

Testing Tomorrow's Technology

Application

For

Part 2, Subpart J, Paragraph 2.907 Equipment Authorization of Certification for an Intentional Radiator per Part 15, Subpart C, paragraphs 15.207, 15.209 and 15.247

And

**Innovation, Science, and Economic Development Canada
Certification Per**

IC RSS-Gen General Requirements for Radio Apparatus

And

**RSS-247 Digital Transmission Systems (DTSs), Frequency Hopping Systems
(FHSs) and License-Exempt Local Area Network (LE-LAN) Devices**

For the

Wink Labs, Inc.

**Model: Wink Hub 2
(WIFI Radio Evaluation)**

**FCC ID: 2ACAJ-WHUB 2
IC: 11938A-WHUB2**

**UST Project: 16-0218
Issue Date: September 8, 2016**

Total Pages in this Report: 100

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Testing Tomorrow's Technology

I certify that I am authorized to sign for the Test Agency and that all of the statements in this report and in the Exhibits attached hereto are true and correct to the best of my knowledge and belief:

US TECH (Agent Responsible For Test):

By: Alan Ghasiani

Name: Alan Ghasiani

Title: Compliance Engineer – President

Date September 8, 2016



NVLAP LAB CODE 200162-0

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MEASUREMENT TECHNICAL REPORT

COMPANY NAME: Wink Labs, Inc.
MODEL: Wink Hub 2
FCC ID: 2ACAJ-WHUB2
IC: 11938A-WHUB2
DATE: September 8, 2016

This report concerns (check one): Original grant Class II change

Equipment type: 2.4 GHz Transmitter Module

Deferred grant requested per 47 CFR 0.457(d)(1)(ii)? yes No

If yes, defer until: N/A
date

agrees to notify the Commission by N/A
date

of the intended date of announcement of the product so that the grant can be issued on that date.

Report prepared by:

US Tech
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Alpharetta, GA 30004

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1 General Information

1.1 Purpose of this Report

This report is prepared as a means of conveying test results and information concerning the suitability of this exact product for public distribution according to the IC RSS 247 and FCC Rules and Regulations Part 15, Section 247.

1.2 Characterization of Test Sample

The sample used for testing was received by US Tech on August 26, 2016 in good operating condition.

1.3 Product Description

The Equipment under Test (EUT) is the Wink Labs, Inc. home automation hub, model Wink Hub 2. The Wink Hub 2 has five transmitters, including: three 2.4 GHZ transmitters (Wifi (2.4/5GHz), Bluetooth, and Zigbee), one 431 MHz transmitter (Lutron), and one 915 MHz transmitter (Zwave). The circuit board uses four on-board transmitter antennas. The Bluetooth and Wifi radios share one antenna and the other transmitters each have their own antennas.

This report will cover in detail the test results for the WiFi transmitter which includes 802.11b, 802.11g, and 802.11n. The test results for the other transmitters will be covered in separate reports.

EUT parameters tested:

802.11b: 11Mbps. DSSS. CCK & QPSK modulation

802.11g/n: 54 Mbps. OFDM with QAM64 modulation

All modes used 20 MHz modulation bandwidth

Measured Peak power: 802.11b= 16.6 dBm

802.11g= 12.6 dBm

802.11n= 11.7 dBm

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1.4 Configuration of Tested System

The Test Sample was tested per *ANSI C63.4:2014, Methods of Measurement of Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz (2014)* and *ANSI C63.10: 2013 American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices* and per FCC KDB Publication number 558074 v03r05 for Digital Transmission Systems Operating Under section 15.247.

A list of EUT and Peripherals is found in Table 1 below. A block diagram of the tested system is shown in Figure 1. Test configuration photographs are provided in separate Appendices.

1.5 Test Facility

Testing was performed at US Tech's measurement facility at 3505 Francis Circle, Alpharetta, GA 30004. This site has been fully described and registered with the FCC. Its designation number is 186022. Additionally this site has also been fully described and submitted to Industry Canada (IC), and has been approved under file number 9900A-1.

1.6 Related Submittal(s)/Grant(s)

The EUT will be used to wirelessly send/receive data. The transceiver presented in this report will be used with other like transceivers.

The EUT is subject to the following FCC Equipment Authorizations:

- a) Certification of the transmitter, see test data presented herein.
- b) Verification as a class B digital device.

This device is a final product and is not a subcomponent; other radio testing was done and is compiled in other reports in this submittal.

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Table 1. EUT and Peripherals

PERIPHERAL MANUFACTURER	MODEL NUMBER	SERIAL NUMBER	FCC/IC ID:	CABLES P/D
Gateway Wink Labs, Inc. (EUT)	WINK HUB 2	Engineering Sample	Pending: FCC ID: 2ACAJ-WHUB2 IC:11938A-WHUB2	1.5 m U P 1.0 m U D
AC/DC Power Supply adapter Wink Labs, Inc.	S012BEU120 0100	None	None	1.5 m U P
Router	Various	Various	Various	1.5 m U P
Antenna See antenna details	--	--	--	--

S= Shielded, U= Unshielded, P= Power, D= Data

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2 Tests and Measurements

2.1 Test Equipment

The table below lists test equipment used to evaluate this product. Model numbers, serial numbers and their calibration status are included herein.

Table 2. Test Instruments

TEST INSTRUMENT	MODEL NUMBER	MANUFACTURER	SERIAL NUMBER	DATE OF LAST CALIBRATION
SPECTRUM ANALYZER	E4407B	AGILENT	US41442935	2/11/2016
SPECTRUM ANALYZER	8593E	HEWLETT-PACKARD	3325A00807	8/5/2016
RF PREAMP 100 kHz to 1.3 GHz	8447D	HEWLETT-PACKARD	1937A02980	12/2/2015
PREAMP 1.0 GHz to 26.0 GHz	8449B	HEWLETT-PACKARD	3008A00480	12/1/2015
LOOP ANTENNA	SAS-200/562	A. H. Systems	142	9/28/2016
BICONICAL ANTENNA	3110B	EMCO	9307-1431	8/25/2015 2 yr cycle
BICONICAL ANTENNA	3110B	EMCO	9306-1708	11/24/2014 2 yr cycle
LOG PERIODIC ANTENNA	3146	EMCO	9110-3236	11/19/2014 2 yr cycle
LOG PERIODIC ANTENNA	3146	EMCO	9305-3600	7/1/2014 2 yr cycle Ext. 90 days
HORN ANTENNA	3115	EMCO	9107-3723	7/8/2014 2 yr cycle Ext. 90 days
HORN ANTENNA	3116	EMCO	9505-2255	1/27/2015 2 yr cycle
CALCULATION PROGRAM	N/A	N/A	Ver. 6.0	N/A

Note: The calibration interval of the above test instruments are 12 months unless stated otherwise and all calibrations are traceable to NIST/USA.

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2.2 Modifications to EUT Hardware

No modifications were made by US Tech to bring the EUT into compliance with FCC Part 15.247 or IC RSS-247 requirements.

2.3 Number of Measurements for Intentional Radiators (15.31(m))

Measurements of intentional radiators or receivers shall be performed and reported for each band in which the device can be operated with the device operating at the number of frequencies in each band specified in Table 3 as follows:

Table 3. Number of Test Frequencies for Intentional Radiators

Frequency Range over which the device operates	Number of Frequencies	Location in the Range of operation
1 MHz or less	1	Middle
1 to 10 MHz	2	1 near the top 1 near the bottom
Greater than 10 MHz	3	1 near top 1 near middle 1 near bottom

Because the EUT operates over 2.4 GHz to 2.4835 GHz, 3 test frequencies were used.

2.4 Frequency Range of Radiated Measurements (Part 15.33)

2.4.1 Intentional Radiator

The spectrum shall be investigated for the intentional radiator from the lowest RF signal generated in the EUT, without going below 9 kHz to the 10th harmonic of the highest fundamental frequency generated or 40 GHz, whichever is the lowest.

2.4.2 Unintentional Radiator

For the digital device, an unintentional radiator, the frequency range shall be 30 MHz to 1000 MHz, or to the range specified in 2.4.1 above, whichever is the higher range of investigation.

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2.5 Measurement Detector Function and Bandwidth (CFR 15.35)

The radiated and conducted emissions limits shown herein are based on the following:

2.5.1 Detector Function and Associated Bandwidth

On frequencies below 1000 MHz, the limits herein are based upon measurement equipment employing a CISPR Quasi-peak detector function and related measurement bandwidths (i.e. 9 kHz from 150 kHz to 30 MHz and 120 kHz from 30 MHz to 1000 MHz). Alternatively, measurements may be made with equipment employing a peak detector function as long as the same bandwidths specified for the Quasi-peak device are used.

2.5.2 Corresponding Peak and Average Requirements

Above 1000 MHz, radiated limits are based on measuring instrumentation employing an average detector function. When average radiated emissions are specified there is also a corresponding Peak requirement, as measured using a peak detector, of 20 dB greater than the average limit. For all measurements above 1000 MHz the Resolution Bandwidth shall be at least 1 MHz.

2.5.3 Pulsed Transmitter Averaging

When the radiated emissions limit is expressed as an average value, and the transmitter is pulsed, the measured field strength shall be determined by applying a Duty Cycle Correction Factor based upon dividing the total ON time during the first 100 ms period by 100 ms (or by the period if less than 100 ms). The duty cycle may also be expressed logarithmically in dB.

NOTE: If the transmitter was programmed to transmit at >98% duty cycle, then, wherever applicable (where the detection mode was AVG) the duty cycle factor calculated will be applied.

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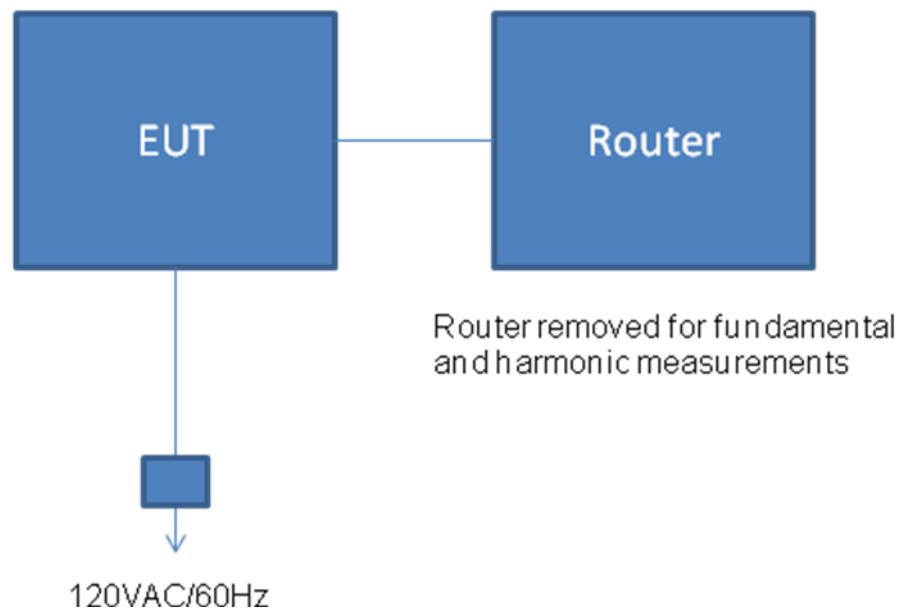


Figure 1. Block Diagram of Test Configuration

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2.6 Transmitter Duty Cycle (CFR 35 (c))

The EUT was placed in normal operation mode and the plots below were recorded to calculate the Duty Cycle factor.

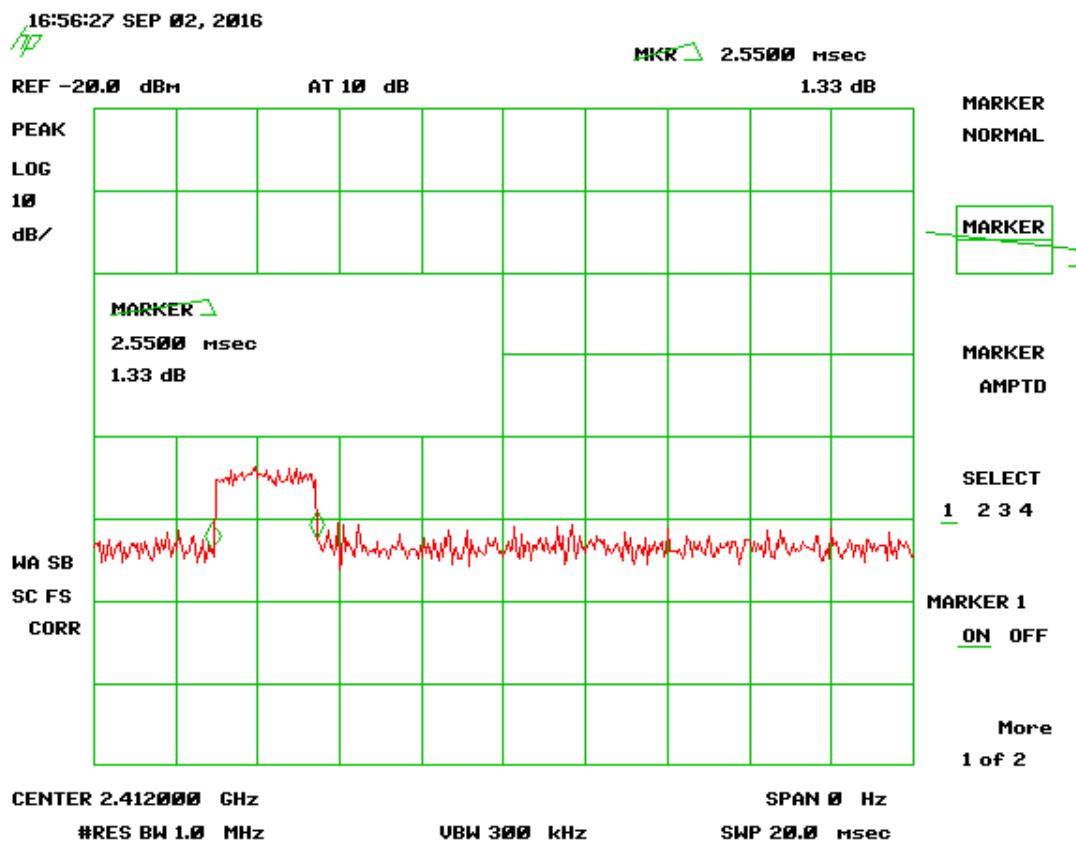


Figure 2. Pulse Width

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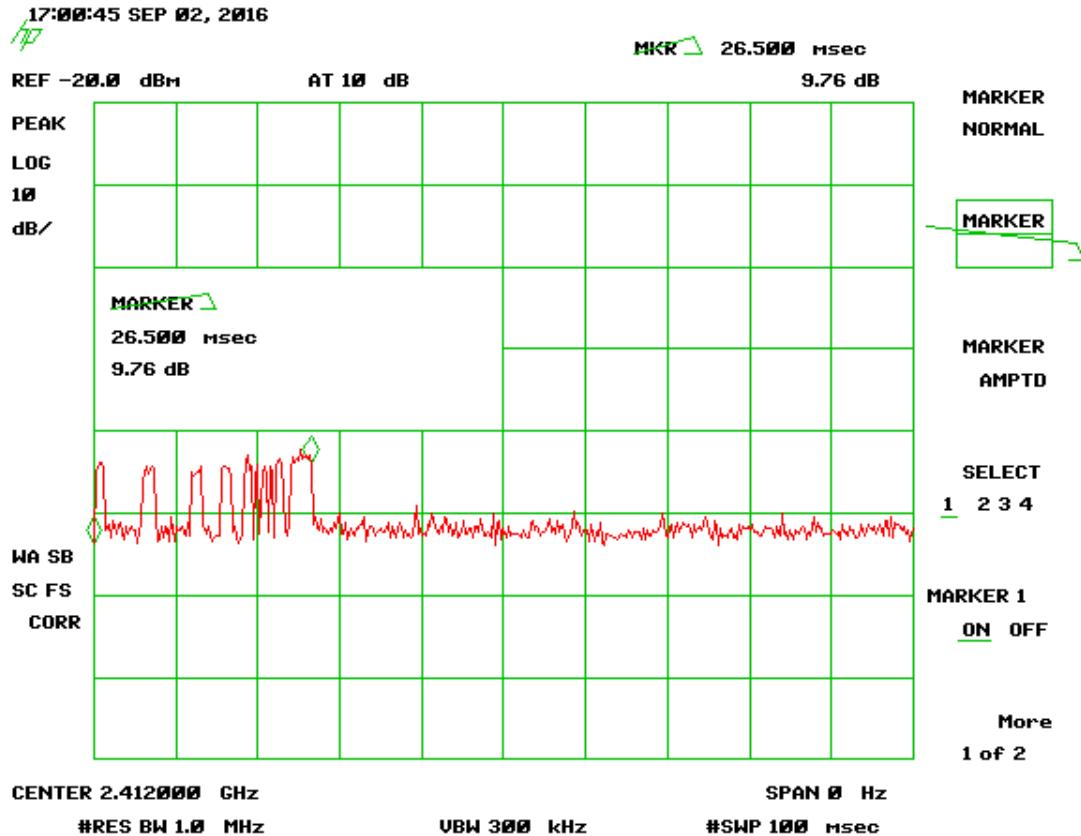


Figure 3. Pulse Train

$$\text{Total Time On} = 2.55\text{mS} \times 8 = 20.4\text{mS}$$

$$\begin{aligned} (20.4\text{mS Total Time On}) / (100\text{mS FCC Standard}) &= 0.204 \text{ Numeric Duty Cycle} \\ \text{Duty Cycle} &= 20 \log (.204) = -13.8 \text{ dB} \end{aligned}$$

NOTE: The transmitter was programmed to transmit at >98% duty cycle, therefore wherever applicable (where the detection mode was AVG) the duty cycle factor calculated above will be applied.

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2.7 EUT Antenna Requirements (CFR 15.203)

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. Only the antenna(s) listed in Table 4 will be used with this module.

Table 4. Allowed Antenna(s)

REPORT REFERENCE	MANUFACTURER	TYPE OF ANTENNA	MODEL	GAIN dB _i	TYPE OF CONNECTOR
Antenna	Johanson Technology	Mini Chip Antenna	2450AD46A 5400	-2.5	Soldered (SMT)

2.8 Maximum Peak Conducted Output Power (CFR 15.247 (b) (3))

For the Wink Hub 2, the transmitter was programmed to operate at a maximum output power across the bandwidth.

Peak power within the band 2400 MHz to 2483.5 MHz was measured per FCC KDB Publication 558074 v03r05 as an Antenna Conducted test with a spectrum analyzer by connecting the spectrum analyzer directly, via a short RF cable, and attenuators to the antenna output terminals on the EUT. The spectrum analyzer was set for an impedance of 50Ω with the RBW set greater than the 6 dB bandwidth of the EUT, and the VBW \geq RBW. If the EUT bandwidth exceeds the RBW of the receiver, the procedures in KDB 558074 v03r05 section 9.1.2 were followed. Peak antenna conducted output power is tabulated in the table below.

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Table 5. Peak Antenna Conducted Output Power per Part 15.247 (b) (3)

Frequency of Fundamental (MHz)	Raw Test Data dBm	Converted Data (mW)	FCC Limit (mW Maximum)
802.11b			
2412.00	16.41	43.75	1000
2442.00	16.60	45.70	1000
2462.00	16.49	44.56	1000
802.11g			
2412.00	12.29	16.94	1000
2442.00	12.58	18.11	1000
2462.00	12.36	17.21	1000
802.11n			
2412.00	11.42	13.86	1000
2442.00	11.55	14.28	1000
2462.00	11.68	14.72	1000

Test Date: Sept 2, 2016

Tested By

Signature: 

Name: Ashton Picas

US Tech Test Report:
FCC ID:
IC:
Test Report Number:
Issue Date:
Customer:
Model:

FCC Part 15 Certification/ RSS 210
2ACAJ-WHUB 2
11938A-WHUB2
16-0218
September 8, 2016
Wink Labs, Inc.
Wink Hub 2

 **Agilent** 16:54:42 Sep 2, 2016

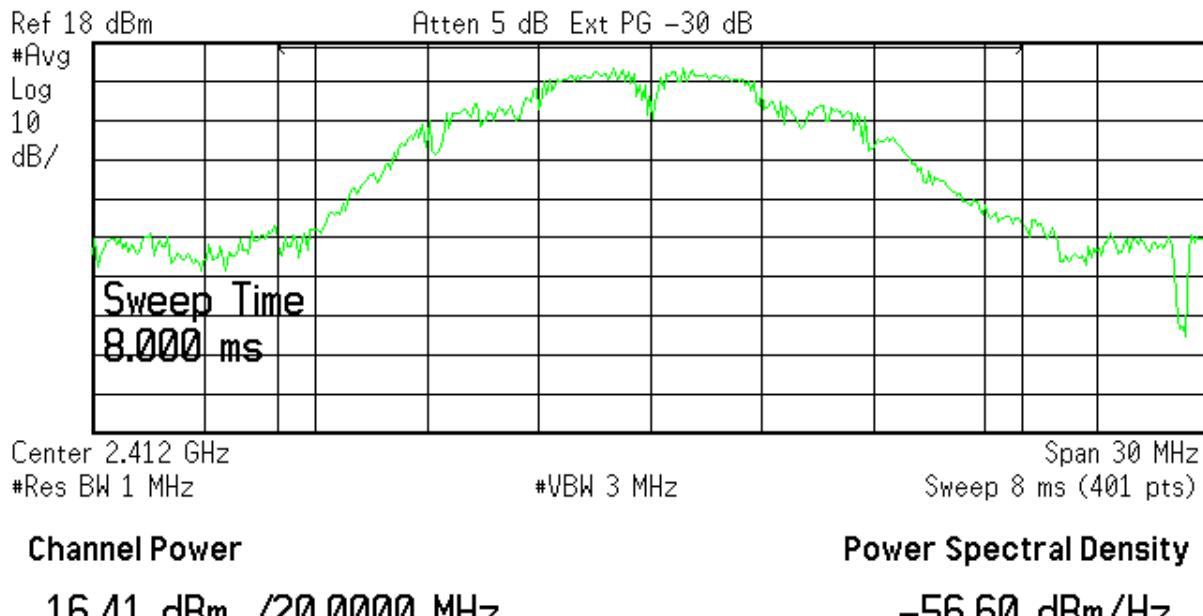
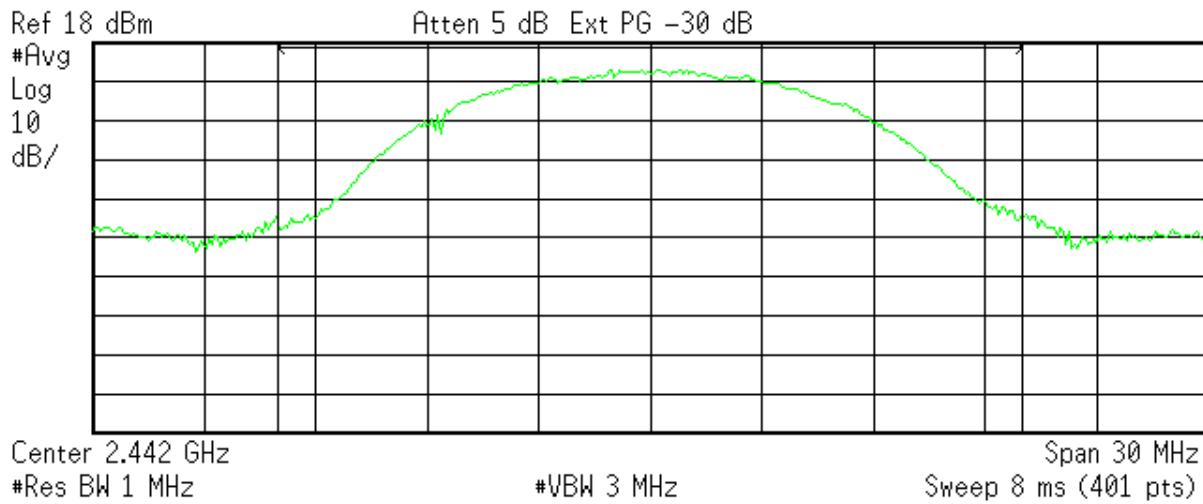


Figure 4. Peak Antenna Conducted Output Power, 802.11b Low Channel

US Tech Test Report:
FCC ID:
IC:
Test Report Number:
Issue Date:
Customer:
Model:

FCC Part 15 Certification/ RSS 210
2ACAJ-WHUB 2
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September 8, 2016
Wink Labs, Inc.
Wink Hub 2

 **Agilent** 17:01:44 Sep 2, 2016



Channel Power

16.60 dBm /20.0000 MHz

Power Spectral Density

-56.41 dBm/Hz

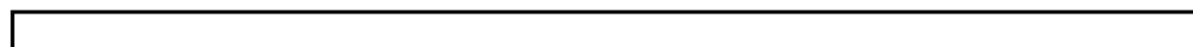
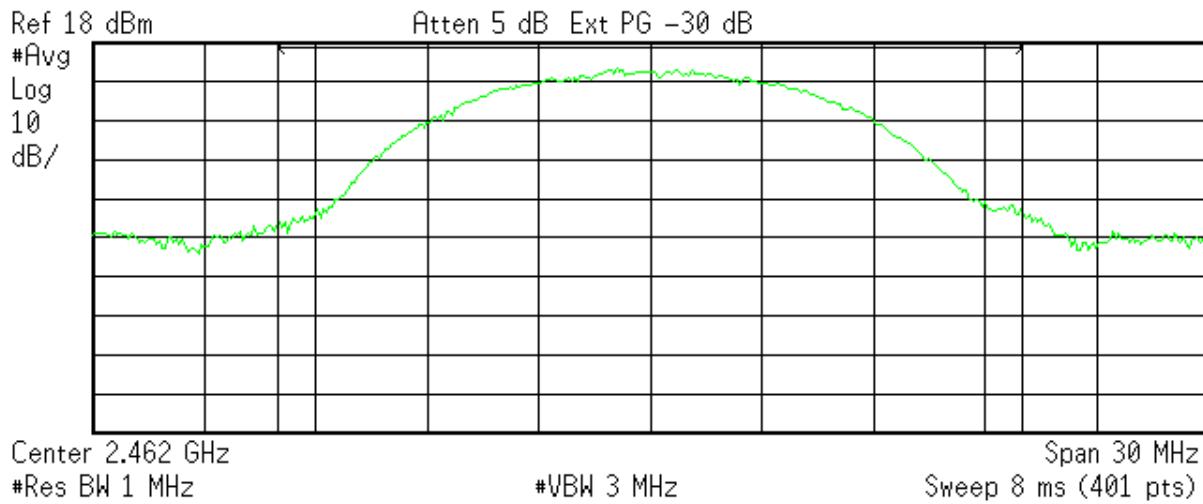


Figure 5. Peak Antenna Conducted Output Power, 802.11b Mid Channel

US Tech Test Report:
FCC ID:
IC:
Test Report Number:
Issue Date:
Customer:
Model:

FCC Part 15 Certification/ RSS 210
2ACAJ-WHUB 2
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16-0218
September 8, 2016
Wink Labs, Inc.
Wink Hub 2

 **Agilent** 17:05:13 Sep 2, 2016



Channel Power

16.49 dBm /20.0000 MHz

Power Spectral Density

-56.52 dBm/Hz

Figure 6. Peak Antenna Conducted Output Power, 802.11b High Channel

US Tech Test Report:
FCC ID:
IC:
Test Report Number:
Issue Date:
Customer:
Model:

FCC Part 15 Certification/ RSS 210
2ACAJ-WHUB 2
11938A-WHUB2
16-0218
September 8, 2016
Wink Labs, Inc.
Wink Hub 2

 **Agilent** 16:58:55 Sep 2, 2016

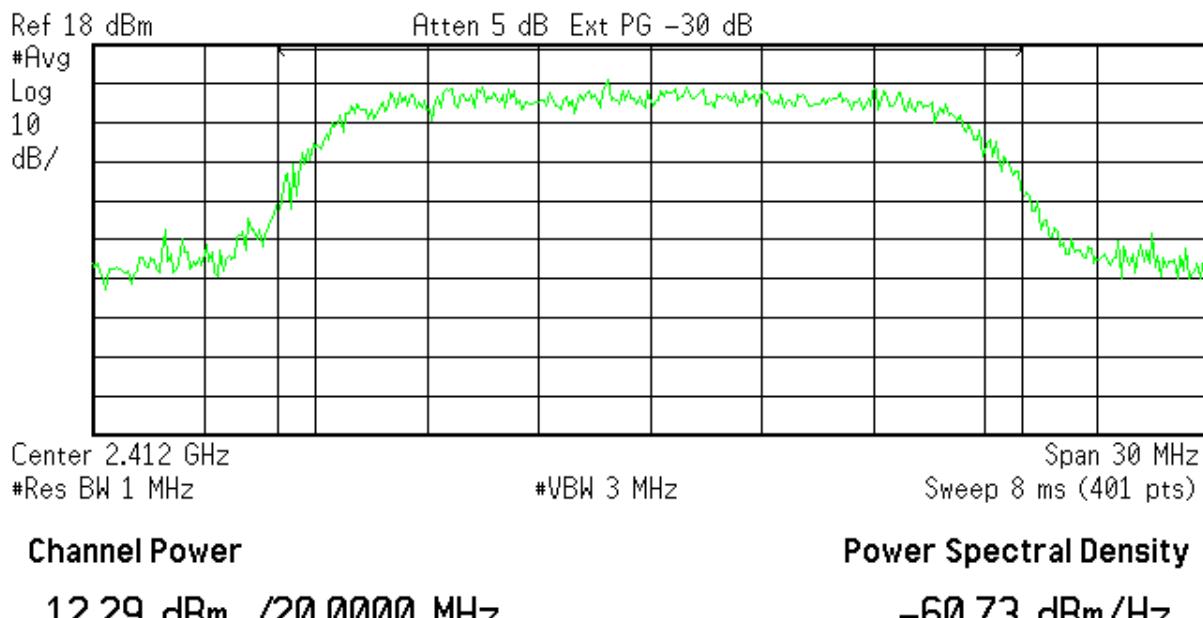
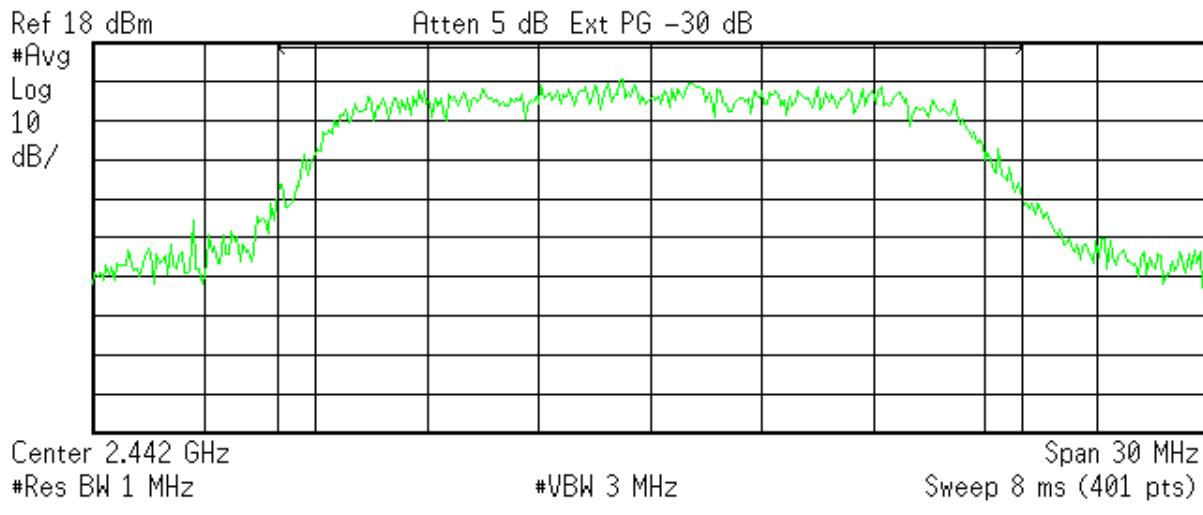


Figure 7. Peak Antenna Conducted Output Power, 802.11g Low Channel

US Tech Test Report:
FCC ID:
IC:
Test Report Number:
Issue Date:
Customer:
Model:

FCC Part 15 Certification/ RSS 210
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 **Agilent** 17:02:29 Sep 2, 2016



Channel Power

12.58 dBm /20.0000 MHz

Power Spectral Density

-60.43 dBm/Hz

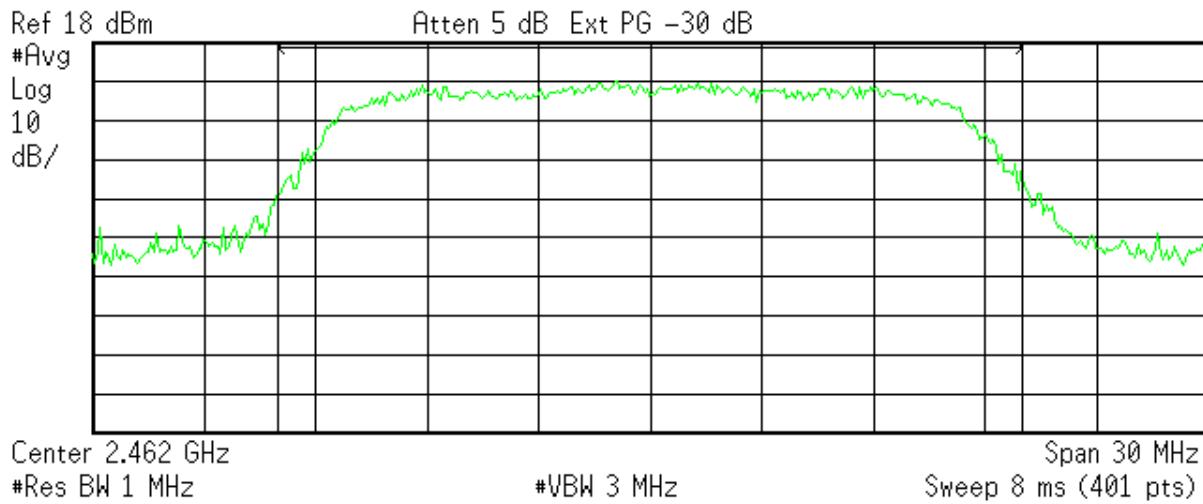


Figure 8. Peak Antenna Conducted Output Power, 802.11g Mid Channel

US Tech Test Report:
FCC ID:
IC:
Test Report Number:
Issue Date:
Customer:
Model:

FCC Part 15 Certification/ RSS 210
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 **Agilent** 17:06:19 Sep 2, 2016

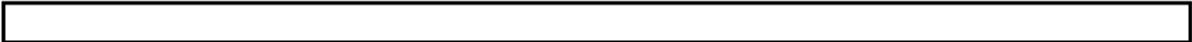


Channel Power

12.36 dBm /20.0000 MHz

Power Spectral Density

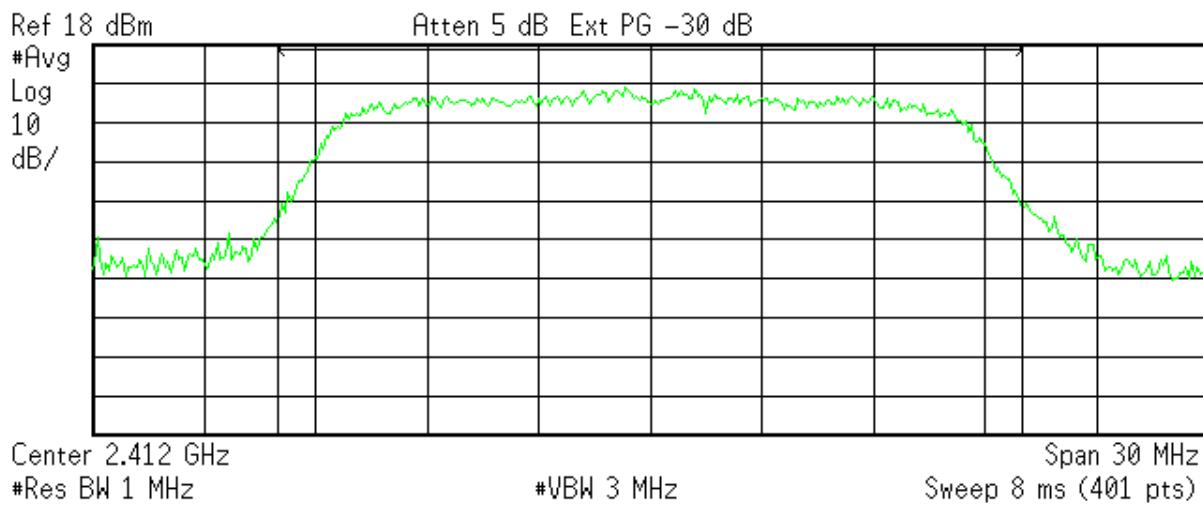
-60.65 dBm/Hz


Figure 9. Peak Antenna Conducted Output Power, 802.11g High Channel

US Tech Test Report:
FCC ID:
IC:
Test Report Number:
Issue Date:
Customer:
Model:

