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 # TR 314305 B
LSR Job #: C-2063

Compliance Testing of:
GVPU

Test Date(s):
November 14, 15, 18, 19, 21, 24, 25, 26, 27 2014

Prepared For:
gogo Business Aviation
Attn: Anthony Beck
105 Edgeview Drive
Suite 300
Broomfield, CO 80021

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

Signature: Date: 2-11-15

Test Report Reviewed by:	**Report by:**
Michael Hintzke, EMC Engineer	Adam Alger, EMC Engineer
Signature: Date: 12-21-14	Signature: Date: 12-15-14

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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

In November 2014 the EUT, GVPU as provided from gogo Business Aviation, was tested and MEETS the following requirements:

Operation in the 5.15 – 5.25 GHz band

FCC Rule Part	Test Description	Test Result
15.407 (a)(1)	Power Limits	Pass
15.407 (a)(1)	Peak Power Spectral Density	Pass
15.407 (a)(1)	26dB Bandwidth	Pass
15.407 (b)(1)	Undesirable emissions Limit	Pass
15.407 (b)(6) & (7)	Spurious Emissions below 1GHz	Pass
15.407 (a)(1)(iv)	Mobile and Portable Client Devices	Pass
15.407 (f)	RF Exposure requirements	Pass[1]
15.407 (g)	Frequency Stability	Pass

Note 1: Not covered in this report

Operation in the 5.725 – 5.85 GHz band

FCC Rule Part	Test Description	Test Result
15.407 (a)(3)	Power Limits	Pass
15.407 (a)(3)	Peak Power Spectral Density	Pass
15.407 (a)(3)	26dB Bandwidth	Pass
15.407 (b)(4)	Undesirable emissions Limit	Pass
15.407 (b)(6) & (7)	Spurious Emissions below 1GHz	Pass
15.407 (f)	RF Exposure requirements	Pass[1]
15.407 (g)	Frequency Stability	Pass
15.407(e)	Minimum 6dB bandwidth	Pass

Note 1: Not covered in this report

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:	gogo Business Aviation
Address:	105 Edgeview Drive Suite 300 Broomfield, CO 80021
Contact Person:	Anthony Beck

3.1 Equipment Under Test (EUT) Information

The following information has been supplied by the applicant.

Product Name:	GVPU
Model Number:	P24486
Serial Number:	Eng. Sample
FCC ID	Y7A-P24486

3.2 Product Description

Gogo Video Processing Unit (GVPU) using LSR's Dual band (2.4/5 GHz) TiWi-5 radio module.

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

3.5 Additional Information

EUT programmed for continuous transmit or receive on selectable channel and data rate (modulation) using HCI commands via proprietary cable.

4.0 Conditions of Test

Environmental:

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

Mains Voltage: 120VAC 60Hz
DC Supply to EUT: 28 VDC (nominal) (18-32.2 VDC range)

5.0 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

6.0 Conformance Summary

The EUT was found to MEET the requirements as described within the specification of FCC Title 47, CFR Part 15.407, 15.109.

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 : 17-Oct-2014 Type Test : Radiated and Conducted Emissions Job # : C-2063

Prepared By: Adam A Customer : gogo Air Quote #: 314305

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960073	Spectrum Analyzer	Agilent	E4446A	US45300564	10/19/2014	10/19/2015	Active Calibration
2	EE 960088	8GHz MXE Spectrum Analyzer	Agilent	N9038A	MY51210138	11/19/2013	12/19/2014	Active Calibration
3	AA 960078	Log Periodic Antenna	EMCO	93146	9701-4855	1/8/2014	1/8/2015	Active Calibration
4	AA 960150	Biconical Antenna	ETS	3110B	0003-3346	1/8/2014	1/8/2015	Active Calibration
5	EE 960146	Std. Gain Horn Ant. w/preamp	Adv. Micro / EMC	WLA622-4 / 3160-09	123001	8/20/2014	8/20/2015	Active Calibration
6	AA 960137	Standard Gain Horn Ant.	EMCO	3160-10	69259	8/20/2014	8/20/2015	Active Calibration
7	AA 960158	Double Ridge Horn Antenna	ETS Lindgren	3117	109300	6/20/2014	6/20/2015	Active Calibration
8	EE 960159	0.8 - 21GHz LNA	Mini-Circuits	ZVA-213X-S+	740411007	6/20/2014	6/20/2015	Active Calibration
9	AA 960161	Highpass Filter	K&L Microwave	11SH10-8000	2	1/14/2014	1/14/2015	Active Calibration
10	EE 960084	LISN - 15A	COM-POWER	LI-215A	191920	5/2/2014	5/2/2015	Active Calibration

Project Engineer: Quality Assurance:

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

Manufacturer	gogo Business Aviation
Test Location	LS Research, LLC
Rule Part	FCC Part 15.407
General Measurement Procedure	FCC KDB 789033 D02 General UNII Test Procedures New Rules v01 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.

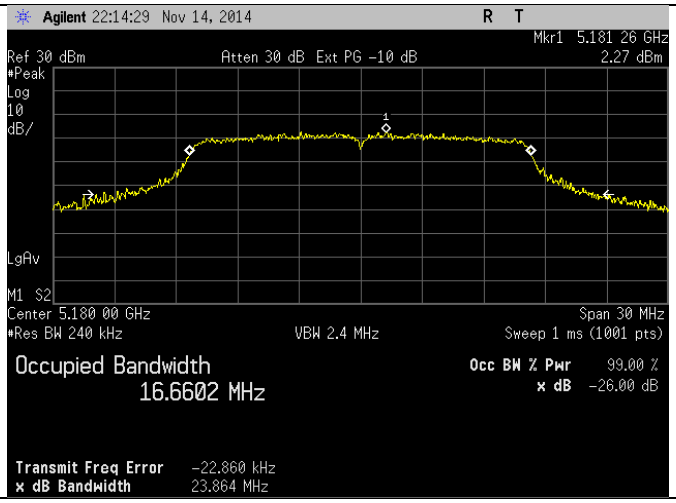
B.1.1 – RF Conducted – Fundamental Bandwidth and Duty Cycle

Manufacturer	gogo Business Aviation
Date	November 14,18,21,24 2014
Operator	Adam A
Temp. / R.H.	20 - 25º C / 30-60% R.H.
Rule Part	FCC Part 15.407
Specific Measurement Procedure	FCC KDB 789033 II B, C, D ANSI C63.10-2009 Section 6.9
Additional Description of Measurement	Peak detector used
Additional Notes	Continuous transmit modulated used for this test.

Table
UNII-1 (5.15-5.25 GHz)

Channel	Frequency (MHz)	Mode (Mbps)	EBW (MHz)	99 % OBW (MHz)
36	5180	6	23.864	16.660
		12	22.968	16.534
		24	22.065	16.525
		54	22.623	16.520
		6.5	24.565	17.761
		65	22.724	17.667
40	5200	6	23.360	16.642
		12	22.896	16.577
		24	22.317	16.542
		54	22.741	16.510
		6.5	25.367	17.761
		65	22.742	17.691
48	5240	6	23.393	16.618
		12	22.695	16.518
		24	21.967	16.529
		54	22.051	16.494
		6.5	24.782	17.732
		65	23.301	17.672

Plots UNII-1
Low Channel – 5180 MHz



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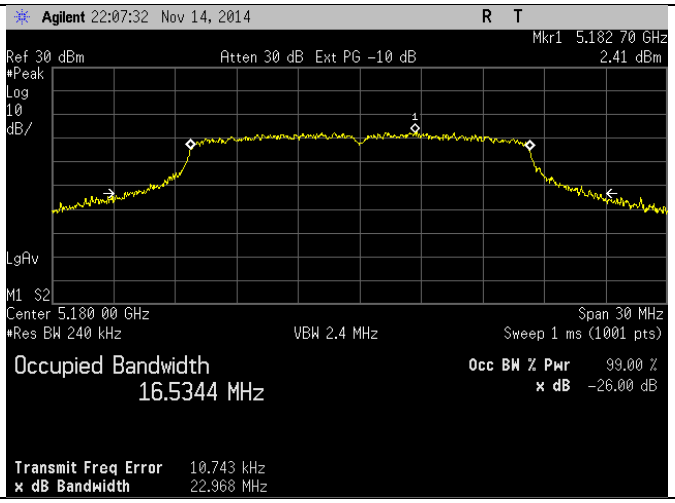

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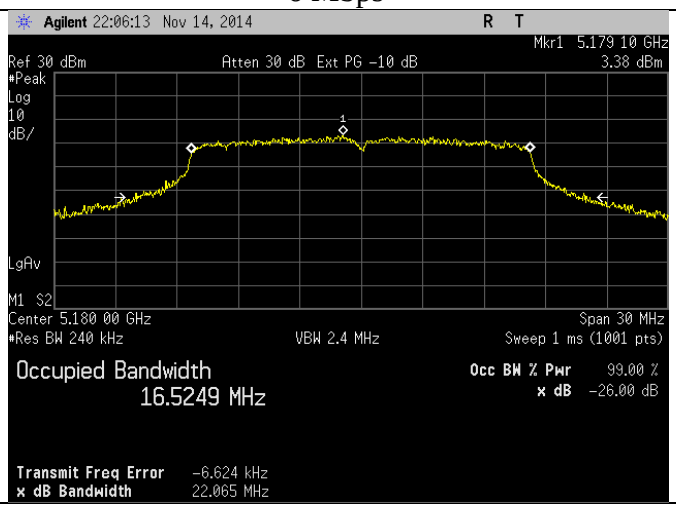

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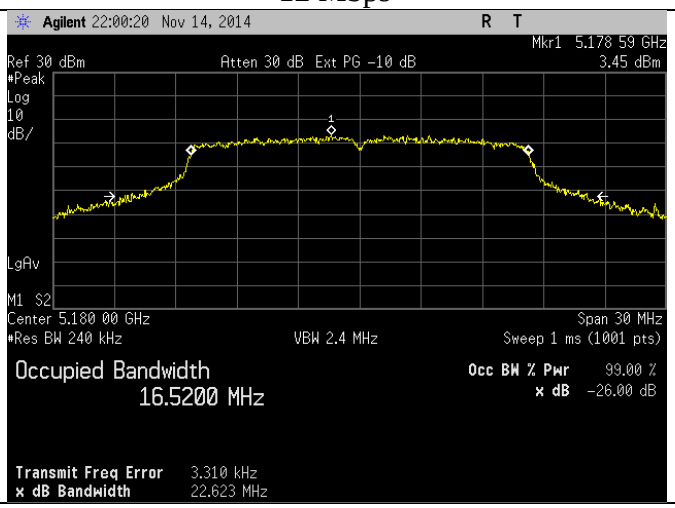

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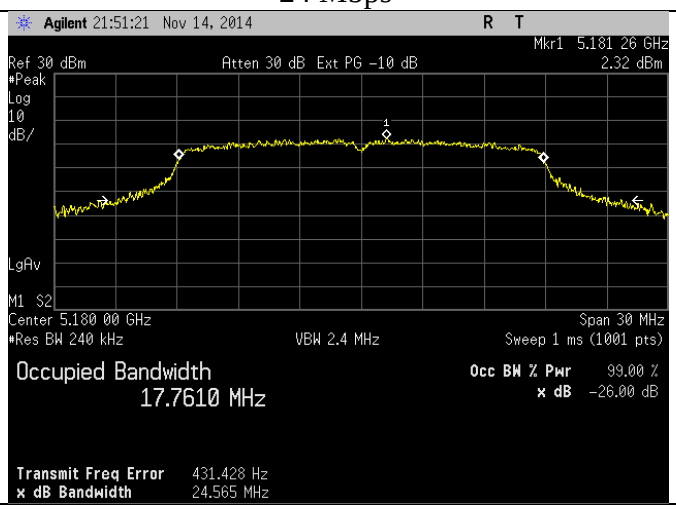
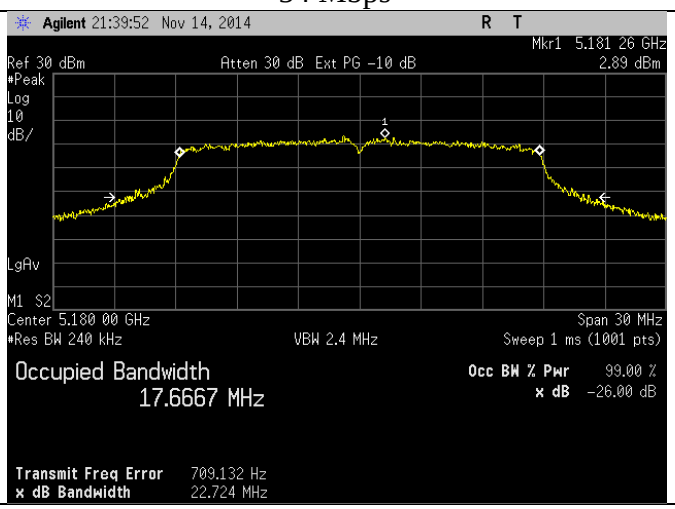
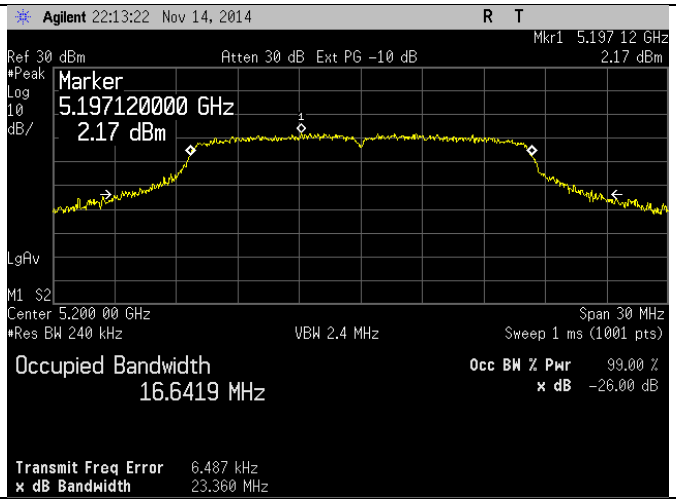


6.5 Mbps



65 Mbps

Plots UNII-1
Mid Channel – 5200 MHz



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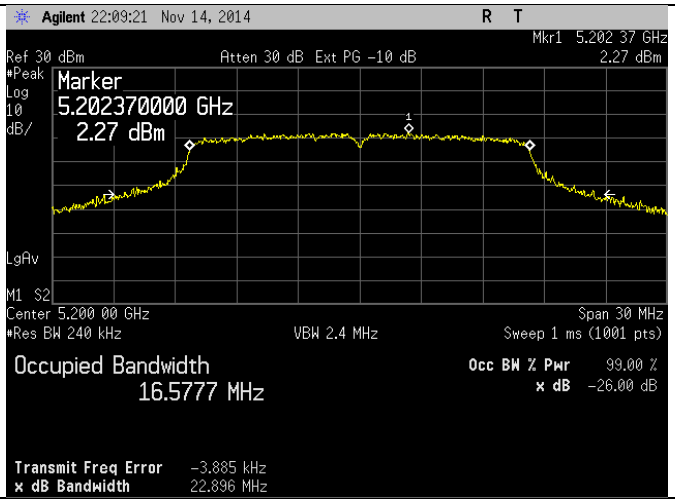

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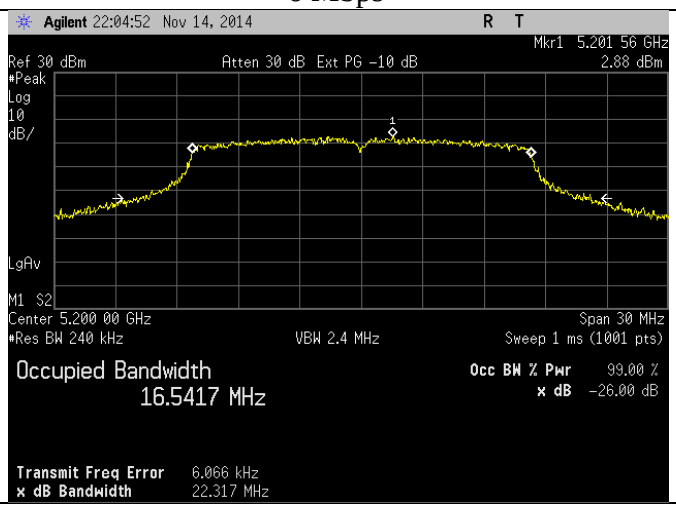

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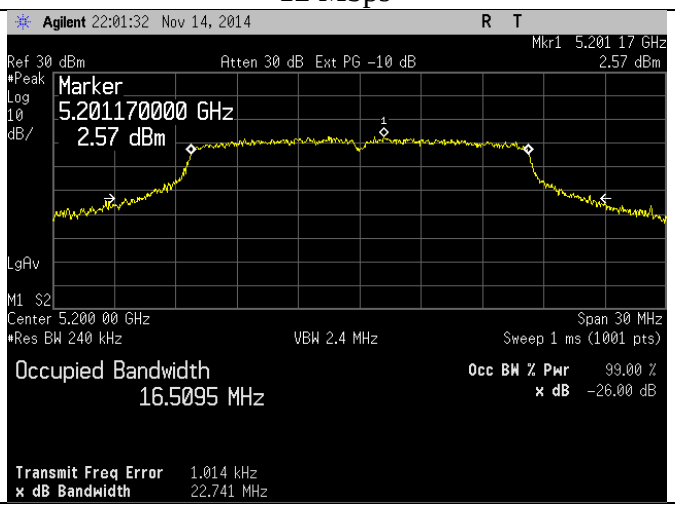

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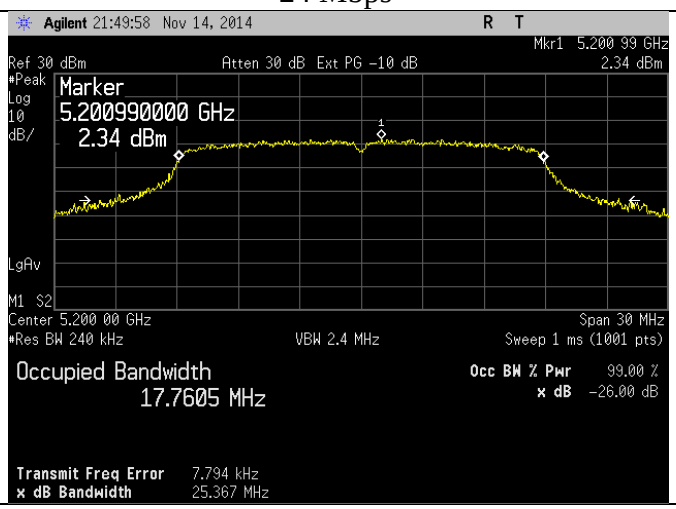

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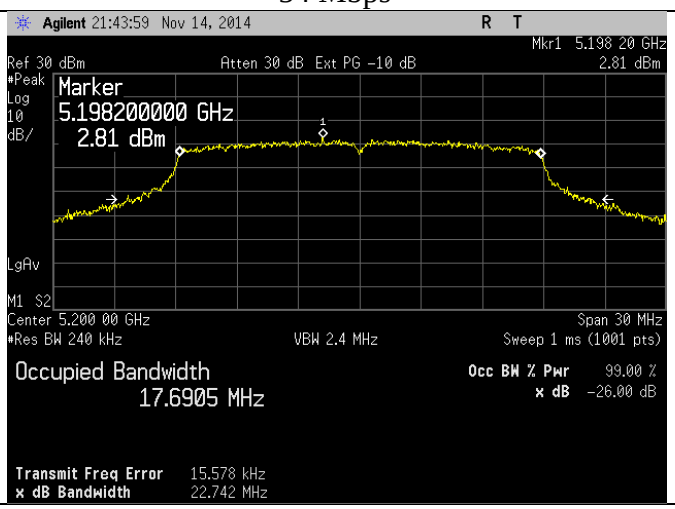
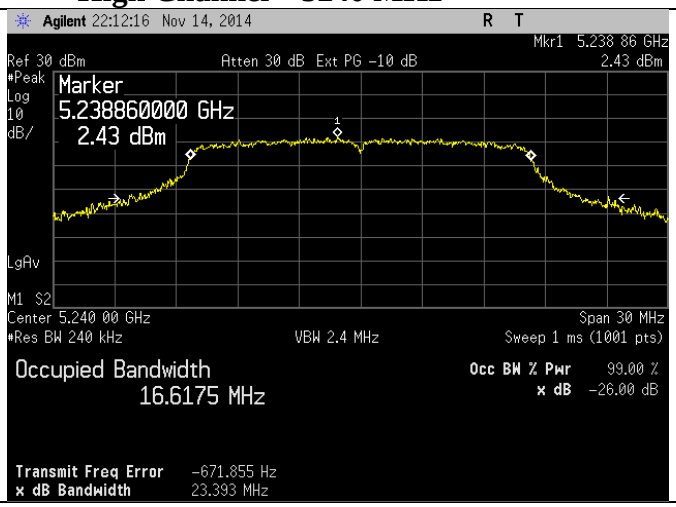


65 Mbps

Plots UNII-1
High Channel – 5240 MHz



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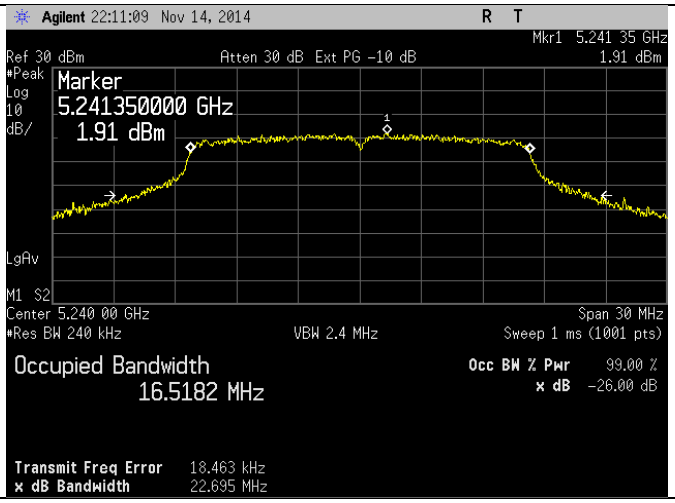

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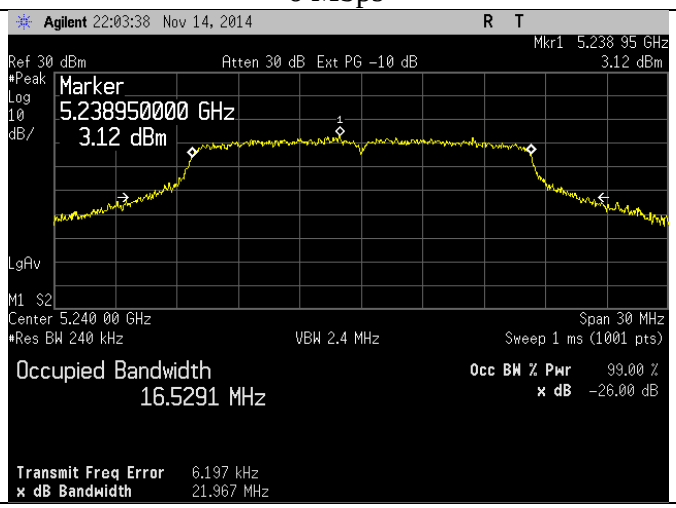

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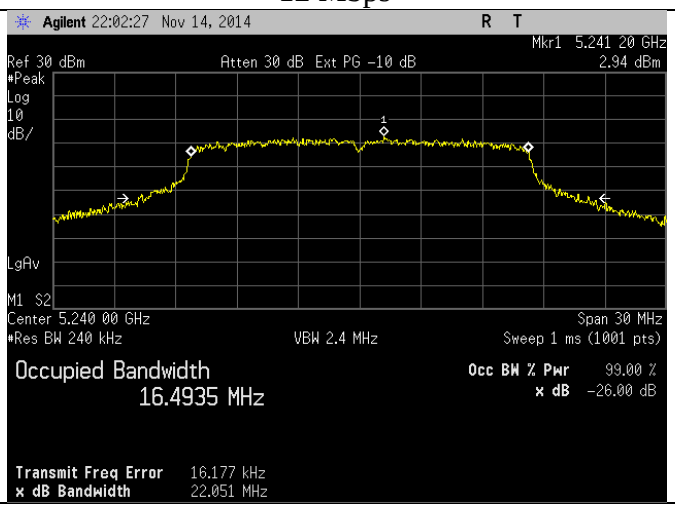

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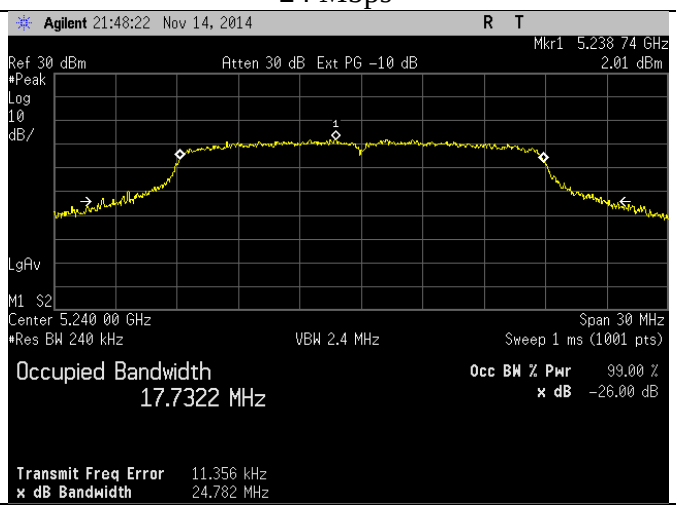

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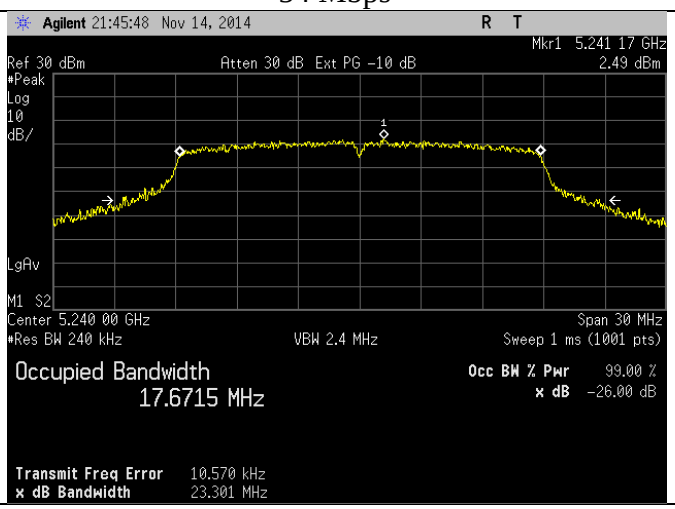
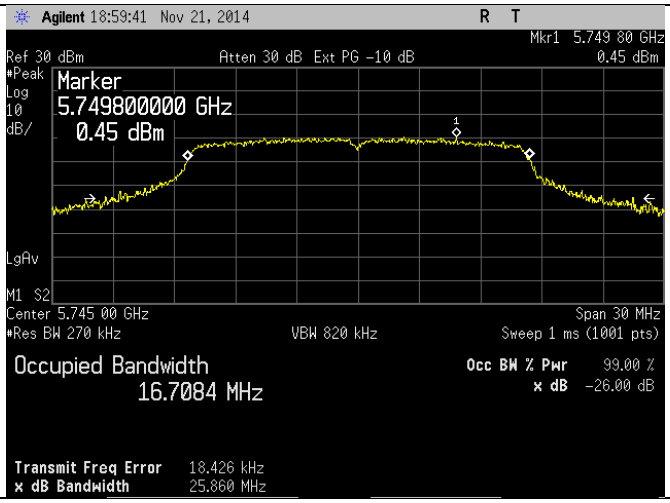


65 Mbps

Table
UNII-3 (5.725-5.85 GHz)

Channel	Frequency (MHz)	Mode (Mbps)	99 % OBW (MHz)	EBW (MHz)
149	5745	6	16.708	25.860
		12	16.566	23.799
		24	16.546	22.077
		54	16.539	21.738
		6.5	17.903	25.491
		65	17.669	22.947
157	5785	6	17.471	29.229
		12	17.041	29.931
		24	17.002	28.427
		54	16.526	21.929
		6.5	18.559	31.648
		65	17.692	22.493
165	5825	6	17.805	34.001
		12	17.203	29.737
		24	16.898	27.519
		54	16.545	21.897
		6.5	18.770	32.817
		65	17.626	22.269

Plots UNII-3
Low Channel – 5745 MHz



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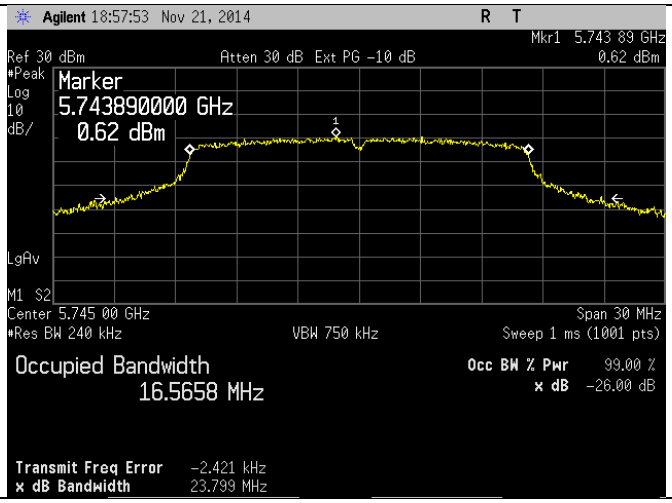

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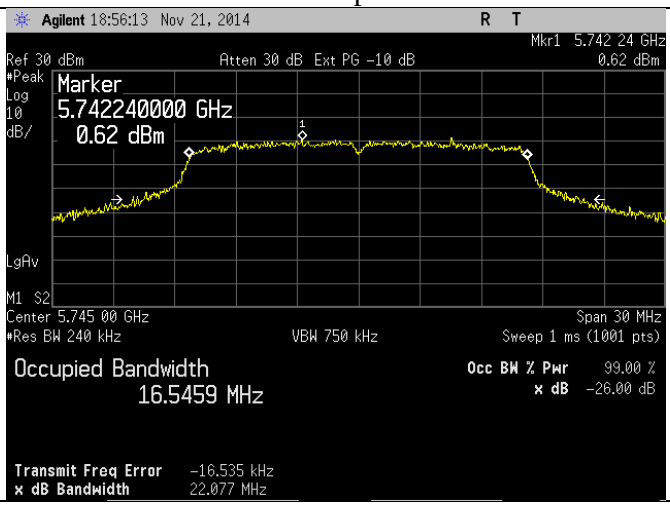

