RF TEST REPORT

Test item	:	Smart Beacon
Model No.	:	Smart Beacon
Order No.	:	DEMC1405-01625
Date of receipt	:	2014-05-02
Test duration	:	2014-05-15~ 2014-05-29
Date of issue	:	2014-06-02
Use of report	:	FCC Original Grant

Applicant : SK Planet, Inc.
475 Brannan Street, Suite 420, San Francisco, CA 94107

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 Subpart C 247
Test environment	:	See appended test report
Test result	:	☒ Pass ☐ Fail

The test results presented in this test report are limited only to the sample supplied by applicant and the use of this test report is inhibited other than its purpose. This test report shall not be reproduced except in full, without the written approval of DIGITAL EMC CO., LTD.

Tested by:

Engineer
HyunSu Son

Reviewed by:

Deputy General Manager
HongHee Lee

Test Report Version

Test Report No.	Date	Description
DRTFCC1406-0700	Jun. 02, 2014	Initial issue

Copyright © 2014, Digital EMC Co., Ltd.

Table of Contents

1. GENERAL INFORMATION 4
2. EUT DESCRIPTION 4
3. SUMMARY OF TESTS 5
4. TEST METHODOLOGY 6
4.1 EUT CONFIGURATION 6
4.2 EUT EXERCISE 6
4.3 GENERAL TEST PROCEDURES 6
4.4 DESCRIPTION OF TEST MODES 6
5. INSTRUMENT CALIBRATION 7
6. FACILITIES AND ACCREDITATIONS 7
6.1 FACILITIES 7
6.2 EQUIPMENT 7
7. ANTENNA REQUIREMENTS 7
8. TEST RESULT 8
8.1 6dB Bandwidth 8
8.2 Maximum Peak Conducted Output Power 15
8.3 Maximum Power Spectral Density 17
8.4 Out of Band Emissions at the Band Edge/ Conducted Spurious Emissions 24
8.5 Radiated Spurious Emissions 49
8.6 Power-line Conducted Emissions 54
8.7Occupied Bandwidth 57
9. LIST OF TEST EQUIPMENT 58
APPENDIX I 59
APPENDIX II 60

Copyright © 2014, Digital EMC Co., Ltd.

1. GENERAL INFORMATION

Applicant	:	SK Planet, Inc.
Address	:	475 Brannan Street, Suite 420, San Francisco, CA 94107
FCC ID	:	2ACB7SKB100
EUT	:	Smart Beacon
Model	:	Smart Beacon
Additional Model(s)	:	N/A
Data of Test	:	2014-05-15 ~ 2014-05-29
Contact person	:	David Hu

2. EUT DESCRIPTION

Product	Smart Beacon
Model Name	Smart Beacon
Power Supply	DC 5 V
Frequency Range	2.4GHz Band ▪ 802.11b/g/n(HT20): 2412 ~ 2462 MHz
Max. RF Output Power	2.4GHz Band ▪ 802.11b: 16.61 dBm ▪ 802.11g: 21.67 dBm ▪ 802.11n(HT20): 20.56 dBm
Modulation Type	802.11b: DSSS/CCK 802.11g/n: OFDM
Antenna Specification	Internal Antenna (1TX ,1RX) ▪ 2.4GHz Band Max. peak gain :3.01dBi

Copyright © 2014, Digital EMC Co., Ltd.

3. SUMMARY OF TESTS

FCC Part Section(s)	RSS Section(s)	Parameter	Limit	Test Condition	Status Note 1
I. Transmitter Mode (TX)					
15.247(a)	RSS-210 [A8.2]	6dB Bandwidth	> 500kHz	Conducted	**C**
15.247(b)	RSS-210 [A8.4]	Transmitter Output Power	< 1Watt		**C**
15.247(d)	RSS-210 [A8.5]	Out of Band Emissions / Band Edge	20dBc in any 100kHz BW		**C**
15.247(e)	RSS-210 [A8.2]	Transmitter Power Spectral Density	< 8dBm / 3kHz		**C**
-	RSS Gen [4.6.1]	Occupied Bandwidth (99%)	RSS-Gen(4.6.1)		**NA**
15.205 15.209	RSS-Gen [7.2.2] [7.2.5]	General Field Strength Limits (Restricted Bands and Radiated Emission Limits)	<FCC 15.209 limits	Radiated	**C**[Note2]
15.207	RSS-Gen [7.2.4]	AC Conducted Emissions	< FCC 15.207 limits	AC Line Conducted	**C**
15.203	-	Antenna Requirements	FCC 15.203	-	**C**

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

Note 2: This test item was performed in each axis and the worst case data was reported.

Copyright © 2014, Digital EMC Co., Ltd.

4. TEST METHODOLOGY

Generally the tests were performed according to the KDB558074 v03r1. 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 15.247 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 KDB 558074 v03r1. 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 KDB 558074 v03r1. 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 section 12.1 of the KDB 558074 v03r1.

The EUT is placed on a turntable, which is 0.8 m above ground plane. The turntable shall rotate360 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 axes..

4.4 DESCRIPTION OF TEST MODES

The EUT has been tested with all modes of operating conditions to determine the worst case emission characteristics.

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

Copyright © 2014, Digital EMC Co., Ltd.

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

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 of this E.U.T is permanently attached using the soldering.
Therefore this E.U.T Complies with the requirement of §15.203

Copyright © 2014, Digital EMC Co., Ltd.

8. TEST RESULT

8.1 6dB Bandwidth

Test Requirements and limit, §15.247(a) & RSS-210 [A8.2]

The bandwidth at 6dB down from the highest in-band spectral density is measured with a spectrum analyzer connected to the receive antenna while the EUT is operating in transmission mode at the appropriate frequencies.

The minimum permissible 6dB bandwidth is 500 kHz.

▣TEST CONFIGURATION

Refer to the APPENDIX I.

▣ TEST PROCEDURE

The transmitter output is connected to the Spectrum Analyzer and used following test procedure of **KDB558074 v03r1**.

1. Set resolution bandwidth (RBW) = 100 kHz
2. Set the video bandwidth (VBW) ≥ 3 x RBW.
   (RBW:100kHz/VBW:300kHz)
3. Detector = **Peak**.
4. Trace mode = **max hold**.
5. Sweep = **auto couple**.
6. Allow the trace to stabilize.
7. Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

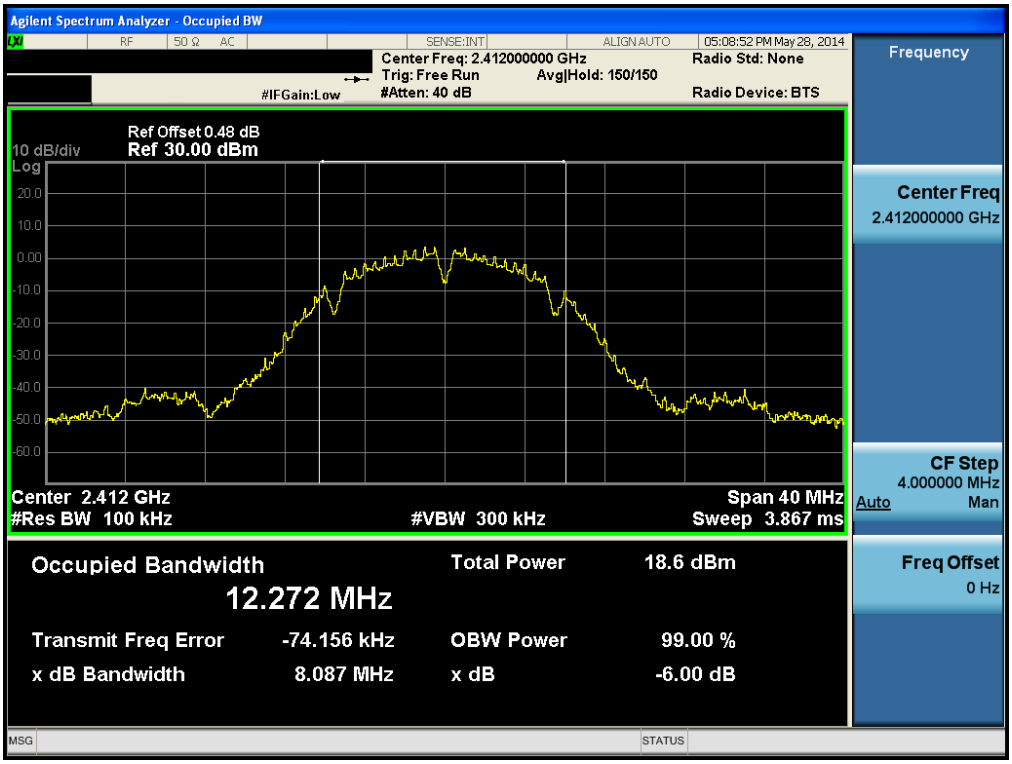
▣TEST RESULTS: Comply

Test Mode	Data Rate	Frequency [MHz]	Test Results[MHz]
802.11b	1 Mbps	2412	8.087
		2437	8.053
		2462	8.025
802.11g	6 Mbps	2412	15.480
		2437	15.710
		2462	15.460
802.11n (HT20)	MCS 0	2412	16.080
		2437	16.140
		2462	16.200

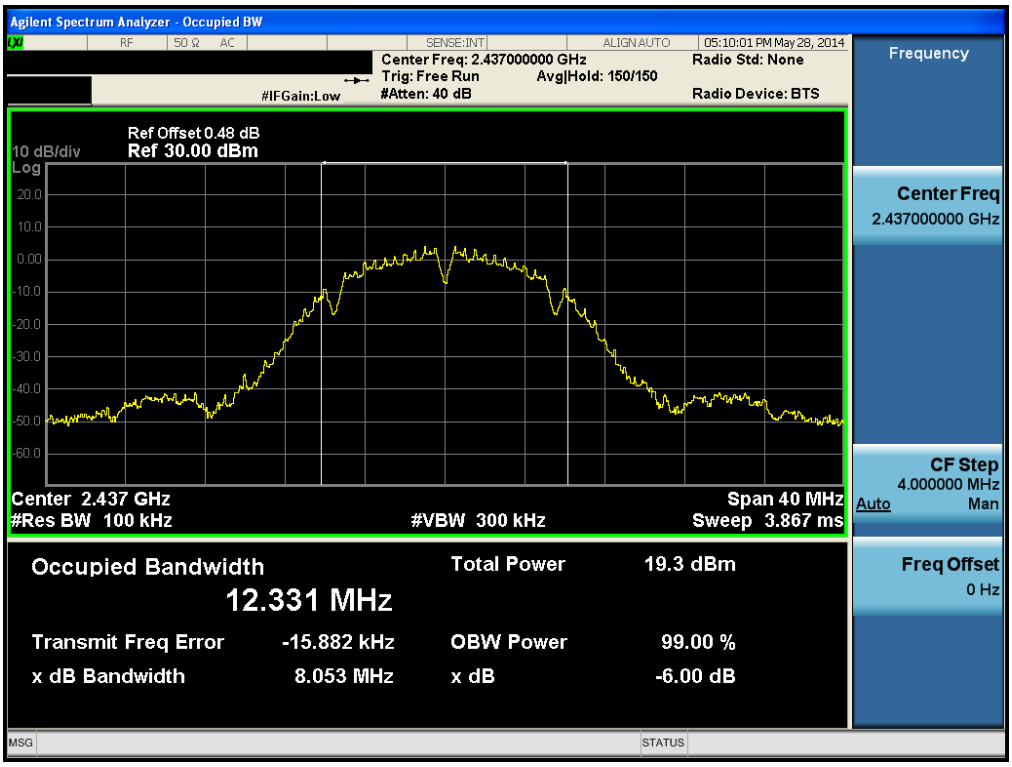
Copyright © 2014, Digital EMC Co., Ltd.

▣RESULT PLOTS

6 dB Bandwidth Test Mode: 802.11b & 1 Mbps & 2412 MHz

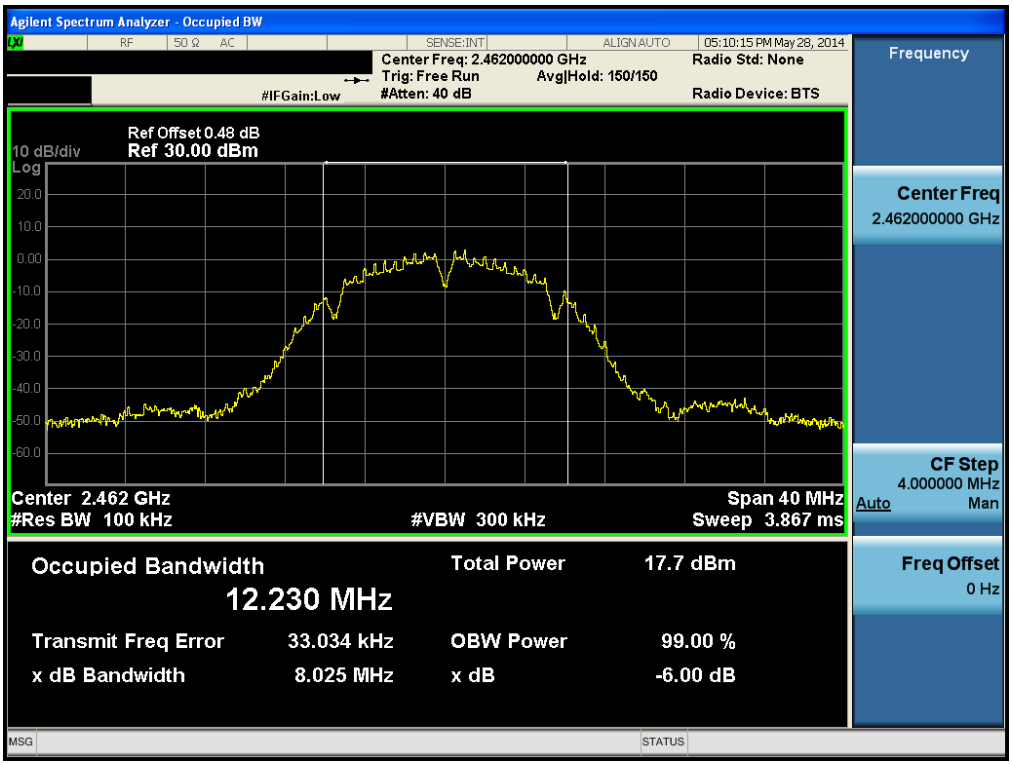


6 dB Bandwidth Test Mode: 802.11b & 1 Mbps & 2437 MHz



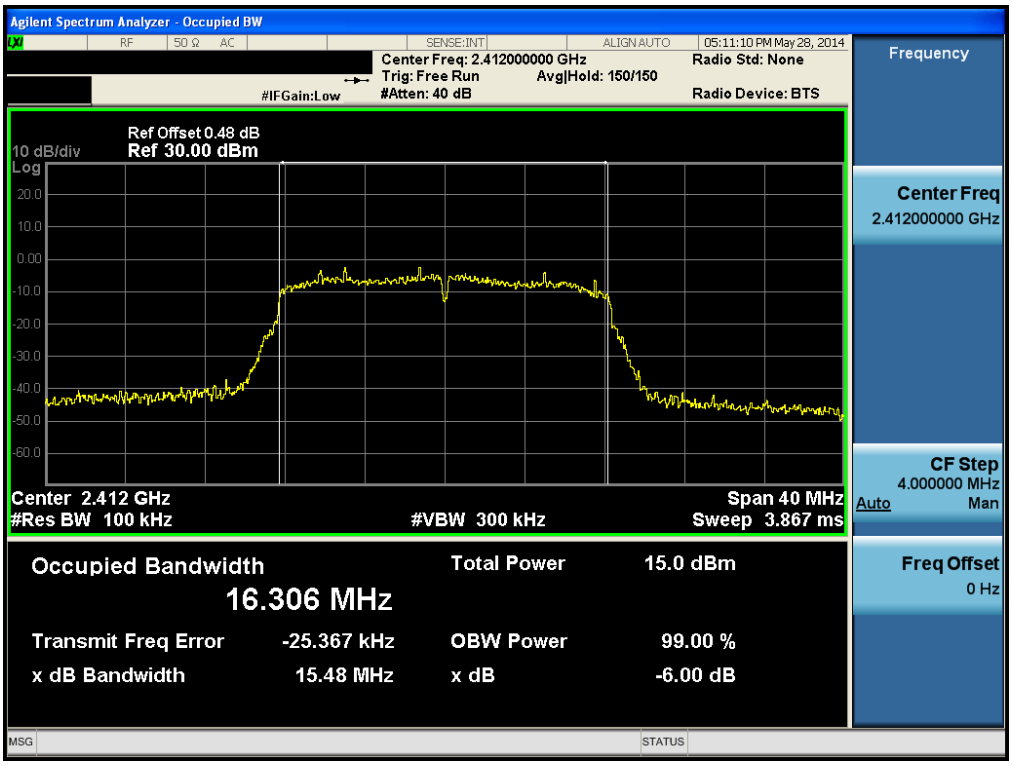
Copyright © 2014, Digital EMC Co., Ltd.

6 dB Bandwidth Test Mode: 802.11b & 1 Mbps & 2462 MHz



Copyright © 2014, Digital EMC Co., Ltd.

6 dB Bandwidth Test Mode: 802.11g & 6 Mbps & 2412 MHz



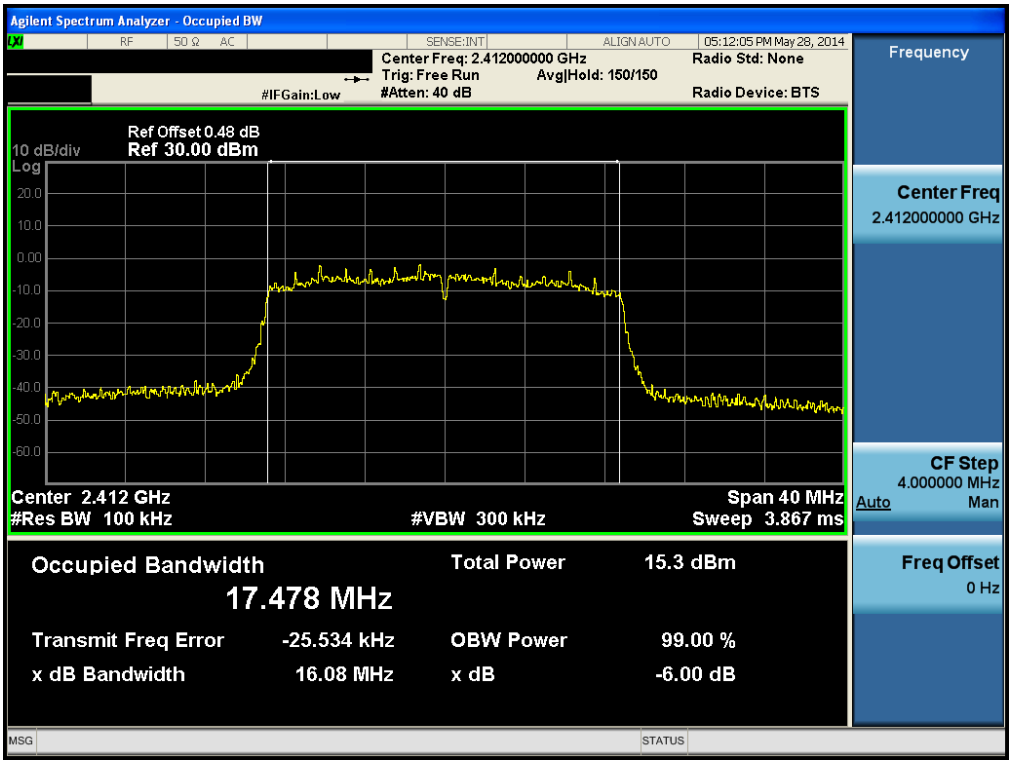
6 dB Bandwidth Test Mode: 802.11g & 6 Mbps & 2437 MHz

Copyright © 2014, Digital EMC Co., Ltd.

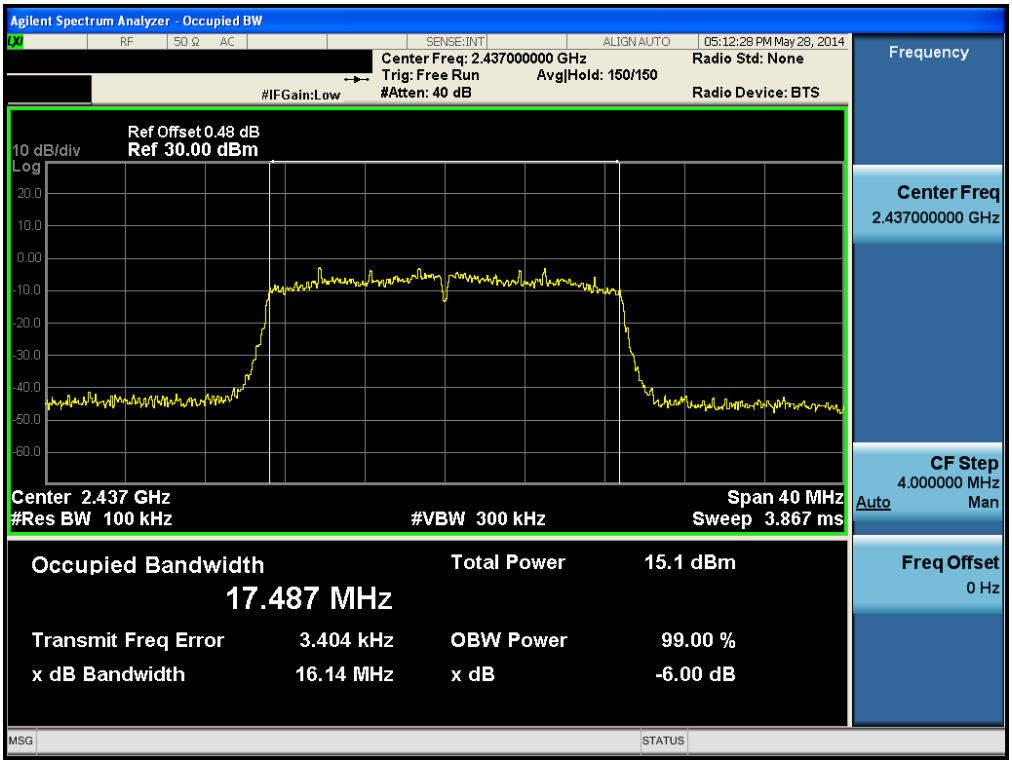
6 dB Bandwidth Test Mode: 802.11g & 6 Mbps & 2462 MHz

Copyright © 2014, Digital EMC Co., Ltd.