FCC Part 15 Certification/ RSS 210
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September 8, 2016
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 **Agilent** 17:00:34 Sep 2, 2016



Channel Power

11.42 dBm /20.0000 MHz

Power Spectral Density

-61.59 dBm/Hz

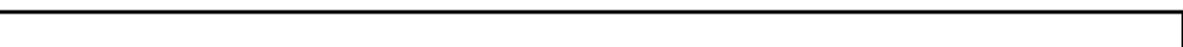


Figure 10. Peak Antenna Conducted Output Power, 802.11n Low Channel

US Tech Test Report:
FCC ID:
IC:
Test Report Number:
Issue Date:
Customer:
Model:

FCC Part 15 Certification/ RSS 210
2ACAJ-WHUB 2
11938A-WHUB2
16-0218
September 8, 2016
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Wink Hub 2

 **Agilent** 17:03:38 Sep 2, 2016

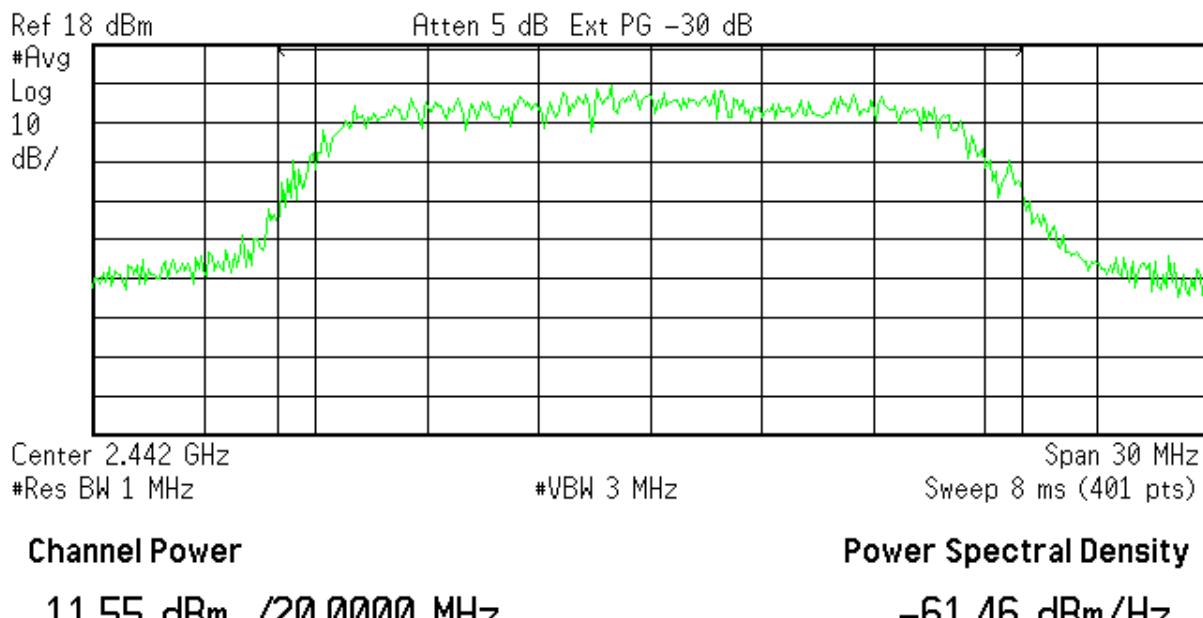
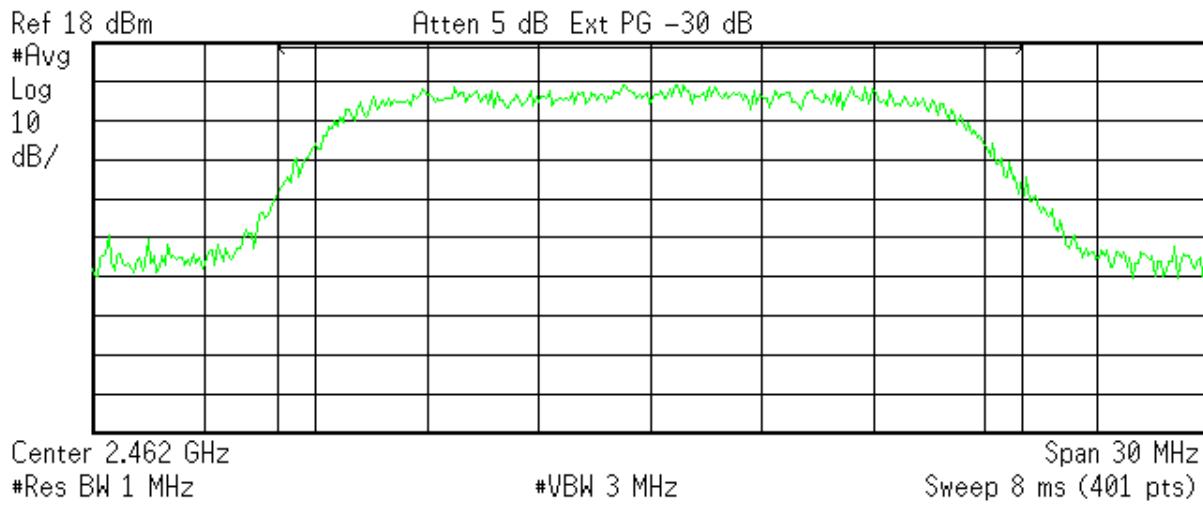


Figure 11. Peak Antenna Conducted Output Power, 802.11n Mid Channel

US Tech Test Report:
FCC ID:
IC:
Test Report Number:
Issue Date:
Customer:
Model:

FCC Part 15 Certification/ RSS 210
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16-0218
September 8, 2016
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 **Agilent** 17:07:01 Sep 2, 2016



Channel Power

11.68 dBm /20.0000 MHz

Power Spectral Density

-61.33 dBm/Hz

Figure 12. Peak Antenna Conducted Output Power, 802.11n High Channel

US Tech Test Report:
FCC ID:
IC:
Test Report Number:
Issue Date:
Customer:
Model:

FCC Part 15 Certification/ RSS 210
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16-0218
September 8, 2016
Wink Labs, Inc.
Wink Hub 2

2.9 Power Spectral Density (CFR 15.247(e)) (IC RSS 210 A8.5)

The transmitter was placed into a continuous mode of operation at all applicable frequencies. The measurements were performed per the procedures of FCC KDB Procedure 558074 v03r05. The RBW was set to 3 kHz and the Video Bandwidth was set to \geq RBW. The trace capture time was set to (Span/3 kHz).

In accordance with 15.247 (e), the power spectral density shall be no greater than +8 dBm per any 3 kHz band.

The following results show that all are less than +8 dBm per 3 kHz band.

Table 6. Power Spectral Density for Low, Mid and High Bands

Frequency (MHz)	Test Data (dBm/3 kHz)	FCC Limit (dBm/3 kHz)
802.11b		
Low-2412	-5.75	+8.0
Mid-2442	-4.30	+8.0
High-2460	-5.54	+8.0
802.11g		
Low-2412	-11.74	+8.0
Mid-2442	-11.89	+8.0
High-2460	-11.87	+8.0
802.11n		
Low-2412	-12.98	+8.0
Mid-2442	-12.55	+8.0
High-2460	-12.54	+8.0

Test Date: Sept 2, 2016

Tested By

Signature: 

Name: Ashton Picas

US Tech Test Report:
FCC ID:
IC:
Test Report Number:
Issue Date:
Customer:
Model:

FCC Part 15 Certification/ RSS 210
2ACAJ-WHUB 2
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16-0218
September 8, 2016
Wink Labs, Inc.
Wink Hub 2

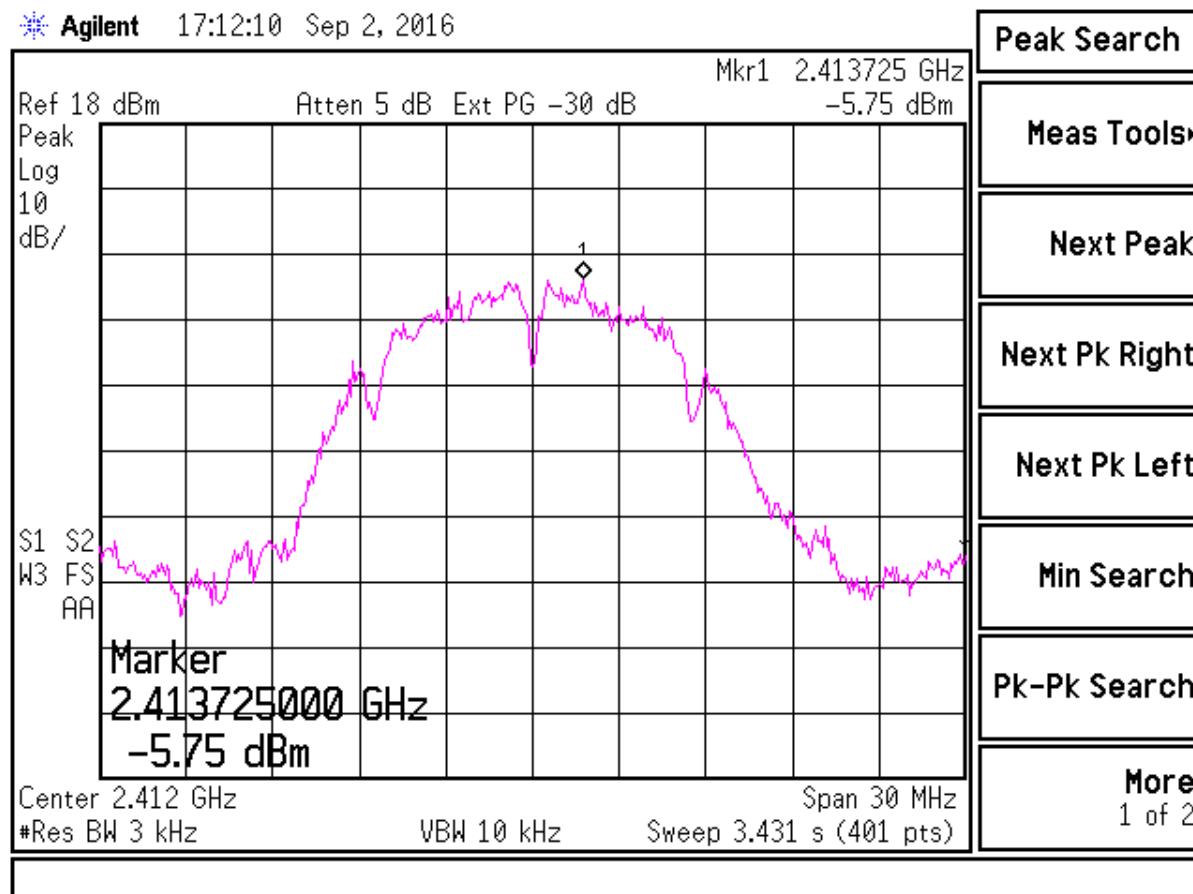


Figure 13. Peak Power Spectral Density - 802.11b - Low Channel

US Tech Test Report:
FCC ID:
IC:
Test Report Number:
Issue Date:
Customer:
Model:

FCC Part 15 Certification/ RSS 210
2ACAJ-WHUB 2
11938A-WHUB2
16-0218
September 8, 2016
Wink Labs, Inc.
Wink Hub 2

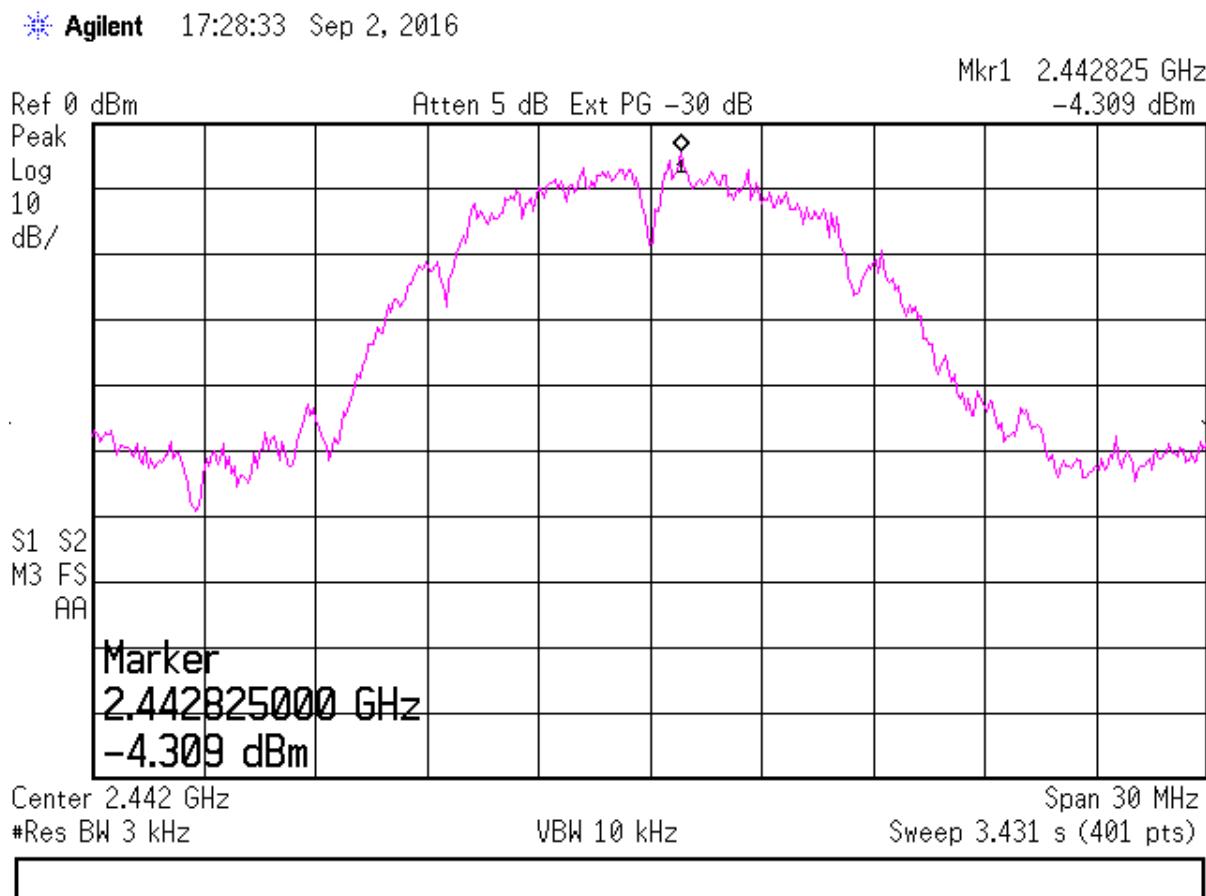


Figure 14. Peak Power Spectral Density - 802.11b - Mid Channel

US Tech Test Report:
FCC ID:
IC:
Test Report Number:
Issue Date:
Customer:
Model:

FCC Part 15 Certification/ RSS 210
2ACAJ-WHUB 2
11938A-WHUB2
16-0218
September 8, 2016
Wink Labs, Inc.
Wink Hub 2

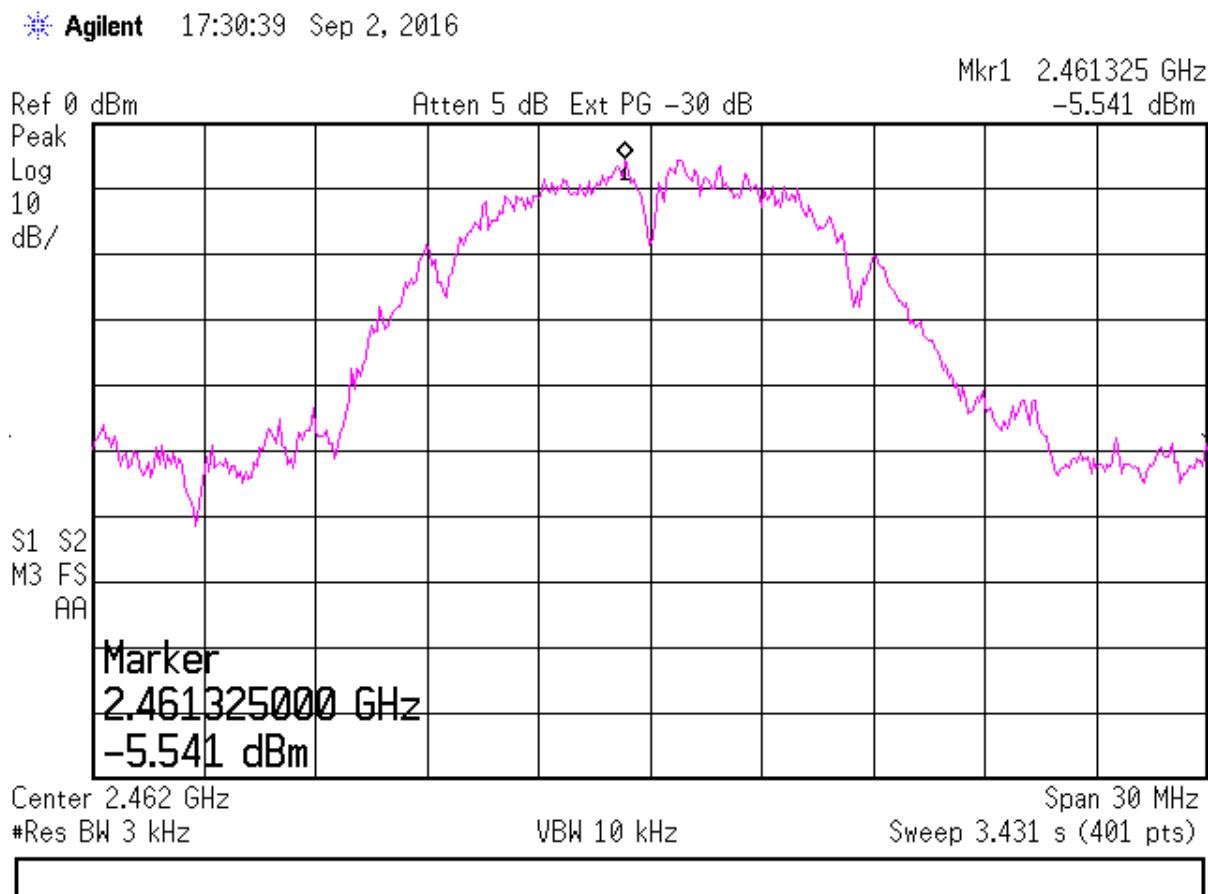


Figure 15. Peak Power Spectral Density - 802.11b - High Channel

US Tech Test Report:
FCC ID:
IC:
Test Report Number:
Issue Date:
Customer:
Model:

FCC Part 15 Certification/ RSS 210
2ACAJ-WHUB 2
11938A-WHUB2
16-0218
September 8, 2016
Wink Labs, Inc.
Wink Hub 2

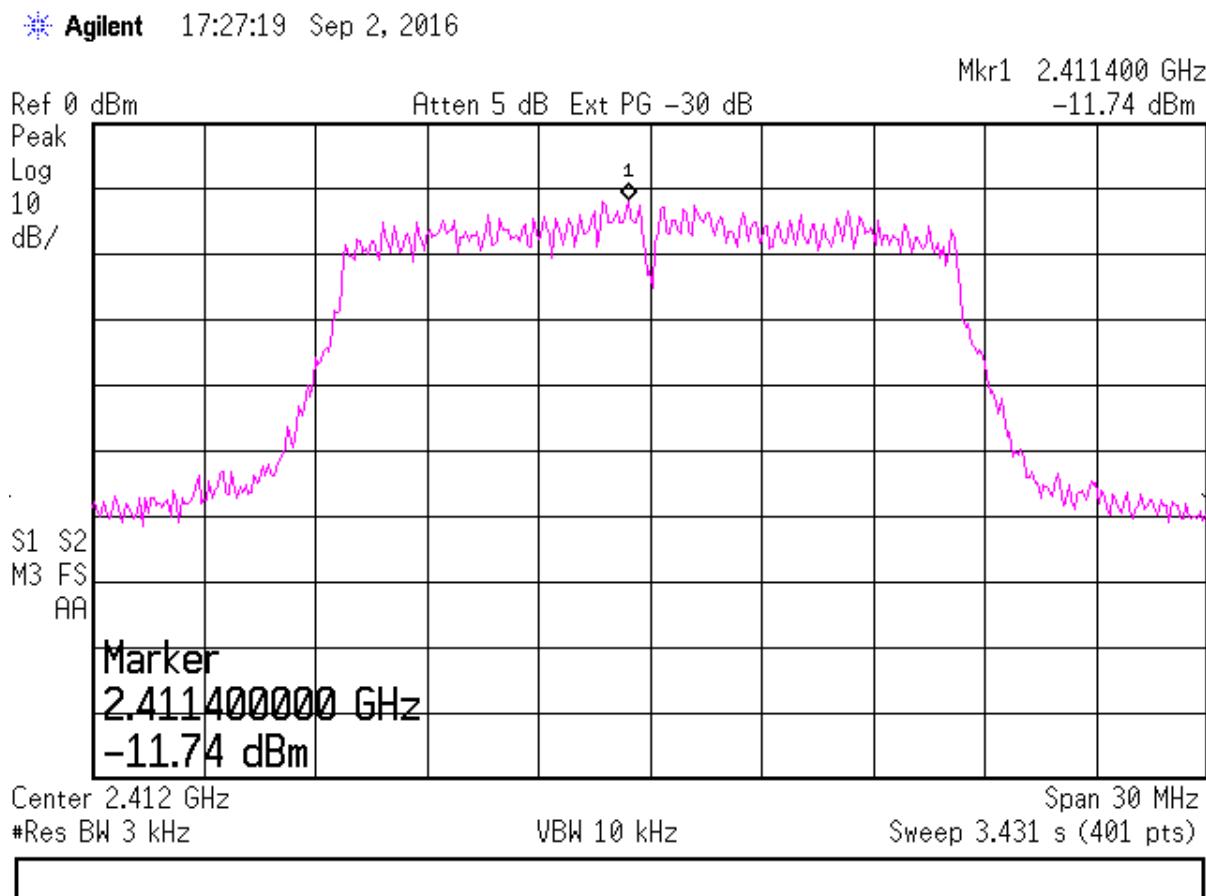


Figure 16. Peak Power Spectral Density - 802.11g - Low Channel

US Tech Test Report:
FCC ID:
IC:
Test Report Number:
Issue Date:
Customer:
Model:

FCC Part 15 Certification/ RSS 210
2ACAJ-WHUB 2
11938A-WHUB2
16-0218
September 8, 2016
Wink Labs, Inc.
Wink Hub 2

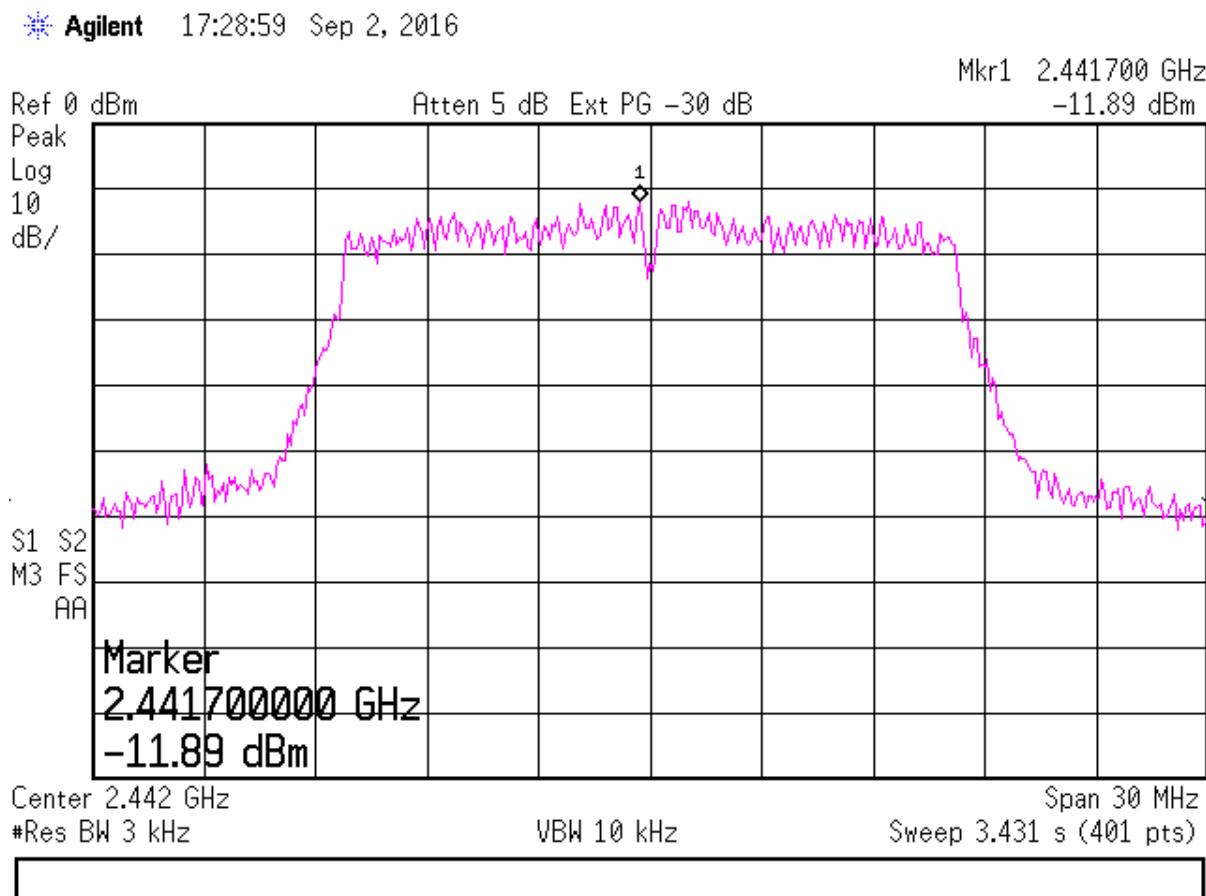


Figure 17. Peak Power Spectral Density - 802.11g - Mid Channel

US Tech Test Report:
FCC ID:
IC:
Test Report Number:
Issue Date:
Customer:
Model:

FCC Part 15 Certification/ RSS 210
2ACAJ-WHUB 2
11938A-WHUB2
16-0218
September 8, 2016
Wink Labs, Inc.
Wink Hub 2

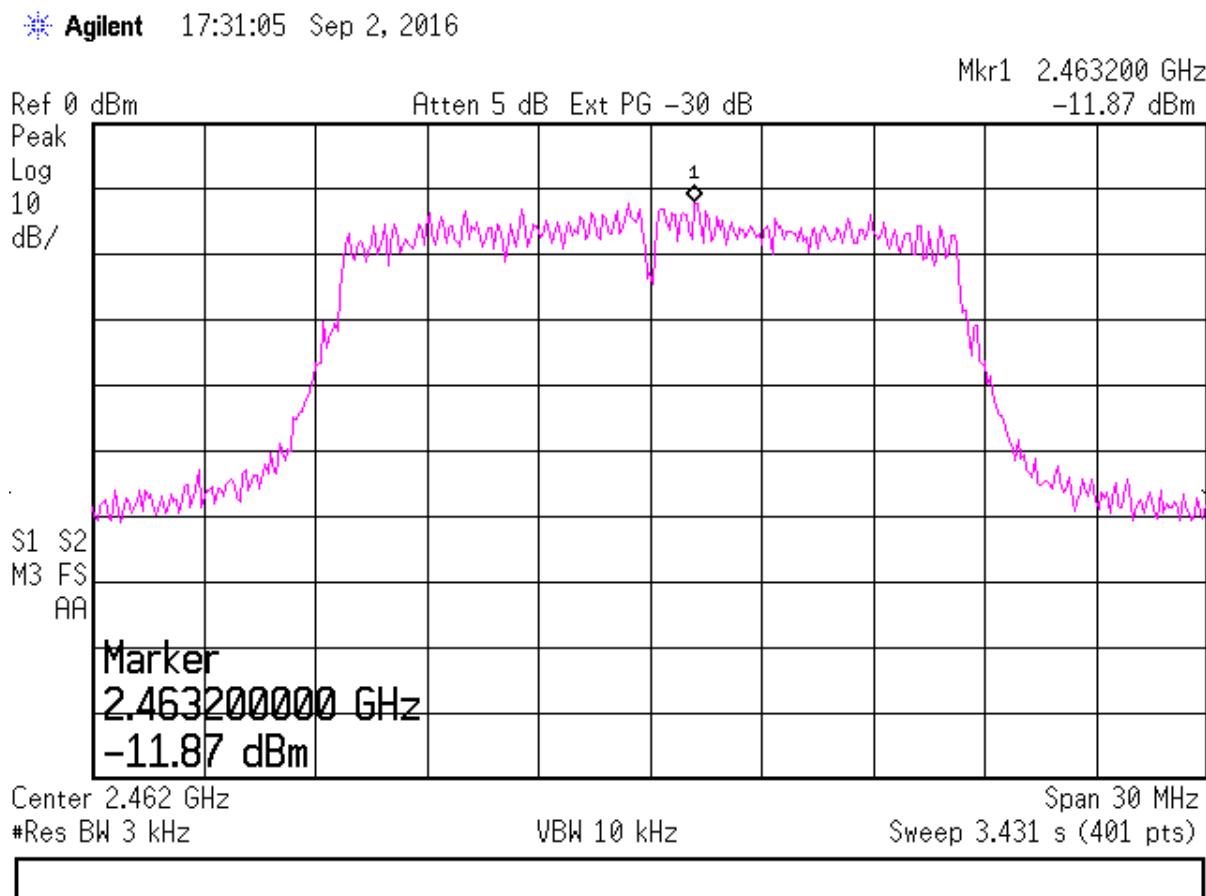


Figure 18. Peak Power Spectral Density - 802.11g - High Channel

US Tech Test Report:
FCC ID:
IC:
Test Report Number:
Issue Date:
Customer:
Model:

FCC Part 15 Certification/ RSS 210
2ACAJ-WHUB 2
11938A-WHUB2
16-0218
September 8, 2016
Wink Labs, Inc.
Wink Hub 2

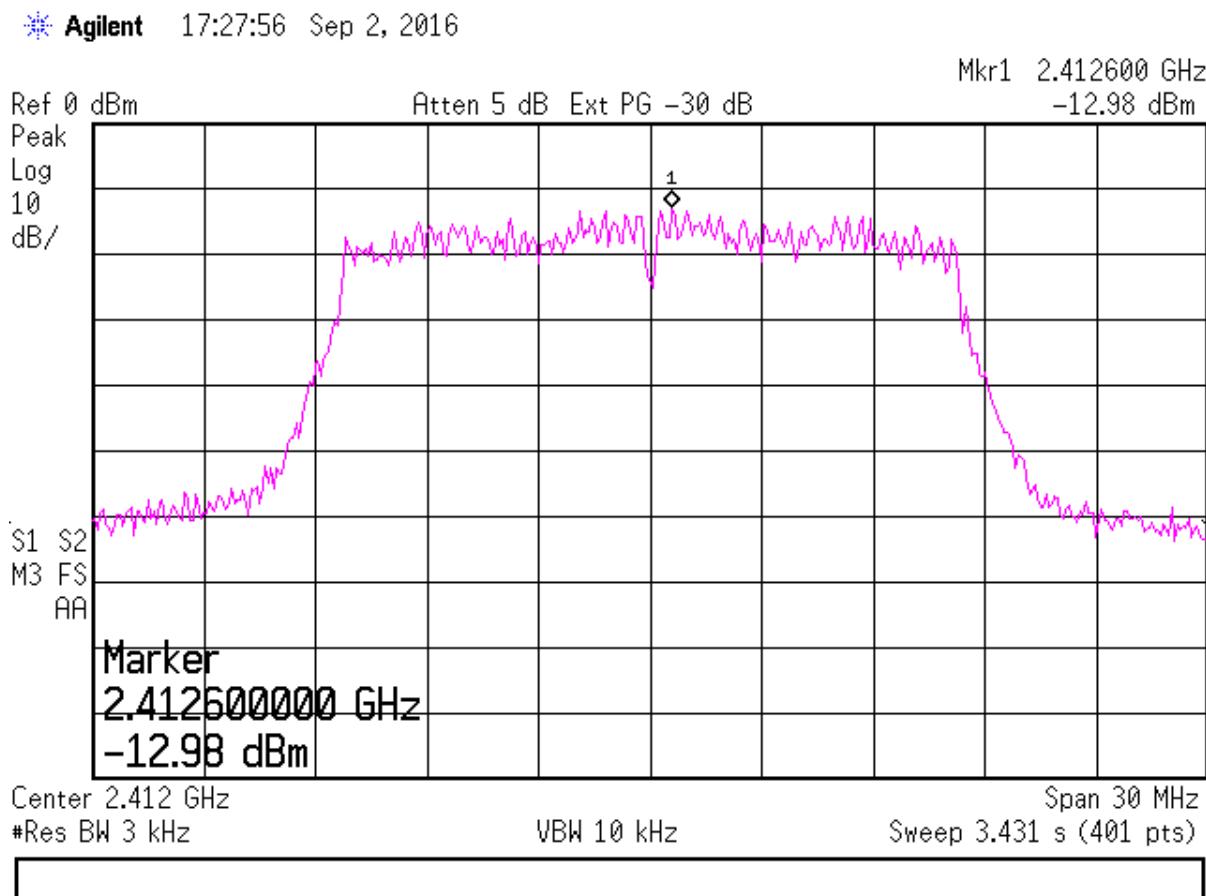


Figure 19. Peak Power Spectral Density - 802.11n - Low Channel

US Tech Test Report:
FCC ID:
IC:
Test Report Number:
Issue Date:
Customer:
Model:

FCC Part 15 Certification/ RSS 210
2ACAJ-WHUB 2
11938A-WHUB2
16-0218
September 8, 2016
Wink Labs, Inc.
Wink Hub 2

