Peak measurements meet average restricted band limits as reported in data table. 4) Plots show reduced VBW(average) for identifying harmonics 5) Tested at 1 meter test distance so a distance correction factor of 9.5 added to 3 meter limit.

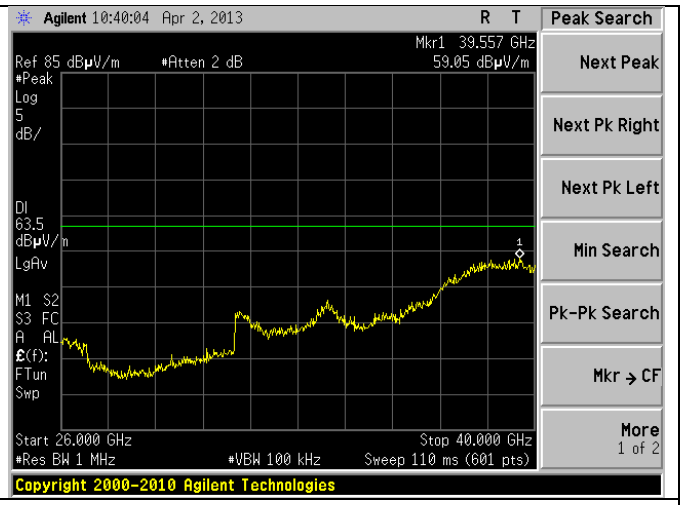
Example Calculation:
FCC 15.209 Average Limit @ 1 meter (dBµV/m) – Peak Reading (dBµV/m) = Margin

Data Table

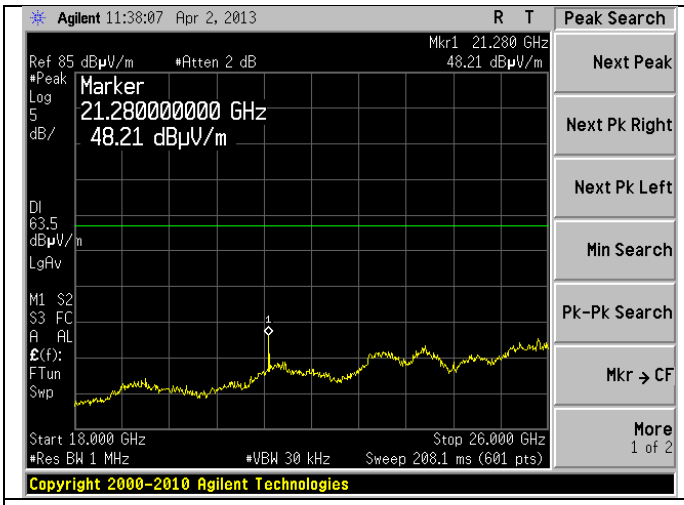
Channel	Fund. Frequency	Emission Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBµV/m)	Avg Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT orientation
36	5180	20720	1.00	205	54.25	63.5	9.25	Vertical	Side
40	5200	20800	1.00	213	54.28	63.5	9.22	Vertical	Side
48	5240	20960	1.00	205	53.78	63.5	9.72	Vertical	Side
52	5260	21040	1.00	211	53.89	63.5	9.61	Vertical	Side
56	5280	21120	1.00	215	54.98	63.5	8.52	Vertical	Side
60	5300	21200	1.00	237	55.01	63.5	8.49	Vertical	Side
64	5320	21280	1.00	298	55.38	63.5	8.12	Vertical	Side
100	5500	22000	1.00	39	51.76	63.5	11.74	Horizontal	Vertical
116	5580	22320	1.00	27	51.85	63.5	11.65	Horizontal	Vertical
140	5700	22800	1.00	25	51.03	63.5	12.47	Horizontal	Vertical

Plots

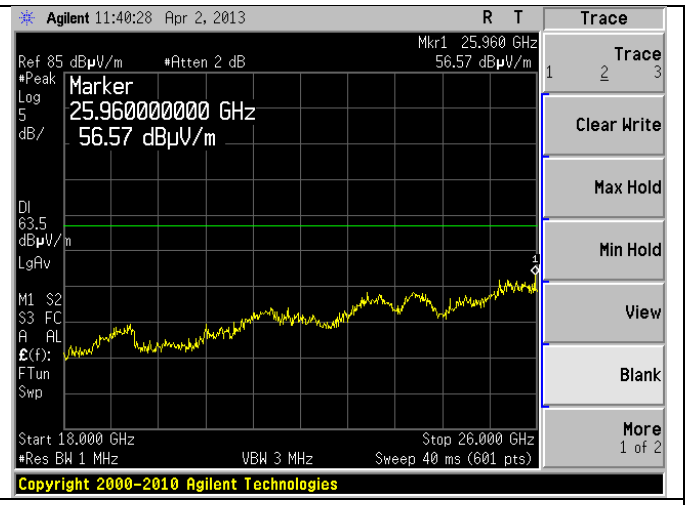
8 – 18 GHz Average



26 – 40 GHz Average



18 - 26 GHz Average



18 - 26 GHz Peak

B2.2 - Radiated Band-edge into restricted bands

Manufacturer	LS Research
Date	2-7, 2-8, 4-1 2013
Operator	Adam A
Temp. / R.H.	20 - 25º C / 30-60% R.H.
Rule Part	15.407 / 15.205 / 15.209
Measurement Procedure	ANSI C63.4 - 2003 ANSI C63.10 - 2009 FCC KDB 789033 G) 2) c) (i) AND 3) b) "Cabinet Emissions Measurements"
Test Distance	1 meter (8-40 GHz)
EUT Placement	80 cm height non-conductive table centered on turn-table
Detectors	Peak; RBW 1MHz
Additional Notes	1) Tested in all modulation modes for radiated harmonics with EUT Antenna terminated in three orthogonal positions at maximum power. Maximum results reported. 2) Antenna port terminated at SMA connector 3) Tested at 1 meter test distance so a distance correction factor of 9.5 added to 3 meter limit.

Example Calculation:
Peak Limit – Peak Reading = Peak Margin; Average Limit – Average Reading = Average Margin

Data Tables

Channel 36, 5180 MHz (LBE)

Data Rate	Avg Reading (dBµV/m)	Avg Limit (dBµV/m)	Avg Margin (dB)	Peak Reading (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)
6	57.53	63.5	5.97	69.13	83.5	14.37
12	57.49	63.5	6.01	68.74	83.5	14.76
24	57.48	63.5	6.02	68.54	83.5	14.96
MCS7	57.53	63.5	5.97	68.25	83.5	15.25

Channel 56, 5280 MHz (LBE)

Data Rate	Avg Reading (dBµV/m)	Avg Limit (dBµV/m)	Avg Margin (dB)	Peak Reading (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)
6	58.86	63.5	4.64	68.39	83.5	15.11
12	58.67	63.5	4.83	68.15	83.5	15.35
24	58.51	63.5	4.99	68.19	83.5	15.31
MCS7	58.43	63.5	5.07	69.80	83.5	13.70

Channel 64, 5320 MHz (UBE)

Data Rate	Avg Reading (dBµV/m)	Avg Limit (dBµV/m)	Avg Margin (dB)	Peak Reading (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)
6	59.10	63.5	4.40	68.70	83.5	14.80
12	58.90	63.5	4.60	70.00	83.5	13.50
24	59.10	63.5	4.40	69.20	83.5	14.30
MCS7	58.80	63.5	4.70	69.40	83.5	14.10

Channel 100, 5500 MHz (LBE)

