

ENGINEERING TEST REPORT



**Wi-Fi POS Terminal
Model No.: NBS5800**

FCC ID: O3JNBS5800

Applicant:

NBS Payment Solutions
703 Evans Ave., Suite 400
Toronto, Ontario
Canada, M9C 5E9

In Accordance With

**FEDERAL COMMUNICATIONS COMMISSION (FCC)
PART 15, SUBPART C, SECTION 15.247
Digital Modulation (Wi-Fi)
Operating in the Frequency Band 2402-2480 MHz**

UltraTech's File No.: MIS-083F15C247

This Test report is Issued under the Authority of
Tri M. Luu, Professional Engineer,
Vice President of Engineering
UltraTech Group of Labs



Date: September 8, 2008

Report Prepared by: Dharmajit Solanki

Tested by: Hung Trinh, RFI Technologist

Issued Date: September 8, 2008

Test Dates: July 29 to August 8, 2008 &
September 4 and 5, 2008

- *The results in this Test Report apply only to the sample(s) tested, and the sample tested is randomly selected.*
- *This report must not be used by the client to claim product endorsement by NVLAP or any agency of the US Government.*

UltraTech

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0685



31040/SIT



C-1376



46390-2049



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SL2-IN-E-1119R

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File #: MIS-083F15C247
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All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

EXHIBIT 1 INTRODUCTION

1.1 SCOPE

Reference:	Part 15, Subpart C, Section 15.247
Title:	Telecommunication - Code of Federal Regulations, CFR 47, Part 15
Purpose of Test:	To gain FCC Equipment Authorization for Digital Modulation Systems Operating in the Frequency Band 2400-2483.5 MHz.
Test Procedures:	Both conducted and radiated emissions measurements were conducted in accordance with American National Standards Institute ANSI C63.4 - 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.
Environmental Classification:	Commercial, light industry & heavy industry

1.2 RELATED SUBMITTAL(S)/GRANT(S)

None.

1.3 NORMATIVE REFERENCES

Publication	Year	Title
FCC 47CFR Parts 0-19	2008	Code of Federal Regulations, Title 47 – Telecommunication
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
CISPR 22 + A1 & A2 EN 55022	2005 2006 2006	Limits and Methods of Measurements of Radio Disturbance Characteristics of Information Technology Equipment
CISPR 16-1-1	2003	Specification for radio disturbance and immunity measuring apparatus and methods. Part 1-1: Measuring Apparatus
CISPR 16-2-1	2003	Specification for radio disturbance and immunity measuring apparatus and methods. Part 2-1: Conducted disturbance measurement
CISPR 16-2-3	2003	Specification for radio disturbance and immunity measuring apparatus and methods. Part 2-3: Radiated disturbance measurement
KDB Publication No. 558074	2005	Guidance on Measurements for Digital Transmission Systems (47 CFR 15.247)

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EXHIBIT 2 PERFORMANCE ASSESSMENT

2.1 CLIENT INFORMATION

APPLICANT:	
Name:	NBS Payment Solutions
Address:	703 Evans Ave., Suite 400 Toronto, ON Canada, M9C 5E9
Contact Person:	Mr. Dragoslav Jovanovic Phone #: 416-621-7410 Fax #: 416-621-2450 Email Address: djovanovic@nbsps.com

MANUFACTURER:	
Name:	SAGEM Monetel
Address:	1, Rue Claude Chappe – BP346 Guilherand-Granges France, 07503
Contact Person:	Mr. Clement Lormeau Phone #: +33 4 75 81 40 47 Fax #: +33 4 75 81 41 57 Email Address: Clement.lormeau@sagem.com

2.2 EQUIPMENT UNDER TEST (EUT) INFORMATION

The following information (with the exception of the Date of Receipt) has been supplied by the applicant.

Brand Name:	NBS Payment Solutions
Product Name:	Wi-Fi POS Terminal
Model Name or Number:	NBS5800
Serial Number:	Test Sample
Oscillators' Frequencies:	32.768kHz, 2.000MHz, 10.000MHz, 20.000MHz
CPU's Frequencies:	3.57MHz, 48MHz, 57MHz (PLL)
Input Power Supply Type:	Li Ion Battery 3.6V 1.7Ah
Primary User Functions of EUT:	Financial Point-of-sales Transactions

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2.3 EUT'S TECHNICAL SPECIFICATIONS

TRANSMITTER	
Equipment Type:	Mobile
Intended Operating Environment:	Commercial & industry
Power Supply Requirement:	Li Ion Battery 3.6V 1.7Ah
RF Output Power Rating:	802.11b: 10.69 dBm peak conducted 802.11g: 15.85 dBm peak conducted
Operating Frequency Range:	2412-2462 MHz
RF Output Impedance:	50 Ω
Channel Spacing:	5 MHz
Duty Cycle:	Maximum 1 %
6 dB bandwidth:	802.11b: 10.97 MHz 802.11g: 16.28 MHz
Modulation Type:	DSSS & OFDM
Antenna Connector Type:	GSC connector mounted on the antenna
Antenna Description:	Manufacturer: SAGEM MONETEL Type: Integral PCB Antenna Bluetooth/Wi-Fi Model No.: 251603930 Freq. Range: 2.4 – 2.5 GHz Gain: 1.2dBi

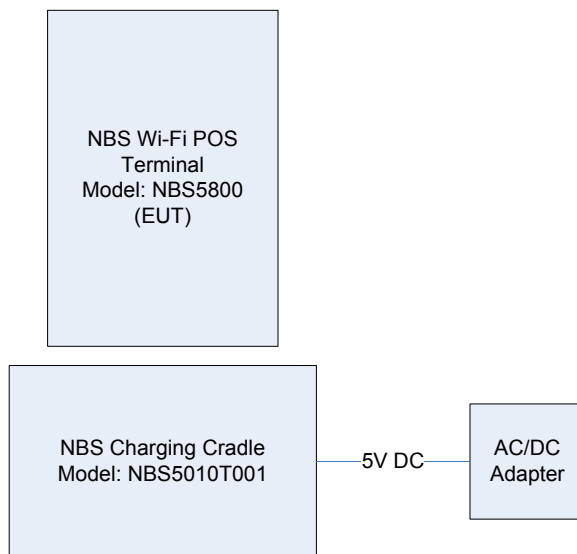
2.4 LIST OF EUT'S PORTS

Port Number	EUT's Port Description	Number of Identical Ports	Connector Type	Cable Type (Shielded/Non-shielded)
1	USB port	1	Mini USB Type A	Shielded
2	USB port	1	Mini USB Type B	Shielded

2.5 ANCILLARY EQUIPMENT

	Description	Manufacturer	Model Number	Serial Number
1	Cradle	NBS Tech	NBS5010B001	TE904991
2	AC Adapter	SAGEM Monetel	FW7601	251957747

2.6 TEST SETUP BLOCK DIAGRAM



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EXHIBIT 3 EUT OPERATING CONDITIONS AND CONFIGURATIONS DURING TESTS

3.1 OPERATIONAL TEST CONDITIONS & ARRANGEMENT FOR TESTS

Operating Modes:	<ul style="list-style-type: none"> ▪ Each of lowest, middle and highest channel frequencies transmits continuously for emissions measurements. ▪ The EUT operates in direct sequence or digital modulation mode.
Special Test Software:	Special software is provided by the applicant to put the EUT into the test mode and Wi-Fi test software was used to select and operate the EUT at different channel frequency and mode of operation such as direct sequence or digital modulation for testing purpose.
Special Hardware Used:	N/A
Transmitter Test Antenna:	The EUT is tested with the antenna fitted in a manner typical of normal intended use as integral antenna equipment.

Transmitter Test Signals	
Frequency Band(s):	2412 - 2462 MHz
Frequency(ies) Tested: (Near lowest, near middle & near highest frequencies in the frequency range of operation.)	2412, 2437 & 2462 MHz.
RF Power Output:	802.11b: 10.69 dBm peak conducted 802.11g: 15.85 dBm peak conducted
Normal Test Modulation:	DSSS, OFDM
Modulating Signal Source:	Internal

EXHIBIT 4 SUMMARY OF TEST RESULTS

4.1 LOCATION OF TESTS

All of the measurements described in this report were performed at Ultratech Group of Labs located in the city of Oakville, Province of Ontario, Canada.

AC Power Line Conducted Emissions were performed in UltraTech's shielded room, 24'(L) by 16'(W) by 8'(H).

Radiated Emissions were performed at the Ultratech's 3-10 TDK Semi-Anechoic Chamber situated in the Town of Oakville, province of Ontario. This test site been calibrated in accordance with ANSI C63.4, and found to be in compliance with the requirements of Sec. 2.948 of the FCC Rules. The descriptions and site measurement data of the Oakville 3-10 TDK Semi-Anechoic Chamber has been filed with FCC office (FCC File No.: 31040/SIT 1300B3) and Industry Canada office (Industry Canada File No.: IC2049A-3). Last Date of Site Calibration: May 17, 2007.

4.2 APPLICABILITY & SUMMARY OF EMC EMISSION TEST RESULTS

FCC Section(s)	Test Requirements	Compliance (Yes/No)
15.203	Antenna requirements	Yes
15.107(a) /15.207(a)	Power Line Conducted Emissions	Yes
15.109(a)	Class B Radiated Emissions	Yes <small>(Note 1)</small>
15.247(a)(2)	Spectrum Bandwidth & 6dB Bandwidth	Yes
15.247(b)(1)	Maximum Peak Output Power	Yes
15.247(d)	Band-edge Measurement	Yes
15.247(d)	Transmitter Conducted Spurious Emissions	Yes
15.247(e)	Peak Power Spectral Density	Yes
15.247(i), 1.1310 & 2.1091	RF Exposure	Yes

Notes:

(1) Please refer to Cetecom engineering test report for compliance with FCC Part 15, Subpart B – Receiver and Unintentional Radiated emissions details.

4.3 MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES

None.

EXHIBIT 5 MEASUREMENTS, EXAMINATIONS & TEST DATA FOR EMC EMISSIONS

5.1 TEST PROCEDURES

This section contains test results only. Details of test methods and procedures can be found in ANSI C63.4; KDB Publication No. 558074: Guidance on Measurements for Digital Transmission Systems (47 CFR 15.247).

5.2 MEASUREMENT UNCERTAINTIES

The measurement uncertainties stated were calculated in accordance with requirements of UKAS Document LAB 34 with a confidence level of 95%. Please refer to Exhibit 6 for Measurement Uncertainties.

5.3 MEASUREMENT EQUIPMENT USED

The measurement equipment used complied with the requirements of the Standards referenced in the Methods & Procedures ANSI C63.4 and CISPR 16-1.

5.4 COMPLIANCE WITH FCC PART 15 – GENERAL TECHNICAL REQUIREMENTS

FCC Section	FCC Rules	
15.203	<p>Described how the EUT complies with the requirement that either its antenna is permanently attached, or that it employs a unique antenna connector, for every antenna proposed for use with the EUT.</p> <p>The exception is in those cases where EUT must be professionally installed. In order to demonstrate that professional installation is required, the following 3 points must be addressed:</p> <ul style="list-style-type: none">• The application (or intended use) of the EUT• The installation requirements of the EUT• The method by which the EUT will be marketed	The integral antenna is permanently mounted on the printed circuit board and located inside the enclosure
15.204	<p>Provided the information for every antenna proposed for use with the EUT:</p> <p>(a) type (e.g. Yagi, patch, grid, dish, etc...), (b) manufacturer and model number (c) gain with reference to an isotropic radiator</p>	Manufacturer: SAGEM MONETEL Type: Integral PCB Antenna Model No.: 251603930 Freq. Range: 2.4 – 2.5 GHz Gain: 1.2dBi

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5.5 AC POWER LINE CONDUCTED EMISSIONS [§15.207(a)]

5.5.1. Limit(s)

The equipment shall meet the limits of the following table:

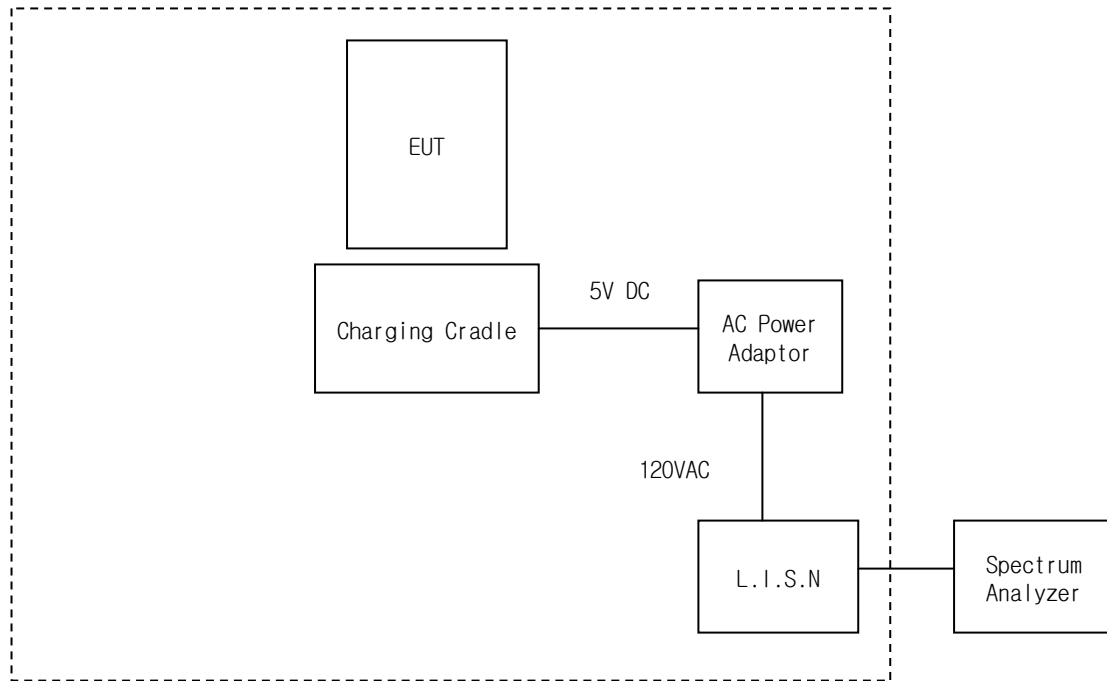
Frequency of emission (MHz)	Conducted Limits (dB μ V)		Measuring Bandwidth
	Quasi-peak	Average	
0.15–0.5	66 to 56*	56 to 46*	RBW = 9 kHz
0.5–5	56	46	VBW \geq 9 kHz for QP
5–30	60	50	VBW = 1 Hz for Average

*Decreases linearly with the logarithm of the frequency

5.5.2. Method of Measurements

ANSI C63.4, 2003.

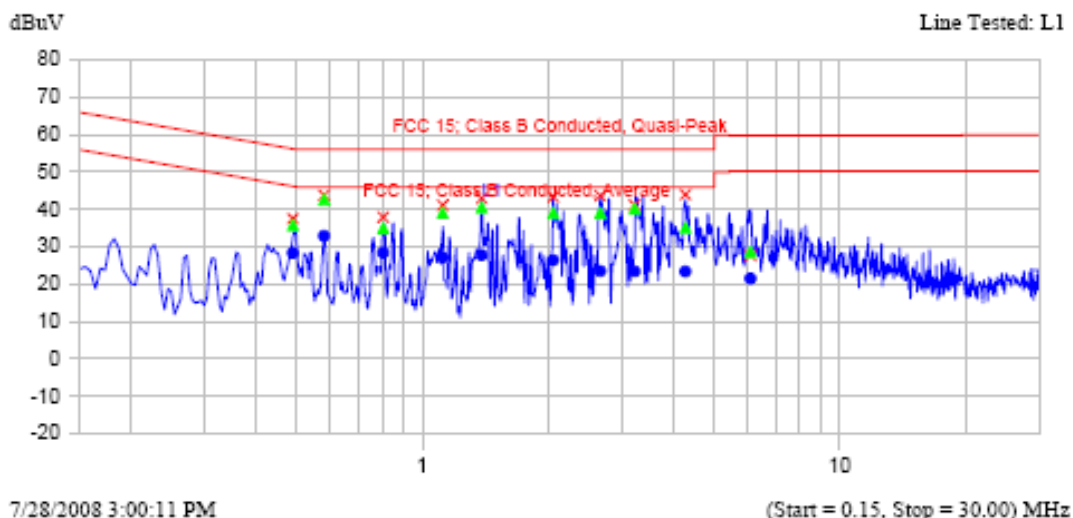
5.5.3. Test Arrangement



Plot 6.5.5.1 Power Line Conducted Emissions
 Line Voltage: 120 VAC 60 Hz, Line Tested: Hot

Description: 120V AC
 Setup Name: FCC 15 Class B
 Customer Name: NBS PAYMENT SOLUTIONS
 Project Number: MIS-082Q
 Operator Name: Wei
 EUT Name: NBS5800 WiFi Terminal
 Date Created: 7/28/2008 2:34:20 PM
 Date Modified: 7/28/2008 3:07:39 PM

