



LS RESEARCH, LLC

Wireless Product Development

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ENGINEERING TEST REPORT # TR 314305 A

LSR Job #: C-2063

Compliance Testing of:

GVPU

Test Date(s):

November 12, 13, 14, 19, 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:
Michael Hintzke, EMC Engineer

Signature: _____ Date: 12-20-14

Report by:
Adam Alger, EMC Engineer

Signature: _____ Date: 12-15-14

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Prepared For: gogo Business Aviation

Report: TR 314305 A

LSR: C-2063

Name: GVPU

Model: P24486

Serial: Eng. Sample

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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

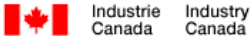
A2LA Certificate Number: 1255.01



Federal Communications Commission (FCC) – USA

Listing of 3 Meter Semi-Anechoic Chamber based on Title 47 CFR – Part 2.948

FCC Registration Number: 90756



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

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1.0 Summary of Test Report

In November 2014 the EUT, GVPU, was tested and MEETS the following requirements:

FCC Requirement	Test Requirements	Compliance (Yes/No)
15.247 (a)(2)	6 dB Bandwidth of a Digital Modulation System	Yes
15.247(b) & 1.1310	Maximum Output Power	Yes
15.247 (d)	Power Spectral Density of a Digital Modulation System	Yes
15.247(d)	RF Conducted Spurious Emissions at the Transmitter Antenna Terminal	Yes
15.247(c), 15.209 & 15.205	Transmitter Radiated Emissions	Yes
15.109	Receive Mode (Digital Device) Radiated Emissions	Yes
2.1055 (d)	Frequency Stability	Yes
15.207	Power Line Conducted Emissions Measurements	N/A

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

Low Channel 1(2412 MHz), Middle Channel 6 (2437 MHz), High Channel 11 (2462 MHz). EUT programmed for continuous transmit or receive on selectable channel and data rate (modulation) using HCI commands via proprietary cable.

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4.0 Conditions of Test

Environmental:

Temperature: 20-25° 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 15.247, 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.

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Appendix B – Test Data

B.1 – RF Conducted Emissions

Manufacturer	gogo Business Aviation
Test Location	LS Research, LLC
Rule Part	FCC Part 15.247
General Measurement Procedure	FCC KDB 558074 D01 DTS Meas Guidance v03r02 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.

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B.1.1 – RF Conducted – Fundamental Bandwidth

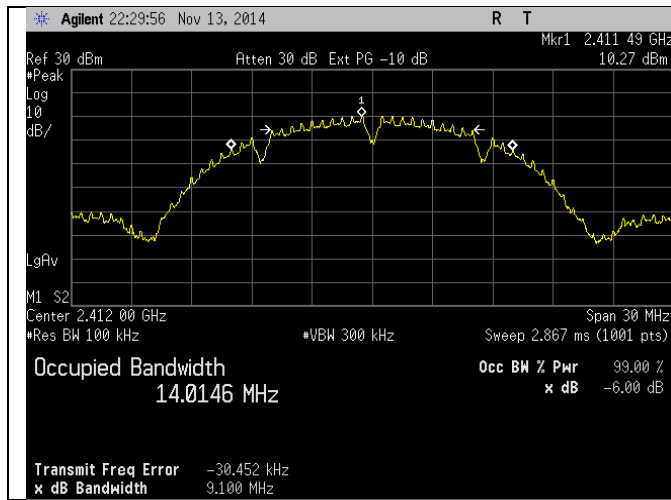
Manufacturer	gogo Business Aviation
Date	11-13-14
Operator	Adam A
Temp. / R.H.	20 - 25° C / 30-60% R.H.
Rule Part	FCC Part 15.247
Specific Measurement Procedure	FCC KDB 558074 Section 8.0 DTS bandwidth ANSI C63.10-2009 Section 6.9
Additional Description of Measurement	Peak detector used
Additional Notes	Continuous transmit modulated used for this test.

Table

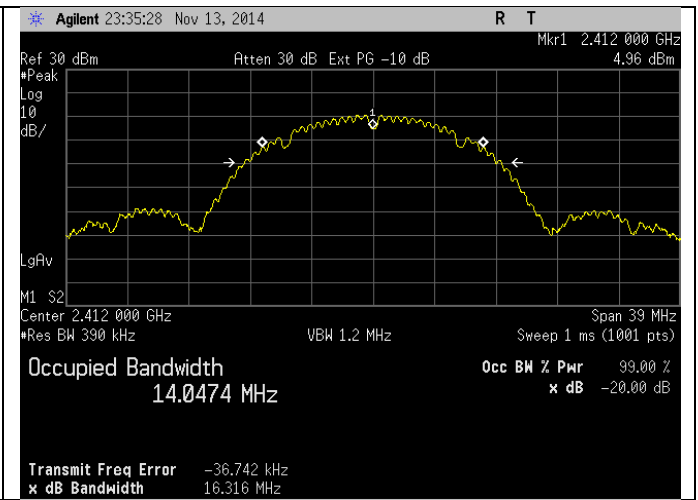
Mode (802.11)	Mode (Mbps)	Frequency (MHz)	20 dB OBW (MHz)	99% BW (MHz)	6 dB DTS BW (MHz)
b	1	2412	16.316	14.047	9.100
		2437	16.295	14.005	9.533
		2462	16.284	13.963	9.075
	11	2412	16.737	14.369	10.120
		2437	16.786	14.387	9.395
		2462	16.713	14.485	10.084
g	6	2412	20.038	17.208	15.165
		2437	20.244	17.070	15.815
		2462	20.303	17.038	15.152
	12	2412	18.855	16.889	15.401
		2437	19.291	16.911	15.172
		2462	19.327	16.953	15.426
	24	2412	19.333	16.944	15.754
		2437	18.871	16.941	16.032
		2462	19.093	16.829	16.417
	54	2412	18.640	16.852	16.066
		2437	19.922	16.900	16.342
		2462	19.266	16.938	16.311
n	6.5	2412	21.435	18.234	15.356
		2437	21.047	18.289	15.139
		2462	21.491	18.342	15.141
	65	2412	20.118	14.947	16.334
		2437	20.345	17.935	17.282
		2462	20.011	17.895	17.061

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Plots 802.11b – 1 Mbps Low Channel – 2412 MHz

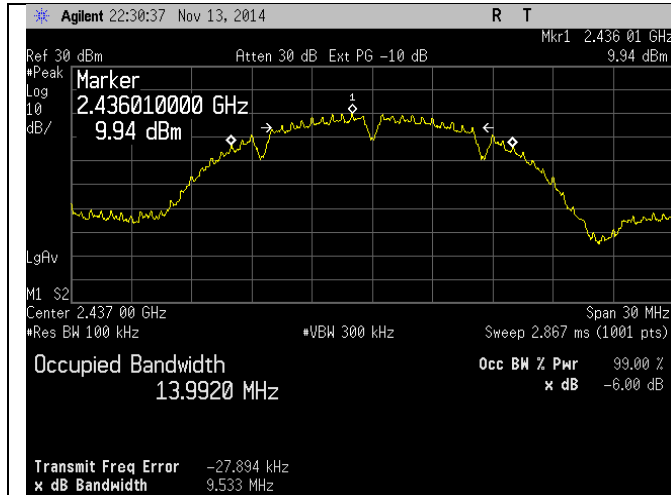


6 dB DTS BW

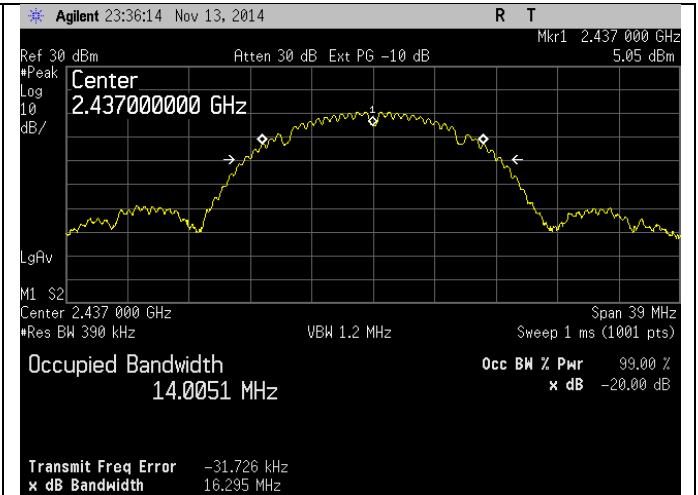


20 dB OBW + 99% BW

Mid Channel – 2437 MHz

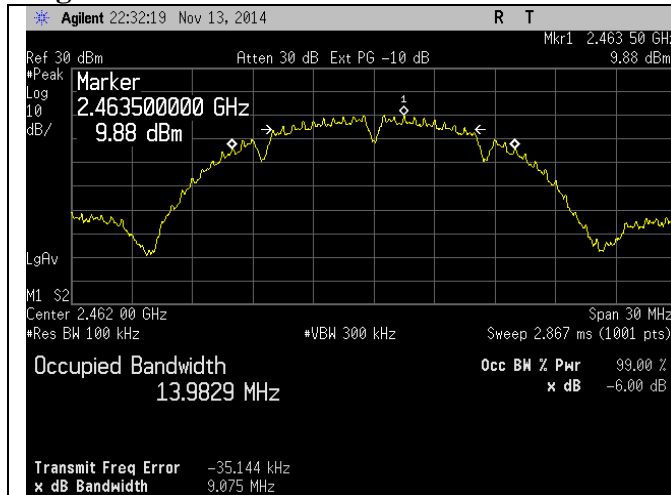


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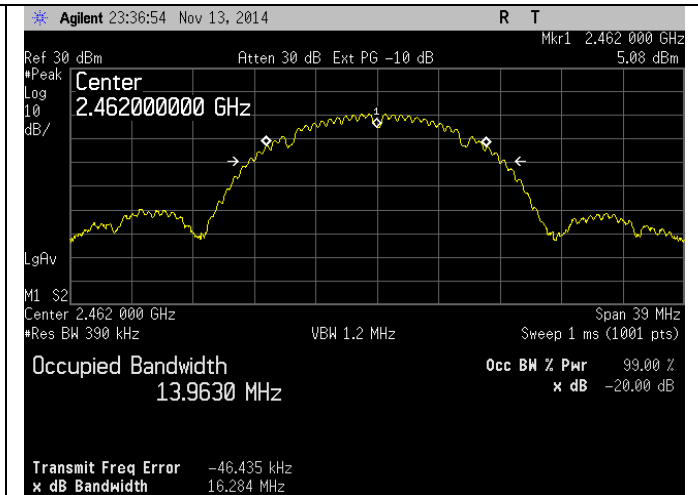


20 dB OBW + 99% BW

High Channel – 2462 MHz



6 dB DTS BW



20 dB OBW + 99% BW

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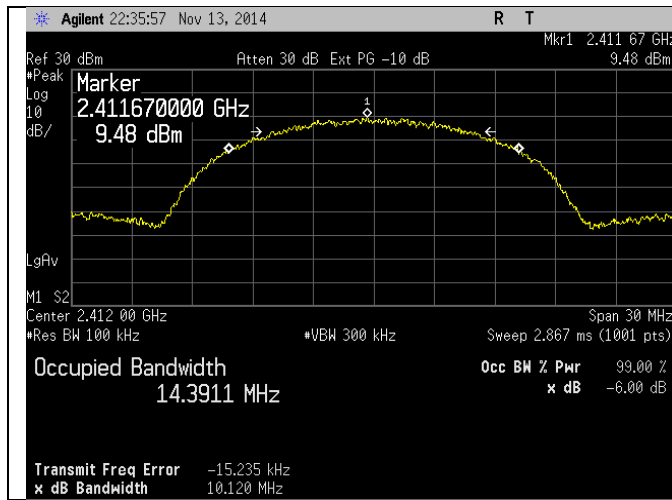
LSR: C-2063

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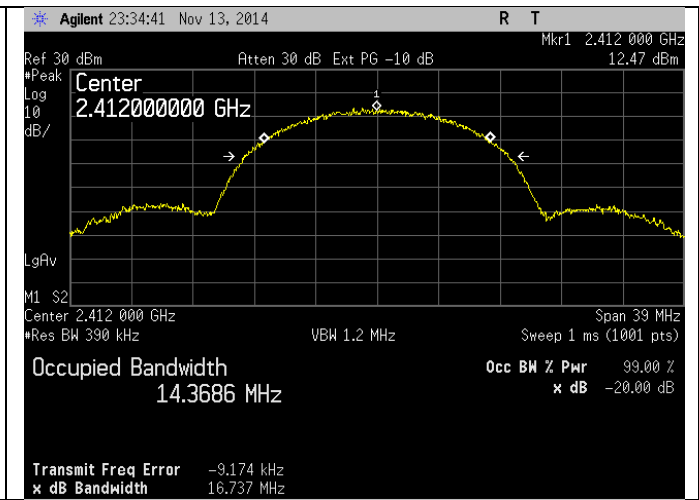
Model: P24486

Serial: Eng. Sample

802.11b – 11 Mbps Low Channel – 2412 MHz

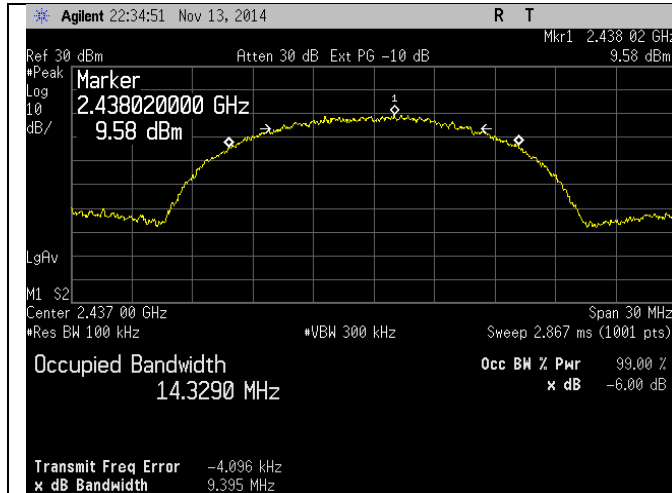


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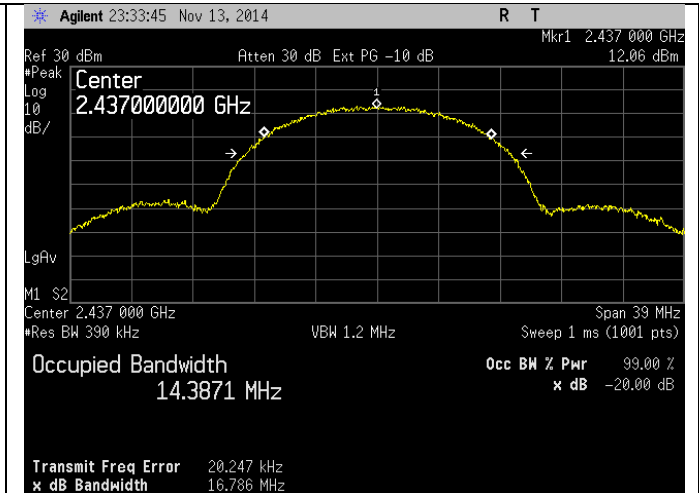


20 dB OBW + 99% BW

Mid Channel – 2437 MHz

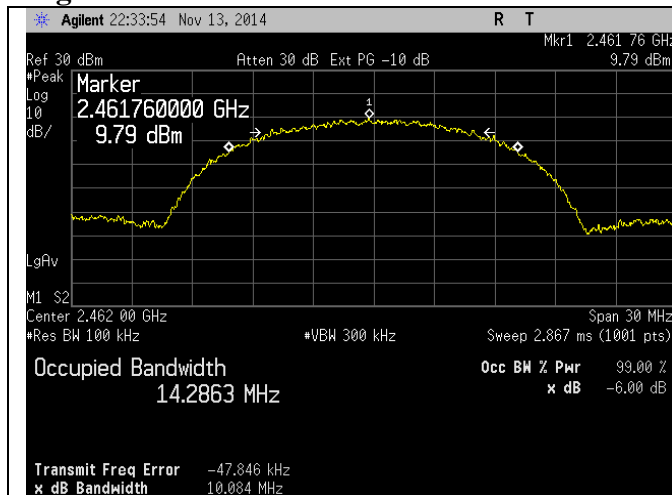


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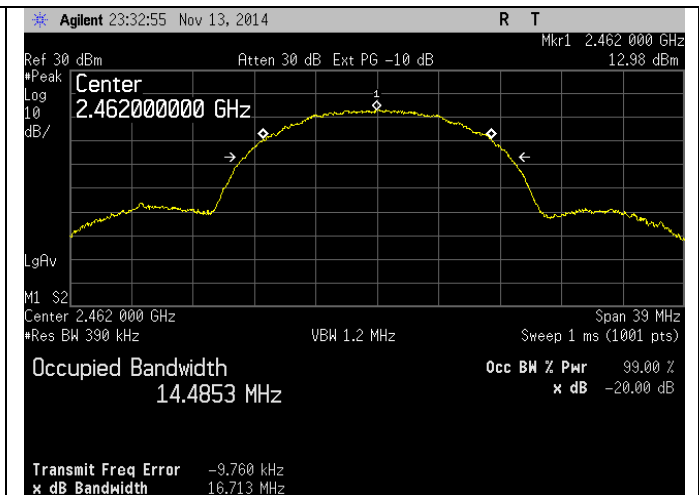


20 dB OBW + 99% BW

High Channel – 2462 MHz



6 dB DTS BW



20 dB OBW + 99% BW

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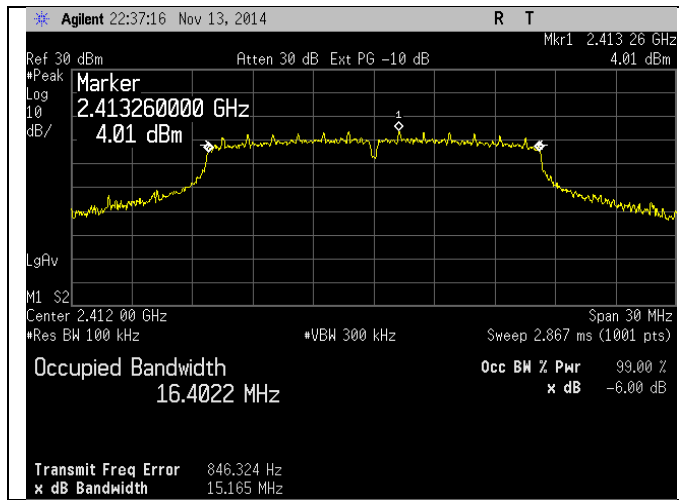
LSR: C-2063

Name: GVPV

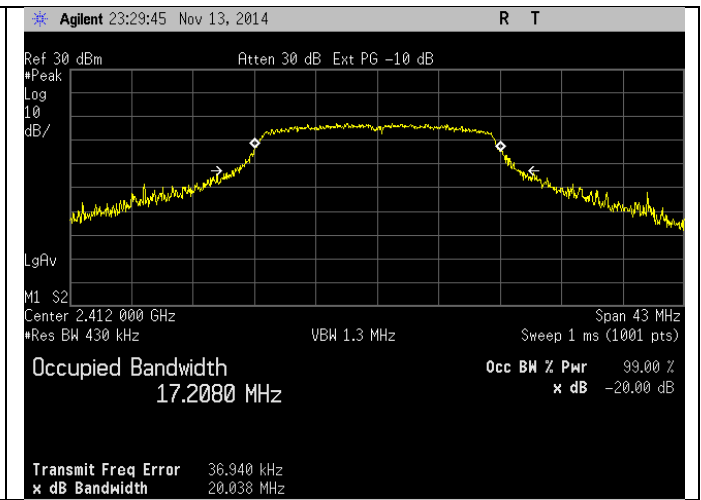
Model: P24486

Serial: Eng. Sample

802.11g – 6 Mbps Low Channel – 2412 MHz

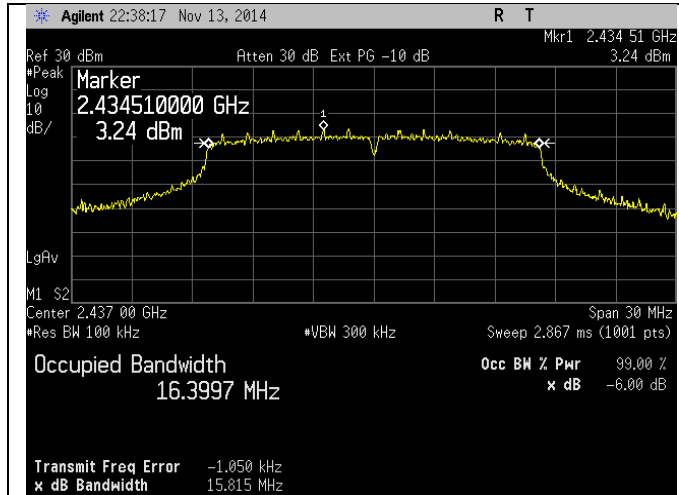


6 dB DTS BW

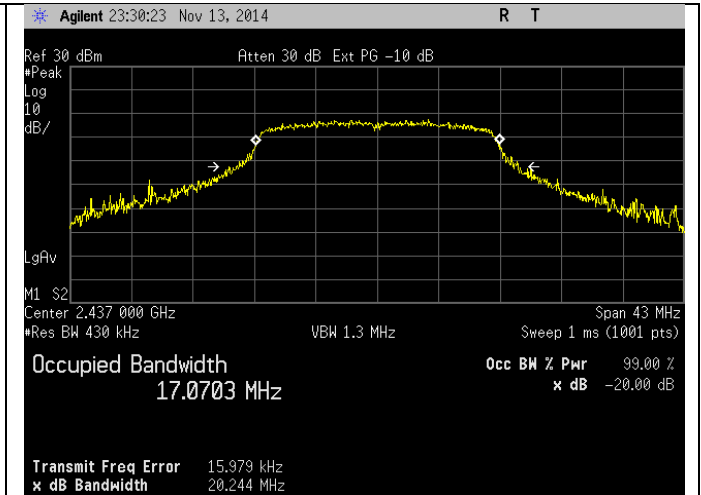


20 dB OBW + 99% BW

Mid Channel – 2437 MHz

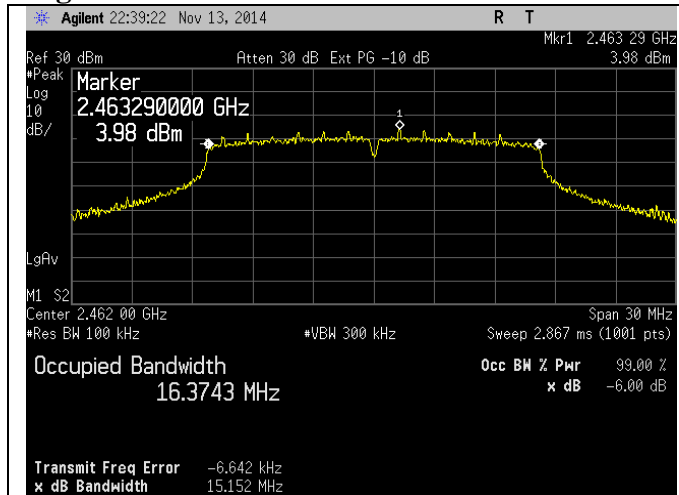


6 dB DTS BW

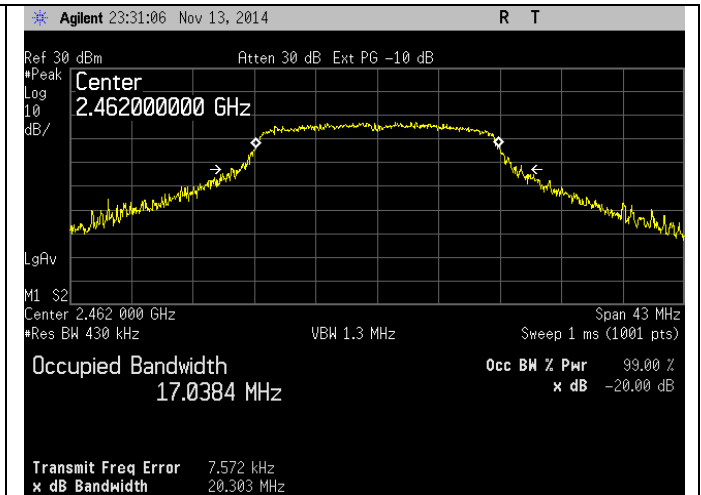


20 dB OBW + 99% BW

High Channel – 2462 MHz



6 dB DTS BW



20 dB OBW + 99% BW

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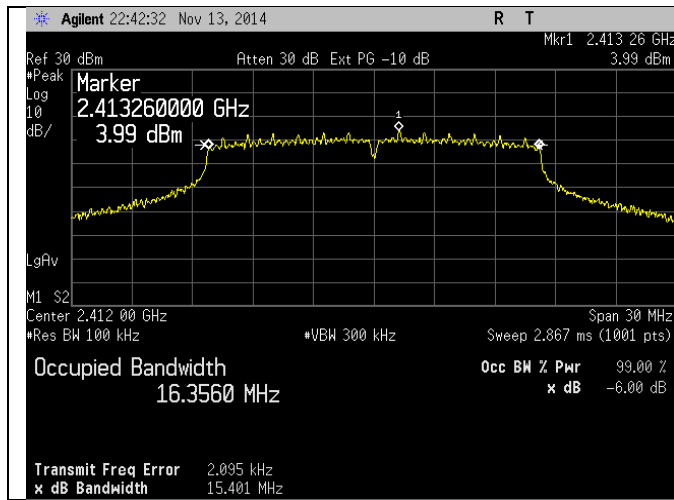
Name: GVPU

Model: P24486

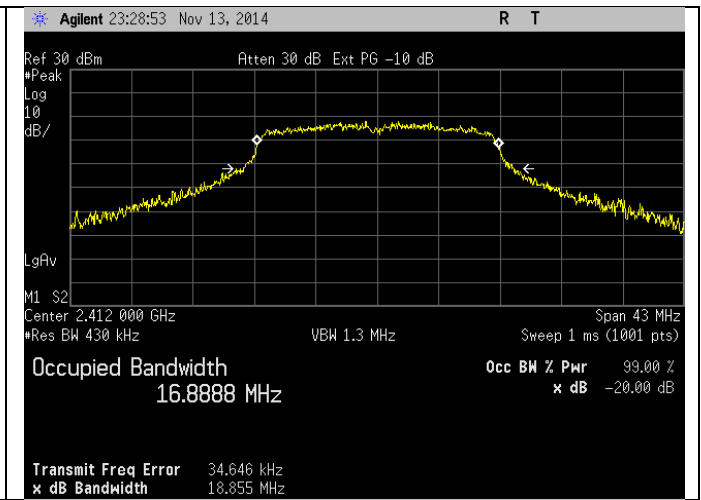
Serial: Eng. Sample

802.11g – 12 Mbps

Low Channel – 2412 MHz

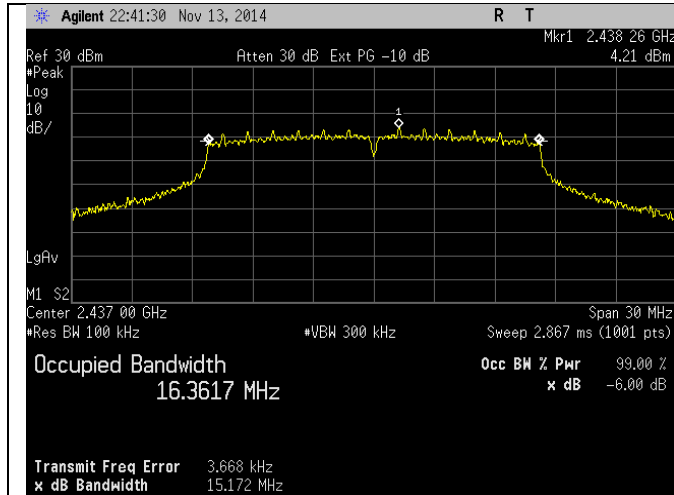


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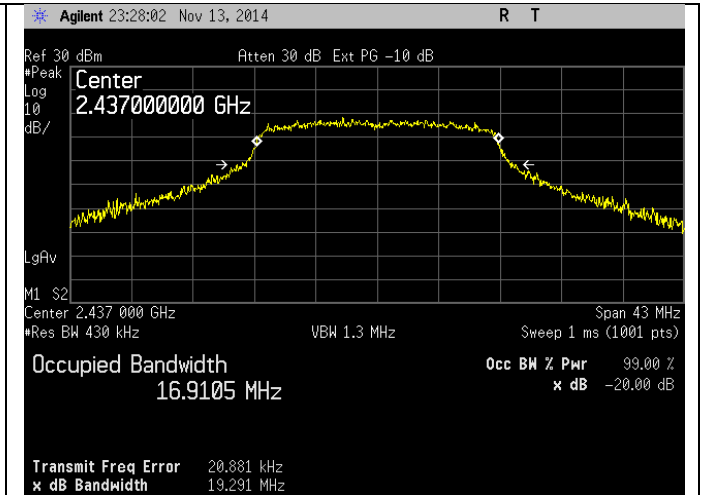