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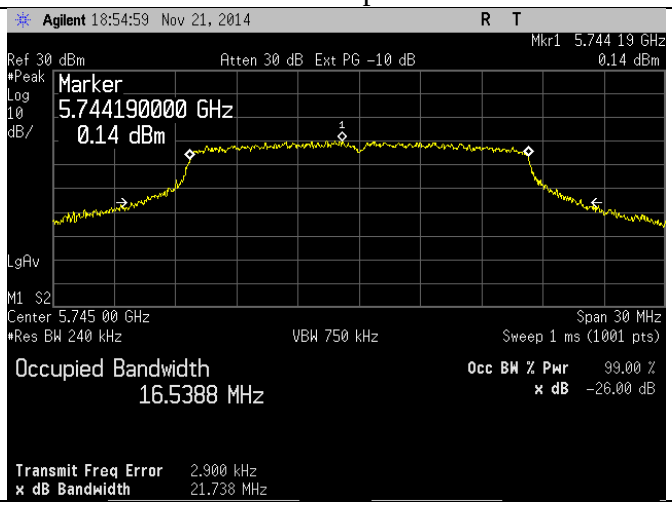

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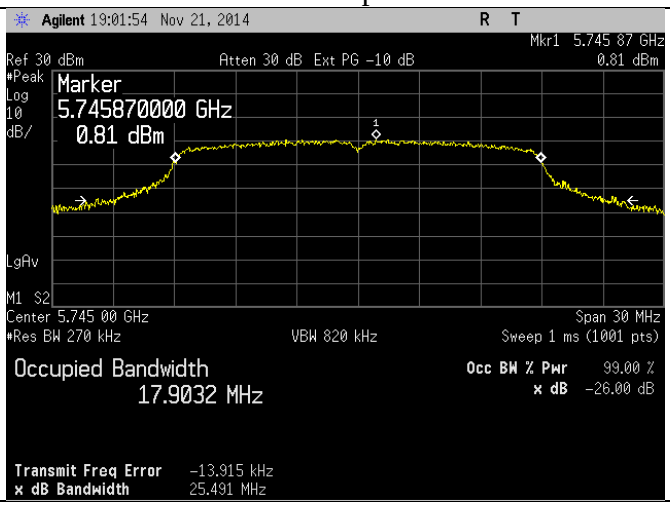

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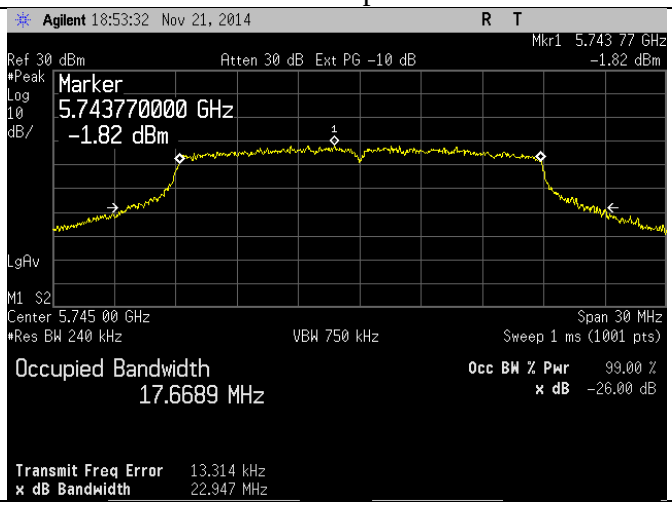

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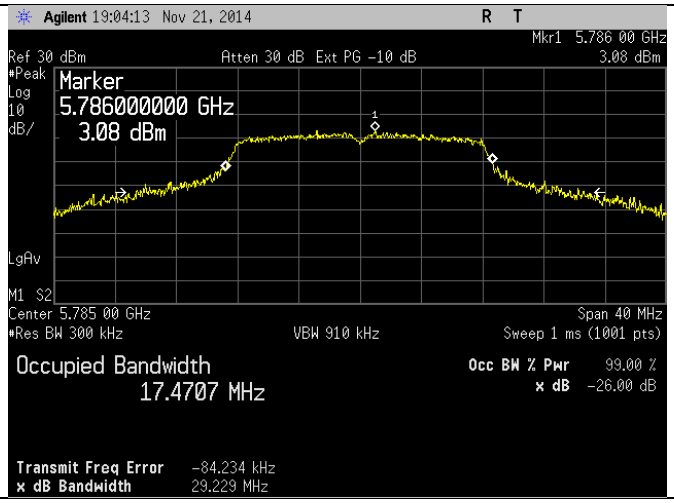
Plots UNII-3
Mid Channel – 5785 MHz



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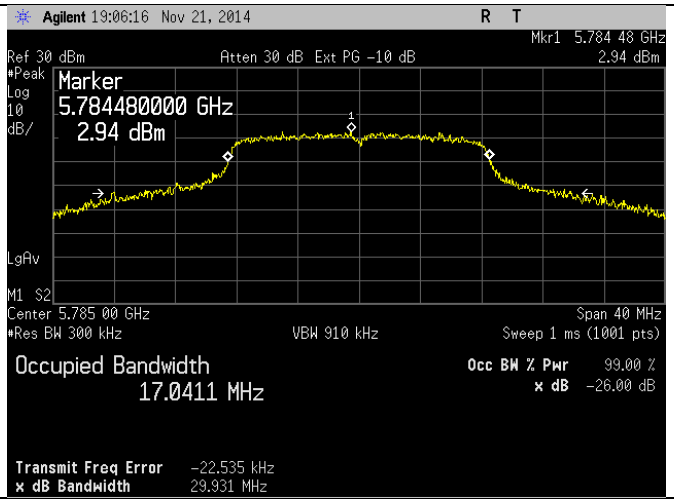

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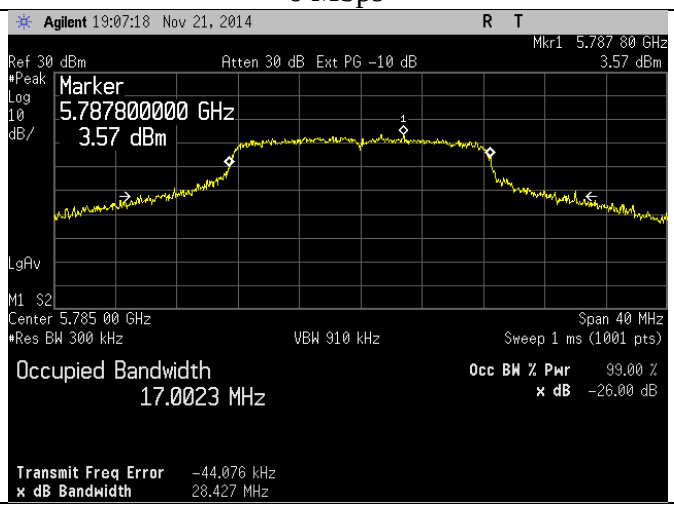

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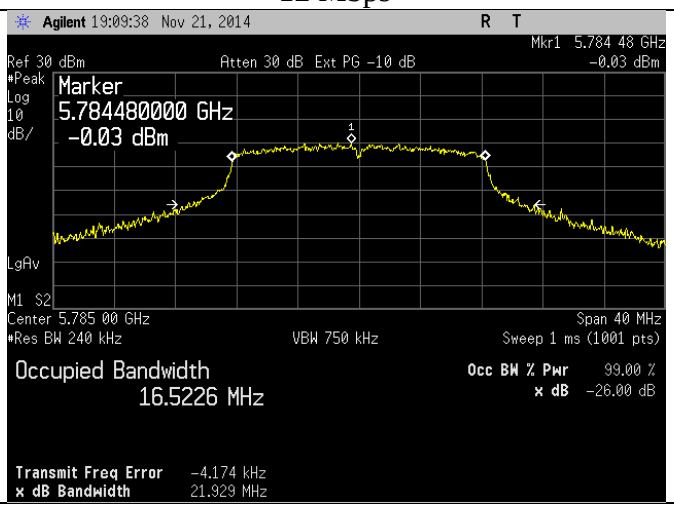

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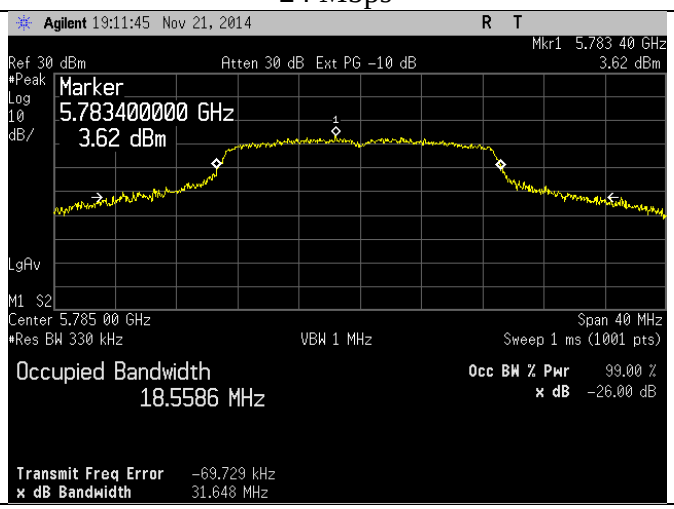

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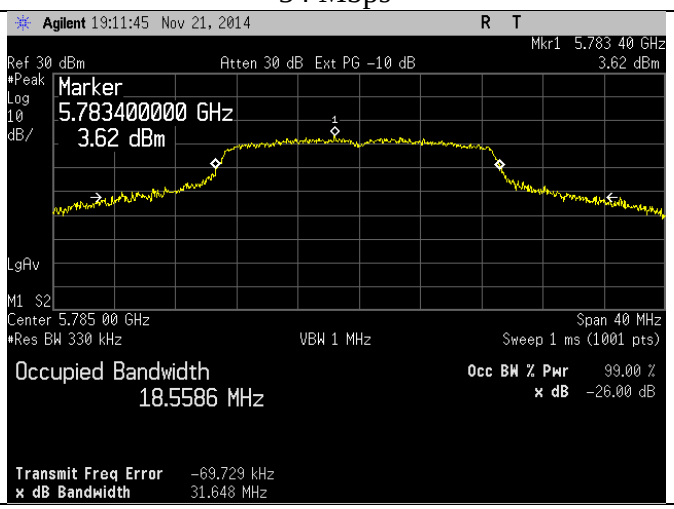
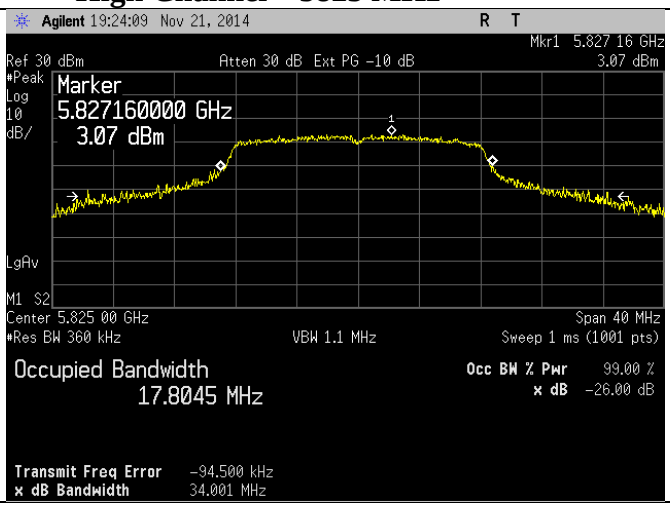
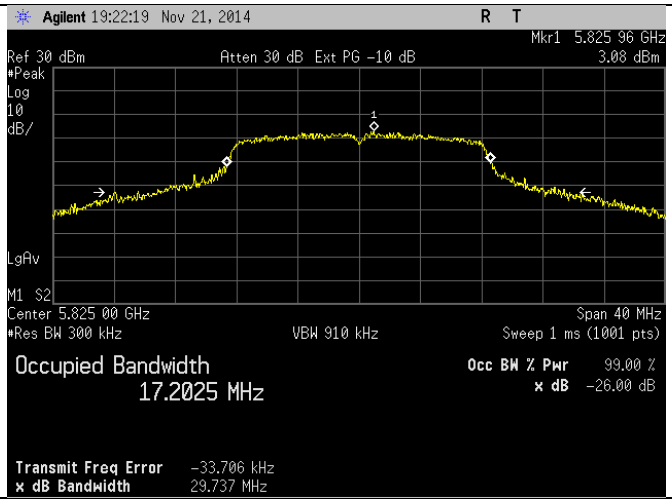


65 Mbps

Plots UNII-3
High Channel – 5825 MHz



6 Mbps



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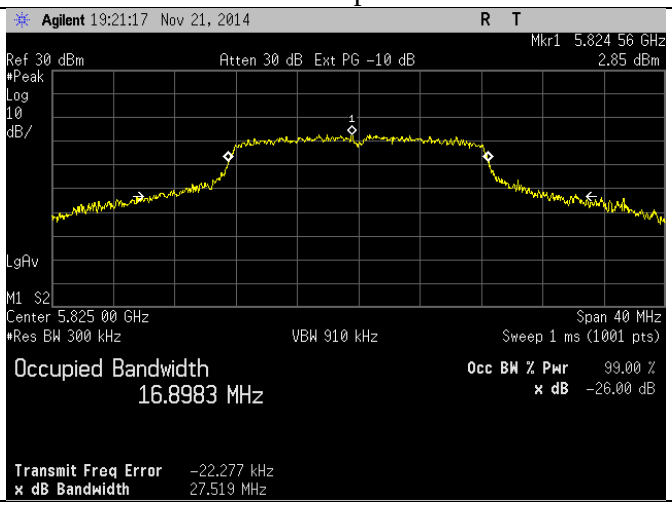

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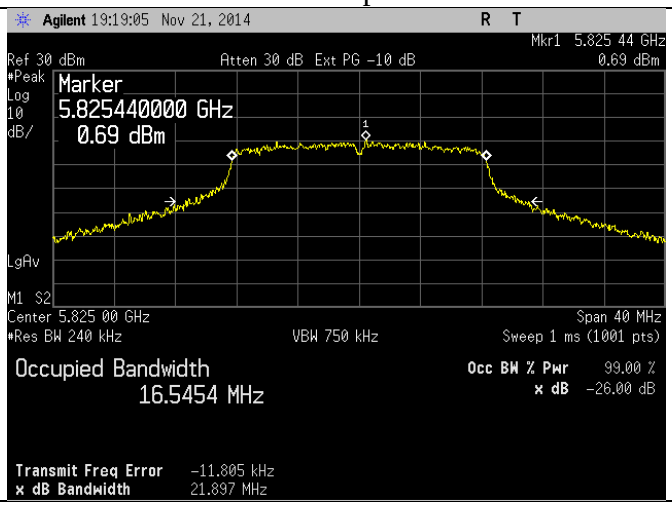

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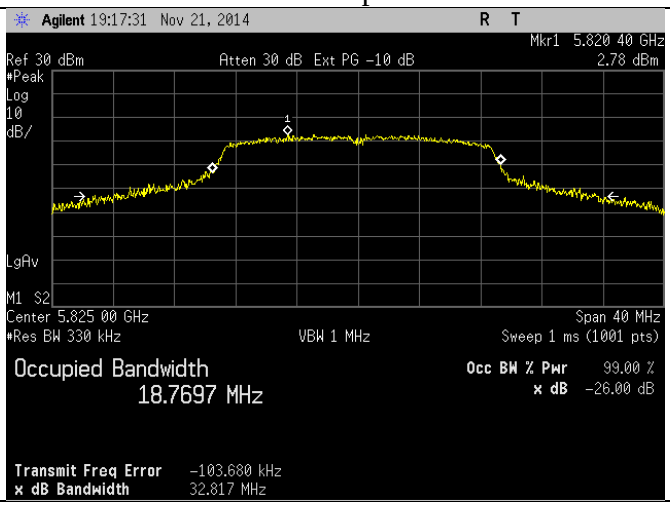
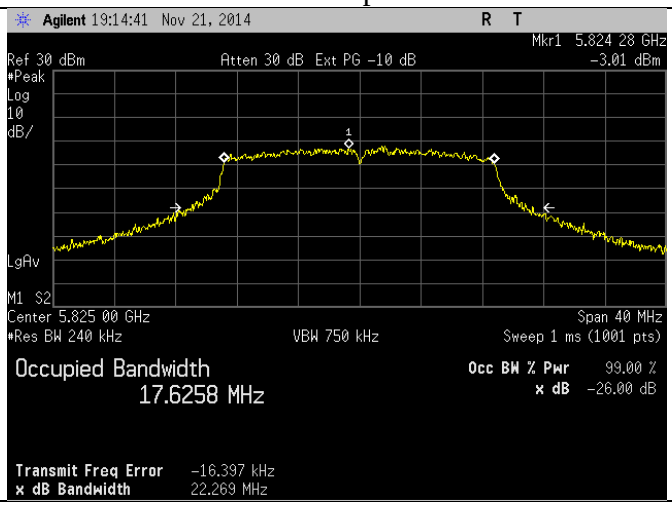


6.5 Mbps

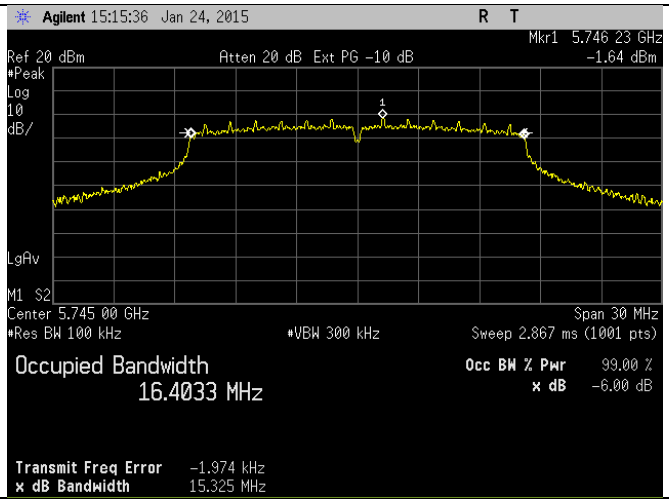


65 Mbps

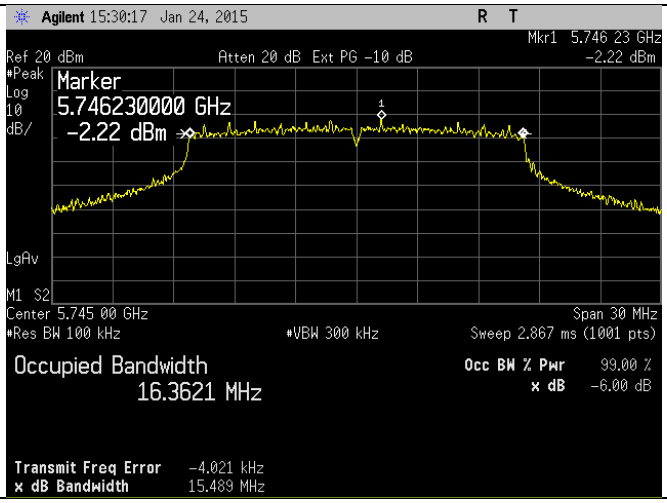
Table
UNII-3 (5.725-5.85 GHz)
DTS BW

Channel	Frequency (MHz)	Mode (Mbps)	DTS BW (MHz)
149	5745	6	15.325
		12	15.489
		24	16.281
		54	16.122
		6.5	15.150
		65	17.001
157	5785	6	15.180
		12	15.163
		24	15.793
		54	16.394
		6.5	15.103
		65	16.640
165	5825	6	15.153
		12	15.487
		24	15.404
		54	16.380
		6.5	15.106
		65	16.925

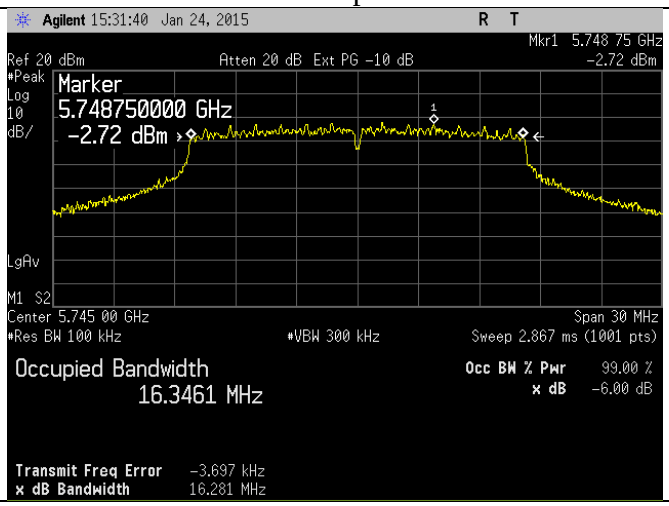
Plots UNII-3 DTS BW
Low Channel – 5745 MHz



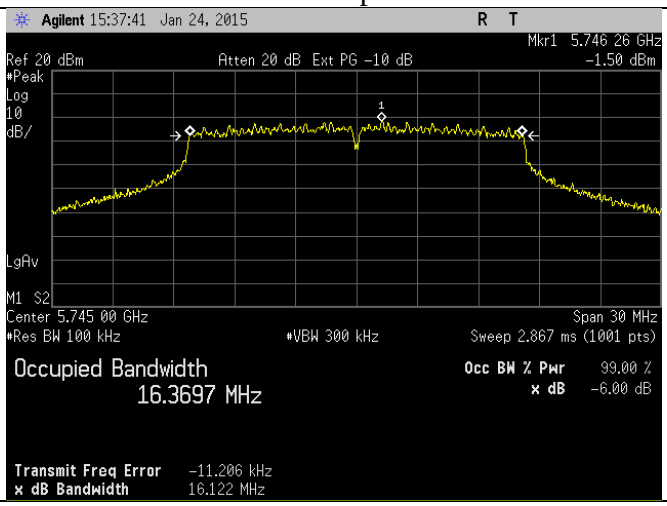
6 Mbps



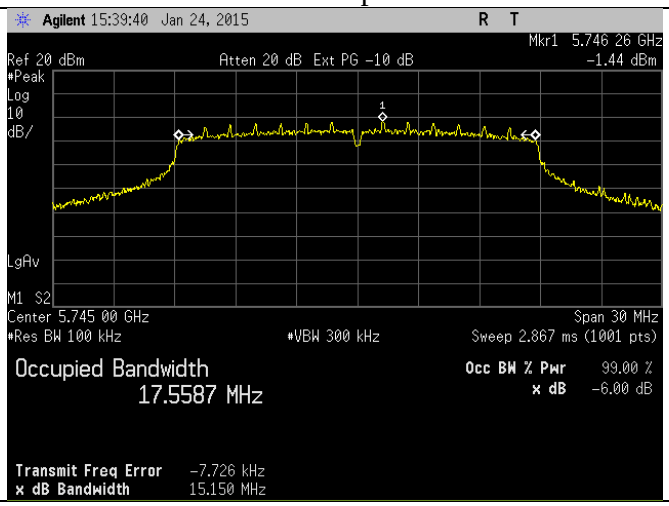
12 Mbps



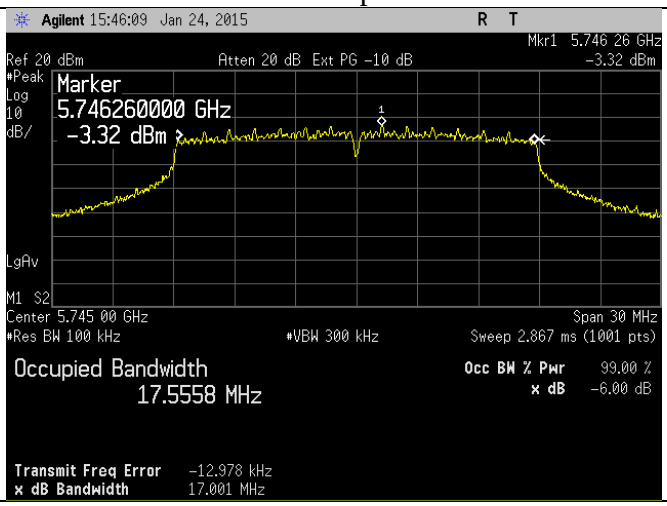
24 Mbps



54 Mbps

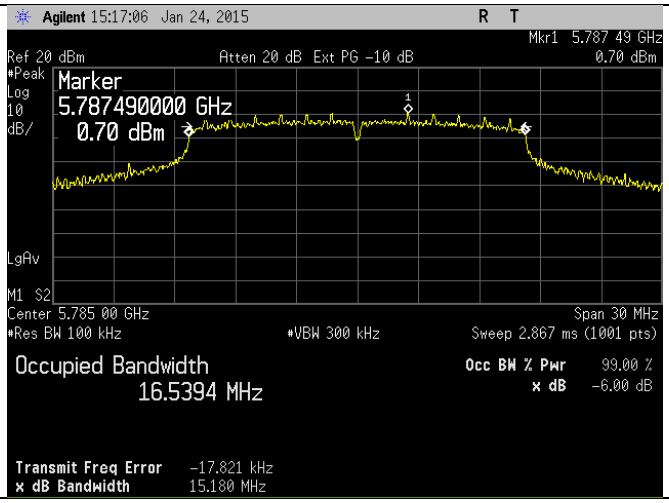


6.5 Mbps

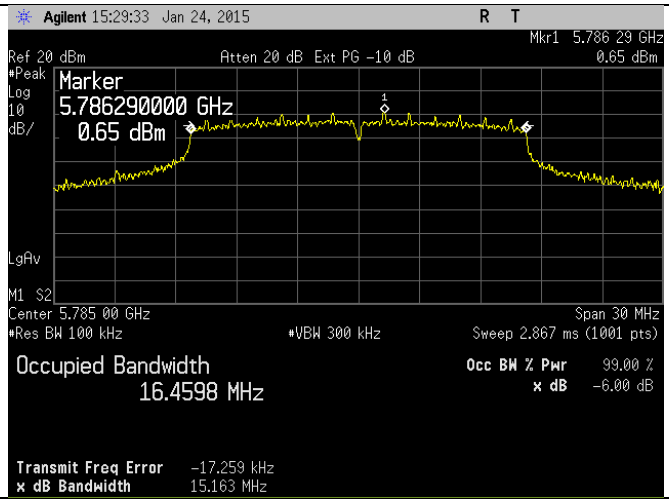


65 Mbps

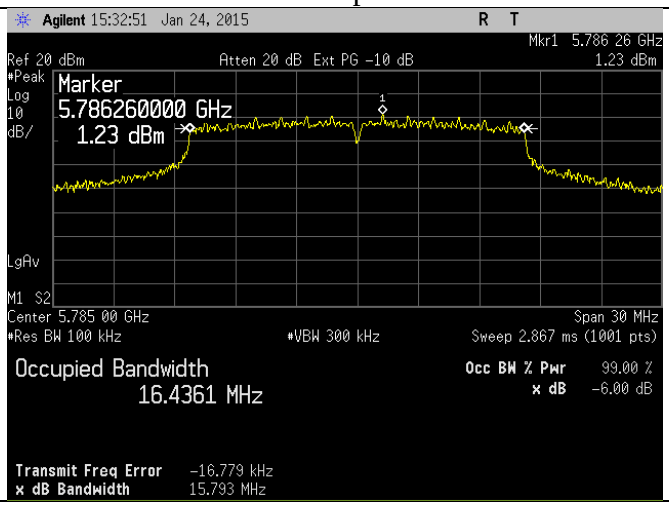
Plots UNII-3 DTS BW
Mid Channel – 5785 MHz