Current Graph

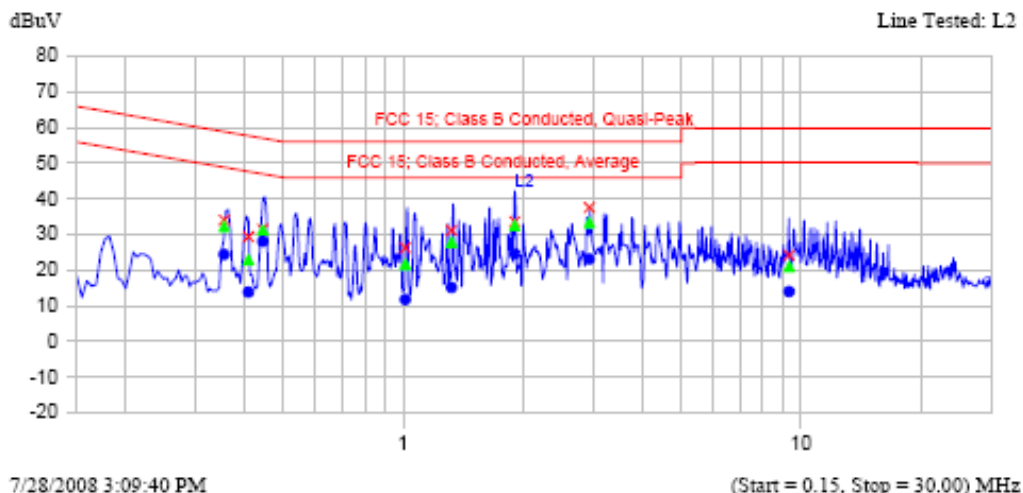


Frequency MHz	Peak dBuV	QP dBuV	Delta QP-QP Limit dB	Avg dBuV	Delta Avg-Avg Limit dB	Trace Name
0.489	37.5	35.8	-20.5	28.4	-17.9	L1
0.581	43.8	42.6	-13.4	32.9	-13.1	L1
0.805	38.0	35.0	-21.0	28.4	-17.6	L1
1.117	41.1	39.1	-16.9	27.2	-18.8	L1
1.385	43.0	40.5	-15.5	27.8	-18.2	L1
2.057	43.4	39.0	-17.0	26.4	-19.6	L1
2.666	43.7	39.0	-17.0	23.5	-22.5	L1
3.226	41.1	40.2	-15.8	23.4	-22.6	L1
4.267	43.9	35.1	-20.9	23.4	-22.6	L1
6.108	27.7	28.7	-31.3	21.5	-28.5	L1

Plot 6.5.5.2 Power Line Conducted Emissions
 Line Voltage: 120 VAC 60 Hz, Line Tested: Neutral

Description: 120V AC
 Setup Name: FCC 15 Class B
 Customer Name: NBS PAYMENT SOLUTIONS
 Project Number: MIS-082Q
 Operator Name: Wei
 EUT Name: NBS5800 WiFi Terminal
 Date Created: 7/28/2008 2:34:20 PM
 Date Modified: 7/28/2008 3:15:50 PM

Current Graph



Frequency MHz	Peak dBuV	QP dBuV	Delta QP-QP Limit dB	Avg dBuV	Delta Avg-Avg Limit dB	Trace Name
0.354	34.0	32.3	-27.8	24.4	-25.7	L2
0.408	29.4	23.0	-35.6	13.8	-34.7	L2
0.444	31.5	31.2	-26.3	28.1	-19.5	L2
1.012	26.3	21.7	-34.3	11.8	-34.2	L2
1.322	31.2	27.9	-28.1	15.2	-30.8	L2
1.905	33.6	32.6	-23.4	24.6	-21.4	L2
2.935	37.6	33.4	-22.6	23.1	-22.9	L2
9.336	24.2	21.1	-38.9	14.0	-36.0	L2

5.6 6 dB BANDWIDTH [§15.247(a)(2)]

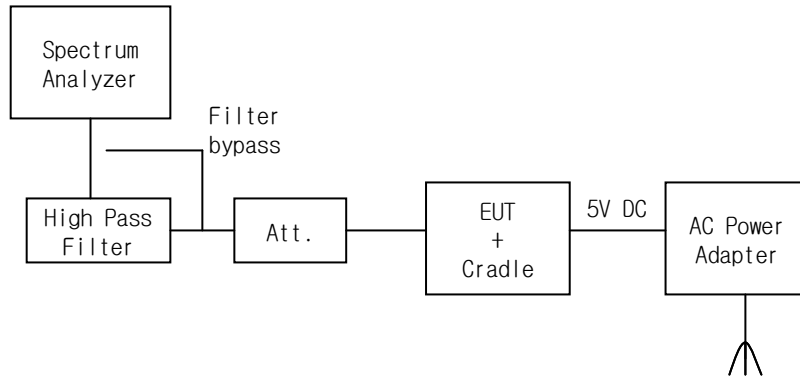
5.6.1. Limits

- **§15.247(a)(2):** Systems using digital modulation techniques may operate in the 902 - 928 MHz, 2400 - 2483.5 MHz, and 5725 - 5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

5.6.2. Method of Measurements

Refer to FCC KDB Publication No. 558074 on DTS and ANSI C63.4 for measurement methods.

5.6.3. Test Arrangement



5.6.4. Test Data

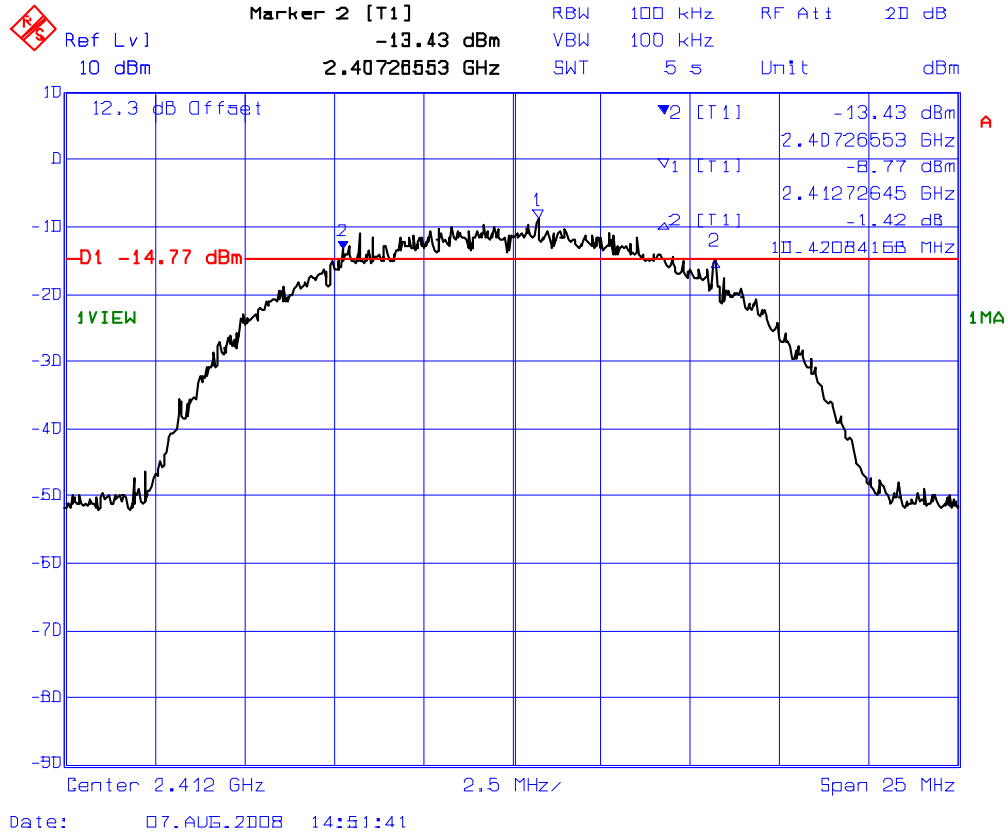
Note: Bandwidth measurements were done using the built-in auto function of the analyzer.

5.6.4.1. For DSSS Mode (802.11b mode, 11 Mbps data rate)

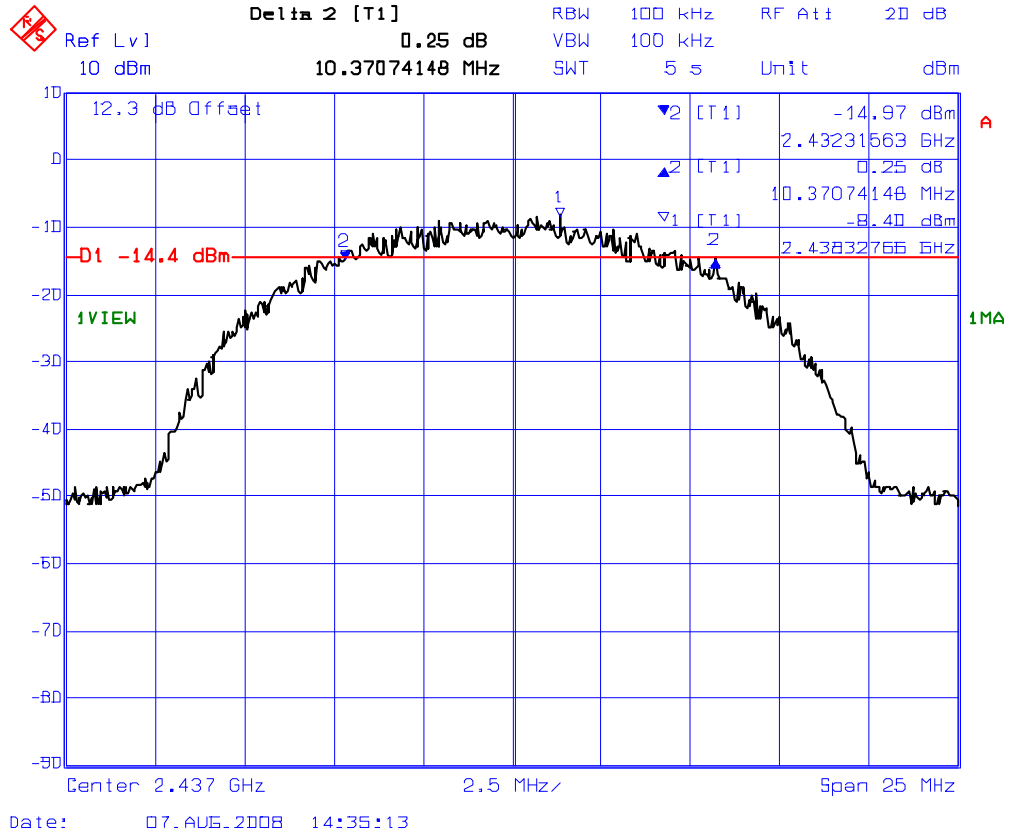
Frequency (MHz)	6 dB Bandwidth (MHz)
2412	10.42
2437	10.37
2462	10.97

See the following plots for detailed measurements.

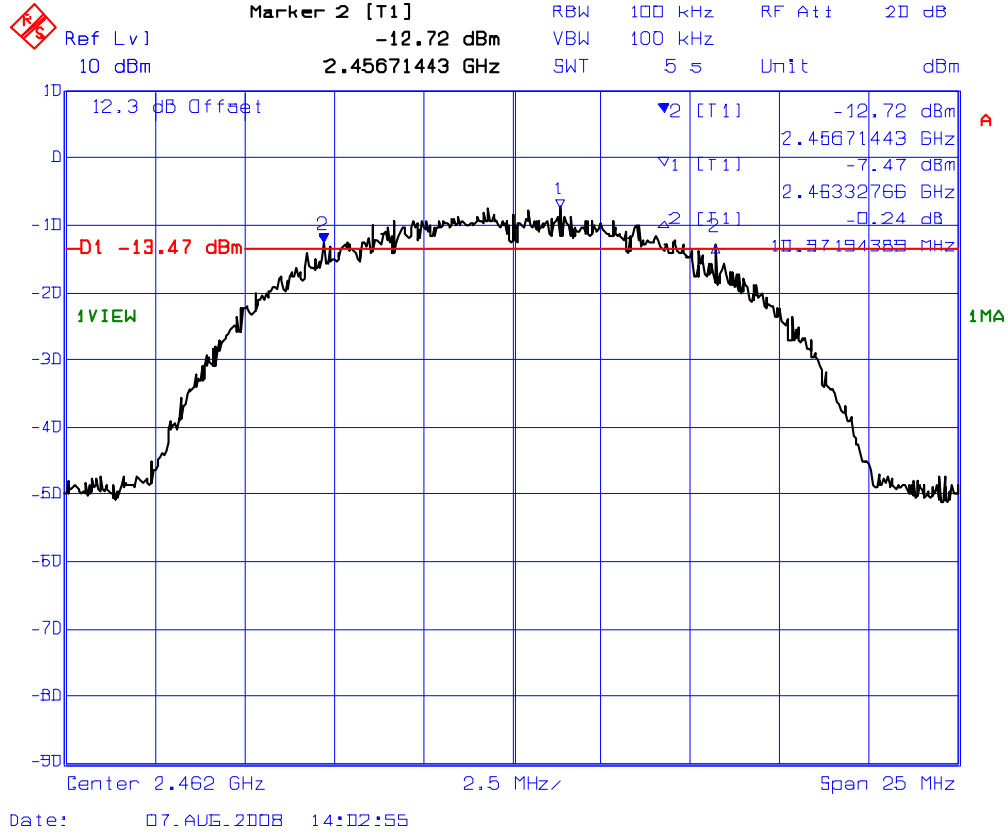
Plot 5.6.4.1.1. 6 dB Bandwidth
 Frequency: 2412 MHz



Plot 5.6.4.1.2. 6 dB Bandwidth
 Frequency: 2437MHz



Plot 5.6.4.1.3. 6 dB Bandwidth
Frequency: 2462MHz

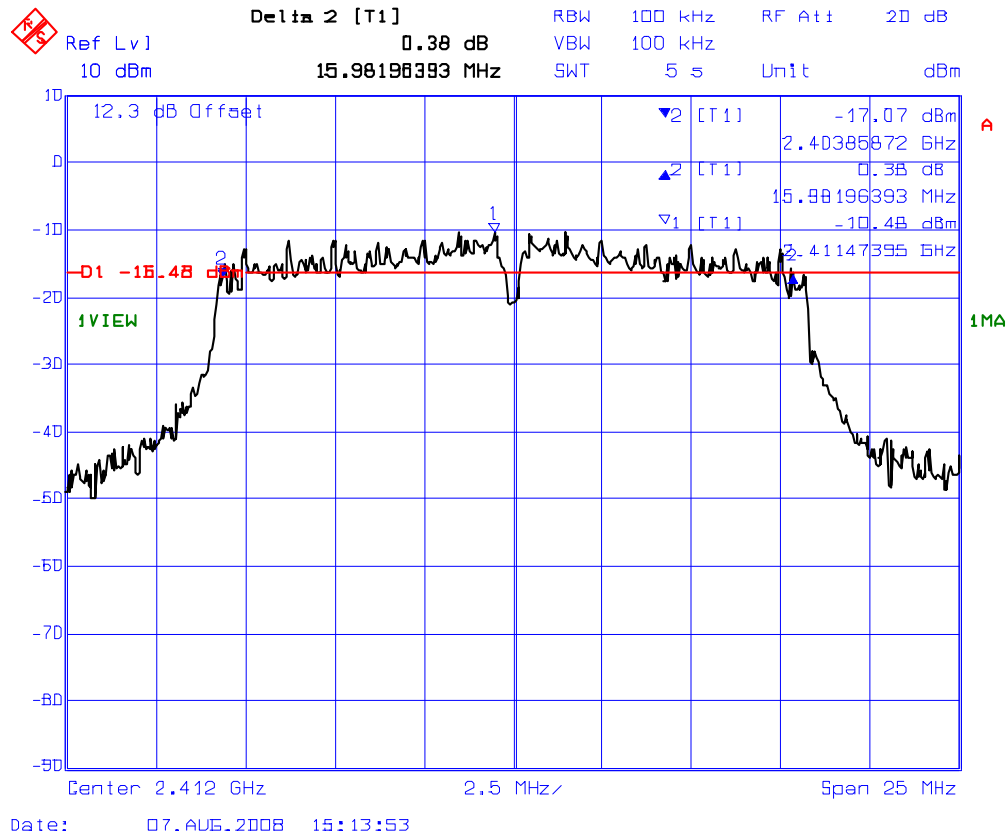


5.6.4.2. OFDM Mode (802.11g mode, 54 Mbps data rate, 64QAM)

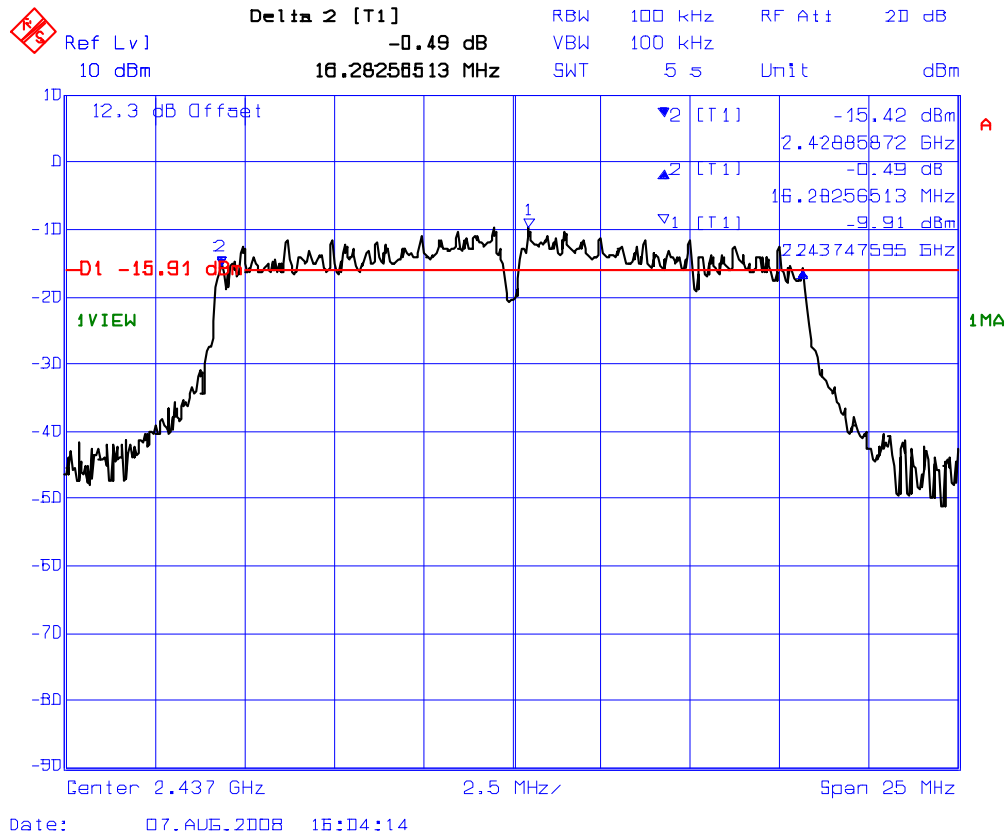
Frequency (MHz)	6 dB Bandwidth (MHz)
2412	15.98
2437	16.28
2462	16.28

See the following plots for detailed measurements.

