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

Industry Canada, RSS-247 Issue 1, Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and License-Exempt Local Area Network (LE-LAN) Devices

And

Part 2, Subpart J, Section 2.902, Verification
Per
Part 15, Subpart B, for Unintentional Radiators, section 15.101, 15.107 and 15.109

For the

HDJ WIRELESS ENTERPRISE LLC

Model: VersaRouter 1100 - Titan

FCC ID: 2AHPM-TITAN
IC: 21163-TITAN

UST Project: 16-0054
Issue Date: April 13, 2016

Total Pages in This Report: 57

3505 Francis Circle Alpharetta, GA 30004
PH: 770-740-0717 Fax: 770-740-1508
www.ustech-lab.com

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:

Title: Compliance Engineer – President

Date April 18, 2016

3505 Francis Circle Alpharetta, GA 30004
PH: 770-740-0717 Fax: 770-740-1508
www.ustech-lab.com

MEASUREMENT TECHNICAL REPORT

COMPANY NAME: HDJ WIRELESS ENTERPRISE LLC

MODEL: VERSA ROUTER 1100 - TITAN

FCC ID: 2AHPM-TITAN

IC: 21163-TITAN

DATE: April 13, 2016

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

Equipment type: DSS Router

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

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
3505 Francis Circle
Alpharetta, GA 30004

Phone Number: (770) 740-0717
Fax Number: (770) 740-1508

Table of Contents

Paragraph Title **Page**

List of Figures

Figures **Title** **Page**

List of Tables

List of Attachments

Agency Agreement
Application Forms
Letter of Confidentiality
Equipment Label(s)
Block Diagram(s)
Schematic(s)
Test Configuration Photographs
Internal Photographs
External Photographs
Antenna Photographs
Theory of Operation
RF Exposure
User's Manual

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 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 March 9, 2016 in good operating condition.

1.3 Product Description

The Equipment Under Test (EUT) is the HDJ WIRELESS ENTERPRISE LLC Model VersaRouter 1100 - Titan. The EUT is a standards-based 802.15.4g compliant router with co-located 3G module for 3G connectivity for IPv6/Internet of Things applications. The 802.15.4g radio module is amplified to supply up to 1Watt output power. The EUT is designed for outdoor operation having a back-up battery and external storage. The 3G radio module is mounted on the same host board, however the 3G radio does not transmit in the 902-928 MHz band and it has its own output RF port and its own external antenna (see attached exhibits). The EUT was tested for co-location emissions and meets the applicable requirements.

Antenna: Omni (3.0 dBi Gain)
Modulation: FHSS
Maximum measured output power: 26.4 dBm

Contains 3G radio module with FCC ID: XPYLISAU230, IC: 8595A-LISAU230

1.4 Configuration of Tested System

The Test Sample was tested per *ANSI C63.4:2009, Methods of Measurement of Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz (2009)* for FCC subpart A Digital equipment Verification requirements and per FCC KDB Publication number 558074 for Digital Transmission Systems Operating Under section 15.247. Also, FCC, KDB Publication No. 558074 and FCC Public Notice DA 00-705 was used as a test procedure guide.

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 Submittals

1.6.1 The EUT is subject to the following FCC authorizations:

a) Certification under section 15.247 as a transmitter.
b) Verification under 15.101 as a digital device and receiver.

1.6.2 Verification of the Digital apparatus

The Verification requirement shares many common report elements with the Certification report. Therefore, though this report is mostly intended to provide data for the Certification process, the Verification authorization report (part 15.107 and 15.109) for the EUT is included herein.

Table 1. EUT and Peripherals

PERIPHERAL MANUFACTURER	MODEL NUMBER	SERIAL NUMBER	FCC ID: IC:	CABLES P/D
EUT	VersaRouter 1100 - Titan	Engineering Sample	2AHPM-TITAN (Pending) 21163-TITAN (Pending)	None
Antenna See antenna details	--	--	--	--

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

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 indicated.

Table 2. Test Instruments

TEST INSTRUMENT	MODEL NUMBER	MANUFACTURER	SERIAL NUMBER	DATE OF LAST CALIBRATION
SPECTRUM ANALYZER	8566B	HEWLETT-PACKARD	2410A00109	5/07/2015
SPECTRUM ANALYZER	E4407B	Agilent	US41442935	2/11/2016
PREAMP	8449B	HEWLETT-PACKARD	3008A00480	12/01/2015
PREAMP	8447D	HEWLETT-PACKARD	1937A02980	12/02/2015
LOOP ANTENNA	SAS-200/562	A. H. Systems	142	9/28/2015 2 yr
BICONICAL ANTENNA	3110B	EMCO	9306-1708	11/24/2014 2 yr
BICONICAL ANTENNA	3110B	EMCO	9307-1431	8/25/2015 2 yr
LOG PERIODIC ANTENNA	3146	EMCO	9110-3236	11/19/2014 2 yr
LOG PERIODIC ANTENNA	3146	EMCO	9305-3600	7/01/2014 2 yr
HORN ANTENNA	3115	EMCO	9107-3723	7/8/2014 2 yr

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

2.2 Modifications to EUT Hardware

No physical modifications were made by US Tech in order to bring the EUT into compliance with FCC Part 15.247, Subpart C Intentional Radiator Limits for the transmitter portion of the EUT, however in order to meet the Part 15.207 & 15.209, Subpart C Intentional Radiator Limits the modifications detailed below were required:

1. An inline EMI filter was installed in order for the EUT to meet the 15.107 and 15.207 conducted power line emissions limits. The inline EMI filter was placed between the terminal block and the MeanWell power supply. See the modifications photograph exhibit for details. The EMI filter used is a Corcom 6VSK1 filter; the Cosel NBC-06-472D din rail mount EMI filter is an acceptable alternative to the Corcom filter.

2. Ferrites were added in order for the EUT to meet the 15.109 and 15.209 radiated emissions limits. The ferrites were placed in several locations. As identified in the modifications photographs exhibit. The following ferrites were used:

- Fair-Rite Model: 0461164281
- Fair-Rite Model: 0461167281
- Fair-Rite Model: 0475164281

3. The Main PCB was grounded to the backplane.

No other modifications were necessary for the EUT to meet the applicable Part 15 subparts.

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 below.

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 at 902.4 MHz to 927.6 MHz, 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 10^{th} 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 5 times the highest internal clock frequency.

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 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.

2.6 EUT Antenna Requirements, External Radio Frequency Power Amplifiers and Antenna Modifications (CFR 15.203, 15.204)

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.

An intentional radiator may be operated only with the antenna with which it is authorized. If an antenna is marketed with the intentional radiator, it shall be of a type which is authorized with the intentional radiator. An intentional radiator may be authorized with multiple antenna types. Exceptions to the following provisions, if any, are noted in the rule section under which the transmitter operates, e.g., §15.255(b)(1)(ii) of this part.

Table 4. Allowed Antenna(s)

REPORT REFERENCE	MANUFACTURER	TYPE OF ANTENNA	MODEL	GAIN dB_i	TYPE OF CONNECTOR
Antenna 1	Fei Teng Wireless Technology Co. Ltd.	Omni	OS-915M03-NM	3.0	N-type

Except as described in paragraph 15.204(d), an external radio frequency power amplifier or amplifier kit shall be marketed only with the system configuration with which it was approved and not as a separate product.

Table 5. Allowed External RF Power Amplifier(s)

REPORT REFERENCE	MANUFACTURER	TYPE OF ANTENNA	MODEL	GAIN dB_i	TYPE OF CONNECTOR
Amplifier 1	SHIREEN	N/A	90303	12.0	SMA

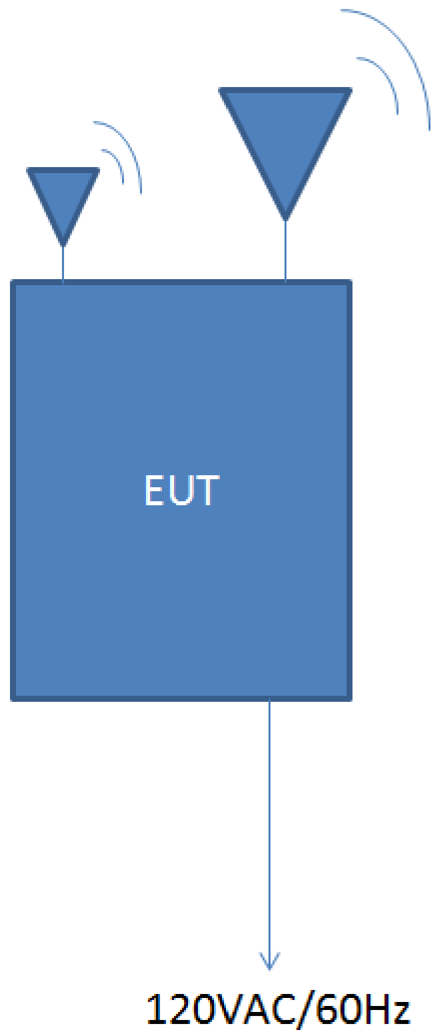

Figure 1. Block Diagram of Test Configuration

2.7 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 emissions cannot exceed the limits of 15.209. Radiated harmonics and other Spurious are examined for this requirement see paragraph 2.10 of the test report.

2.8 Transmitter Duty Cycle (CFR 15.35 (c))

Measurements of the duty cycle and transmission duration were performed using the zero span method per ANSI C63.10-2013. The spectrum analyzer was set to the center frequency of the transmission. The RBW and VBW were set to the largest available value. The method was used because the RBW and VBW were > 50/T.

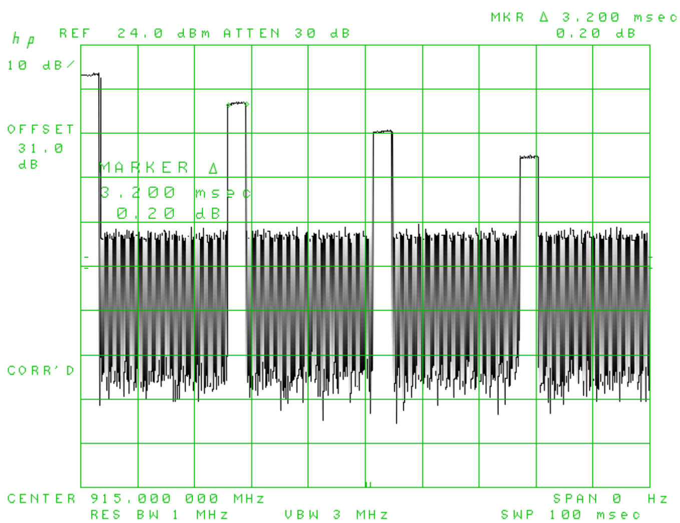

Figure 2. Transmitter Pulse Width in 100 mSec Period

Total Time On from Figure 2 = 3.2 ms * 4= 12.8mS

(0.013 s Total Time On)/(0.100 s Time period) = 0.13 Numeric Duty Cycle
Duty Cycle = 20 Log (0.13) = -17.7 dB

Duty Cycle reported in this test report is -17.7 dB.

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

For an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the 15.207 limits

The EUT is designed to be connected the public utility (AC) power line, therefore this test was performed. The results are presented in the table below.

