LS RESEARCH, LLC
WIRELESS PRODUCT DEVELOPMENT
ACCREDITED
Testing Cert. 1255.01
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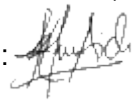
TEST REPORT # 313179 C
LSR Job #: C-1818

Compliance Testing of:
E0150-MOD

Test Date(s):
April 25th 2012, October 25th to November 11th 2013

Prepared For:
Attention: Chris Cartile
Nikon Metrology Canada Inc.
Integrated Systems and Technologies
13-55 Fleming Dr.
Cambridge, Ontario, Canada
NIT 2A9

This Test Report is issued under the Authority of:
Khairul Aidi Zainal, Senior EMC Engineer.

Signature:  Date: 11/26/13

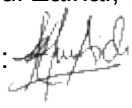
Test Report Reviewed by:	Project Engineer:
Peter Feilen, EMC Engineer.	Khairul Aidi Zainal, Senior EMC Engineer.
Signature: Date: 11/26/13	Signature:  Date: 11/13/13

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EXHIBIT 1. INTRODUCTION

1.1 - Scope

References:	FCC Part 15, Subpart C, Section 15.407 RSS GEN issue 3 and RSS 210 issue 8 Annex 9
Title:	FCC : Telecommunication – Code of Federal Regulations, CFR 47, Part 15. IC : Low-power License-exempt Radio-communication Devices (All Frequency Bands): Category I Equipment
Purpose of Test:	To gain FCC and IC Certification Authorization for Low-Power License-Exempt Transmitters.
Test Procedures:	OET KDB 789033 D01 v01r03 General UNII Test Procedure

1.2 – Normative References

Publication	Year	Title
FCC CFR Parts 0-15	2013	Code of Federal Regulations – Telecommunications
ANSI C63.4	2003	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
RSS-210 Annex 9	2010	Low-power License-exempt Radio communication Devices (All Frequency Bands): Category I Equipment
RSS-GEN Issue 3	2010	General Requirements and Information for the Certification of Radio Apparatus
ANSI C63.10	2009	American National Standard for Testing Unlicensed Wireless Devices
FCC KDB 789033 D01 v01r03	2013	Guidelines for Compliance Testing of Unlicensed National Information Infrastructure (U-NII) Devices- Part 15 Subpart E.
Appendix B. FCC order, ET Docket No. 03-122 (FCC 06-96)	2006	Compliance measurement procedures for U-NII devices operating in the 5.25-5.35GHz and 5.47-5.725GHz bands incorporating dynamic Frequency Selection.

1.3 - LS Research, LLC Test Facility

LS Research, LLC is accredited by A2LA (American Association for Laboratory Accreditation) as conforming to ISO/IEC 17025, 2005 “General Requirements for the Competence of Calibration and Testing Laboratories”.

LS Research, LLC’s scope of accreditation includes all test methods listed herein, unless otherwise noted.

1.4 – Location of Testing

All testing was performed at the following location utilizing the facilities listed below, unless otherwise noted.

LS Research, LLC
W66 N220 Commerce Court
Cedarburg, Wisconsin, 53012 USA,

List of Facilities Located at LS Research, LLC:

Compact Chamber
Semi-Anechoic Chamber
Open Area Test Site (OATS)

1.5 – Test Equipment Utilized

A complete list of equipment utilized in testing is provided in Appendix A of this test report. Calibration dates are indicated in Appendix A. All test equipment is calibrated by a calibration laboratory accredited to the requirements of ISO/IEC 17025, and traceable to the SI standard.

EXHIBIT 2. PERFORMANCE ASSESSMENT

2.1 – Client Information

Manufacturer Name:	Nikon Metrology Canada Inc.
Address:	13-55 Fleming Dr. Cambridge, Ontario, Canada. N1t 2A9
Contact Name:	Chris Cartile

2.2 - Equipment Under Test (EUT) Information

The following information has been supplied by the applicant.

Product Name:	E0150-MOD
Model Number:	E0150-MOD
Serial Number:	10534

2.3 - Associated Antenna Description

The antenna associated with the module is an Ethertronics Prestta™ WLAN Embedded Antenna. The antenna is a multi-band antenna that operates in the 2.4GHz, 4.9GHz, 5.2GHz and the 5.8GHz bands.

The antenna performance is as listed:

WLAN a/b/g/n + Japan Antenna (GHz)	2.390-2.490 b, g	4.900-5.100 Japan	5.150-5.350 a	5.70-5.900 a
Peak Gain	-0.6dBi	2.5dBi	4.5dBi	3.5dBi
Average Efficiency	55%	71%	75%	65%
VSWR Match	3.0:1 max	2.5:1 max	2.5:1 max	3.0:1 max
Feed Point Impedance	50 Ω unbalanced (other if required)			

2.4 - EUT'S Technical Specifications

EUT Frequency Range (in MHz)	5180 to 5240 MHz 5280 to 5320 MHz 5500 to 5700 MHz
RF Power in Watts (Conducted measurement)	
Minimum:	5180 to 5240 MHz 802.11 a = 0.0129 Watts 802.11 n(HT20) = 0.0105 Watts 5280 to 5320 MHz 802.11 a = 0.0191 Watts 802.11 n(HT20) = 0.0093 Watts 5500 to 5700 MHz 802.11 a = 0.0151 Watts 802.11 n(HT20) = 0.0095 Watts
Maximum:	5180 to 5240 MHz 802.11 a = 0.0148 Watts 802.11 n(HT20) = 0.0155 Watts 5280 to 5320 MHz 802.11 a = 0.0245 Watts 802.11 n(HT20) = 0.0200 Watts 5500 to 5700 MHz 802.11 a = 0.0204 Watts 802.11 n(HT20) = 0.0200 Watts
Max Conducted Output Power (in dBm)	5180 to 5240 MHz 802.11 a = 11.7 dBm 802.11 n(HT20) = 11.9 dBm 5280 to 5320 MHz 802.11 a = 13.9 dBm 802.11 n(HT20) = 13.0 dBm 5500 to 5700 MHz 802.11 a = 13.1 dBm 802.11 n(HT20) = 13.0 dBm
Field Strength at 3 meters (Maximum)	Not Applicable
Bandwidths (MHz)	5180 to 5240 MHz 802.11 a 26dB = 22.3 MHz 99% = 16.6 MHz 802.11 n(HT20) 26dB = 23.0 MHz 99% = 17.7 MHz

	5280 to 5320 MHz 802.11 a 26dB = 24.6 MHz 99% = 16.8 MHz 802.11 n(HT20) 26dB = 27.3 MHz 99% = 17.9 MHz 5500 to 5700 MHz 802.11 a 26dB = 24.9 MHz 99% = 16.8 MHz 802.11 n(HT20) 26dB = 31.0 MHz 99% = 18.3 MHz
Type of Modulation	OFDM
1Transmitter Spurious (worst case) at 3 meters	52.73 dBµV/m at 5243.8 MHz.
Stepped (Y/N)	Y
Step Value:	0.25dBm
Frequency Tolerance %, Hz, ppm	Better than 1 PPM
Transceiver Model # (if applicable)	WL1273L
Antenna Information	
Detachable/non-detachable	detachable
Type	Isolated Magnetic Dipole stamped metal antenna ™.
Gain	4.5 dBi
EUT will be operated under FCC Rule Part(s)	Title 47 part 15.407
EUT will be operated under RSS Rule Part(s)	RSS 210 A9
Modular Filing	☒ Yes ☐ No
Portable or Mobile?	Mobile

RF Technical Information:

Type of Evaluation (check one)		SAR Evaluation: Device Used in the Vicinity of the Human Head
		SAR Evaluation: Body-worn Device
	X	RF Evaluation

If RF Evaluation checked above, test engineer to complete the following:

Evaluated against exposure limits: ☒ General Public Use ☐ Controlled Use
Duty Cycle used in evaluation: 100 %
Document used for evaluation: *KDB 447498 D01 General RF Exposure Guidance*
Measurement Distance: 20 cm
RF Value: **0.138** ☐ V/m ☐ A/m ☒ W/m^2
☐ Measured ☐ Computed ☒ Calculated

2.5 - Product Description

The module is a multi-standard module with support for WLAN (802.11 a/b/g/n), Bluetooth 2.1+EDR and Bluetooth 4.0 (LE).

EXHIBIT 3. EUT OPERATING CONDITIONS & CONFIGURATIONS DURING TESTS

3.1 - Climate Test Conditions

Temperature:	70 -71° F
Humidity:	32-42%
Pressure:	728-741mmHg

3.2 - Applicability & Summary Of EMC Emission Test Results

3.2.1 Operation in the 5.15 – 5.25 GHz band

FCC Rule Part	RSS Rule Part	Test Description	Test Result
15.407 (a)(1)	210 A9.2 (1)	Power Limits	Pass
15.407 (a)(1)	210 A9.2 (1)	Peak Power Spectral Density	Pass
15.407 (a)(1)	210 A9.2 (1)	26dB Bandwidth	Pass
15.407 (a)(6)	N/A	Peak Excursion Ratio	Pass
15.407 (b)(1)	210 A9.2 (1)	Undesirable emissions Limit	Pass
15.407 (b)(6) & (7),	210 A9.2 (1) GEN	Spurious Emissions below 1GHz AC Mains emissions	Pass
15.407 (e)	210 A.9.2 (1)	Indoor Operation	Pass
15.407 (f)	102 (4)	RF Exposure requirements	Pass
15.407 (g)	N/A	Frequency Stability	Pass

3.2.2 Operation in the 5.25 – 5.35 GHz band

FCC Rule Part	RSS Rule Part	Test Description	Test Result
15.407 (a)(2)	210 A9.2 (2)	Power Limits	Pass
15.407 (a)(2)	210 A9.2 (2)	Peak Power Spectral Density	Pass
15.407 (a)(2)	210 A9.2 (2)	26dB Bandwidth	Pass
15.407 (a)(6)	N/A	Peak Excursion Ratio	Pass
15.407 (b)(2)	210 A9.2 (2)	Undesirable emissions Limit	Pass
15.407 (b)(6) & (7),	210 A9.2 (2) GEN	Spurious Emissions below 1GHz AC Mains emissions	Pass
15.407 (f)	102 (4)	RF Exposure requirements	Pass
15.407 (g)	N/A	Frequency Stability	Pass
15.407 (h)(1)	210 A9.2 (2)	Transmit Power Control (TPC)	N/A**
15.407 (h)(2)	210 A9.3 (a)	Dynamic Frequency Selection	N/A*
15.407 (h)(2)(ii)	210 A9.3 (b)(ii)	Channel Availability Check Time	N/A*
15.407 (h)(2)(iii)	210 A9.3 (b)(iii)	Channel Move Time	Pass
15.407 (h)(2)(iv)	210 A9.3 (b)(v)	Non-Occupancy period	Pass

* : The EUT is a client device

** : The EUT has an EIRP of less than 500mW.

3.2.3 Operation in the 5.47 – 5.725 GHz band

FCC Rule Part	RSS Rule Part	Test Description	Test Result
15.407 (a)(2)	210 A9.2 (3)	Power Limits	Pass
15.407 (a)(2)	210 A9.2 (3)	Peak Power Spectral Density	Pass
15.407 (a)(2)	210 A9.2 (3)	26dB Bandwidth	Pass
15.407 (a)(6)	N/A	Peak Excursion Ratio	Pass
15.407 (b)(3)	210 A9.2 (3)	Undesirable emissions Limit	Pass
15.407 (b)(6) & (7),	210 A9.2 (3) GEN	Spurious Emissions below 1GHz AC Mains emissions	Pass
15.407 (f)	1025 (4)	RF Exposure requirements	Pass
15.407 (g)	N/A	Frequency Stability	Pass
15.407 (h)(1)	A9.2 (3)	Transmit Power Control (TPC)	N/A**
15.407 (h)(2)	A9.3 (a)	Dynamic Frequency Selection	N/A*
15.407 (h)(2)(ii)	A9.3 (b)(ii)	Channel Availability Check Time	N/A*
15.407 (h)(2)(iii)	A9.3 (b)(iii)	Channel Move Time	Pass
15.407 (h)(2)(iv)	A9.3 (b)(v)	Non-Occupancy period	Pass

* : The EUT is a client device

** : The EUT has an EIRP of less than 500mW.

3.3 - Modifications Incorporated In The EUT For Compliance Purposes

☐ None ☒ Yes (explain below)

Channel 52 of the EUT shall not be used and will be disabled.
Statement from manufacturer:

"The permitted channels are activated through firmware control and customers are not allowed to change the settings. Channel 52 is not activated in the firmware settings therefore customers may not activate channel 52."

3.4 - Deviations & Exclusions From Test Specifications

☒ None ☐ Yes (explain below)

EXHIBIT 4. DECLARATION OF CONFORMITY

The EUT was found to MEET the requirements as described within the specification of FCC Title 47, CFR Part 15.407, and Industry Canada RSS-210, Issue 8 (2010), Annex 9.

Note: If some emissions are seen to be within 3 dB of their respective limits; as these levels are within the tolerances of the test equipment and site employed, there is a possibility that this unit, or a similar unit selected out of production may not meet the required limit specification if tested by another agency.

LS Research, LLC certifies that the data contained herein was taken under conditions that meet or exceed the requirements of the test specifications. The results in this Test Report apply only to the item(s) tested on the above-specified dates. Any modifications made to the EUT subsequent to the indicated test date(s) will invalidate the data herein, and void this certification.

EXHIBIT 5. General Procedures.

5.1 Radiated measurements

Radiated RF measurements were performed on the EUT in a 3 meter Semi-Anechoic, FCC listed Chamber. The frequency range from 30 MHz to 40000 MHz was scanned and investigated. The radiated RF emission levels were manually noted at the various fixed degree settings of azimuth on the turntable and antenna height. The EUT was placed on a non-conductive pedestal in the 3 meter Semi-Anechoic Chamber, with the antenna mast placed such that the antenna was 3 meters from the EUT. A Biconical Antenna was used to measure emissions from 30 MHz to 300 MHz, and a Log Periodic Antenna was used to measure emissions from 300 MHz to 1000 MHz. A Double-Ridged Waveguide Horn Antenna was used from 1 GHz to 18 GHz while a standard gain horn antenna was used in the 18 GHz to 40 GHz range. The maximum radiated RF emissions between 30MHz to 4 GHz were found by raising and lowering the sense antenna between 1 and 4 meters in height, using both horizontal and vertical antenna polarities. Measurements above 4 GHz are performed at 1 meter separation distance.

The EUT was positioned in 3 orthogonal orientations.

5.2 Calculation of Radiated emissions limits and reported data.

Reported data:

For both fundamental and spurious emissions measurement, the data reported includes all necessary correction factors. These correction factors are loaded onto the EMI receiver when measurements are performed.

Reported Measurement data = Raw receiver measurement (dBµV/m) + Antenna correction Factor + Cable factor (dB) + Miscellaneous factors when applicable (dB) – amplification factor when applicable (dB).

Generic example of reported data:

Reported Measurement data = 18.2 (raw receiver measurement) + 15.8 (antenna factor) + 1.45 (cable factor) = 35.45 (dBµV/m).

As specified in 15.247 (d) and RSS 210 A8.5, radiated emissions that fall within the restricted band described in 15.205(c) for FCC and section 2.2 of RSS 210 for IC, must comply with the general emissions limit.

The following table depicts the general radiated emission limits above 30 MHz. These limits are obtained from Title 47 CFR, Part 15.209, for radiated emissions measurements. These limits were applied to any signals found in the 15.205 restricted bands. The mentioned limits correspond to those limits listed in RSS GEN.

Frequency (MHz)	3 m Limit μV/m	3 m Limit (dBμV/m)	1 m Limit (dBμV/m)
30-88	100	40.0	-
88-216	150	43.5	-
216-960	200	46.0	-
960-24,000	500	54.0	63.5

Sample conversion of field strength (μV/m to dBμV/m):
dBμV/m = 20 log $_{10}$ (100)= 40 dBμV/m (from 30-88 MHz)

Conversion of field strength measurements to EIRP (KDB 412172).

E[dBμV/m] = EIRP[dBm] – 20 log(d[meters]) + 104.77

E is the field strength
d is the measurements distance

Example:

1. Field strength to EIRP:

   E = 105.2 [dBμV/m], d = 3 [meters]
   EIRP = 105.2 – 95.2 = 10 dBm

   E = 54 [dBμV/m]*, d = 3 [meters]
   EIRP = 54.0 – 95.2 = -41.2 dBm
   * Average limit for emissions above 1GHz

2. EIRP to field strength:

   EIRP = -30.0 dBm, d = 3 [meters]
   E = -30.0 + 95.2 = 65.2 [dBμV/m]

EXHIBIT 6. EUT Duty Cycle

Test Engineer: Khairul Aidi Zainal

All measurements are to be performed with the EUT transmitting at greater than or equal to 98% percent duty cycle. If greater than or equal to 98 percent duty cycle is not available, the actual duty cycle needs to be measured so that power and peak spectral density measurements can be corrected upwards.

6.1 Test Procedure.

Per **KDB 789033 D01 v01r03** section B, a spectrum analyzer with zero span at the frequency of interest was used to measure the on and off times of the transmitted signal.

6.2 Data.

The data reported includes all necessary correction factors. These correction factors are loaded onto the EMI receiver when measurements are performed.

Reported Measurement data = Raw receiver measurement (dBm) + Cable factor (dB) + Miscellaneous factors when applicable (dB).

Generic example of reported data:

Reported Measurement data = 8.55 (raw receiver measurement in dBm) + 0.85 (cable factor in dB) = 9.4 (dBm).

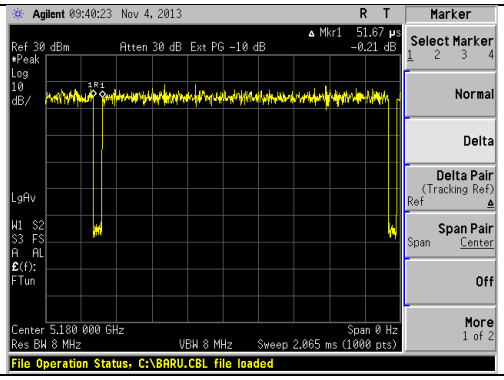
Duty Cycle correction = 10 log (1/x),
Where, x is the duty cycle.

Example:

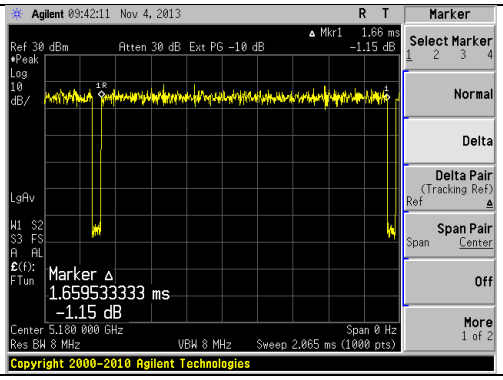
x = 0.97

Duty Cycle Correction = 10 log(1/0.97) = **0.12dB**

6.2.1 6MBPS.



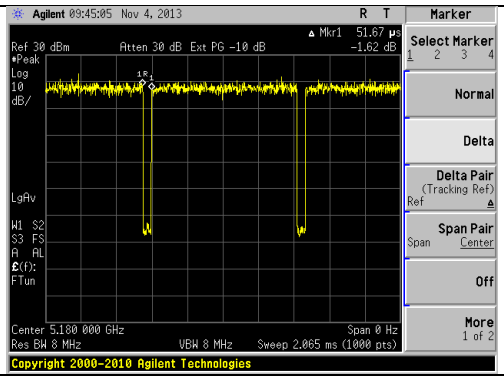
Off time



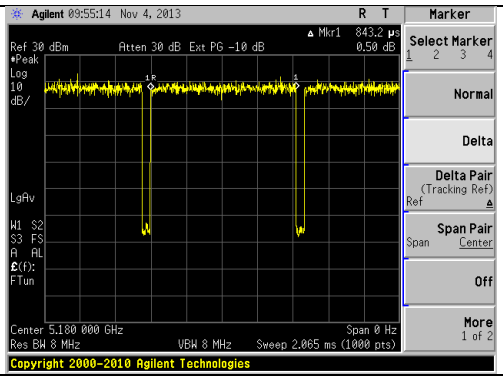
On time

Modulation	803.11 Standard	Data Rate (MBPS)	TX on time (ms)	TX off time (ms)	Duty Cycle	Duty cycle correction factor (dB)
BPSK	802.11a	6.0	1.660	0.052	0.97	0.1

6.2.2 12MBPS



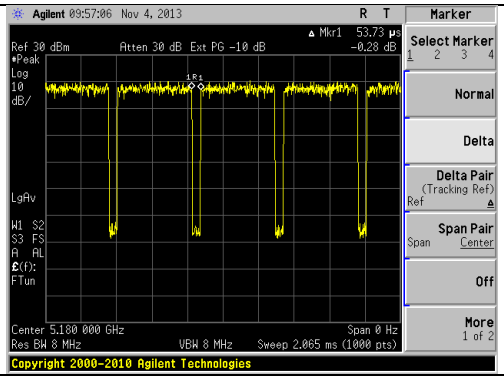
Off time



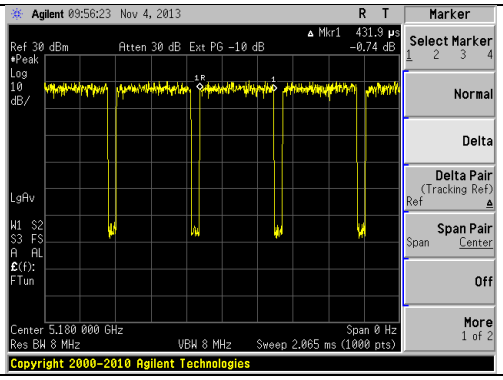
On time

Modulation	803.11 Standard	Data Rate (MBPS)	TX on time (ms)	TX off time (ms)	Duty Cycle	Duty cycle correction factor (dB)
QPSK	802.11a	12.0	0.843	0.052	0.94	0.3

6.2.3 24MBPS



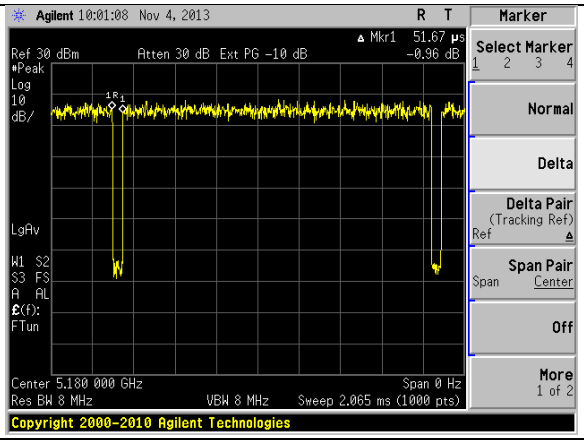
Off time



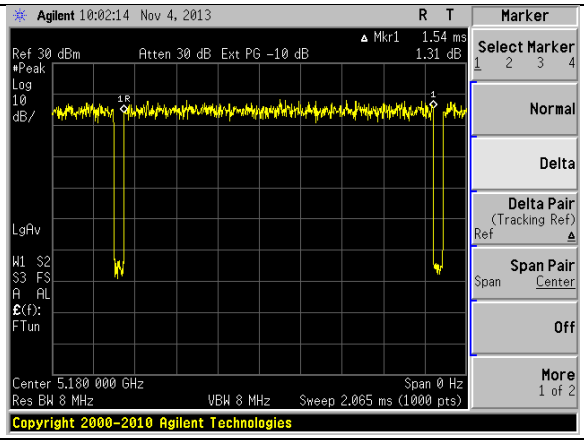
On time

Modulation	803.11 Standard	Data Rate (MBPS)	TX on time (ms)	TX off time (ms)	Duty Cycle	Duty cycle correction factor (dB)
16-QAM	802.11a	24.0	0.432	0.054	0.89	0.5

6.2.4 MCS0



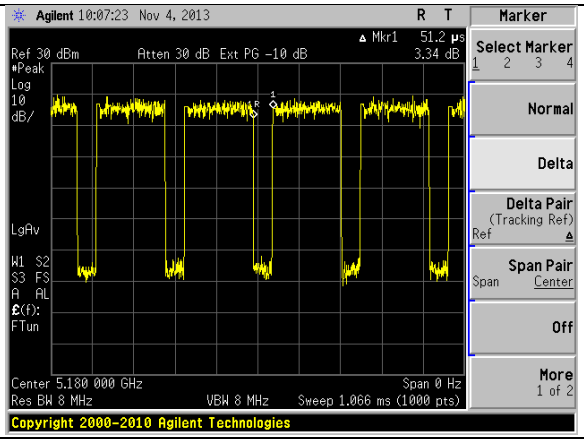
Off time



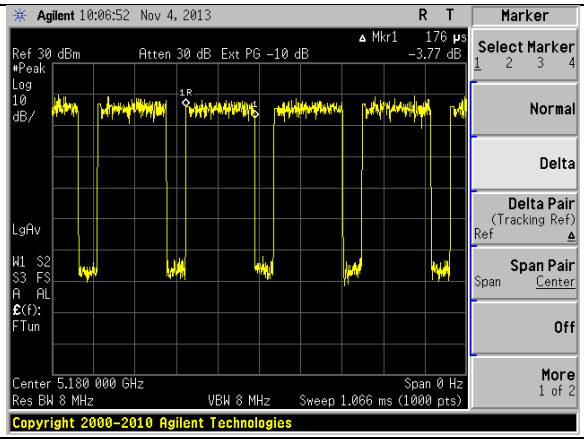
On time

Modulation	803.11 Standard	Data Rate (MBPS)	TX on time (ms)	TX off time (ms)	Duty Cycle	Duty cycle correction factor (dB)
BPSK	802.11n	MC0	1.540	0.052	0.97	0.1

6.2.4 MCS7



Off time



On time

Modulation	803.11 Standard	Data Rate (MBPS)	TX on time (ms)	TX off time (ms)	Duty Cycle	Duty cycle correction factor (dB)
64-QAM	802.11n	MCS7	0.176	0.051	0.77	1.1

EXHIBIT 7. Emission Bandwidth (EBW) and 99% Bandwidth

Test Engineer: Khairul Aidi Zainal

The emission bandwidth is the 26dB bandwidth in MHz. This bandwidth is used to determine the maximum conducted output power measurement and the appropriate limit.

7.1 Test procedure.

KDB 789033 D01 v01r03 section C and D.

7.2 Test Data.

The data reported includes all necessary correction factors. These correction factors are loaded onto the EMI receiver when measurements are performed.

Reported Measurement data = Raw receiver measurement (dBm) + Cable factor (dB) + Miscellaneous factors when applicable (dB).

7.2.1 Operation in the 5.15 – 5.25 GHz band

Data Rate	Channel	Frequency (MHz)	EBW 26dB (MHz)	99% BW (MHz)
6 Mbps	36	5180	22.2	16.6
	40	5200	22.2	16.5
	48	5240	22.2	16.6

Data Rate	Channel	Frequency (MHz)	EBW 26dB (MHz)	99% BW (MHz)
12 Mbps	36	5180	22.3	16.6
	40	5200	22.0	16.5
	48	5240	22.1	16.5

Data Rate	Channel	Frequency (MHz)	EBW 26dB (MHz)	99% BW (MHz)
24 Mbps	36	5180	21.3	16.4
	40	5200	21.0	16.4
	48	5240	21.3	16.5

Data Rate	Channel	Frequency (MHz)	EBW 26dB (MHz)	99% BW (MHz)
6.5 Mbps (MCS0)	36	5180	22.8	17.7
	40	5200	22.6	17.6
	48	5240	23.0	17.7

Data Rate	Channel	Frequency (MHz)	EBW 26dB (MHz)	99% BW (MHz)
65 Mbps (MCS7)	36	5180	22.0	17.6
	40	5200	22.6	17.6
	48	5240	22.0	17.7

7.2.2 Operation in the 5.25 – 5.35 GHz band

Data Rate	Channel	Frequency (MHz)	EBW 26dB (MHz)	99% BW (MHz)
6 Mbps	56	5280	24.2	16.8
	60	5300	22.1	16.6
	64	5320	23.5	16.7

Data Rate	Channel	Frequency (MHz)	EBW 26dB (MHz)	99% BW (MHz)
12 Mbps	56	5280	24.6	16.7
	60	5300	22.2	16.5
	64	5320	21.9	16.5

Data Rate	Channel	Frequency (MHz)	EBW 26dB (MHz)	99% BW (MHz)
24 Mbps	56	5280	22.7	16.4
	60	5300	22.3	16.6
	64	5320	22.0	16.5

Data Rate	Channel	Frequency (MHz)	EBW 26dB (MHz)	99% BW (MHz)
6.5 Mbps (MCS0)	56	5280	27.3	17.9
	60	5300	25.4	17.8
	64	5320	25.6	17.8

Data Rate	Channel	Frequency (MHz)	EBW 26dB (MHz)	99% BW (MHz)
65 Mbps (MCS7)	56	5280	22.2	17.7
	60	5300	22.1	17.6
	64	5320	21.8	17.6

7.2.3 Operation in the 5.47 – 5.725 GHz band

Data Rate	Channel	Frequency (MHz)	EBW 26dB (MHz)	99% BW (MHz)
6 Mbps	100	5500	23.7	16.7
	116	5580	24.8	16.8
	140	5700	24.0	16.7

Data Rate	Channel	Frequency (MHz)	EBW 26dB (MHz)	99% BW (MHz)
12 Mbps	100	5500	24.3	16.6
	116	5580	23.5	16.6
	140	5700	24.9	16.6

Data Rate	Channel	Frequency (MHz)	EBW 26dB (MHz)	99% BW (MHz)
24 Mbps	100	5500	22.1	16.5
	116	5580	23.8	16.6
	140	5700	24.0	16.6

Data Rate	Channel	Frequency (MHz)	EBW 26dB (MHz)	99% BW (MHz)
6.5 Mbps (MCS0)	100	5500	31.0	18.3
	116	5580	25.7	17.9
	140	5700	26.2	17.9

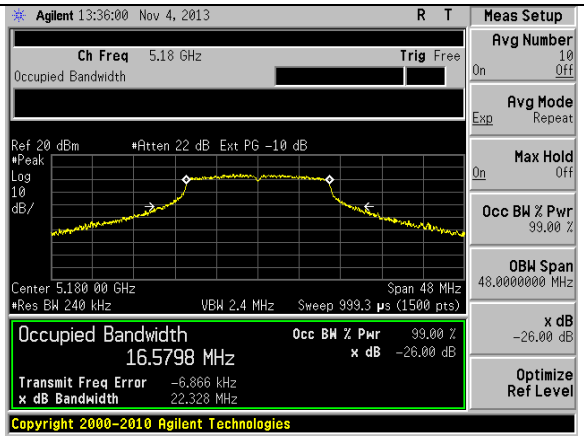
Data Rate	Channel	Frequency (MHz)	EBW 26dB (MHz)	99% BW (MHz)
65 Mbps (MCS7)	100	5500	21.7	17.6
	116	5580	22.3	17.6
	140	5700	22.6	17.6

7.3 Screen Captures

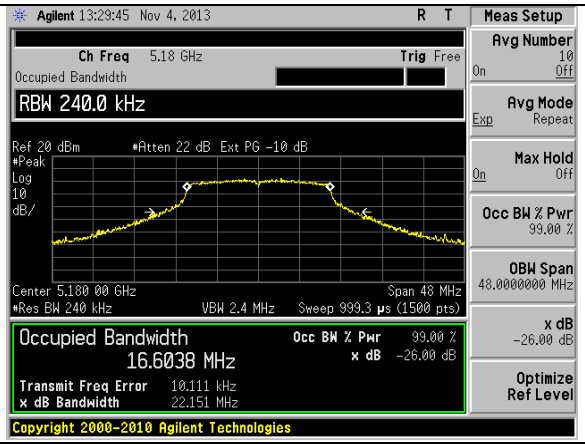
(Shows only widest bandwidth)

7.3.1 Operation in the 5.15 – 5.25 GHz band

802.11 a

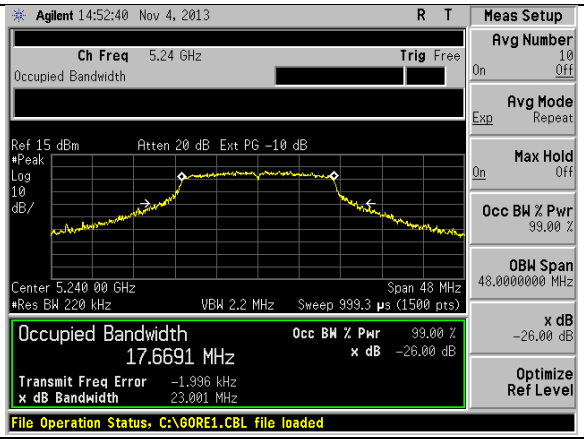


26dB EBW

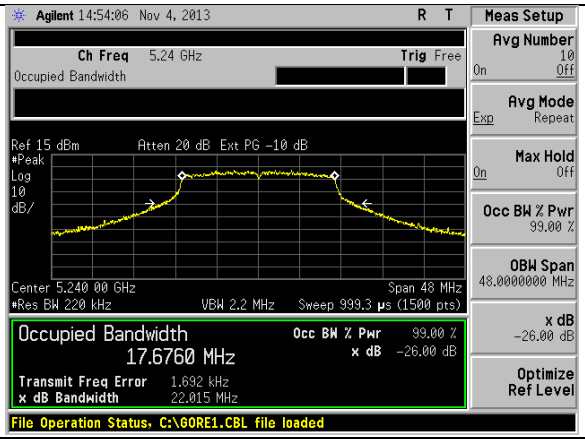


99% BW

802.11 n



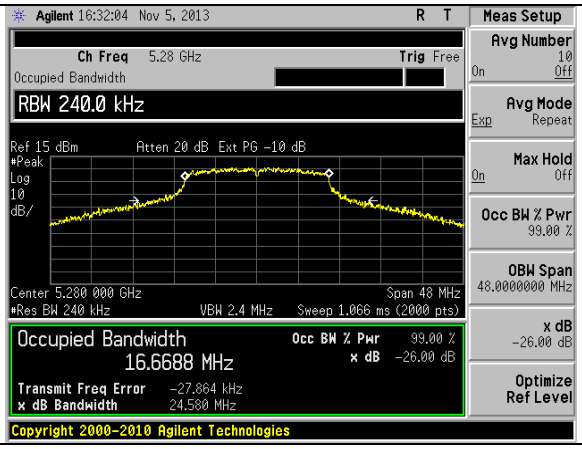
26dB EBW



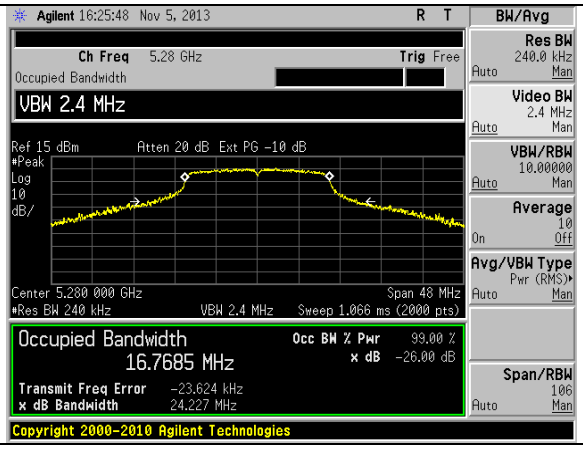
99% BW

7.3.2 Operation in the 5.25 – 5.35 GHz band

802.11 a

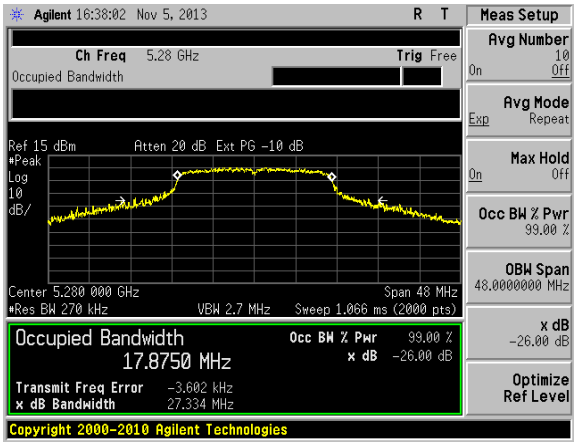


26dB EBW



99% BW

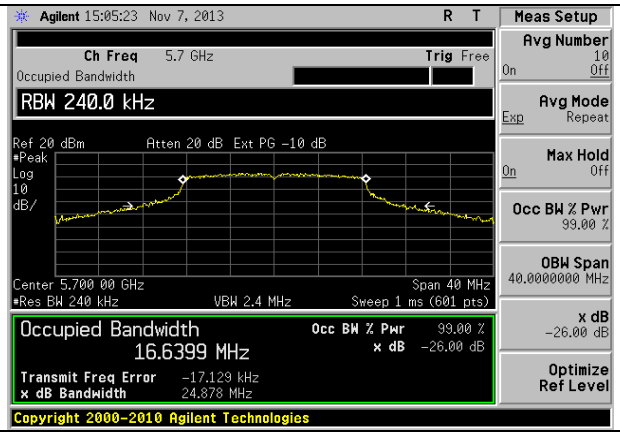
802.11 n



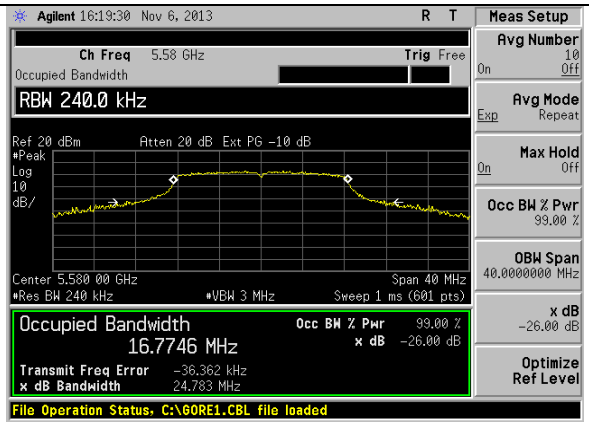
26dB and 99% bandwidth

7.3.1 Operation in the 5.47 – 5.725 GHz band

802.11 a

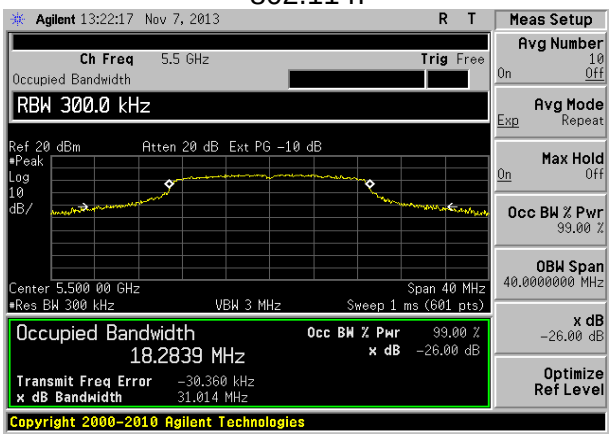


26dB EBW



99% BW

802.11 n



26dB and 99% bandwidth

EXHIBIT 8 Maximum Conducted Output Power And Peak Power Spectral Density

Test Engineer: Khairul Aidi Zainal

8.1 Test Procedure

KDB 789033 D01 v01r03 section E 2(d) (Maximum Conducted Output Power) and F (Peak Power Spectral Density)

8.2 Limits

8.2.1 Operation in the band 5.15 to 5.25 GHz

Maximum conducted output power = Lesser of 50mW or 4dBm + 10 log EBW

Peak Power Spectral Density = 4 dBm/MHz

8.2.2 Operation in the band 5.25 to 5.35 GHz

Maximum conducted output power = Lesser of 250mW or 11dBm + 10 log EBW

Peak Power Spectral Density = 11 dBm/MHz

8.2.3 Operation in the band 5.47 to 5.725 GHz

Maximum conducted output power = Lesser of 250mW or 11dBm + 10 log EBW

Peak Power Spectral Density = 11 dBm/MHz

8.2.4 Operation in the band 5.725 to 5.825 GHz

Maximum conducted output power = Lesser of 1W or 4dBm + 17 log EBW

Peak Power Spectral Density = 17 dBm/MHz

8.3 Test Data

The data reported includes all necessary correction factors. These correction factors are loaded onto the EMI receiver when measurements are performed.