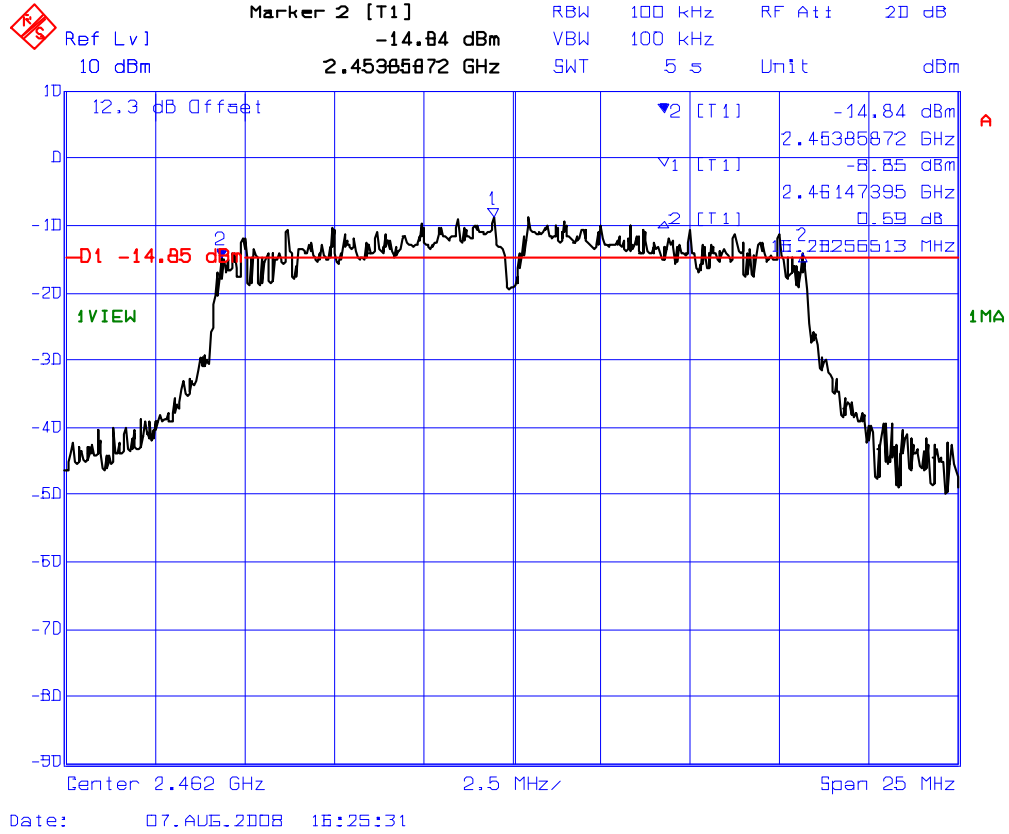
Plot 5.6.4.2.1. 6 dB Bandwidth
 Frequency: 2412 MHz



Plot 5.6.4.2.2. 6 dB Bandwidth
 Frequency: 2437MHz



Plot 5.6.4.2.3. 6 dB Bandwidth
Frequency: 2462MHz



5.7 PEAK OUTPUT POWER [§ 15.247(b)(1)]

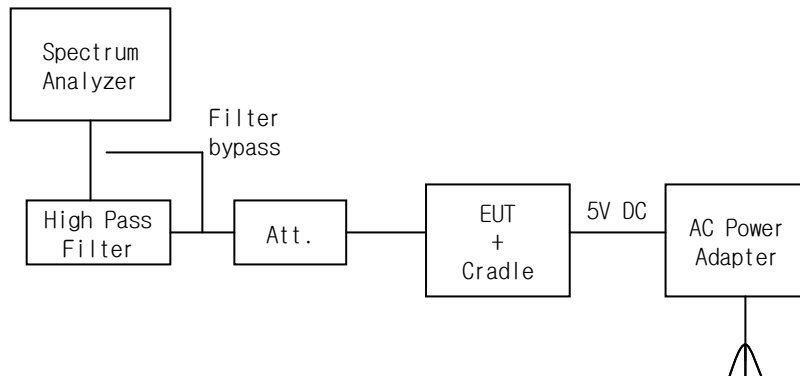
5.7.1. Limits

FCC § 15.247(b)(3): For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the *maximum conducted output power* is the highest total transmit power occurring in any mode.

5.7.2. Method of Measurements

Refer to FCC KDB Publication No. 558074, Power Option method 1 and ANSI C63.4 for measurement methods.

5.7.3. Test Arrangement



5.7.4. Test Data

5.7.4.1. 802.11b mode

Data Rate (Mbps)	Bandwidth Factor	Peak Power Conducted (dBm)		
		2412 MHz (CH1)	2437 MHz (CH6)	2462 MHz (CH11)
1 (BPSK)	0.40 dB	7.00	9.72	10.69

5.7.4.2. 802.11g mode

Data Rate (Mbps)	Bandwidth Factor	Peak Power Conducted (dBm)		
		2412 MHz (CH1)	2437 MHz (CH6)	2462 MHz (CH11)
64 (64QAM)	2.12 dB	15.58	15.85	13.78

Bandwidth Factor:

1. 802.11b mode = $10 \log (10.97 \text{ MHz} / 10 \text{ MHz}) = 0.40 \text{ dB}$
2. 802.11g mode = $10 \log (16.28 \text{ MHz} / 10 \text{ MHz}) = 2.12 \text{ dB}$

5.8 TRANSMITTER BAND-EDGE & SPURIOUS CONDUCTED EMISSIONS [§ 15.247(d)]

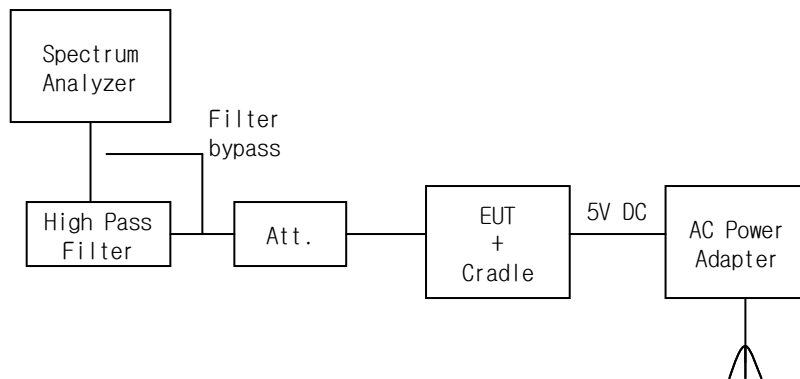
5.8.1. Limit(s)

§ 15.247 (d): In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.

5.8.2. Method of Measurements

KDB Publication No. 558074: Guidance on Measurements for Digital Transmission Systems (47 CFR 15.247)

5.8.3. Test Arrangement

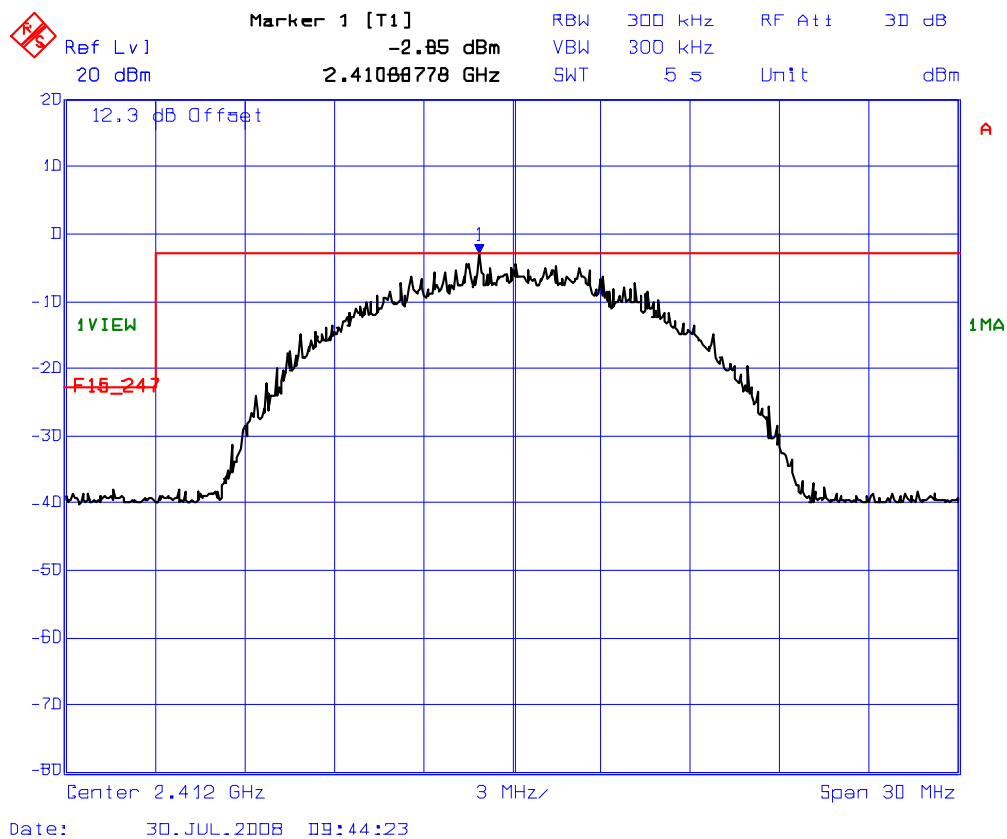


5.8.4. Test Data

5.8.4.1. Band-Edge RF Conducted Emissions

802.11b mode, Data rate auto

Plot 5.8.4.1.1.1. Band-Edge RF Conducted Emissions
Low End of Frequency Band



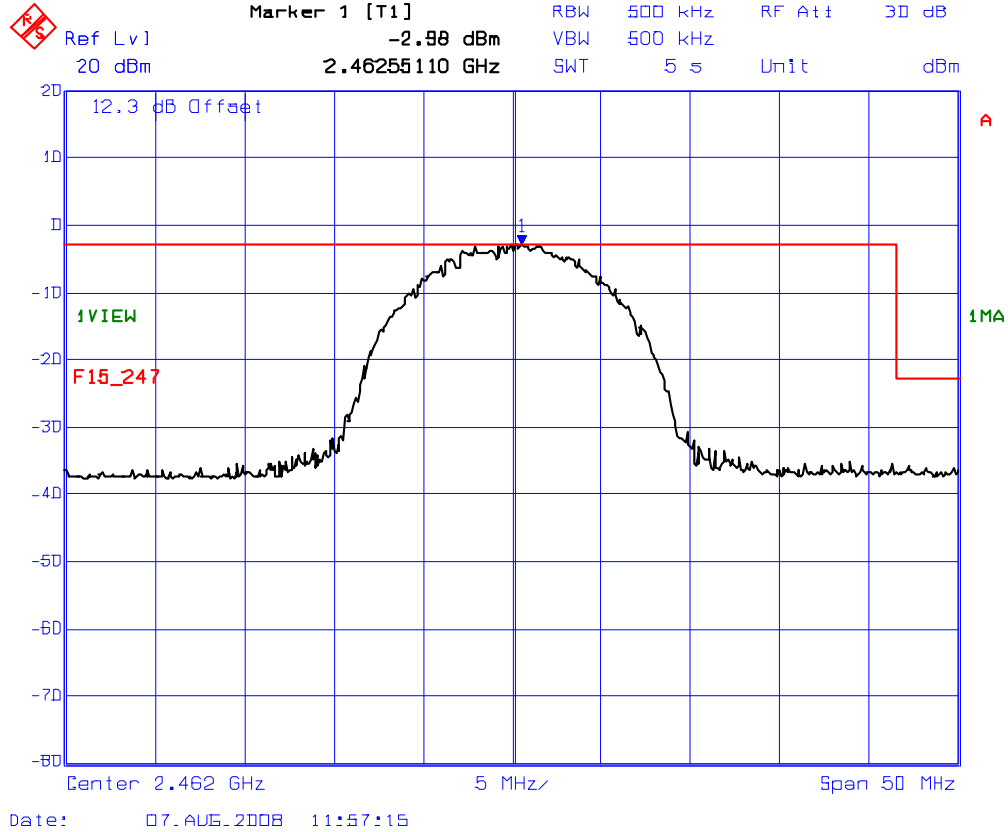
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September 8, 2008

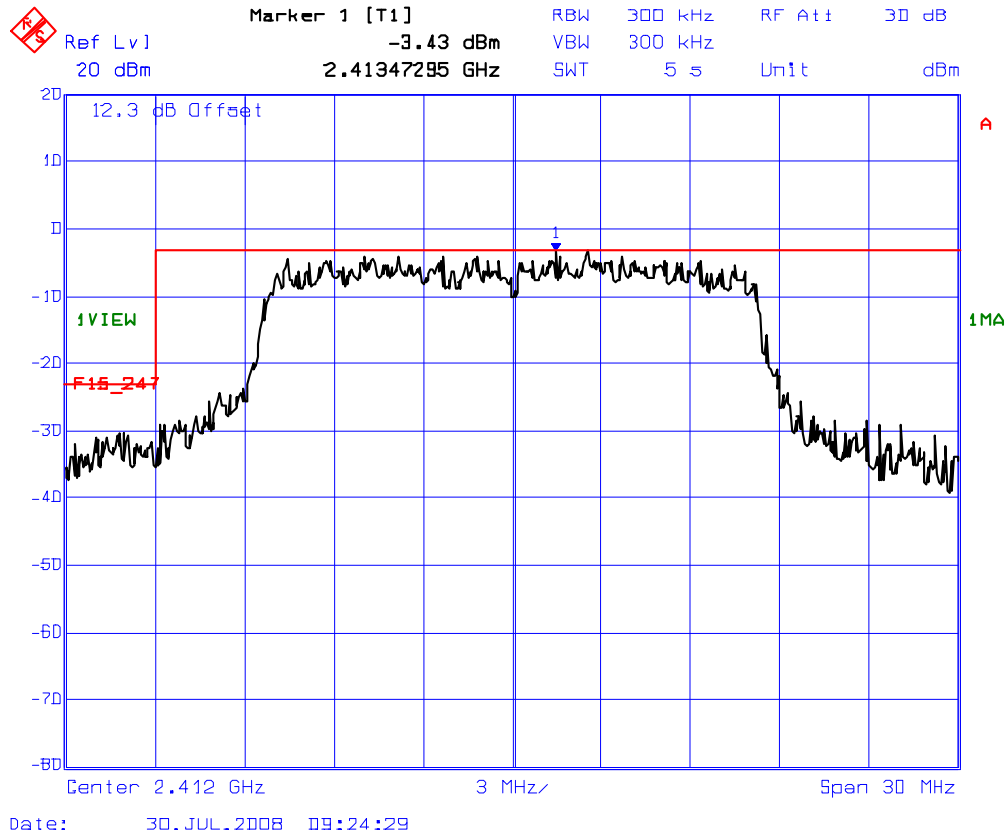
All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

