

ENGINEERING TEST REPORT



P60 WIFI G BOARD Model No.: 160630

FCC ID: T89-160630

Applicant:

EPSON Canada Limited

185 Renfrew Dr.
Markham, Ontario
Canada L3R 6G3

In Accordance With

**Federal Communications Commission (FCC)
Part 15, Subpart C, Section 15.247
Digital Modulation Systems (DTS)
Operating in 2412-2462 MHz Band**

UltraTech's File No.: EPS-102_F15C247

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

Date: January 18, 2012

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Tested by: Hung Trinh, EMI/RFI Technician

Issued Date: January 18, 2012

Test Dates: Dec 28, 2011 to Jan 12, 2012

*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.*

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NvLap Lab Code 200093-0



SL2-IN-E-1119R



TABLE OF CONTENTS

EXHIBIT 1. INTRODUCTION	2
1.1. SCOPE.....	2
1.2. RELATED SUBMITTAL(S)/GRANT(S)	2
1.3. NORMATIVE REFERENCES	2
EXHIBIT 2. PERFORMANCE ASSESSMENT	3
2.1. CLIENT INFORMATION.....	3
2.2. EQUIPMENT UNDER TEST (EUT) INFORMATION	3
2.3. EUT'S TECHNICAL SPECIFICATIONS	4
2.4. LIST OF EUT'S PORTS.....	4
2.5. ANCILLARY EQUIPMENT.....	5
EXHIBIT 3. EUT OPERATING CONDITIONS AND CONFIGURATIONS DURING TESTS	6
3.1. CLIMATE TEST CONDITIONS	6
3.2. OPERATIONAL TEST CONDITIONS & ARRANGEMENT FOR TESTS	6
EXHIBIT 4. SUMMARY OF TEST RESULTS	7
4.1. LOCATION OF TESTS.....	7
4.2. APPLICABILITY & SUMMARY OF EMC EMISSION TEST RESULTS	7
4.3. MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES.....	7
EXHIBIT 5. MEASUREMENTS, EXAMINATIONS & TEST DATA FOR EMC EMISSIONS.....	8
5.1. TEST PROCEDURES.....	8
5.2. MEASUREMENT UNCERTAINTIES	8
5.3. MEASUREMENT EQUIPMENT USED	8
5.4. ESSENTIAL/PRIMARY FUNCTIONS AS DECLARED BY THE MANUFACTURER.....	8
5.5. POWER LINE CONDUCTED EMISSIONS [§15.207(A)]	9
5.6. OCCUPIED BANDWIDTH [§ 15.247(A)(2)].....	12
5.7. PEAK CONDUCTED OUTPUT POWER - DTS [§ 15.247(B)(3)].....	34
5.8. TRANSMITTER BAND-EDGE & SPURIOUS CONDUCTED EMISSIONS [§ 15.247(D)].....	36
5.9. TRANSMITTER SPURIOUS RADIATED EMISSIONS AT 3 METERS [§§ 15.247(D), 15.209 & 15.205]	53
5.10. POWER SPECTRAL DENSITY [§ 15.247(E)]	64
5.11. RF EXPOSURE REQUIREMENTS [§§ 15.247(I), 1.1307(B)(1) & 2.1093]	86
EXHIBIT 6. TEST EQUIPMENT LIST	88
EXHIBIT 7. MEASUREMENT UNCERTAINTY.....	89
7.1. LINE CONDUCTED EMISSION MEASUREMENT UNCERTAINTY	89
7.2. RADIATED EMISSION MEASUREMENT UNCERTAINTY	89

EXHIBIT 1. INTRODUCTION

1.1. SCOPE

Reference:	FCC Part 15, Subpart C, Section 15.247
Title:	Code of Federal Regulations (CFR), Title 47 – Telecommunication, Part 15
Purpose of Test:	Equipment Certification for Digital Modulation Systems (DTS) Transmitter 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:	<input checked="" type="checkbox"/> Commercial, industrial or business environment <input type="checkbox"/> Residential environment

1.2. RELATED SUBMITTAL(S)/GRANT(S)

None

1.3. NORMATIVE REFERENCES

Publication	Year	Title
47 CFR Parts 0-19	2011	Code of Federal Regulations – Telecommunication
ANSI C63.4	2009	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 & EN 55022	2006 2006	Information Technology Equipment - Radio Disturbance Characteristics – Limits and Methods of Measurement
CISPR 16-1-1	2007	Specification for radio disturbance and immunity measuring apparatus and methods. Part 1-1: Measuring Apparatus
CISPR 16-2-1	2007	Specification for radio disturbance and immunity measuring apparatus and methods. Part 2-1: Conducted disturbance measurement
FCC Measurement Guidance	2005	Measurements of Digital Transmission Systems operating under (47 CFR 15.247)
KDB Publication No. 447498, v04	2009	Mobile and Portable Device RF Exposure Procedure and Equipment Authorization Policies
FCC Public Notice DA 00-1407	2000	Part 15 Unlicensed Modular Transmitter Approval

EXHIBIT 2. PERFORMANCE ASSESSMENT

2.1. CLIENT INFORMATION

APPLICANT	
Name:	EPSON Canada Limited.
Address:	185 Renfrew Dr. Markham, Ontario Canada L3R 6G3
Contact Person:	Mr. Daniel Lehotsky Phone #: 905-940-3254 Fax #: 905-944-3762 Email Address: Dan_Lehotsky@ea.epson.com

MANUFACTURER	
Name:	EPSON Canada Limited.
Address:	185 Renfrew Dr. Markham, Ontario Canada L3R 6G3
Contact Person:	Mr. Christopher Wu Phone #: 905-940-3254 Fax #: 905-944-3762 Email Address: Christopher_wu@ea.epson.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:	EPSON Canada
Product Name:	P60 WIFI G BOARD
Model Name or Number:	160630
Serial Number:	03338
Type of Equipment:	Wi-Fi Transceiver
Input Power Supply Type:	3.3V DC derived from the Printer
Primary User Functions of EUT:	Wi-Fi Interface for Handheld Printer

2.3. EUT'S TECHNICAL SPECIFICATIONS

TRANSMITTER	
Equipment Type:	Portable
Intended Operating Environment:	Commercial, industrial or business
Power Supply Requirement:	3.3 VDC
RF Output Power Rating:	802.11b: 14.05 dBm peak conducted 802.11g: 18.49 dBm peak conducted
Operating Frequency Range:	2412-2462 MHz
Channel Spacing:	5 MHz for 802.11b 20 MHz for 802.11g
Duty Cycle:	100%
6 dB bandwidth:	802.11b : 10.37 MHz 802.11g : 16.62 MHz
Modulation Type:	DBPSK, DQPSK, CCK (DSSS), OFDM
Antenna Description:	Manufacturer: Taiyo Yuden Type: Integral PCB Antenna Wi-Fi Model No.: AH104F245001-T Freq. Range: 2.412 – 2.462 GHz Gain: 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	RIDB (Epson proprietary interface)	1	20 position Flat Flex cable connector	Non-shielded
2	GND port	1	2-pin cable connector	Non-shielded

2.5. ANCILLARY EQUIPMENT

The EUT was tested while connected to the following representative configuration of ancillary equipment necessary to exercise the ports during tests:

Ancillary Equipment # 1	
Description:	Portable Printer
Brand name:	EPSON
Model Name or Number:	P60
Serial Number:	MY5F002040
Connected to EUT's Port:	Module serial port

Ancillary Equipment # 2	
Description:	AC/DC Power Adapter
Brand name:	EPSON
Model Name or Number:	DA-42Y12
Serial Number:	FYYZB06848
Connected to EUT's Port:	DC jack of printer

EXHIBIT 3. EUT OPERATING CONDITIONS AND CONFIGURATIONS DURING TESTS

3.1. CLIMATE TEST CONDITIONS

The climate conditions of the test environment are as follows:

Temperature:	20 - 22°C
Humidity:	48 – 55 %
Pressure:	102 kPa
Power input source:	3.3 VDC via Printer using external AC/DC adapter

3.2. OPERATIONAL TEST CONDITIONS & ARRANGEMENT FOR TESTS

Operating Modes:	Each of lowest, middle and highest channel frequencies transmits continuously for emissions measurements.
Special Test Software:	Special software and hardware by the Applicant to operate the EUT at each channel frequency continuously. For example, the transmitter will be operated at each of the lowest, middle and highest frequencies individually continuously during testing.
Special Hardware Used:	The RF Module was tested outside of the enclosure using Flat Flex cable connected to Epson printer.
Transmitter Test Antenna:	The EUT is tested with the antenna fitted in a manner typical of normal intended use as integrated PCB antenna.

Transmitter Test Signals	
Frequency Band(s):	2412-2462 MHz
RF Power Output:	802.11b: 14.05 dBm peak conducted 802.11g: 18.49 dBm peak conducted
Normal Test Modulation:	DBPSK, DQPSK, CCK (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.: 91038) and Industry Canada office (Industry Canada File No.: 2049A-3). Expiry Date: 2014-04-04.

4.2. APPLICABILITY & SUMMARY OF EMC EMISSION TEST RESULTS

FCC Section(s)	Test Requirements	Compliance (Yes/No)
15.203	Antenna requirements	Yes*
15.207(a)	Power Line Conducted Emissions	Yes
15.247(a)(2)	6 dB Bandwidth	Yes
15.247(b)(3)	Peak Conducted Output Power - DTS	Yes
15.247(d)	Band-Edge and RF Conducted Spurious Emissions at the Transmitter Antenna Terminal	Yes
15.247(d), 15.209 & 15.205	Transmitter Spurious Radiated Emissions	Yes
15.247(e)	Power Spectral Density	Yes
15.247(b)(5), (e)(i) 1.1307, 1.1310, 2.1091 & 2.1093	RF Exposure	Yes

P60 WIFI G BOARD, Model No.: 160630, by EPSON Canada Limited has also been tested and found to comply with **FCC Part 15, Subpart B - Class B Digital Devices**. The engineering test report has been documented and kept on file and it is available upon request.

* The Module has integral antenna permanently mounted on the PCB.