6 dB Bandwidth Test Mode: 802.11n(HT20) & MCS 0 & 2412 MHz

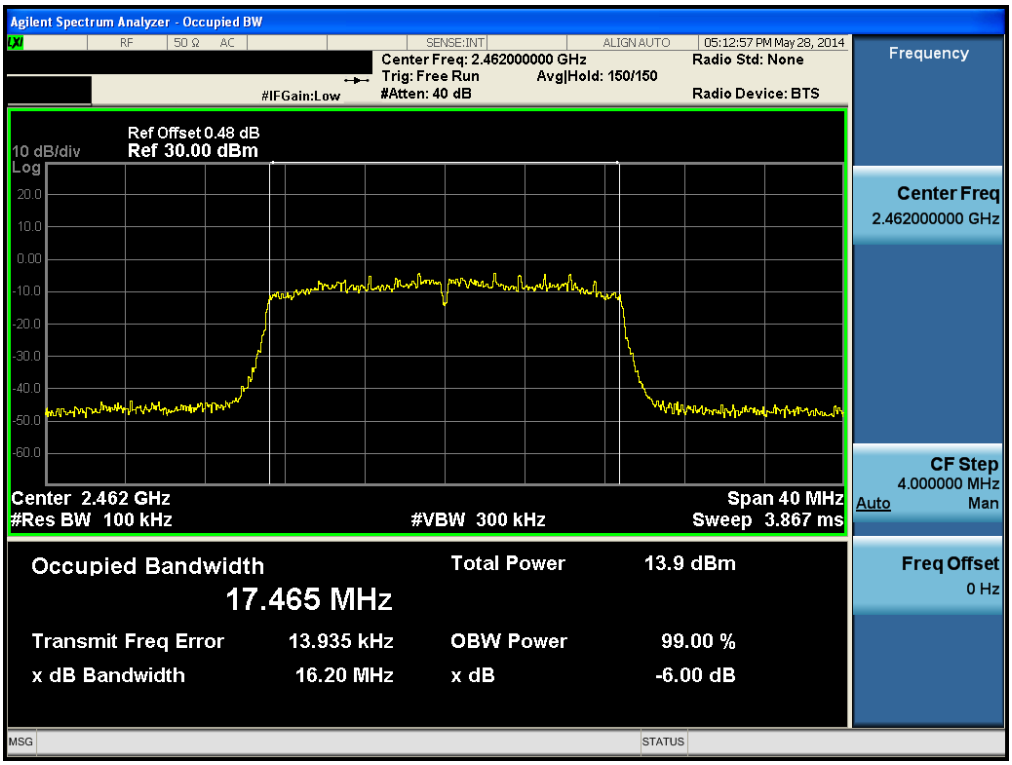


6 dB Bandwidth Test Mode: 802.11n(HT20) & MCS 0 & 2437 MHz



Copyright © 2014, Digital EMC Co., Ltd.

6 dB Bandwidth Test Mode: 802.11n(HT20) & MCS 0 & 2462 MHz



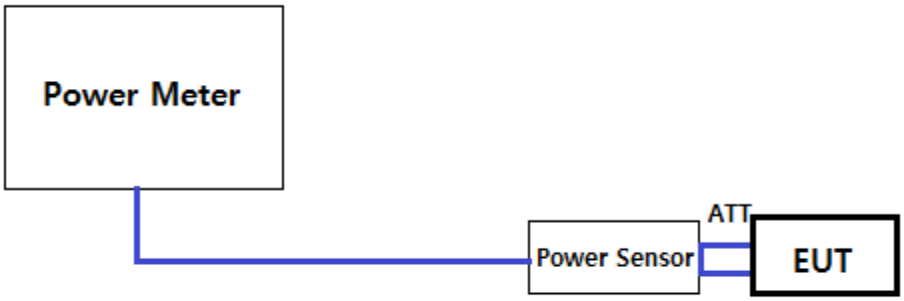
Copyright © 2014, Digital EMC Co., Ltd.

8.2 Maximum Peak Conducted Output Power

Test Requirements and limit, §15.247(b)& RSS-210 [A8.4]

The maximum permissible conducted output power is **1 Watt**.

▣TEST CONFIGURATION



▣TEST PROCEDURE:

1. **PKPM1 Peak power meter method of KDB558074 v03r1**
   The maximum conducted output powers were measured using a broadband peak RF power meter which has greater video bandwidth than DUT's DTS bandwidth and utilize a fast-responding diode detector.

2. **Method AVGPM-G (Measurement using a gated RF average power meter) of KDB558074 v03r1**
   The average conducted output powers were measured using a wideband gated RF power meter provided that the gate parameters are adjusted such that the power is measured only when the EUT is transmitting at its maximum power control level. Since this measurement is made only during the ON time of the transmitter, no duty cycle correction is required.

Copyright © 2014, Digital EMC Co., Ltd.

▣TEST RESULTS: Comply

- **Measurement Data: Comply**

- Test Results

Mode	Channel	Frequency [MHz]	Detector	Test Result [dBm]							
				DATA RATE [Mbps]							
				1	2	5.5	11	N/A	N/A	N/A	N/A
802.11b	1	2412	PK	**16.61**	16.05	15.78	15.56	-	-	-	-
			AV	13.03	12.76	12.59	12.33	-	-	-	-
	6	2437	PK	16.24	15.74	15.62	15.35	-	-	-	-
			AV	12.81	12.55	12.44	12.21	-	-	-	-
	11	2462	PK	15.89	15.39	15.39	15.07	-	-	-	-
			AV	12.43	12.17	12.05	11.79	-	-	-	-

Mode	Channel	Frequency [MHz]	Detector	Test Result [dBm]							
				DATA RATE [Mbps]							
				6	9	12	18	24	36	48	54
802.11g	1	2412	PK	**21.67**	20.33	20.02	19.95	20.01	20.15	20.20	20.19
			AV	8.85	8.70	8.77	8.79	8.72	8.67	8.76	8.75
	6	2437	PK	21.64	20.47	20.17	20.14	19.88	19.92	20.06	19.92
			AV	8.78	8.76	8.69	8.68	8.62	8.67	8.71	8.64
	11	2462	PK	20.75	20.31	19.96	19.53	19.51	19.65	19.75	19.74
			AV	8.33	8.25	8.30	8.18	8.19	8.21	8.14	8.11

Mode	Channel	Frequency [MHz]	Detector	Test Result [dBm]							
				DATA RATE [MCS]							
				0	1	2	3	4	5	6	7
802.11n (HT20)	1	2412	PK	20.45	20.25	20.03	20.02	20.14	20.13	20.03	20.03
			AV	8.72	8.69	8.67	8.61	8.56	8.65	8.67	8.60
	6	2437	PK	**20.56**	20.42	20.24	20.07	20.16	20.00	19.95	19.87
			AV	8.63	8.61	8.55	8.55	8.57	8.57	8.38	8.40
	11	2462	PK	20.06	19.87	19.69	19.57	19.69	19.65	20.34	20.08
			AV	8.21	8.05	8.07	8.14	8.05	8.10	7.99	8.03

Copyright © 2014, Digital EMC Co., Ltd.

8.3 Maximum Power Spectral Density

Test requirements and limit, §15.247(e)& RSS-210[A8.2]

The peak power density is measured with a spectrum analyzer connected to the antenna terminal while the EUT is operating in transmission mode at the appropriate frequencies.

Minimum Standard –specifies a conducted power spectral density (PSD) limit of 8 dBm in any 3 kHz Band segment within the fundamental EBW during any time interval of continuous transmission.

▣TEST CONFIGURATION

Refer to the APPENDIX I.

▣TEST PROCEDURE:

Method PKPSD of KDB558074 v03r1 is used.
1. Set analyzer center frequency to DTS channel center frequency.
2. Set the span to **1.5 times** the DTS bandwidth.
3. Set the RBW to: **3 kHz ≤ RBW ≤ 100 kHz**.
4. Set the VBW **≥3 x RBW.**
5. Detector = **peak.**
6. Sweep time = **auto couple.**
7. Trace mode = **max hold.**
8. Allow trace to fully stabilize.
9. Use the **peak marker function** to determine the maximum amplitude level within the RBW.
10. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

▣TEST RESULTS: Comply

Test Mode	Data Rate	Frequency [MHz]	RBW	PKPSD [dBm]
802.11b	1 Mbps	2412	3 kHz	-8.32
		2437	3 kHz	-9.30
		2462	3 kHz	-10.31
802.11g	6 Mbps	2412	3 kHz	-14.84
		2437	3 kHz	-15.67
		2462	3 kHz	-16.13
802.11n (HT20)	MCS 0	2412	3 kHz	-14.80
		2437	3 kHz	-15.86
		2462	3 kHz	-16.44

Copyright © 2014, Digital EMC Co., Ltd.

▣RESULT PLOTS

Maximum PKPSD Test Mode: 802.11b & 1 Mbps & 2412 MHz

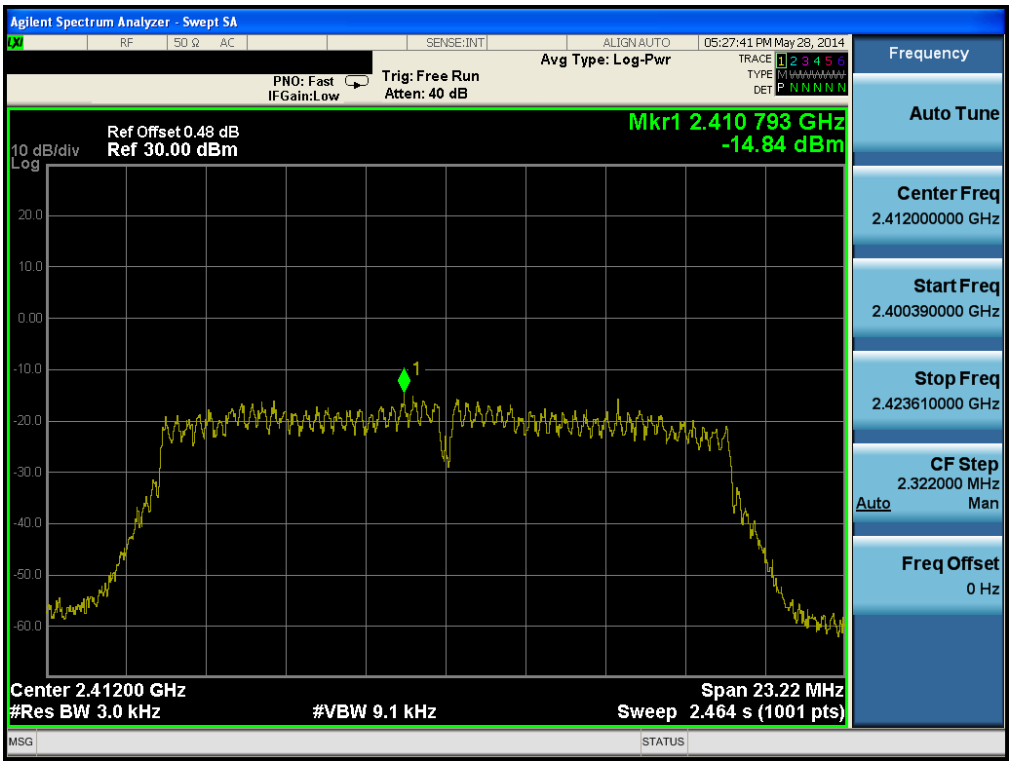
Maximum PKPSD Test Mode: 802.11b &1 Mbps & 2437 MHz

Copyright © 2014, Digital EMC Co., Ltd.

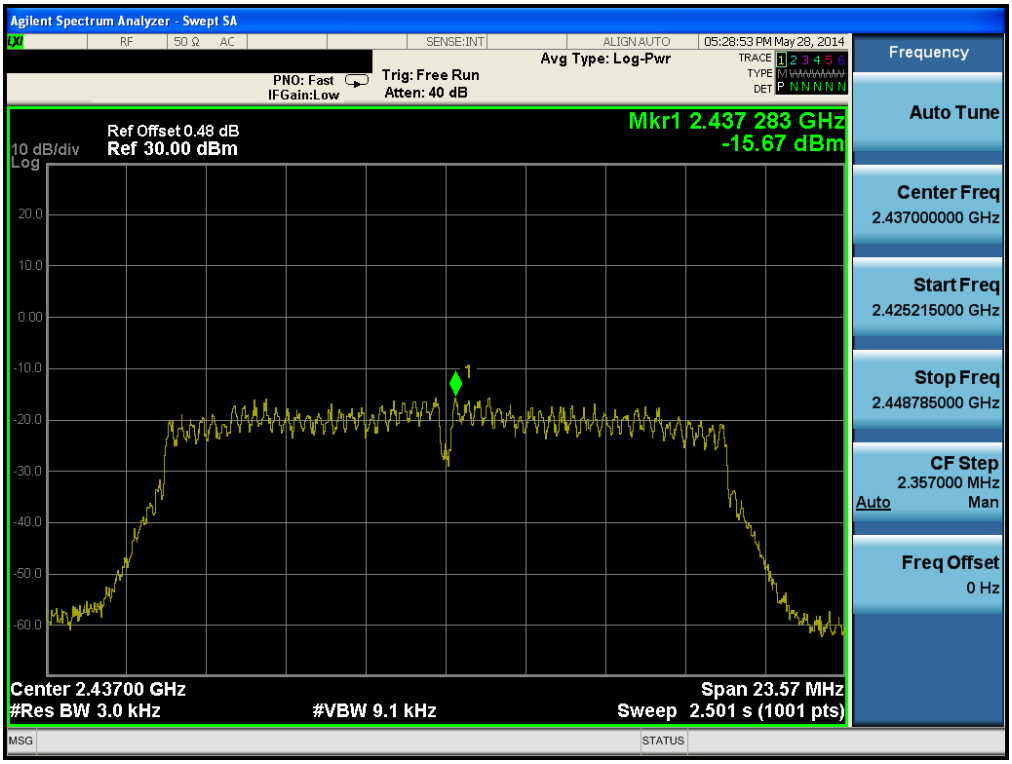
Maximum PKPSD Test Mode: 802.11b & 1 Mbps & 2462 MHz

Copyright © 2014, Digital EMC Co., Ltd.

Maximum PKPSD Test Mode: 802.11g & 6 Mbps & 2412 MHz

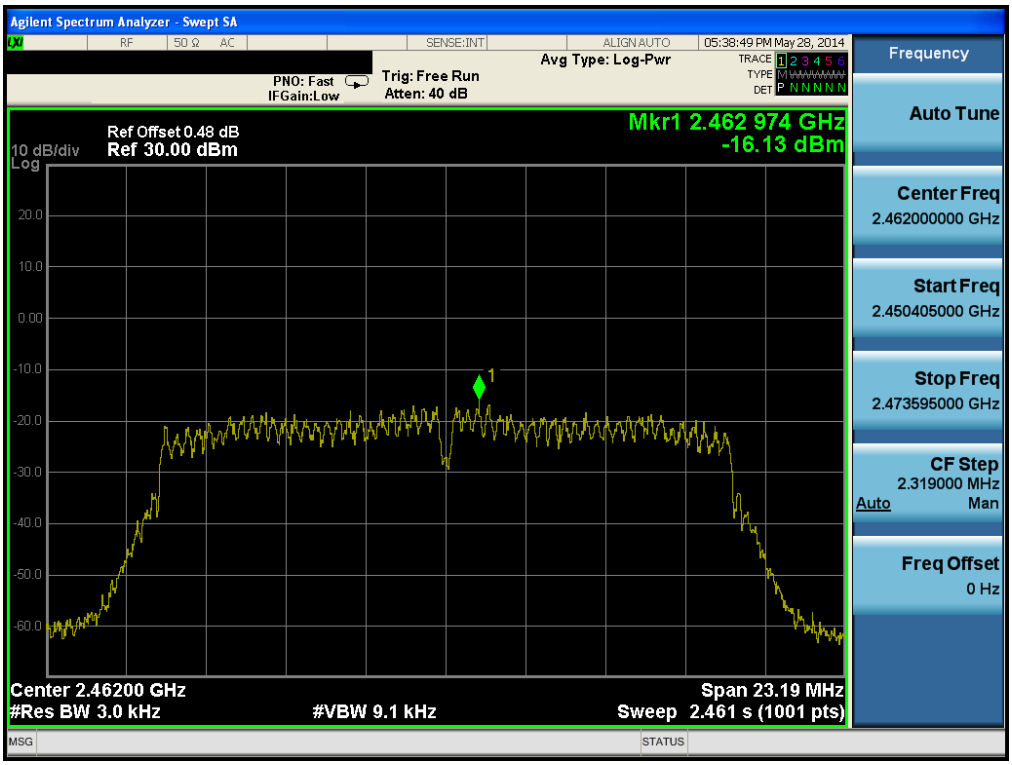


Maximum PKPSD Test Mode: 802.11g & 6 Mbps & 2437 MHz



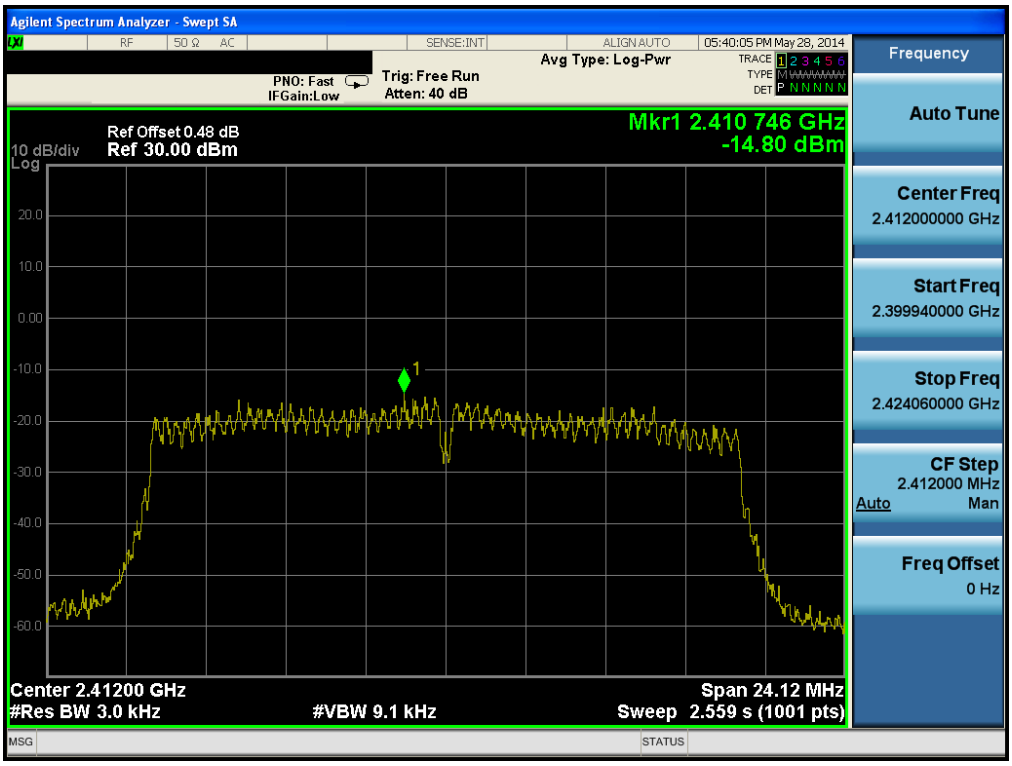
Copyright © 2014, Digital EMC Co., Ltd.

Maximum PKPSD Test Mode: 802.11g &6 Mbps & 2462 MHz

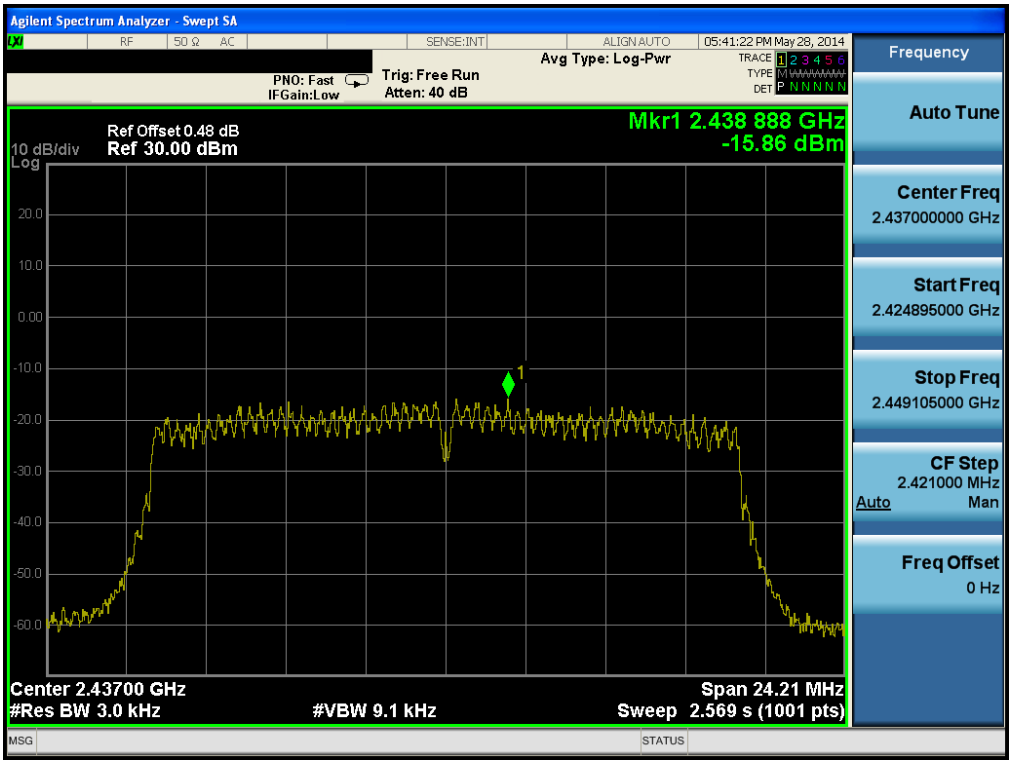


Copyright © 2014, Digital EMC Co., Ltd.

Maximum PKPSD Test Mode: 802.11n(HT20) & MCS 0 & 2412 MHz

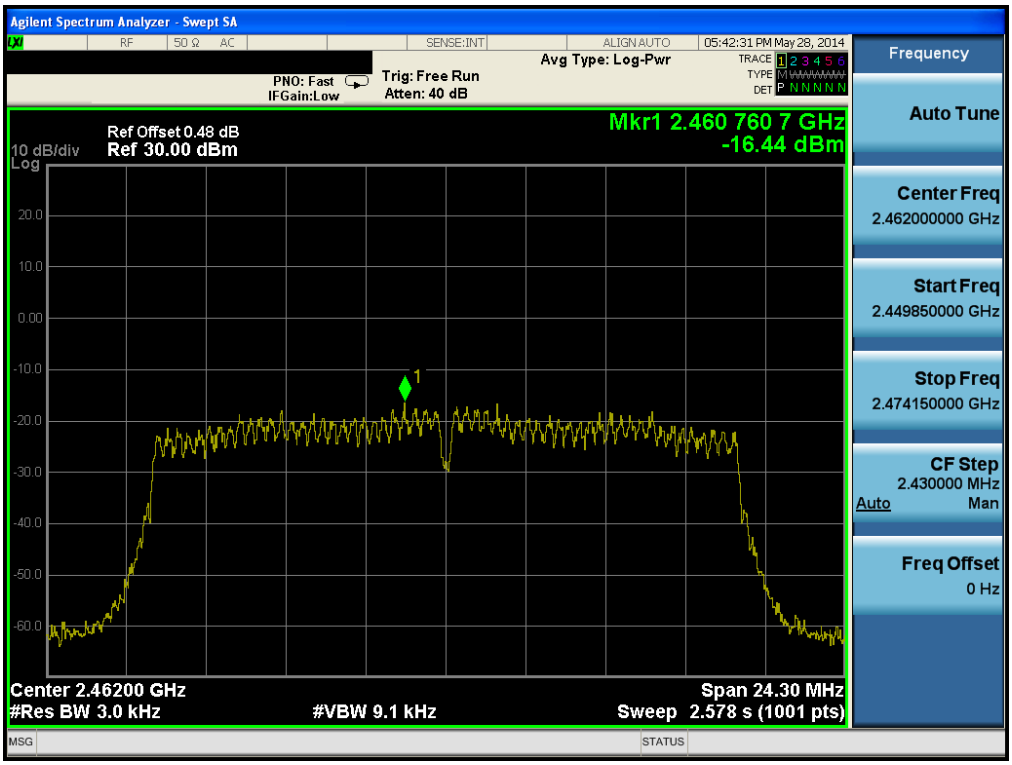


Maximum PKPSD Test Mode: 802.11n(HT20) & MCS 0 & 2437 MHz



Copyright © 2014, Digital EMC Co., Ltd.