Plot 5.8.4.1.1.2. Band-Edge RF Conducted Emissions
High End of Frequency Band

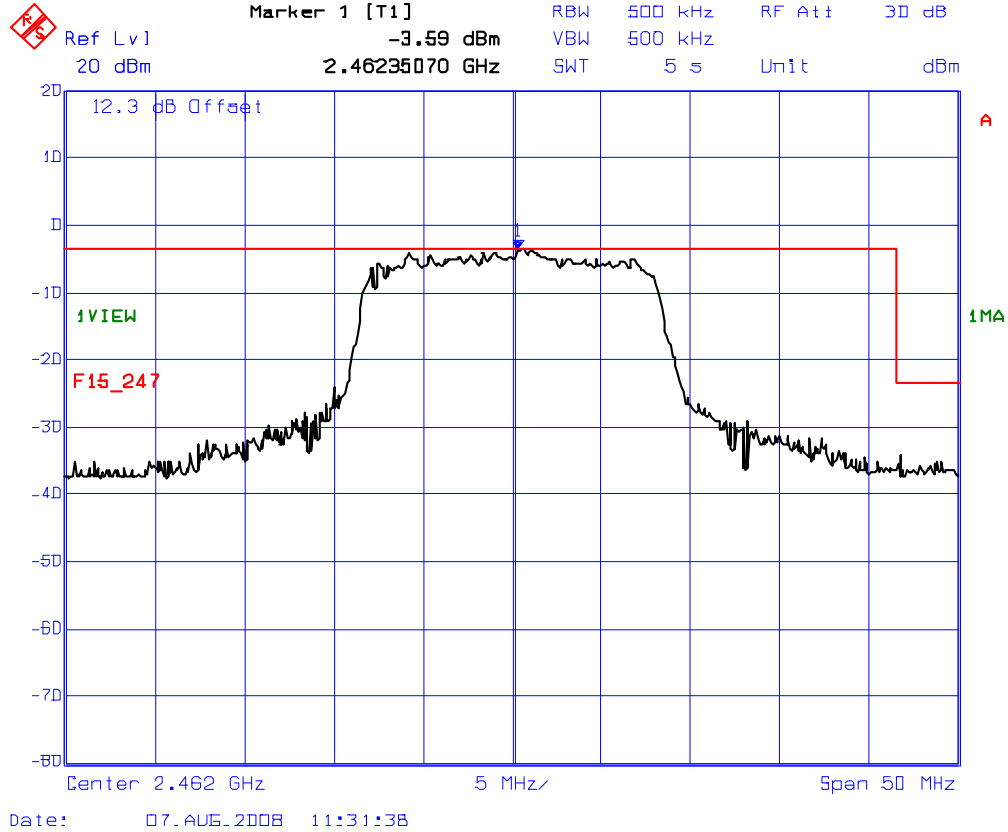


802.11g mode, Data rate auto

Plot 5.8.4.1.1.3. Band-Edge RF Conducted Emissions
Low End of Frequency Band



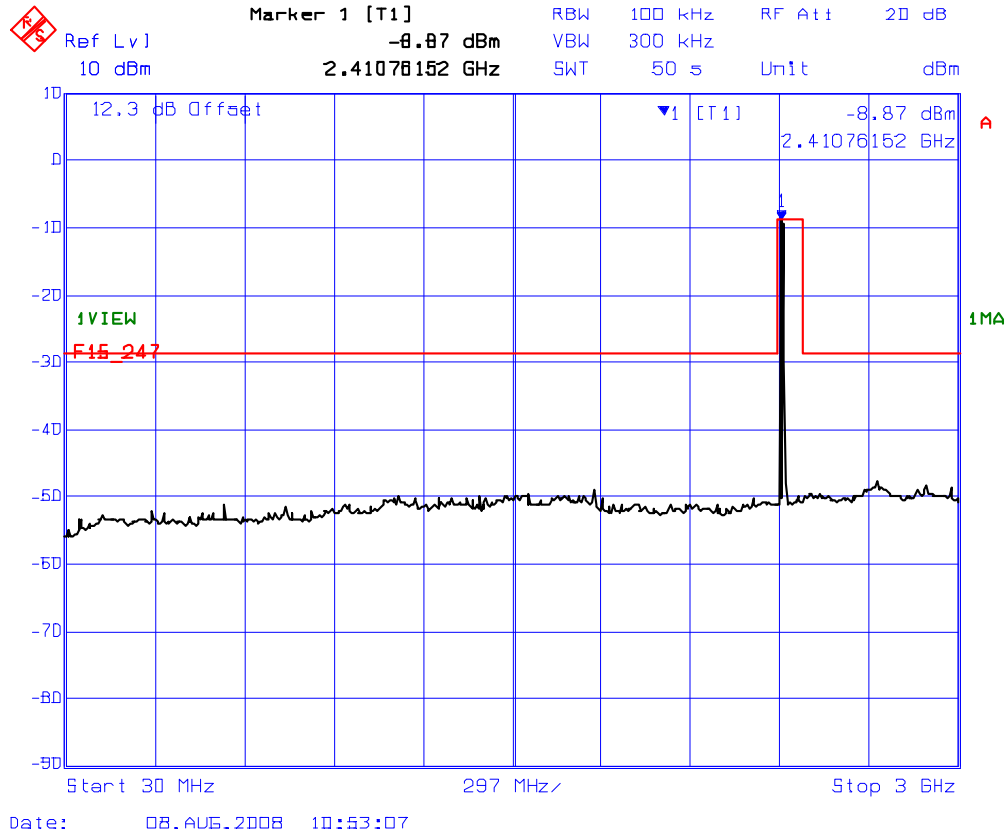
Plot 5.8.4.1.1.4. Band-Edge RF Conducted Emissions
High End of Frequency Band



5.8.4.2. Spurious RF Conducted Emissions

802.11b mode, 11 Mbps data rate

Plot 5.8.4.2.1.1. Spurious RF Conducted Emissions
Transmitter Frequency: 2412 MHz



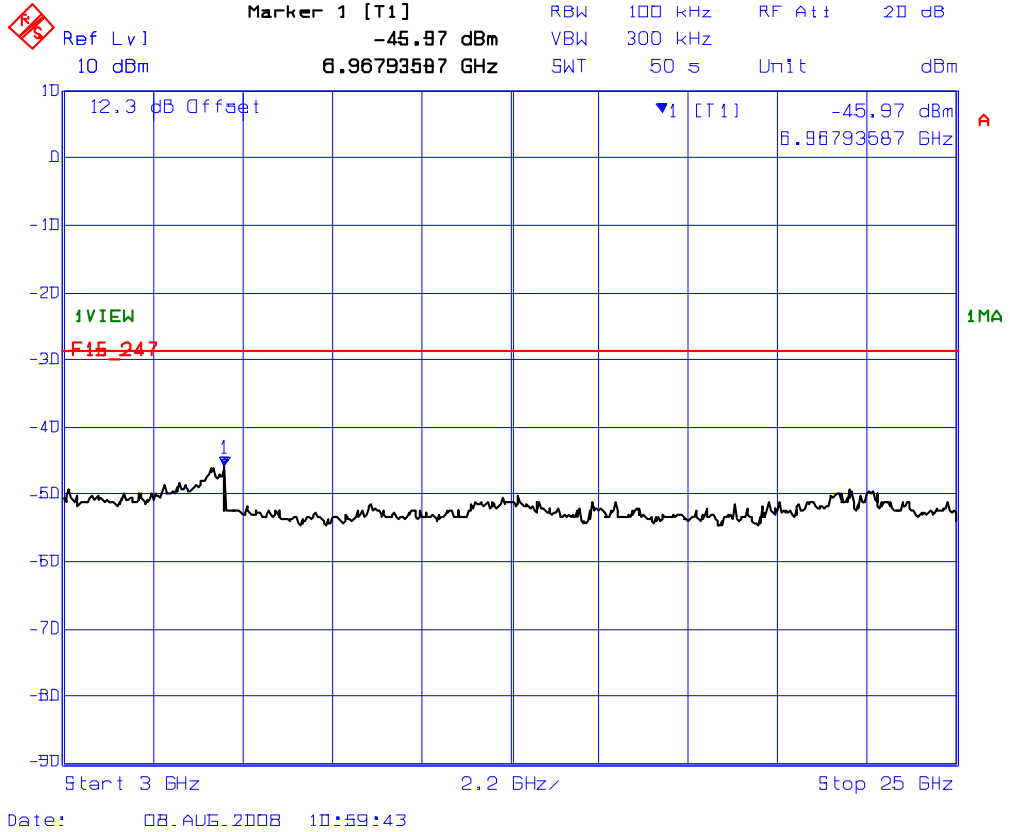
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Tel. #: 905-829-1570, Fax. #: 905-829-8050 Email: vic@ultratech-labs.com, Website: <http://www.ultratech-labs.com>

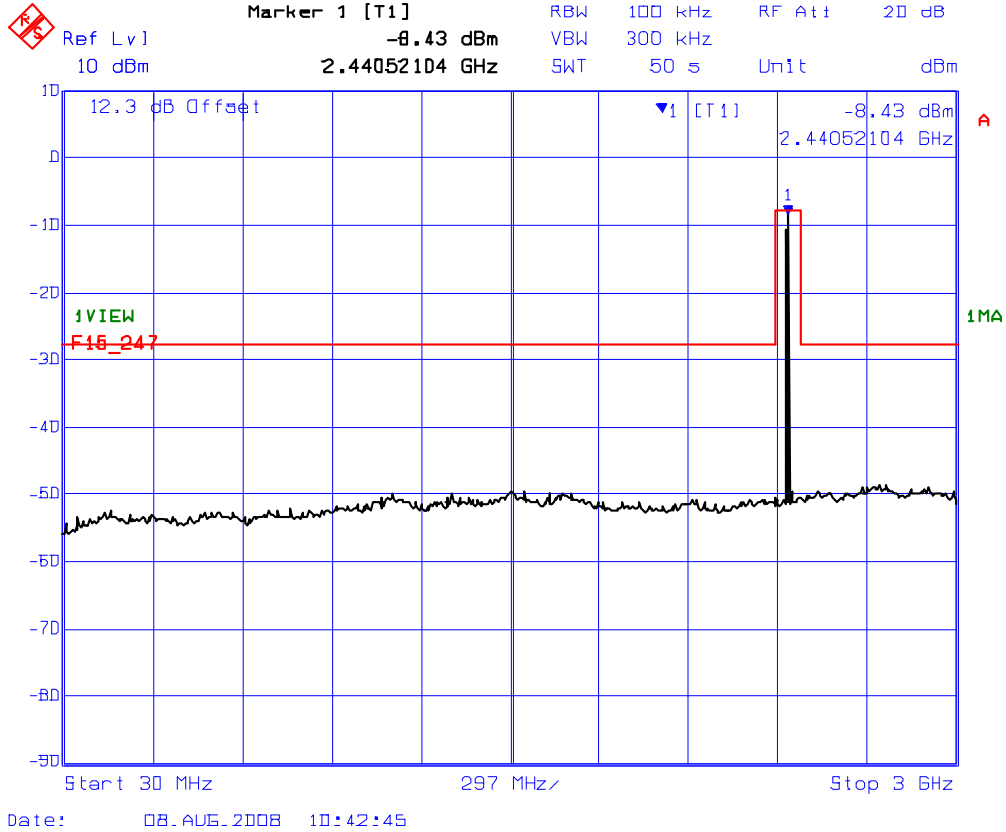
File #: MIS-083F15C247
September 8, 2008

All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

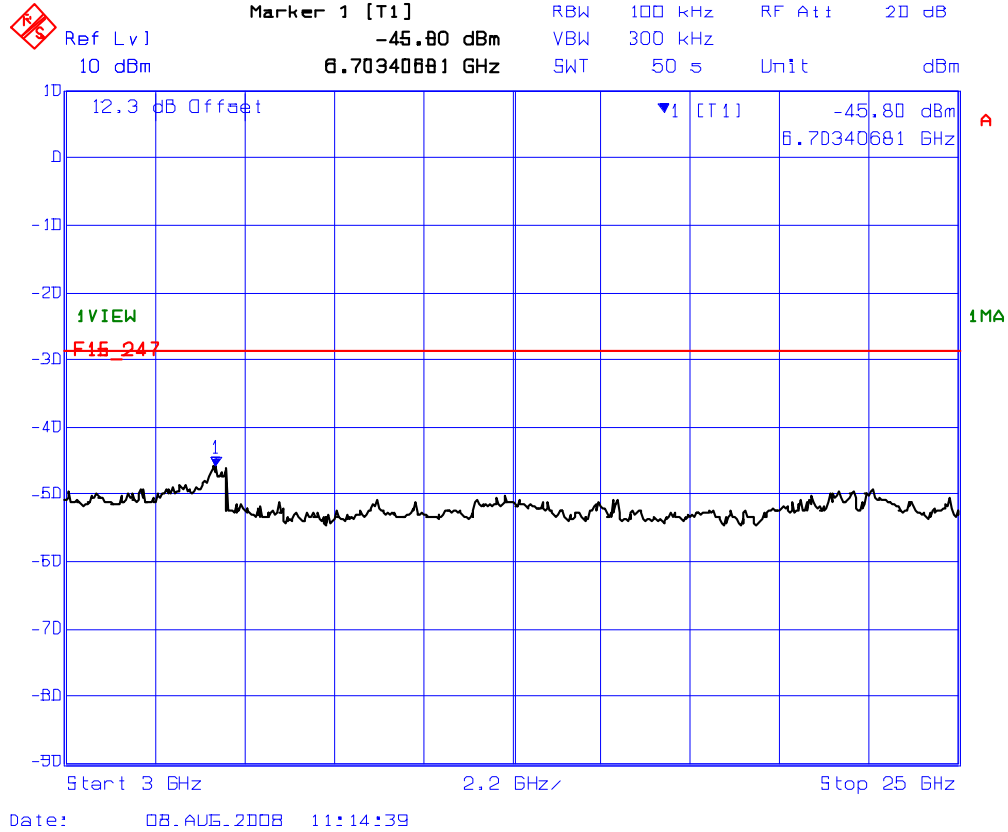
Plot 5.8.4.2.1.2. Spurious RF Conducted Emissions
Transmitter Frequency: 2412 MHz



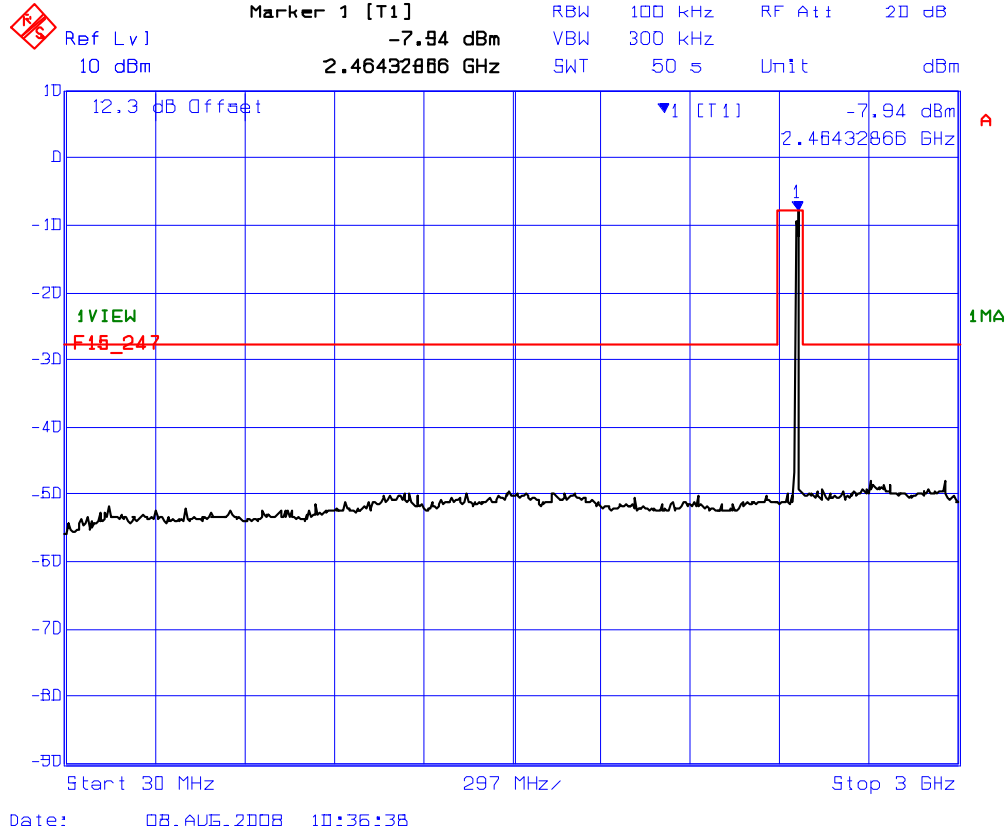
Plot 5.8.4.2.1.3. Spurious RF Conducted Emissions
Transmitter Frequency: 2437 MHz



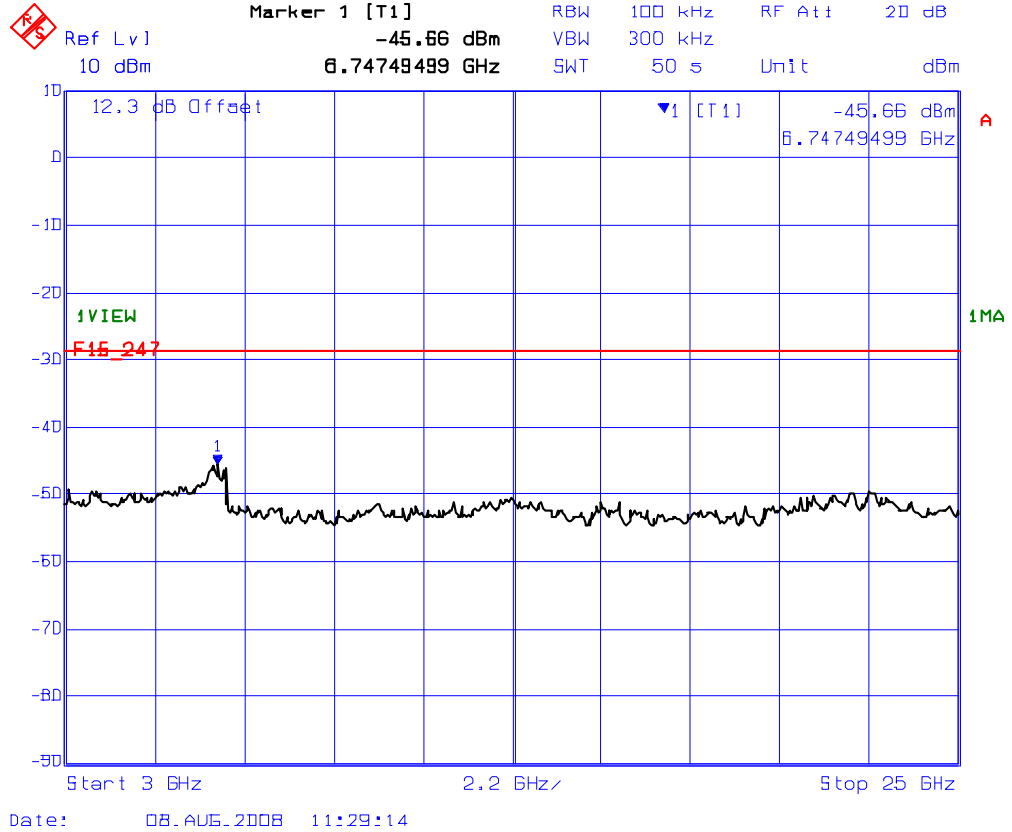
Plot 5.8.4.2.1.4. Spurious RF Conducted Emissions
Transmitter Frequency: 2437 MHz