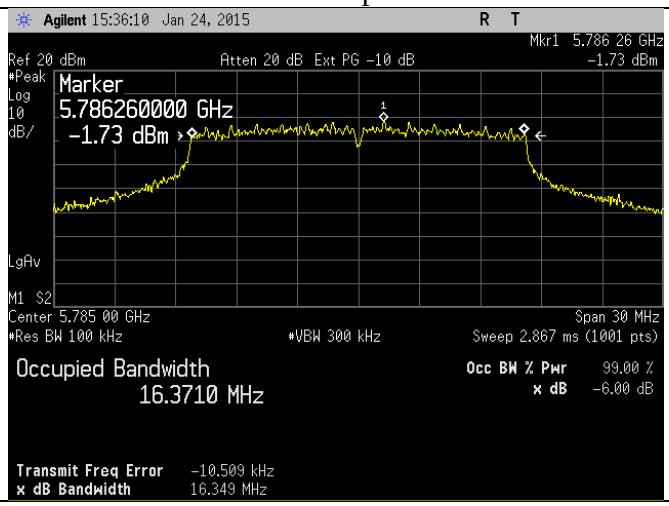
6 Mbps



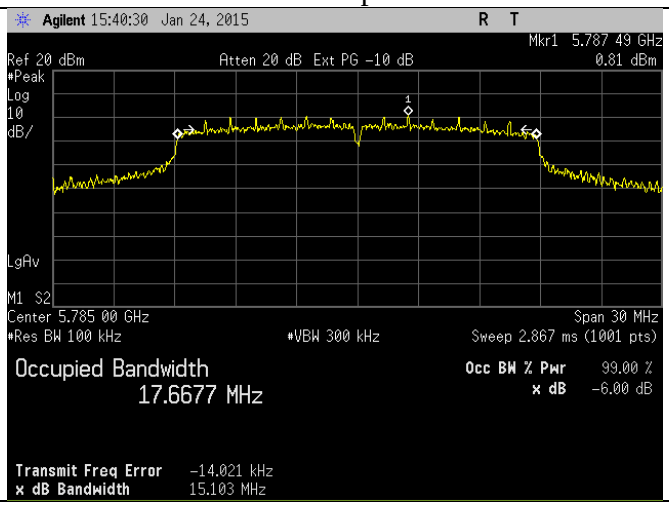
12 Mbps



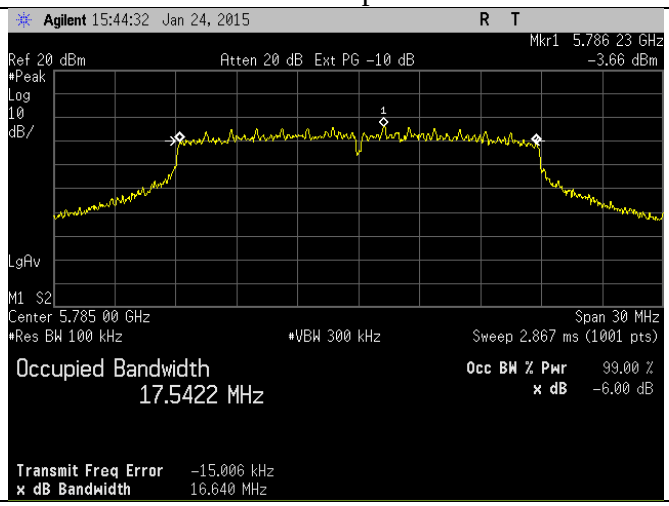
24 Mbps



54 Mbps

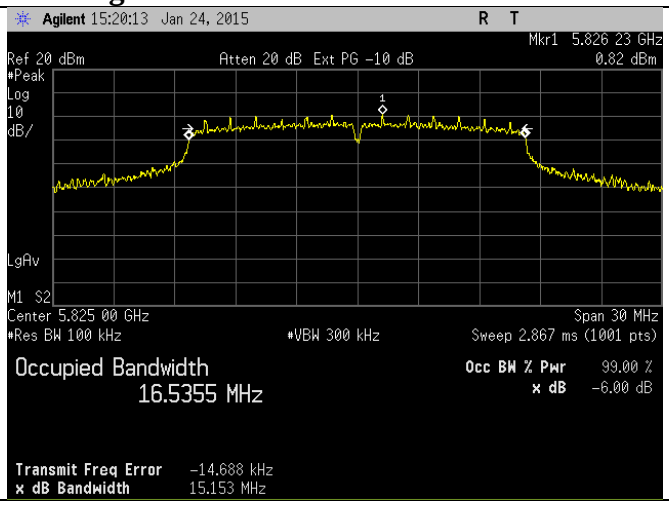


6.5 Mbps

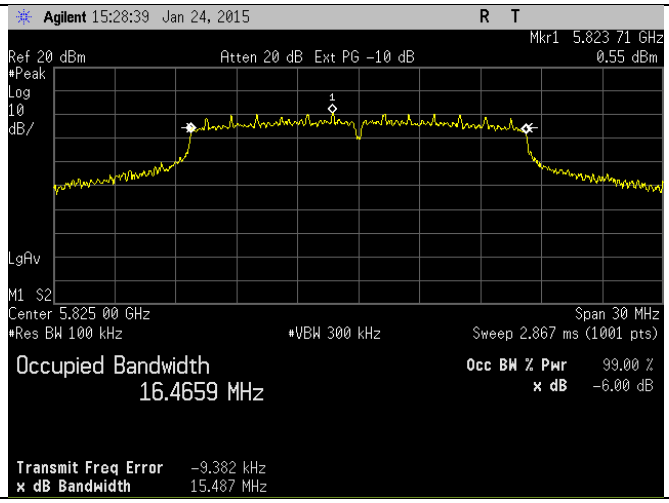


65 Mbps

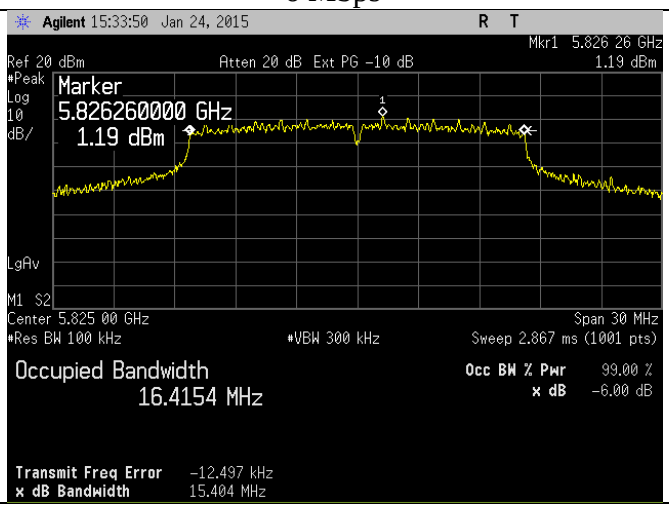
Plots UNII-3 DTS BW
High Channel – 5825 MHz



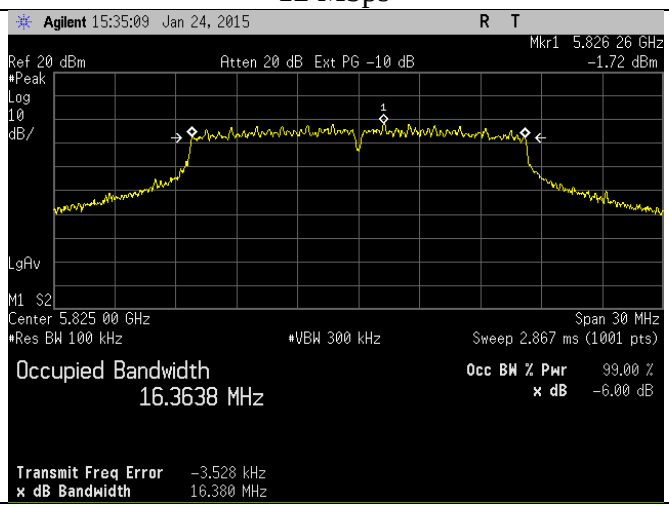
6 Mbps



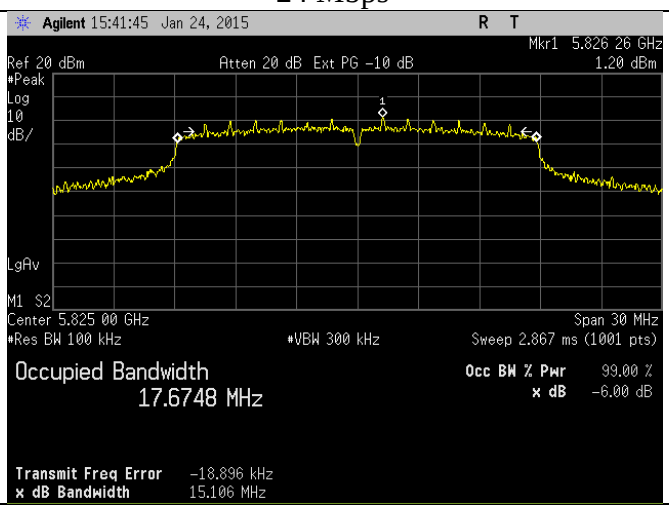
12 Mbps



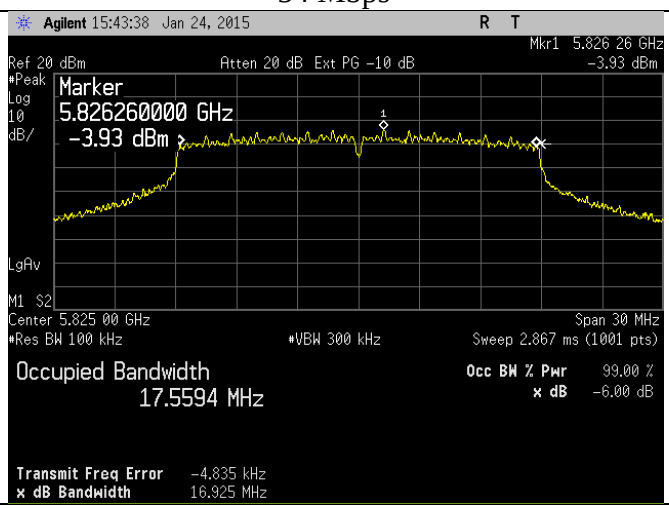
24 Mbps



54 Mbps



6.5 Mbps



65 Mbps

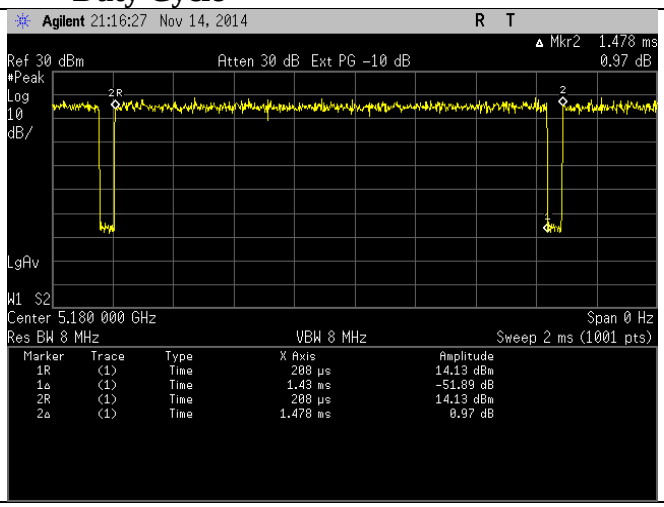
Table
Duty Cycle

Mode (802.11)	Mode (Mbps)	On-time (ms)	Total Time (ms)	Duty Cycle (x)	Duty Cycle Correction (dB)
a	6	1.43	1.478	0.97	0.14
	12	0.726	0.774	0.94	0.28
	24	0.374	0.424	0.88	0.54
	54	0.181	0.23	0.79	1.04
n	6.5	1.326	1.374	0.97	0.15
	65	0.157	0.207	0.76	1.20

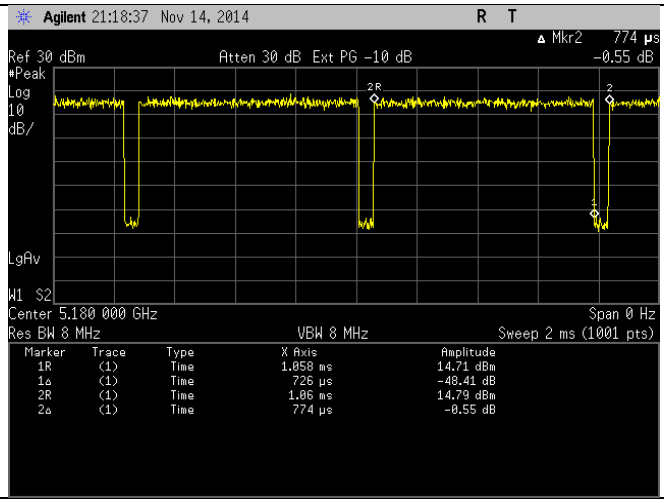
Duty Cycle Correction (dB) = 10*log (1/x)

Plots

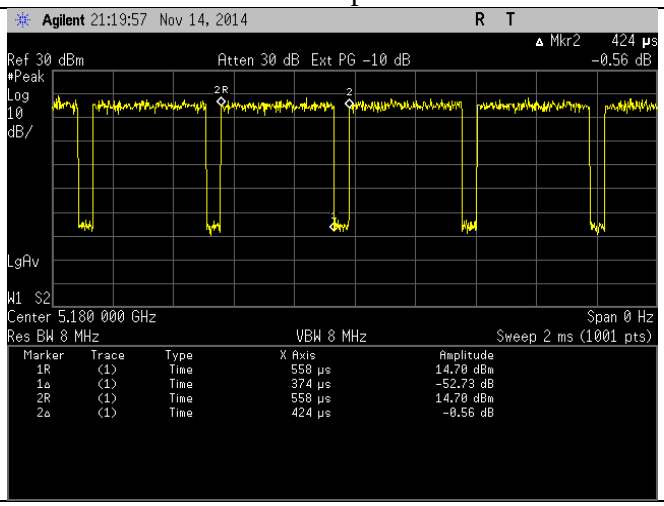
Duty Cycle



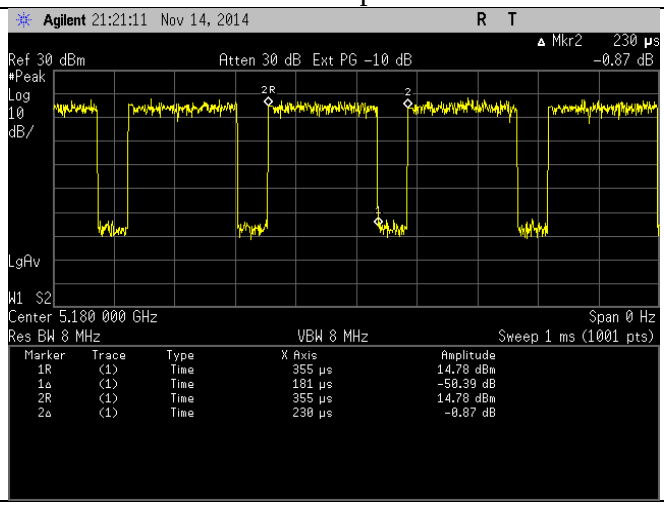
6 Mbps



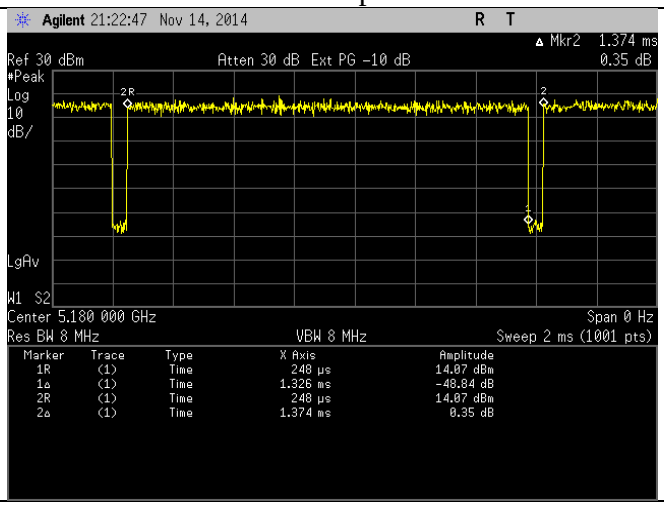
12 Mbps



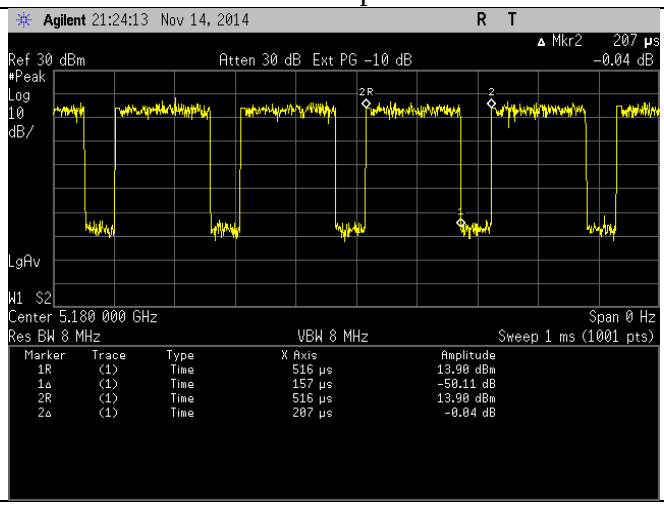
24 Mbps



54 Mbps



6.5 Mbps



65 Mbps

B.1.2 – RF Conducted – Fundamental Power and Spectral Density

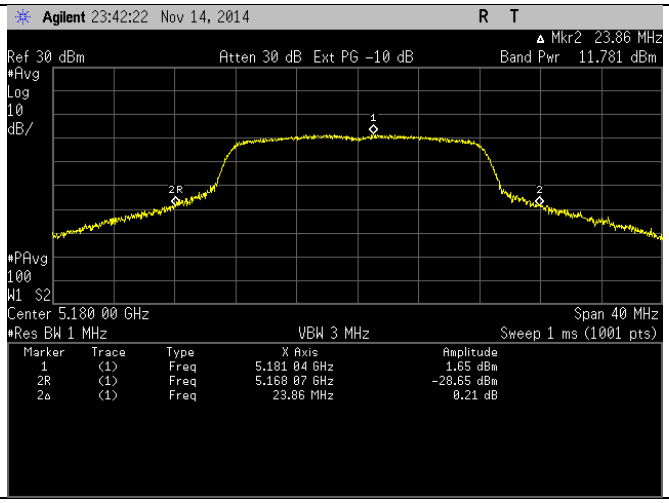
Manufacturer	gogo Business Aviation
Date	November 14,15,18,19,21 2014
Operator	Adam A
Temp. / R.H.	20 - 25º C / 30-60% R.H.
Rule Part	15.407
Specific Measurement Procedure	FCC KDB 789033 II E. (Method SA-1) & F.
Additional Description of Measurement	Average power over the on time of the transmission.
Additional Notes	Continuous transmit modulated used for this test. Stated antenna gain: 3.9 dBi

Table
UNII-1 (5.15-5.25 GHz)

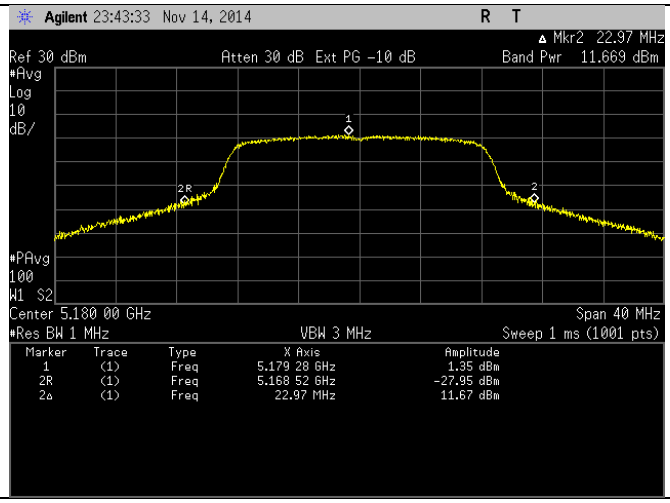
Channel	Frequency (MHz)	Mode (Mbps)	EBW (MHz)	99 % OBW (MHz)	Power (dBm)	PSD (dBm/MHz)
36	5180	6	23.864	16.660	11.78	1.65
		12	22.968	16.534	11.67	1.35
		24	22.065	16.525	11.33	1.45
		54	22.623	16.520	10.92	1.10
		6.5	24.565	17.761	11.75	1.32
		65	22.724	17.667	9.91	-0.03
40	5200	6	23.360	16.642	11.58	1.09
		12	22.896	16.577	11.51	1.39
		24	22.317	16.542	11.08	0.75
		54	22.741	16.510	10.67	0.67
		6.5	25.367	17.761	11.50	1.27
		65	22.742	17.691	9.64	-0.44
48	5240	6	23.393	16.618	11.15	1.06
		12	22.695	16.518	10.98	1.17
		24	21.967	16.529	10.69	0.63
		54	22.051	16.494	10.24	0.44
		6.5	24.782	17.732	11.19	0.78
		65	23.301	17.672	9.36	-0.75

FCC 15.407 (a) (1) (iv) maximum conducted power limit = 250 mW = 24 dBm
FCC 15.407 (a) (1) (iv) maximum conducted power spectral density limit = 11 dBm/MHz