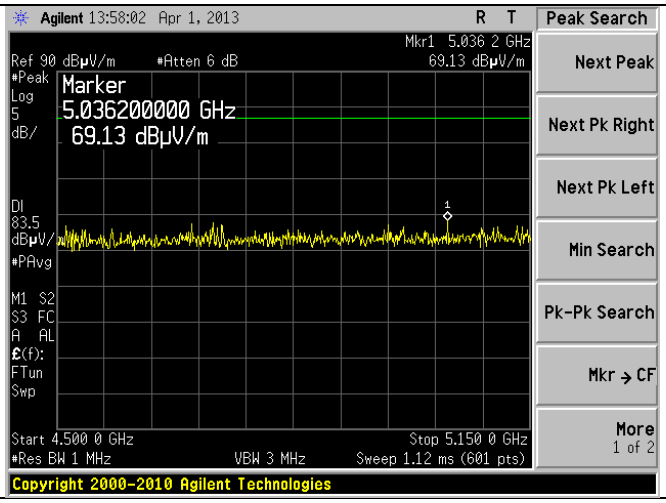
Data Rate	Avg Reading (dBµV/m)	Avg Limit (dBµV/m)	Avg Margin (dB)	Peak Reading (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)
6	59.20	63.5	4.30	70.10	83.5	13.40
12	58.90	63.5	4.60	69.00	83.5	14.50
24	59.10	63.5	4.40	69.50	83.5	14.00
MCS7	59.30	63.5	4.20	69.50	83.5	14.00

Channel 140, 5700 MHz (UBE)

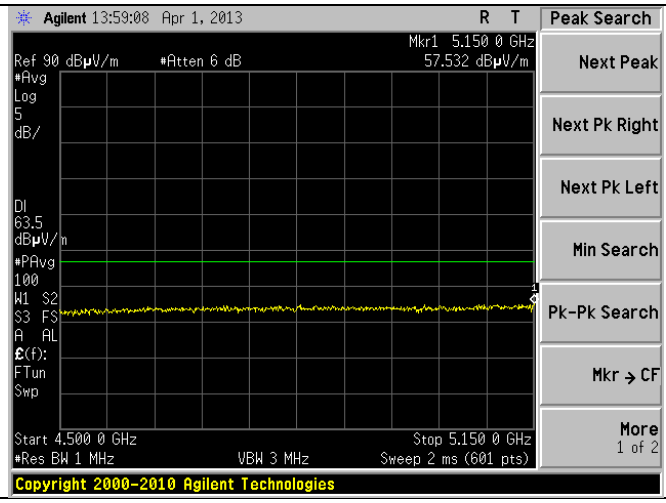
Data Rate	Avg Reading (dBµV/m)	Avg Limit (dBµV/m)	Avg Margin (dB)	Peak Reading (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)
6	58.90	63.5	4.60	69.70	83.5	13.80
12	58.50	63.5	5.00	69.00	83.5	14.50
24	59.00	63.5	4.50	68.50	83.5	15.00
MCS7	58.90	63.5	4.60	69.00	83.5	14.50

