RF TEST REPORT

Test item	:	Industrial Image Processing Unit
Model No.	:	1417WGB
Order No.	:	DEMC1401-00237, DEMC1401-00246
Date of receipt	:	2014-01-20
Test duration	:	2014-01-30 ~ 2014-03-14
Date of issue	:	2014-03-11
Use of report	:	FCC& IC Original Grant

Applicant : Rayence Co., Ltd.
1F, 2F, 3F, #402, 14, Samsung 1ro 1-gil, Hwaseong-si, Gyeonggi-do, 445-170, Korea

Test laboratory : Digital EMC Co., Ltd.
42, Yurim-ro, 154beon-gil, Cheoin-gu, Yongin-si, Gyeonggi-do, Korea 449-935

Test specification	:	FCC Part 15.407 Subpart E RSS-210 Issue 8: 2010
Test environment	:	See appended test report
Test result	:	☒ Pass ☐ Fail

Tested by:

Engineer
HongHee Lee

Reviewed by:

Technical Director
Harvey Sung

Test Report Version

Test Report No.	Date	Description
DRTFCC1403-0353	Mar. 11, 2014	Initial issue
DRTFCC1403-0353(1)	Mar. 17, 2014	Update peak Excursion

CONTENTS

1.EUT DESCRIPTION

FCC Equipment Class	Unlicensed National Information Infrastructure (UNII)
Product	Industrial Image Processing Unit
Model Name	1417WGB
Add Model Name	N/A
Power Supply	DC 11.1 V
Frequency Range	**Band I(5150 ~ 5250MHz)** ▪ 802.11a/n(HT20): 5180 ~ 5240 MHz ▪ 802.11n(HT40): 5190 ~ 5230 MHz
Modulation type	▪ 802.11a/n: OFDM
Transmissions category	Completely uncorrelated signal
Antenna Specification	**Antenna type**: Internal Antenna **Antenna gain** ▪ Band I: ANT 1 : 2.960 dBi & ANT 2 : - 4.870 dBi **Antenna configuration** ▪ 802.11a: Multiple Transmitting (ANT 1 and ANT 2) ▪ 802.11n(MCS0 ~ 7) : Multiple Transmitting (ANT 1 and ANT 2)

2. INFORMATION ABOUT TESTING

2.1 Test mode

5GHz Band	Mode	Worst data rate
Band I	802.11a	6 Mbps
	802.11n(HT20)	MCS 0
	802.11n(HT40)	MCS 0

The worst case data rate for each modulation is determined as above test mode. And all tests conducted in this report were made at the worst case data rate of each modulation.

2.2 Tested channel information

5GHz Band	802.11a/n(HT20)		802.11n(HT40)	
	Channel	Frequency [MHz]	Channel	Frequency [MHz]
Band I	36	5180	38	5190
	40	5220	-	-
	48	5240	46	5230

2.3 Auxiliary equipment

Equipment	Model No.	Serial No.	Manufacturer	Note
Laptop	PP22L	H7R1GBX	DELL	FCC DoC
-	-	-	-	-

2.4 Tested environment

Temperature	:	23 ~ 24°C
Relative humidity content	:	40 ~ 48 % R.H.
Details of power supply	:	DC 11.1 V

2.5 EMI Suppression Device(s) / Modifications

EMI suppression device(s) added and/or modifications made during testing
→ None

3. SUMMARY OF TESTS

FCC Part Section(s)	RSS Section(s)	Parameter	Limit	Test Condition	Status Note 1
I. Transmitter Mode (TX)					
15.407(a)	N/A	Emission Bandwidth (26 dB Bandwidth)	N/A	Conducted	NT Note 3
15.407(a)	RSS-210 [A9.2]	Maximum Conducted Output Power	5150 ~ 5250MHz For FCC 50mW or < 4 + 10log$_{10}$(B) dBm, whichever power is less. 5150 ~ 5250MHz For IC 200mW or <10 + 10log$_{10}$(B) dBm, whichever power is less. 5250 ~ 5350MHz For FCC & IC 250mW or <11 + 10log$_{10}$(B) dBm, whichever power is less. 5470 ~ 5725MHz For FCC & IC 250mW or <11 + 10log$_{10}$(B) dBm, whichever power is less.		C
15.407(a)	RSS-210 [A9.2]	Peak Power Spectral Density	5150 ~ 5250MHz For FCC: 4dBm/MHz 5150 ~ 5250MHz For IC: 10dBm/MHz 5250 ~ 5350MHz For FCC & IC: 11dBm/MHz 5470 ~ 5725MHz For FCC & IC: 11dBm/MHz		NT Note 3
15.407(a)	N/A	Peak Excursion	< 13 dB/MHz maximum difference		C
15.407(g)	N/A	Frequency Stability	N/A		NT Note 3
-	RSS Gen [4.6.1]	Occupied Bandwidth (99%)	N/A		C
15.407(b)	RSS-210 [A9.2]	Undesirable Emissions	< -27 dBm/MHz EIRP	Radiated	C Note 4
15.205 15.209 15.407(b)	RSS-Gen [7.2.5]	General Field Strength Limits(Restricted Bands and Radiated Emission Limits)	Emissions in restricted bands must meet the radiated limits detailed in 15.209		C Note 4
15.407(h)	RSS-210 [A9.3]	Dynamic Frequency Selection	See DFS test report	-	NA
15.207	RSS-Gen [7.2.4]	AC Conducted Emissions	FCC 15.207	AC Line Conducted	NA Note 5
15.203	RSS-Gen [7.1.2]	Antenna Requirements	FCC 15.203	-	C

Note 1: **C**=Comply **NC**=Not Comply **NT**=Not Tested **NA**=Not Applicable

Note 2: The test items were performed according to the KDB789033 and ANSI C63.10.

Note 3: These test items were not performed because this device uses the granted module.
(FCCID: PPD-AR5B116)
Please refer to the test report of the granted module.
The module test report number:
FR080603B(By SPORTON INTERNATIONAL INC.)

Note 4: These test items were performed in each axis and the worst case data was reported.

Note 5: The EUT use only battery operating.

4. TEST METHODOLOGY

Generally the tests were performed according to the KDB789033 D01 v01r03. And ANSI C63.10-2009 was used to reference appropriate EUT setup and maximizing procedures of radiated spurious emission and AC line conducted emission testing

4.1 EUT configuration

The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and operating in a manner that intends to maximize its emission characteristics in a continuous normal application.