Reported Measurement data = Raw receiver measurement (dBm) + Cable factor (dB) + Miscellaneous factors when applicable (dB).

Generic example of reported data:

Reported Measurement data = 8.55 (raw receiver measurement in dBm) + 0.85 (cable factor in dB) = 9.4 (dBm).

8.3.1 Operation in the band 5.15 to 5.25 GHz

8.3.1.1 802.11 a

Data Rate	Channel	Frequency (MHz)	Power *SA2 (dBm)	D.C. Correction (dB)	D.C. corrected Power (dBm)	Power Limit (dBm)	Power Margin (dB)	*PPSD (dBm)	D.C. Correction (dB)	D.C. corrected PPSD (dBm)	PKPSD Limit (dBm)	PKPSD Margin (dB)
6 Mbps	36	5180	11.4	0.1	11.5	17	5.5	1.0	0.1	1.1	4	2.9
	40	5200	11.3	0.1	11.4	17	5.6	1.0	0.1	1.1	4	2.9
	48	5240	11.5	0.1	11.6	17	5.4	1.3	0.1	1.4	4	2.6

Data Rate	Channel	Frequency (MHz)	Power *SA2 (dBm)	D.C. Correction (dB)	D.C. corrected Power (dBm)	Power Limit (dBm)	Power Margin (dB)	*PPSD (dBm)	D.C. Correction (dB)	D.C. corrected PPSD (dBm)	PKPSD Limit (dBm)	PKPSD Margin (dB)
12 Mbps	36	5180	11.4	0.3	11.7	17	5.3	1.0	0.3	1.3	4	2.7
	40	5200	11.2	0.3	11.5	17	5.6	1.0	0.3	1.3	4	2.7
	48	5240	11.4	0.3	11.7	17	5.3	1.3	0.3	1.6	4	2.4

Data Rate	Channel	Frequency (MHz)	Power *SA2 (dBm)	D.C. Correction (dB)	D.C. corrected Power (dBm)	Power Limit (dBm)	Power Margin (dB)	*PPSD (dBm)	D.C. Correction (dB)	D.C. corrected PPSD (dBm)	PKPSD Limit (dBm)	PKPSD Margin (dB)
24 Mbps	36	5180	10.6	0.5	11.1	17	5.9	0.5	0.5	1.0	4	3.0
	40	5200	10.9	0.5	11.4	17	5.7	0.9	0.5	1.4	4	2.6
	48	5240	10.8	0.5	11.3	17	5.7	1.0	0.5	1.5	4	2.5

8.3.1.2 802.11 n

Data Rate	Channel	Frequency (MHz)	Power *SA2 (dBm)	D.C. Correction (dB)	D.C. corrected Power (dBm)	Power Limit (dBm)	Power Margin (dB)	*PPSD (dBm)	D.C. Correction (dB)	D.C. corrected PPSD (dBm)	PKPSD Limit (dBm)	PKPSD Margin (dB)
6.5 Mbps (MCS0)	36	5180	11.8	0.1	11.9	17	5.1	1.1	0.1	1.2	4	2.8
	40	5200	11.0	0.1	11.1	17	5.9	0.9	0.1	1.0	4	3.0
	48	5240	11.1	0.1	11.2	17	5.8	1.2	0.1	1.3	4	2.7

Data Rate	Channel	Frequency (MHz)	Power *SA2 (dBm)	D.C. Correction (dB)	D.C. corrected Power (dBm)	Power Limit (dBm)	Power Margin (dB)	*PPSD (dBm)	D.C. Correction (dB)	D.C. corrected PPSD (dBm)	PKPSD Limit (dBm)	PKPSD Margin (dB)
65 Mbps (MCS7)	36	5180	9.1	1.1	10.2	17	6.8	-0.8	1.1	0.3	4	3.7
	40	5200	9.1	1.1	10.2	17	6.8	-0.5	1.1	0.6	4	3.4
	48	5240	9.3	1.1	10.4	17	6.6	-0.2	1.1	0.9	4	3.1

Sample calculation:

Power (Chan 36) = 11.4dBm (6MBPS power measurement) + 0.1dB (duty cycle correction) = 11.5dBm
PPSD (Chan 36) = 1.3dBm (6MBPS PSD measurement) + 0.1dB (duty cycle correction) = 1.4dBm

8.3.2 Operation in the band 5.25 to 5.35 GHz

8.3.2.1 802.11 a

Data Rate	Channel	Frequency (MHz)	Power *SA2 (dBm)	D.C. Correction (dB)	D.C. corrected Power (dBm)	Power Limit (dBm)	Power Margin (dB)	*PPSD (dBm)	D.C. Correction (dB)	D.C. corrected PPSD (dBm)	PKPSD Limit (dBm)	PKPSD Margin (dB)
6 Mbps	56	5280	13.8	0.1	13.9	24.0	10.1	2.2	0.1	2.3	11.0	8.7
	60	5300	13.0	0.1	13.1	24.0	10.9	1.9	0.1	2.0	11.0	9.0
	64	5320	12.7	0.1	12.8	24.0	11.2	2.2	0.1	2.3	11.0	8.7

Data Rate	Channel	Frequency (MHz)	Power *SA2 (dBm)	D.C. Correction (dB)	D.C. corrected Power (dBm)	Power Limit (dBm)	Power Margin (dB)	*PPSD (dBm)	D.C. Correction (dB)	D.C. corrected PPSD (dBm)	PKPSD Limit (dBm)	PKPSD Margin (dB)
12 Mbps	56	5280	13.3	0.3	13.6	24.0	10.4	2.3	0.3	2.6	11.0	8.4
	60	5300	12.8	0.3	13.1	24.0	10.9	2.0	0.3	2.3	11.0	8.7
	64	5320	12.6	0.3	12.9	24.0	11.1	1.8	0.3	2.1	11.0	8.9

Data Rate	Channel	Frequency (MHz)	Power *SA2 (dBm)	D.C. Correction (dB)	D.C. corrected Power (dBm)	Power Limit (dBm)	Power Margin (dB)	*PPSD (dBm)	D.C. Correction (dB)	D.C. corrected PPSD (dBm)	PKPSD Limit (dBm)	PKPSD Margin (dB)
24 Mbps	56	5280	13.0	0.5	13.5	24.0	10.5	2.4	0.5	2.9	11.0	8.1
	60	5300	12.6	0.5	13.1	24.0	10.9	1.8	0.5	2.3	11.0	8.7
	64	5320	12.3	0.5	12.8	24.0	11.2	2.0	0.5	2.5	11.0	8.5

8.3.2.2 802.11 n

Data Rate	Channel	Frequency (MHz)	Power *SA2 (dBm)	D.C. Correction (dB)	D.C. corrected Power (dBm)	Power Limit (dBm)	Power Margin (dB)	*PPSD (dBm)	D.C. Correction (dB)	D.C. corrected PPSD (dBm)	PKPSD Limit (dBm)	PKPSD Margin (dB)
6.5 Mbps (MCS0)	56	5280	12.9	0.1	13.0	24.0	11.0	1.9	0.1	2.0	11.0	9.0
	60	5300	12.5	0.1	12.6	24.0	11.4	1.5	0.1	1.6	11.0	9.4
	64	5320	12.2	0.1	12.3	24.0	11.7	1.9	0.1	2.0	11.0	9.0

Data Rate	Channel	Frequency (MHz)	Power *SA2 (dBm)	D.C. Correction (dB)	D.C. corrected Power (dBm)	Power Limit (dBm)	Power Margin (dB)	*PPSD (dBm)	D.C. Correction (dB)	D.C. corrected PPSD (dBm)	PKPSD Limit (dBm)	PKPSD Margin (dB)
65 Mbps (MCS7)	56	5280	9.2	1.1	10.3	24.0	13.7	-1.6	1.1	-0.5	11.0	11.5
	60	5300	8.6	1.1	9.7	24.0	14.3	-1.5	1.1	-0.4	11.0	11.4
	64	5320	8.7	1.1	9.8	24.0	14.2	-1.7	1.1	-0.6	11.0	11.6

Sample calculation:

Power (Chan 56) = 13.8dBm (6MBPS power measurement) + 0.1dB (duty cycle correction) = 13.9dBm
PPSD (Chan 56) = 2.2dBm (6MBPS PSD measurement) + 0.1dB (duty cycle correction) = 2.3dBm

8.3.3 Operation in the band 5.470 to 5.725 GHz

8.3.3.1 802.11 a

Data Rate	Channel	Frequency (MHz)	Power *SA2 (dBm)	D.C. Correction (dB)	D.C. corrected Power (dBm)	Power Limit (dBm)	Power Margin (dB)	*PPSD (dBm)	D.C. Correction (dB)	D.C. corrected PPSD (dBm)	PKPSD Limit (dBm)	PKPSD Margin (dB)
6 Mbps	100	5500	12.1	0.1	12.2	24.0	11.8	1.5	0.1	1.6	11.0	9.4
	116	5580	11.8	0.1	11.9	24.0	12.1	1.2	0.1	1.3	11.0	9.7
	140	5700	11.7	0.1	11.8	24.0	12.2	0.9	0.1	1.0	11.0	10.0

Data Rate	Channel	Frequency (MHz)	Power *SA2 (dBm)	D.C. Correction (dB)	D.C. corrected Power (dBm)	Power Limit (dBm)	Power Margin (dB)	*PPSD (dBm)	D.C. Correction (dB)	D.C. corrected PPSD (dBm)	PKPSD Limit (dBm)	PKPSD Margin (dB)
12 Mbps	100	5500	12.4	0.3	12.7	24.0	11.3	1.7	0.3	2.0	11.0	9.0
	116	5580	12.2	0.3	12.5	24.0	11.5	1.5	0.3	1.8	11.0	9.2
	140	5700	12.8	0.3	13.1	24.0	10.9	2.0	0.3	2.3	11.0	8.7

Data Rate	Channel	Frequency (MHz)	Power *SA2 (dBm)	D.C. Correction (dB)	D.C. corrected Power (dBm)	Power Limit (dBm)	Power Margin (dB)	*PPSD (dBm)	D.C. Correction (dB)	D.C. corrected PPSD (dBm)	PKPSD Limit (dBm)	PKPSD Margin (dB)
24 Mbps	100	5500	12.0	0.5	12.5	24.0	11.5	1.4	0.5	1.9	11.0	9.1
	116	5580	11.9	0.5	12.4	24.0	11.6	1.3	0.5	1.8	11.0	9.2
	140	5700	12.6	0.5	13.1	24.0	10.9	1.8	0.5	2.3	11.0	8.7

8.3.3.2 802.11 n

Data Rate	Channel	Frequency (MHz)	Power *SA2 (dBm)	D.C. Correction (dB)	D.C. corrected Power (dBm)	Power Limit (dBm)	Power Margin (dB)	*PPSD (dBm)	D.C. Correction (dB)	D.C. corrected PPSD (dBm)	PKPSD Limit (dBm)	PKPSD Margin (dB)
6.5 Mbps (MCS0)	100	5500	12.4	0.1	12.5	24.0	11.5	1.5	0.1	1.6	11.0	9.4
	116	5580	12.4	0.1	12.5	24.0	11.5	1.4	0.1	1.5	11.0	9.5
	140	5700	12.9	0.1	13.0	24.0	11.0	2.0	0.1	2.1	11.0	8.9

Data Rate	Channel	Frequency (MHz)	Power *SA2 (dBm)	D.C. Correction (dB)	D.C. corrected Power (dBm)	Power Limit (dBm)	Power Margin (dB)	*PPSD (dBm)	D.C. Correction (dB)	D.C. corrected PPSD (dBm)	PKPSD Limit (dBm)	PKPSD Margin (dB)
65 Mbps (MCS7)	100	5500	8.7	1.1	9.8	24.0	14.2	-1.9	1.1	-0.8	11.0	11.8
	116	5580	8.7	1.1	9.8	24.0	14.2	-2.0	1.1	-0.9	11.0	11.9
	140	5700	9.3	1.1	10.4	24.0	13.6	-1.2	1.1	-0.1	11.0	11.1

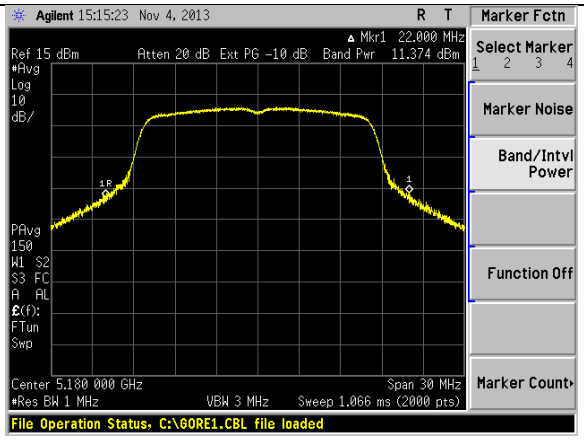
Sample calculation:

Power (Chan 100) = 12.1dBm (6MBPS power measurement) + 0.1dB (duty cycle correction) = 12.2dBm
PPSD (Chan 100) = 1.5dBm (6MBPS PSD measurement) + 0.1dB (duty cycle correction) = 1.6dBm