Plots

Channel 36
6 Mbps

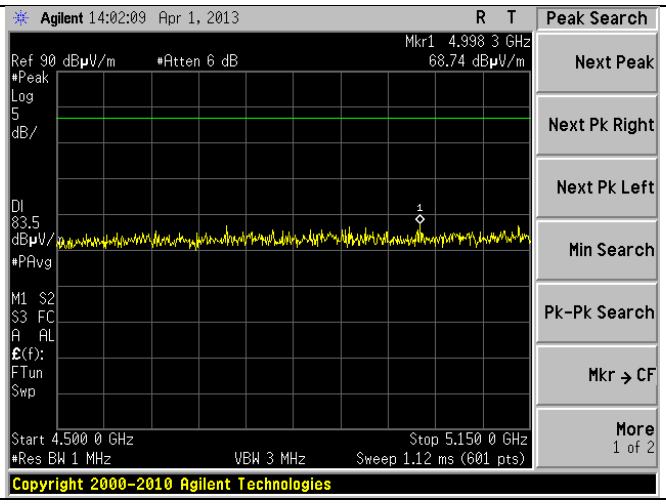


Peak

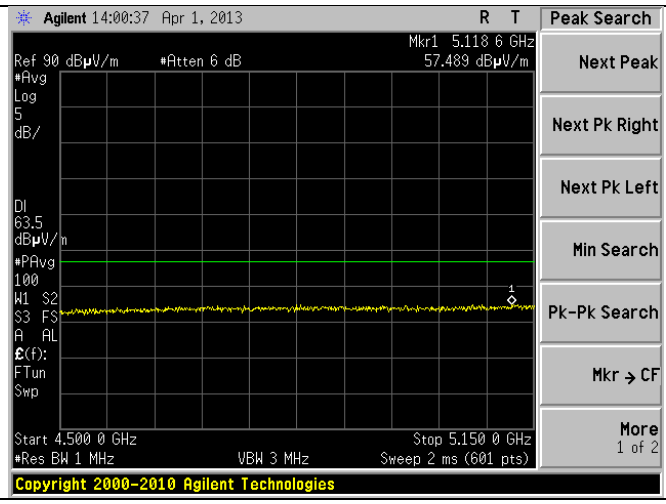


Average

12 Mbps

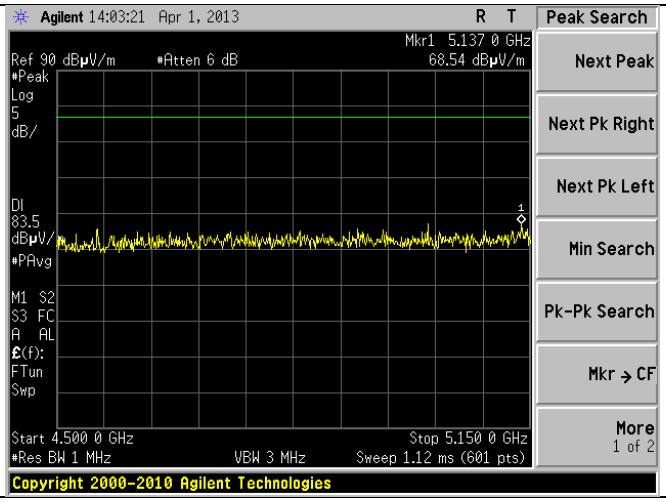


Peak

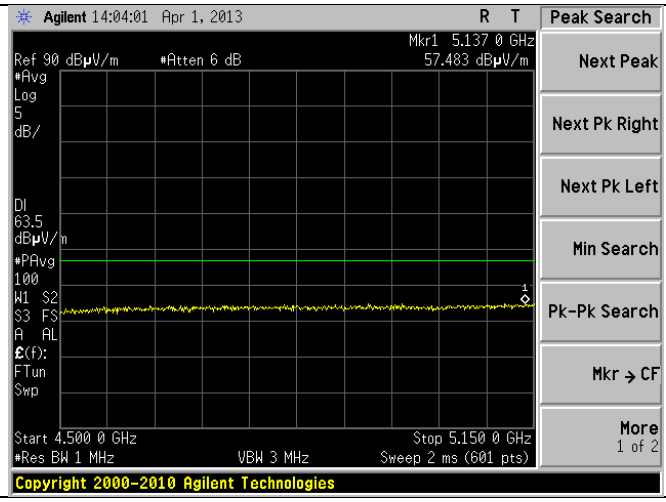


Average

24 Mbps

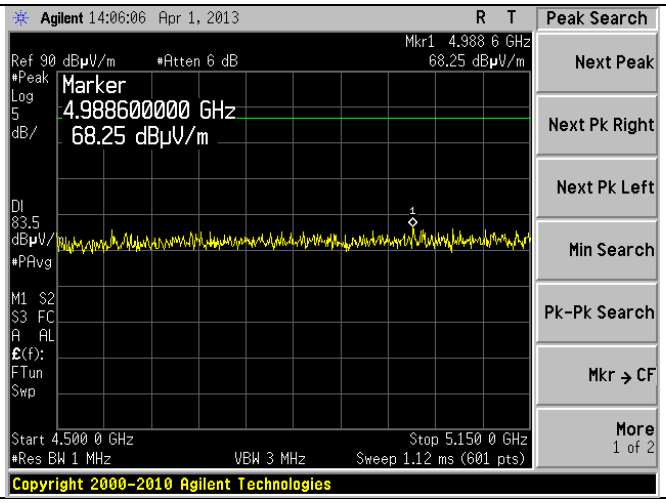


Peak

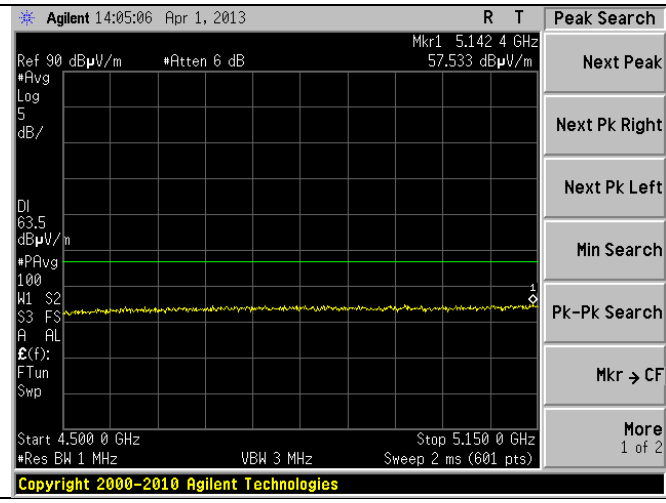


Average

MCS7

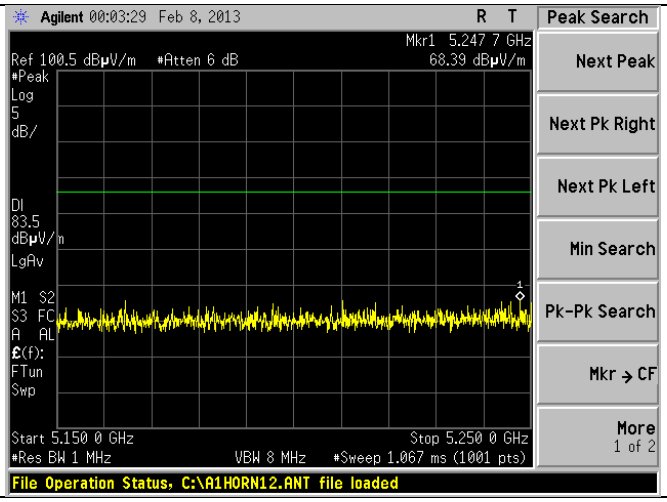


Peak

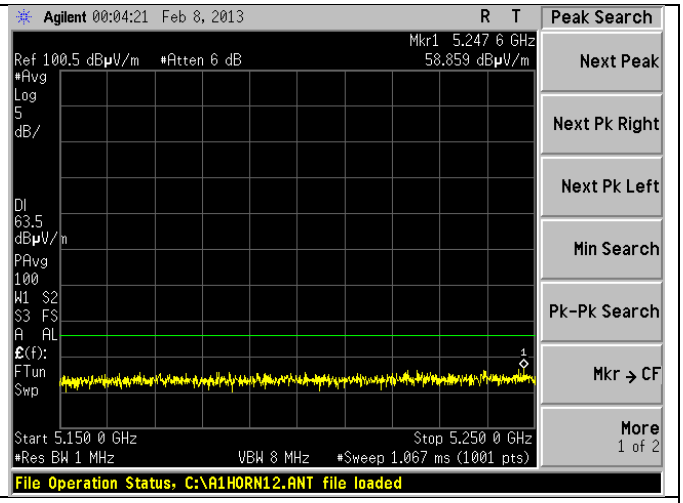


Average

Channel 56
6 Mbps

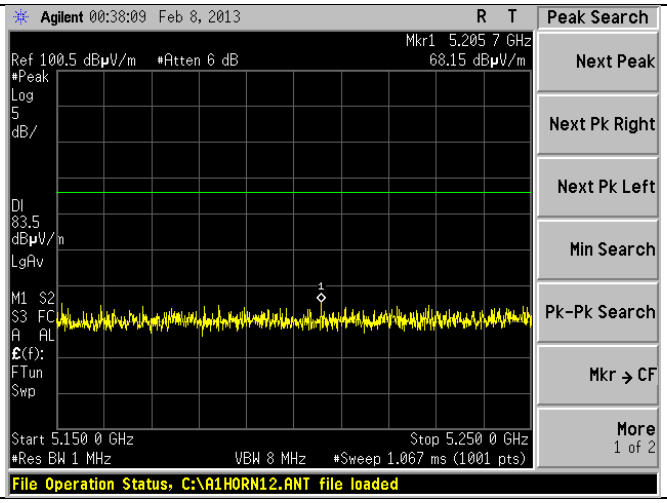


Peak

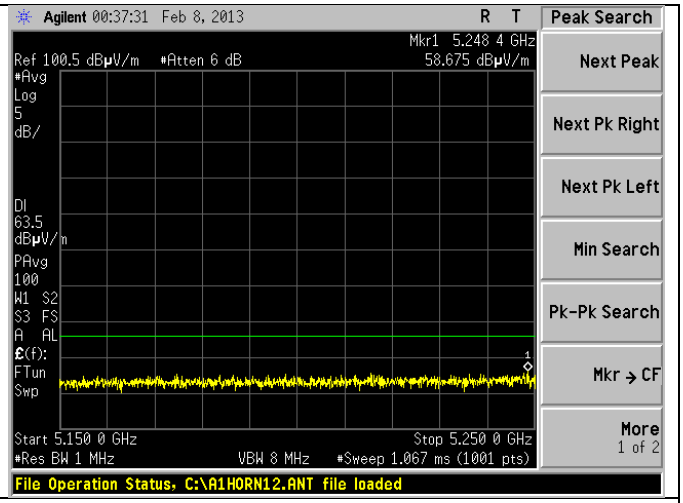


Average

12 Mbps

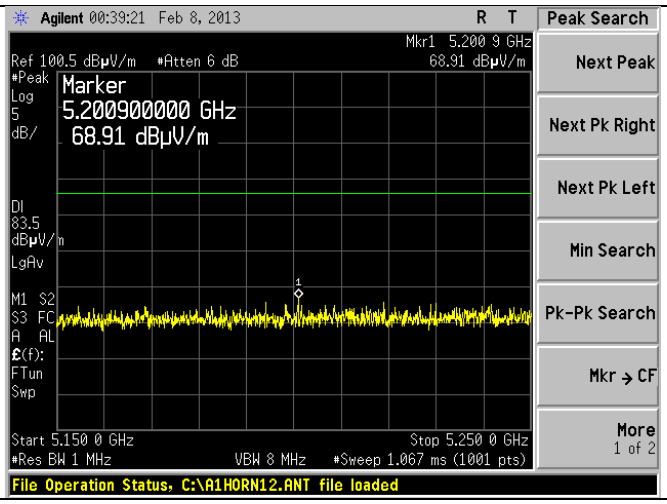


Peak

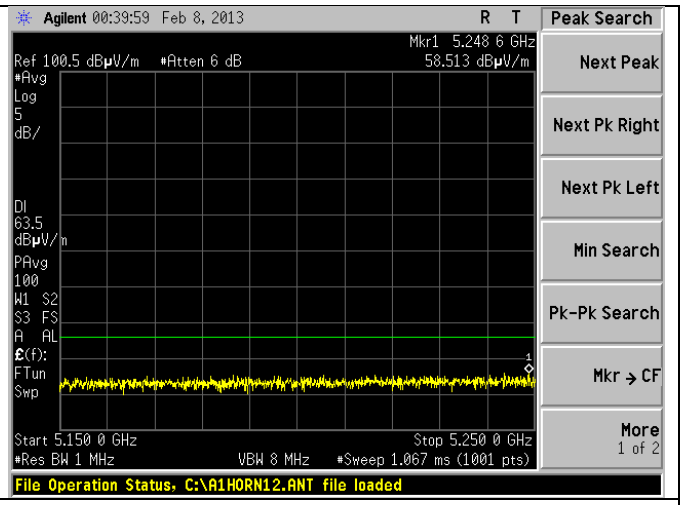


Average

24 Mbps