Maximum PKPSD Test Mode: 802.11n(HT20) & MCS 0 & 2462 MHz



Copyright © 2014, Digital EMC Co., Ltd.

8.4 Out of Band Emissions at the Band Edge/ Conducted Spurious Emissions

Test requirements and limit, §15.247(d)& RSS-210 [A8.5]

§15.247(d) specifies that in any 100 kHz bandwidth outside of the authorized frequency band, the power shall be attenuated according to the following conditions:

If **the peak output power procedure** is used to measure the fundamental emission power to demonstrate compliance to **15.247(b)(3)** requirements, then the peak conducted output power measured within any 100 kHz outside the authorized frequency band shall be attenuated **by at least 20 dB** relative to the maximum measured in-band peak PSD level.

If the average output power procedure is used to measure the fundamental emission power to demonstrate compliance to **15.247(b)(3)** requirements, then the power in any 100 kHz outside of the authorized frequency band shall be attenuated by at least 30 dB relative to the maximum measured inband average PSD level.

In either case, attenuation to levels below the general emission limits specified in **§15.209(a)** is not required.

▣TEST CONFIGURATION

Refer to the APPENDIX I.

▣TEST PROCEDURE

The transmitter output is connected to a spectrum analyzer.

- Measurement Procedure 1 – Reference Level

1. Set instrument center frequency to DTS channel center frequency.
2. Set the span to ≥ 1.5 times the DTS bandwidth.
3. Set the RBW = 100 kHz.
4. Set the VBW ≥ 3 x RBW.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum PSD level

- Measurement Procedure 2 - Unwanted Emissions

1. Set the center frequency and span to encompass frequency range to be measured.
2. Set the RBW = **100 kHz.(Actual 1 MHz , See below note)**
3. Set the VBW **≥3 x RBW.(Actual 3 MHz, See below note)**
4. Detector = **peak**.
5. Ensure that the number of measurement points ≥ span/RBW
6. Sweep time = **auto couple.**
7. Trace mode = **max hold.**
8. **Allow the trace to stabilize** (this may take some time, depending on the extent of the span).
9. Use the peak marker function to determine the maximum amplitude level.

Note: The conducted spurious emission was tested with below settings.
Frequency range: 9 kHz ~ 30 MHz
RBW= 100 kHz, VBW= 300 kHz, SWEEP TIME = AUTO, DETECTOR = PEAK, TRACE = MAX HOLD, SWEEP POINT: 40001

Frequency range: 30 MHz ~ 10 GHz, 10 GHz~25 GHz
RBW= 1MHz, VBW= 3MHz, SWEEP TIME = AUTO, DETECTOR = PEAK, TRACE = MAX HOLD, SWEEP POINT: 40001

LIMIT LINE = 20 dB below of the reference level of above measurement procedure Step 2. (RBW = 100 kHz, VBW = 300 kHz)

If the emission level with above setting was close to the limit (ie, less than 3 dB margin) then zoom scan is required using RBW = 100 kHz, VBW = 300 kHz, SAPN = 100 MHz and BINS = 2001 to get accurate emission level within 100 kHz BW.

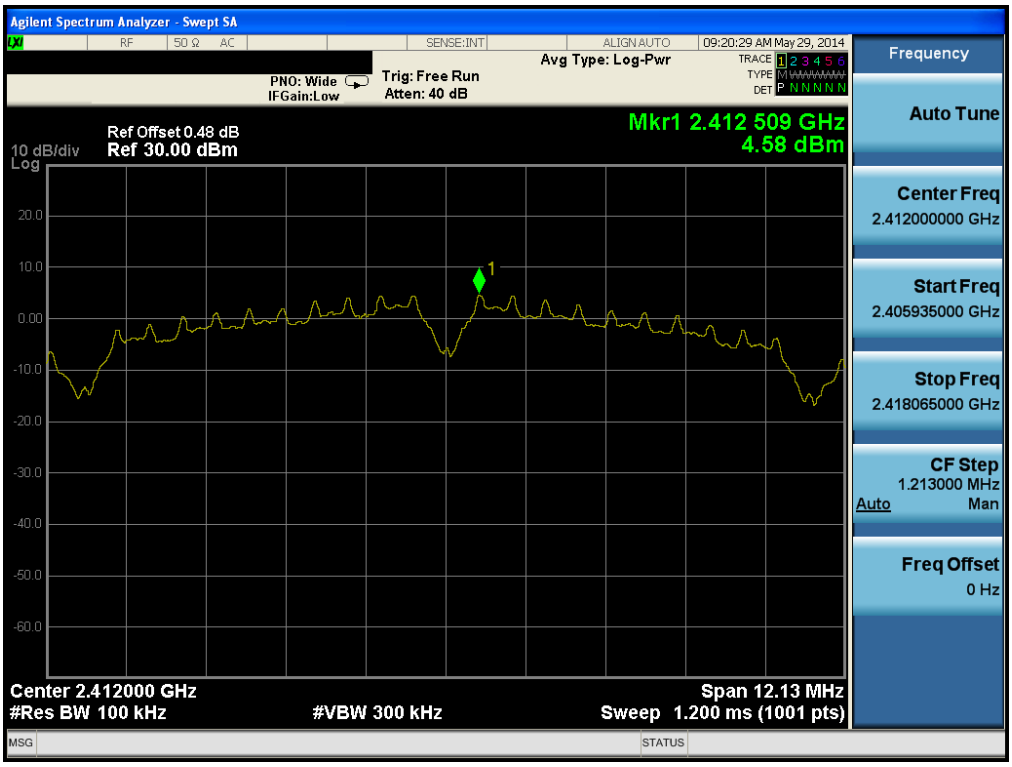
Also the path loss for conducted measurement setup was used as described on the Appendix I of this test report.

Copyright © 2014, Digital EMC Co., Ltd.

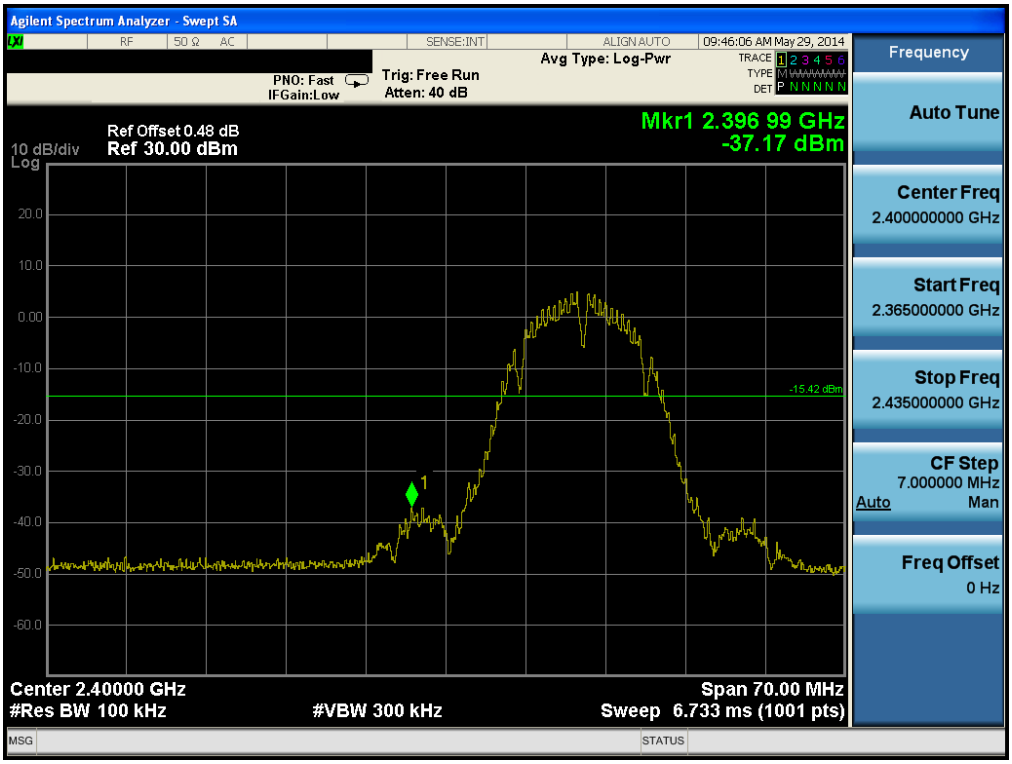
▣RESULT PLOTS

802.11b & 1 Mbps & 2412 MHz

Reference

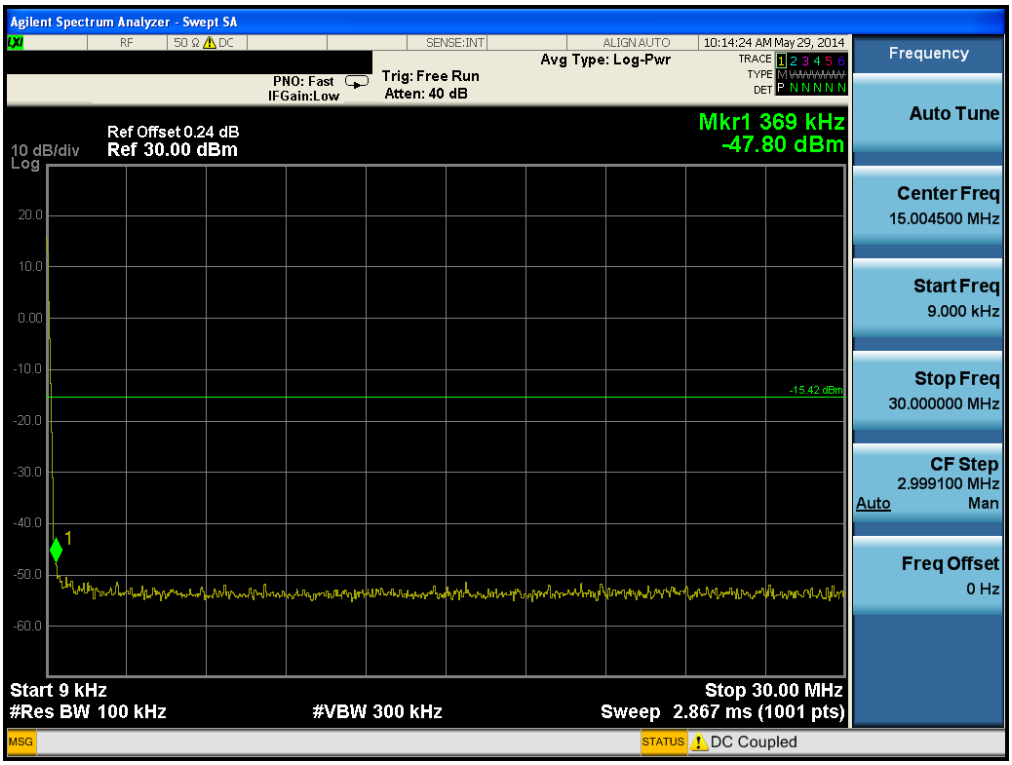


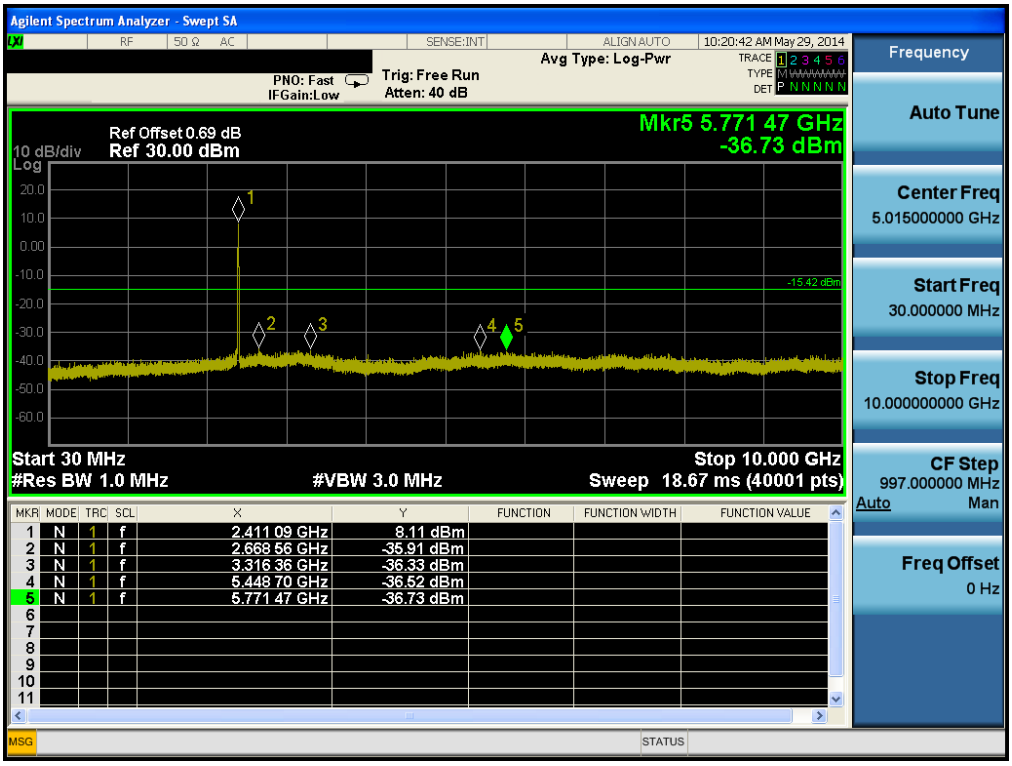
Low Band-edge



Copyright © 2014, Digital EMC Co., Ltd.

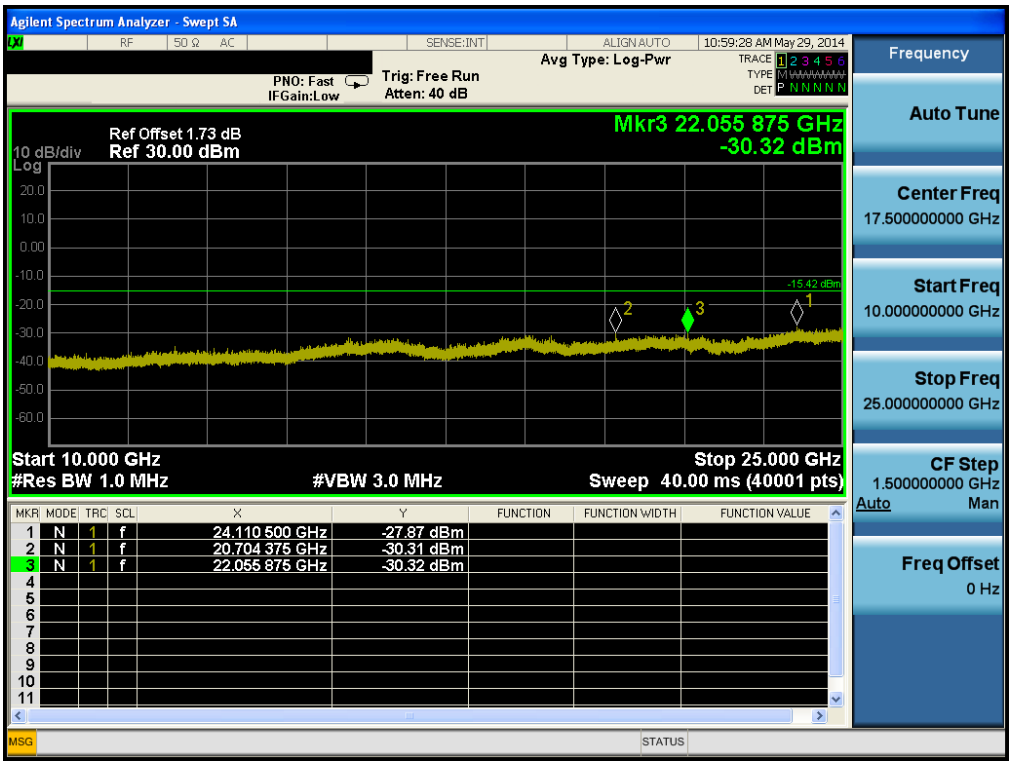
Conducted Spurious Emissions





Copyright © 2014, Digital EMC Co., Ltd.

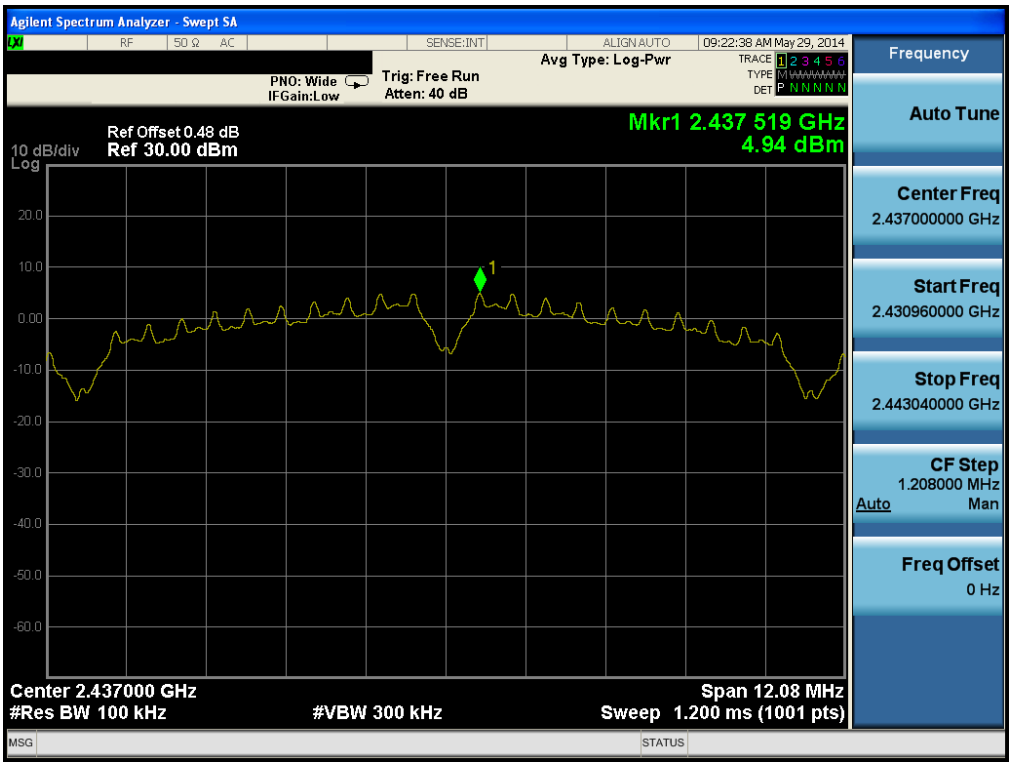
Conducted Spurious Emissions



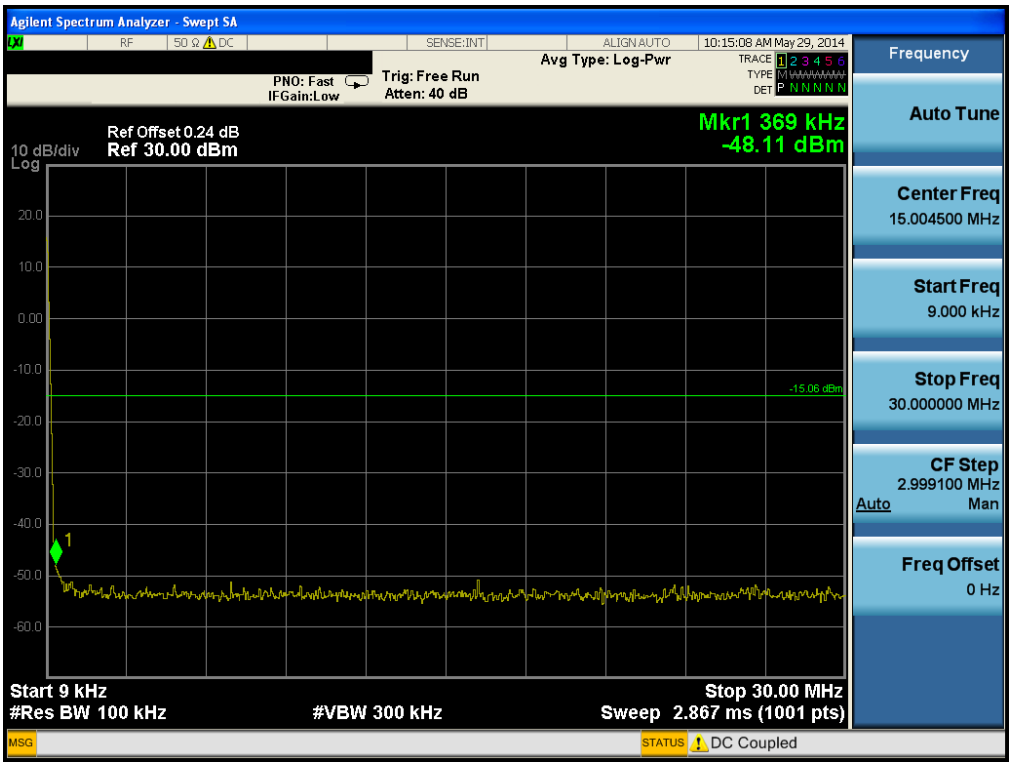
Copyright © 2014, Digital EMC Co., Ltd.