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; FCC KDB Publication No. 558074: Guidance on Measurements for Digital Transmission Systems.

5.2. MEASUREMENT UNCERTAINTIES

The measurement uncertainties stated were calculated in accordance with requirements of UKAS Document NIS 81 with a confidence level of 95%. Please refer to Exhibit 7 for Measurement Uncertainties.

5.3. MEASUREMENT EQUIPMENT USED

The measurement uncertainties were calculated in accordance with the requirements of CISPR 16-4-2; 2003 and JCGM 100:2008 (GUM 1995) – Guide to the Expression of Uncertainty in Measurement.

5.4. ESSENTIAL/PRIMARY FUNCTIONS AS DECLARED BY THE MANUFACTURER

To provide data communication link to printer using Wi-Fi 802.11 b/g.

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

5.5.1. Limit(s)

The equipment shall meet the limits of the following table:

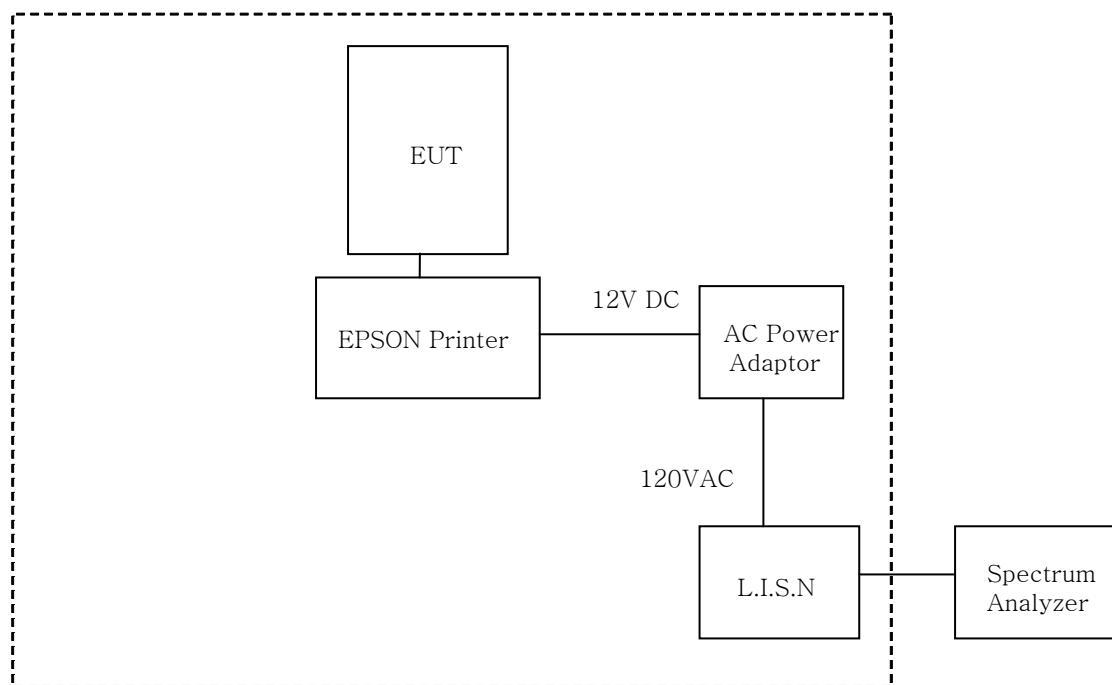
Frequency of emission (MHz)	Conducted Limits (dB μ V)	
	Quasi-peak	Average
0.15–0.5	66 to 56*	56 to 46*
0.5–5	56	46
5–30	60	50

*Decreases linearly with the logarithm of the frequency

5.5.2. Method of Measurements

ANSI C63.4, 2009.

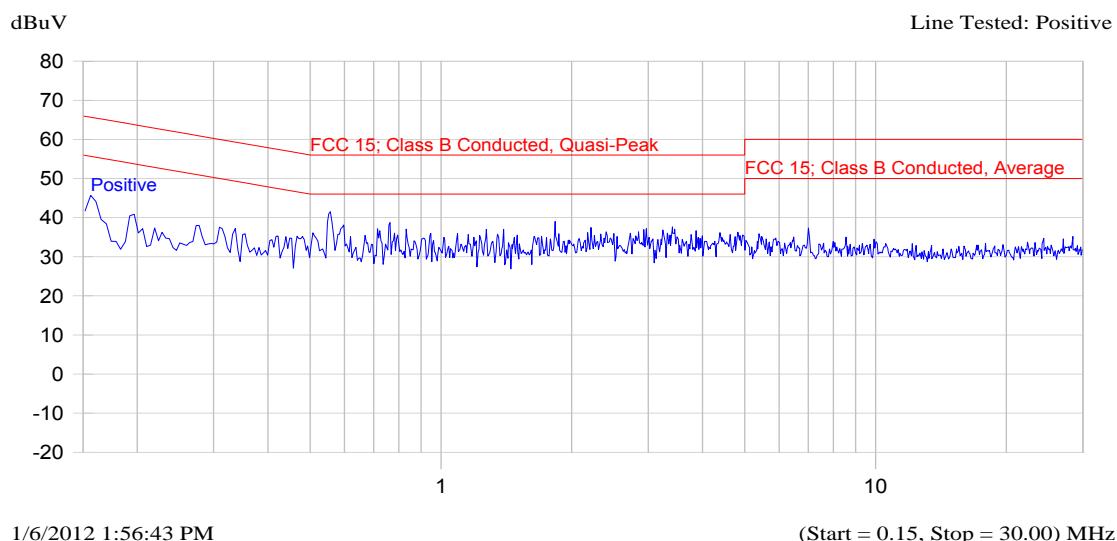
5.5.3. Test Arrangement



5.5.4. Test Data

Plot 6.5.5.1(i) Power Line Conducted Emissions
Mode: Tx Mode, Line Voltage: 120 VAC 60 Hz; Line Tested: Line

Current Graph

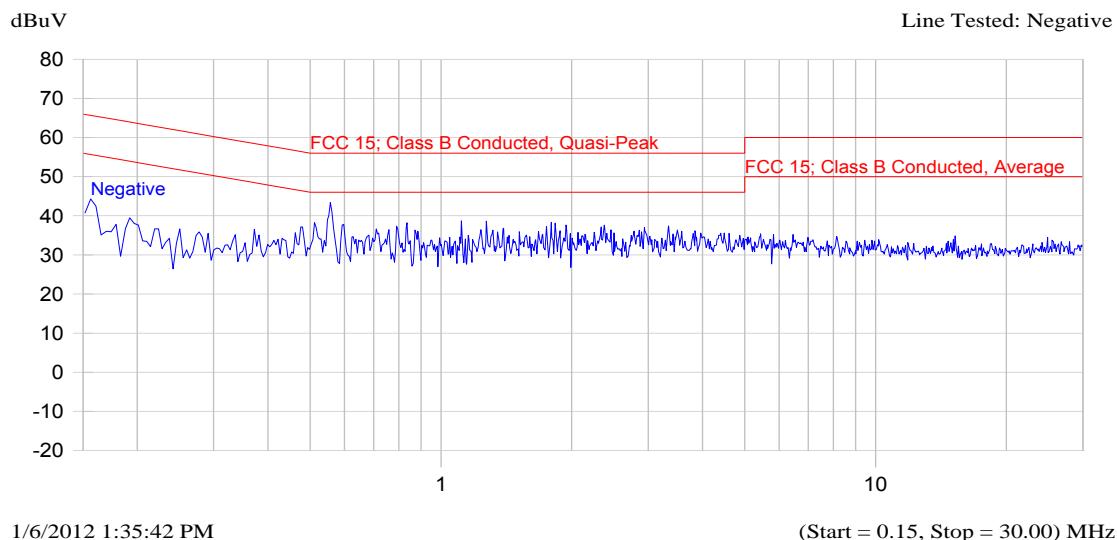


Current List

Frequency MHz	Peak dBuV	QP dBuV	Delta dB	QP-QP Limit dB	Avg dBuV	Delta dB	Avg-Avg Limit dB	Trace Name
0.159	49.8	46.0	-19.7		40.0	-15.8		Positive
0.562	43.6	39.3	-16.7		33.1	-12.9		Positive
1.818	40.7	36.4	-19.6		32.1	-13.9		Positive

Plot 6.5.5.1(ii) Power Line Conducted Emissions
Mode: Tx Mode, Line Voltage: 120 VAC 60 Hz; Line Tested: Neutral

Current Graph



Current List

Frequency MHz	Peak dBuV	QP dBuV	Delta QP-QP Limit dB	Avg dBuV	Delta Avg-Avg Limit dB	Trace Name
0.159	47.6	43.8	-21.9	37.4	-18.4	Negative
0.554	45.5	42.8	-13.2	40.8	-5.2	Negative
1.108	38.3	34.6	-21.4	29.1	-16.9	Negative

5.6. OCCUPIED BANDWIDTH [§ 15.247(a)(2)]

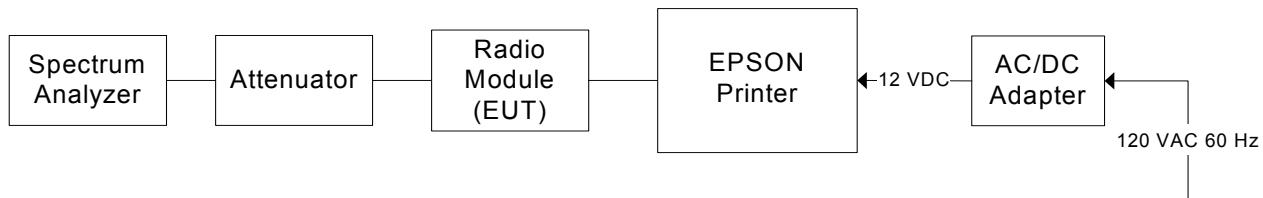
5.6.1. Limit(s)

For a Digital Modulation System, the minimum 6 dB bandwidth shall be at least 500 kHz.