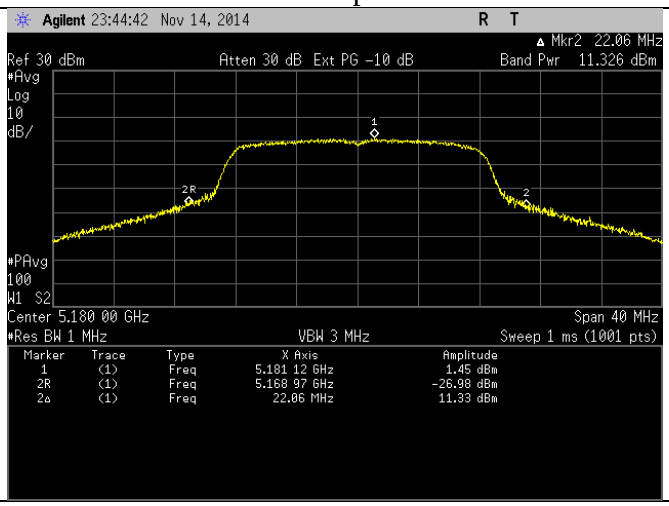
Plots UNII-1
Low Channel – 5180 MHz



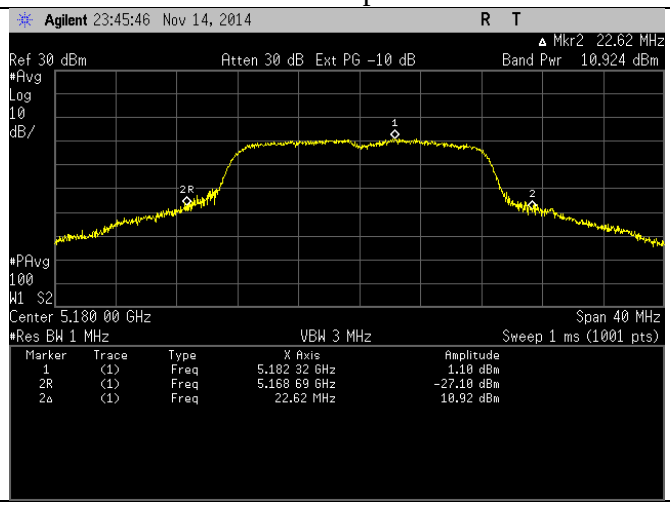
6 Mbps



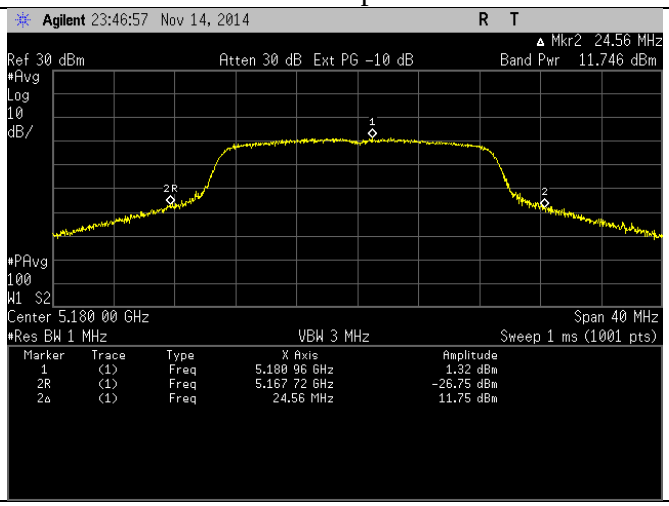
12 Mbps



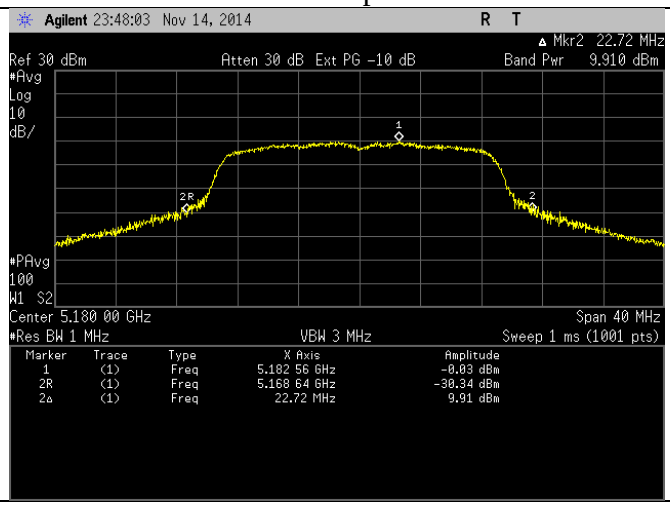
24 Mbps



54 Mbps

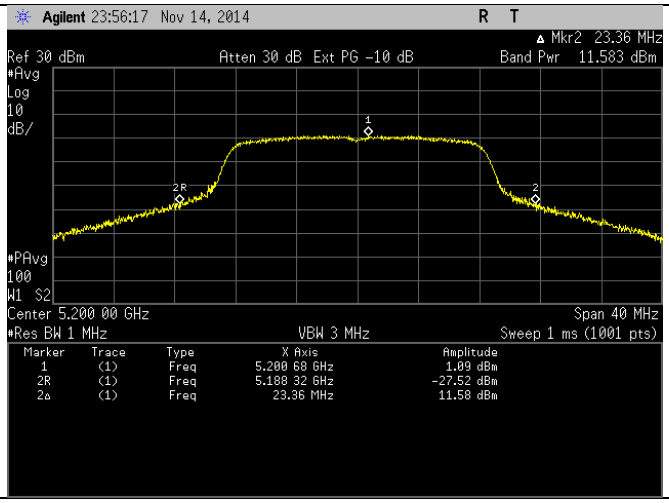


6.5 Mbps

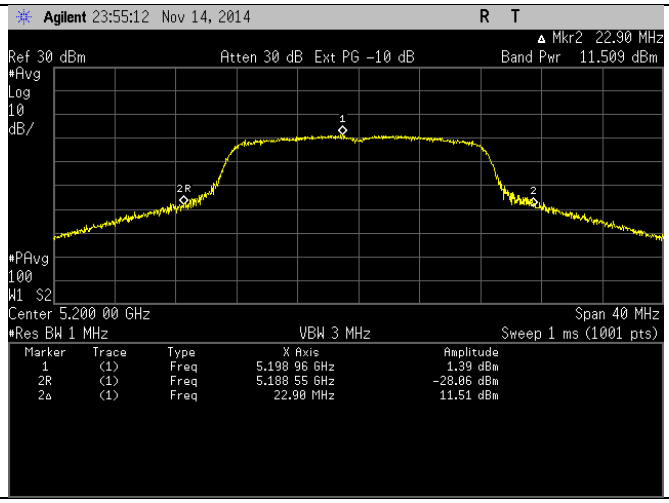


65 Mbps

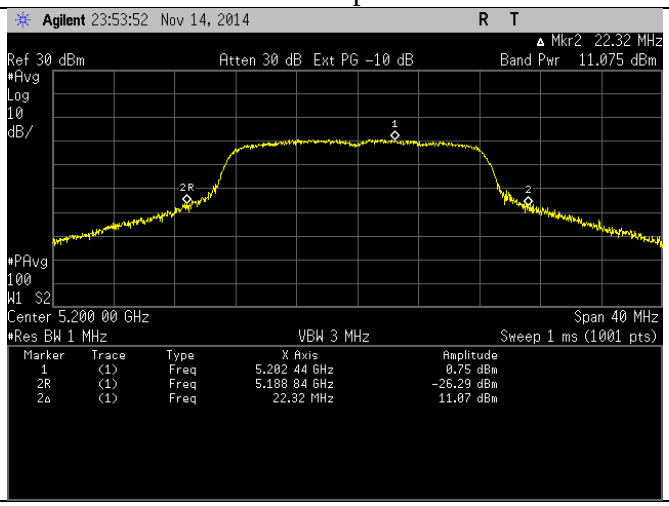
Plots UNII-1
Mid Channel – 5200 MHz



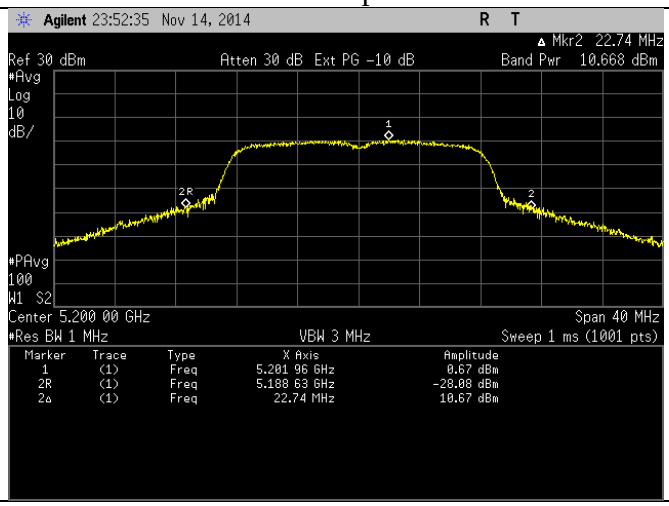
6 Mbps



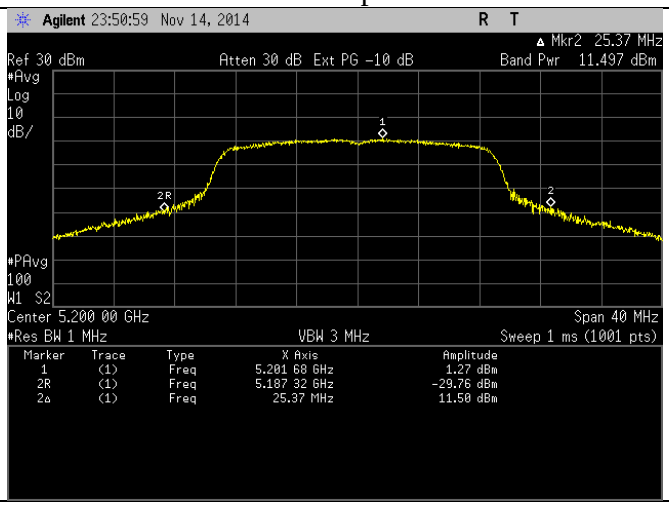
12 Mbps



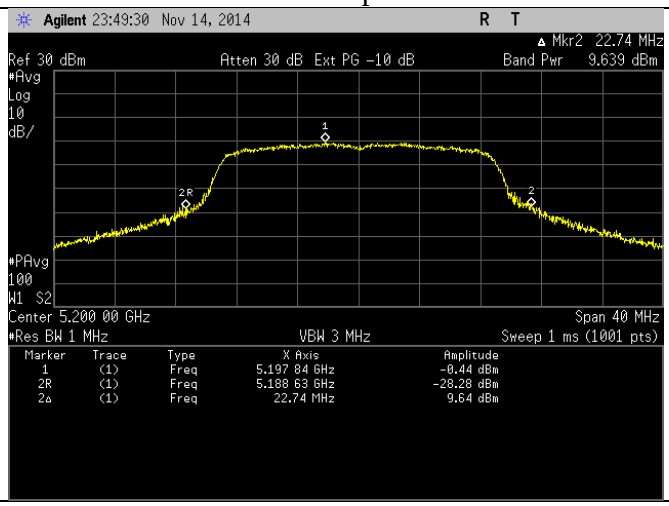
24 Mbps



54 Mbps

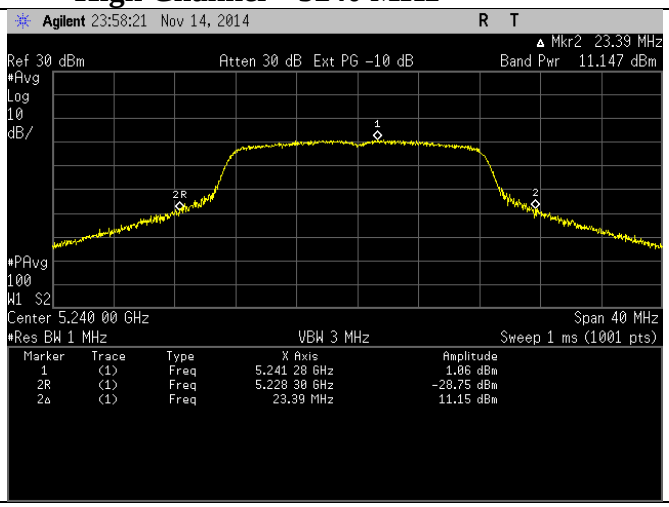


6.5 Mbps

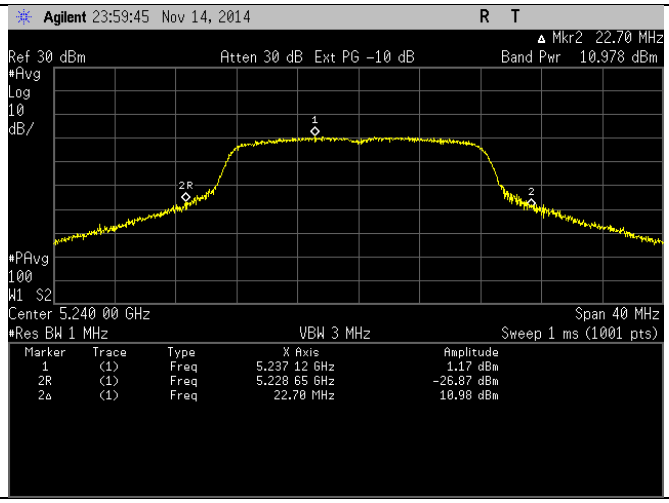


65 Mbps

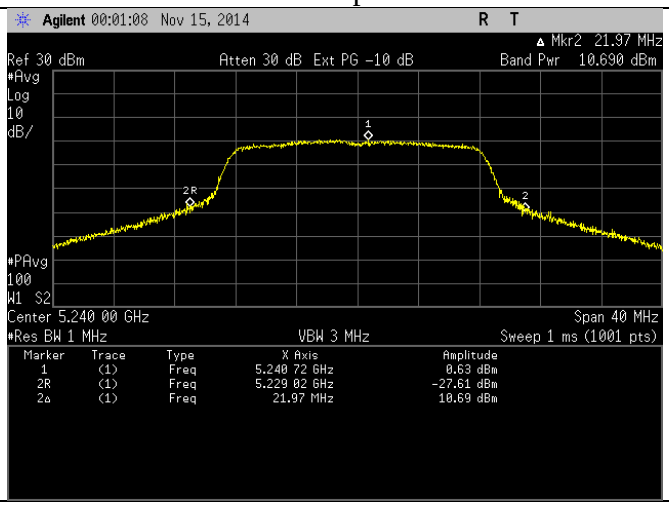
Plots UNII-1
High Channel – 5240 MHz



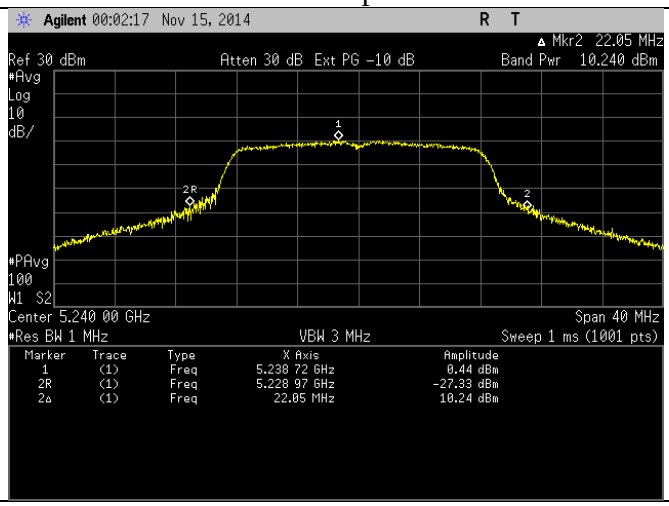
6 Mbps



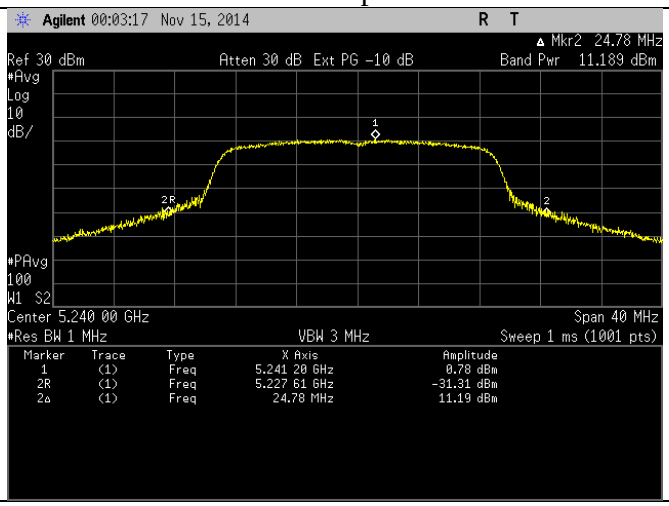
12 Mbps



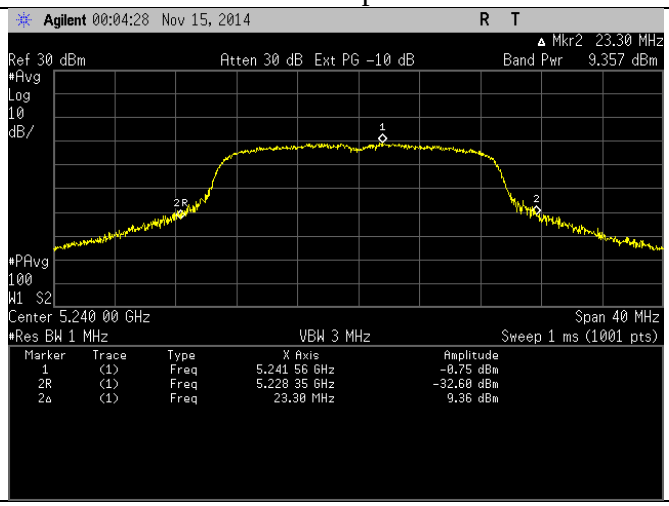
24 Mbps



54 Mbps



6.5 Mbps



65 Mbps

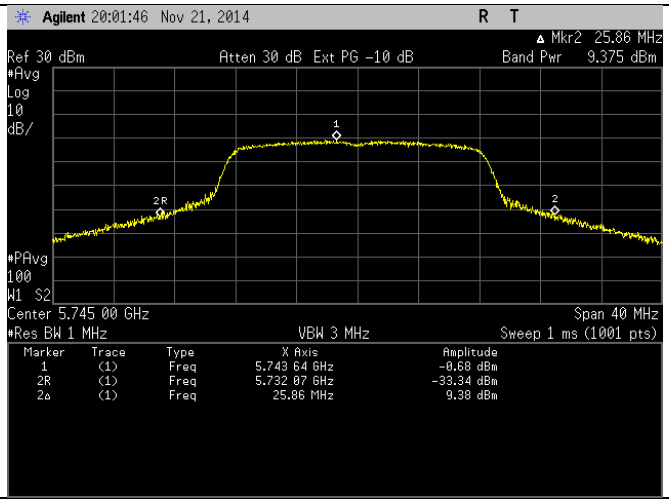
Table
UNII-3 (5.725-5.85GHz)

Channel	Frequency (MHz)	Mode (Mbps)	99 % OBW (MHz)	EBW (MHz)	Power (dBm)	PSD (dBm/MHz)
149	5745	6	16.708	25.860	9.38	-0.68
		12	16.566	23.799	9.21	-0.67
		24	16.546	22.077	8.90	-1.38
		54	16.539	21.738	7.80	-2.01
		6.5	17.903	25.491	9.29	-1.11
		65	17.669	22.947	5.42	-4.75
157	5785	6	17.471	29.229	10.86	0.70
		12	17.041	29.931	10.66	0.39
		24	17.002	28.427	10.44	0.67
		54	16.526	21.929	7.39	-2.89
		6.5	18.559	31.648	10.82	0.59
		65	17.692	22.493	4.84	-5.34
165	5825	6	17.805	34.001	10.79	0.62
		12	17.203	29.737	10.66	0.44
		24	16.898	27.519	10.38	0.34
		54	16.545	21.897	7.49	-2.48
		6.5	18.770	32.817	10.78	0.19
		65	17.626	22.269	5.10	-5.04

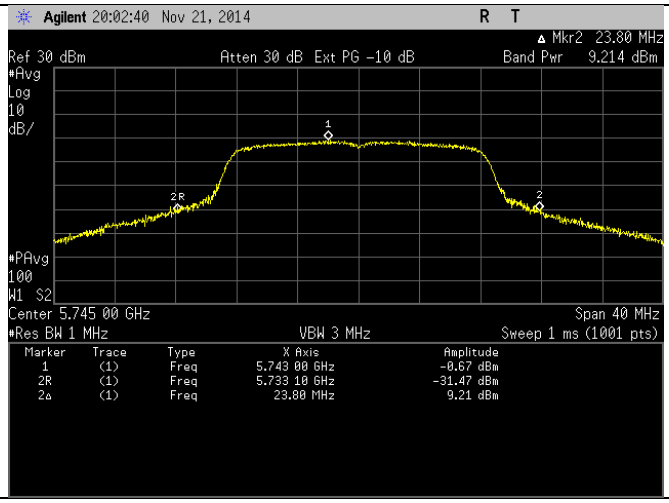
Note: PSD measured in 1 MHz represents worst case for FCC.

FCC 15.407 (a) (3) maximum conducted power limit = 1 W = 30 dBm
FCC 15.407 (a) (3) maximum conducted power spectral density limit = 30 dBm/500 kHz

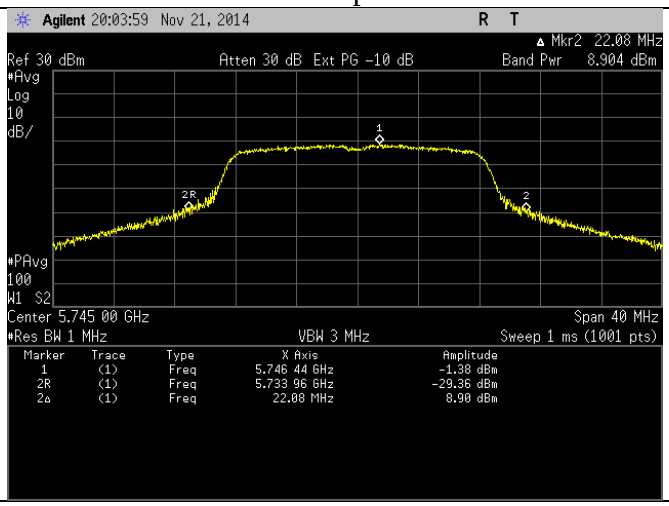
Plots UNII-3
Low Channel – 5745 MHz



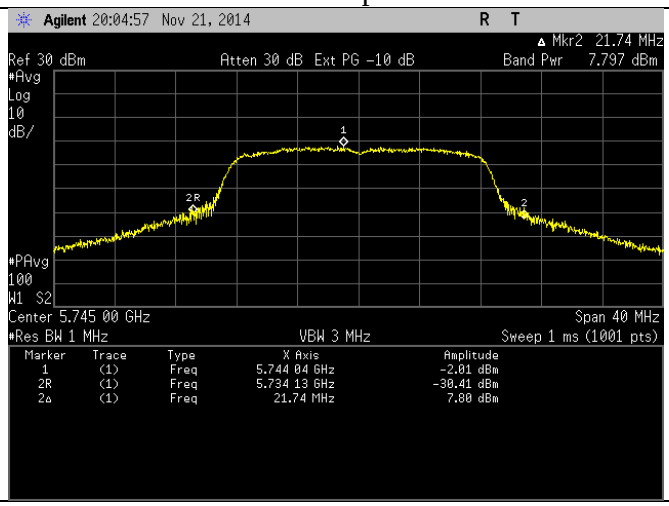
6 Mbps



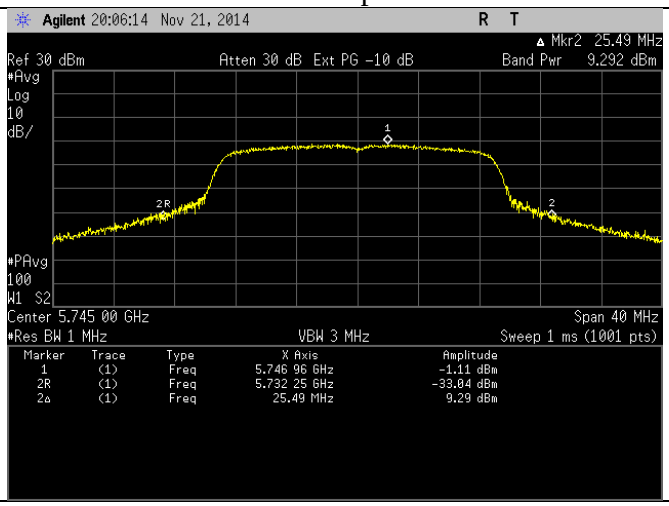
12 Mbps



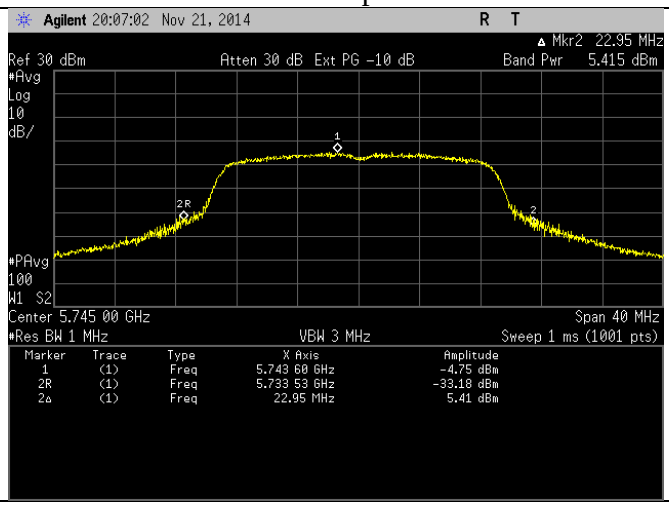
24 Mbps



54 Mbps

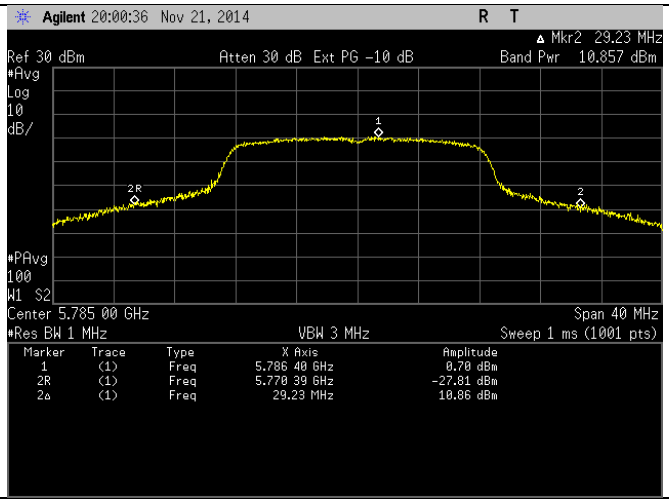


6.5 Mbps

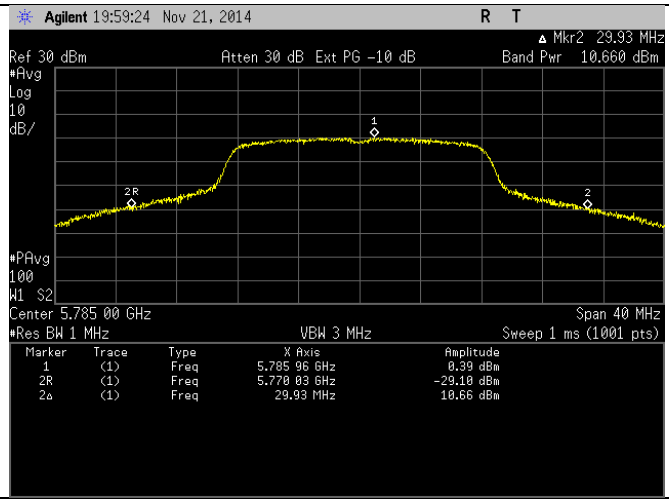


65 Mbps

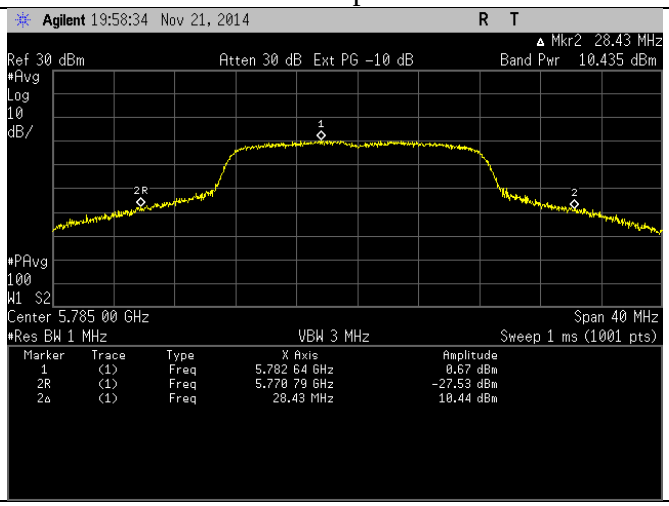
Plots UNII-3
Mid Channel – 5785 MHz



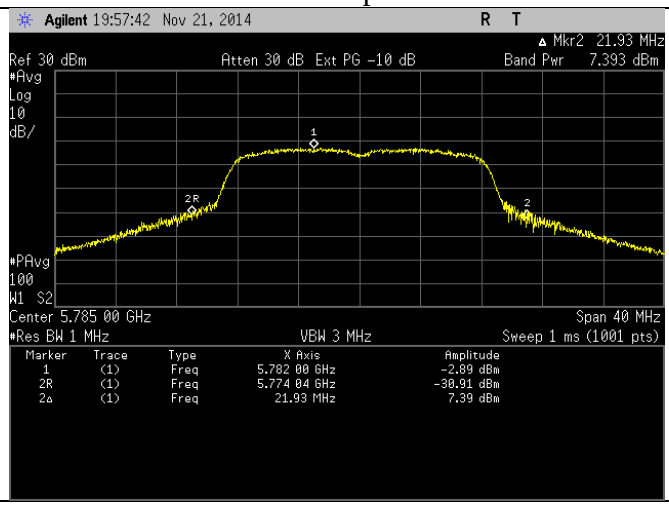
6 Mbps



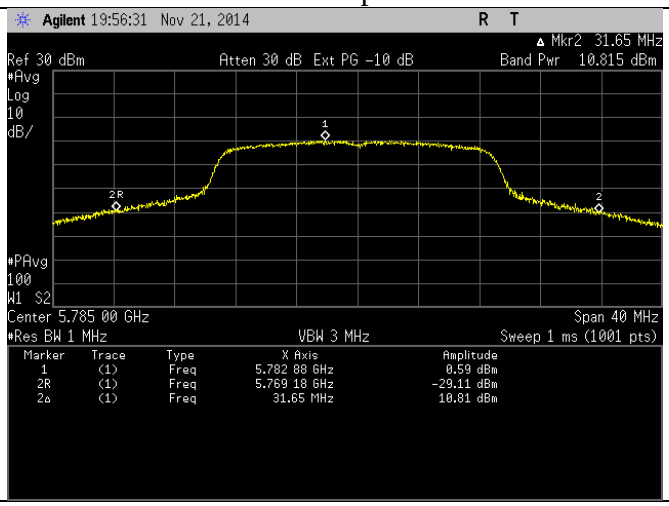
12 Mbps



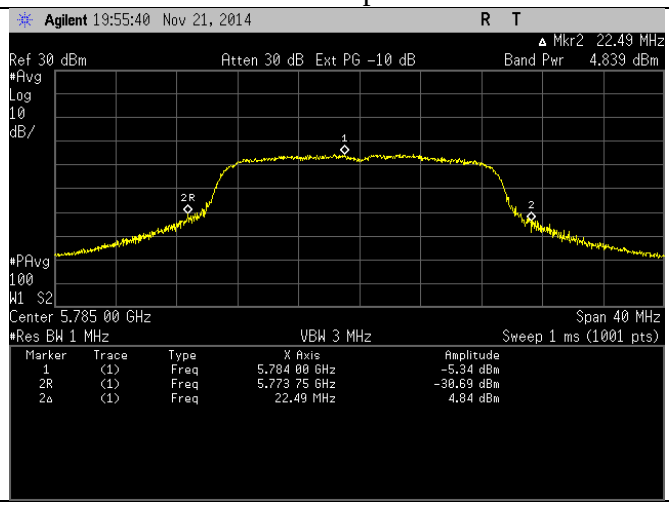
24 Mbps



54 Mbps

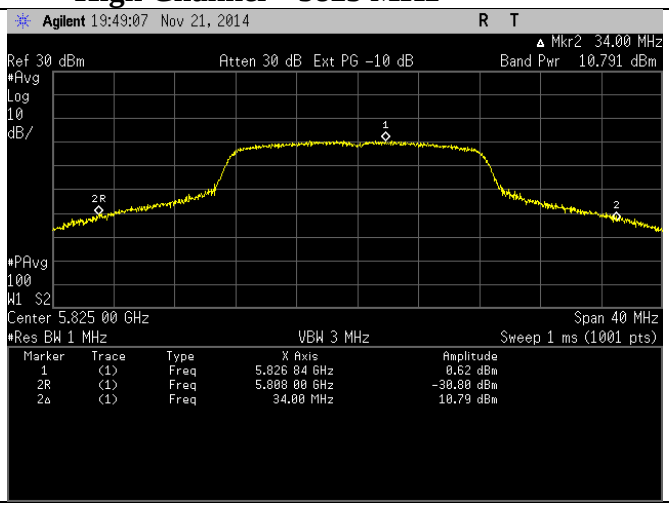


6.5 Mbps

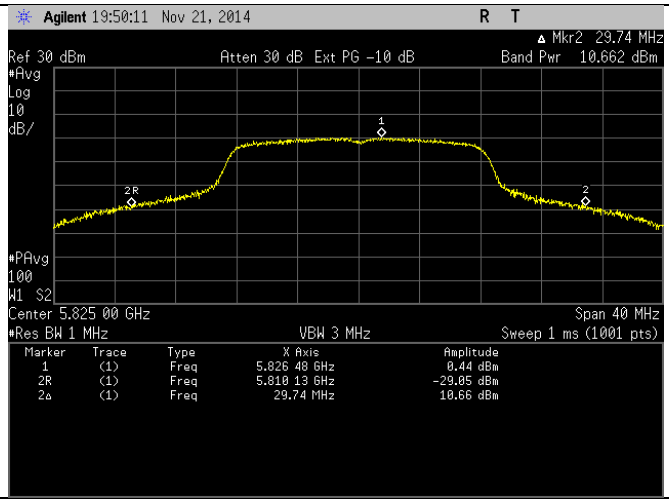


65 Mbps

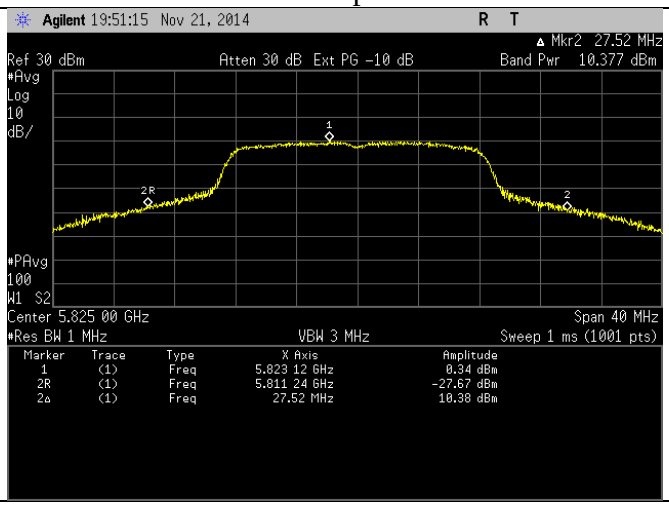
Plots UNII-3
High Channel – 5825 MHz



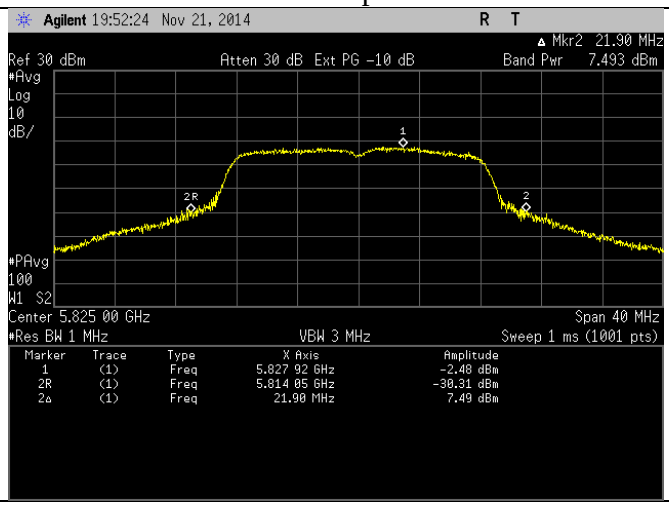
6 Mbps



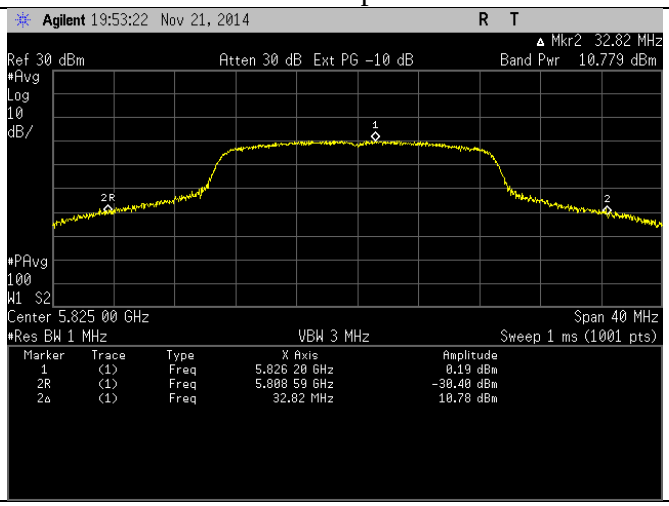
12 Mbps



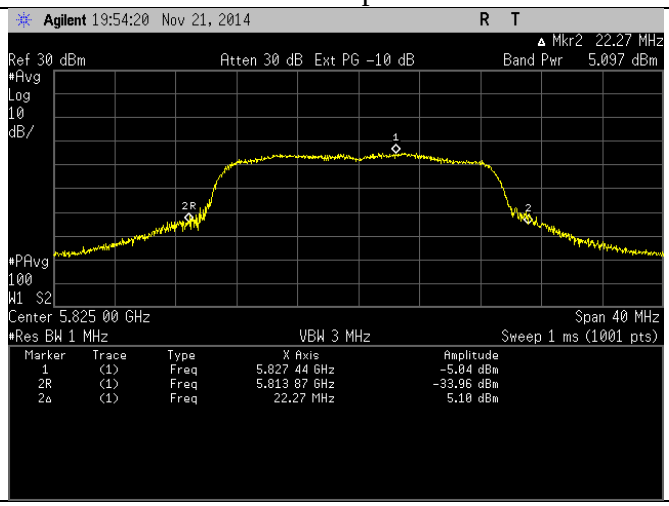
24 Mbps



54 Mbps



6.5 Mbps



65 Mbps

B.1.3 – RF Conducted – Undesirable Emissions (Band-Edge)

Manufacturer	Gogo Business Aviation
Date	November 14,18,19,21 2014
Operator	Adam A
Temp. / R.H.	20 - 25º C / 30-60% R.H.
Rule Part	15.407
Specific Measurement Procedure	FCC KDB 789033 Section II. G.
Additional Description of Measurement	RF Conducted Measurement with antenna gain and conversion from dBm to dBµV/m @ 3m to compare to 15.209 limit.
Additional Notes	Continuous transmit modulated used for this test. Stated antenna gain: 3.90 dBi

Table
UNII-1 (5.15-5.25 GHz) (Lower Band-Edge)

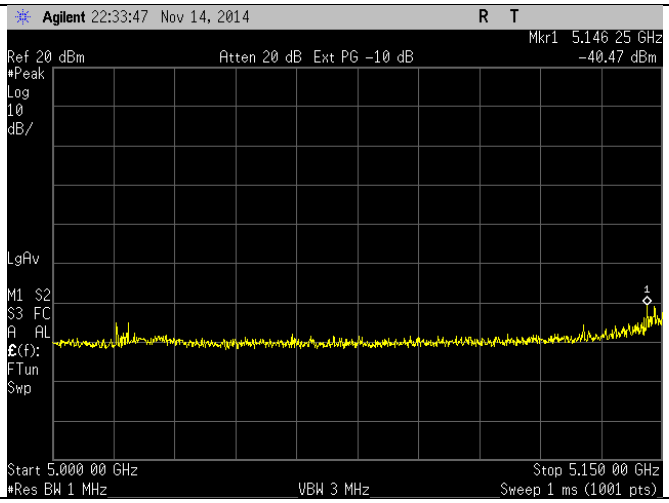
Peak

Mode (802.11)	Mode (Mbps)	Frequency (GHz)	Meas (dBm)	Antenna Gain (dBi)	Conversion to (dBµV/m)	Average (dBµV/m)	Limit	Margin
a	6	5.1463	-40.47	3.90	95.26	58.69	74	15.3
	12	5.1463	-40.40	3.90	95.26	58.76		15.2
	24	5.1491	-41.32	3.90	95.26	57.84		16.2
	54	5.1475	-40.34	3.90	95.26	58.82		15.2
n	6.5	5.1475	-39.12	3.90	95.26	60.04		14.0
	65	5.1499	-42.41	3.90	95.26	56.75		17.3

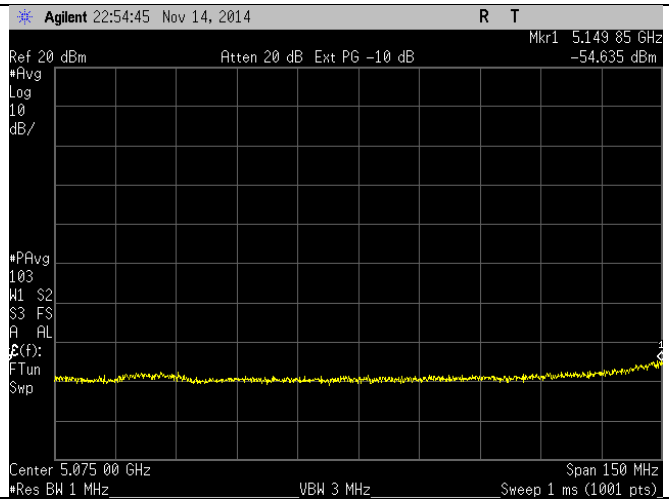
Average

Mode (802.11)	Mode (Mbps)	Frequency (GHz)	Average Meas (dBm)	Antenna Gain (dBi)	Duty Cycle Correction	Conversion to (dBµV/m)	Average (dBµV/m)	Limit	Margin
a	6	5.1499	-54.64	3.90	0.14	95.26	44.67	54	9.3
	12	5.1494	-54.90	3.90	0.28	95.26	44.54		9.5
	24	5.1500	-54.99	3.90	0.54	95.26	44.72		9.3
	54	5.1497	-55.02	3.90	1.04	95.26	45.18		8.8
n	6.5	5.1473	-54.36	3.90	0.15	95.26	44.95		9.0
	65	5.1490	-55.49	3.90	1.20	95.26	44.87		9.1