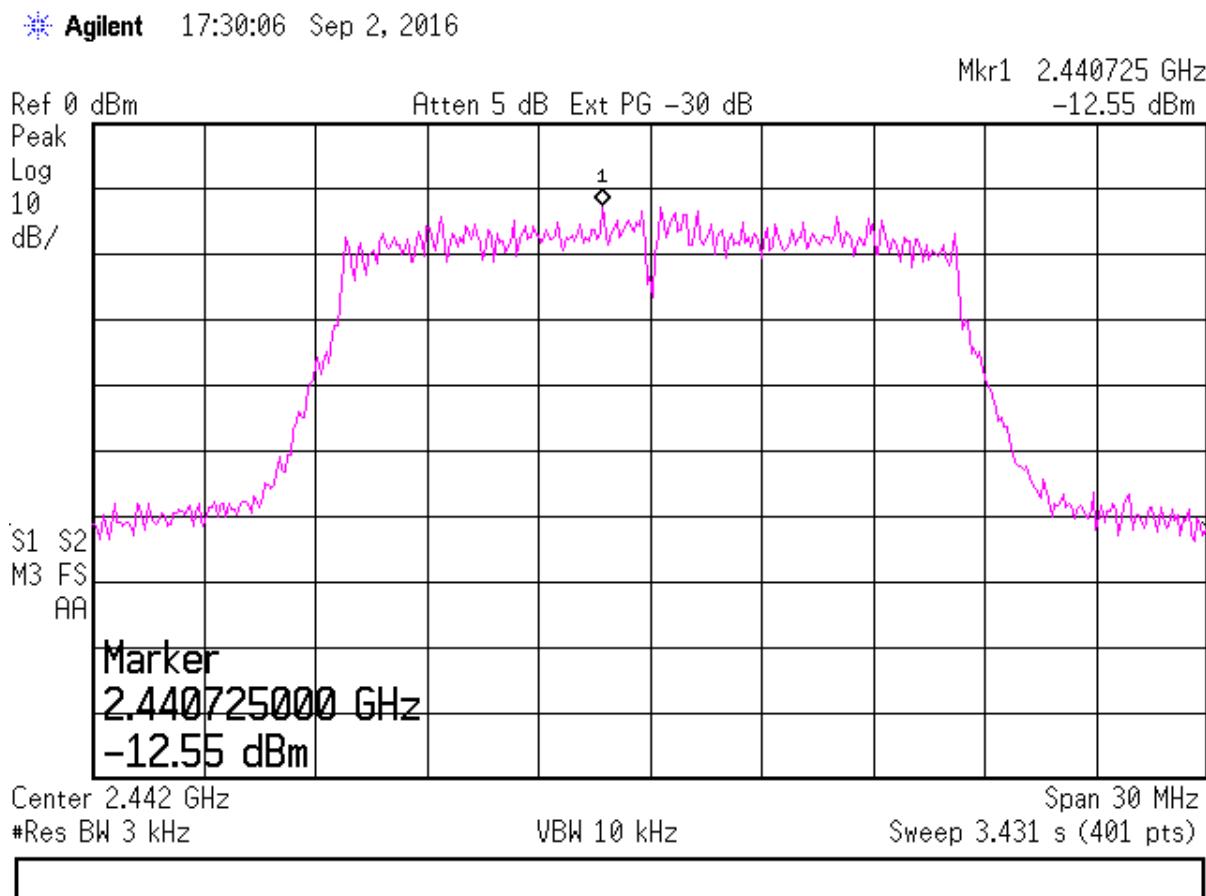


Figure 20. Peak Power Spectral Density - 802.11n - Mid Channel

US Tech Test Report:
FCC ID:
IC:
Test Report Number:
Issue Date:
Customer:
Model:

FCC Part 15 Certification/ RSS 210
2ACAJ-WHUB 2
11938A-WHUB2
16-0218
September 8, 2016
Wink Labs, Inc.
Wink Hub 2

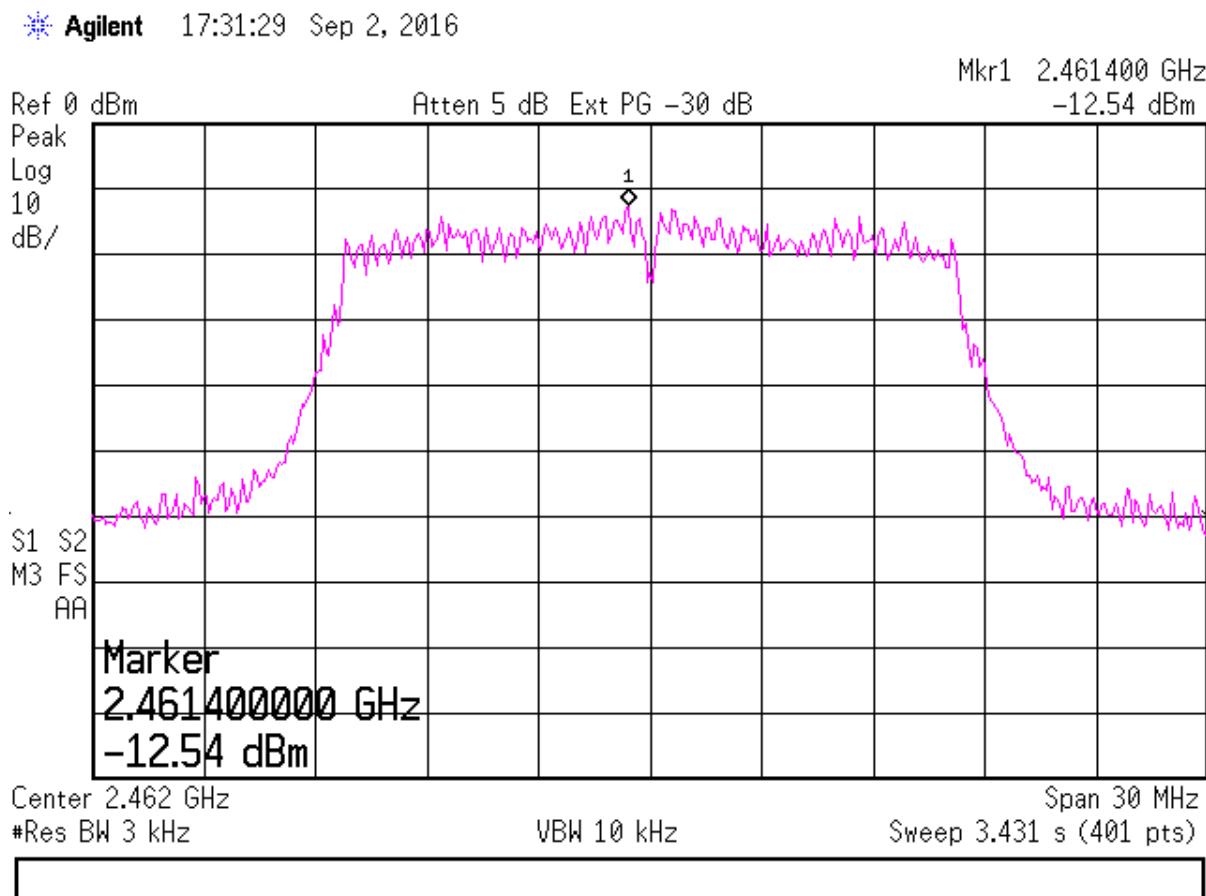


Figure 21. Peak Power Spectral Density - 802.11n - High Channel

US Tech Test Report:	FCC Part 15 Certification/ RSS 210
FCC ID:	2ACAJ-WHUB 2
IC:	11938A-WHUB2
Test Report Number:	16-0218
Issue Date:	September 8, 2016
Customer:	Wink Labs, Inc.
Model:	Wink Hub 2

2.10 Restricted Bands of Operation (Part 15.205)

Only spurious emissions can fall in the frequency bands of CFR 15.205. The field strength of these spurious cannot exceed the limits of 15.209. Radiated harmonics and other Spurious are examined for this requirement see paragraph I in the sections below.

2.11 Intentional Radiator, Power Lines Conducted Emissions (CFR 15.207)

The test data provided in this section is to support the Verification requirement for the digital apparatus. The power line conducted voltage measurements for Receiver and Digital Devices have been carried out in accordance with CFR 15.107 and ANSI C63.4:2014, Paragraph 7, with a spectrum analyzer connected to an LISN and the EUT placed into an idle condition or a continuous mode of receive (non-transmitting). Please refer to the results as shown in the table below.

The power line conducted voltage emission measurements have been carried out in accordance with CFR 15.207, per ANSI C63.4:2014, Paragraph 7, with a spectrum analyzer connected to an LISN and the EUT placed into a continuous mode of transmission.

The transmitter evaluated in this report is considered a co-located radio because it is located less than 20 cm from all other radios on this product. The end product was therefore tested with all radios simultaneously transmitting as this was considered the worst case operation. The power line emissions data is collected and presented below. This data is meant to show that this product has been evaluated as a product with co-located radios. Reports showing the evaluation of each of the other radios in this end product will be submitted separately.

The worst-case results for conducted emissions were determined to be produced when the EUT was operating under continuous transmission. The worst case measurement was 8.3 dB from the applicable limit. All other emissions were at least 13.1 dB from the limit. Those results are given in the table below.

US Tech Test Report:
 FCC ID:
 IC:
 Test Report Number:
 Issue Date:
 Customer:
 Model:

FCC Part 15 Certification/ RSS 210
 2ACAJ-WHUB 2
 11938A-WHUB2
 16-0218
 September 8, 2016
 Wink Labs, Inc.
Wink Hub 2

Table 7. Transmitter Power Line Conducted Emissions Test Data, Part 15.207

CONDUCTED EMISSIONS 150 kHz to 30 MHz						
Tested By: RKM	Specification Requirement: FCC Part 15.207 FCC Part 15.107 Class B		Project No.: 16-0218	Manufacturer: Wink Labs, Inc. Model: Wink Hub 2		
Frequency (MHz)	Test Data (dBuV)	LISN+CL (dB)	Corrected Results (dBuV)	Avg Limits (dBuV)	Margin (dB)	Detector
120 VAC, 60 Hz, Phase Line						
0.2999	46.80	0.35	47.15	60.2*	13.1	QP
0.2999	23.90	0.35	24.25	50.2	26.0	AVG
0.5008	37.37	0.32	37.69	46.0	8.3	PK
3.0603	26.56	0.36	26.92	46.0	19.1	PK
8.6666	27.23	0.51	27.74	50.0	22.3	PK
10.2833	25.80	0.54	26.34	50.0	23.7	PK
22.7000	21.06	0.85	21.91	50.0	28.1	PK
120 VAC, 60 Hz, Neutral Line						
0.3413	42.51	0.24	42.75	59.2*	16.4	QP
0.3413	15.20	0.24	15.44	49.2	33.7	AVG
0.5300	31.82	0.18	32.00	46.0	14.0	QP
1.0000	37.51	0.20	37.71	46.0	8.3	PK
9.7250	28.58	0.40	28.98	50.0	21.0	PK
10.2166	27.63	0.39	28.02	50.0	22.0	PK
27.1666	21.40	0.76	22.16	50.0	27.8	PK

(*)= Quasi-Peak limit used

SAMPLE CALCULATION AT 0.2999 MHz:

Magnitude of Measured Frequency	46.80	dBuV
+ Cable Loss+ LISN Loss	0.35	dB
Corrected Result	47.15	dBuV

Test Date: September 1, 2016

Tested By

Signature:



Name: Robert K. Mills

US Tech Test Report:
FCC ID:
IC:
Test Report Number:
Issue Date:
Customer:
Model:

FCC Part 15 Certification/ RSS 210
2ACAJ-WHUB 2
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September 8, 2016
Wink Labs, Inc.
Wink Hub 2

2.12 Intentional Radiator, Spurious Emissions (Antenna Conducted) (CFR 15.209, 15.247(d)) (IC RSS 210, A2.9 (a))

The EUT was put into a continuous-transmit mode of operation and tested per FCC KDB Publication 558074 v03r05 for conducted out of band emissions emanating from the antenna port over the frequency range of 30 MHz to 25 GHz. A conducted scan was performed on the EUT to identify and record spurious signals that were related to the transmitter. Antenna Conducted Emissions of a significant magnitude that fell within restricted bands were then measured as radiated emissions on the OATS. The conducted emissions graphs are found in the figures following. The limit for antenna conducted power is 1 Watt (30 dBm) per 15.247 (b)(3).

For antenna conducted measurements a short coax with a SMA connector was soldered to the board; also the trace antenna was disconnected. The EUT was set into a continuous transmission mode. The RBW of the measuring instrument was set equal to 100 kHz. The VBW was set to an equal or larger bandwidth, $VBW \geq RBW$. Power option 2 of 15.247 was not applied therefore all spurious emissions must be at least 20 dB from the fundamental level.

For Average Voltage measurements above 1 GHz, the emissions were measured using $RBW = 1$ MHz and $VBW = 10$ Hz. For a pulse-modulated transmitter, the EUT's average emissions are further modified by adding to them the worst-case duty cycle, determined by adding the EUT's total pulse widths (on time) over a 100 ms period and dividing by 100 ms.

The screen shots below show that the spurious emissions are all less than 20dB from the fundamental signal. All plots are considered to have met the 15.247 requirement.

US Tech Test Report:
FCC ID:
IC:
Test Report Number:
Issue Date:
Customer:
Model:

FCC Part 15 Certification/ RSS 210
2ACAJ-WHUB 2
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16-0218
September 8, 2016
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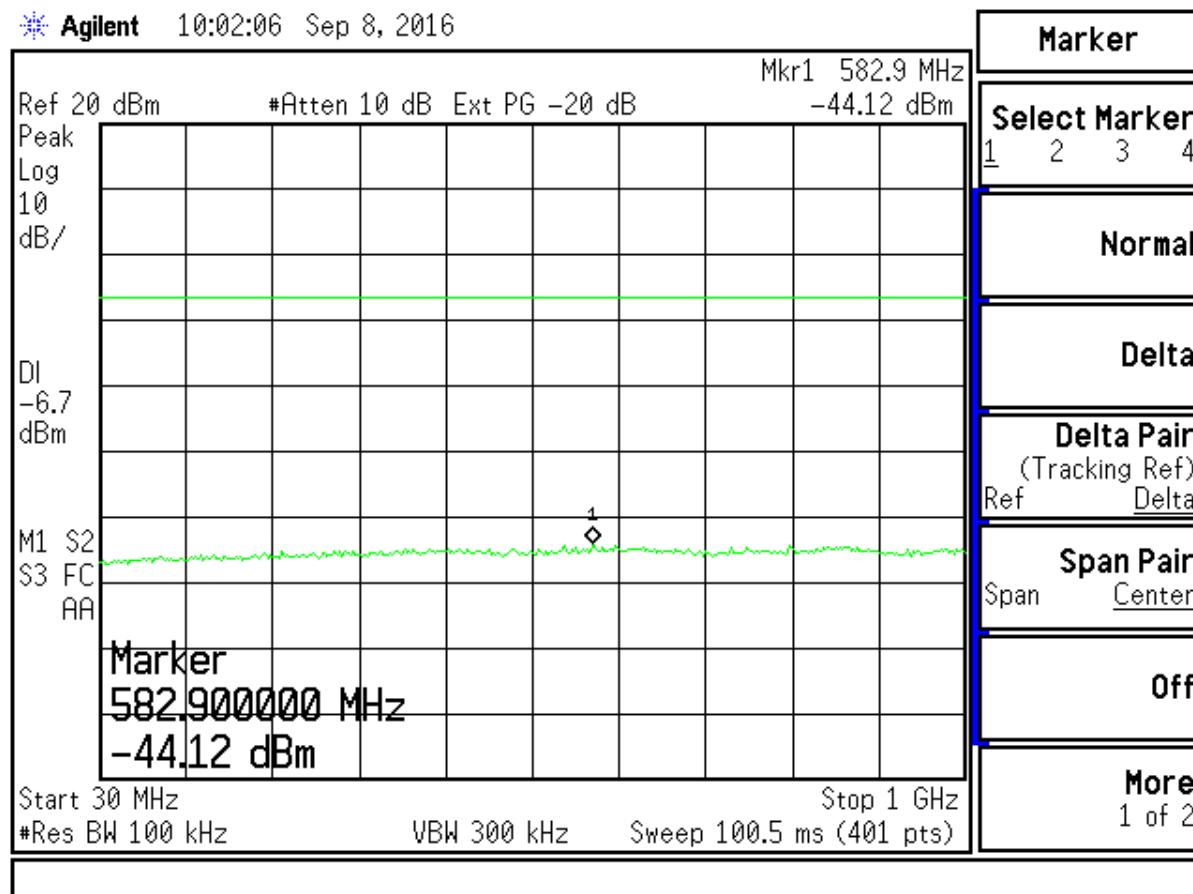


Figure 22. Antenna Conducted Emissions 802.11b Low, Part 1

Note: Display line shows the 20 dB limit line.

US Tech Test Report:
FCC ID:
IC:
Test Report Number:
Issue Date:
Customer:
Model:

FCC Part 15 Certification/ RSS 210
2ACAJ-WHUB 2
11938A-WHUB2
16-0218
September 8, 2016
Wink Labs, Inc.
Wink Hub 2

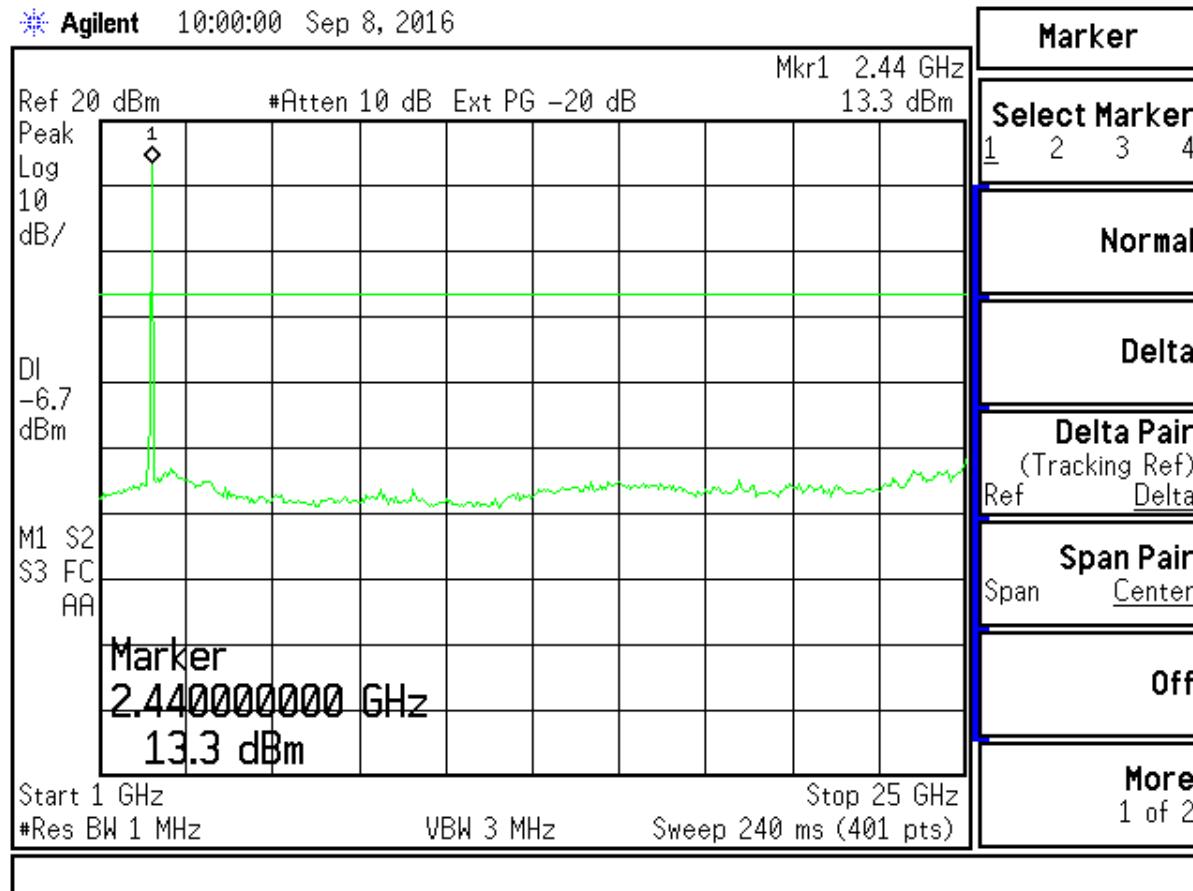


Figure 23. Antenna Conducted Emissions 802.11b Low, Part 2

Note: Display line shows the 20 dB limit line.

US Tech Test Report:
FCC ID:
IC:
Test Report Number:
Issue Date:
Customer:
Model:

FCC Part 15 Certification/ RSS 210
2ACAJ-WHUB 2
11938A-WHUB2
16-0218
September 8, 2016
Wink Labs, Inc.
Wink Hub 2

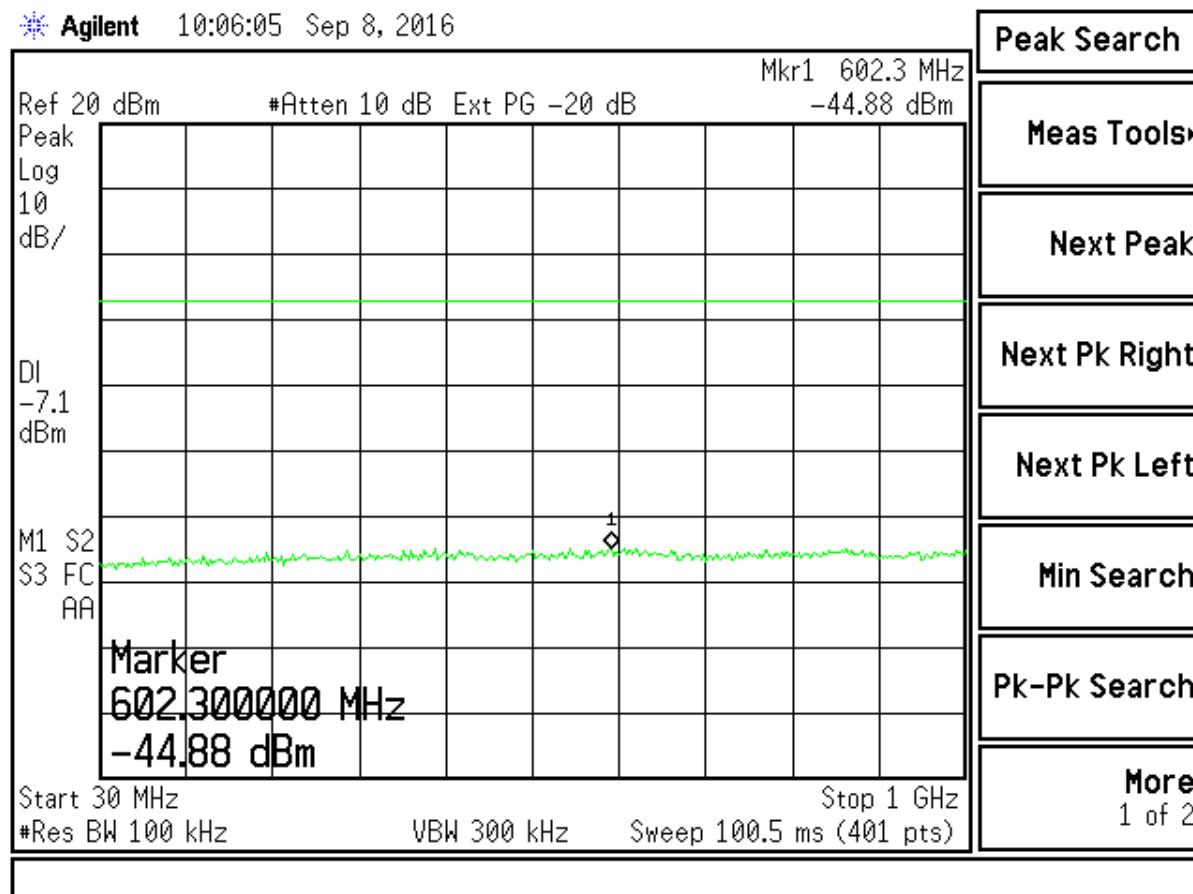


Figure 24. Antenna Conducted Emissions 802.11b Mid, Part 1

Note: Display line shows the 20 dB limit line.

US Tech Test Report:
FCC ID:
IC:
Test Report Number:
Issue Date:
Customer:
Model:

FCC Part 15 Certification/ RSS 210
2ACAJ-WHUB 2
11938A-WHUB2
16-0218
September 8, 2016
Wink Labs, Inc.
Wink Hub 2

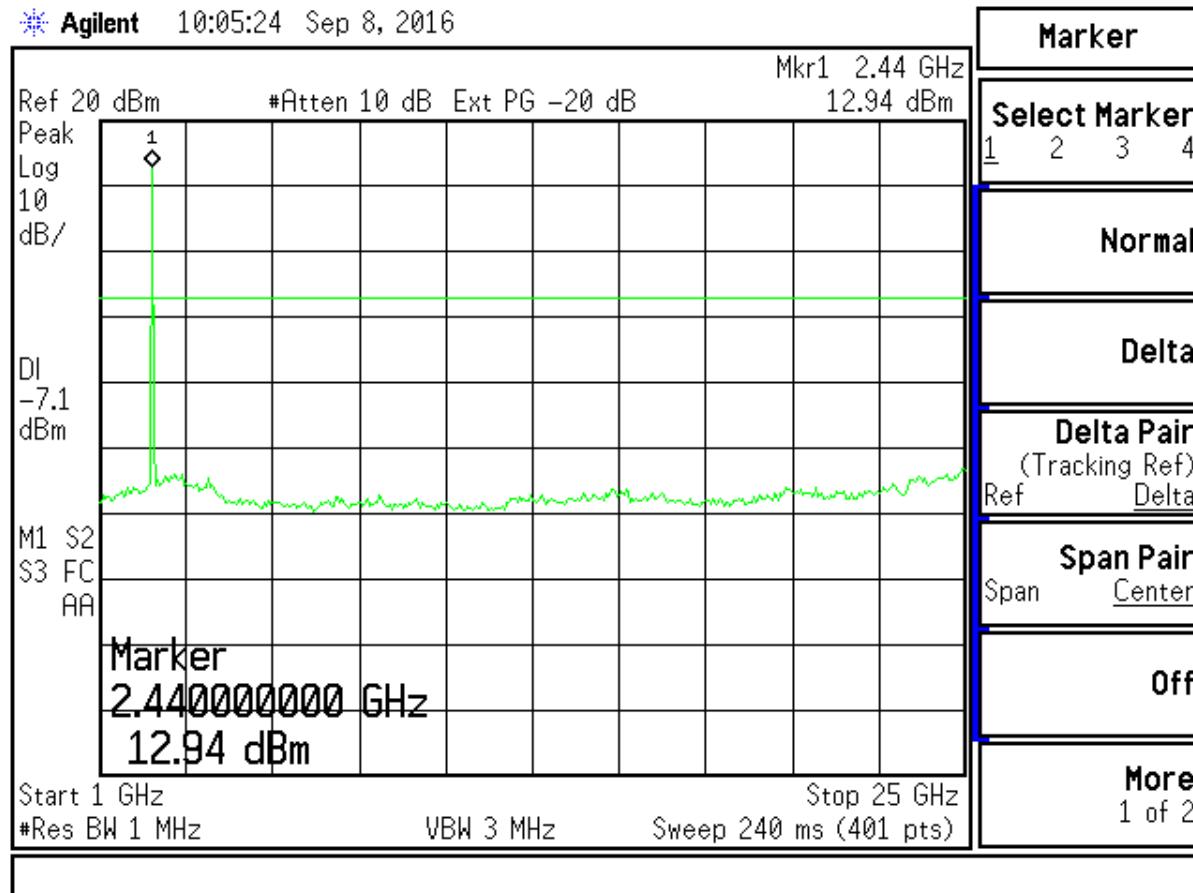


Figure 25. Antenna Conducted Emissions 802.11b Mid, Part 2

Note: Display line shows the 20 dB limit line.

US Tech Test Report:
FCC ID:
IC:
Test Report Number:
Issue Date:
Customer:
Model:

FCC Part 15 Certification/ RSS 210
2ACAJ-WHUB 2
11938A-WHUB2
16-0218
September 8, 2016
Wink Labs, Inc.
Wink Hub 2

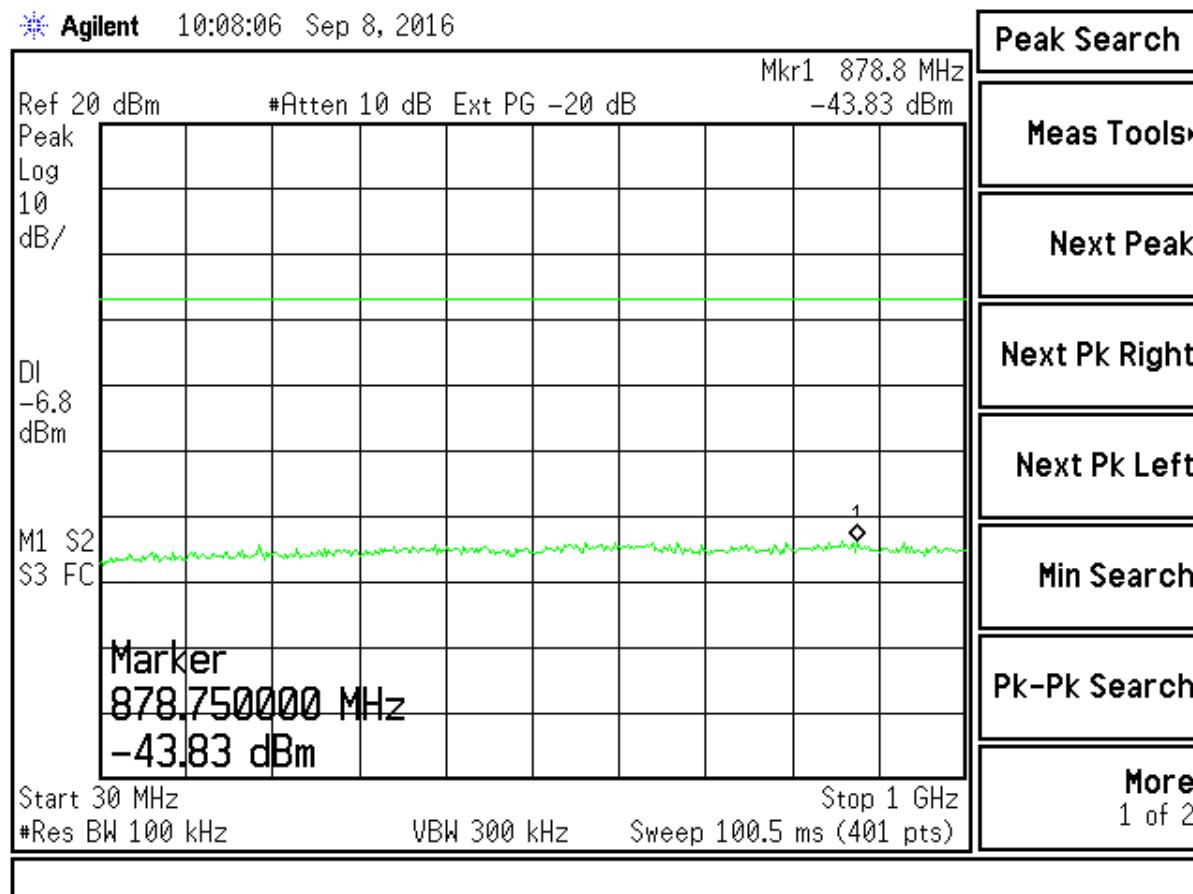


Figure 26. Antenna Conducted Emissions 802.11b High, Part 1

Note: Display line shows the 20 dB limit line.

US Tech Test Report:
FCC ID:
IC:
Test Report Number:
Issue Date:
Customer:
Model:

FCC Part 15 Certification/ RSS 210
2ACAJ-WHUB 2
11938A-WHUB2
16-0218
September 8, 2016
Wink Labs, Inc.
Wink Hub 2

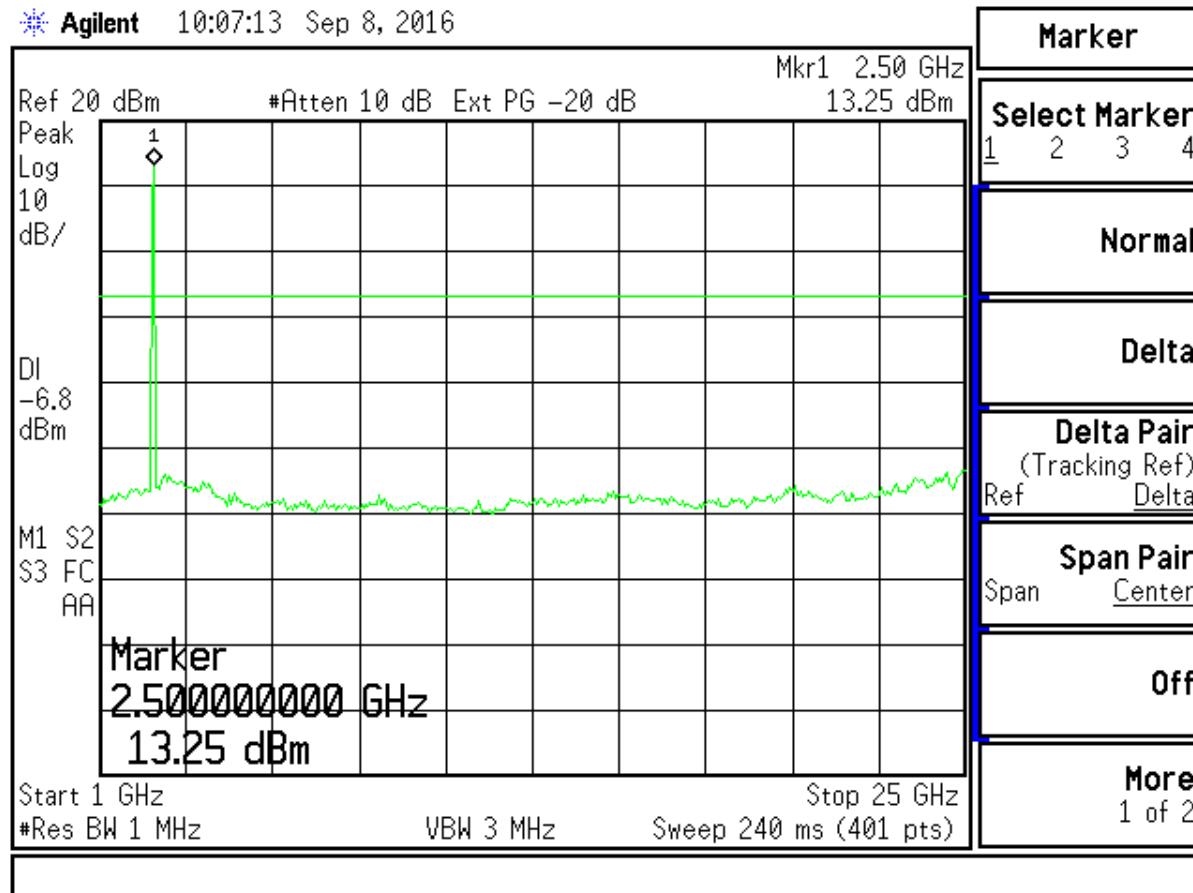


Figure 27. Antenna Conducted Emissions 802.11b High, Part 2

Note: Display line shows the 20 dB limit line.

US Tech Test Report:
FCC ID:
IC:
Test Report Number:
Issue Date:
Customer:
Model:

FCC Part 15 Certification/ RSS 210
2ACAJ-WHUB 2
11938A-WHUB2
16-0218
September 8, 2016
Wink Labs, Inc.
Wink Hub 2

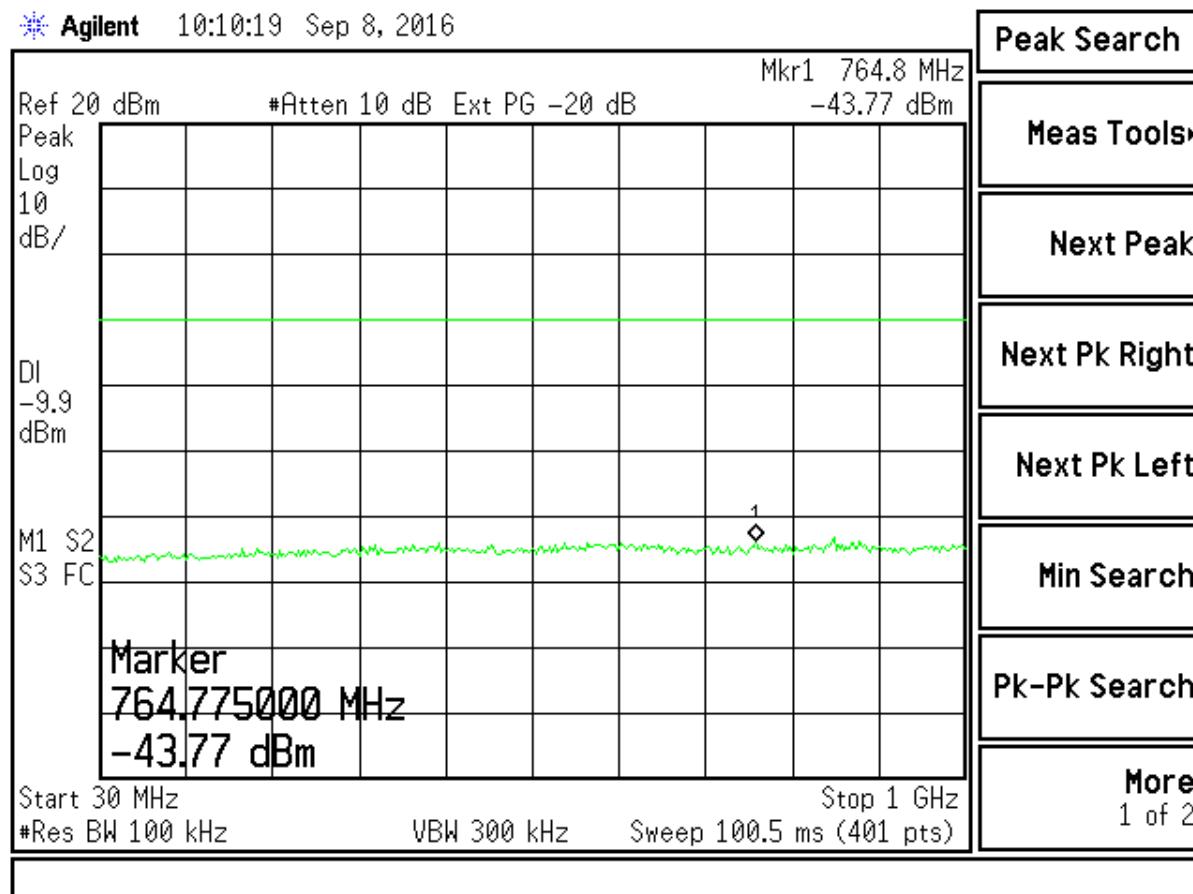


Figure 28. Antenna Conducted Emissions 802.11g Low, Part 1

Note: Display line shows the 20 dB limit line.