5.6.2. Method of Measurements

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

5.6.3. Test Arrangement



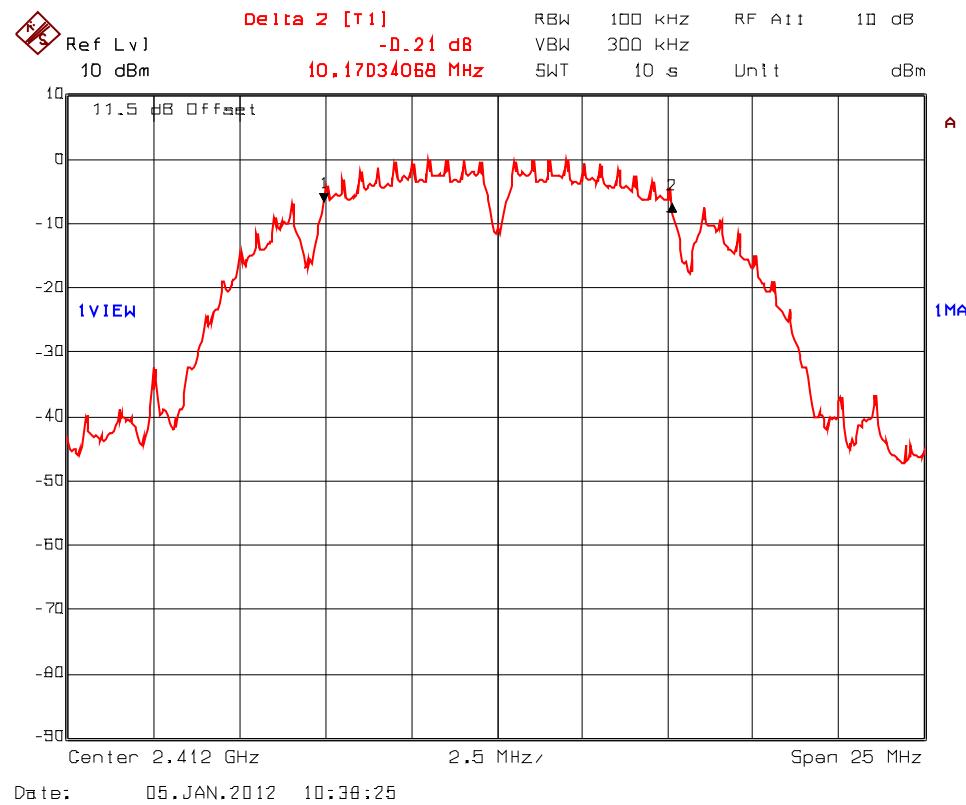
5.6.4. Test Data

6 dB Bandwidth (MHz):

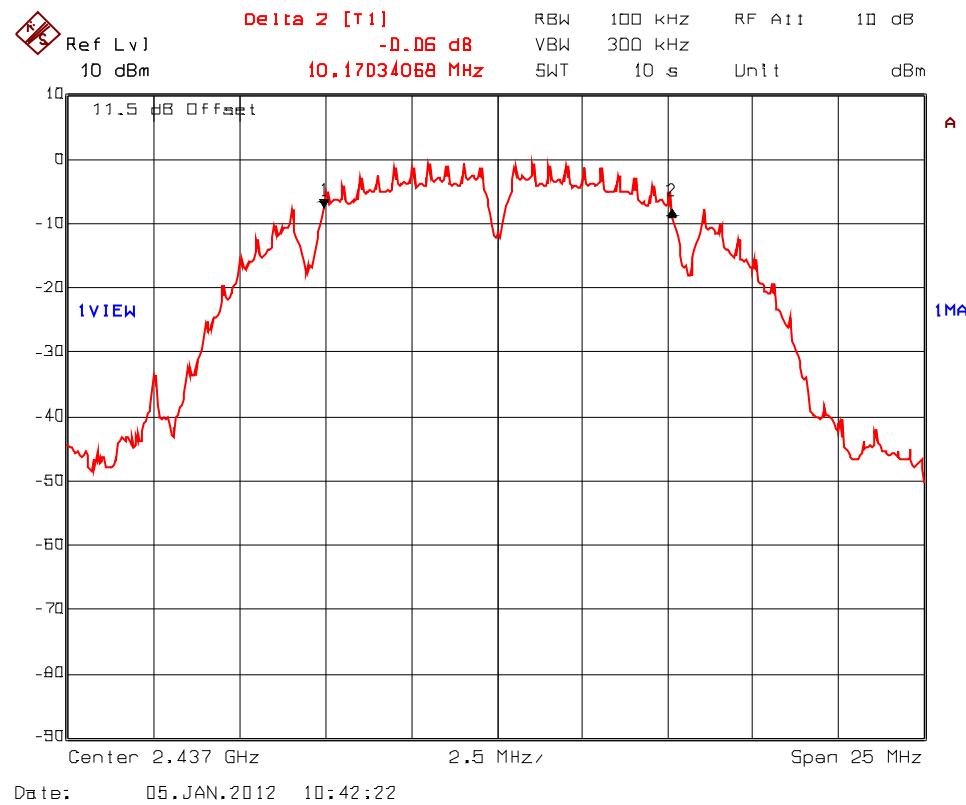
Data Rate (Mbps)	Modulation	Channel 1 2412 MHz (MHz)	Channel 7 2437 MHz (MHz)	Channel 11 2462 MHz (MHz)
802.11b				
1	DBPSK	10.17	10.17	10.17
2	DQPSK	10.17	10.17	10.17
11	CCK	10.02	10.12	10.37
802.11g				
9	BPSK	16.55	16.55	16.55
18	QPSK	16.55	16.55	16.55
36	16-QAM	16.55	16.55	16.55
54	64-QAM	16.55	16.62	16.62

See the following plots for detailed measurements.

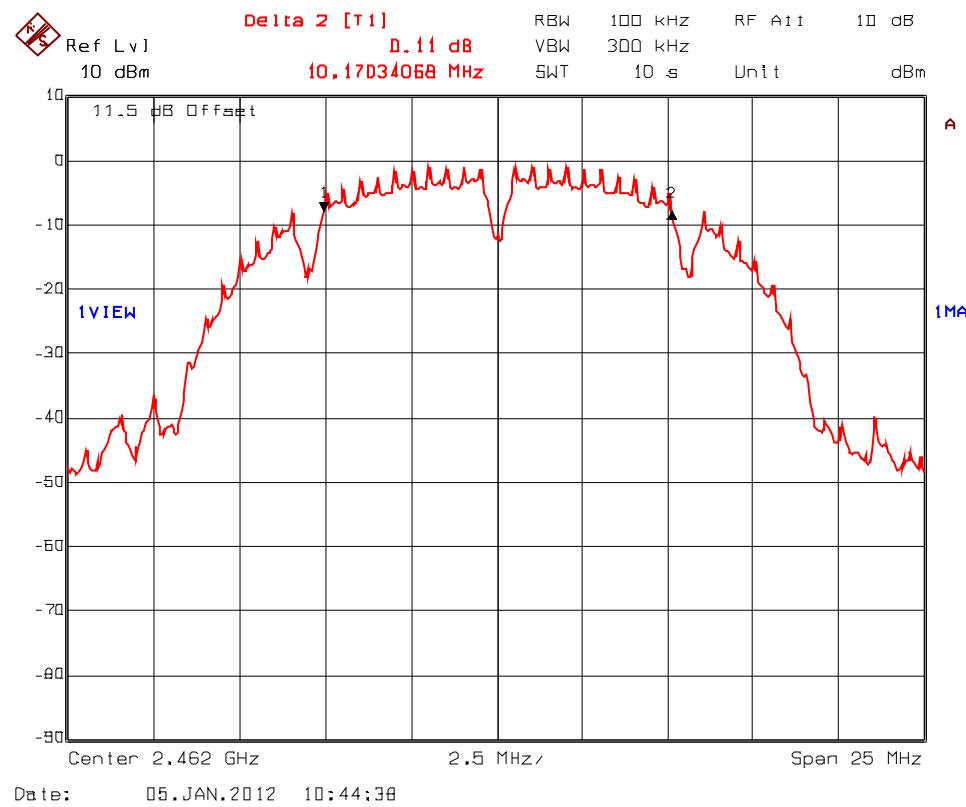
Plot 6.6.5.1 6 dB Bandwidth
Frequency: 2412 MHz; Modulation: DBPSK at 1 Mbps



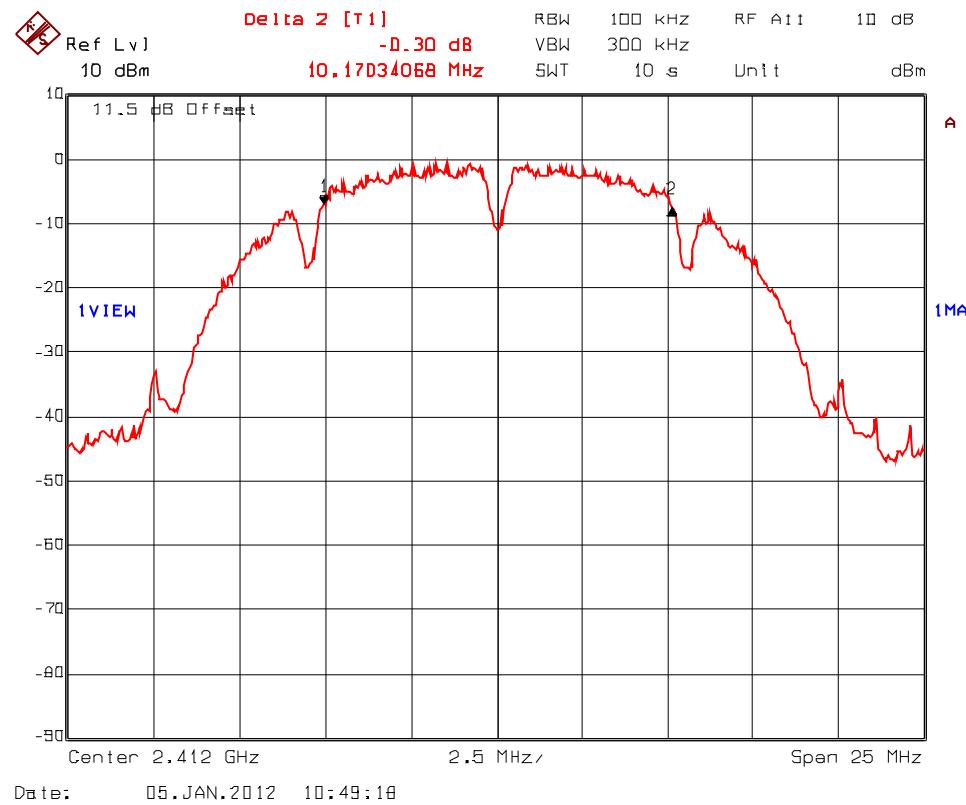
Plot 6.6.5.2 6 dB Bandwidth
Frequency: 2437 MHz; Modulation: DBPSK at 1 Mbps