Table 6. Power Line Conducted Emissions Test Data, Part 15.207

150KHz to 30 MHz						
Test: Power Line Conducted Emissions				**Client:** HDJ WIRELESS ENTERPRISE LLC		
Project: 16-0054				**Model:** VERSA ROUTER 1100 TITAN		
Frequency (MHz)	**Test Data (dBuv)**	**LISN+CL-PA (dB)**	**Results (dBuV)**	**AVG Limits (dBuV)**	**Margin (dB)**	**Detector PK, QP, or AVG**
Phase Line						
0.1585	48.10	0.51	48.61	55.5	6.9	**PK**
0.7920	54.80	0.22	55.02	56.0	1.0	**QP**
0.7920	32.40	0.22	32.62	46.0	13.4	**AVG**
4.9920	42.90	0.42	43.32	56.0	12.7	**QP**
4.9920	31.20	0.42	31.62	46.0	14.4	**AVG**
7.9050	50.40	0.55	50.95	60.0	9.1	**QP**
7.9050	40.00	0.55	40.55	50.0	9.5	**AVG**
10.1900	45.60	0.65	46.25	60.0	13.7	**QP**
10.1900	41.20	0.65	41.85	50.0	8.1	**AVG**
22.1500	46.60	1.10	47.70	60.0	12.3	**QP**
22.1500	43.30	1.10	44.40	50.0	5.6	**AVG**

SAMPLE CALCULATION: 0.1585 MHz:

Magnitude of Measured Frequency	48.10	dBuV
+LISN Factor + Cable Loss+ Amplifier Gain	0.51	dB/m
Corrected Result	48.61	dBuV/m

Test Date: March 16, 2016

Tested By
Signature:__________ Name: **Robert Nevels**

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

150KHz to 30 MHz						
Test: Power Line Conducted Emissions				**Client:** HDJ WIRELESS ENTERPRISE LLC		
Project: 16-0054				**Model:** VERSA ROUTER 1100 TITAN		
Frequency (MHz)	**Test Data (dBuv)**	**LISN+CL-PA (dB)**	**Results (dBuV)**	**AVG Limits (dBuV)**	**Margin (dB)**	**Detector PK, QP, or AVG**
Neutral Line						
0.4698	39.70	0.23	39.93	46.5	6.6	**PK**
0.7877	52.10	0.22	52.32	56.0	3.7	**QP**
0.7877	28.80	0.22	29.02	46.0	17.0	**AVG**
4.9920	44.30	0.42	44.72	56.0	11.3	**QP**
4.9920	32.80	0.42	33.22	46.0	12.8	**AVG**
7.3650	52.20	0.49	52.69	60.0	7.3	**QP**
7.3650	41.00	0.49	41.49	50.0	8.5	**AVG**
15.3200	47.30	0.87	48.17	60.0	11.8	**QP**
15.3200	40.70	0.87	41.57	50.0	8.4	**AVG**
21.9300	49.60	1.11	50.71	60.0	9.3	**QP**
21.9300	45.70	1.11	46.81	50.0	3.2	**AVG**

SAMPLE CALCULATION: 0.4698 MHz:

Magnitude of Measured Frequency	39.70	dBuV
+LISN Factor + Cable Loss+ Amplifier Gain	0.23	dB/m
Corrected Result	39.93	dBuV/m

Test Date: March 16, 2015

Tested By
Signature: ____________ Name: **Robert Nevels**

2.10 Intentional Radiator, Radiated Emissions (CFR 15.209, 15.247(d))

Radiated Spurious measurements: The EUT was placed into a continuous transmit mode of operation (>98%) duty cycle) and tested per ANSI C63.10:2013. A preliminary scan was performed on the EUT to find signal frequencies that were caused by the transmitter part of the device. A preliminary scan was performed on the EUT to find the worse case results the EUT was tested in X, Y, and Z axes or in the orientation of normal operation if the device is designed to operate in a fixed position. The EUT was placed in the FHSS modulation because the output power of the FHSS modulation was larger than the DTS modulation output power and the normal mode of operation is when the EUT is frequency hopping.

Radiated measurements were then conducted between the frequency range of 9 kHz (or lowest frequency used/generated by the device) up to the tenth harmonic of the device (not greater than 40 GHz). In the band below 30 MHz, a resolution bandwidth (RBW) of 9 kHz was used; emissions below 1 GHz were tested with a RBW of 100/120 kHz and emissions above 1 GHz were tested with a RBW of 1 MHz. All video bandwidth settings were at least three times the RBW value.

The EUT was investigated per CFR 15.209, General requirements for unwanted spurious emissions. The conducted spurious method as described below was used to investigate all other emissions emanating from the antenna port.

Conducted Spurious measurements: The EUT was put into a continuous-transmit mode of operation (>98% duty cycle) and tested per FCC Public Notice DA 00-705 for conducted out of band emissions emanating form 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 the spurious signals that were related to the transmitter. The EUT was placed in the FHSS modulation because the output power of the FHSS modulation was larger than the DTS modulation output power and the normal mode of operation is when the EUT is frequency hopping.

Table 8. Intentional Radiator, Spurious Radiated Emissions (CFR 15.209), 9 kHz to 30 MHz

9 kHz to 30 MHz							
Test: Radiated Emissions				**Client:** HDJ WIRELESS ENTERPRISE LLC			
Project: 16-0054				**Model:** VERSA ROUTER 1100 TITAN			
Frequency (MHz)	**Test Data (dBuv)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**QP Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector PK, or QP**
All emissions seen were 20 dB or more from the limit.							

Tested from 9 kHz to 30 MHz

SAMPLE CALCULATION: N/A

Test Date: March 18, 2016

Tested By
Signature: ____________ Name: George Yang

Table 9. Average Radiated Fundamental & Harmonic Emissions

Test: FCC Part 15, Para 15.209, 15.247(d)				**Client:** HDJ WIRELESS ENTERPRISE LLC			
Project: 16-0054				**Model:** VERSA ROUTER 1100 TITAN			
Frequency (MHz)	**Test Data (dBuv)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**AVG Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Receiver Detector Mode**
Low Channel – AVERAGE							
902.40	95.63	6.96	102.59		3m./VERT		**PK**
1804.55	62.21	-25.20	37.01	54.0	3.0m./VERT	17.0	**PK**
2707.20	52.59	-21.97	30.62	54.0	3.0m./VERT	23.4	**PK**
3609.58	44.98	-18.36	26.62	54.0	3.0m./VERT	27.4	**PK**
4511.70	43.71	-16.07	27.64	54.0	3.0m./VERT	26.4	**PK**
5417.48	42.94	-13.27	29.67	54.0	3.0m./VERT	24.3	**PK**
Mid Channel – AVERAGE							
914.93	94.79	6.86	101.65		3m./VERT		**PK**
1830.00	59.66	-25.28	34.38	54.0	3.0m./VERT	19.6	**PK**
2745.13	56.24	-21.90	34.34	54.0	3.0m./VERT	19.7	**PK**
3660.33	46.34	-18.13	28.21	54.0	3.0m./VERT	25.8	**PK**
4574.58	45.49	-16.07	29.42	54.0	3.0m./VERT	24.6	**PK**
5490.38	44.98	-13.33	31.65	54.0	3.0m./VERT	22.4	**PK**
High Channel – AVERAGE							
927.54	94.36	7.00	101.36		3m./VERT		**PK**
1855.25	58.53	-25.09	33.44	54.0	3.0m./VERT	20.6	**PK**
2782.55	54.73	-21.78	32.95	54.0	3.0m./VERT	21.1	**PK**
3709.70	47.28	-17.57	29.71	54.0	3.0m./VERT	24.3	**PK**
4639.23	44.10	-15.92	28.18	54.0	3.0m./VERT	25.8	**PK**
5565.60	46.68	-13.01	33.67	54.0	3.0m./VERT	20.3	**PK**

1. No other signals detected within 20 dB of specification limit. Harmonics investigated up to the 10^{th} harmonic
2. 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.
3. Duty cycle factor of -17 dB was applied to the Peak values.

Sample Calculation at 902 MHz:

Magnitude of Measured Frequency	95.63	dBuV
+Antenna Factor + Cable Loss+ Amplifier Gain	6.96	dB/m
Corrected Result	102.59	dBuV/m

Test Date: March 18, 2016

Tested By
Signature: ____________ Name: George Yang

Table 10. Peak Radiated Fundamental & Harmonic Emissions

Test: FCC Part 15, Para 15.209, 15.247(d)				**Client:** HDJ WIRELESS ENTERPRISE LLC			
Project: 16-0054				**Model:** VERSA ROUTER 1100 TITAN			
Frequency (MHz)	**Test Data (dBuv)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**PK Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Receiver Detector Mode**
Low Channel – PEAK							
902.40	95.63	23.96	119.59		3m./VERT		**PK**
1804.55	62.21	-8.20	54.01	74.0	3.0m./VERT	20.0	**PK**
2707.20	52.59	-4.97	47.62	74.0	3.0m./VERT	26.4	**PK**
3609.58	44.98	-1.36	43.62	74.0	3.0m./VERT	30.4	**PK**
4511.70	43.71	0.93	44.64	74.0	3.0m./VERT	29.4	**PK**
5417.48	42.94	3.73	46.67	74.0	3.0m./VERT	27.3	**PK**
Mid Channel – PEAK							
914.93	94.79	23.86	118.65		3m./VERT		**PK**
1830.00	59.66	-8.28	51.38	74.0	3.0m./VERT	22.6	**PK**
2745.13	56.24	-4.90	51.34	74.0	3.0m./VERT	22.7	**PK**
3660.33	46.34	-1.13	45.21	74.0	3.0m./VERT	28.8	**PK**
4574.58	45.49	0.93	46.42	74.0	3.0m./VERT	27.6	**PK**
5490.38	44.98	3.67	48.65	74.0	3.0m./VERT	25.4	**PK**
High Channel – PEAK							
927.54	94.36	24.00	118.36		3m./VERT		**PK**
1855.25	58.53	-8.09	50.44	74.0	3.0m./VERT	23.6	**PK**
2782.55	54.73	-4.78	49.95	74.0	3.0m./VERT	24.1	**PK**
3709.70	47.28	-0.57	46.71	74.0	3.0m./VERT	27.3	**PK**
4639.23	44.10	1.08	45.18	74.0	3.0m./VERT	28.8	**PK**
5565.60	46.68	3.99	50.67	74.0	3.0m./VERT	23.3	**PK**

1. No other signals detected within 20 dB of specification limit. Harmonics investigated up to the 10^{th} harmonic
2. 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 902.40 MHz:

Magnitude of Measured Frequency	95.63	dBuV
+Antenna Factor + Cable Loss+ Amplifier Gain	23.96	dB/m
Corrected Result	119.59	dBuV/m

Test Date: March 18, 2016

Tested By
Signature: ______________ Name: George Yang

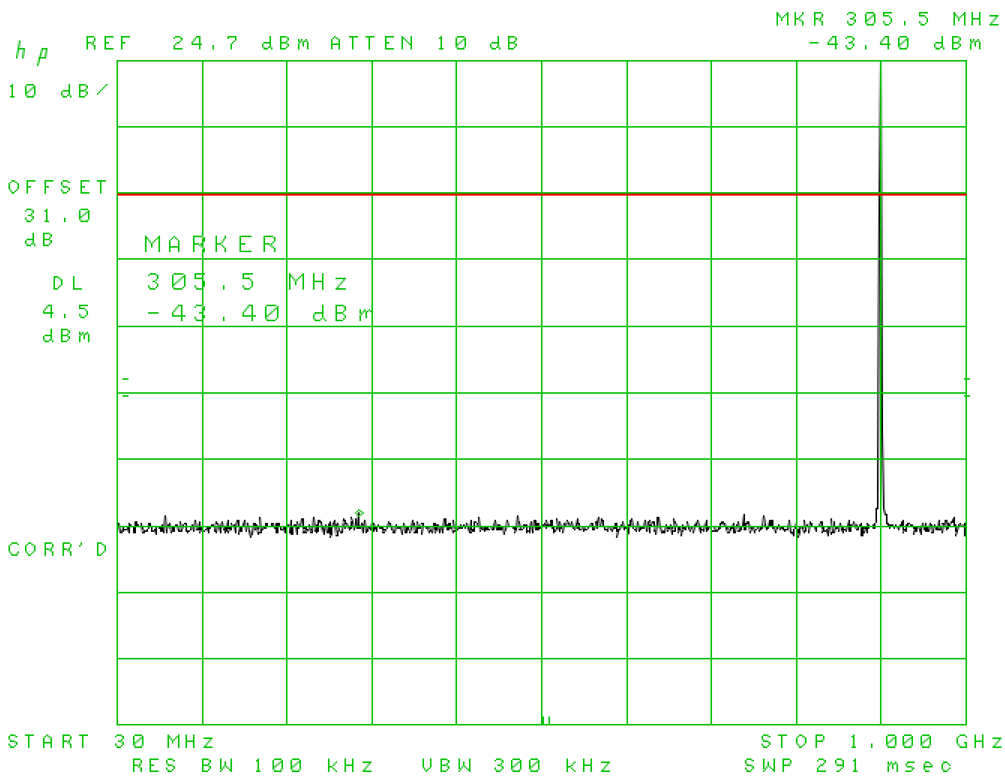

Figure 3. Antenna Conducted Emissions Low, Part 1

Note: Large emission seen is the fundamental emission.

