Testing Tomorrow's Technology

Application for

US Code Title 47, Part 2, Subpart J, Section 2.947, Certification
Per
Part 15, Subpart C, for Intentional Radiators, Section 15.249, Intentional Radiator Operating within the Band 2400 MHz to 2483.5 MHz

For the

Wink Inc.

Model: Hub
(Bluetooth Radio Evaluation)

UST Project: 14-0071
Test Date(s): April 14 to May 7, 2014
Issue Date: May 13, 2013

Total Number of Pages in this Report: 25

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I certify that I am authorized to sign for the test facility 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: 

Name: Alan Ghasiani

Title: Consulting Engineer - President

Date: May 13, 2014

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MEASUREMENT/TECHNICAL REPORT

COMPANY NAME: Wink Inc.

MODEL(S): Hub

FCC ID: 2ACAJ-WINK22

DATE: May 13, 2014

This report concerns (check one): Original grant_X
Class II change_____

Equipment type: Intentional Radiator Operating within the bands 2400-2483.5 MHz

Deferred grant requested per 47 CFR 0.457(d) (1) (ii)? yes_____ No_X

If yes, defer until:_____
date

__N.A.__ 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:

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SUMMARY OF TEST REQUIREMENTS

FCC Requirement	Title	Disposition
15.205	Restricted Bands	Pass
15.207	Intentional Radiator Power Line Conducted Emissions	Pass
15.209	Intentional Radiator Radiated Emissions	Pass
15.249(a)	Fundamental Field Strength	Pass

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1 General Information

1.1 Purpose of this Report

This report is prepared as a means of presenting test data to be used by a Telecom Certification Body in determination of whether this product is permitted for unlicensed dissemination to the general public according to the FCC Rules and Regulations for RF Devices Intentional Radiators.

1.2 Product Description

The Equipment under Test (EUT) is the WINK Inc. home automation radio module, model HUB. The HUB has five transmitters, including: three 2.4 GHZ transmitters (Wifi, Bluetooth, and Zigbee), one 908 MHz transmitter (Zwave), and one 431 MHz transmitter (Lutron). The circuit board uses four trace antennas. The Bluetooth and Wifi radios share one antenna and the other transmitters each have their own antennas.

This report will cover in detail test results for the Bluetooth transmitter; test results for the other transmitters will be covered in different reports.

Below is an excerpt from a customer email describing the function parameters of the transmitters.

Our specific test:

Hopping on 79 channels starting at 2402MHz with 1MHz channel spacing. Symbol rate = 1M symbol / second with 8-DPSK modulation (EDR) with a PBRS9 test pattern, total data rate= 3Mb/s, which is worst case.

EUT used proprietary software to adjust frequencies and power level.

1.3 Related Submittal(s)/Grant(s)

1.3.1 The EUT is subject to the following FCC authorizations:

a) Certification under section 15.249 as a transmitter.

b) Verification/Declaration of Conformity under 15.101 as a digital device and receiver.

1.3.2 Certification of the Transmitter

The EUT employs spread spectrum modulation, but is not being certified under CFR 15.247 because the field strength of the fundamental and its harmonics are within the limits specified in 47 CFR 15.249. Therefore the EUT is instead being presented under the requirements of CFR 15.249. The EUT will operate within the frequency band of 2400 MHz to 2483.5 MHz.

1.3.3 Verification of the Digital apparatus

The verification report is submitted separately, in combination with the certification report for the Zigbee radio.

2 Tests and Measurements

2.1 Configuration of Tested System

The sample was set up and tested per ANSI C63.4, Methods of Measurement from Low-Voltage Electrical and Electronic Equipment in the Frequency Range of 9 kHz to 40 GHz (2003). Conducted and radiated emissions data were taken with the EMC test receiver (or spectrum analyzer's) resolution bandwidth adjusted to 9 kHz and 120 kHz, respectively. All measurements are peak unless stated otherwise. The video filter associated with the spectrum analyzer was off throughout the evaluation process. A Block diagram of the tested system is shown in Figure 1. A listing of the EUT and its test peripherals is found in Table 1 below. Test configuration photographs for spurious and fundamental emissions measurements are in the attached appendices.

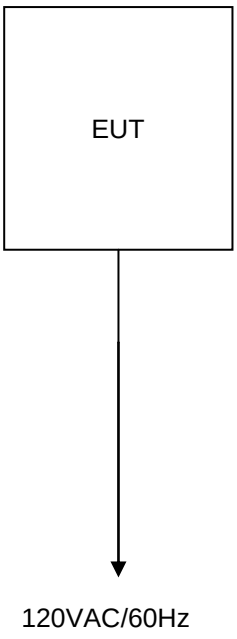


Figure 1. Test Configuration

Table 1. EUT and Peripherals

PERIPHERAL MANUFACTURER	MODEL NUMBER	SERIAL NUMBER	FCC ID:	CABLES P/D
Gateway WINK Inc. (EUT)	HUB	Engineering Sample	Pending: 2ACAJ-WINK22	1.5 m U Power cable
Antenna See antenna details	--	--	--	--

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

2.2 EUT Characterization

The sample used for testing was received by US Tech on April 14, 2014 in good operating condition.

2.3 Test Facility

Testing was performed at US Tech's measurement facility at 3505 Francis Circle, Alpharetta, GA. This site has been fully described and registered with the FCC under site designation number 186022. Additionally this site has also been fully described and submitted to Industry Canada (IC), and has been approved under file number 2982A-1.

2.4 Test Equipment

Table 2 describes test equipment used to evaluate this product.