Plot 5.8.4.2.1.5. Spurious RF Conducted Emissions
Transmitter Frequency: 2462 MHz

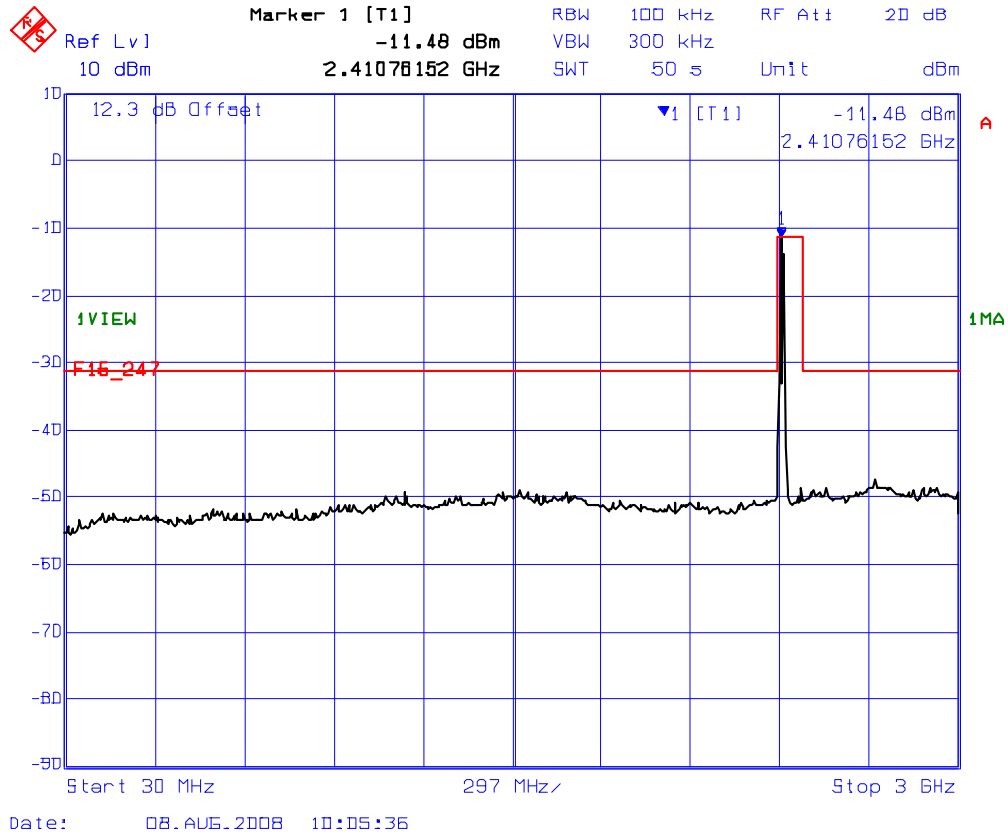


Plot 5.8.4.2.1.6. Spurious RF Conducted Emissions
Transmitter Frequency: 2462 MHz

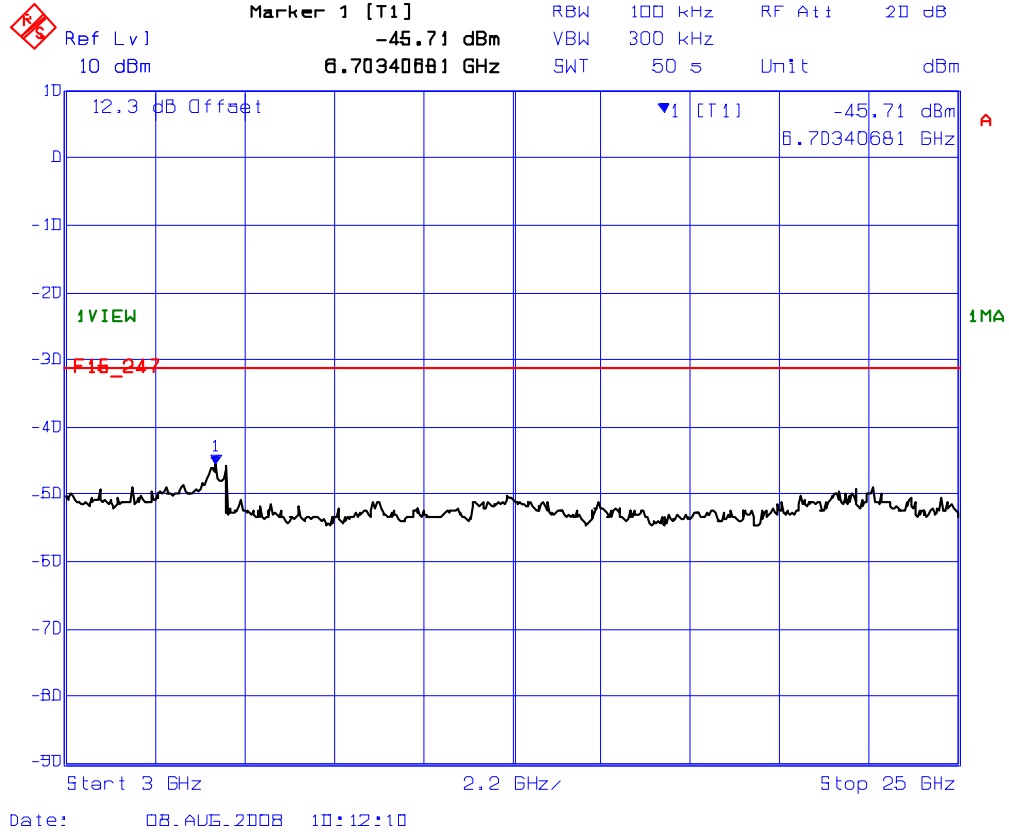


802.11g mode, 54 Mbps data rate, 64QAM

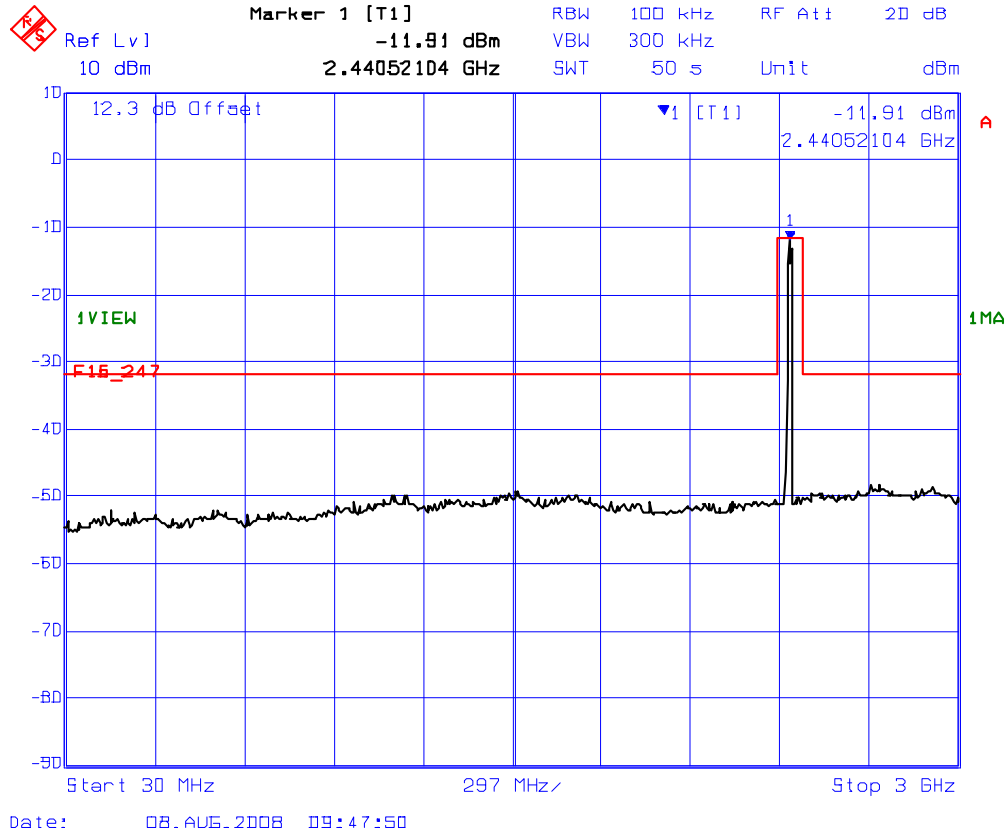
Plot 5.8.4.2.1.7. Spurious RF Conducted Emissions
Transmitter Frequency: 2412 MHz



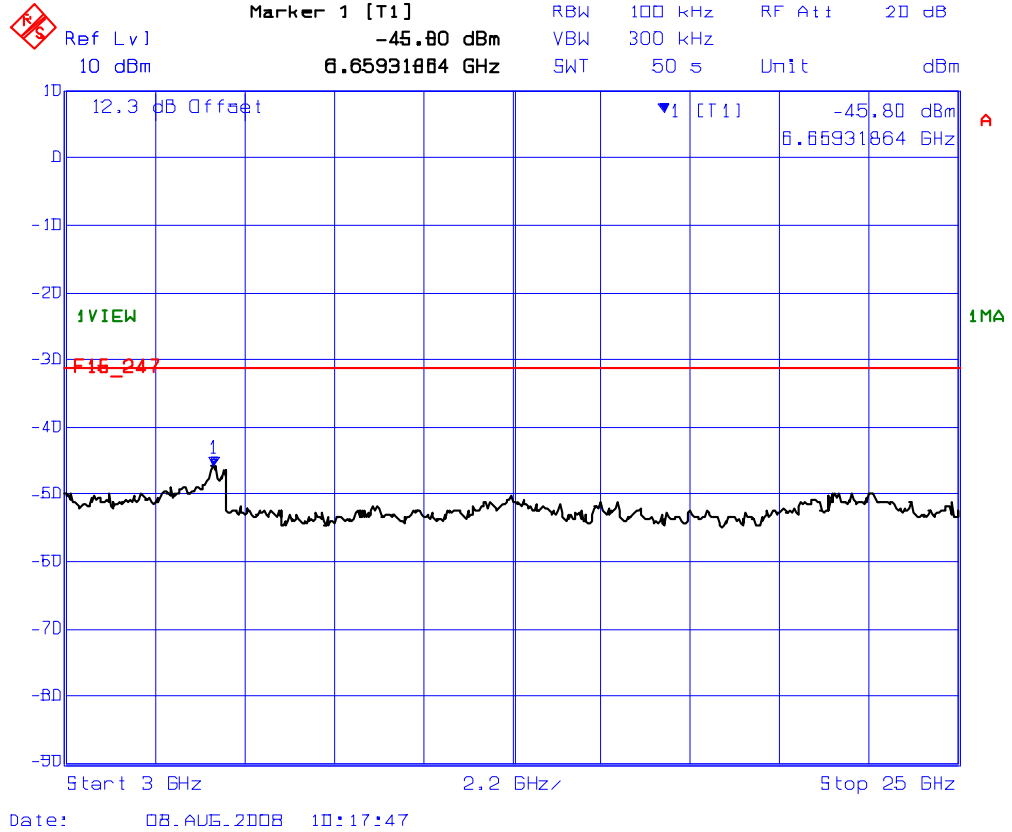
Plot 5.8.4.2.1.8. Spurious RF Conducted Emissions
Transmitter Frequency: 2412 MHz



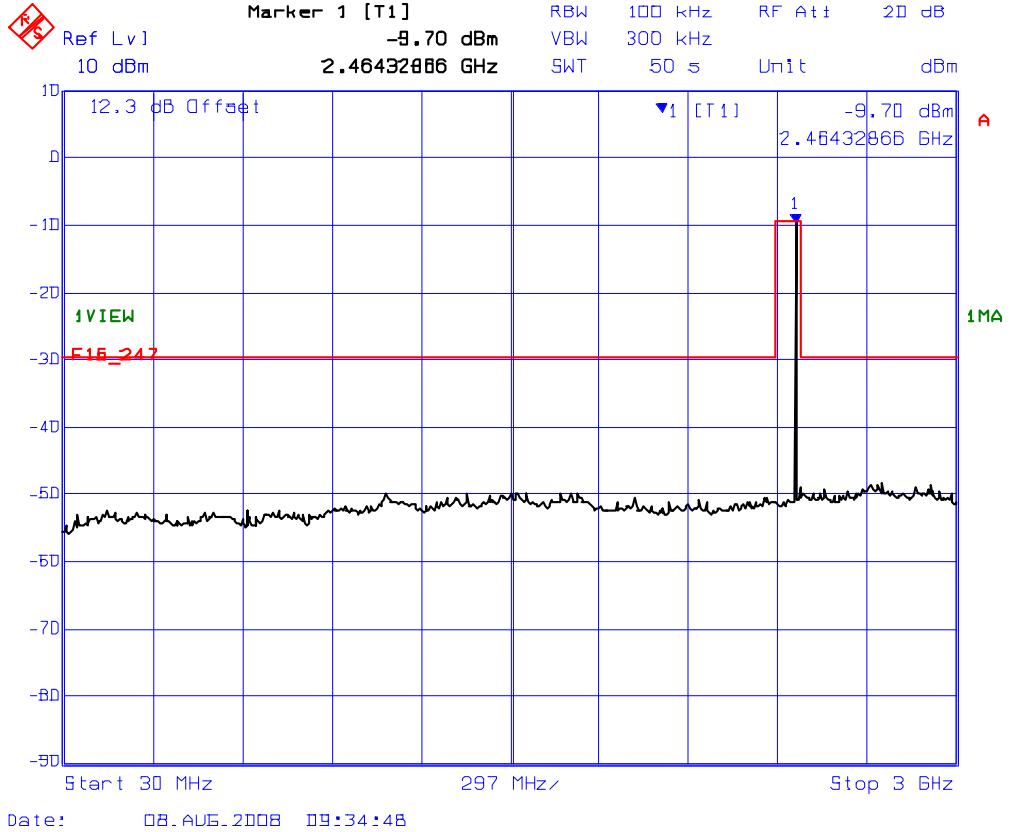
Plot 5.8.4.2.1.9. Spurious RF Conducted Emissions
Transmitter Frequency: 2437 MHz



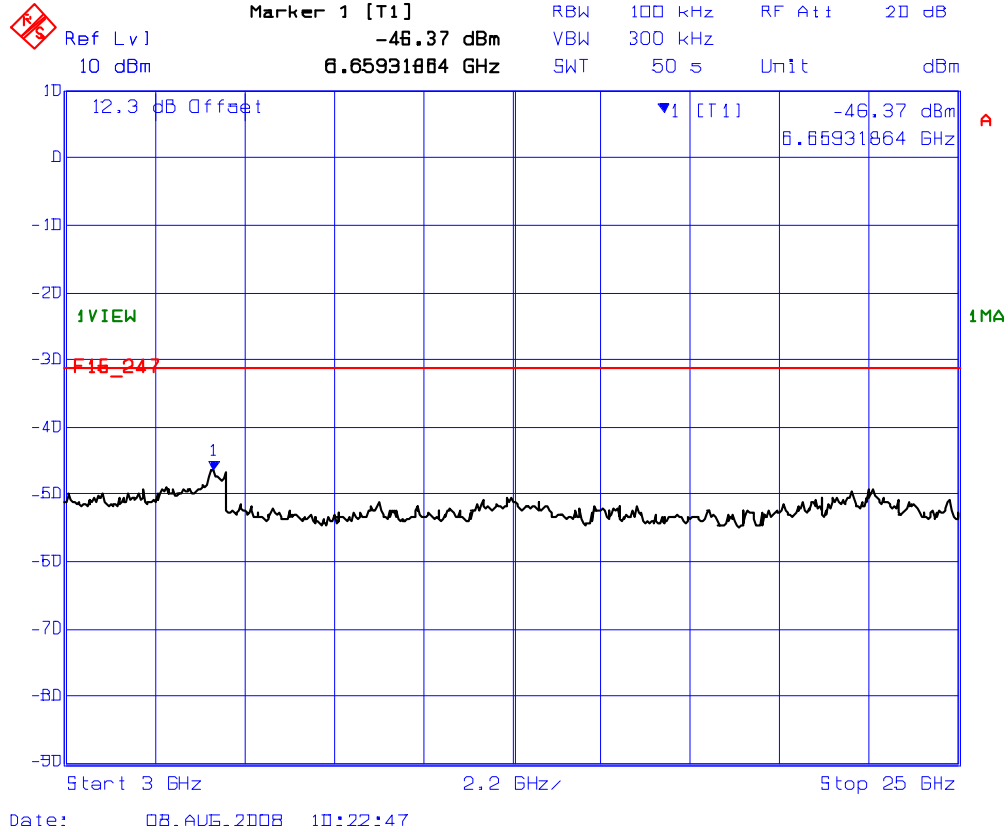
Plot 5.8.4.2.1.10. Spurious RF Conducted Emissions
Transmitter Frequency: 2437 MHz



Plot 5.8.4.2.1.11. Spurious RF Conducted Emissions
Transmitter Frequency: 2462 MHz



Plot 5.8.4.2.1.12. Spurious RF Conducted Emissions
Transmitter Frequency: 2462 MHz



5.9 RADIATED SPURIOUS EMISSIONS @ 3 METERS [§ 15.209 & § 15.247(d)]

5.9.1. Limits

- FCC 15.247(d):** In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in Section 15.209(a) is not required.
- FCC 15.209:** In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

47 CFR 15.205(a) - Restricted Bands of Operation

MHz	MHz	MHz	GHz
0.090 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
¹ 0.495 - 0.505	16.69475 - 16.69525	608 - 614	5.35 - 5.46
2.1735 - 2.1905	16.80425 - 16.80475	960 - 1240	7.25 - 7.75
4.125 - 4.128	25.5 - 25.67	1300 - 1427	8.025 - 8.5
4.17725 - 4.17775	37.5 - 38.25	1435 - 1626.5	9.0 - 9.2
4.20725 - 4.20775	73 - 74.6	1645.5 - 1646.5	9.3 - 9.5
6.215 - 6.218	74.8 - 75.2	1660 - 1710	10.6 - 12.7
6.26775 - 6.26825	108 - 121.94	1718.8 - 1722.2	13.25 - 13.4
6.31175 - 6.31225	123 - 138	2200 - 2300	14.47 - 14.5
8.291 - 8.294	149.9 - 150.05	2310 - 2390	15.35 - 16.2
8.362 - 8.366	156.52475 - 156.52525	2483.5 - 2500	17.7 - 21.4
8.37625 - 8.38675	156.7 - 156.9	2690 - 2900	22.01 - 23.12
8.41425 - 8.41475	162.0125 - 167.17	3260 - 3267	23.6 - 24.0
12.29 - 12.293	167.72 - 173.2	3332 - 3339	31.2 - 31.8
12.51975 - 12.52025	240 - 285	3345.8 - 3358	36.43 - 36.5
12.57675 - 12.57725	322 - 335.4	3600 - 4400	(2)
13.36 - 13.41			

¹ Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz.