4.2 EUT exercise

The EUT was operated in the engineering mode to fix the Tx frequency that was for the purpose of the measurements. According to its specifications, the EUT must comply with the requirements of the Section 15.207, 15.209 and 15.407 under the FCC Rules Part 15 Subpart C.

4.3 General test procedures

Conducted Emissions

The power-line conducted emission test procedure is not described on the KDB789033 D01 v01r03. So this test was fulfilled with the requirements in Section 6.2 of ANSI C63.10.

The EUT is placed on the turntable, which is 0.8 m above ground plane and the conducted emissions from the EUT measured in the frequency range between 0.15MHz and 30MHz using CISPR Quasi-peak and Average detector.

Radiated Emissions

Basically the radiated tests were performed with KDB789033 D01 v01r03. But some requirements and procedures like test site requirements, EUT setup and maximizing procedure were fulfilled with the requirements in Section 5 and 6 of the ANSI C63.10 as stated on KDB789033 D01 v01r03.

The EUT is placed on a turn table, which is 0.8 m above ground plane. The turntable shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 3 m away from the receiving antenna, which varied from 1 m to 4 m to find out the highest emission. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. In order to find out the highest emission, the relative positions of the EUT were rotated through three orthogonal axis.

4.4 Description of test modes

A test program is used to control the EUT for staying in continuous transmitting mode.

5. INSTRUMENT CALIBRATION

The measuring equipment, which was utilized in performing the tests documented herein, has been calibrated in accordance with the manufacturer's recommendations for utilizing calibration equipments, which is traceable to recognized national standards.

6. FACILITIES AND ACCREDITATIONS

6.1 Facilities

The open area test site(OATS) or semi anechoic chamber and conducted measurement facility used to collect the radiated and conducted test data are located at the 38, Yurim-ro, 154beon-gil, Cheoin-gu, Yongin-si, Gyeonggi-do, Korea 449-935. The site is constructed in conformance with the requirements.

- Semi anechoic chamber registration Number : 678747

6.2 Equipment

Radiated emissions are measured with one or more of the following types of Linearly polarized antennas: tuned dipole, bi-conical, log periodic, bi-log, and/or ridged waveguide, horn. Spectrum analyzers with pre-selectors and peak, quasi-peak detectors are used to perform radiated measurements. Conducted emissions are measured with Line Impedance Stabilization Networks and EMI Test Receivers. Calibrated wideband preamplifiers, coaxial cables, and coaxial attenuators are also used for making measurements. All receiving equipment conforms to CISPR Publication 16-1, “Radio Interference Measuring Apparatus and Measurement Methods.”

7. ANTENNA REQUIREMENTS

7.1 According to FCC 47 CFR §15.203& RSS-Gen [7.1.2]:

An intentional radiator antenna shall be designed to ensure that no antenna other than that furnished by the responsible party can 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.

The internal antenna is attached on the main PCB using the special spring tension.

(Please refer to the internal photo.)

Therefore this E.U.T Complies with the requirement of §15.203

7.2 Directional antenna gain for MIMO :

Bands	ANT 1 [dBi]	ANT 2 [dBi]	Directional Gain for uncorrelated signals [dBi]
Band I	2.960	-4.870	0.612

Directional gain = 10 log[($10^{G1/10}$ + $10^{G2/10}$ + … + $10^{GN/10}$) /N_{ANT}] dBi for MIMO uncorrelated signal

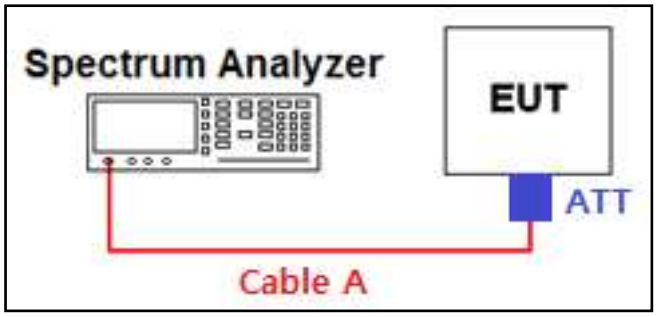
8. TEST RESULT

8.1 Emission Bandwidth(26 dB Bandwidth)

▣ Test Requirements

The bandwidth at 26 dB down from the highest in-band spectral density is measured with a spectrum analyzer connected to the antenna terminal while the EUT is operating in transmission mode at the appropriate frequencies. The 26dB bandwidth is used to determine the conducted output power limit.

▣ Test Configurations



▣ Test Procedure

The transmitter output is connected to the Spectrum Analyzer and used following test procedure of **KDB789033**.

1. Set resolution bandwidth (RBW) = approximately **1 %** of the **EBW**
2. Set the video bandwidth (VBW) **> RBW**.
3. Detector = **Peak**.
4. Trace mode = **max hold**.
5. Measure the maximum width of the emission that is 26 dB down from the peak of the emission. Compare this with the RBW setting of the analyzer. Readjust RBW and repeat measurement as needed until the RBW/EBW ratio is approximately 1%.

▣ TEST RESULTS: N/T

8.2 Maximum Conducted Output Power

▣ FCC Requirements

(1) For the band 5.15~5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed the lesser of 50 mW or 4 dBm + 10log B, where B is the 26dB emission bandwidth in MHz. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the peak power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(2) For the 5.25~5.35 GHz and 5.47~5.725 GHz bands, the maximum conducted output power over the frequency bands of operation shall not exceed the lesser of 250 mW or 11 dBm + 10log B, where B is the 26 dB emission bandwidth in megahertz. If transmitting antennas of directional gain greater than 6dBi are used, both the maximum conducted output power and the peak power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

▣ IC Requirements

(1) For the band 5.15 ~ 5.25 GHz, the maximum e.i.r.p. shall not exceed 200 mW or 10 + 10 $\log_{10}$ B, dBm, whichever power is less. B is the 99% emission bandwidth in MHz.

(2) For the 5.25 ~ 5.35 GHz, the maximum conducted output power shall not exceed 250 mW or 11 + 10 $\log_{10}$ B, dBm, whichever power is less.