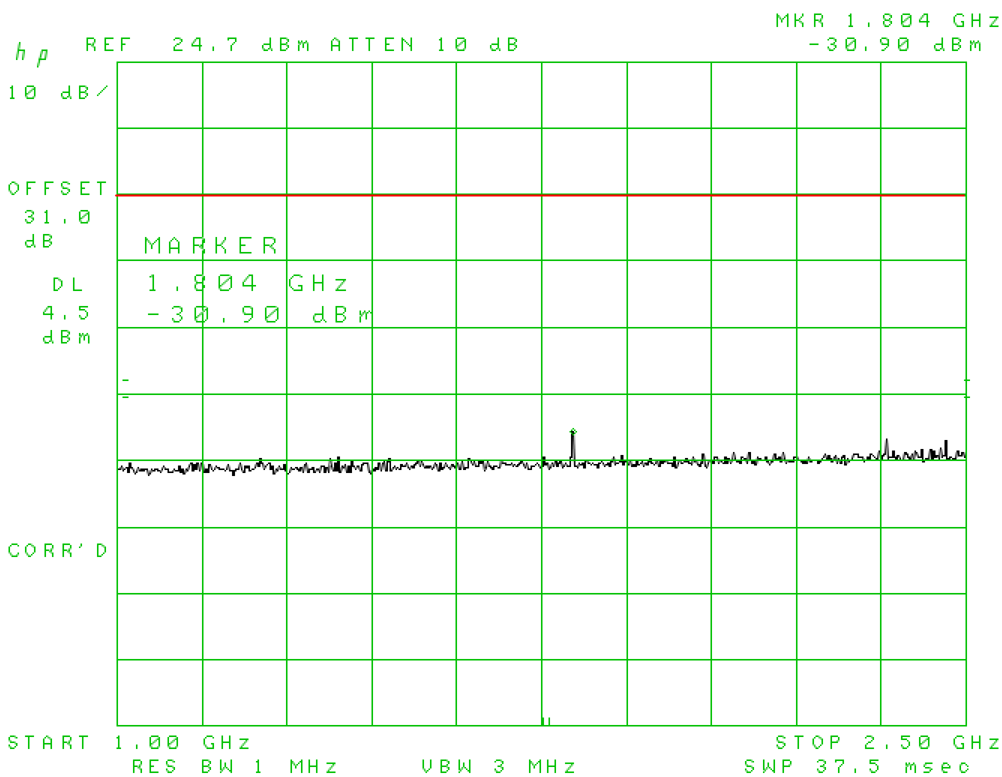

Figure 4. Antenna Conducted Emissions Low, Part 2

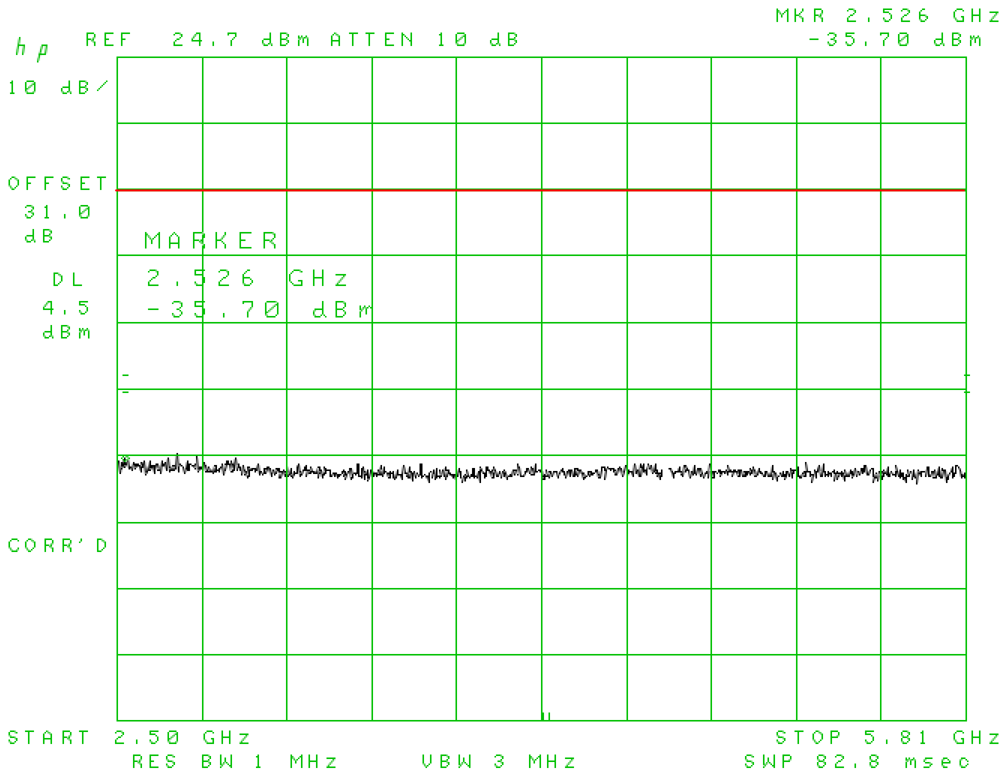

Figure 5. Antenna Conducted Emissions Low, Part 3

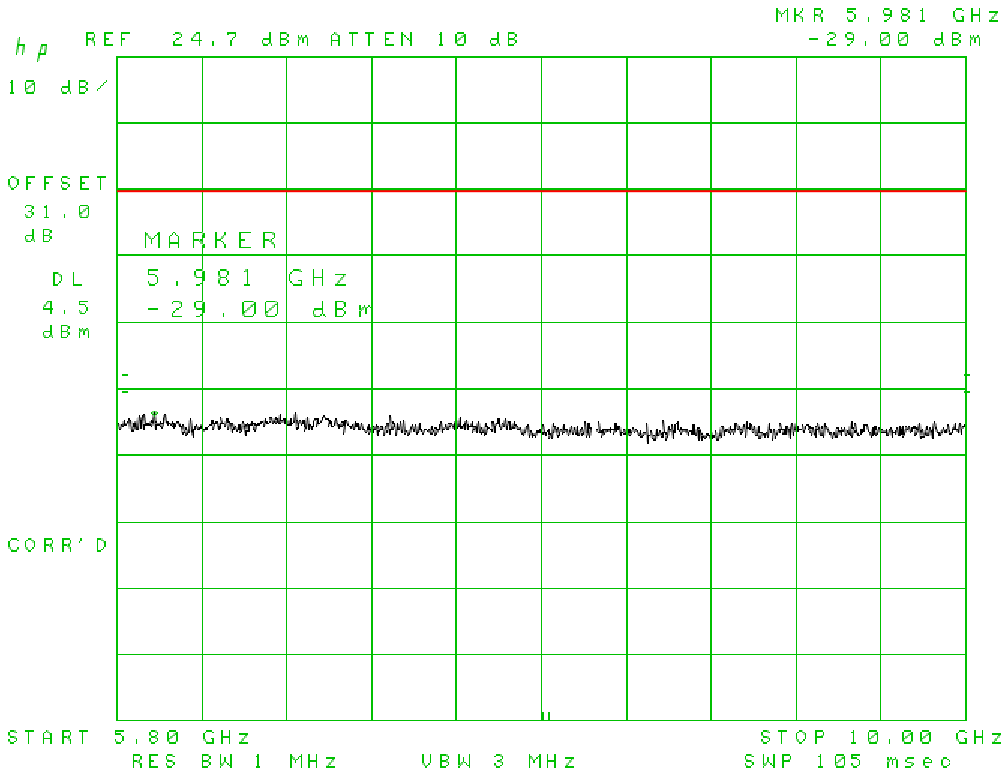

Figure 6. Antenna Conducted Emissions Low, Part 4

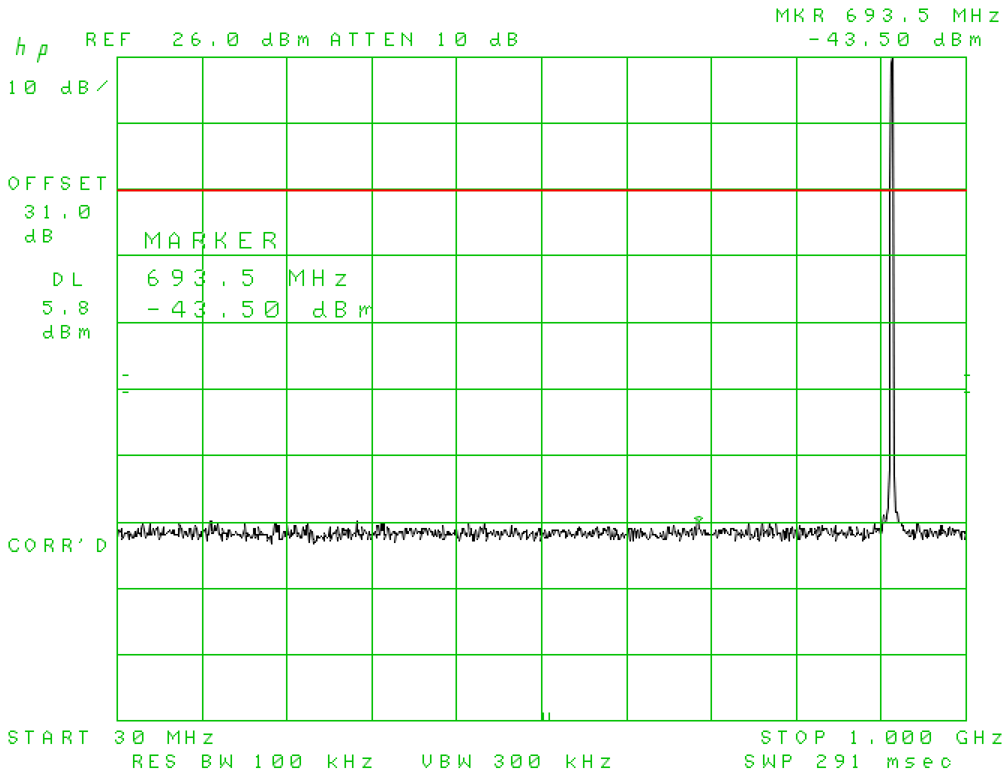

Figure 7. Antenna Conducted Emissions Mid, Part 1

Note: Large emission seen is the fundamental emission.