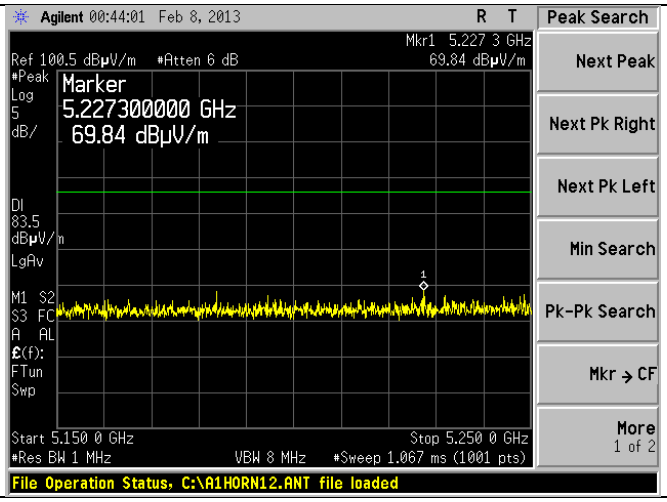


Peak

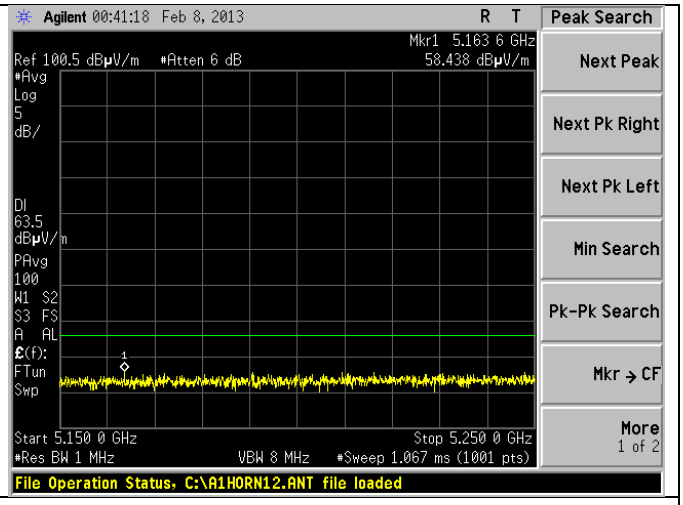


Average

MCS7

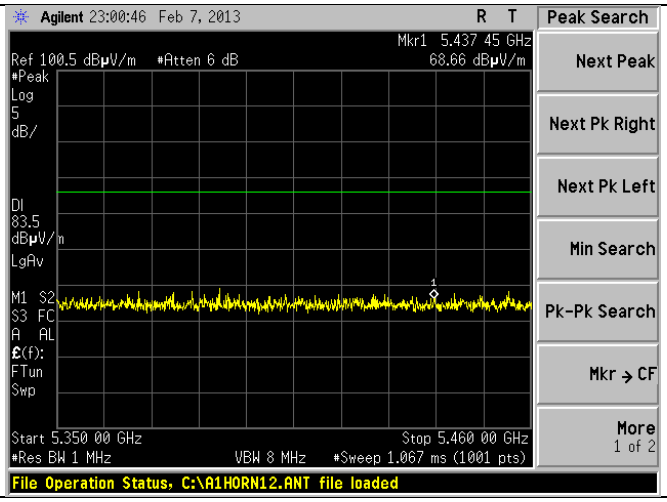


Peak

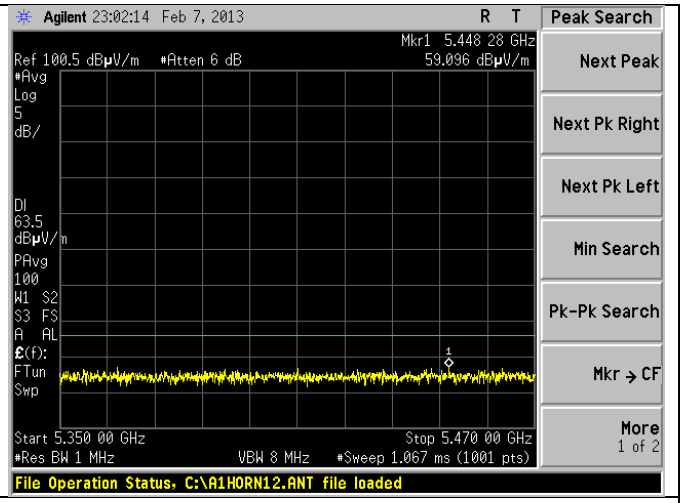


Average

Channel 64
6 Mbps

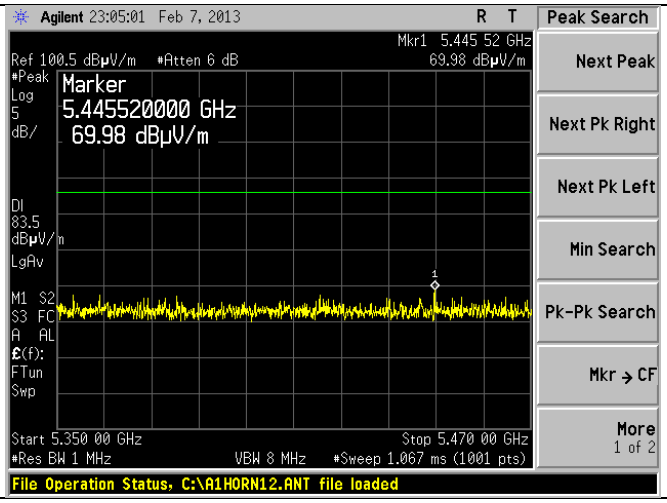


Peak

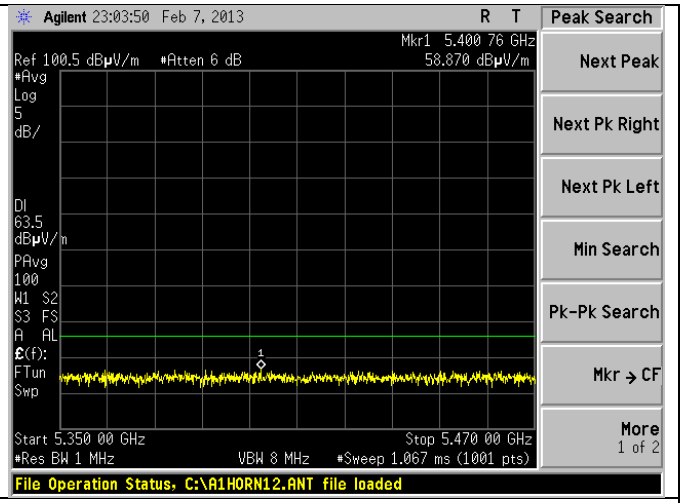


Average

12 Mbps

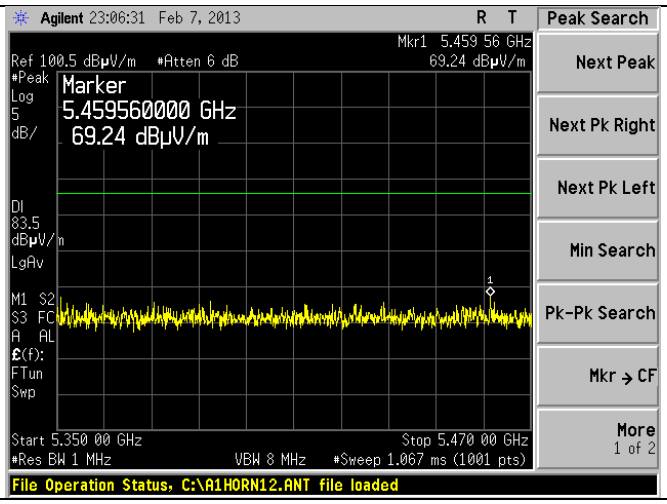


Peak

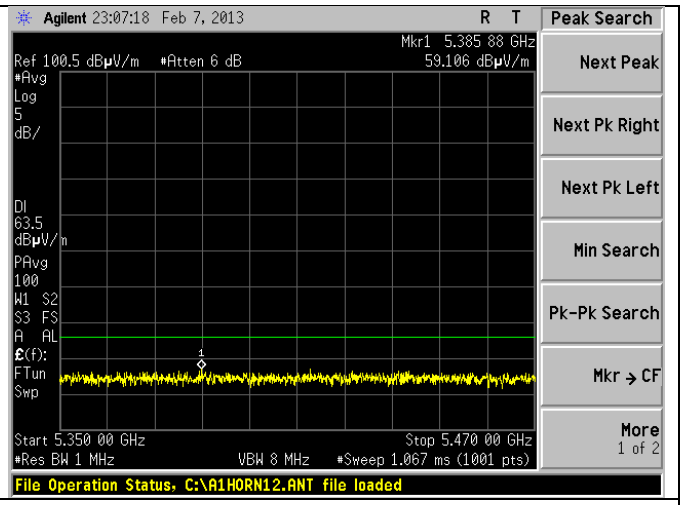


Average

24 Mbps

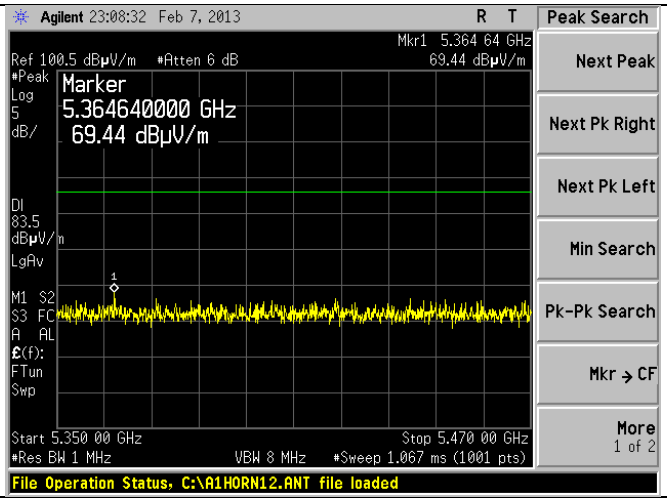


Peak

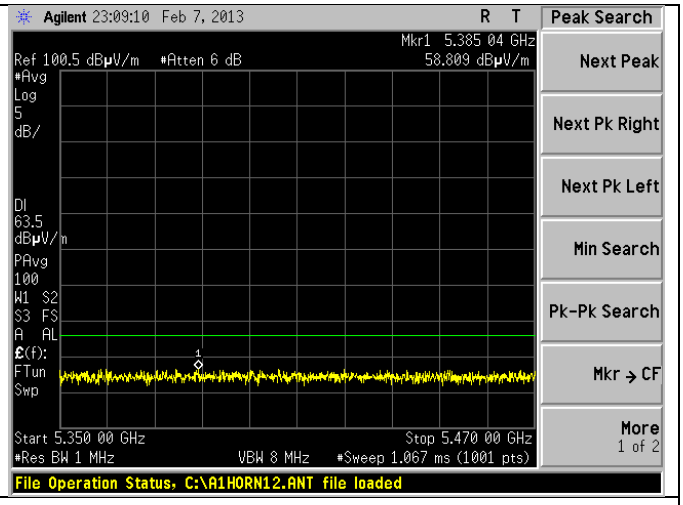


Average

MCS7

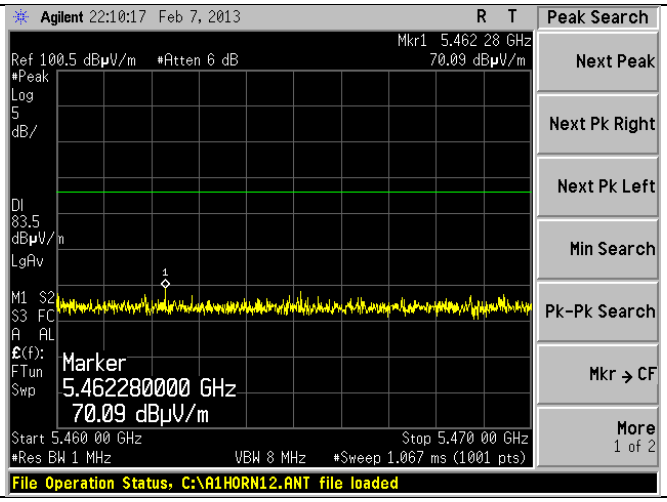


Peak

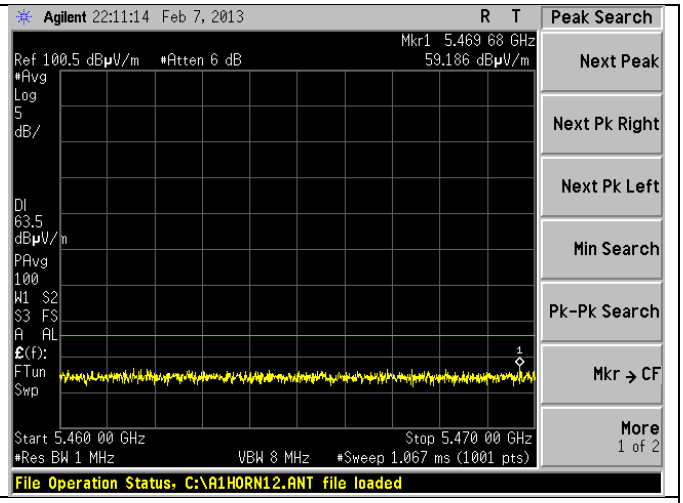


Average

Channel 100
6 Mbps

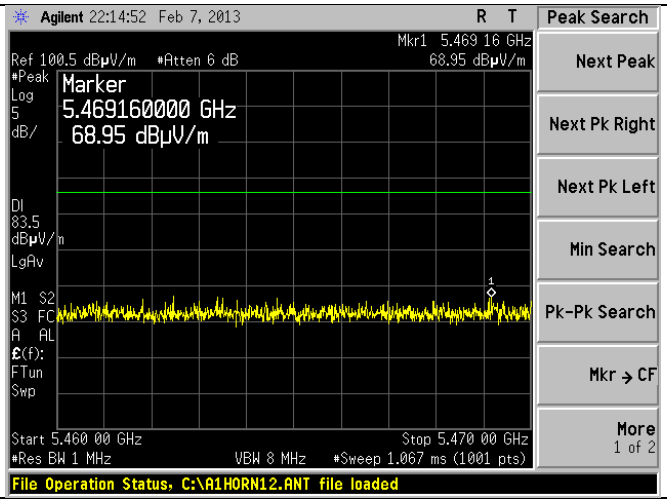