802.11b & 1 Mbps & 2437 MHz

Reference

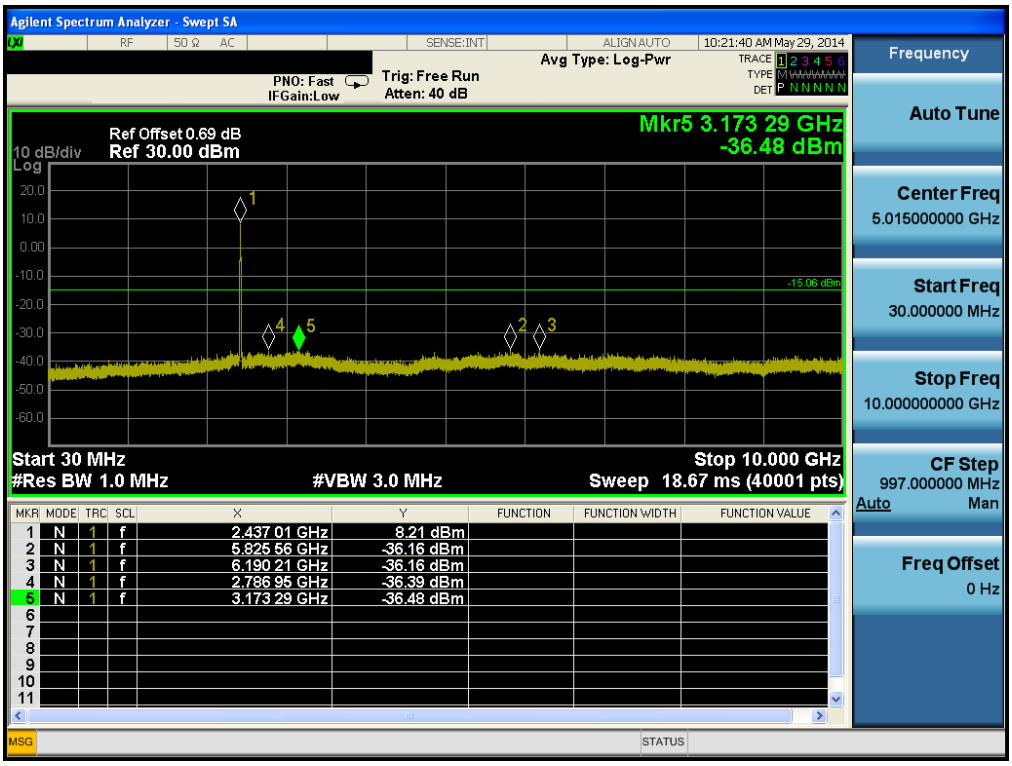


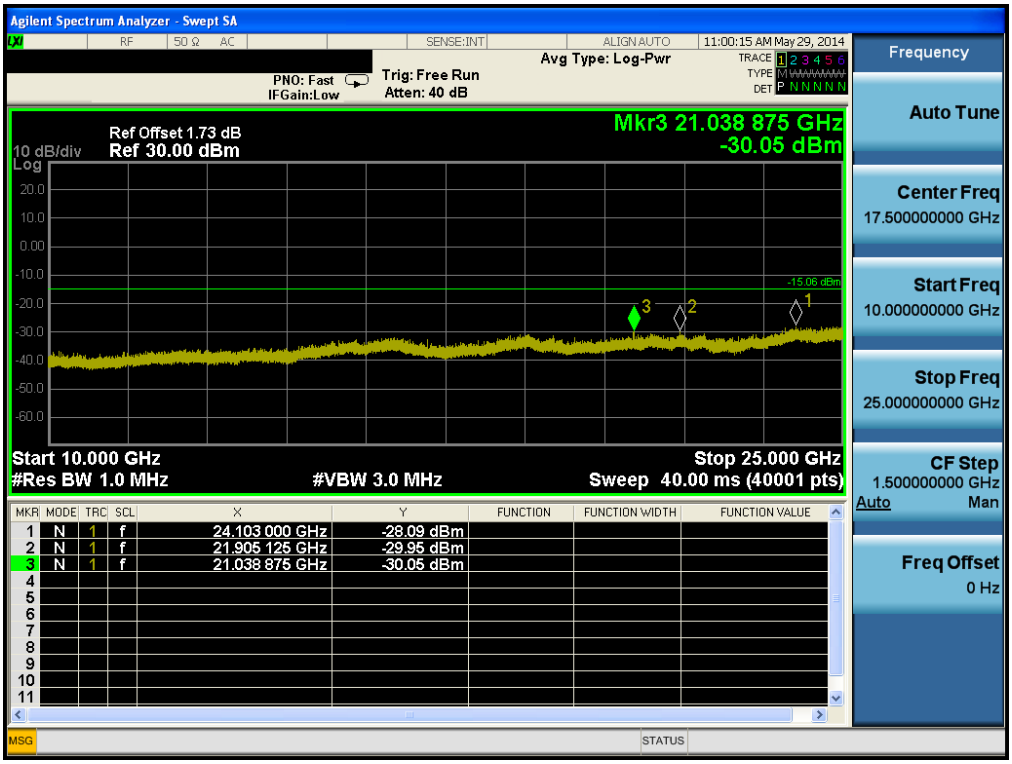
Conducted Spurious Emissions



Copyright © 2014, Digital EMC Co., Ltd.

Conducted Spurious Emissions

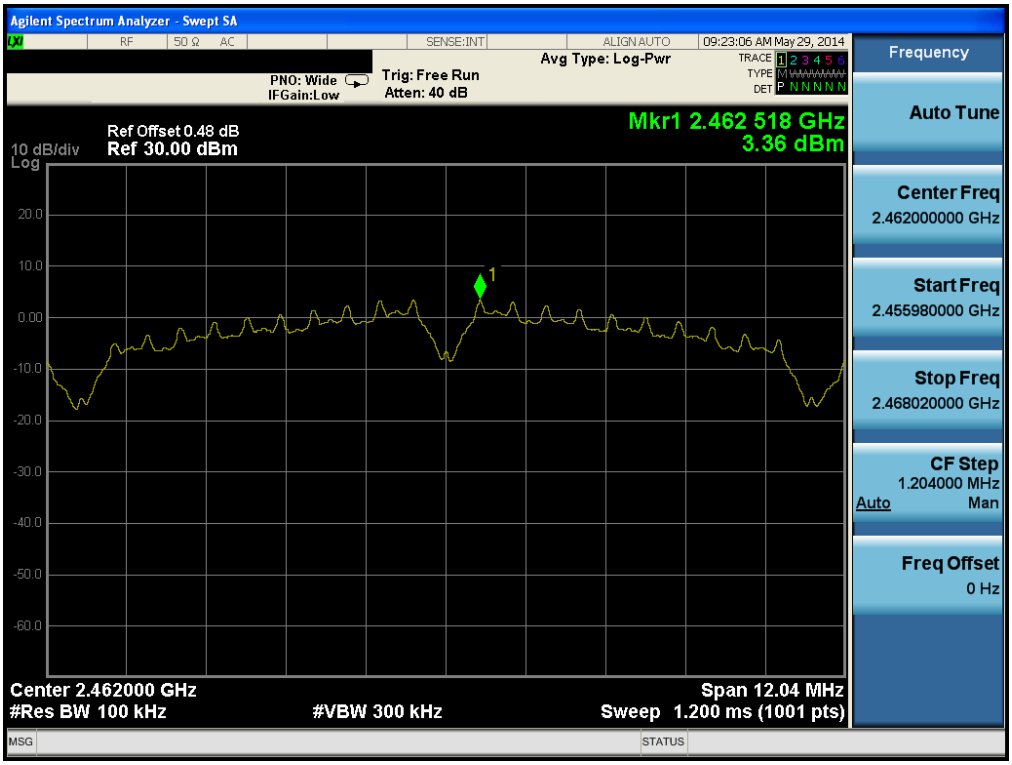




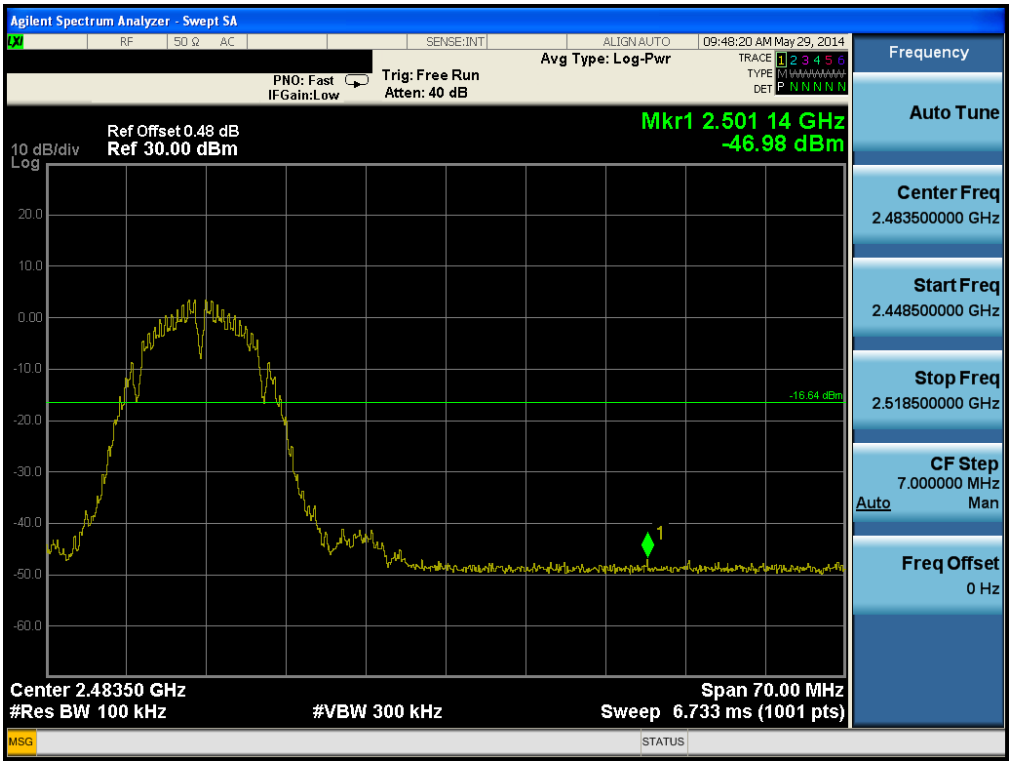
Copyright © 2014, Digital EMC Co., Ltd.

802.11b & 1 Mbps & 2462 MHz

Reference

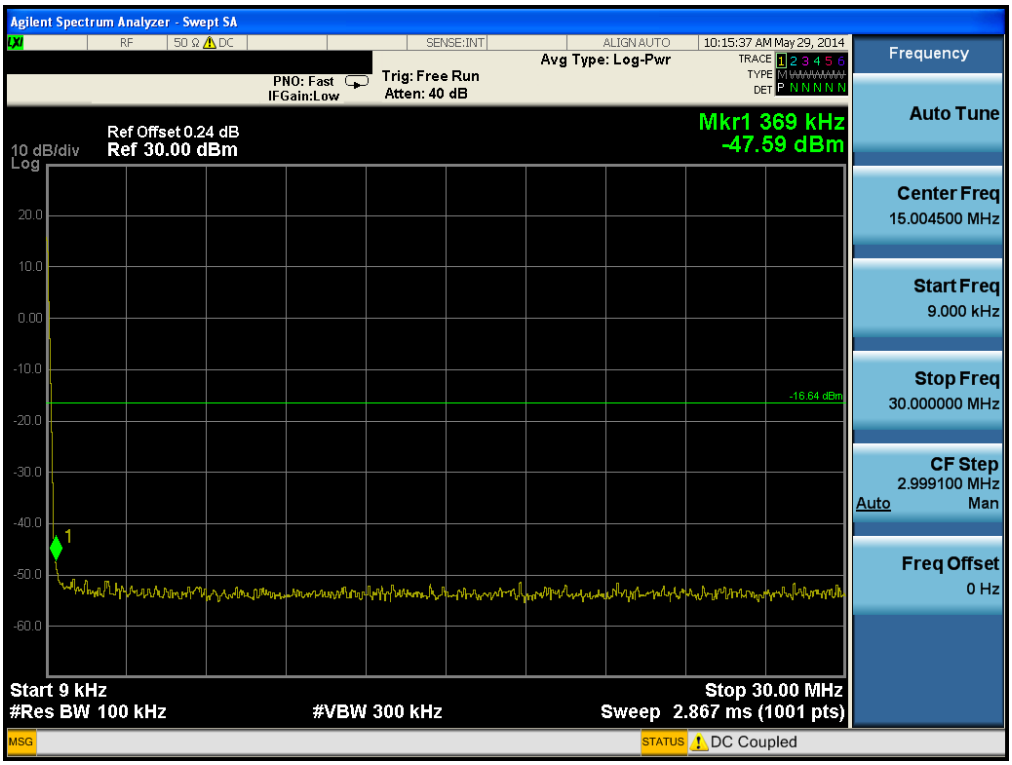


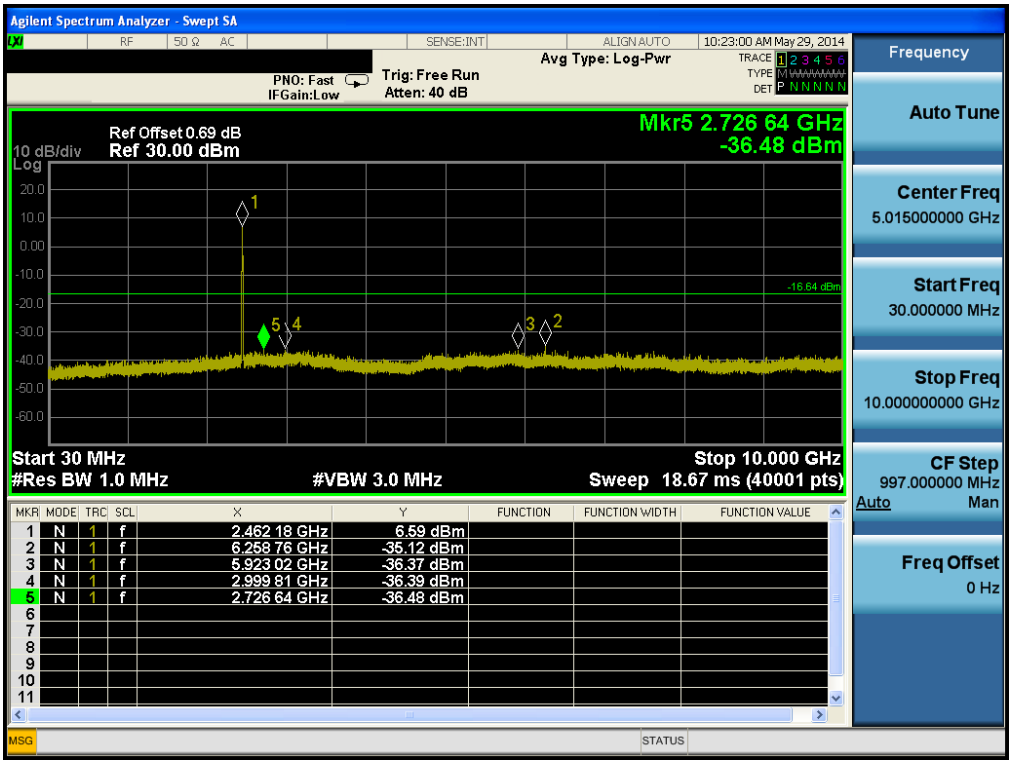
High Band-edge



Copyright © 2014, Digital EMC Co., Ltd.

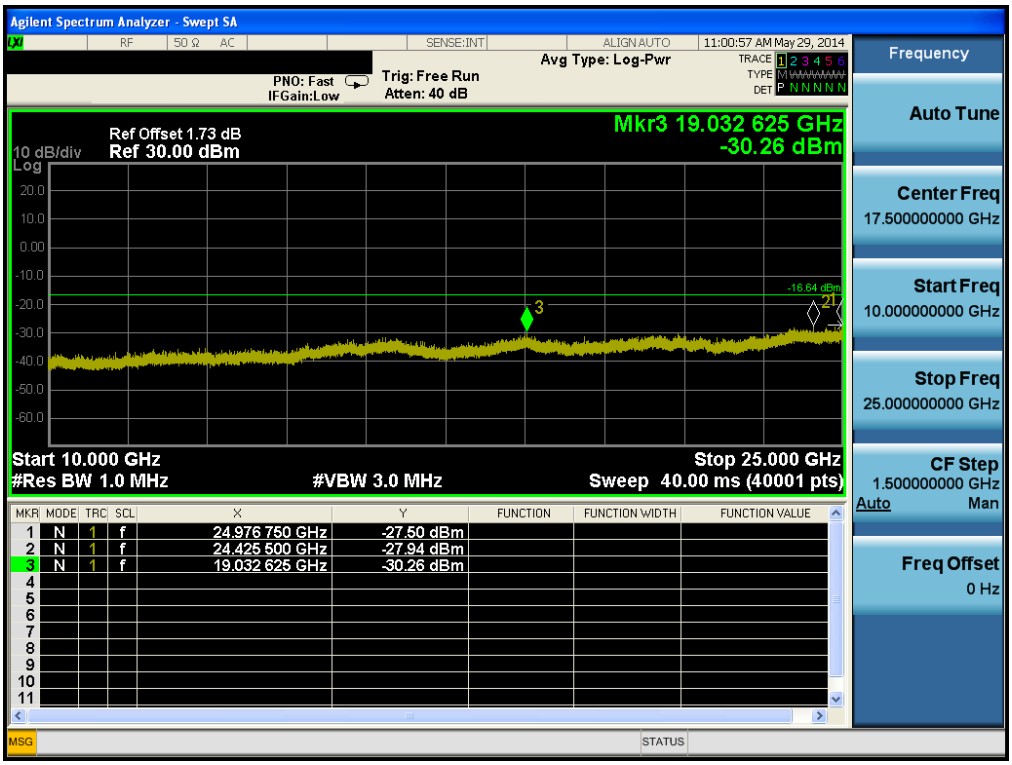
Conducted Spurious Emissions





Copyright © 2014, Digital EMC Co., Ltd.

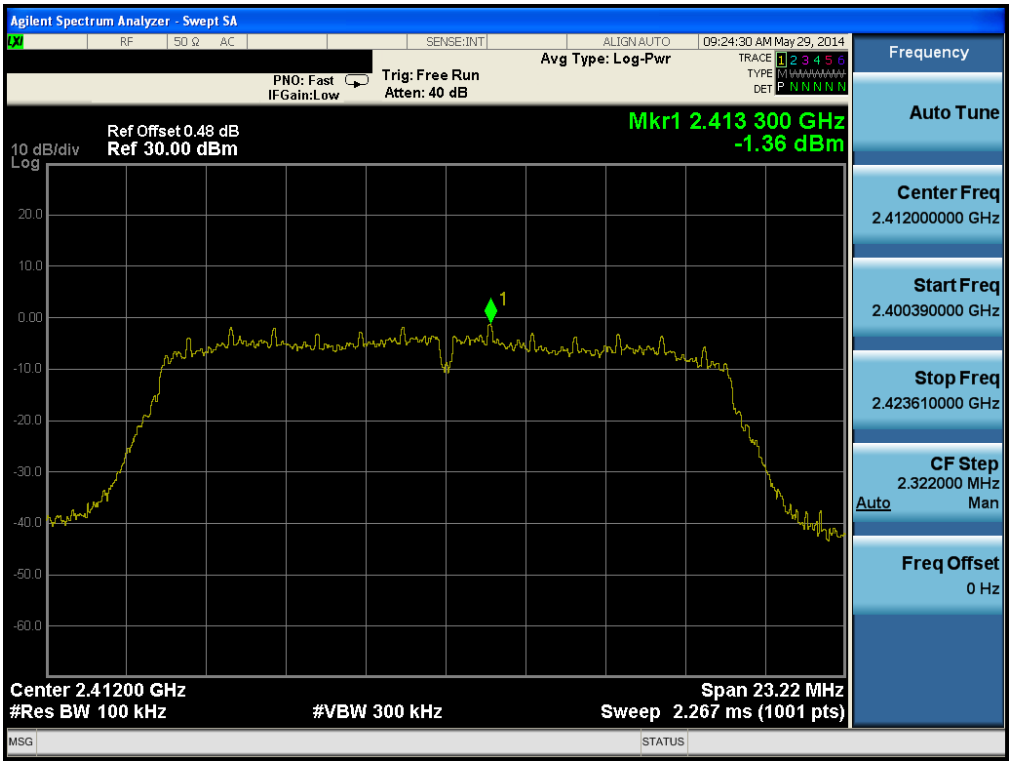
Conducted Spurious Emissions



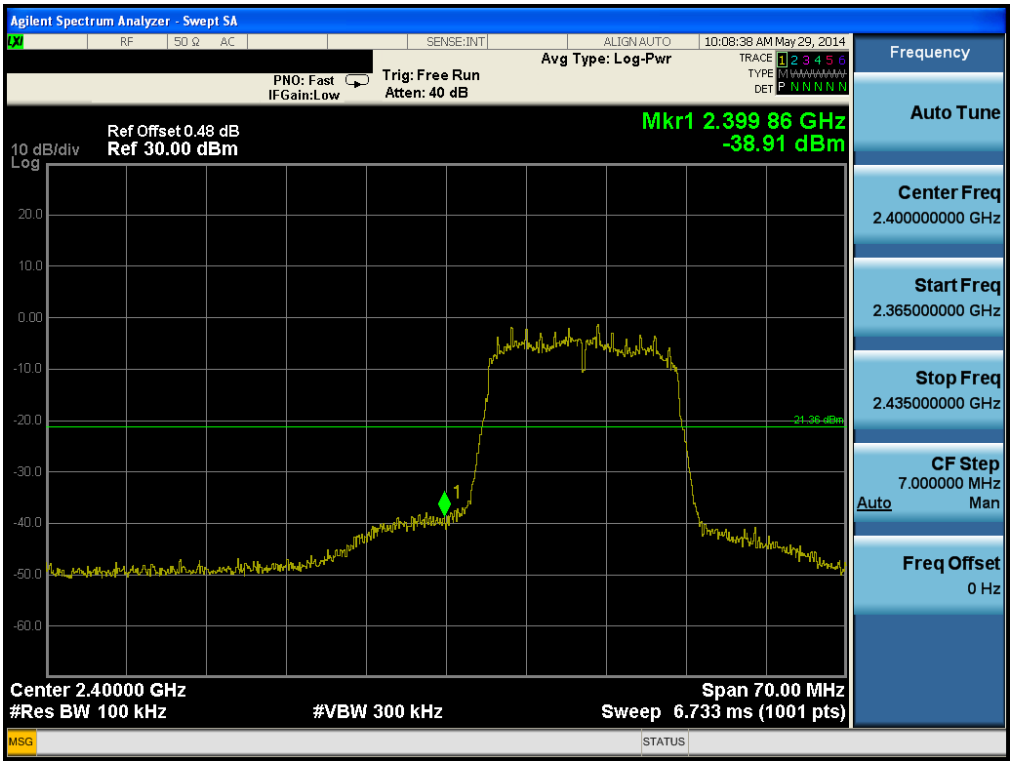
Copyright © 2014, Digital EMC Co., Ltd.

802.11g & 6 Mbps & 2412 MHz

Reference

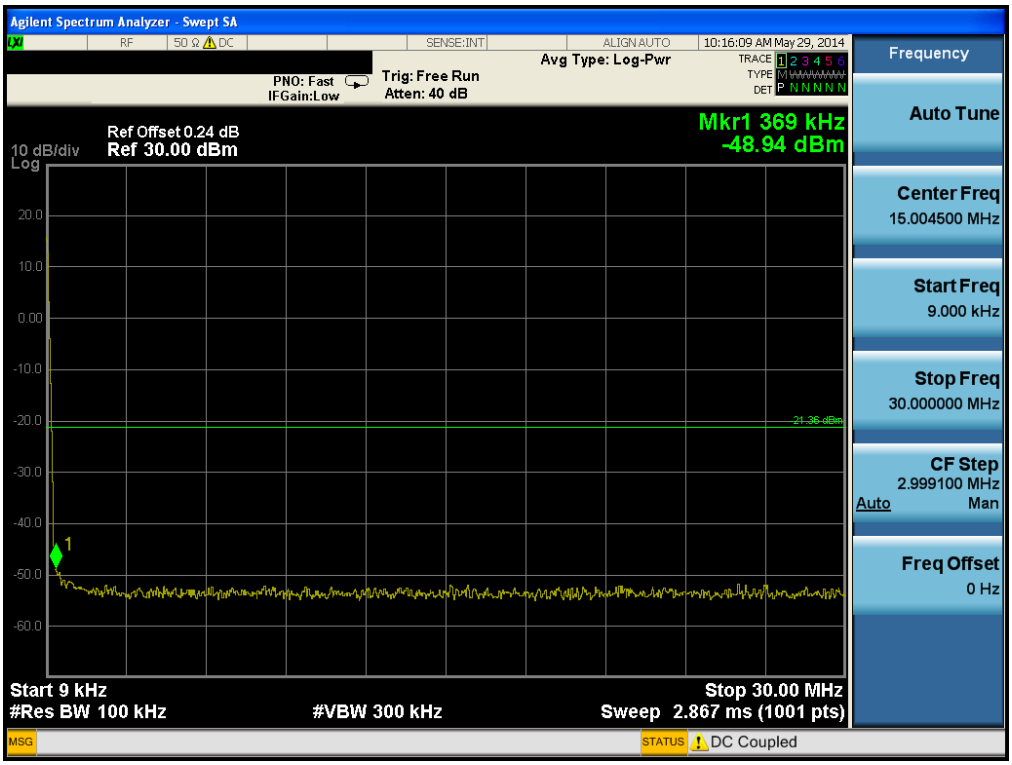


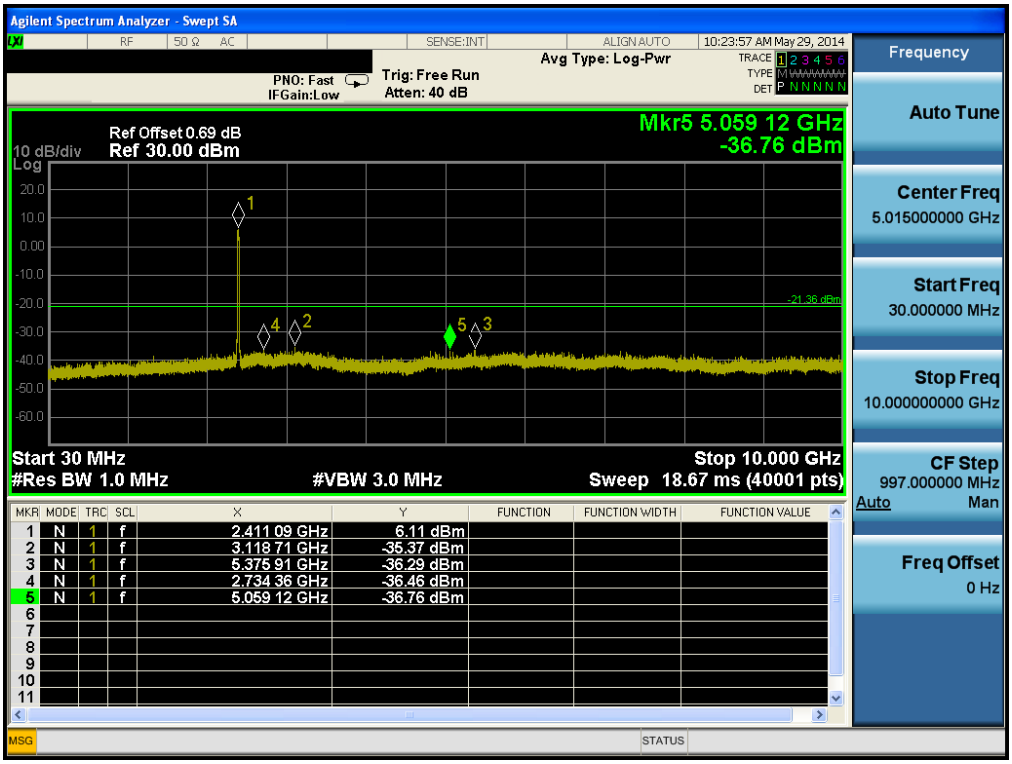
Low Band-edge



Copyright © 2014, Digital EMC Co., Ltd.