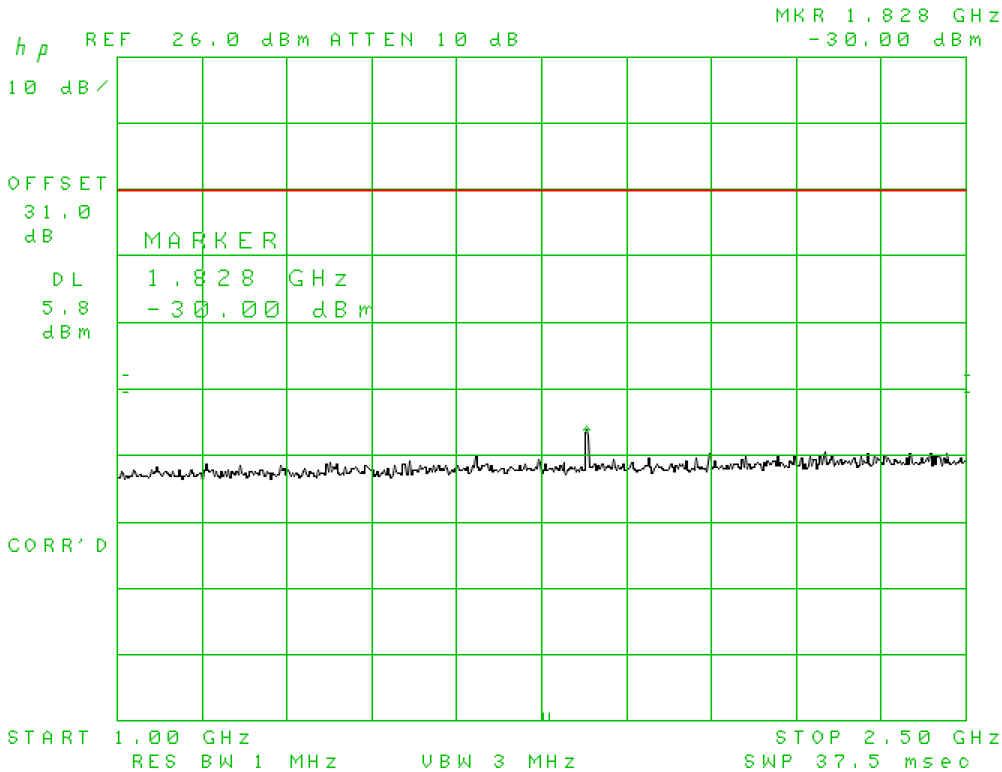

Figure 8. Antenna Conducted Emissions Mid, Part 2

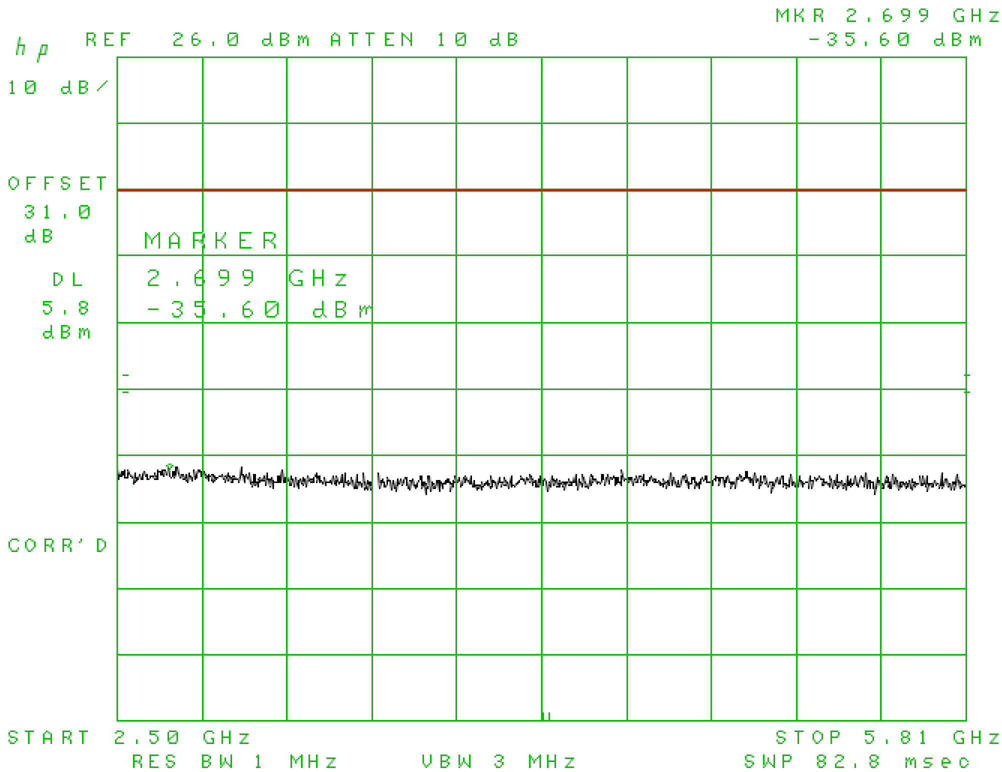

Figure 9. Antenna Conducted Emissions Mid, Part 3

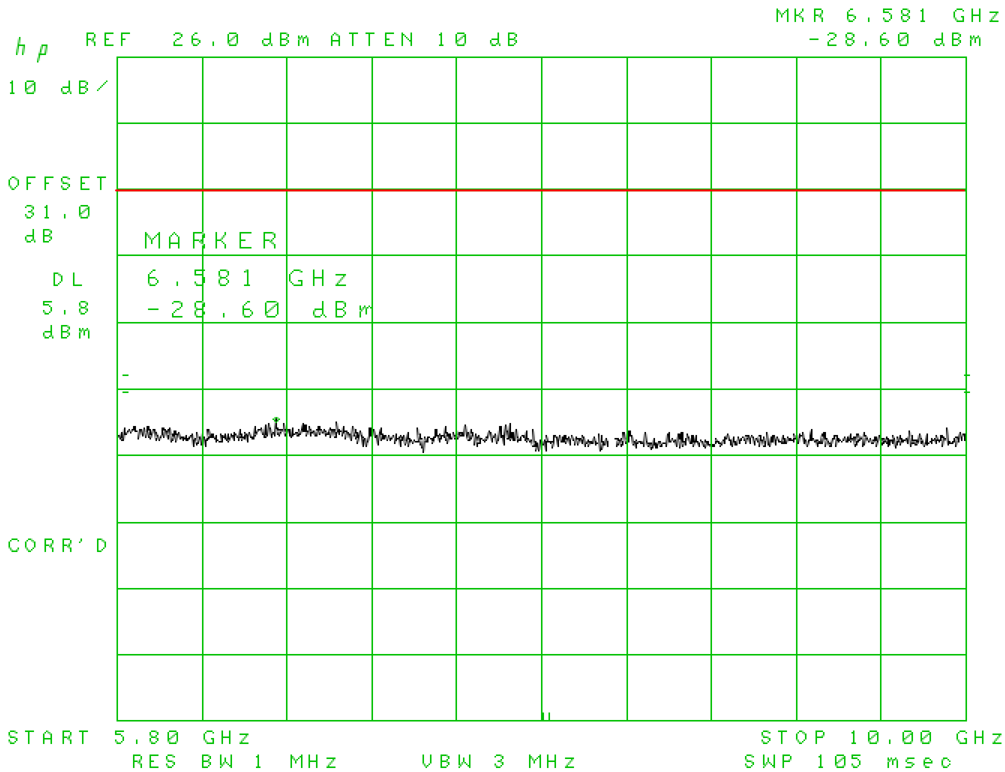

Figure 10. Antenna Conducted Emissions Mid, Part 4

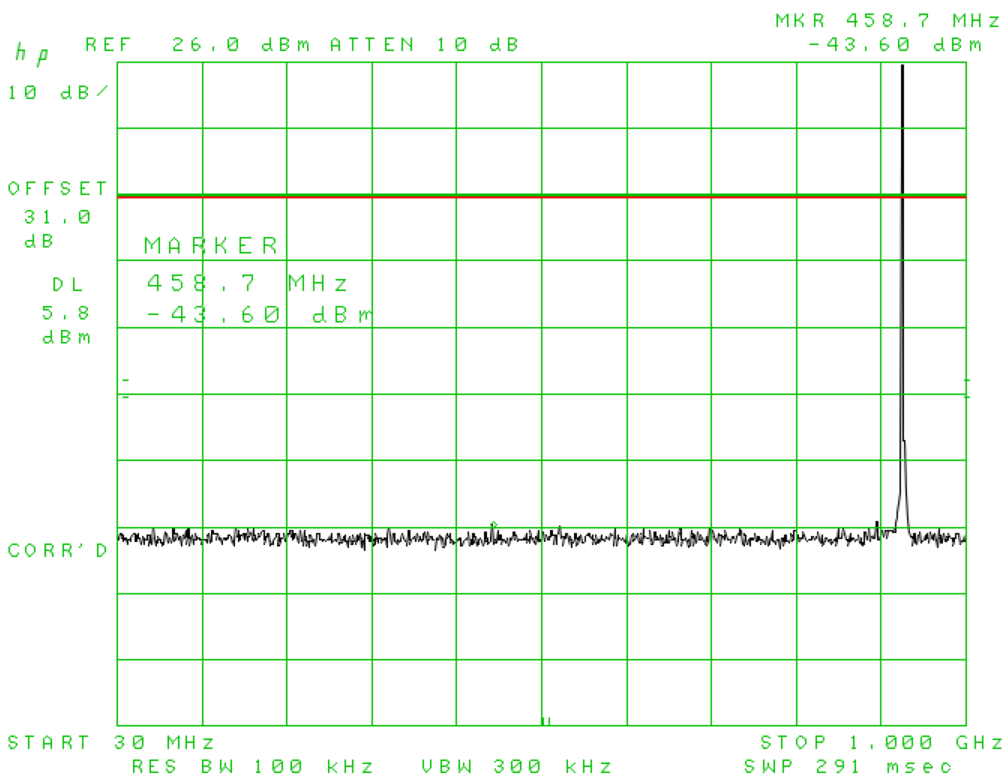

Figure 11. Antenna Conducted Emissions High, Part 1

Note: Large emission seen is the fundamental emission.