² Above 38.6

47 CFR 15.209(a) - Radiated emission limits, general requirements

Frequency (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
0.009 - 0.490	2400/F(kHz)	300
0.490 - 1.705	24000/F(kHz)	30
1.705 - 30.0	30	30
30 - 88	100 **	3
88 - 216	150 **	3
216 - 960	200 **	3
Above 960	500	3

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

5.9.2. Method of Measurements

KDB Publication No. 558074: Guidance on Measurements for Digital Transmission Systems (47 CFR 15.247)

5.9.3. Test Arrangement

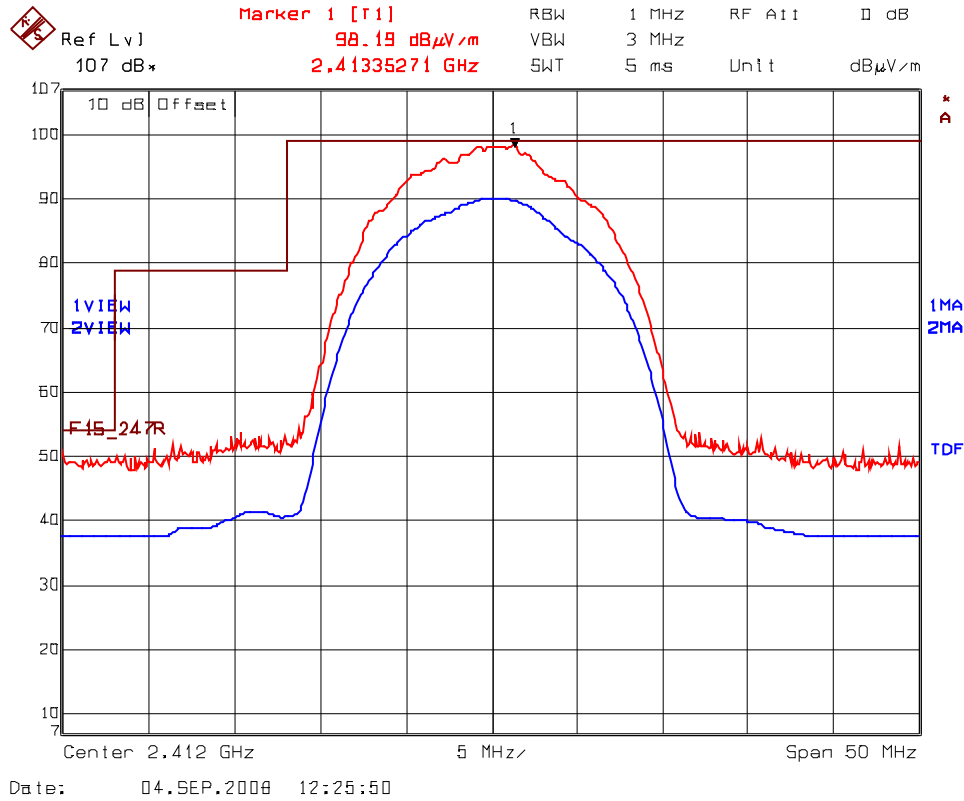
Refer to Section 2.6 of this test report for test setup.

5.9.4. Test Data

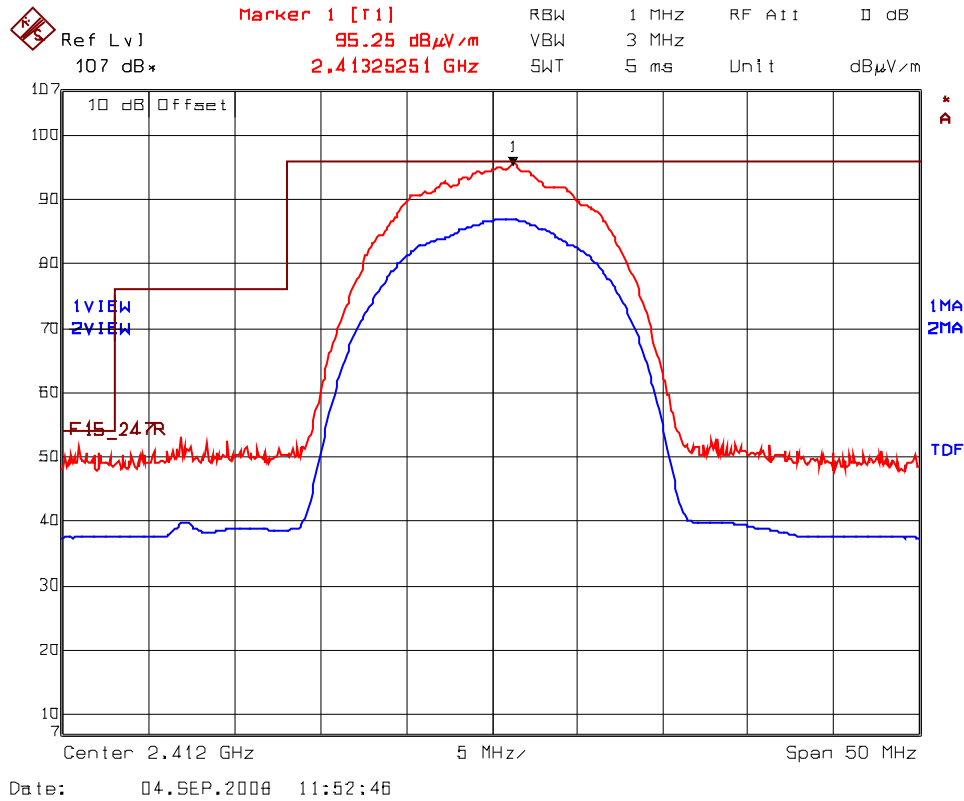
5.9.4.1. Band-Edge RF Radiated Emissions @ 3m

802.11b mode, 11 Mbps data rate, CCK

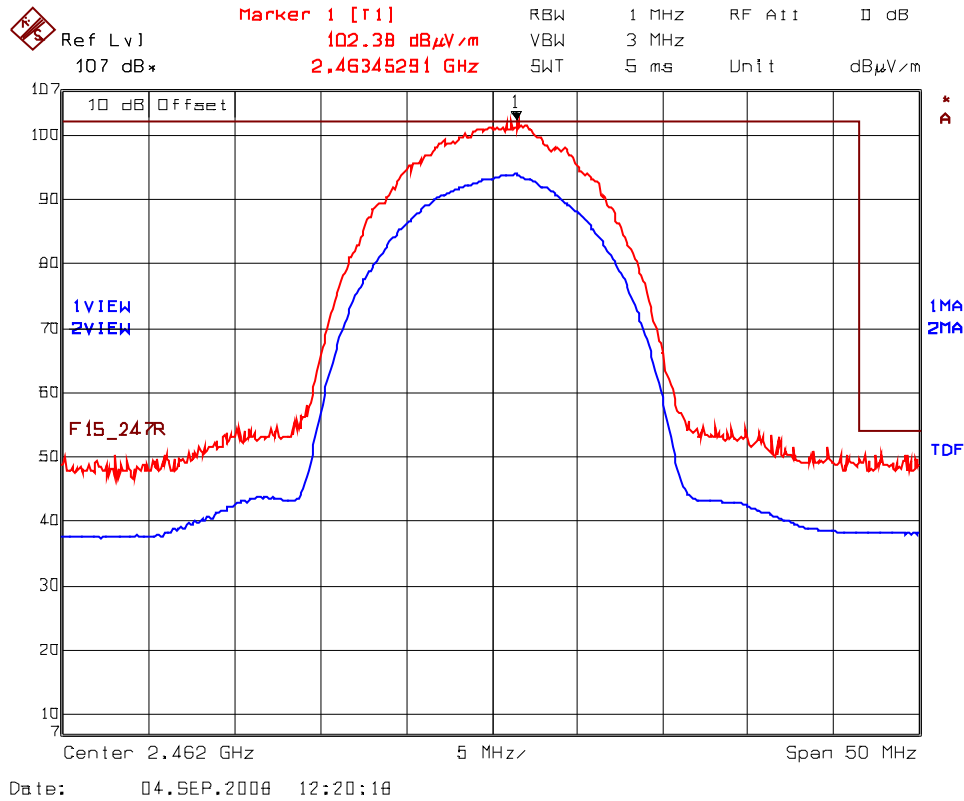
Plot 5.9.4.1.1. Band-Edge RF Radiated Emissions @ 3 m
Low End of Frequency Band
Rx Antenna Orientation: Horizontal
Trace 1: RBW= 1 MHz, VBW= 3 MHz
Trace 2: RBW= 1 MHz, VBW= 10Hz



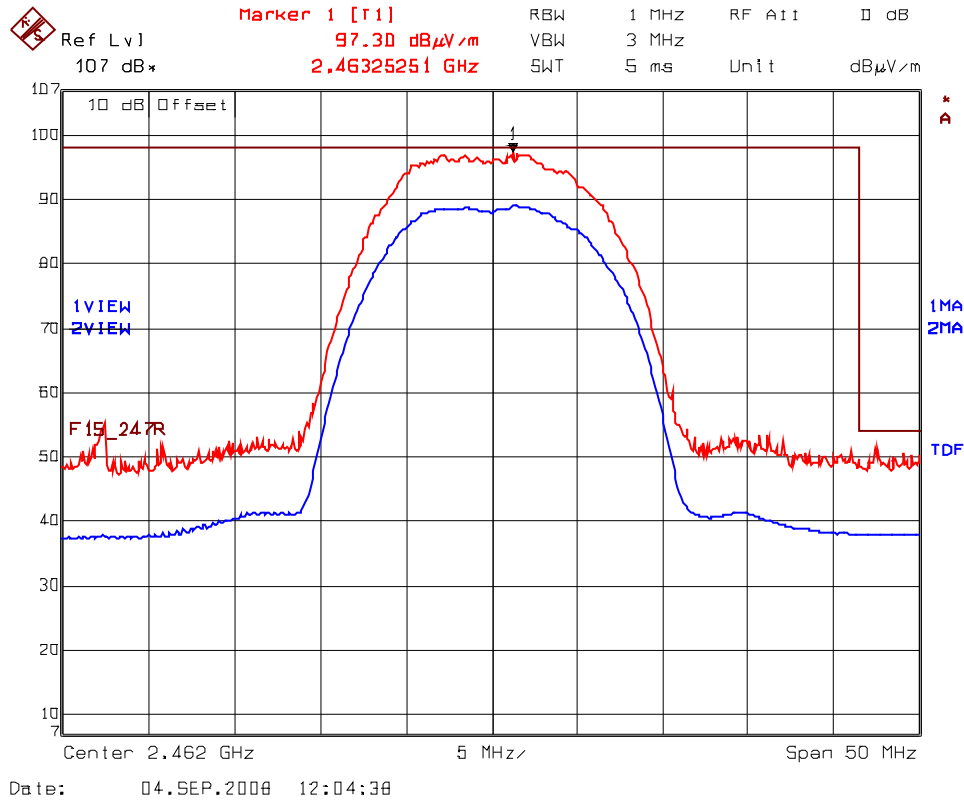
Plot 5.9.4.1.1.2. Band-Edge RF Radiated Emissions @ 3 m
Low End of Frequency Band
Rx Antenna Orientation: Vertical
Trace 1: RBW= 1 MHz, VBW= 3 MHz
Trace 2: RBW= 1 MHz, VBW= 10Hz



Plot 5.9.4.1.1.3. Band-Edge RF Radiated Emissions @ 3 m
 High End of Frequency Band
 Rx Antenna Orientation: Horizontal
 Trace 1: RBW= 1 MHz, VBW= 3 MHz
 Trace 2: RBW= 1 MHz, VBW= 10Hz



Plot 5.9.4.1.1.4. Band-Edge RF Radiated Emissions @ 3 m
 High End of Frequency Band
 Rx Antenna Orientation: Vertical
 Trace 1: RBW= 1 MHz, VBW= 3 MHz
 Trace 2: RBW= 1 MHz, VBW= 10Hz



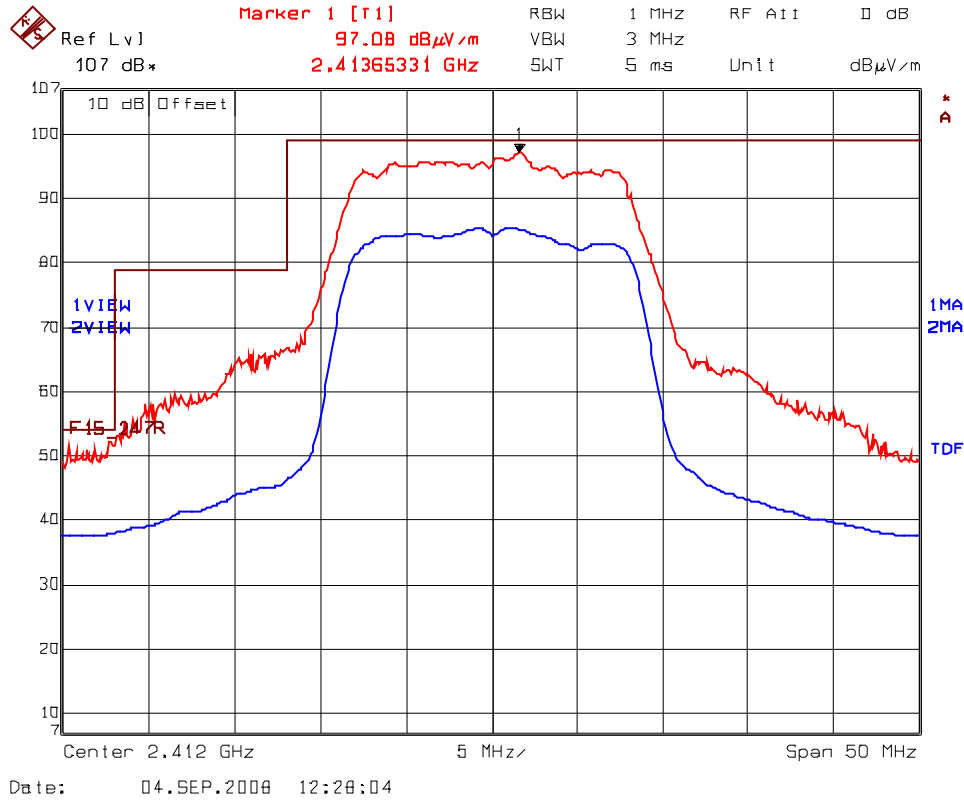
802.11g mode, 54 Mbps data rate, 64QAM

Plot 5.9.4.1.1.5. Band-Edge RF Radiated Emissions @ 3 m
Low End of Frequency Band