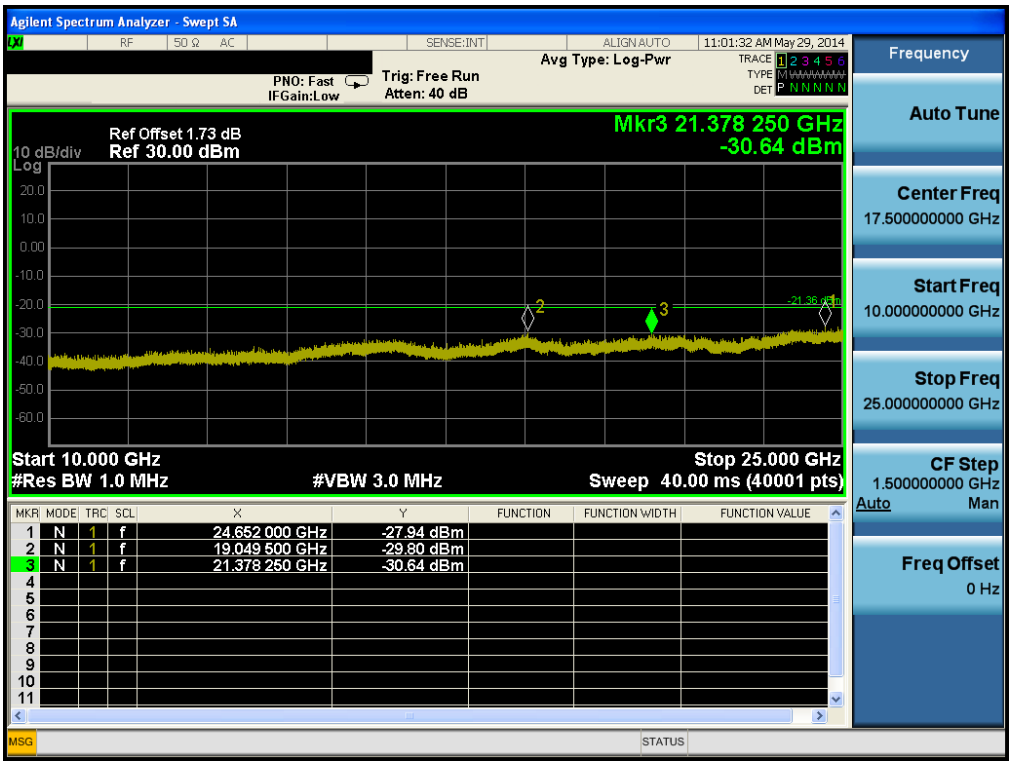
Conducted Spurious Emissions





Copyright © 2014, Digital EMC Co., Ltd.

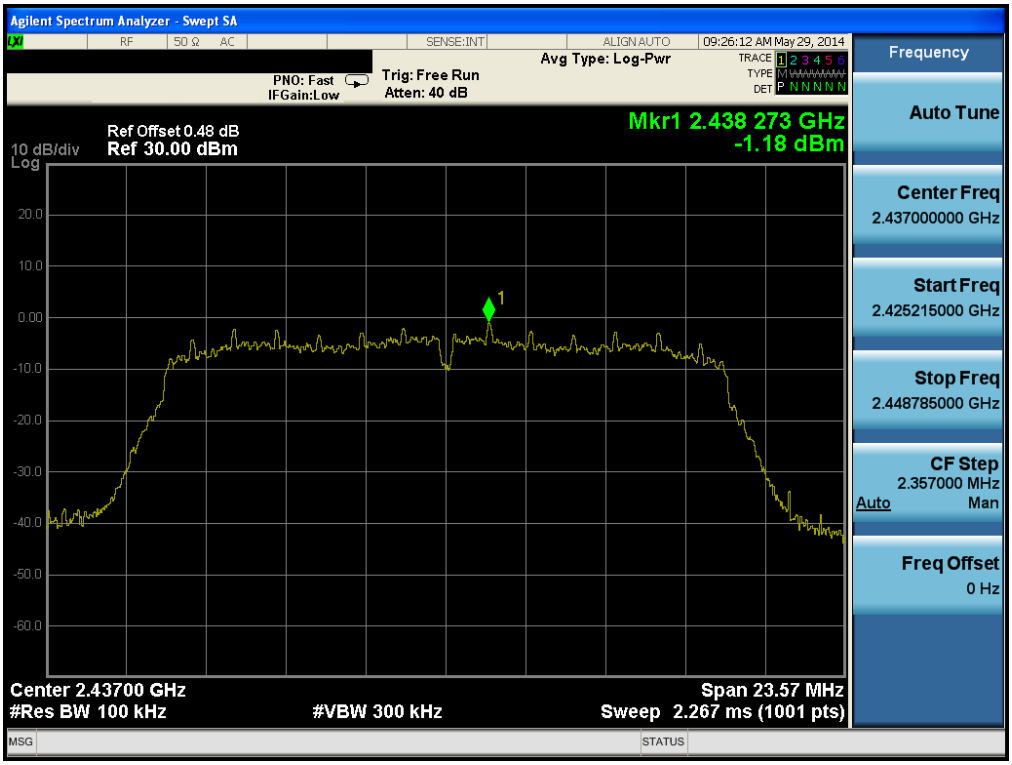
Conducted Spurious Emissions



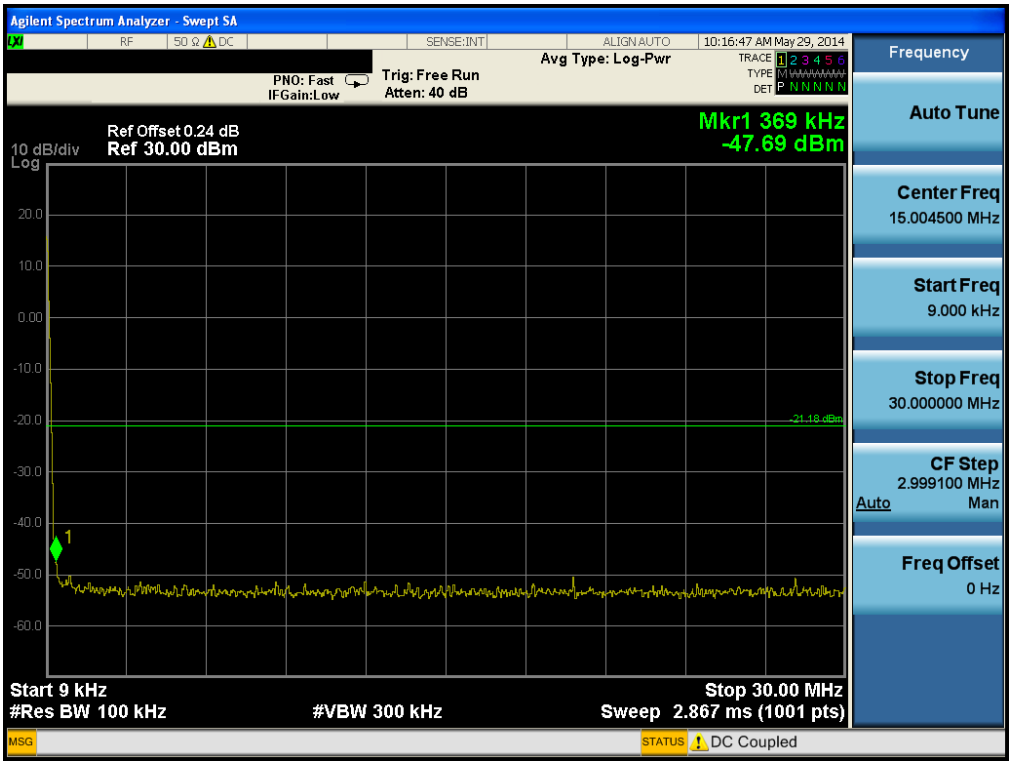
Copyright © 2014, Digital EMC Co., Ltd.

802.11g & 6 Mbps & 2437 MHz

Reference

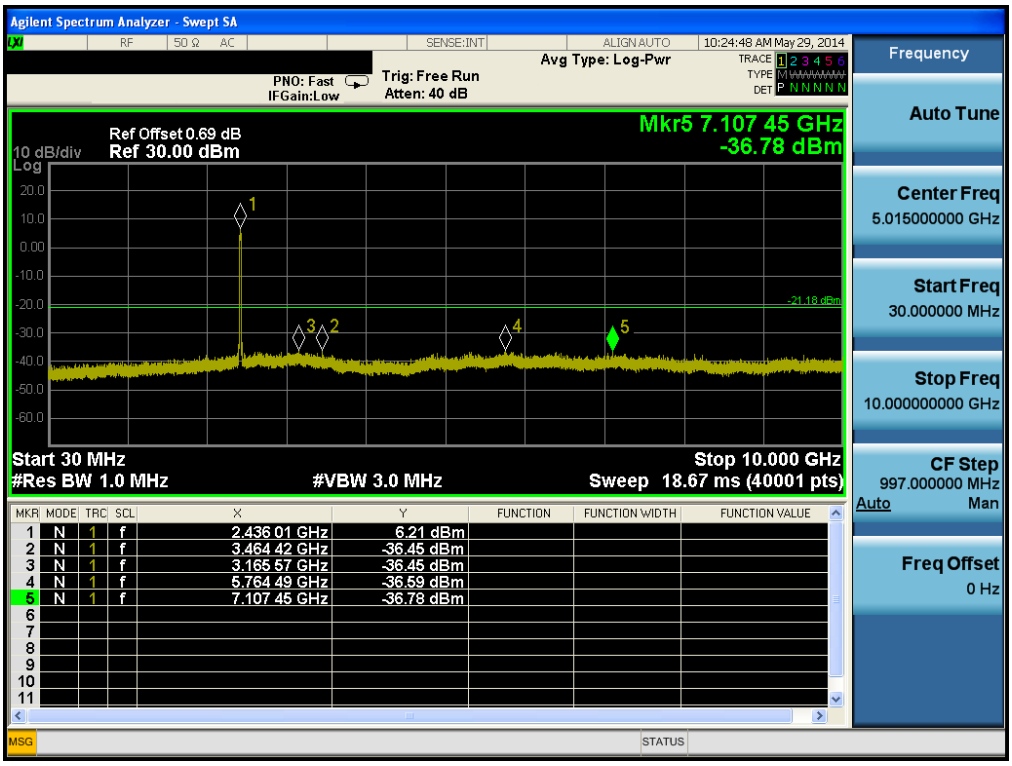


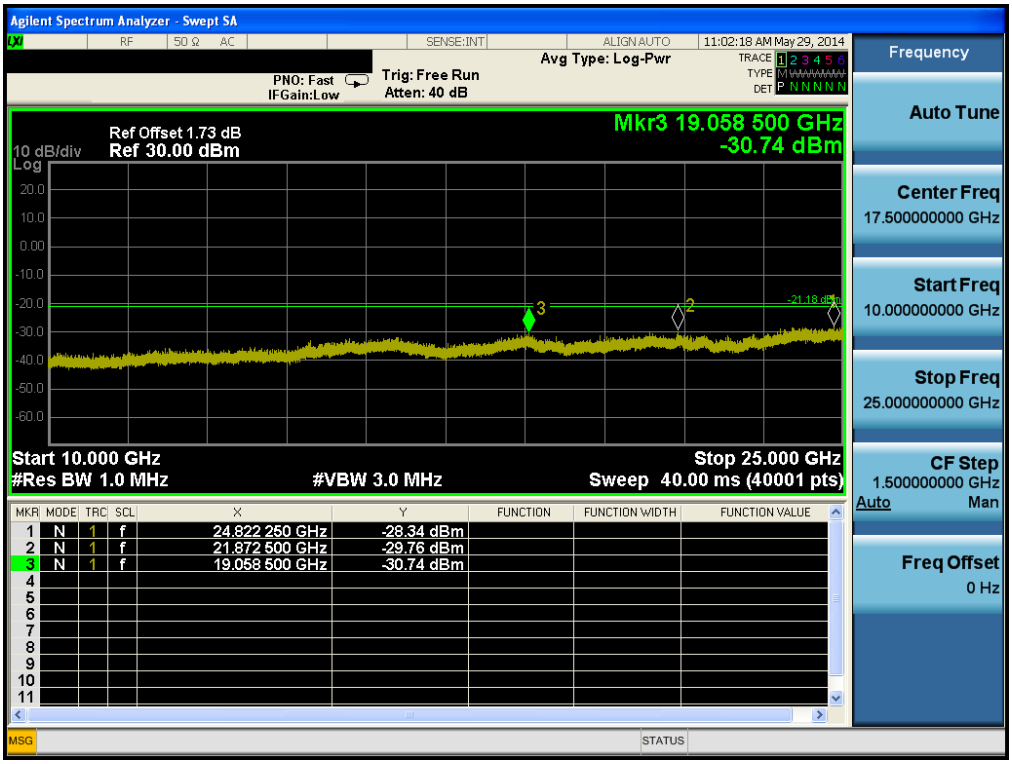
Conducted Spurious Emissions



Copyright © 2014, Digital EMC Co., Ltd.

Conducted Spurious Emissions

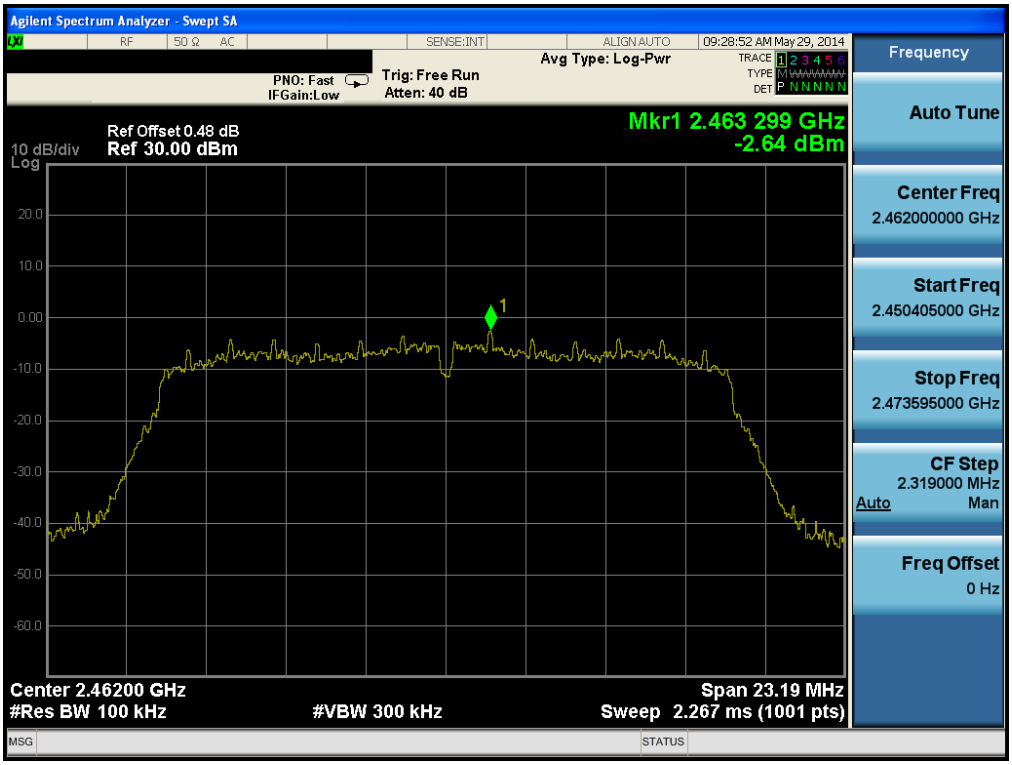




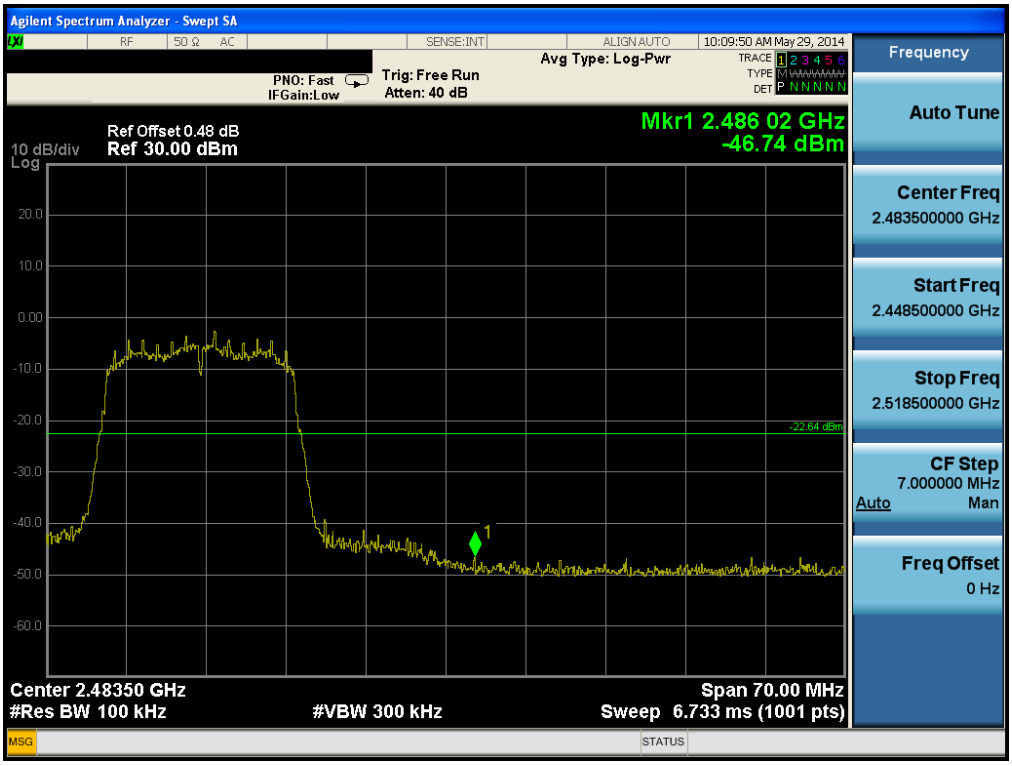
Copyright © 2014, Digital EMC Co., Ltd.

802.11g & 6 Mbps & 2462 MHz

Reference

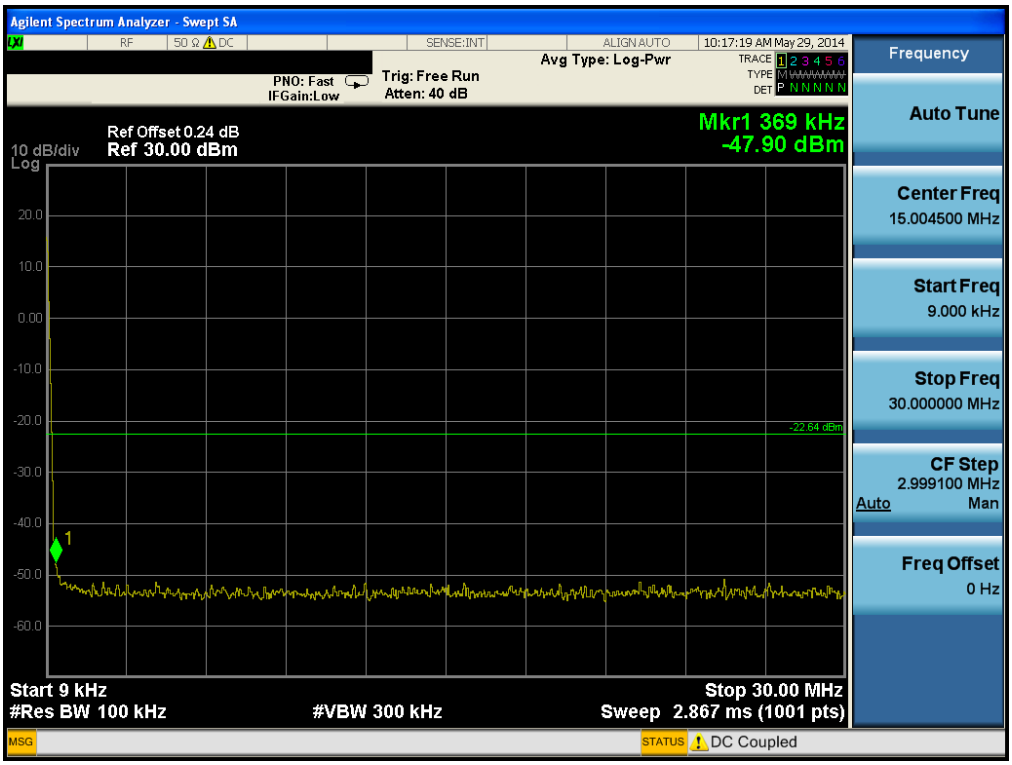


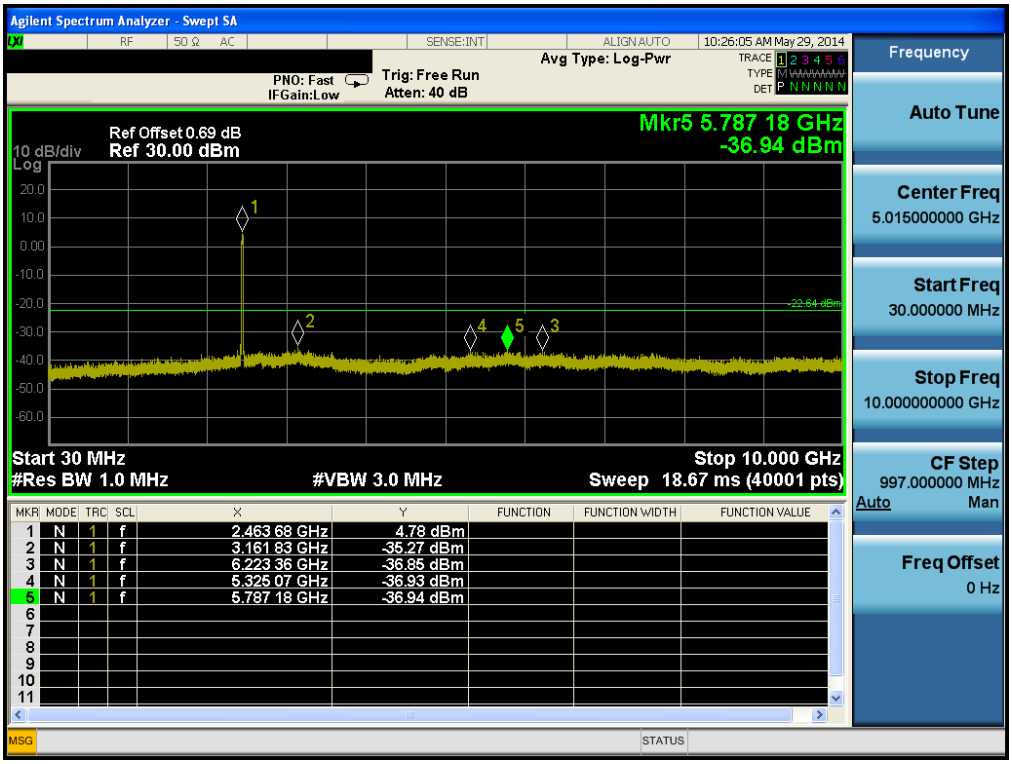
High Band-edge



Copyright © 2014, Digital EMC Co., Ltd.