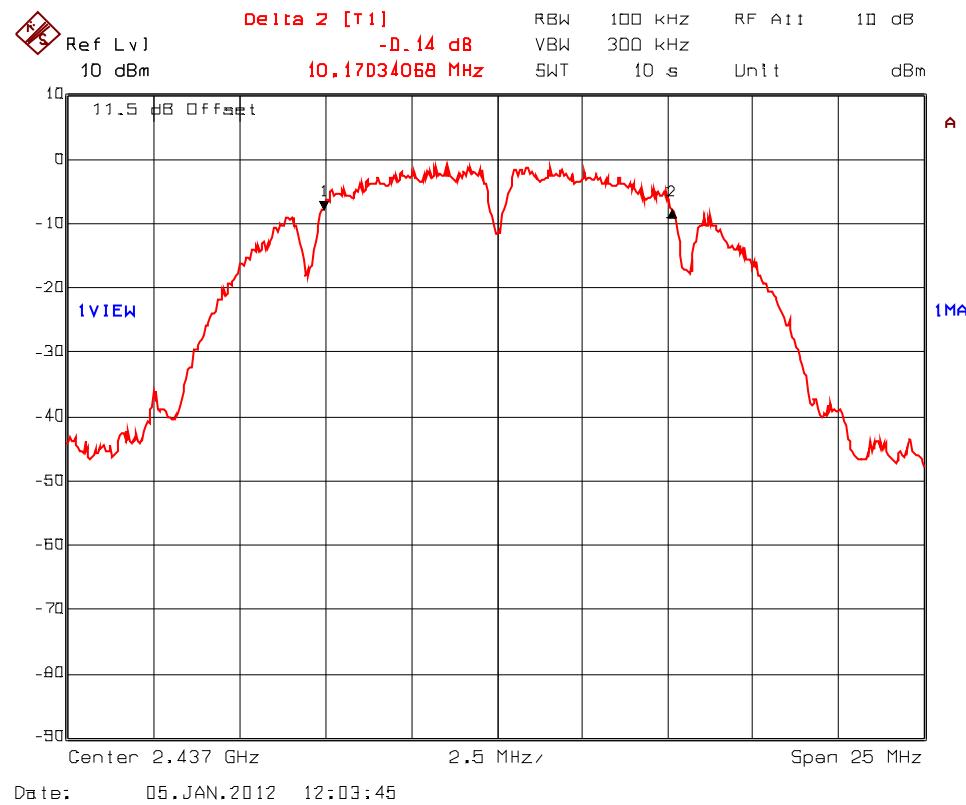
Plot 6.6.5.3 6 dB Bandwidth
Frequency: 2462 MHz; Modulation: DBPSK at 1 Mbps



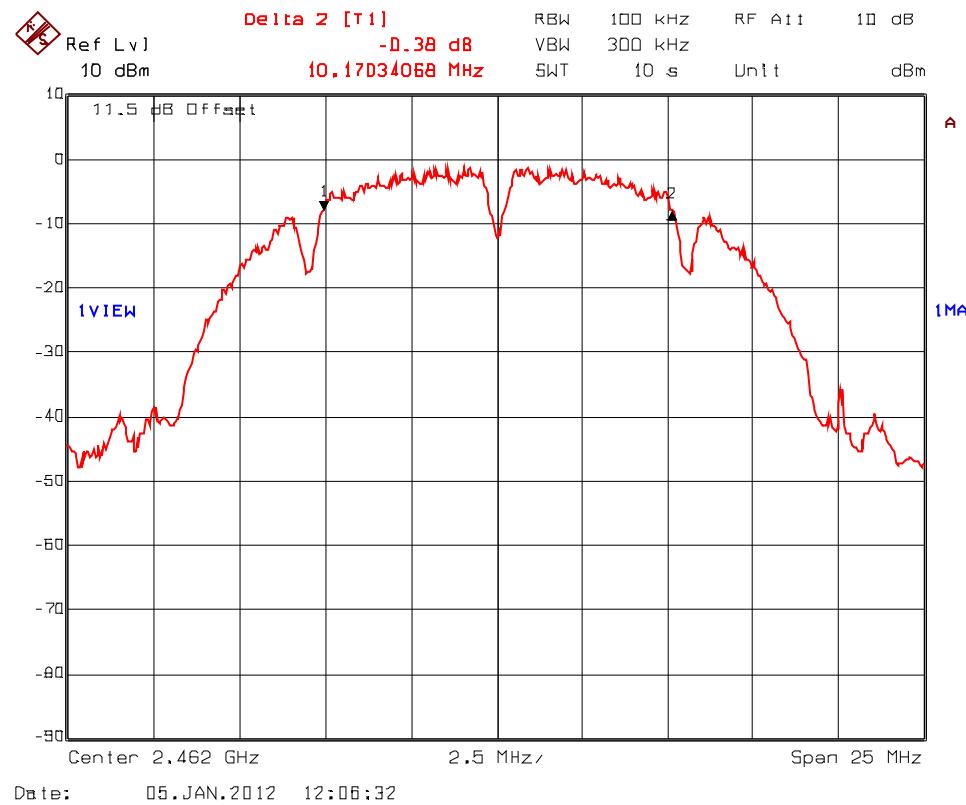
Plot 6.6.5.4 6 dB Bandwidth
Frequency: 2412 MHz; Modulation: DQPSK at 2 Mbps



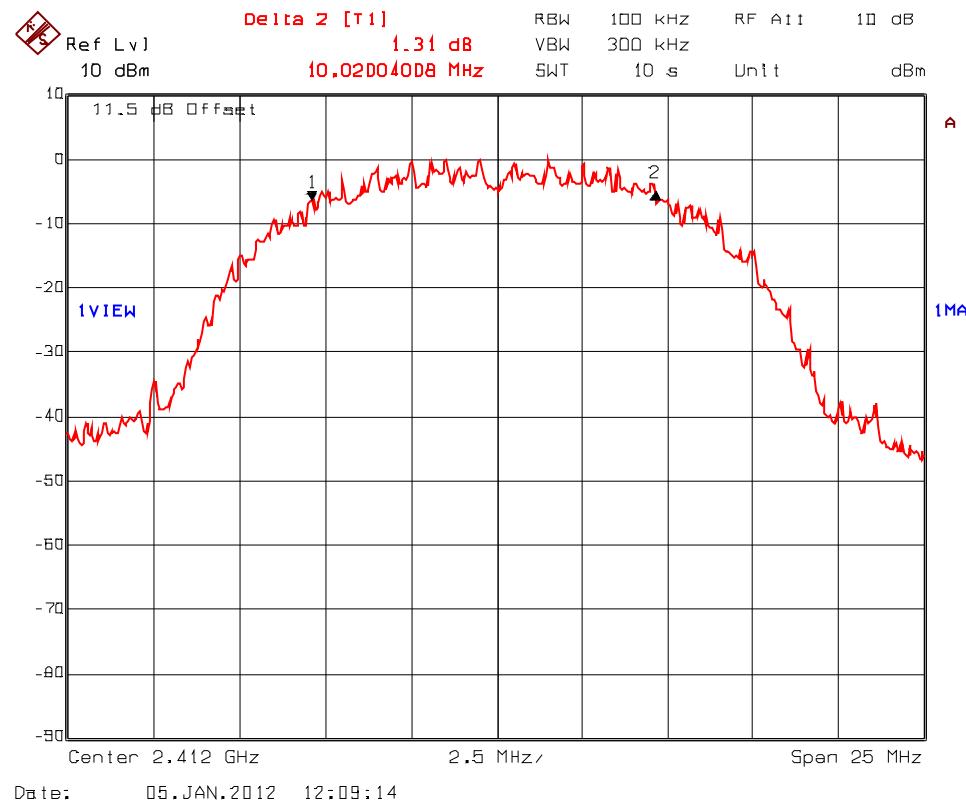
Plot 6.6.5.5 6 dB Bandwidth
Frequency: 2437 MHz; Modulation: DQPSK at 2 Mbps