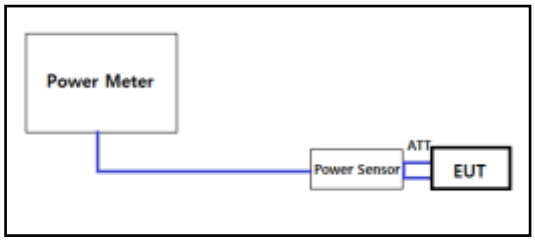
(3) For the 5470~5600 MHz and 5650 ~ 5725 MHz, the maximum conducted output power shall not exceed 250 mW or 11 + 10 $\log_{10}$ B, dBm, whichever power is less.

▣ Maximum conducted Output power Limit Calculation

Bands	Mode	Power Limit [mW] / Least 26dB BW [MHz]	Calculation Limit [dBm]	Determined Limit [dBm]
Band I	802.11a	50	16.98	***16.98***
		25.060	17.98	
	802.11n HT20	50	16.98	***16.98***
		27.330	18.36	
	802.11n HT40	50	16.98	***16.98***
		70.710	22.49	

Note 1: The directional gain does not exceed 6dBi. Please refer to clause 7.2.
Note 2: The FCC limit was used.

▣ **Test Configuration**



▣ **Test Procedure**

Maximum Conducted Output Power is measured using Measurement Procedure **Method PM-G of KDB789033**

▣ **Test Results : Comply**

Mode	CH	Freq. [MHz]	Test Result			
			ANT 1 [dBm]	ANT 2 [dBm]	SUM Power Note1	
					[dBm]	[W]
802.11a	36	5180	12.18	11.43	14.83	0.03042
	40	5220	11.75	11.58	14.68	0.02935
	48	5240	11.82	11.67	14.76	0.02989
802.11n HT20	36	5180	13.93	13.41	16.69	0.04665
	40	5220	13.67	13.29	16.49	0.04461
	48	5240	13.83	13.18	16.53	0.04495
802.11n HT40	38	5190	13.94	13.48	16.73	0.04706
	46	5230	13.87	13.31	16.61	0.04581

Note 1: SUM power = $10\log(10^{(\frac{\text{ANT 1 Result}}{10})} + 10^{(\frac{\text{ANT 2 Result}}{10})})$

8.3 Peak Power Spectral Density

▣ **FCC Requirements**

(1) For the band 5.15-5.25 GHz, the peak power spectral density shall not exceed 4 dBm in any 1 MHz band.
(2) For the 5.25-5.35 GHz and 5.47-5.725 GHz bands, the peak power spectral density shall not exceed 11 dBm in any 1 megahertz band.

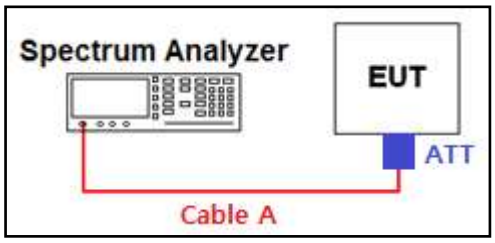
▣ **IC Requirements**

(1) For the band 5.15~5.25 GHz, the e.i.r.p. spectral density shall not exceed 10 dBm in any 1.0 MHz band.
(2) For the 5.25~5.35 GHz, the power spectral density shall not exceed 11 dBm in any 1.0 MHz band.
(3) For the 5470~5600 MHz and 5650 ~ 5725 MHz, the power spectral density shall not exceed 11 dBm in any 1.0 MHz band.

▣ **Peak Power Spectral Density Limit Calculation**

Note 1: The directional gain does not exceed 6dBi. Please refer to clause 7.2.

▣ **Test Configuration**



▣ **Test Procedure**

Peak Power Spectral Density is measured using Measurement Procedure of **KDB789033**

1) Create an average power spectrum for the EUT operating mode being tested by following the instructions in section E)2) for measuring maximum conducted output power using a spectrum analyzer: select the appropriate test method (SA-1, SA-2, SA-3, or alternatives to each) and apply it up to, but not including, the step labeled, “Compute power…”. (This procedure is required even if the maximum conducted output power measurement was performed using a power meter, method PM.)
2) Use the peak search function on the spectrum analyzer to find the peak of the spectrum.
3) Make the following adjustments to the peak value of the spectrum, if applicable:
a) If Method SA-2 or SA-2 Alternative was used, add 10 log(1/x), where x is the duty cycle, to the peak of the spectrum.
b) If Method SA-3 Alternative was used and the linear mode was used in step E)2)g)(viii), add 1 dB to the final result to compensate for the difference between linear averaging and power averaging.
4) The result is the PPSD.

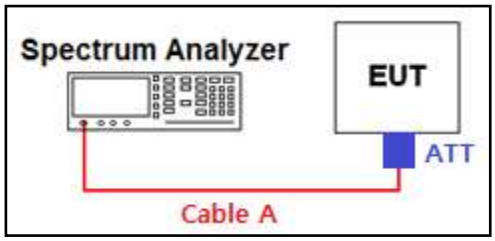
▣**TEST RESULTS : N/T**

8.4 Peak Excursion Ratio

▣ **Test requirements**

The ratio of the peak excursion of the modulation envelope (measured using a peak hold function) to the maximum conducted output power (measured as specified above) shall not exceed **13 dB/MH**z.

▣ **Test Configuration**



▣ **Test Procedure**

Peak Excursion Ratio is measured using Measurement Procedure **of KDB789033**

1) Compliance with the peak excursion requirement of Section 15.407(a)(6) shall be demonstrated by confirming that the ratio of the maximum of the peak-max-hold spectrum to the maximum of the average spectrum for continuous transmission does not exceed 13 dB. (Earlier procedures that required computing the ratio of the two spectra at each frequency across the emission bandwidth can lead to unintended failures at band edges and will no longer be required.)
2) Set the spectrum analyzer span to view the entire emission bandwidth.
3) Find the maximum of the peak-max-hold spectrum.
   a) Set **RBW = 1 MHz & VBW ≥ 3 MHz**.
   c) **Detector = peak.**
   d) **Trace mode = max-hold.**
   e) Allow the sweeps to continue until the trace stabilizes.
   f) Use the peak search function to find the peak of the spectrum.
4) **Use the procedure found under F) to measure the PPSD.**
5) Compute the ratio of the maximum of the peak-max-hold spectrum to the PPSD.