20 dB OBW + 99% BW

Mid Channel – 2437 MHz

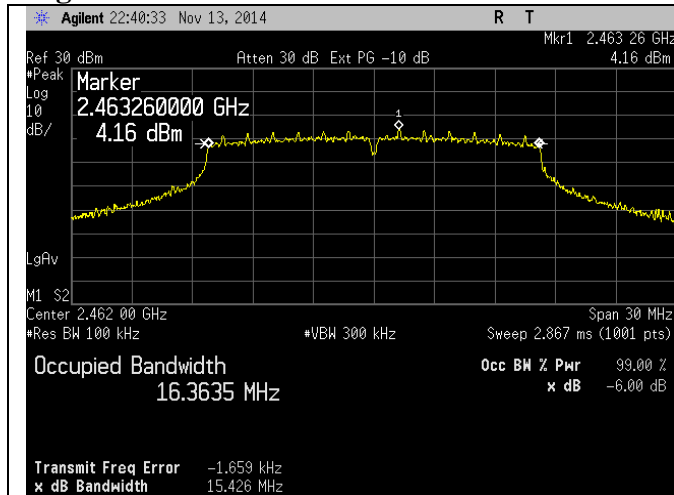


6 dB DTS BW

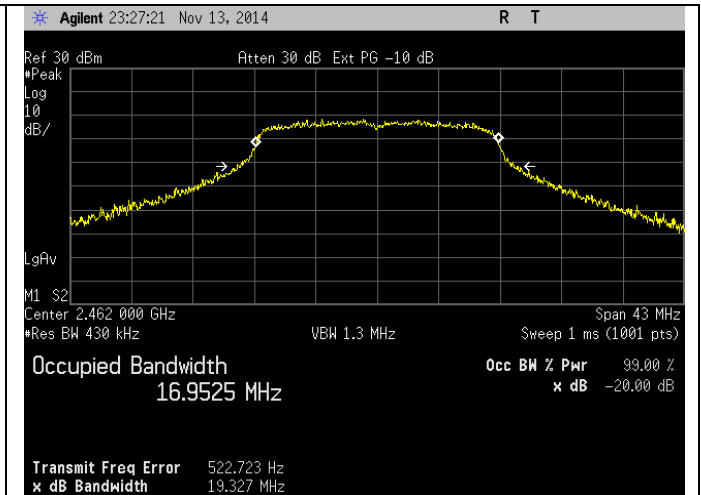


20 dB OBW + 99% BW

High Channel – 2462 MHz



6 dB DTS BW



20 dB OBW + 99% BW

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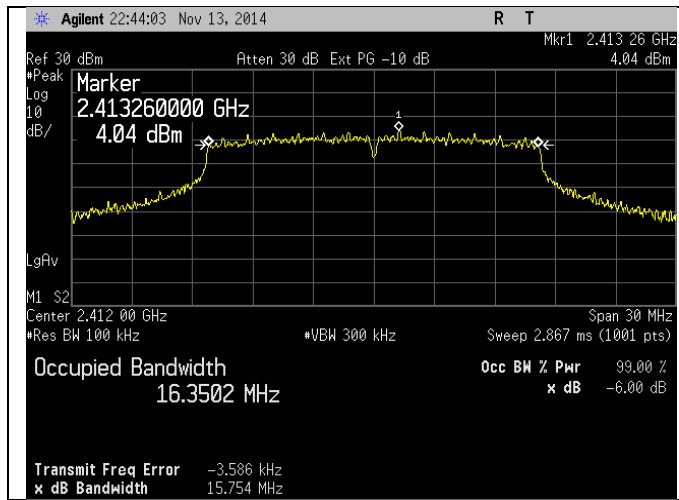
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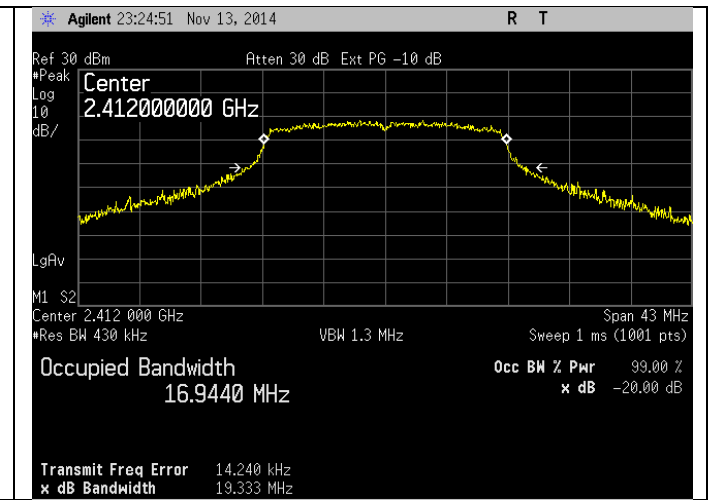
Model: P24486

Serial: Eng. Sample

802.11g – 24 Mbps Low Channel – 2412 MHz

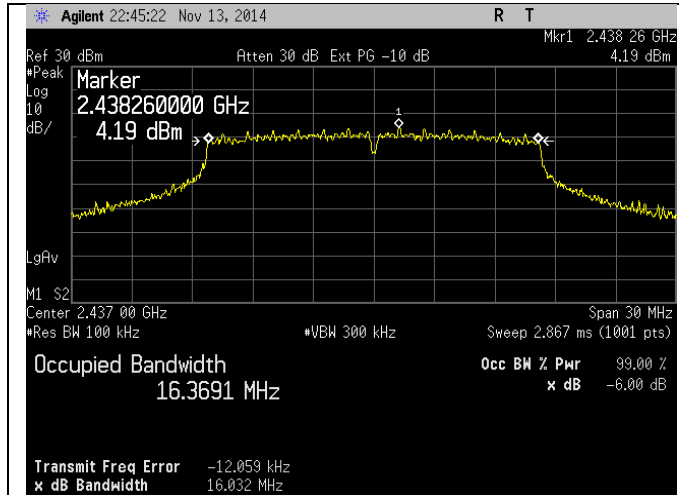


6 dB DTS BW

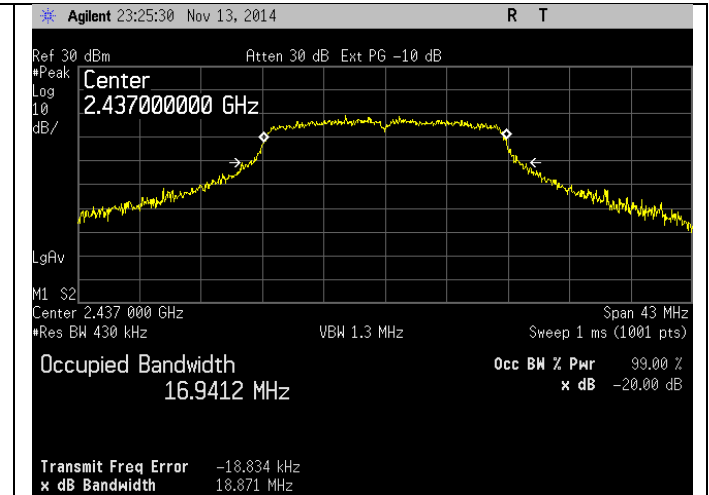


20 dB OBW + 99% BW

Mid Channel – 2437 MHz

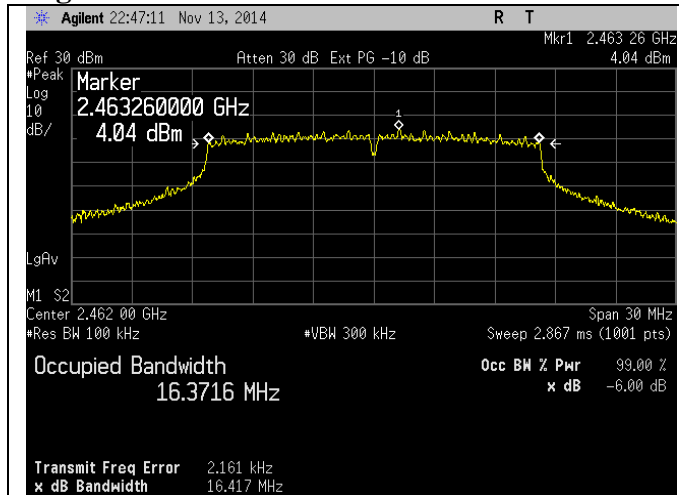


6 dB DTS BW

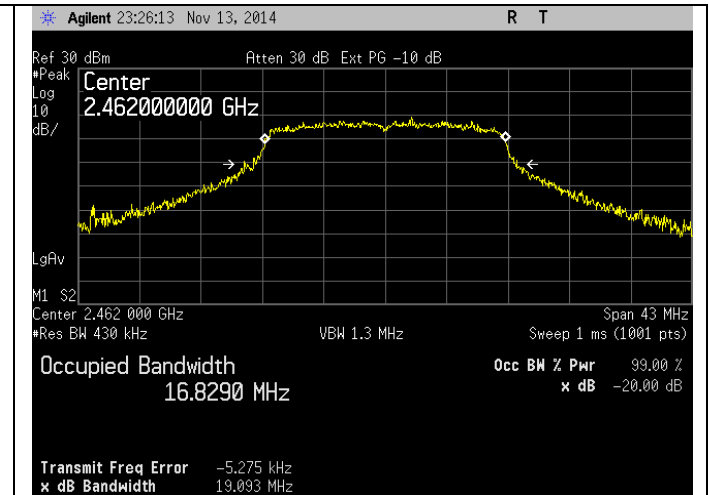


20 dB OBW + 99% BW

High Channel – 2462 MHz



6 dB DTS BW



20 dB OBW + 99% BW

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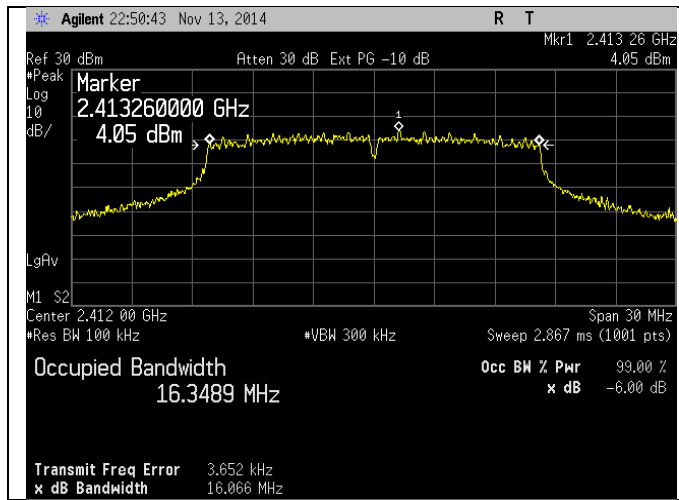
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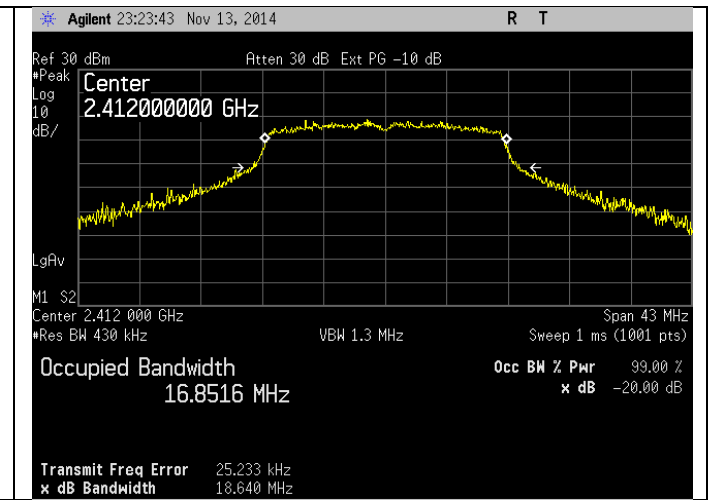
Model: P24486

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802.11g – 54 Mbps Low Channel – 2412 MHz

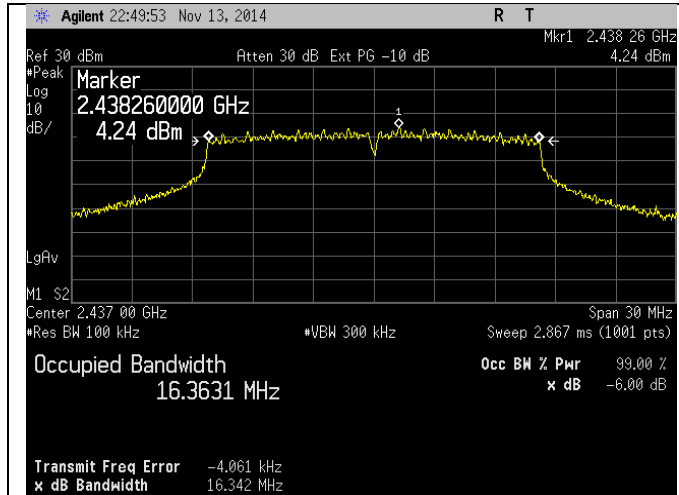


6 dB DTS BW

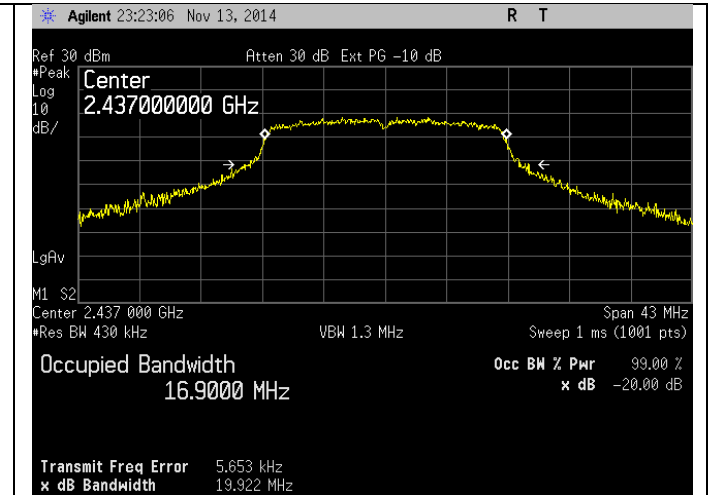


20 dB OBW + 99% BW

Mid Channel – 2437 MHz

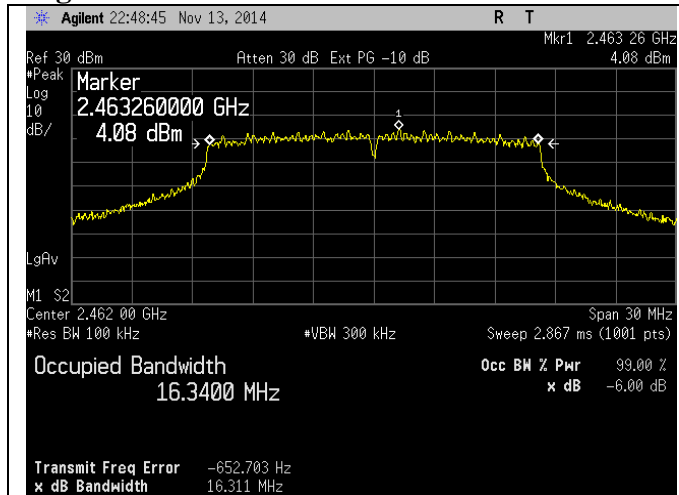


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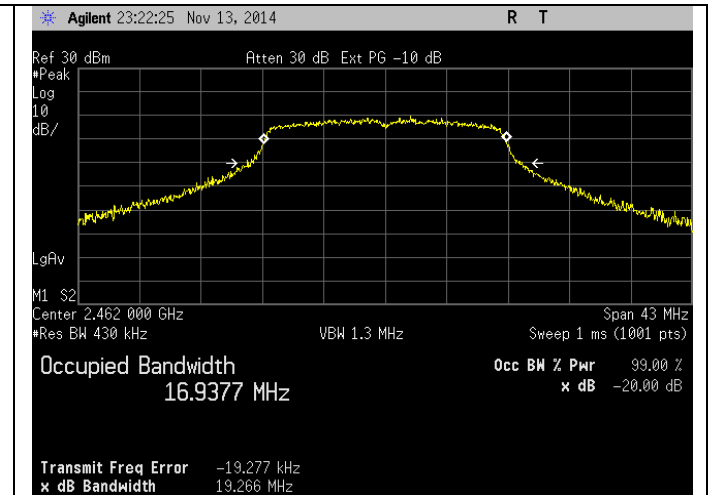


20 dB OBW + 99% BW

High Channel – 2462 MHz



6 dB DTS BW



20 dB OBW + 99% BW

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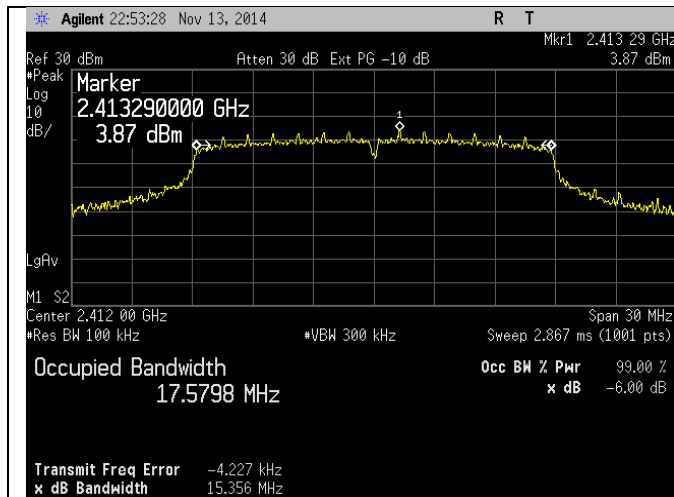
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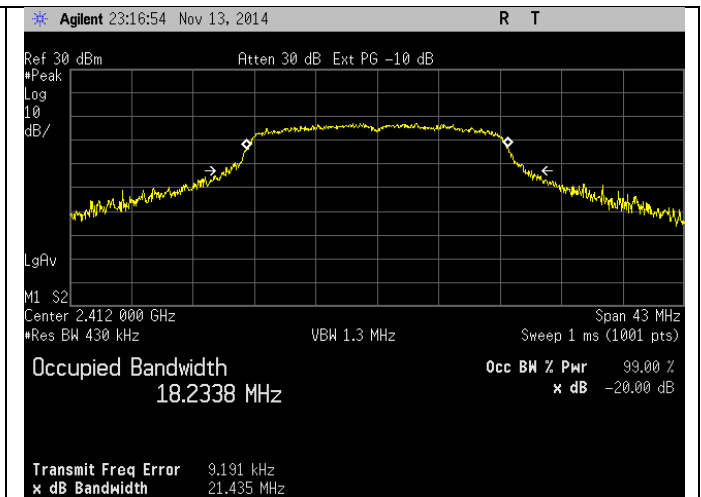
Model: P24486

Serial: Eng. Sample

802.11n – 6.5 Mbps Low Channel – 2412 MHz

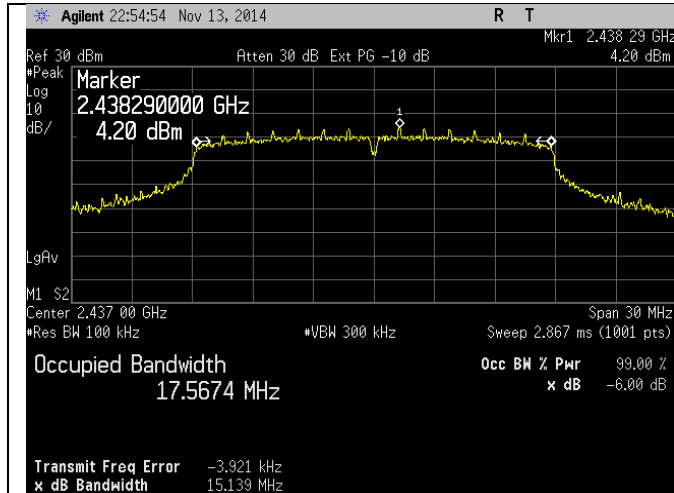


6 dB DTS BW

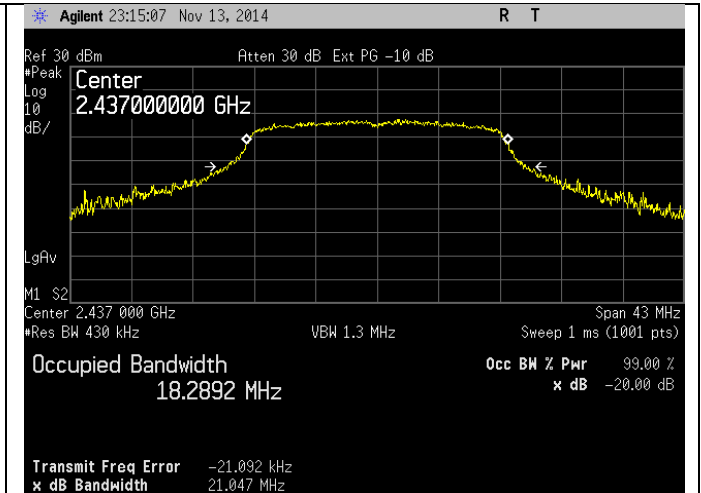


20 dB OBW + 99% BW

Mid Channel – 2437 MHz

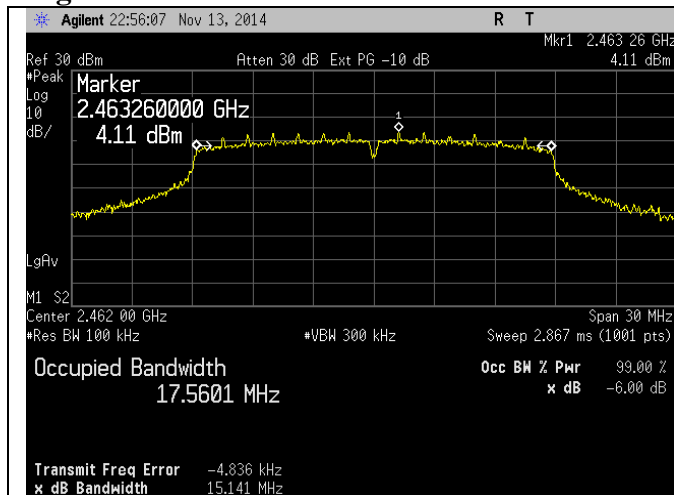


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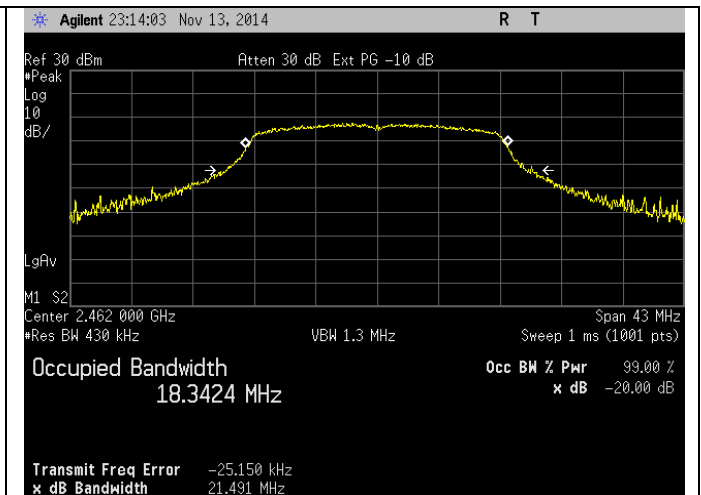


20 dB OBW + 99% BW

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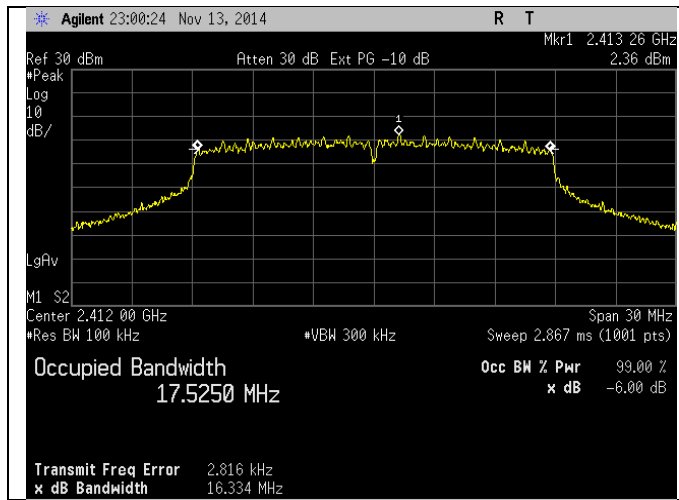
LSR: C-2063

Name: GVPU

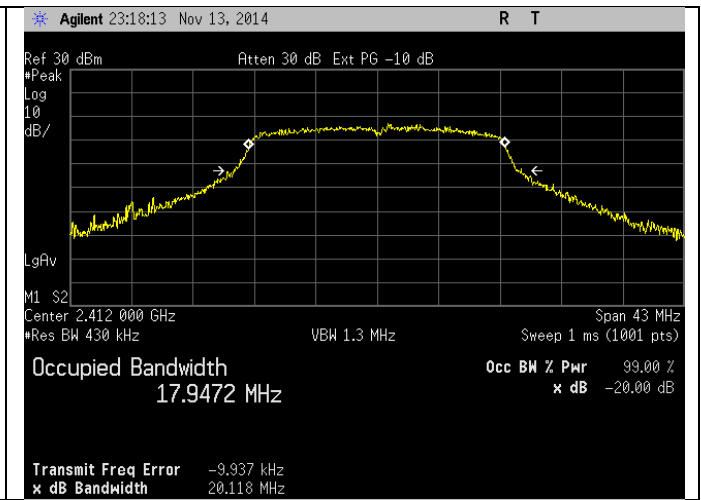
Model: P24486

Serial: Eng. Sample

802.11n – 65 Mbps Low Channel – 2412 MHz

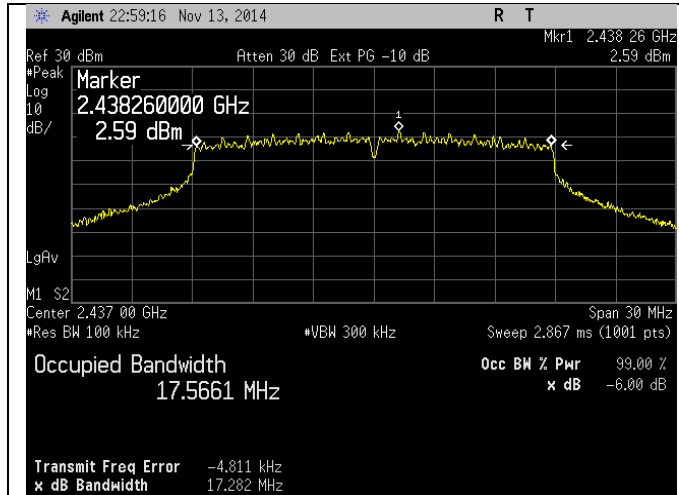


6 dB DTS BW

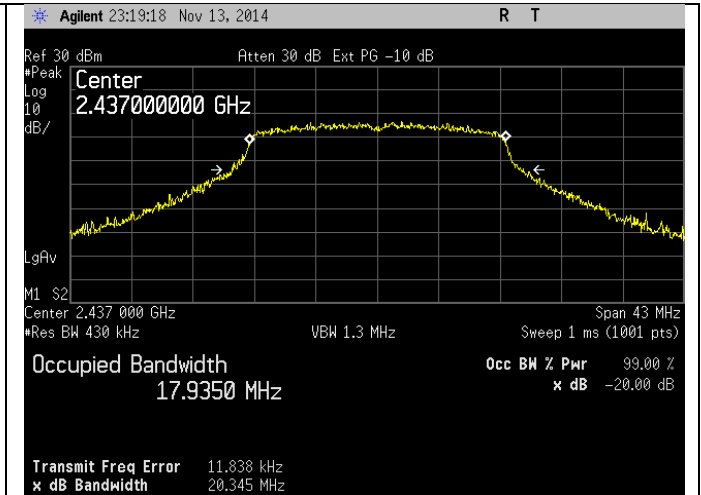


20 dB OBW + 99% BW

Mid Channel – 2437 MHz

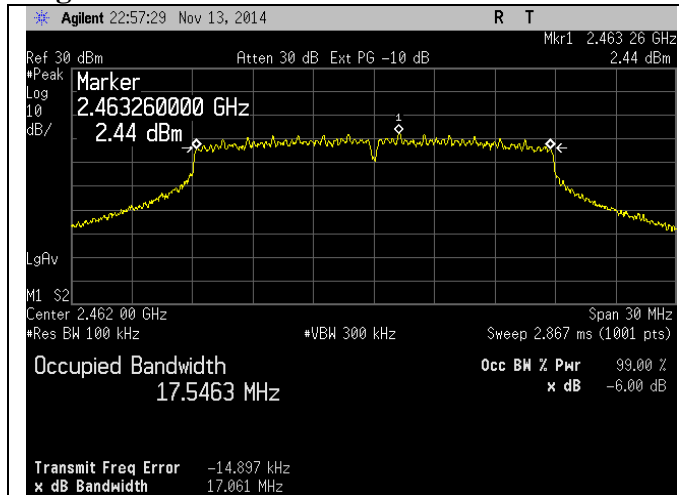


6 dB DTS BW

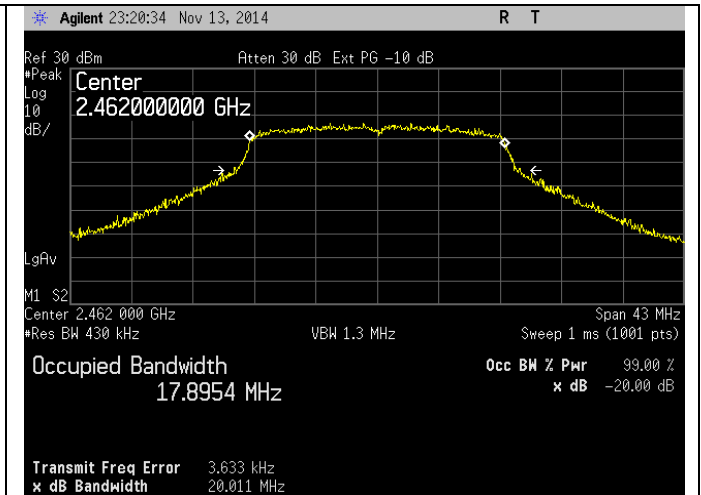


20 dB OBW + 99% BW

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6 dB DTS BW



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Model: P24486

Serial: Eng. Sample

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

Manufacturer	gogo Business Aviation
Date	11-13-14
Operator	Adam A
Temp. / R.H.	20 - 25° C / 30-60% R.H.
Rule Part	15.247
Specific Measurement Procedure	FCC KDB 558074 Section 9.2.2.2 FCC KDB 558074 Section 10.3
Additional Description of Measurement	100 kHz resolution bandwidth used for Power Spectral Density measurement
Additional Notes	Continuous transmit modulated used for this test. Sample Calculation: Margin (dB) = Limit – Measured level Average Output power = 18.881 dBm < 30 dBm (limit)