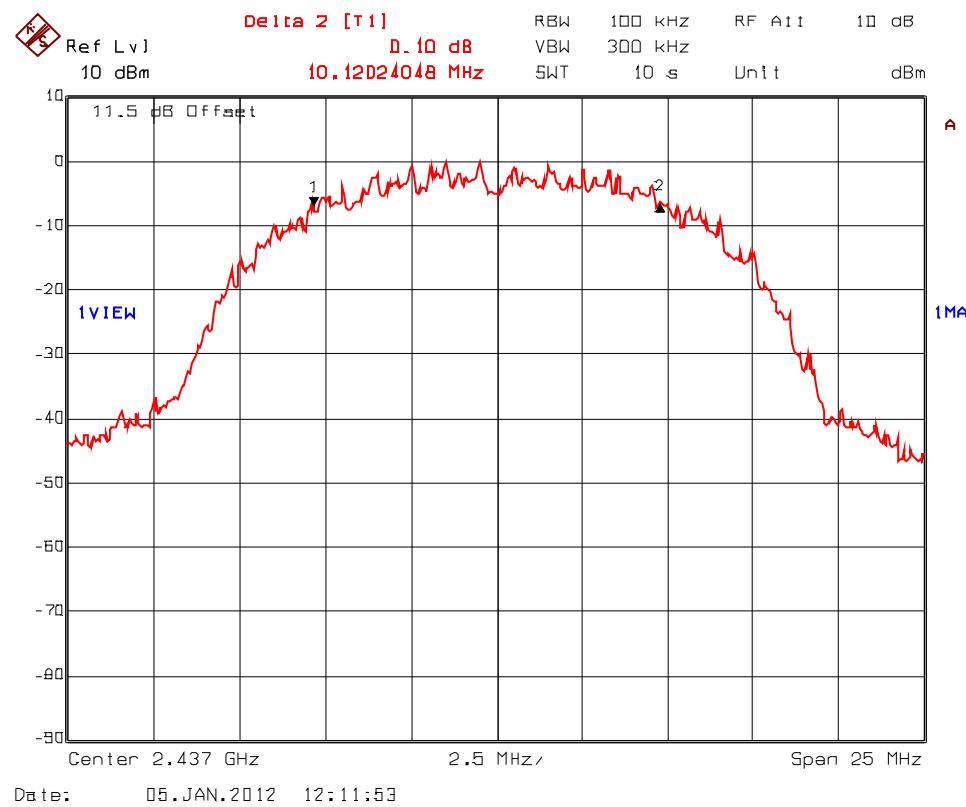
Plot 6.6.5.6 6 dB Bandwidth
Frequency: 2462 MHz; Modulation: DQPSK at 2 Mbps



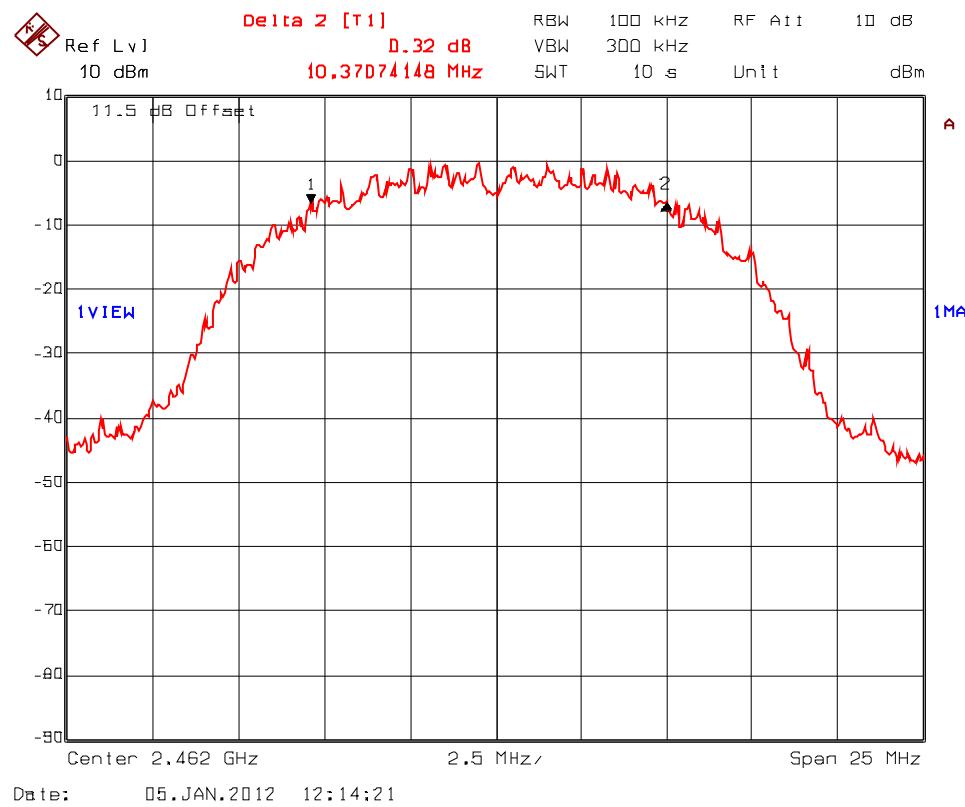
Plot 6.6.5.7 6 dB Bandwidth
Frequency: 2412 MHz; Modulation: CCK at 11 Mbps



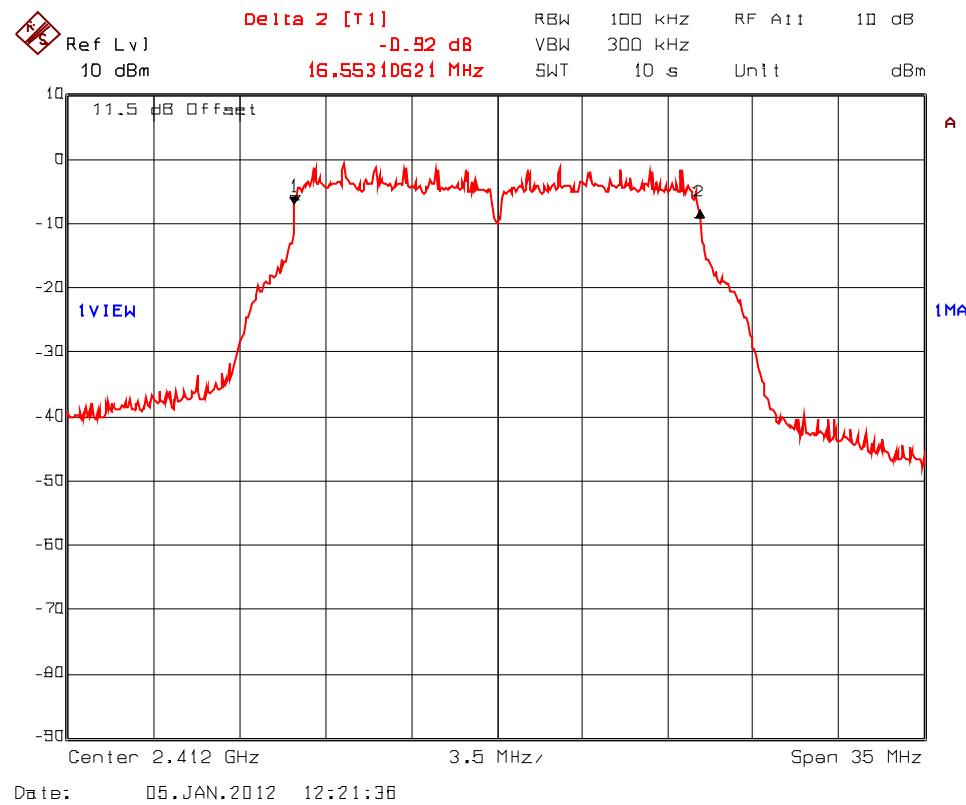
Plot 6.6.5.8 6 dB Bandwidth
Frequency: 2437 MHz; Modulation: CCK at 11 Mbps



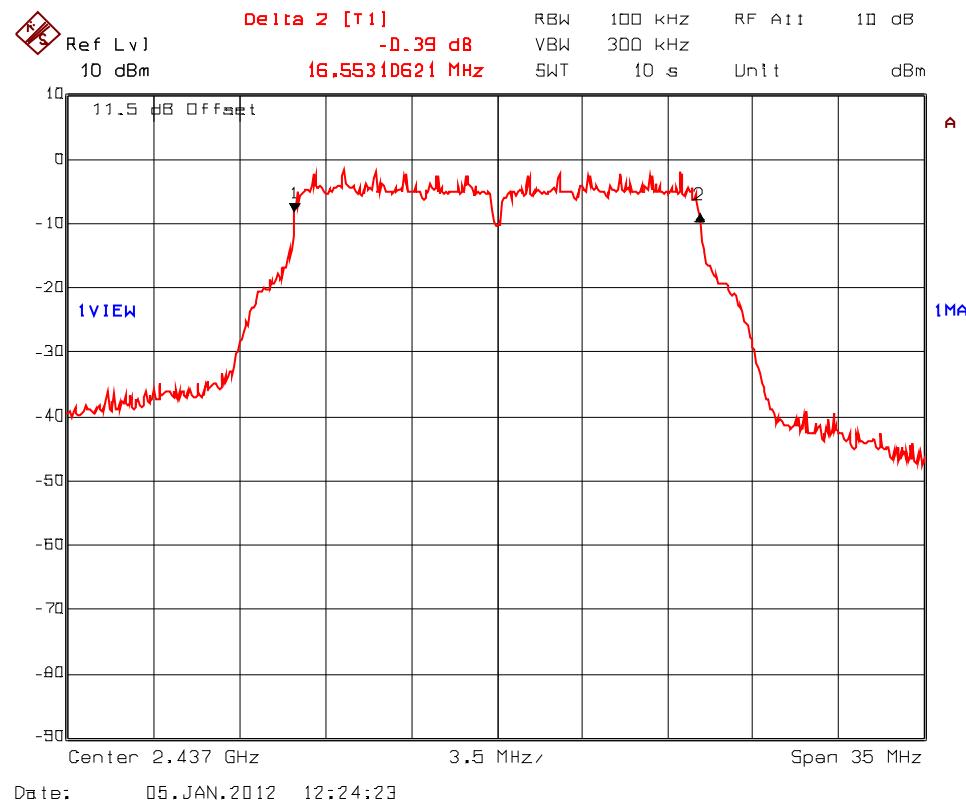
Plot 6.6.5.9 6 dB Bandwidth
Frequency: 2462 MHz; Modulation: CCK at 11 Mbps