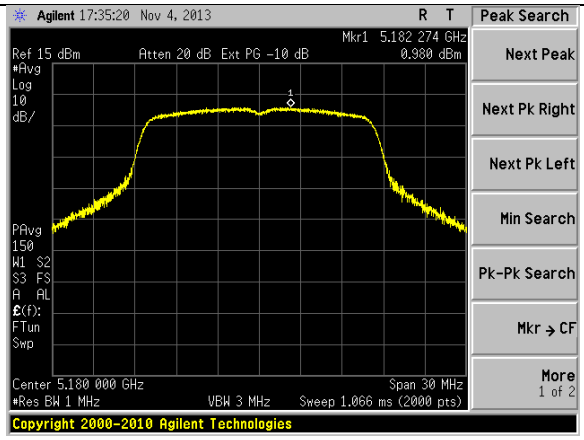
8.4 Screen Captures

8.4.1 Operation in the band 5.15 to 5.25 GHz

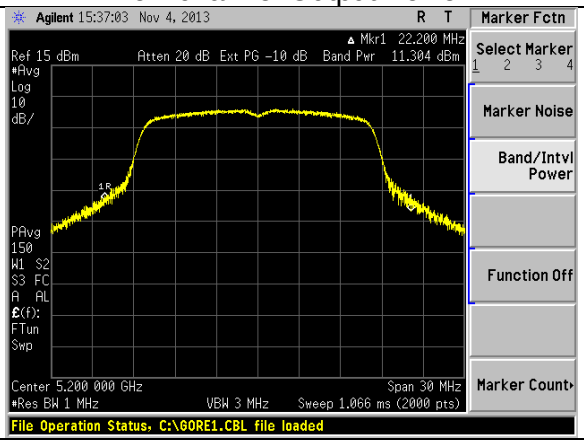
8.4.1.1 802.11 a 6MBPS



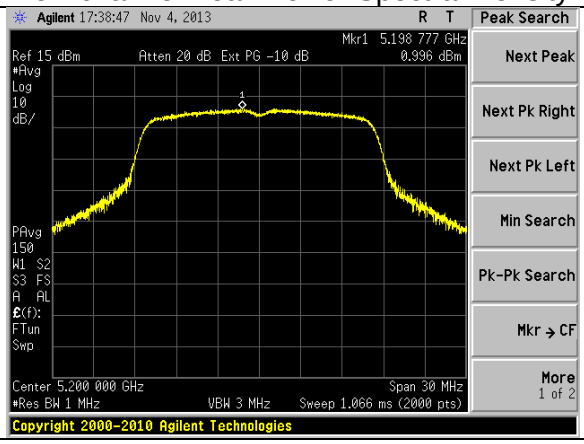
Low channel Output Power



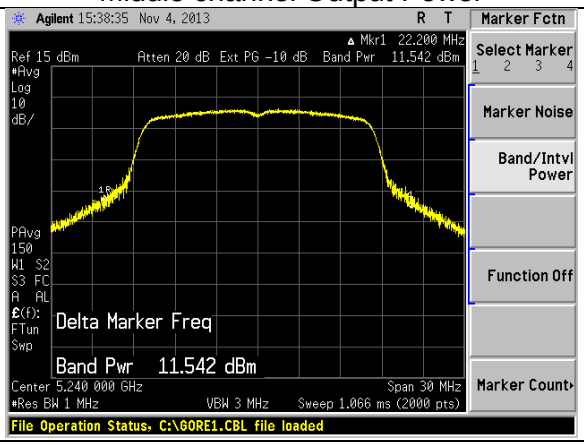
Low channel Peak Power Spectral Density



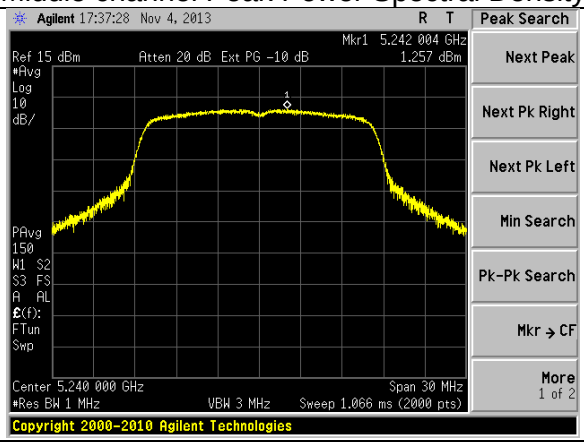
Middle channel Output Power



Middle channel Peak Power Spectral Density

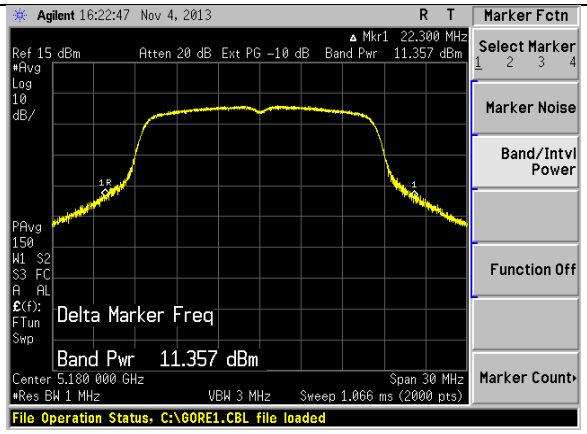


High channel Output Power

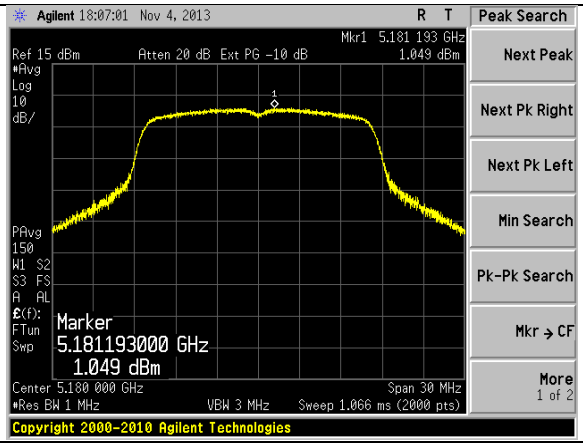


High channel Peak Power Spectral Density

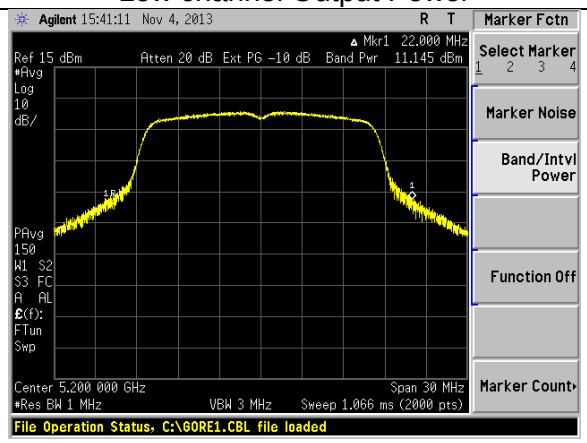
8.4.1.2 802.11 a 12MBPS



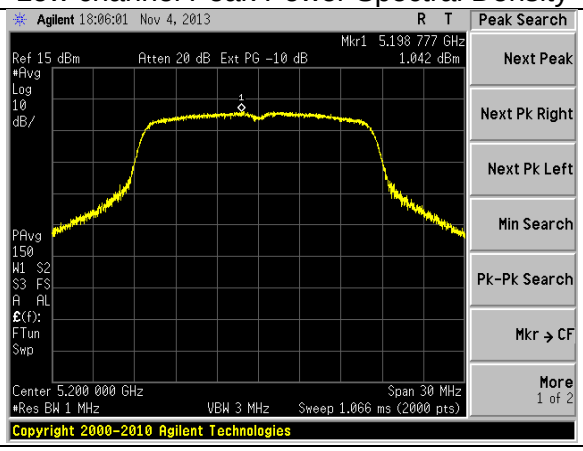
Low channel Output Power



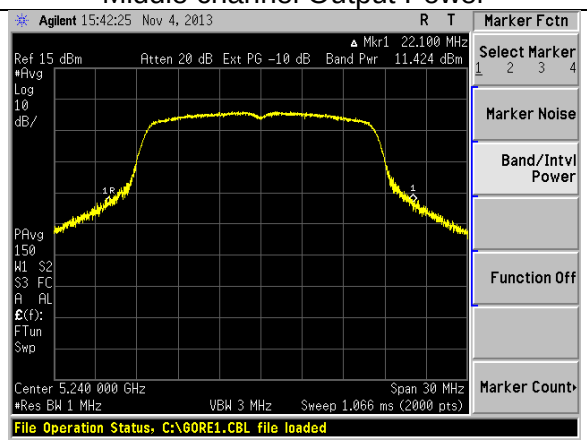
Low channel Peak Power Spectral Density



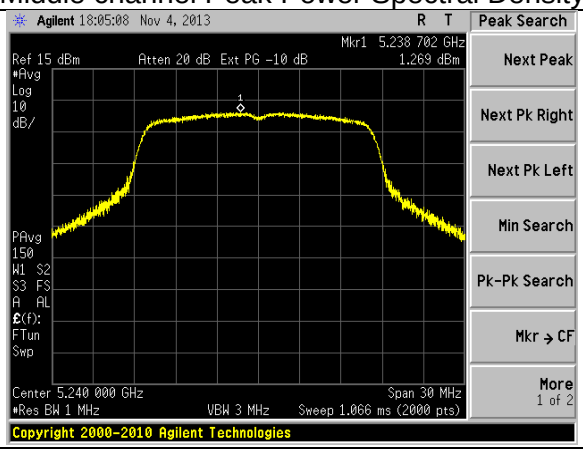
Middle channel Output Power



Middle channel Peak Power Spectral Density

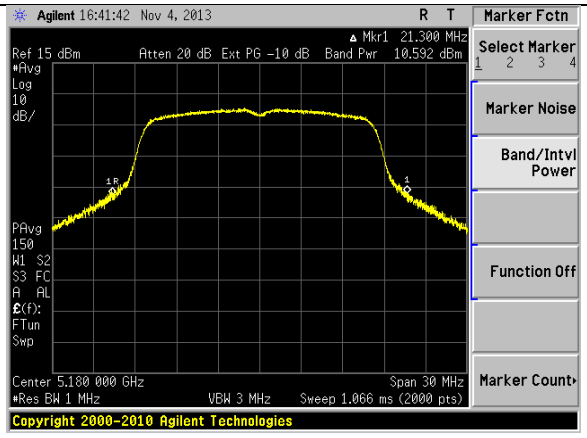


High channel Output Power

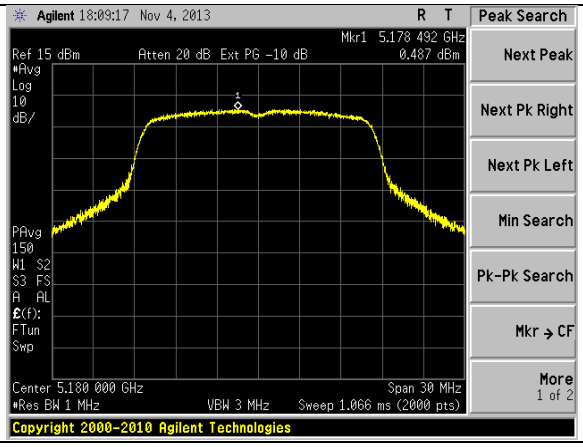


High channel Peak Power Spectral Density

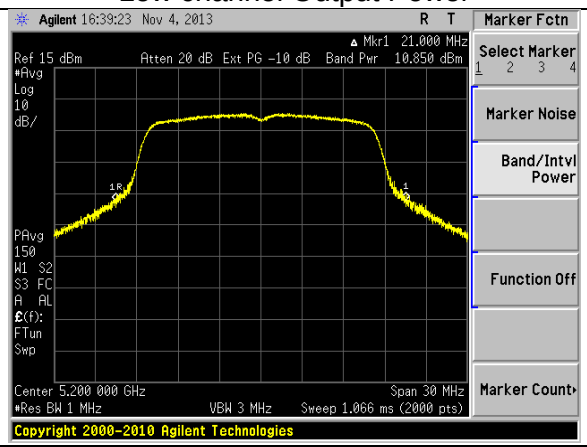
8.4.1.3 802.11 a 24MBPS



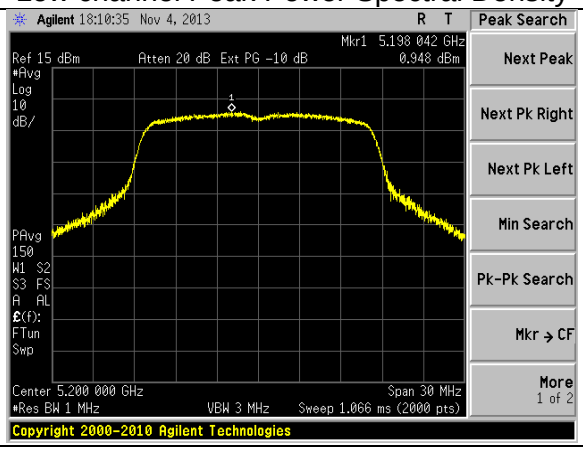
Low channel Output Power



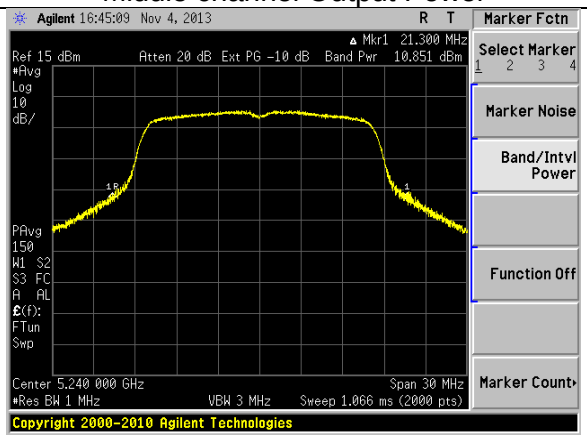
Low channel Peak Power Spectral Density



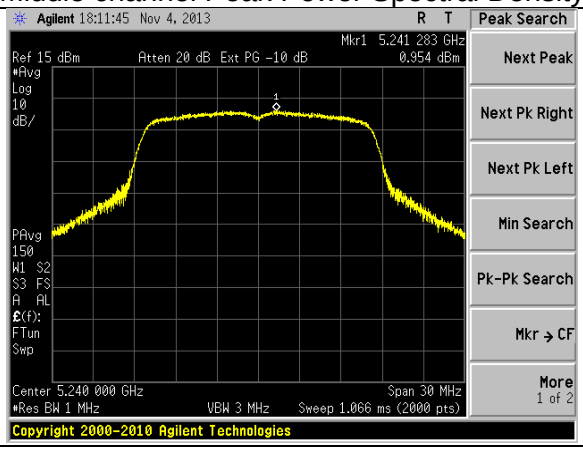
Middle channel Output Power



Middle channel Peak Power Spectral Density

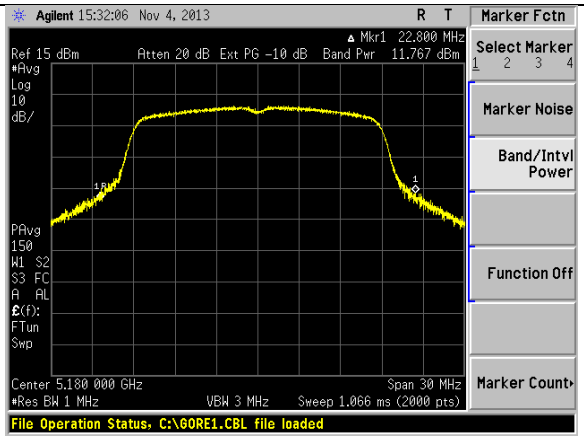


High channel Output Power

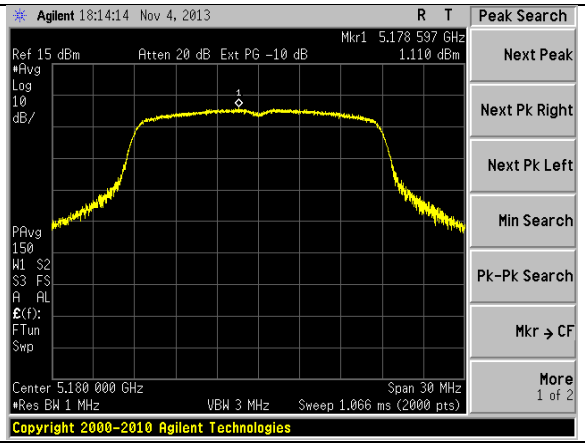


High channel Peak Power Spectral Density

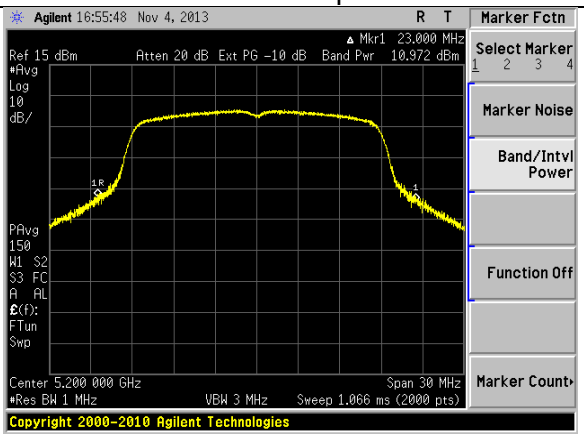
8.4.1.4 802.11 n MCS0



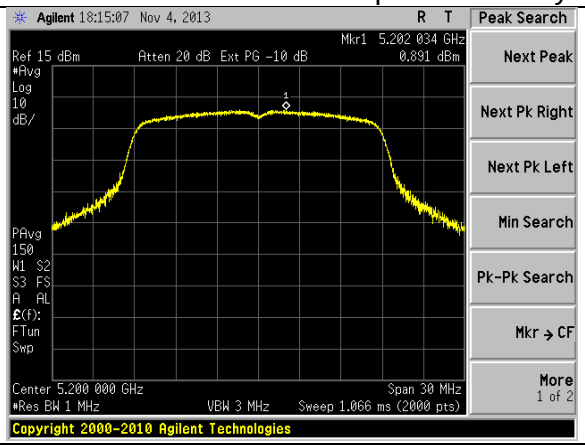
Low channel Output Power



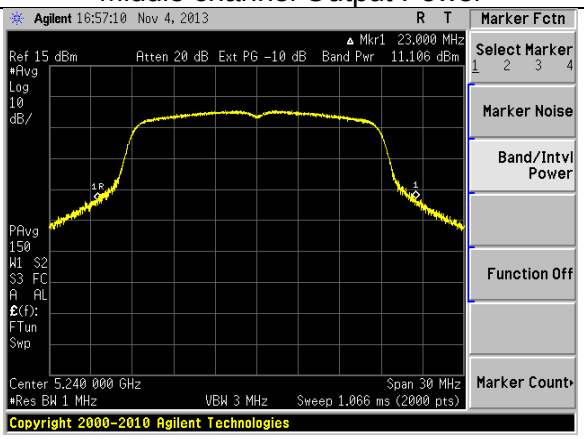
Low channel Peak Power Spectral Density



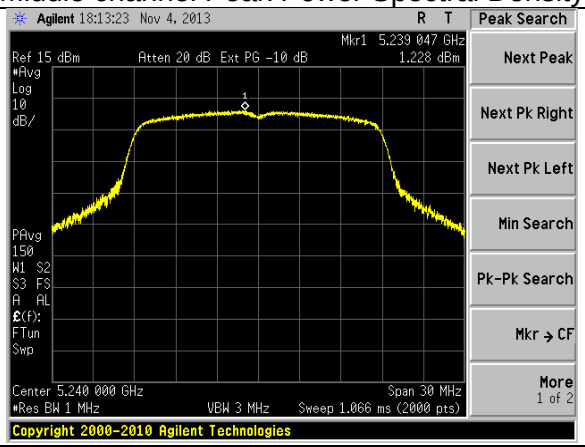
Middle channel Output Power



Middle channel Peak Power Spectral Density

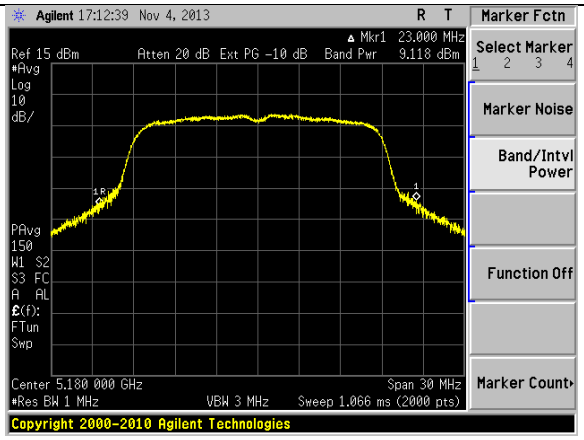


High channel Output Power

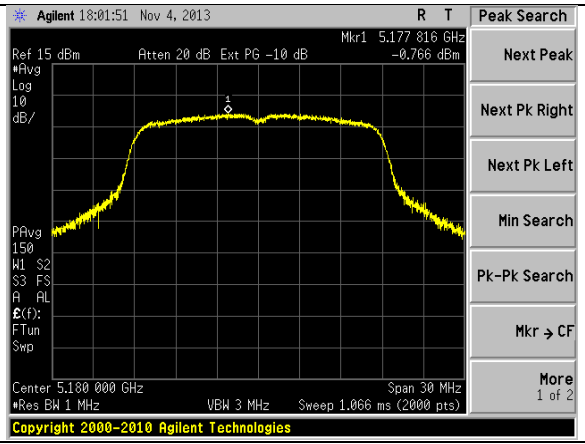


High channel Peak Power Spectral Density

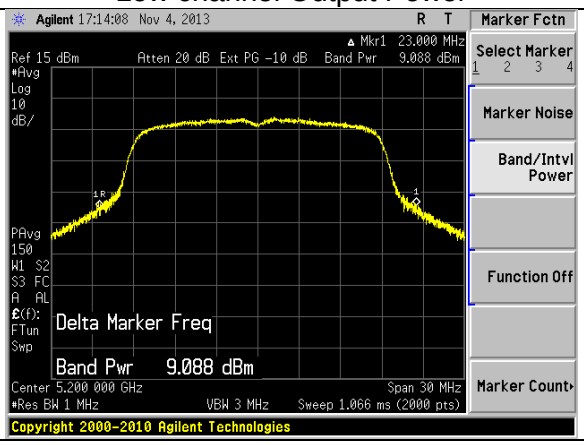
8.4.1.5 802.11 n MCS7



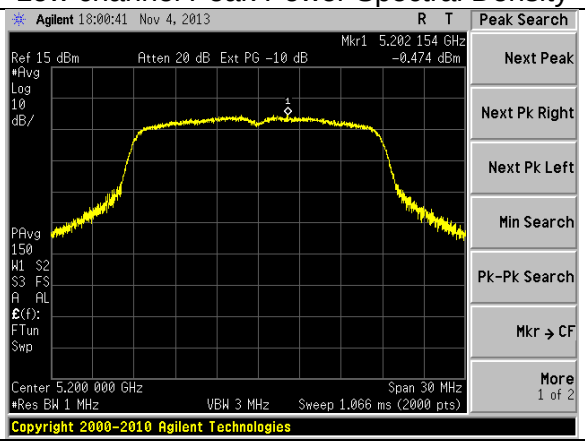
Low channel Output Power



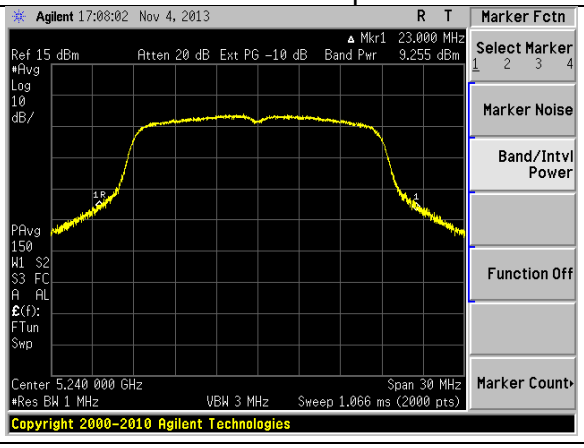
Low channel Peak Power Spectral Density



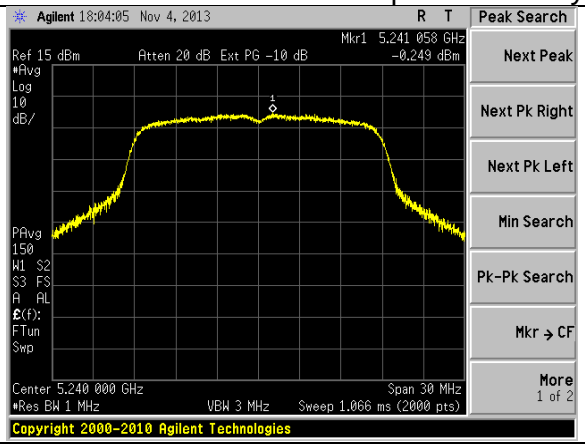
Middle channel Output Power



Middle channel Peak Power Spectral Density



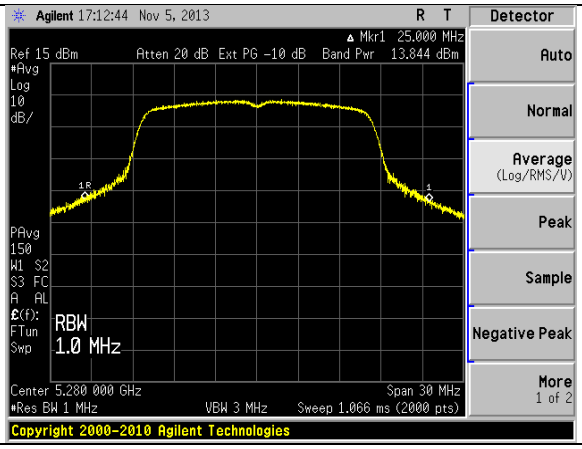
High channel Output Power



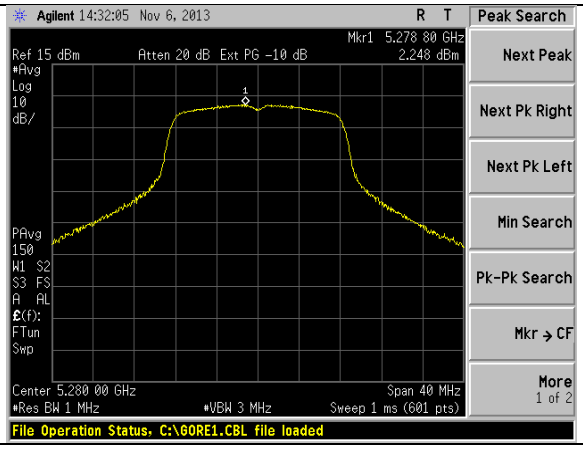
High channel Peak Power Spectral Density

8.4.2 Operation in the band 5.25 to 5.35 GHz

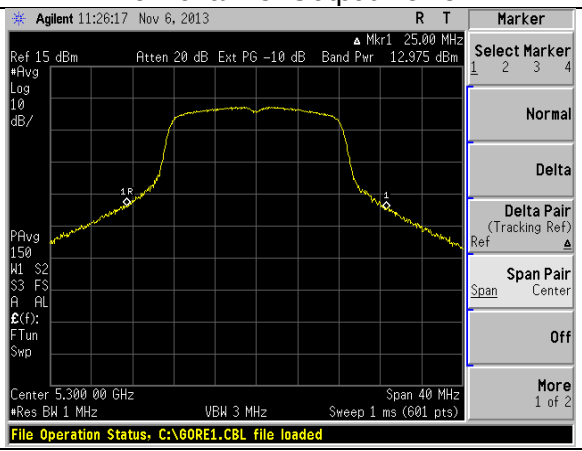
8.4.2.1 802.11 a 6MBPS



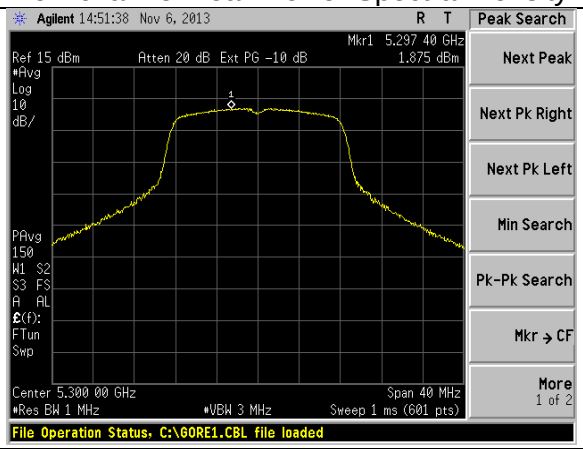
Low channel Output Power



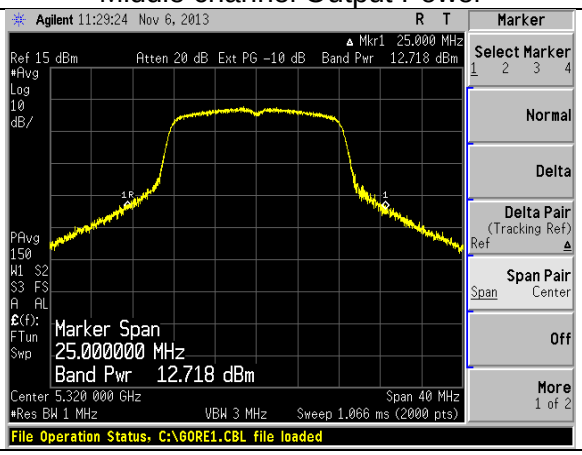
Low channel Peak Power Spectral Density



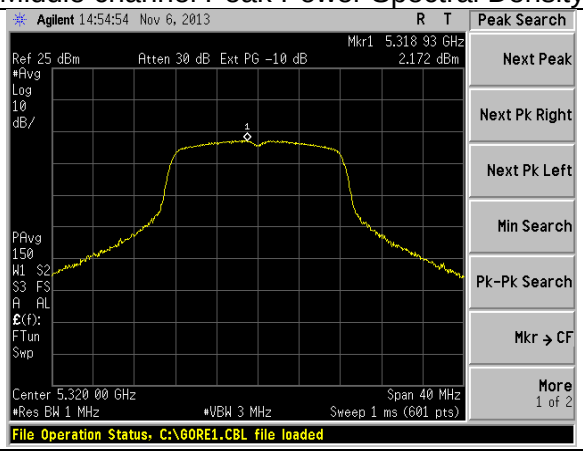
Middle channel Output Power



Middle channel Peak Power Spectral Density

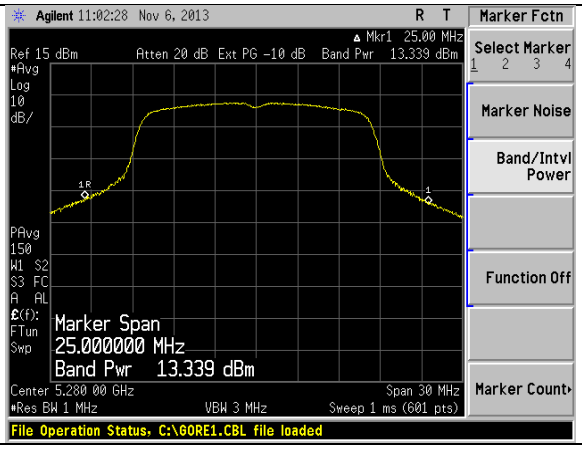


High channel Output Power

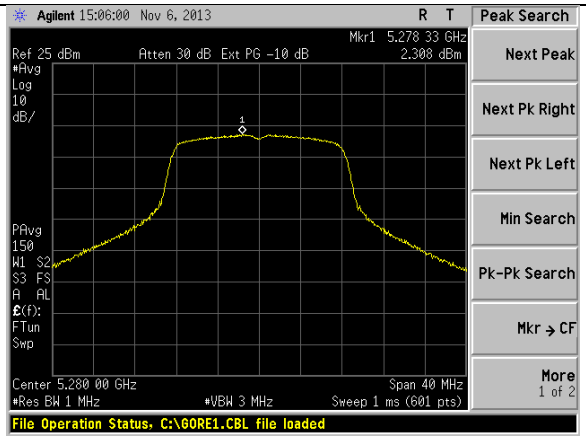


High channel Peak Power Spectral Density

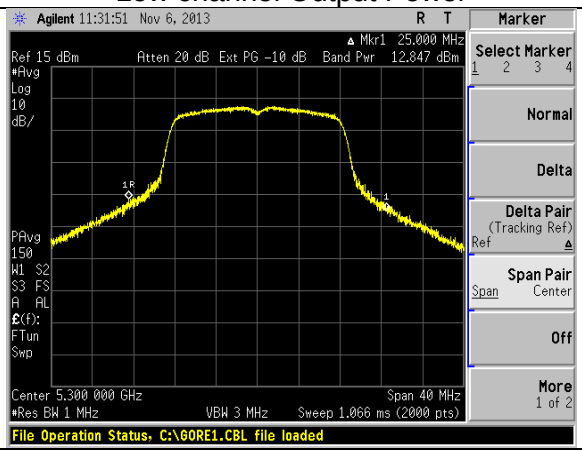
8.4.2.2 802.11 a 12MBPS



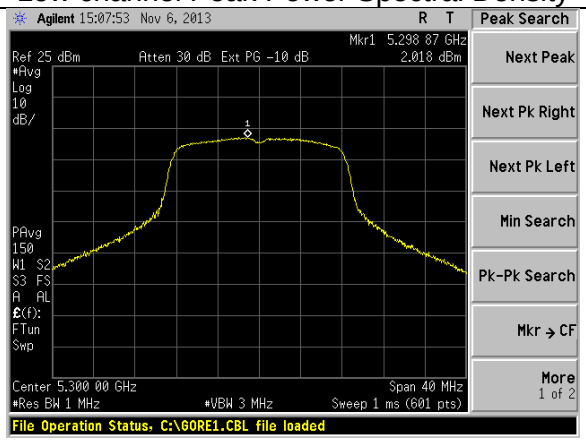
Low channel Output Power



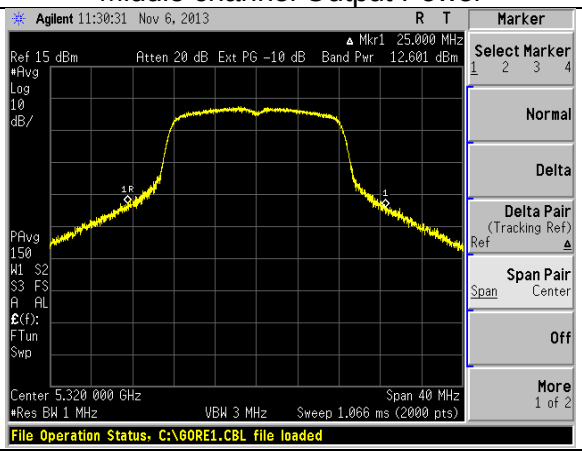
Low channel Peak Power Spectral Density



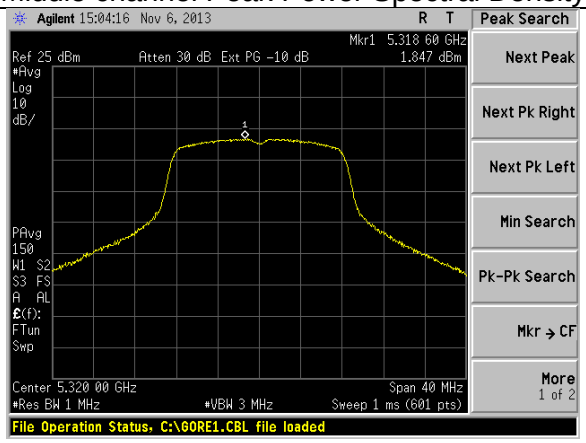
Middle channel Output Power



Middle channel Peak Power Spectral Density

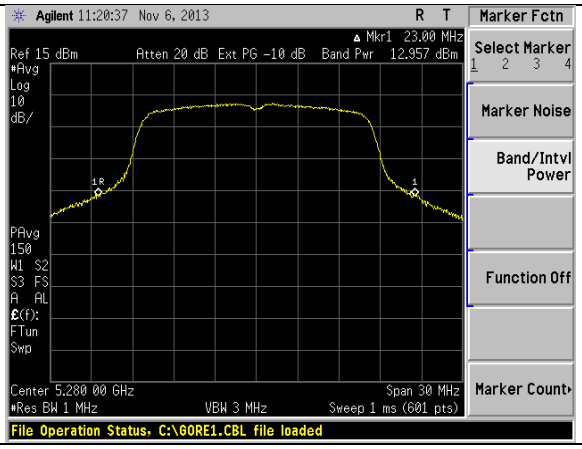


High channel Output Power

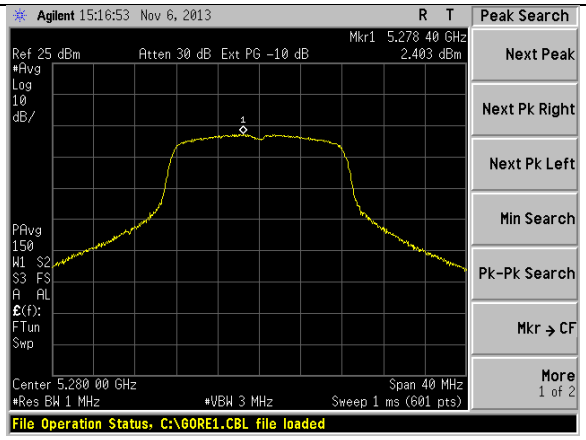


High channel Peak Power Spectral Density

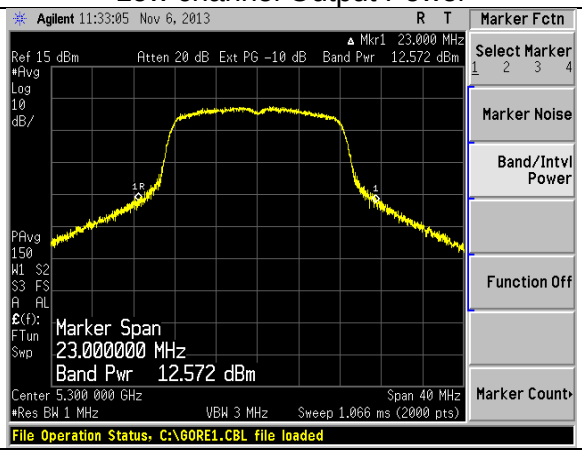
8.4.2.3 802.11 a 24MBPS



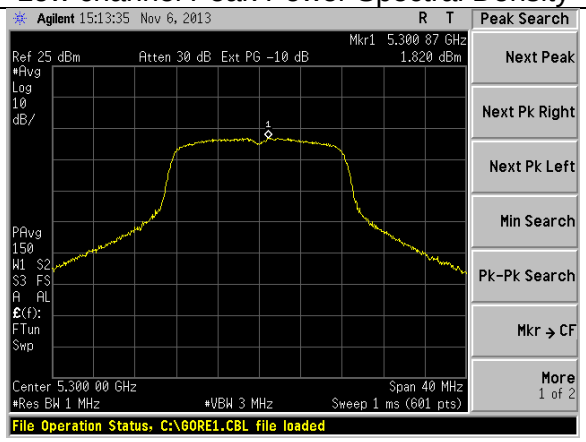
Low channel Output Power



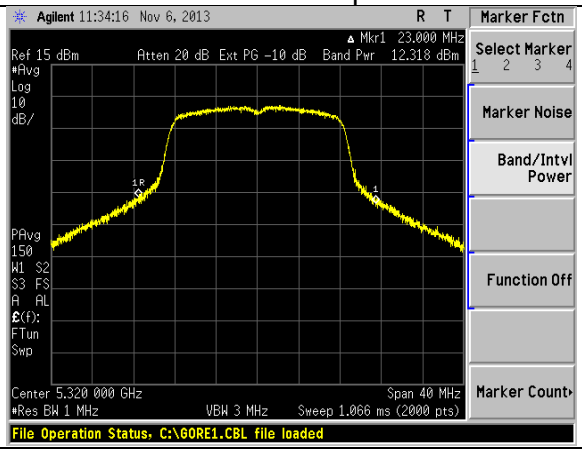
Low channel Peak Power Spectral Density



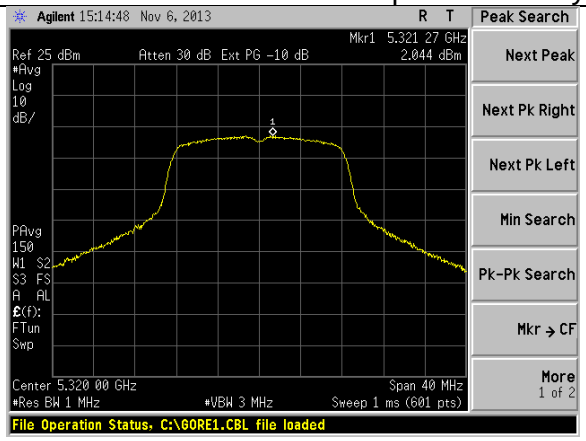
Middle channel Output Power



Middle channel Peak Power Spectral Density

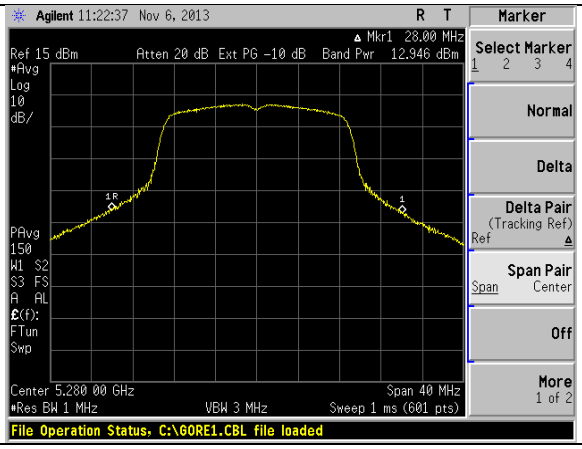


High channel Output Power

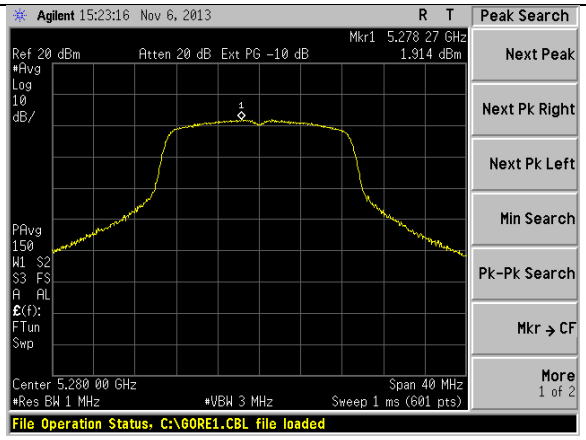


High channel Peak Power Spectral Density

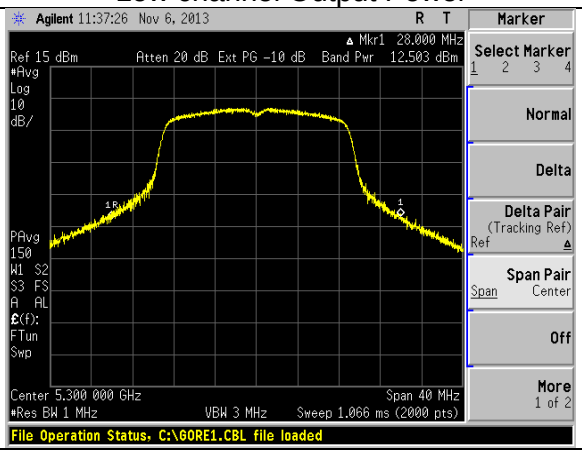
8.4.2.4 802.11 n MCS0



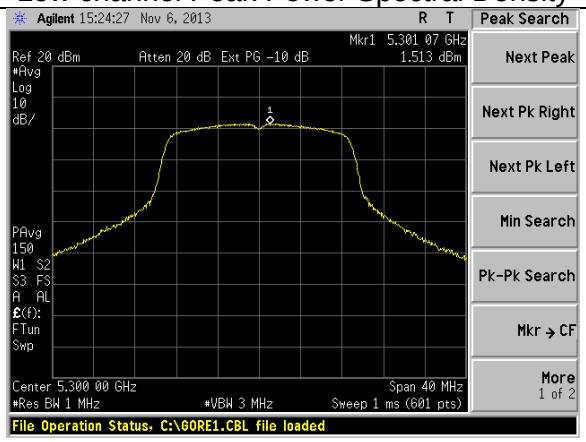
Low channel Output Power



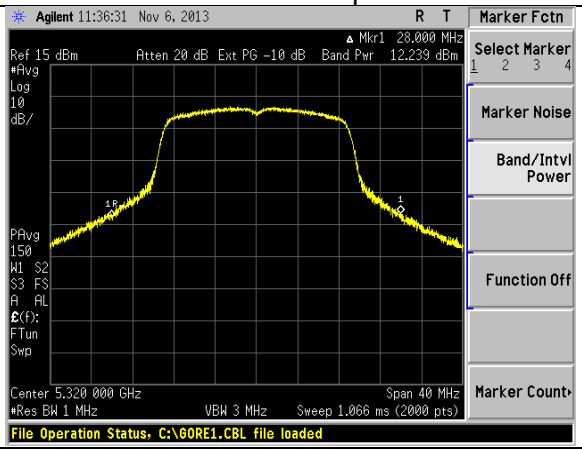
Low channel Peak Power Spectral Density



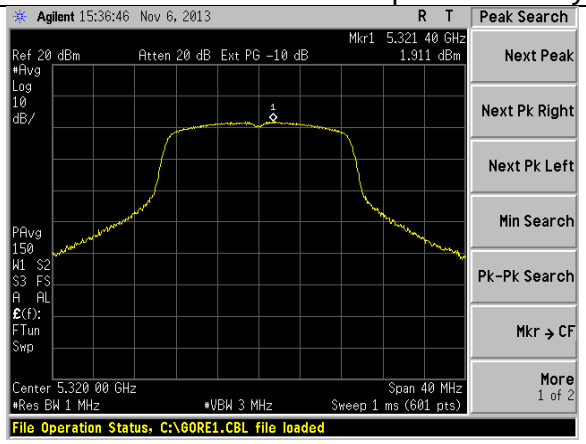
Middle channel Output Power



Middle channel Peak Power Spectral Density

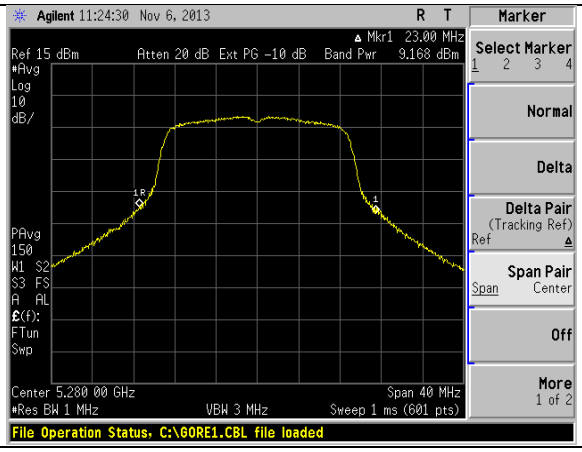


High channel Output Power

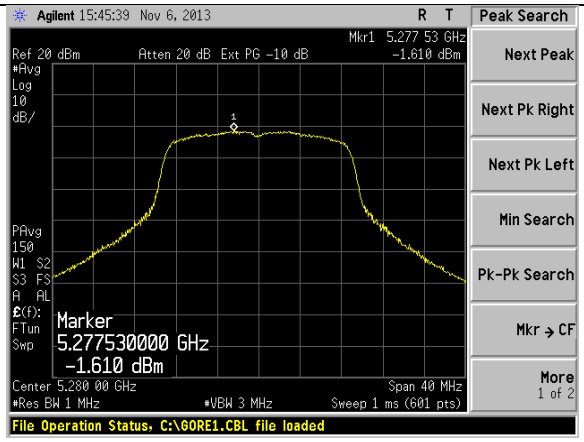


High channel Peak Power Spectral Density

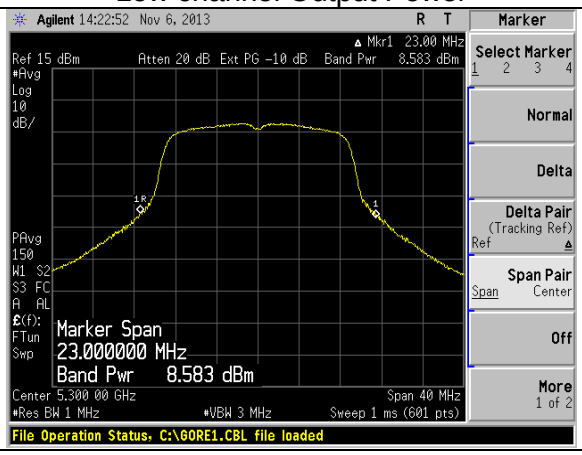
8.4.2.5 802.11 n MCS7



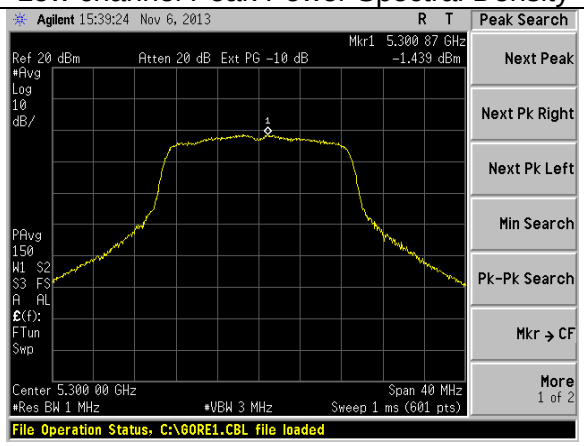
Low channel Output Power



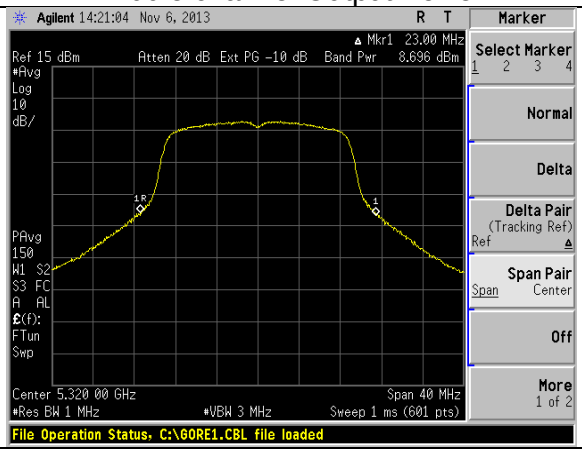
Low channel Peak Power Spectral Density



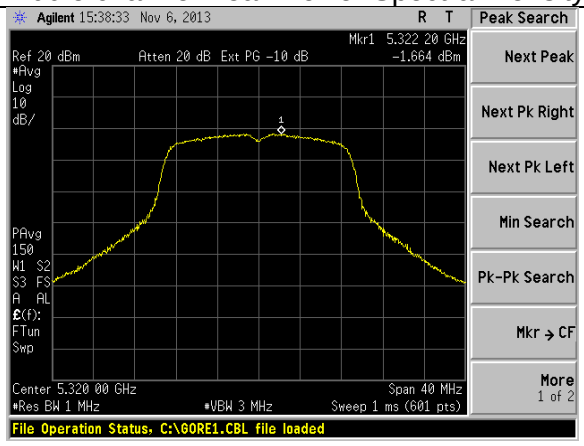
Middle channel Output Power



Middle channel Peak Power Spectral Density



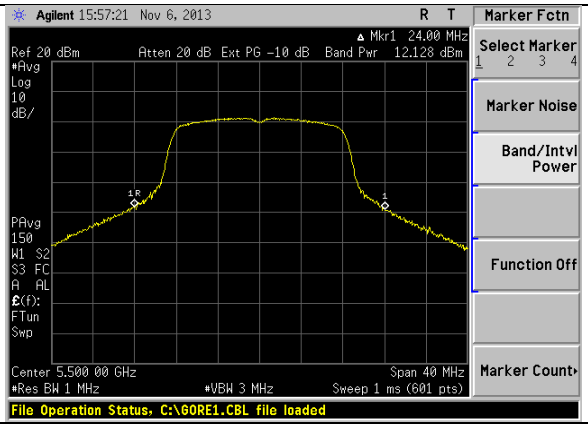
High channel Output Power



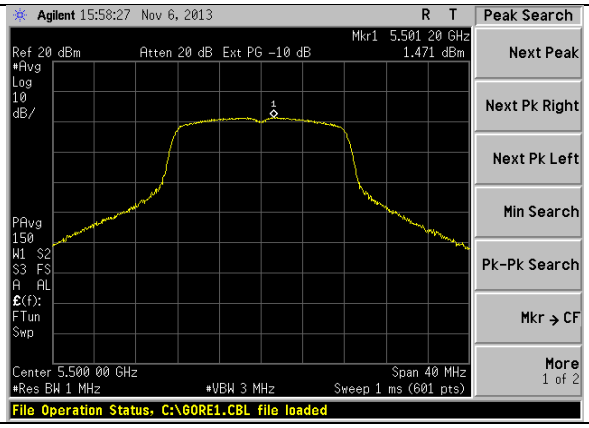
High channel Peak Power Spectral Density