Table 2.Test Instruments

TEST INSTRUMENT	MODEL NUMBER	MANUFACTURER	SERIAL NUMBER	DATE OF LAST CALIBRATION
SPECTRUM ANALYZER	E4407B	AGILENT	US41442935	11/8/2013
SPECTRUM ANALYZER	8566B	HEWLETT-PACKARD	2410A00109	2/03/2014
RF PREAMP 100 kHz to 1.3 GHz	8447D	HEWLETT-PACKARD	2944A06291	2/06/2014
LOOP ANTENNA	SAS-200/562	A. H. Systems	142	9/12/2013 2 yr cycle
BICONICAL ANTENNA	3110B	EMCO	9306-1708	7/02/2012 2 yr cycle
LOG PERIODIC ANTENNA	3146	EMCO	3110-3236	6/05/12 2 yr cycle
HORN ANTENNA	SAS-571	A. H. Systems	605	7/23/2013 2 yr cycle
PREAMP 1.0 GHz to 26.0 GHz	8449B	HEWLETT-PACKARD	3008A00480	2/06/14
HORN ANTENNA	3116	EMCO	9505-2255	8/9/2012 2 yr cycle
LISN	8028-50-TS24-BNC	Solar Electronics	910495 & 910496	3/19/2014
CALCULATION PROGRAM	N/A	N/A	Ver. 6.0	N/A

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

2.5 Modifications to EUT

No modifications were made by US Tech to bring the EUT into compliance with FCC Part 15, Subpart B, Class B Limits for the receiver and digital portion of the EUT or the Subpart C, Transmitter requirements.

2.6 Measurement Standards (CFR 15.31)

Intentional and unintentional radiators are to use the methods of ANSI C63.4: 2003. Measurements were made on an Open Area Test Site (OATS) wherever possible. For battery powered equipment, new (or fully charged) batteries are used. Section 15.31(m) indicates that if the EUT System operates over the 2400 MHz to 2483.5 MHz ISM band, measurements must be made near the bottom of the band (around 2400 MHz for example) and in the middle of the band (2440 MHz for example) as well as near the top of the band (2483.5 MHz for example).

2.7 Frequency Range of Radiated Measurements (CFR 15.33)

The frequency range is detailed below for intentional and unintentional radiators.

2.7.1 Frequency Range for Intentional Radiators

The spectrum was investigated from the lowest RF signal generated without going below 9 kHz to the 10^{th} harmonic of the highest fundamental transmitter frequency.

2.7.2 Frequency Range for Unintentional Radiators

The spectrum was investigated from the lowest RF signal generated without going below the lowest frequency for which an emissions limit is specified (30 MHz) to the 5^{th} harmonic of the highest fundamental frequency of the digital device (12.5 GHz maximum).

2.7.3 Measurement Detector Function and Bandwidth (CFR 15.35)

On any frequency below 1000 MHz, the limits shown are based upon measuring equipment employing a CISPR quasi-peak detector function and related measurement bandwidths. On frequencies above 1000 MHz, the radiation limits are based upon the use of measuring instrumentation employing an average detector function.

When average detector measurements are specified for use, including emission measurements below 1000 MHz, there is also a corresponding limit for Peak detector measurements having a limit of 20 dB above the corresponding average limit unless a different peak emission limit is specified. Measurements above 1000 MHz utilize a minimum resolution bandwidth of 1 MHz.

When radiated emissions limits are expressed in terms of the average value of the emission and pulsed operation is employed, the measurement field strength is determined by averaging over one complete pulse train (Duty Cycle) including blanking intervals for pulse trains up to 0.1 second in duration. The exact method of calculating the average field strength for this radio is expressed below.

1. Adaptive frequency hopping is turned on, then all 1600 timeslots are used, this requires 1 second
2. Each time slot is therefore 625uS
3. Each BT packet is 366uS
4. A unit is setup is a master or slave but not both
5. Master transmits on odd numbered timeslots, slave on even number time slots

Based on those specifications:

FCC 100mS window = 160 timeslots, if unit is master, then 80 timeslots are used so signal length = 80 x 366uS = 29mS

FCC window =100mS so duty cycle = 29/100 = 29% worst case, duty correction factor = 20 Log .29 =

-10.75dB,

DUTY CYCLE= -10.75 dB

Figure 2. Duty Cycle

Note: The transmitter was programmed to transmit at > 98% Duty cycle (the frequency sweeping/hopping was stopped and pulsed operation was disabled) for all testing; therefore throughout the test report the duty cycle factor calculated above was applied where applicable (to AVG detection measurements).

2.8 Antenna Requirement (CFR 15.203)

The EUT has an internal radiator; there are no external antenna ports.

Table 3. Allowed Antenna(s)

MANUFACTURER	TYPE OF ANTENNA	MODEL	REPORT REFERENCE	GAIN dB_i	TYPE OF CONNECTOR
Antenna 1	WINK INC.	'F' Trace	NA	2.3	Trace antenna

2.9 Intentional Radiator, Power Line Conducted Emissions (CFR 15.207)

The EUT requires 12.0 VDC to operate; this power is supplied by switching power supply that is plugged in to AC Mains. The EUT is not intended to be operated without this power supply.

2.10 Intentional Radiator, Radiated Emissions (CFR 15.249 (a), (e))

The EUT was placed into a continuous transmit mode of operation. A preliminary scan was performed on the EUT to find signal frequencies that were caused by the transmitter part of the product and to obtain the worse case result the EUT tested in all X, Y and Z axis. Radiated measurements below 30 MHz were tested with a RBW = 9 kHz; emissions below 1 GHz were tested with a RBW = 120 kHz and radiated measurements above 1 GHz were measured using a RBW =1 MHz and VBW = 3 MHz.