US Tech Test Report:
FCC ID:
IC:
Test Report Number:
Issue Date:
Customer:
Model:

FCC Part 15 Certification/ RSS 210
2ACAJ-WHUB 2
11938A-WHUB2
16-0218
September 8, 2016
Wink Labs, Inc.
Wink Hub 2

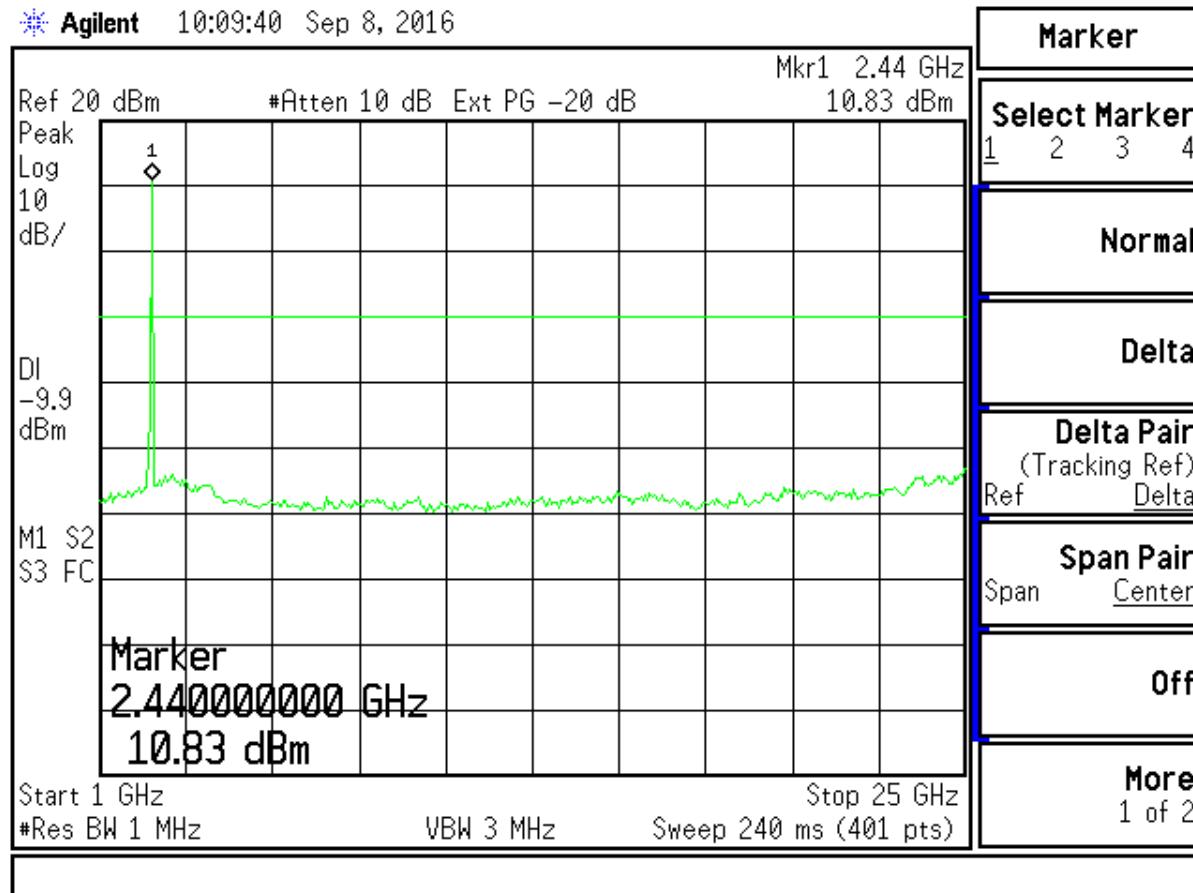


Figure 29. Antenna Conducted Emissions 802.11g Low, Part 2

Note: Display line shows the 20 dB limit line.

US Tech Test Report:
FCC ID:
IC:
Test Report Number:
Issue Date:
Customer:
Model:

FCC Part 15 Certification/ RSS 210
2ACAJ-WHUB 2
11938A-WHUB2
16-0218
September 8, 2016
Wink Labs, Inc.
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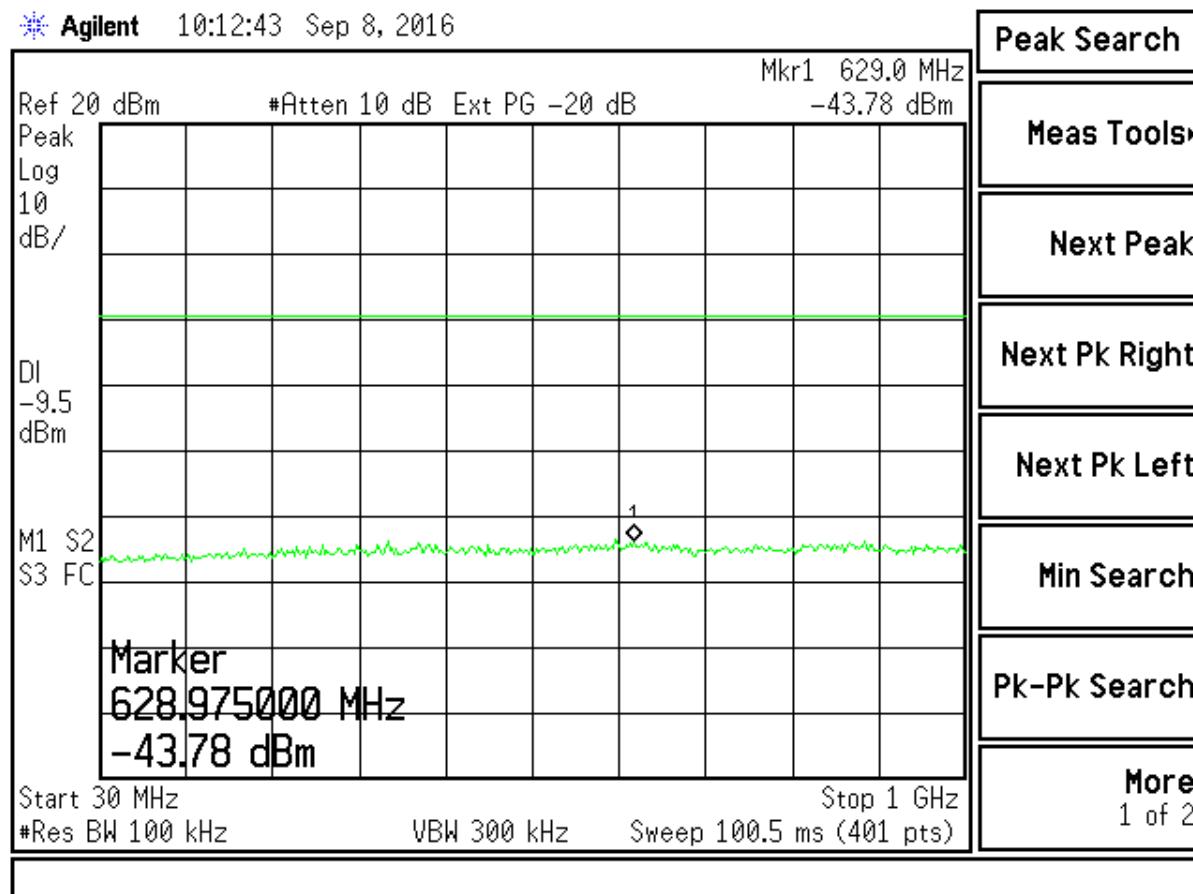


Figure 30. Antenna Conducted Emissions 802.11g Mid, Part 1

Note: Display line shows the 20 dB limit line.

US Tech Test Report:
FCC ID:
IC:
Test Report Number:
Issue Date:
Customer:
Model:

FCC Part 15 Certification/ RSS 210
2ACAJ-WHUB 2
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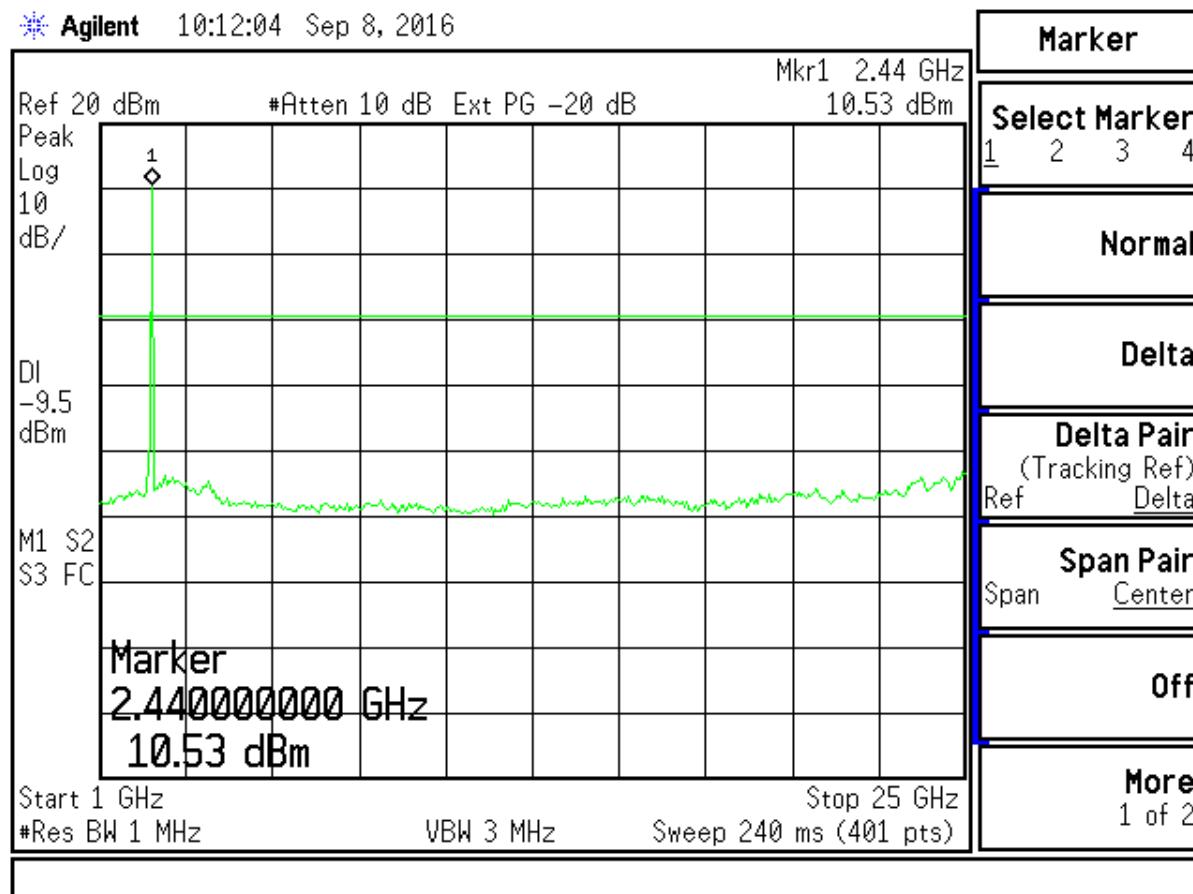


Figure 31. Antenna Conducted Emissions 802.11g Mid, Part 2

Note: Display line shows the 20 dB limit line.

US Tech Test Report:
FCC ID:
IC:
Test Report Number:
Issue Date:
Customer:
Model:

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Wink Labs, Inc.
Wink Hub 2

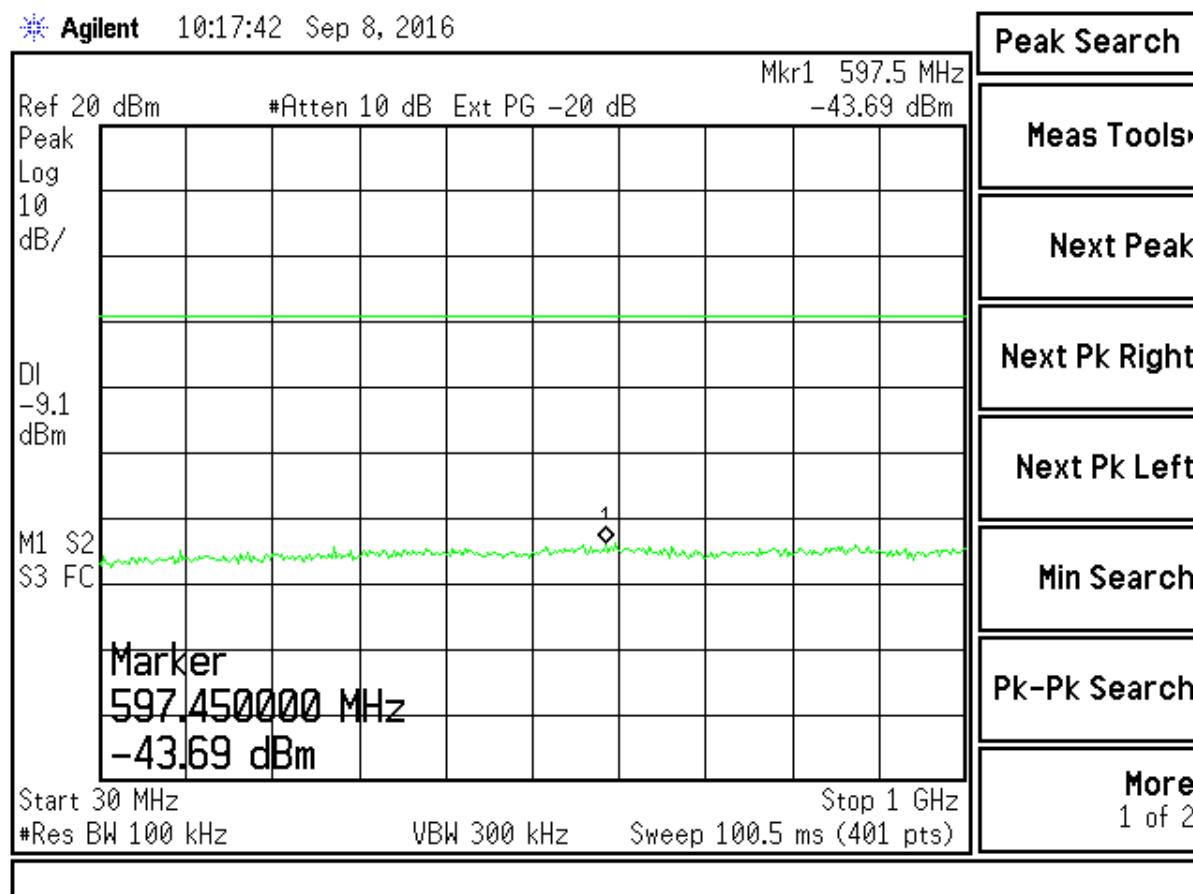


Figure 32. Antenna Conducted Emissions 802.11g High, Part 1

Note: Display line shows the 20 dB limit line.

US Tech Test Report:
FCC ID:
IC:
Test Report Number:
Issue Date:
Customer:
Model:

FCC Part 15 Certification/ RSS 210
2ACAJ-WHUB 2
11938A-WHUB2
16-0218
September 8, 2016
Wink Labs, Inc.
Wink Hub 2

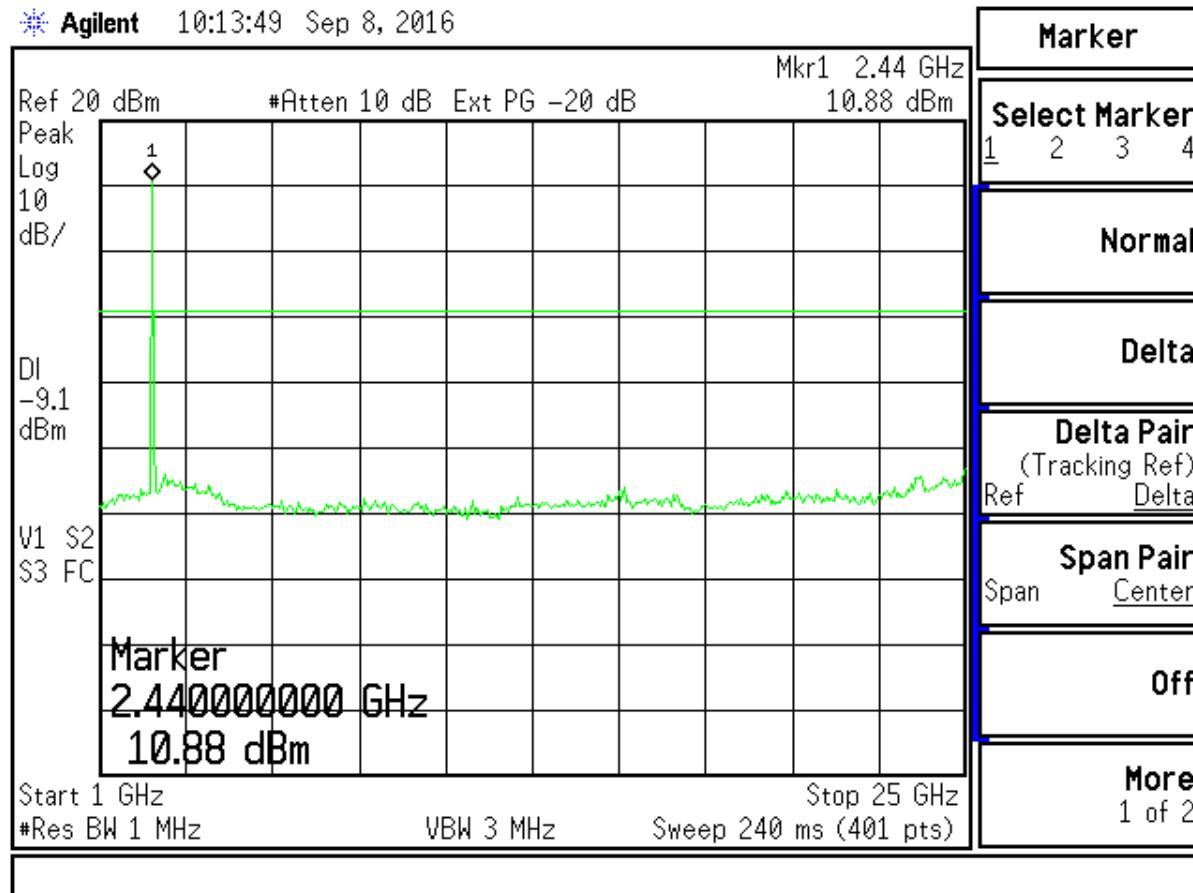


Figure 33. Antenna Conducted Emissions 802.11g High, Part 2

Note: Display line shows the 20 dB limit line.

US Tech Test Report:
FCC ID:
IC:
Test Report Number:
Issue Date:
Customer:
Model:

FCC Part 15 Certification/ RSS 210
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11938A-WHUB2
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Wink Labs, Inc.
Wink Hub 2

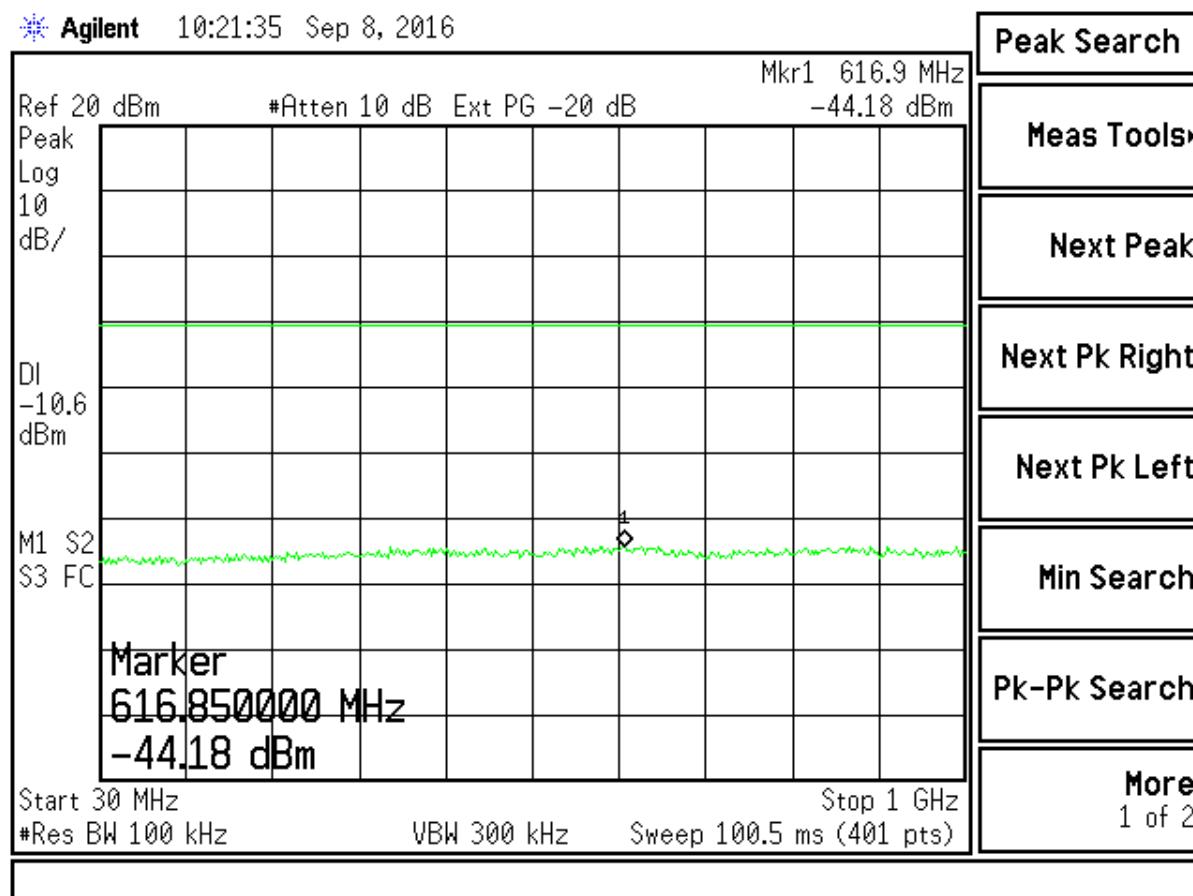


Figure 34. Antenna Conducted Emissions 802.11n Low, Part 1

Note: Display line shows the 20 dB limit line.

US Tech Test Report:
FCC ID:
IC:
Test Report Number:
Issue Date:
Customer:
Model:

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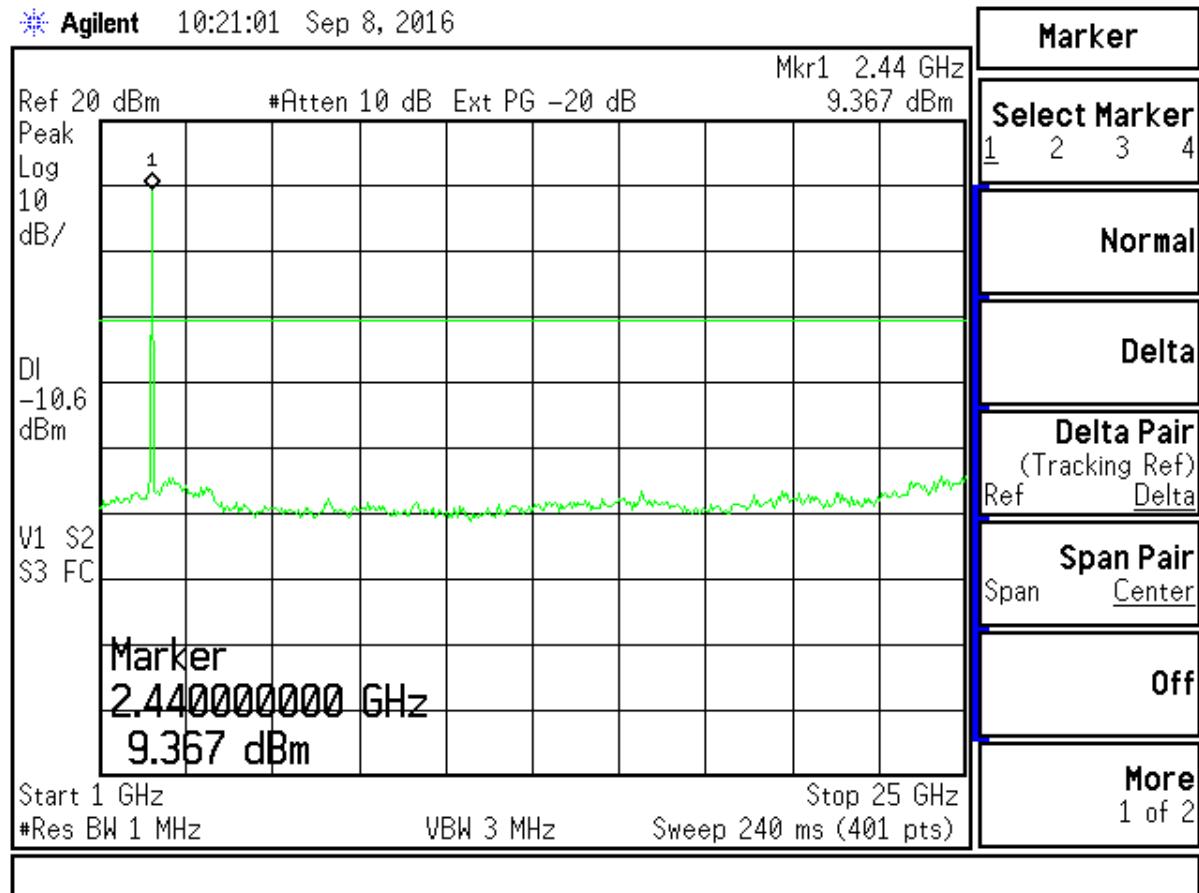


Figure 35. Antenna Conducted Emissions 802.11n Low, Part 2

Note: Display line shows the 20 dB limit line.

US Tech Test Report:
FCC ID:
IC:
Test Report Number:
Issue Date:
Customer:
Model:

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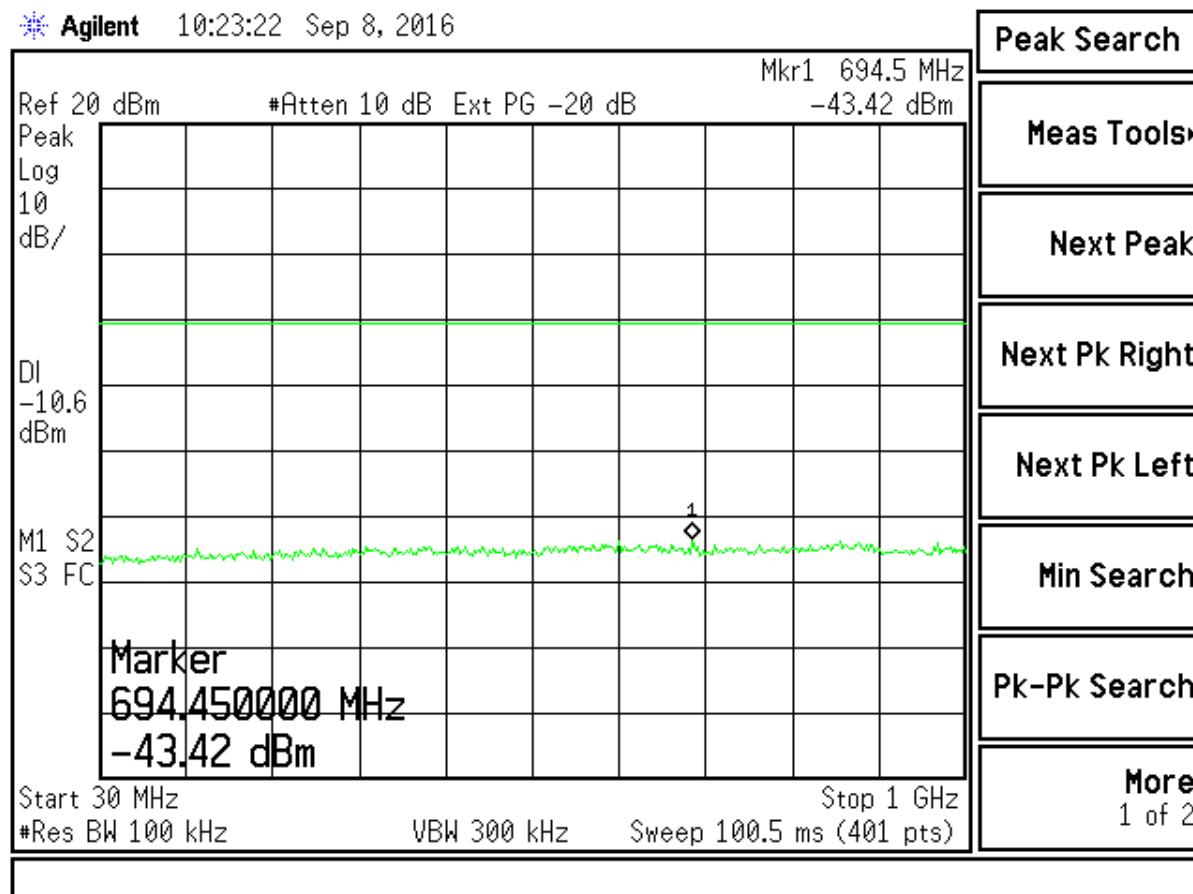


Figure 36. Antenna Conducted Emissions 802.11n Mid, Part 1

Note: Display line shows the 20 dB limit line.

US Tech Test Report:
FCC ID:
IC:
Test Report Number:
Issue Date:
Customer:
Model:

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Wink Hub 2

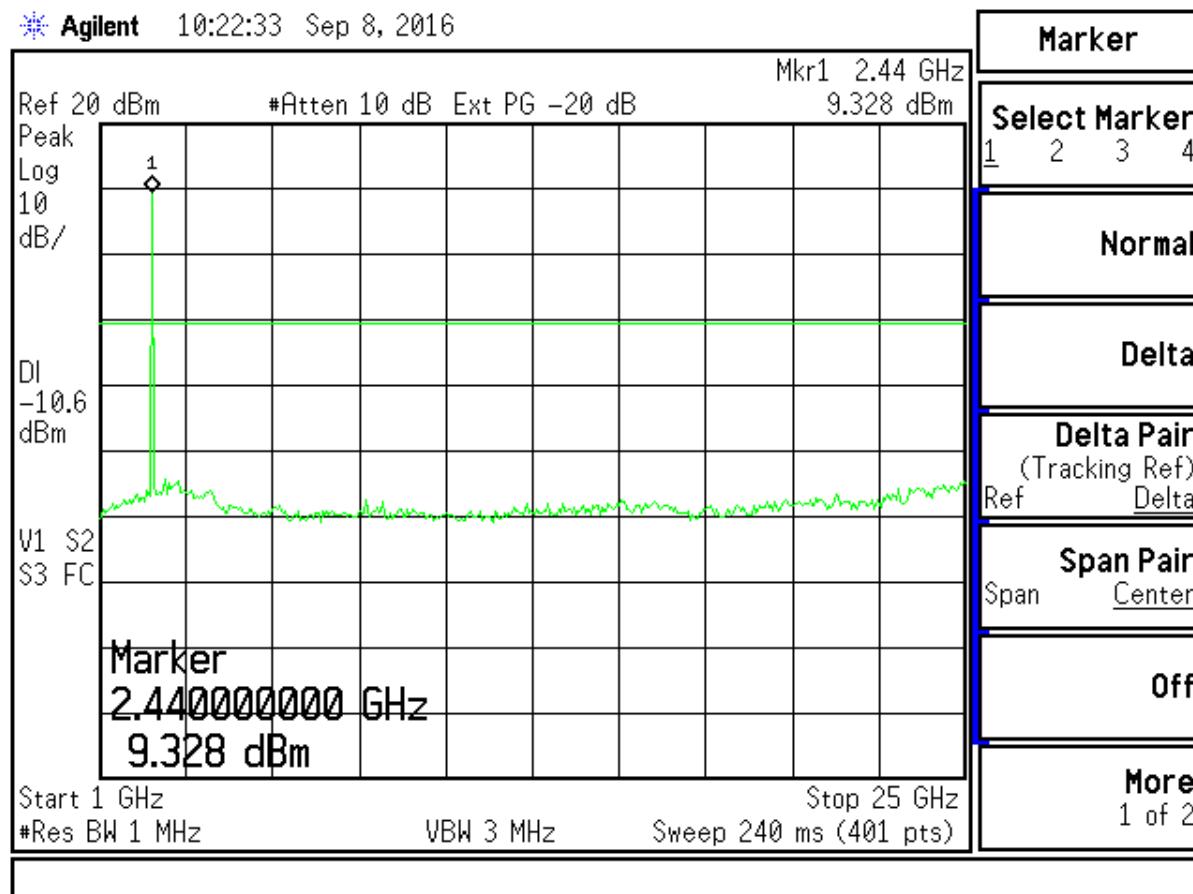


Figure 37. Antenna Conducted Emissions 802.11n Mid, Part 2

Note: Display line shows the 20 dB limit line.