Peak

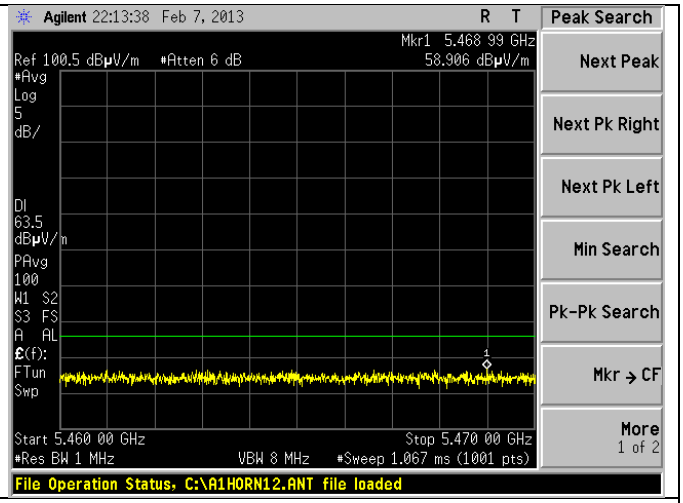


Average

12 Mbps

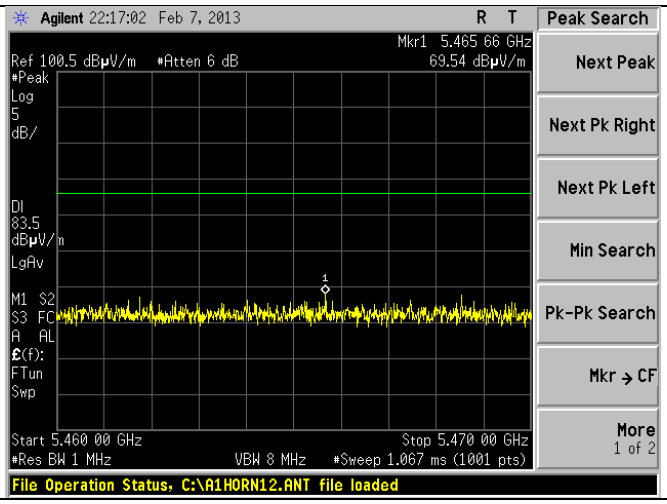


Peak

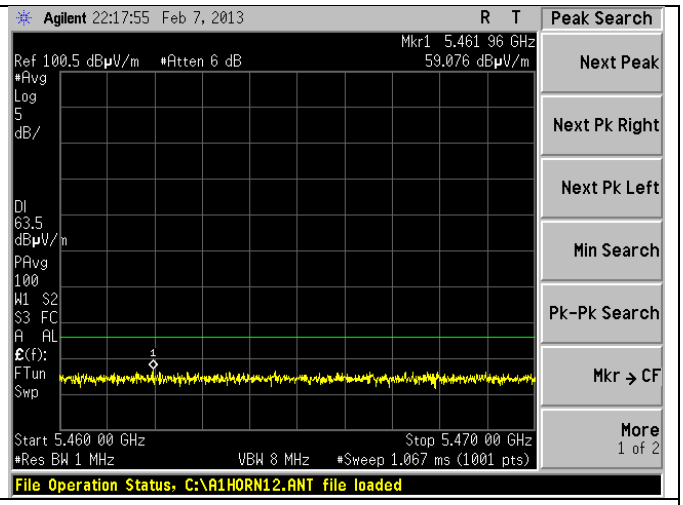


Average

24 Mbps

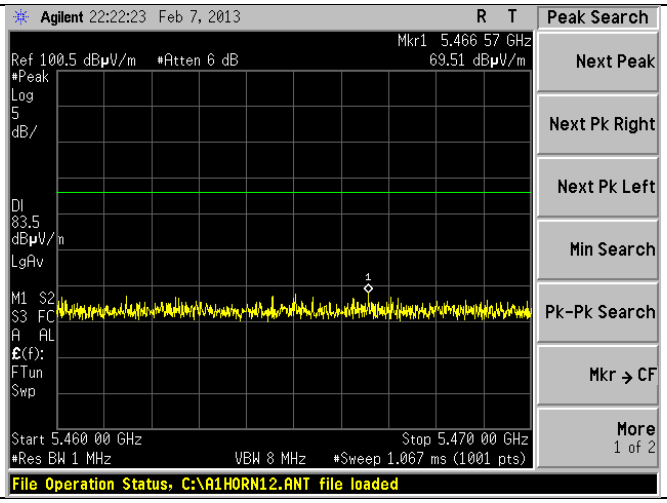


Peak

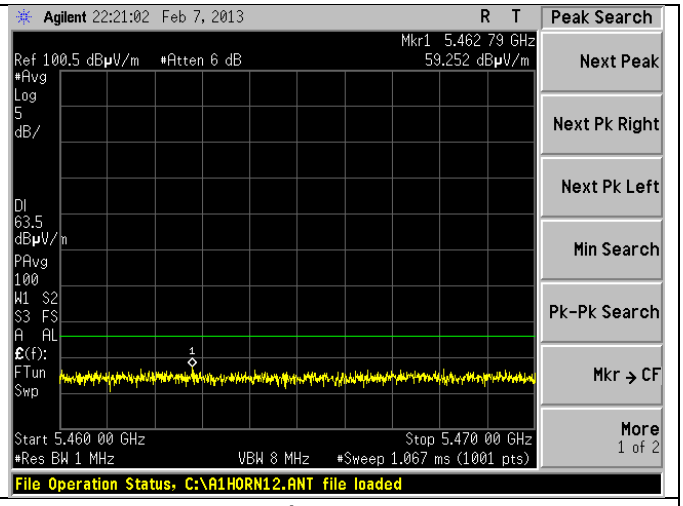


Average

MCS7

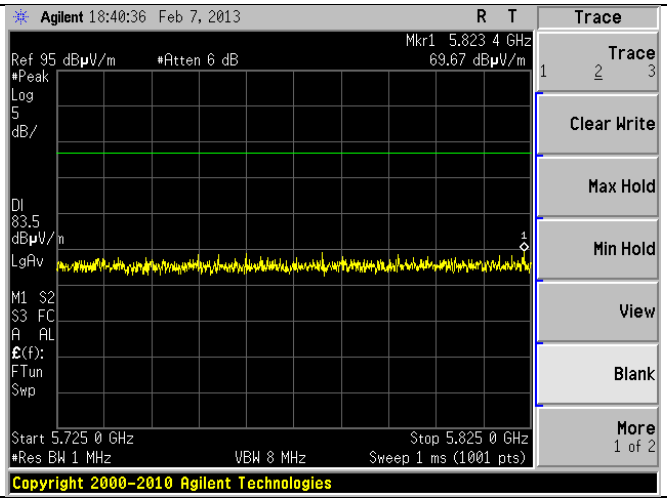


Peak

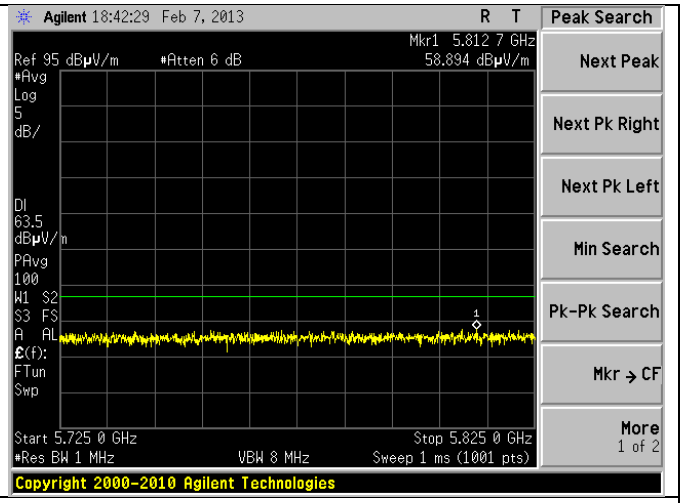


Average

Channel 140
6 Mbps

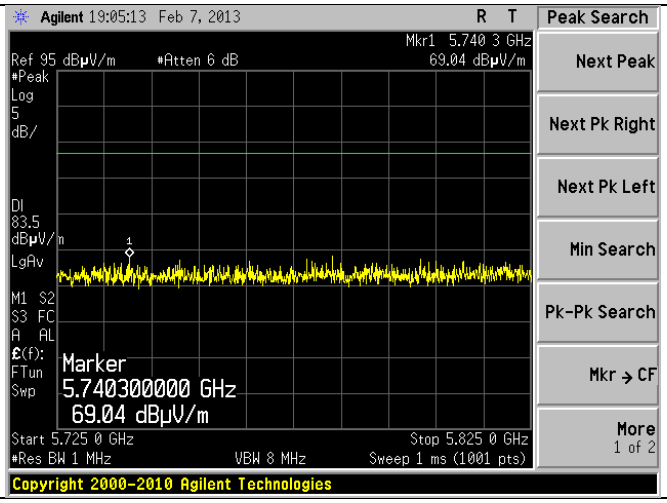


Peak

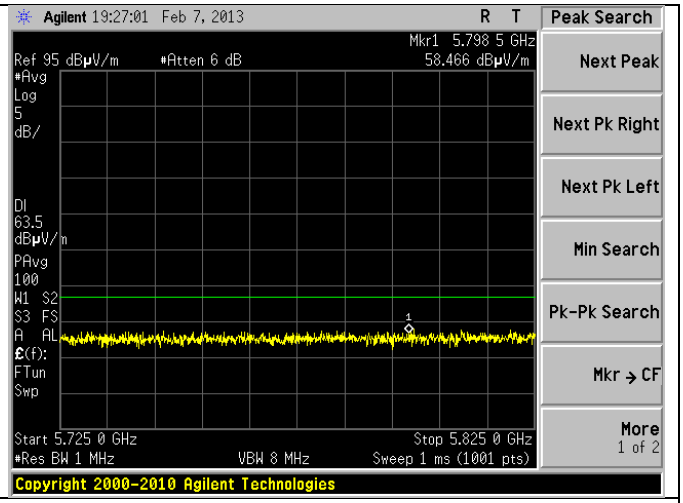


Average

12 Mbps

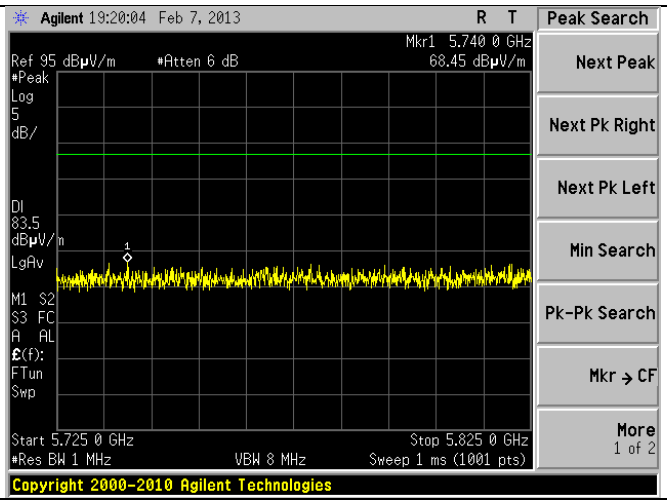


Peak

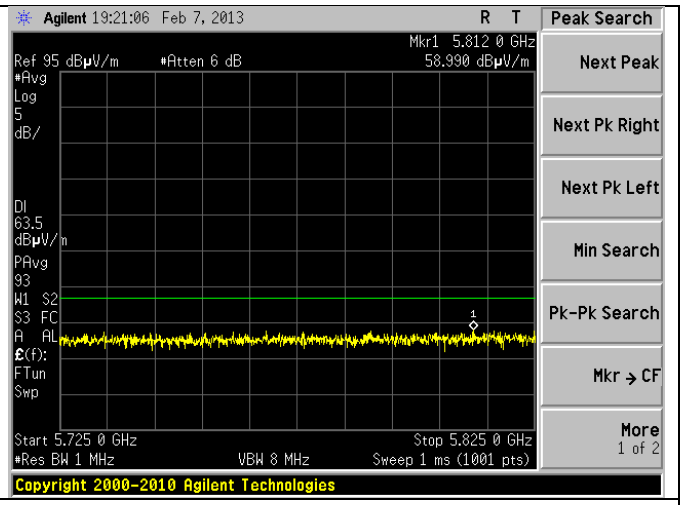


Average

24 Mbps

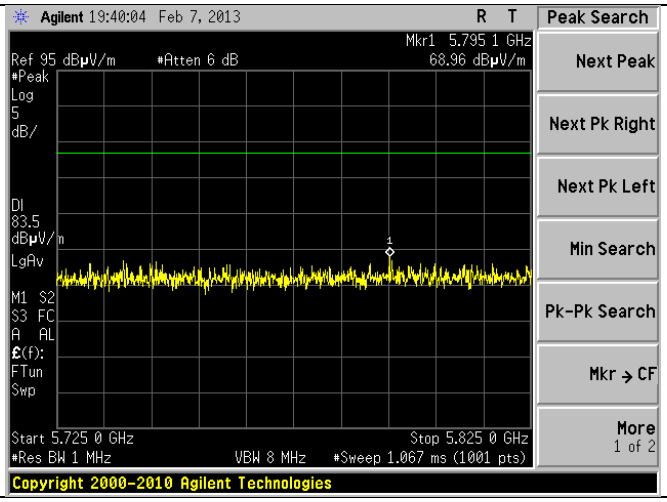


Peak