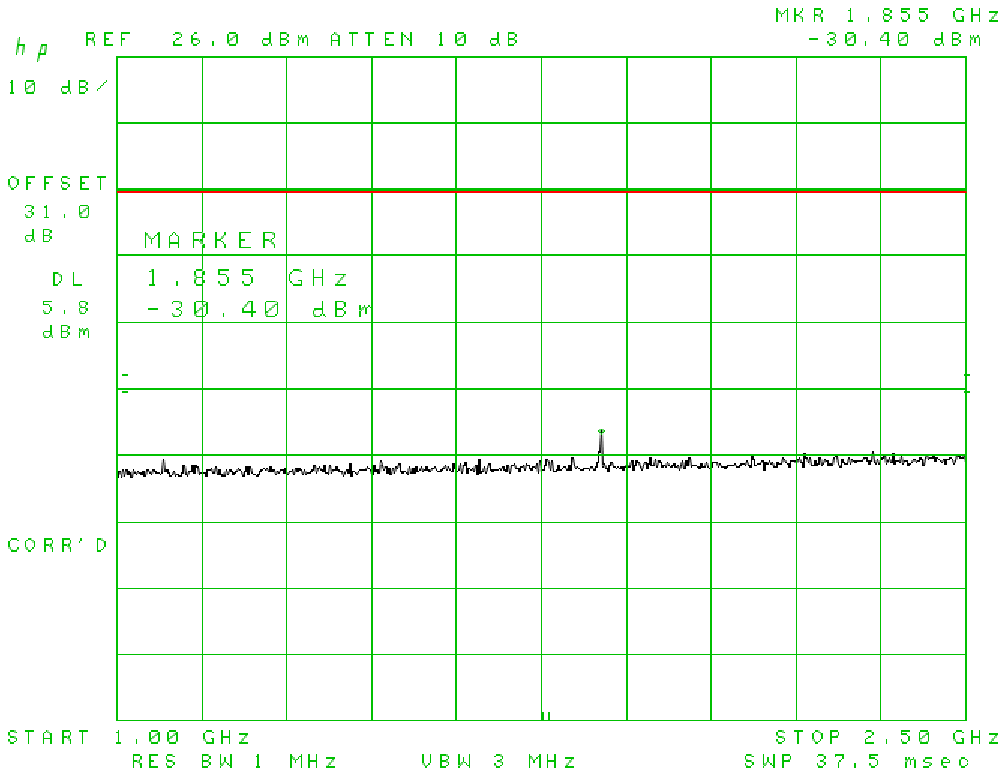

Figure 12. Antenna Conducted Emissions High, Part 2

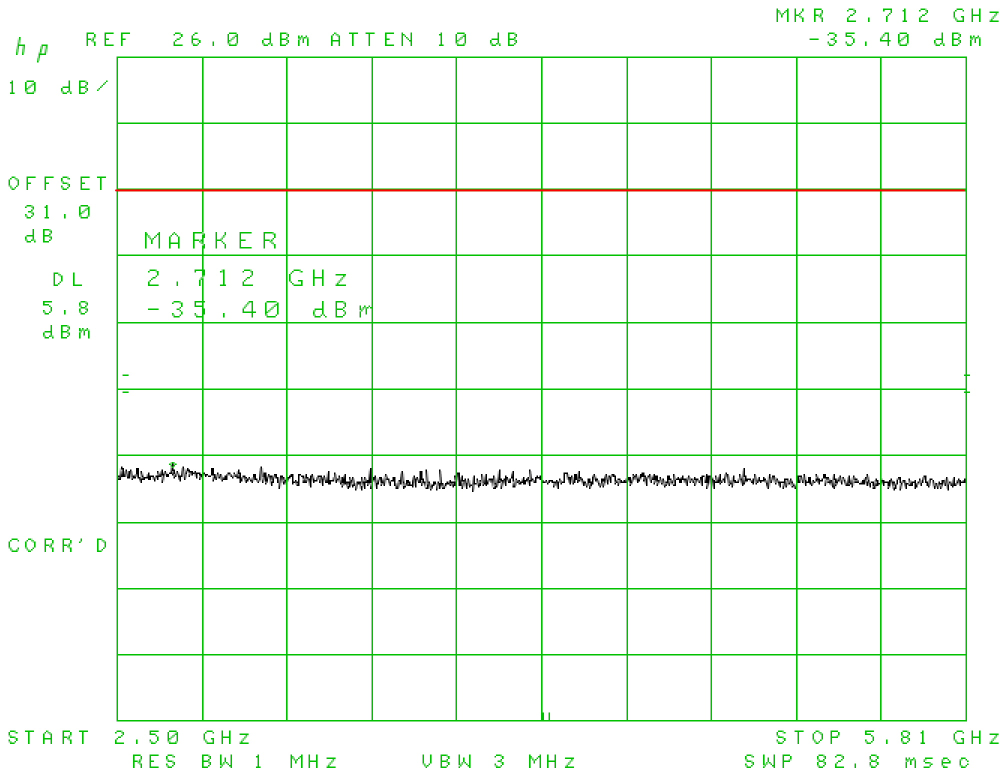

Figure 13. Antenna Conducted Emissions High, Part 3

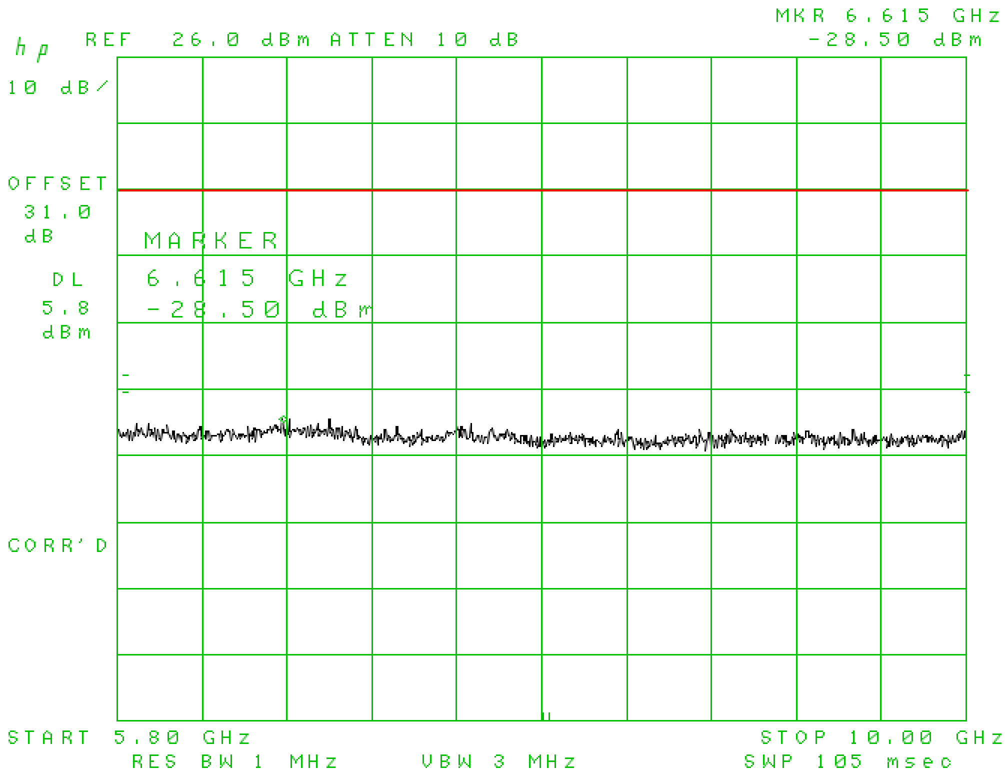

Figure 14. Antenna Conducted Emissions High, Part 4

2.11 Band Edge Measurements – (CFR 15.247 (d))

Band Edge measurements are made, following the guidelines in FCC Publication DA 00-705 and ANSI C63.10-2013 for the FHSS modulation, 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).

To capture the band edge, set the Spectrum Analyzer frequency span large enough (usually around 2 MHz) 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= 100kHz for measurements of the DTS modulation and with RBW ≥ 1% of the span for measurements of the FHSS modulation. In all cases, the VBW is set ≥ RBW. See figure and calculations below for more detail.

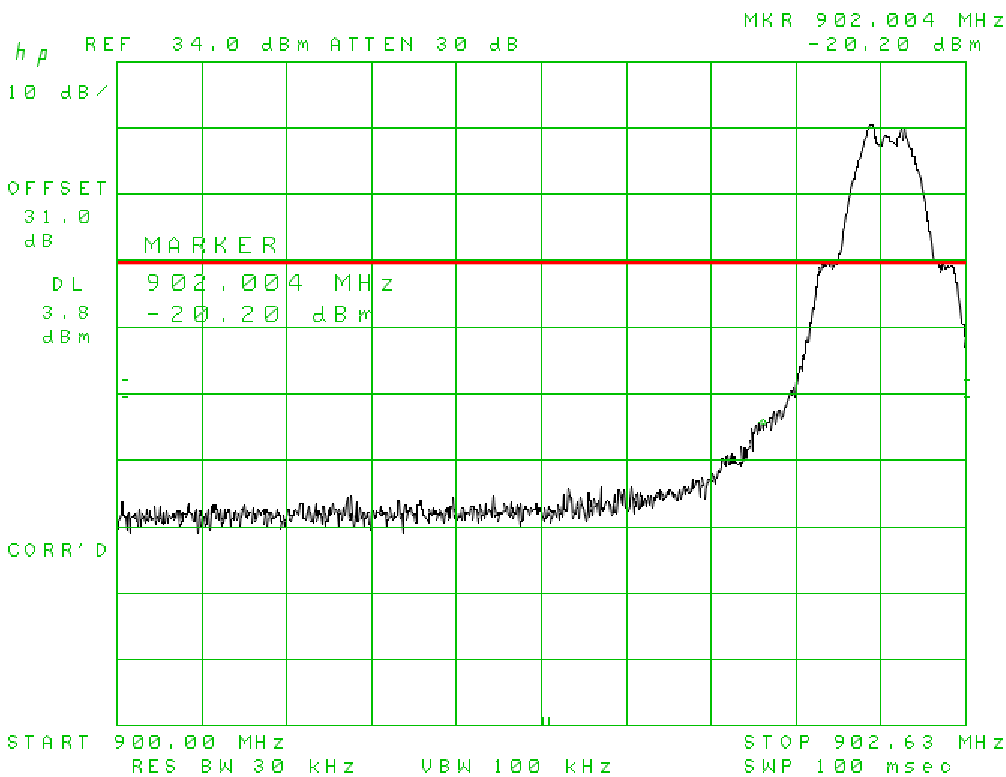

Figure 15. Band Edge Compliance, Low Channel Delta – Continuous Transmission

Red line is set to the limit, 20 dB down from the fundamental.

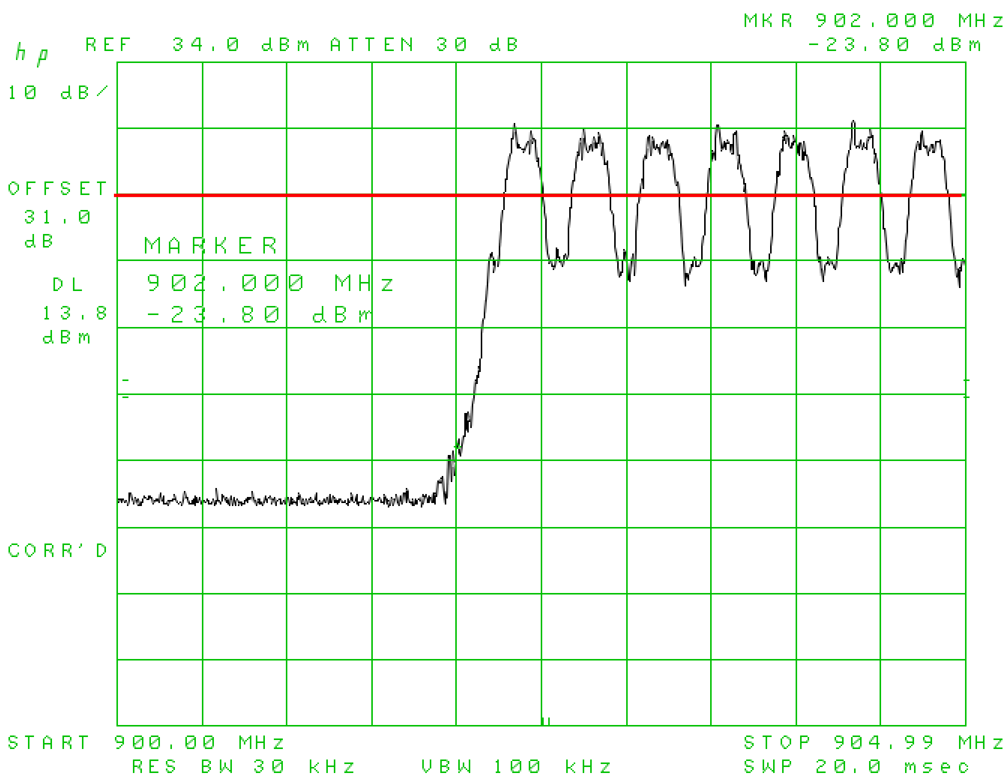

Figure 16. Band Edge Compliance, Low Channel Delta – Channel Hopping

Red line is set to the limit, 20 dB down from the fundamental.