8.4.3 Operation in the band 5.47 to 5.725 GHz

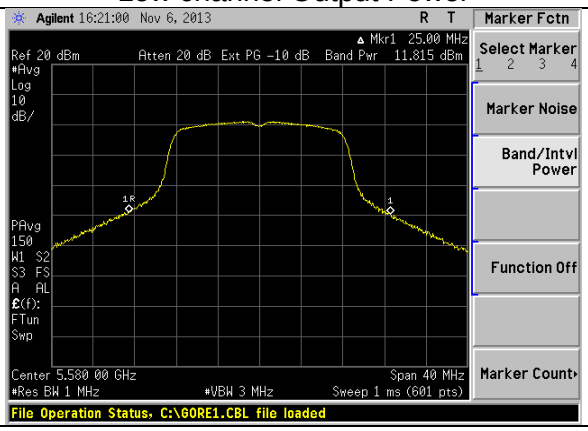
8.4.3.1 802.11 a 6MBPS



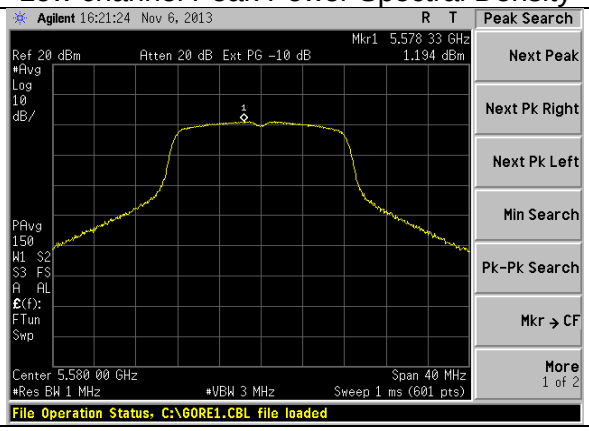
Low channel Output Power



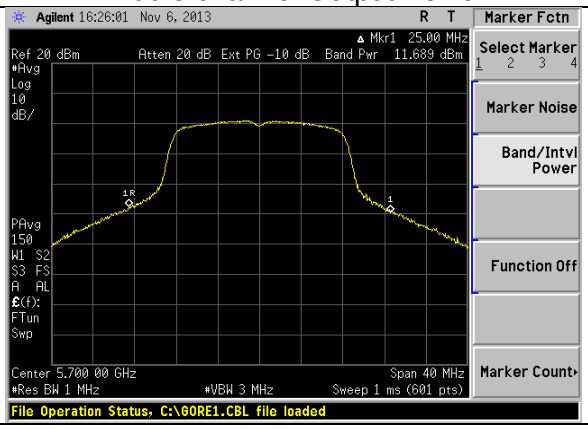
Low channel Peak Power Spectral Density



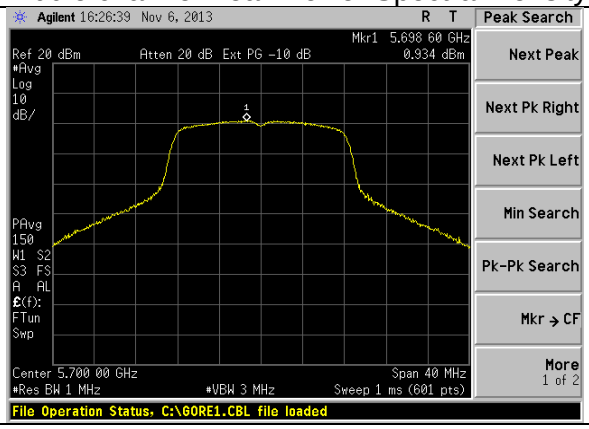
Middle channel Output Power



Middle channel Peak Power Spectral Density

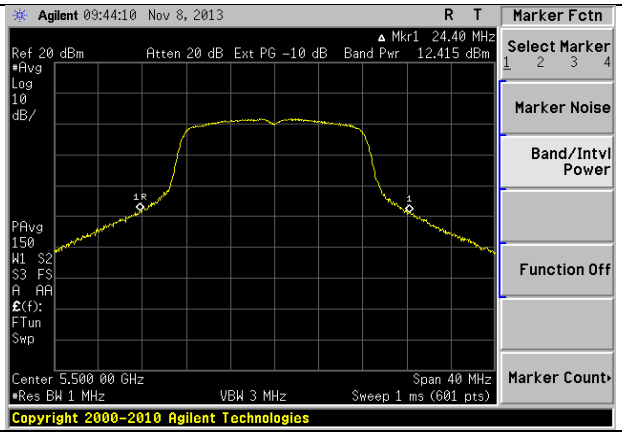


High channel Output Power

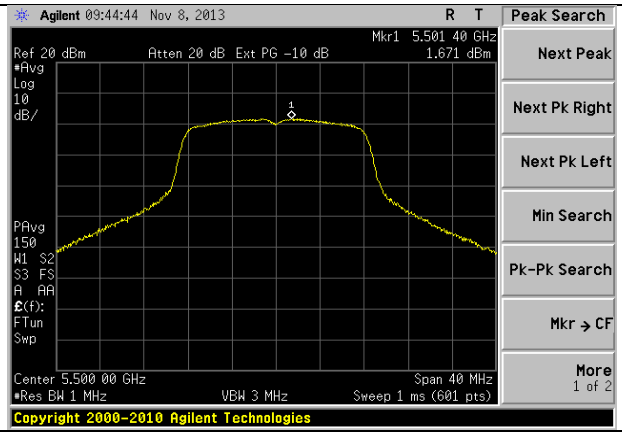


High channel Peak Power Spectral Density

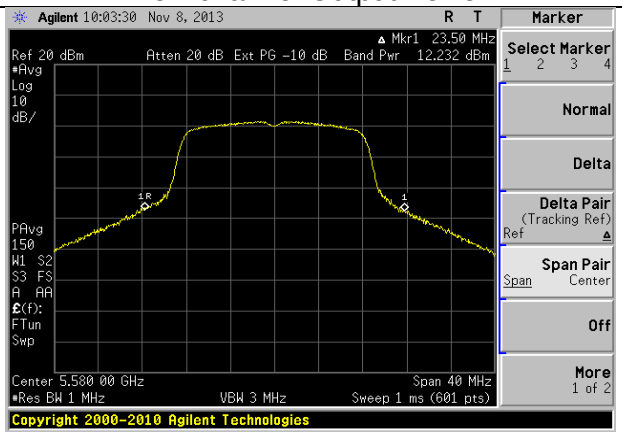
8.4.3.2 802.11 a 12MBPS



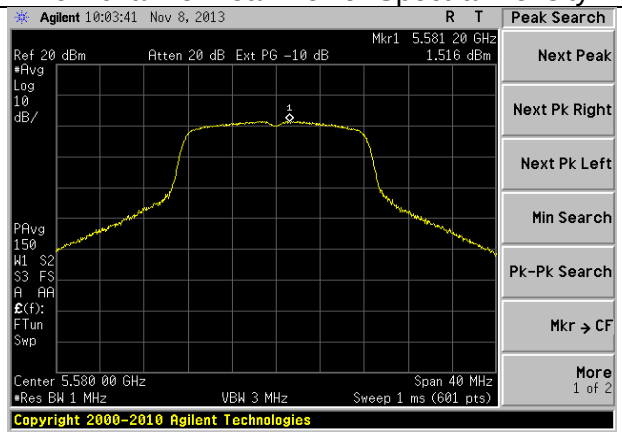
Low channel Output Power



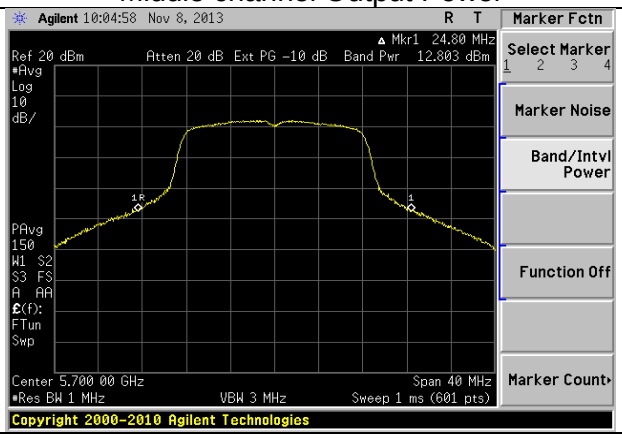
Low channel Peak Power Spectral Density



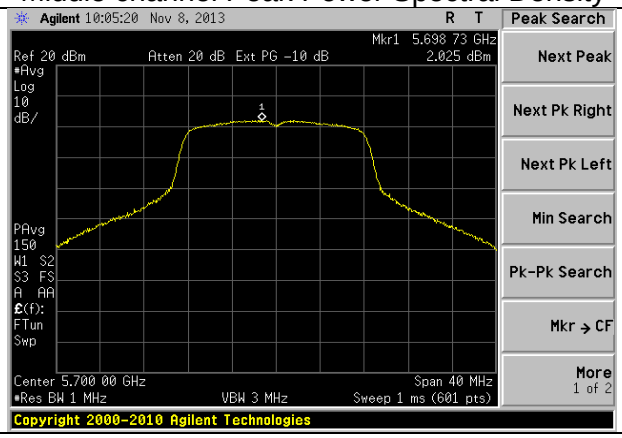
Middle channel Output Power



Middle channel Peak Power Spectral Density

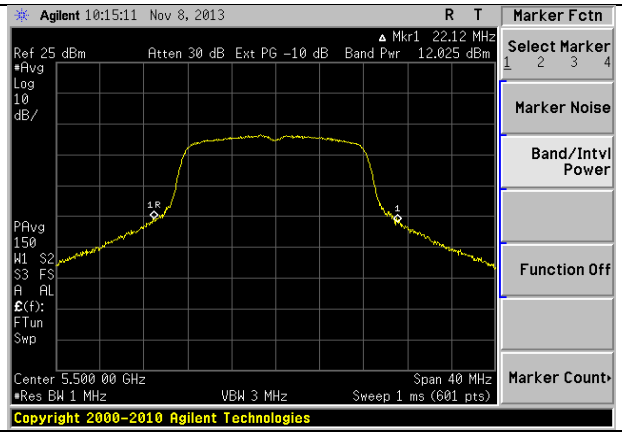


High channel Output Power

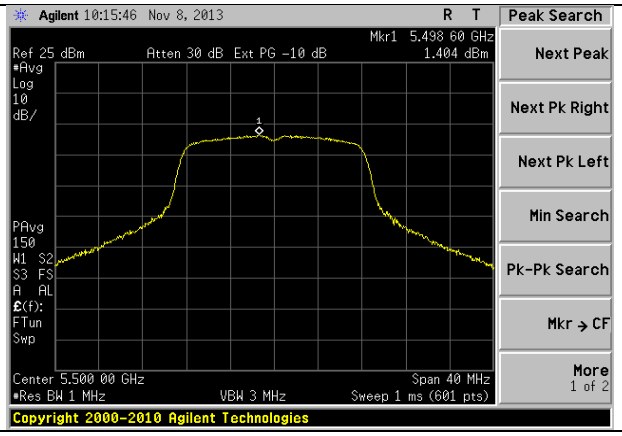


High channel Peak Power Spectral Density

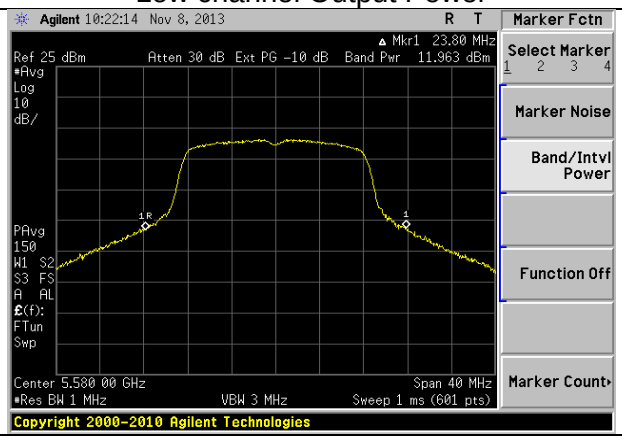
8.4.3.3 802.11 a 24MBPS



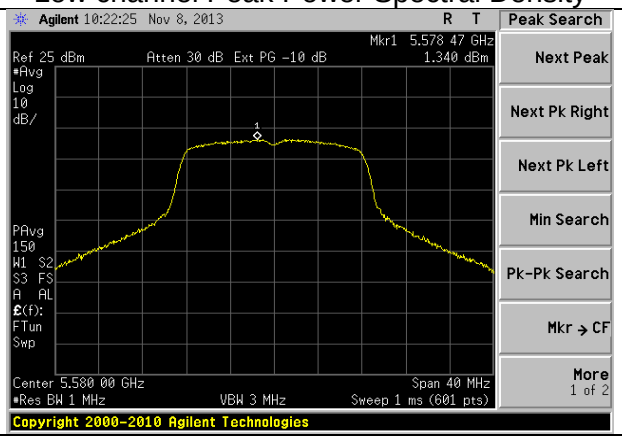
Low channel Output Power



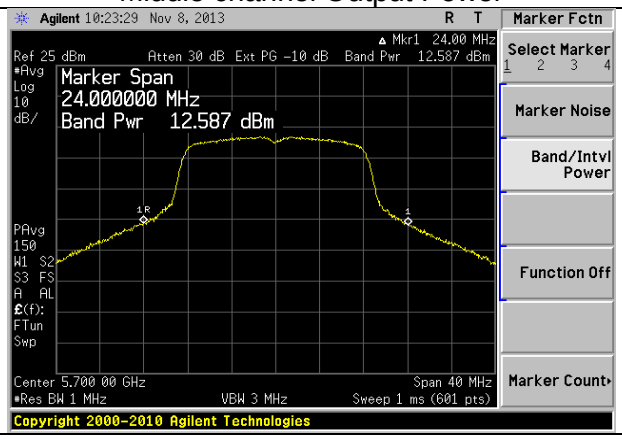
Low channel Peak Power Spectral Density



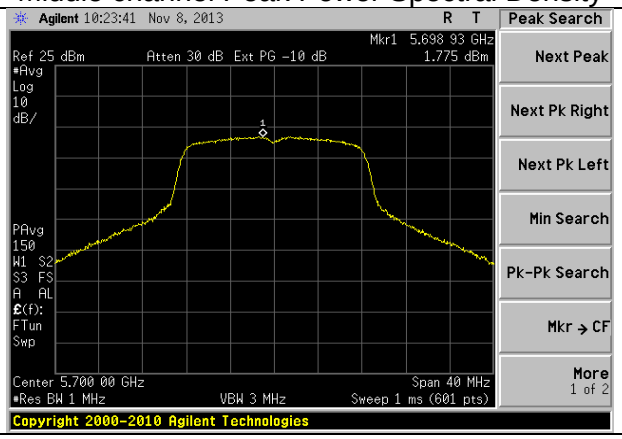
Middle channel Output Power



Middle channel Peak Power Spectral Density

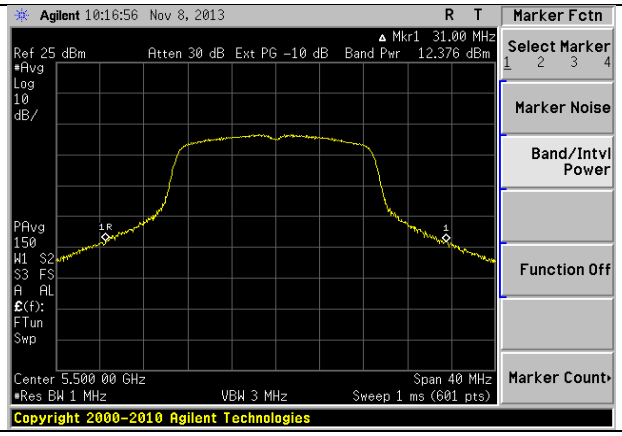


High channel Output Power

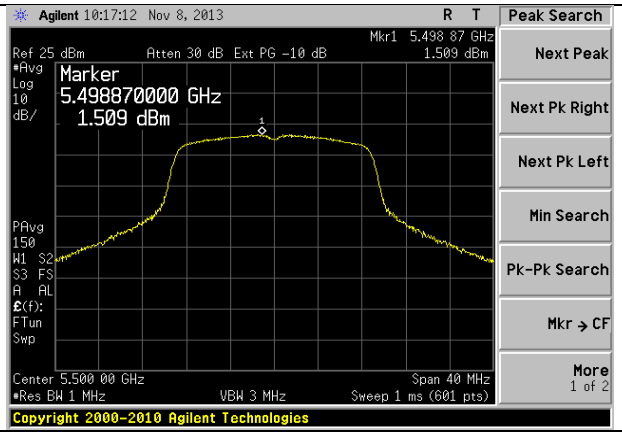


High channel Peak Power Spectral Density

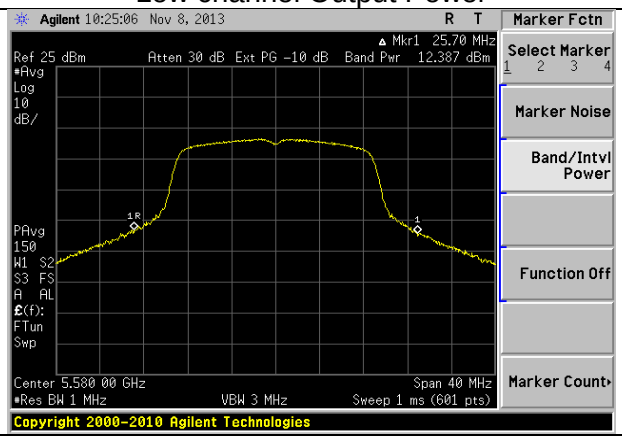
8.4.3.4 802.11 n MCS0



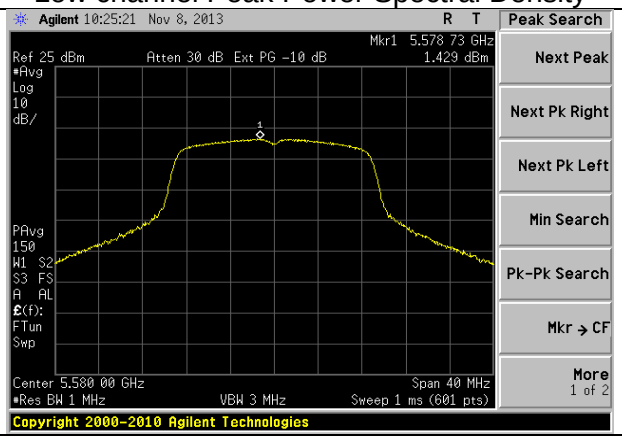
Low channel Output Power



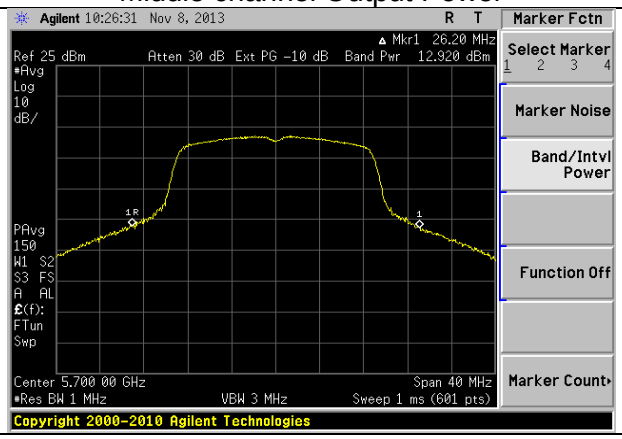
Low channel Peak Power Spectral Density



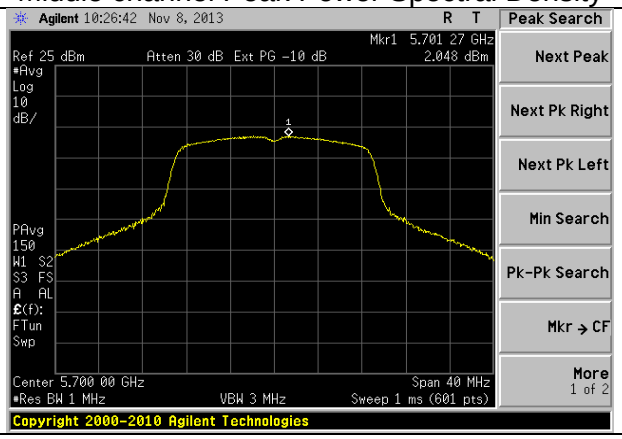
Middle channel Output Power



Middle channel Peak Power Spectral Density

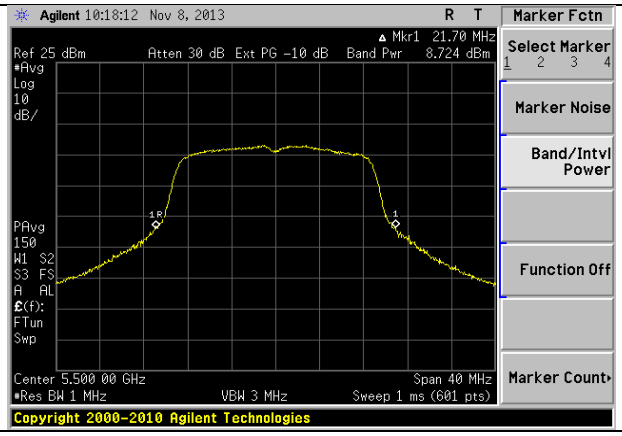


High channel Output Power

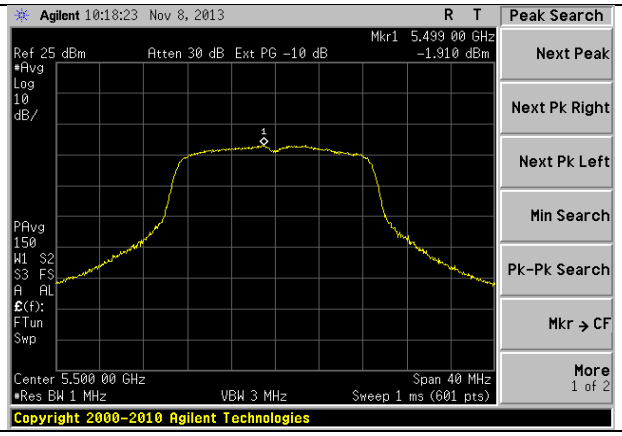


High channel Peak Power Spectral Density

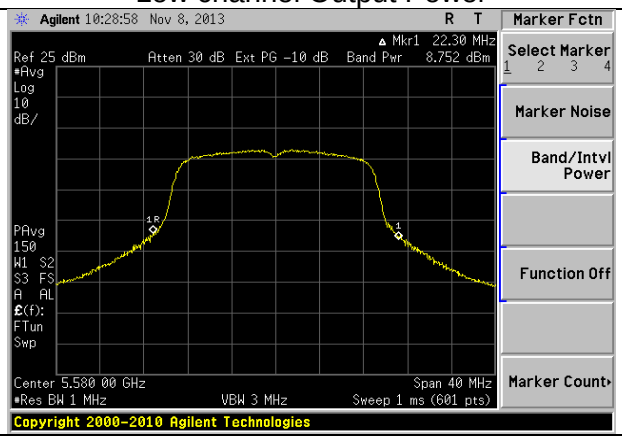
8.4.3.5 802.11 n MCS7



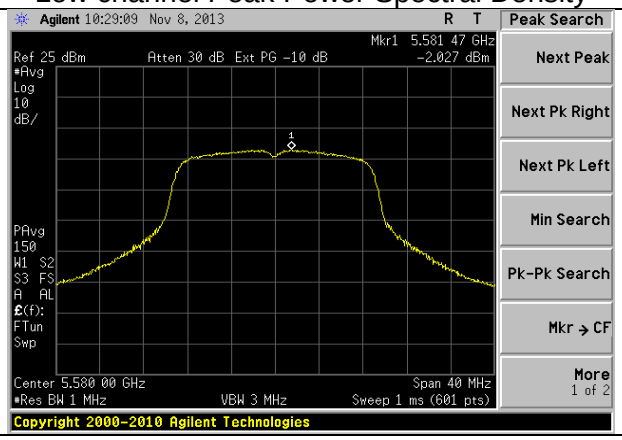
Low channel Output Power



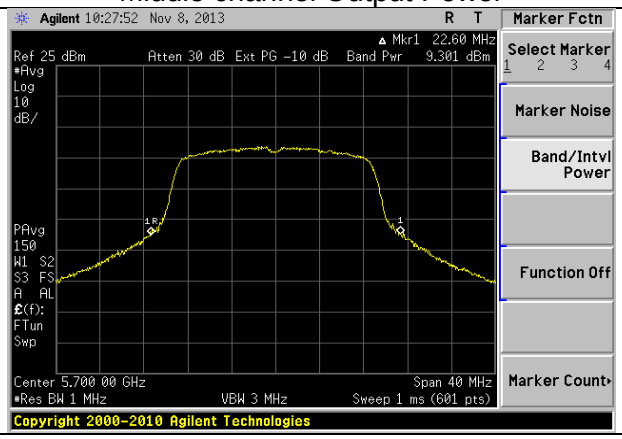
Low channel Peak Power Spectral Density



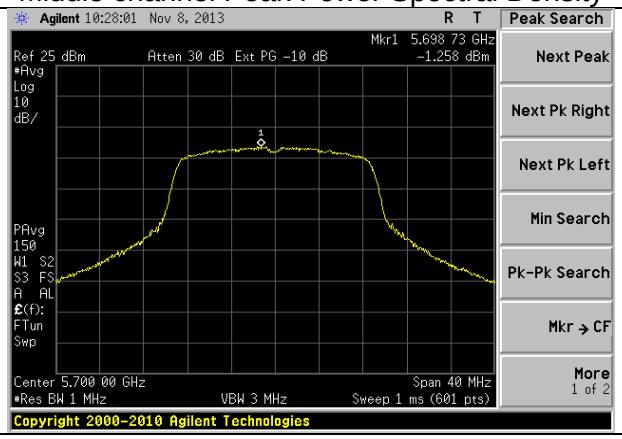
Middle channel Output Power



Middle channel Peak Power Spectral Density



High channel Output Power



High channel Peak Power Spectral Density

EXHIBIT 9. Peak Excursion Ratio

Test Engineer: Khairul Aidi Zainal

9.1 Test Procedure

KDB 789033 D01 v01r03 section G. Per measurement method, testing on separate modulation mode on a single channel is sufficient to demonstrate compliance with the peak excursion requirements.

9.2 Limit

The ratio of the peak excursion of the modulation envelope to the maximum conducted output power shall not exceed 13dB across any 1 MHz bandwidth or the emission bandwidth, whichever is less.

9.3 Test Data

The data reported includes all necessary correction factors. These correction factors are loaded onto the EMI receiver when measurements are performed.

Reported Measurement data = Raw receiver measurement (dBm) + Cable factor (dB) + Miscellaneous factors when applicable (dB).

Generic example of reported data:

Reported Measurement data = 8.55 (raw receiver measurement in dBm) + 0.85 (cable factor in dB) = 9.4 (dBm).

Sample calculation for PPSD value:

PPSD (dBm) = SA reading + cable correction factor + duty cycle correction factor
PPSD = -3.71dBm + 1.39dB + 0.51dB (duty cycle correction) = -1.8dBm

Sample calculation for peak excursion:

Peak Excursion = Maximum Peak Hold (dBm) – Peak PSD (dBm)
Peak Excursion = 7.4 dBm (Maximum Peak Hold) – -0.9dBm(PPSD) = 8.3dBm

9.3.1. Operation in the 5.15 – 5.25 GHz band

Data Rate (MBPS)	Channel	Frequency (MHz)	PPSD (dBm)	Maximum Peak Hold (dBm)	Peak Excursion (dB)	Peak Excursion Limit (dB)	Peak Excursion Margin (dB)
6	40	5200	1.1	9.6	8.5	13	4.5
12	40	5200	1.3	9.6	8.3	13	4.7
24	40	5200	1.4	9.5	8.0	13	5.0
6.5	40	5200	1.0	8.8	7.8	13	5.2
65	40	5200	0.6	9.7	9.1	13	3.9

9.3.2 Operation in the 5.25 – 5.35 GHz band

Data Rate (MBPS)	Channel	Frequency (MHz)	PPSD (dBm)	Maximum Peak Hold (dBm)	Peak Excursion (dB)	Peak Excursion Limit (dB)	Peak Excursion Margin (dB)
6	60	5300	2.0	10.0	8.0	13	5.0
12	60	5300	2.3	11.5	9.2	13	3.8
24	60	5300	2.3	11.2	8.9	13	4.1
6.5	60	5300	1.6	10.2	8.6	13	4.4
65	60	5300	-0.4	9.2	9.6	13	3.4

9.3.3 Operation in the 5.47 – 5.725 GHz band

Data Rate (MBPS)	Channel	Frequency (MHz)	PPSD (dBm)	Maximum Peak Hold (dBm)	Peak Excursion (dB)	Peak Excursion Limit (dB)	Peak Excursion Margin (dB)
6	116	5580	1.3	9.3	8.0	13	5.0
12	116	5580	1.8	11.2	9.4	13	3.6
24	116	5580	1.8	10.1	8.3	13	4.8
6.5	116	5580	1.5	9.4	7.9	13	5.1
65	116	5580	-0.9	7.4	8.3	13	4.7

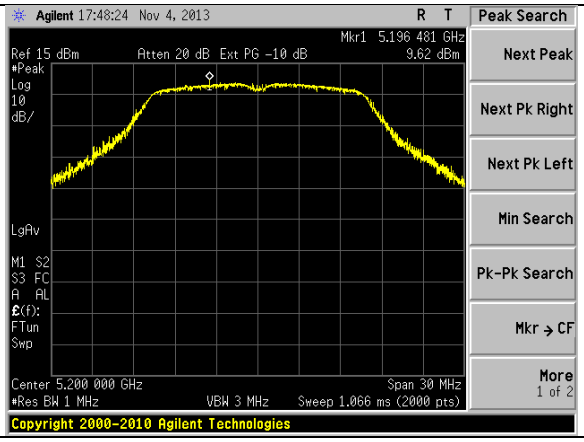
Sample calculation for peak excursion:

Peak Excursion (Channel 116/65MBPS) = 7.4 dBm (Maximum Peak Hold) – -0.9dBm(PPSD) = 8.3dBm

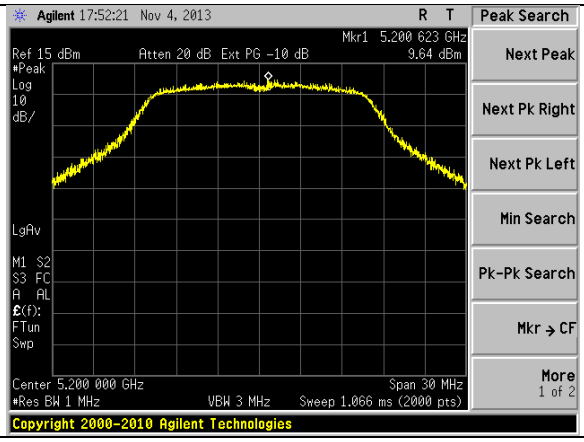
9.4 Screen Captures

The screen captures are of the 'Peak Max Hold' plot. The Peak PSD (corrected for Duty cycle) value is then subtracted from this peak value to get Peak Excursion.

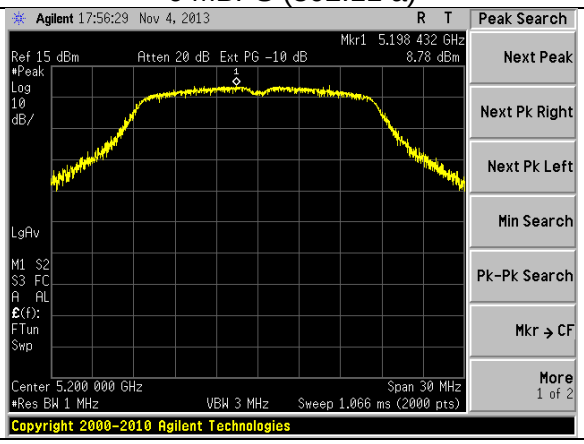
9.4.1 Operation in the 5.15 – 5.25 GHz band



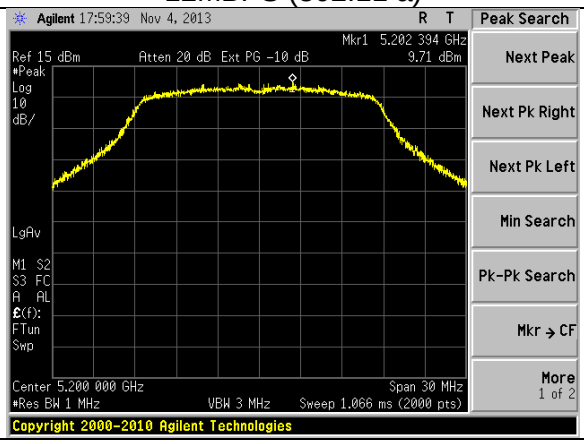
6 MBPS (802.11 a)



12MBPS (802.11 a)

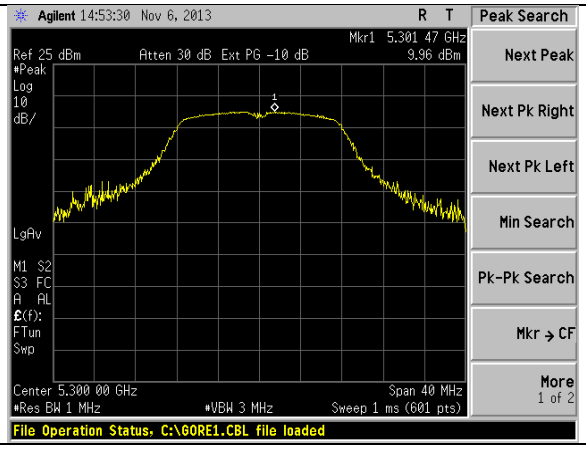


MCS0 (802.11 n)

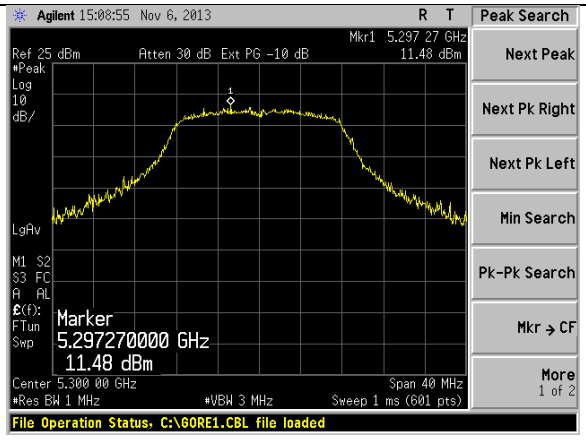


MCS7 (802.11 n)

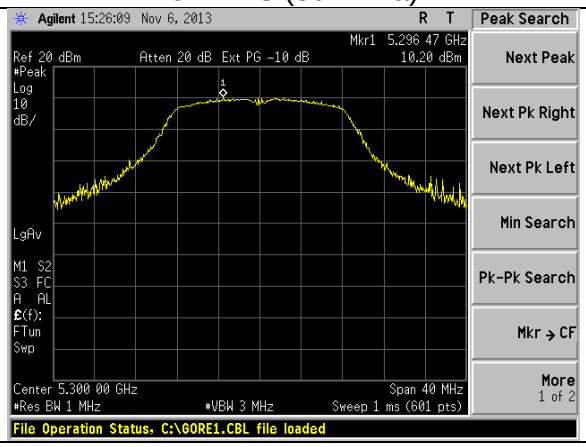
9.4.2 Operation in the 5.25 – 5.35 GHz band



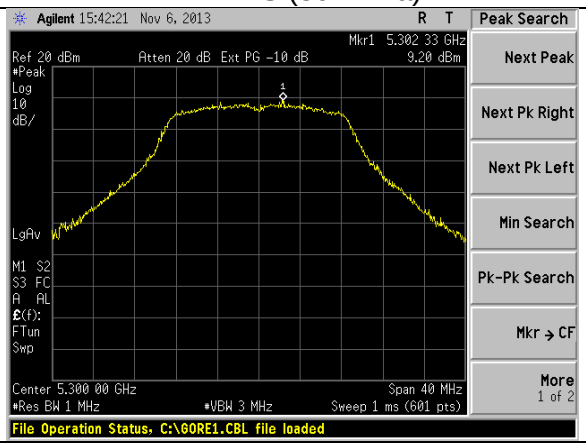
6 MBPS (802.11 a)



12MBPS (802.11 a)

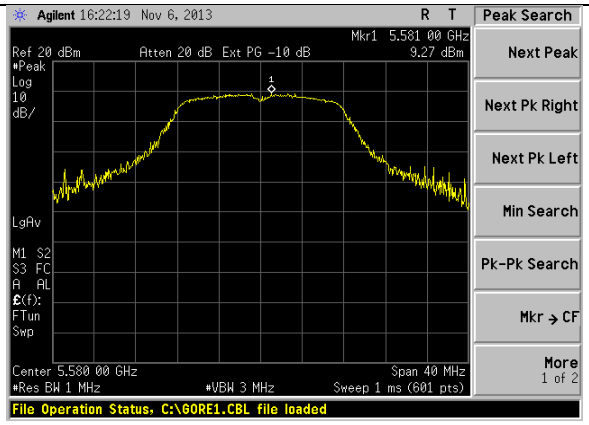


MCS0 (802.11 n)

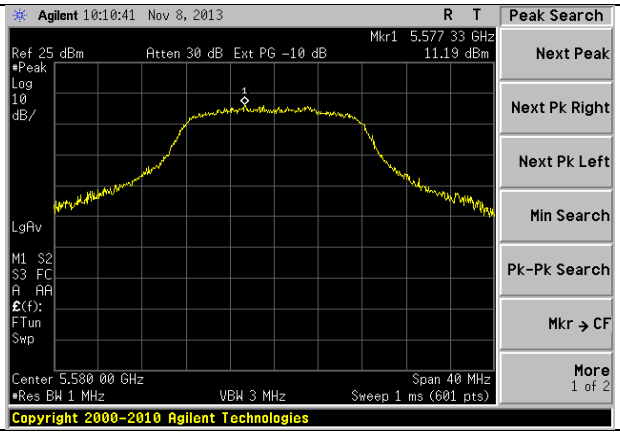


MCS7 (802.11 n)

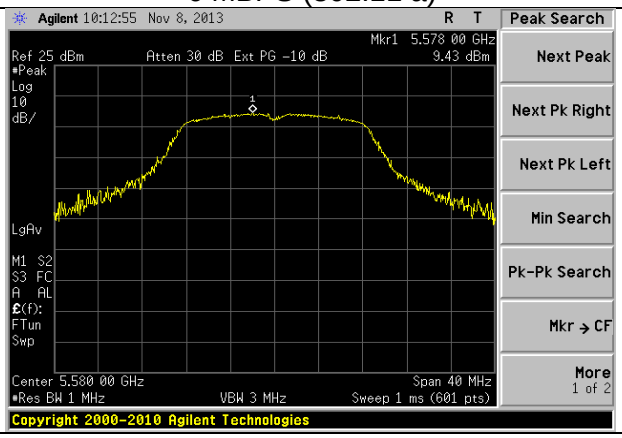
9.4.3 Operation in the 5.47 – 5.725 GHz band



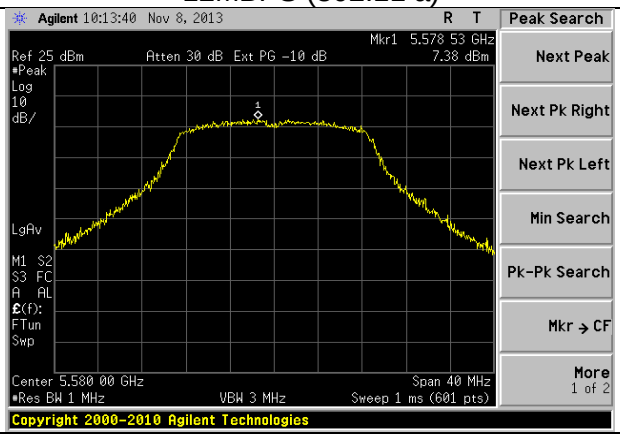
6 MBPS (802.11 a)



12MBPS (802.11 a)



MCS0 (802.11 n)



MCS7 (802.11 n)

EXHIBIT 10 Spurious Emissions

Test Engineers: Khairul Aidi Zainal, Adam Alger

10.1 Test Procedure

1. KDB 789033 D01 section H.
2. ANSI C63.4-2003

The unwanted emissions measurements both in the restricted and non-restricted bands were performed via antenna-port conducted measurements in conjunction with cabinet emissions test. In the cabinet emissions tests, the EUT antenna was replaced with a termination matching the nominal impedance of the antenna.