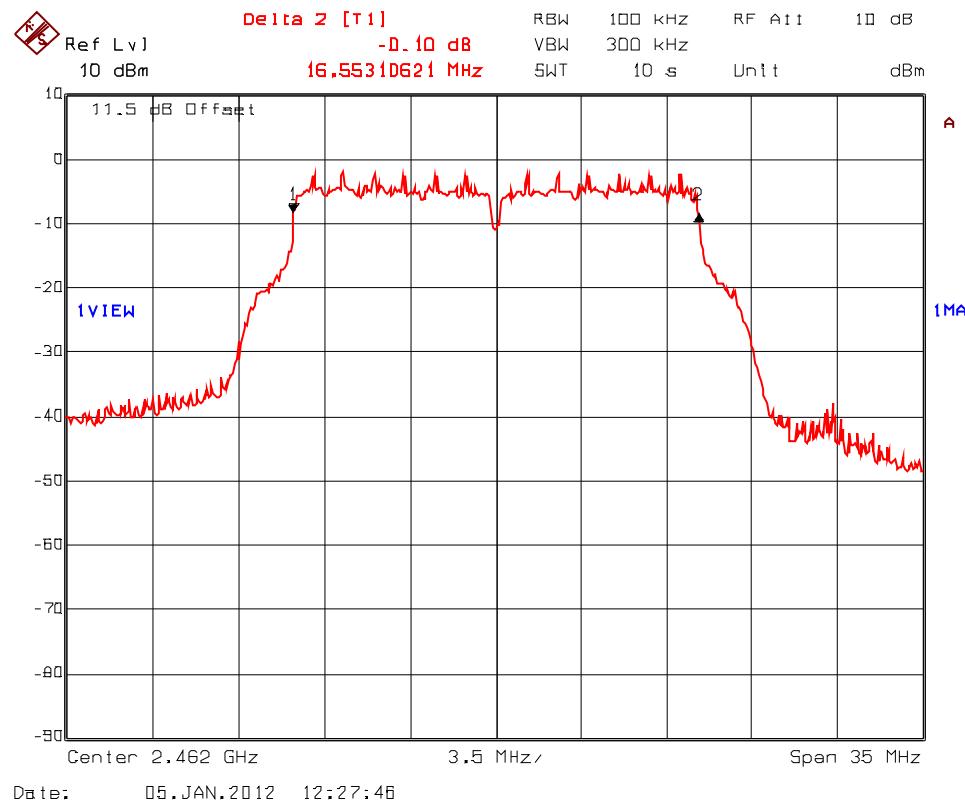
Plot 6.6.5.10 6 dB Bandwidth
Frequency: 2412 MHz; Modulation: BPSK 9 Mbps



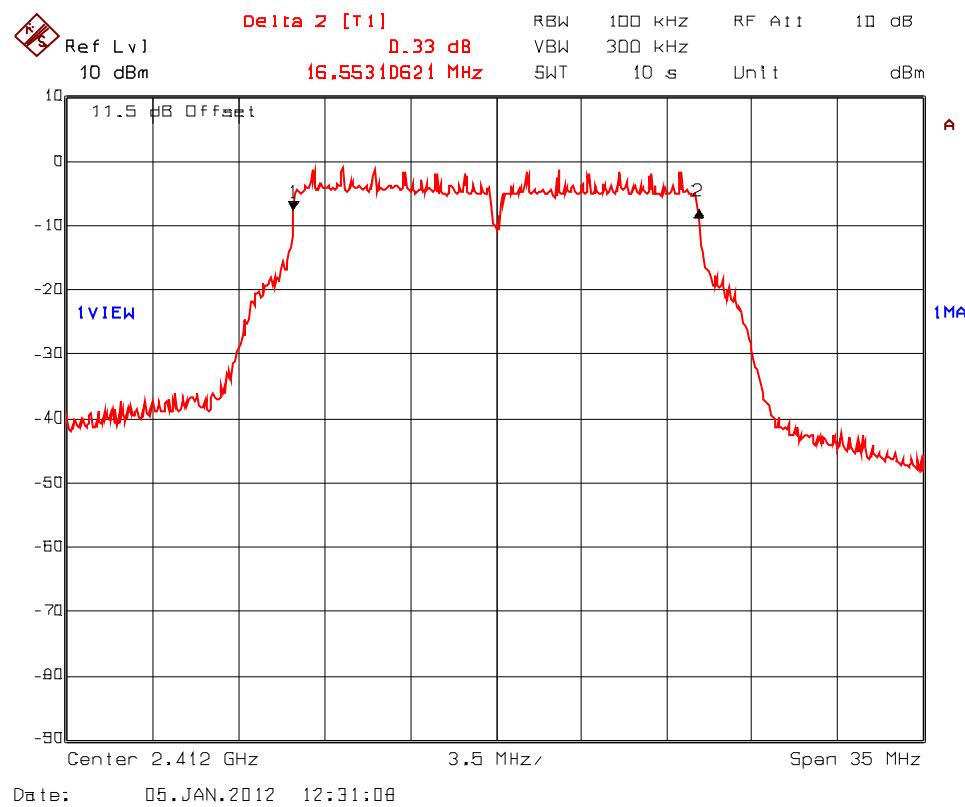
Plot 6.6.5.11 6 dB Bandwidth
Frequency: 2437 MHz; Modulation: BPSK 9 Mbps



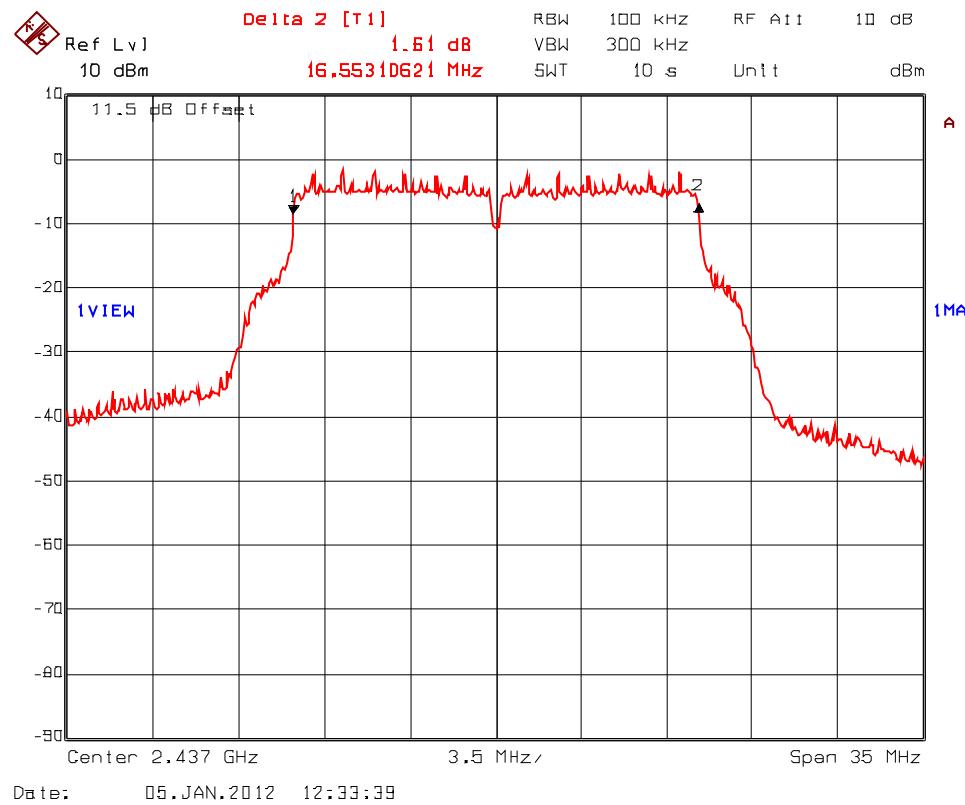
Plot 6.6.5.12 6 dB Bandwidth
Frequency: 2462 MHz; Modulation: BPSK 9 Mbps



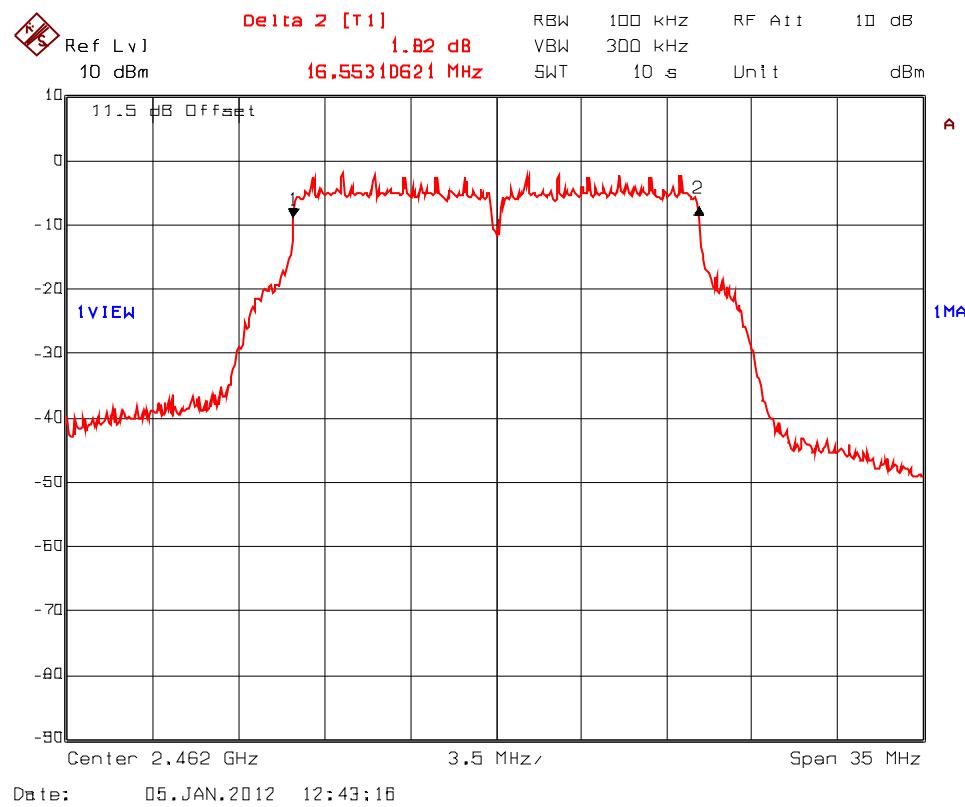
Plot 6.6.5.13 6 dB Bandwidth
Frequency: 2412 MHz; Modulation: QPSK at 18 Mbps