Output Power Table

Mode (802.11)	Mode (Mbps)	Frequency (MHz)	20 dB OBW (MHz)	Power (dBm)
b	1	2412	16.316	18.584
		2437	16.295	18.881
		2462	16.284	18.702
	11	2412	16.737	18.409
		2437	16.786	18.675
		2462	16.713	18.499
g	6	2412	20.038	14.153
		2437	20.244	14.359
		2462	20.303	14.202
	12	2412	18.855	14.043
		2437	19.291	14.283
		2462	19.327	14.045
	24	2412	19.333	13.722
		2437	18.871	13.952
		2462	19.093	13.803
	54	2412	18.640	13.274
		2437	19.922	13.603
		2462	19.266	13.413
n	6.5	2412	21.435	14.141
		2437	21.047	14.361
		2462	21.491	14.216
	65	2412	20.118	11.406
		2437	20.345	11.613
		2462	20.011	11.400

Prepared For: gogo Business Aviation

Name: GVPV

Report: TR 314305 A

Model: P24486

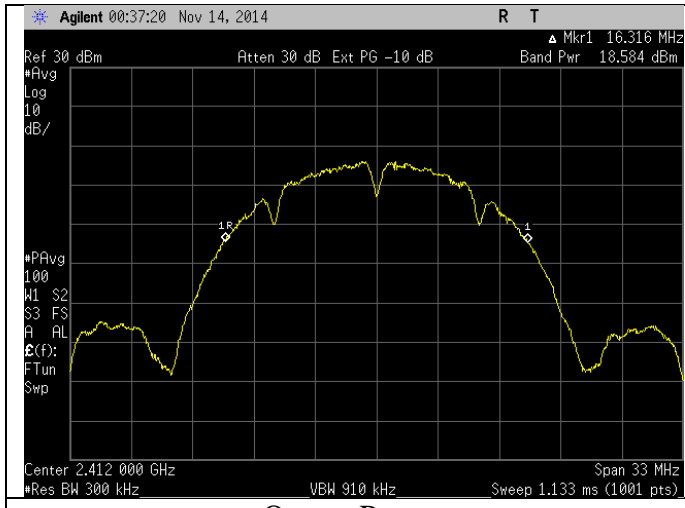
LSR: C-2063

Serial: Eng. Sample

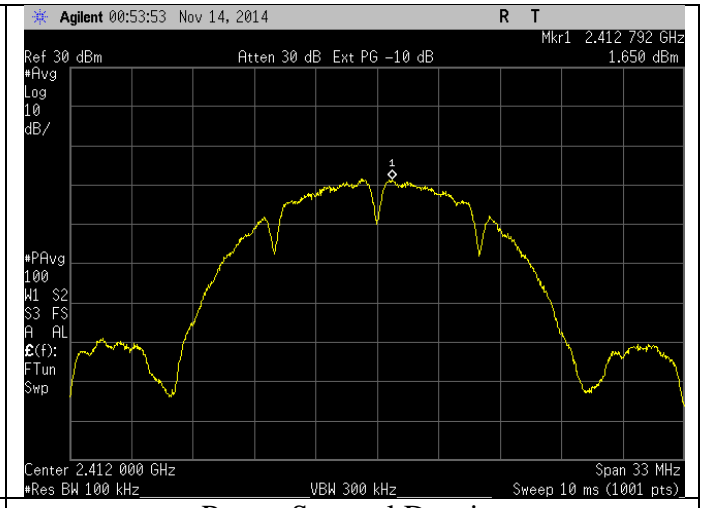
PSD Table

Mode (802.11)	Mode (Mbps)	Frequency (MHz)	20 dB OBW (MHz)	Power (dBm)	PSD dBm/100kHz	PSD Limit (3kHz)	PSD Margin
b	1	2412	16.316	18.584	1.650	8	6.4
		2437	16.295	18.881	1.525		6.5
		2462	16.284	18.702	1.670		6.3
	11	2412	16.737	18.409	0.912		7.1
		2437	16.786	18.675	1.170		6.8
		2462	16.713	18.499	0.711		7.3
g	6	2412	20.038	14.153	-5.183		13.2
		2437	20.244	14.359	-5.077		13.1
		2462	20.303	14.202	-5.253		13.3
n	6.5	2412	21.435	14.141	-4.782	12.8	
		2437	21.047	14.361	-5.314	13.3	
		2462	21.491	14.216	-4.872	12.9	

Plots - 802.11b - 1 Mbps
Low Channel - 2412 MHz

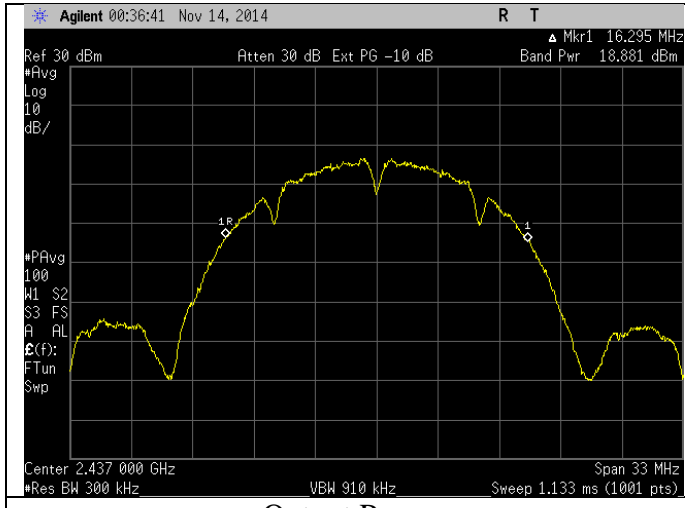


Output Power

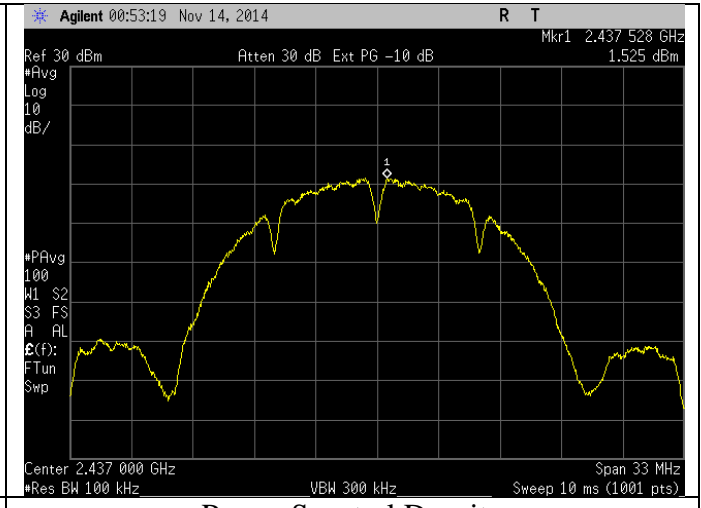


Power Spectral Density

Mid Channel - 2437 MHz

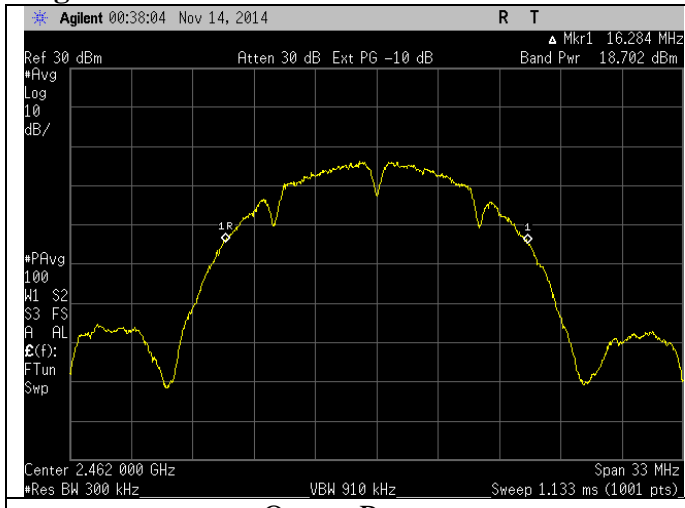


Output Power

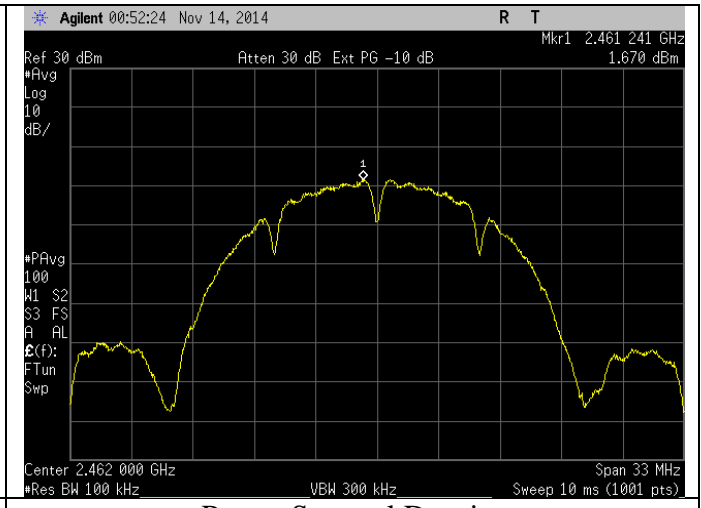


Power Spectral Density

High Channel - 2462 MHz



Output Power



Power Spectral Density

Prepared For: gogo Business Aviation

Report: TR 314305 A

LSR: C-2063

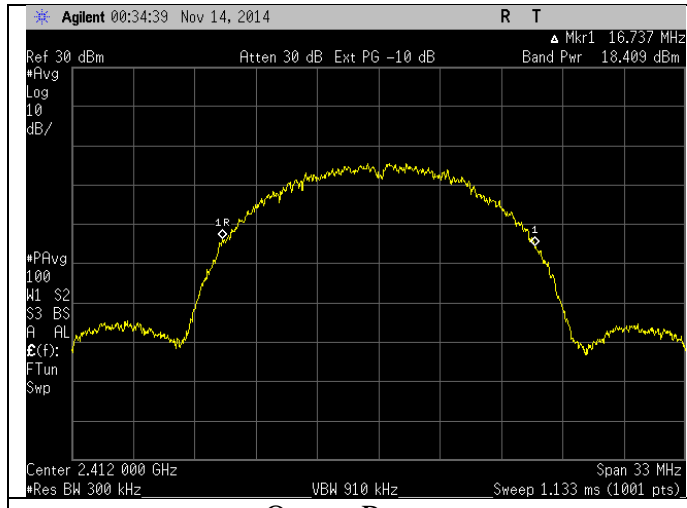
Name: GVPU

Model: P24486

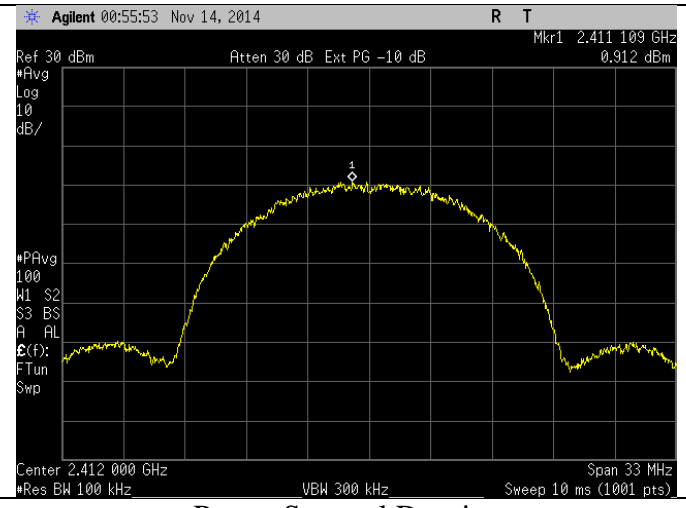
Serial: Eng. Sample

802.11b – 11 Mbps

Low Channel – 2412 MHz

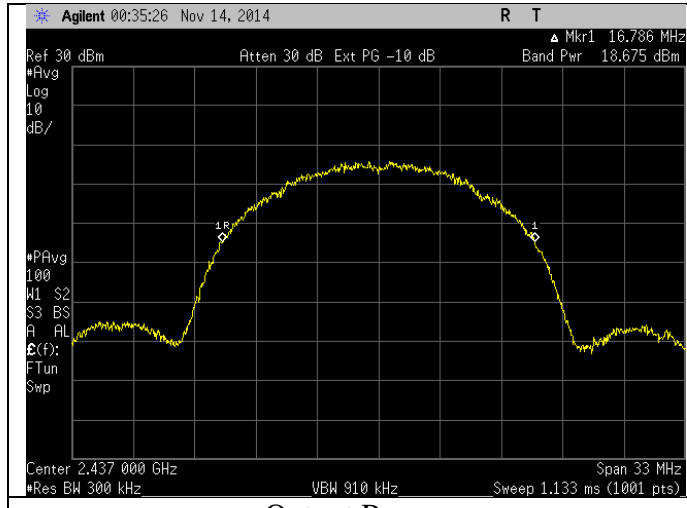


Output Power

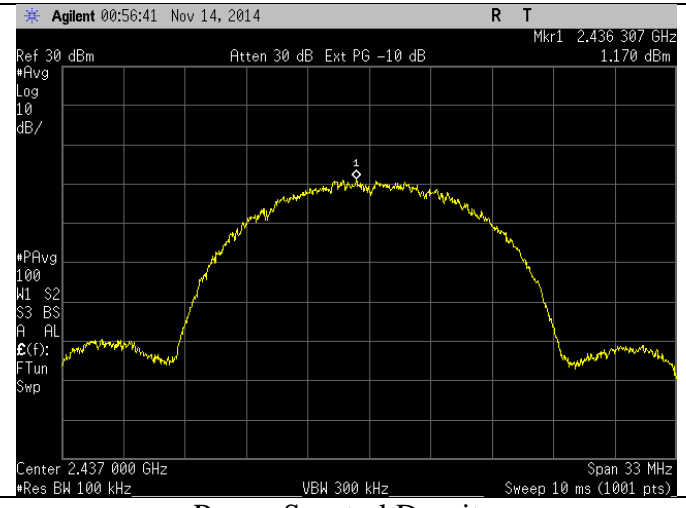


Power Spectral Density

Mid Channel – 2437 MHz

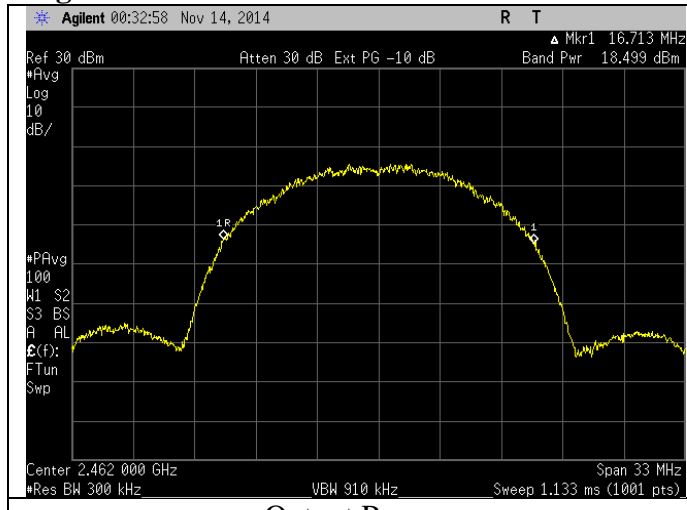


Output Power

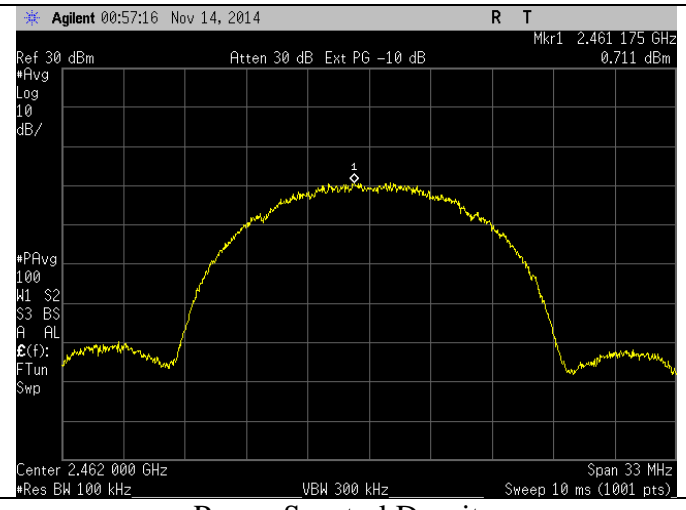


Power Spectral Density

High Channel – 2462 MHz



Output Power



Power Spectral Density

Prepared For: gogo Business Aviation

Report: TR 314305 A

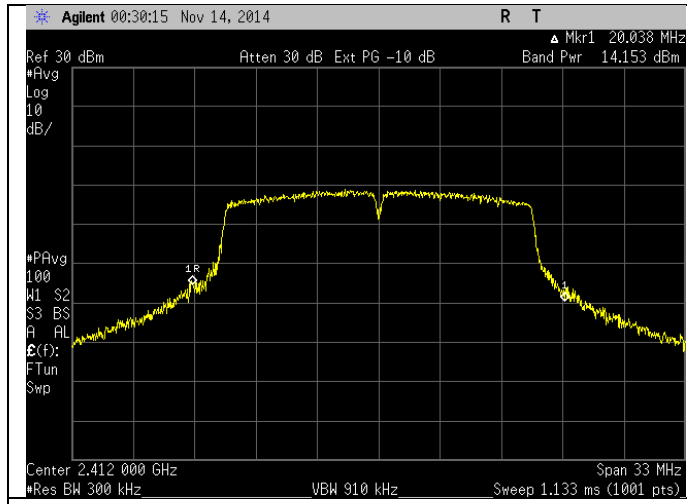
LSR: C-2063

Name: GVPV

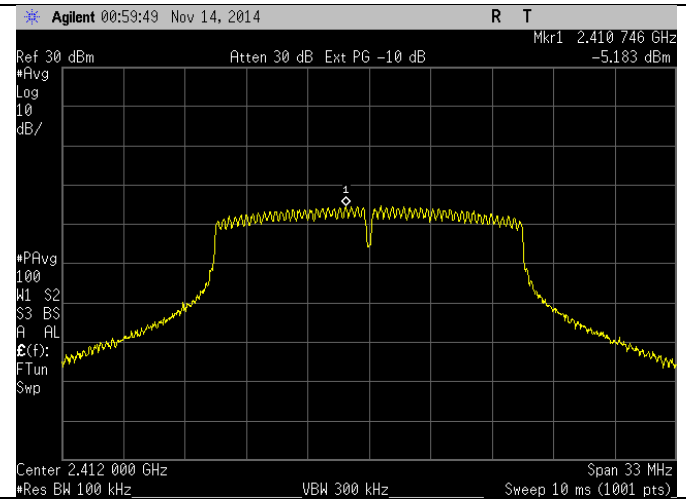
Model: P24486

Serial: Eng. Sample

802.11g – 6 Mbps Low Channel – 2412 MHz

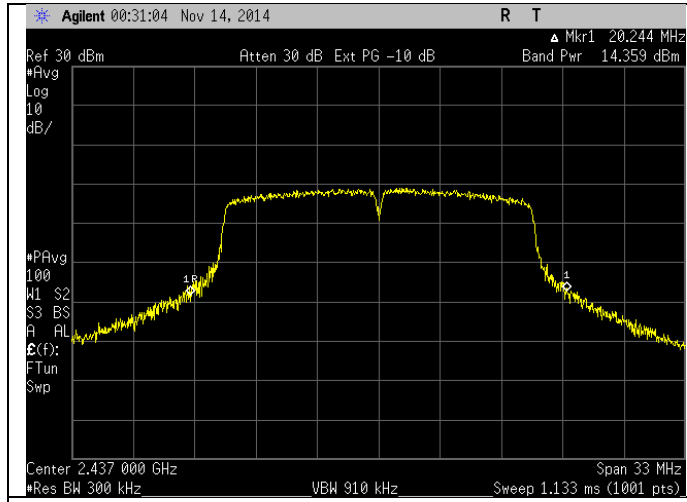


Output Power

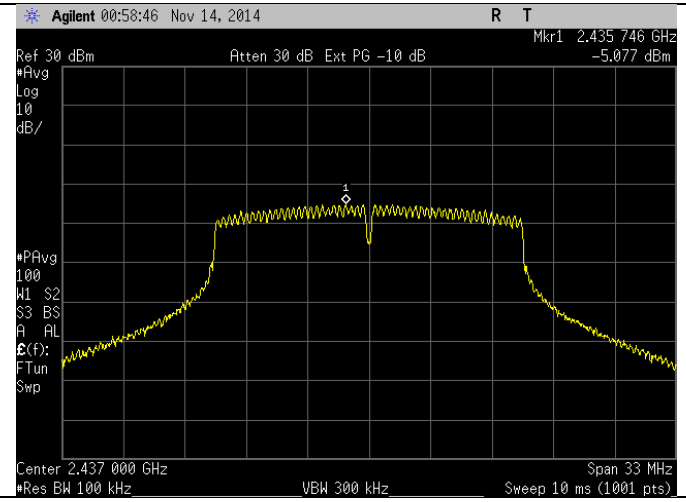


Power Spectral Density

Mid Channel – 2437 MHz

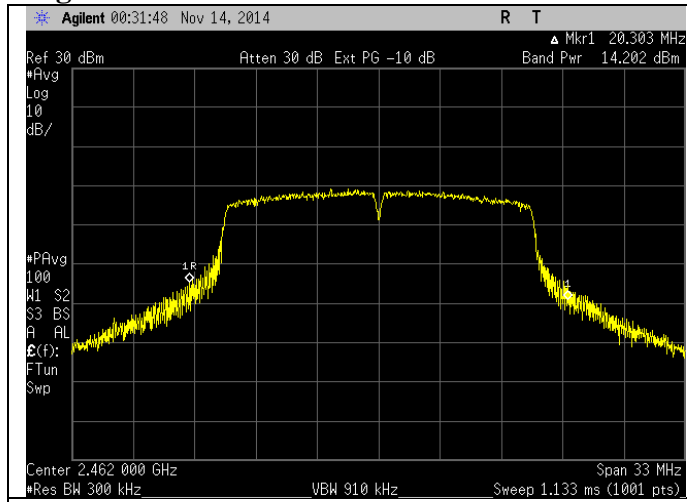


Output Power

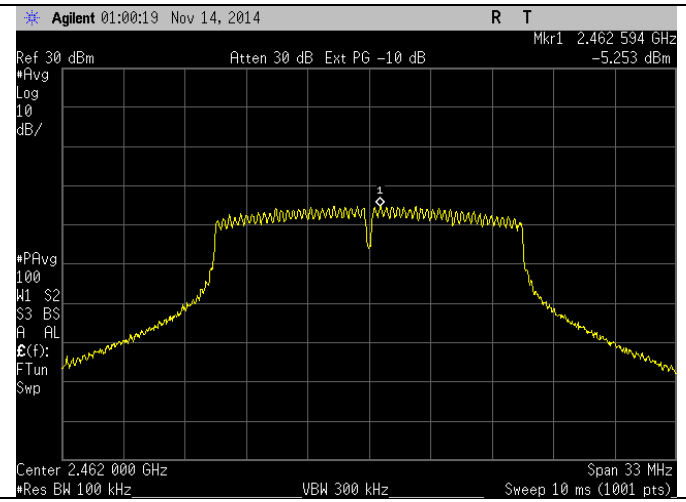


Power Spectral Density

High Channel – 2462 MHz



Output Power



Power Spectral Density

Prepared For: gogo Business Aviation

Report: TR 314305 A

LSR: C-2063

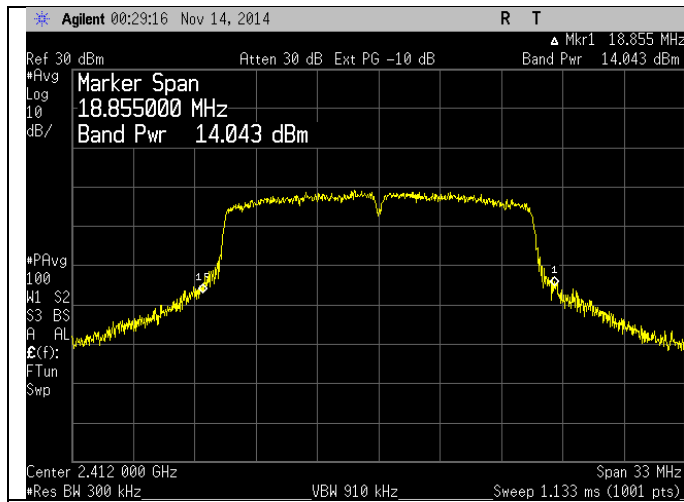
Name: GVPV

Model: P24486

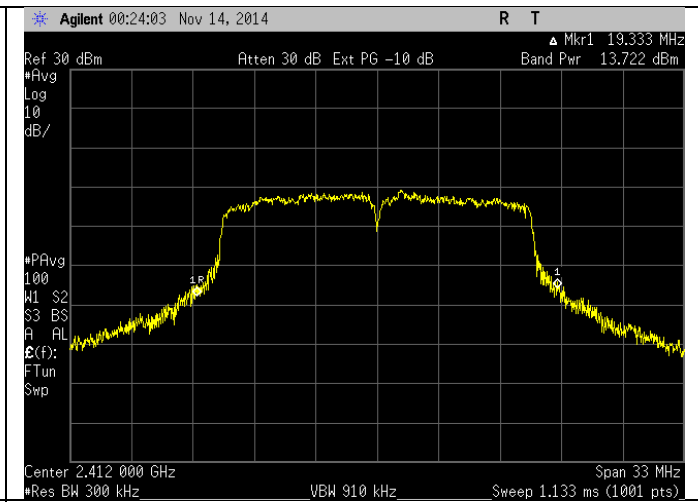
Serial: Eng. Sample

802.11g – 12 Mbps / 24 Mbps

Low Channel – 2412 MHz

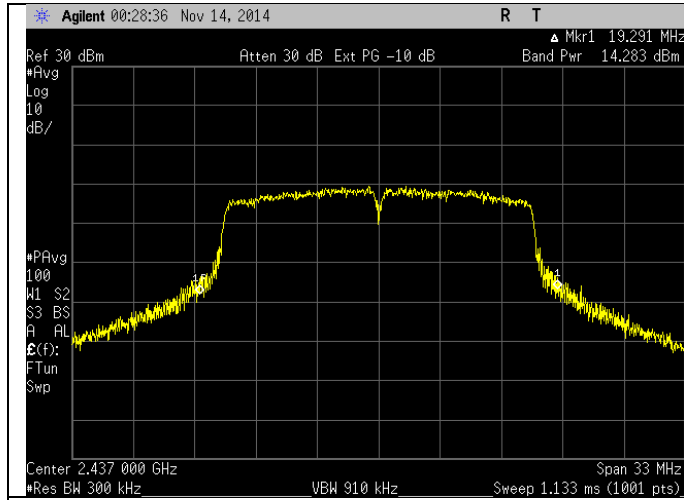


Output Power (12 Mbps)

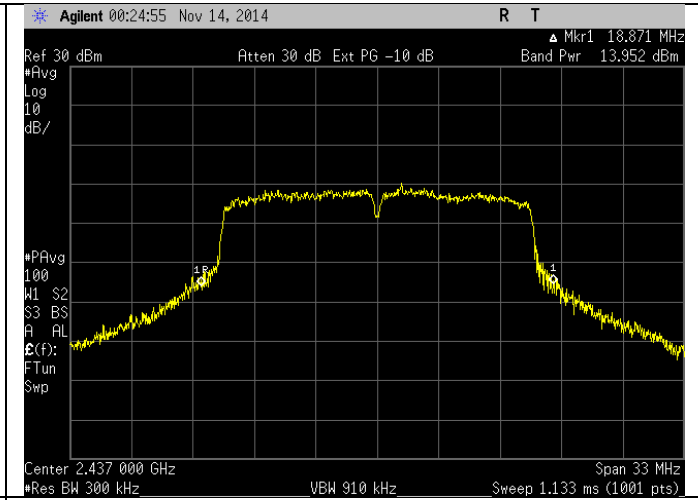


Output Power (24 Mbps)