▣ **Test Result : Comply**

Mode	Band	Channel	Frequency [MHz]	Modulation Type	Test Result [MHz]	
					ANT 1	ANT 2
802.11a	Band I	36	5180	QPSK	9.436	9.490
				BPSK	9.667	9.167
				16QAM	8.739	8.704
				64QAM	9.352	9.450
802.11n (HT20)	Band I	36	5180	QPSK	8.517	8.414
				BPSK	9.005	8.995
				16QAM	9.714	9.529
				64QAM	9.806	9.667
802.11n (HT40)	Band I	38	5190	QPSK	9.401	9.368
				BPSK	8.918	9.252
				16QAM	9.521	9.446
				64QAM	9.220	9.962

▣ **Result Plots**

Peak Excursion Ratio Test Mode: ANT 1 & 802.11a & Ch.36 & QPSK

Peak Excursion Ratio Test Mode: ANT 1 & 802.11a & Ch.36 & BPSK

Peak Excursion Ratio Test Mode: ANT 1 & 802.11a & Ch.36 & 16QAM

Peak Excursion Ratio Test Mode: ANT 1 & 802.11a & Ch.36 & 64QAM

▣ **Result Plots**

Peak Excursion Ratio Test Mode: ANT 1 & 802.11n HT20 & Ch.36 & QPSK

Peak Excursion Ratio Test Mode: ANT 1 & 802.11n HT20 & Ch.36 & BPSK

Peak Excursion Ratio Test Mode: ANT 1 & 802.11n HT20 & Ch.36 & 16QAM

Peak Excursion Ratio Test Mode: ANT 1 & 802.11n HT20 & Ch.36 & 64QAM

▣ **Result Plots**

Peak Excursion Ratio Test Mode: ANT 1 & 802.11n HT40 & Ch.38 & QPSK

Peak Excursion Ratio Test Mode: ANT 1 & 802.11n HT40 & Ch.38 & BPSK

Peak Excursion Ratio Test Mode: ANT 1 & 802.11n HT40 & Ch.38 & 16QAM

Peak Excursion Ratio Test Mode: ANT 1 & 802.11n HT40 & Ch.38 & 64QAM

▣ **Result Plots**

Peak Excursion Ratio Test Mode: ANT 2 & 802.11a & Ch.36 & QPSK

Peak Excursion Ratio Test Mode: ANT 2 & 802.11a & Ch.36 & BPSK

Peak Excursion Ratio Test Mode: ANT 2 & 802.11a & Ch.36 & 16QAM

Peak Excursion Ratio Test Mode: ANT 2 & 802.11a & Ch.36 & 64QAM

▣ **Result Plots**

Peak Excursion Ratio Test Mode: ANT 2 & 802.11n HT20 & Ch.36 & QPSK

Peak Excursion Ratio Test Mode: ANT 2 & 802.11n HT20 & Ch.36 & BPSK

Peak Excursion Ratio Test Mode: ANT 2 & 802.11n HT20 & Ch.36 & 16QAM

Peak Excursion Ratio Test Mode: ANT 2 & 802.11n HT20 & Ch.36 & 64QAM

▣ **Result Plots**

Peak Excursion Ratio Test Mode: ANT 2 & 802.11n HT40 & Ch.38 & QPSK

Peak Excursion Ratio Test Mode: ANT 2 & 802.11n HT40 & Ch.38 & BPSK

Peak Excursion Ratio Test Mode: ANT 2 & 802.11n HT40 & Ch.38 & 16QAM

Peak Excursion Ratio Test Mode: ANT 2 & 802.11n HT40 & Ch.38 & 64QAM

8.5 Frequency Stability

▣ **Test requirements**

Manufacturers of U-NII devices are responsible for ensuring frequency stability such that an emission is maintained within the band of operation under all conditions of normal operation as specified in the user's manual.

▣ **Test Procedure**

The EUT was placed inside of an environmental chamber as the temperature in the chamber was varied between -10℃ and +60℃. The temperature was incremented by 10℃ intervals and the unit was allowed to stabilize at each measurement. The center frequency of the transmitting channel was evaluated at each temperature and the frequency deviation from the channel's center frequency was recorded.

▣ **Test Result : N/T**

8.6 Radiated Spurious Emission Measurements

▣ Test Procedure

▪ **FCC Part 15.209(a) and (b)**

Frequency (MHz)	Limit (uV/m)	Measurement Distance (meter)
0.009 – 0.490	2400/F(KHz)	300
0.490 – 1.705	24000/F(KHz)	30
1.705 – 30.0	30	30
30 ~ 88	100 **	3
88 ~ 216	150 **	3
216 ~ 960	200 **	3
Above 960	500	3

** Except as provided in 15.209(g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54-72 MHz, 76-88MHz, 174-216MHz or 470-806MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g. 15.231 and 15.241.

▪ **FCC Part 15.205 (a):** Only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	MHz	GHz	GHz
0.009 ~ 0.110	8.41425 ~ 8.41475	108 ~ 121.94	1300 ~ 1427	4.5 ~ 5.15	14.47 ~ 14.5
0.495 ~ 0.505	12.29 ~ 12.293	123 ~ 138	1435 ~ 1626.5	5.35 ~ 5.46	15.35 ~ 16.2
2.1735 ~ 2.1905	12.51975 ~	149.9 ~ 150.05	1645.5 ~ 1646.5	7.25 ~ 7.75	17.7 ~ 21.4
4.125 ~ 4.128	12.52025	160.52475 ~	1660 ~ 1710	8.025 ~ 8.5	22.01 ~ 23.12
4.17725 ~ 4.17775	12.57675 ~	160.52525	1718.8 ~ 1722.2	9.0 ~ 9.2	23.6 ~ 24.0
4.20725 ~ 4.20775	12.57725	160.7 ~ 160.9	2200 ~ 2300	9.3 ~ 9.5	31.2 ~ 31.8
6.215 ~ 6.218	13.36 ~ 13.41	162.0125 ~ 167.17	2310 ~ 2390	10.6 ~ 12.7	36.43 ~ 36.5
6.26775 ~ 6.26825	16.42 ~ 16.423	167.72 ~ 173.2	2483.5 ~ 2500	13.25 ~ 13.4	Above 38.6
6.31175 ~ 6.31225	16.69475 ~	240 ~ 285	2655 ~ 2900		
8.291 ~ 8.294	16.69525	322 ~ 335.4	3260 ~ 3267		
8.362 ~ 8.366	16.80425 ~	399.90 ~ 410	3332 ~ 3339		
8.37625 ~ 8.38675	16.80475	608 ~ 614	3345.8 ~ 3358		
	25.5 ~ 25.67	960 ~ 1240	3600 ~ 4000		
	37.5 ~ 38.25				
	73 ~ 74.6				
	74.8 ~ 75.2				

▪ **FCC Part 15.205(b):** The field strength of emissions appearing within these frequency bands shall not exceed the limits shown in §15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in §15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in §15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in §15.35 apply to these measurements.