US Tech Test Report:
FCC ID:
IC:
Test Report Number:
Issue Date:
Customer:
Model:

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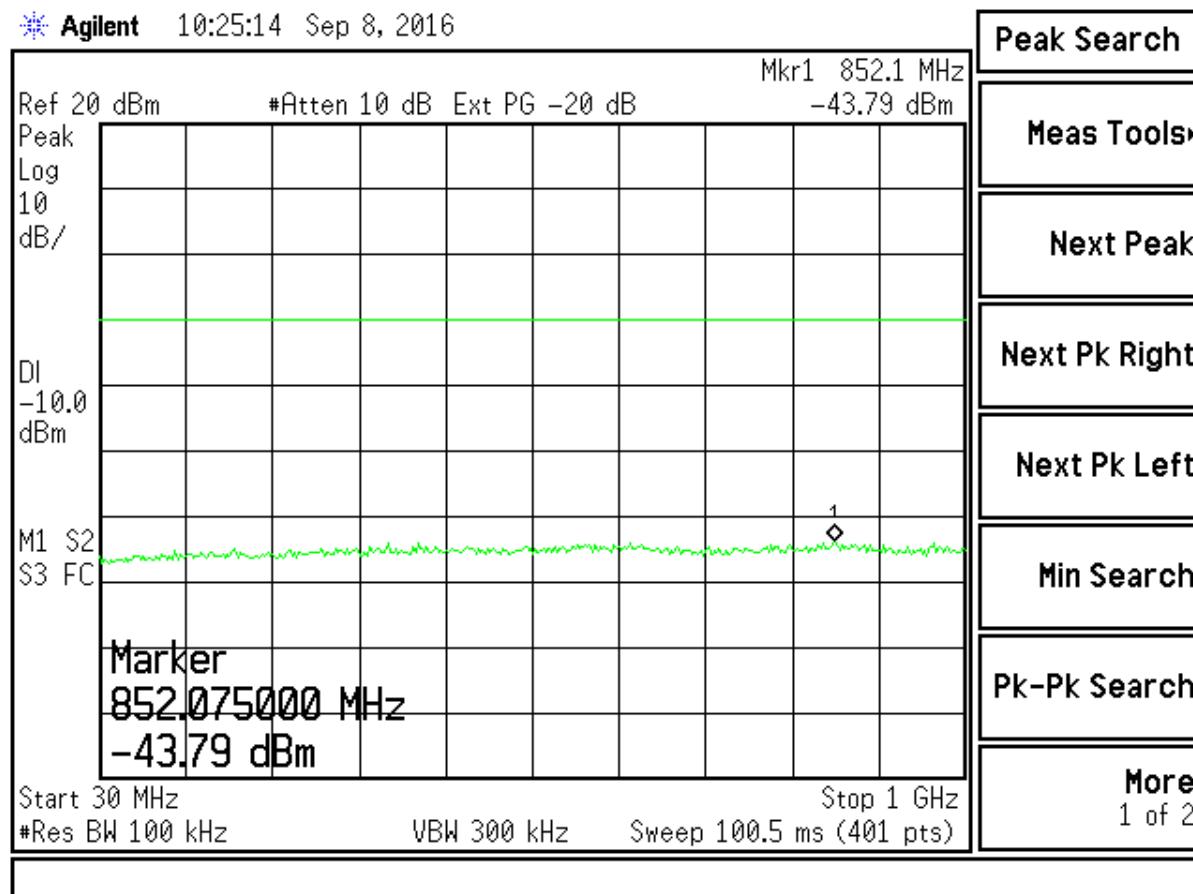


Figure 38. Antenna Conducted Emissions 802.11n High, Part 1

Note: Display line shows the 20 dB limit line.

US Tech Test Report:
FCC ID:
IC:
Test Report Number:
Issue Date:
Customer:
Model:

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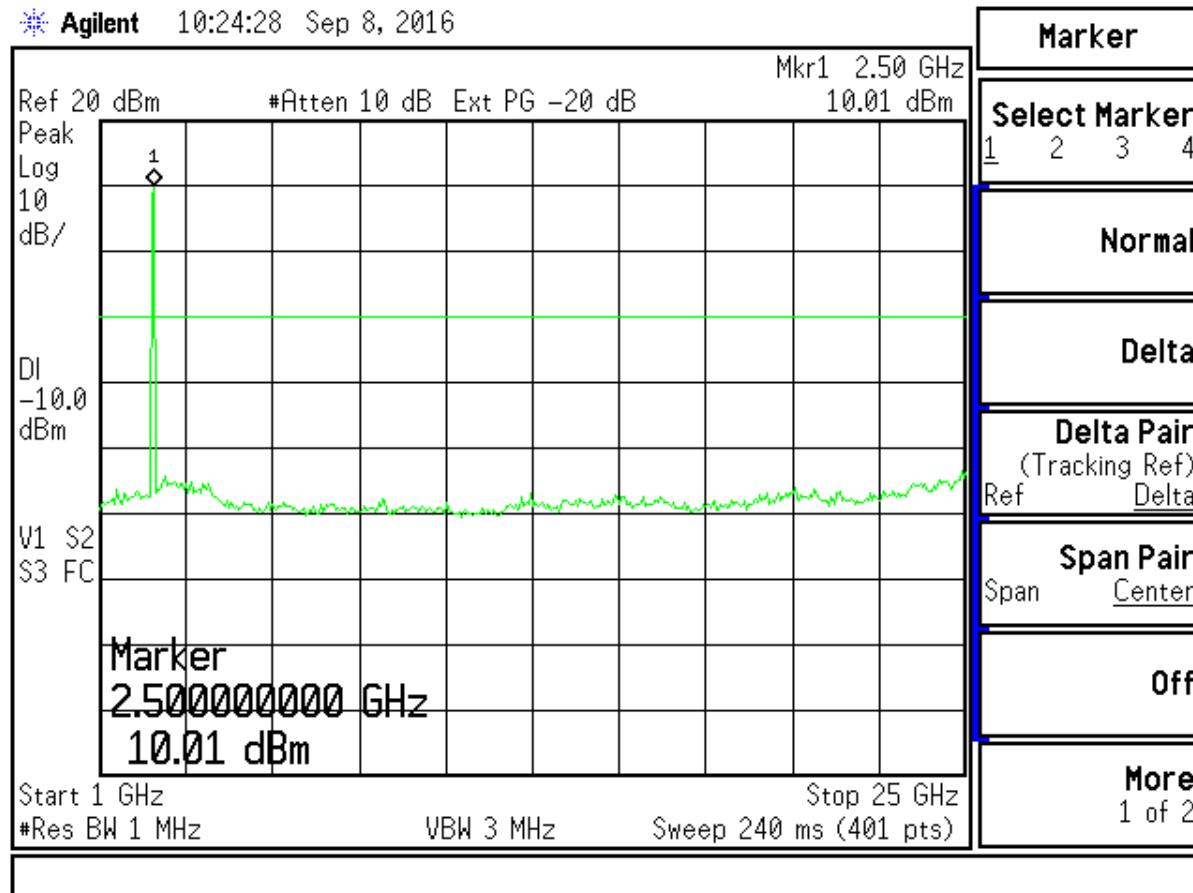


Figure 39. Antenna Conducted Emissions 802.11n High, Part 2

Note: Display line shows the 20 dB limit line.

US Tech Test Report:
FCC ID:
IC:
Test Report Number:
Issue Date:
Customer:
Model:

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2.13 Intentional Radiator, Radiated Emissions (CFR 15.209, 15.247(d)) (IC RSS 210, A2.9 (a))

On the OATS, the EUT was mounted on top of a non-conductive table, 80 cm above the floor, by placing it in the X-Z plane along the Z axis with its bottom cover in parallel with the ground. The front of the EUT faced the measurement antenna located 3 meters away. Each signal measured was maximized by raising and lowering the receive antenna between 1 and 4 meters in height while monitoring the ever changing spectrum analyzer display (with channel A in the Clear-Write mode and channel B in the Max-Hold mode) for the largest signal visible. That exact antenna height where the signal was maximized was recorded for reproducibility purposes. Also, the EUT was rotated about its Y-axis while monitoring the Spectrum Analyzer display for maximum. The EUT azimuth was recorded for reproducibility purposes. The EUT was measured when both maxima were simultaneously satisfied. The testing was repeated with the antenna in either the horizontal or vertical position.

The tabulated test data below shows the worst case radiated emissions.

US Tech Test Report:
 FCC ID:
 IC:
 Test Report Number:
 Issue Date:
 Customer:
 Model:

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Table 8. Peak Radiated Fundamental & Harmonic Emissions, 802.11b

Tested By: AP	Test: FCC Part 15, Para 15.247(d) Project: 16-0218			Client: Wink Labs, Inc. Model: Wink Hub 2			
Frequency (MHz)	Test Data (dBuV)	AF+CL-PA (dB/m)	Corrected Results (dBuV/m)	Limits (dBuV/m)	Distance / Polarization	Margin (dB)	Detection Mode
Low Channel - PEAK							
2412	68.12	30.87	98.99		3M/Vert.		PK
4824*	46.59	6.58	53.17	74.0	3M/Vert.	20.8	PK
Mid Channel - PEAK							
2442	69.19	30.94	100.13		3M/Vert.		PK
4884*	45.22	7.04	52.26	74.0	3M/Vert.	21.7	PK
High Channel - PEAK							
2462	68.26	30.94	99.20		3M/Vert.		PK
4924*	45.14	7.88	53.02	74.0	3M/Vert.	21.0	PK

1. (*) Falls within the restricted bands of CFR 15.205. Limits based on CFR15.209 & 20 dB relaxation for peak measurements of CFR 15.35.
2. No other signals detected within 20 dB of specification limit. Harmonics investigated up to the 10th harmonic
3. The EUT was oriented upright in a position consistent with end user installation, and the transmitter was placed in constant broadcast mode (>98% duty cycle). The emissions were measured with the receive antenna in vertical and horizontal polarizations.
4. The data listed in the table above are worst case emissions.

Sample Calculation at 2412 MHz:

Magnitude of Measured Frequency	68.12	dBuV
+ Antenna Factor + Cable Loss + Amplifier Gain	30.87	dB/m
<u>1 meter to 3 meter extrapolation</u>	N/A	dB
Corrected Result	98.99	dBuV/m

Test Date: Aug 30, 2016

Tested By

Signature: 

Name: Ashton Picas

US Tech Test Report:
 FCC ID:
 IC:
 Test Report Number:
 Issue Date:
 Customer:
 Model:

FCC Part 15 Certification/ RSS 210
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 11938A-WHUB2
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 Wink Labs, Inc.
 Wink Hub 2

Table 9. Average Radiated Fundamental & Harmonic Emissions, 802.11b

Tested By: AP	Test: FCC Part 15, Para 15.247(d)			Client: Wink Labs, Inc.			
	Project: 16-0218			Model: Wink Hub 2			
Frequency (MHz)	Test Data (dBuV)	AF+CL-PA + DC (dB/m)	Corrected Results (dBuV/m)	Limits (dBuV/m)	Distance / Polarization	Margin (dB)	Detection Mode
Low Channel – Average							
2412	57.30	30.87	88.17		3M/Vert.		AVG
4824*	33.72	6.58	40.30	54	3M/Vert.	13.7	AVG
Mid Channel – Average							
2442	58.06	30.94	89.00		3M/Vert.		AVG
4884*	33.76	7.04	40.80	54	3M/Vert.	13.2	AVG
High Channel – Average							
2462	57.32	30.94	88.26		3M/Vert.		AVG
4924*	33.98	7.88	41.86	54	3M/Vert.	12.1	AVG

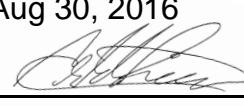
1. (*) Falls within the restricted bands of CFR 15.205. Limits based on CFR15.209
2. No other signals detected within 20 dB of specification limit. Harmonics investigated up to the 10th harmonic
3. The EUT was oriented upright in a position consistent with end user installation, and the transmitter was placed in constant broadcast mode (>98% duty cycle). The emissions were measured with the receive antenna in vertical and horizontal polarizations.
4. The data listed in the table above are worst case emissions.

Sample Calculation at 2412 MHz:

Magnitude of Measured Frequency	57.30	dBuV
+ Antenna Factor + Cable Loss + Amplifier Gain – Duty Cycle	30.87	dB/m
1 meter to 3 meter extrapolation	N/A	dB
Corrected Result	88.17	dBuV/m

Test Date: Aug 30, 2016

Tested By

Signature: 

Name: Ashton Picas

US Tech Test Report:
 FCC ID:
 IC:
 Test Report Number:
 Issue Date:
 Customer:
 Model:

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 September 8, 2016
 Wink Labs, Inc.
 Wink Hub 2

Table 10. Peak Radiated Fundamental & Harmonic Emissions, 802.11g

Tested By: AP	Test: FCC Part 15, Para 15.247(d)			Client: Wink Labs, Inc.			
	Project: 16-0218			Model: Wink Hub 2			
Frequency (MHz)	Test Data (dBuV)	AF+CL-PA (dB/m)	Corrected Results (dBuV/m)	Limits (dBuV/m)	Distance / Polarization	Margin (dB)	Detection Mode
Low Channel – PEAK							
2412	64.46	30.87	95.33		3M/Vert.		PK
4824*	45.14	6.58	51.72	74.0	3M/Vert.	22.3	PK
Mid Channel – PEAK							
2442	65.39	30.94	96.33		3M/Vert.		PK
4884*	45.02	6.99	52.01	74.0	3M/Vert.	22.0	PK
High Channel – PEAK							
2462	64.74	30.94	95.68		3M/Vert.		PK
4924*	44.66	7.88	52.54	74.0	3M/Vert.	21.5	PK

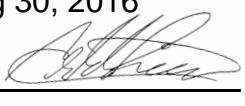
1. (*) Falls within the restricted bands of CFR 15.205. Limits based on CFR15.209 & 20 dB relaxation for peak measurements of CFR 15.35.
2. No other signals detected within 20 dB of specification limit. Harmonics investigated up to the 10th harmonic
3. The EUT was oriented upright in a position consistent with end user installation, and the transmitter was placed in constant broadcast mode (>98% duty cycle). The emissions were measured with the receive antenna in vertical and horizontal polarizations.
4. The data listed in the table above are worst case emissions.

Sample Calculation at 2412 MHz:

Magnitude of Measured Frequency	64.46	dBuV
+ Antenna Factor + Cable Loss + Amplifier Gain	30.87	dB/m
1 meter to 3 meter extrapolation	NA	dB
Corrected Result	95.33	dBuV/m

Test Date: Aug 30, 2016

Tested By

Signature: 

Name: Ashton Picas

US Tech Test Report:
 FCC ID:
 IC:
 Test Report Number:
 Issue Date:
 Customer:
 Model:

FCC Part 15 Certification/ RSS 210
 2ACAJ-WHUB 2
 11938A-WHUB2
 16-0218
 September 8, 2016
 Wink Labs, Inc.
 Wink Hub 2

Table 11. Average Radiated Fundamental & Harmonic Emissions, 802.11g

Tested By: AP	Test: FCC Part 15, Para 15.247(d) Project: 16-0218			Client: Wink Labs, Inc. Model: Wink Hub 2			
Frequency (MHz)	Test Data (dBuV)	AF+CL-PA - DC (dB/m)	Corrected Results (dBuV/m)	Limits (dBuV/m)	Distance / Polarization	Margin (dB)	Detection Mode
Low Channel – Average							
2412	46.13	30.87	77.00		3M/Vert.		AVG
4824*	33.60	6.58	40.18	54.0	3M/Vert.	13.8	AVG
Mid Channel – Average							
2442	46.73	30.94	77.67		3M/Vert.		AVG
4884*	33.98	6.99	40.97	54.0	3M/Vert.	13.0	AVG
High Channel – Average							
2462	46.03	30.94	76.97		3M/Vert.		AVG
4924*	33.96	7.88	41.84	54.0	3M/Vert.	12.2	AVG

1. (*) Falls within the restricted bands of CFR 15.205. Limits based on CFR15.209
2. No other signals detected within 20 dB of specification limit. Harmonics investigated up to the 10th harmonic
3. The EUT was oriented upright in a position consistent with end user installation, and the transmitter was placed in constant broadcast mode (>98% duty cycle). The emissions were measured with the receive antenna in vertical and horizontal polarizations.
4. The data listed in the table above are worst case emissions.

Sample Calculation at 2412 MHz:

Magnitude of Measured Frequency	46.13	dBuV
+ Antenna Factor + Cable Loss + Amplifier Gain – Duty Cycle	30.87	dB/m
<u>1 meter to 3 meter extrapolation</u>	N/A	dB
Corrected Result	77.00	dBuV/m

Test Date: Aug 30, 2016

Tested By



Signature:

Name: Ashton Picas

US Tech Test Report:
 FCC ID:
 IC:
 Test Report Number:
 Issue Date:
 Customer:
 Model:

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 Wink Hub 2

Table 12. Peak Radiated Fundamental & Harmonic Emissions, 802.11n

Tested By: AP	Test: FCC Part 15, Para 15.247(d) Project: 16-0218			Client: Wink Labs, Inc. Model: Wink Hub 2			
Frequency (MHz)	Test Data (dBuV)	AF+CL-PA (dB/m)	Corrected Results (dBuV/m)	Limits (dBuV/m)	Distance / Polarization	Margin (dB)	Detection Mode
Low Channel – PEAK							
2412	62.31	30.87	93.18		3M/Vert.		PK
4824*	44.32	6.58	50.90	74.0	3M/Vert.	23.1	PK
Mid Channel – PEAK							
2442	64.43	30.94	95.37		3M/Vert.		PK
4884*	45.92	6.99	52.91	74.0	3M/Vert.	21.1	PK
High Channel – PEAK							
2462	64.00	30.94	94.94		3M/Vert.		PK
4924*	45.11	7.88	52.99	74.0	3M/Vert.	21.0	PK

- (*) Falls within the restricted bands of CFR 15.205. Limits based on CFR15.209 & 20 dB relaxation for peak measurements of CFR 15.35.
- No other signals detected within 20 dB of specification limit. Harmonics investigated up to the 10th harmonic
- The EUT was oriented upright in a position consistent with end user installation, and the transmitter was placed in constant broadcast mode (>98% duty cycle). The emissions were measured with the receive antenna in vertical and horizontal polarizations.
- The data listed in the table above are worst case emissions.

Sample Calculation at 2412 MHz:

Magnitude of Measured Frequency	62.31	dBuV
+ Antenna Factor + Cable Loss + Amplifier Gain	30.87	dB/m
1 meter to 3 meter extrapolation	NA	dB
Corrected Result	93.18	dBuV/m

Test Date: Aug 30, 2016

Tested By



Signature:

Name: Ashton Picas

US Tech Test Report:
 FCC ID:
 IC:
 Test Report Number:
 Issue Date:
 Customer:
 Model:

FCC Part 15 Certification/ RSS 210
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 11938A-WHUB2
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 Wink Labs, Inc.
 Wink Hub 2

Table 13. Average Radiated Fundamental & Harmonic Emissions, 802.11n

Tested By: AP	Test: FCC Part 15, Para 15.247(d) Project: 16-0218			Client: Wink Labs, Inc. Model: Wink Hub 2			
Frequency (MHz)	Test Data (dBuV)	AF+CL-PA -DC (dB/m)	Corrected Results (dBuV/m)	Limits (dBuV/m)	Distance / Polarization	Margin (dB)	Detection Mode
Low Channel – Average							
2412	45.14	30.87	76.01		3M/Vert.		AVG
4824*	33.67	6.58	40.25	54.0	3M/Vert.	13.8	AVG
Mid Channel – Average							
2442	46.16	30.94	77.10		3M/Vert.		AVG
4884*	33.88	6.99	40.87	54.0	3M/Vert.	13.1	AVG
High Channel – Average							
2462	45.97	30.94	76.91		3M/Vert.		AVG
4924*	33.98	7.88	41.86	54.0	3M/Vert.	12.1	AVG

1. (*) Falls within the restricted bands of CFR 15.205. Limits based on CFR15.209
2. No other signals detected within 20 dB of specification limit. Harmonics investigated up to the 10th harmonic
3. The EUT was oriented upright in a position consistent with end user installation, and the transmitter was placed in constant broadcast mode (>98% duty cycle). The emissions were measured with the receive antenna in vertical and horizontal polarizations.
4. The data listed in the table above are worst case emissions.

Sample Calculation at 2412 MHz:

Magnitude of Measured Frequency	45.14	dBuV
+ Antenna Factor + Cable Loss + Amplifier Gain – Duty Cycle	30.87	dB/m
<u>1 meter to 3 meter extrapolation</u>	NA	dB
Corrected Result	76.01	dBuV/m

Test Date: Aug 30, 2016

Tested By



Signature: _____

Name: Ashton Picas

US Tech Test Report:
FCC ID:
IC:
Test Report Number:
Issue Date:
Customer:
Model:

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Wink Hub 2

2.14 Band Edge and Restricted band Measurements – (CFR 15.247 (d))

Band Edge measurements are made following the guidelines in FCC KDB Publication No. 558074 v03r05 with the EUT initially operating on the Lowest Channel and then operating on the Highest Channel within its band of operation. Antenna port conducted measurements are performed to demonstrate compliance with the requirement of 15.247(d) that all emissions outside of the band edges be attenuated by at least 20 dB when compared to its highest in-band value (contained in a 100 kHz band). Because these frequencies occur above 1000 MHz they have both a peak and average requirement.

To capture the band edge set the Spectrum Analyzer frequency span large enough to capture the peak level of the emission operating on the channel closest to the band edge as well as any modulation products falling outside of the authorized band of operation. Conducted measurements are performed with $RBW \geq 1\%$ of the frequency span. In all cases, the VBW is set $\geq RBW$. See figure and calculations below for more detail.

Restricted band measurements were performed using both radiated and conducted methods. The high channel restricted band measurements were tested using radiated test methods while the low channel restricted band measurements were tested using the conducted test method. Both methods are based on the test standards cited above.

US Tech Test Report:
FCC ID:
IC:
Test Report Number:
Issue Date:
Customer:
Model:

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Wink Hub 2

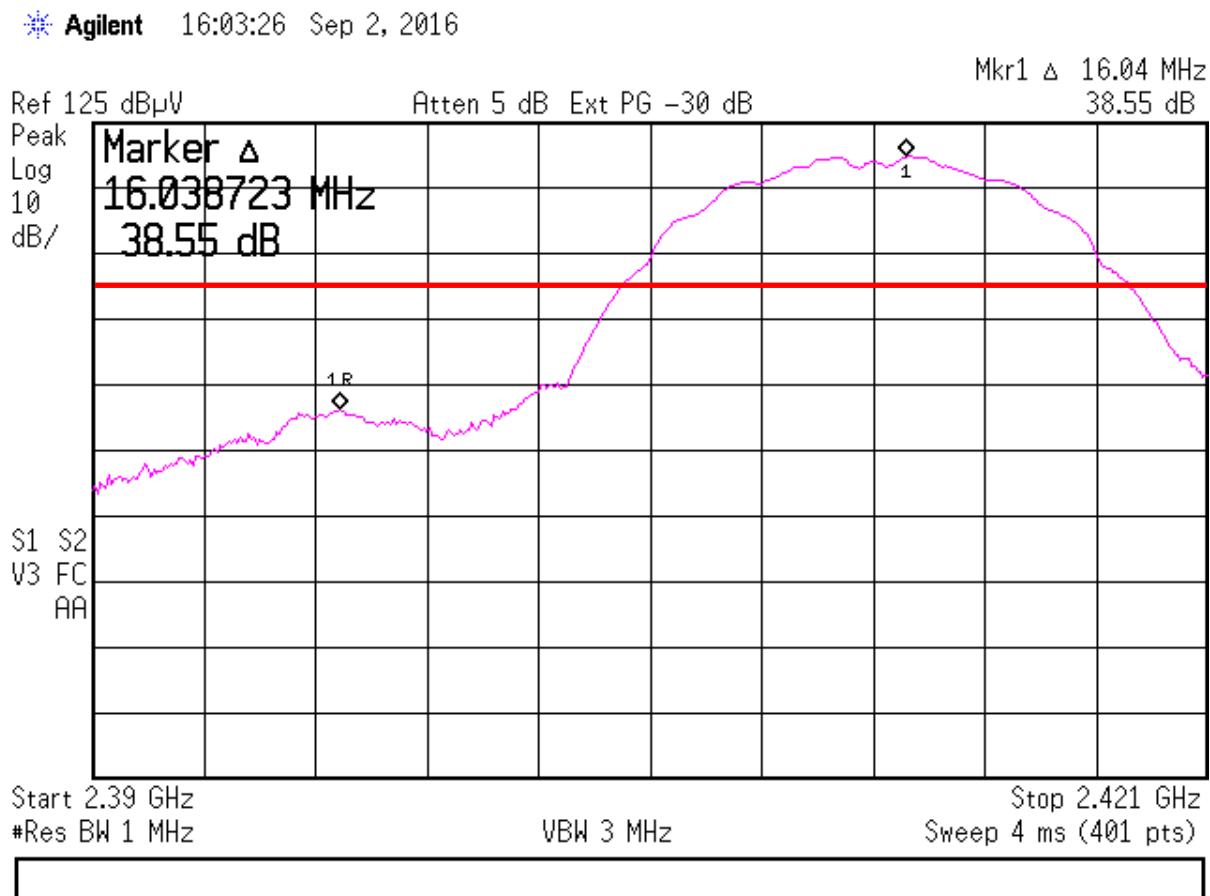


Figure 40. Band Edge Compliance – 802.11b – Low Channel Delta - Peak

(Lower band edge must be greater than 20 dB)

US Tech Test Report:
FCC ID:
IC:
Test Report Number:
Issue Date:
Customer:
Model:

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Wink Labs, Inc.
Wink Hub 2

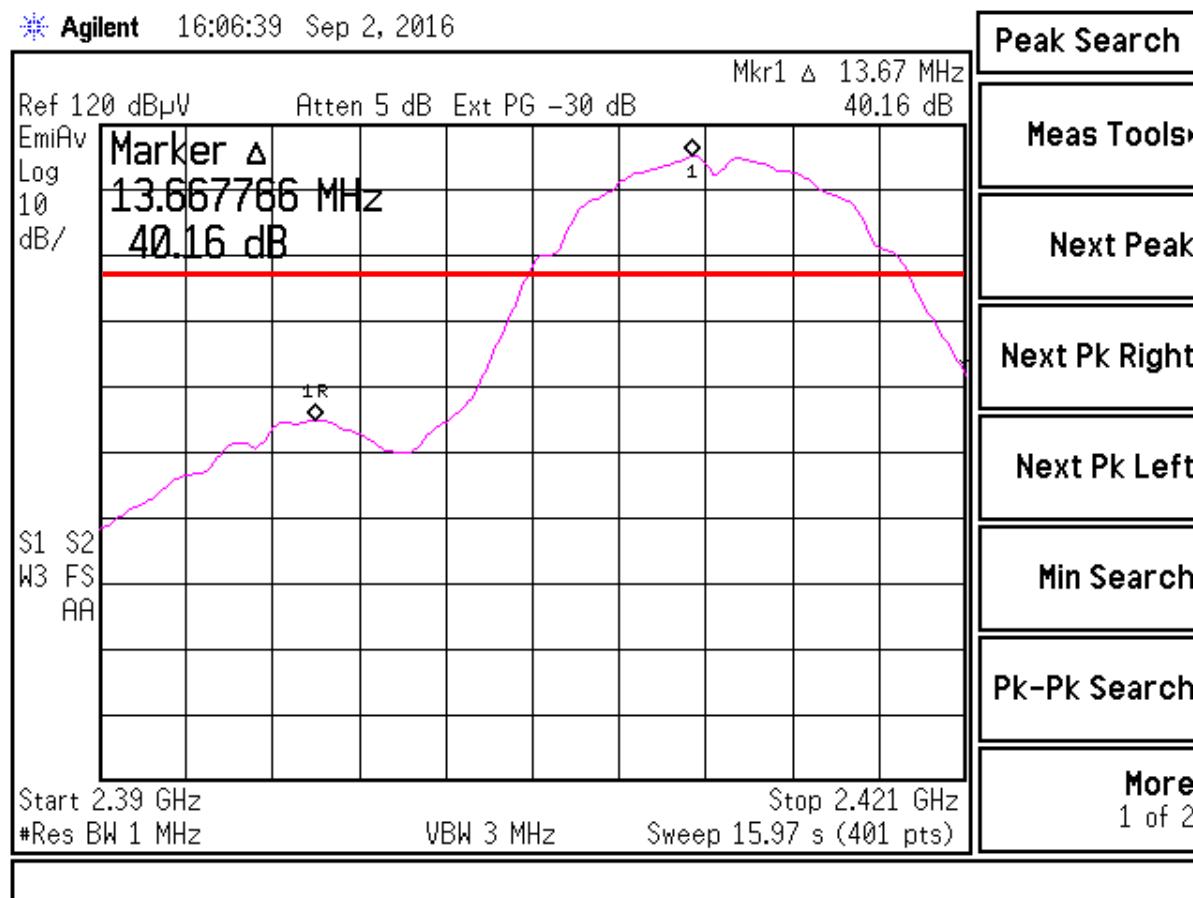


Figure 41. Band Edge Compliance – 802.11b – Low Channel Delta - Average

(Lower band edge must be greater than 20 dB)

US Tech Test Report:
 FCC ID:
 IC:
 Test Report Number:
 Issue Date:
 Customer:
 Model:

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 11938A-WHUB2
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 Wink Labs, Inc.
Wink Hub 2

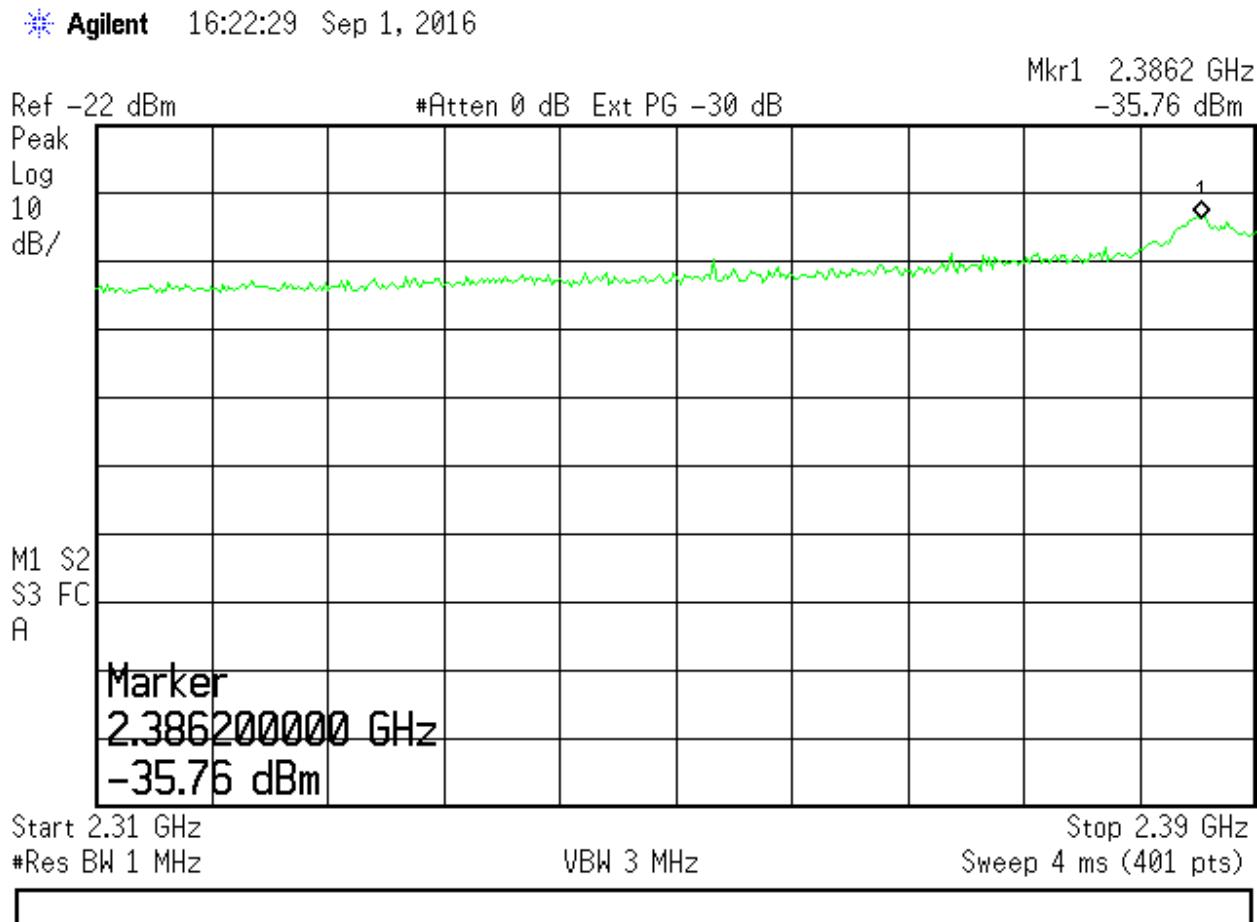


Figure 42. Conducted Restricted Band 2310 MHz to 2390 MHz – 802.11b – Peak

The restricted band plot above was performed using the conducted method per KDB 558074 v03r05, section 12.2.2.

Measured conducted output power	-35.76	dBm
Maximum transmit antenna gain	-2.50	dBi
Ground reflection factor	0.00	dB
Calculated EIRP Result	-38.26	dBm

Electric Field Conversion: $E = \text{EIRP} - 20 \log D + 104.8$

Note: D = 3 meters

$$E = -38.26 \text{ dBm} - 20 \log (3) + 104.8 = -38.26 - 9.54 + 104.8 = 57 \text{ dBuV/m}$$

PEAK limit	74.00	dBuV/m
Calculated Result	-57.00	dBuV/m
Margin	17.00	dB

US Tech Test Report:
FCC ID:
IC:
Test Report Number:
Issue Date:
Customer:
Model:

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Wink Hub 2

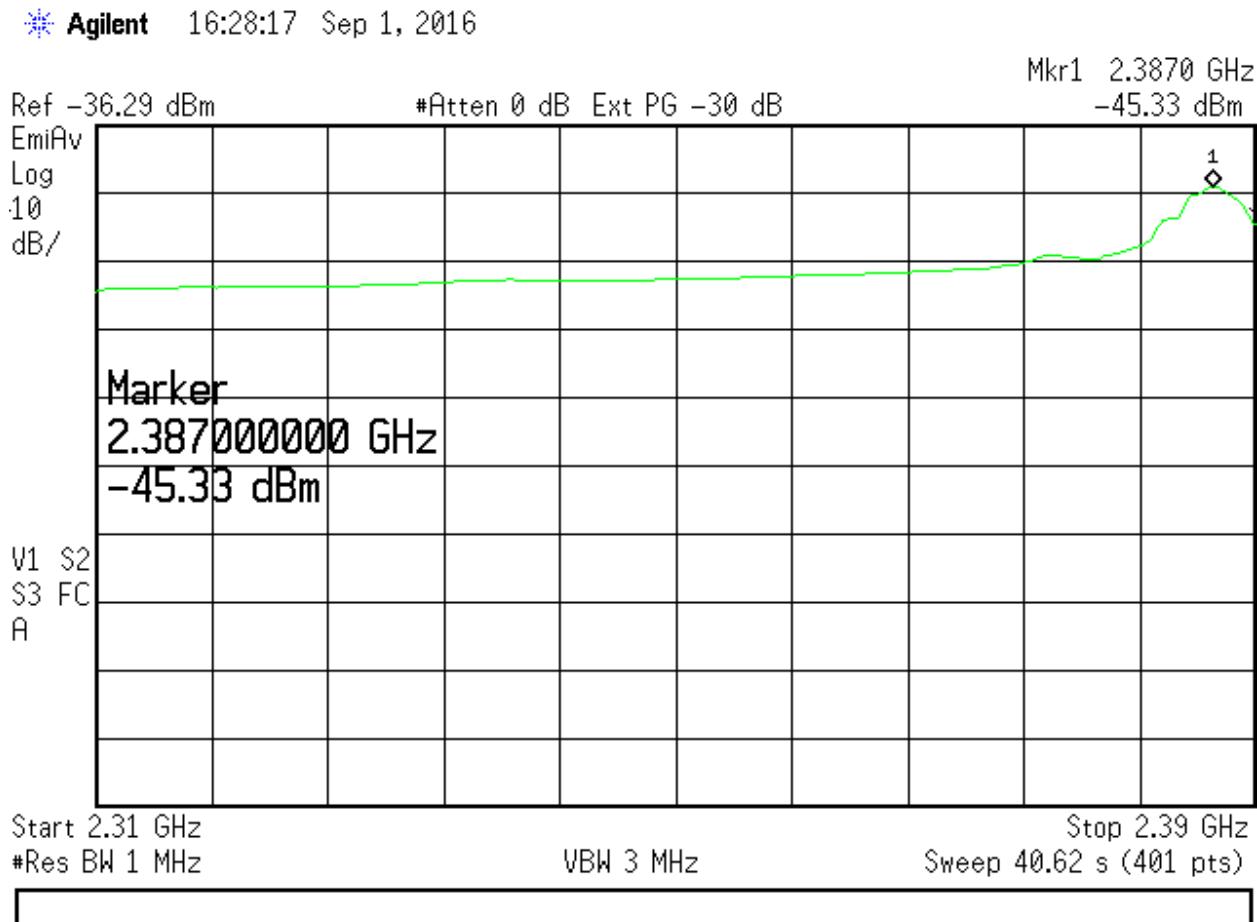


Figure 43. Conducted Restricted Band 2310 MHz to 2390 MHz – 802.11b – AVG

The restricted band plot above was performed using the conducted method per KDB 558074 v03r05, section 12.2.2.