Test data is found in the tables below.

2.11 Restricted Bands of Operation (CFR 15.205)

Only radiated harmonics and other spurious signals can be permitted to fall into the restricted bands of 15.205. All signals found in paragraph 2.7 above shall be examined for this requirement. Limits are based upon the limits of paragraph 15.209. Above 1 GHz, the limits are for Average value. See Table 4 and Table 5 below for peak and Average measurements. According to CFR 15.35, the peak limits can exceed the average limits by 20 dB.

Table 4. Peak Measurements (CFR15.249 (a))

Tested By: JW	Test: FCC Part 15, Para 15.249(a) Project: 14-0071		Client: Wink Inc. Model: HUB				
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							
2402.00	65.24	31.78	97.02	114.0	3m/Vert.	17.0	PK
4945.07	48.28	3.58	51.86	74.0	3m/Vert.	22.1	PK
Mid Channel - Peak							
2438.13	62.90	31.88	94.78	114.0	3m/Vert.	19.2	PK
4884.78	47.14	4.19	51.33	74.0	3m/Vert.	22.7	PK
High Channel - Peak							
2480.20	63.14	31.73	94.87	114.0	3m/Vert.	19.1	PK
4883.18	45.23	4.19	49.42	74.0	3m/Vert.	24.6	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 (25GHz using EMCO 3116 Horn Antenna)
3. The EUT was placed in three orthogonal positions and the transmitter was in constant broadcast mode, with a duty cycle of greater than 98%. The emissions were measured with the receive antenna in vertical and horizontal polarizations. The data listed in the above table was worst case.

Sample Calculation at 2402.00MHz:

Magnitude of Measured Frequency	65.24	dBuV
+Antenna Factor + Cable Loss+ Amplifier Gain	31.78	dBVm
Corrected Result	97.02	dBuV/m

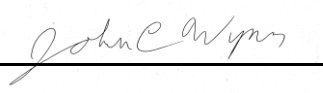
Test Date: April 28, 2014 and May 8, 2014
Tested By
Signature:  Name: John Wynn

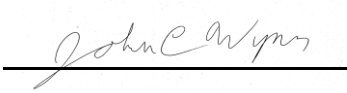
Table 5. Average Measurements (CFR 15.35(b), 15.249(a))

Tested By: JW	Test: FCC Part 15, Para 15.249(a) Project: 14-0071		Client: Wink Inc. Model: HUB				
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 - Average							
2402.00	64.85	21.03	85.88	94.0	3m/Vert.	8.1	AVG
4945.07	44.68	-7.17	37.51	54.0	3m/Vert.	16.5	AVG
Mid Channel - Average							
2438.13	61.90	21.13	83.03	94.0	3m/Vert.	11.0	AVG
4884.78	44.89	-6.56	38.33	54.0	3m/Vert.	15.7	AVG
High Channel - Average							
2480.20	62.71	20.98	83.69	94.0	3m/Vert.	10.3	AVG
4883.18	45.23	-6.56	38.67	54.0	3m/Vert.	15.3	AVG

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 (25GHz using EMCO 3116 Horn Antenna)
3. (~)Measurements taken at 1 meter were extrapolated to 3 meter using a factor of (-9.5 dB).
4. The EUT was placed in three orthogonal positions and the transmitter was in constant broadcast mode, with a duty cycle of greater than 98%. The emissions were measured with the receive antenna in vertical and horizontal polarizations. The data listed in the above table was worst case.
5. A -10.75 duty cycle reduction was applied to the average measurements. See section 2.7.3.

Sample Calculation at 2402.00MHz:

Magnitude of Measured Frequency	64.85	dBuV
+Antenna Factor + Cable Loss+ Amplifier Gain +Duty Cycle	21.03	dB/m
Corrected Result	85.88	dBuV/m

Test Date: April 28, 2014 and May 8, 2014
Tested By
Signature:  Name: John Wynn

2.12 Band Edge Measurements (CFR15.249(d))

Band Edge measurements were made at a Low Channel and High Channel peak at highest EUT related emission outside the upper and lower occupied bandwidth. A measurement was made of the fundamental and the emission was measured using a quasi peak setting. A Resolution Bandwidth of > 1% of the emission bandwidth was used. This procedure was repeated for the high channel. The limits were derived as described in the following sections.

2.12.1 High Band Edge

Above 2483.5 MHz the limit per section 15.249(d) is 50 dB below the fundamental or the value expressed by CFR 15.209 (54 dBuV/m) whichever is the lesser attenuation.