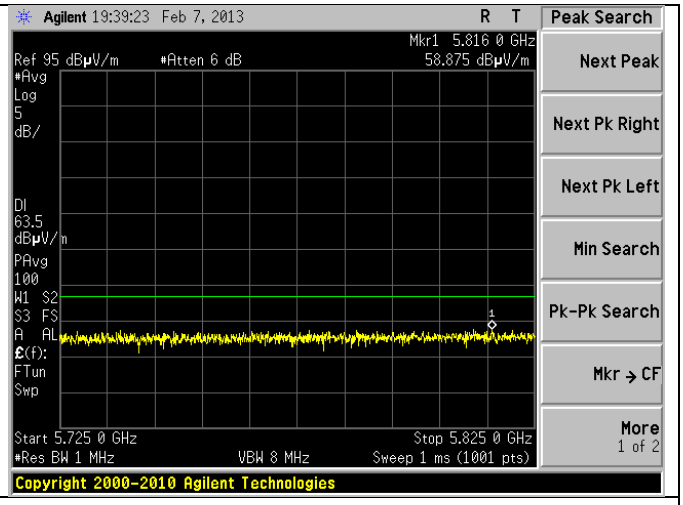


Average

MCS7



Peak



Average

B3 – Frequency Stability

Manufacturer	LS Research
Operator	Khairul Aidi Zainal
Additional Notes	For this test, the EUT was placed inside an environmental chamber. Antenna port conducted measurements were performed at the operating temperature ranges specified by the manufacturer owner's manual. In addition, the supply voltage was varied per the operating ranges specified in the owner's manual. Manufacturer of U-NII devices are responsible for insuring frequency stability such that an emission is maintained within the band of operation under all conditions of normal operation as specified in the user's manual.

			Supply Voltage (V)		
			3.00	3.60	4.80
Temp	Channel	Nominal Frequency (MHz)	Measured Frequency (Hz)	Measured Frequency (Hz)	Measured Frequency (Hz)
-40°C	36	5180.0	5180013165	5180013365	5180013155
	64	5320.0	5320013625	5320013625	5320013285
	112	5560.0	5560013884	5560014095	5560014135
23°C	36	5180.0	5180009465	5180009890	5180010355
	64	5320.0	5320009720	5320010420	5320010500
	112	5560.0	5560009870	5560010820	5560011020
+85°C	36	5180.0	5180011400	5180014950	5180020650
	64	5320.0	5320016875	5320021625	5320016375
	112	5560.0	5560004500	5560012250	5560018625

The data collected shows that the frequency stability of the EUT is better than 1PPM and hence will result in the EUT will remain within the bands of operation.