Sample calculations of reported data are presented in the respective section.

10.2 Limits

10.2.1 Operation in the 5150 to 5250 MHz band

All emissions outside of the 5150 to 5350 MHz band shall not exceed an EIRP of -27dBm.

Emissions in the restricted band shall comply with the general emissions limit:

For below 1000 MHz, the limits are:

30 to 88 MHz
Quasi Peak Limit at 3m
EIRP (dBm) = E (dBµV/m) – 95.2 = 40.0 -95.2 = -55.2 dBm

88 to 216 MHz
Quasi Peak Limit at 3m
EIRP (dBm) = E (dBµV/m) – 95.2 = 43.0 -95.2 = -52.2 dBm

216 to 960 MHz
Quasi Peak Limit at 3m
EIRP (dBm) = E (dBµV/m) – 95.2 = 46.0 -95.2 = -49.2 dBm

For above 960 MHz, the limits are:

Peak Limit = 74dBµV/m at 3m
EIRP (dBm) = E (dBµV/m) – 95.2 = 74 -95.2 = -21.2 dBm

Average Limit = 54dBµV/m at 3m
EIRP (dBm) = E (dBµV/m) – 95.2 = 54 -95.2 = -41.2 dBm

10.2.2 Operation in the 5250 to 5350 MHz band

All emissions outside of the 5150 to 5350 MHz band shall not exceed an EIRP of -27dBm.
Devices operating in the 5250 to 5350 MHz band that generate emissions in the 5150 to 5250 MHz band must meet all applicable technical requirements for operation in the 5150 to 5250 MHz band (including indoor use) or alternatively meet an out of band emission EIRP limit of -27dBm/MHz in the 5150 to 5250 MHz band.

Emissions in the restricted band shall comply with the general emissions limit:

For below 1000 MHz, the limits are:

30 to 88 MHz
Quasi Peak Limit at 3m
EIRP (dBm) = E (dBµV/m) – 95.2 = 40.0 -95.2 = -55.2 dBm

88 to 216 MHz
Quasi Peak Limit at 3m
EIRP (dBm) = E (dBµV/m) – 95.2 = 43.0 -95.2 = -52.2 dBm

216 to 960 MHz
Quasi Peak Limit at 3m
EIRP (dBm) = E (dBµV/m) – 95.2 = 46.0 -95.2 = -49.2 dBm

For above 960 MHz, the limits are:

Peak Limit = 74dBµV/m at 3m
EIRP (dBm) = E (dBµV/m) – 95.2 = 74 -95.2 = -21.2 dBm

Average Limit = 54dBµV/m at 3m
EIRP (dBm) = E (dBµV/m) – 95.2 = 54 -95.2 = -41.2 dBm

10.2.3 Operation in the 5470 to 5725 MHz band

All emissions outside of the 5150 to 5350 MHz band shall not exceed an EIRP of -27dBm

Emissions in the restricted band shall comply with the general emissions limit:

For below 1000 MHz, the limits are:

30 to 88 MHz
Quasi Peak Limit at 3m
EIRP (dBm) = E (dBµV/m) – 95.2 = 40.0 -95.2 = -55.2 dBm

88 to 216 MHz
Quasi Peak Limit at 3m
EIRP (dBm) = E (dBµV/m) – 95.2 = 43.0 -95.2 = -52.2 dBm

216 to 960 MHz
Quasi Peak Limit at 3m
EIRP (dBm) = E (dBµV/m) – 95.2 = 46.0 -95.2 = -49.2 dBm

For above 960 MHz, the limits are:

Peak Limit = 74dBµV/m at 3m
EIRP (dBm) = E (dBµV/m) – 95.2 = 74 -95.2 = -21.2 dBm

Average Limit = 54dBµV/m at 3m
EIRP (dBm) = E (dBµV/m) – 95.2 = 54 -95.2 = -41.2 dBm

10.2.4 Operation in the 5725 MHz to 5825 MHz 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 -17dBm/MHz.

For frequencies 10 MHz or greater above or below the band edge, emissions shall not exceed an EIRP of -27dBm/MHz.

Emissions in the restricted band shall comply with the general emissions limit:

For below 1000 MHz, the limits are:

30 to 88 MHz
Quasi Peak Limit at 3m
EIRP (dBm) = E (dBµV/m) – 95.2 = 40.0 -95.2 = -55.2 dBm

88 to 216 MHz
Quasi Peak Limit at 3m
EIRP (dBm) = E (dBµV/m) – 95.2 = 43.0 -95.2 = -52.2 dBm

216 to 960 MHz
Quasi Peak Limit at 3m
EIRP (dBm) = E (dBµV/m) – 95.2 = 46.0 -95.2 = -49.2 dBm

For above 960 MHz, the limits are:

Peak Limit = 74dBµV/m at 3m
EIRP (dBm) = E (dBµV/m) – 95.2 = 74 -95.2 = -21.2 dBm

Average Limit = 54dBµV/m at 3m
EIRP (dBm) = E (dBµV/m) – 95.2 = 54 -95.2 = -41.2 dBm

10.3 Test Data

10.3.1 Antenna port conducted measurements.

10.3.1.1 Operation in the 5150 to 5250 MHz band

10.3.1.1.1 Lower Band edge: 4500 to 5150 MHz (Restricted Band)

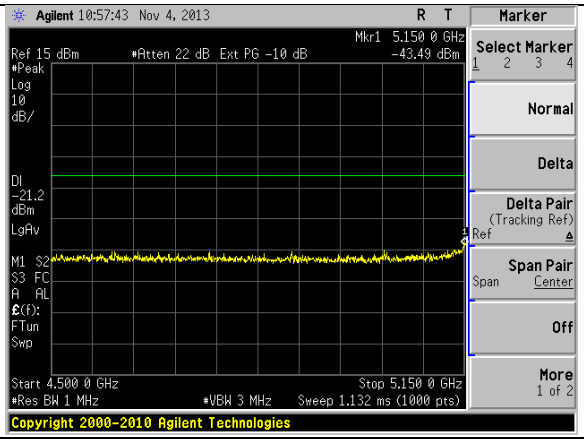
802.11 Standard	Data Rate (MBPS)	Peak data Frequency (MHz)	Restricted band Band-edge: Peak (dBm)	Average data Frequency (MHz)	Restricted band Band-edge: Avg (dBm)	Duty Cycle correction for average measureme	Antenna gain (dBi)	Final peak Band-edge	Peak Limit (dBm)	Peak Margin (dB)	Final average Band-	Average Limit (dBm)	Average Margin (dB)
a	6	5150.0	-43.5	5150.0	-52.9	0.1	4.5	-39.0	-21.2	17.8	-48.2	-41.2	7.0
a	12	5150.0	-42.6	5150.0	-53.0	0.3	4.5	-38.1	-21.2	16.9	-48.2	-41.2	7.0
a	24	5150.0	-44.4	5150.0	-53.2	0.5	4.5	-39.9	-21.2	18.7	-48.2	-41.2	7.0
n	MCSO	5144.4	-42.3	5150.0	-52.8	0.1	4.5	-37.8	-21.2	16.6	-48.2	-41.2	6.9
n	MCS7	5150.0	-45.2	5150.0	-54.0	1.1	4.5	-40.7	-21.2	19.5	-48.4	-41.2	7.2

Generic sample calculation:

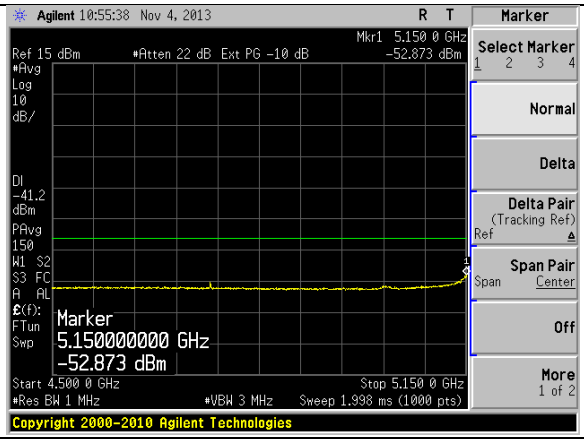
Final Peak Band-edge = Peak measurement (dBm) + antenna gain (dBi)
= -43.5 + 4.5 = -39.0 (dBm)

Final Average Band-edge = Average measurement (dBm) + Duty cycle correction (dB) + antenna gain (dBi)
= -52.9 + 0.1 + 4.5 = -48.2 (dBm)

6 MBPS

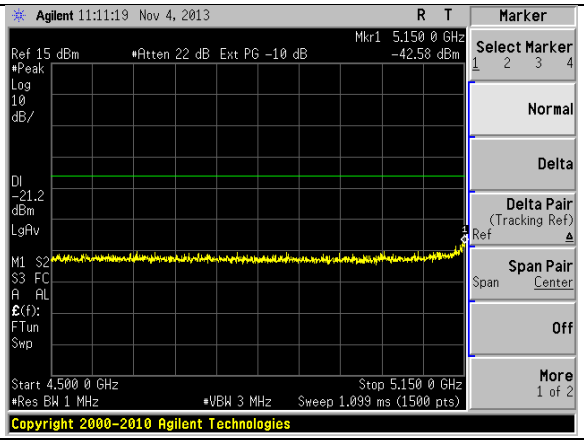


Peak

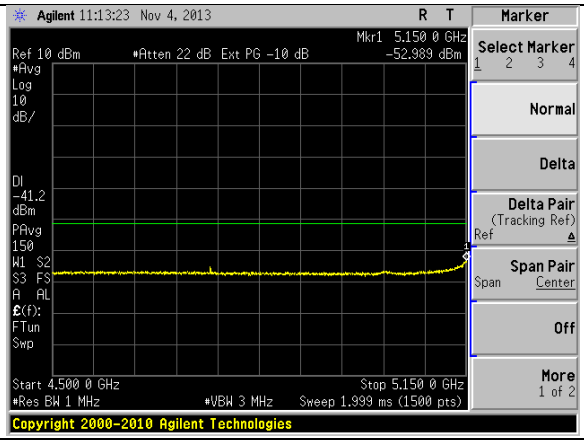


Average

12 MBPS

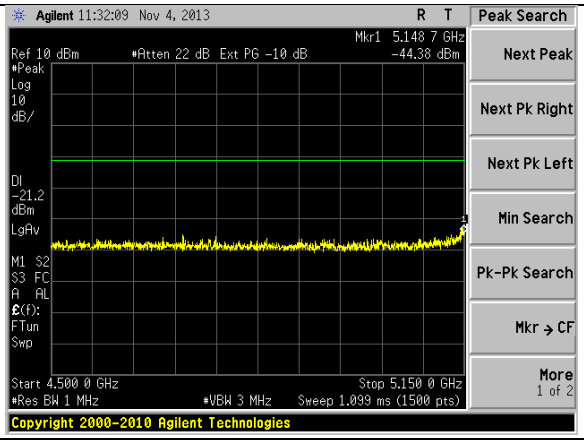


Peak

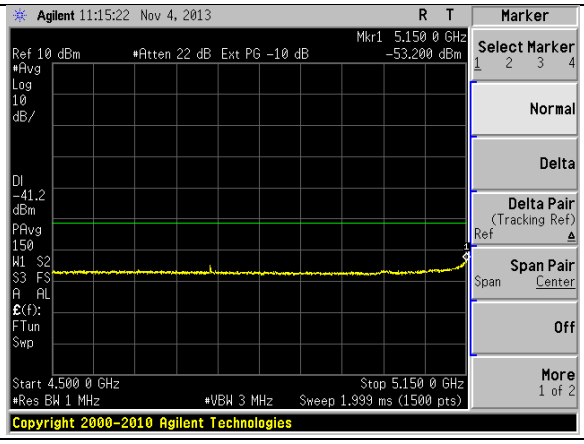


Average

24 MBPS

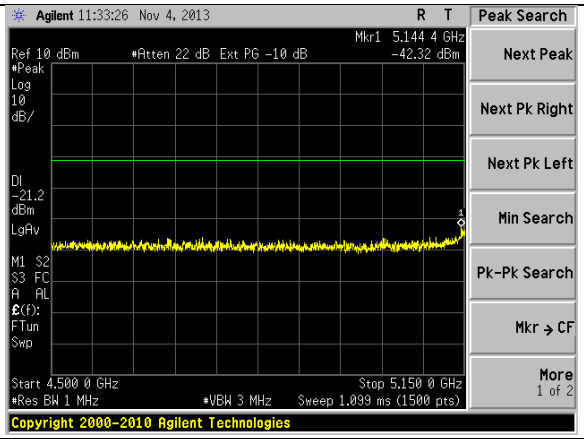


Peak

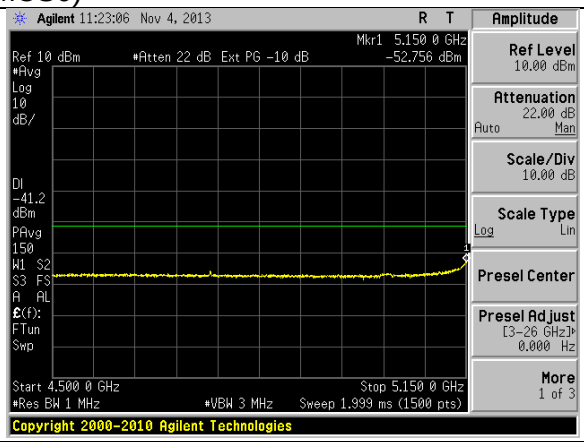


Average

6.5 MBPS (MCS0)

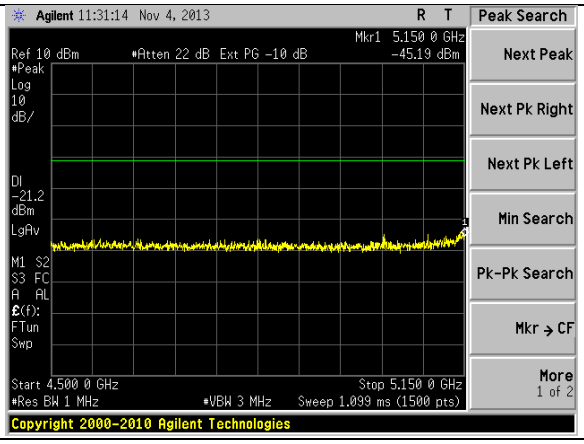


Peak

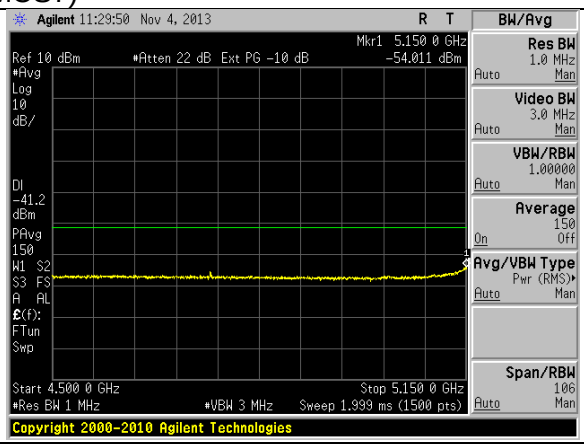


Average

65 MBPS (MCS7)



Peak



Average

10.3.1.1.2 Upper Band edge: 5350 to 5460 MHz (Restricted Band)

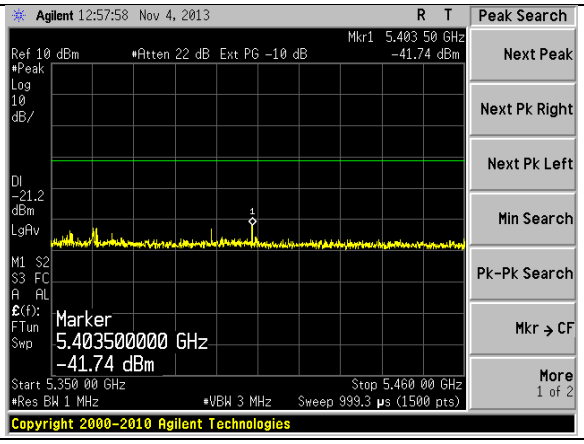
802.11 Standard	Data Rate (MBPS)	Peak data Frequency (MHz)	Restricted band Band-edge: Peak (dBm)	Average data Frequency (MHz)	Restricted band Band-edge: Avg (dBm)	Duty Cycle correction for average measureme	Antenna gain (dBi)	Final peak Band-edge	Peak Limit (dBm)	Peak Margin (dB)	Final average Band-	Average Limit (dBm)	Average Margin (dB)
a	6	5403.5	-41.7	5395.4	-55.9	0.1	4.5	-37.2	-21.2	16.0	-51.3	-41.2	10.0
a	12	5399.4	-39.4	5399.5	-55.2	0.3	4.5	-34.9	-21.2	13.6	-50.4	-41.2	9.2
a	24	5395.8	-40.4	5395.1	-55.6	0.5	4.5	-35.9	-21.2	14.7	-50.6	-41.2	9.4
n	MCSO	5398.4	-39.7	5398.7	-55.6	0.1	4.5	-35.2	-21.2	13.9	-51.0	-41.2	9.8
n	MCS7	5399.5	-39.8	5395.9	-55.7	1.1	4.5	-35.3	-21.2	14.0	-50.1	-41.2	8.9

Generic sample calculation:

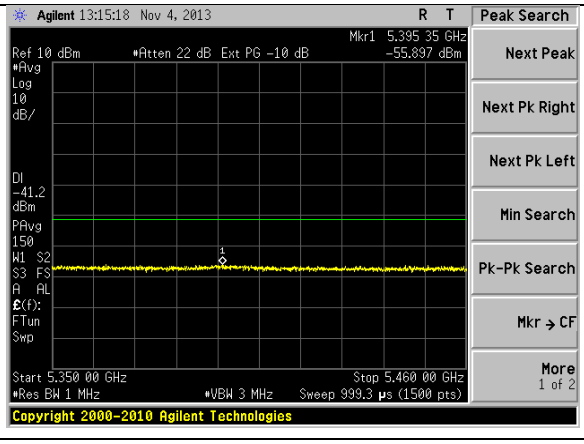
Final Peak Band-edge = Peak measurement (dBm) + antenna gain (dBi)
= -43.5 + 4.5 = -39.0 (dBm)

Final Average Band-edge = Average measurement (dBm) + Duty cycle correction (dB) + antenna gain (dBi)
= -52.9 + 0.1 + 4.5 = -48.2 (dBm)

6 MBPS

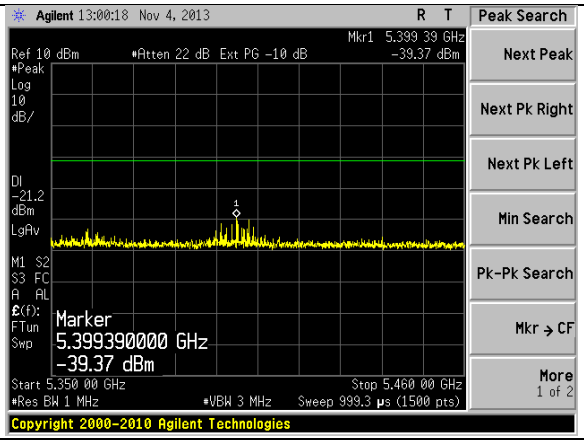


Peak

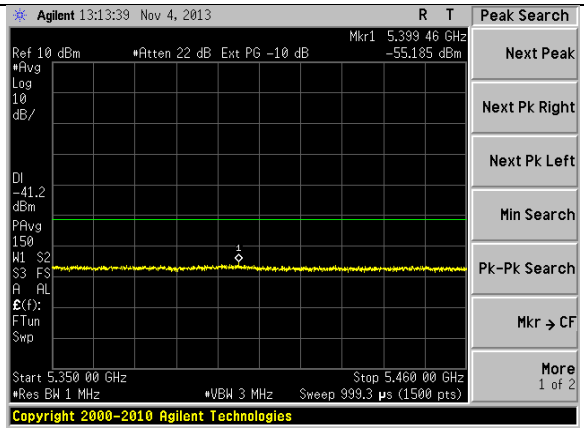


Average

12 MBPS

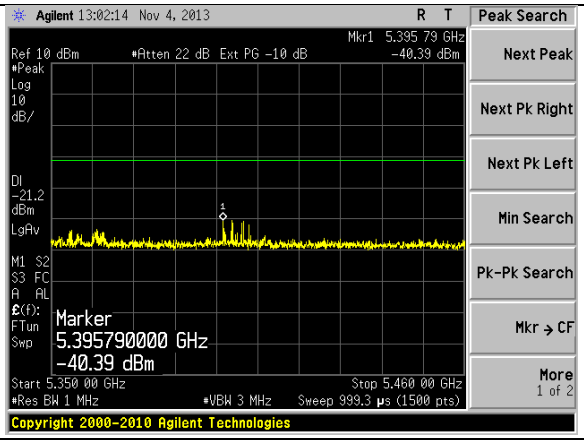


Peak

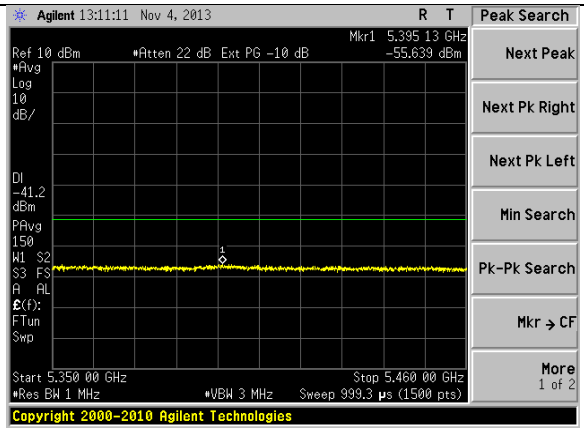


Average

24 MBPS

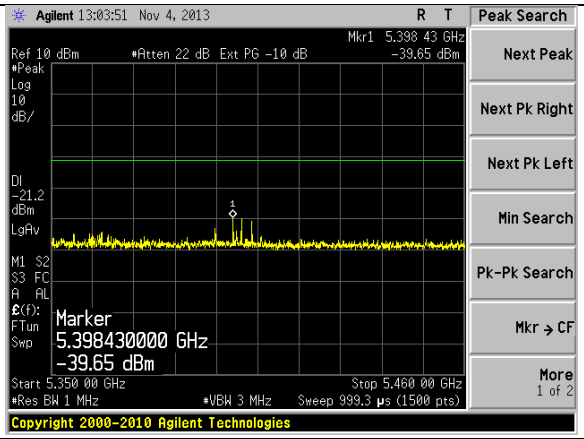


Peak

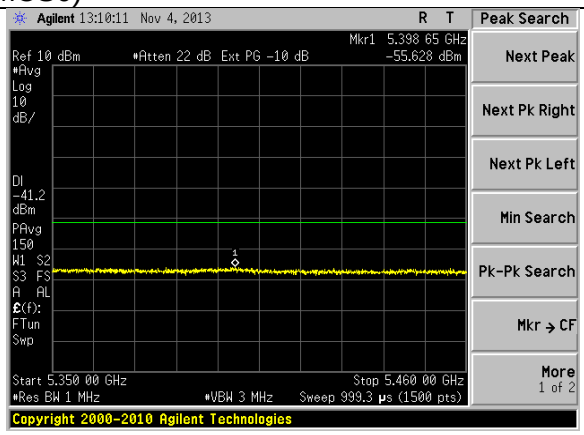


Average

6.5 MBPS (MCS0)

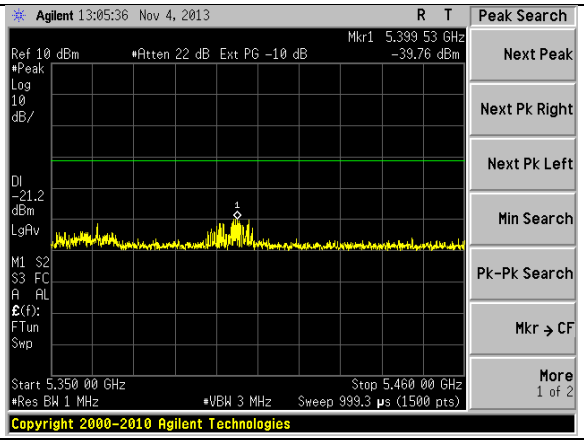


Peak

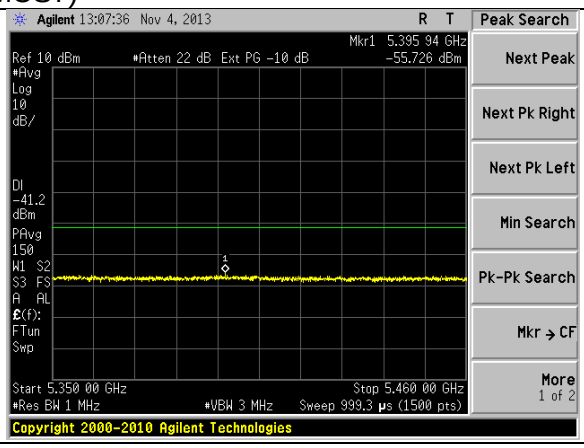


Average

65 MBPS (MCS7)



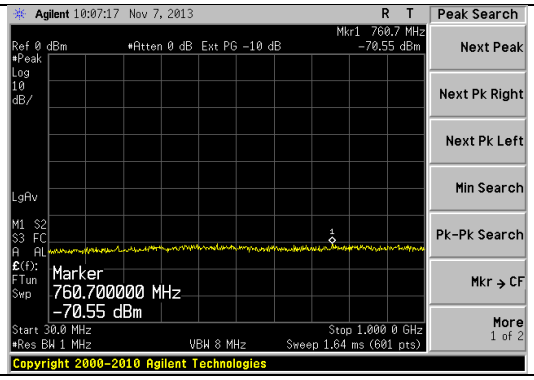
Peak



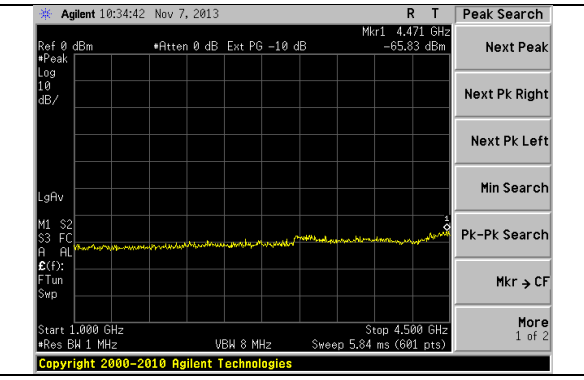
Average

10.3.1.1.3 Unwanted Emissions other than band-edges.

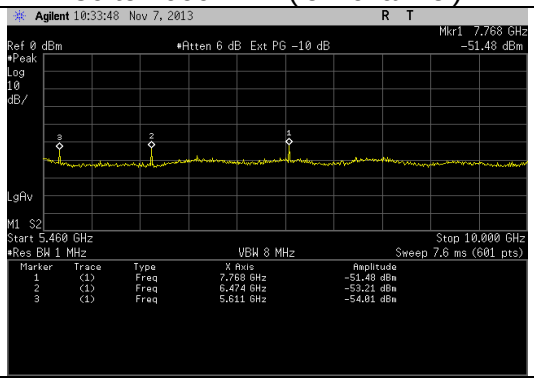
The plots shown below are those of 6MBPS which is representative of the worst case.



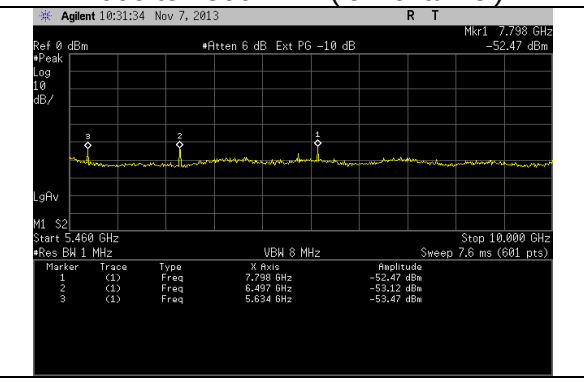
30 to 1000 MHz (low channel)



1000 to 4500 MHz (low channel)

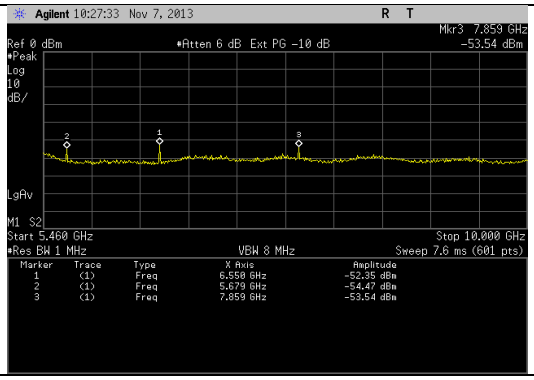


5460 to 10000 MHz (low channel)

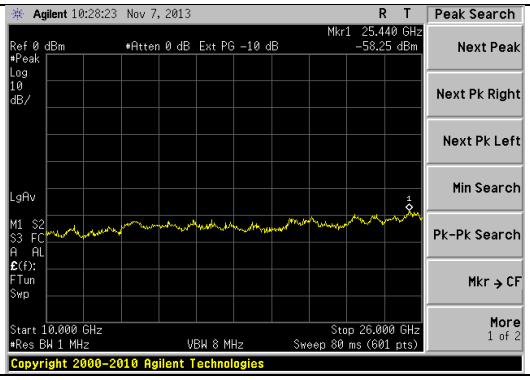


5460 to 10000 MHz (middle channel)

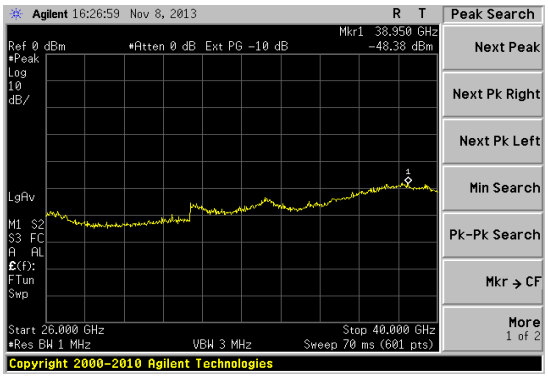
Note: The band edges are shown in the preceding section.



5460 to 10000 MHz (high channel)



10000 to 26000 MHz (high Channel)



26000 to 40000 MHz

10.3.1.2 Operation in the 5250 to 5350 MHz band

10.3.1.2.1 Lower Band-edge: 5150 to 5250 MHz

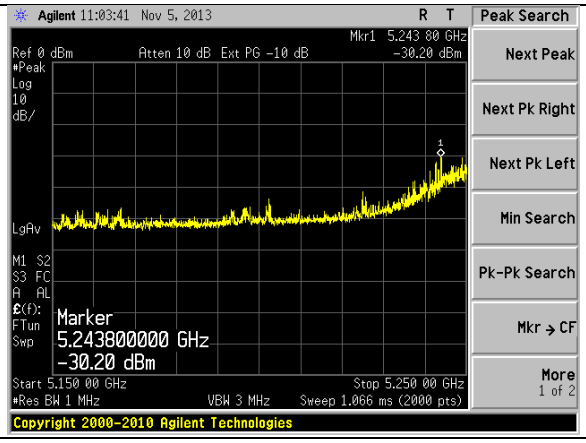
802.11 Standard	Data Rate (MBPS)	Peak data Frequency (MHz)	Band-edge: Peak (dBm)	Average data Frequency (MHz)	Band-edge: Avg (dBm)	Duty Cycle correction for average measureme	Antenna gain (dBi)	Final peak Band-edge	Peak Limit (dBm)	Peak Margin (dB)	Final average Band-	Average Limit (dBm)	Average Margin (dB)
a	6	5243.8	-30.2	5249.7	-47.1	0.1	4.5	-25.7	-21.2	4.5	-42.5	-41.2	1.3
a	12	5247.7	-33.0	5250.0	-48.0	0.3	4.5	-28.5	-21.2	7.3	-43.2	-41.2	2.0
a	24	5250.0	-33.4	5249.5	-47.7	0.5	4.5	-28.9	-21.2	7.7	-42.7	-41.2	1.5
n	MCSO	5248.3	-31.2	5249.9	-47.5	0.1	4.5	-26.7	-21.2	5.5	-42.9	-41.2	1.7
n	MCS7	5249.8	-40.9	5250.0	-53.8	1.1	4.5	-36.4	-21.2	15.2	-48.2	-41.2	7.0

Generic sample calculation:

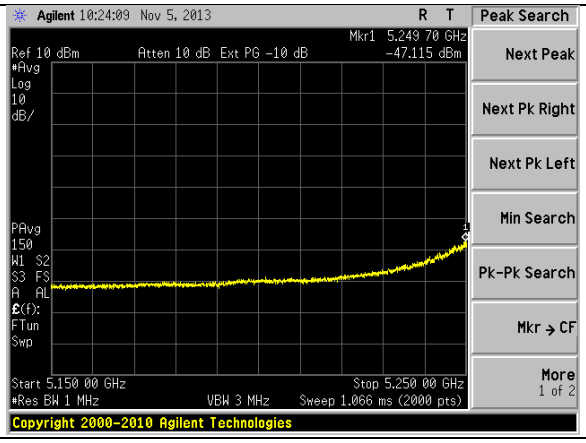
Final Peak Band-edge = Peak measurement (dBm) + antenna gain (dBi)
= -43.5 + 4.5 = -39.0 (dBm)

Final Average Band-edge = Average measurement (dBm) + Duty cycle correction (dB) + antenna gain (dBi)
= -52.9 + 0.1 + 4.5 = -48.2 (dBm)