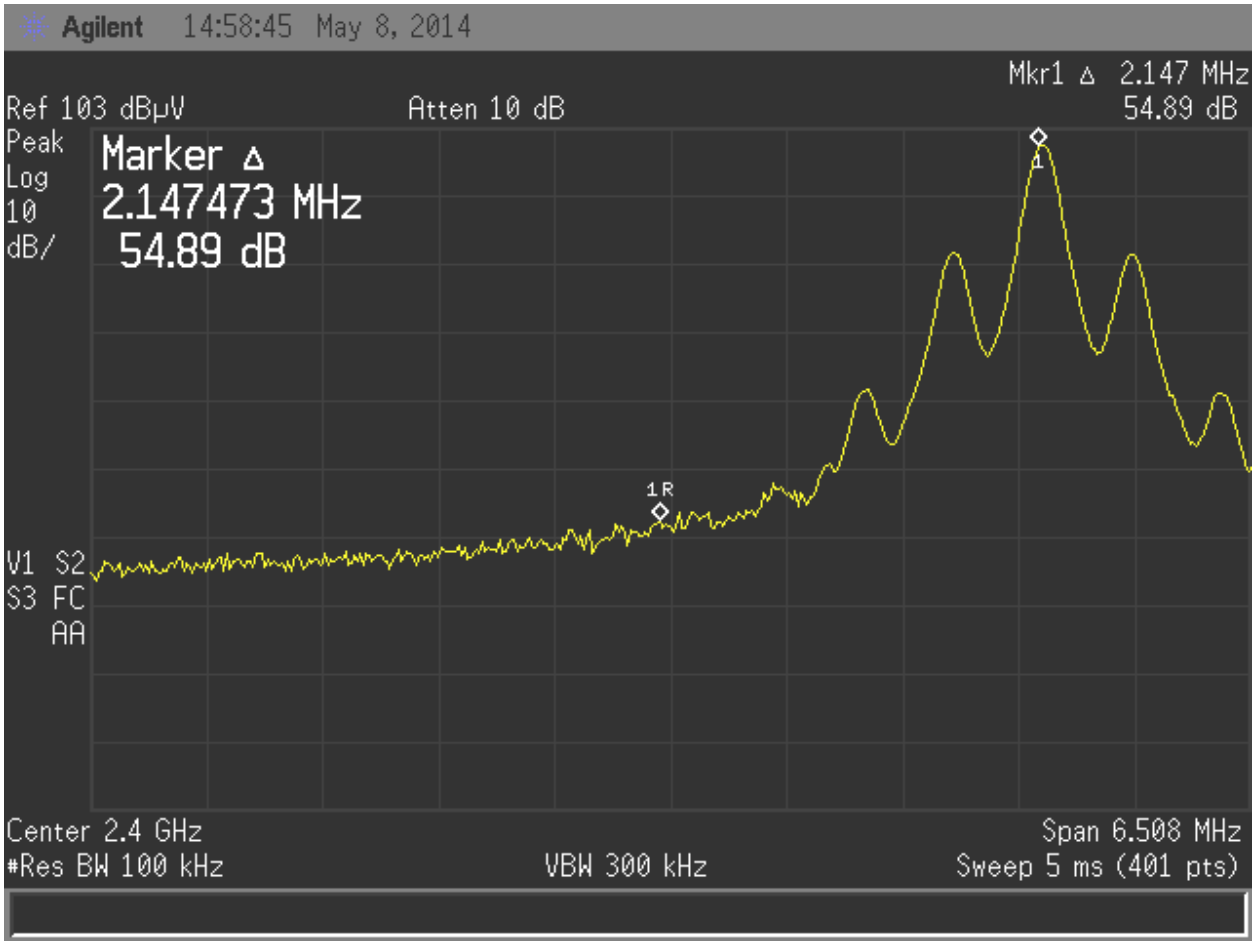


Figure 3. Radiated Band Edge – Low Channel Delta – Peak
Note: Low channel sideband is greater than 20 dB