B4 – AC Mains Conducted Emissions

Test Setup

The test area and setup are in accordance with ANSI C63.4-2003 and with Title 47 CFR, FCC Part 15, Industry Canada RSS-210 and RSS GEN. The EUT was placed on a non-conductive wooden table, with a height of 80 cm above the reference ground plane. The EUT's power cable was plugged into a 50Ω (ohm), 50/250 μH Line Impedance Stabilization Network (LISN). The AC power supply of 120V was provided via an appropriate broadband EMI Filter, and then to the LISN line input. Final readings were then taken and recorded. After the EUT was setup and connected to the LISN, the RF Sampling Port of the LISN was connected to a 10 dB Attenuator-Limiter, and then to the EMI Receiver. The EMCO LISN used has the ability to terminate the unused port with a 50Ω (ohm) load when switched to either L1 (line) or L2 (neutral).

Test Procedure

The EUT was investigated in continuous modulated transmit mode and continuous receive mode for this portion of the testing. The appropriate frequency range and bandwidths were selected on the EMI Receiver, and measurements were made. The bandwidth used for these measurements is 9 kHz, as specified in CISPR 16-1, Section 1, Table 1, for Quasi-Peak and Average detectors in the frequency range of 150 kHz to 30 MHz. Final readings were then taken and recorded.

An off-the-shelf DC power supply was used during the test to supply the EUT with the appropriate DC voltage.

Limits of Conducted Emissions at the AC Mains Ports

Frequency Range (MHz)	**Class B Limits (dBμV)**		**Measuring Bandwidth**
	Quasi-Peak	Average	
0.150 -0.50 *	66-56	56-46	RBW = 9 kHz VBW ≥ 9 kHz for QP VBW = 1 Hz for Average
0.5 – 5.0	56	46	
5.0 – 30	60	50	
* The limit decreases linearly with the logarithm of the frequency in this range.			

Test Data

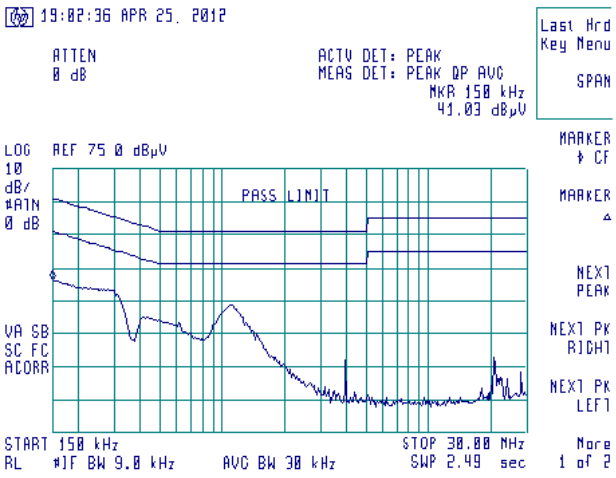
Manufacturer:	LS Research					
Date(s) of Test:	April 25th 2012					
Project Engineer:	Khairul Aidi Zainal					
Test Engineer:	Mike Hintzke					
Voltage:	120 VAC					
Operation Mode:	Continuous transmit, modulated					
Environmental Conditions in the Lab:	Temperature: 71° F Relative Humidity: 40%					
Test Location:	X	AC Mains Test area				Chamber
EUT Placed On:	X	40cm from Vertical Ground Plane				10cm Spacers
	X	80cm above Ground Plane				Other:
Measurements:		Pre-Compliance		Preliminary	X	Final
Detectors Used:		Peak	X	Quasi-Peak	X	Average

		Quasi-Peak			Average		
Frequency (MHz)	Line	Q-Peak Reading (dBµV)	Q-Peak Limit (dBµV)	Quasi-Peak Margin (dB)	Average Reading (dBµV)	Average Limit (dBµV)	Average Margin (dB)
0.150	L1	35.2	66.0	30.8	5.2	56.0	50.8
0.302	L1	32.2	60.2	28.0	10.7	50.2	39.5
1.106	L1	27.2	56.0	28.8	-2.7	46.0	48.7
0.150	L2	34.6	66.0	31.4	4.9	56.0	51.1
0.416	L2	20.0	57.5	37.5	-7.0	47.5	54.5
0.295	L2	30.0	60.4	30.4	0.6	50.4	49.8
1.025	L2	27.6	56.0	28.4	-2.4	46.0	48.4
0.618	L2	22.1	56.0	33.9	17.7	46.0	28.3

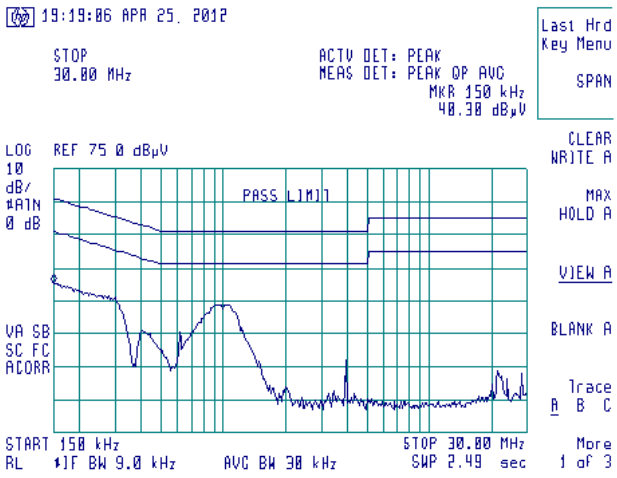
Notes:

1) The emissions listed are characteristic of the power supply used, and did not change by the EUT.

These screen captures represent Peak Emissions. For conducted emission measurements, both a Quasi-Peak detector function and an Average detector function are utilized. The emissions must meet both the Quasi-peak limit and the Average limit as described in 47 CFR 15.207 and RSS GEN 7.2.2 (Table 2).



Line 1



Line 2

Appendix C - Uncertainty Summary

This uncertainty represents an expanded uncertainty expressed at approximately the 95 % confidence level, using a coverage factor of k=2.

Table of Expanded Uncertainty Values, (K=2) for Specified Measurements

Measurement Type	Particular Configuration	Uncertainty Values
Radiated Emissions	3 – Meter chamber, Biconical Antenna	4.82 dB
Radiated Emissions	3-Meter Chamber, Log Periodic Antenna	4.88 dB
Radiated Emissions	3-Meter Chamber, Horn Antenna	4.85 dB
Radiated Emissions	10-Meter OATS, Biconical Antenna	4.32 dB
Radiated Emissions	10-Meter OATS, Log Periodic Antenna	3.63 dB
Absolute Conducted Emissions	Agilent PSA/ESA Series	1.38 dB
AC Line Conducted Emissions	Shielded Room/EMCO LISN	3.20 dB
Radiated Immunity	3 Volts/Meter in 3-Meter Chamber	2.05 Volts/Meter
Conducted Immunity	3 Volts level	2.33 V
EFT Burst, Surge, VDI	230 VAC	54.4 V
ESD Immunity	Discharge at 15kV	3200 V
Temperature/Humidity	Thermo-hygrometer	0.64°/ 2.88 %RH

Appendix D - References

Publication	Year	Title
FCC CFR Parts 0-15	2013	Code of Federal Regulations – Telecommunications
ANSI C63.4	2003	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
RSS-210 Annex 8	2010	Low-power License-exempt Radio communication Devices (All Frequency Bands): Category I Equipment
RSS-GEN Issue 3	2010	General Requirements and Information for the Certification of Radio Apparatus
ANSI C63.10	2009	American National Standard for Testing Unlicensed Wireless Devices
FCC KDB 789033 D01 General UNII Test Procedures v01r02	2012	General UNII Test Procedures

END OF REPORT

Date	Version	Comments	Person
5-13-13	V0	Initial Draft Release	Adam A
5-16-13	V1	Final Release	Adam A