6 MBPS

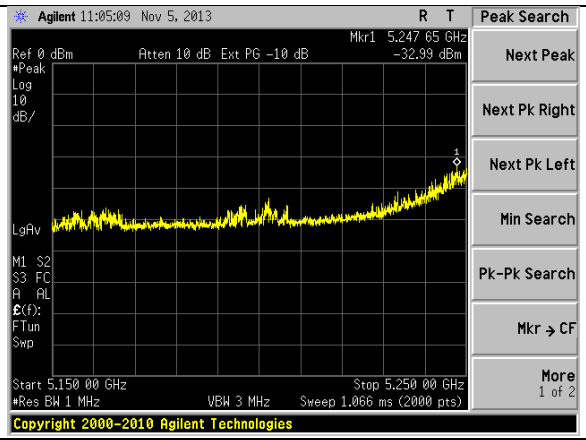


Peak

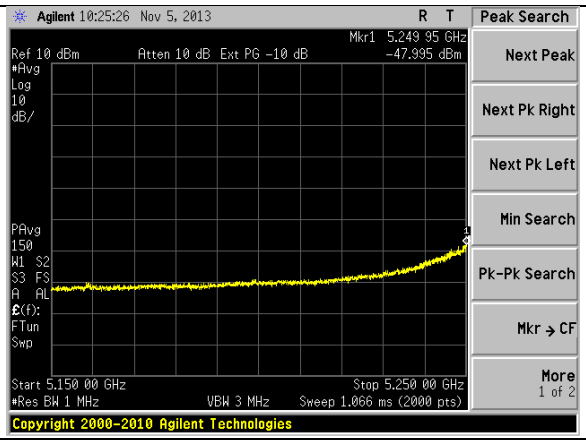


Average

12 MBPS

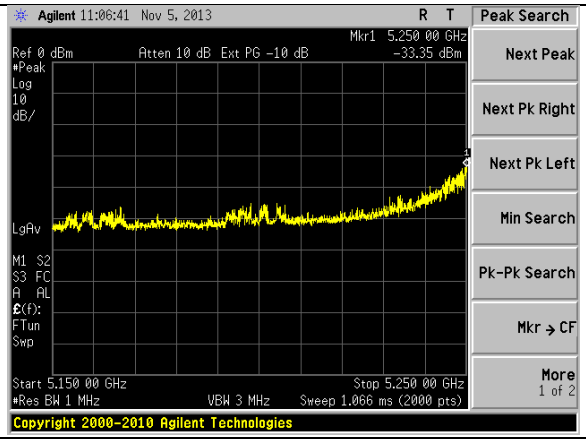


Peak

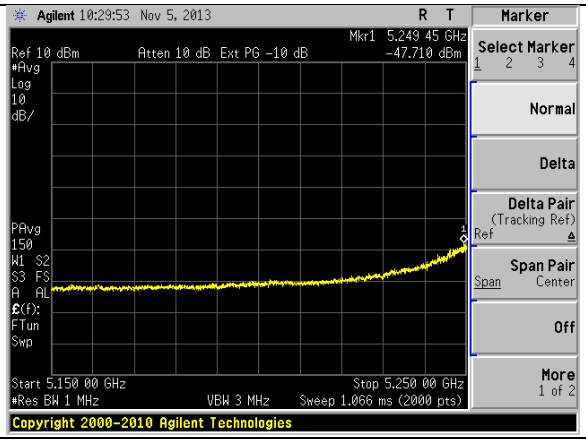


Average

24 MBPS

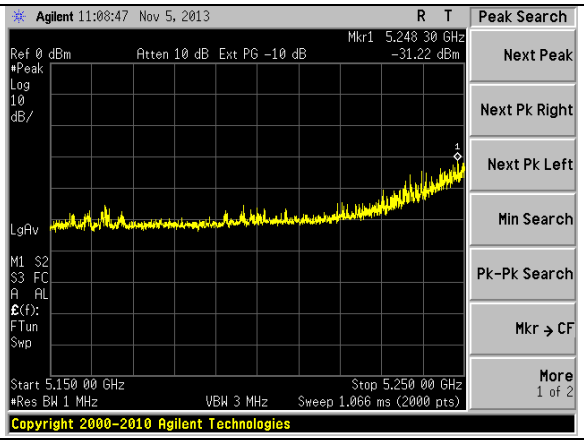


Peak

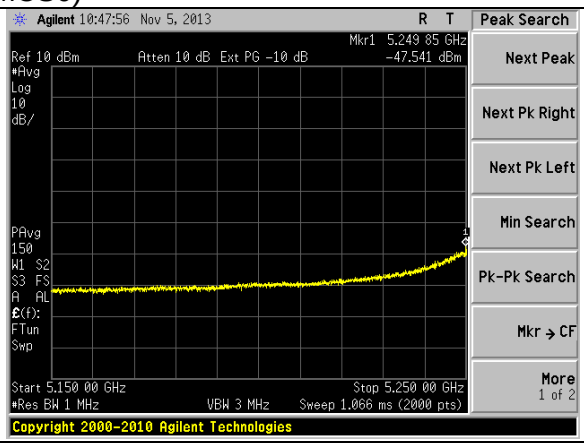


Average

6.5 MBPS (MCS0)

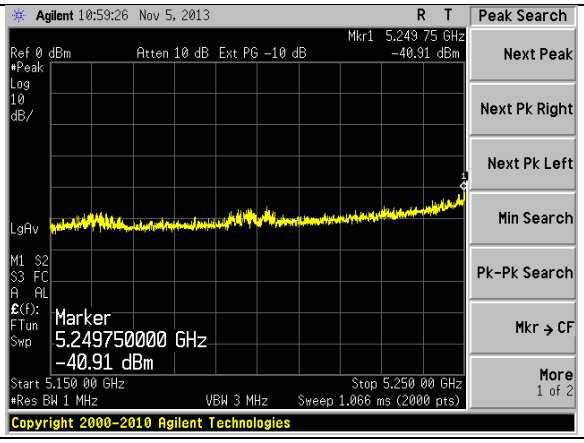


Peak

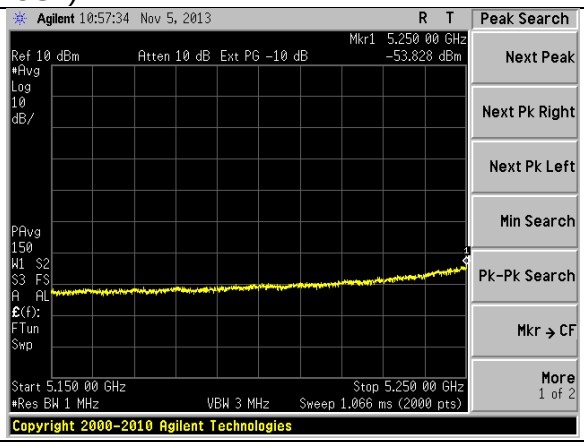


Average

65 MBPS (MCS7)



Peak



Average

10.3.1.2.2 Upper Band edge: 5350 to 5460 MHz (Restricted Band)

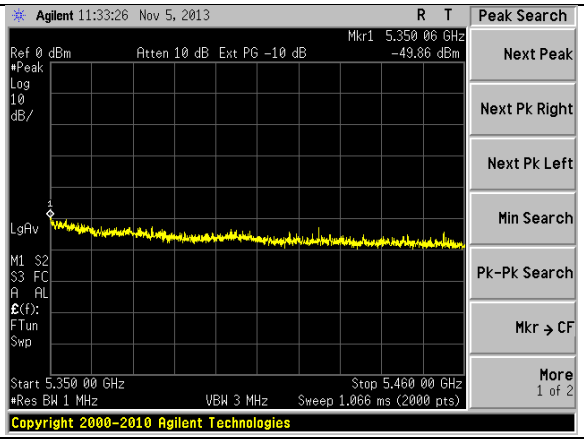
802.11 Standard	Data Rate (MBPS)	Peak data Frequency (MHz)	Restricted band Band-edge: Peak (dBm)	Average data Frequency (MHz)	Restricted band Band-edge: Avg (dBm)	Duty Cycle correction for average measureme	Antenna gain (dBi)	Final peak Band-edge	Peak Limit (dBm)	Peak Margin (dB)	Final average Band-	Average Limit (dBm)	Average Margin (dB)
a	6	5350.1	-49.9	5350.1	-51.8	0.1	4.5	-45.4	-21.2	24.1	-47.1	-41.2	5.9
a	12	5350.1	-35.4	5351.2	-52.0	0.3	4.5	-30.9	-21.2	9.7	-47.3	-41.2	6.0
a	24	5350.4	-35.5	5350.3	-50.9	0.5	4.5	-31.0	-21.2	9.7	-45.9	-41.2	4.7
n	MCSO	5351.2	-31.9	5350.9	-49.1	0.1	4.5	-27.4	-21.2	6.2	-44.5	-41.2	3.3
n	MCS7	5402.4	-42.5	5350.3	-56.1	1.1	4.5	-38.0	-21.2	16.7	-50.5	-41.2	9.3

Generic sample calculation:

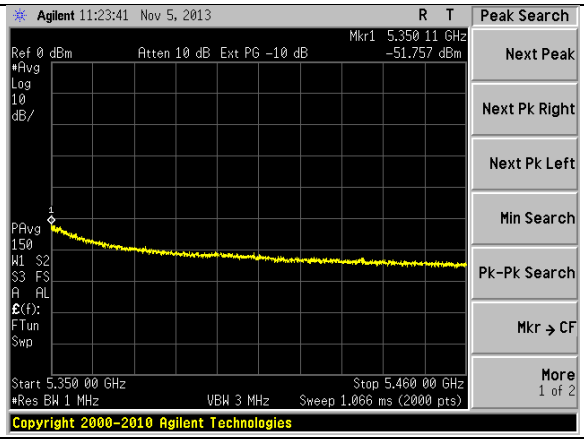
Final Peak Band-edge = Peak measurement (dBm) + antenna gain (dBi)
= -43.5 + 4.5 = -39.0 (dBm)

Final Average Band-edge = Average measurement (dBm) + Duty cycle correction (dB) + antenna gain (dBi)
= -52.9 + 0.1 + 4.5 = -48.2 (dBm)

6 MBPS

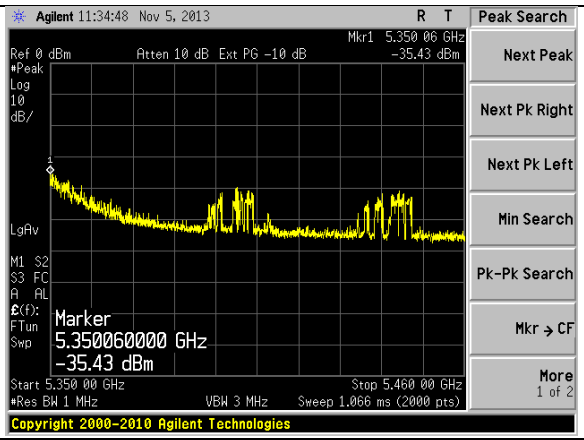


Peak

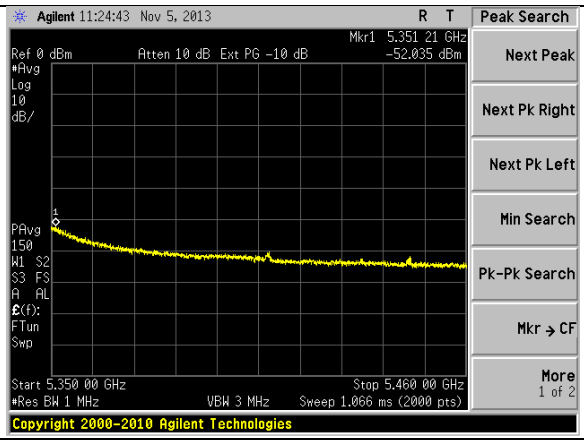


Average

12 MBPS

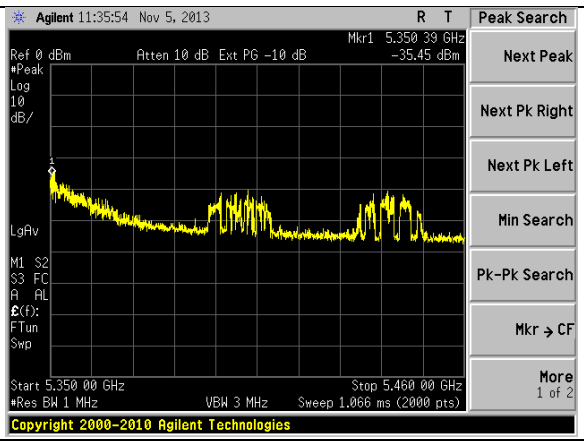


Peak

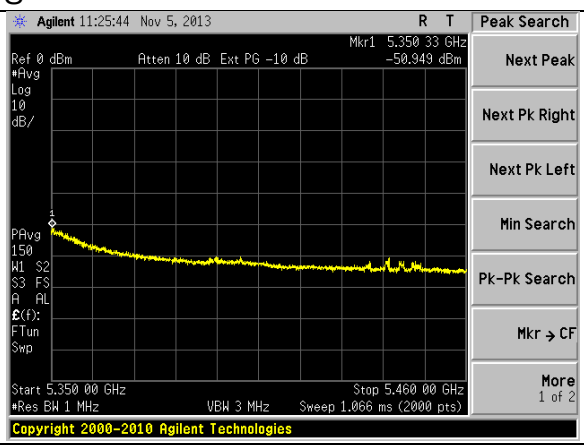


Average

24 MBPS

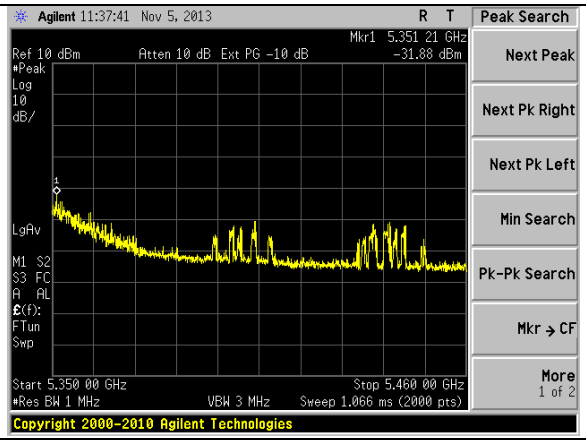


Peak

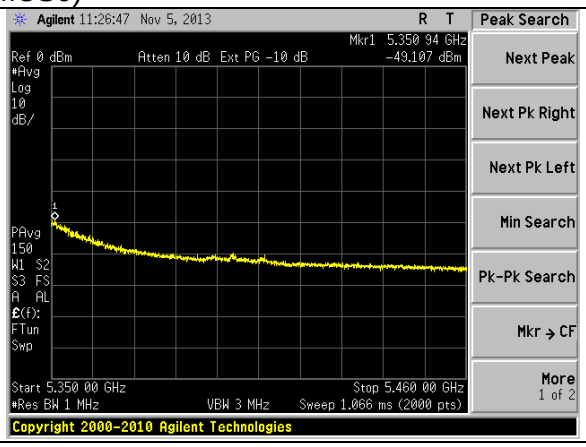


Average

6.5 MBPS (MCS0)

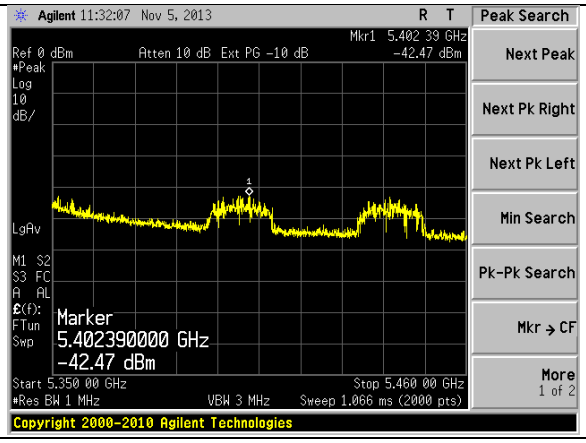


Peak

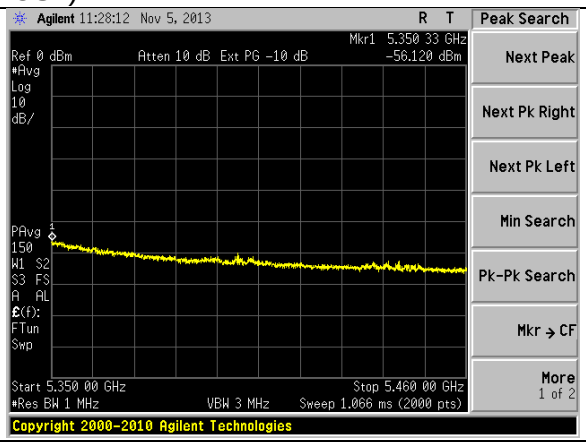


Average

65 MBPS (MCS7)



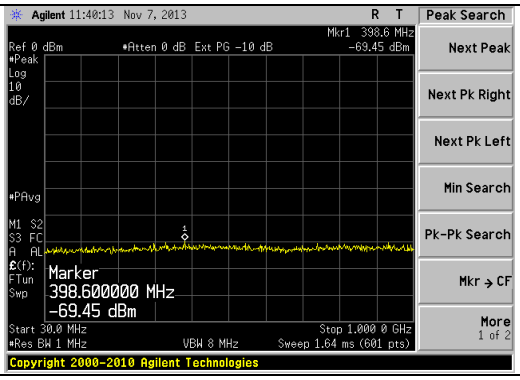
Peak



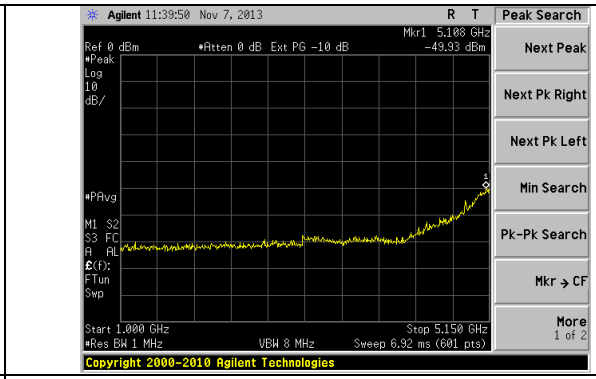
Average

10.3.1.2.3 Unwanted Emissions

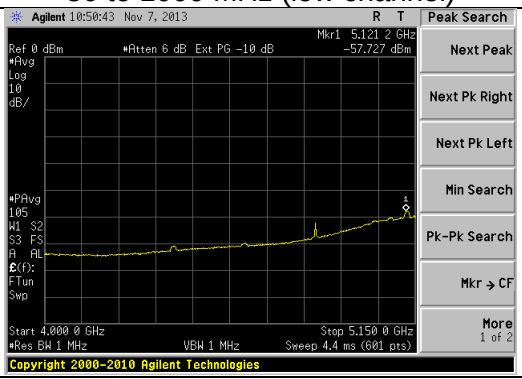
The plots shown below are those of 6MBPS which is representative of the worst case.



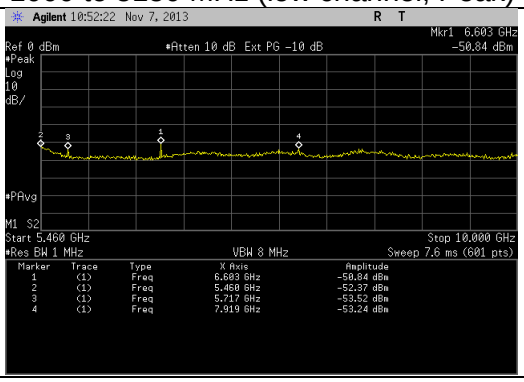
30 to 1000 MHz (low channel)



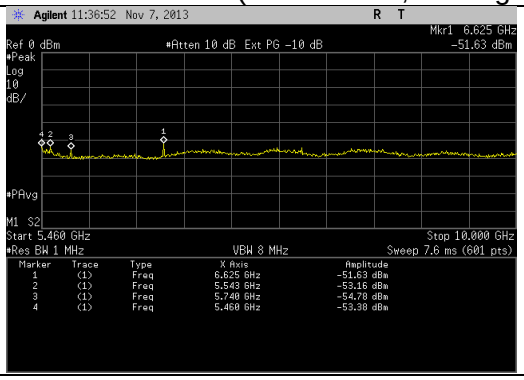
1000 to 5150 MHz (low channel, Peak)



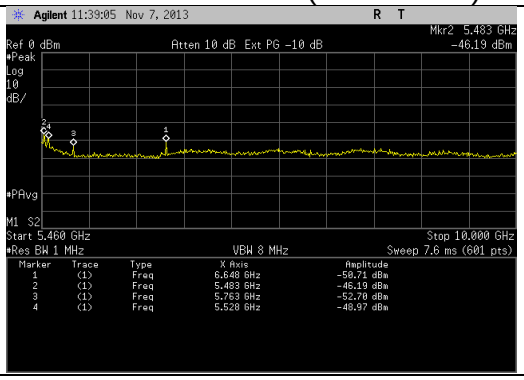
4000 to 5150 MHz (low channel, Average)



5460 to 10000 MHz (low channel)

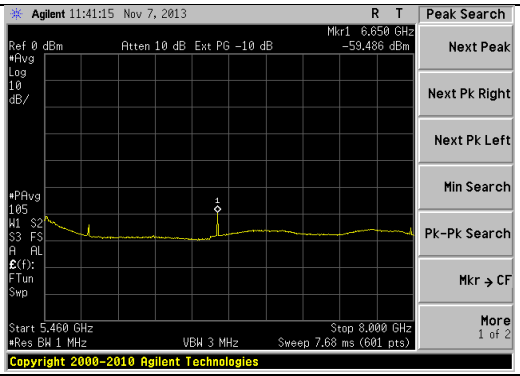


5460 to 10000 MHz (middle channel)

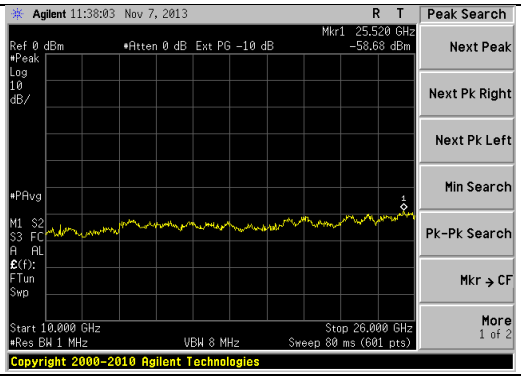


5460 to 10000 MHz (high channel, peak)

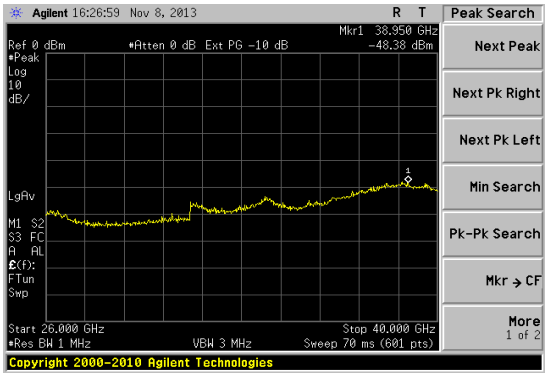
Note: The band edges are shown in the preceding section.



5460 to 8000 MHz (high channel, Average)



10000 to 26000 MHz (high channel)



26000 to 40000 MHz

10.3.1.3 Operation in the 5470 to 5725 MHz band

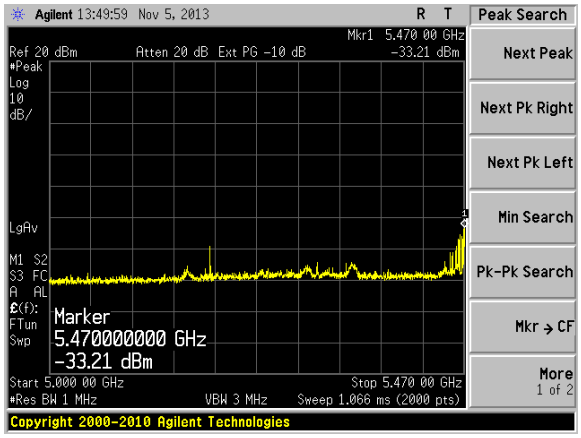
10.3.1.3.1 Lower Band-edge: 5000 to 5470 MHz

802.11 Standard	Data Rate (MBPS)	Peak data Frequency (MHz)	Band-edge: Peak (dBm)	Antenna gain (dBi)	Final peak Band-edge	Peak Limit (dBm)	Peak Margin (dB)
a	6	5470.0	-33.2	4.5	-28.7	-27.0	1.7
a	12	5468.4	-38.1	4.5	-33.6	-27.0	6.6
a	24	5467.9	-36.7	4.5	-32.2	-27.0	5.2
n	MCSO	5470.0	-35.0	4.5	-30.5	-27.0	3.5
n	MCS7	5469.5	-34.5	4.5	-30.0	-27.0	3.0

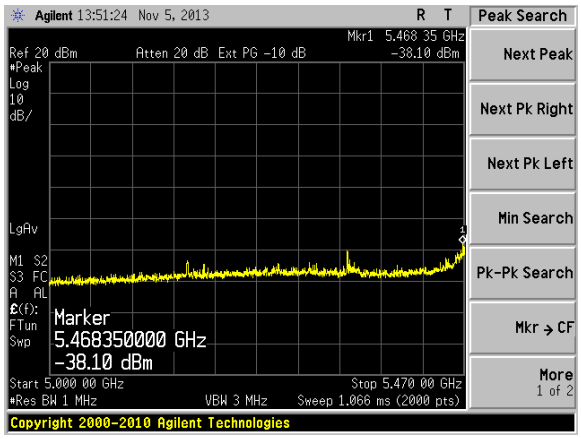
Generic sample calculation:

Final Peak Band-edge = Peak measurement (dBm) + antenna gain (dBi)
= -43.5 + 4.5 = -39.0 (dBm)

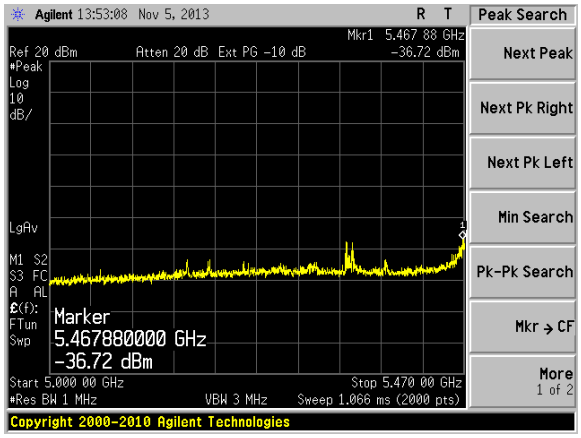
6 MBPS



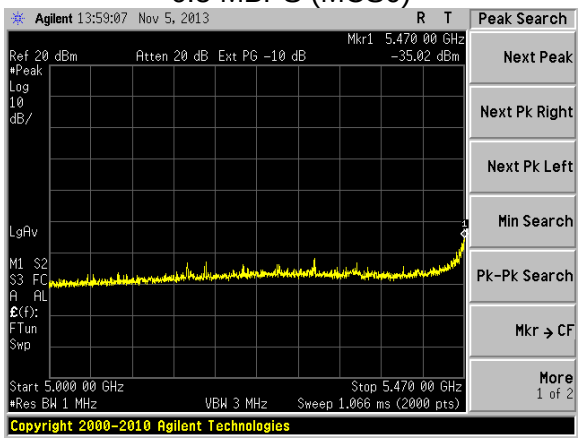
12 MBPS



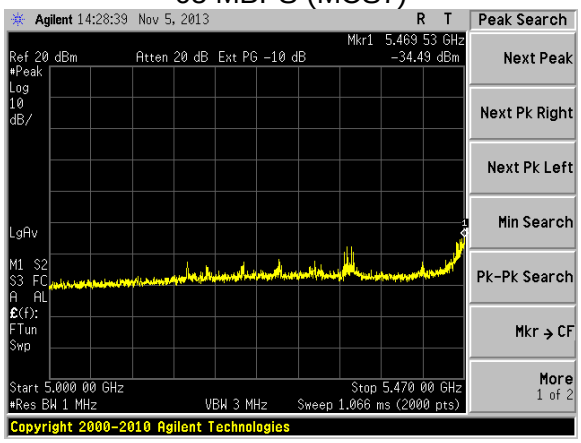
24 MBPS



6.5 MBPS (MCS0)



65 MBPS (MCS7)



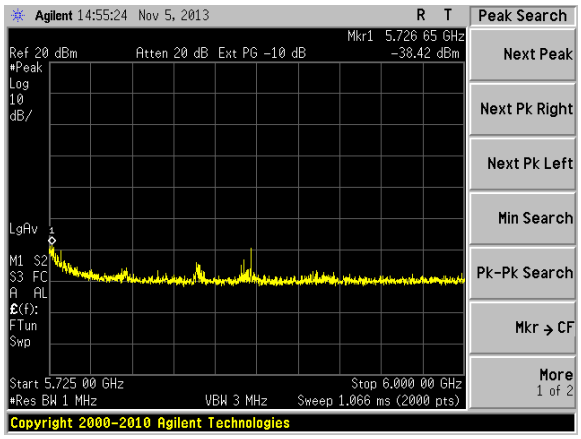
10.3.1.3.2 Upper Band edge: 5725 to 6000 MHz

802.11 Standard	Data Rate (MBPS)	Peak data Frequency (MHz)	Band-edge: Peak (dBm)	Antenna gain (dBi)	Final peak Band-edge	Peak Limit (dBm)	Peak Margin (dB)
a	6	5726.7	-38.4	4.5	-33.9	-27.0	6.9
a	12	5863.1	-39.9	4.5	-35.4	-27.0	8.4
a	24	5726.7	-35.6	4.5	-31.1	-27.0	4.1
n	MCSO	5725.7	-37.4	4.5	-32.9	-27.0	5.9
n	MCS7	5862.4	-41.5	4.5	-37.0	-27.0	10.0

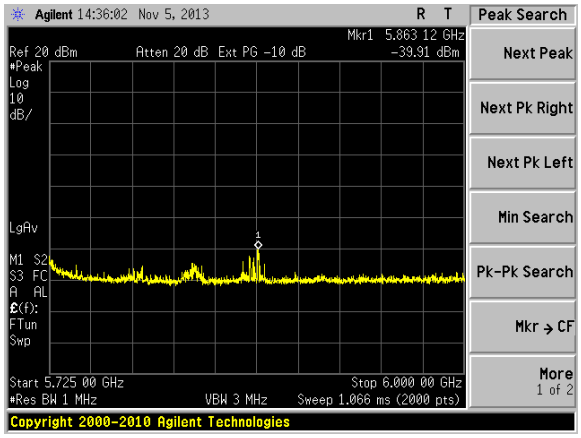
Generic sample calculation:

Final Peak Band-edge = Peak measurement (dBm) + antenna gain (dBi)
= -43.5 + 4.5 = -39.0 (dBm)

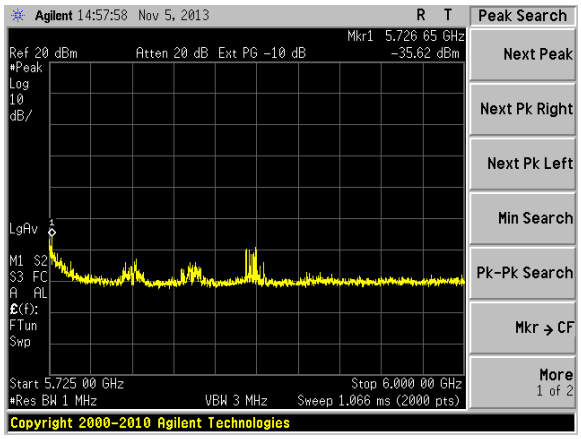
6 MBPS



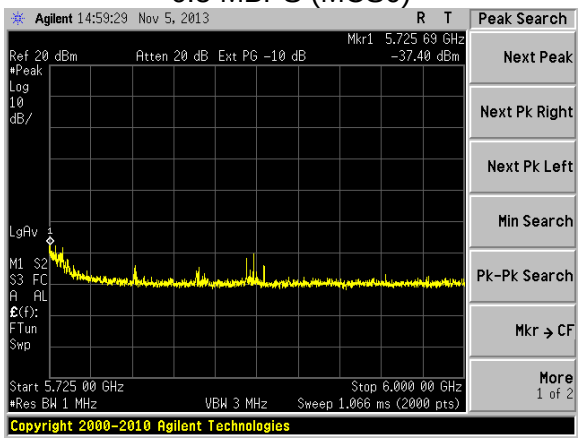
12 MBPS



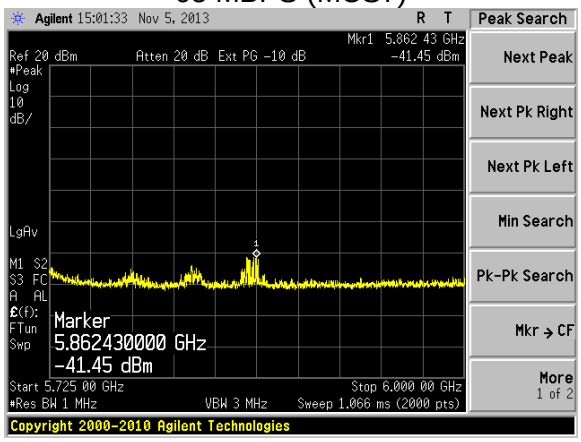
24 MBPS



6.5 MBPS (MCS0)

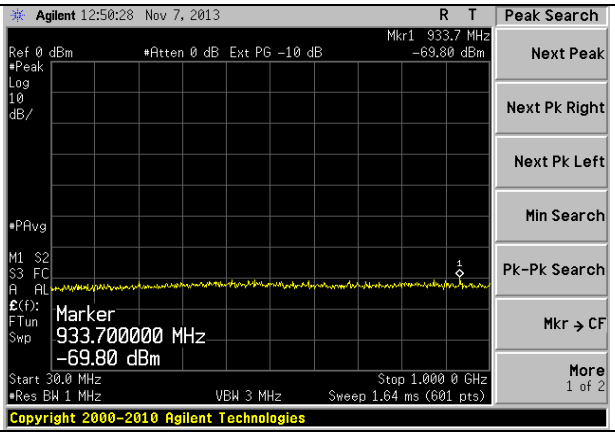


65 MBPS (MCS7)

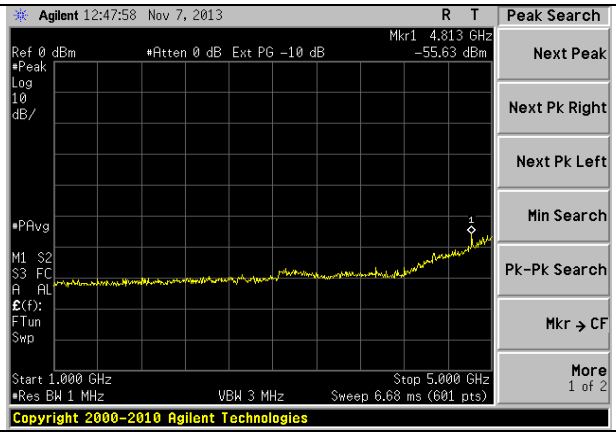


10.3.1.3.3 Unwanted Emissions

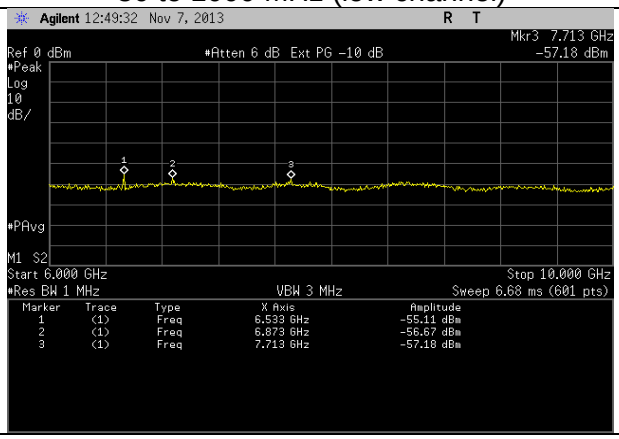
The plots shown below are those of 6MBPS which is representative of the other data rates.



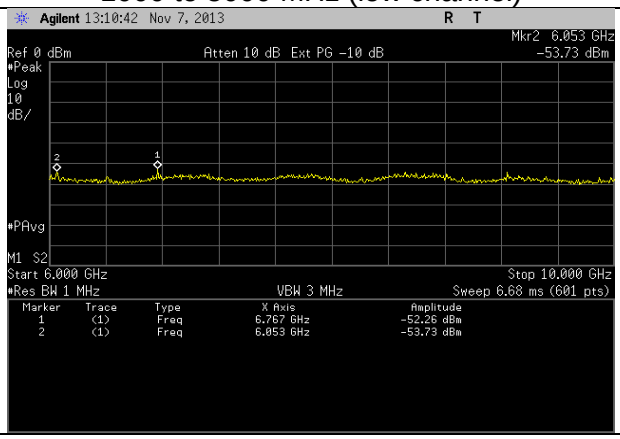
30 to 1000 MHz (low channel)



1000 to 5000 MHz (low channel)

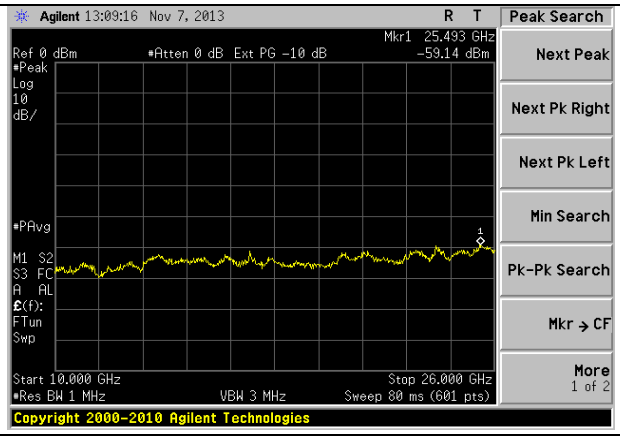


6000 to 10000 MHz (low channel)

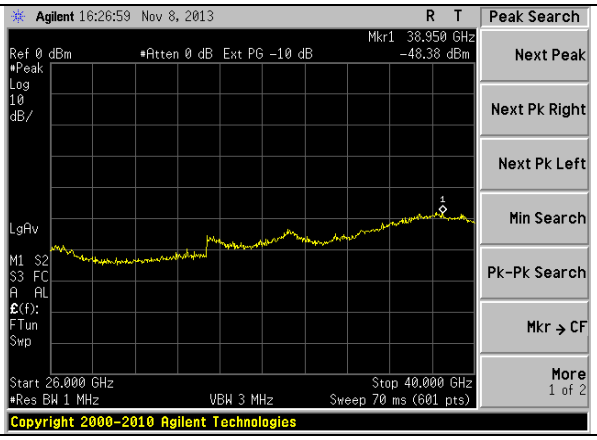


6000 to 10000 MHz (high channel)

Note: The band edges are shown in the preceding section.