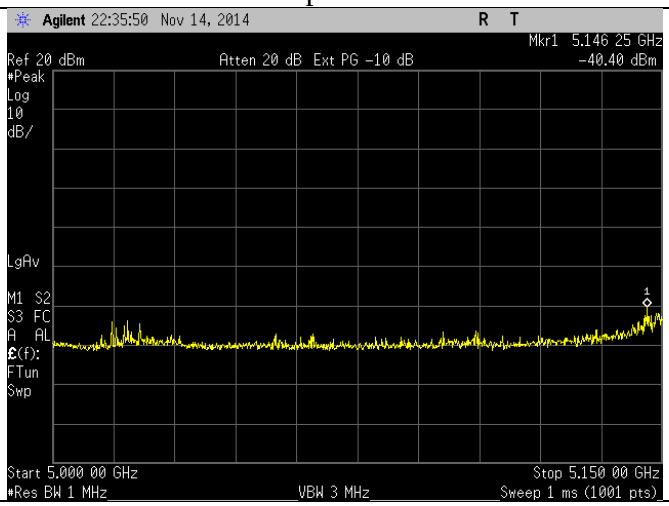
Plots UNII-1
Low Channel – 5180 MHz



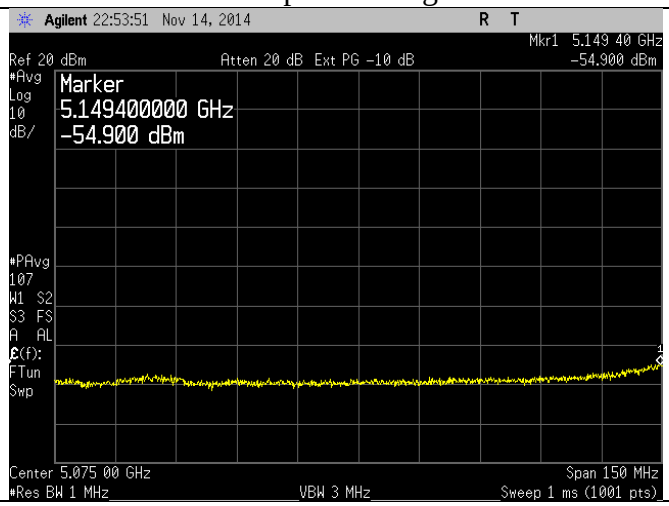
6 Mbps – Peak



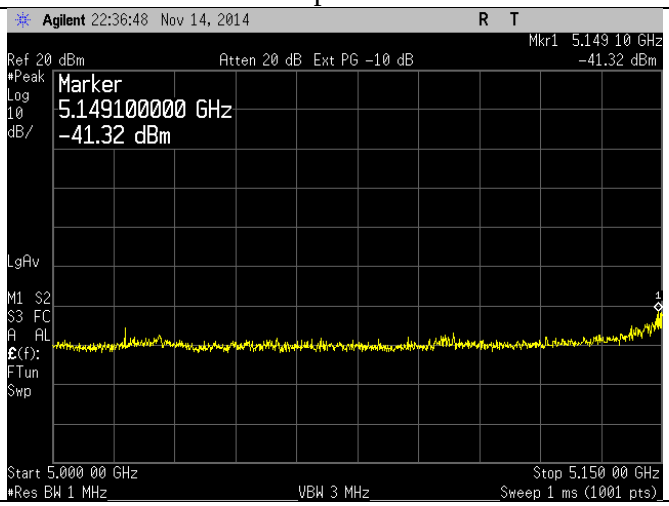
6 Mbps – Average



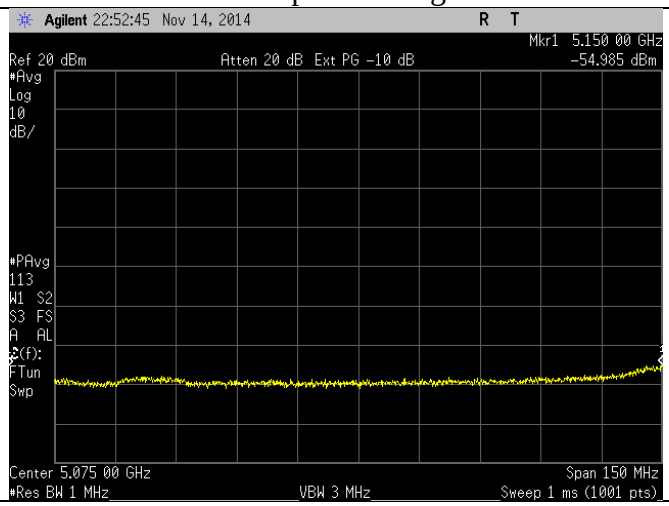
12 Mbps – Peak



12 Mbps – Average

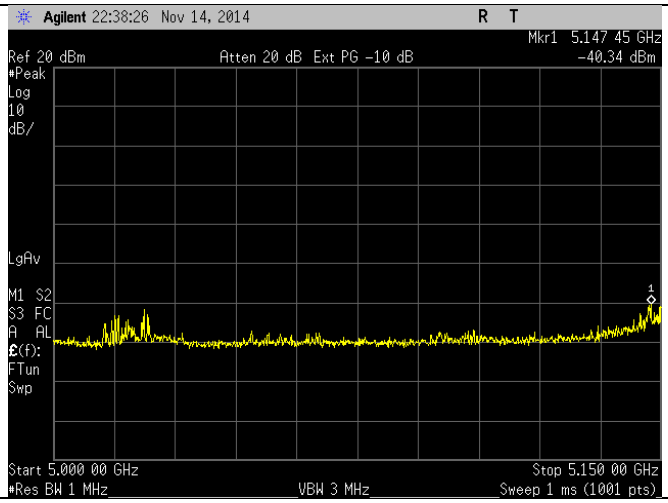


24 Mbps – Peak

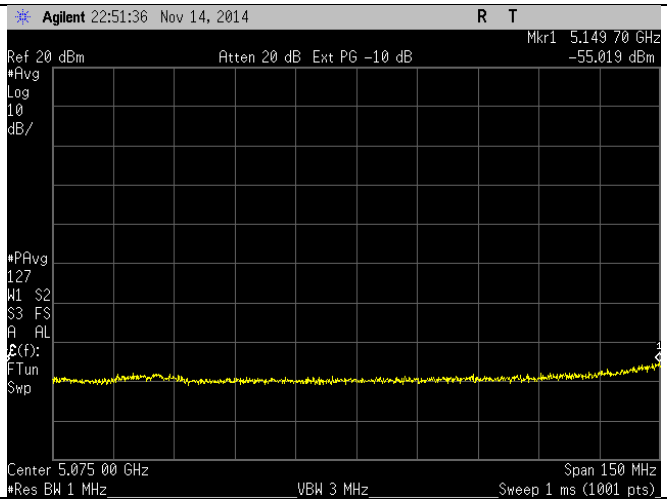


24 Mbps – Average

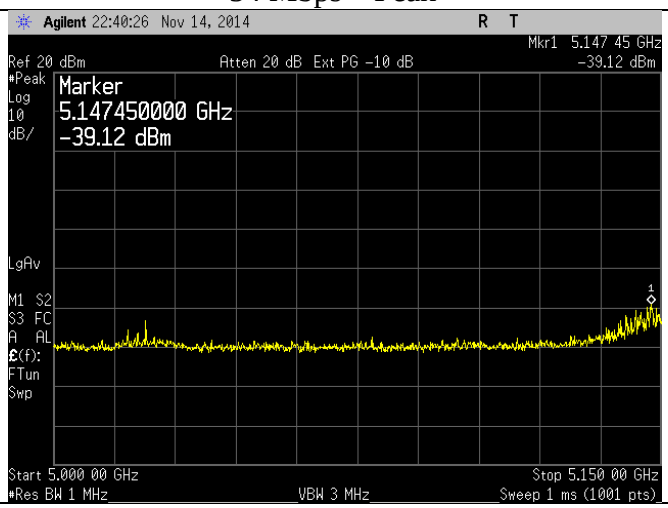
Plots UNII-1
Low Channel – 5180 MHz



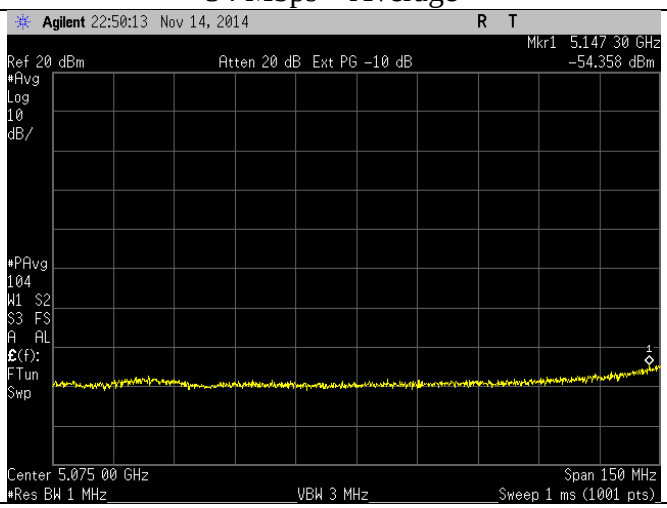
54 Mbps – Peak



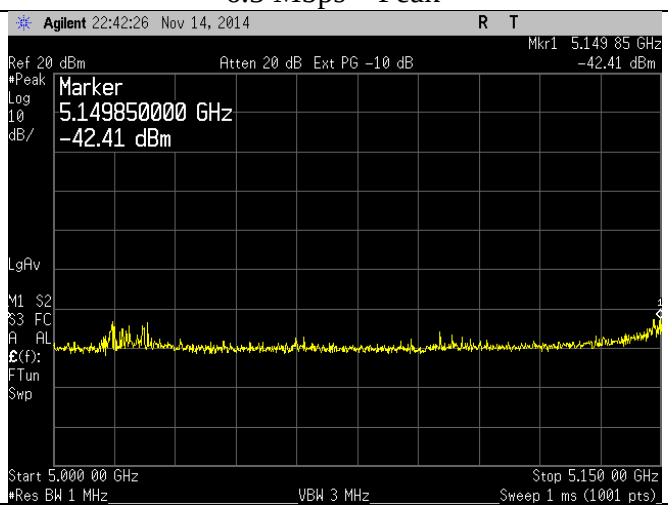
54 Mbps – Average



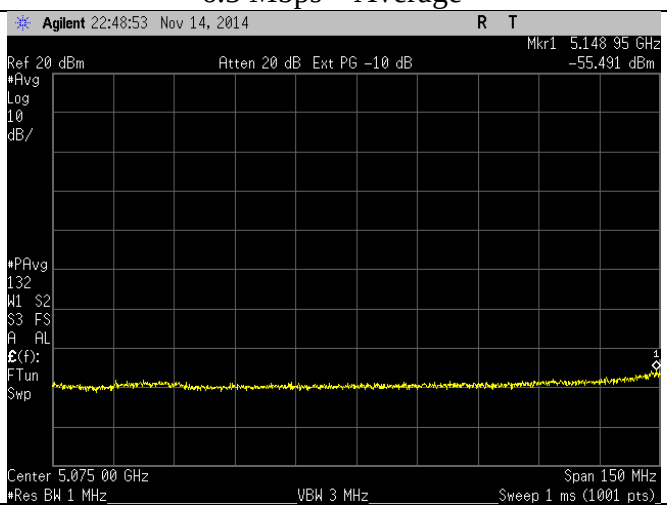
6.5 Mbps – Peak



6.5 Mbps – Average



65 Mbps – Peak



65 Mbps – Average

Table
UNII-1 (Upper Band-Edge)

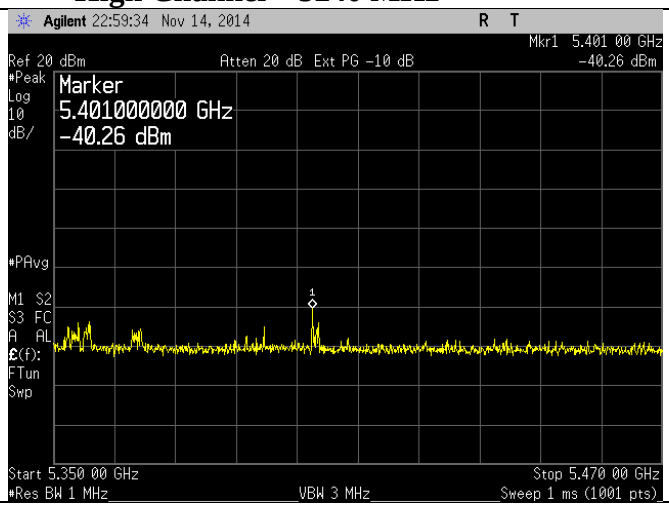
Peak

Mode (802.11)	Mode (Mbps)	Frequency (GHz)	Meas (dBm)	Antenna Gain (dBi)	Conversion to (dBµV/m)	Average (dBµV/m)	Limit	Margin
a	6	5.4010	-40.26	3.90	95.26	58.90	74	15.1
	12	5.3984	-38.93	3.90	95.26	60.23		13.8
	24	5.4030	-38.18	3.90	95.26	60.98		13.0
	54	5.4032	-38.45	3.90	95.26	60.71		13.3
n	6.5	5.3992	-39.65	3.90	95.26	59.51		14.5
	65	5.3984	-39.47	3.90	95.26	59.69		14.3

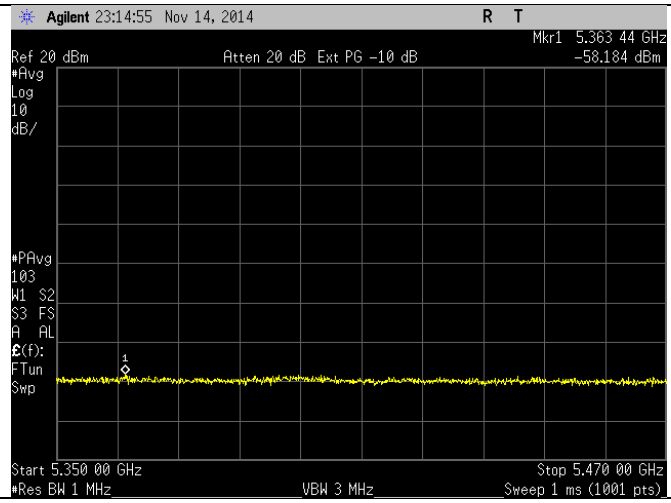
Average

Mode (802.11)	Mode (Mbps)	Frequency (GHz)	Average Meas (dBm)	Antenna Gain (dBi)	Duty Cycle Correction	Conversion to (dBµV/m)	Average (dBµV/m)	Limit	Margin
a	6	5.3634	-58.18	3.90	0.14	95.26	41.12	54	12.9
	12	5.4000	-58.28	3.90	0.28	95.26	41.16		12.8
	24	5.3937	-57.54	3.90	0.54	95.26	42.16		11.8
	54	5.3999	-56.94	3.90	1.04	95.26	43.26		10.7
n	6.5	5.3607	-58.14	3.90	0.15	95.26	41.17		12.8
	65	5.4011	-57.62	3.90	1.20	95.26	42.74		11.3

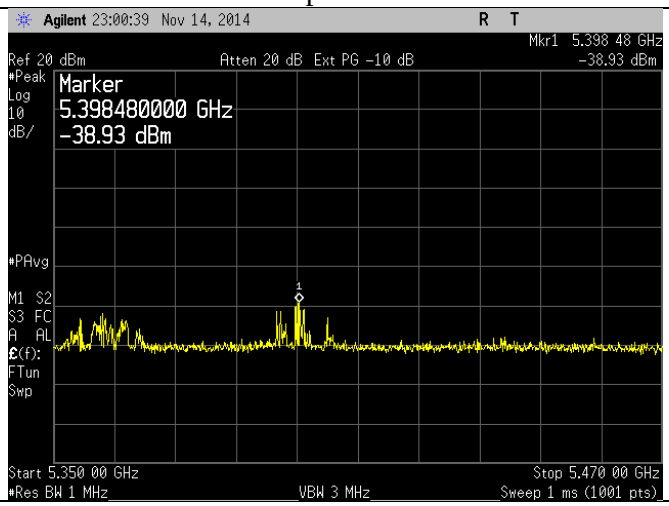
Plots UNII-1
High Channel – 5240 MHz



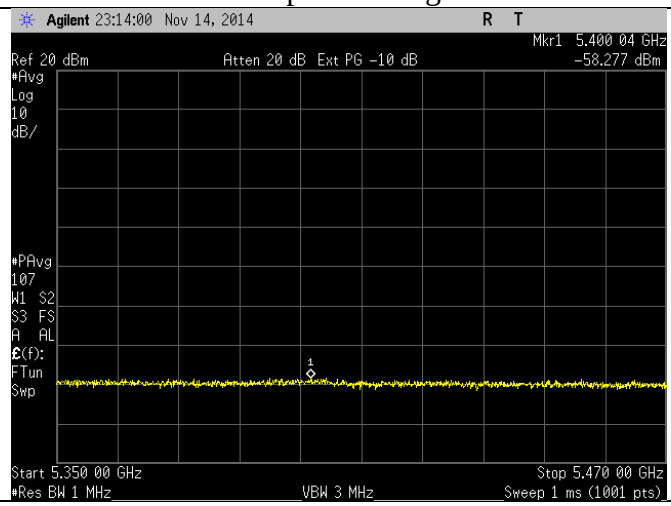
6 Mbps – Peak



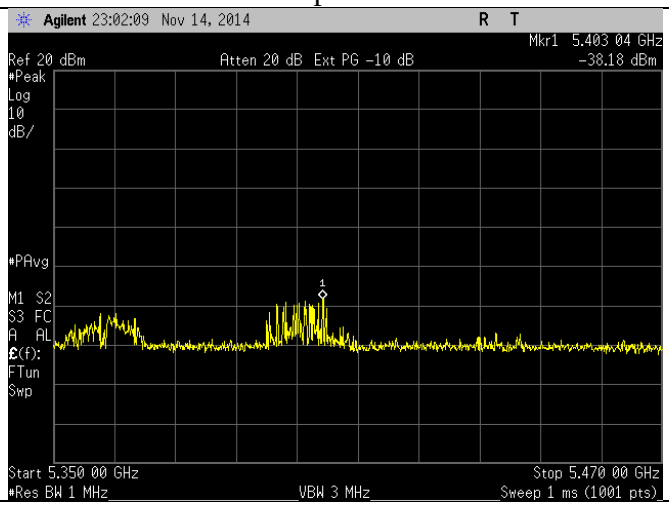
6 Mbps – Average



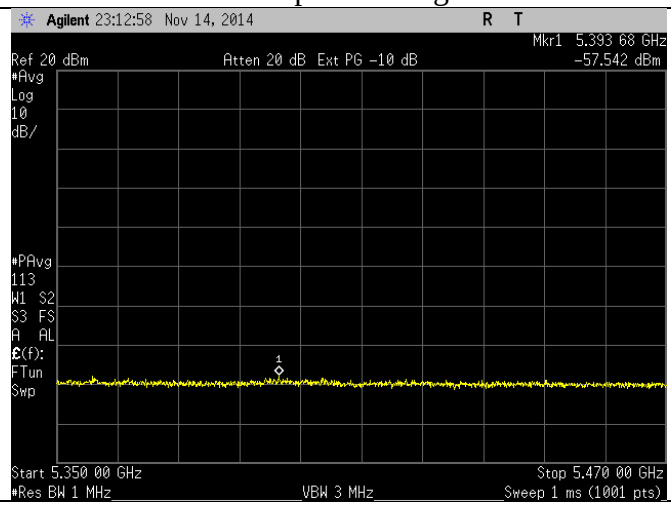
12 Mbps – Peak



12 Mbps – Average

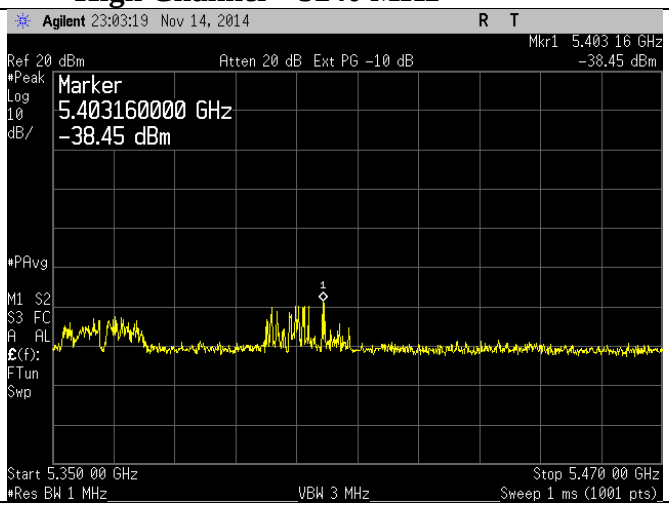


24 Mbps – Peak

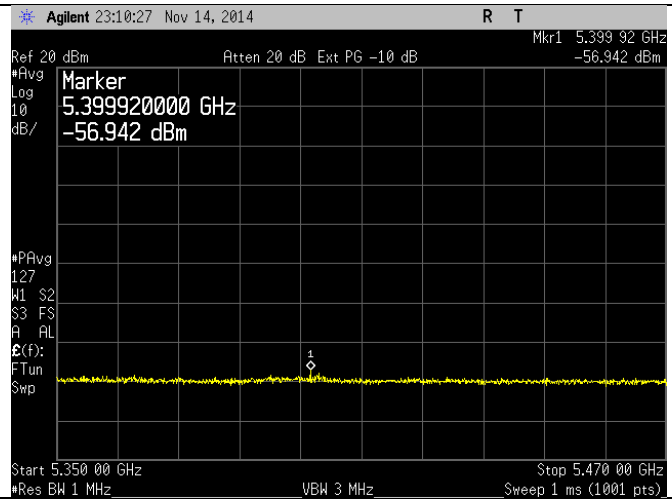


24 Mbps – Average

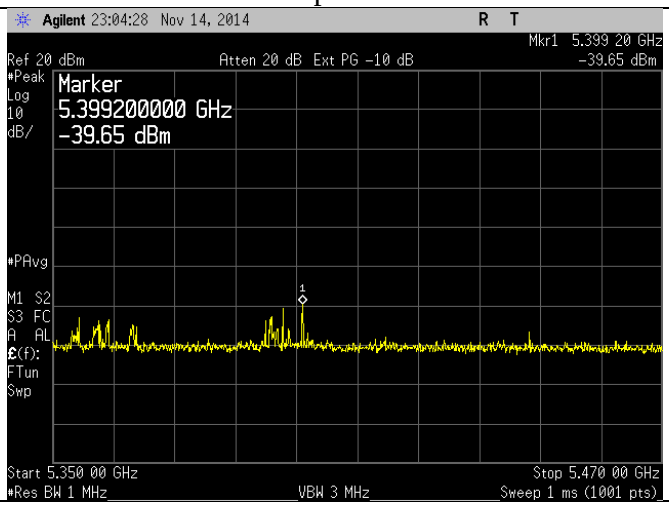
Plots UNII-1
High Channel – 5240 MHz



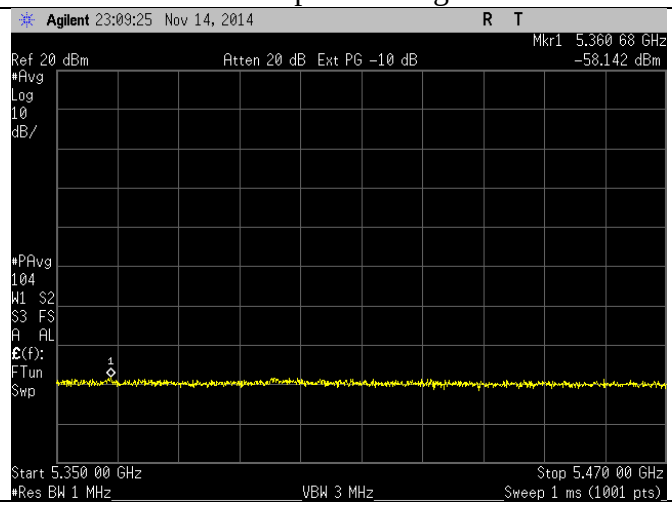
54 Mbps – Peak



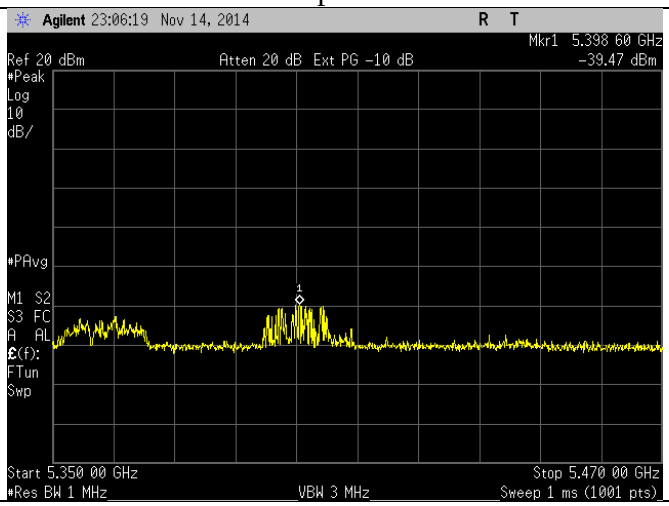
54 Mbps – Average



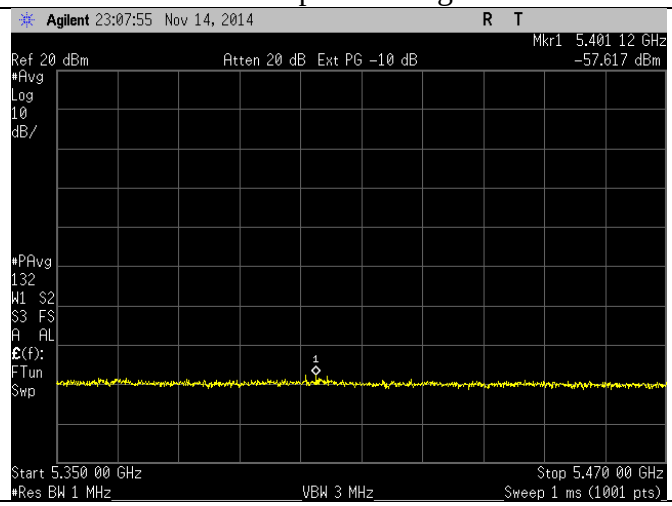
6.5 Mbps – Peak



6.5 Mbps – Average



65 Mbps – Peak



65 Mbps – Average

Table

UNII-3 (Lower Band-Edge)

Peak (5715-5725 MHz)

Mode (802.11)	Mode (Mbps)	Frequency (GHz)	Meas (dBm)	Antenna Gain (dBi)	EIRP (dBm)	Limit	Margin
a	6	5.7248	-22.09	3.90	-18.19	-17	1.2
	12	5.7247	-26.21	3.90	-22.31		5.3
	24	5.7248	-23.74	3.90	-19.84		2.8
	54	5.7248	-28.13	3.90	-24.23		7.2
n	6.5	5.7248	-22.07	3.90	-18.17		1.2
	65	5.7250	-35.32	3.90	-31.42		14.4

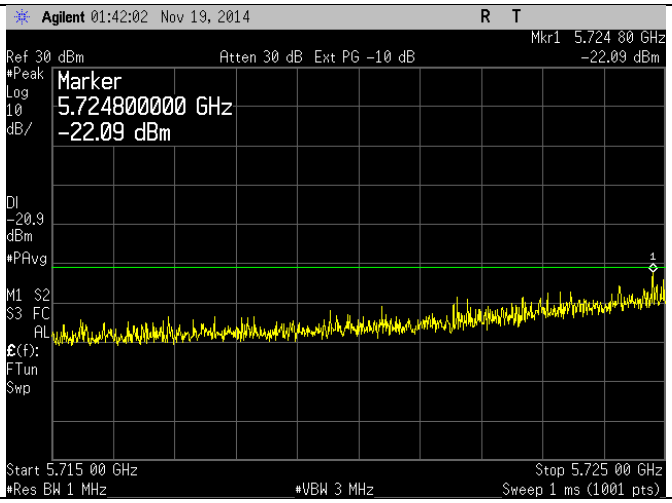
Peak (5600-5715MHz)

Mode (802.11)	Mode (Mbps)	Frequency (GHz)	Meas (dBm)	Antenna Gain (dBi)	Conversion to (dBµV/m)	Average (dBµV/m)	Limit	Margin
a	6	5.7128	-37.79	3.90	95.26	61.37	74	12.6
	12	5.7145	-38.57	3.90	95.26	60.59		13.4
	24	5.7086	-41.13	3.90	95.26	58.03		16.0
	54	5.7150	-42.37	3.90	95.26	56.79		17.2
n	6.5	5.7125	-37.68	3.90	95.26	61.48		12.5
	65	5.7133	-45.92	3.90	95.26	53.24		20.8

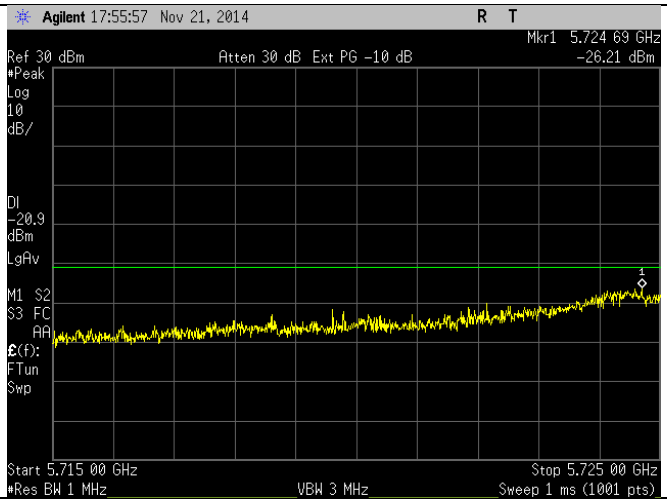
Average(5600-5715MHz)