▪ **FCC Part 15.407 (b):** Undesirable Emission Limits: Except as shown in Paragraph (b)(6) of this section, the peak emissions outside of the frequency bands of operation shall be attenuated in accordance with thefollowing limits:

(1) For transmitters operating in the **5.15-5.25 GHz band**: all emissions outside of the **5.15-5.35 GHz band** shall not exceed an **EIRP of -27 dBm/MHz**.
(2) For transmitters operating in the **5.25-5.35 GHz band**: all emissions outside of the **5.15-5.35 GHz band** shall not exceed an **EIRP of -27 dBm/MHz**. Devices operating in the 5.25-5.35 GHz band that generate emissions in the 5.15-5.25 GHz band must meet all applicable technical requirements for operation in the 5.15-5.25 GHz band (including indoor use) or alternatively meet an out-of-band emission EIRP limit of -27 dBm/MHz in the 5.15-5.25 GHz band.
(3) For transmitters operating in the **5.47-5.725 GHz band**: all emissions outside of the **5.47-5.725 GHz band** shall not exceed an **EIRP of -27 dBm/MHz.**
(4) For transmitters operating in the 5.725-5.825 GHz band: all emissions within the frequency range from the band edge to 10 MHz above or below the band edge shall not exceed an EIRP of -17 dBm/MHz; for frequencies 10 MHz or greater above or below the band edge, emissions shall not exceed an EIRP of -27 dBm/MHz.
(5) The above emission measurements shall be performed using a minimum resolution bandwidth of 1 MHz. A lower resolution bandwidth may be employed near the band edge, when necessary, provided the measured energy is integrated to show the total power over 1 MHz.
(6) Unwanted emissions **below 1 GHz** must comply with the general field strength limits set forth in **Section 15.209**. Further, any U-NII devices using an **AC power line** are required to comply also with the conducted limits set forth in **Section 15.207**.

▣ Test Procedure

The EUT was placed on a 0.8m high wooden table inside a shielded enclosure. An antenna was placed near the EUT and measurements of frequencies and amplitudes of field strengths were recorded for reference during final measurements. For final radiated testing, measurements were performed in semi anechoic chamber. Measurements were performed with the EUT oriented in 3 orthogonal axis and rotated 360 degrees to determine the worst-case orientation for maximum emissions.

Radiated spurious emission measured using following Measurement Procedure **of KDB789033**

► General Requirements for Unwanted Emissions Measurements

The following requirements apply to all unwanted emissions measurements, both in and outside of the restricted bands:

- EUT Duty Cycle

(1) The EUT shall be configured or modified to **transmit continuously** except as stated in (ii), below. The intent is to test at 100 percent duty cycle; however a small reduction in duty cycle(**to no lower than 98 percent**) is permitted if required by the EUT for amplitude control purposes. Manufacturers are expected to provide software to the test lab to permit such continuous operation.

(2) If **continuous transmission (or at least 98 percent duty cycle) cannot be achieved** due to hardware limitations of the EUT (e.g., overheating), the following additions to the measurement and reporting procedures are required:

- The EUT shall be configured to operate at the maximum achievable duty cycle.
- Measure the duty cycle, x, of the transmitter output signal.
- Adjustments to measurement procedures (e.g., increasing test time and number of traces averaged) shall be performed as described in the procedures below.
- The test report shall include the following additional information:
  - The reason for the duty cycle limitation.
  - The duty cycle achieved for testing and the associated transmit duration and interval between transmissions.
  - The sweep time and the amount of time used for trace stabilization during max-hold measurements for peak emission measurements.

(3) **Reduction of the measured emission amplitude levels to account for operational duty factor is not permitted. Compliance is based on emission levels occurring during transmission - not on an average across on and off times of the transmitter.**

► Measurements Below 1000MHz

a) Follow the requirements in section H)3), “General Requirements for Unwanted Emissions Measurements”.

b) Compliance shall be demonstrated using **CISPR quasi-peak detection**; however, **peak detection** is permitted as an alternative to quasi-peak detection.

► **Measurements Above 1000MHz(Peak)**

a) Follow the requirements in section H)3), “General Requirements for Unwanted Emissions Measurements”.
b) Peak emission levels are measured by setting the analyzer as follows:
(1) **RBW = 1 MHz**.
(2) **VBW ≥ 3 MHz.**
(3) **Detector = Peak.**
(4) Sweep time = auto.
(5) Trace mode = max hold.
(6) Allow sweeps to continue until the trace stabilizes. Note that if the transmission is not continuous, the time required for the trace to stabilize will increase by a factor of approximately 1/x, where x is the duty cycle. For example, at 50 percent duty cycle, the measurement time will increase by a factor of two relative to measurement time for continuous transmission.

► **Measurements Above 1000MHz(Method AD)**

(1) **RBW = 1 MHz.**
(2) **VBW ≥ 3 MHz.**
(3) **Detector = RMS**, if span/(# of points in sweep) ≤ RBW/2. Satisfying this condition may require increasing the number of points in the sweep or reducing the span. If the condition is not satisfied, the detector mode shall be set to peak.
(4) Averaging type = power (i.e., RMS)
• As an alternative, the detector and averaging type may be set for linear voltage averaging. Some analyzers require linear display mode in order to use linear voltage averaging. Log or dB averaging shall not be used.
(5) Sweep time = auto.
(6) Perform a trace average of at least 100 traces if the transmission is continuous. If the transmission is not continuous, the number of traces shall be increased by a factor of 1/x, where x is the duty cycle. For example, with 50 percent duty cycle, at least 200 traces should be averaged.
(7) If tests are performed with the EUT transmitting at a duty cycle less than 98 percent, a correction factor shall be added to the measurement results prior to comparing to the emission limit in order to compute the emission level that would have been measured had the test been performed at 100 percent duty cycle. The correction factor is computed as follows:

• **If power averaging (RMS) mode was used in step (iv) above, the correction factor is 10 log(1/x), where x is the duty cycle.**
For example, if the transmit duty cycle was 50 percent, then 3 dB must be added to the measured emission levels.
• If linear voltage averaging mode was used in step (iv) above, the correction factor is 20 log(1/x), where x is the duty cycle. For example, if the transmit duty cycle was 50 percent, then 6 dB must be added to the measured emission levels.
• If a specific emission is demonstrated to be continuous (100 percent duty cycle) rather than turning on and off with the transmit cycle, no duty cycle correction is required for that emission.