Measured conducted output power	-45.33	dBm
Maximum transmit antenna gain	-2.50	dBi
Ground reflection factor	0.00	dB
Calculated EIRP Result	-47.83	dBm

Electric Field Conversion: $E = \text{EIRP} - 20 \log D + 104.8$

Note: D = 3 meters

$$E = -47.83 \text{ dBm} - 20 \log (3) + 104.8 = -47.83 - 9.54 + 104.8 = 47.43 \text{ dBuV/m}$$

AVG limit	54.00	dBuV/m
Calculated Result	-47.43	dBuV/m
Margin	6.57	dB

US Tech Test Report:
FCC ID:
IC:
Test Report Number:
Issue Date:
Customer:
Model:

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Wink Labs, Inc.
Wink Hub 2

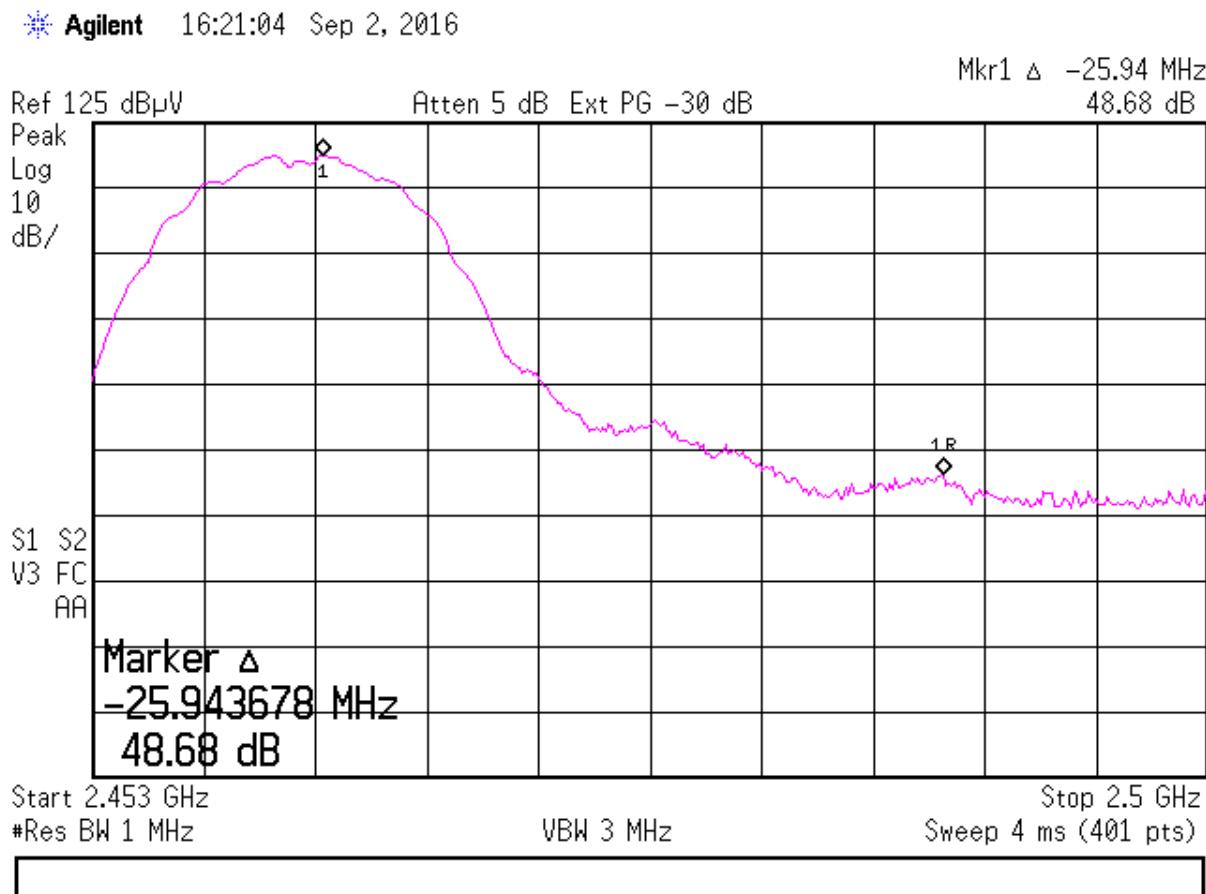


Figure 44. Band Edge Compliance – 802.11b – High Channel Delta – Peak

Calculation of worst case 802.11b PEAK upper band edge measurement:

High Channel Corrected Measured Value from Table 6	99.20	dB μ V
<u>High Channel Band Edge Delta from Figure 33</u>	-48.68	dB
Calculated Result	50.52	dB μ V/m
Average Limit + 20dB Relaxation for PEAK	74.00	dB μ V/m
<u>Calculated Result</u>	-50.52	dB μ V/m
Band Edge Margin	23.48	dB μ V/m

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September 8, 2016
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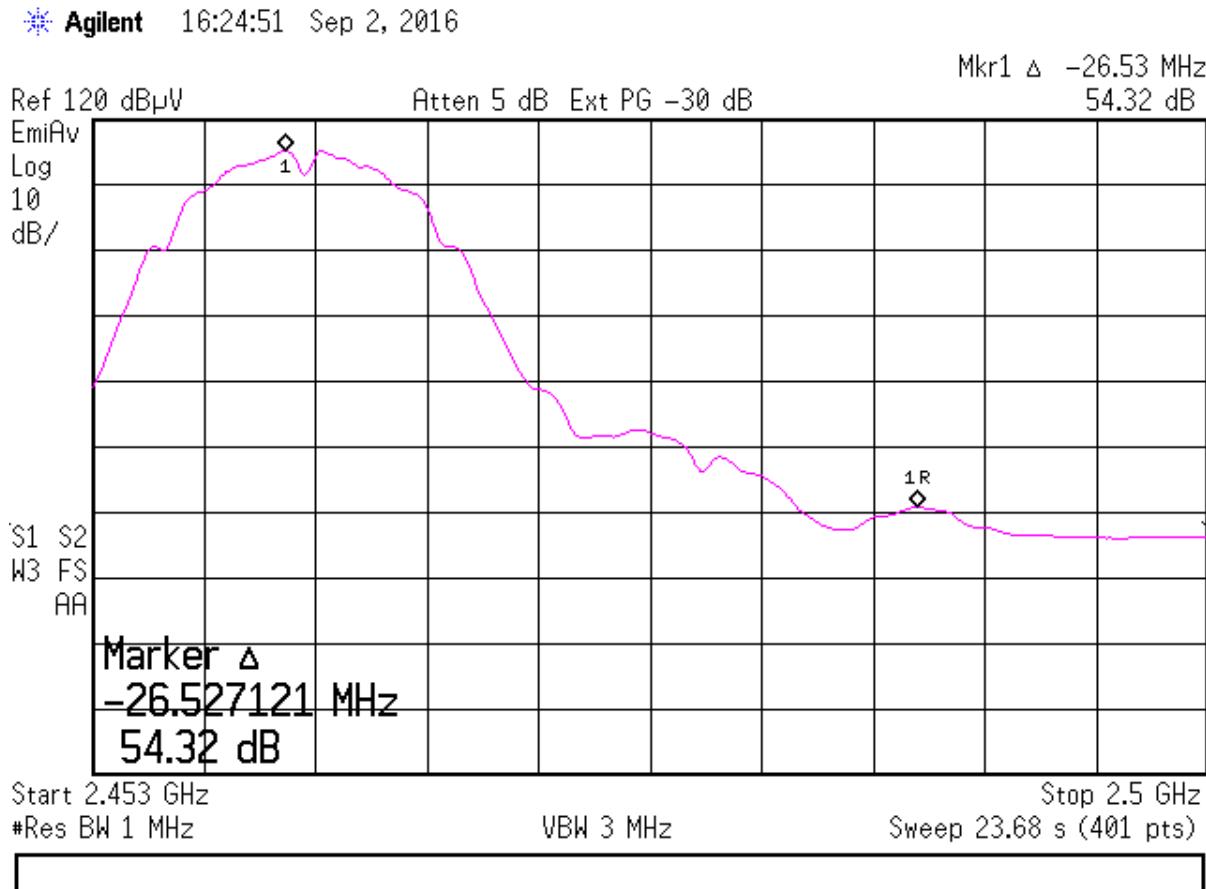


Figure 45. Band Edge Compliance – 802.11b – High Channel Delta – Average

Calculation of worst case 802.11b AVERAGE upper band edge measurement:

High Channel Corrected Measured Value from Table 7	88.26	dB μ V
High Channel Band Edge Delta from Figure 34	-54.32	dB
Calculated Result	33.94	dB μ V/m
Peak Limit	54.00	dB μ V/m
Calculated Result	-33.94	dB μ V/m
Band Edge Margin	20.06	dB μ V/m

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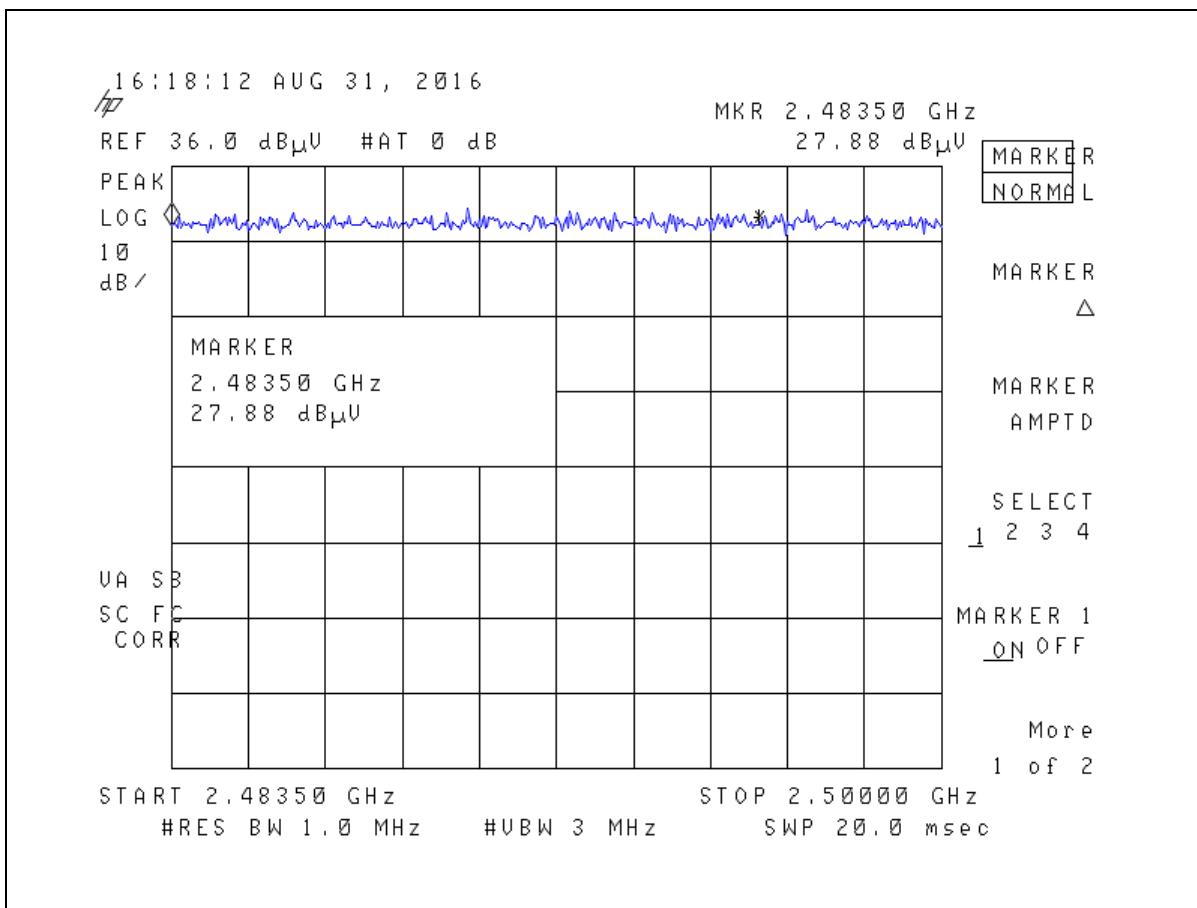


Figure 46. Radiated Restricted Band 2483.5 MHz to 2500 MHz – 802.11b – Peak

Table 14. Radiated Restricted Band 2483.5 MHz to 2500 MHz – 802.11b – Peak

2483.5 MHz to 2500 MHz Restricted Band Peak Measurements							
Test: Radiated Emissions				Client: Wink Labs, Inc.			
Project: 16-0218				Model: Wink Hub 2			
Frequency (MHz)	Test Data (dB μ V)	AF+CA-AMP (dB/m)	Results (dB μ V/m)	PK Limits (dB μ V/m)	Antenna Distance/Polarization	Margin (dB)	Detector PK, or AVG
2483.50	27.88	30.94	58.82	74.0	3.0m./VERT	15.2	PK

Test Date: Aug 29, 2016

Tested By

Signature: 

Name: Ashton Picas

US Tech Test Report:
 FCC ID:
 IC:
 Test Report Number:
 Issue Date:
 Customer:
 Model:

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 Wink Labs, Inc.
Wink Hub 2

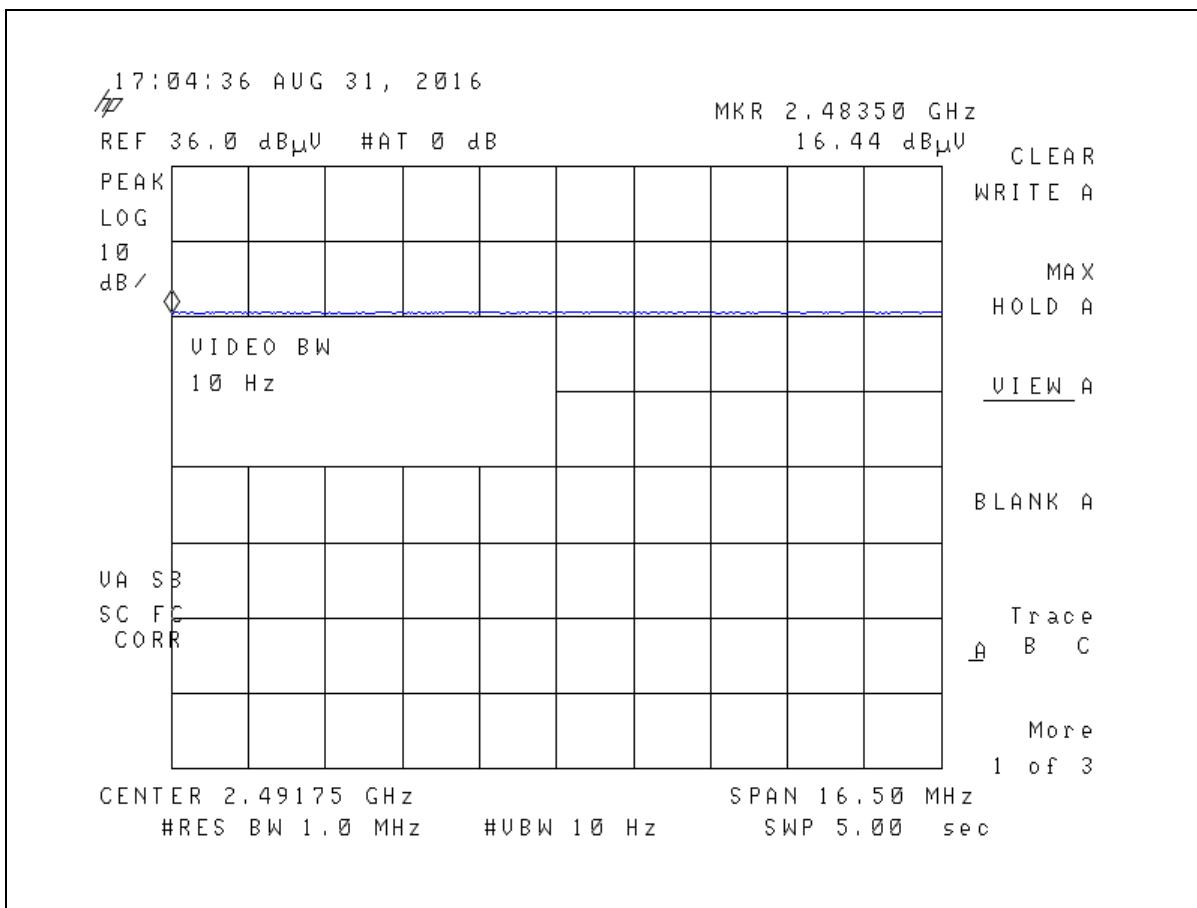


Figure 47. Radiated Restricted Band 2483.5 MHz to 2500 MHz – 802.11b – AVG

Table 15. Radiated Restricted Band 2483.5 MHz to 2500 MHz – 802.11b – AVG

2483.5 MHz to 2500 MHz Restricted Band Average Measurements							
Test: Radiated Emissions				Client: Wink Labs, Inc.			
Project: 16-0218				Model: Wink Hub 2			
Frequency (MHz)	Test Data (dB _{uv})	AF+CA-AMP (dB/m)	Results (dB _{uV} /m)	AVG Limits (dB _{uV} /m)	Antenna Distance/Polarization	Margin (dB)	Detector PK, or AVG
2483.50	16.44	30.94	47.38	54.0	3.0m./VERT	6.6	AVG

Test Date: Aug 29, 2016

Tested By

Signature: Ashton Picas

Name: Ashton Picas

US Tech Test Report:
FCC ID:
IC:
Test Report Number:
Issue Date:
Customer:
Model:

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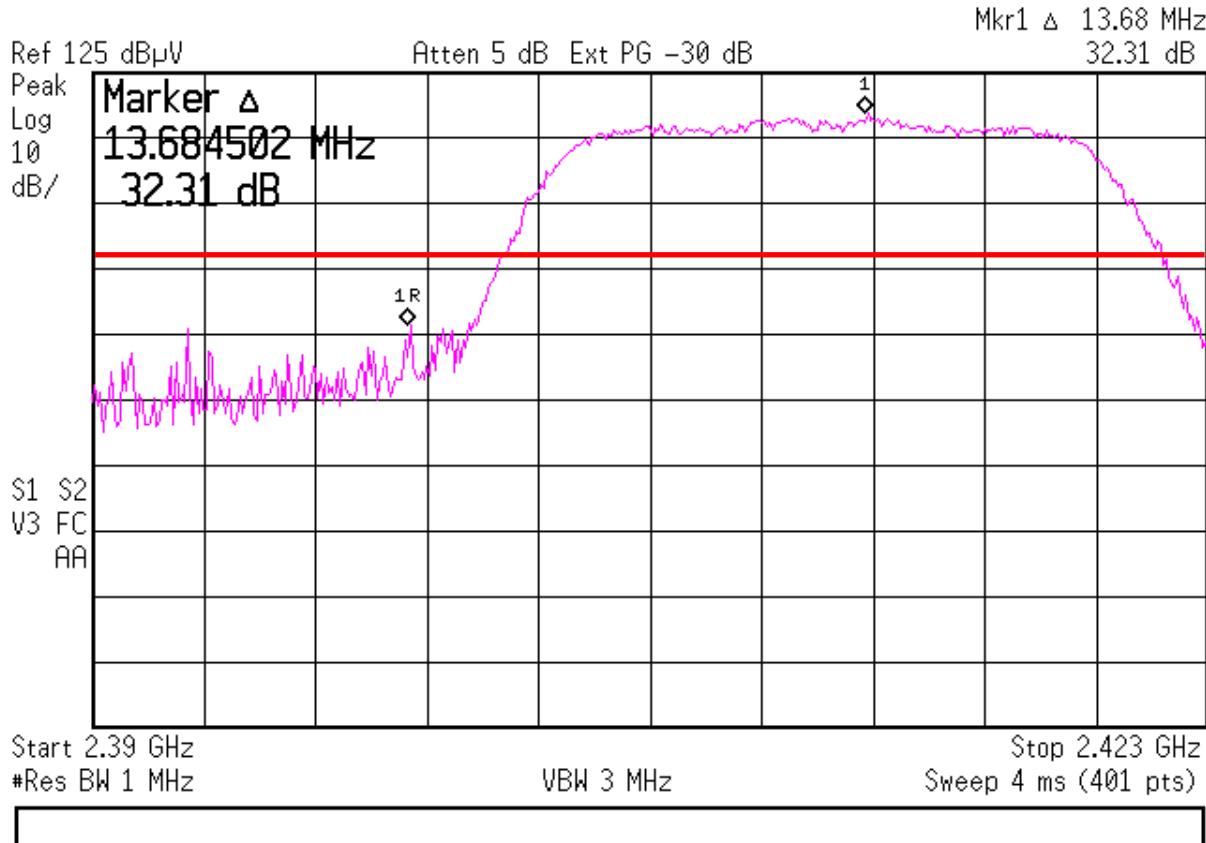


Figure 48. Band Edge Compliance – 802.11g – Low Channel Delta - Peak
(Lower band edge must be greater than 20 dB)

US Tech Test Report:
FCC ID:
IC:
Test Report Number:
Issue Date:
Customer:
Model:

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Wink Labs, Inc.
Wink Hub 2

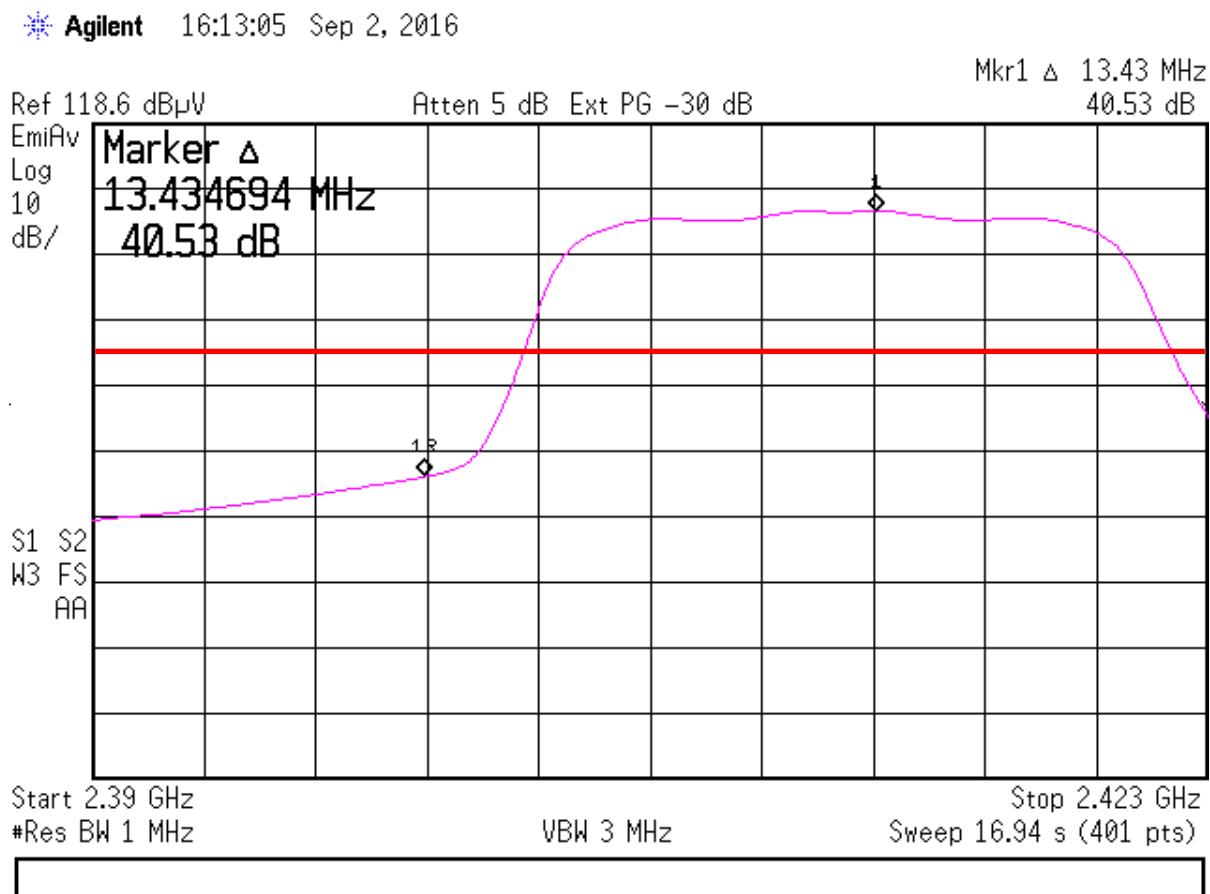


Figure 49. Band Edge Compliance – 802.11g – Low Channel Delta – Average
(Lower band edge must be greater than 20 dB)

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FCC ID:
IC:
Test Report Number:
Issue Date:
Customer:
Model:

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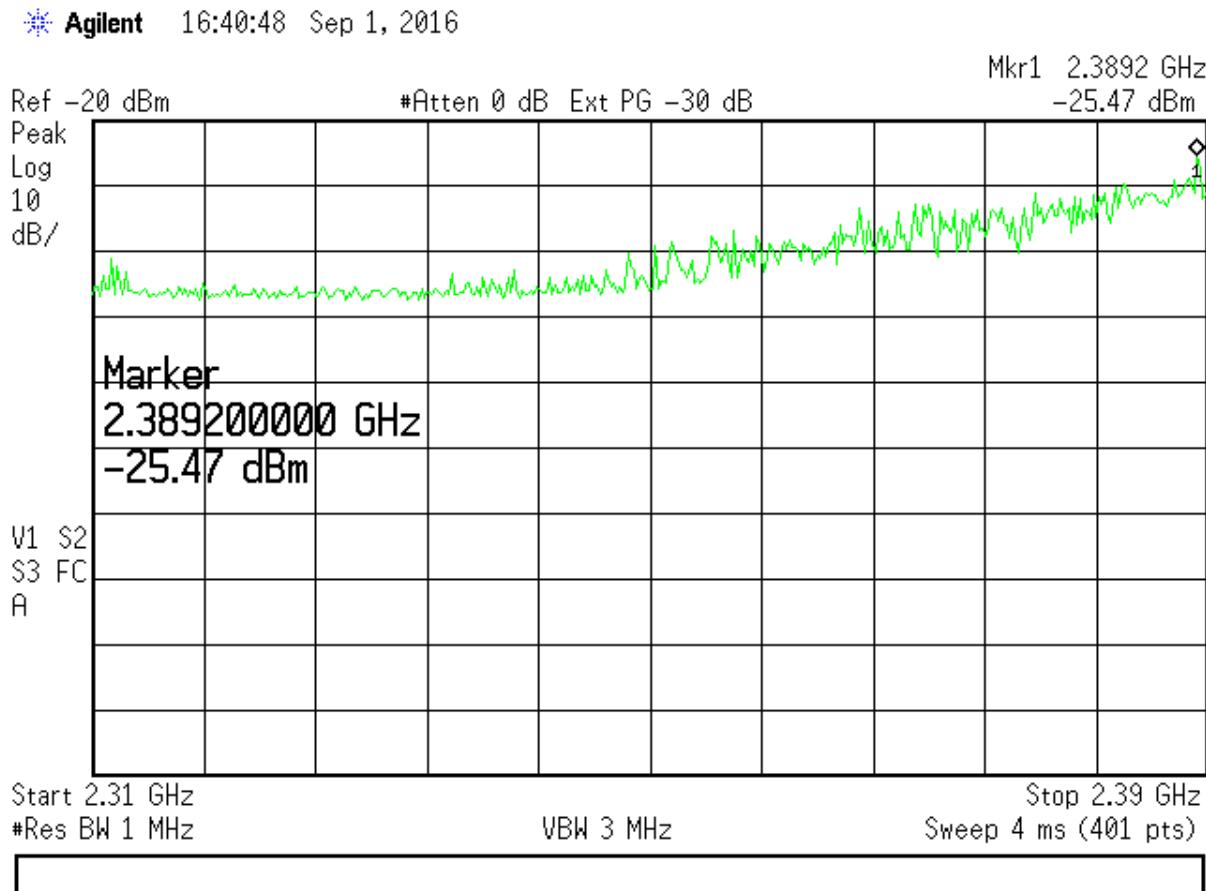


Figure 50. Conducted Restricted Band 2310 MHz to 2390 MHz – 802.11g – Peak

The restricted band plot above was performed using the conducted method per KDB 558074 v03r05, section 12.2.2.

Measured conducted output power	-25.47	dBm
Maximum transmit antenna gain	-2.50	dBi
Ground reflection factor	0.00	dB
Calculated EIRP Result	-27.97	dBm

Electric Field Conversion: $E = \text{EIRP} - 20 \log D + 104.8$

Note: D = 3 meters

$$E = -27.97 \text{ dBm} - 20 \log (3) + 104.8 = -27.97 - 9.54 + 104.8 = 67.29 \text{ dBuV/m}$$

PEAK limit	74.00	dBuV/m
Calculated Result	-67.29	dBuV/m
Margin	6.71	dB

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Model:

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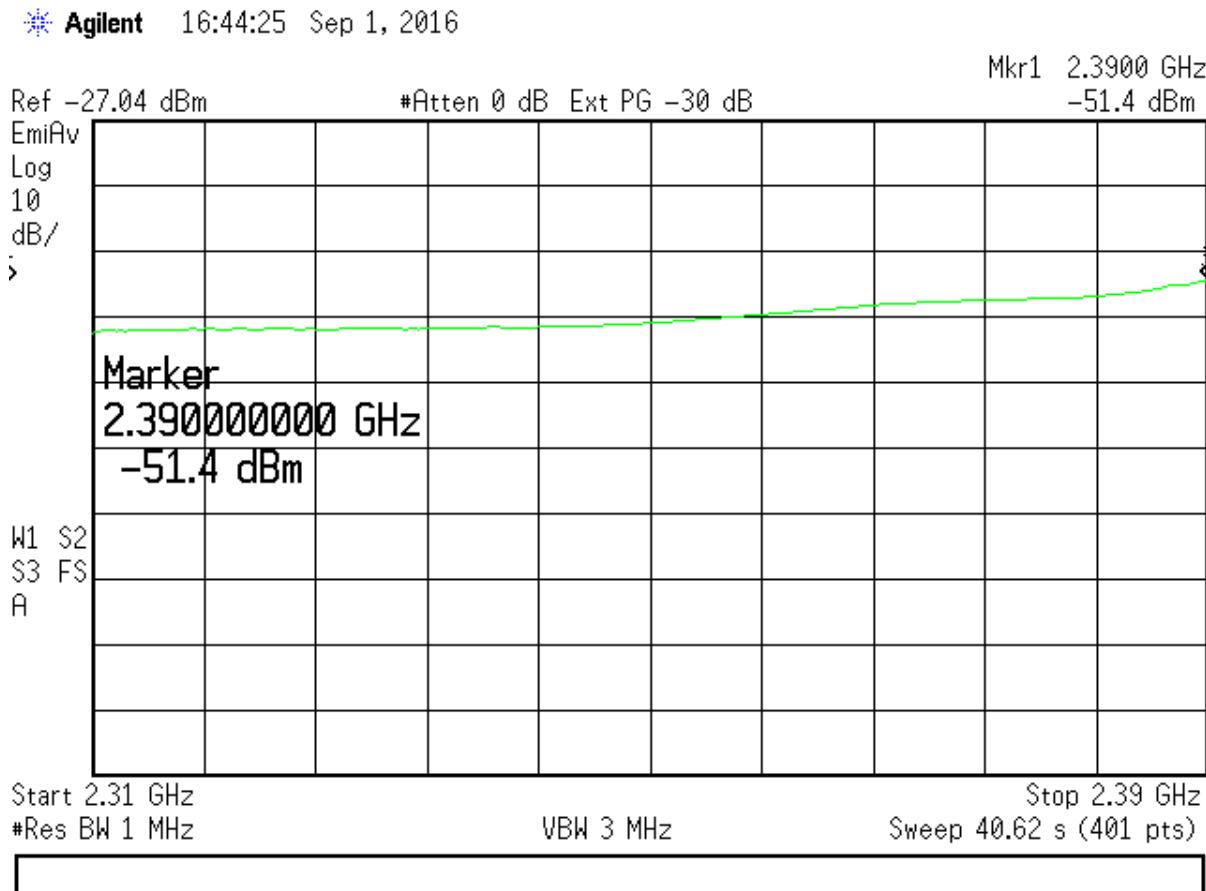


Figure 51. Conducted Restricted Band 2310 MHz to 2390 MHz – 802.11g – Peak

The restricted band plot above was performed using the conducted method per KDB 558074 v03r05, section 12.2.2.