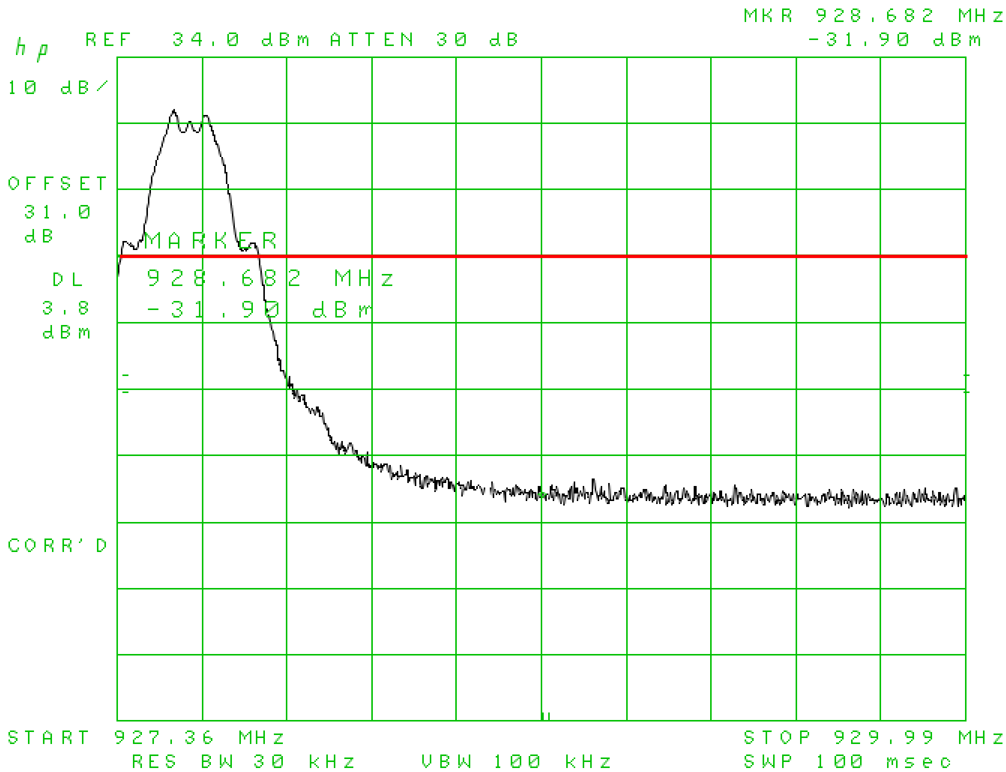

Figure 17. Band Edge Compliance, High Channel Delta – Continuous Transmission GFSK Modulation

Red line is set to the limit, 20 dB down from the fundamental.

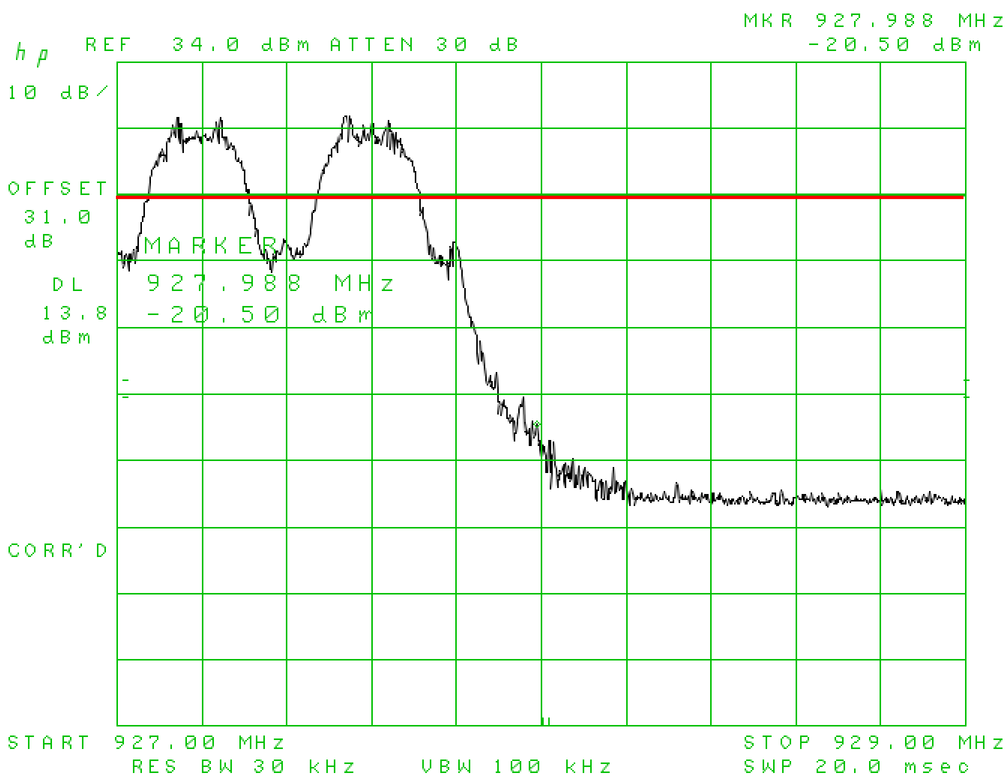

Figure 18. Band Edge Compliance, High Channel Delta – Channel Hopping GFSK Modulation

Red line is set to the limit, 20 dB down from the fundamental.

2.12 20 dB Bandwidth (CFR 15.247 (a) (1))

For frequency hopping systems operating in the 902-928 MHz band the maximum allowed 20 dB bandwidth is 500 kHz.

These measurements were performed while the EUT was in a constant transmit mode. A method similar to the marker delta method was used to capture the points. The RBW was set to approximately 1 % of the manufacturers claimed RBW and with the VBW ≥ RBW. The results of this test are shown in the following table and figures.

The EUT was test at 50kbps and 200kbps.

Table 11. 20 dB Bandwidth

Frequency (MHz)	20 dB Bandwidth (kHz)	Maximum Limit (kHz)
Bandwidth in 50kbps mode		
902.4	130	500
915.0	130	500
927.6	128	500
Bandwidth in 200kbps mode		
902.4	270	500
915.0	274	500
927.6	272	500