Radiated Spurious Emissions data(9kHz ~ 40GHz) : *802.11a & Band I*

Tested ANT	Tested Channel	Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	T.F (dB/m)	DCCF (dB)	DCF (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
ANT 1 + ANT 2	36 (5180MHz)	5149.880	V	Z	PK	44.44	7.43	N/A	N/A	51.87	74.00	22.13
		5149.160	V	Z	AV	33.05	7.43	0.18	N/A	40.66	54.00	13.34
		10359.090	V	Z	PK	43.02	11.3	N/A	-9.54	44.78	68.20	23.42
		-	-	-	-	-	-	-	-	-	-	-
	40 (5220MHz)	10440.970	V	Z	PK	42.16	11.37	N/A	-9.54	43.99	68.20	24.21
		-	-	-	-	-	-	-	-	-	-	-
		-	-	-	-	-	-	-	-	-	-	-
	48 (5240MHz)	10480.260	V	Z	PK	41.7	11.41	N/A	-9.54	43.57	68.20	24.63
		-	-	-	-	-	-	-	-	-	-	-
		-	-	-	-	-	-	-	-	-	-	-

Note.

1. No other spurious and harmonic emissions were found greater than listed emissions on above table.
2. Sample Calculation.
   Margin = Limit – Result / Result = Reading + T.F+ DCCF + DCF / T.F = AF + CL – AG
   Where, T.F = Total Factor, AF = Antenna Factor, CL = Cable Loss, AG = Amplifier Gain,
   DCCF = Duty Cycle Correction Factor, DCF = Distance Correction Factor
3. Measurement Distance = 3 m for below 10 GHz, Measurement Distance = 1 m for above 10 GHz.
   Therefore Distance Correction Factor(DCF) : - 9.54 dB = 20*log(1m/3m)
4. The limit is converted to field strength.
   E[dBuV/m] = EIRP[dBm] + 95.2 dB = -27dBm + 95.2 = 68.2dBuV/m
5. If peak measurement satisfy the average limit, then average measurement are not required.

Radiated Spurious Emissions data(9kHz ~ 40GHz) : *802.11n HT20 & Band I*

Tested ANT	Tested Channel	Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	T.F (dB/m)	DCCF (dB)	DCF (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
ANT 1 + ANT 2	36 (5180MHz)	5149.970	V	Z	PK	55.03	7.43	N/A	N/A	62.46	74.00	11.54
		5149.860	V	Z	AV	35.62	7.43	0.18	N/A	43.23	54.00	10.77
		10359.950	V	Z	PK	42.66	11.3	N/A	-9.54	44.42	68.20	23.78
		-	-	-	-	-	-	-	-	-	-	-
	40 (5220MHz)	10440.040	V	Z	PK	42.73	11.37	N/A	-9.54	44.56	68.20	23.64
		-	-	-	-	-	-	-	-	-	-	-
		-	-	-	-	-	-	-	-	-	-	-
	48 (5240MHz)	10480.090	V	Z	PK	42.69	11.41	N/A	-9.54	44.56	68.20	23.64
		-	-	-	-	-	-	-	-	-	-	-
		-	-	-	-	-	-	-	-	-	-	-

Note.

1. No other spurious and harmonic emissions were found greater than listed emissions on above table.
2. Sample Calculation.
   Margin = Limit – Result / Result = Reading + T.F+ DCCF + DCF / T.F = AF + CL – AG
   Where, T.F = Total Factor, AF = Antenna Factor, CL = Cable Loss, AG = Amplifier Gain,
   DCCF = Duty Cycle Correction Factor, DCF = Distance Correction Factor
3. Measurement Distance = 3 m for below 10 GHz, Measurement Distance = 1 m for above 10 GHz.
   Therefore Distance Correction Factor(DCF) : - 9.54 dB = 20*log(1m/3m)
4. The limit is converted to field strength.
   E[dBuV/m] = EIRP[dBm] + 95.2 dB = -27dBm + 95.2 = 68.2dBuV/m
5. If peak measurement satisfy the average limit, then average measurement are not required.

Radiated Spurious Emissions data(9kHz ~ 40GHz) : *802.11n HT40 & Band I*

Tested ANT	Tested Channel	Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	T.F (dB/m)	DCCF (dB)	DCF (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
ANT 1 + ANT 2	38 (5190MHz)	5147.250	V	Z	PK	60.37	7.43	N/A	N/A	67.80	74.00	6.20
		5146.860	V	Z	AV	44.89	7.43	0.23	N/A	52.55	54.00	1.45
		10379.980	V	Z	PK	42.22	11.32	N/A	-9.54	44.00	68.20	24.20
		-	-	-	-	-	-	-	-	-	-	-
	46 (5230MHz)	10460.960	V	Z	PK	42	11.39	N/A	-9.54	43.85	68.20	24.35
		-	-	-	-	-	-	-	-	-	-	-
		-	-	-	-	-	-	-	-	-	-	-

Note.

1. No other spurious and harmonic emissions were found greater than listed emissions on above table.
2. Sample Calculation.
   Margin = Limit – Result / Result = Reading + T.F+ DCCF + DCF / T.F = AF + CL – AG
   Where, T.F = Total Factor, AF = Antenna Factor, CL = Cable Loss, AG = Amplifier Gain,
   DCCF = Duty Cycle Correction Factor, DCF = Distance Correction Factor
3. Measurement Distance = 3 m for below 10 GHz, Measurement Distance = 1 m for above 10 GHz.
   Therefore Distance Correction Factor(DCF) : - 9.54 dB = 20*log(1m/3m)
4. The limit is converted to field strength.
   E[dBuV/m] = EIRP[dBm] + 95.2 dB = -27dBm + 95.2 = 68.2dBuV/m
5. If peak measurement satisfy the average limit, then average measurement are not required.