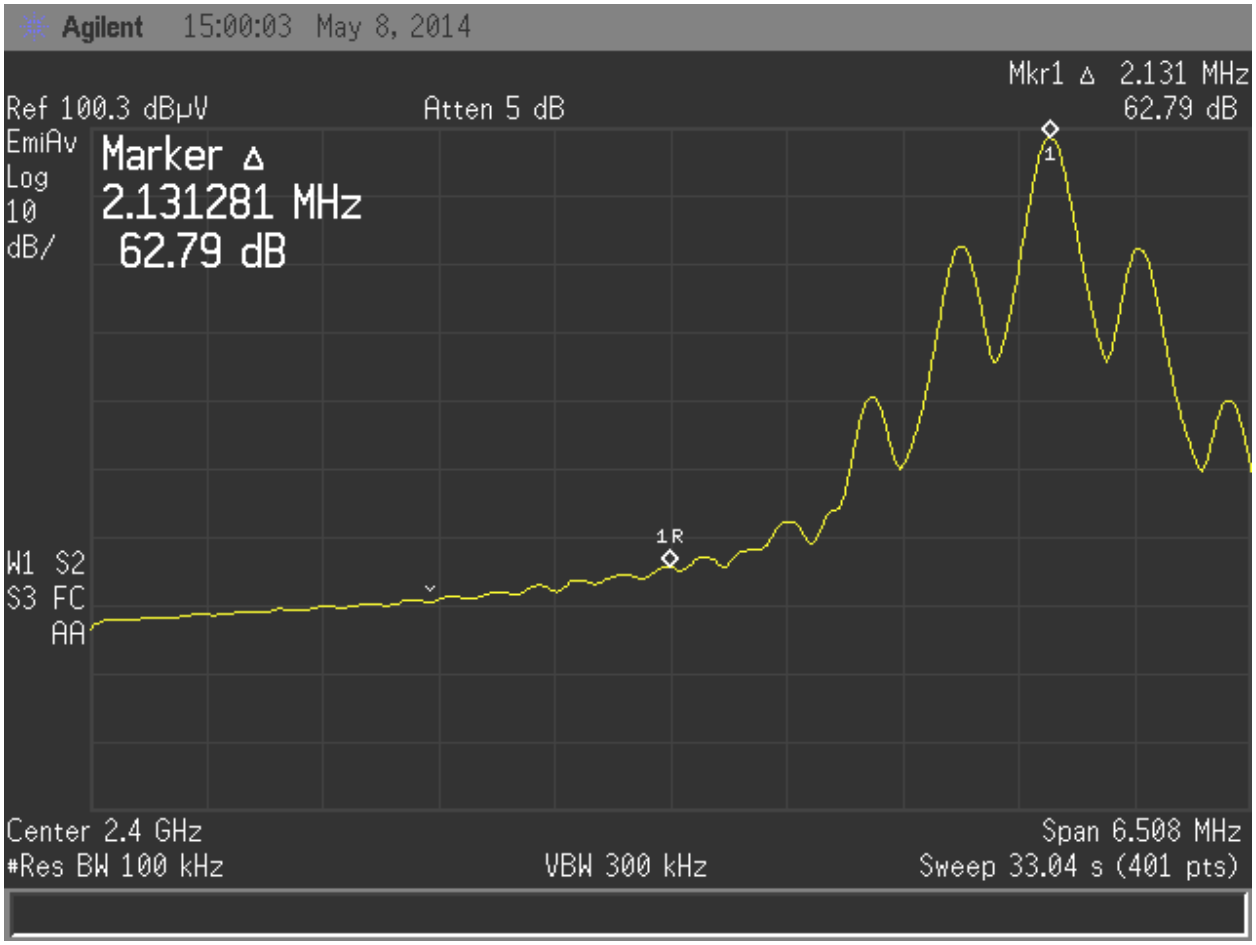


Figure 4. Radiated Band Edge – High Channel Delta – Average

Note: Low channel sideband is greater than 20 dB

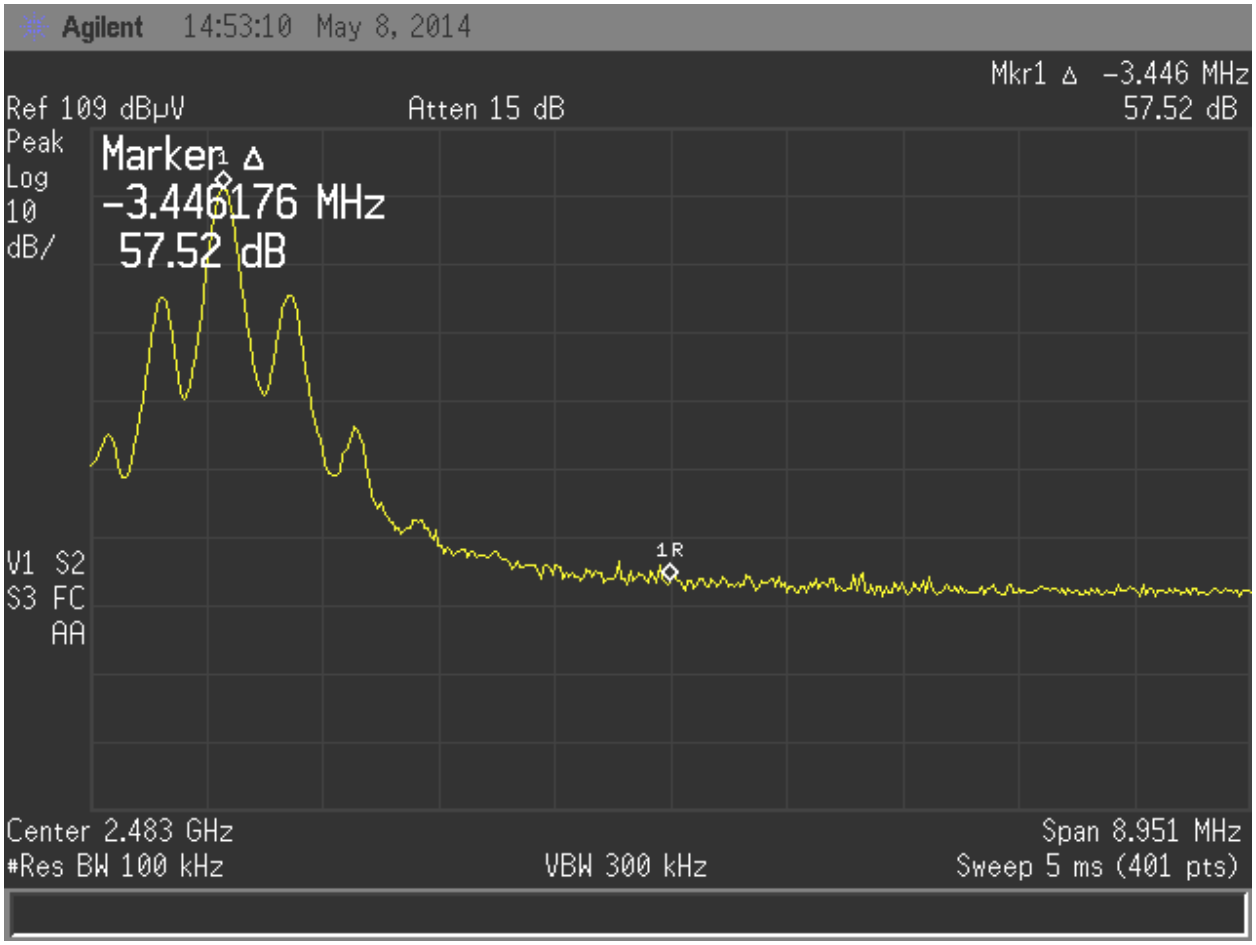


Figure 5. Radiated Band Edge – High Channel Delta – Peak

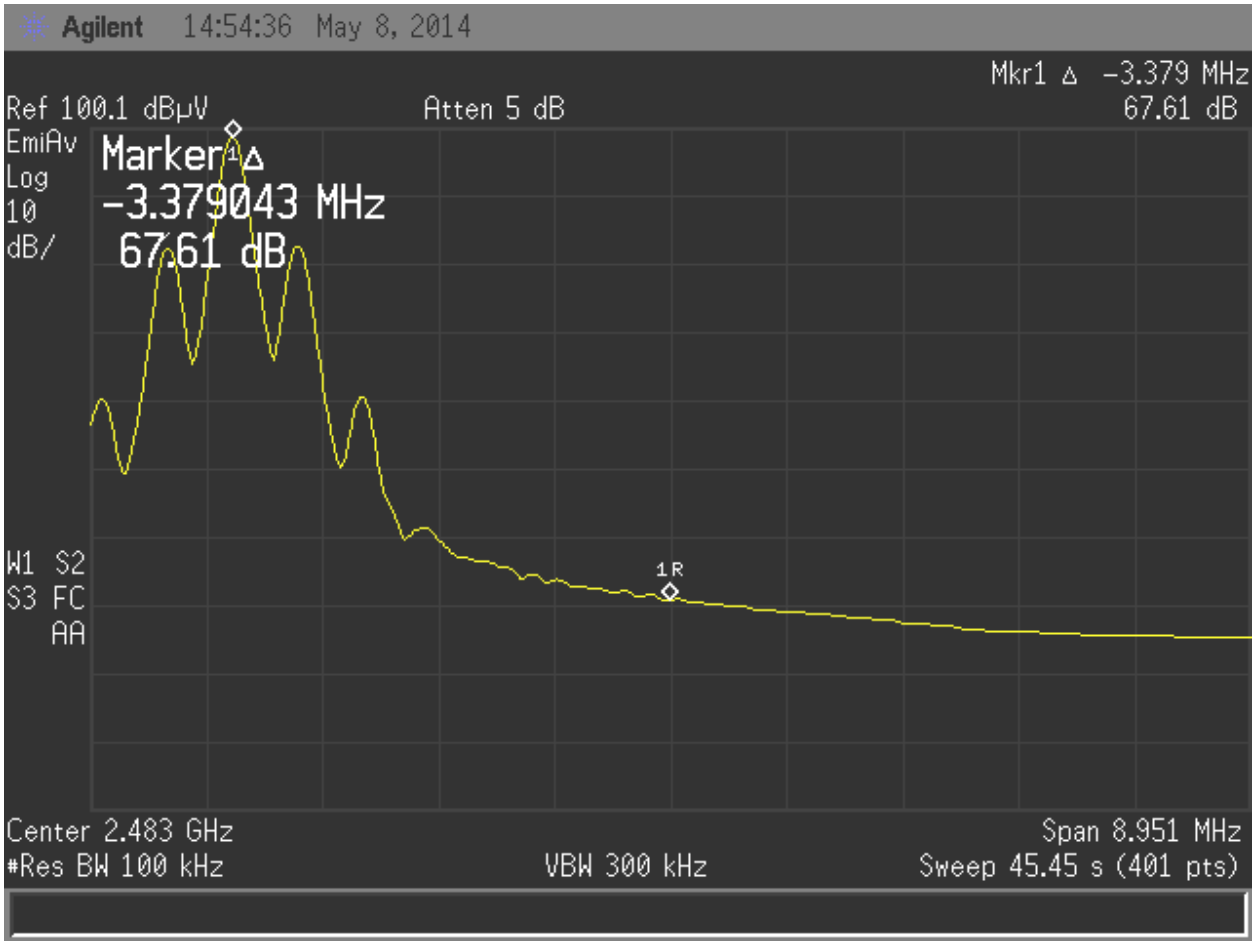


Figure 6. Radiated Band Edge – High Channel Delta - Average

Test Date: May 8, 2014
Tested By
Signature: _____ Name: John Wynn

Calculation of worst case PEAK upper band edge measurement:

High Channel Corrected Measured Value from Table 5	98.87	dBuV
High Channel Band Edge Delta from Figure 7	-57.52	dB
Calculated Result	41.35	dBuV/m
Average Limit + 20dB Relaxation for PEAK	74.00	dBuV/m
Calculated Result	-41.35	dBuV/m
Band Edge Margin	32.65	dBuV/m

Calculation of worst case AVERAGE upper band edge measurement:

High Channel Corrected Measured Value from Table 6	83.69	dBuV
High Channel Band Edge Delta from Figure 7	-45.65	dB
Calculated Result	38.04	dBuV/m
Peak Limit	54.00	dBuV/m
Calculated Result	38.04	dBuV/m
Band Edge Margin	15.96	dBuV/m

2.13 6 dB Bandwidth Measurement per CFR 15.249

The EUT antenna port was connected to a spectrum analyzer having a 50 Ω input impedance. Measurements were performed similar to the method of FCC, KDB Publication No. DA for a bandwidth of 6 dB. The RBW was set to approximately 1/100 of the manufacturers claimed RBW and with the VBW ≥ RBW.

Table 6. Bandwidth Measurements, 6 dB

Frequency (MHz)	6dB Bandwidth Limit (MHz)	6dB Bandwidth Measured (MHz)
2402	<0.5	0.159
2440	<0.5	0.158
2480	<0.5	0.159