Mid Channel – 2437 MHz

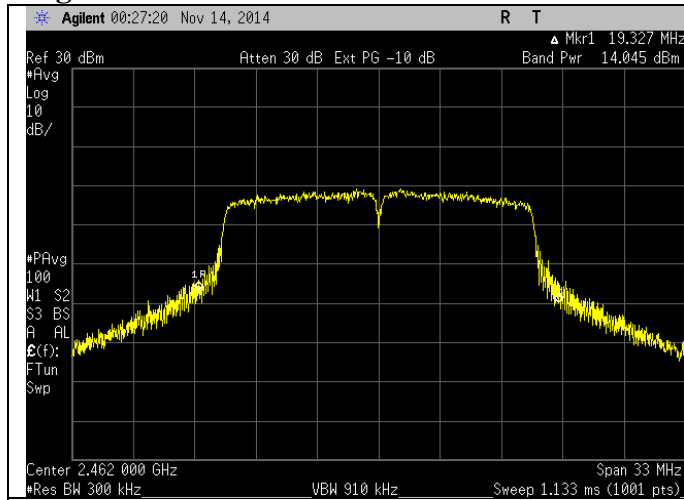


Output Power (12 Mbps)

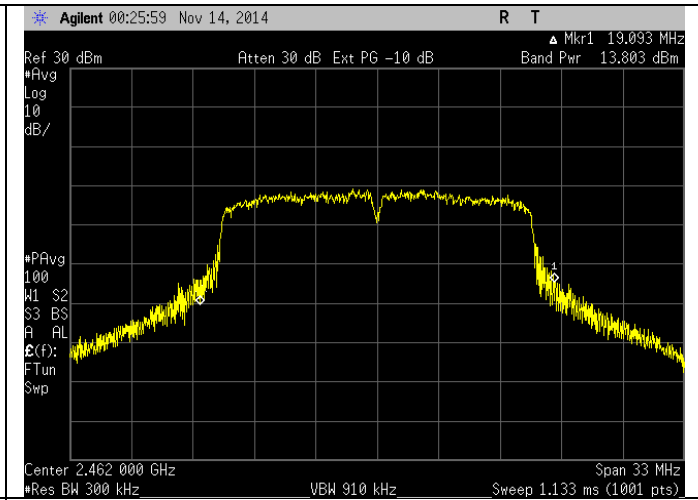


Output Power (24 Mbps)

High Channel – 2462 MHz



Output Power (12 Mbps)



Output Power (24 Mbps)

Prepared For: gogo Business Aviation

Report: TR 314305 A

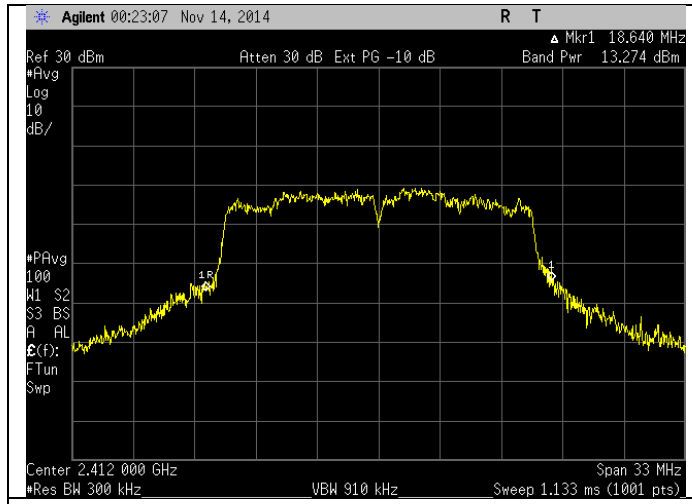
LSR: C-2063

Name: GVPU

Model: P24486

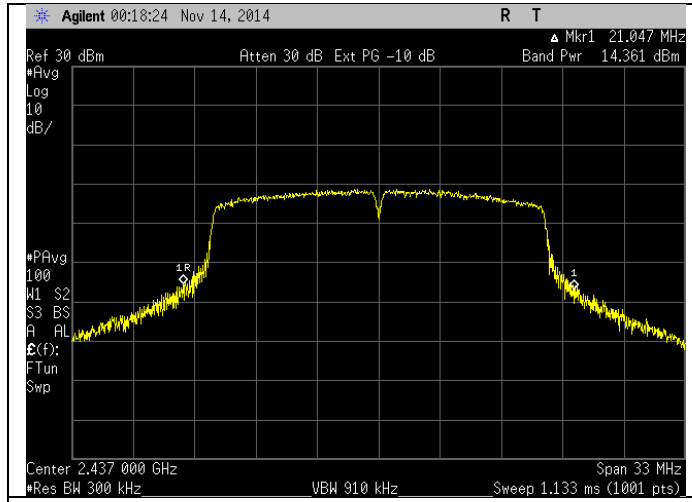
Serial: Eng. Sample

802.11g – 54 Mbps
Low Channel – 2412 MHz



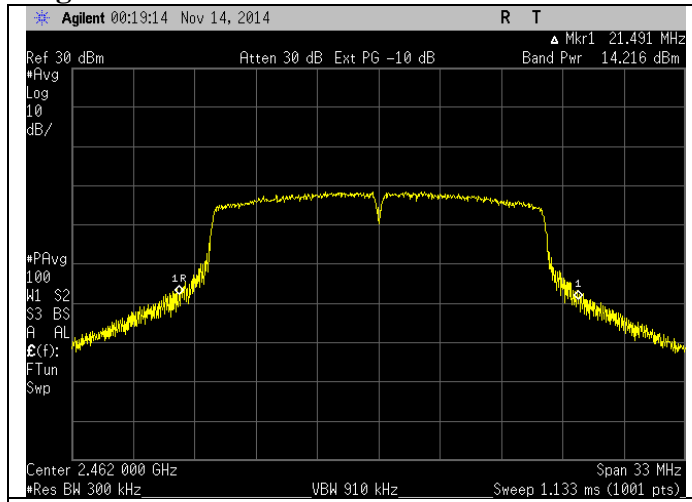
Output Power

Mid Channel – 2437 MHz



Output Power

High Channel – 2462 MHz



Output Power

Prepared For: gogo Business Aviation

Report: TR 314305 A

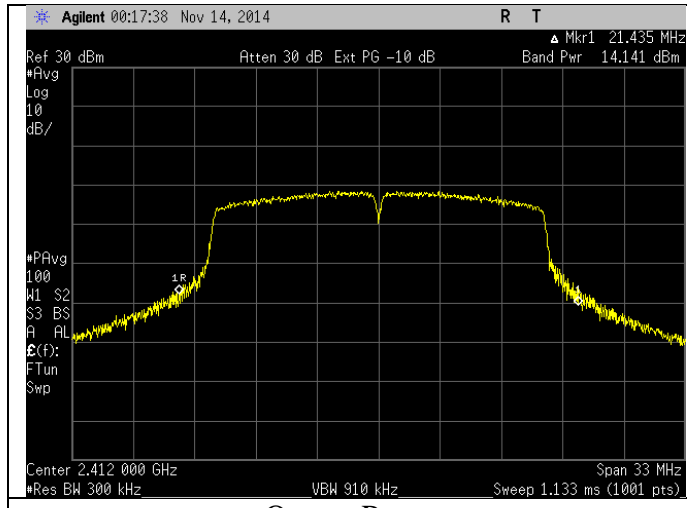
LSR: C-2063

Name: GVPV

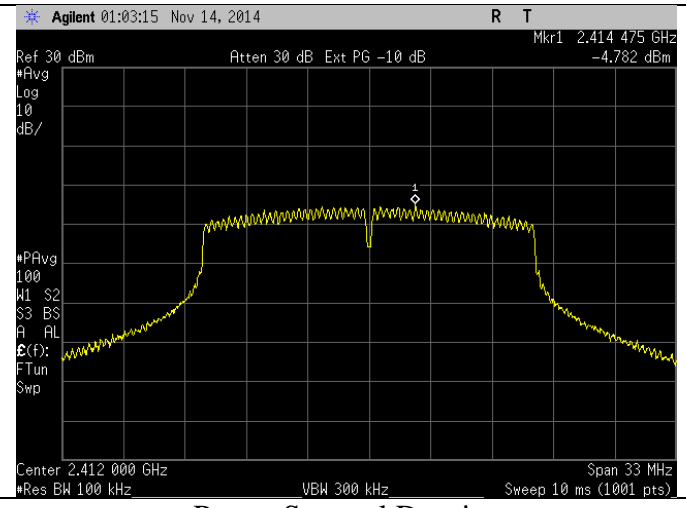
Model: P24486

Serial: Eng. Sample

802.11n – 6.5 Mbps
Low Channel – 2412 MHz

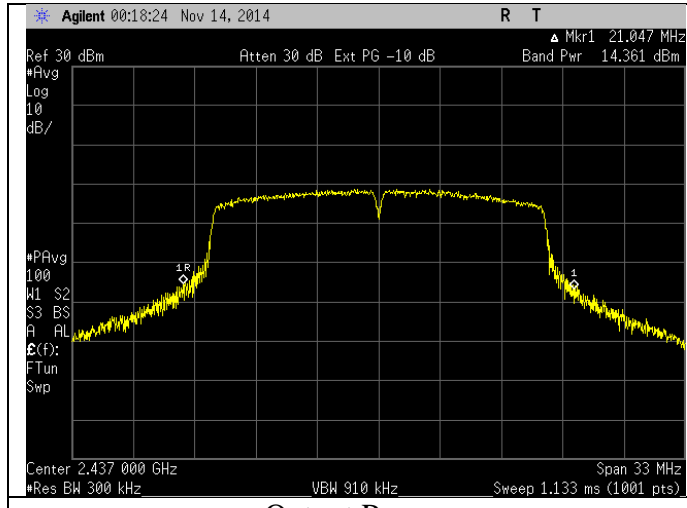


Output Power

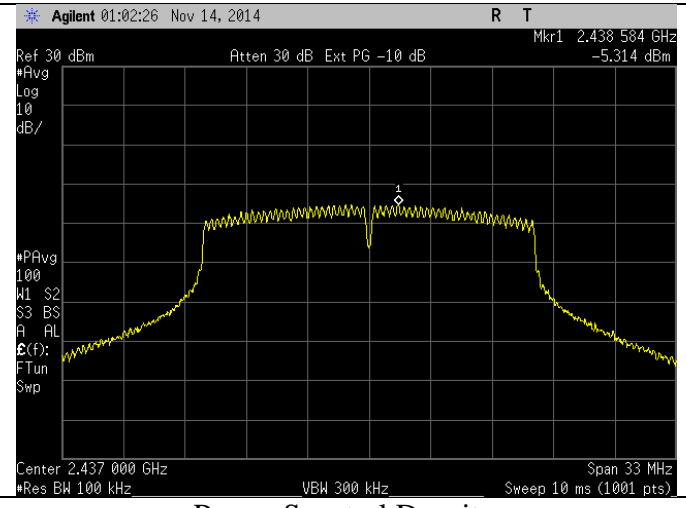


Power Spectral Density

Mid Channel – 2437 MHz

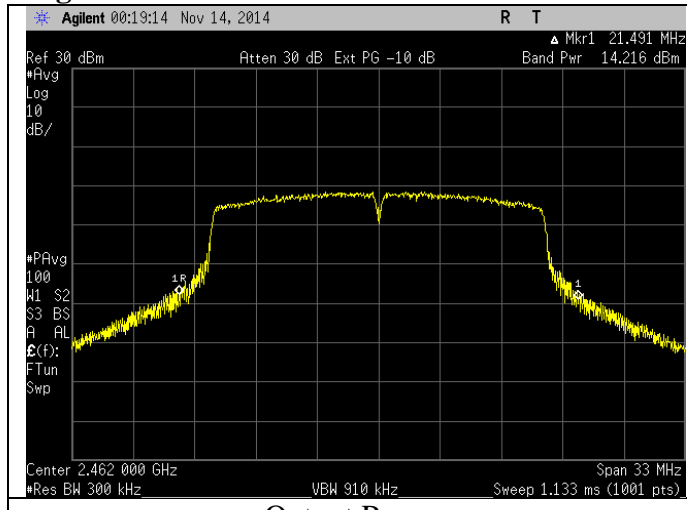


Output Power

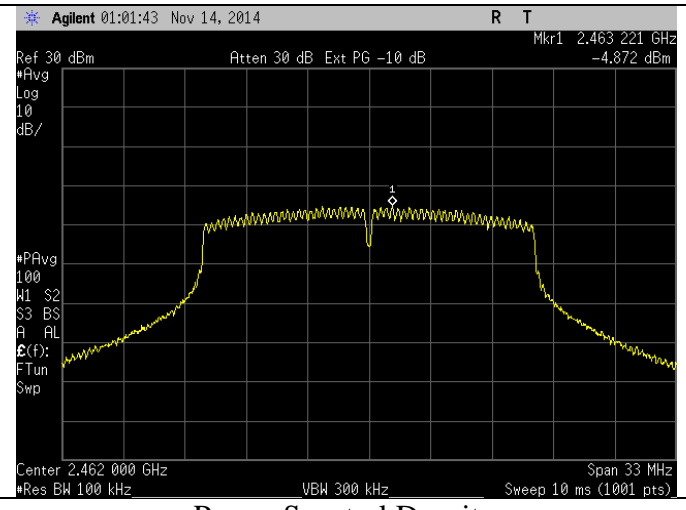


Power Spectral Density

High Channel – 2462 MHz



Output Power



Power Spectral Density

Prepared For: gogo Business Aviation

Report: TR 314305 A

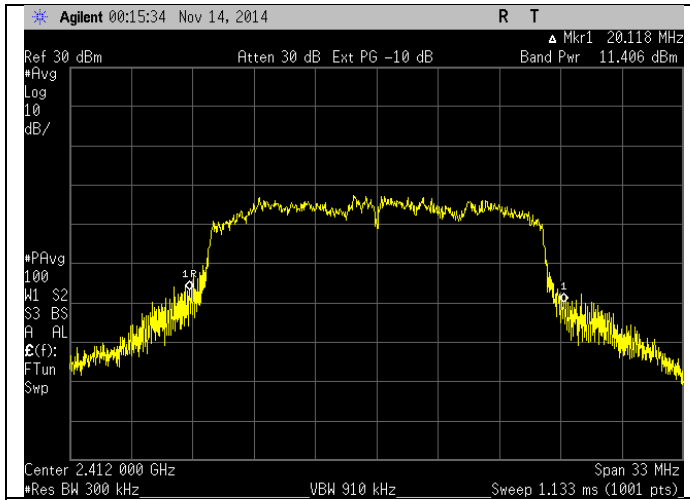
LSR: C-2063

Name: GVPU

Model: P24486

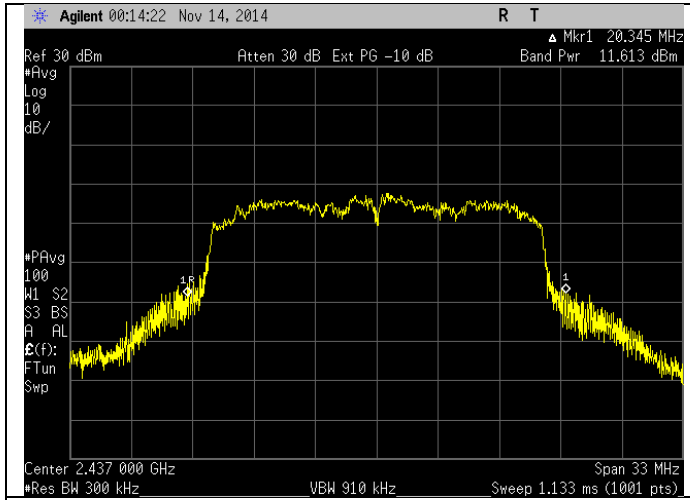
Serial: Eng. Sample

802.11n – 65 Mbps
Low Channel – 2412 MHz



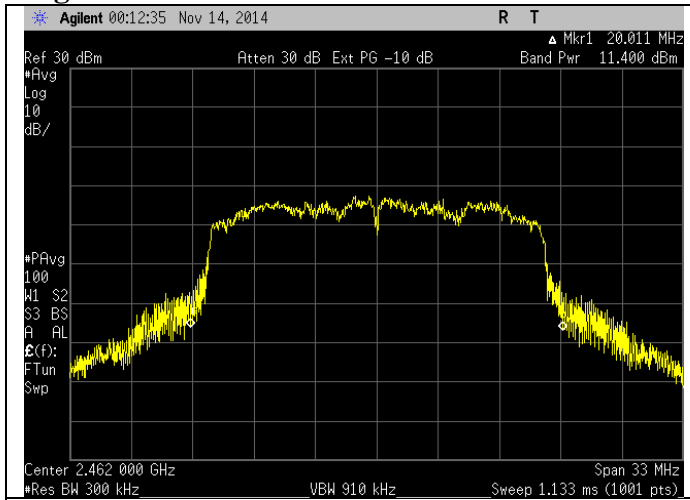
Output Power

Mid Channel – 2437 MHz



Output Power

High Channel – 2462 MHz



Output Power

Prepared For: gogo Business Aviation

Report: TR 314305 A

LSR: C-2063

Name: GVPV

Model: P24486

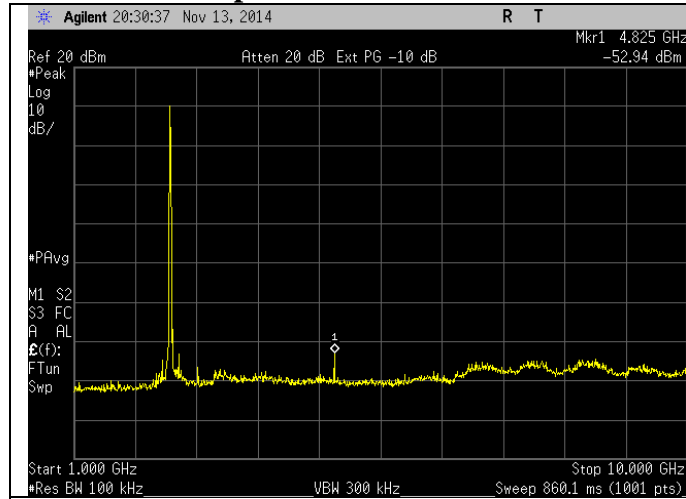
Serial: Eng. Sample

B.1.3 – RF Conducted – Emissions in non-restricted frequency bands

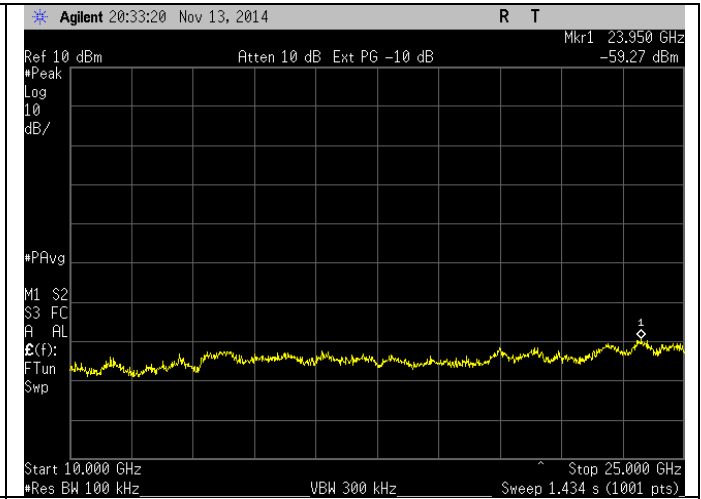
Manufacturer	gogo Business Aviation
Date	11-13-14
Operator	Adam A
Temp. / R.H.	20 - 25° C / 30-60% R.H.
Rule Part	15.247
Specific Measurement Procedure	FCC KDB 558074 Section 11.0 – Emissions in non-restricted frequency bands
Additional Description of Measurement	RF Conducted Measurement
Additional Notes	No Emissions found to be within 15 dB of limit Continuous transmit modulated used for this test.

Plots start next page

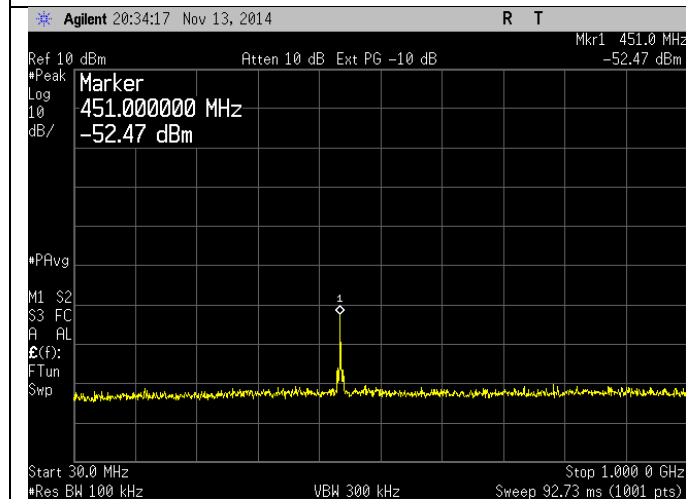
802.11b - 1 Mbps - Low Channel - 2412 MHz



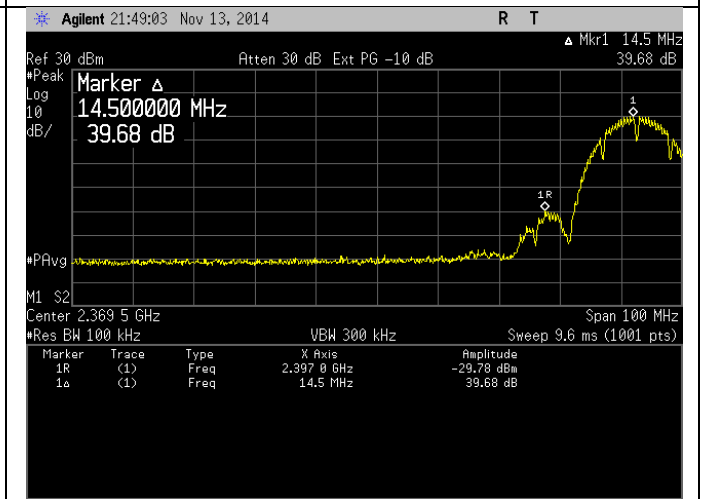
1 - 10 GHz



10-25 GHz



30-1000 MHz



Band-Edge

Prepared For: gogo Business Aviation

Report: TR 314305 A

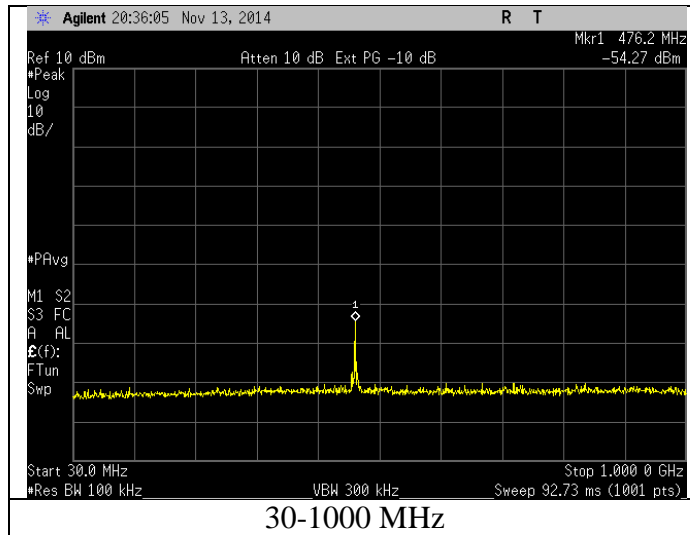
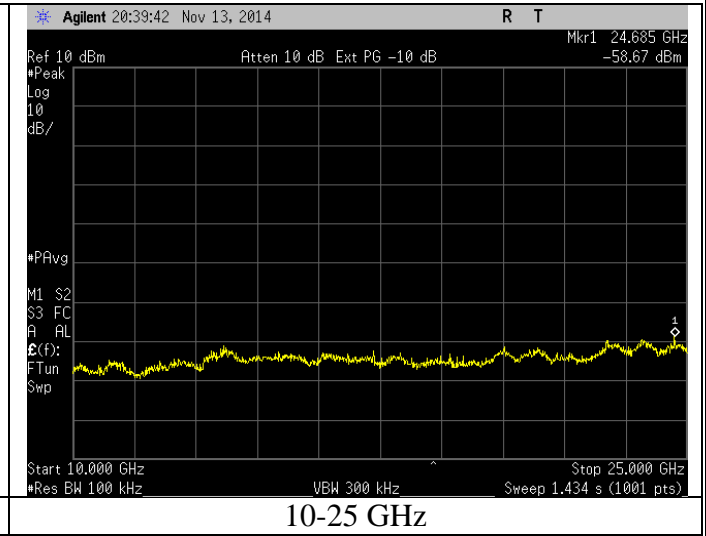
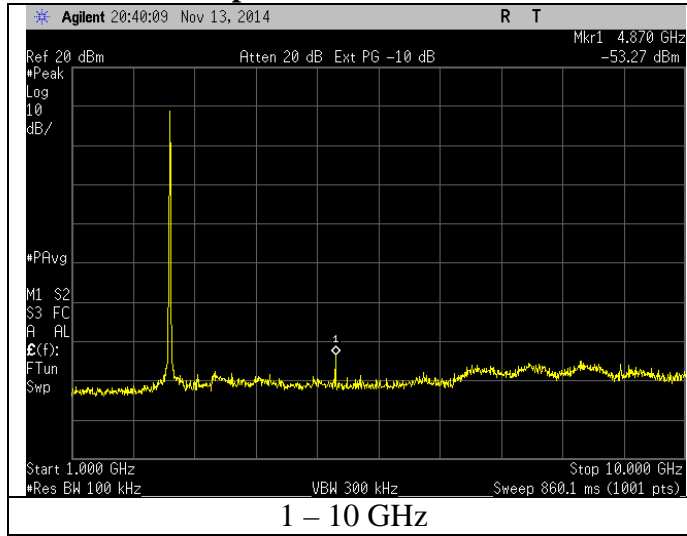
LSR: C-2063

Name: GVPU

Model: P24486

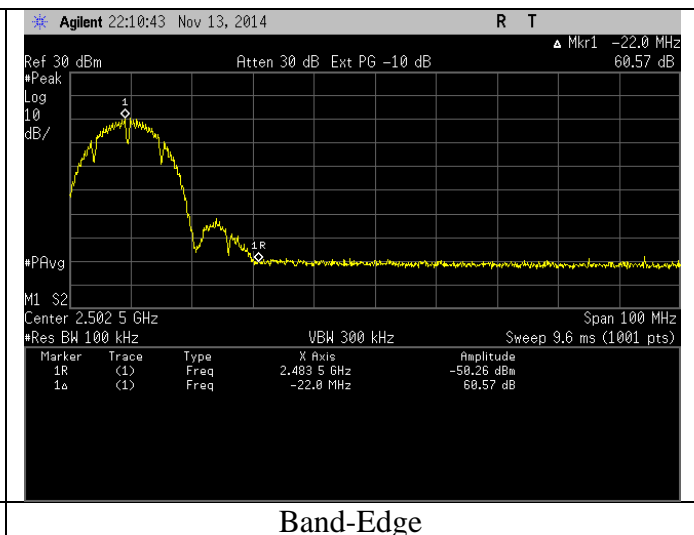
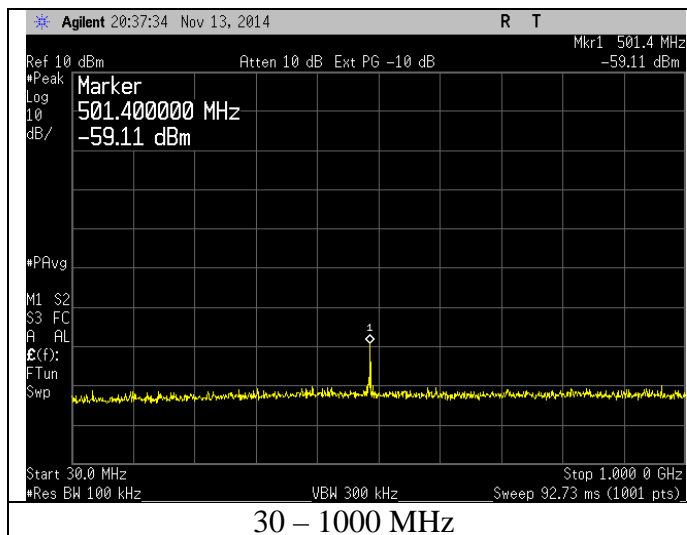
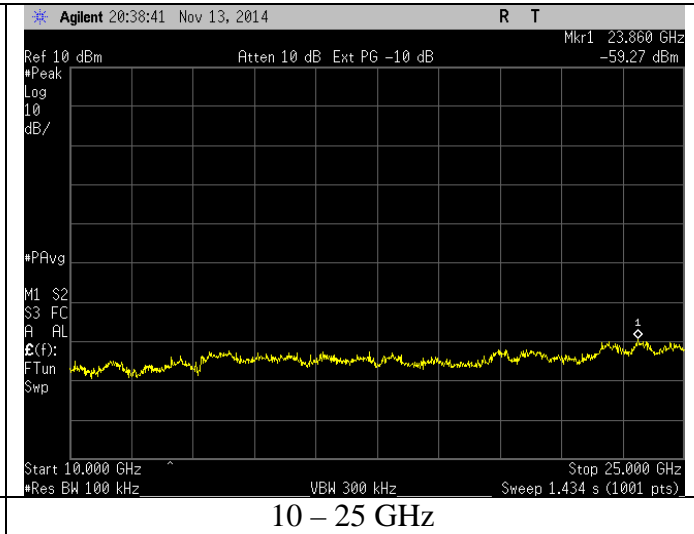
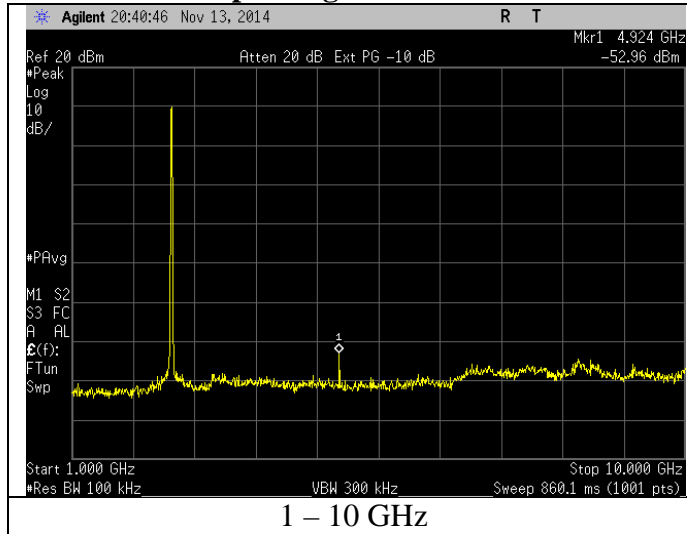
Serial: Eng. Sample