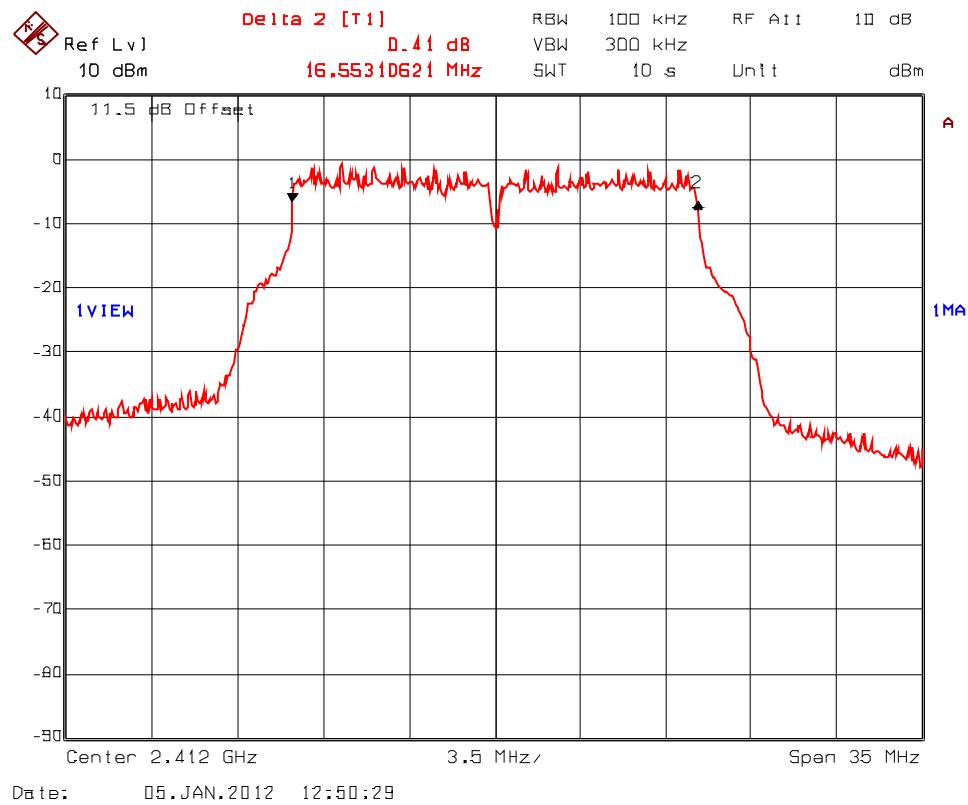
Plot 6.6.5.14 6 dB Bandwidth
Frequency: 2437 MHz; Modulation: QPSK at 18 Mbps



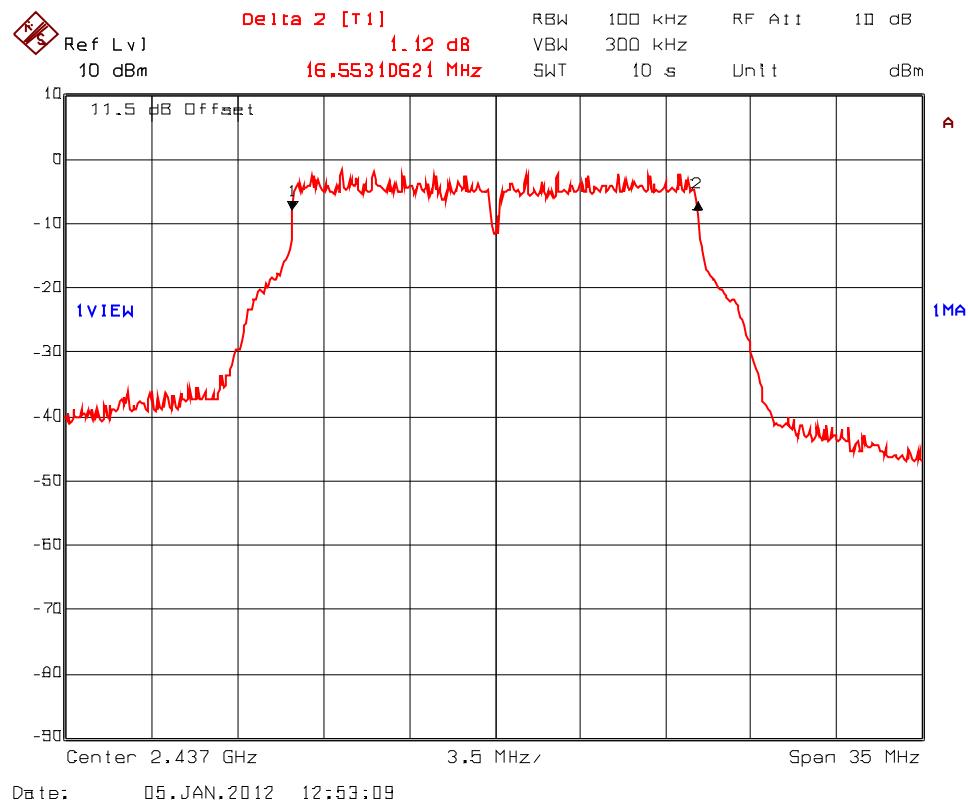
Plot 6.6.5.15 6 dB Bandwidth
Frequency: 2462 MHz; Modulation: QPSK at 18 Mbps



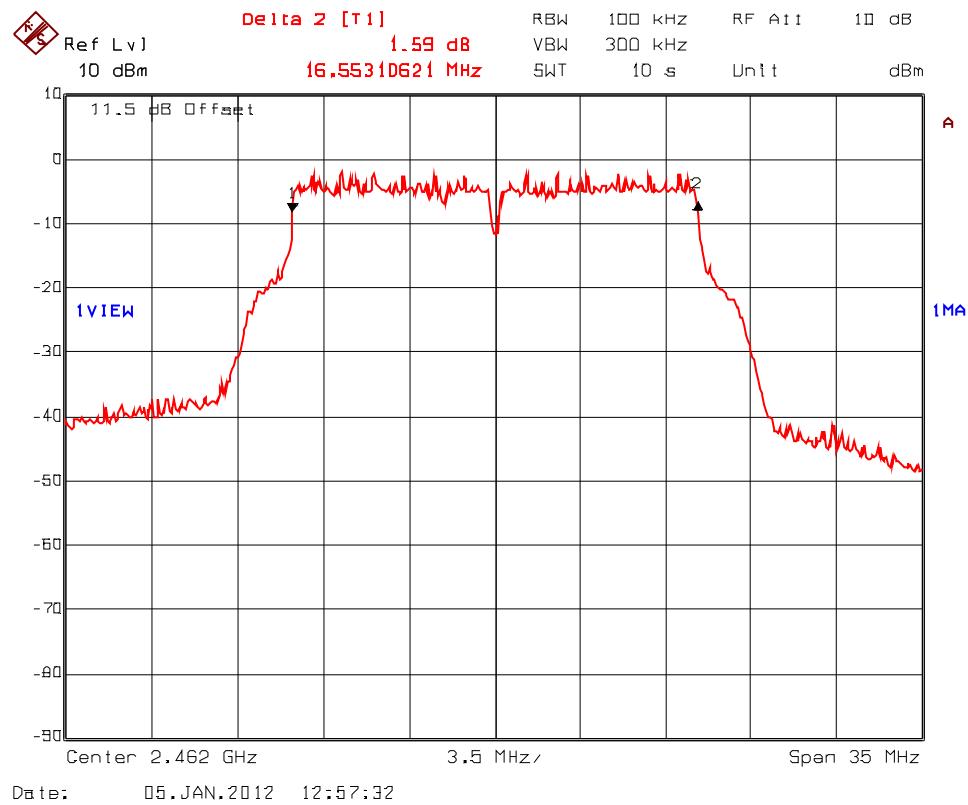
Plot 6.6.5.16 6 dB Bandwidth
Frequency: 2412 MHz; Modulation: 16QAM at 36 Mbps



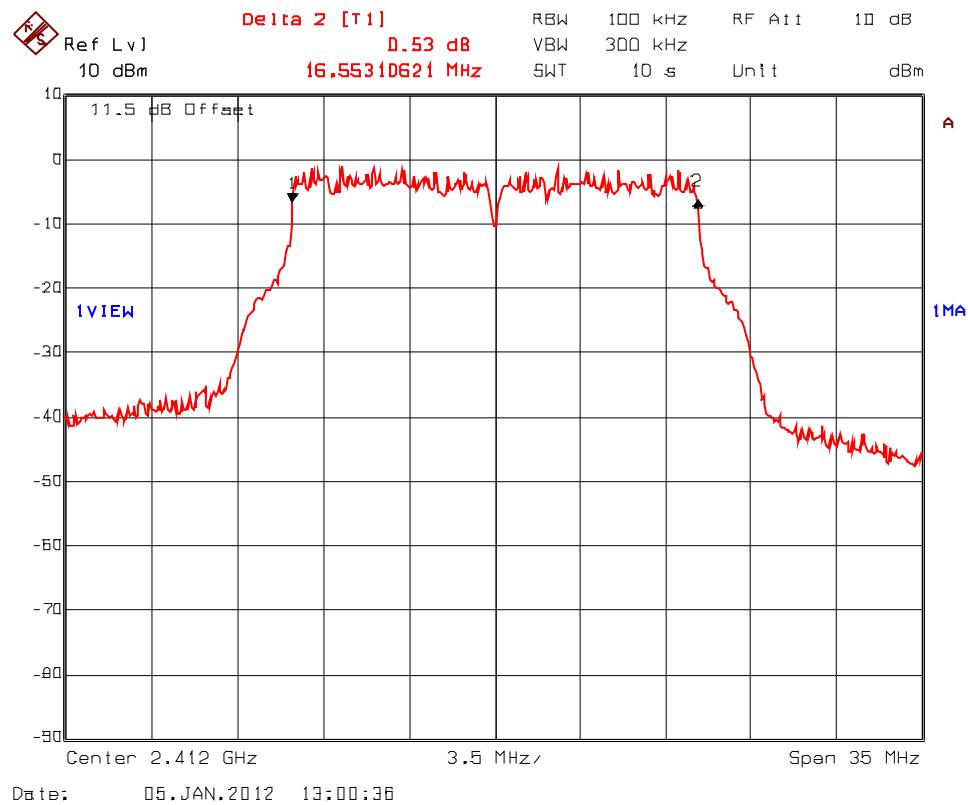
Plot 6.6.5.17 6 dB Bandwidth
Frequency: 2437 MHz; Modulation: 16QAM at 36 Mbps