10000 to 26000 MHz (high channel)



26000 to 40000 MHz (high channel)

10.3.2 Cabinet radiation measurements.

Emissions that are present but not a function of the transmitter:

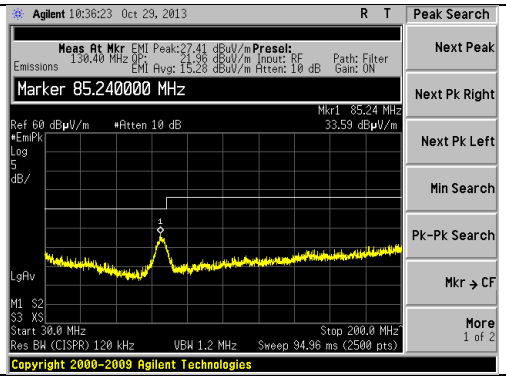
Frequency (MHz)	Antenna	EUT	Height (m)	Azimuth (°)	Peak (dBµV/m)	Q.Peak (dBµV/m)	Average (dBµV/m)	Peak limit (dBµV/m)	Q.Peak limit (dBµV/m)	Average limit (dBµV/m)	Peak margin (dB)	Q.Peak margin (dB)	Average margin (dB)	Notes
300.0	H	V	1.00	0	23.3	17.8	11.3	N/A	46.0	N/A	N/A	28.2	N/A	1
933.1	H	V	1.00	0	33.1	27.6	20.9	N/A	46.0	N/A	N/A	18.5	N/A	1
210.4	V	V	1.00	150	24.5	19.1	10.6	N/A	40.0	N/A	N/A	20.9	N/A	2
133.0	H	V	1.00	0	28.5	22.4	16.4	N/A	43.0	N/A	N/A	20.6	N/A	1
85.5	V	V	1.00	0	35.5	30.6	21.8	N/A	40.0	N/A	N/A	9.4	N/A	2
130.4	V	V	1.00	313	29.9	24.5	17.8	N/A	40.0	N/A	N/A	15.5	N/A	2

Notes:

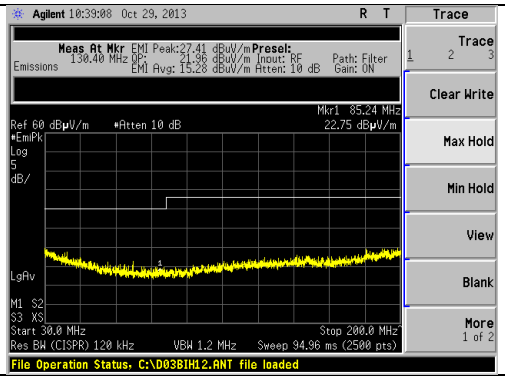
1. Measurement of system noise floor.
2. Emission does not change with channel. Found to be a function of the power supply used.
3. H: Horizontal, V: Vertical, S: Side, F: Flat.
4. Measurement above 4GHz performed at 1m separation distance. The limit value in the table reflects this separation distance.
5. Refer to exhibit 5.5 on explanation of how data is reported.

10.3.2.1 Emissions below 1000 MHz

30 to 200 MHz, 3m distance.

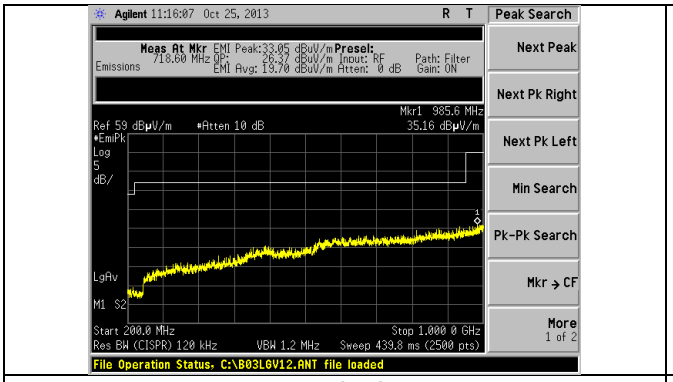


Vertical

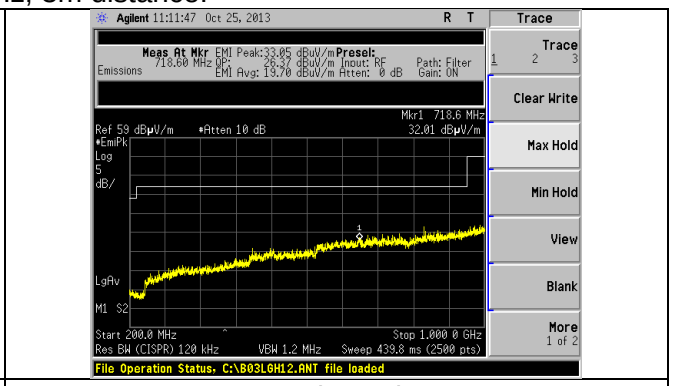


Horizontal

200 to 1000 MHz, 3m distance.



Vertical



Horizontal

Note:

1. The screen captures between 30 MHz to 1000 MHz are common between the UNII bands. The emissions seen are independent of the band the module was in.

10.3.2.2 Emissions above 1000 MHz

For the following data, measurements were performed at a separation distance of **1 meter**. The field strength was then converted to EIRP per KDB 789033:

$$EIRP\ [dBm] = E[dBuV/m] + 20\log(d[meters]) - 104.77$$
$$= E[dBuV/m] + 20\log(1) - 104.77 = E[dBuV/m] - 104.77$$

EIRP is the equivalent isotropically radiated power in Watts
E is the field strength
D is the measurement distance

Once converted to EIRP, the measurements are compared to the limits (dBm).

Examples:

Above 960MHz Restricted band **limit** (at 3m) conversion to EIRP:

EIRP = 54[dBuV/m]+9.54-104.77= **-41.27dBm**

10.3.2.2.1 Operation in the 5150 to 5250 MHz band

10.3.2.2.1.1 Significant emissions data table

Channel 36

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBµV/m)	Peak Reading (dBm)	Avg Reading (dBµV/m)	Avg Reading (dBm)	Peak limit (dBm)	Avg Limit (dBm)	Peak Margin (dB)	Average Margin (dB)	Antenna Polarity	EUT orientation
10360	1.02	133	54.7	-50.1	N/A	N/A	-27.0	N/A	23.1	N/A	Vertical	Flat
15540	1.00	354	52.0	-52.8	44.8	-60.0	-21.2	-41.2	31.6	18.8	Horizontal	Vertical
20720	1.05	287	61.3	-43.4	57.8	-46.9	-21.2	-41.2	22.2	5.7	Horizontal	Vertical

Channel 40

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBµV/m)	Peak Reading (dBm)	Avg Reading (dBµV/m)	Avg Reading (dBm)	Peak limit (dBm)	Avg Limit (dBµV/m)	Peak Margin (dB)	Average Margin (dB)	Antenna Polarity	EUT orientation
10400	1.03	284	54.7	-50.1	N/A	N/A	-27.0	N/A	23.1	N/A	Horizontal	Flat
15600	1.00	104	54.0	-50.8	49.0	-55.8	-21.2	-41.2	29.5	14.5	Horizontal	Vertical
20800	1.00	285	61.1	-43.7	57.5	-47.3	-21.2	-41.2	22.5	6.1	Horizontal	Vertical

Channel 48

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBµV/m)	Peak Reading (dBm)	Avg Reading (dBµV/m)	Avg Reading (dBm)	Peak limit (dBm)	Avg Limit (dBµV/m)	Peak Margin (dB)	Average Margin (dB)	Antenna Polarity	EUT orientation
10480	1.02	195	53.6	-51.2	N/A	N/A	-27.0	N/A	24.2	N/A	Horizontal	Flat
15720	1.00	0	52.6	-52.2	45.2	-59.6	-21.2	-41.2	30.9	18.3	Vertical	Side
20960	1.06	290	61.5	-43.3	57.5	-47.3	-21.2	-41.2	22.1	6.1	Horizontal	Vertical

Generic example of how Field strength measurement is calculated:

E[dBuV/m] = 18.2 (raw receiver measurement) + 15.8 (antenna factor) + 1.45 (cable factor)
= 35.45 (dBµV/m).

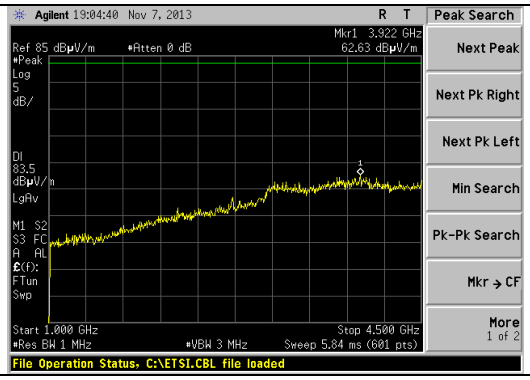
Sample measurement (conversion of field strength to EIRP):

Measurement at 10480MHz,

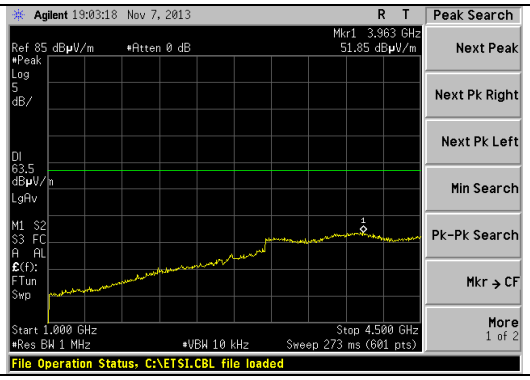
EIRP [dBm] = E[dBuV/m] +20 log(1)-104.77
= 53.6 – 104.77
= -51.2dBm

10.3.2.2.1.2 Emissions between 1000 to 8000 MHz

1000 to 4500 MHz

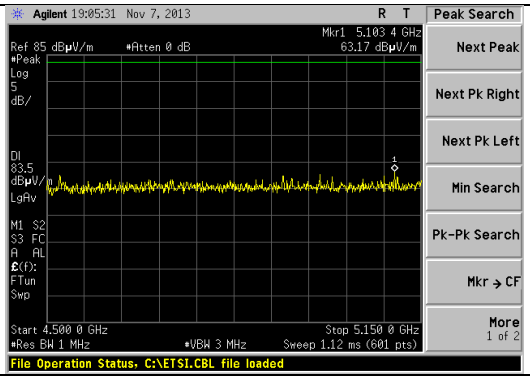


Peak Scan

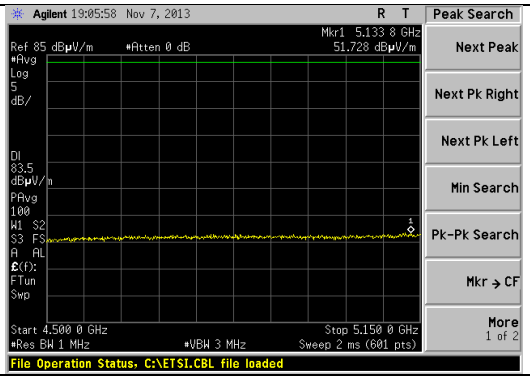


Reduced Bandwidth

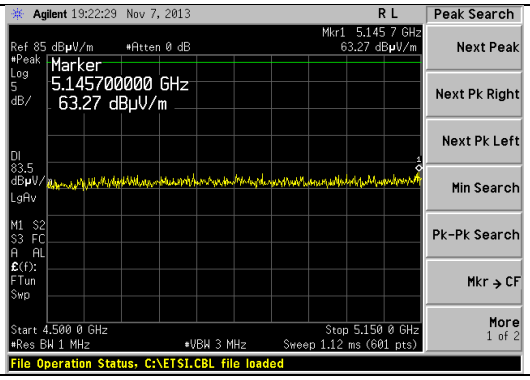
4500 to 5150 MHz



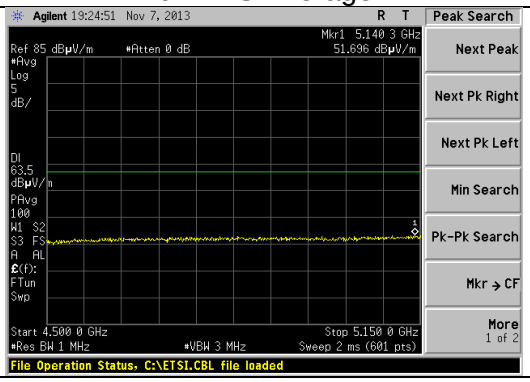
6MBPS Peak



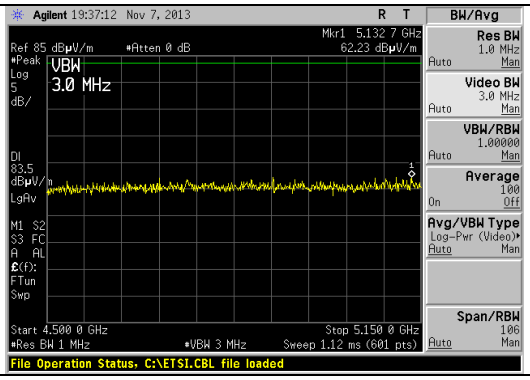
6MBPS Average



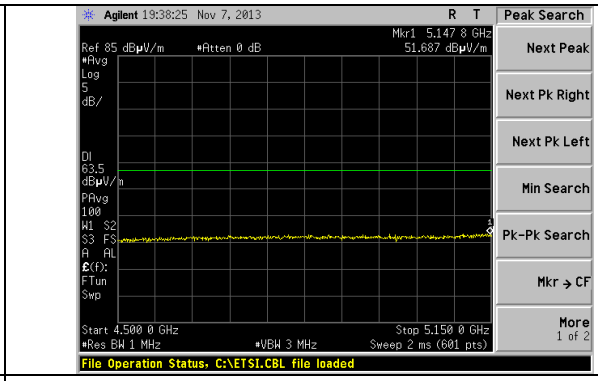
12MBPS Peak



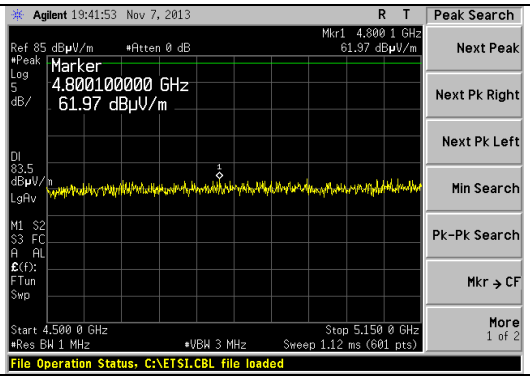
12MBPS Average



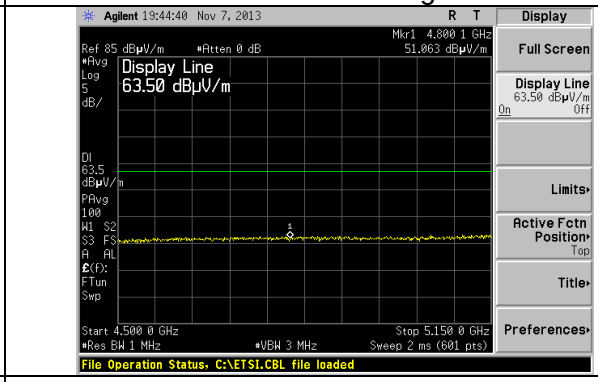
24MBPS Peak



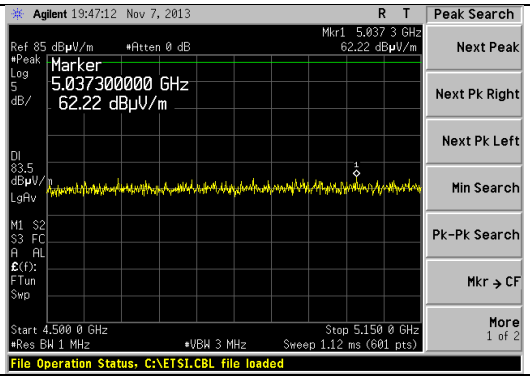
24MBPS Average



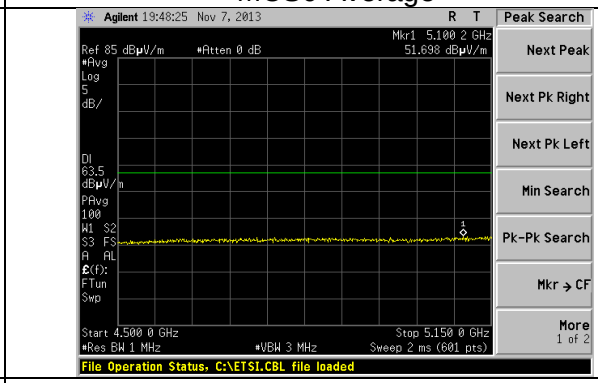
MCS0 Peak



MCS0 Average

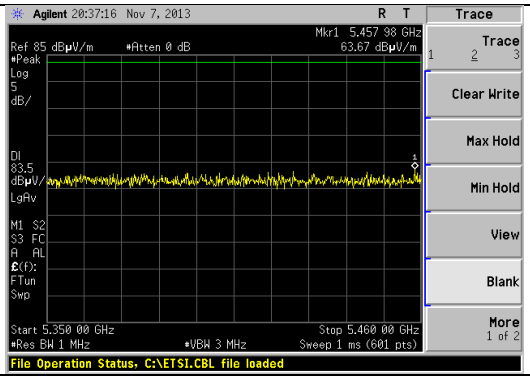


MCS7 Peak

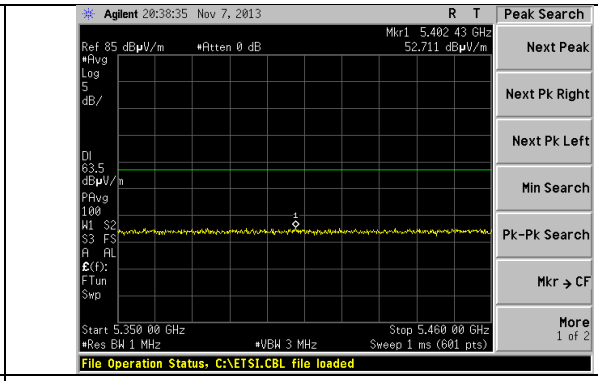


MCS7 Average

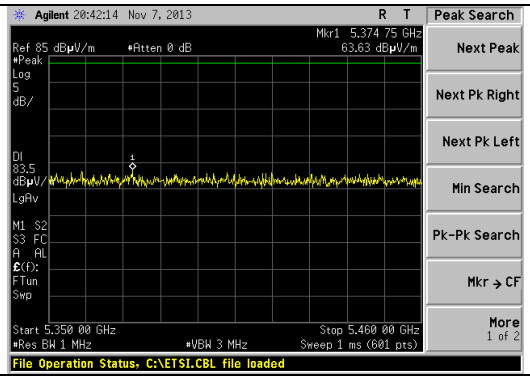
5350 to 5460 MHz



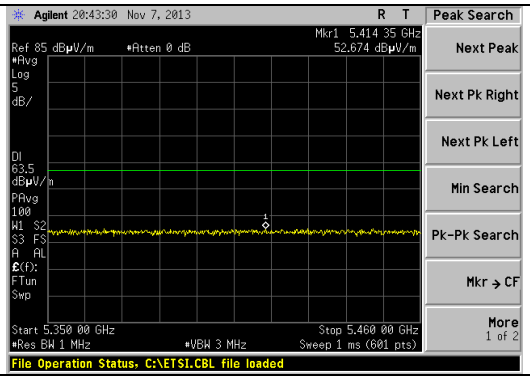
6MBPS Peak



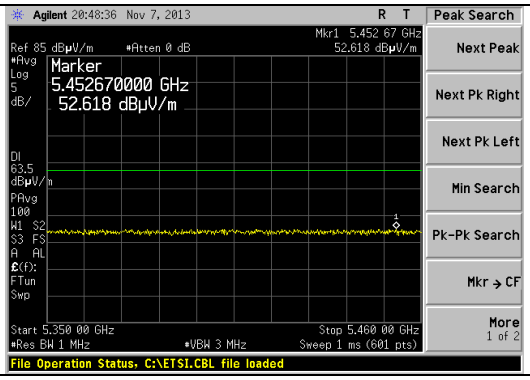
6MBPS Average



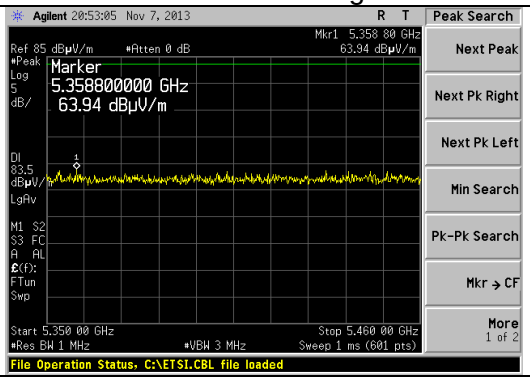
12MBPS Peak



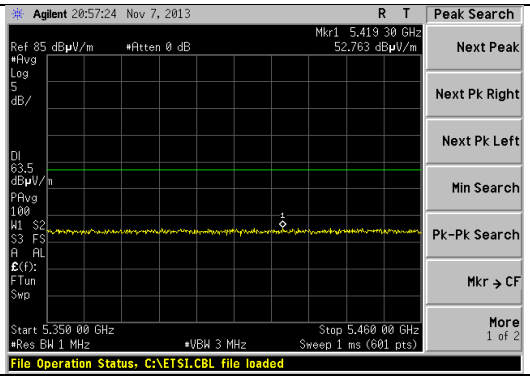
12MBPS Average



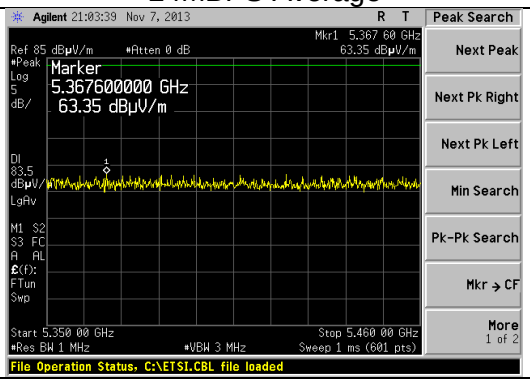
24MBPS Peak



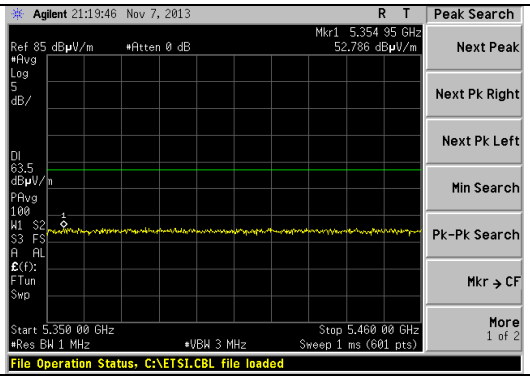
24MBPS Average



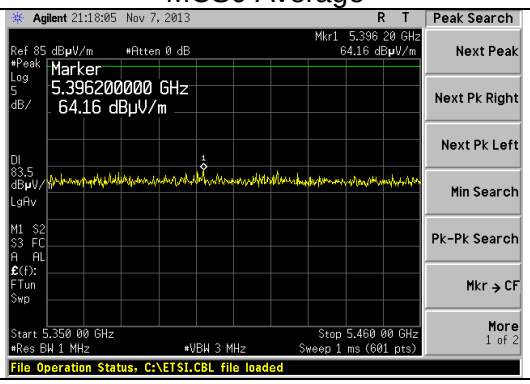
MCS0 Peak



MCS0 Average

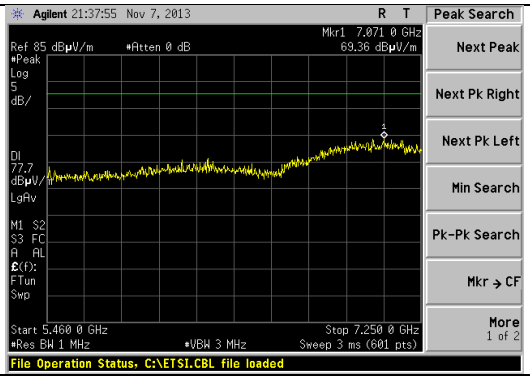


MCS7 Peak

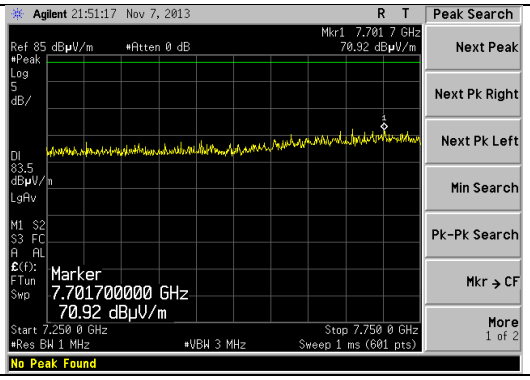


MCS7 Average

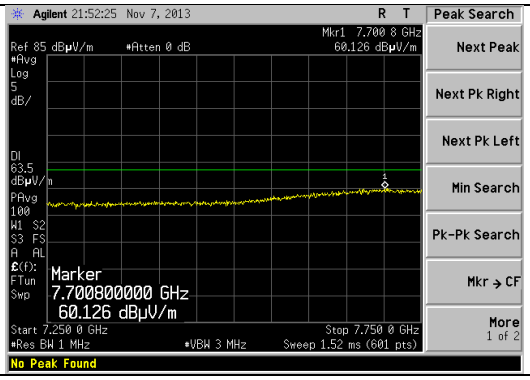
5460 to 8000 MHz



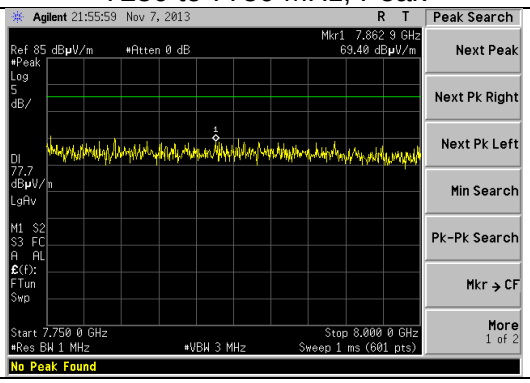
5460 to 7250 MHz



7250 to 7750 MHz, Peak



7250 to 7750 MHz, Average



7750 to 8000 MHz

Note:

1. Green display line in the plots are the limits: 77dBuV/m = -27dBm (non- restricted band peak); 63.5 dBuV/m = -41.2dBm (restricted band, average); 83.5dBuV/m = -21.2 (restricted band, peak)
2. Measurements performed at 1m separation distance.

10.3.2.2.2 Operation in the 5250 to 5350 MHz band

10.3.2.2.2.1 Significant emissions data table

Channel 56

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBµV/m)	Peak Reading (dBm)	Avg Reading (dBµV/m)	Avg Reading (dBm)	Peak Limit (dBm)	Avg Limit (dBm)	Peak Margin (dB)	Avg Margin (dB)	Antenna Polarity	EUT orientation
10560	1.00	124	53.1	-51.7	N/A	N/A	-27.0	N/A	24.7	#VALUE!	Vertical	Flat
15840	1.00	345	54.9	-49.9	45.8	-59.0	-21.2	-41.2	28.6	17.8	Vertical	Side
21120	1.00	46	62.5	-42.2	57.7	-47.1	-21.2	-41.2	21.0	5.8	Horizontal	Side

Channel 60

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBµV/m)	Peak Reading (dBm)	Avg Reading (dBµV/m)	Avg Reading (dBm)	Peak Limit (dBm)	Avg Limit (dBm)	Peak Margin (dB)	Avg Margin (dB)	Antenna Polarity	EUT orientation
10600	1.00	189	52.3	-52.47	N/A	N/A	-27.0	N/A	25.5	N/A	Horizontal	Vertical
21200	1.00	42	62.3	-42.5	57.3	-47.5	-21.2	-41.2	21.3	6.3	Horizontal	Side

Channel 64

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBµV/m)	Peak Reading (dBm)	Avg Reading (dBµV/m)	Avg Reading (dBm)	Peak Limit (dBµV/m)	Avg Limit (dBm)	Peak Margin (dB)	Avg Margin (dB)	Antenna Polarity	EUT orientation
10640	1.14	197	53.0	-51.8	N/A	N/A	-27.0	N/A	24.8	N/A	Horizontal	Vertical
21280	1.02	46	62.3	-42.5	56.9	-47.8	63.5	-41.2	106.0	6.6	Horizontal	Side

Generic example of how Field strength measurement is calculated:

E[dBuV/m] = 18.2 (raw receiver measurement) + 15.8 (antenna factor) + 1.45 (cable factor)
= 35.45 (dBµV/m).

Sample measurement (conversion of field strength to EIRP):

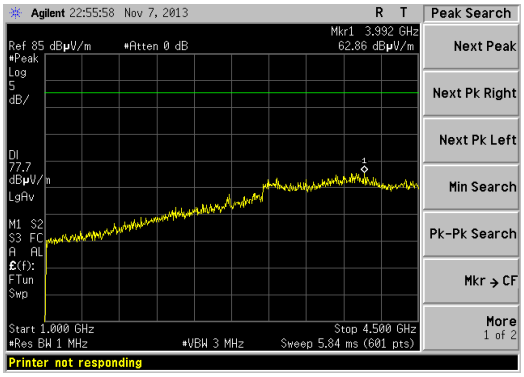
Measurement at 21280 MHz,

Peak measurement:
EIRP [dBm] = E[dBuV/m] +20 log(1)-104.77
= 62.3 – 104.77
= -42.5dBm

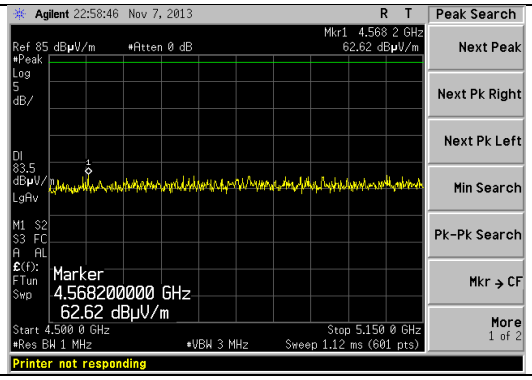
Average measurement:
EIRP [dBm] = E[dBuV/m] +20 log(1)-104.77
= 56.9 – 104.77
= -47.8dBm

10.3.2.2.2.2 Emissions between 1000 to 8000 MHz

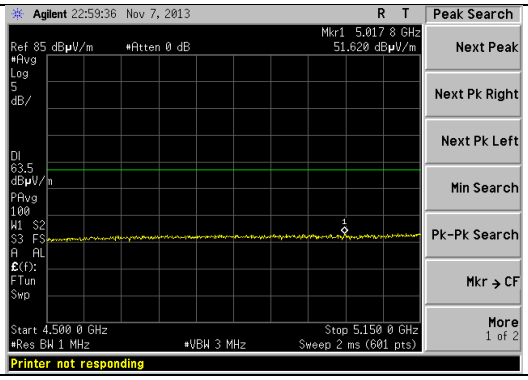
1000MHz to 4500 MHz



4500 to 5150 MHz



Peak

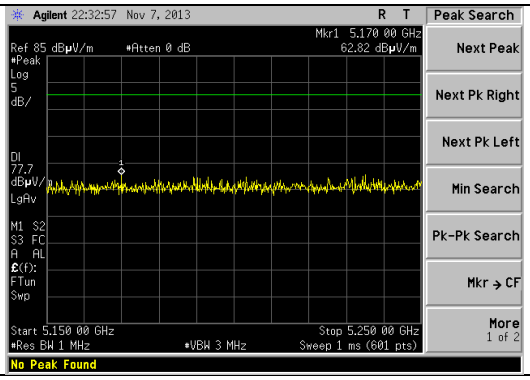


Average

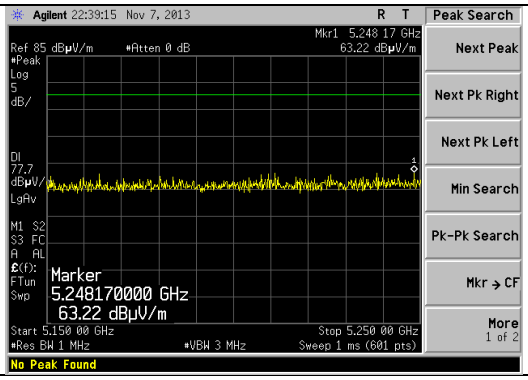
Note:

1. Green display line in the plots are the limits: 77dBuV/m = -27dBm (non- restricted band peak); 63.5 dBuV/m = -41.2dBm (restricted band, average); 83.5dBuV/m = -21.2 (restricted band, peak)
2. Measurements performed at 1m separation distance.

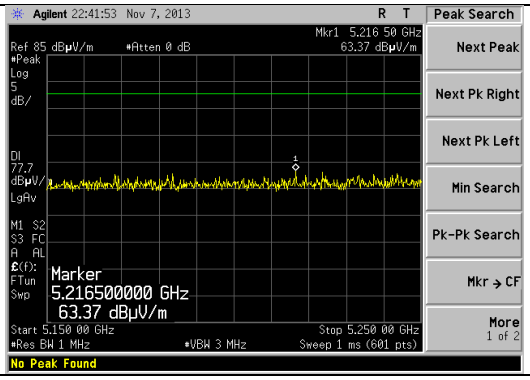
5150 MHz to 5250 MHz



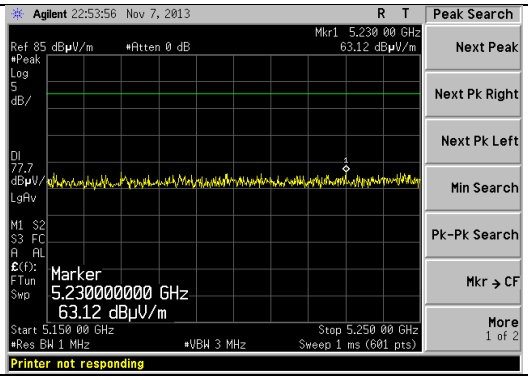
6MBPS



12MBPS



24MBPS

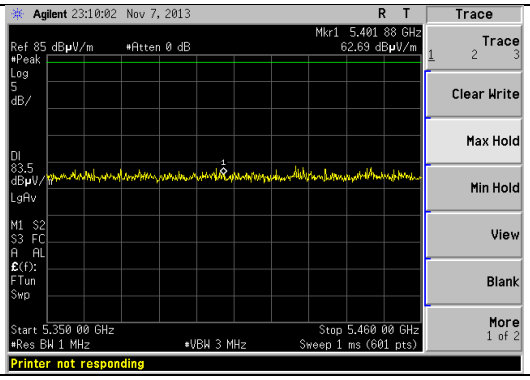


MCS7

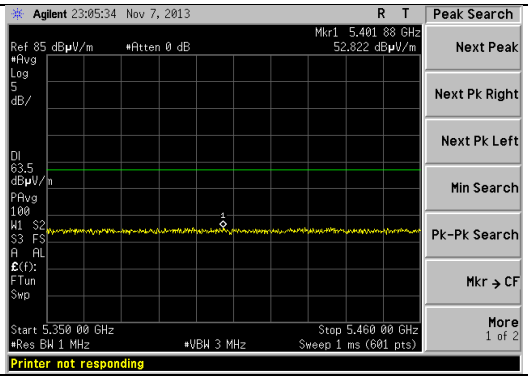
Note:

1. Green display line in the plots are the limits: 77dBuV/m = -27dBm (non- restricted band peak); 63.5 dBuV/m = -41.2dBm (restricted band, average); 83.5dBuV/m = -21.2 (restricted band, peak)
2. Measurements performed at 1m separation distance.