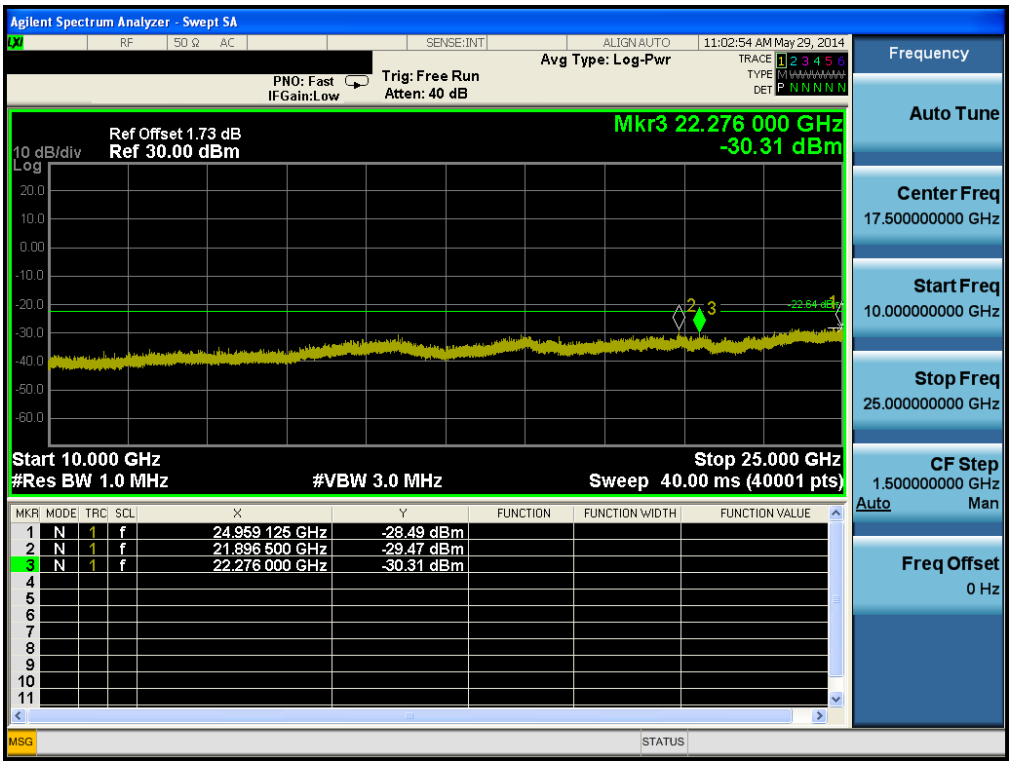
Conducted Spurious Emissions





Copyright © 2014, Digital EMC Co., Ltd.

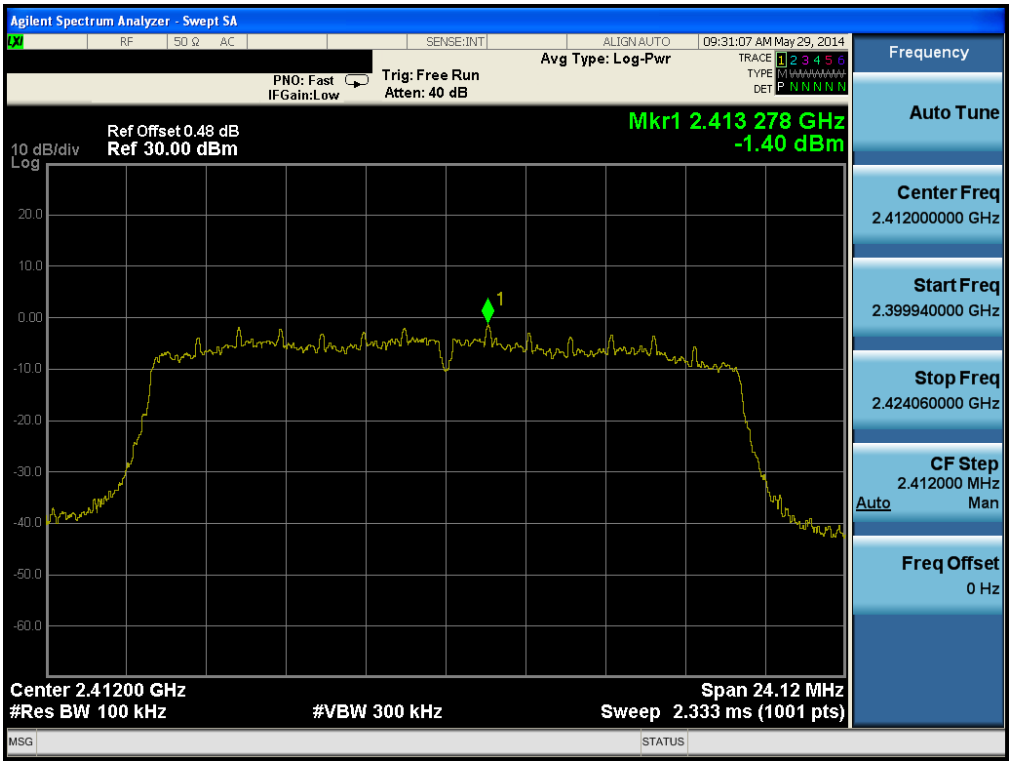
Conducted Spurious Emissions



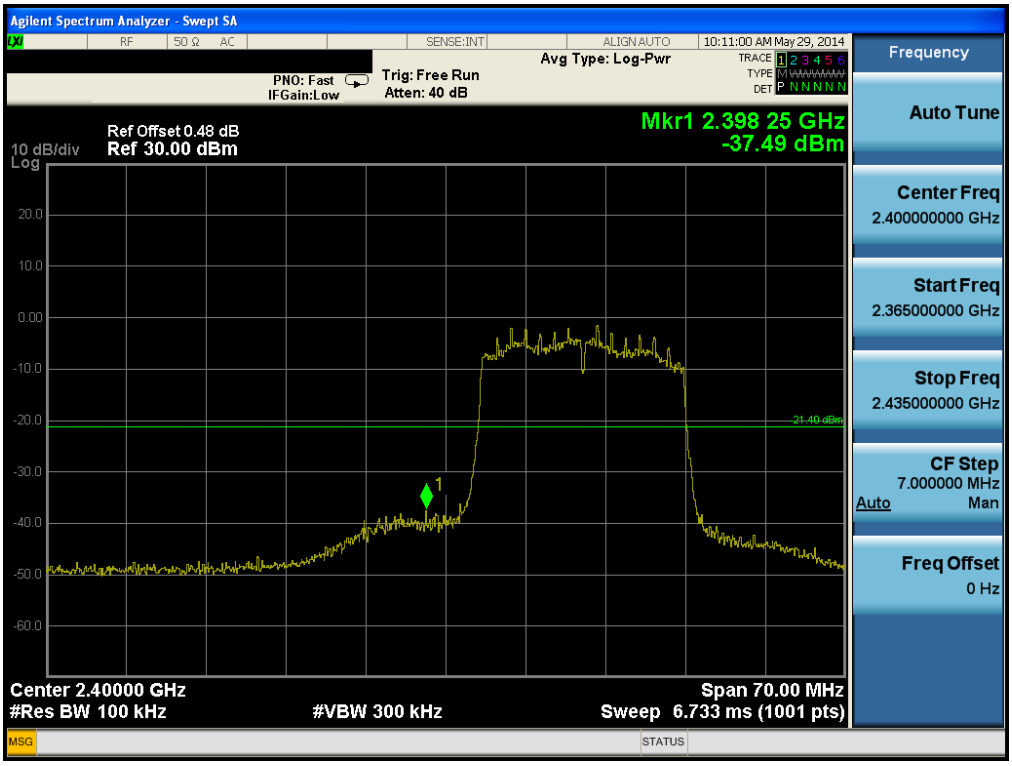
Copyright © 2014, Digital EMC Co., Ltd.

802.11n(HT20) & MCS 0 & 2412 MHz

Reference

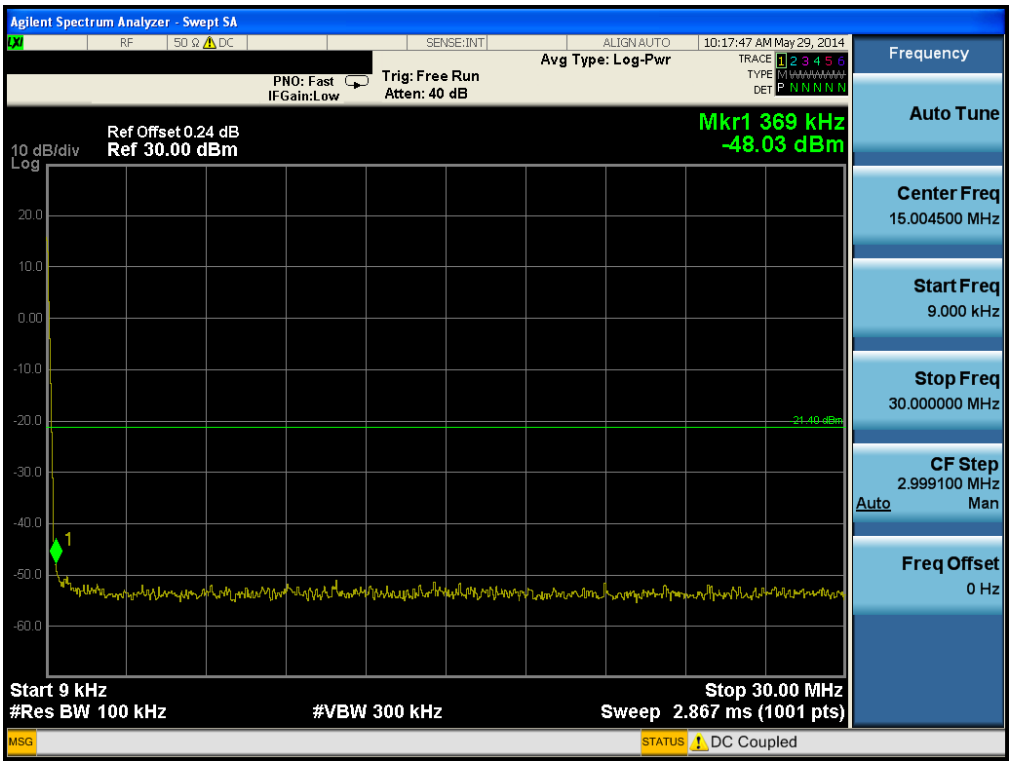


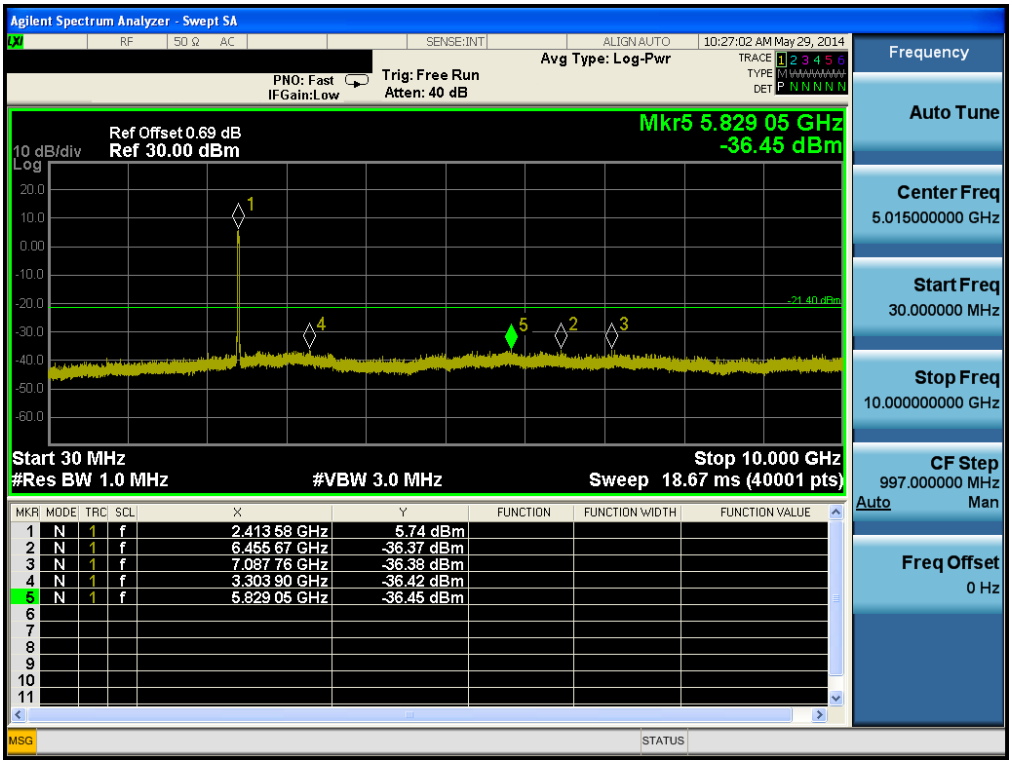
Low Band-edge



Copyright © 2014, Digital EMC Co., Ltd.

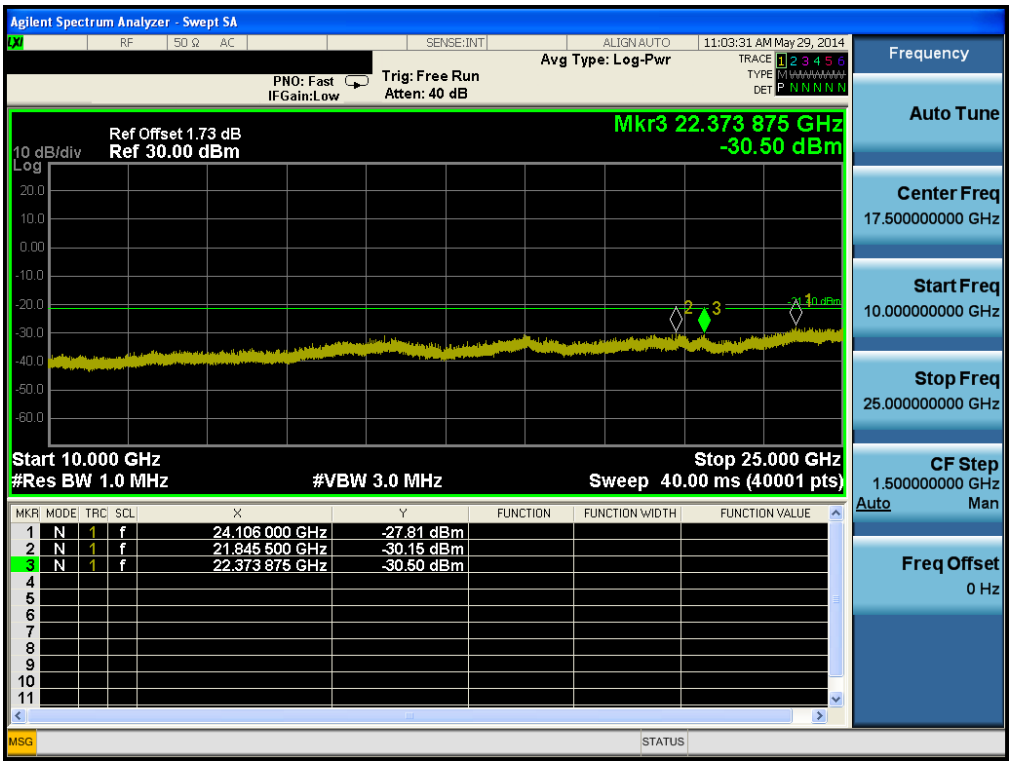
Conducted Spurious Emissions





Copyright © 2014, Digital EMC Co., Ltd.

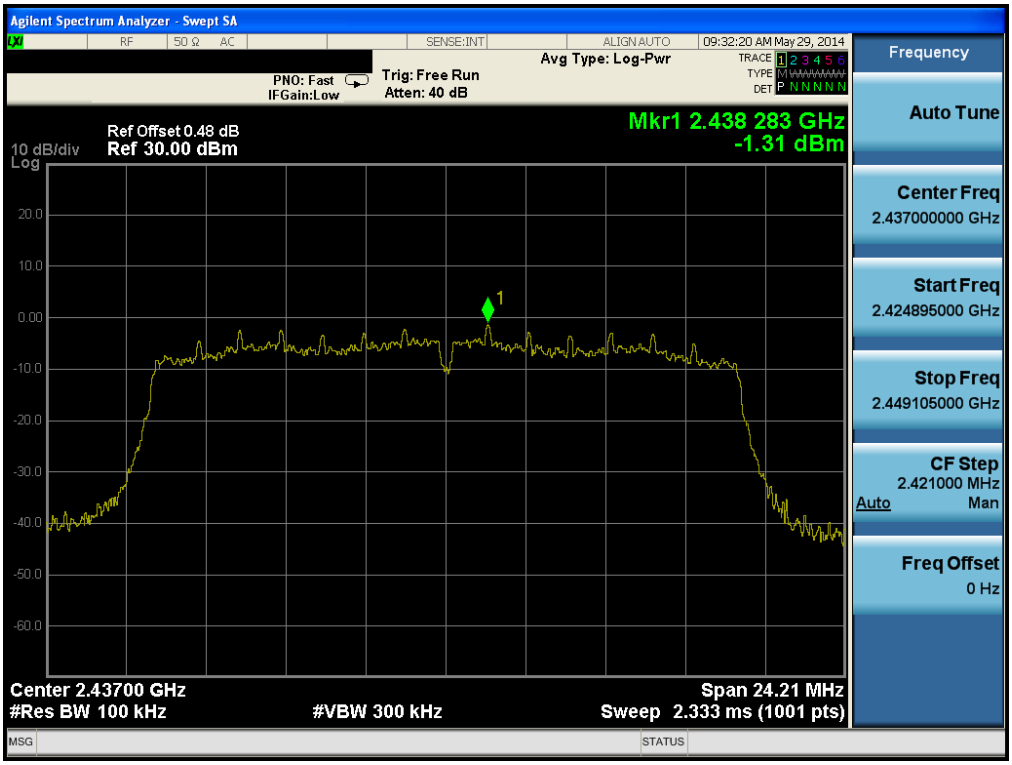
Conducted Spurious Emissions



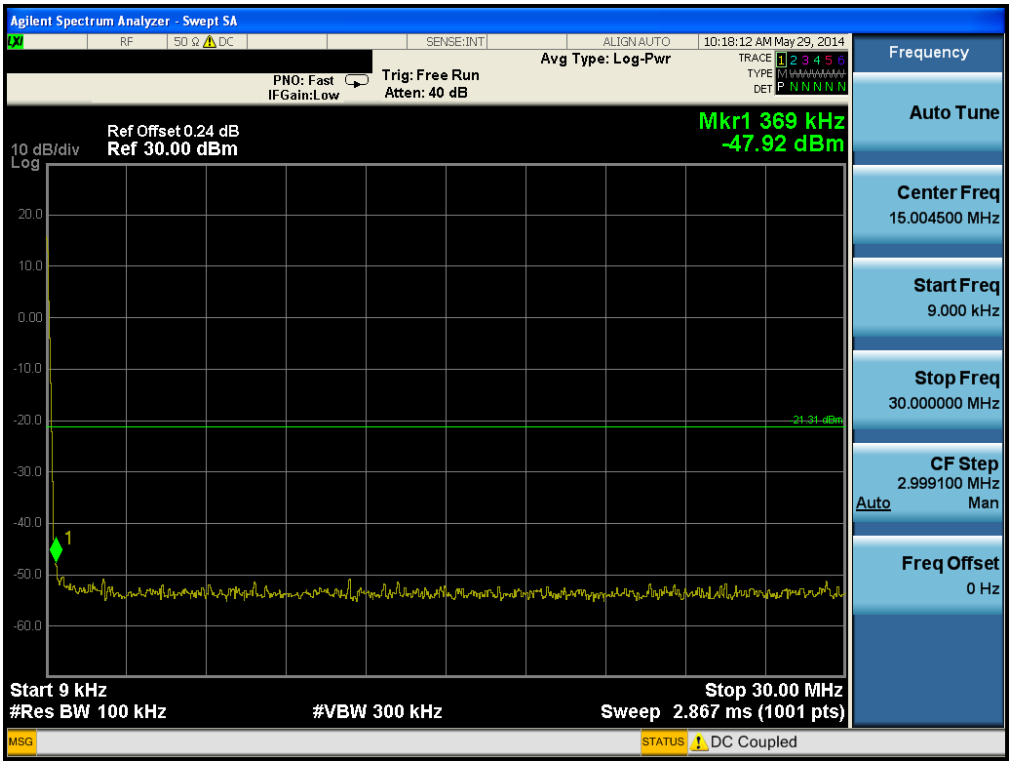
Copyright © 2014, Digital EMC Co., Ltd.