Test Date: April 30, 2014
Tested By
Signature: _____ **Name: John Wynn**

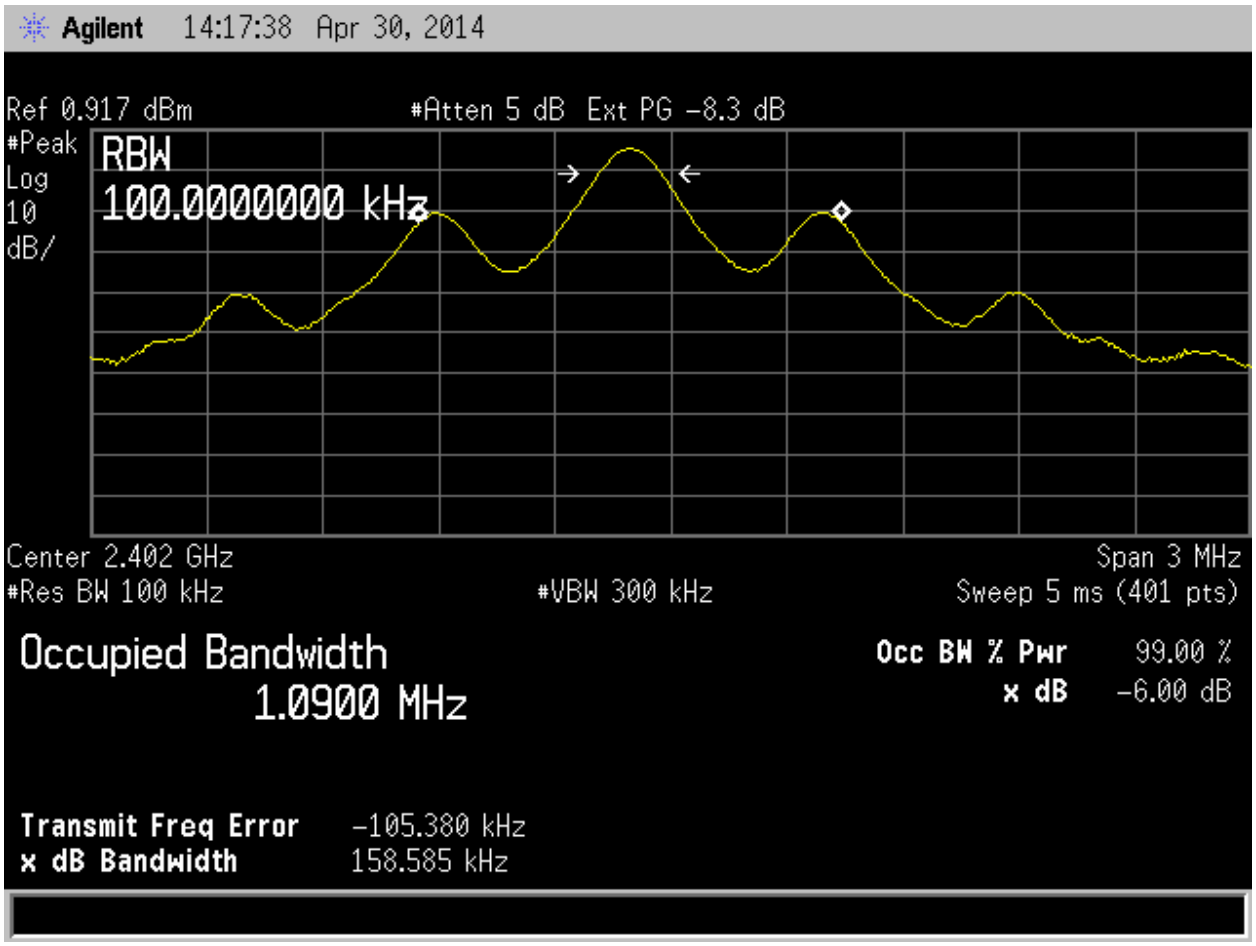


Figure 7. Low Channel 20 dB Bandwidth