Mode (802.11)	Mode (Mbps)	Frequency (GHz)	Average Meas (dBm)	Antenna Gain (dBi)	Duty Cycle Correction	Conversion to (dBµV/m)	Average (dBµV/m)	Limit	Margin
a	6	5.7145	-53.12	3.90	0.14	95.26	46.18	54	7.8
	12	5.7149	-53.14	3.90	0.28	95.26	46.30		7.7
	24	5.7149	-53.88	3.90	0.54	95.26	45.83		8.2
	54	5.7137	-54.84	3.90	1.04	95.26	45.36		8.6
n	6.5	5.7148	-52.54	3.90	0.15	95.26	46.77		7.2
	65	5.7126	-57.90	3.90	1.20	95.26	42.46		11.5

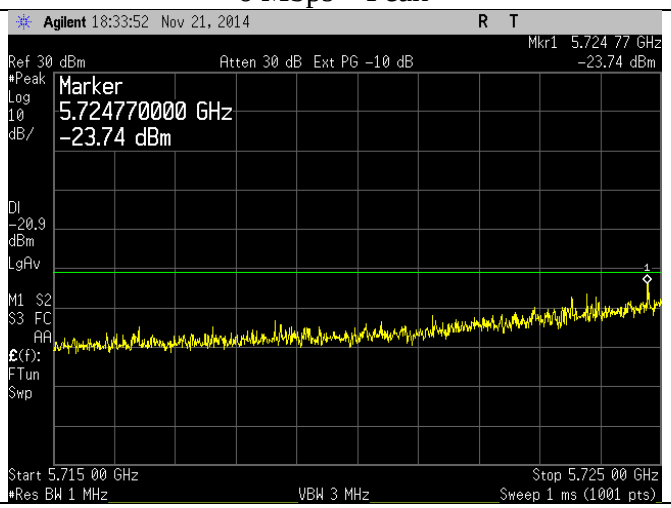
Plots UNII-3 (5715-5725 MHz)
Low Channel – 5745 MHz



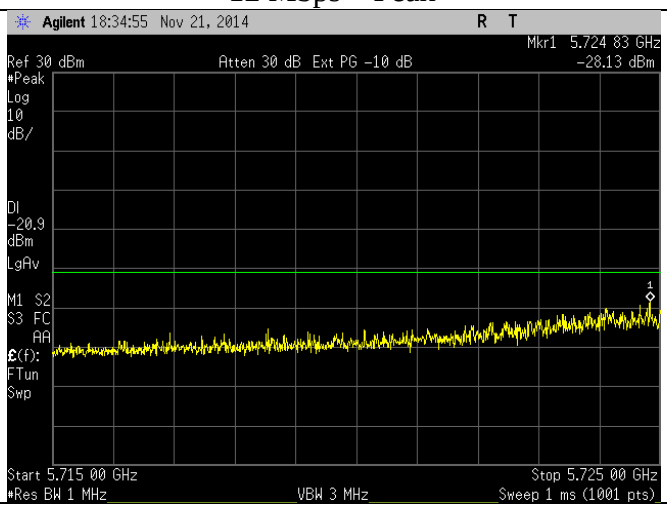
6 Mbps – Peak



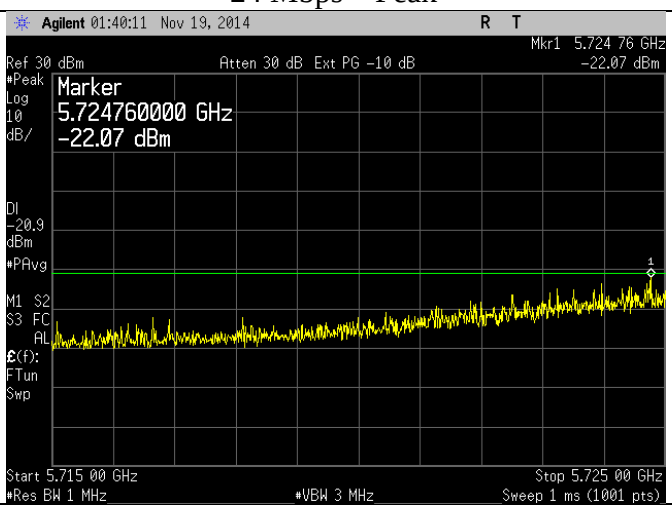
12 Mbps – Peak



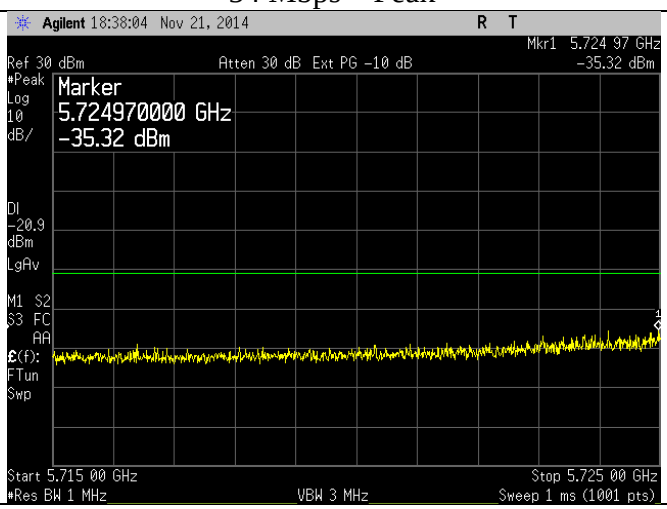
24 Mbps – Peak



54 Mbps – Peak

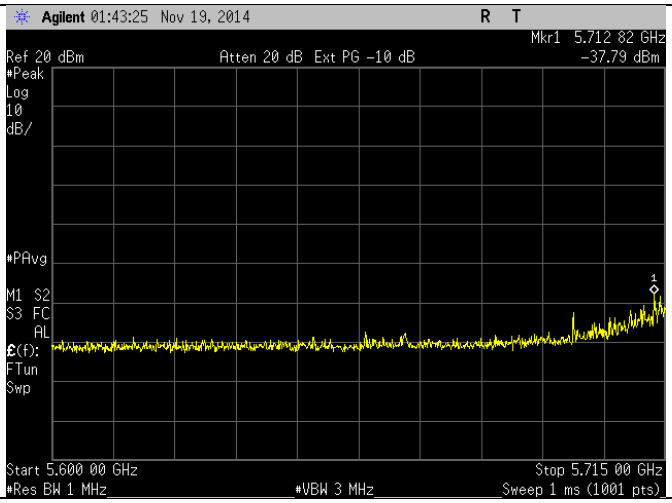


6.5 Mbps – Peak

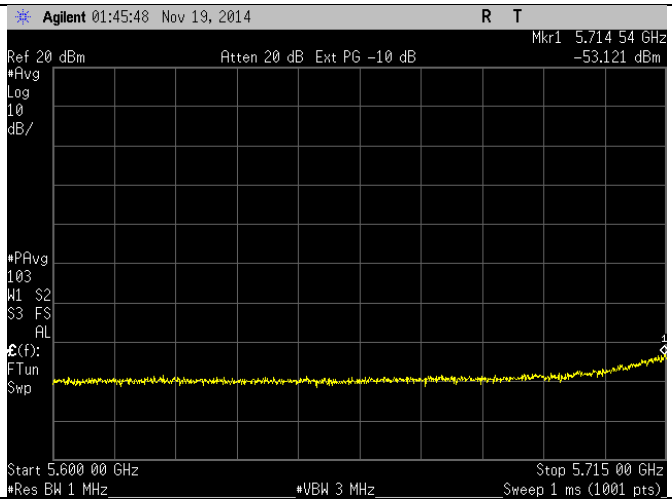


65 Mbps – Peak

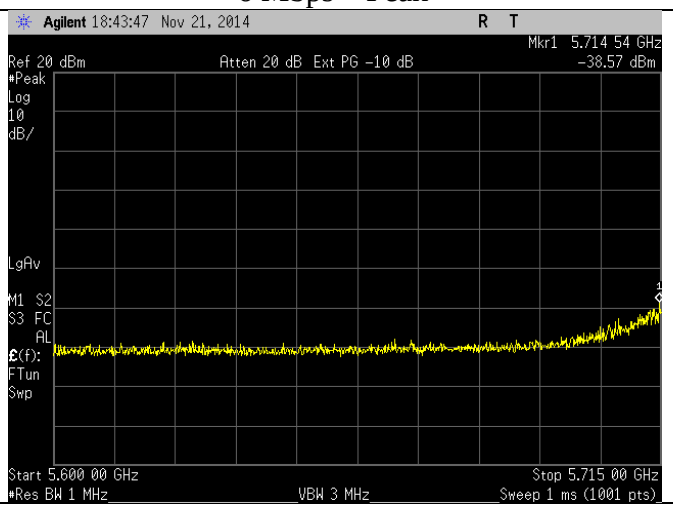
Plots UNII-3 (5600-5715 MHz)
Low Channel – 5745 MHz



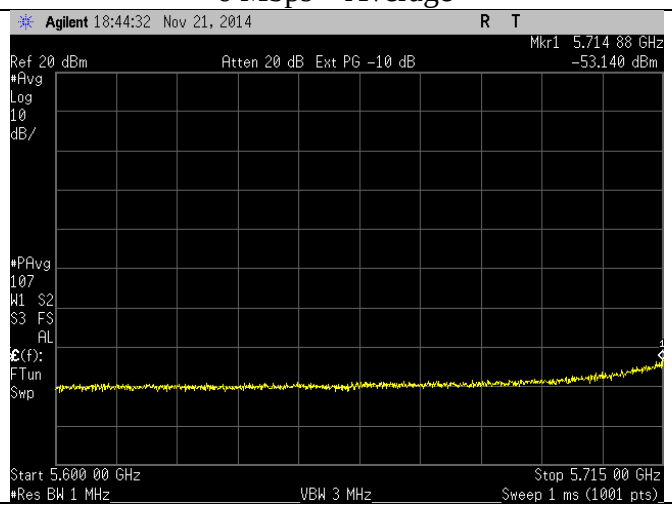
6 Mbps – Peak



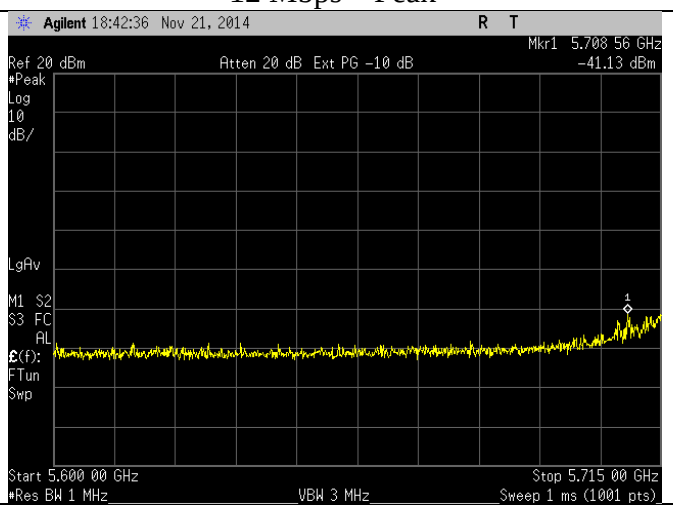
6 Mbps – Average



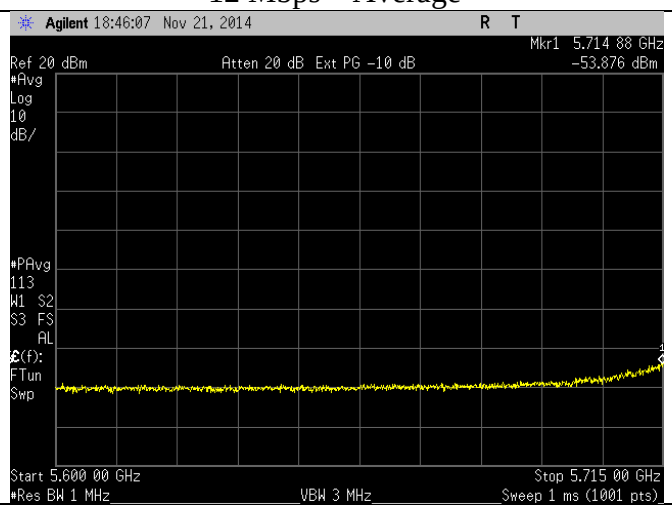
12 Mbps – Peak



12 Mbps – Average

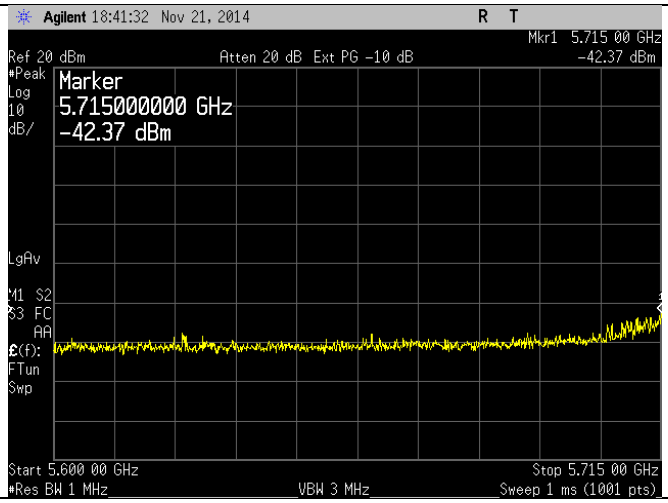


24 Mbps – Peak

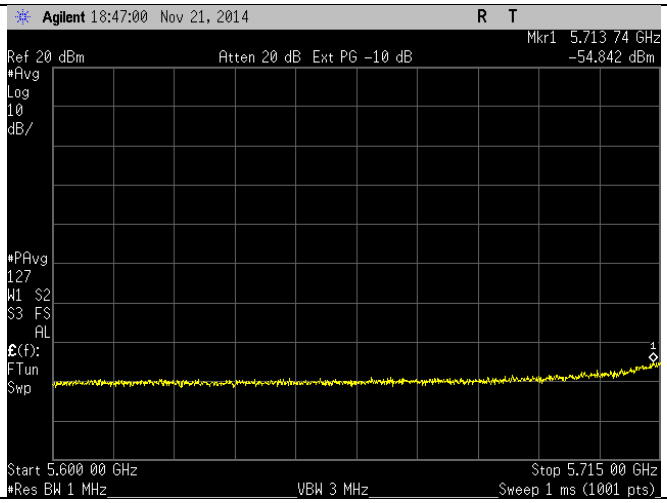


24 Mbps – Average

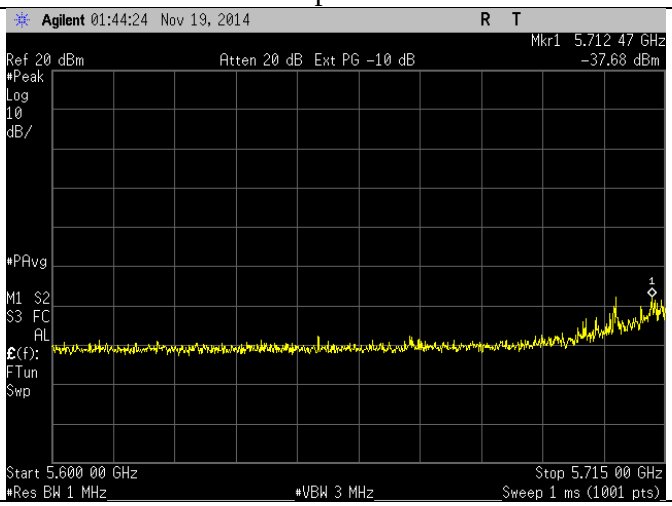
Plots UNII-3 (5600-5715 MHz)
Low Channel – 5745 MHz



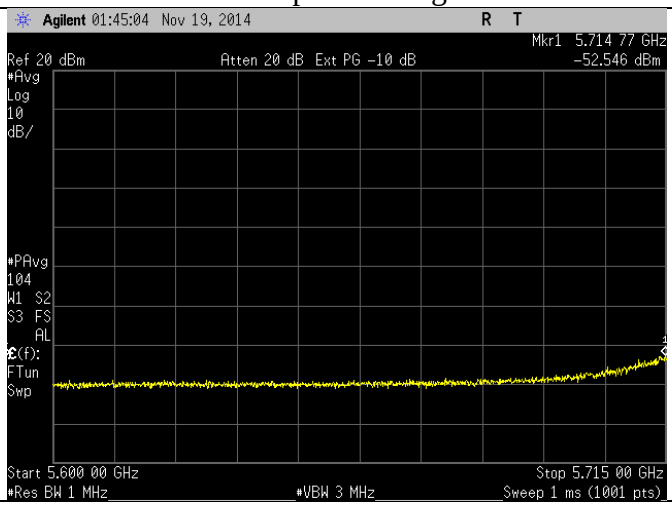
54 Mbps – Peak



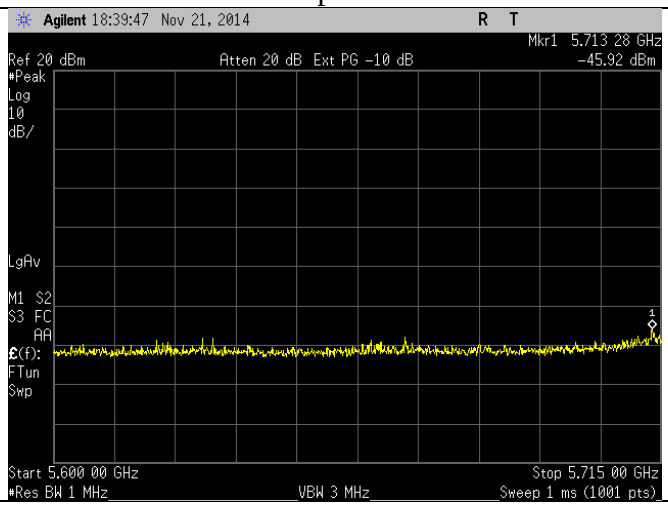
54 Mbps – Average



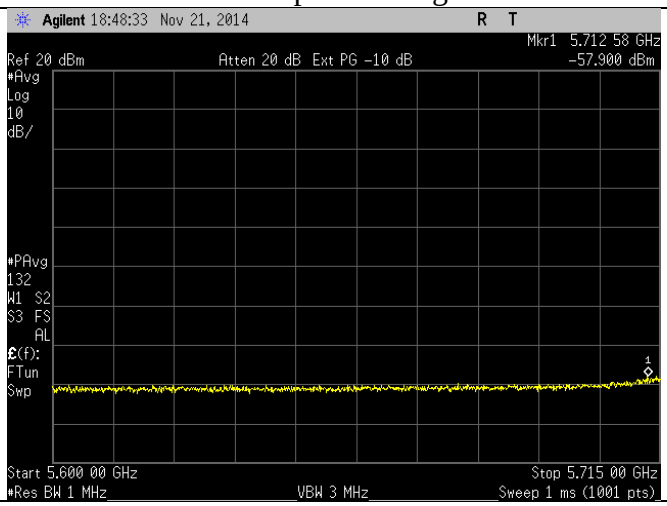
6.5 Mbps – Peak



6.5 Mbps – Average



65 Mbps – Peak



65 Mbps – Average

Table
UNII-3 (Upper Band-Edge)

Peak (5850-5860 MHz)

Mode (802.11)	Mode (Mbps)	Frequency (GHz)	Meas (dBm)	Antenna Gain (dBi)	eirp (dBm)	Limit	Margin
a	6	5.8540	-29.36	3.90	-25.46	-17	8.5
	12	5.8508	-30.70	3.90	-26.80		9.8
	24	5.8501	-27.43	3.90	-23.53		6.5
	54	5.8503	-38.40	3.90	-34.50		17.5
n	6.5	5.8500	-27.31	3.90	-23.41		6.4
	65	5.8543	-38.56	3.90	-34.66		17.7

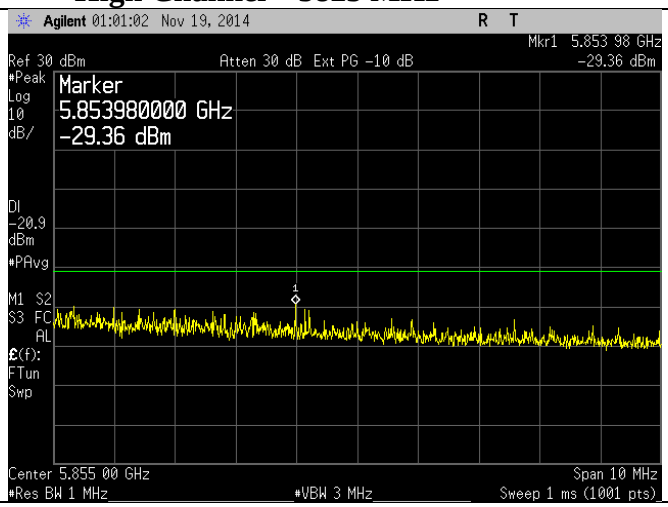
Peak (5860-6000 MHz)

Mode (802.11)	Mode (Mbps)	Frequency (GHz)	Meas (dBm)	Antenna Gain (dBi)	Conversion to (dBµV/m)	Average (dBµV/m)	Limit	Margin
a	6	5.8606	-38.61	3.90	95.26	60.55	74	13.5
	12	5.8615	-40.34	3.90	95.26	58.82		15.2
	24	5.8601	-38.71	3.90	95.26	60.45		13.6
	54	5.9854	-42.61	3.90	95.26	56.55		17.5
n	6.5	5.8641	-37.65	3.90	95.26	61.51		12.5
	65	5.9814	-43.85	3.90	95.26	55.31		18.7

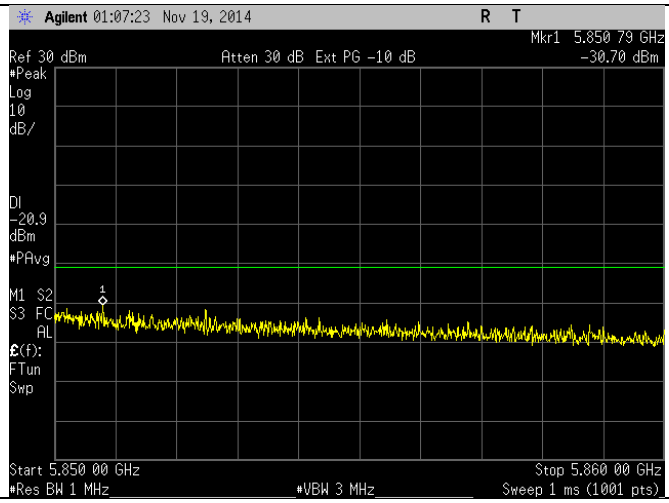
Average (5860-6000 MHz)

Mode (802.11)	Mode (Mbps)	Frequency (GHz)	Average Meas (dBm)	Antenna Gain (dBi)	Duty Cycle Correction	Conversion to (dBµV/m)	Average (dBµV/m)	Limit	Margin
a	6	5.8604	-52.11	3.90	0.14	95.26	47.19	54	6.8
	12	5.8611	-52.14	3.90	0.28	95.26	47.29		6.7
	24	5.8610	-52.96	3.90	0.54	95.26	46.74		7.3
	54	5.8621	-56.94	3.90	1.04	95.26	43.26		10.7
n	6.5	5.8608	-51.98	3.90	0.15	95.26	47.33		6.7
	65	5.8656	-58.27	3.90	1.20	95.26	42.09		11.9

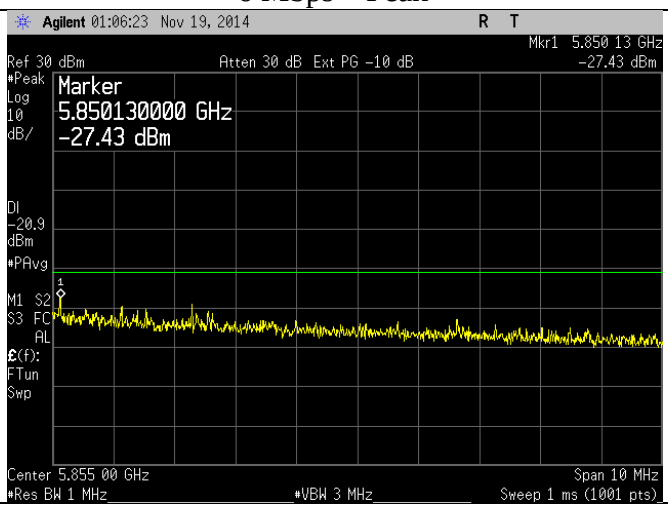
Plots UNII-3 (5850-5860 MHz)
High Channel – 5825 MHz



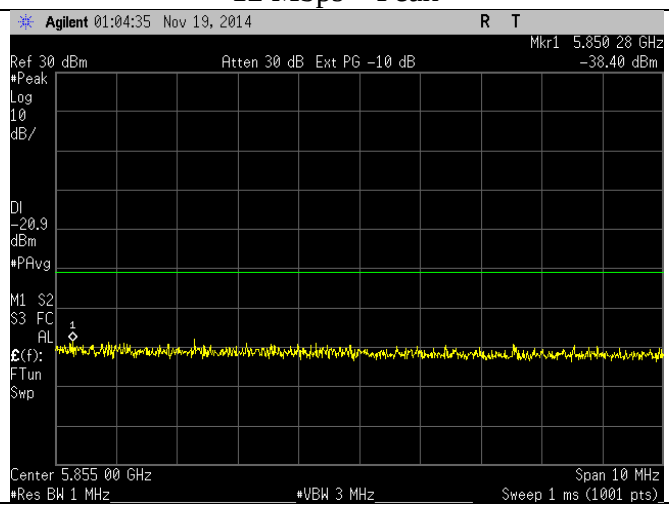
6 Mbps – Peak



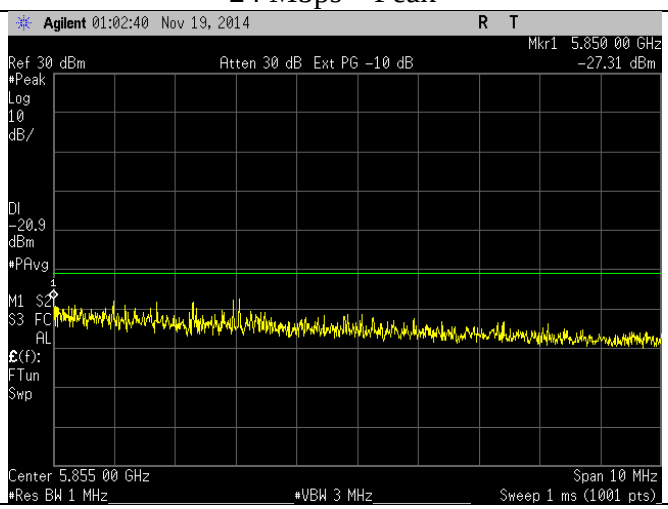
12 Mbps – Peak



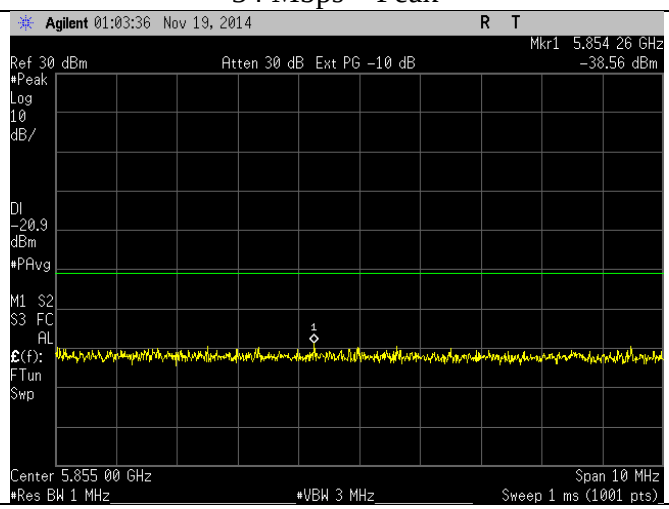
24 Mbps – Peak



54 Mbps – Peak

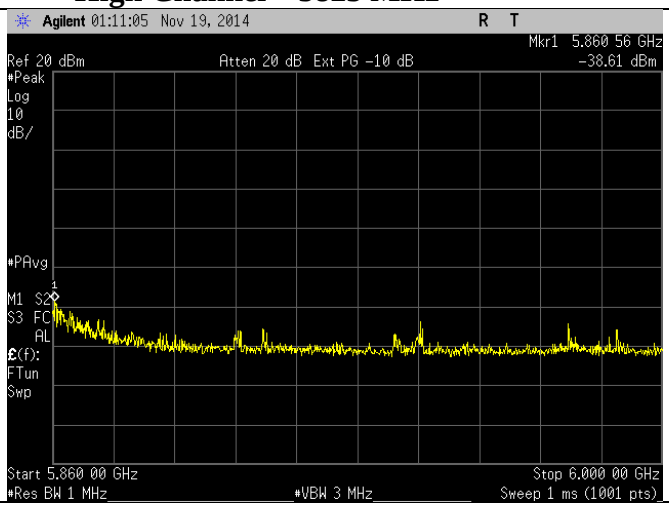


6.5 Mbps – Peak

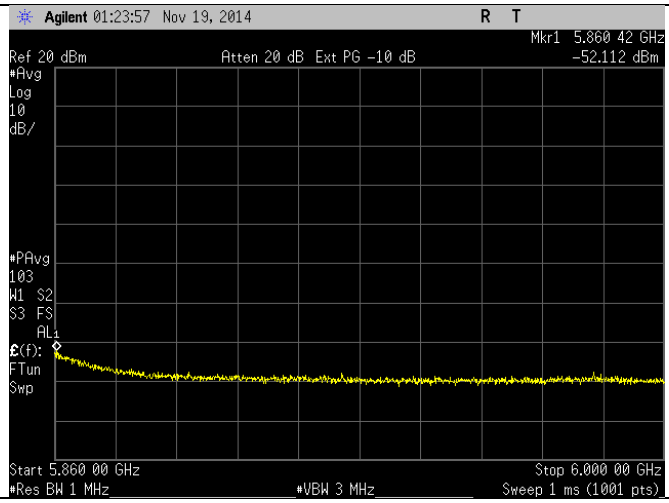


65 Mbps – Peak

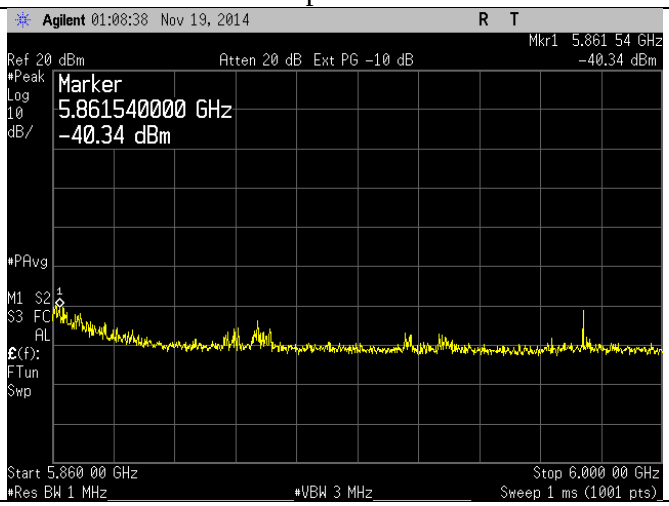
Plots UNII-3 (5860-6000 MHz)
High Channel – 5825 MHz