802.11b - 1 Mbps - Mid Channel - 2437 MHz



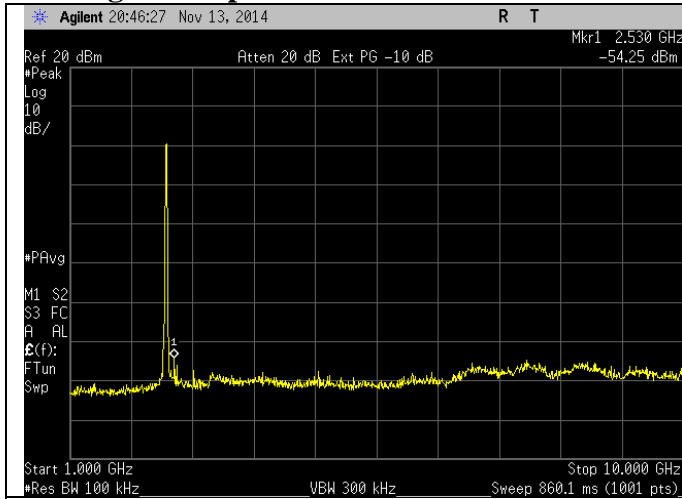
Prepared For: gogo Business Aviation	Name: GVPU
Report: TR 314305 A	Model: P24486
LSR: C-2063	Serial: Eng. Sample

802.11b – 1 Mbps - High Channel – 2462 MHz

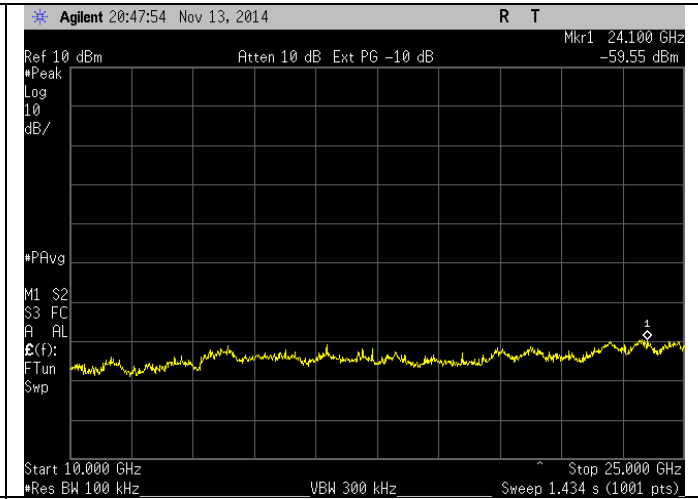


Prepared For: gogo Business Aviation	Name: GVPU
Report: TR 314305 A	Model: P24486
LSR: C-2063	Serial: Eng. Sample

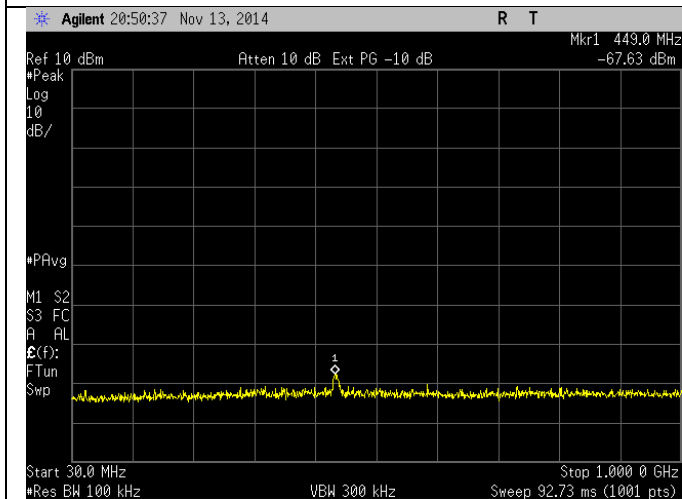
802.11g - 6 Mbps - Low Channel - 2412 MHz



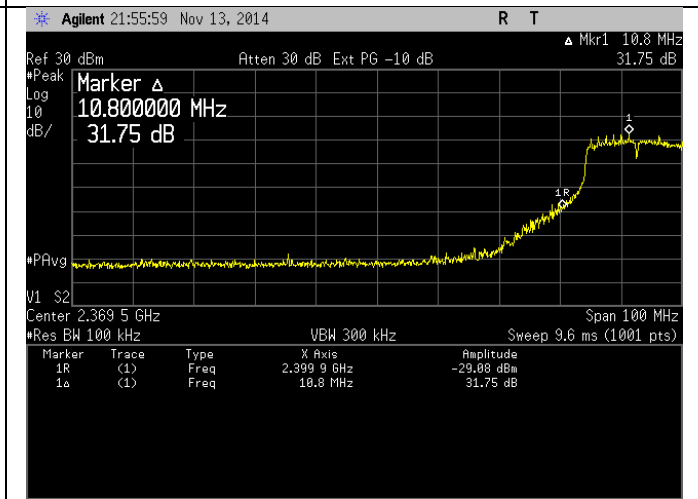
1 - 10 GHz



10-25 GHz



30-1000 MHz



Band-Edge

Prepared For: gogo Business Aviation

Report: TR 314305 A

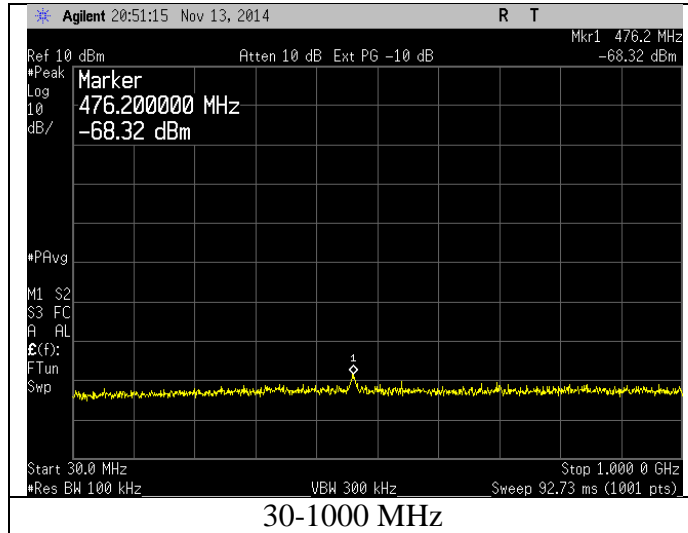
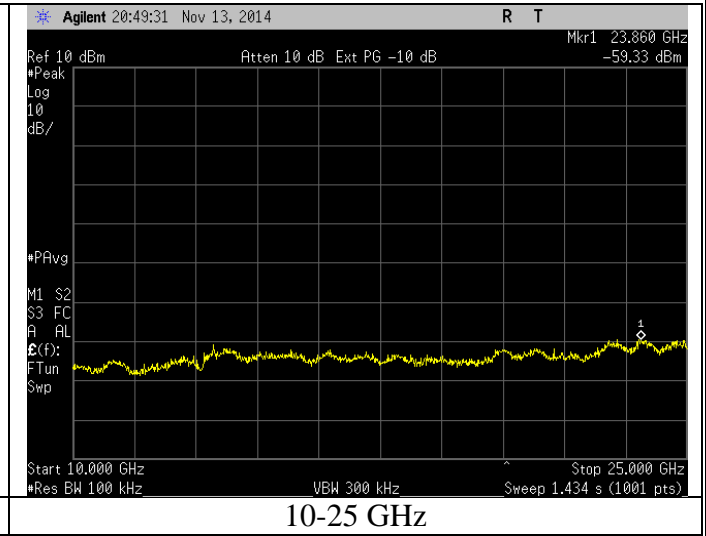
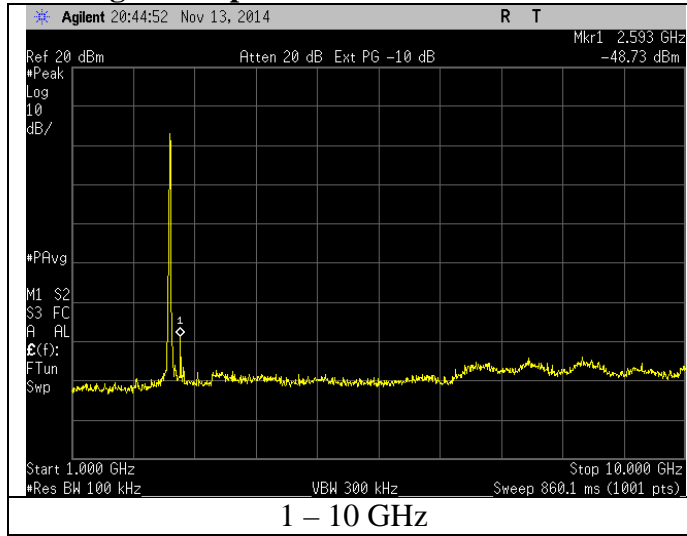
LSR: C-2063

Name: GVPU

Model: P24486

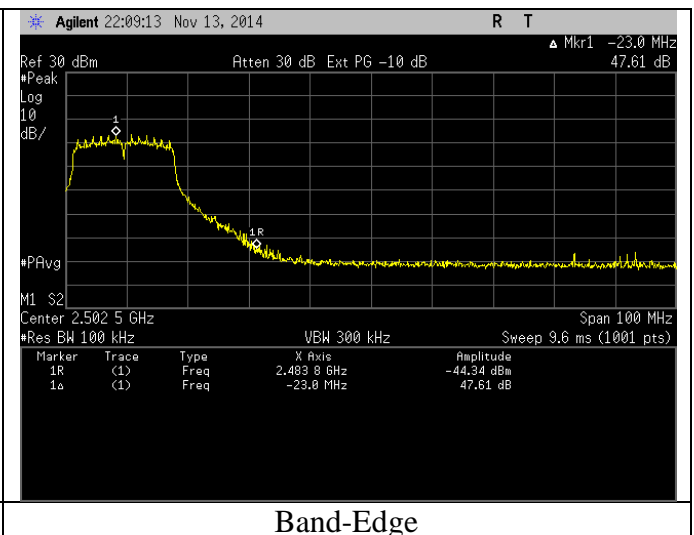
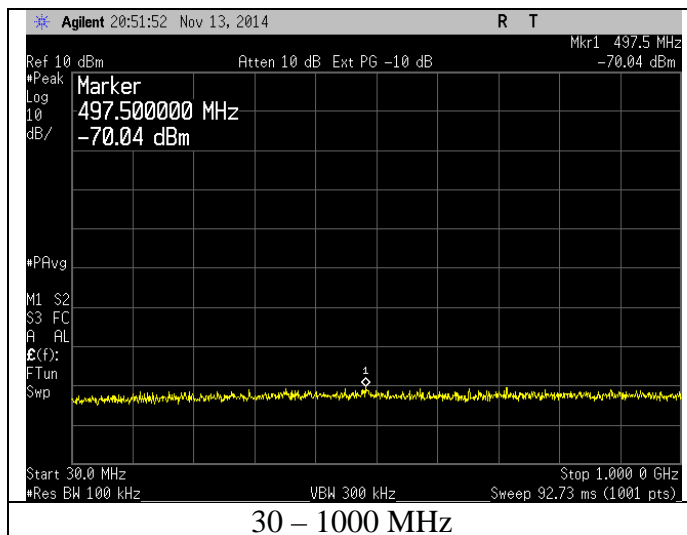
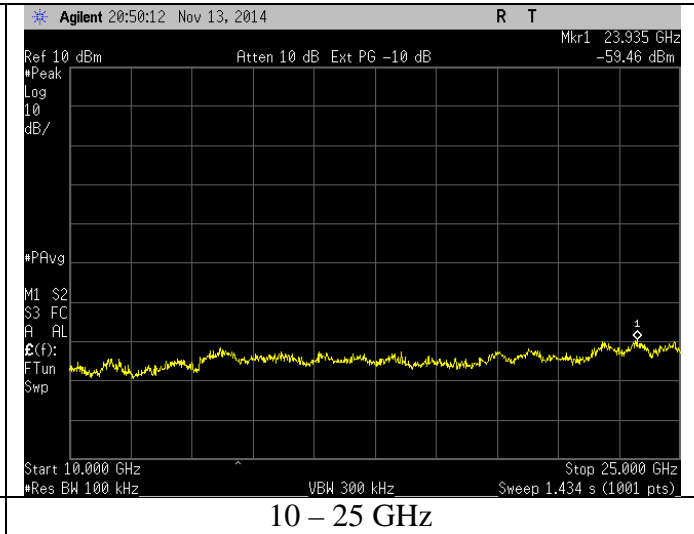
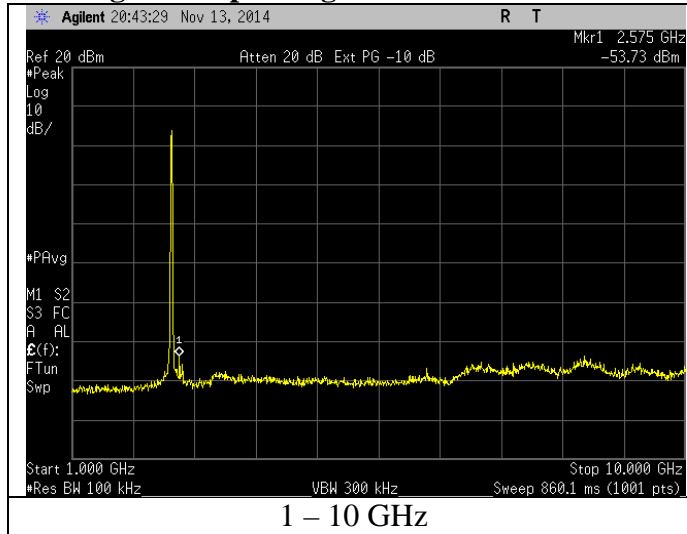
Serial: Eng. Sample

802.11g – 6 Mbps - Mid Channel – 2437 MHz



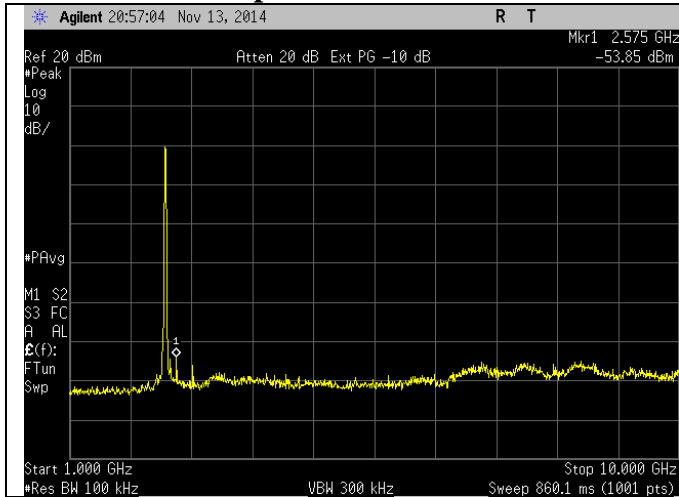
Prepared For: gogo Business Aviation	Name: GVPU
Report: TR 314305 A	Model: P24486
LSR: C-2063	Serial: Eng. Sample

802.11g - 6 Mbps - High Channel - 2462 MHz

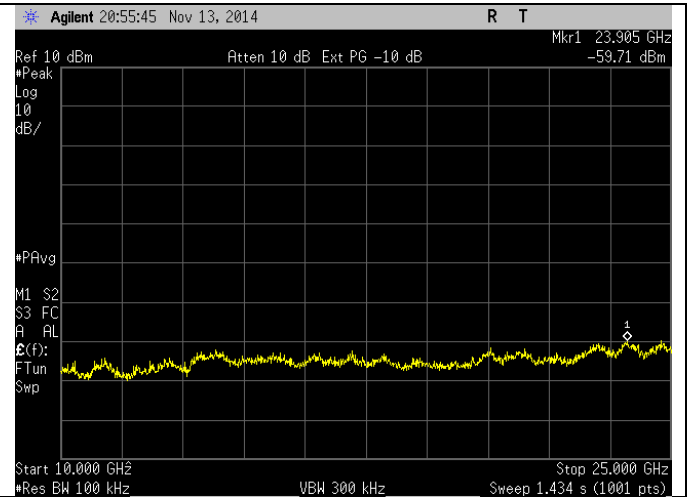


Prepared For: gogo Business Aviation	Name: GVPU
Report: TR 314305 A	Model: P24486
LSR: C-2063	Serial: Eng. Sample

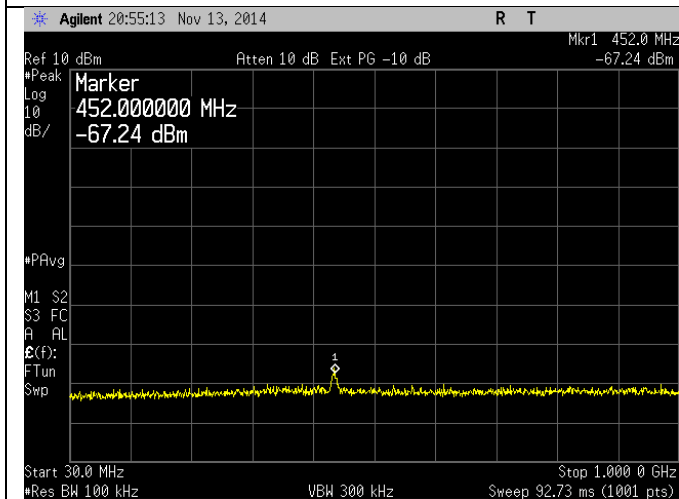
802.11n – 6.5 Mbps - Low Channel – 2412 MHz



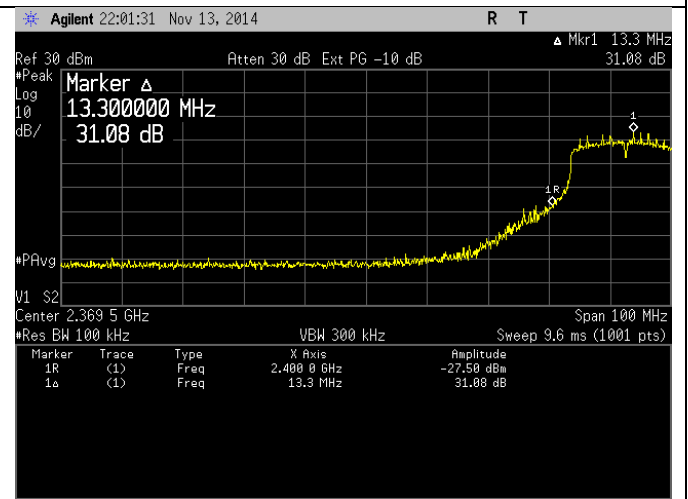
1 - 10 GHz



10-25 GHz



30-1000 MHz



Band-Edge

Prepared For: gogo Business Aviation

Report: TR 314305 A

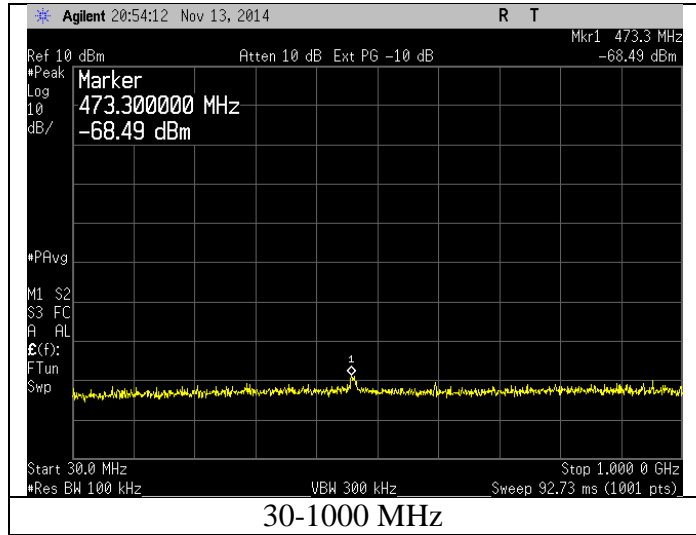
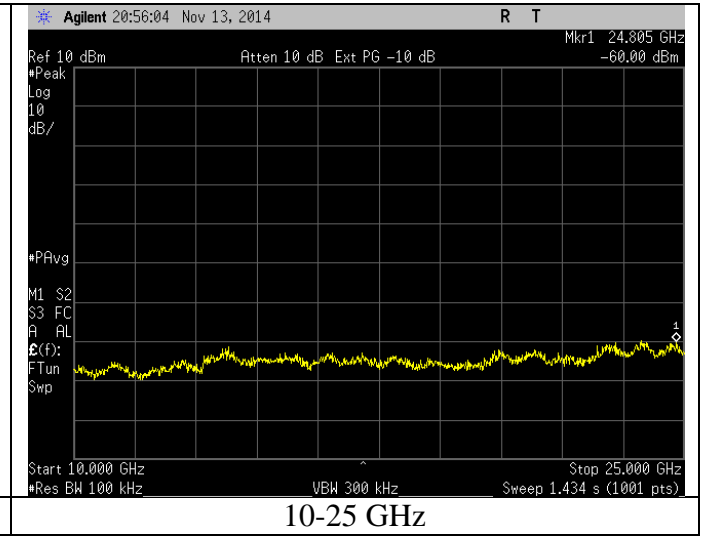
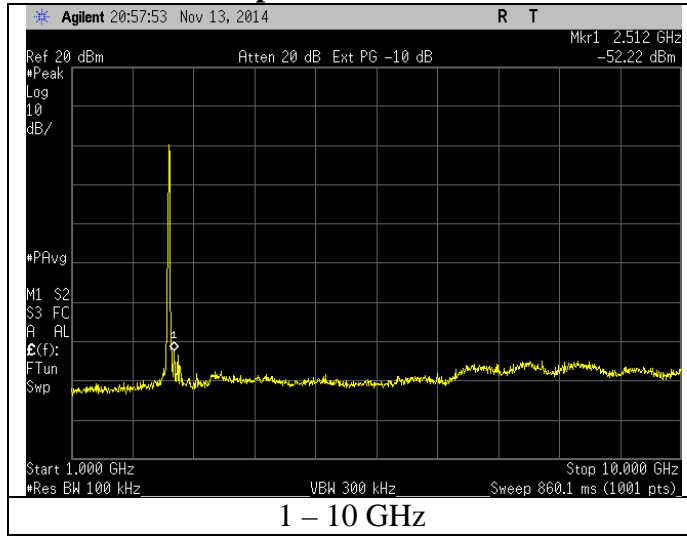
LSR: C-2063

Name: GVPU

Model: P24486

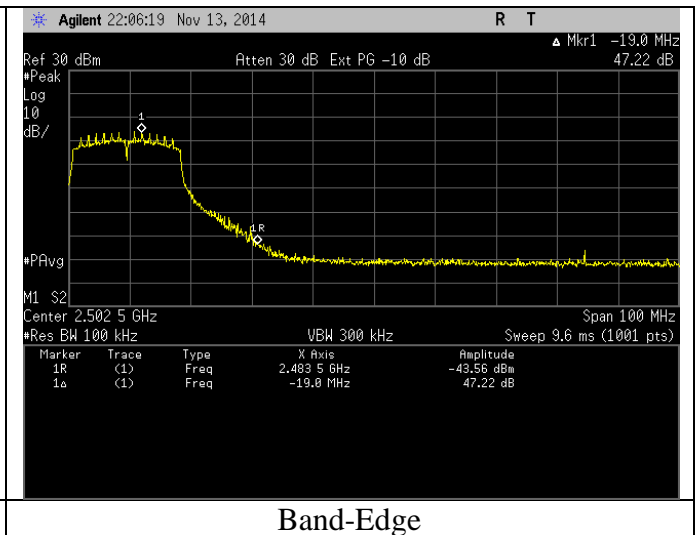
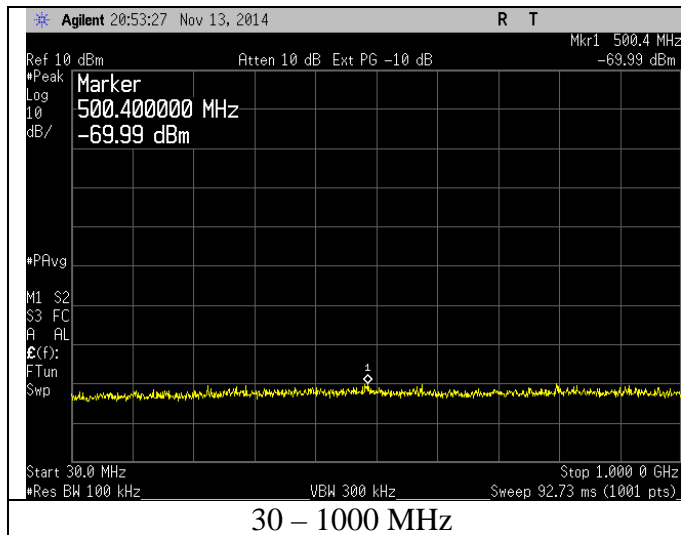
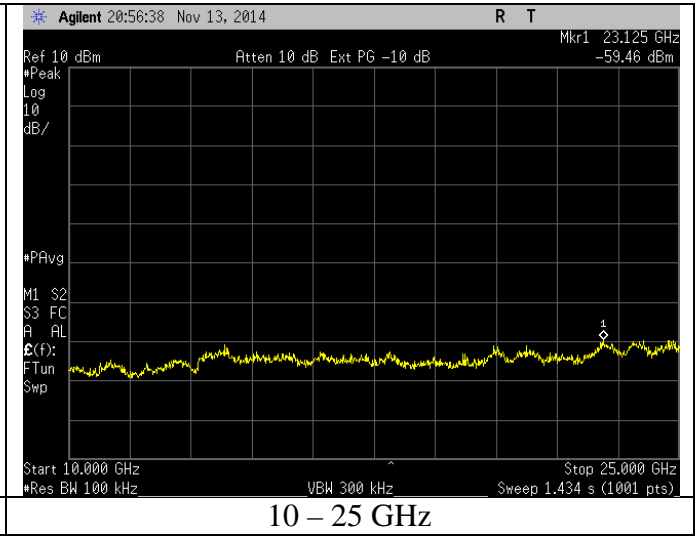
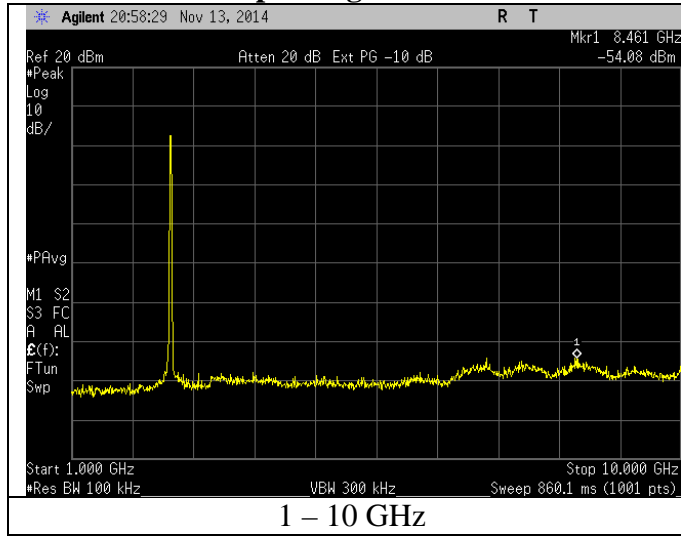
Serial: Eng. Sample

802.11n – 6.5 Mbps - Mid Channel – 2437 MHz



Prepared For: gogo Business Aviation	Name: GVPU
Report: TR 314305 A	Model: P24486
LSR: C-2063	Serial: Eng. Sample

802.11n – 6.5 Mbps - High Channel – 2462 MHz



Prepared For: gogo Business Aviation	Name: GVPU
Report: TR 314305 A	Model: P24486
LSR: C-2063	Serial: Eng. Sample

B.1.4 – RF Conducted – Emissions in restricted frequency bands

Manufacturer	gogo Business Aviation
Date	11-13-14
Operator	Adam A
Temp. / R.H.	20 - 25° C / 30-60% R.H.
Rule Part	15.247
Specific Measurement Procedure	FCC KDB 558074 Section 12.0 Emissions in restricted frequency bands
Additional Description of Measurement	RF Conducted Measurement
Additional Notes	Continuous transmit modulated used for this test.