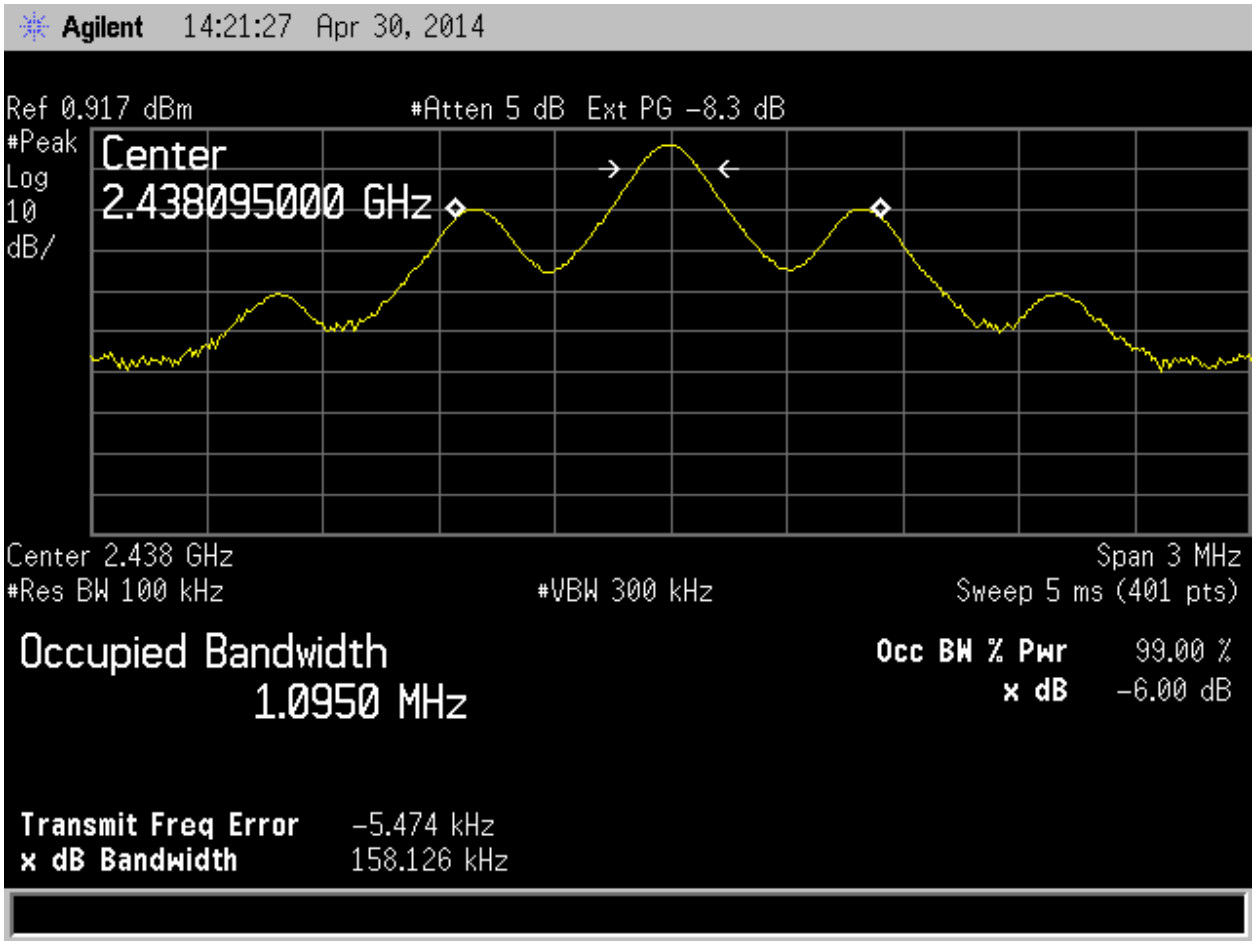


Figure 8. Mid Channel 20dB Bandwidth

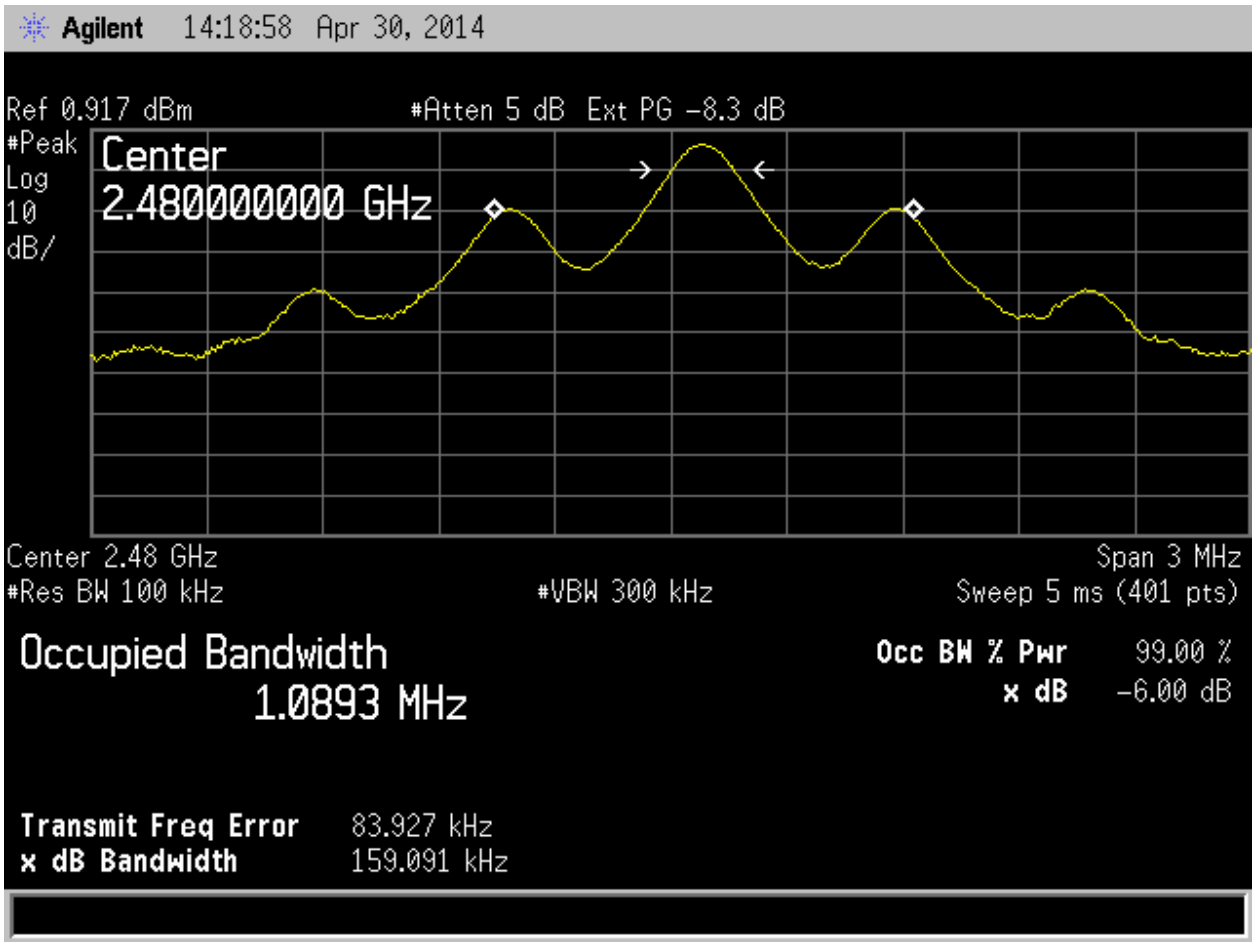


Figure 9. High Channel 20dB Bandwidth