802.11n(HT20) & MCS 0 & 2437 MHz

Reference

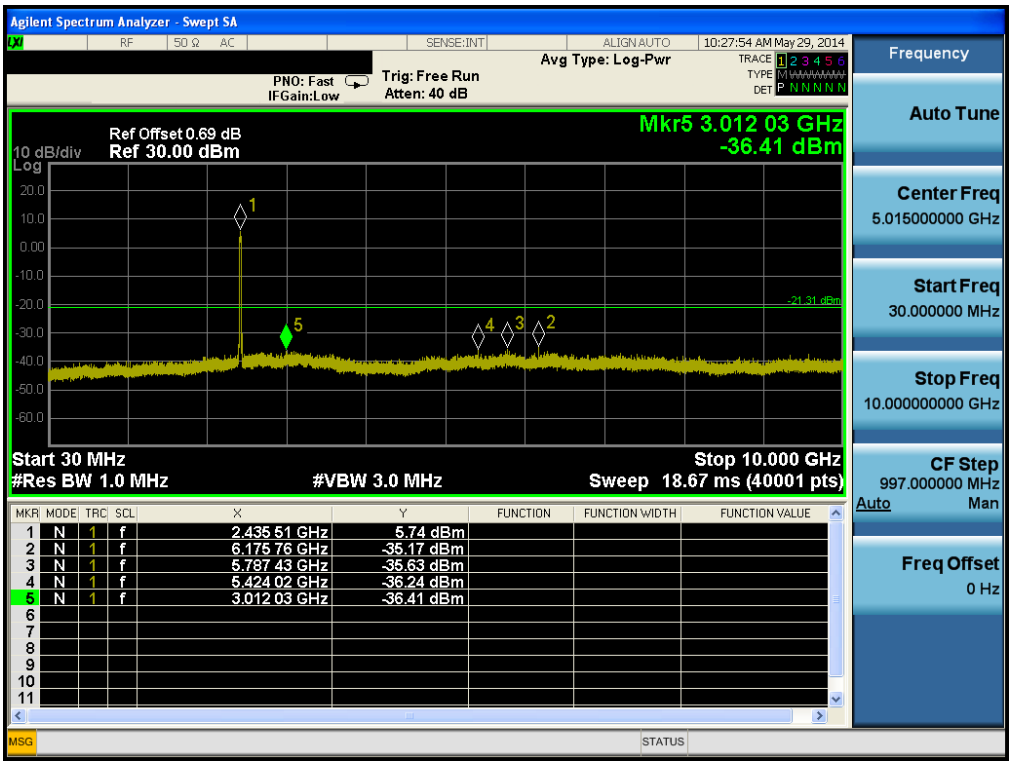


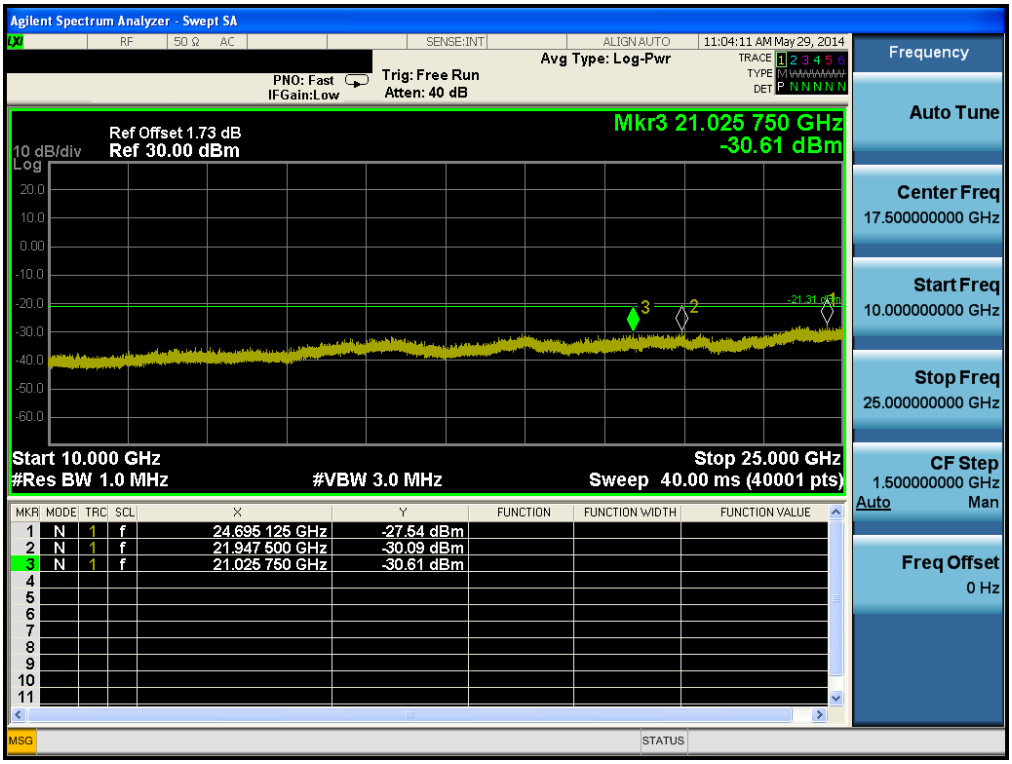
Conducted Spurious Emissions



Copyright © 2014, Digital EMC Co., Ltd.

Conducted Spurious Emissions

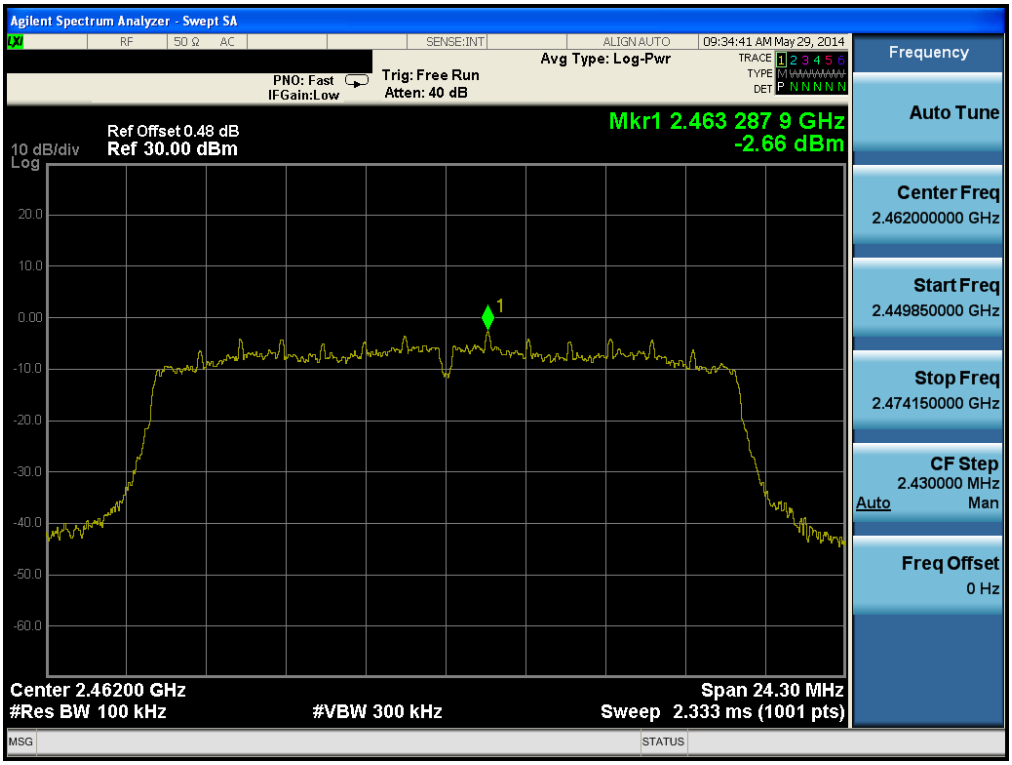




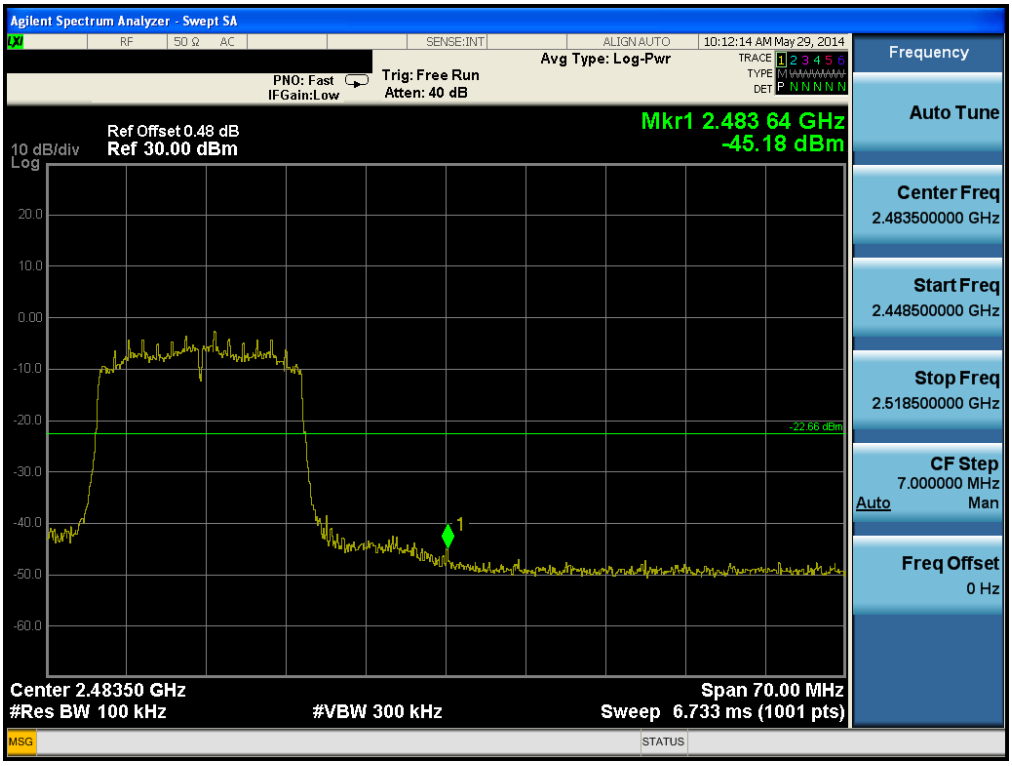
Copyright © 2014, Digital EMC Co., Ltd.

802.11n(HT20) & MCS 0 & 2462 MHz

Reference

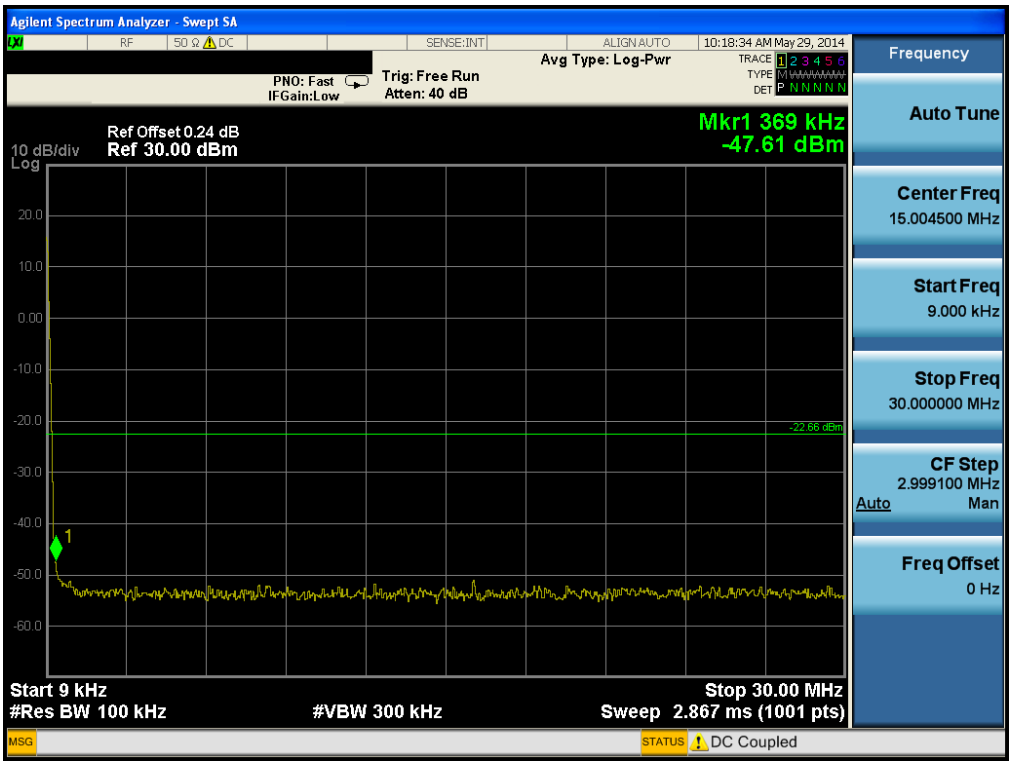


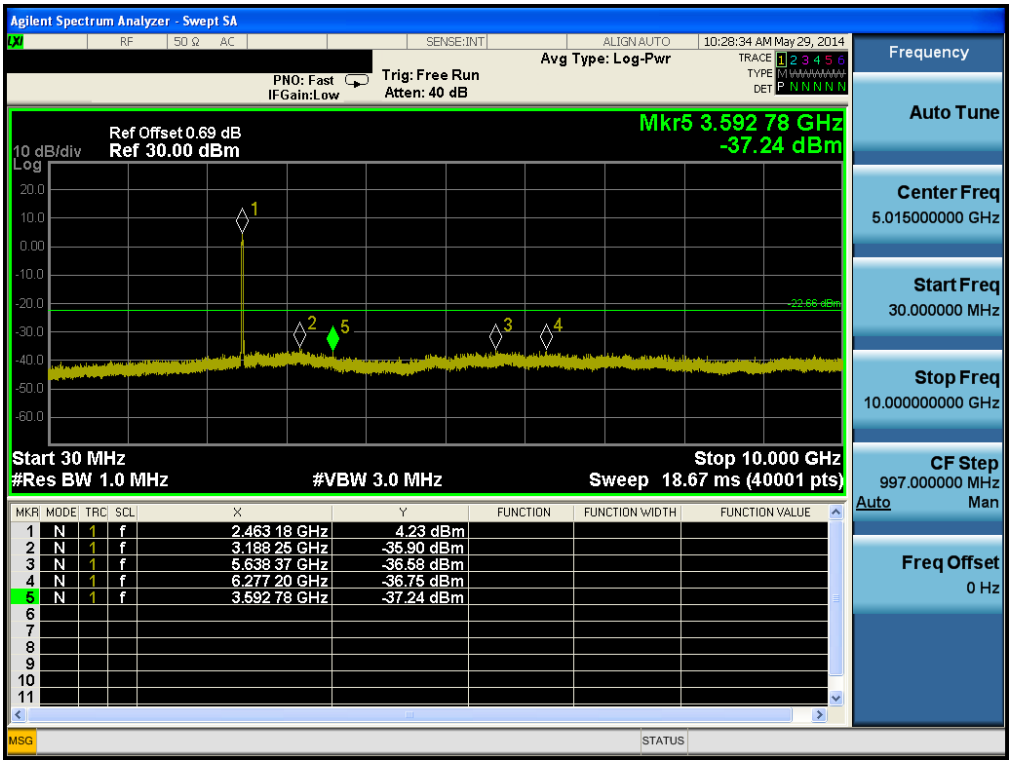
High Band-edge



Copyright © 2014, Digital EMC Co., Ltd.

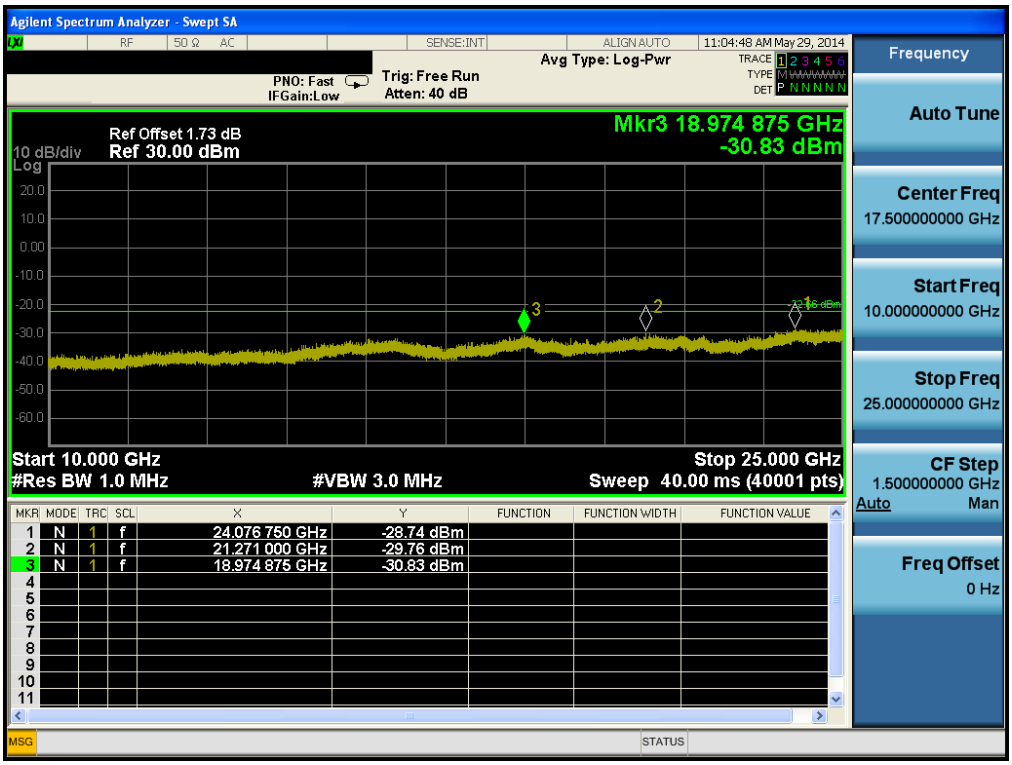
Conducted Spurious Emissions





Copyright © 2014, Digital EMC Co., Ltd.

Conducted Spurious Emissions



Copyright © 2014, Digital EMC Co., Ltd.

8.5 Radiated Spurious Emissions

Test Requirements and limit,

§15.247(d), §15.205, §15.209 & RSS-210 [A8.5], RSS-Gen [7.2.2], RSS-Gen [7.2.5]

In any 100kHz bandwidth outside the operating frequency band. In case the emission fall within the restricted band specified on 15.205(a) and (b), then the 15.209(a) limit in the table below has to be followed

▪ **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.

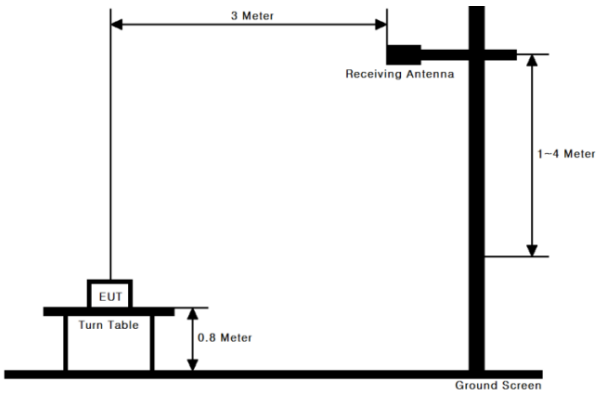
▪ **FCC Part 15.205 (a):** Only spurious emissions are permitted in any of the frequency bands listed below:

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	156.52475 ~	1660 ~ 1710	8.025 ~ 8.5	22.01 ~ 23.12
4.17725 ~ 4.17775	12.57675 ~	156.52525	1718.8 ~ 1722.2	9.0 ~ 9.2	23.6 ~ 24.0
4.20725 ~ 4.20775	12.57725	156.7 ~ 156.9	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 ~ 4400		
	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.

Copyright © 2014, Digital EMC Co., Ltd.

Test Configuration



▣ TEST PROCEDURE

1. The EUT is placed on a turntable, which is 0.8 m above ground plane.
2. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
3. EUT is set 3 m away from the receiving antenna, which is varied from 1m to 4m to find out the highest emissions.
4. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
5. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
6. Repeat above procedures until the measurements for all frequencies are complete.

▣ Measurement Instrument Setting for Radiated Emission Measurements.

The radiated emission was tested according to the section 6.3 6.4, 6.5 and 6.6 of the ANSI C63.10-2009 with following settings.

Peak Measurement:

RBW = As specified in below table , VBW ≥ 3 x RBW, Sweep = Auto, Detector = Peak, Trace mode = Max Hold until the trace stabilizes.

Frequency	RBW
9-150 kHz	200-300 Hz
0.15-30 MHz	9-10 kHz
30-1000 MHz	100-120 kHz
> 1000 MHz	1 MHz

Average Measurement :

1.RBW = 1 MHz (unless otherwise specified).
2. VBW ≥ 3 x RBW.
3. Detector = RMS (Number of points ≥ 2 x Span / RBW)
4. Averaging type = power (i.e., RMS).
5. Sweep time = auto.
6. Perform a trace average of at least 100 traces.
7. 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:

1) If power averaging (RMS) mode was used in step 4, then the applicable correction factor is 10 log(1/x), where x is the duty cycle.
2) If linear voltage averaging mode was used in step 4, then the applicable correction factor is 20 log(1/x), where x is the duty cycle.
3) If a specific emission is demonstrated to be continuous (≥ 98 percent duty cycle) rather than turning on and off with the transmit cycle, then no duty cycle correction is required for that emission.

Duty Cycle Corrections (Refer to appendix II for duty cycle measurement procedure and plots)

Band	Duty Cycle(%)	T_{on}(ms)	T_{on}+ T_{off}(ms)	DCF = 10log(1/Duty) (dB)
802.11b	99.59	8.415	8.450	0.02
802.11g	97.83	1.396	1.427	0.10
802.11n(HT20)	97.68	1.308	1.339	0.10
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-

Copyright © 2014, Digital EMC Co., Ltd.

9kHz ~ 25GHz Data(*802.11b & 1 Mbps*)

▪ Lowest Channel

Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	T.F (dB/m)	DCF (dB)	Distance Factor(dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
2389.44	H	X	PK	63.28	-4.20	-	-	59.08	74.00	14.92
2389.92	H	X	AV	47.48	-4.20	-	-	43.28	54.00	10.72
4824.10	H	Y	PK	45.50	4.91	-	-	50.41	74.00	23.59
4824.08	H	Y	AV	37.03	4.91	-	-	41.94	54.00	12.06
-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-

▪ Middle Channel

Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	T.F (dB/m)	DCF (dB)	Distance Factor(dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
4874.24	H	Y	PK	45.16	5.09	-	-	50.25	74.00	23.75
4874.00	H	Y	AV	35.57	5.09	-	-	40.66	54.00	13.34
-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-

▪ Highest Channel

Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	T.F (dB/m)	DCF (dB)	Distance Factor(dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
2484.95	H	X	PK	56.73	-4.06	-	-	52.67	74.00	21.33
2483.58	H	X	AV	45.61	-4.06	-	-	41.55	54.00	12.45
4924.29	H	Y	PK	45.31	5.27	-	-	50.58	74.00	23.42
4924.04	H	Y	AV	35.38	5.27	-	-	40.65	54.00	13.35
-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-

Note.

1. Measurement Distance = 3 m for below 10 GHz, Measurement Distance = 1 m for above 10 GHz.
   So Distance Correction Factor :- 9.54dB = 20*log(1m/3m)

2.No other spurious and harmonic emissions were found greater than listed emissions on above table.

3.Above listed point data is the worst case data.

4.Sample Calculation.

Margin = Limit – Result / Result = Reading + T.F+ DCF + Distance Factor/ T.F = AF + CL – AG
Where,T.F = Total Factor, AF = Antenna Factor, CL = Cable Loss, AG = Amplifier Gain,
DCF = Duty Cycle Correction Factor.

Copyright © 2014, Digital EMC Co., Ltd.

9kHz ~ 25GHz Data(*802.11g & 6 Mbps*)

▪ Lowest Channel

Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	T.F (dB/m)	DCF (dB)	Distance Factor(dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
2389.36	H	X	PK	72.74	-4.20	-	-	68.54	74.00	5.46
2390.00	H	X	AV	51.19	-4.20	0.10	-	47.09	54.00	6.91
4824.14	H	X	PK	43.97	4.91	-	-	48.88	74.00	25.12
4824.20	H	X	AV	31.85	4.91	0.10	-	36.86	54.00	17.14
-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-

▪ Middle Channel

Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	T.F (dB/m)	DCF (dB)	Distance Factor(dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
4873.93	H	X	PK	43.30	5.09	-	-	48.39	74.00	25.61
4873.80	H	X	AV	31.76	5.09	0.10	-	36.95	54.00	17.05
-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-

▪ Highest Channel

Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	T.F (dB/m)	DCF (dB)	Distance Factor(dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
2484.00	H	X	PK	67.68	-4.06	-	-	63.62	74.00	10.38
2483.53	H	X	AV	49.35	-4.06	0.10	-	45.39	54.00	8.61
4924.22	H	X	PK	43.63	5.27	-	-	48.90	74.00	25.10
4924.81	H	X	AV	31.78	5.27	0.10	-	37.15	54.00	16.85
-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-

Note.