Upper Band Edge Restricted Band (2.4835 – 2.5 GHz)

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
b	1	2.4836	-52.45	2.15	0.00	95.26	44.95	54	9.0
	11	2.4871	-51.00	2.15	0.20	95.26	46.60		7.4
g	6	2.4836	-46.01	2.15	0.15	95.26	51.55		2.5
	12	2.4839	-46.04	2.15	0.29	95.26	51.66		2.3
	24	2.4838	-46.53	2.15	0.55	95.26	51.43		2.6
	54	2.4835	-46.32	2.15	1.06	95.26	52.14		1.9
n	6.5	2.4835	-44.17	2.15	0.15	95.26	53.39		0.6
	65	2.4839	-50.44	2.15	1.18	95.26	48.15		5.8

Peak

Mode (802.11)	Mode (Mbps)	Frequency (GHz)	Meas (dBm)	Antenna Gain (dBi)	Conversion to (dBμV/m)	Peak (dBμV/m)	Limit	Margin
b	1	2.4998	-40.69	2.15	95.26	56.72	74	17.3
	11	2.4988	-39.94	2.15	95.26	57.47		16.5
g	6	2.4836	-27.32	2.15	95.26	70.09		3.9
	12	2.4838	-27.38	2.15	95.26	70.03		4.0
	24	2.4837	-27.72	2.15	95.26	69.69		4.3
	54	2.4835	-26.24	2.15	95.26	71.17		2.8
n	6.5	2.4835	-23.99	2.15	95.26	73.42		0.6
	65	2.4835	-33.60	2.15	95.26	63.81		10.2

Lower Band Edge Restricted Band (2.4835 – 2.5 GHz)

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
b	1	2.3850	-48.39	2.15	0.00	95.26	49.01	54	5.0
	11	2.3884	-49.30	2.15	0.20	95.26	48.30		5.7
g	6	2.3891	-44.05	2.15	0.15	95.26	53.51		0.5
	12	2.3899	-44.39	2.15	0.29	95.26	53.31		0.7
	24	2.3893	-44.83	2.15	0.55	95.26	53.13		0.9
	54	2.3899	-45.26	2.15	1.06	95.26	53.21		0.8
n	6.5	2.3898	-43.93	2.15	0.15	95.26	53.63		0.4
	65	2.3896	-48.89	2.15	1.18	95.26	49.69		4.3

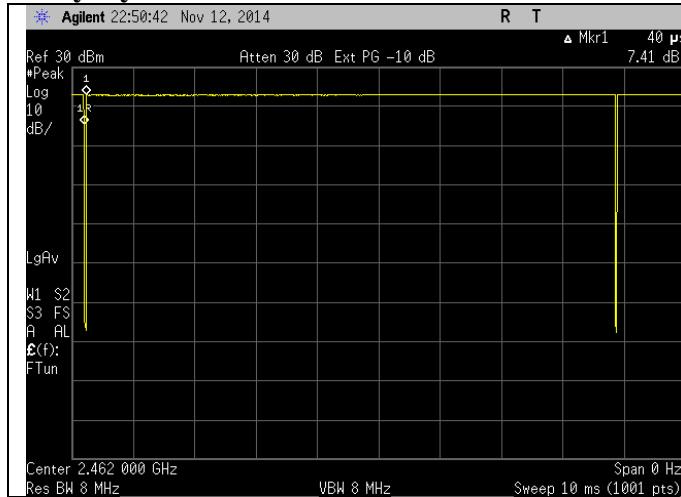
Peak

Mode (802.11)	Mode (Mbps)	Frequency (GHz)	Meas (dBm)	Antenna Gain (dBi)	Conversion to (dBμV/m)	Average (dBμV/m)	Limit	Margin
b	1	2.3862	-39.96	2.15	95.26	57.45	74	16.6
	11	2.3890	-38.83	2.15	95.26	58.58		15.4
g	6	2.3900	-25.98	2.15	95.26	71.43		2.6
	12	2.3898	-28.19	2.15	95.26	69.22		4.8
	24	2.3900	-25.90	2.15	95.26	71.51		2.5
	54	2.3898	-25.98	2.15	95.26	71.43		2.6
n	6.5	2.3897	-23.76	2.15	95.26	73.65		0.4
	65	2.3897	-28.37	2.15	95.26	69.04		5.0

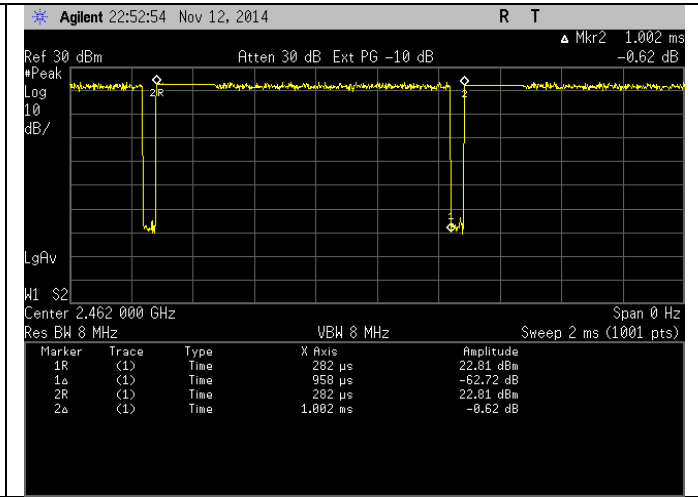
Duty Cycle Calculation

Mode (802.11)	Mode (Mbps)	On-time (ms)	Total Time (ms)	Duty Cycle	Duty Cycle Correction
b	11	0.958	1.002	0.96	0.20
g	6	1.43	1.48	0.97	0.15
	12	0.726	0.776	0.94	0.29
	24	0.373	0.423	0.88	0.55
	54	0.181	0.231	0.78	1.06
n	6.5	1.326	1.374	0.97	0.15
	65	0.157	0.206	0.76	1.18

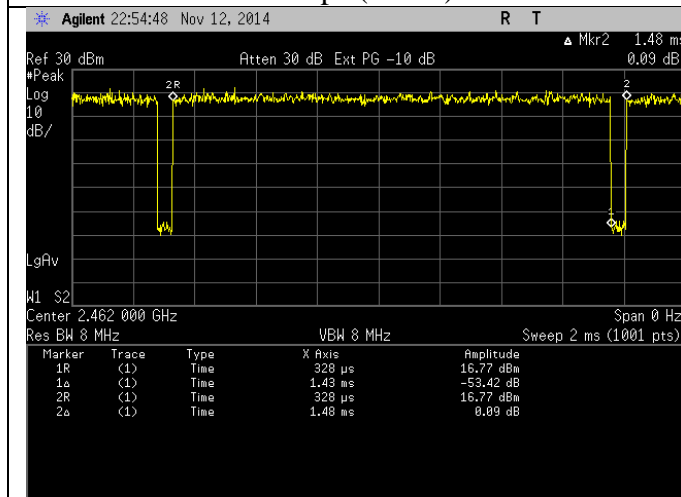
Duty Cycle



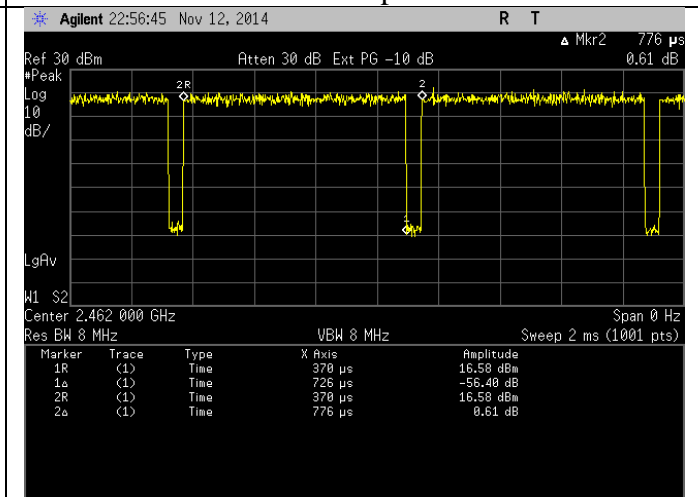
1 Mbps (>98%)



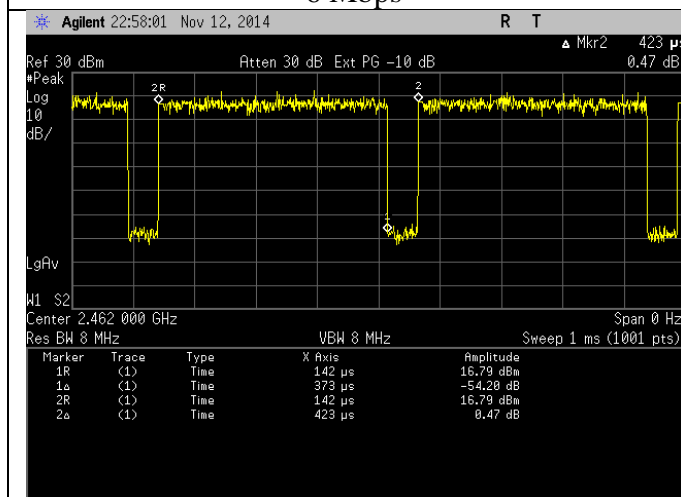
11 Mbps



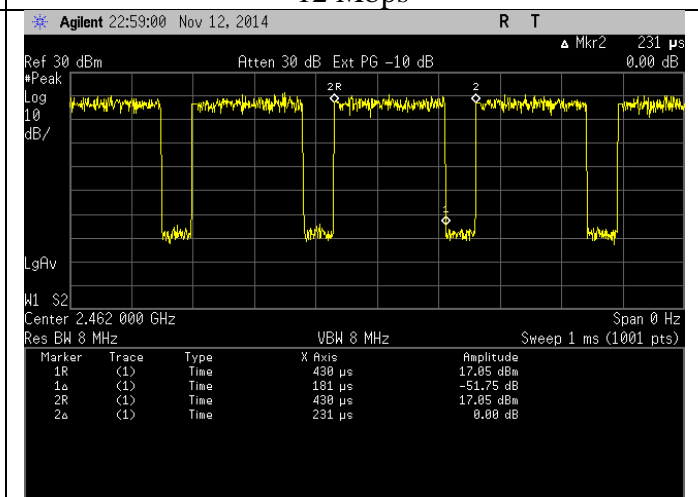
6 Mbps



12 Mbps



24 Mbps



54 Mbps

Prepared For: gogo Business Aviation

Report: TR 314305 A

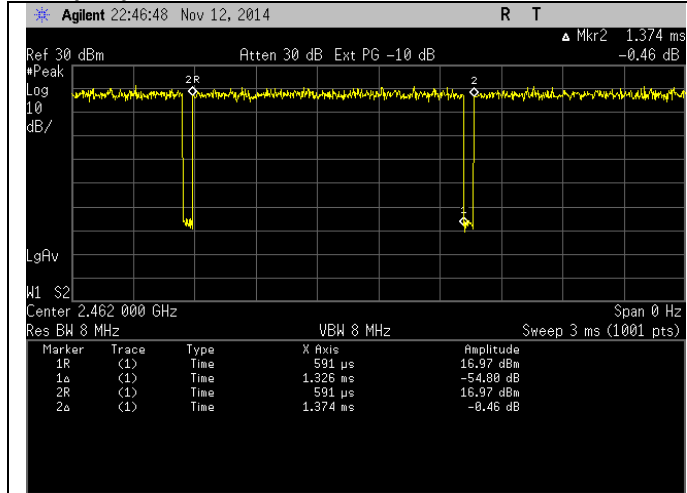
LSR: C-2063

Name: GVPU

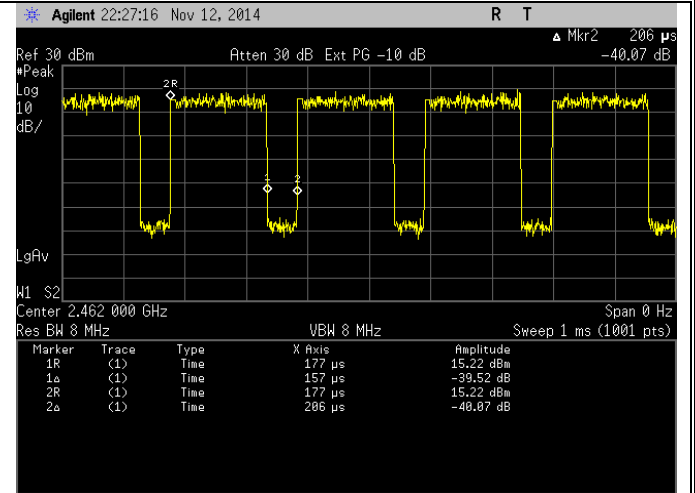
Model: P24486

Serial: Eng. Sample

Duty Cycle

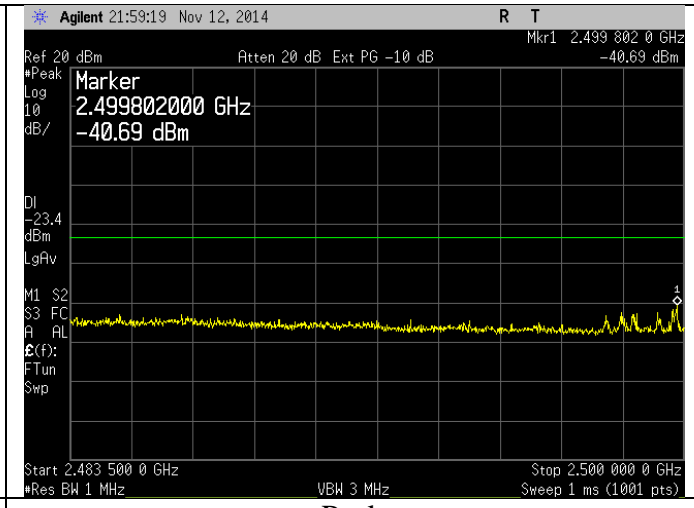
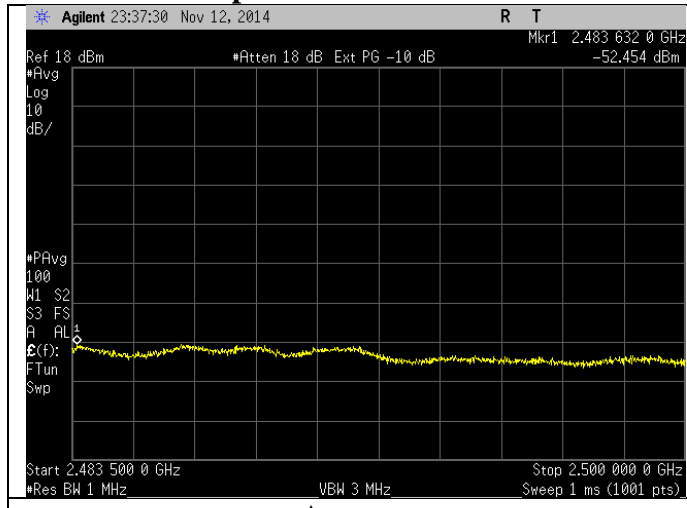


6.5 Mbps

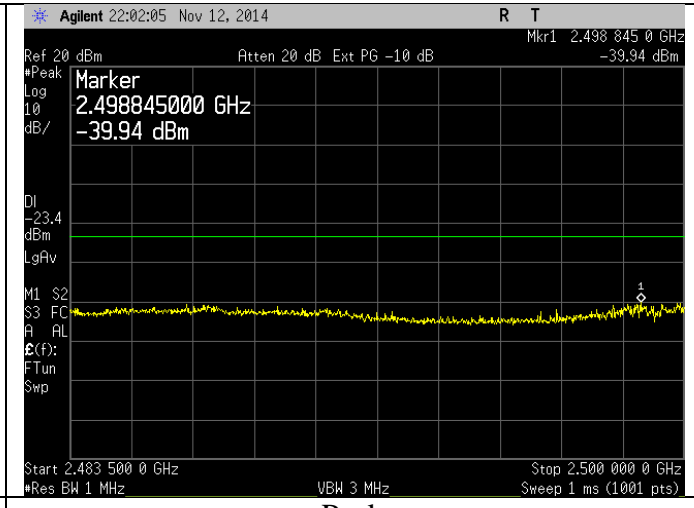
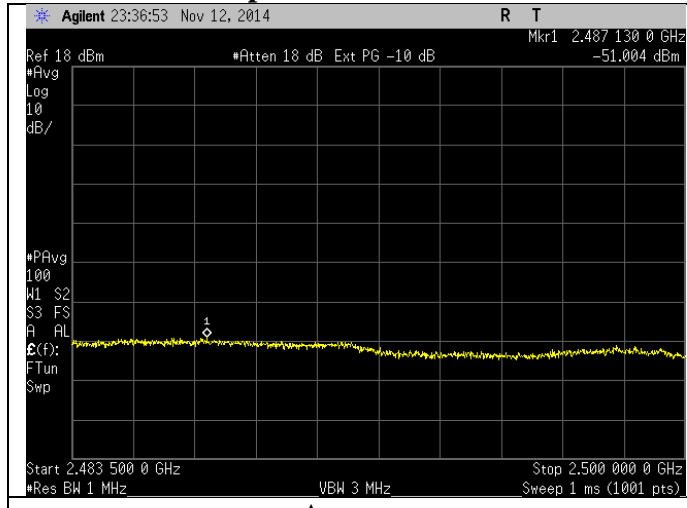


65 Mbps

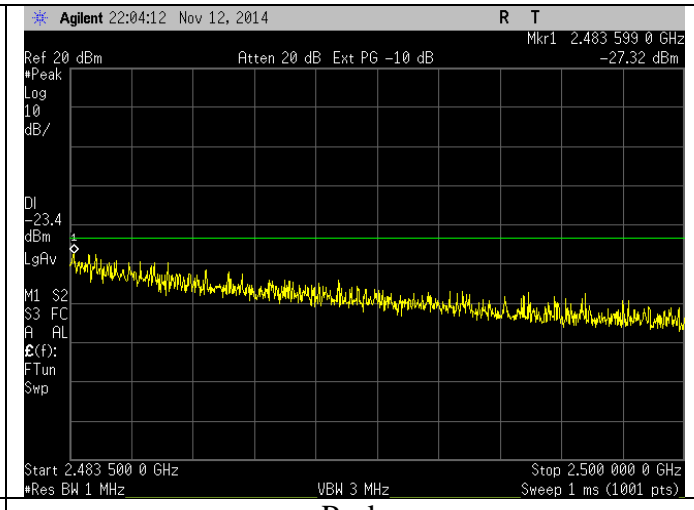
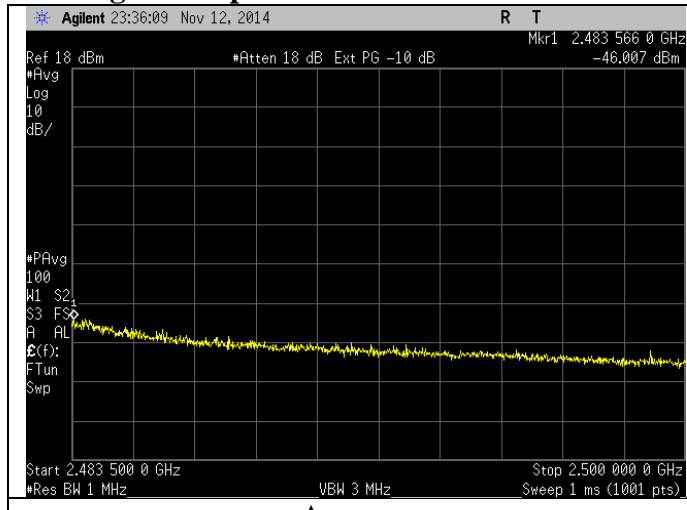
Upper Band Edge Restricted Band 802.11b – 1 Mbps



802.11b – 11 Mbps

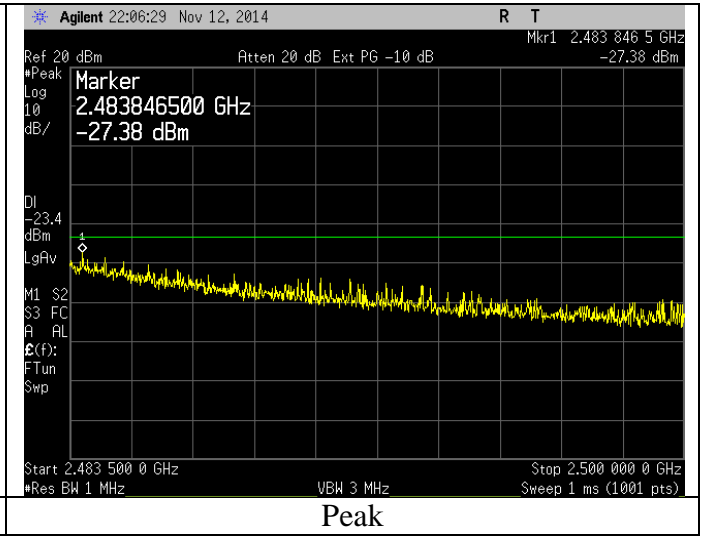
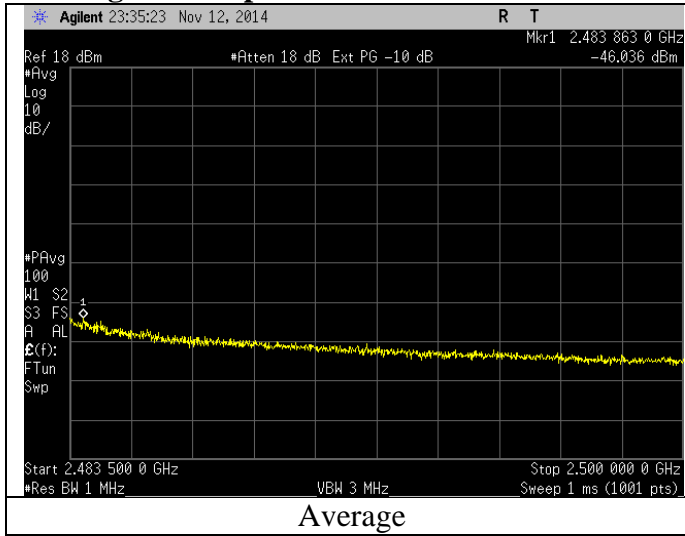


802.11g – 6 Mbps

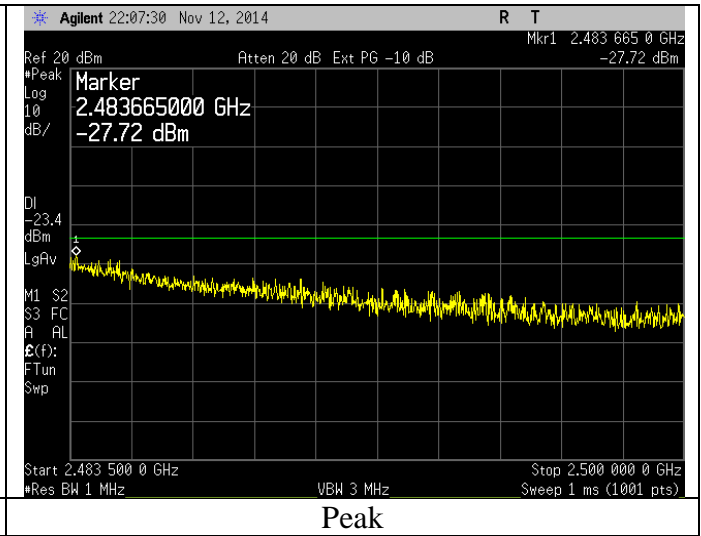
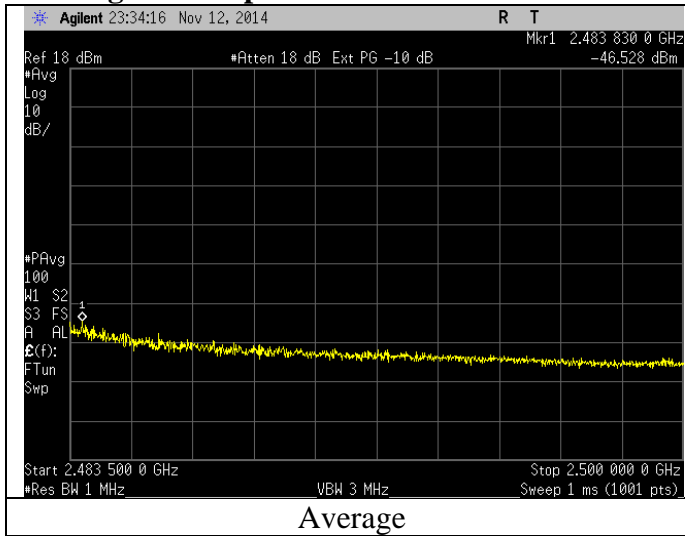


Prepared For: gogo Business Aviation	Name: GVPU
Report: TR 314305 A	Model: P24486
LSR: C-2063	Serial: Eng. Sample

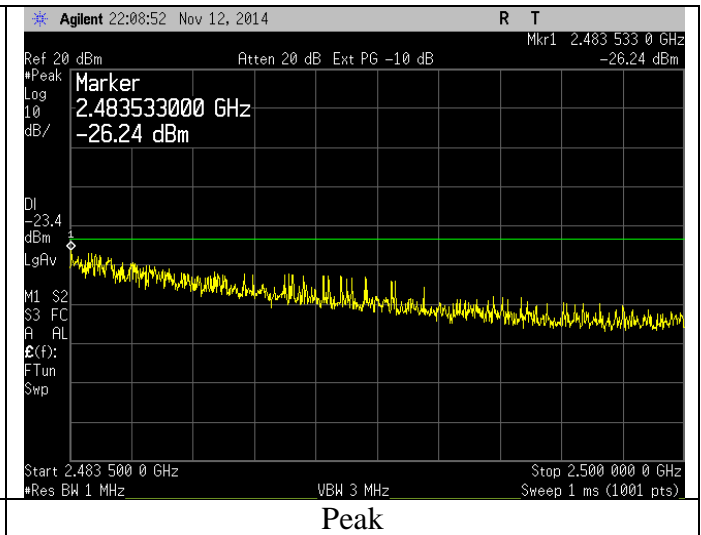
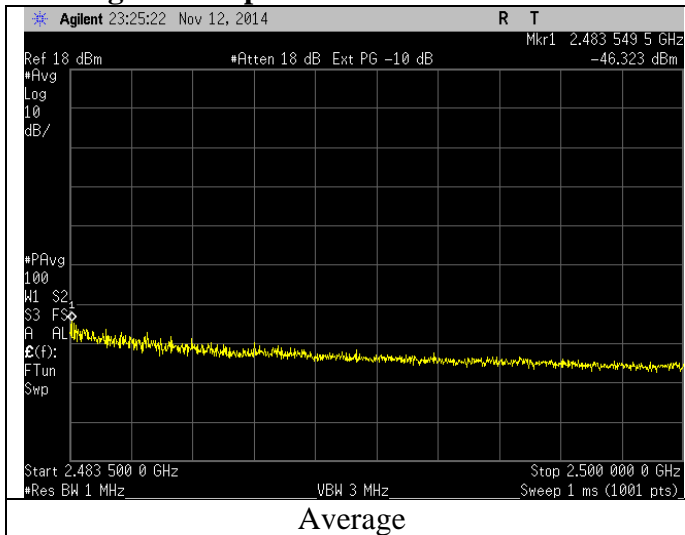
802.11g – 12 Mbps



802.11g – 24 Mbps



802.11g – 54 Mbps



Prepared For: gogo Business Aviation

Report: TR 314305 A

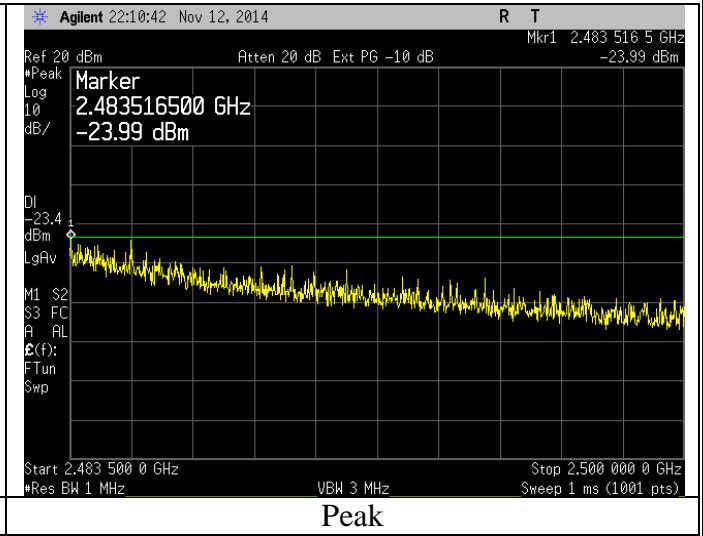
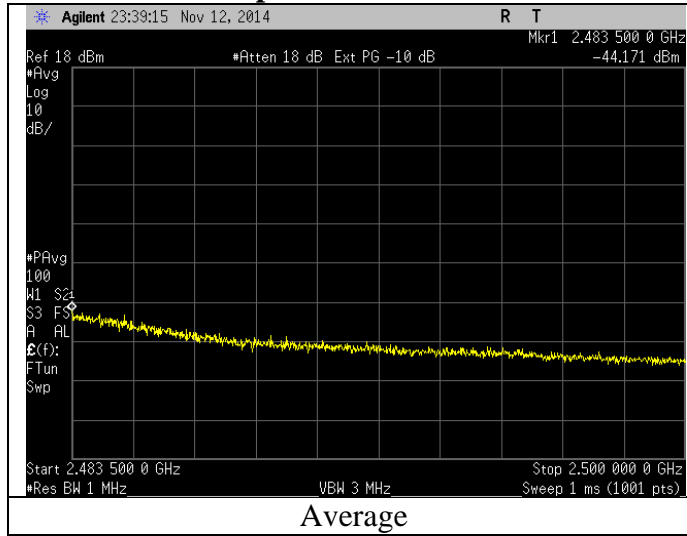
LSR: C-2063