Measured conducted output power	-51.40	dBm
Maximum transmit antenna gain	-2.50	dBi
Ground reflection factor	0.00	dB
Calculated EIRP Result	-53.90	dBm

Electric Field Conversion: $E = \text{EIRP} - 20 \log D + 104.8$

Note: D = 3 meters

$$E = -53.90 \text{ dBm} - 20 \log (3) + 104.8 = -53.90 - 9.54 + 104.8 = 41.36 \text{ dBuV/m}$$

AVG limit	54.00	dBuV/m
Calculated Result	-41.36	dBuV/m
Margin	12.64	dB

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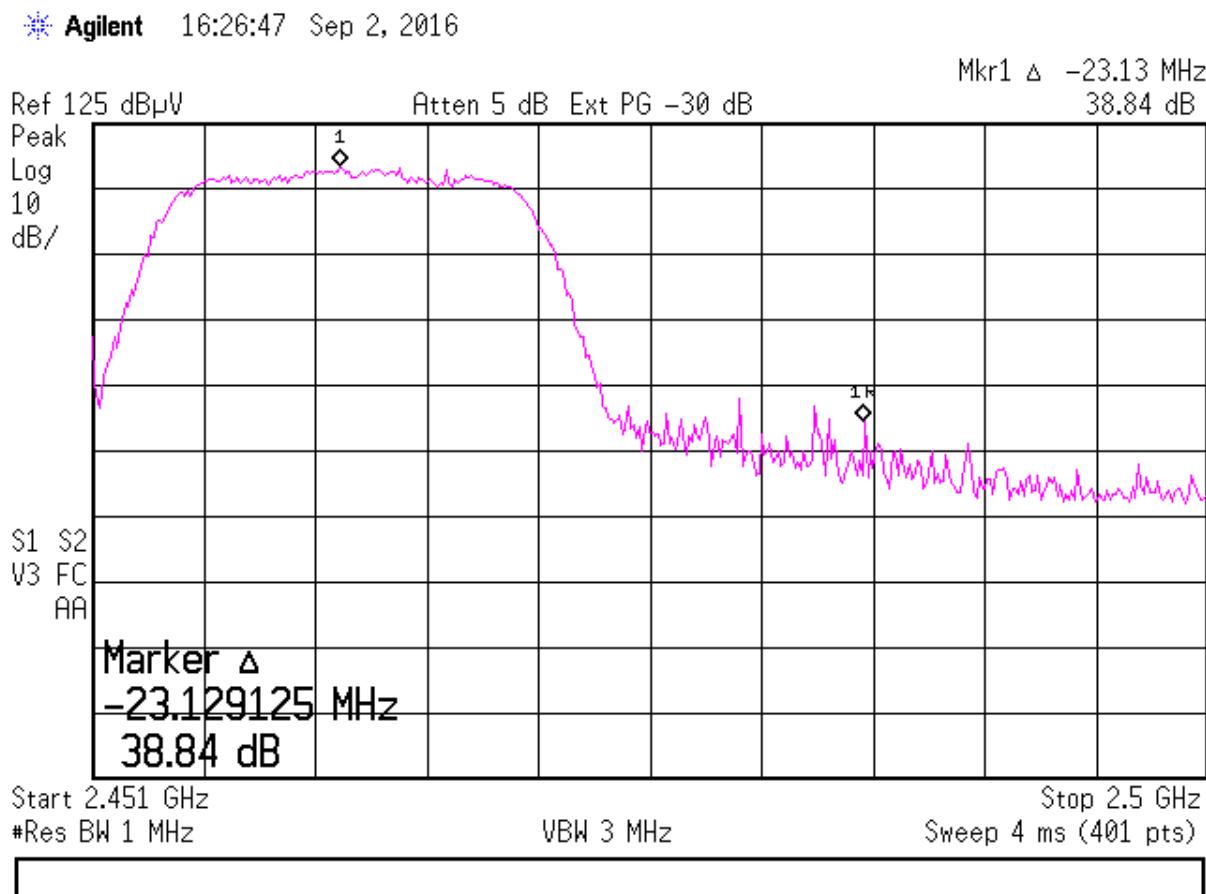


Figure 52. Band Edge Compliance – 802.11g – High Channel Delta – Peak

Calculation of worst case 802.11g PEAK upper band edge measurement:

High Channel Corrected Measured Value from Table 8	95.68	dB μ V
High Channel Band Edge Delta from Figure 37	-38.84	dB
Calculated Result	56.84	dB μ V/m
Average Limit + 20dB Relaxation for PEAK	74.00	dB μ V/m
Calculated Result	-56.84	dB μ V/m
Band Edge Margin	17.16	dB μ V/m

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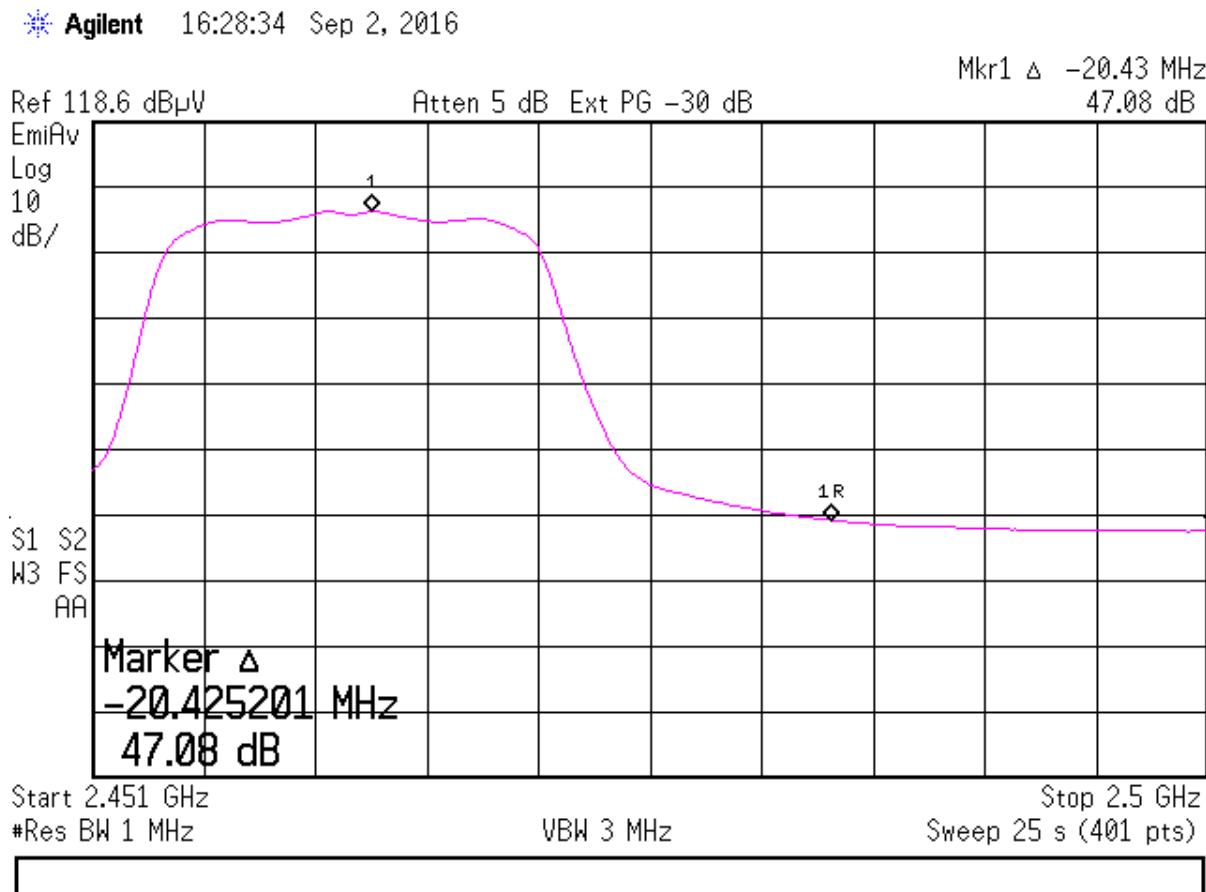


Figure 53. Band Edge Compliance – 802.11g – High Channel Delta – Average

Calculation of worst case 802.11g AVERAGE upper band edge measurement:

High Channel Corrected Measured Value from Table 9	76.97	dB μ V
High Channel Band Edge Delta from Figure 38	-47.08	dB
Calculated Result	29.89	dB μ V/m
Peak Limit	54.00	dB μ V/m
Calculated Result	-29.89	dB μ V/m
Band Edge Margin	24.11	dB μ V/m

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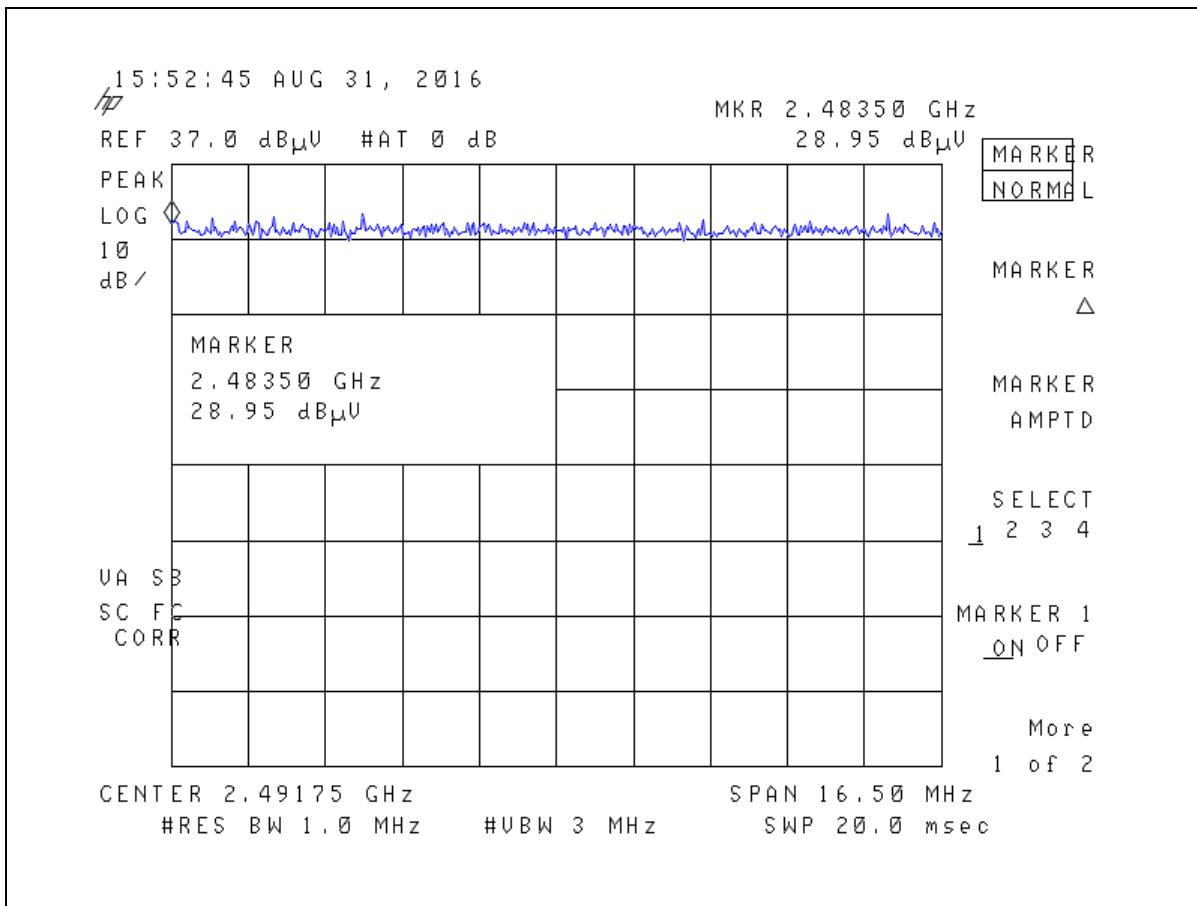


Figure 54. Radiated Restricted Band 2483.5 MHz to 2500 MHz – 802.11g – Peak

Table 16. Radiated Restricted Band 2483.5 MHz to 2500 MHz – 802.11g – Peak

2483.5 MHz to 2500 MHz Restricted Band Peak Measurements							
Test: Radiated Emissions				Client: Wink Labs, Inc.			
Project: 16-0218				Model: Wink Hub 2			
Frequency (MHz)	Test Data (dB _{BuV})	AF+CA-AMP (dB/m)	Results (dB _{BuV/m})	PK Limits (dB _{BuV/m})	Antenna Distance/Polarization	Margin (dB)	Detector PK, or AVG
2483.50	28.95	30.94	59.89	74.0	3.0m./VERT	14.1	PK

Test Date: Aug 29, 2016

Tested By

Signature: Ashton Picas

Name: Ashton Picas

US Tech Test Report:
 FCC ID:
 IC:
 Test Report Number:
 Issue Date:
 Customer:
 Model:

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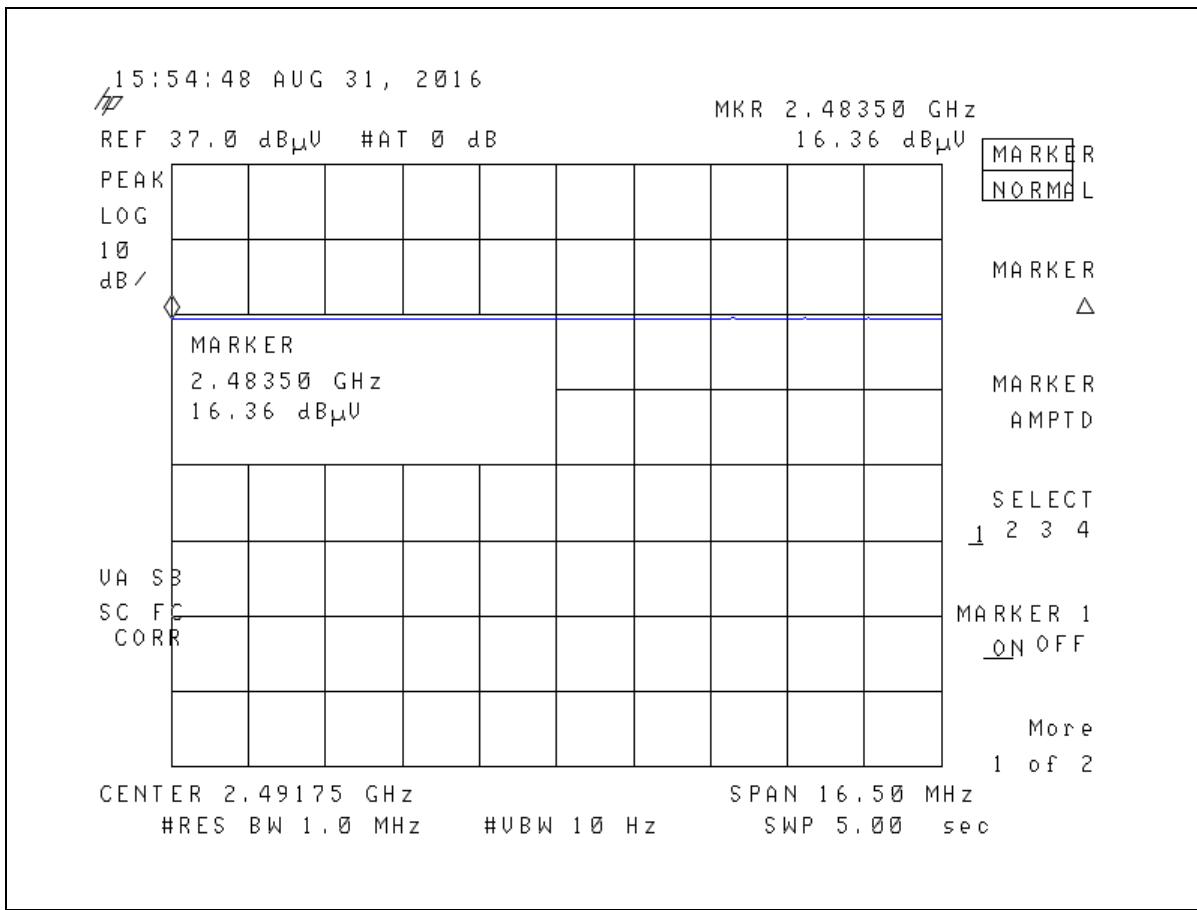


Figure 55. Radiated Restricted Band 2483.5 MHz to 2500 MHz – 802.11g – AVG

Table 17. Radiated Restricted Band 2483.5 MHz to 2500 MHz – 802.11g – AVG

2483.5 MHz to 2500 MHz Restricted Band Average Measurements							
Test: Radiated Emissions				Client: Wink Labs, Inc.			
Project: 16-0218				Model: Wink Hub 2			
Frequency (MHz)	Test Data (dB _{BuV})	AF+CA-AMP (dB/m)	Results (dB _{BuV/m})	AVG Limits (dB _{BuV/m})	Antenna Distance/Polarization	Margin (dB)	Detector PK, or AVG
2483.50	16.36	30.94	47.30	54.0	3.0m./VERT	6.7	AVG

Test Date: Aug 29, 2016

Tested By

Signature: Ashton Picas

Name: Ashton Picas

US Tech Test Report:
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Issue Date:
Customer:
Model:

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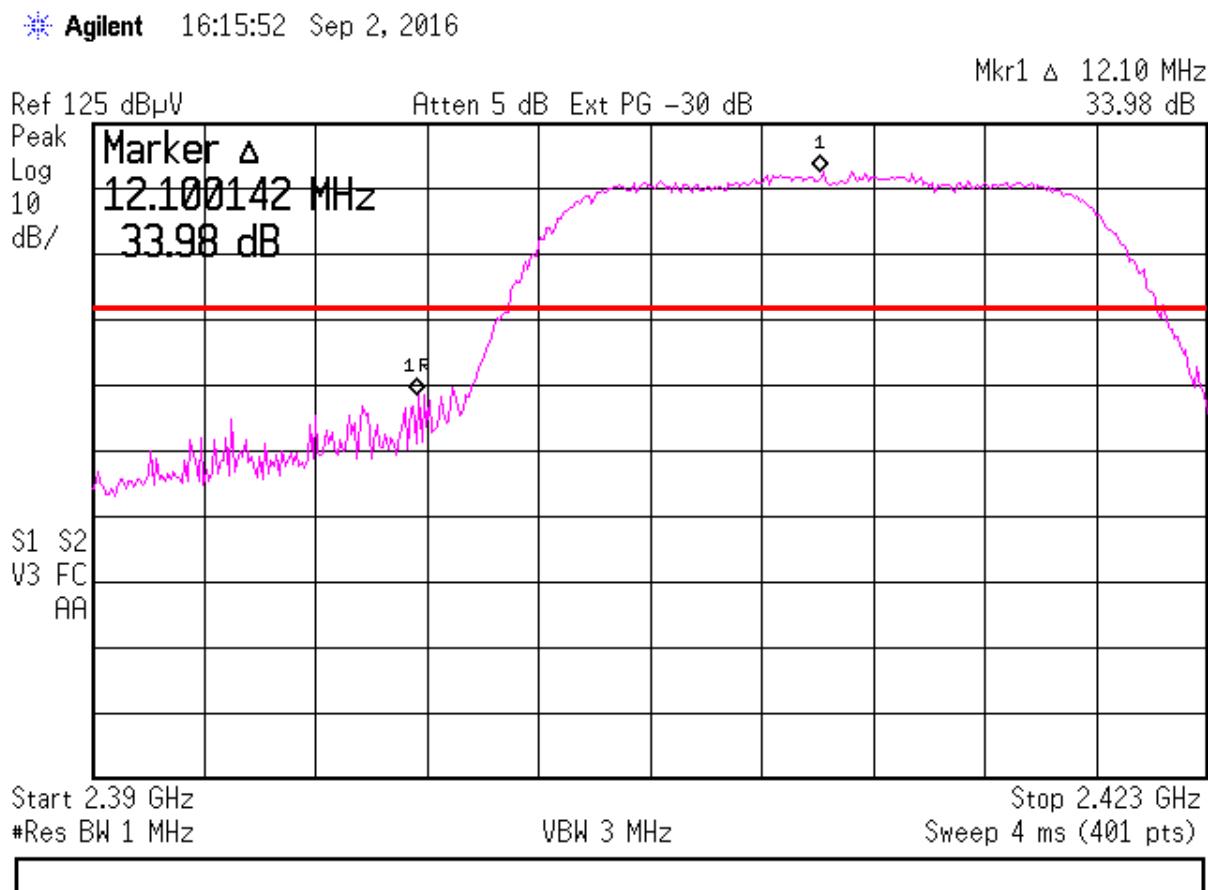


Figure 56. Band Edge Compliance – 802.11n – Low Channel Delta – Peak
(Lower band edge must be greater than 20 dB)

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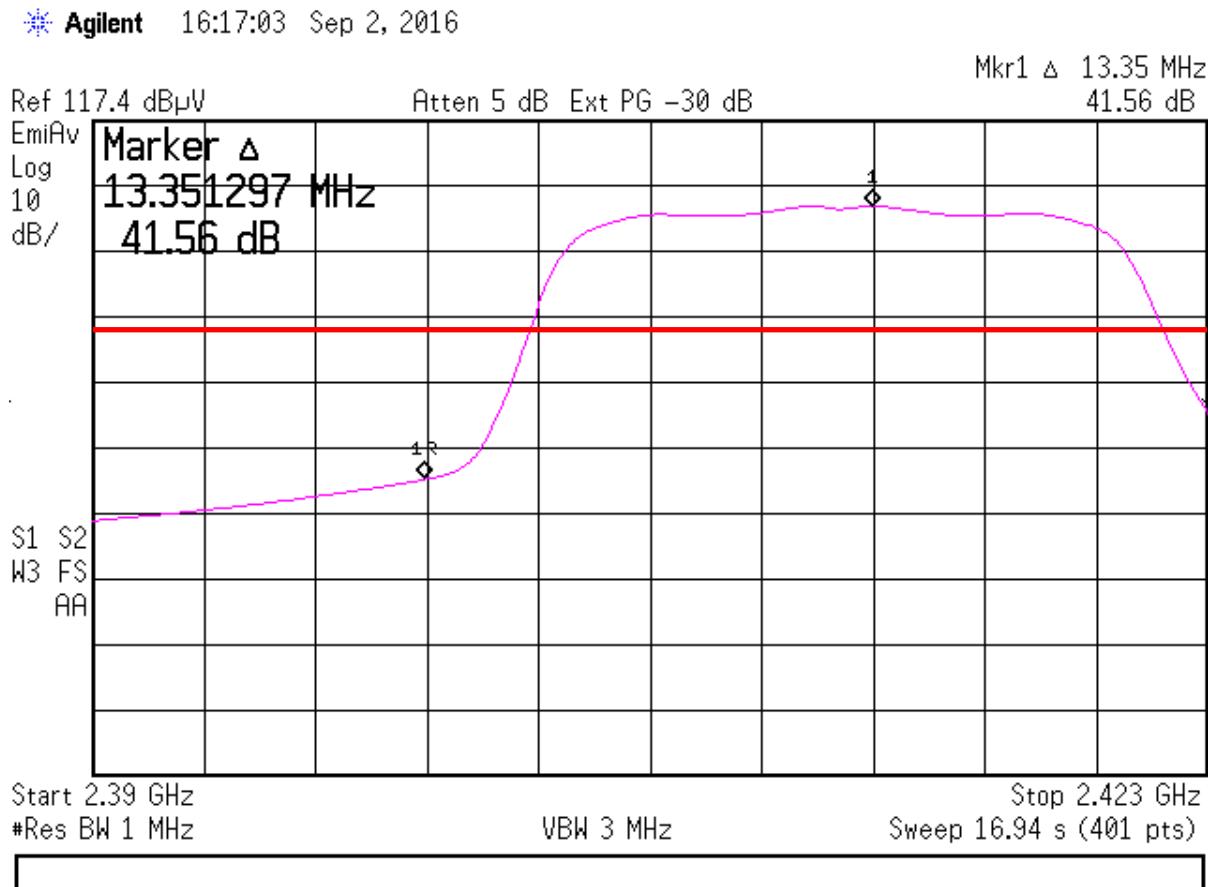


Figure 57. Band Edge Compliance – 802.11n – Low Channel Delta – Average
(Lower band edge must be greater than 20 dB)

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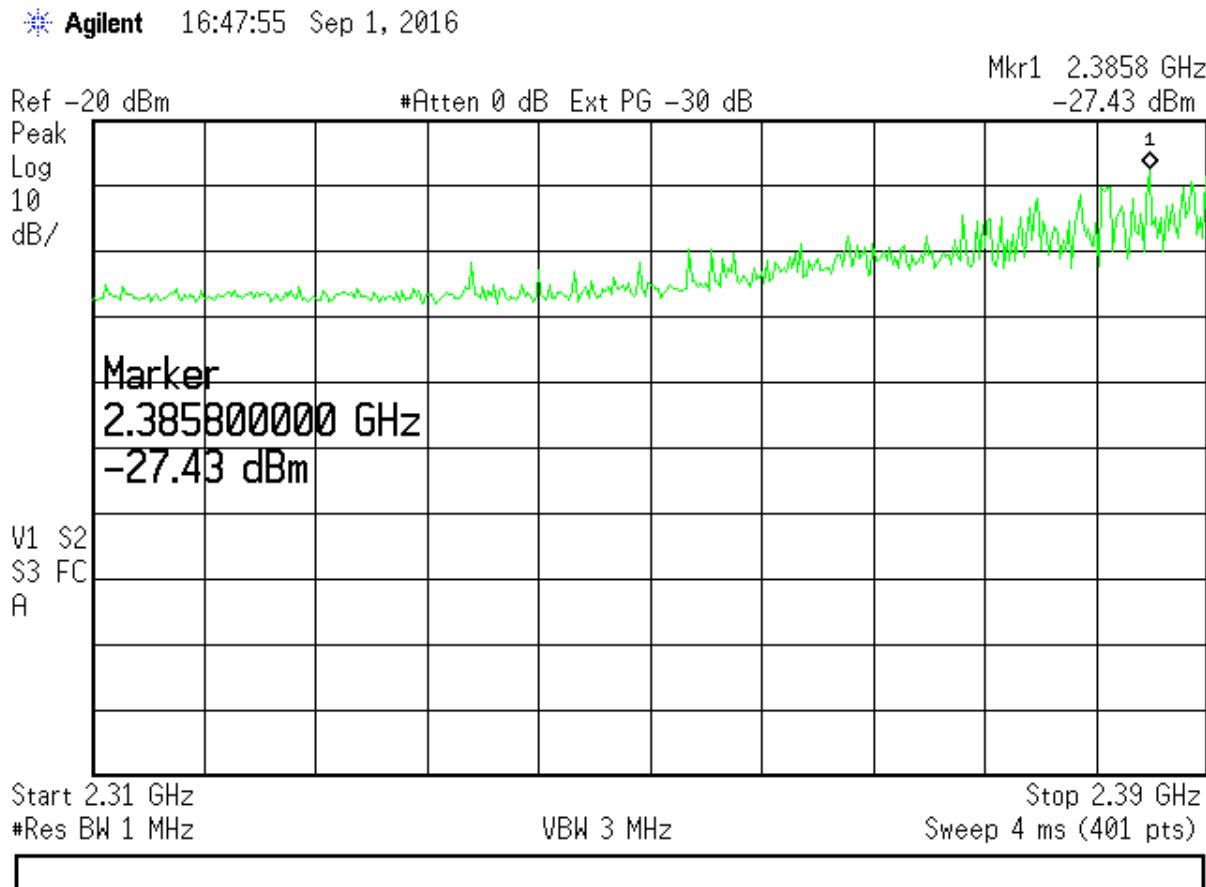


Figure 58. Conducted Restricted Band 2310 MHz to 2390 MHz – 802.11n – Peak

The restricted band plot above was performed using the conducted method per KDB 558074 v03r05, section 12.2.2.

Measured conducted output power	-27.43	dBm
Maximum transmit antenna gain	-2.50	dB
<u>Ground reflection factor</u>	0.00	dB
Calculated EIRP Result	-29.93	dBm

Electric Field Conversion: $E = \text{EIRP} - 20 \log D + 104.8$

Note: D = 3 meters

$$E = -29.93 \text{ dBm} - 20 \log (3) + 104.8 = -29.93 - 9.54 + 104.8 = 65.33 \text{ dBuV/m}$$

<u>PEAK limit</u>	74.00	dBuV/m
<u>Calculated Result</u>	-65.33	dBuV/m
Margin	8.67	dB

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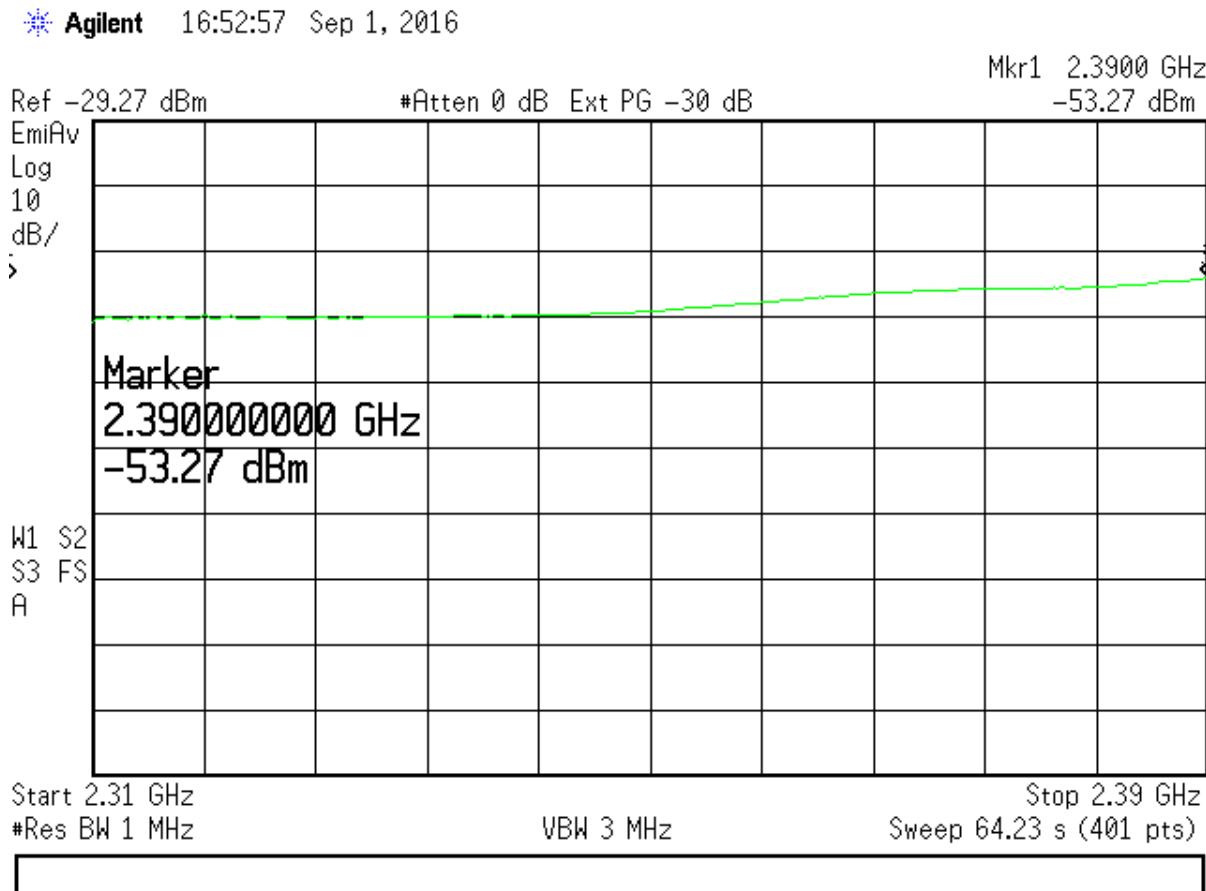


Figure 59. Conducted Restricted Band 2310 MHz to 2390 MHz – 802.11n – Peak

The restricted band plot above was performed using the conducted method per KDB 558074 v03r05, section 12.2.2.

Measured conducted output power	-53.27	dBm
Maximum transmit antenna gain	-2.50	dBi
Ground reflection factor	0.00	dB
Calculated EIRP Result	-55.77	dBm

Electric Field Conversion: $E = \text{EIRP} - 20 \log D + 104.8$

Note: D = 3 meters

$$E = -55.77 \text{ dBm} - 20 \log (3) + 104.8 = -55.77 - 9.54 + 104.8 = 39.49 \text{ dBuV/m}$$

AVG limit	54.00	dBuV/m
Calculated Result	-39.49	dBuV/m
Margin	14.51	dB

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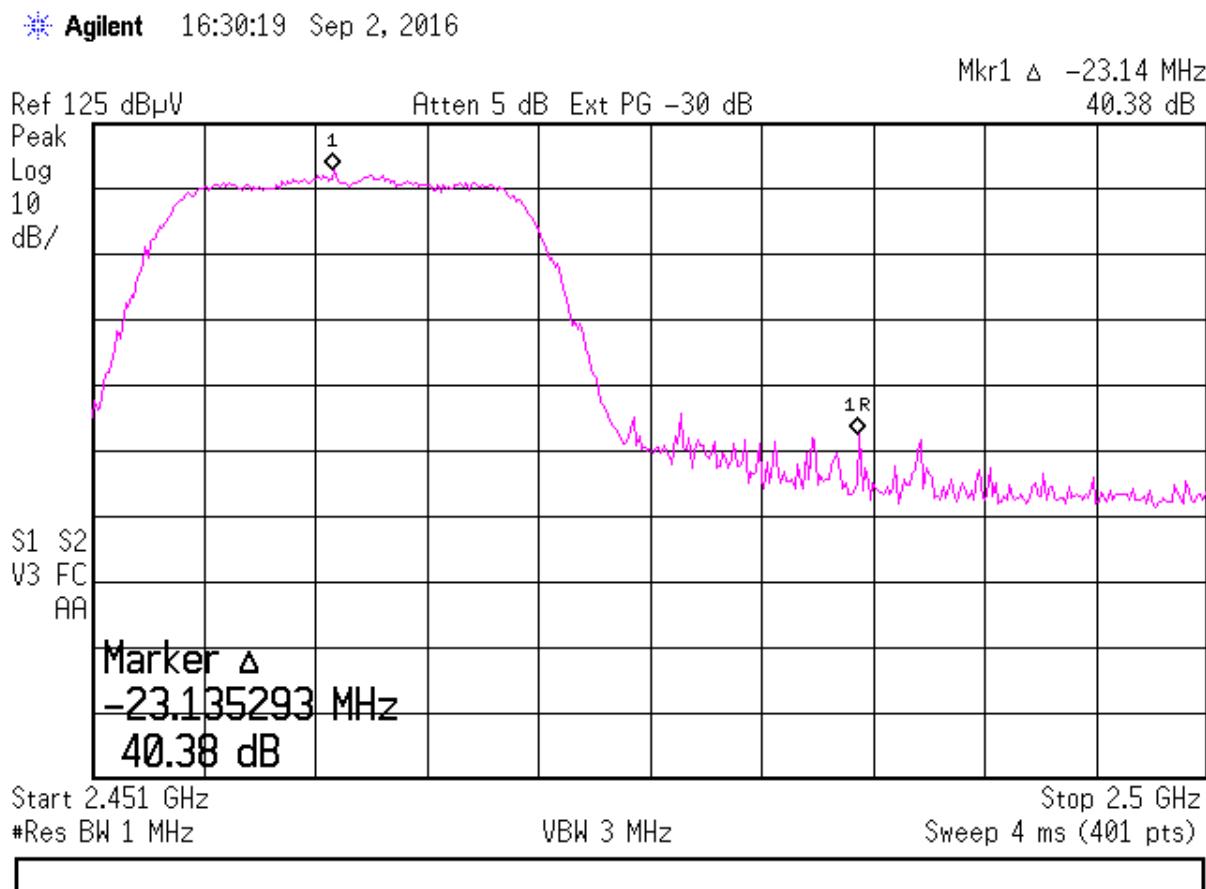


Figure 60. Band Edge Compliance – 802.11n – High Channel Delta – Peak

Calculation of worst case 802.11n PEAK upper band edge measurement:

High Channel Corrected Measured Value from Table 10 94.94 dB μ V

High Channel Band Edge Delta from Figure 41 -40.38 dB

Calculated Result 54.56 dB μ V/m

Average Limit + 20dB Relaxation for PEAK 74.00 dB μ V/m

Calculated Result -54.56 dB μ V/m

Band Edge Margin 19.44 dB μ V/m

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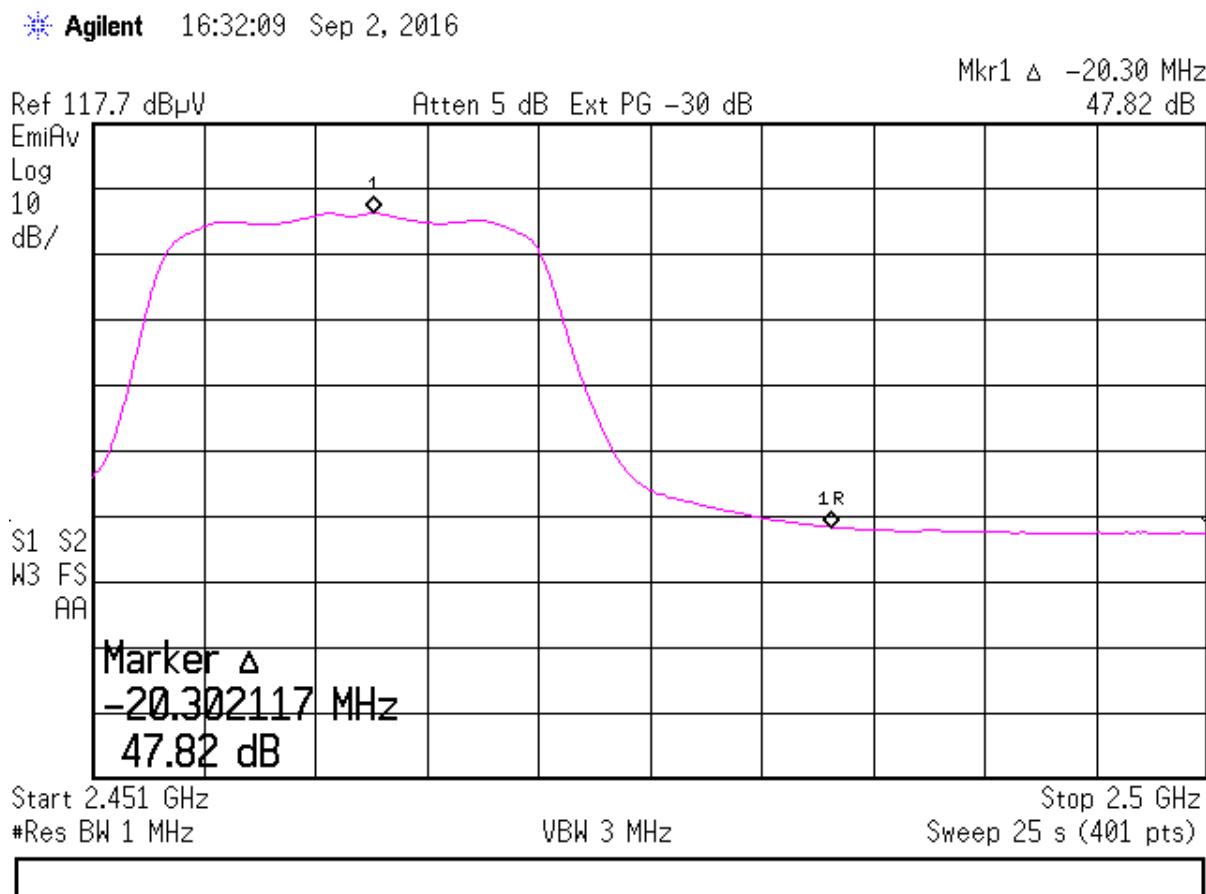


Figure 61. Band Edge Compliance – 802.11n – High Channel Delta – Average

Calculation of worst case 802.11n AVERAGE upper band edge measurement:

High Channel Corrected Measured Value from Table 11	76.91	dB μ V
High Channel Band Edge Delta from Figure 42	-47.82	dB
Calculated Result	29.09	dB μ V/m
Peak Limit	54.00	dB μ V/m
Calculated Result	-29.09	dB μ V/m
Band Edge Margin	24.91	dB μ V/m

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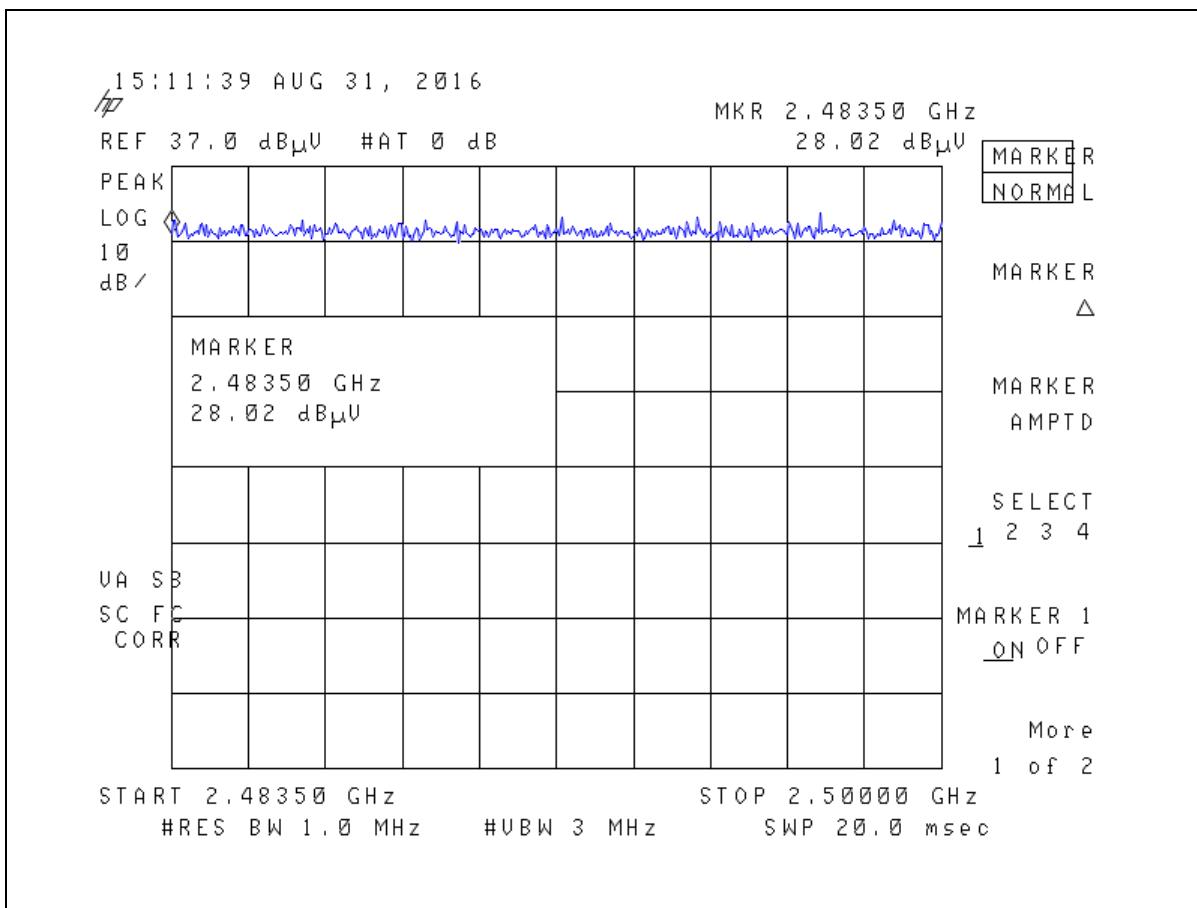


Figure 62. Radiated Restricted Band 2483.5 MHz to 2500 MHz – 802.11n – Peak

Table 18. Radiated Restricted Band 2483.5 MHz to 2500 MHz – 802.11n – Peak

2483.5 MHz to 2500 MHz Restricted Band Peak Measurements							
Test: Radiated Emissions				Client: Wink Labs, Inc.			
Project: 16-0218				Model: Wink Hub 2			
Frequency (MHz)	Test Data (dB μ V)	AF+CA-AMP (dB/m)	Results (dB μ V/m)	PK Limits (dB μ V/m)	Antenna Distance/Polarization	Margin (dB)	Detector PK, or AVG
2483.50	28.02	30.94	58.96	74.0	3.0m./VERT	15.0	PK

Test Date: Aug 29, 2016

Tested By

Signature: Ashton Picas

Name: Ashton Picas

US Tech Test Report:
 FCC ID:
 IC:
 Test Report Number:
 Issue Date:
 Customer:
 Model:

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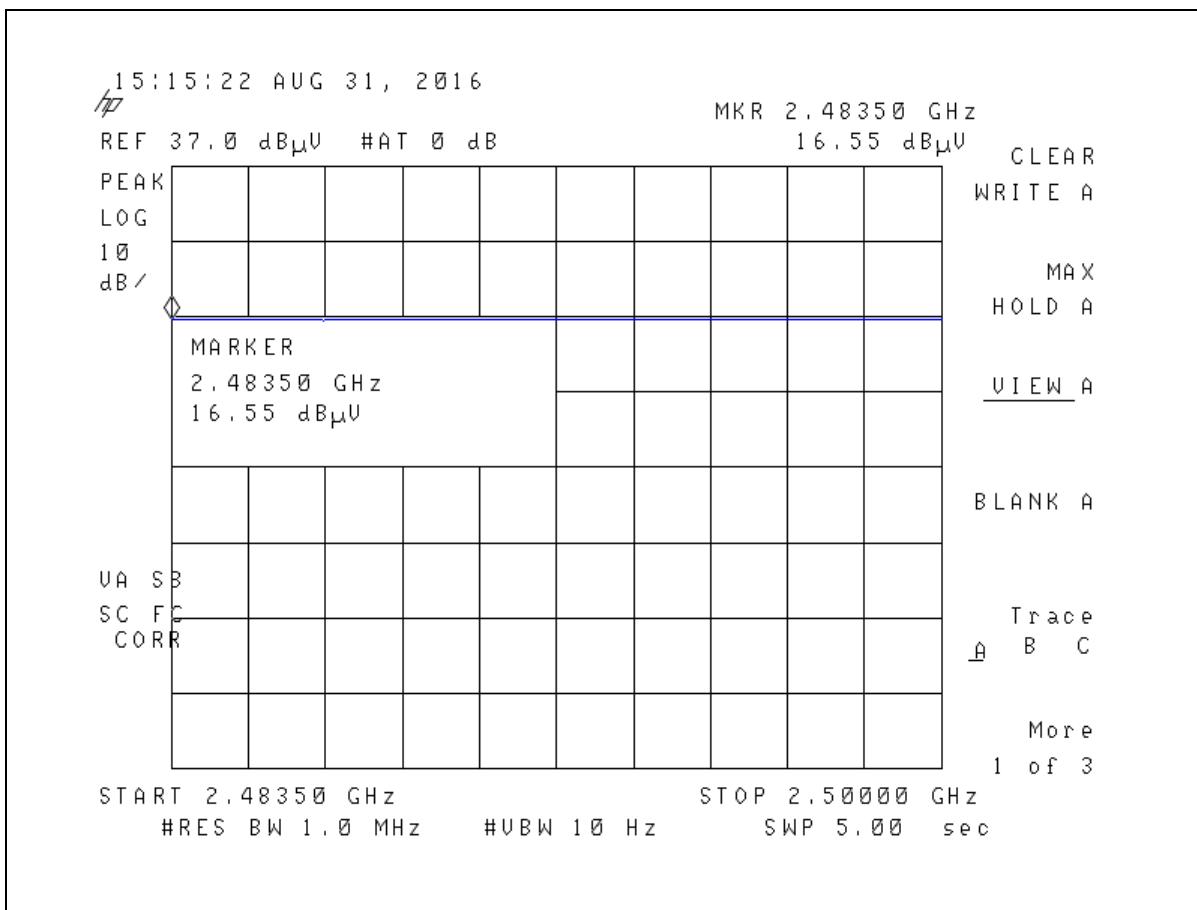


Figure 63. Radiated Restricted Band 2483.5 MHz to 2500 MHz – 802.11n – AVG

Table 19. Radiated Restricted Band 2483.5 MHz to 2500 MHz – 802.11n – AVG

2483.5 MHz to 2500 MHz Restricted Band Average Measurements							
Test: Radiated Emissions				Client: Wink Labs, Inc.			
Project: 16-0218				Model: Wink Hub 2			
Frequency (MHz)	Test Data (dB _{uv})	AF+CA-AMP (dB/m)	Results (dB _{uV} /m)	AVG Limits (dB _{uV} /m)	Antenna Distance/Polarization	Margin (dB)	Detector PK, or AVG
2483.50	16.55	30.94	47.49	54.0	3.0m./VERT	6.5	AVG

Test Date: Aug 29, 2016

Tested By

Signature: Ashton Picas

Name: Ashton Picas

US Tech Test Report:
FCC ID:
IC:
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Model:

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2.15 Six (6) dB Bandwidth per CFR 15.247(a)(2)/99% Occupied Bandwidth per RSS-Gen 6.6

The EUT antenna port was connected to a spectrum analyzer having a 50Ω input impedance. Measurements were performed similar to the method of FCC, KDB Publication No. 558074 v03r05 for a bandwidth of 6 dB. The RBW was set to approximately 1/100 of the manufacturers claimed RBW and with the VBW \geq RBW. The results of this test are given in the table below and Figures below.

Table 20. Six (6) dB Bandwidth

Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum 6 dB Bandwidth Limit (MHz)	99% Occupied Bandwidth (MHz)
802.11b			
2412	8.90	0.500	12.20
2442	8.90	0.500	12.20
2462	8.90	0.500	12.20
802.11g			
2412	15.90	0.500	17.10
2442	15.90	0.500	17.20
2462	15.80	0.500	17.10
802.11n			
2412	15.80	0.500	17.10
2442	15.80	0.500	17.20
2462	15.80	0.500	17.10

Test Date: Sept 1, 2016

Tested By

Signature: 

Name: Ashton Picas

US Tech Test Report:
FCC ID:
IC:
Test Report Number:
Issue Date:
Customer:
Model:

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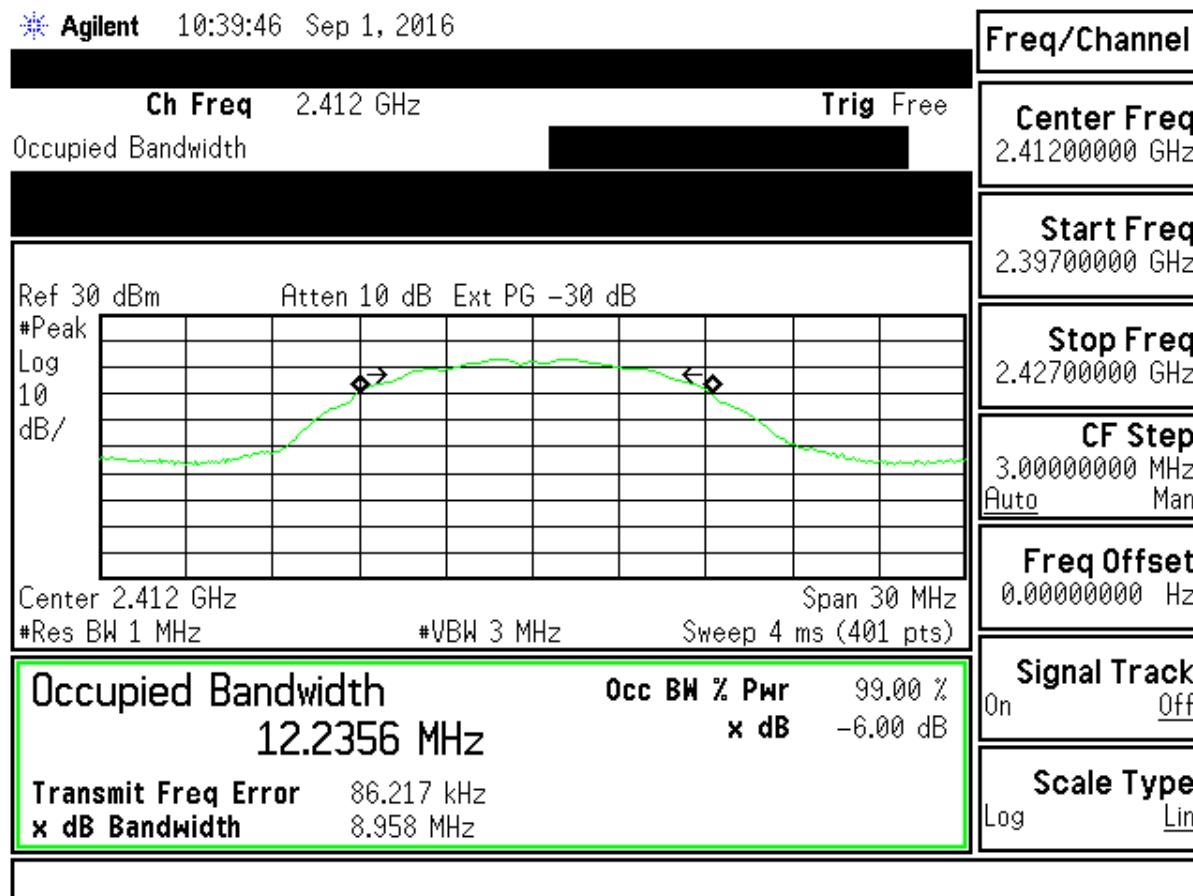
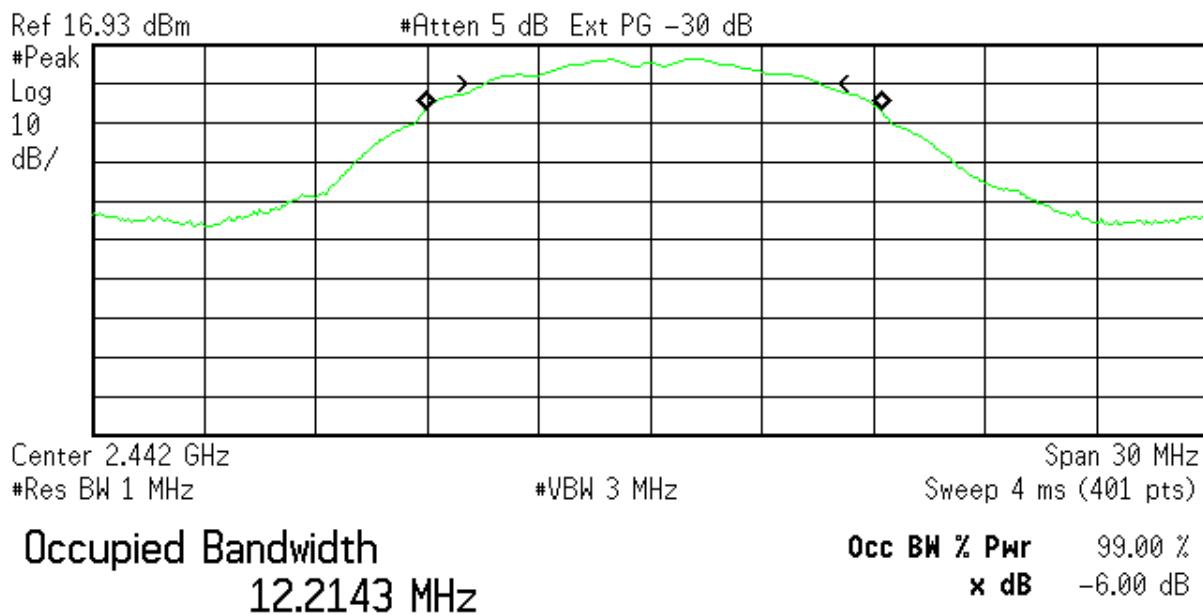


Figure 64. Bandwidth - Low Channel - 802.11b

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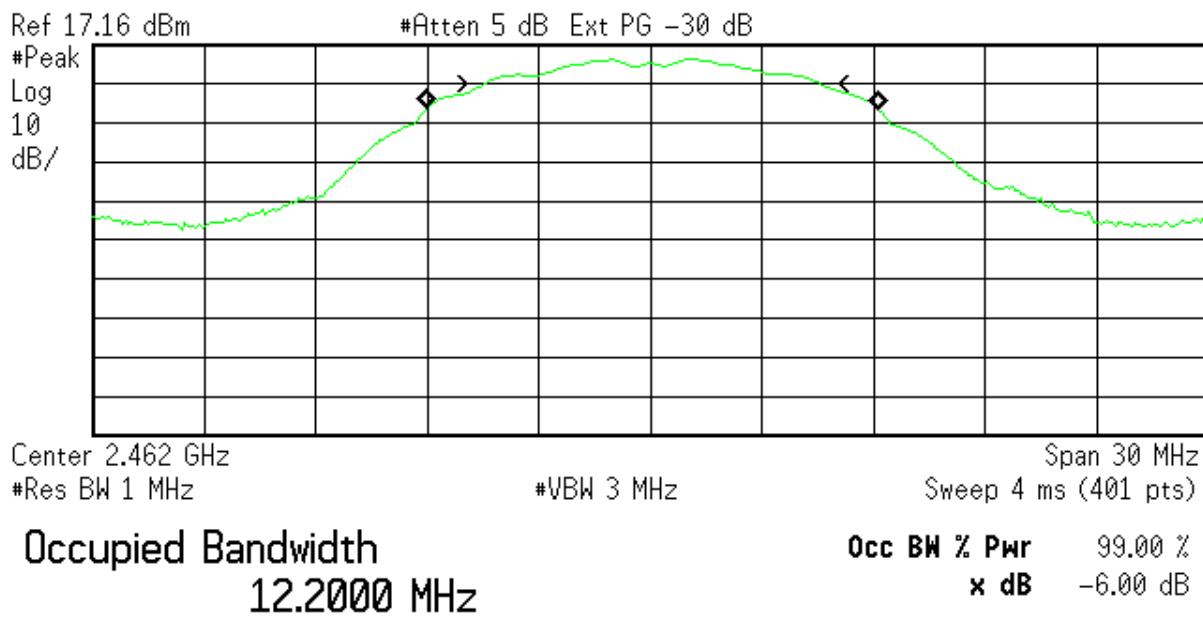
Transmit Freq Error 82.310 kHz
Occupied Bandwidth 8.959 MHz

Figure 65. Bandwidth - Mid Channel - 802.11b

US Tech Test Report:
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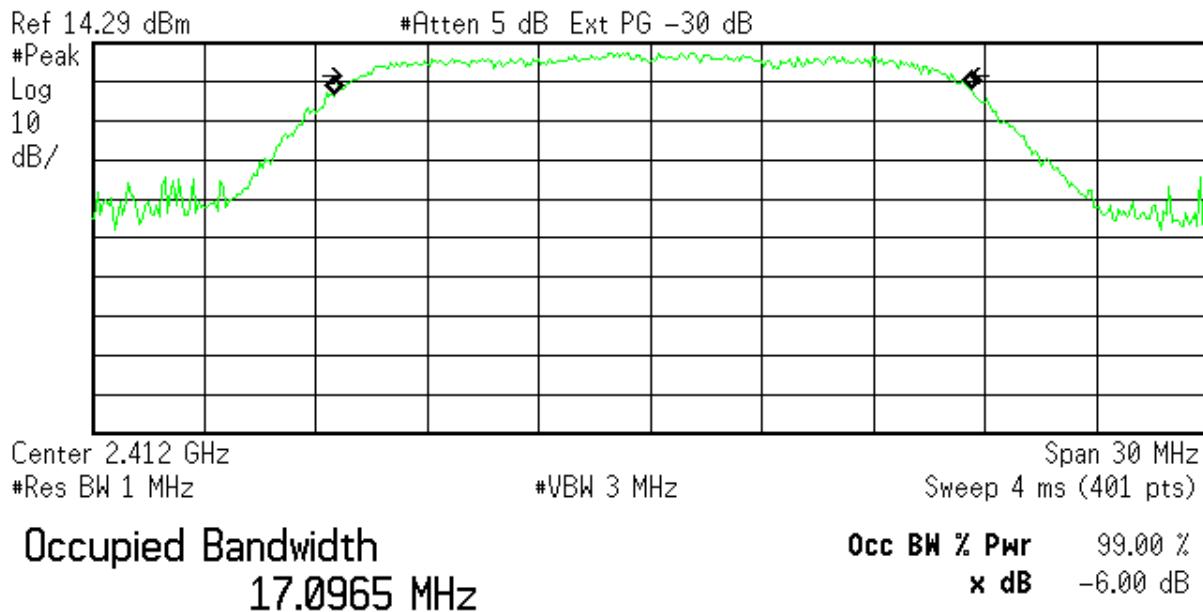
Transmit Freq Error 77.230 kHz
Occupied Bandwidth 8.948 MHz

Figure 66. Bandwidth - High Channel - 802.11b

US Tech Test Report:
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Test Report Number:
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Customer:
Model:

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Transmit Freq Error 83.877 kHz
Occupied Bandwidth 15.961 MHz

Figure 67. Bandwidth - Low Channel - 802.11g

US Tech Test Report:
FCC ID:
IC:
Test Report Number:
Issue Date:
Customer:
Model:

FCC Part 15 Certification/ RSS 210
2ACAJ-WHUB 2
11938A-WHUB2
16-0218
September 8, 2016
Wink Labs, Inc.
Wink Hub 2

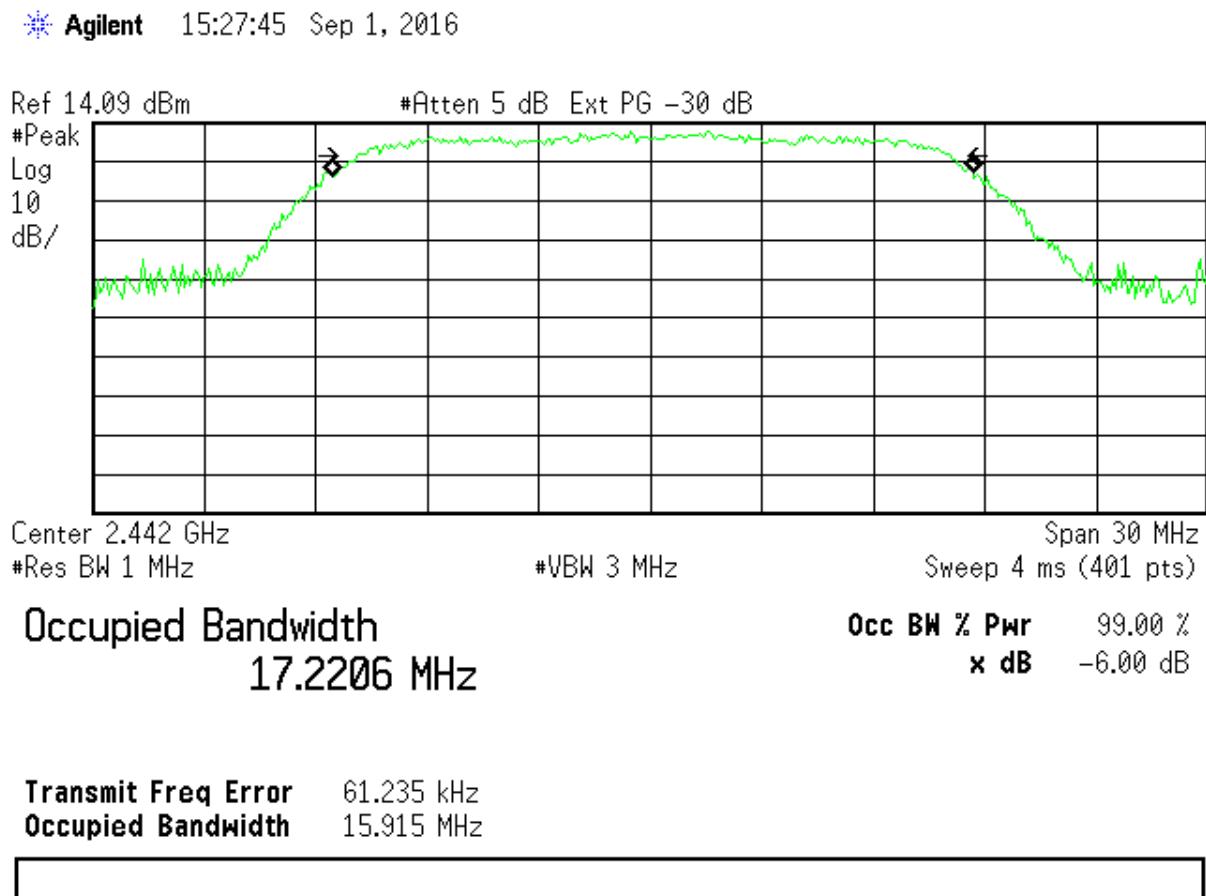
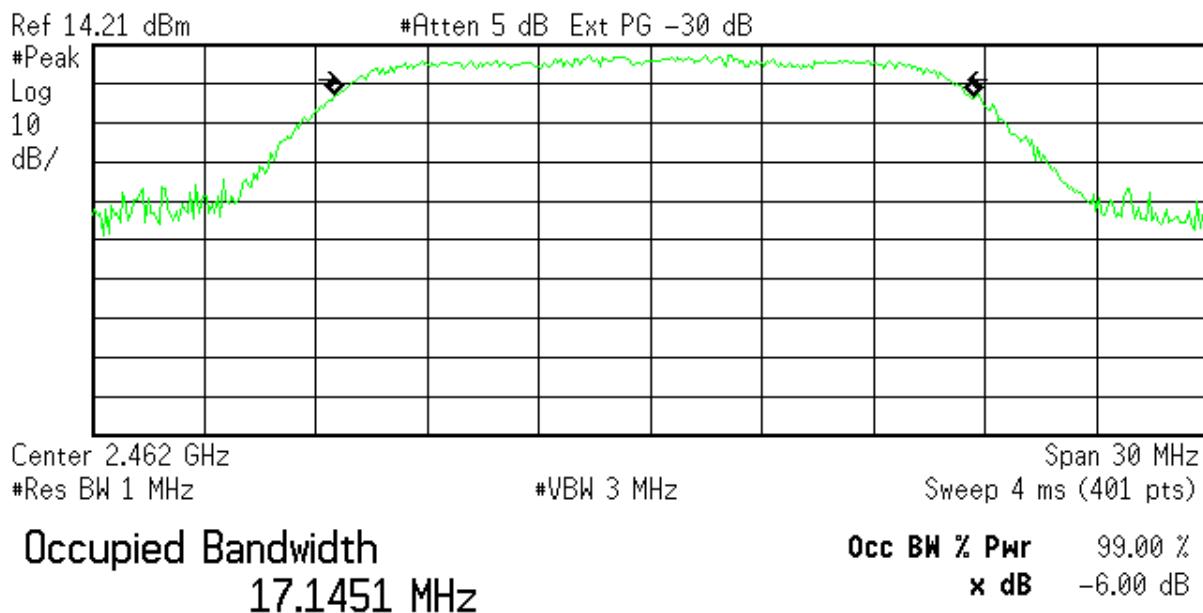


Figure 68. Bandwidth - Mid Channel - 802.11g

US Tech Test Report:
FCC ID:
IC:
Test Report Number:
Issue Date:
Customer:
Model:

FCC Part 15 Certification/ RSS 210
2ACAJ-WHUB 2
11938A-WHUB2
16-0218
September 8, 2016
Wink Labs, Inc.
Wink Hub 2

* Agilent 15:26:02 Sep 1, 2016



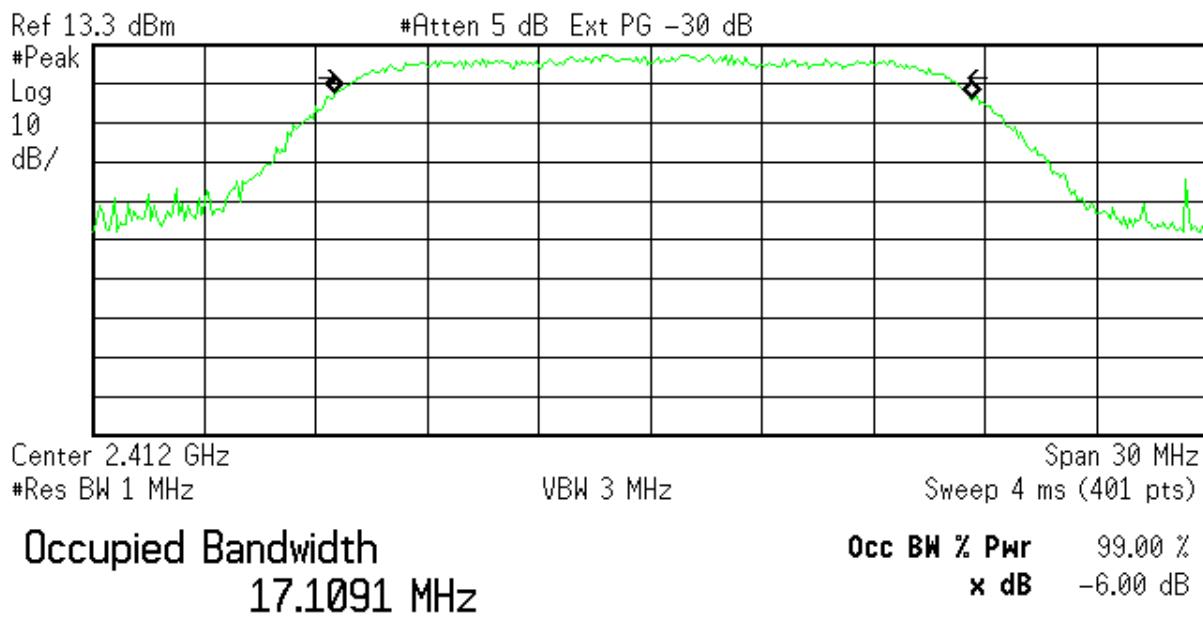
Transmit Freq Error 134.970 kHz
Occupied Bandwidth 15.889 MHz

Figure 69. Bandwidth- High Channel - 802.11g

US Tech Test Report:
FCC ID:
IC:
Test Report Number:
Issue Date:
Customer:
Model:

FCC Part 15 Certification/ RSS 210
2ACAJ-WHUB 2
11938A-WHUB2
16-0218
September 8, 2016
Wink Labs, Inc.
Wink Hub 2

* Agilent 15:07:45 Sep 1, 2016



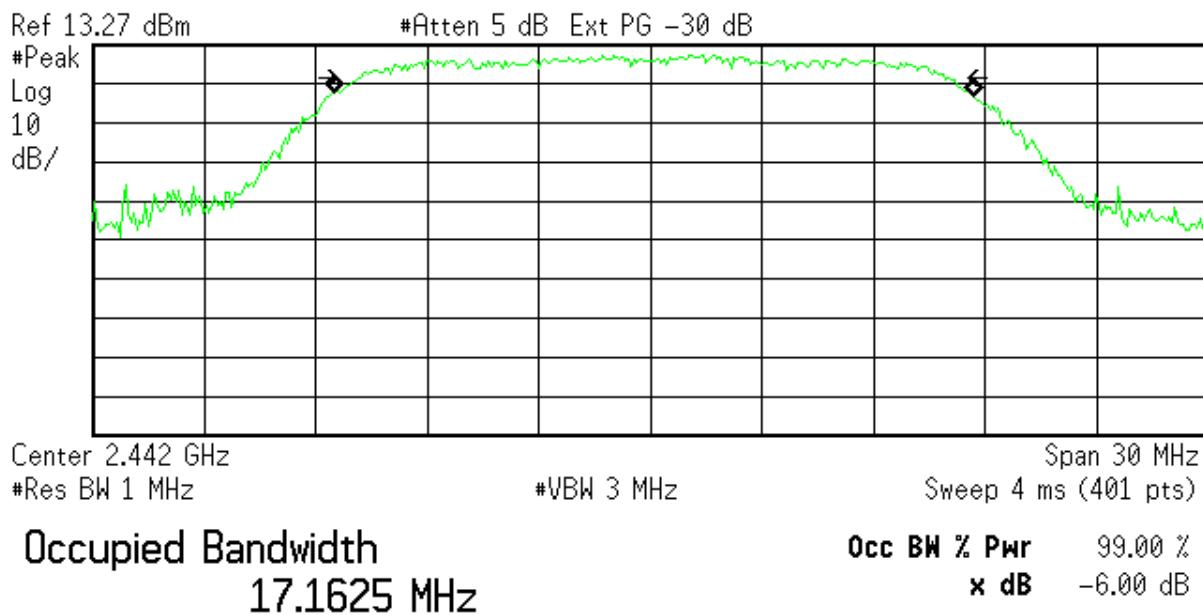
Transmit Freq Error 107.259 kHz
Occupied Bandwidth 15.872 MHz

Figure 70. Bandwidth - Low Channel - 802.11n

US Tech Test Report:
FCC ID:
IC:
Test Report Number:
Issue Date:
Customer:
Model:

FCC Part 15 Certification/ RSS 210
2ACAJ-WHUB 2
11938A-WHUB2
16-0218
September 8, 2016
Wink Labs, Inc.
Wink Hub 2

* Agilent 15:14:15 Sep 1, 2016



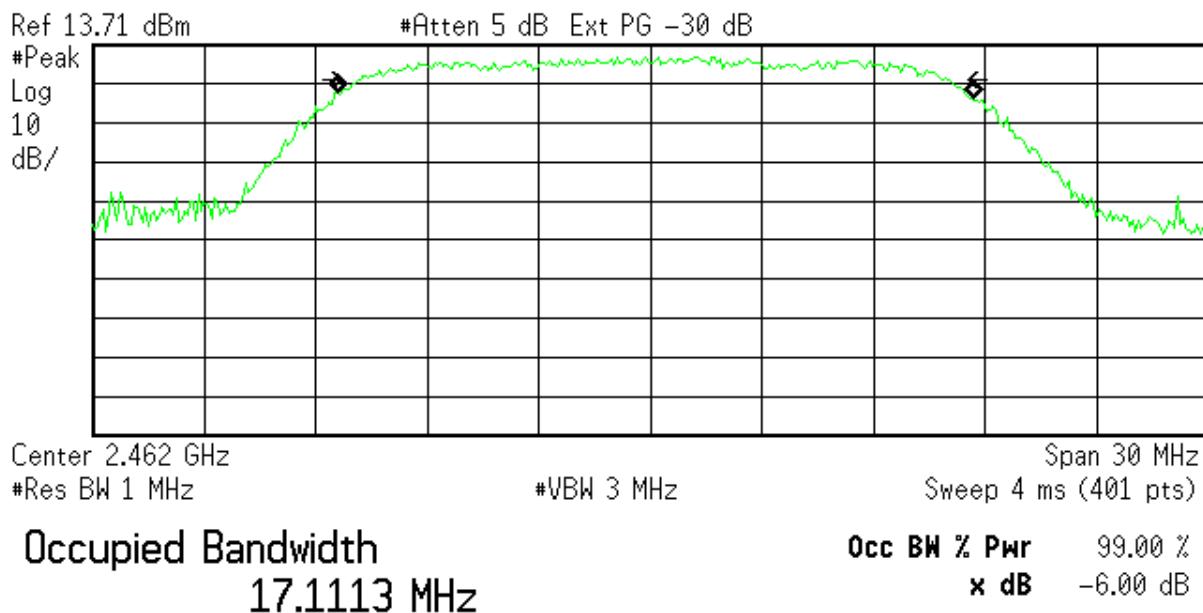
Transmit Freq Error 94.291 kHz
Occupied Bandwidth 15.892 MHz

Figure 71. Bandwidth - Mid Channel - 802.11n

US Tech Test Report:
FCC ID:
IC:
Test Report Number:
Issue Date:
Customer:
Model:

FCC Part 15 Certification/ RSS 210
2ACAJ-WHUB 2
11938A-WHUB2
16-0218
September 8, 2016
Wink Labs, Inc.
Wink Hub 2

* Agilent 15:22:16 Sep 1, 2016



Transmit Freq Error 125.206 kHz
Occupied Bandwidth 15.872 MHz

Figure 72. Bandwidth- High Channel - 802.11n