8.7 AC Conducted Emissions

▣ **Test Procedure :**

The conducted emissions are measured in the shielded room with a spectrum analyzer in peak hold. Emissions closest to the limit are measured in the quasi-peak mode (QP) and average mode (AV) with the tuned receiver using a bandwidth of 9 kHz. The emissions are maximized further by cable manipulation and Exerciser operation. The highest emissions relative to the limit are listed.

▣ **Measurement Data: N/A**

▣ **Minimum Standard: FCC Part 15.207(a)/EN 55022**

Frequency Range (MHz)	Conducted Limit (dBuV)	
	Quasi-Peak	Average
0.15 ~ 0.5	66 to 60 *	60 to 46 *
0.5 ~ 5	60	46
5 ~ 30	60	50

* Decreases with the logarithm of the frequency

8.8 Occupied Bandwidth

▣ **Test Requirements**

When an occupied bandwidth value is not specified in the applicable RSS, the transmitted signal bandwidth to be reported is to be its 99% emission bandwidth, as calculated or measured

▣ **Test Configuration**

Refer to the APPENDIX I.

▣ **Test Procedure :**

The resolution bandwidth shall be set to as close to 1% of the selected span as is possible without being below 1%.
The video bandwidth shall be set to 3 times the resolution bandwidth. Video averaging is not permitted.
Where practical, a sampling detector shall be used given that a peak or peak hold may produce a wider bandwidth than actual

▣ **Test Result : Comply**

Mode	Band	Channel	Frequency [MHz]	Test Result [MHz]	
				ANT 1	ANT 2
802.11a	Band I	36	5180	17.805	17.300
		40	5220	17.582	17.164
		48	5240	17.514	17.239
802.11n (HT20)	Band I	36	5180	18.841	18.561
		40	5220	18.750	18.553
		48	5240	18.633	18.548
802.11n (HT40)	Band I	38	5190	37.901	37.543
		46	5230	37.912	37.453

▣ RESULT PLOTS

Occupied Bandwidth 99% Test Mode: ANT 1 & 802.11a & Ch.36

Occupied Bandwidth 99% Test Mode: ANT 1 & 802.11a & Ch.40

Occupied Bandwidth 99% Test Mode: ANT 1 & 802.11a & Ch.48

Occupied Bandwidth 99% Test Mode: ANT 1 & 802.11n HT20 & Ch.36

Occupied Bandwidth 99% Test Mode: ANT 1 & 802.11n HT20 & Ch.40

Occupied Bandwidth 99% Test Mode: ANT 1 & 802.11n HT20 & Ch.48

Occupied Bandwidth 99% Test Mode: ANT 1 & 802.11n HT40 & Ch.38

Occupied Bandwidth 99% Test Mode: ANT 1 & 802.11n HT40 & Ch.46

Occupied Bandwidth 99% Test Mode: ANT 2 & 802.11a & Ch.36

Occupied Bandwidth 99% Test Mode: ANT 2 & 802.11a & Ch.40

Occupied Bandwidth 99% Test Mode: ANT 2 & 802.11a & Ch.48

Occupied Bandwidth 99% Test Mode: ANT 2 & 802.11n HT20 & Ch.36

Occupied Bandwidth 99% Test Mode: ANT 2 & 802.11n HT20 & Ch.40

Occupied Bandwidth 99% Test Mode: ANT 2 & 802.11n HT20 & Ch.48

Occupied Bandwidth 99% Test Mode: ANT 2 & 802.11n HT40 & Ch.38

Occupied Bandwidth 99% Test Mode: ANT 2 & 802.11n HT40 & Ch.46

9. LIST OF TEST EQUIPMENT

Type	Manufacturer	Model	Cal.Date (yy/mm/dd)	Next.Cal.Date (yy/mm/dd)	S/N
Spectrum Analyzer	Agilent	N9030A	13/11/05	14/11/05	MY48011075
Spectrum Analyzer	Agilent	N9020A	14/01/07	15/01/07	MY49100833
Spectrum Analyzer	R&S	FSQ26	13/02/14	14/02/14	200445
			14/02/07	15/02/07	
Harmonic Mixer for FSQ	OML	WR28HWD	13/02/14	14/02/14	KA100224-1
			14/02/07	15/02/07	
Power Meter & Wide Bandwidth Sensor	Anritsu	ML2496A	13/10/29	14/10/29	1338004
		MA2411B			1306053
		MA2490A			1249303
Wideband Power Sensor	Rohde Schwarz	NRP-Z81	13/05/27	14/05/27	1137.9009.02-101001
Vector Signal Generator	Rohde Schwarz	SMJ100A	14/01/07	15/01/07	100148
Signal Generator	Rohde Schwarz	SMF100A	13/07/22	14/07/22	102341
Digital Multimeter	H.P	34401A	13/02/27	14/02/27	3146A13475
			14/02/27	15/02/27	
DC Power Supply	Agilent	66332A	13/10/21	14/10/21	US37474353
Thermo hygrometer	BODYCOM	BJ5478	13/06/01	14/06/01	120612-1
Thermo hygrometer	BODYCOM	BJ5478	13/06/01	14/06/01	120612-2
Attenuator(3dB)	SMAJK	SMAJK-2-3	13/10/22	14/10/22	5
High-pass filter	Wainwright	WHNX8.5	13/09/12	14/09/12	1
Amplifier (30dB)	Agilent	8449B	13/02/27	14/02/27	3008A00370
			14/02/27	15/02/27	
LOOP Antenna	Schwarzbeck	FMZB1513	12/09/24	14/09/24	1513-128
BILOG ANTENNA	SCHAFFNER	CBL6112B	12/11/06	14/11/06	2737
Horn Antenna	ETS	3117	13/06/14	15/06/14	00140394
HORN ANT	A.H.Systems	SAS-574	13/03/20	15/03/20	154

APPENDIX I

Duty Cycle Information

TEST PROCEDURE

Duty Cycle [X = On Time / (On + Off time)] is measured using Measurement Procedure **of KDB789033**