Name: GVPU

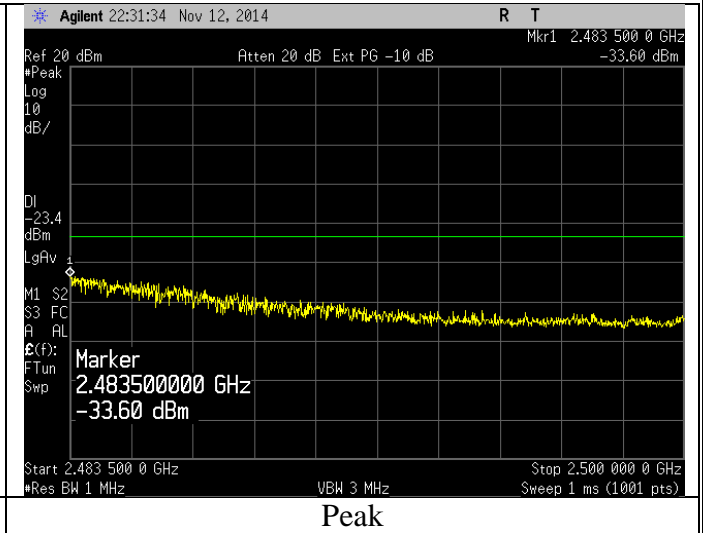
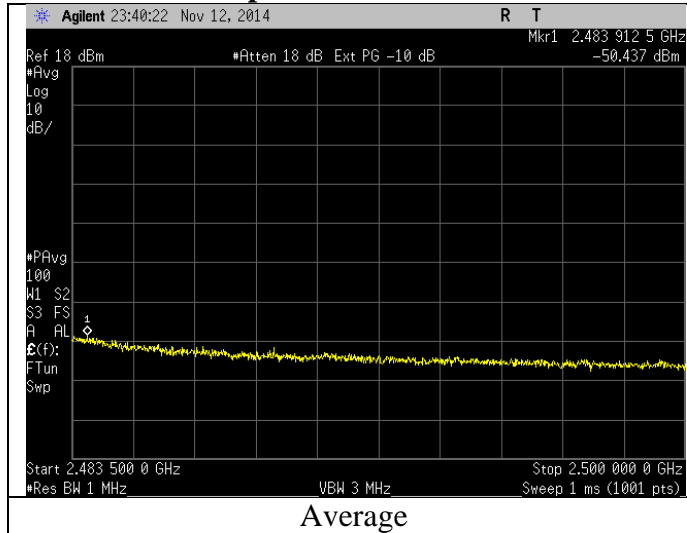
Model: P24486

Serial: Eng. Sample

802.11n – 6.5 Mbps

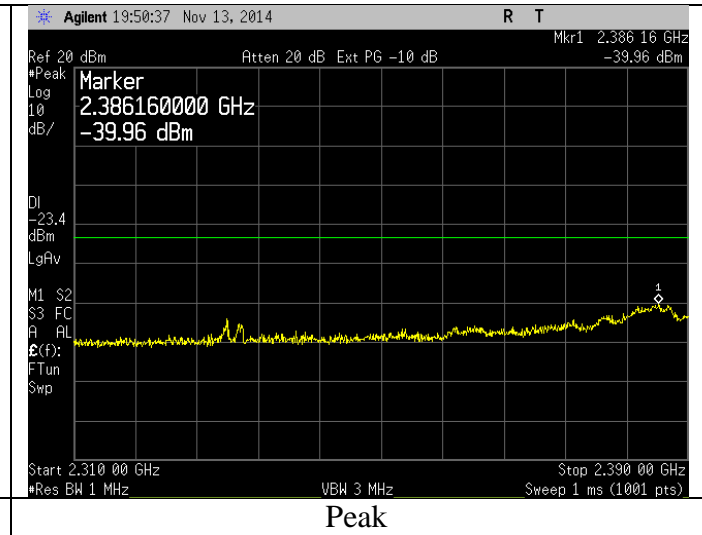
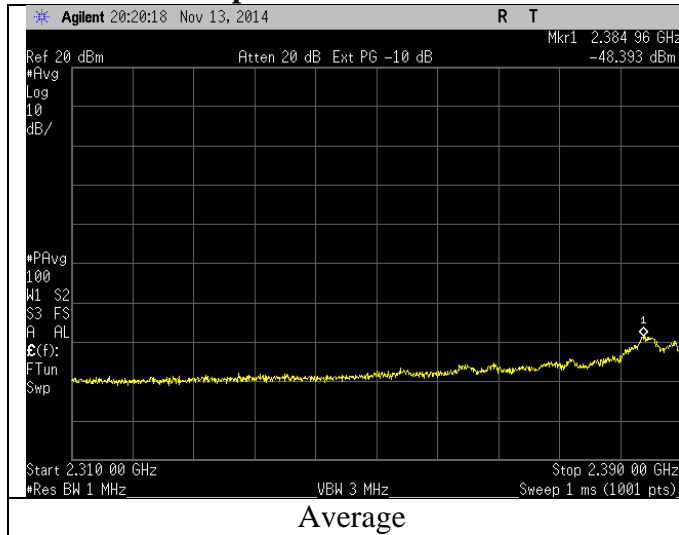


802.11n – 65 Mbps

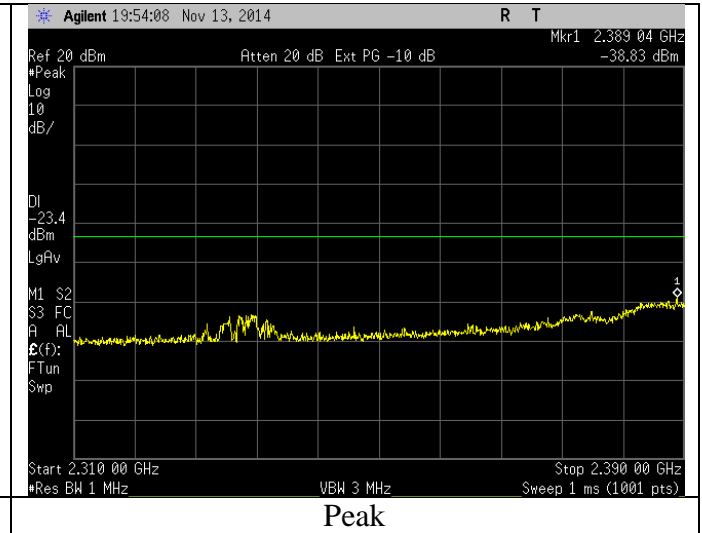
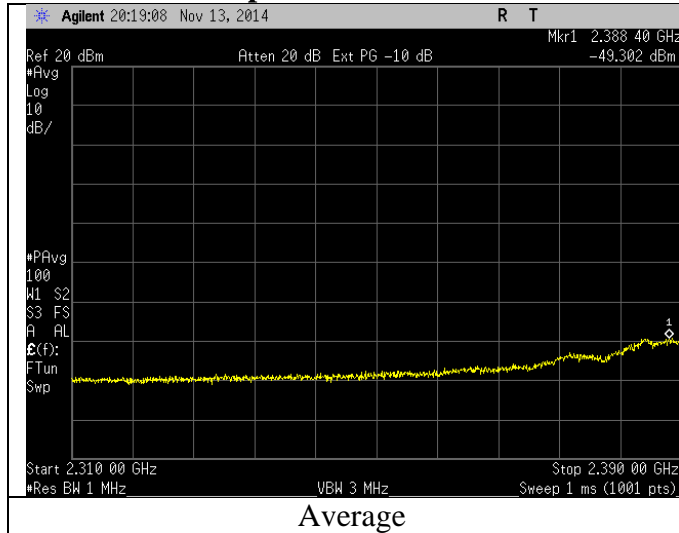


Prepared For: gogo Business Aviation	Name: GVPV
Report: TR 314305 A	Model: P24486
LSR: C-2063	Serial: Eng. Sample

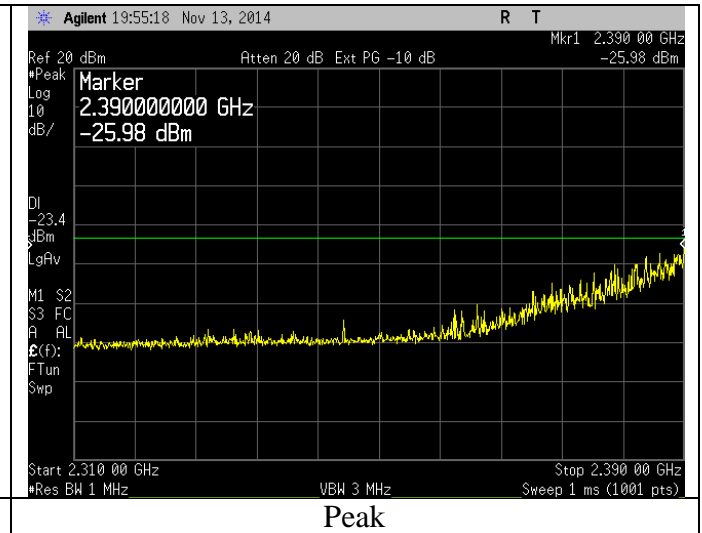
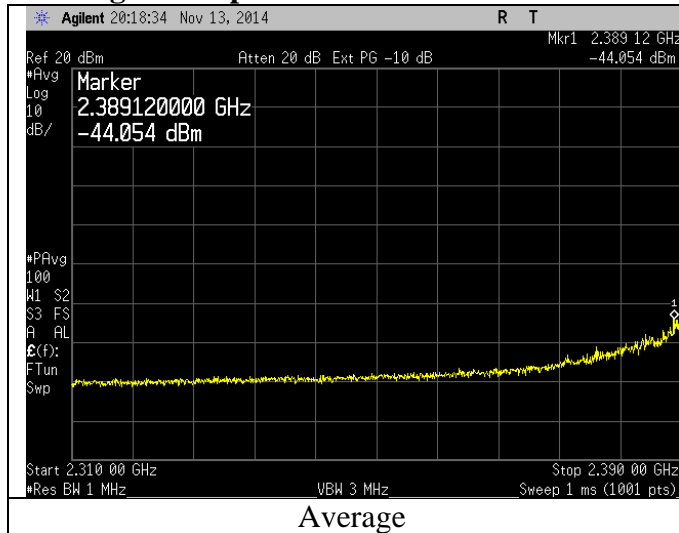
Lower Band Edge Restricted Band 802.11b – 1 Mbps



802.11b – 11 Mbps



802.11g – 6 Mbps



Prepared For: gogo Business Aviation

Name: GVPV

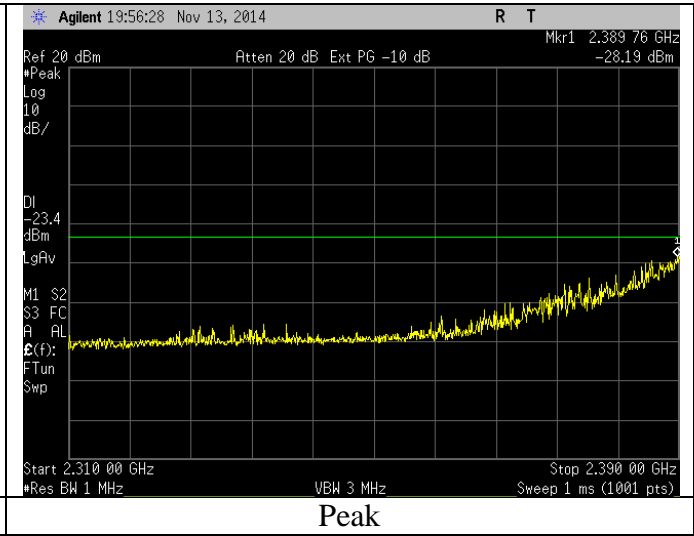
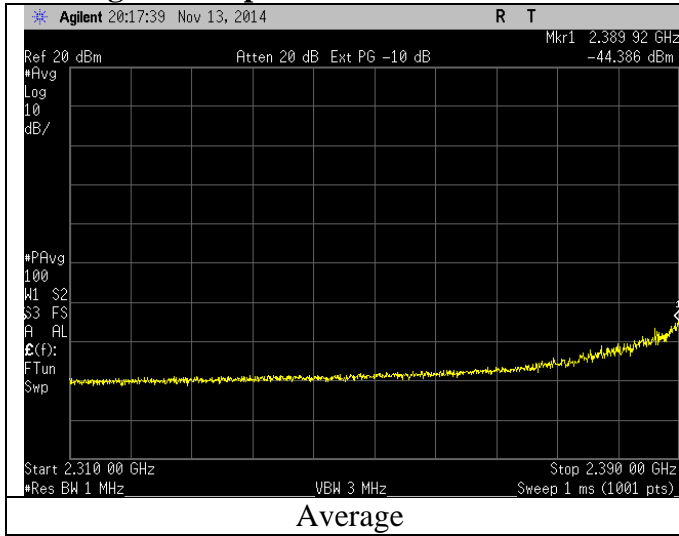
Report: TR 314305 A

Model: P24486

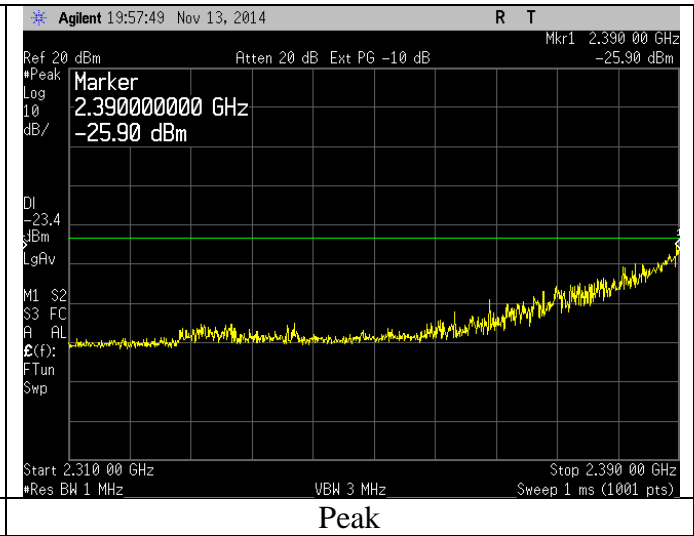
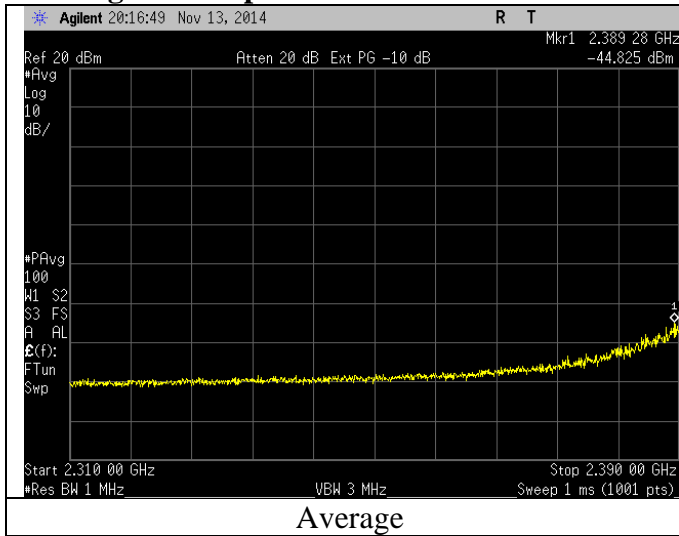
LSR: C-2063

Serial: Eng. Sample

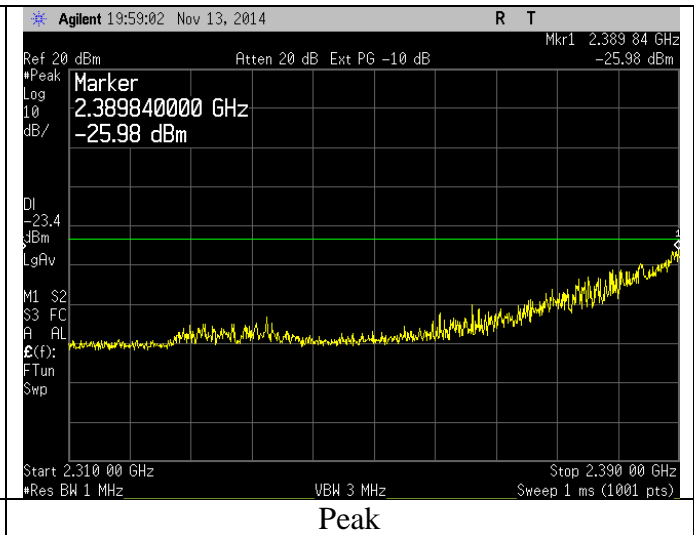
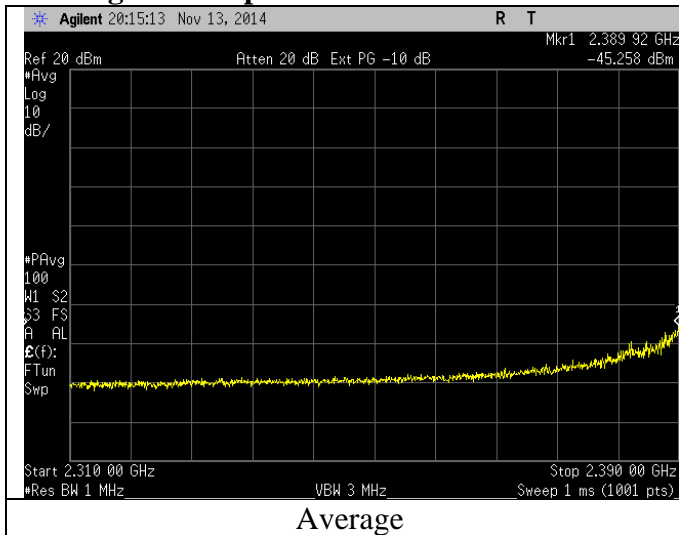
802.11g – 12 Mbps



802.11g – 24 Mbps



802.11g – 54 Mbps



Prepared For: gogo Business Aviation

Report: TR 314305 A

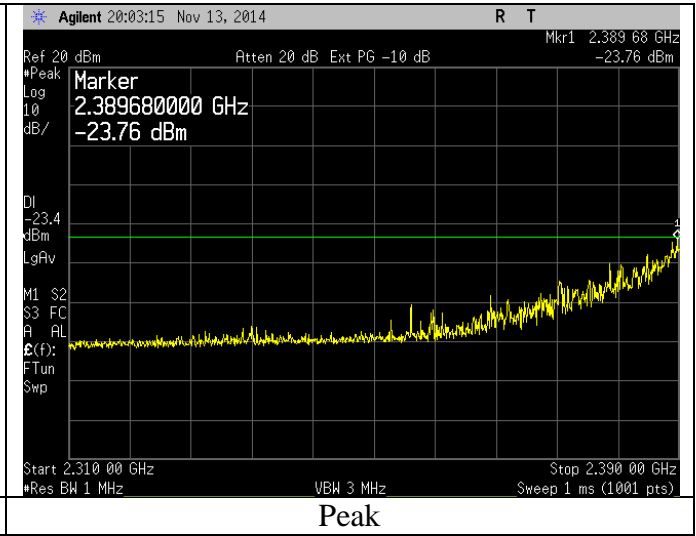
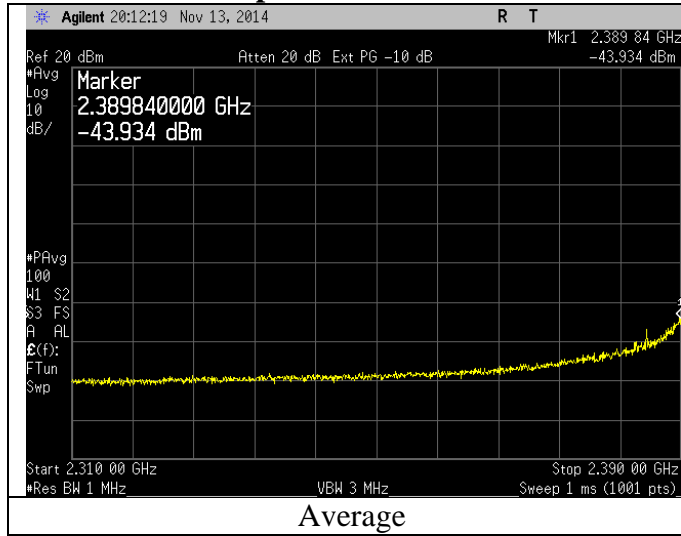
LSR: C-2063

Name: GVPU

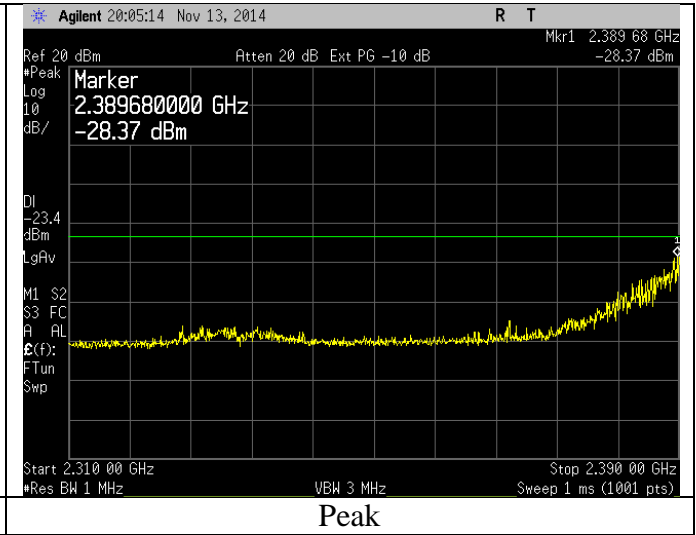
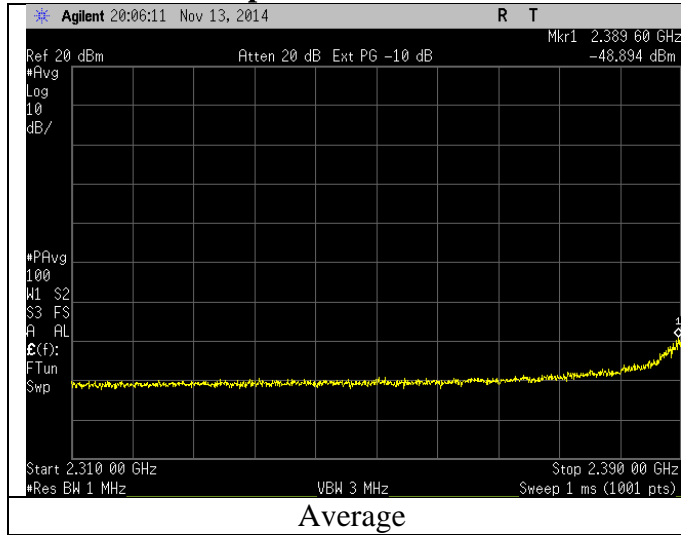
Model: P24486

Serial: Eng. Sample

802.11n – 6.5 Mbps



802.11n – 65 Mbps



Prepared For: gogo Business Aviation

Report: TR 314305 A

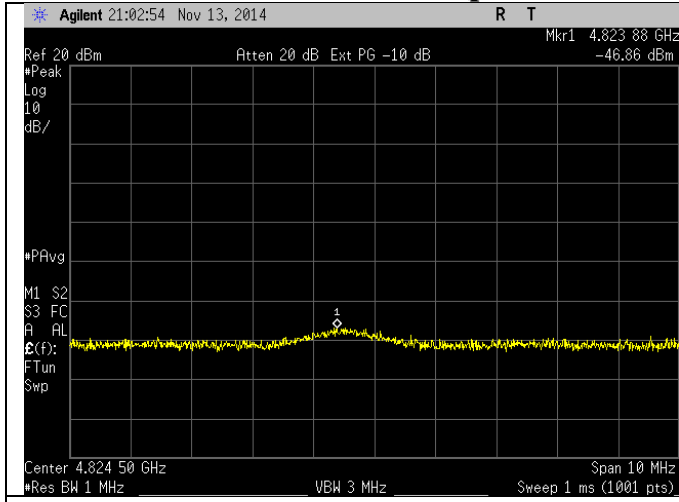
LSR: C-2063

Name: GVPU

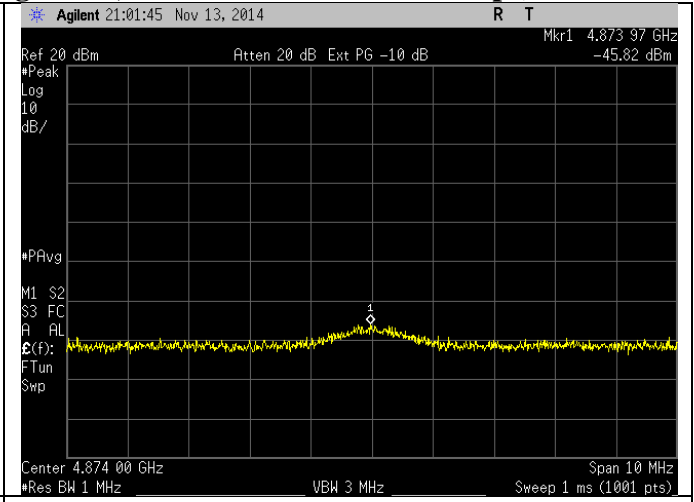
Model: P24486

Serial: Eng. Sample

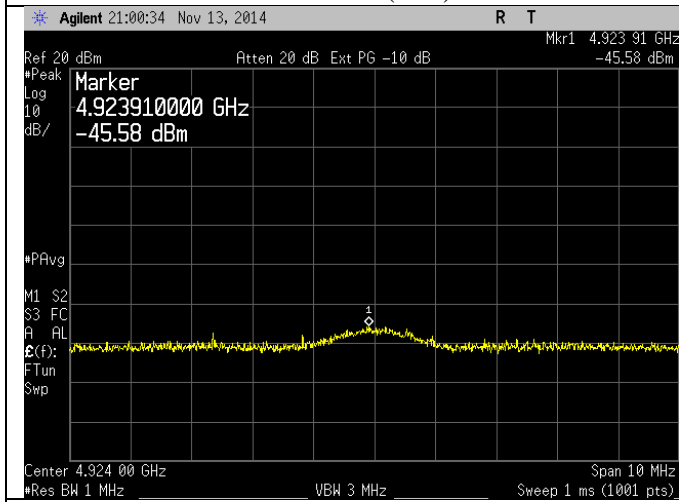
2nd harmonic in restricted band (peak meets average limit, worst case 802.11b – 1 Mbps)



Channel 1 (low)



Channel 6 (mid)



Channel 11 (high)

Prepared For: gogo Business Aviation

Report: TR 314305 A

LSR: C-2063

Name: GVPU

Model: P24486

Serial: Eng. Sample

B.2 – Radiated Emissions

Rule Part(s)	FCC: 15.247 / 15.205 / 15.209			
Measurement Procedure	ANSI C63.4 - 2009 ANSI C63.10 – 2009 FCC KDB 558074 D01 DTS Meas Guidance v03r02			
Test Location	LS Research, LLC - FCC Listed 3 meter Semi-Anechoic Chamber			
Test Distance	See 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	Standard Gain Horn: 18-26GHz
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	<p>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.</p> <p>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</p> <p>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.</p>			
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 ($\mu\text{V/m}$)	3 m Limit ($\text{dB}\mu\text{V/m}$)	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)

Prepared For: gogo Business Aviation	Name: GVPU
Report: TR 314305 A	Model: P24486
LSR: C-2063	Serial: Eng. Sample

B.2.1 – Radiated Band-Edge Restricted Bands

Manufacturer	gogo Business Aviation
Date	11-26-14
Operator	Adam A
Temp. / R.H.	20 - 25° C / 30-60% R.H.
Rule Part	15.247/ 15.205 / 15.209
Measurement Procedure	ANSI C63.4 - 2009 ANSI C63.10 - 2009 FCC KDB 558074 v03r02 Section 12.2.7 Radiated spurious emission test
Test Distance	3 meter (1-4 GHz)
EUT Placement	80 cm height non-conductive table centered on turn-table
Detectors	Peak; RBW 1MHz VBW 3 MHz (10Hz VBW for average measurements)
Additional Notes	<ol style="list-style-type: none"> 1) Tested in the worst case of continuous transmit modulated mode based on conducted measurements (54 Mbps) with EUT rotated in three orientations. 2) EUT maximized in azimuth and antenna height with maximum results reported. 3) Antenna port terminated with matching 50 ohm termination.