Test Date: March 14, 2016

Tested By
Signature: ____________ Name: George Yang

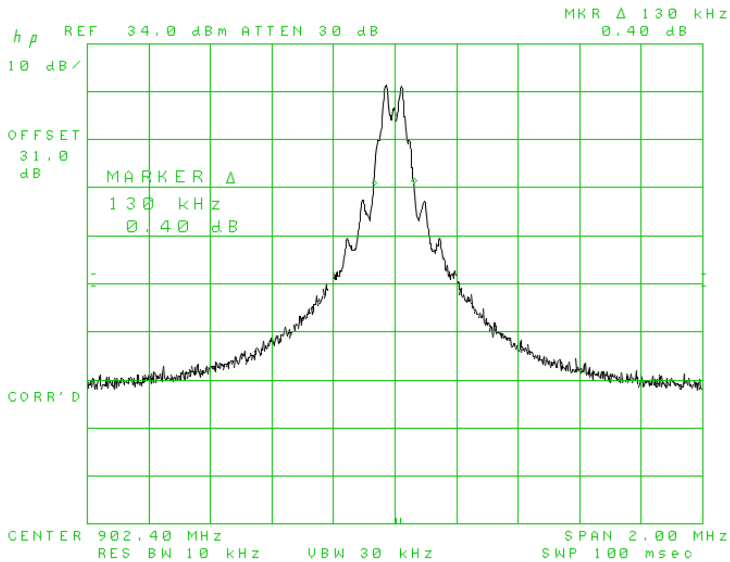

Figure 19. Low Channel 20 dB BW, 50kbps

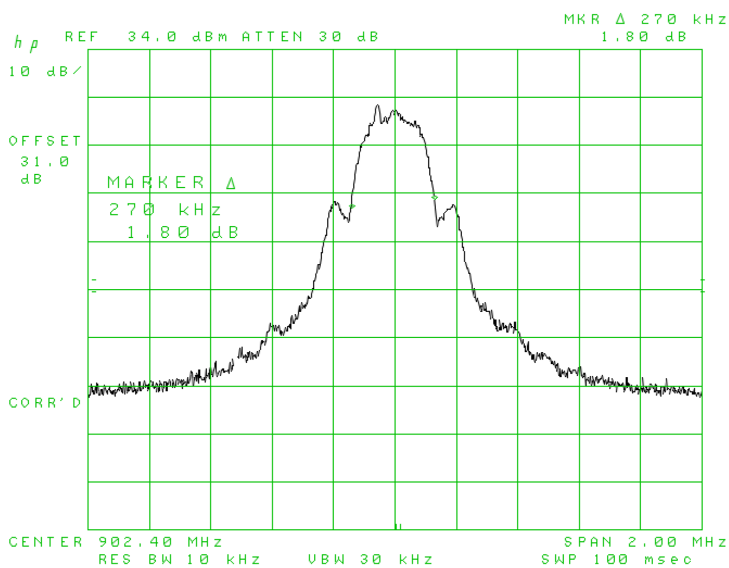

Figure 20. Low Channel 20 dB BW, 200kbps

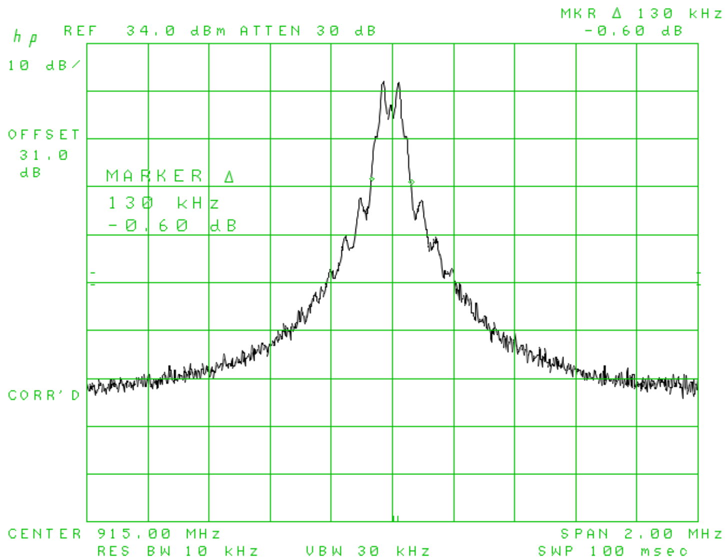

Figure 21. Mid Channel 20 dB BW, 50kbps

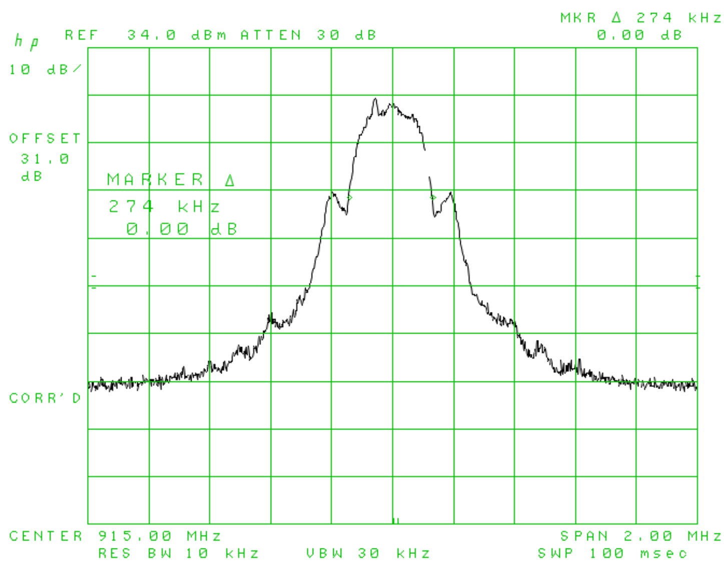

Figure 22. Mid Channel 20 dB BW, 200kbps

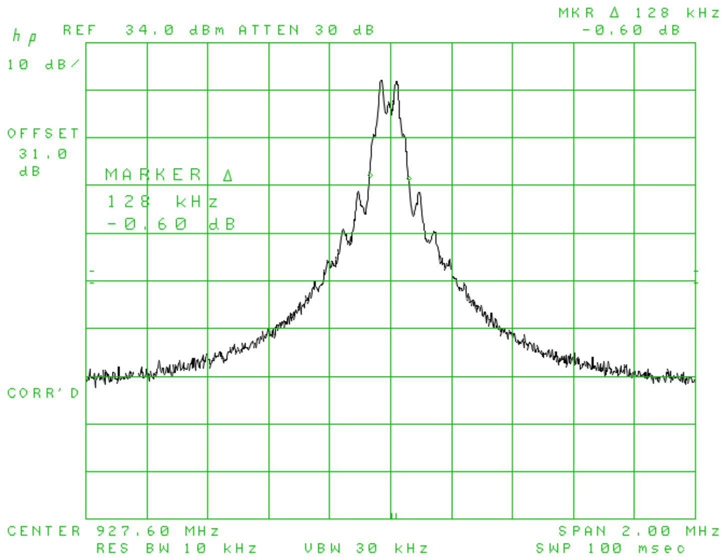

Figure 23. High Channel 20 dB BW, 50kbps

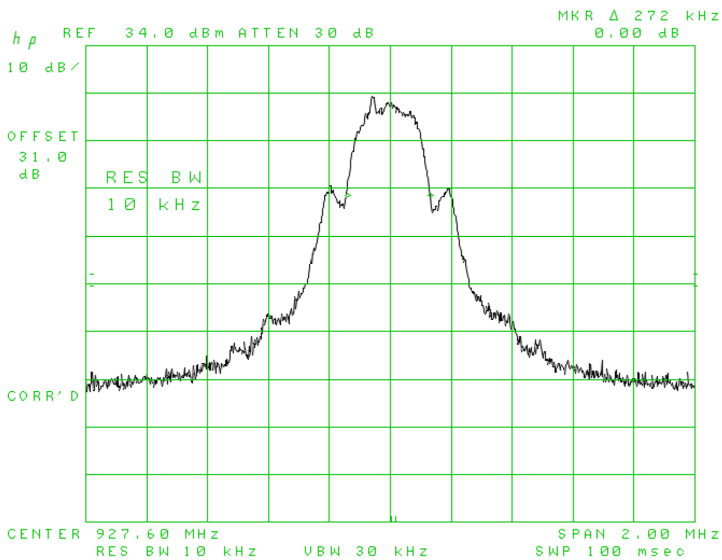

Figure 24. High Channel 20 dB BW, 200kbps

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

For frequency hopping systems in the 902-928 MHz band with at least 50 hopping channels, the maximum peak conducted output power of the intentional radiator shall not exceed 1 watt. Systems with less than 50 hopping channels, but at least 25 hopping channels, the maximum peak conducted output power of the intentional radiator shall not exceed 0.25 watts. Since the EUT has 121 hopping channels, the maximum peak conducted output power shall not exceed 1 watt.

Peak power within the band 902 MHz to 928 MHz was measured per FCC KDB Publication DA 00-705 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 50 Ω with the RBW set greater than the 6 dB bandwidth of the EUT, and the VBW ≥ RBW. Peak antenna conducted output power is tabulated below.

Table 12. 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)
902.4	25.3	0.339	1000
915.0	26.4	0.437	1000
927.6	26.2	0.417	1000

Test Date: March 14, 2016

Tested By
Signature: ____________ Name: George Yang

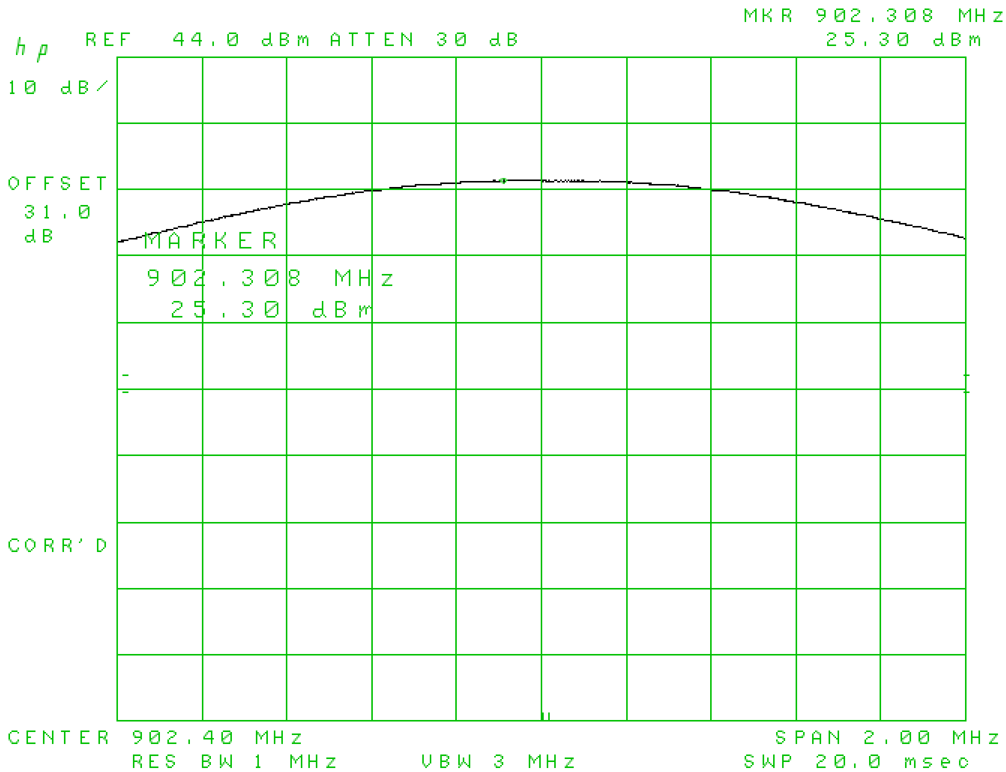

Figure 25. Peak Antenna Conducted Output Power, Low Channel

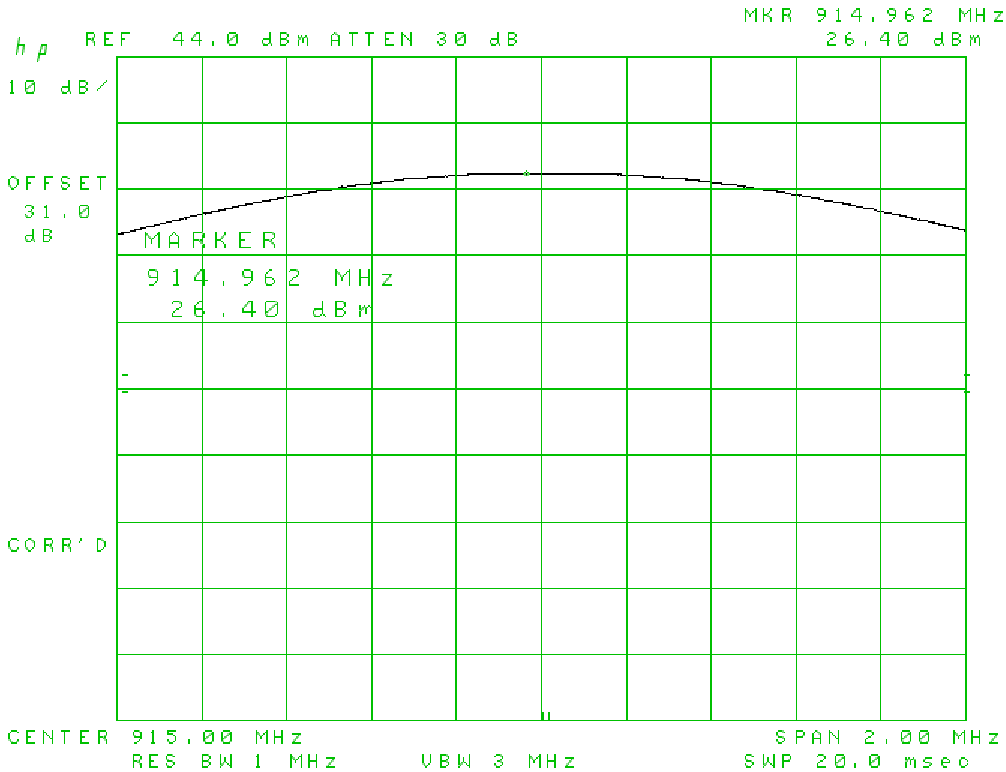

Figure 26. Peak Antenna Conducted Output Power, Mid Channel

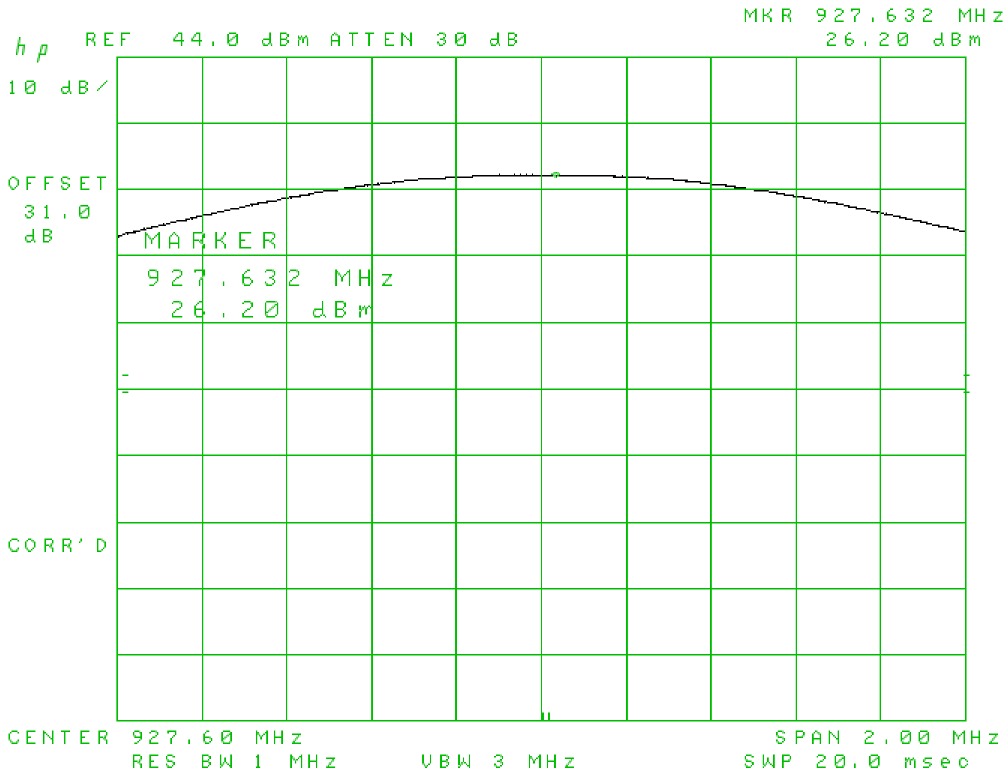

Figure 27. Peak Antenna Conducted Output Power, High Channel

2.14 Number of Hopping Frequencies (CFR 15.247 (a)(1)) (CRF 15.247(b)(1))

Frequency hopping systems in the 902-928 MHz band shall have at least 50 hopping frequencies if the 20 dB bandwidth is less than 250 kHz. If the 20 dB bandwidth is 250 kHz or greater, then the system shall have at least 25 hopping frequencies. Since the EUT has a 20 dB bandwidth less than 250 kHz, then at least 25 hopping frequencies shall be used.

The test procedures outlined in FCC Public Notice DA 00-705 were used to conduct measurements.

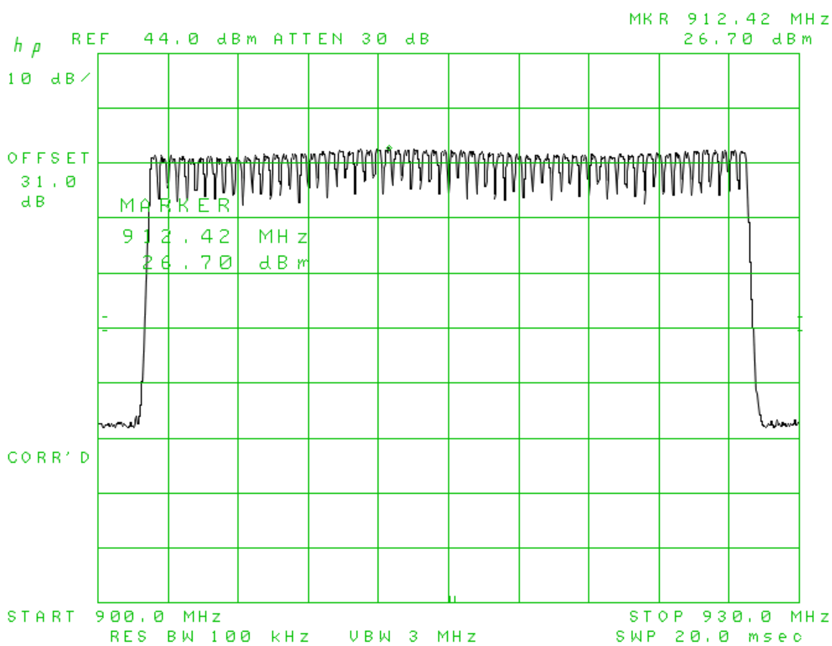

Figure 28. Hopping Channels

2.15 Frequency Separation (CRF 15.247(a)(1))

For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

The EUT uses meet the frequency separation and dwell time requirement.