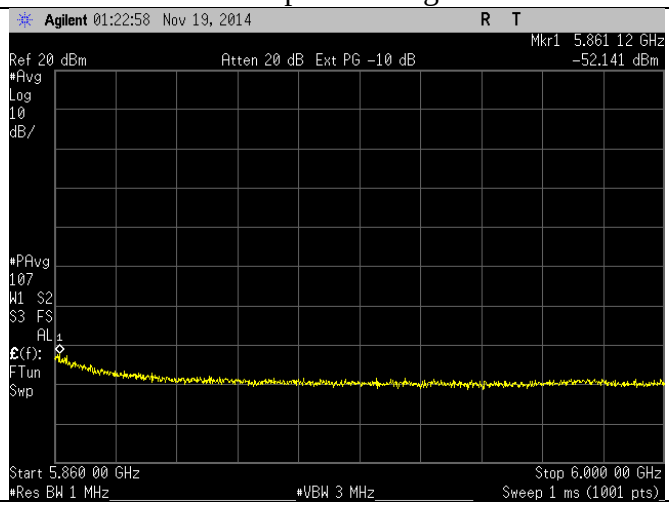
6 Mbps – Peak



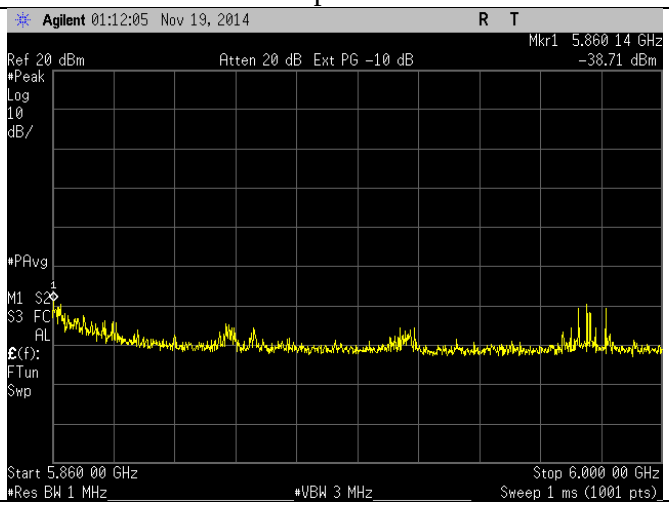
6 Mbps – Average



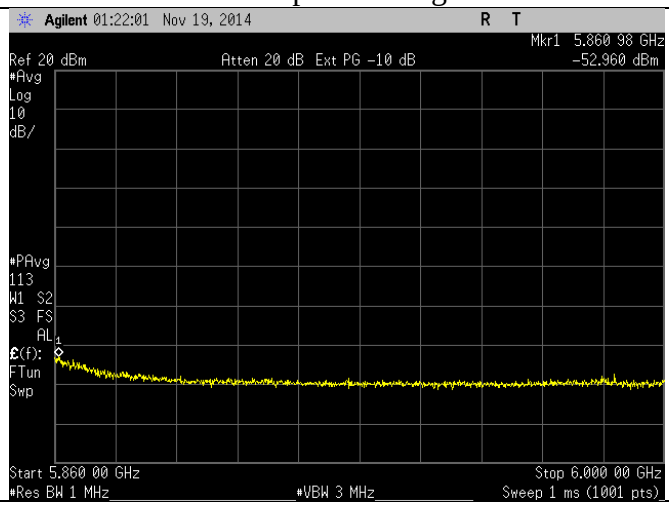
12 Mbps – Peak



12 Mbps – Average

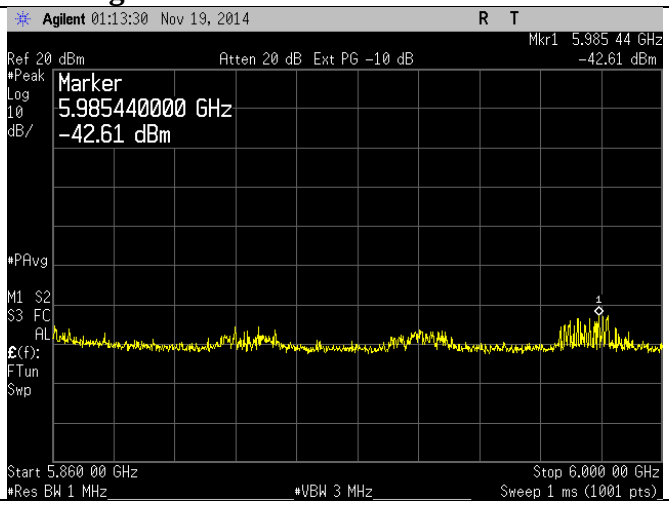


24 Mbps – Peak

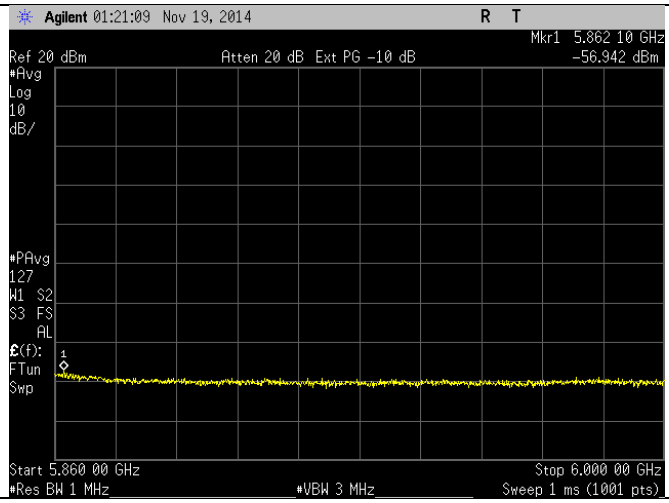


24 Mbps – Average

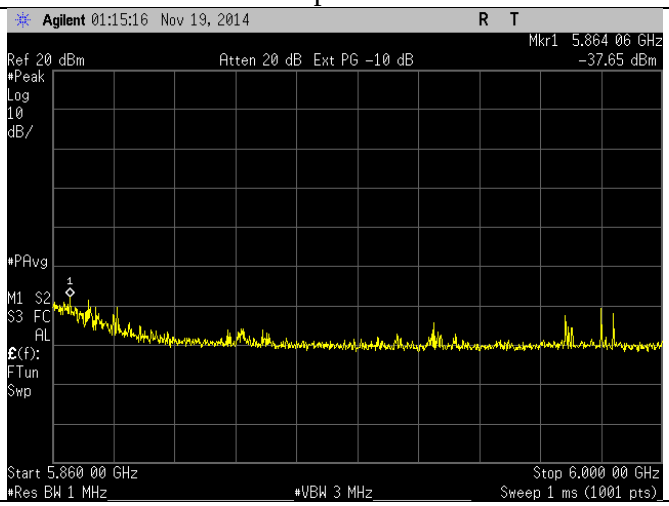
Plots UNII-3 (5860-6000 MHz)
High Channel – 5825 MHz



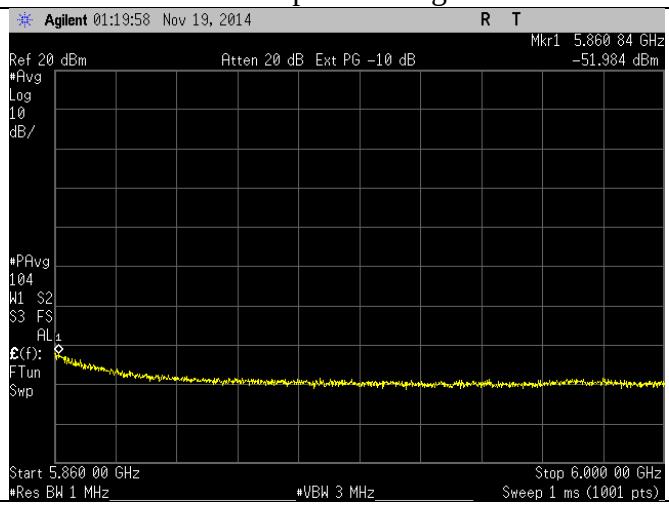
54 Mbps – Peak



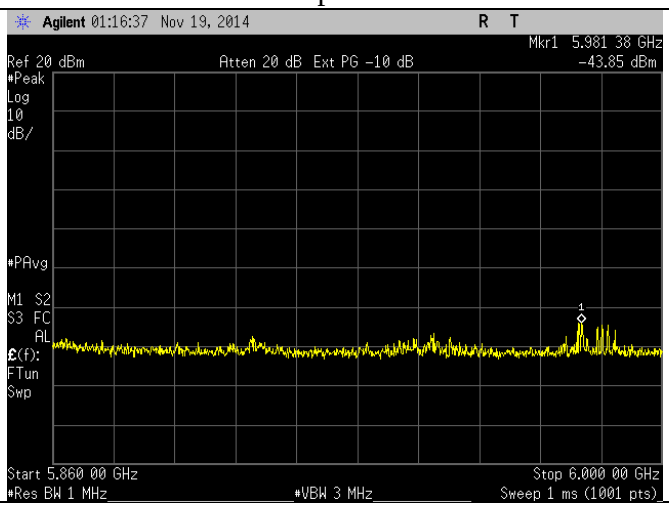
54 Mbps – Average



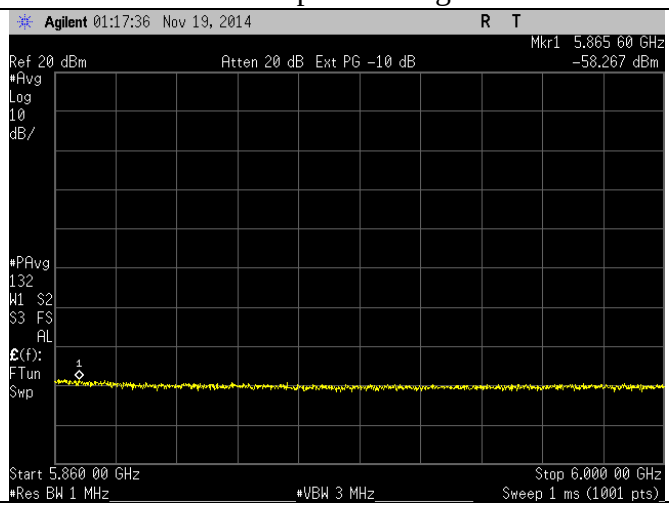
6.5 Mbps – Peak



6.5 Mbps – Average



65 Mbps – Peak

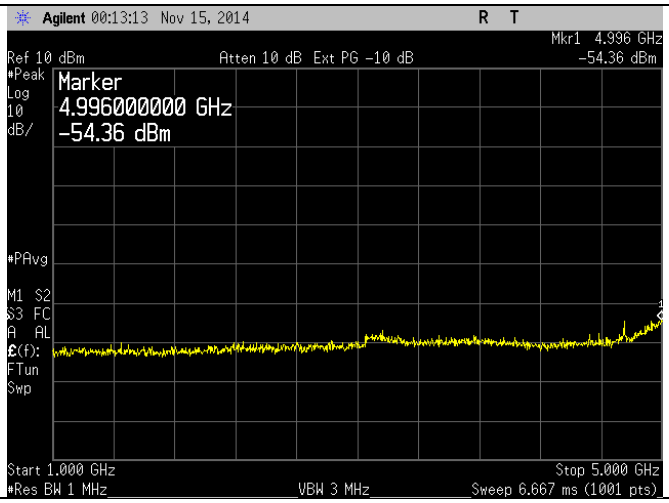


65 Mbps – Average

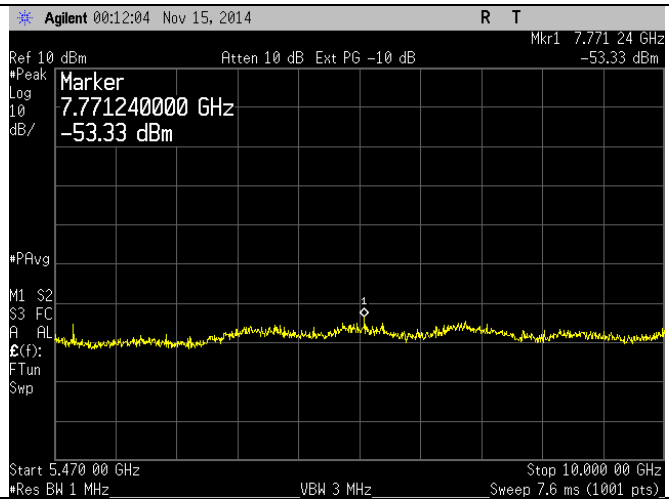
B.1.4 – RF Conducted – Undesirable Emissions (Spurious)

Manufacturer	Gogo Business Aviation
Date	November 15,18,19,21 2014
Operator	Adam A
Temp. / R.H.	20 - 25º C / 30-60% R.H.
Rule Part	15.407
Specific Measurement Procedure	FCC KDB 789033 Section II. G.
Additional Description of Measurement	RF Conducted Measurement
Additional Notes	Continuous transmit modulated used for this test.

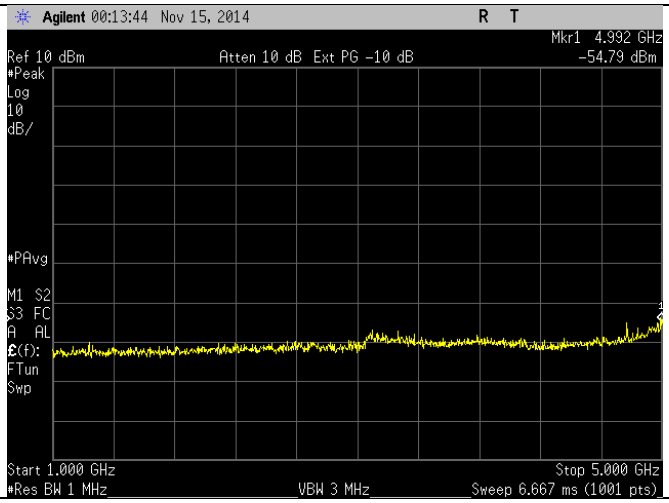
Plots UNII-1



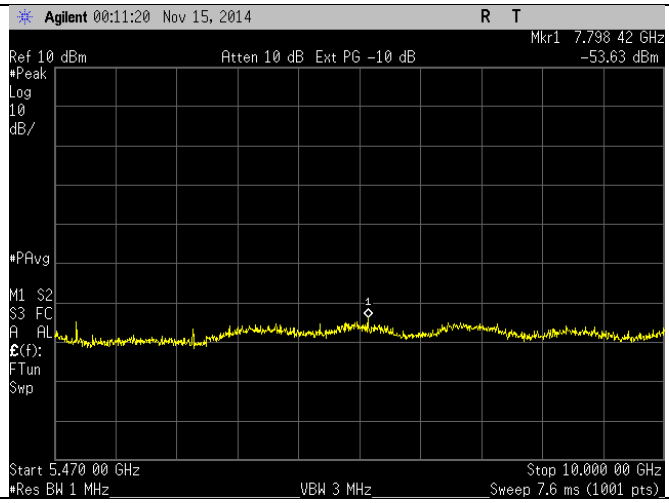
Low Channel - 1-5 GHz



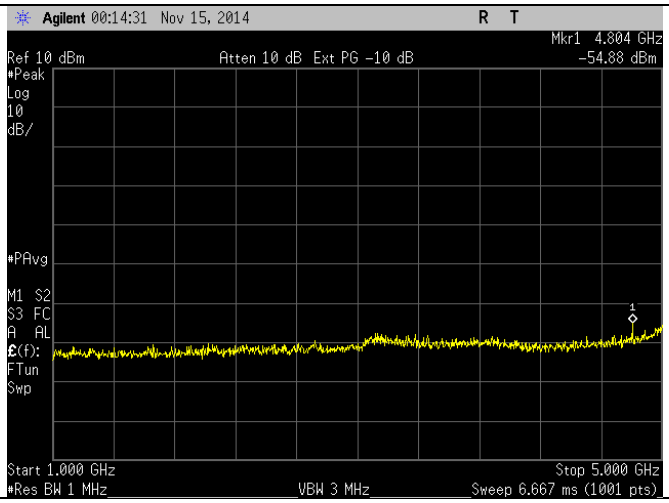
Low Channel - 5.47-10 GHz



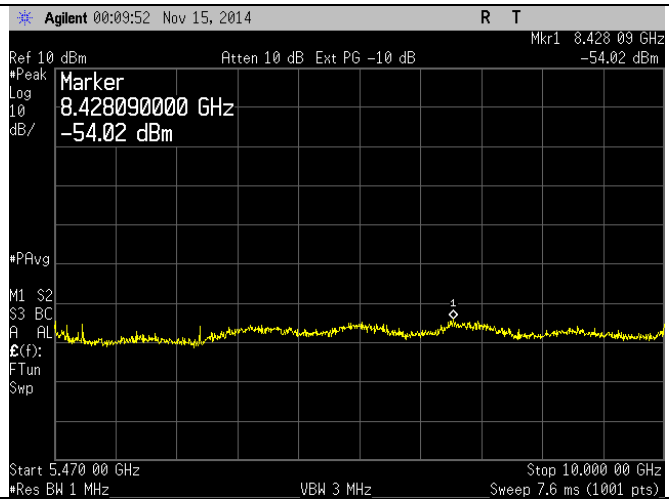
Mid Channel - 1-5 GHz



Mid Channel - 5.47-10 GHz

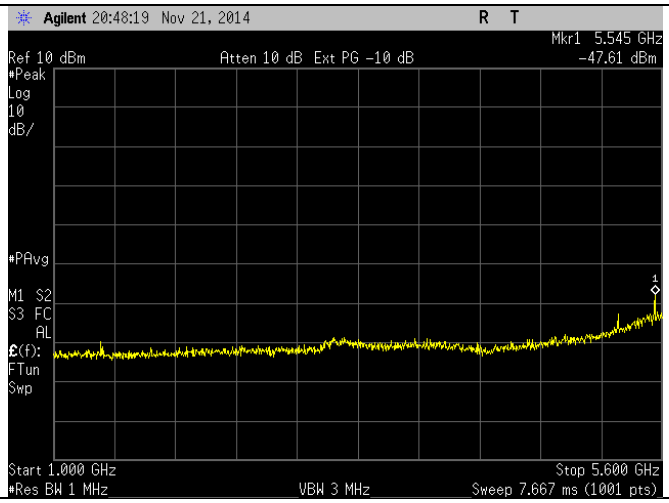


High Channel - 1-5 GHz

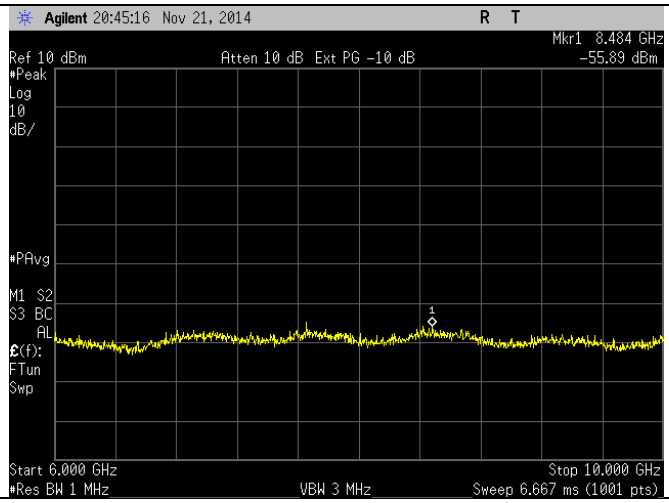


High Channel - 5.47-10 GHz

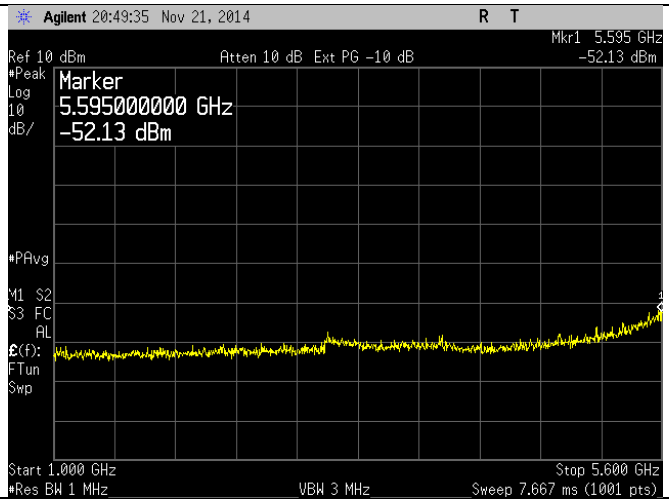
Plots UNII-3



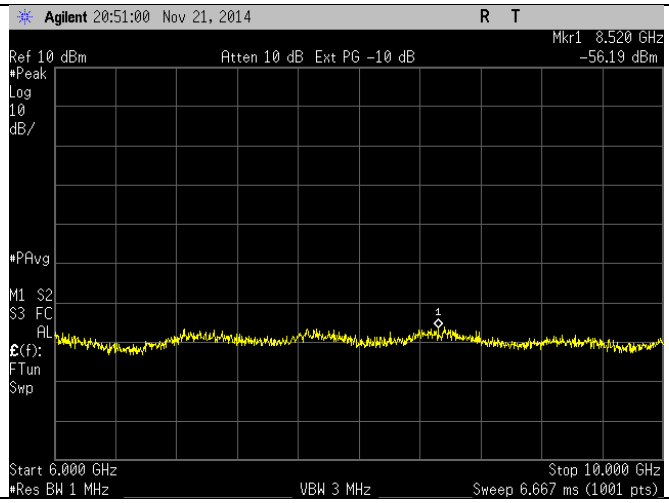
Low Channel - 1-5.6 GHz



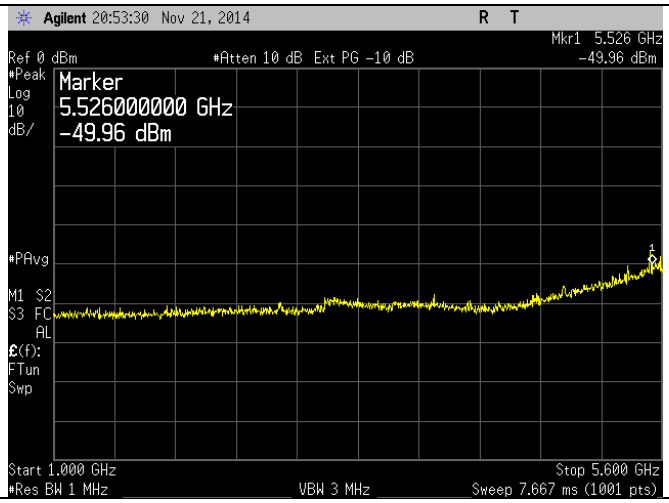
Low Channel - 6-10 GHz



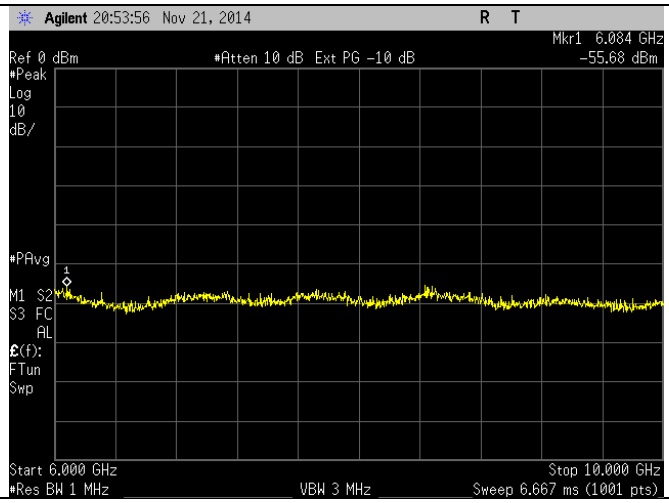
Mid Channel - 1-5.6 GHz



Mid Channel - 6-10 GHz

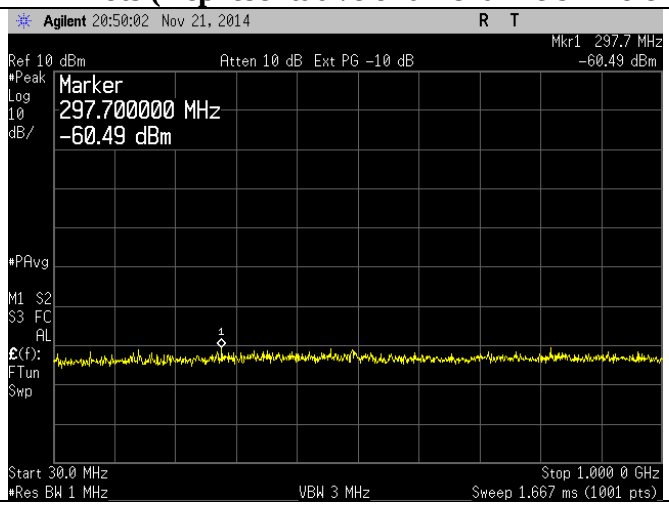


High Channel - 1-5.6 GHz

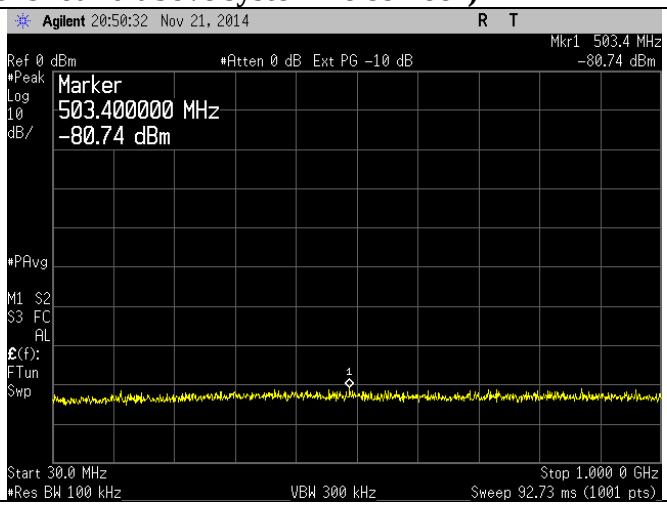


High Channel - 6-10 GHz

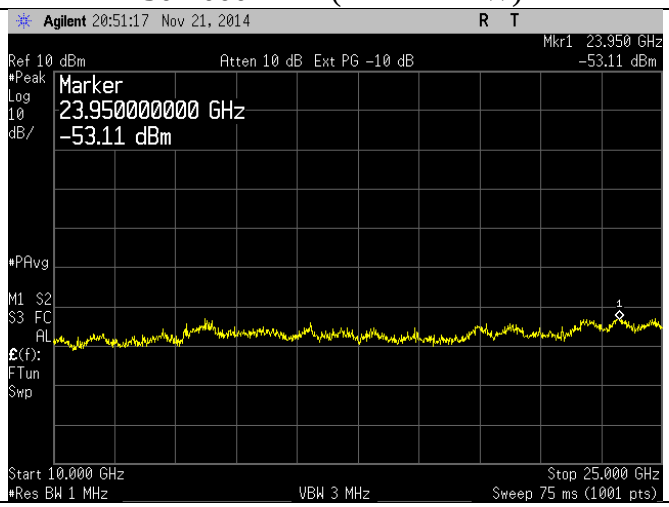
Plots (Representative of all channels – no emissions found above system noise floor)



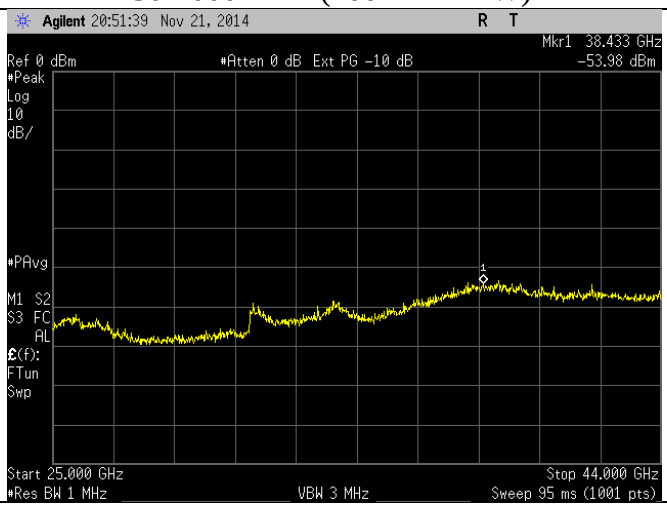
30-1000 MHz (1 MHz RBW)



30-1000 MHz (100 kHz RBW)



10-25 GHz



25-44 GHz

B.1.5 – RF Conducted – Frequency Stability

Manufacturer	Gogo Business Aviation
Date	11-21-14
Operator	Adam A
Temp. / R.H.	20 - 25º C / 30-60% R.H.
Rule Part	15.407
Specific Measurement Procedure	ANSI C63.10-2009
Additional Description of Measurement	RF Conducted Measurement
Additional Notes	1. Continuous transmit modulated used for this test. 2. Better than 1 PPM stability

		Supply Voltage			
		Lower	Nominal	Upper	
Temp.	Nominal Frequency (MHz)	Measured Frequency (Hz)			Delta (Hz)
-40° C	5180	5180013165	5180013365	5180013155	210
+23° C	5180	5180009465	5180009890	5180010355	890
+85° C	5180	5180011400	5180014950	5180020650	9250

B.2 – Radiated Emissions

Rule Part(s)	15.407 / 15.205 / 15.209			
Measurement Procedure	ANSI C63.4 - 2009 ANSI C63.10 – 2009 FCC KDB 789033 D02 General UNII Test Procedures New Rules v01			
Test Location	LS Research, LLC - FCC Listed Semi-Anechoic Chamber (with absorbers placed on ground plane for measurements above 1 GHz)			
Test Distance	3 meter (30-4000 MHz) 1 meter (4-40 GHz)			
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	Standard Gain Horn: 1) 18-26 GHz 2) 26-40 GHz
Measurement Detectors	30-1000MHz RBW: 120 kHz VBW: At least 300 kHz		1 - 40 GHz: RBW : 1MHz VBW: At least 3 (MHz) Peak 10 Hz Average	
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 performed. 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 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 Undesirable Emissions

Manufacturer	gogo Business Aviation
Date	November 24,25,26 2014
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 - 2009 ANSI C63.10 - 2009 FCC KDB 789033
Test Distance	3 meter (30-4000 MHz) 1 meter (4-40 GHz)
EUT Placement	80 cm height non-conductive table centered on turn-table
Detectors	Peak / Quasi-Peak; 120 kHz RBW, 1.2 MHz VBW Peak; RBW 1MHz VBW 3 MHz (10Hz VBW for average measurements) – Above 1 GHz
Additional Notes	1) Tested in continuous transmit modulated mode (1 Mbps worst case) with EUT in three orientations at maximum power. 2) Antenna port terminated with matching termination per KDB (cabinet radiation).