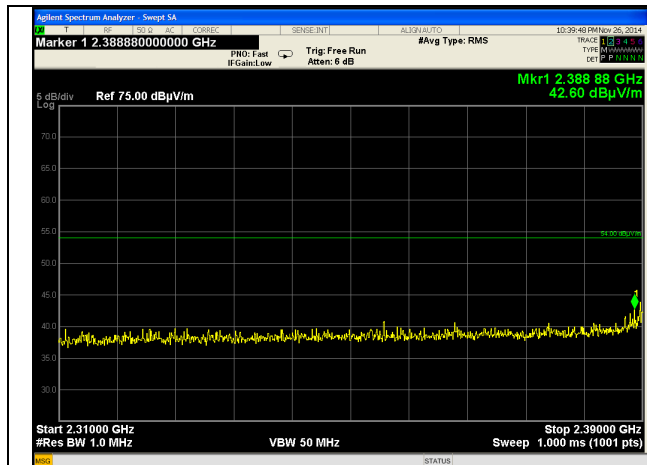
Example Calculation:

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

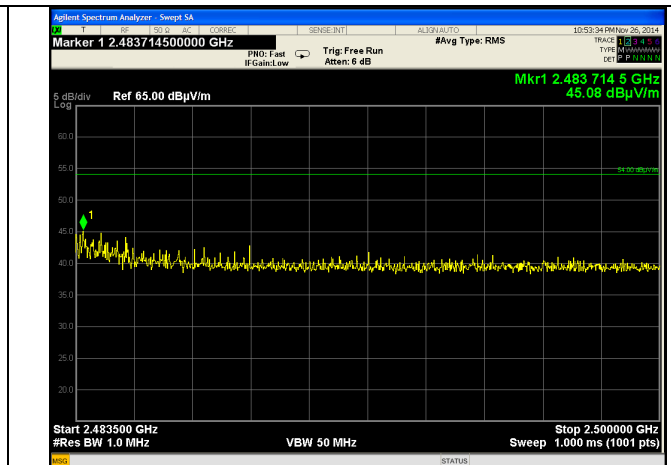
Data Table

Channel	Frequency (MHz)	EUT orientation	Antenna Polarity	Height (cm)	Azimuth (degree)	Peak Reading (dBμV/m)	Average Limit (dBμV/m)	Margin (dB)
1 (Low)	2388.8	Flat	Horizontal	100	125	42.60	54	11.4
11 (High)	2483.7	Flat	Horizontal	100	125	45.80	54	8.2

Plots



Low Channel (2412 MHz)
Lower Band-edge (2310-2390 MHz)
Peak Meets Average limit



High Channel (2462MHz)
Upper Band-edge (2483.5-2500 MHz)
Peak Meets Average limit

Prepared For: gogo Business Aviation

Report: TR 314305 A

LSR: C-2063

Name: GVPU

Model: P24486

Serial: Eng. Sample

B.2.2 – Radiated Harmonics in Restricted Bands

Manufacturer	gogo Business Aviation
Date	11-19-14, 11-24-14
Operator	Peter F / Adam A
Temp. / R.H.	20 - 25° C / 30-60% R.H.
Rule Part	15.247/ 15.205 / 15.209
Measurement Procedure	ANSI C63.4 - 2009 ANSI C63.10 - 2009
Test Distance	3 meter 4-18 GHz, 1 meter 18-26 GHz
EUT Placement	80 cm height non-conductive table centered on turn-table
Detectors	Peak; RBW 1 MHz Average VBW (10Hz)
Additional Notes	<ol style="list-style-type: none"> 1) Tested in continuous transmit modulated mode with EUT in three orientations at maximum power. (Worst case 1 Mbps) 2) No emissions found above system noise floor. 3) Antenna port terminated with matching 50 ohm termination.

Example Calculation:

FCC 15.209 Average Limit @ 1 meter (dB μ V/m) – Peak Reading (dB μ V/m) = Margin

Data Table

Frequency (GHz)	Height (cm)	Azimuth (degree)	Peak Reading (dB μ V/m)	Avg Reading (dB μ V/m)	Peak Limit (dB μ V/m)	Peak Margin (dB)	Avg Limit (dB μ V/m)	Avg Margin (dB)	Antenna Polarity	EUT orientation	Note
16.460	100	0	55.09	45.54	74	18.9	54	8.4	H	Low Ch – Side Pos	1
16.446	100	0	55.37	44.83	74	18.6	54	9.1	H	Mid Ch – Flat Pos	1
4.912	100	0	40.22	30.76	74	33.8	54	23.2	V	High Ch – Vert Pos	1

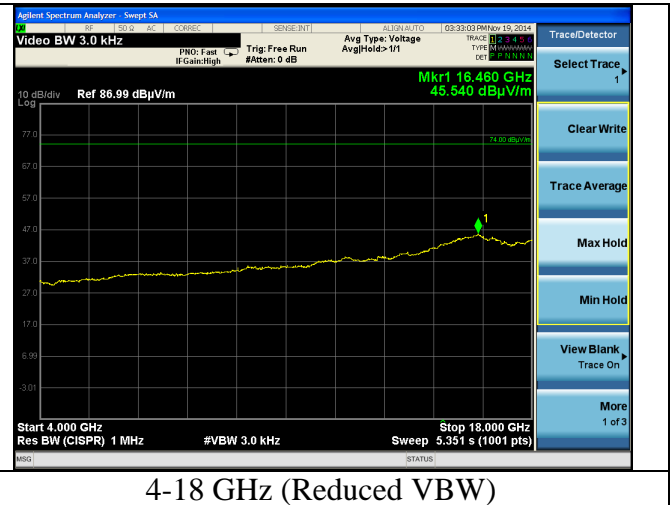
Note 1: Measurement that of system noise floor. No emissions found above noise floor from EUT.

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Plots - Low Channel

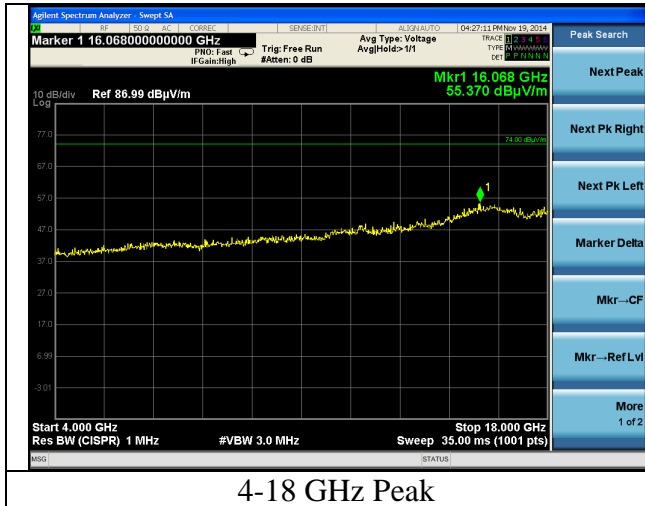


4-18 GHz Peak

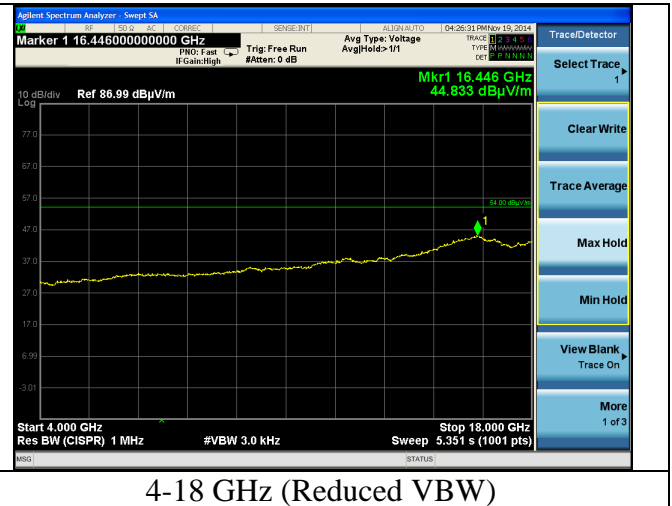


4-18 GHz (Reduced VBW)

Middle Channel

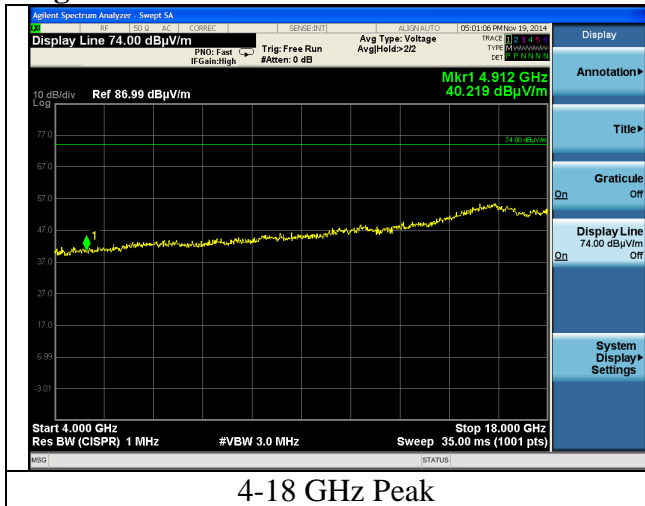


4-18 GHz Peak

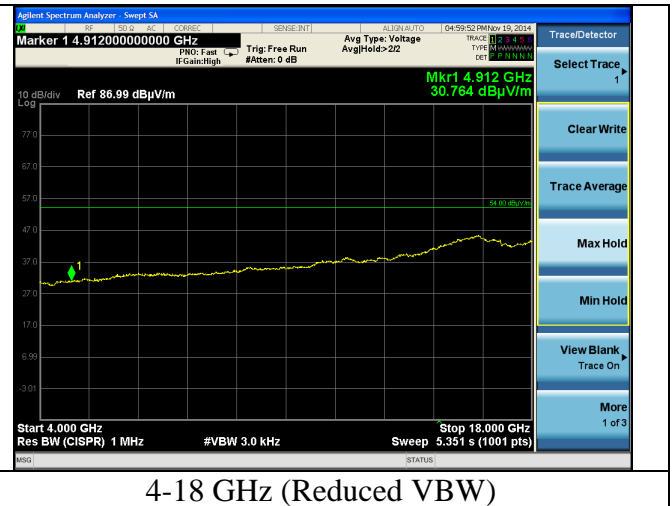


4-18 GHz (Reduced VBW)

High Channel



4-18 GHz Peak



4-18 GHz (Reduced VBW)

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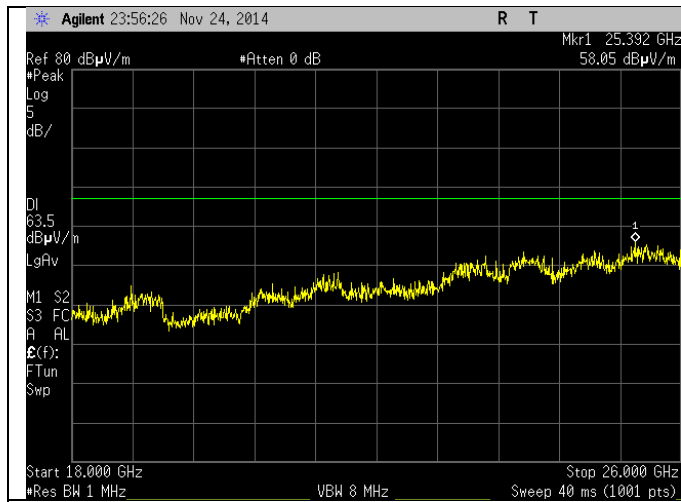
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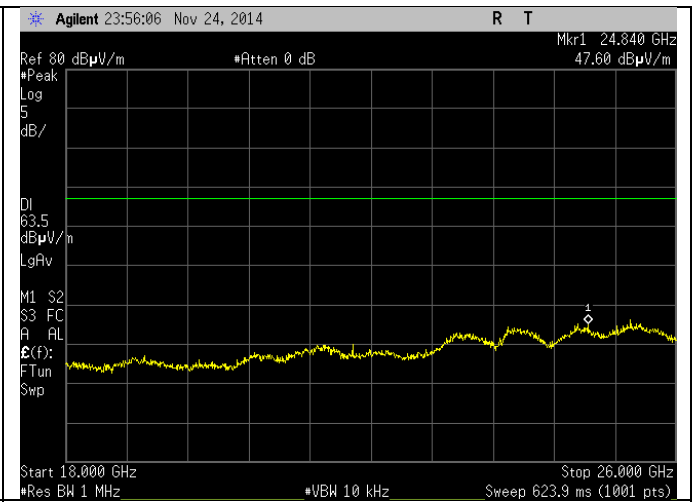
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18-26 GHz Peak



18-26 GHz (reduced VBW)

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Model: P24486

Serial: Eng. Sample

B.2.3 – Radiated Emissions Transmit Mode

Manufacturer	gogo Business Aviation
Date	11-26-14
Operator	Adam A
Temp. / R.H.	20 - 25° C / 30-60% R.H.
Rule Part	15.247/ 15.205 / 15.209
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	<ol style="list-style-type: none"> 1) Tested in continuous transmit modulated mode with EUT in three orientations at maximum power. 2) Antenna port terminated with matching 50 ohm termination. 3) Emissions not effected by channel or transmit or receive mode.

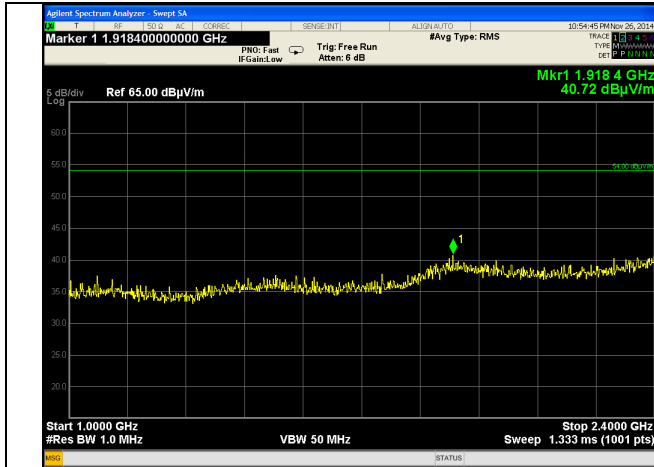
Example Calculation:

$$\text{Limit (dB}\mu\text{V/m)} - \text{Reading (dB}\mu\text{V/m)} = \text{Margin}$$

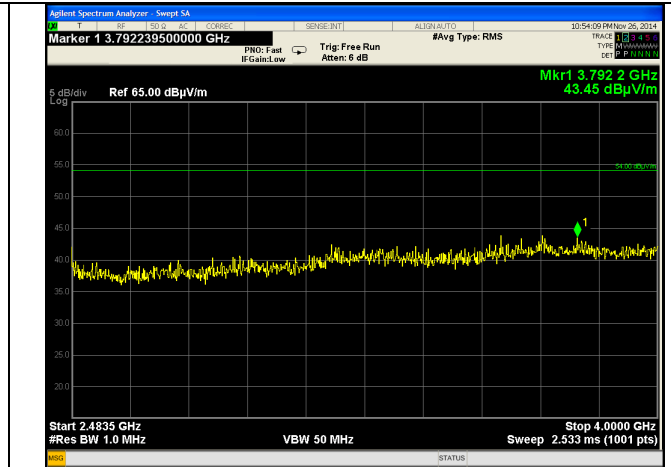
Table

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

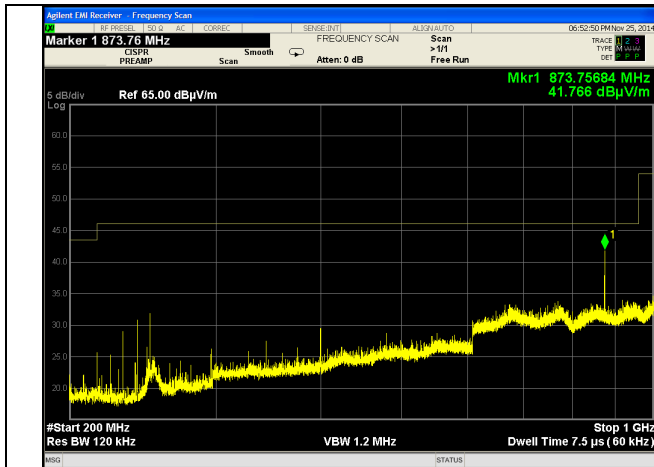
Plots



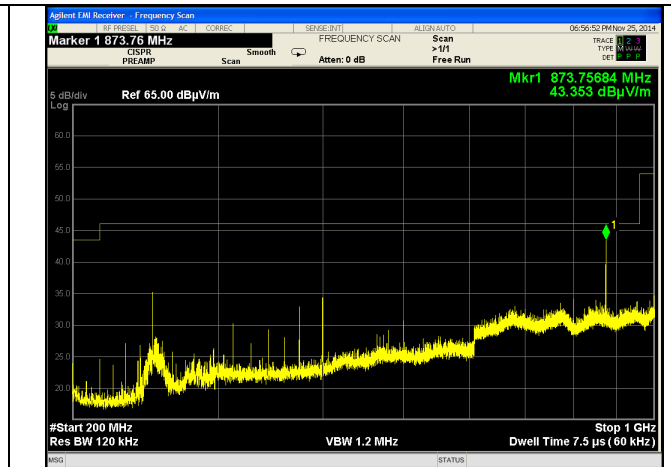
1000 - 2400 MHz (Peak meets Average Limit)



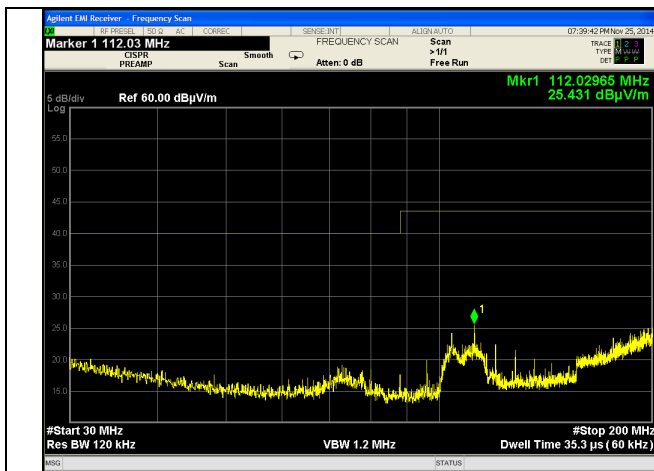
2483.5 - 4000 MHz (Peak meets Average Limit)



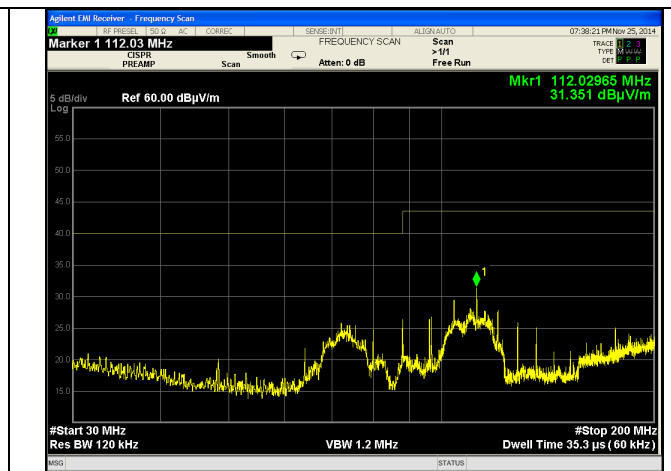
200-1000 MHz Vertical



200-1000 MHz Horizontal



30-200 MHz Vertical



30-200 MHz Horizontal

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B.2.4 – Radiated Emissions Receive Mode

Manufacturer	gogo Business Aviation
Date	11-19-14
Operator	Mike H / Adam A
Temp. / R.H.	20 - 25° 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	<ol style="list-style-type: none"> 1) Tested in continuous transmit modulated mode with EUT in three orientations at maximum power. 2) Maximum results reported 3) Emissions not effected by channel or transmit or receive mode.

Example Calculation:

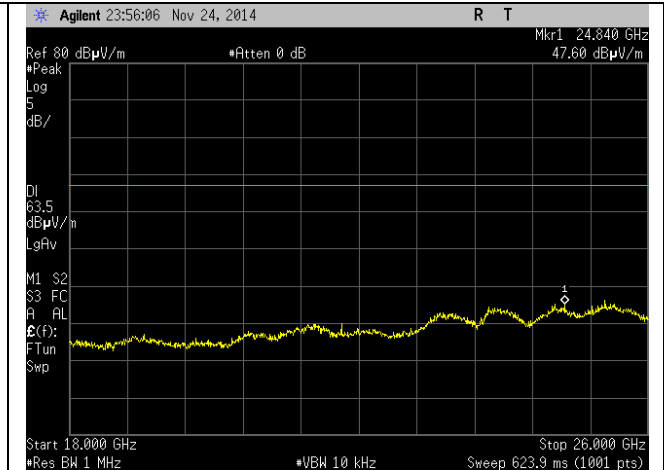
$$\text{Limit (dB}\mu\text{V/m)} - \text{Reading (dB}\mu\text{V/m)} = \text{Margin}$$

Table

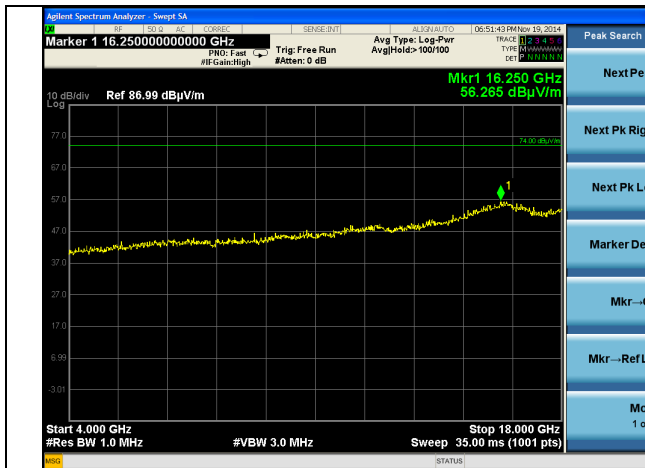
Frequency (MHz)	Height (cm)	Azimuth (degree)	Quasi Peak Reading (dB μ V/m)	Quasi Peak Limit (dB μ V/m)	Margin (dB)	Antenna Polarity	EUT orientation
875	121	289	43.29	46	2.71	Horizontal	Flat
875	134	350	42.87	46	3.13	Horizontal	Vertical
875	103	315	42.54	46	3.46	Vertical	Horizontal
400	119	53	35.11	46	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



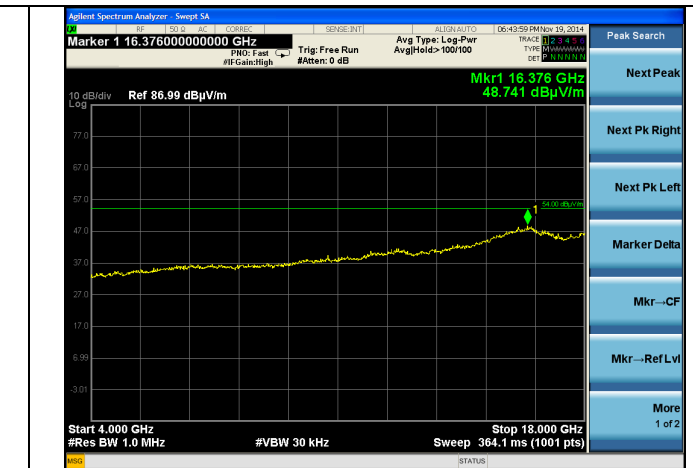
1000 – 4000 MHz (average)



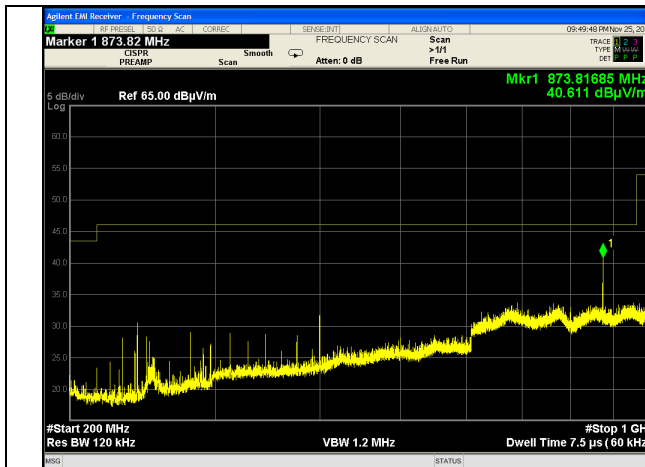
18-26 GHz (average)



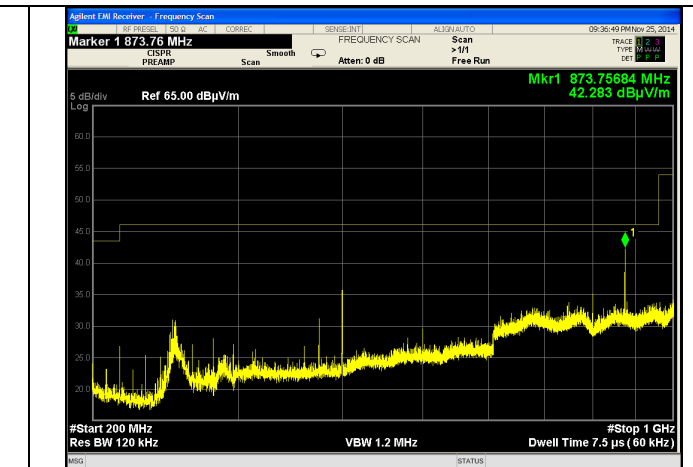
4-18 GHz (peak)



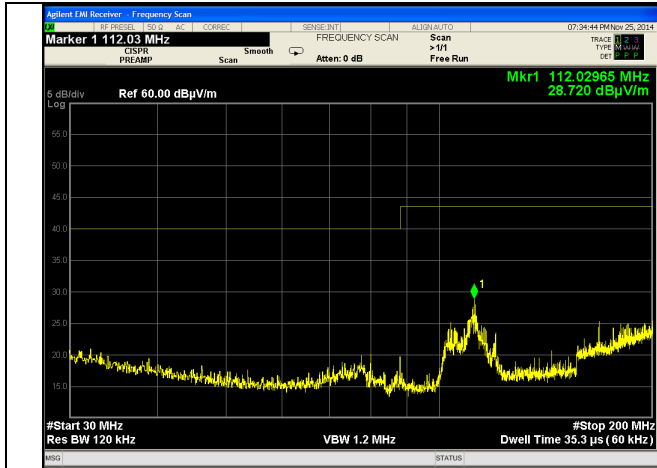
4-18 GHz (reduced VBW)



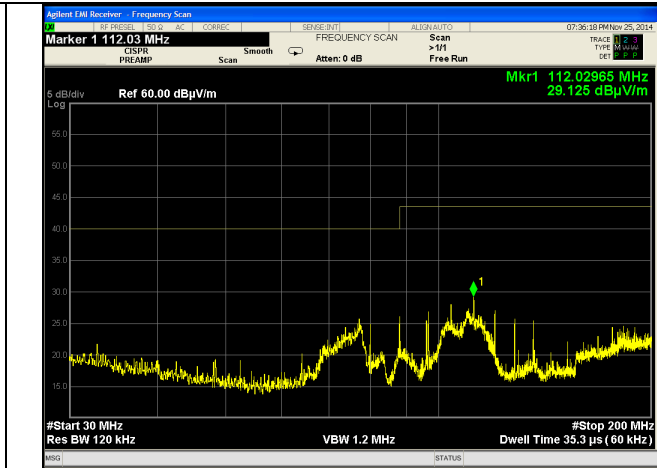
200-1000 MHz Vertical



200-1000 MHz Horizontal



30-200 MHz Vertical



30-200 MHz Horizontal

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B3 – Frequency Stability

Manufacturer	gogo Business Aviation
Operator	Adam A
Additional Notes	<p>The power and frequency stability of the device was examined as a function of the input voltage available to the EUT. A Spectrum Analyzer was used to measure the RF output power and frequency at the appropriate frequency markers. Power was supplied by an external bench-type DC power supply and was varied from the nominal.</p> <p>The power was then cycled On/Off to observe system response. No unusual response was observed, the emission characteristics were well behaved, and the system returned to the same state of operation as before the power cycle.</p> <p>Below is data showing stability of the fundamental frequency.</p> <p>Continuous transmit modulated used for this test. EUT does not operate below 18-32.2 VDC, 28VDC nominal</p>

Channel	Minimum VDC (Hz)	Nominal VDC (Hz)	Maximum VDC (Hz)	freq drift (Hz)
Low (2412 MHz)	2412000969	2412000990	2412000990	21
Mid (2437 MHz)	2437000920	2437000940	2437000960	40
High (2462 MHz)	2462000939	2462000960	2462000960	21

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B4 – AC Mains Conducted Emissions

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

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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 558074 D01 DTS Meas Guidance v03r02	2014	Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247

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END OF REPORT

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

Prepared For: gogo Business Aviation

Name: GVPU

Report: TR 314305 A

Model: P24486

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