The test procedures outlined in FCC Public Notice DA 00-705 were used to conduct measurements. The EUT hopping function was enabled during the testing.

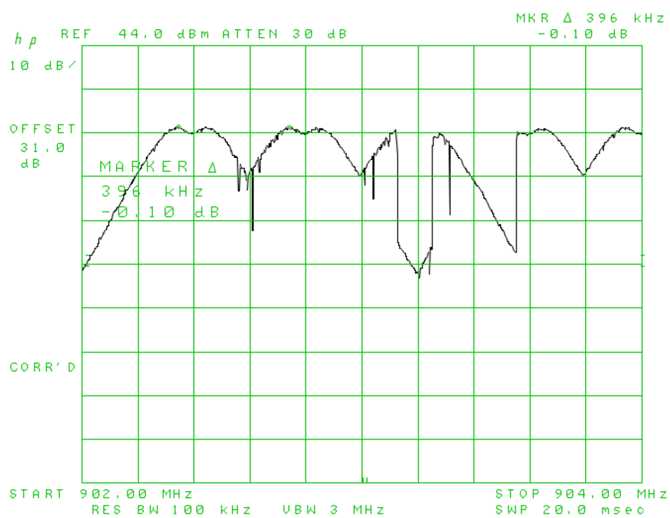

Figure 29. Channel Separation

Table 13. Maximum Dwell time

Data Rate (kbps)	Single Occupation On Time (ms)	Number of Occupations / 20s	Total Dwell Time (ms)
200	57.78	5	288.90
200	23.17	2	46.34
Total:			335.24

2.16 Unintentional Radiator, Powerline Emissions (CFR 15.107)

The power line conducted voltage emission measurements have been carried out in accordance with CFR 15.107, per ANSI C63.4:2009, Paragraph 7, with a spectrum analyzer connected to a LISN and the EUT placed into normal mode of operation. Both on board radios were on and exercising. The 3G module was programmed to continuously search for a network, the Titan module was continuously hopping a cross all channels. The test data is presented below:

NOTE: THE FOLLOWING IS PROVIDED AS COMPLIANCE DATA FOR WHICH THE EUT HAS BEEN TESTED AS A HOST PRODUCT WHICH CONTAINS CO-LOCATED MODULES. BOTH MODULES WERE ON AND EXERCISING IN A MODE THAT SIMULATED NORMAL OPERATION.

Table 14. Power Line Conducted Emissions Test Data, Part 15.107

150KHz to 30 MHz						
Test: Power Line Conducted Emissions				**Client:** HDJ WIRELESS ENTERPRISE LLC		
Project: 16-0054				**Model:** VERSA ROUTER 1100 TITAN		
Frequency (MHz)	**Test Data (dBuv)**	**LISN+CL-PA (dB)**	**Results (dBuV)**	**AVG Limits (dBuV)**	**Margin (dB)**	**Detector PK, QP, or AVG**
Phase Line						
0.1585	48.10	0.51	48.61	55.5	6.9	**PK**
0.7920	54.80	0.22	55.02	56.0	1.0	**QP**
0.7920	32.40	0.22	32.62	46.0	13.4	**AVG**
4.9920	42.90	0.42	43.32	56.0	12.7	**QP**
4.9920	31.20	0.42	31.62	46.0	14.4	**AVG**
7.9050	50.40	0.55	50.95	60.0	9.1	**QP**
7.9050	40.00	0.55	40.55	50.0	9.5	**AVG**
10.1900	45.60	0.65	46.25	60.0	13.7	**QP**
10.1900	41.20	0.65	41.85	50.0	8.1	**AVG**
22.1500	46.60	1.10	47.70	60.0	12.3	**QP**
22.1500	43.30	1.10	44.40	50.0	5.6	**AVG**

SAMPLE CALCULATION: 0.1585 MHz:

Magnitude of Measured Frequency	48.10	dBuV
+LISN Factor + Cable Loss+ Amplifier Gain	0.51	dB/m
Corrected Result	48.61	dBuV/m

Test Date: March 16, 2016

Tested By
Signature: ______ Name: **Robert Nevels**

Table 15. Power Line Conducted Emissions Test Data, Part 15.107

150KHz to 30 MHz						
Test: Power Line Conducted Emissions				**Client:** HDJ WIRELESS ENTERPRISE LLC		
Project: 16-0054				**Model:** VERSA ROUTER 1100 TITAN		
Frequency (MHz)	**Test Data (dBuv)**	**LISN+CL-PA (dB)**	**Results (dBuV)**	**AVG Limits (dBuV)**	**Margin (dB)**	**Detector PK, QP, or AVG**
Neutral Line						
0.4698	39.70	0.23	39.93	46.5	6.6	**PK**
0.7877	52.10	0.22	52.32	56.0	3.7	**QP**
0.7877	28.80	0.22	29.02	46.0	17.0	**AVG**
4.9920	44.30	0.42	44.72	56.0	11.3	**QP**
4.9920	32.80	0.42	33.22	46.0	12.8	**AVG**
7.3650	52.20	0.49	52.69	60.0	7.3	**QP**
7.3650	41.00	0.49	41.49	50.0	8.5	**AVG**
15.3200	47.30	0.87	48.17	60.0	11.8	**QP**
15.3200	40.70	0.87	41.57	50.0	8.4	**AVG**
21.9300	49.60	1.11	50.71	60.0	9.3	**QP**
21.9300	45.70	1.11	46.81	50.0	3.2	**AVG**

SAMPLE CALCULATION: 0.4698 MHz:

Magnitude of Measured Frequency	39.70	dBuV
+LISN Factor + Cable Loss+ Amplifier Gain	0.23	dB/m
Corrected Result	39.93	dBuV/m

Test Date: March 16, 2015

Tested By
Signature: ____________ Name: **Robert Nevels**

2.17 Unintentional and Intentional Radiator, Radiated Emissions (CFR 15.109, 15.209)

Radiated emissions disturbance measurements were performed with the transmitter turned OFF and the test was repeated with the intentional transmitter circuit ON. The worst case mode of operation is with the transmitter circuit ON. The EUT was placed into normal mode of operation. Both co-located radios were on and exercising. The 3G module was programmed to continuously search for a network, the Titan module was continuously hopping a cross all channels. That test data is presented below to show compliance to both parts.

An instrument having both peak and quasi-peak detectors was used to perform the test over the frequency range of 30 MHz to five times the highest clock frequency (ten times to cover 15.209 requirements). Measurements of the radiated emissions were made with the receiver antenna at a distance of 3 m from the boundary of the test unit.

The test antenna was varied from 1 m to 4 m in height while watching the analyzers' display for the maximum magnitude of the signal at the test frequency. The antenna polarization (horizontal or vertical) and test sample azimuth were varied during the measurements to find the maximum field strength readings to record.

Only the fundamental and corresponding harmonics were determined to be coming from the EUT. The fundamental and harmonics were tested to 15.247 and can be found in Table 6 and 7. Below are radiated emission plots of the EUT from 30 MHz to 10 GHz with a receiving antenna 1 m away from the EUT. The measurement was completed with the receiving antenna in vertical and horizontal polarity. No signification difference was seen in either polarity.

NOTE: THE FOLLOWING IS PROVIDED AS COMPLIANCE DATA FOR WHICH THE EUT HAS BEEN TESTED AS A HOST PRODUCT WHICH CONTAINS CO-LOCATED MODULES. BOTH MODULES WERE ON AND EXERCISING IN A MODE THAT SIMULATED NORMAL OPERATION.

Table 16. Unintentional and Intentional Radiator, Spurious Radiated Emissions (CFR 15.109, 15.209) 30 MHz to 1000 MHz

30 MHz to 1000 MHz with Class B Limits							
Test: Radiated Emissions				**Client:** HDJ WIRELESS ENTERPRISE LLC			
Project: 16-0054				**Model:** VERSA ROUTER 1100 TITAN			
Frequency (MHz)	**Test Data (dBuV)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**QP Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector PK, or QP**
84.37	43.03	-10.29	32.74	40.0	3m./VERT	7.3	**PK**
84.45	36.28	-10.29	25.99	40.0	3m./VERT	14.0	**PK**
216.80	49.29	-7.46	41.83	46.0	3m./VERT	4.2	**QP**
219.90	49.56	-7.46	42.10	46.0	3m./VERT	3.9	**QP**
788.09	38.75	5.17	43.92	46.0	3m./VERT	2.1	**QP**
215.50	48.44	-6.93	41.51	43.5	3m./HORZ	2.0	**QP**
112.07	52.19	-9.48	42.71	43.5	3m./VERT	0.8	**QP**
84.41	42.38	-11.69	30.69	40.0	3m./HORZ	9.3	**QP**
112.11	51.09	-9.58	41.51	43.5	3m./HORZ	2.0	**QP**
110.38	50.01	-9.78	40.23	43.5	3m./HORZ	3.3	**QP**
215.50	46.00	-8.79	37.21	43.5	3m./HORZ	6.3	**QP**
770.80	40.40	2.15	42.55	46.0	3m./HORZ	3.4	**PK**

Tested from 30 MHz to 1 GHz

SAMPLE CALCULATION: 84.37 MHz:

Magnitude of Measured Frequency	43.03	dBuV
+Antenna Factor + Cable Loss+ Amplifier Gain	-10.29	dB/m
Corrected Result	32.74	dBuV/m

Test Date: March 18, 2016

Tested By
Signature: ____________ Name: George Yang

Table 17. Unintentional and Intentional Radiator, Spurious Radiated Emissions (CFR 15.109, 15.209) 1 GHz to 10 GHz

1 GHz to 10 GHz with Class B Limits							
Test: Radiated Emissions				**Client:** HDJ WIRELESS ENTERPRISE LLC			
Project: 16-0054				**Model:** VERSA ROUTER 1100 TITAN			
Frequency (MHz)	**Test Data (dBuV)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**AVG Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector PK, or AVG**
All emissions seen were 20 dB or more from the limit.							

Tested from 1 GHz to 6 GHz

SAMPLE CALCULATION: N/A

Test Date: March 18, 2016

Tested By
Signature: ____________ Name: George Yang

2.18 Measurement Uncertainty

The measurement uncertainties given were calculated using the method detailed in CISPR 16-4. A coverage factor of k=2 was used to give a level of confidence of approximately 95%.

2.18.1 Conducted Emissions Measurement Uncertainty

Measurement Uncertainty (within a 95% confidence level) for this test is ± 2.78 dB.

The data listed in this test report does have sufficient margin to negate the effects of uncertainty. Therefore, the EUT unconditionally meets this requirement.

2.18.2 Radiated Emissions Measurement Uncertainty

For a measurement distance of 3 m the measurement uncertainty (with a 95% confidence level) for this test using a Biconical Antenna (30 MHz to 200 MHz) is ± 5.39 dB. This value includes all elements of measurement.

The measurement uncertainty (with a 95% confidence level) for this test using a Log Periodic Antenna (200 MHz to 1000 MHz) is ± 5.18 dB.

The measurement uncertainty (with a 95% confidence level) for this test using a Horn Antenna is ± 5.21dB.

The data listed in this test report does not have sufficient margin to negate the effects of uncertainty. Therefore, the EUT conditionally meets this requirement.