Example Calculation:

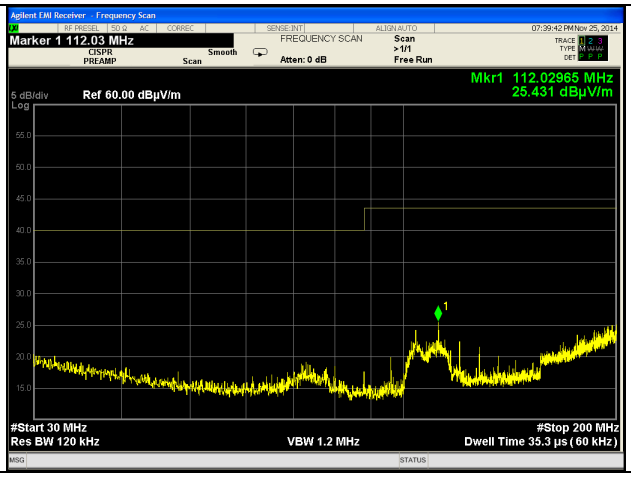
FCC 15.209 Limit @ 3 meter (dBµV/m) – Reading (dBµV/m) = Margin

Table (30-1000 MHz)

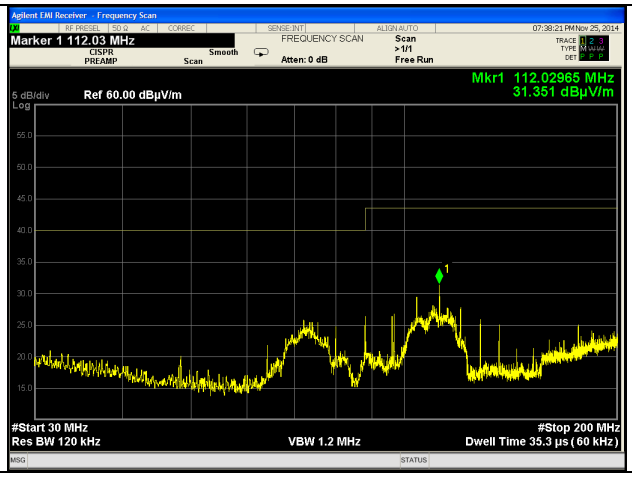
Frequency (MHz)	Height (cm)	Azimuth (degree)	Quasi Peak Reading (dBµV/m)	Quasi Peak Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT orientation
875	121	289	43.29	46	2.71	Horizontal	Flat
875	134	350	42.87	46	3.13	Horizontal	Vertical
875	103	315	42.54	46	3.46	Vertical	Horizontal
400	119	53	35.11	46	10.89	Horizontal	Flat
375	100	9	35.01	46	10.99	Vertical	Flat
112	153	179	30.42	43.5	13.08	Horizontal	Flat

Note: Emissions not related to channel, mode, transmit, or receive.

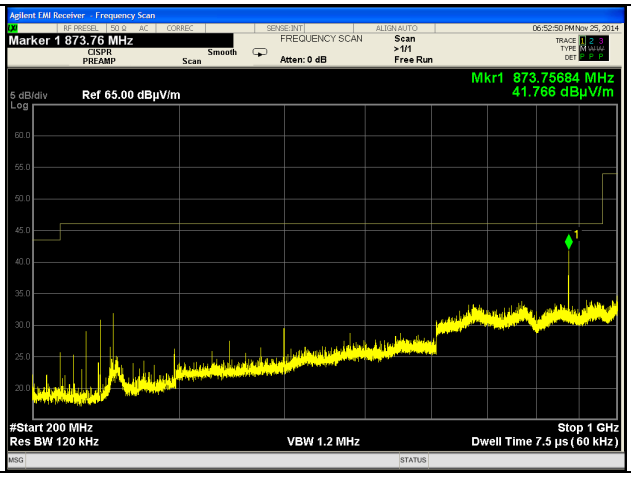
Plots 30-1000 MHz



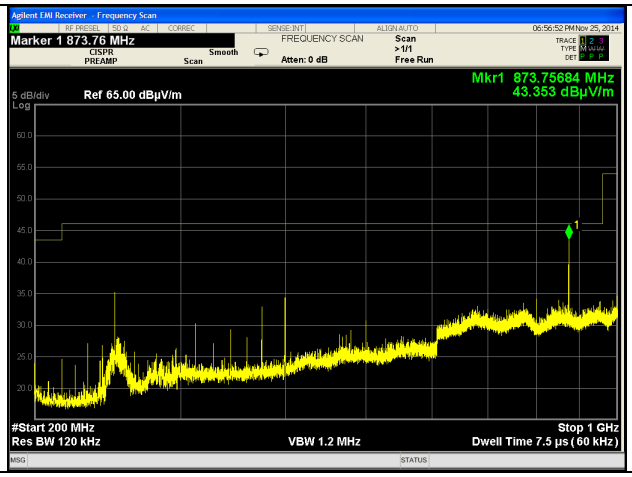
30-200 MHz Vertical



30-200 MHz Horizontal



200-1000 MHz Vertical



200-1000 MHz Horizontal

Plots 1000-4000 MHz

Channel 36 - Vertical

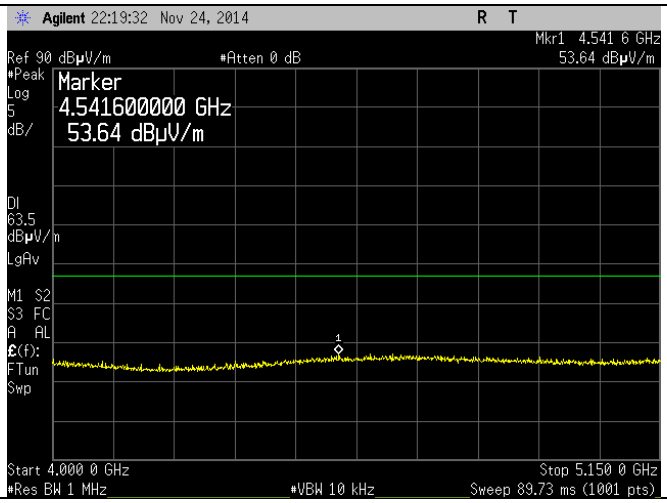
Channel 36 - Horizontal

Channel 165 - Vertical

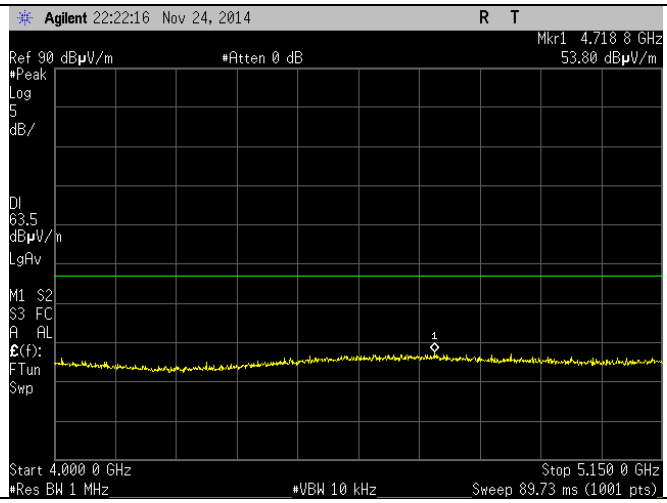
Channel 165 – Horizontal

Note: Emissions not related to channel, mode, transmit, or receive and greater than 15 dB below limit.

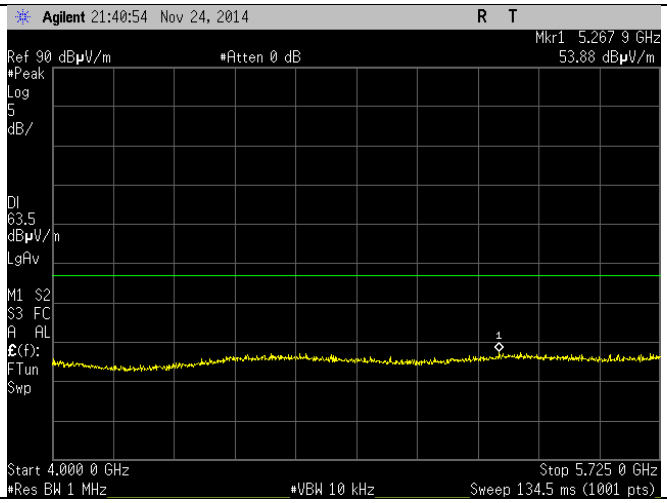
Plots 4000-8000 MHz



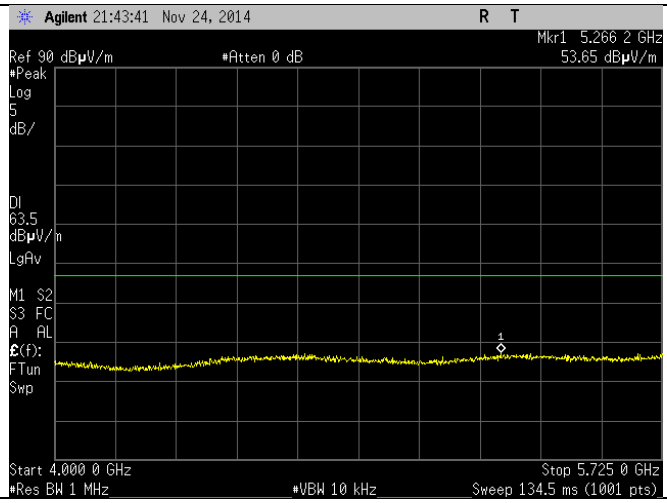
Channel 36 - Vertical



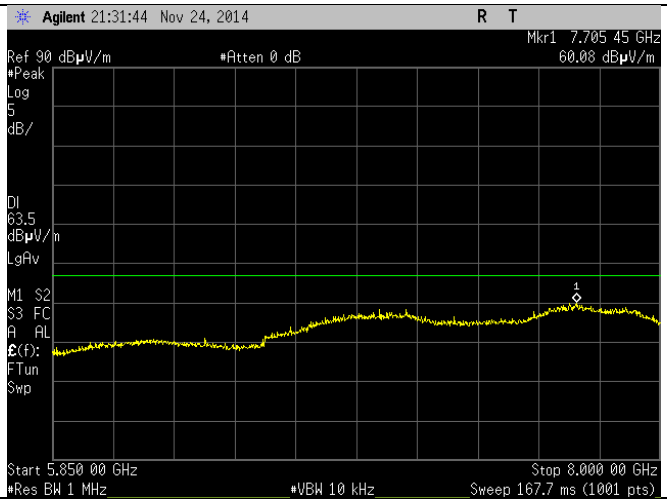
Channel 36 - Horizontal



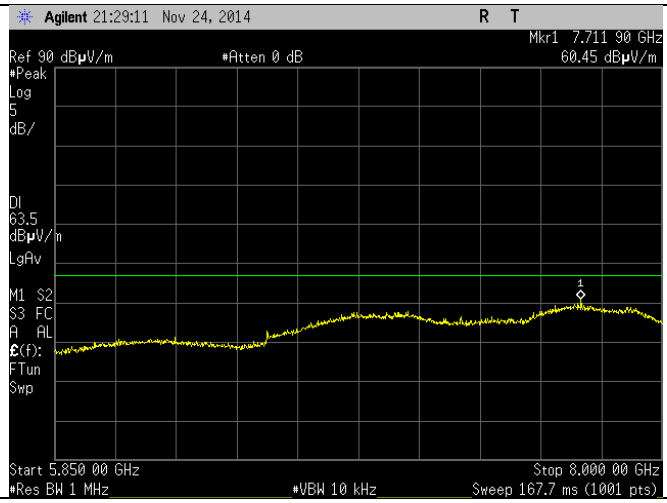
Channel 149 - Vertical



Channel 149 – Horizontal



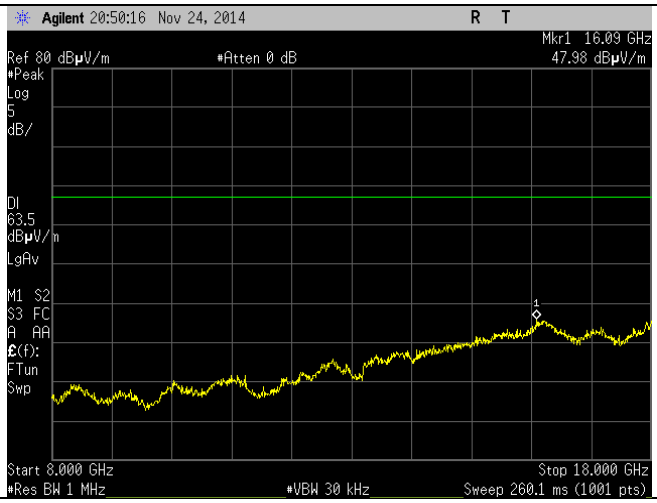
Channel 165 - Vertical



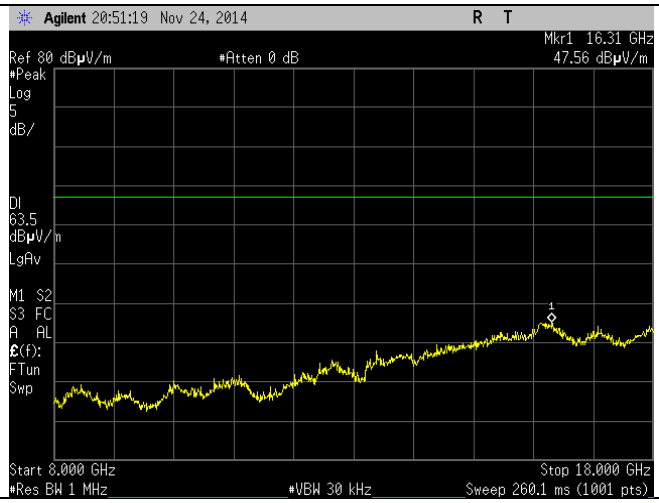
Channel 165 – Horizontal

Note: No Emissions found above system noise floor.

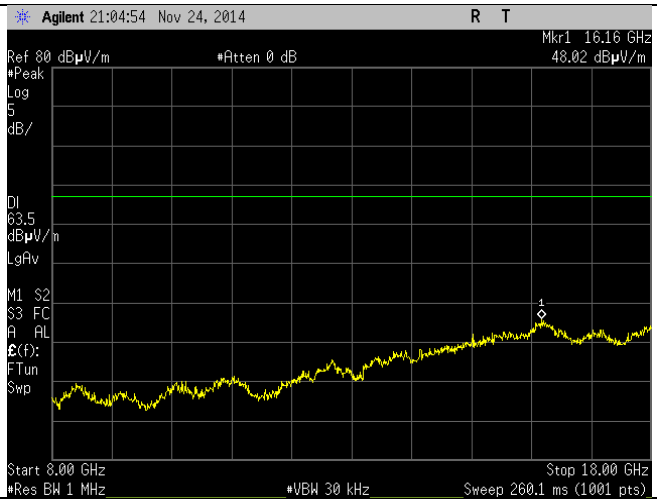
Plots 8000-18000 MHz



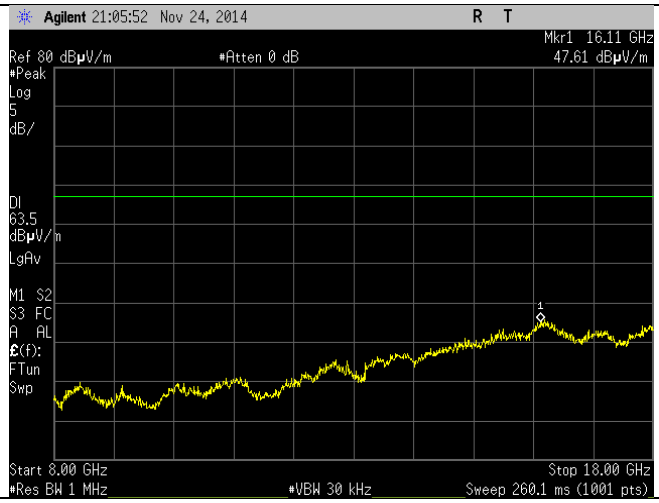
Channel 40 - Vertical



Channel 40 - Horizontal



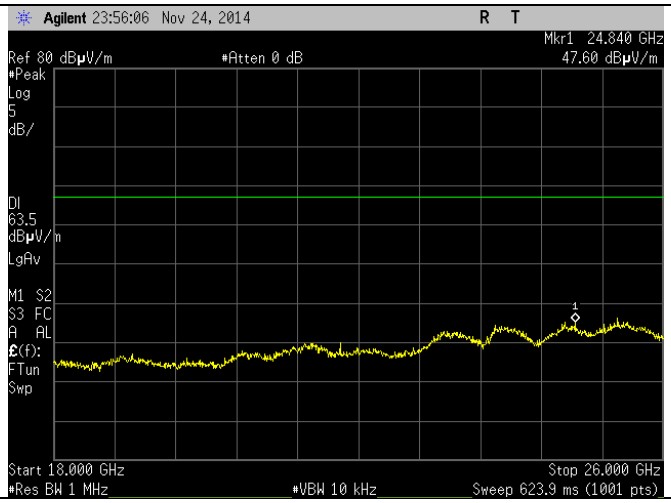
Channel 157 - Vertical



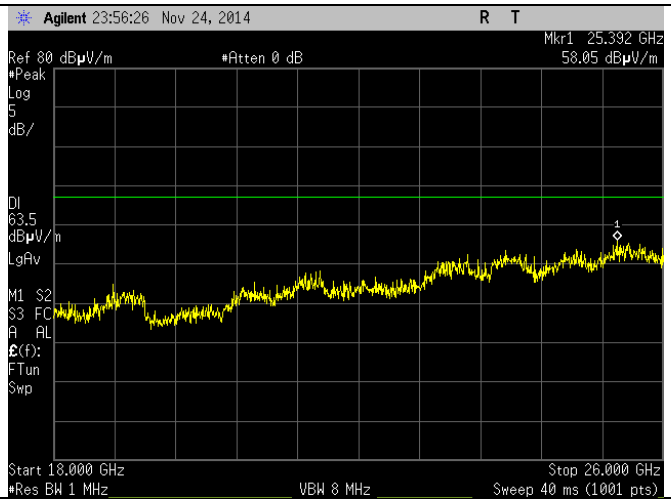
Channel 157 – Horizontal

Note: No Emissions found above system noise floor.

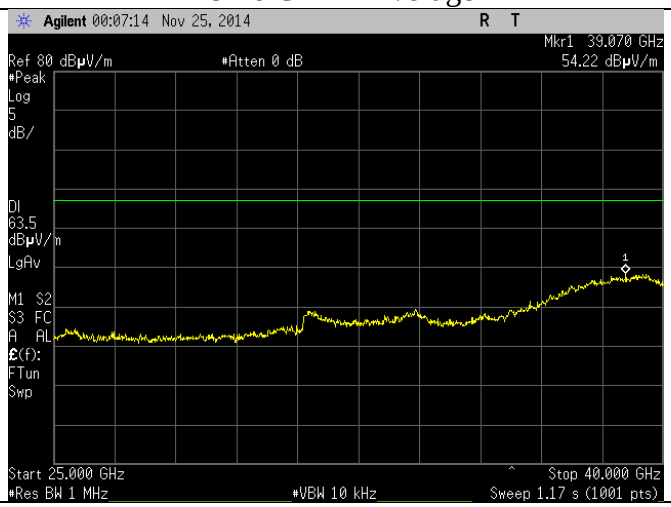
Plots 18-40 GHz



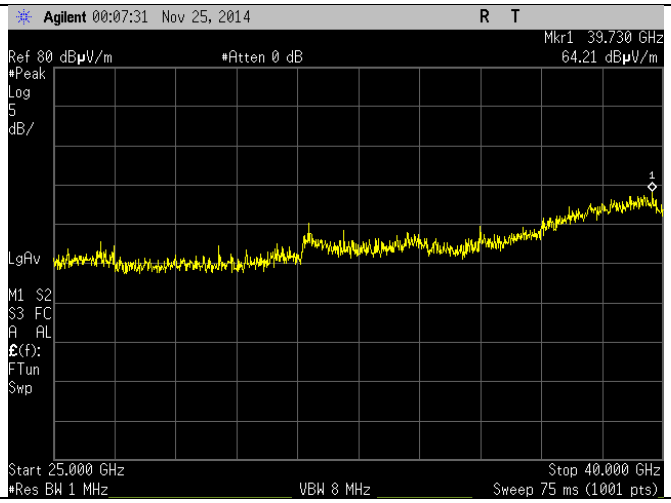
18-26 GHz – Average



18-26 GHz – Peak



25-40 GHz – Average



25-40 GHz – Peak

Note: No Emissions found above system noise floor (representative of all channels, rates)

B.2.2 – Radiated Emissions Receive Mode

Manufacturer	gogo Business Aviation
Date	November 19,24,25,26 2014
Operator	Mike H / Adam A
Temp. / R.H.	20 - 25º C / 30-60% R.H.
Rule Part	15.109
Measurement Procedure	ANSI C63.4 - 2009 ANSI C63.10 - 2009
Test Distance	3 meter 30-4000 MHz
EUT Placement	80 cm height non-conductive table centered on turn-table
Detectors	Peak; RBW 1 MHz
Additional Notes	1) Tested in continuous receive mode with EUT in three orientations 2) Emissions not effected by change in channel.

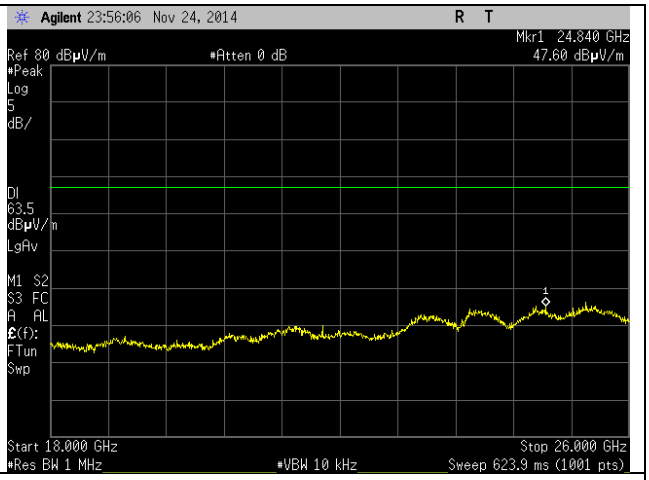
Example Calculation:

Limit (dBµV/m) – Reading (dBµV/m) = Margin

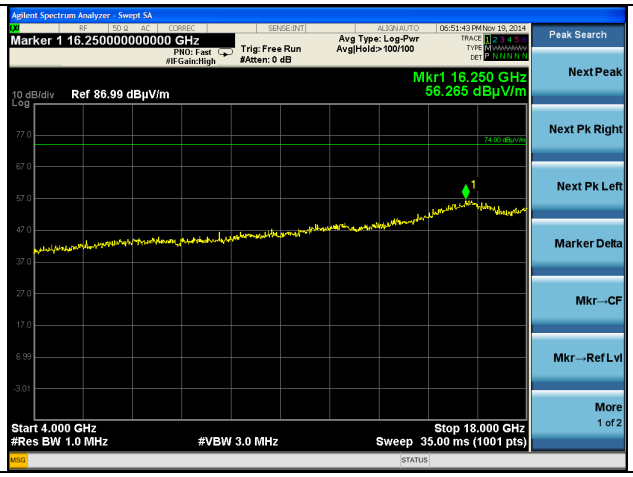
Table

Frequency (MHz)	Height (cm)	Azimuth (degree)	Quasi Peak Reading (dBµV/m)	Quasi Peak Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT orientation
875	121	289	43.29	46	2.71	Horizontal	Flat
875	134	350	42.87	46	3.13	Horizontal	Vertical
875	103	315	42.54	46	3.46	Vertical	Horizontal
400	119	53	35.11	46	10.89	Horizontal	Flat
375	100	9	35.01	46	10.99	Vertical	Flat
112	153	179	30.42	43.5	13.08	Horizontal	Flat

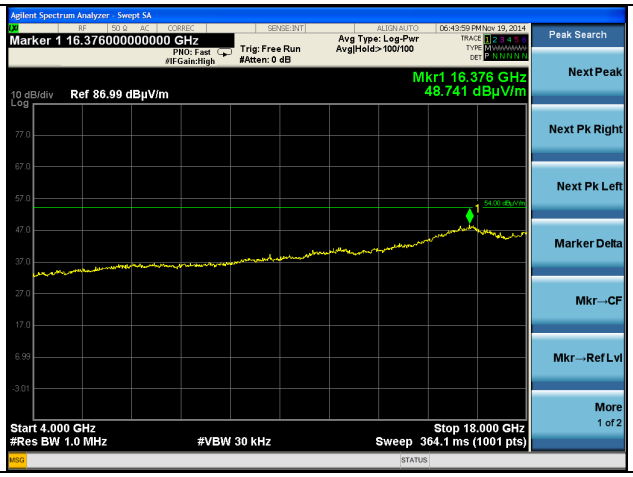
1000 – 4000 MHz (average)



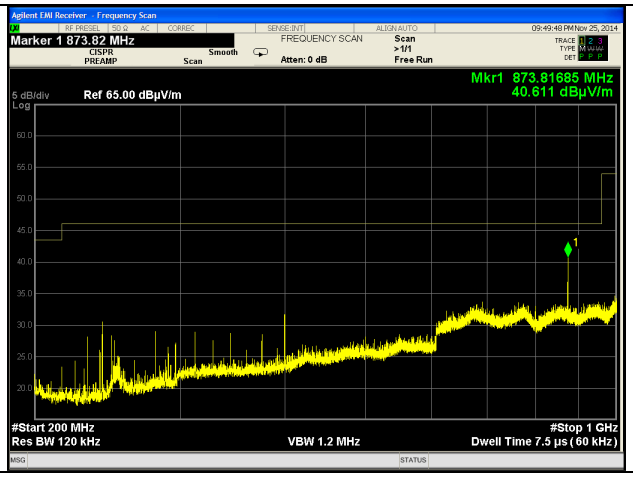
18-26 GHz (average)



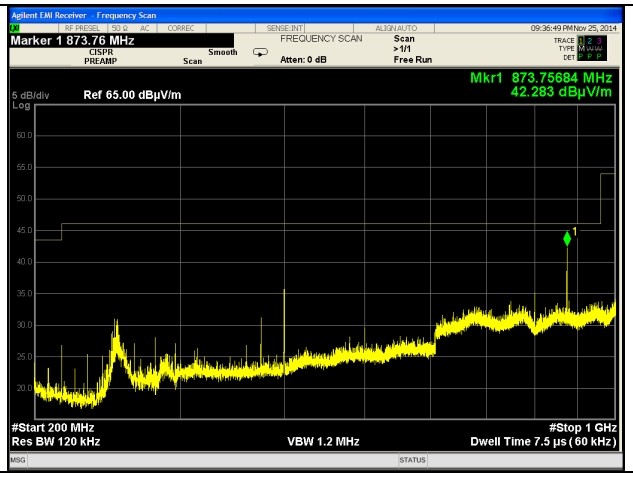
4-18 GHz (peak)



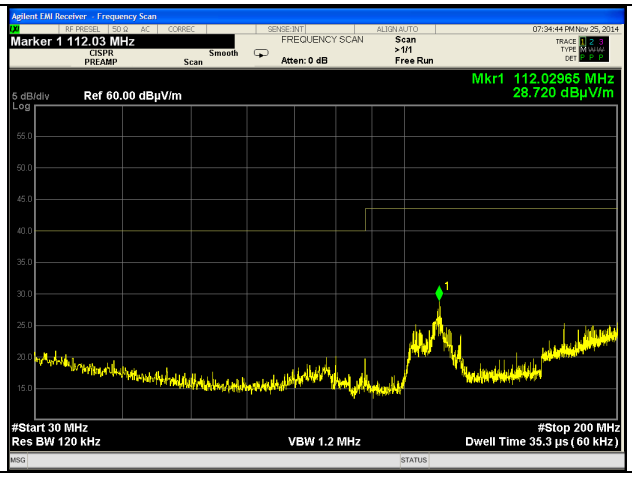
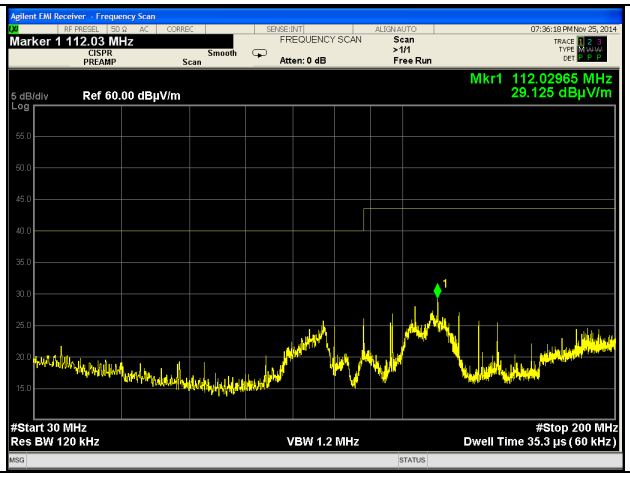
4-18 GHz (reduced VBW)



200-1000 MHz Vertical



200-1000 MHz Horizontal

	
30-200 MHz Vertical	30-200 MHz Horizontal

B.3 – AC Mains Conducted Emissions

Test Not Applicable - EUT powered by On-board DC supply only

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
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	2014	Code of Federal Regulations – Telecommunications
ANSI C63.4	2009	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.
ANSI C63.10	2009	American National Standard for Testing Unlicensed Wireless Devices
FCC KDB 789033 D02 General UNII Test Procedures New Rules v01	June 6, 2014	Guidance for Compliance Testing of Unlicensed National Information Infrastructure (U-NII) Devices Part 15, Subpart E

END OF REPORT

Date	Version	Comments	Person
12-15-14	V0	Initial Draft Release	Adam A
2-11-15	V1	Final	Adam A
5-26-15	V1a	TCB Comments	Adam A