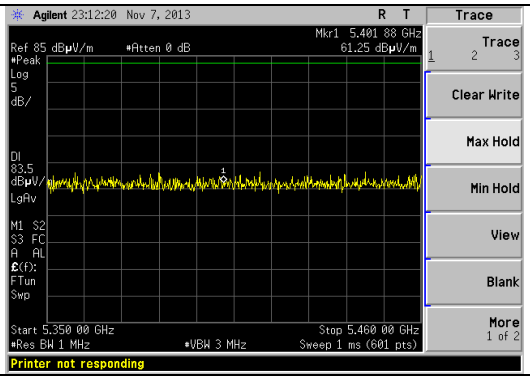
5350 to 5460 MHz



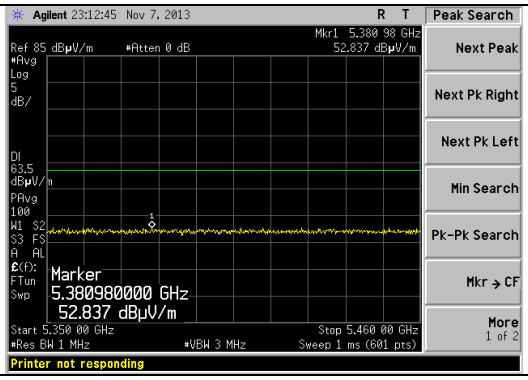
6MBPS Peak



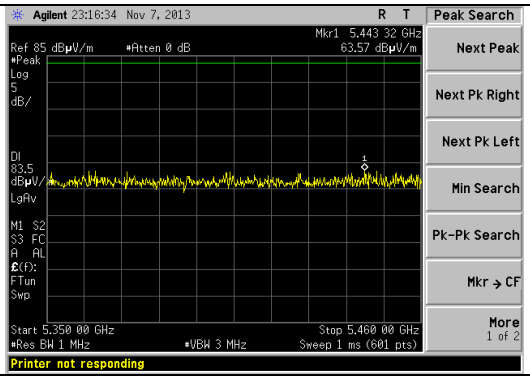
6MBPS Average



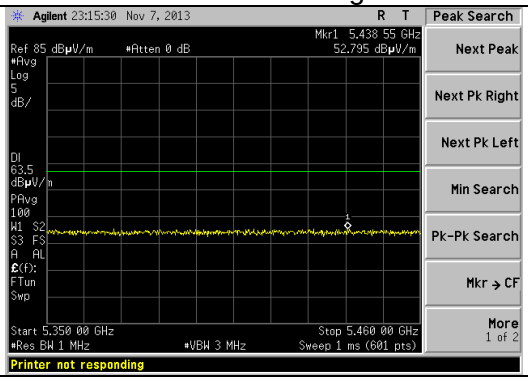
12MBPS Peak



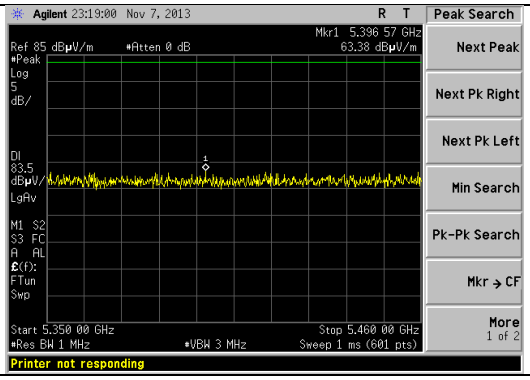
12MBPS Average



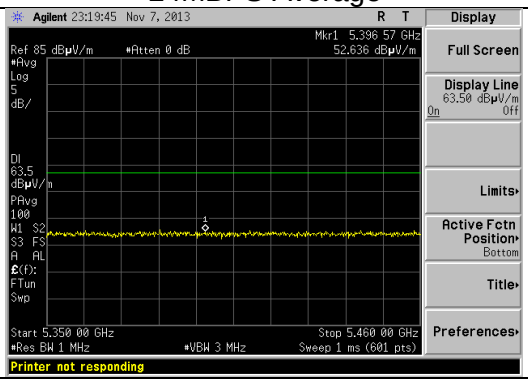
24MBPS Peak



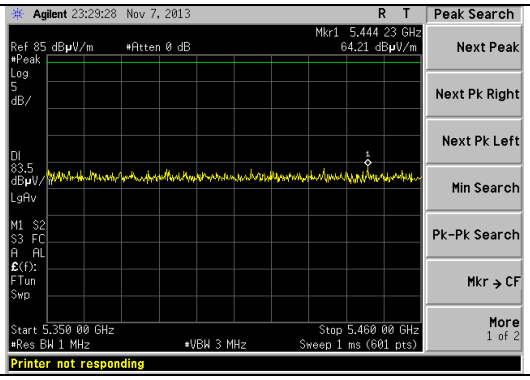
24MBPS Average



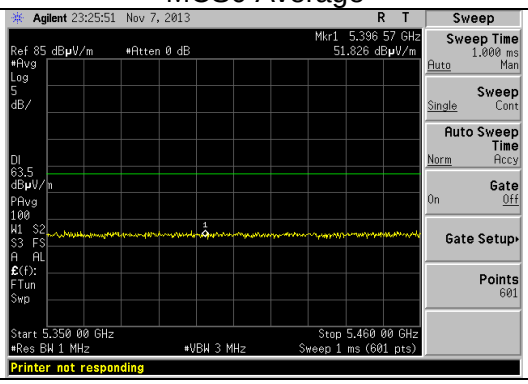
MCS0 Peak



MCS0 Average

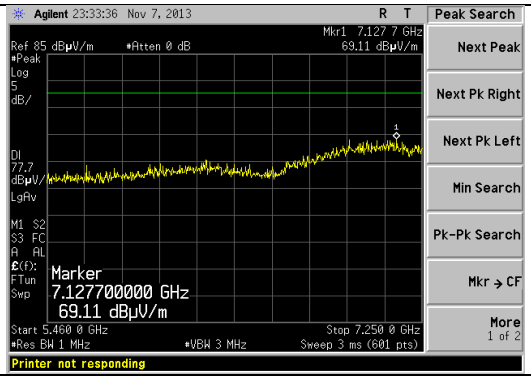


MCS7 Peak

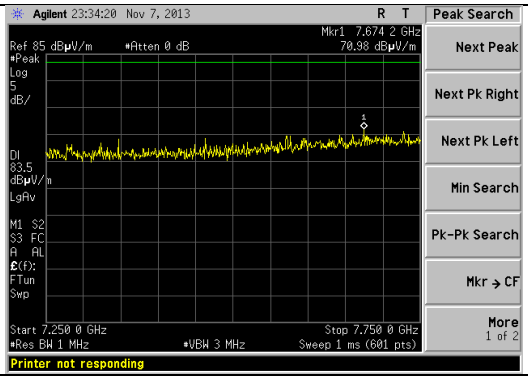


MCS7 Average

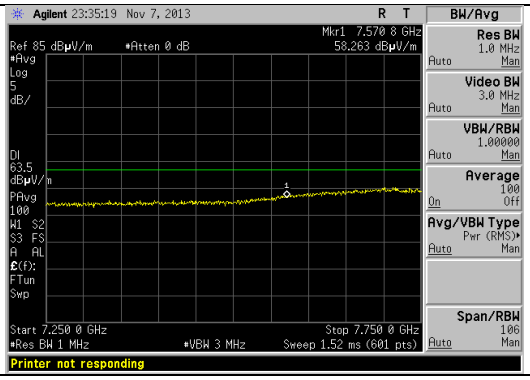
5460MHz to 8000MHz



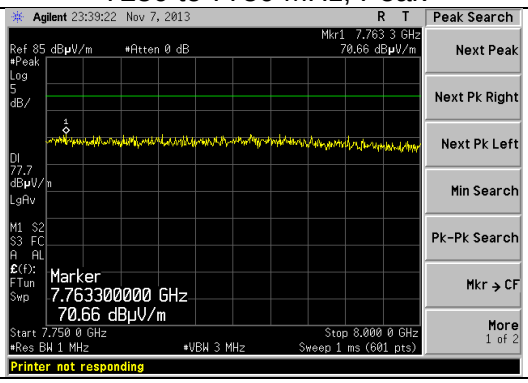
5460 to 7250 MHz



7250 to 7750 MHz, Peak



7250 to 7750 MHz, Average



7750 to 8000 MHz

Note:

1. Green display line in the plots are the limits: 77dBuV/m = -27dBm (non- restricted band peak); 63.5 dBuV/m = -41.2dBm (restricted band, average); 83.5dBuV/m = -21.2 (restricted band, peak)
2. Measurements performed at 1m separation distance.

10.3.2.2.3 Operation in the 5470MHz to 5725MHz band

10.3.2.2.3.1 Significant emissions data table

Channel 100

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBµV/m)	Peak Reading (dBm)	Avg Reading (dBµV/m)	Avg Reading (dBm)	Peak Limit (dBm)	Avg Limit (dBm)	Peak Margin (dB)	Avg Margin (dB)	Antenna Polarity	EUT orientation
11000	1.14	189	55.8	-49.0	51.2	-53.6	-21.2	-41.2	27.8	12.3	Horizontal	Vertical
22000	1.00	50	60.3	-44.5	53.4	-51.4	-21.2	-41.2	23.3	10.2	Horizontal	Side

Channel 116

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBµV/m)	Peak Reading (dBm)	Avg Reading (dBµV/m)	Avg Reading (dBm)	Peak Limit (dBm)	Avg Limit (dBm)	Peak Margin (dB)	Avg Margin (dB)	Antenna Polarity	EUT orientation
11160	1.13	187	56.1	-48.7	52.1	-52.7	-21.2	-41.2	27.5	11.5	Horizontal	Vertical
22320	1.00	329	62.2	-42.6	56.5	-48.3	-21.2	-41.2	21.4	7.1	Horizontal	Vertical

Channel 140

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBµV/m)	Peak Reading (dBm)	Avg Reading (dBµV/m)	Avg Reading (dBm)	Peak Limit (dBm)	Avg Limit (dBm)	Peak Margin (dB)	Avg Margin (dB)	Antenna Polarity	EUT orientation
11400	1.14	231	55.1	-49.7	51.7	-53.1	-21.2	-41.2	28.5	11.9	Horizontal	Vertical
22800	1.04	332	62.4	-42.4	56.6	-48.2	-21.2	-41.2	21.2	7.0	Horizontal	Vertical

Generic example of how Field strength measurement is calculated:

E[dBuV/m] = 18.2 (raw receiver measurement) + 15.8 (antenna factor) + 1.45 (cable factor)
= 35.45 (dBµV/m).

Sample measurement (conversion of field strength to EIRP):

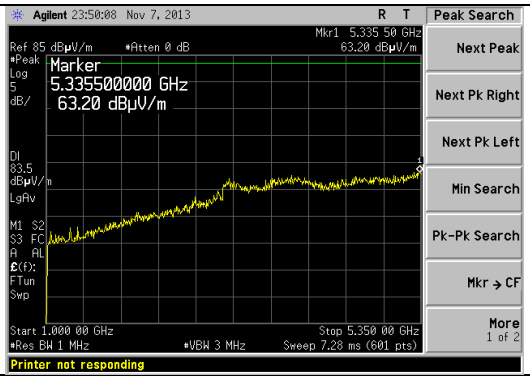
Measurement at 11400MHz,

Peak measurement:
EIRP [dBm] = E[dBuV/m] +20 log(1)-104.77
= 55.1 – 104.77
= -49.7dBm

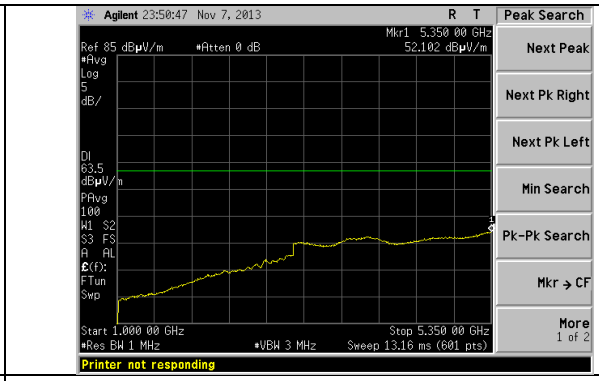
Average measurement:
EIRP [dBm] = E[dBuV/m] +20 log(1)-104.77
= 51.7 – 104.77
= -53.1dBm

10.3.2.2.3.2 Emissions between 1000 to 8000 MHz

1000MHz to 5350MHz

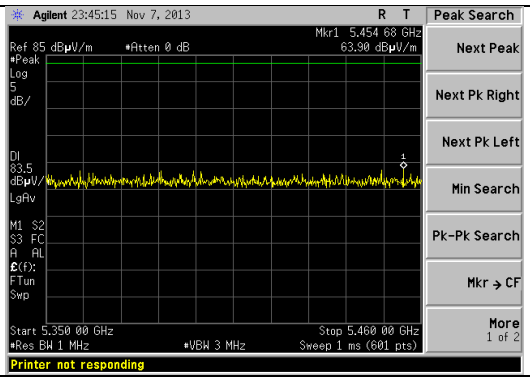


Peak

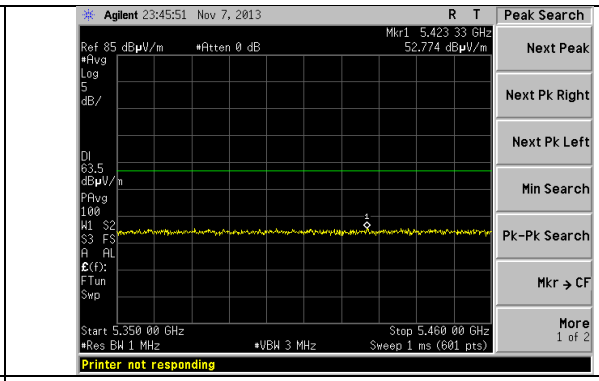


Average

5350MHz to 5460MHz



Peak

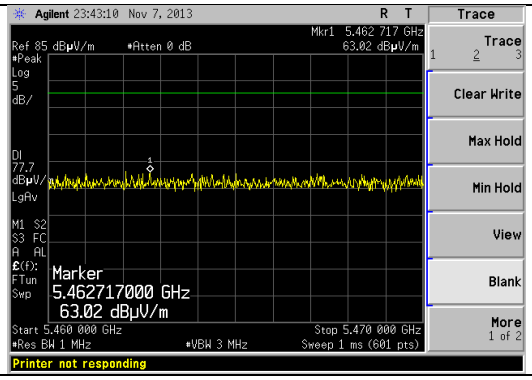


Average

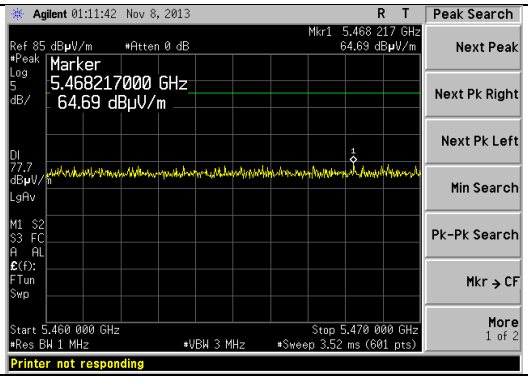
Note:

1. Green display line in the plots are the limits: 77dBuV/m = -27dBm (non- restricted band peak); 63.5 dBuV/m = -41.2dBm (restricted band, average); 83.5dBuV/m = -21.2 (restricted band, peak)
2. Measurements performed at 1m separation distance.

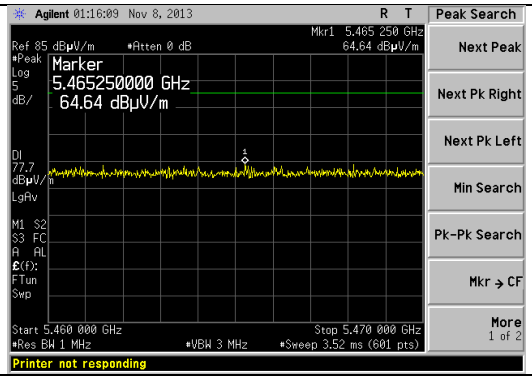
5460MHz to 5470MHz



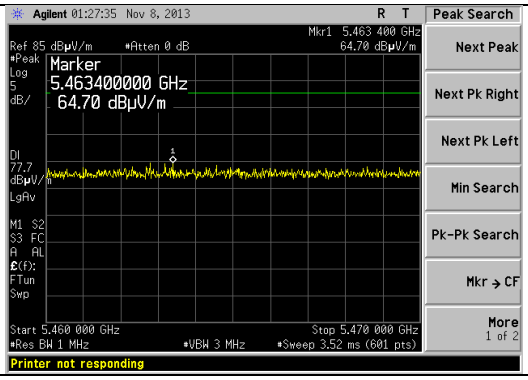
6MBPS



12MBPS



24MBPS

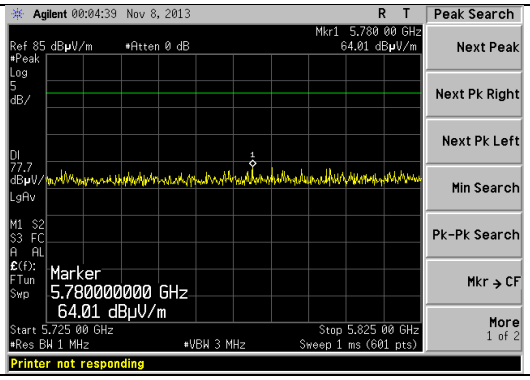


MCS7

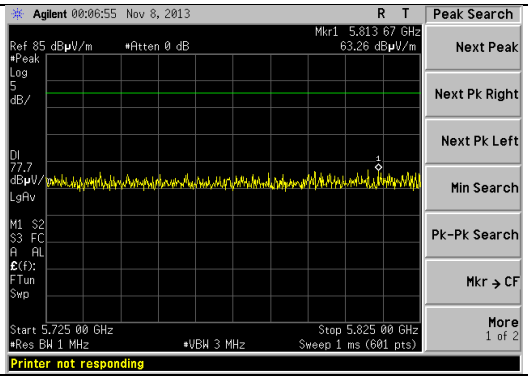
Note:

1. Green display lines in the plots are the limits: 77dBuV/m = -27dBm (non- restricted band peak).
2. Measurements performed at 1m separation distance.

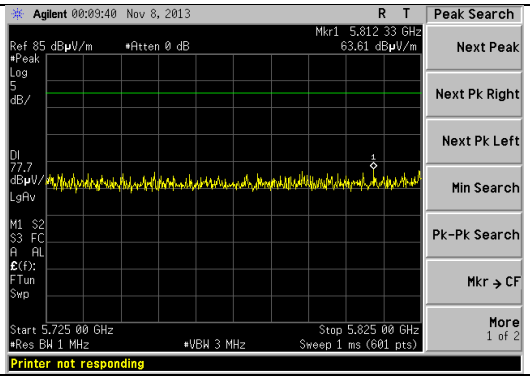
5725MHz to 5825MHz



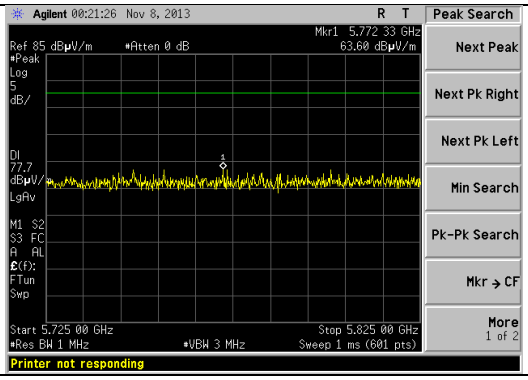
6MBPS



12MBPS

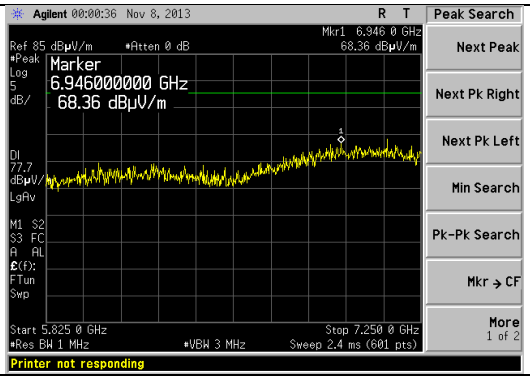


24MBPS

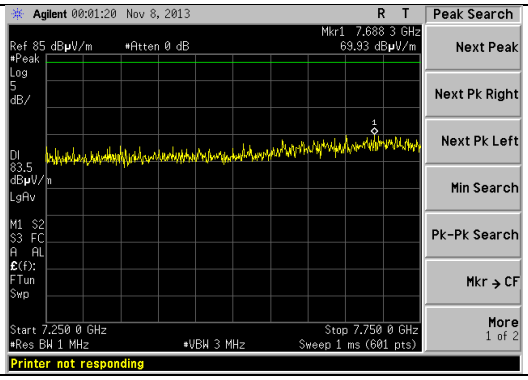


MCS7

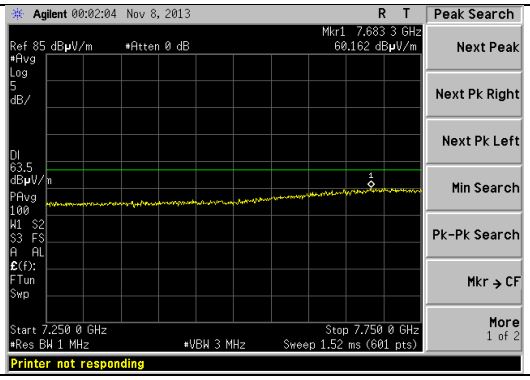
5825MHz to 8000MHz



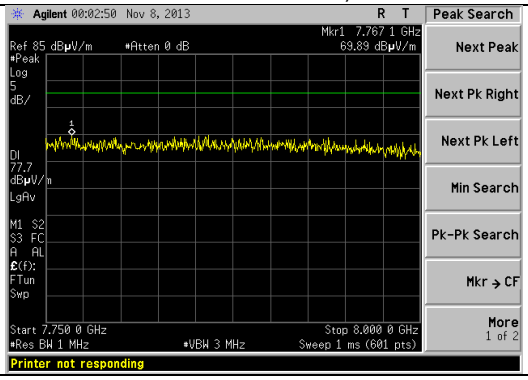
5825 to 7250 MHz



7250 to 7750 MHz, Peak



7250 to 7750 MHz, Average



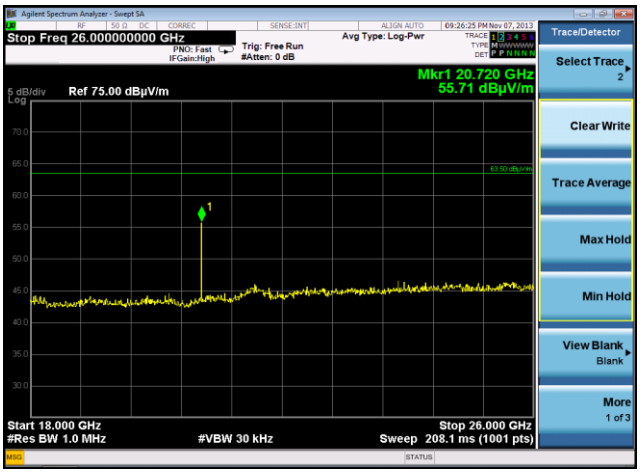
7750 to 8000 MHz

10.3.2.2.4 Emissions between 8000MHz to 40000MHz

The plots shown below are those of 6MBPS which is representative of the other data rates.

800MHz to 18000MHz

18000MHz to 26000MHz



Note:

1. Green display line in the plots are the limits: 63.5 dBuV/m = -41.2dBm (restricted band, average)
2. Measurements performed at 1m separation distance.

26000MHz to 40000MHz

Note:

3. Green display line in the plots are the limits: 63.5 dBuV/m = -41.2dBm (restricted band, average)
4. Measurements performed at 1m separation distance.

EXHIBIT 11 Frequency Stability

Test Engineer: Peter Feilen

11.1 Test Procedure

For this test, the EUT was placed inside an environmental chamber. Antenna port conducted measurements were performed at the operating temperature ranges specified by the manufacturer owner's manual. In addition, the supply voltage was varied per the operating ranges specified in the owner's manual.

11.2 Limit

Manufacturer of U-NII devices are responsible for insuring 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.

11.3 Test Data

			Supply Voltage (V)		
			3.00	3.60	4.80
Temp	Channel	Nominal Frequency (MHz)	Measured Frequency (Hz)	Measured Frequency (Hz)	Measured Frequency (Hz)
-40°C	36	5180.0	5180013165	5180013365	5180013155
	64	5320.0	5320013625	5320013625	5320013285
	112	5560.0	5560013884	5560014095	5560014135
23°C	36	5180.0	5180009465	5180009890	5180010355
	64	5320.0	5320009720	5320010420	5320010500
	112	5560.0	5560009870	5560010820	5560011020
+85°C	36	5180.0	5180011400	5180014950	5180020650
	64	5320.0	5320016875	5320021625	5320016375
	112	5560.0	5560004500	5560012250	5560018625

The data collected shows that the frequency stability of the EUT is better than 1PPM and hence will result in the EUT will remain within the bands of operation.

EXHIBIT 12 Conducted Emissions Test, AC Power Line

Test Engineer: Khairul Aidi Zainal

12.1 Test Setup

The test area and setup are in accordance with ANSI C63.4 and with Title 47 CFR, FCC Part 15, Industry Canada RSS-210 and RSS GEN. The EUT was placed on a non-conductive wooden table, with a height of 80 cm above the reference ground plane. The Generic DC power supply was then plugged into a 50Ω (ohm), 50/250 μH Line Impedance Stabilization Network (LISN). The AC power supply of 120V was provided via an appropriate broadband EMI Filter, and then to the LISN line input. Final readings were then taken and recorded. After the EUT was setup and connected to the LISN, the RF Sampling Port of the LISN was connected to a 10 dB Attenuator-Limiter, and then to EMI receiver System. The EMCO LISN used has the ability to terminate the unused port with a 50Ω (ohm) load when switched to either L1 (line) or L2 (neutral).

12.2 Test Procedure

The EUT was investigated in continuous modulated transmit mode and continuous receive mode for this portion of the testing. The appropriate frequency range and bandwidths were selected on the EMI Receiver, and measurements were made. The bandwidth used for these measurements is 9 kHz, as specified in CISPR 16-1, Section 1, Table 1, for Quasi-Peak and Average detectors in the frequency range of 150 kHz to 30 MHz. Final readings were then taken and recorded.

An off-the-shelf DC power supply was used during the test to supply the EUT with the appropriate DC voltage.

12.3 Limits of Conducted Emissions at the AC Mains Ports

Frequency Range (MHz)	**Class B Limits (dBμV)**		**Measuring Bandwidth**
	Quasi-Peak	Average	
0.150 -0.50 *	66-56	56-46	RBW = 9 kHz VBW ≥ 9 kHz for QP VBW = 1 Hz for Average
0.5 – 5.0	56	46	
5.0 – 30	60	50	
* The limit decreases linearly with the logarithm of the frequency in this range.			

12.4 Test Data

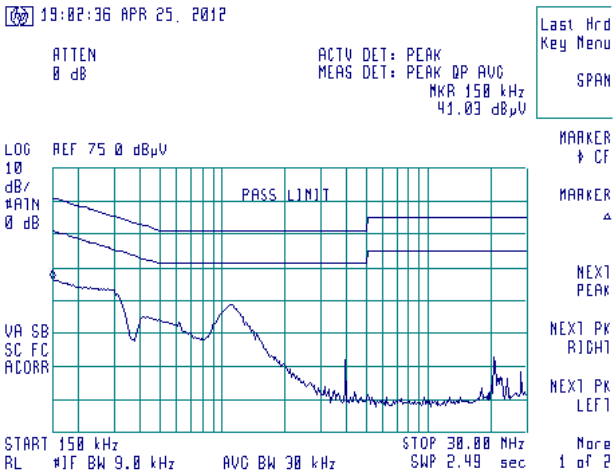
Manufacturer:	LS Research					
Date(s) of Test:	April 25th 2012					
Project Engineer:	Khairul Aidi Zainal					
Test Engineer:	Mike Hintzke					
Voltage:	120 VAC					
Operation Mode:	Continuous transmit, modulated					
Environmental Conditions in the Lab:	Temperature: 71° F Relative Humidity: 40%					
Test Location:	X	AC Mains Test area				Chamber
EUT Placed On:	X	40cm from Vertical Ground Plane				10cm Spacers
	X	80cm above Ground Plane				Other:
Measurements:		Pre-Compliance		Preliminary	X	Final
Detectors Used:		Peak	X	Quasi-Peak	X	Average

		Quasi-Peak			Average		
Frequency (MHz)	Line	Q-Peak Reading (dBµV)	Q-Peak Limit (dBµV)	Quasi-Peak Margin (dB)	Average Reading (dBµV)	Average Limit (dBµV)	Average Margin (dB)
0.150	L1	35.2	66.0	30.8	5.2	56.0	50.8
0.302	L1	32.2	60.2	28.0	10.7	50.2	39.5
1.106	L1	27.2	56.0	28.8	-2.7	46.0	48.7
0.150	L2	34.6	66.0	31.4	4.9	56.0	51.1
0.416	L2	20.0	57.5	37.5	-7.0	47.5	54.5
0.295	L2	30.0	60.4	30.4	0.6	50.4	49.8
1.025	L2	27.6	56.0	28.4	-2.4	46.0	48.4
0.618	L2	22.1	56.0	33.9	17.7	46.0	28.3

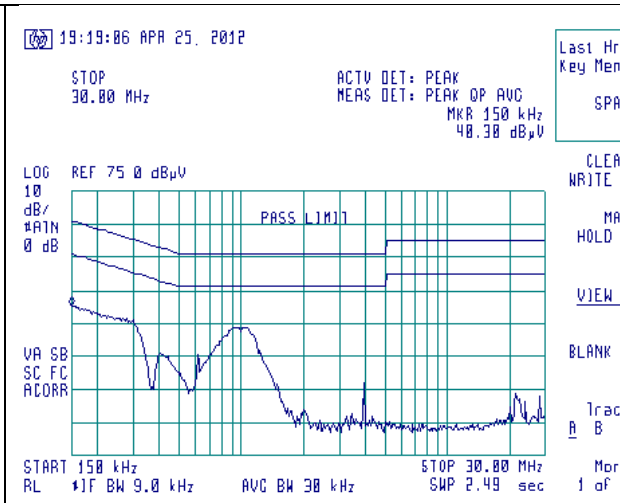
Notes:

1) The emissions listed are characteristic of the power supply used, and did not change by the EUT.

These screen captures represent Peak Emissions. For conducted emission measurements, both a Quasi-Peak detector function and an Average detector function are utilized. The emissions must meet both the Quasi-peak limit and the Average limit as described in 47 CFR 15.207 and RSS GEN 7.2.2 (Table 2).

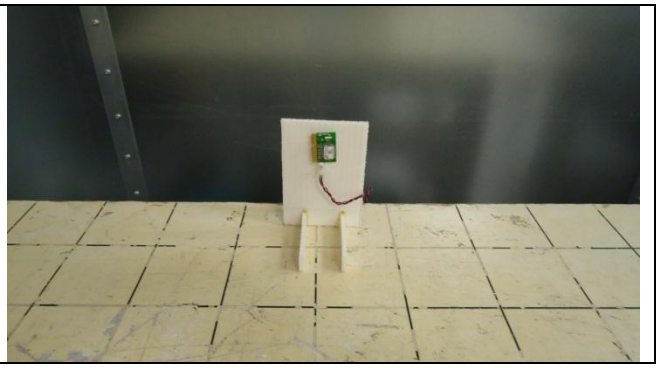


Line 1



Line 2

6.5 Test Setup Photo(s)



APPENDIX A – Test Equipment List

LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date : 8-Oct-2013 Type Test : Radiated measurements Job # : C-1818

Prepared By: Aidi Zainal Customer : Nikon Metrology Quote #: 313179

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960156	100kHz-1GHz Analog Signal Generator	Agilent	N5181A	MY49060062	9/5/2013	9/5/2014	Active Calibration
2	EE 960157	3Hz-13.2GHz Spectrum Analyzer	Agilent	E4445A	MY48250225	9/5/2013	9/5/2014	Active Calibration
3	EE 960158	RF Preselecter	Agilent	N9039A	MY46520110	9/5/2013	9/5/2014	Active Calibration
4	AA 960081	Double Ridge Horn Antenna	EMCO	3115	6907	1/29/2013	1/29/2014	Active Calibration
5	AA 960007	Double Ridge Horn Antenna	EMCO	3115	9311-4138	6/10/2013	6/10/2014	Active Calibration
6	AA 960078	Log Periodic Antenna	EMCO	93146	9701-4855	12/10/2012	12/10/2013	Active Calibration
7	AA 960150	Bicon Antenna	ETS	3110B	0003-3346	12/12/2012	12/12/2013	Active Calibration
8	EE 960073	Spectrum Analyzer	Agilent	E4446A	US45300564	5/28/2013	5/28/2014	Active Calibration
9	AA 960153	2.4GHz High Pass Filter	KWM	HPF-L-14186	7272-04	4/1/2013	4/1/2014	Active Calibration
10	EE 960147	Pre-Amp	Adv. Micro	WLA612	123101	2/1/2013	2/1/2014	Active Calibration
11	EE 960087	44GHz EXA Spectrum Analyzer	Agilent	N9010A	MY53400296	10/27/2013	10/27/2014	Active Calibration
12	EE 960161	26.5-40GHz LNA	Ducommun Techno	ALN-33144030	1103717-01	9/24/2013	9/24/2014	Active Calibration
13	AA 960161	Highpass Filter	K&L Microwave	11SH10-8000	2	12/24/2013	12/24/2014	Active Calibration
14	AA 960144	Phaseflex	Gore	EKD01D010720	5800373	6/1/2011	7/1/2013	Syatem
15	EE 960146	Std. Gain Horn Ant. w/preamp	Adv. Micro / EMCO	WLA622-4 / 3160-09	123001	9/24/2013	9/24/2014	Active Calibration
16	AA 960137	Standard Gain Horn Ant.	EMCO	3160-10	69259	10/4/2011	10/4/2014	Active Calibration
17	AA 960160	UTiFLEX Cable	Micro-Coax	UFC142A-0-0720-2002(	218652-001	9/24/2013	9/24/2014	Active Calibration

Project Engineer: Quality Assurance: Peter Fiebon

LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date : 8-Oct-2013 Type Test : Conducted measurements Job # : C-1818

Prepared By: Aidi Zainal Customer : Nikon Metrology Quote #: 313179

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960085	N9038A MXE 26.5GHz Receiver	Agilent	N9038A	MY51210148	8/7/2013	8/7/2014	Active Calibration
2	AA 960144	Phaseflex	Gore	EKD01D010720	5800373	6/1/2011	7/1/2013	System
3	EE 960073	Spectrum Analyzer	Agilent	E4446A	US45300564	5/28/2013	5/28/2014	Active Calibration
4	AA 960143	Phaseflex	Gore	EKD01D01048.0	5546519	6/14/2013	6/14/2015	Active Calibration
5	AA 960160	UTiFLEX Cable	Micro-Coax	UFC142A-0-0720-2002(	218652-001	9/24/2013	9/24/2014	Active Calibration

Project Engineer: Quality Assurance:

LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date : 20-Dec-2011 Type Test : AC mains Job # : C-1371

Prepared By: Aidi Customer : LSR Quote #: 311362

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960013	EMI Receiver	HP	8546A System	3617A00320;3448A	11/22/2011	11/22/2012	Active Calibration
2	EE 960014	EMI Receiver-filter section	HP	85460A	3448A00296	11/22/2011	11/22/2012	Active Calibration
3	AA 960072	Transient Limiter	HP	11947A	3107A02515	11/2/2011	11/2/2012	Active Calibration
4	AA 960075	LISN	EMCO	3810/2NM	9612-1710	9/19/2011	9/19/2012	Active Calibration

Project Engineer: Aidi Quality Assurance: Mike Hintzke

APPENDIX B – Test Standards: CURRENT PUBLICATION DATES RADIO

STANDARD #	DATE	Am. 1	Am. 2
ANSI C63.4	2003		
ANSI C63.10	2009		
FCC 47 CFR, Parts 0-15, 18, 90, 95	2013		
RSS GEN	2010		
RSS 210	2010		
RSS 102	2010		

APPENDIX C - Uncertainty Statement

Table of Expanded Uncertainty Values, (K=2) for Specified Measurements

Measurement Type	*Particular Configuration*	*Uncertainty Values*
Radiated Emissions	*3 – Meter chamber, Biconical Antenna*	*4.82 dB*
Radiated Emissions	*3-Meter Chamber, Log Periodic Antenna*	*4.88 dB*
Radiated Emissions	*3-Meter Chamber, Horn Antenna*	*4.85 dB*
Radiated Emissions	*10-Meter OATS, Biconical Antenna*	*4.32 dB*
Radiated Emissions	*10-Meter OATS, Log Periodic Antenna*	*3.63 dB*
Absolute Conducted Emissions	*Agilent PSA/ESA Series*	*1.38 dB*
AC Line Conducted Emissions	*Shielded Room/EMCO LISN*	*3.20 dB*
Radiated Immunity	*3 Volts/Meter in 3-Meter Chamber*	*2.05 Volts/Meter*
Conducted Immunity	*3 Volts level*	*2.33 V*
EFT Burst, Surge, VDI	*230 VAC*	*54.4 V*
ESD Immunity	*Discharge at 15kV*	*3200 V*
Temperature/Humidity	*Thermo-hygrometer*	*0.64° / 2.88 %RH*