Rx Antenna Orientation: Horizontal

Trace 1: RBW= 1 MHz, VBW= 3 MHz

Trace 2: RBW= 1 MHz, VBW= 10Hz



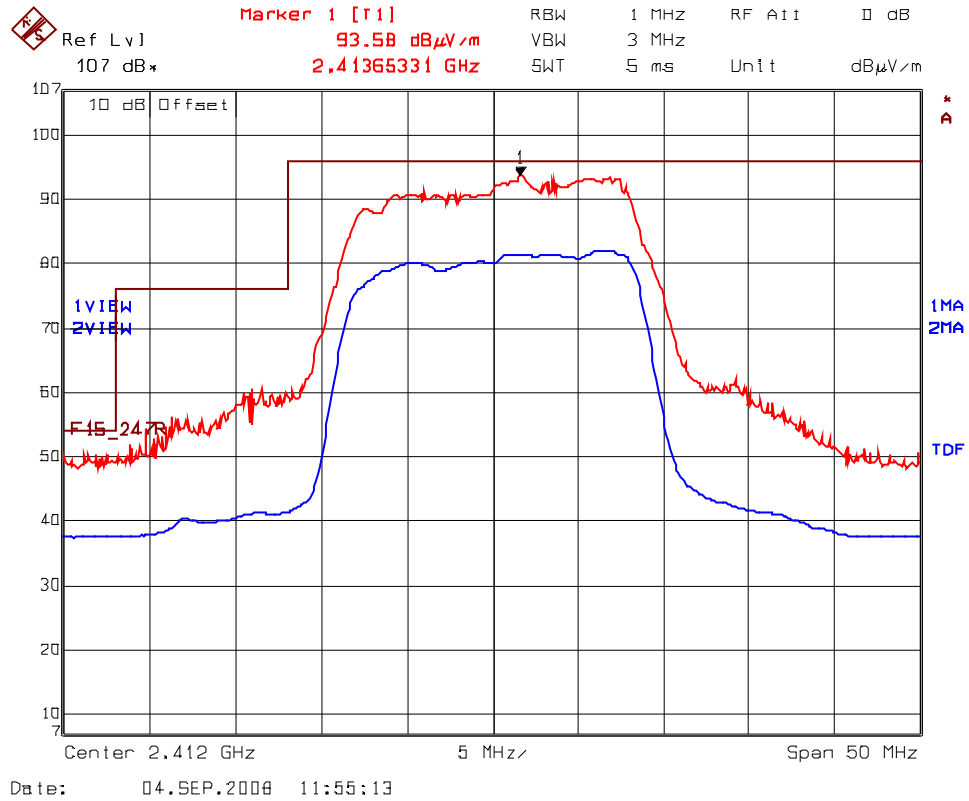
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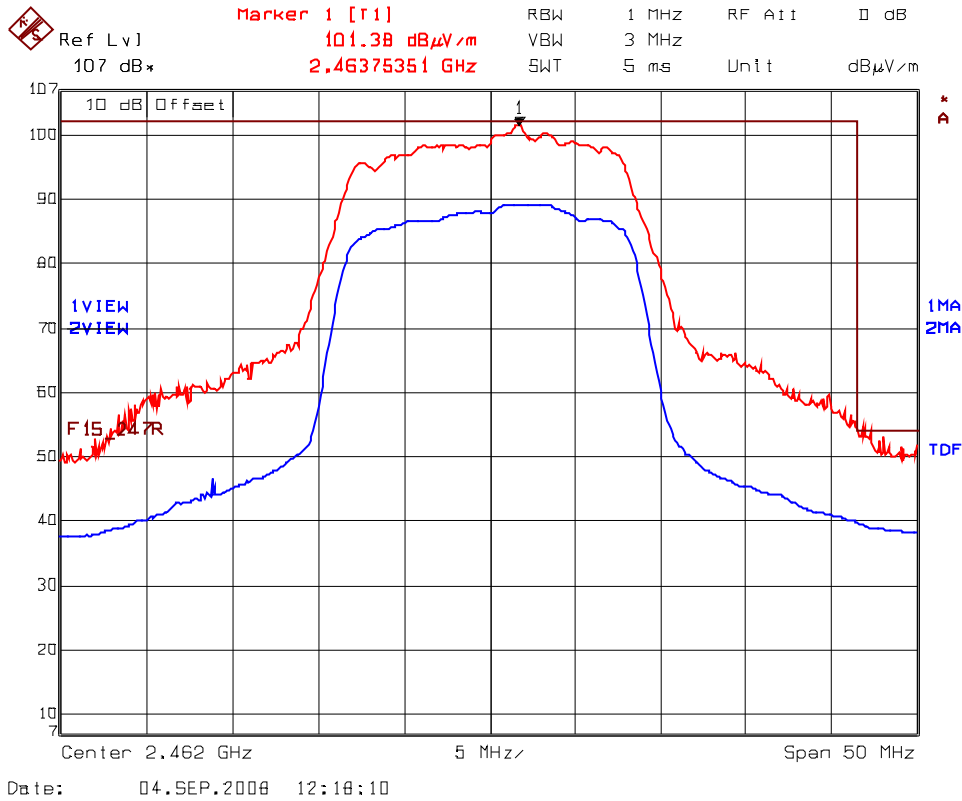
File #: MIS-083F15C247
September 8, 2008

All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

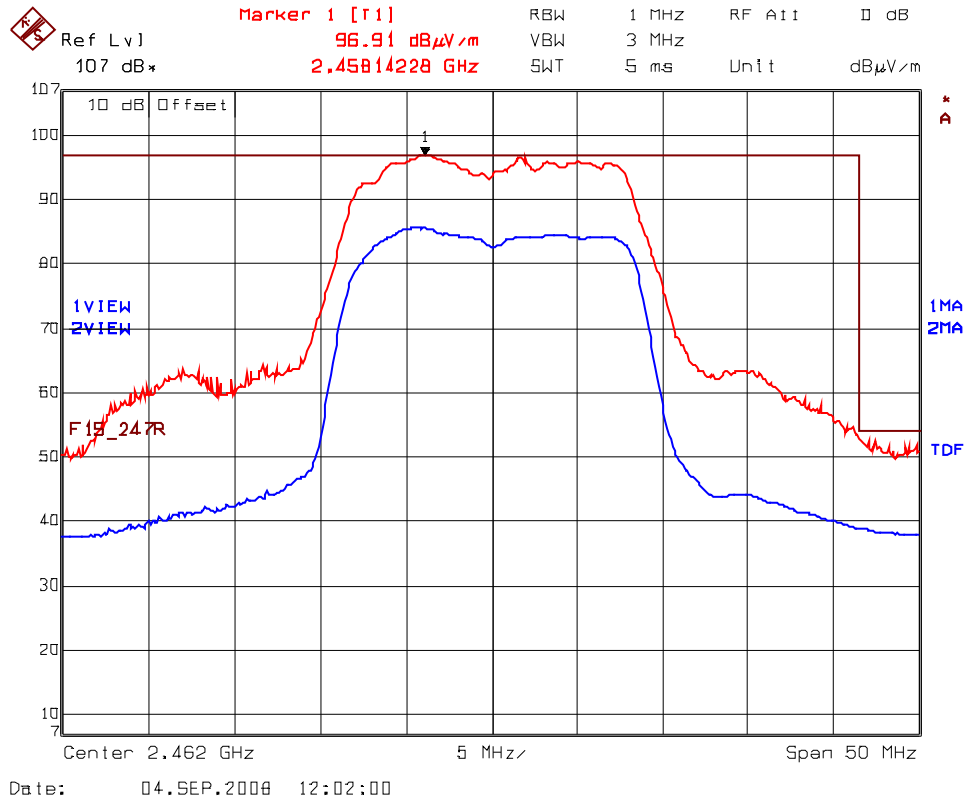
Plot 5.9.4.1.1.6. Band-Edge RF Radiated Emissions @ 3 m
Low End of Frequency Band
Rx Antenna Orientation: Vertical
Trace 1: RBW= 1 MHz, VBW= 3 MHz
Trace 2: RBW= 1 MHz, VBW= 10Hz



Plot 5.9.4.1.1.7. Band-Edge RF Radiated Emissions @ 3 m
High End of Frequency Band
Rx Antenna Orientation: Horizontal
Trace 1: RBW= 1 MHz, VBW= 3 MHz
Trace 2: RBW= 1 MHz, VBW= 10Hz



Plot 5.9.4.1.1.8. Band-Edge RF Radiated Emissions @ 3 m
High End of Frequency Band
Rx Antenna Orientation: Vertical
Trace 1: RBW= 1 MHz, VBW= 3 MHz
Trace 2: RBW= 1 MHz, VBW= 10Hz



5.9.4.2. Transmitter Radiated Spurious Emissions

Remarks:

- All spurious emissions that are in excess of 20 dB below the specified limit shall be recorded.
- EUT is tested in normal position (Rx vertical) and vertical position (Rx horizontal).
- The following test results are the worst-case measurements in 802.11b mode. Level in 802.11g mode were found to be lower than that in 802.11b mode.
- The **Peak-Average correction factor** was obtained from the duty cycle calculation. See below for details.

Fundamental Frequency:		2412 MHz					
Frequency Test Range:		30 MHz – 25 GHz					
Frequency (MHz)	RF Peak Level (dBµV/m)	Avg Level (Peak-Avg correct. fac) (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit 15.247 (dBµV/m)	Margin (dB)	Pass/Fail
2412	95.25	--	V	--	--	--	--
2412	98.19	--	H	--	--	--	--
4824	68.61	28.61	V	54.00	78.19	-25.39	Pass*
4824	68.20	28.20	H	54.00	78.19	-25.80	Pass*

*Field strength of emissions appearing within restricted frequency bands shall not exceed the limits shown in § 15.209.

Fundamental Frequency:		2437MHz					
Frequency Test Range:		30 MHz – 25 GHz					
Frequency (MHz)	RF Peak Level (dBµV/m)	Avg Level (Peak-Avg correct. fac) (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit 15.247 (dBµV/m)	Margin (dB)	Pass/Fail
2437	96.54	--	V	--	--	--	--
2437	100.71	--	H	--	--	--	--
4874	71.63	31.63	V	54.00	80.71	-22.37	Pass*
4874	69.59	29.59	H	54.00	80.71	-24.41	Pass*

*Field strength of emissions appearing within restricted frequency bands shall not exceed the limits shown in § 15.209.

Fundamental Frequency:		2462MHz					
Frequency Test Range:		30 MHz – 25 GHz					
Frequency (MHz)	RF Peak Level (dBµV/m)	Avg Level (Peak-Avg correct. fac) (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit 15.247 (dBµV/m)	Margin (dB)	Pass/Fail
2462	97.30	--	V	--	--	--	--
2462	102.38	--	H	--	--	--	--
4924	72.16	32.16	V	54.00	82.38	-21.84	Pass*
4924	70.05	30.05	H	54.00	82.38	-23.95	Pass*

*Field strength of emissions appearing within restricted frequency bands shall not exceed the limits shown in § 15.209.

Duty Cycle: 1% max. as declared by the manufacturer

Peak-Average Correction factor: $20 \log(\text{Duty Cycle}) = 20 \log(0.01) = -40.0$

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5.10 POWER SPECTRAL DENSITY [§ 15.247(e)]

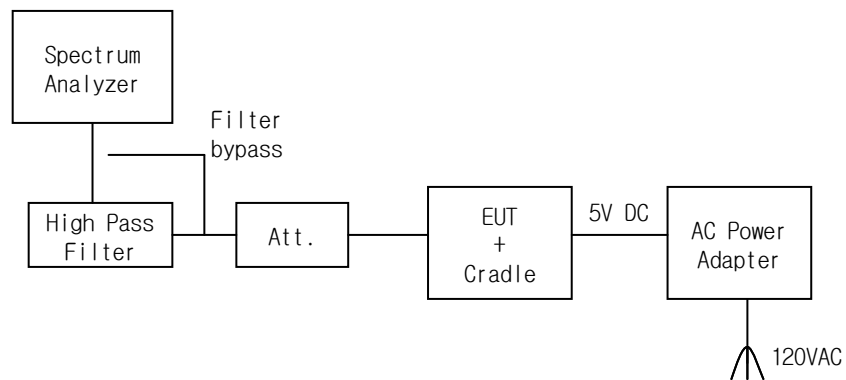
5.10.1. Limit(s)

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

5.10.2. Method of Measurements

KDB Publication No. 558074: Guidance on Measurements for Digital Transmission Systems (47 CFR 15.247), PSD Option 1 method.

5.10.3. Test Arrangement



5.10.4. Test Data

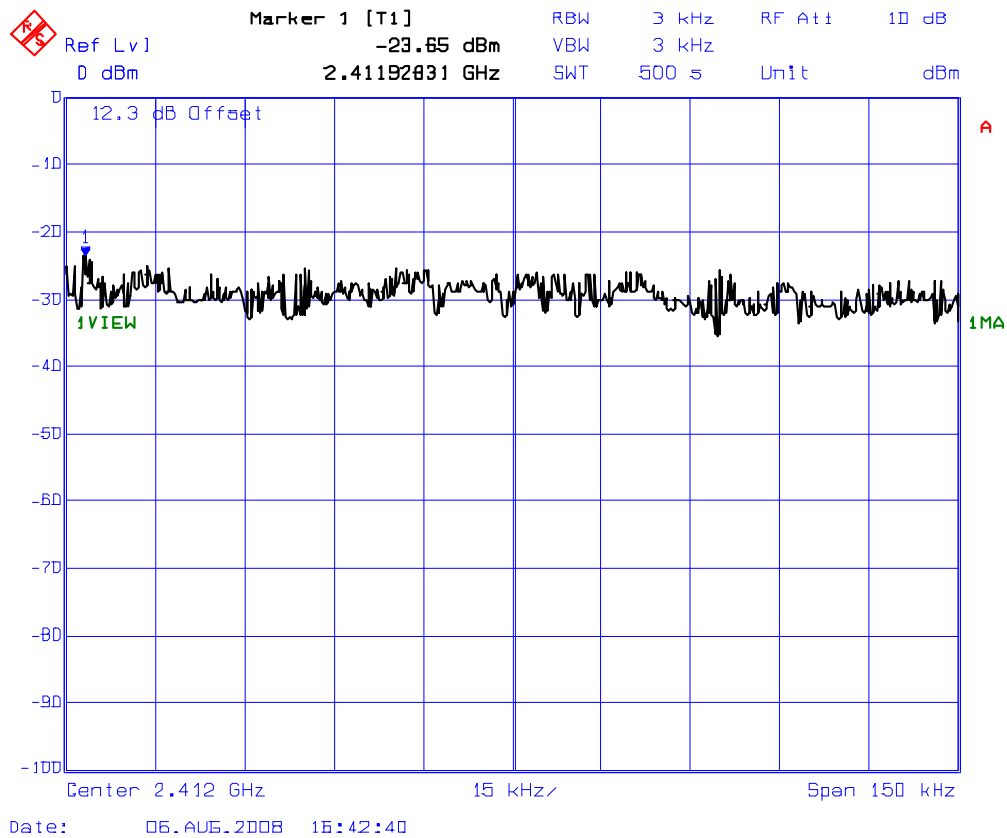
Remark: Measurement method: Power spectral density (PSD) Option 1.

5.10.4.1. 802.11b mode, 11 Mbps, CCK

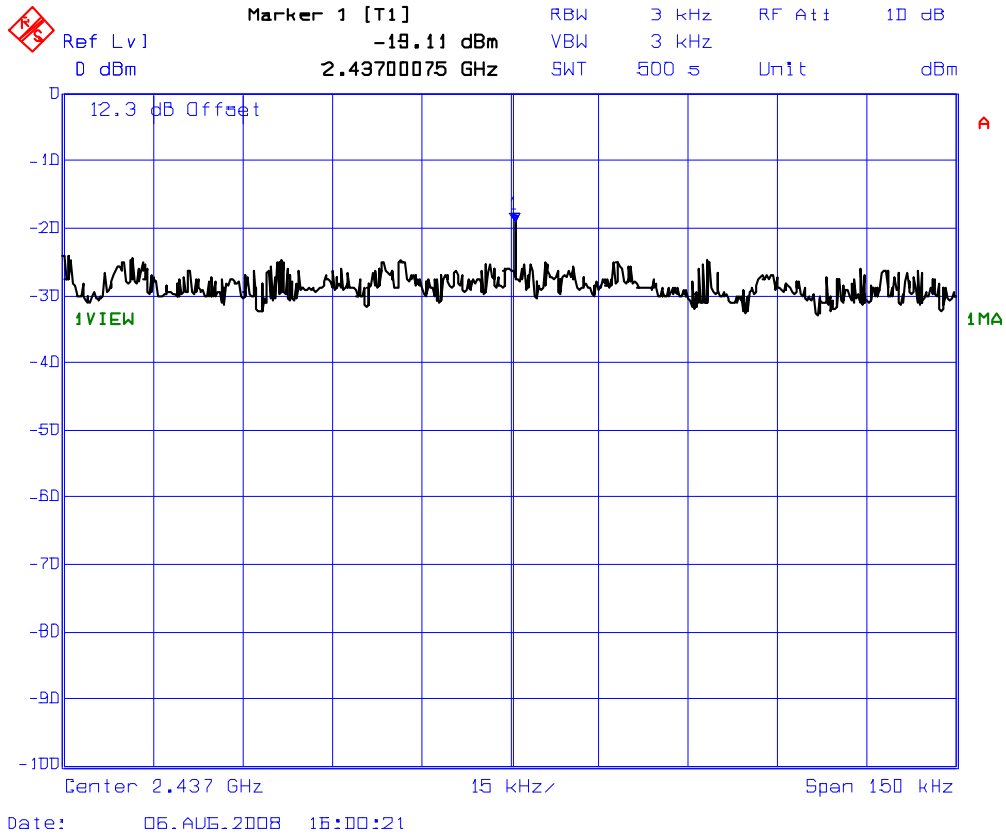
Frequency (MHz)	*PSD in 3 kHz BW (dBm)	Limit (dBm)	Margin (dB)	Comments (Pass/Fail)
2412	-23.6	8	-31.6	Pass
2437	-19.1	8	-27.1	Pass
2462	-23.8	8	-31.8	Pass

*See the following plots for measurement details.