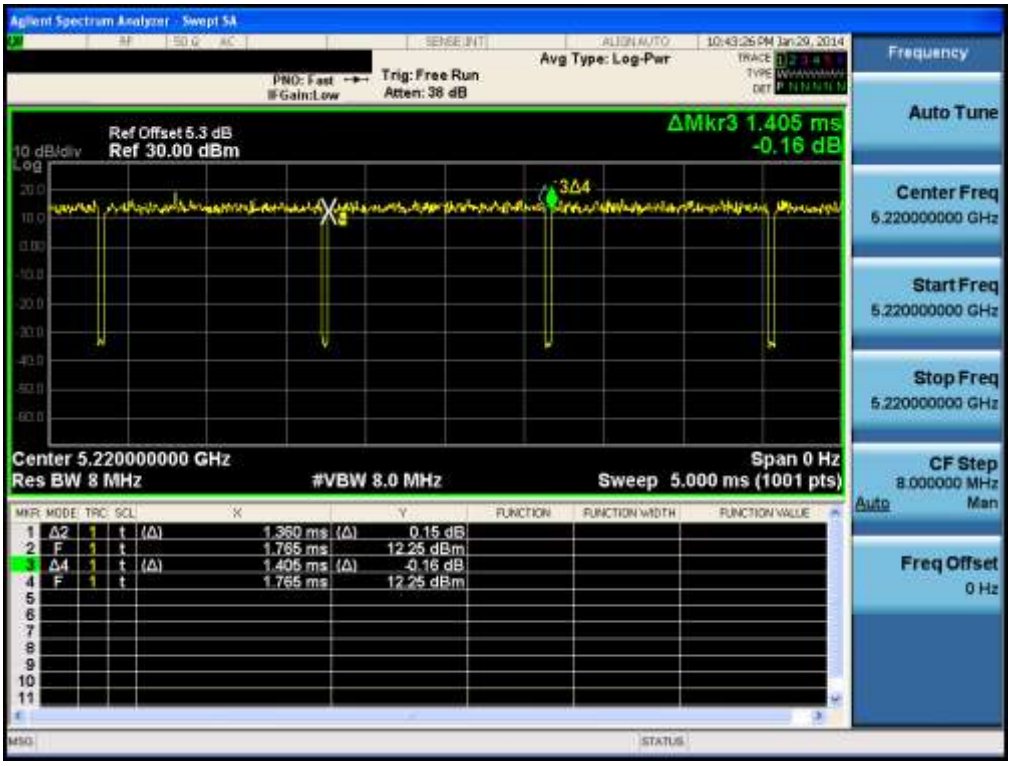
1. Set the center frequency of the spectrum analyzer to the center frequency of the transmission.
2. Set RBW ≥ EBW if possible; otherwise, set RBW to the largest available value.
3. Set VBW ≥ RBW.
4. Set detector = peak.
5. Note : The zero-span measurement method shall not be used unless both **RBW and VBW are> 50/*T***, where *T* is defined in section B)1)a), and **the number of sweep points across duration *T* exceeds 100**. (For example, if VBW and/or RBW are limited to 3 MHz, then the zero-span method of measuring duty cycle shall not be used if *T* ≤ 16.7 microseconds.)

   T : The minimum transmission duration over which the transmitter is on and is transmitting at its maximum power control level for the tested mode of operation.
   (***T* = On time** of the above table since the EUT operates with above fixed Duty Cycle and it is the minimum On time)

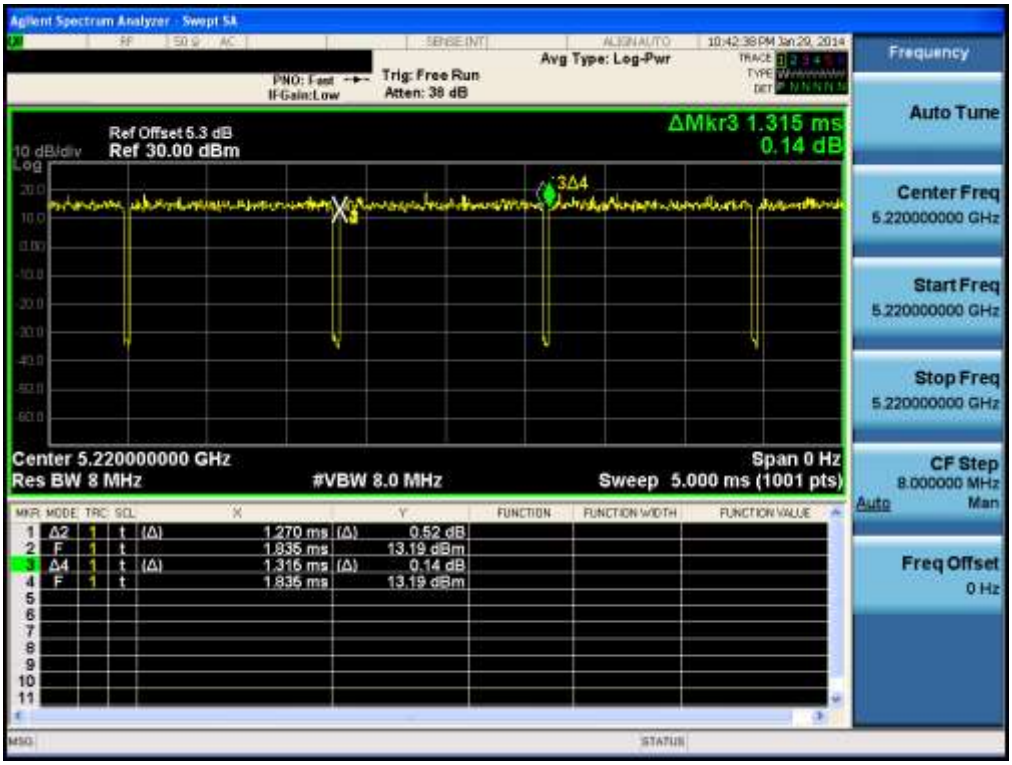
TEST DATA

Mode	Tested ANT	Channel	Tested Frequency [MHz]	Maximum Achievable Duty Cycle (*x*) = On / (On+Off)			Duty Cycle Correction Factor [dB]
				On Time [ms]	On+Off Time [ms]	*x*	
802.11a	ANT 1	40	5220	1.360	1.405	0.968	0.14
802.11n (HT20)		40	5220	1.270	1.315	0.965	0.15
802.11n (HT40)		38	5190	0.630	0.663	0.950	0.22

Duty Cycle Test Mode: ANT 1 & 802.11a & Ch.44



Duty Cycle Test Mode: ANT 1 & 802.11n HT20 & Ch.44



Duty Cycle Test Mode: ANT 1 & 802.11n HT40 & Ch.38