1. Measurement Distance = 3 m for below 10 GHz, Measurement Distance = 1 m for above 10 GHz.
   So Distance Correction Factor :- 9.54dB = 20*log(1m/3m)
2. No other spurious and harmonic emissions were found greater than listed emissions on above table.
3. Above listed point data is the worst case data.
4. Sample Calculation.

   Margin = Limit – Result / Result = Reading + T.F+ DCF + Distance Factor/ T.F = AF + CL – AG
   Where,T.F = Total Factor, AF = Antenna Factor, CL = Cable Loss, AG = Amplifier Gain,
   DCF = Duty Cycle Correction Factor.

Copyright © 2014, Digital EMC Co., Ltd.

9kHz ~ 25GHz Data(*802.11n HT20 & MCS 0*)

▪ Lowest Channel

Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	T.F (dB/m)	DCF (dB)	Distance Factor(dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
2388.80	H	X	PK	68.22	-4.20	-	-	64.02	74.00	9.98
2390.00	H	X	AV	50.85	-4.20	0.10	-	46.75	54.00	7.25
4824.80	H	X	PK	43.74	4.91	-	-	48.65	74.00	25.35
4824.94	H	X	AV	31.94	4.91	0.10	-	36.95	54.00	17.05
-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-

▪ Middle Channel

Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	T.F (dB/m)	DCF (dB)	Distance Factor(dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
4874.56	H	X	PK	43.90	5.09	-	-	48.99	74.00	25.01
4874.68	H	X	AV	31.73	5.09	0.10	-	36.92	54.00	17.08
-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-

▪ Highest Channel

Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	T.F (dB/m)	DCF (dB)	Distance Factor(dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
2483.62	H	X	PK	66.86	-4.06	-	-	62.80	74.00	11.20
2483.53	H	X	AV	51.03	-4.06	0.10	-	47.07	54.00	6.93
4924.64	H	X	PK	43.70	5.27	-	-	48.97	74.00	25.03
4924.61	H	X	AV	31.73	5.27	0.10	-	37.10	54.00	16.90
-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-

Note.

1. Measurement Distance = 3 m for below 10 GHz, Measurement Distance = 1 m for above 10 GHz.
   So Distance Correction Factor :- 9.54dB = 20*log(1m/3m)
2. No other spurious and harmonic emissions were found greater than listed emissions on above table.
3. Above listed point data is the worst case data.
4. Sample Calculation.

   Margin = Limit – Result / Result = Reading + T.F+ DCF + Distance Factor/ T.F = AF + CL – AG
   Where,T.F = Total Factor, AF = Antenna Factor, CL = Cable Loss, AG = Amplifier Gain,
   DCF = Duty Cycle Correction Factor.

Copyright © 2014, Digital EMC Co., Ltd.

8.6 Power-line Conducted Emissions

Test Requirements and limit, §15.207& RSS-Gen [7.2.4]

For an intentional radiator which 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 250 microvolts (The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz). The limits at specific frequency range is listed as follows:

Frequency Range (MHz)	Conducted Limit (dBuV)	
	Quasi-Peak	Average
0.15 ~ 0.5	66 to 56 *	56 to 46 *
0.5 ~ 5	56	46
5 ~ 30	60	50

* Decreases with the logarithm of the frequency

Compliance with this provision shall be based on the measurement of the radio frequency voltage between each power line (LINE and NEUTRAL) and ground at the power terminals.

Test Configuration

See test photographs for the actual connections between EUT and support equipment.

Test Mode

The all modes of EUT operation were investigated and the worst case mode was reported.

TEST PROCEDURE

1. The EUT is placed on a wooden table 80 cm above the reference ground plane.
2. The EUT is connected via LISN to the test power supply.
3. The measurement results are obtained as described below:
4. Detectors – Quasi Peak and Average Detector.

Copyright © 2014, Digital EMC Co., Ltd.

▣RESULT PLOTS

AC Line Conducted Emissions (Graph)

Test Mode: 802.11b & 1Mbps & 2437MHz

Digital EMC

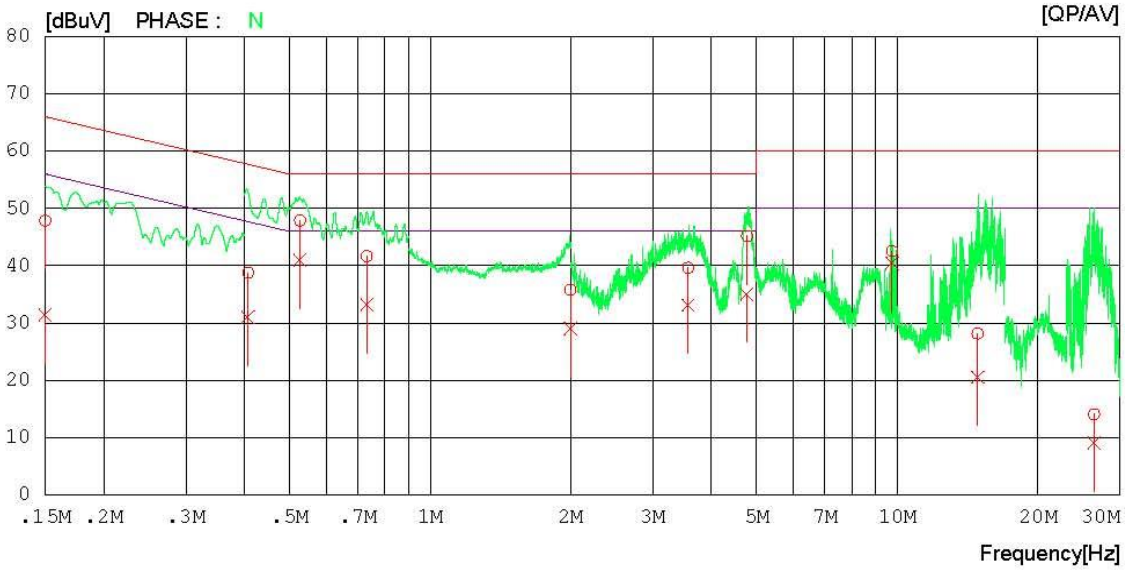
Results of Conducted Emission

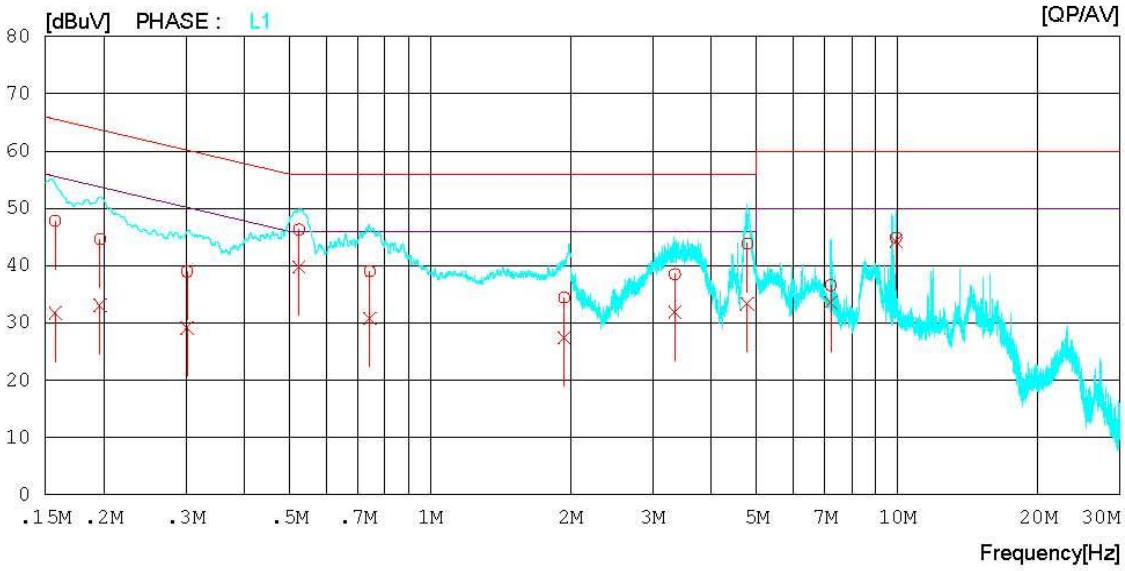
Digital EMC
Date : 2014-05-29

Model No.	:	Smart Beacon	Referrence No.	:	
Type	:		Power Supply	:	120 V 60 Hz
Serial No.	:	Identical prototype	Temp/Humi.	:	24 'C 43 % R.H.
Test Condition	:	WLAN_802.11b	Operator	:	H.S.SON

Memo :

LIMIT : FCC P15.207 QP
FCC P15.207 AV





Copyright © 2014, Digital EMC Co., Ltd.

AC Line Conducted Emissions (List)

Test Mode: 802.11b & 1Mbps & 2437MHz

Results of Conducted Emission

Digital EMC
Date : 2014-05-29

Model No.	:	Smart Beacon	Referrence No.	:	
Type	:		Power Supply	:	120 V 60 Hz
Serial No.	:	Identical prototype	Temp/Humi.	:	24 'C 43 % R.H.
Test Condition	:	WLAN_802.11b	Operator	:	H.S.SON

Memo :

LIMIT : FCC P15.207 QP
FCC P15.207 AV

NO	FREQ [MHz]	READING QP [dBuV]	READING AV [dBuV]	C.FACTOR [dB]	RESULT QP [dBuV]	RESULT AV [dBuV]	LIMIT QP [dBuV]	LIMIT AV [dBuV]	MARGIN QP [dBuV]	MARGIN AV [dBuV]	PHASE
1	0.15000	47.7	31.2	0.1	47.8	31.3	66.0	56.0	18.2	24.7	N
2	0.40750	38.7	30.9	0.1	38.8	31.0	57.7	47.7	18.9	16.7	N
3	0.52667	47.8	40.9	0.1	47.9	41.0	56.0	46.0	8.1	5.0	N
4	0.73221	41.5	33.1	0.1	41.6	33.2	56.0	46.0	14.4	12.8	N
5	1.99672	35.6	28.8	0.2	35.8	29.0	56.0	46.0	20.2	17.0	N
6	3.56600	39.3	32.8	0.3	39.6	33.1	56.0	46.0	16.4	12.9	N
7	4.77136	44.9	34.7	0.3	45.2	35.0	56.0	46.0	10.8	11.0	N
8	9.75052	42.3	40.2	0.2	42.5	40.4	60.0	50.0	17.5	9.6	N
9	14.85852	27.8	20.3	0.3	28.1	20.6	60.0	50.0	31.9	29.4	N
10	26.40040	13.8	8.8	0.3	14.1	9.1	60.0	50.0	45.9	40.9	N
11	0.15750	47.8	31.7	0.1	47.9	31.8	65.6	55.6	17.7	23.8	L1
12	0.19650	44.5	33.0	0.1	44.6	33.1	63.8	53.8	19.2	20.7	L1
13	0.30187	38.8	29.0	0.2	39.0	29.2	60.2	50.2	21.2	21.0	L1
14	0.52402	46.1	39.6	0.2	46.3	39.8	56.0	46.0	9.7	6.2	L1
15	0.74250	38.8	30.6	0.2	39.0	30.8	56.0	46.0	17.0	15.2	L1
16	1.93668	34.2	27.1	0.3	34.5	27.4	56.0	46.0	21.5	18.6	L1
17	3.34176	38.2	31.6	0.3	38.5	31.9	56.0	46.0	17.5	14.1	L1
18	4.77704	43.6	33.1	0.3	43.9	33.4	56.0	46.0	12.1	12.6	L1
19	7.20632	36.3	33.2	0.3	36.6	33.5	60.0	50.0	23.4	16.5	L1
20	9.94980	44.6	44.0	0.3	44.9	44.3	60.0	50.0	15.1	5.7	L1

Copyright © 2014, Digital EMC Co., Ltd.

8.7Occupied Bandwidth

Test Requirements, RSS-Gen [4.6.1]

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 RESULTS: N/A

Copyright © 2014, Digital EMC Co., Ltd.

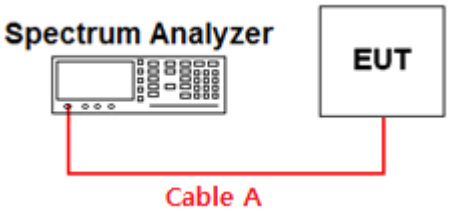
9. LIST OF TEST EQUIPMENT

Type	Manufacturer	Model	Cal.Date (yy/mm/dd)	Next.Cal.Date (yy/mm/dd)	S/N
Spectrum Analyzer	Agilent Technologies	E4440A	13/10/24	14/10/24	US45303051
MXA Signal Analyzer	Agilent Technologies	N9020A	13/09/24	14/09/24	MY50200834
Digital Multimeter	H.P	34401A	14/02/27	15/02/27	3146A13475
Dynamic Measurement DC Source	Agilent Technologies	66332A	14/02/07	15/02/07	GB37470190
Thermohygrometer	BODYCOM	BJ5478	14/05/13	15/05/13	120612-2
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
High-pass filter	Wainwright	WHKX3.0	13/09/12	14/09/12	9
LOOP Antenna	Schwarzbeck	FMZB1513	14/04/29	16/04/29	1513-128
BILOG ANTENNA	SCHAFFNER	CBL6112B	12/11/06	14/11/06	2737
Horn Antenna	ETS	3115	13/02/28	15/02/28	00021097
HORN ANT	A.H.Systems	SAS-574	13/03/20	15/03/20	154
Amplifier (22dB)	H.P	8447E	14/01/07	15/01/07	2945A02865
Amplifier (30dB)	Agilent	8449B	14/02/27	15/02/27	3008A00370
EMI TEST RECEIVER	R&S	ESU	14/01/07	15/01/07	100014
EMI TEST RECEIVER	ROHDE&SCHWARZ	ESR	14/02/07	15/02/07	101767
CVCF	NF	4420	13/09/12	14/09/12	3049354420023
LISN	R&S	ESH2-Z5	13/09/12	14/09/12	828739/006
Power Meter & Wide Bandwidth Sensor	Anritsu	ML2496A/ MA2411B	13/10/29	14/10/29	1338004 / 1306053

Copyright © 2014, Digital EMC Co., Ltd.

APPENDIX I
Conducted Test set up Diagram & Path loss Information

▪Conducted Measurement



Path loss information

Frequency (GHz)	Path Loss (dB)	Frequency (GHz)	Path Loss (dB)
0.03	0.24	15	1.28
1	0.32	20	1.46
2402 & 2440 & 2480	0.48	25	1.73
5	0.50	-	-
10	0.69	-	-

Note. 1: The path loss from EUT to Spectrum analyzer was measured and used for test.
Path loss = Cable A

Copyright © 2014, Digital EMC Co., Ltd.

APPENDIX II
Duty cycle plots

▣ TEST PROCEDURE

Duty Cycle measured using **section 6.0 b) of KDB558074 v03r1 :**

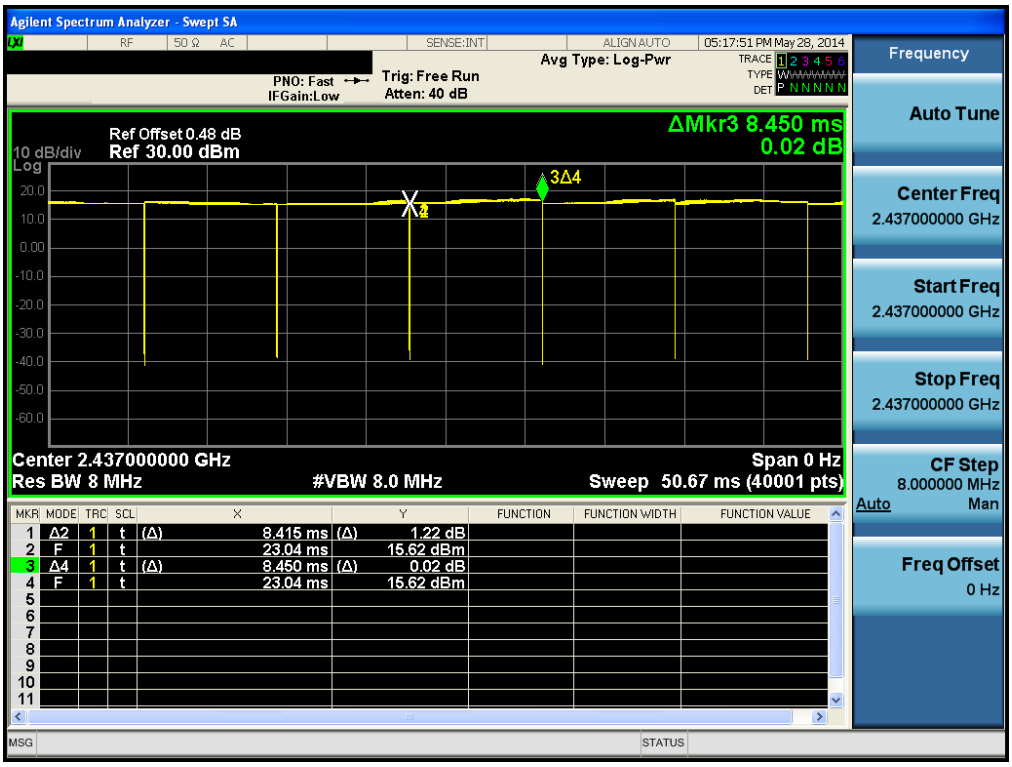
The zero-span mode on a spectrum analyzer or EMI receiver if the response time and spacing between bins on the sweep are sufficient to permit accurate measurements of the on and off times of the transmitted signal.

Set the center frequency of the instrument to the center frequency of the transmission. Set RBW ≥ OBW if possible; otherwise, set RBW to the largest available value. Set VBW≥ RBW. Set detector = peak or average.

The zero-span measurement method shall not be used unless both RBW and VBW are > 50/T 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.)

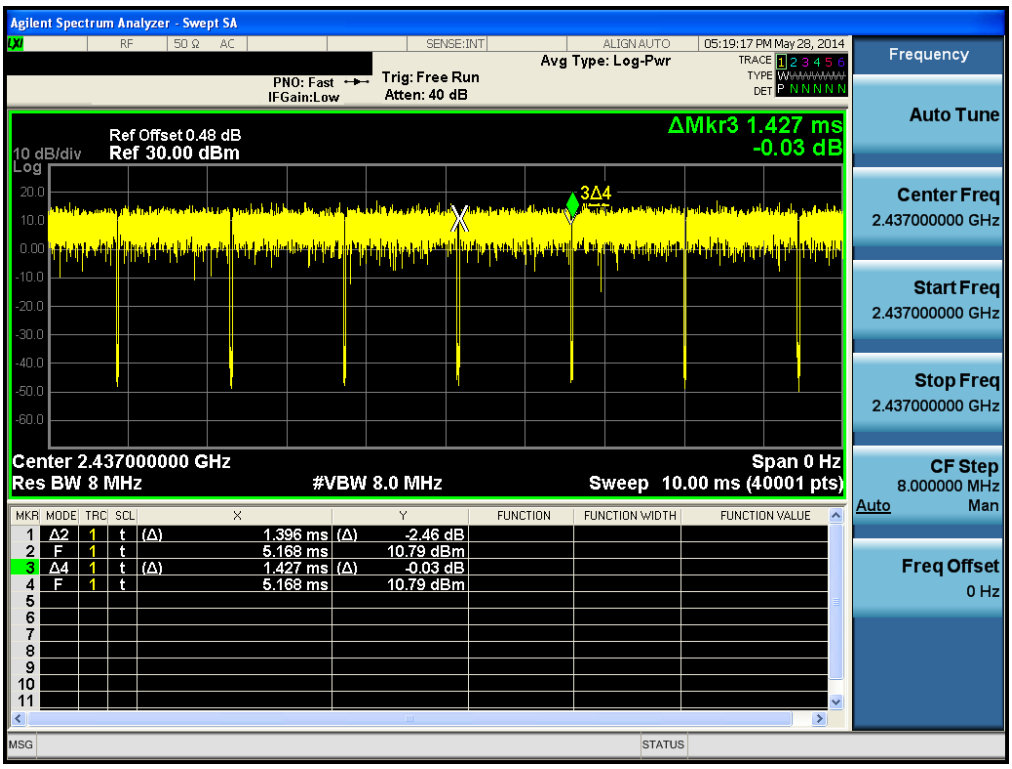
Test Plots :

Duty Cycle Test Mode: 802.11b & 1 Mbps & 2437 MHz



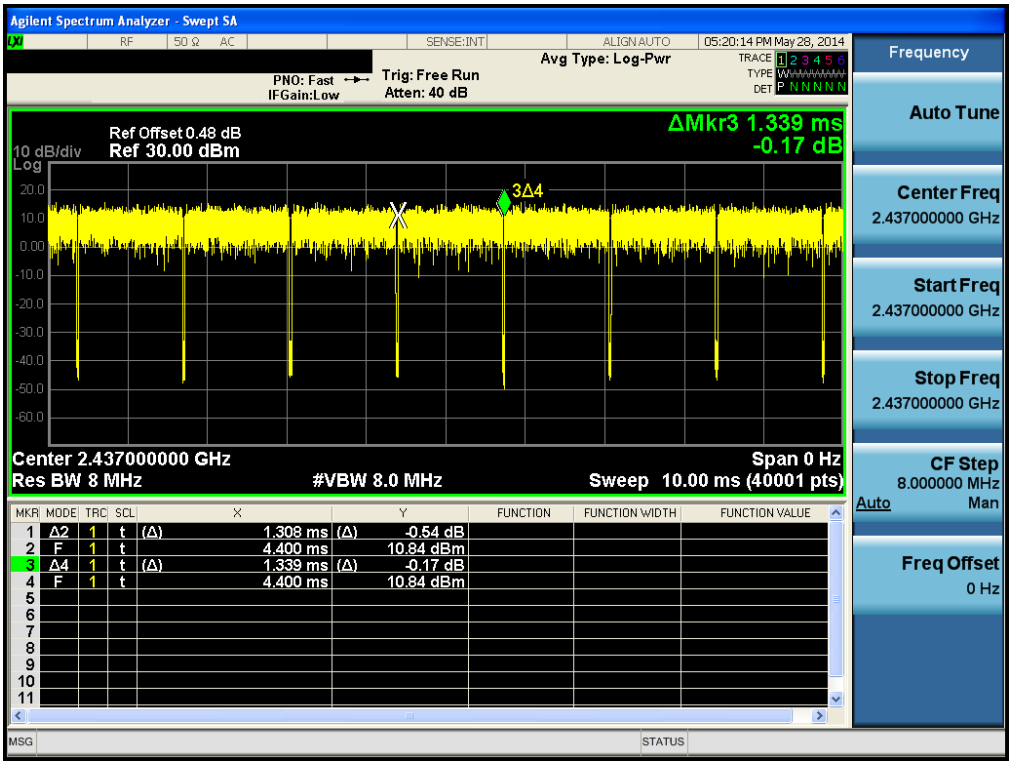
Copyright © 2014, Digital EMC Co., Ltd.

Duty Cycle Test Mode: 802.11g & 6 Mbps & 2437 MHz



Copyright © 2014, Digital EMC Co., Ltd.

Duty Cycle Test Mode: 802.11n(HT20) & MCS 0 & 2437 MHz



Copyright © 2014, Digital EMC Co., Ltd.