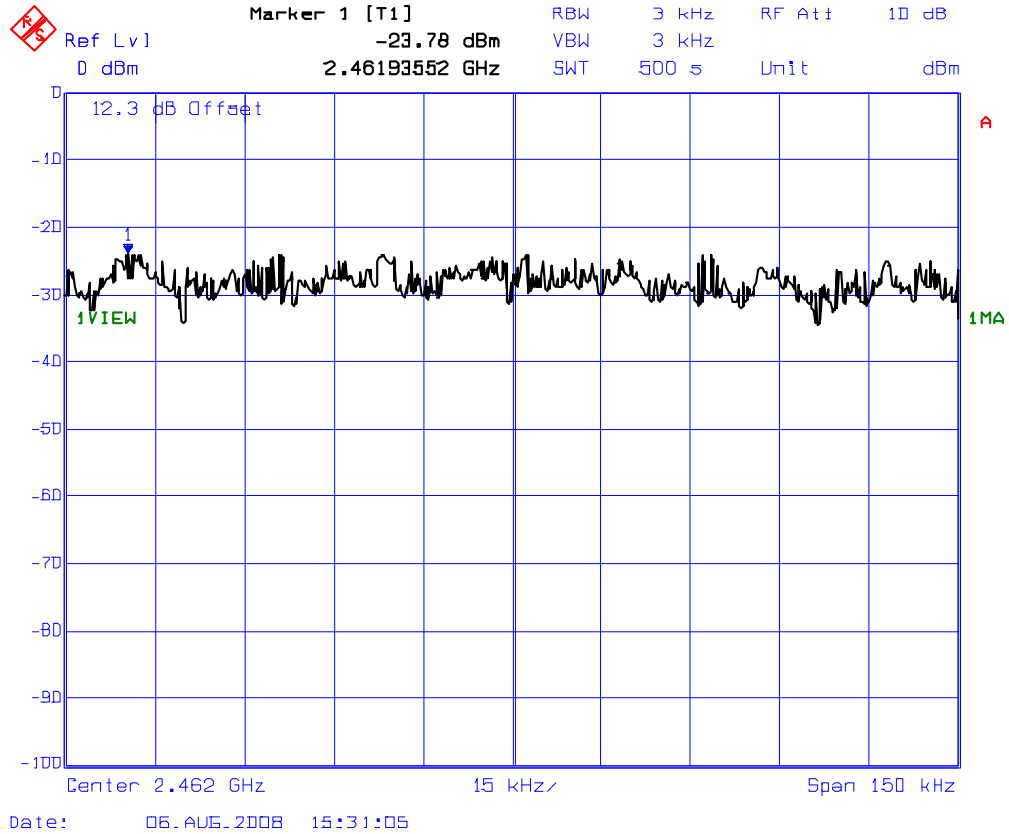
Plot 5.10.4.1.1. Power Spectral Density
 Frequency: 2412 MHz



Plot 5.10.4.1.2. Power Spectral Density
Frequency: 2437 MHz



Plot 5.10.4.1.3. Power Spectral Density
Frequency: 2462 MHz

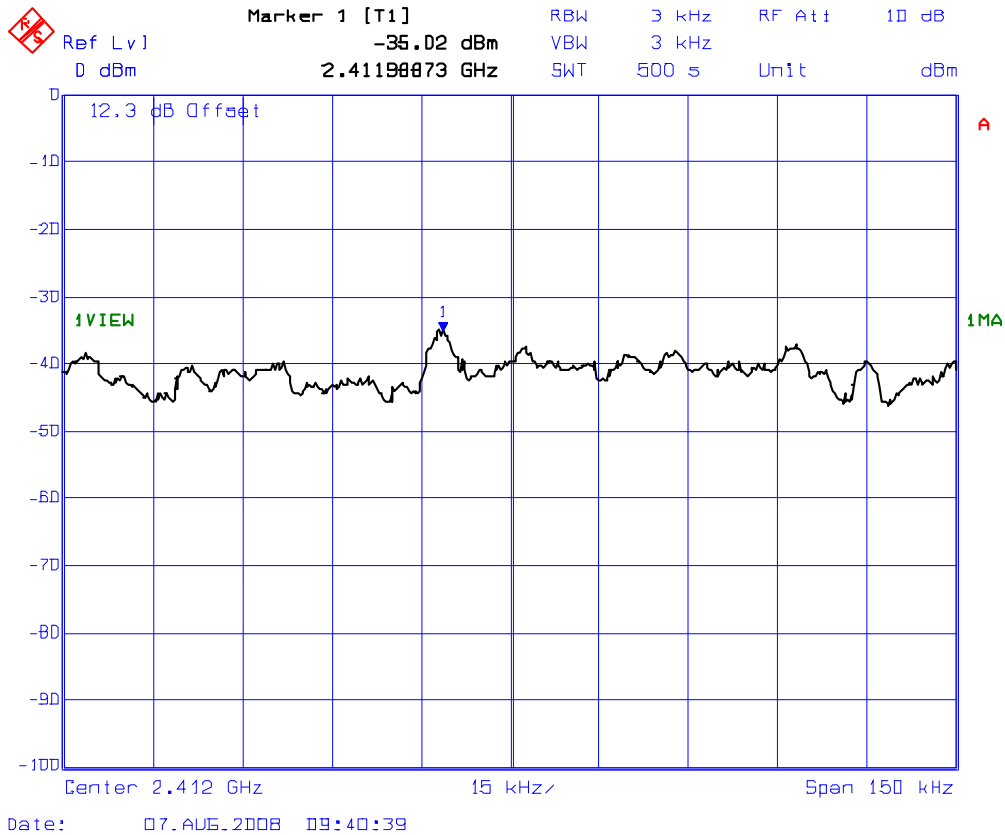


5.10.4.2. 802.11g mode, 54 Mbps, 64QAM

Frequency (MHz)	*PSD in 3 kHz BW (dBm)	Limit (dBm)	Margin (dB)	Comments (Pass/Fail)
2412	-35.0	8	-43.0	Pass
2437	-34.7	8	-42.7	Pass
2462	-33.6	8	-41.6	Pass

*See the following plots for measurement details.

Plot 5.10.4.2.1. Power Spectral Density
 Frequency: 2412 MHz



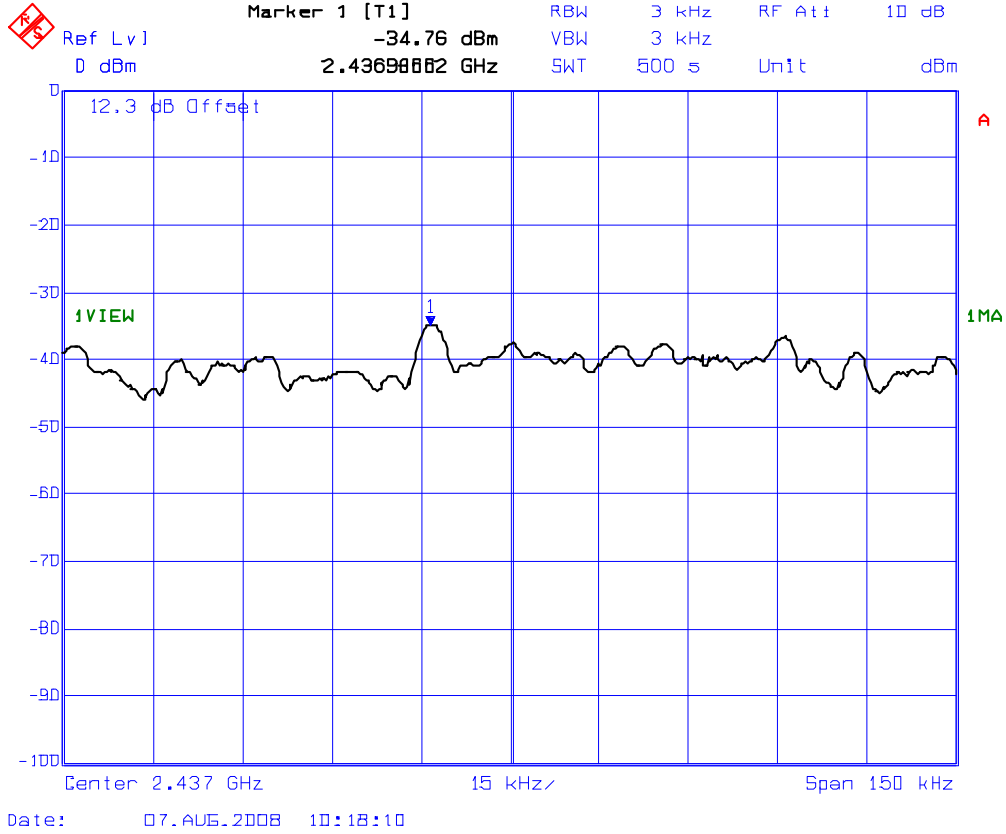
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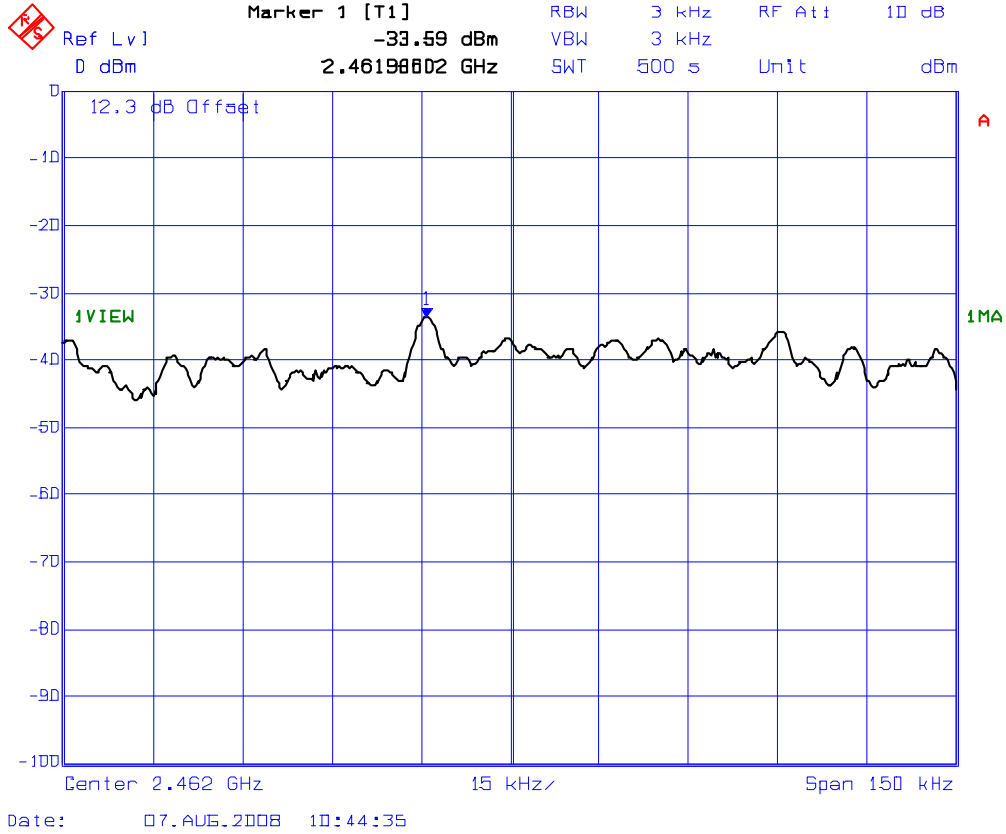
File #: MIS-083F15C247
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Plot 5.10.4.2.2. Power Spectral Density
Frequency: 2437 MHz



Plot 5.10.4.2.3. Power Spectral Density
Frequency: 2462 MHz



5.11 RF Exposure Requirement [§ 15.247 (i), 1.1310 & 2.1093]

5.11.1. Limits

- **§ 15.247(i):** Systems operating under provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission’s guidelines. See 1.1307(b)(1).
- **§ 1.1310:-** The criteria listed in the following table shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in 1.1307(b).

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm ²)	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposures				
0.3–3.0	614	1.63	*(100)	6
3.0–30	1842/f	4.89/f	*(900/f ²)	6
30–300	61.4	0.163	1.0	6
300–1500 .....	.....	.....	f/300	6
1500–100,000 .....	.....	.....	5	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3–1.34	614	1.63	*(100)	30
1.34–30	824/f	2.19/f	*(180/f ²)	30
30–300	27.5	0.073	0.2	30
300–1500 .....	.....	.....	f/1500	30
1500–100,000 .....	.....	.....	1.0	30

f = frequency in MHz

* = Plane-wave equivalent power density

NOTE 1 TO TABLE 1: Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.

NOTE 2 TO TABLE 1: General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or can not exercise control over their exposure.

5.11.2. Method of Measurements

Refer to Sections 1.1310, 2.1091.

Spread spectrum transmitters operating under section 15.247 are categorically excluded from routine environmental evaluation to demonstrating RF exposure compliance with respect to MPE and/or SAR limits. These devices are not exempted from compliance (As indicated in Section 15.247(b)(4), these transmitters are required to operate in a manner that ensures that exposure to public users and nearby persons) does not exceed the Commission’s RF exposure guidelines (see Section 1.1307 and 2.1093). Unless a device operates at substantially low power levels, with a low gain antenna(s), supporting information is generally needed to establish the various potential operating configurations and exposure conditions of a transmitter and its antenna(s) in order to determine compliance with the RF exposure guidelines.

For portable transmitters (see Section 2.1093), or devices designed to operate next to a person’s body, compliance is determined with respect to the SAR limit (define in the body tissues) for near-field exposure conditions. If the maximum average output power, operating condition configurations and exposure conditions are comparable to those of existing cellular and PCS phones, SAR evaluation may be required in order to determine if such a device complies with SAR limit. When SAR evaluation data is not available, and the additional supporting information cannot assure compliance, the Commission may request that an SAR evaluation be performed, as provided for in Section 1.1307(d)

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5.11.3. Test Data

Measured Total Peak Power = 15.85 dBm or 38.5 mW

Max. Duty Cycle declared by applicant = 1%

Duty cycle factor = $10 \log(0.01) = -20\text{dB}$

Total Average power = Total Peak Power in dB – Duty Cycle factor (dB)
= 15.85 dBm – 20 dB
= -4.15 dBm or 0.4 mW

SAR is exempted as average power (0.4 mW) is below the low threshold value 24 mW.

Threshold Value = $[60/f(\text{GHz})]$ mW
= $(60/2.48)$ mW
= 24 mW

EXHIBIT 6 Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Attenuator (10dB)	Narda	4768-20	N/A	DC – 40 GHz
Attenuator (10dB)	Narda	4768-10	N/A	DC – 40 GHz
Biconilog antenna	EMCO	3142C	34792	26 - 3000 MHz
High Pass Filter	K & L	11SH10-4000/T12000	4	Cut off 3.4 GHz
Horn Antenna	EMCO	3155	6570	1 – 18 GHz
Horn Antenna	EMCO	3160-09	1007	18 – 26.5 GHz
L.I.S.N.	Emco	3825/2	8.9E+07	9 kHz- 200 MHz (50ohms/50uH)
Peak Power Meter	Hewlett Packard	8900D	2131A01044	0.1 - 18 GHz
Power Sensor	Hewlett Packard	84811A	2551A01484	0.1 - 18 GHz
RF Amplifier	Com-Power	PA-103	161057	1 - 1000 MHz
RF Amplifier	Hewlett Packard	8449B	3008A00769	1 – 26.5 GHz
Spectrum Analyzer	Hewlett Packard	8593EM	3412A00103	9 kHz- 26.5 GHz
Spectrum Analyzer	Rohde & Schwarz	FSEK30	100077	20 Hz – 40 GHz
Transient Limiter	Hewlett Packard	11947A	3.1E+08	9 kHz- 200 MHz (10dB)

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EXHIBIT 7 MEASUREMENT UNCERTAINTY

The measurement uncertainties stated were calculated in accordance with the requirements of NIST Technical Note 1297 and NIS 81 (1994)

7.1 LINE CONDUCTED EMISSION MEASUREMENT UNCERTAINTY

CONTRIBUTION (Line Conducted)	PROBABILITY DISTRIBUTION	UNCERTAINTY (dB)	
		9-150 kHz	0.15-30 MHz
EMI Receiver specification	Rectangular	± 1.5	± 1.5
LISN coupling specification	Rectangular	± 1.5	± 1.5
Cable and Input Transient Limiter calibration	Normal (k=2)	± 0.3	± 0.5
Mismatch: Receiver VRC $\Gamma_1 = 0.03$ LISN VRC $\Gamma_R = 0.8(9 \text{ kHz}) 0.2 (30 \text{ MHz})$ Uncertainty limits $20\text{Log}(1+\Gamma_1\Gamma_R)$	U-Shaped	± 0.2	± 0.3
System repeatability	Std. deviation	± 0.2	± 0.05
Repeatability of EUT	--	--	--
Combined standard uncertainty	Normal	± 1.25	± 1.30
Expanded uncertainty U	Normal (k=2)	± 2.50	± 2.60

Sample Calculation for Measurement Accuracy in 450 kHz to 30 MHz Band:

$$u_c(y) = \sqrt{\sum_{i=1}^m u_i^2(y)} = \pm \sqrt{(1.5^2 + 1.5^2)/3 + (0.5/2)^2 + (0.05/2)^2 + 0.35^2} = \pm 1.30 \text{ dB}$$

$$U = 2u_c(y) = \pm 2.6 \text{ dB}$$

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7.2 RADIATED EMISSION MEASUREMENT UNCERTAINTY

CONTRIBUTION (Radiated Emissions)	PROBABILITY DISTRIBUTION	UNCERTAINTY (+ dB)	
		3 m	10 m
Antenna Factor Calibration	Normal (k=2)	± 1.0	± 1.0
Cable Loss Calibration	Normal (k=2)	± 0.3	± 0.5
EMI Receiver specification	Rectangular	± 1.5	± 1.5
Antenna Directivity	Rectangular	+0.5	+0.5
Antenna factor variation with height	Rectangular	± 2.0	± 0.5
Antenna phase center variation	Rectangular	0.0	± 0.2
Antenna factor frequency interpolation	Rectangular	± 0.25	± 0.25
Measurement distance variation	Rectangular	± 0.6	± 0.4
Site imperfections	Rectangular	± 2.0	± 2.0
Mismatch: Receiver VRC $\Gamma_1 = 0.2$ Antenna VRC $\Gamma_R = 0.67(Bi) 0.3 (Lp)$ Uncertainty limits $20\text{Log}(1 \pm \Gamma_1 \Gamma_R)$	U-Shaped	+1.1 -1.25	± 0.5
System repeatability	Std. Deviation	± 0.5	± 0.5
Repeatability of EUT		-	-
Combined standard uncertainty	Normal	+2.19 / -2.21	+1.74 / -1.72
Expanded uncertainty U	Normal (k=2)	+4.38 / -4.42	+3.48 / -3.44

Calculation for maximum uncertainty when 3m biconical antenna including a factor of k = 2 is used:

$$U = 2u_c(y) = 2x(+2.19) = +4.38 \text{ dB} \quad \text{And} \quad U = 2u_c(y) = 2x(-2.21) = -4.42 \text{ dB}$$