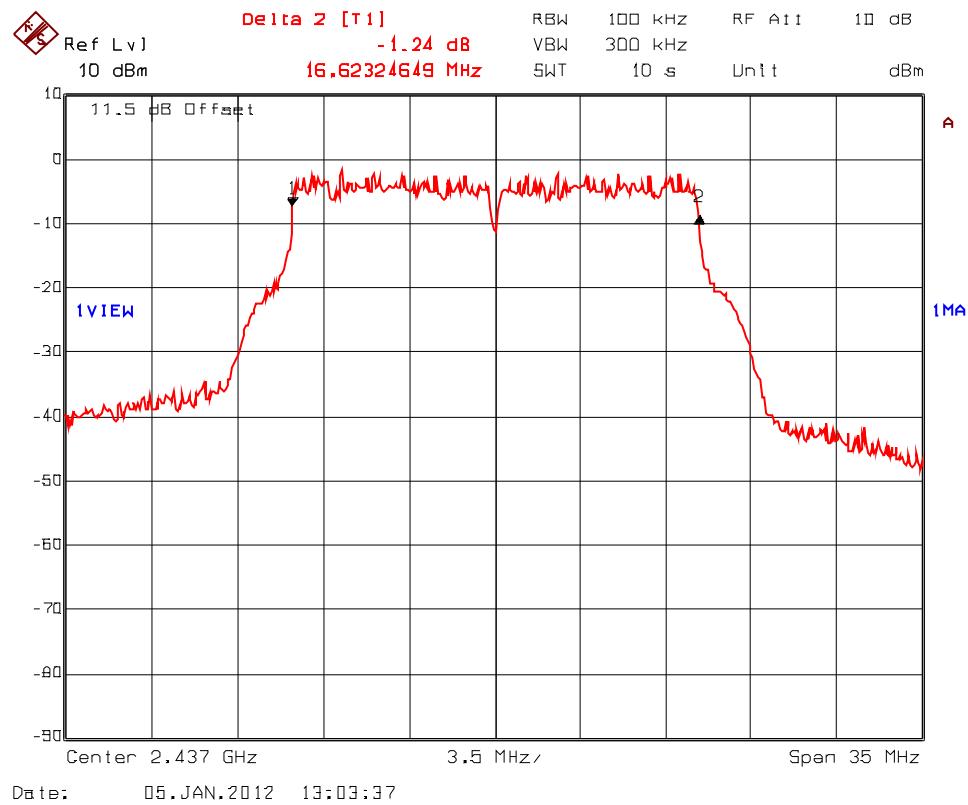
Plot 6.6.5.18 6 dB Bandwidth
Frequency: 2462 MHz; Modulation: 16QAM at 36 Mbps



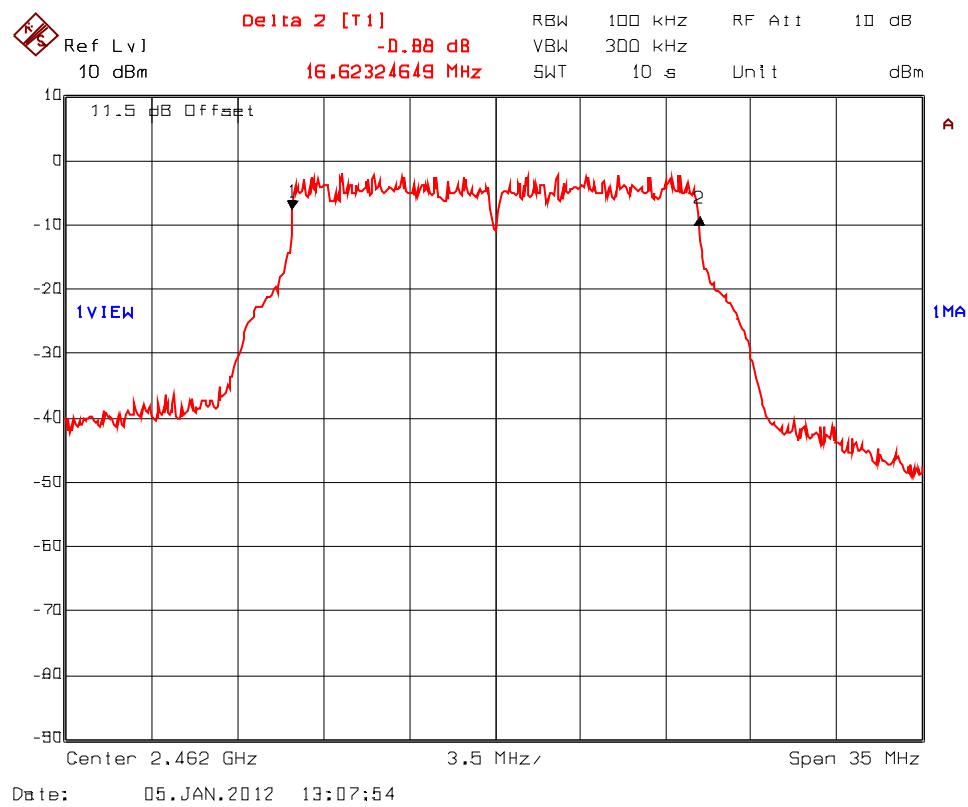
Plot 6.6.5.19 6 dB Bandwidth
Frequency: 2412 MHz; Modulation: 64-QAM at 54 Mbps



Plot 6.6.5.20 6 dB Bandwidth
Frequency: 2437 MHz; Modulation: 64-QAM at 54 Mbps



Plot 6.6.5.21 6 dB Bandwidth
Frequency: 2462 MHz; Modulation: 64-QAM at 54 Mbps



5.7. PEAK CONDUCTED OUTPUT POWER - DTS [§ 15.247(b)(3)]

5.7.1. Limit(s)

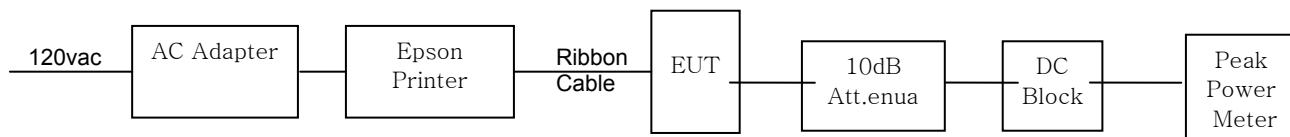
§ 15.247(b)(3):

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 & Test Arrangement

Refer to FCC DTS Measurement Guidance, Power Option method 1 and ANSI C63.4 for measurement methods.

5.7.3. Test Arrangement



5.7.4. Test Data

Remarks: Test method: Power Output Option 1, peak measurement

5.7.4.1. Peak Conducted Power

(a) 802.11b mode

Data Rate (Mbps)	Peak Power Conducted in dBm (in mW)		
	2412 MHz (CH1)	2437 MHz (CH6)	2462 MHz (CH11)
1 (DBPSK)	14.05 (25.4)	13.54 (22.6)	13.54 (22.6)
2 (DQPSK)	14.05 (25.4)	13.54 (22.6)	13.54 (22.6)
11 (CCK)	14.05 (25.4)	13.54 (22.6)	13.54 (22.6)

(b) 802.11g mode

Data Rate (Mbps)	Peak Power Conducted in dBm (in mW)		
	2412 MHz (CH1)	2437 MHz (CH6)	2462 MHz (CH11)
9 (BPSK)	18.31 (67.8)	17.93 (62.1)	17.83 (60.7)
18 (QPSK)	18.13 (65.0)	17.73 (59.3)	17.73 (59.3)
36 (16-QAM)	18.49 (70.6)	18.03 (63.5)	17.93 (62.1)
54 (64-QAM)	18.22 (66.4)	17.83 (60.7)	17.73 (59.3)

5.7.4.2. Average Conducted Power

(c) 802.11b mode

Data Rate (Mbps)	Average Conducted Power in dBm (in mW)		
	2412 MHz (CH1)	2437 MHz (CH6)	2462 MHz (CH11)
1 (DBPSK)	10.64 (11.6)	9.33 (8.57)	9.18 (9.28)
2 (DQPSK)	10.37 (10.9)	9.05 (8.04)	8.98 (7.91)
11 (CCK)	9.98 (9.95)	8.84 (7.65)	8.83 (7.64)

(d) 802.11g mode

Data Rate (Mbps)	Peak Power Conducted in dBm (in mW)		
	2412 MHz (CH1)	2437 MHz (CH6)	2462 MHz (CH11)
9 (BPSK)	10.19 (10.45)	9.24 (8.40)	9.09 (8.11)
18 (QPSK)	9.82 (9.59)	9.01 (7.96)	8.88 (7.73)
36 (16-QAM)	9.45 (8.81)	8.75 (7.50)	8.59 (7.23)
54 (64-QAM)	9.27 (8.45)	8.58 (7.21)	8.42 (6.95)

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

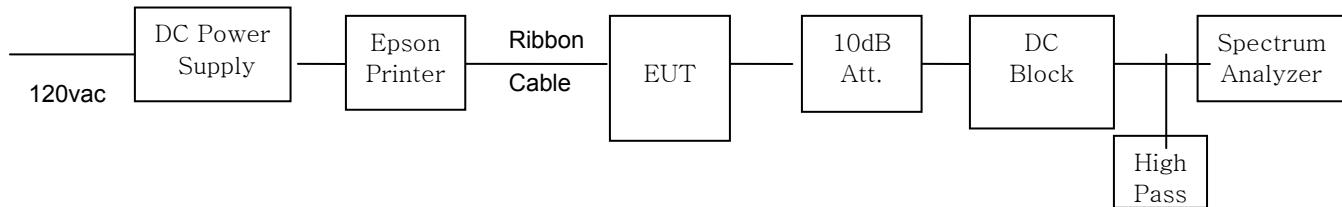
5.8.1. Limit(s)

§ 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)

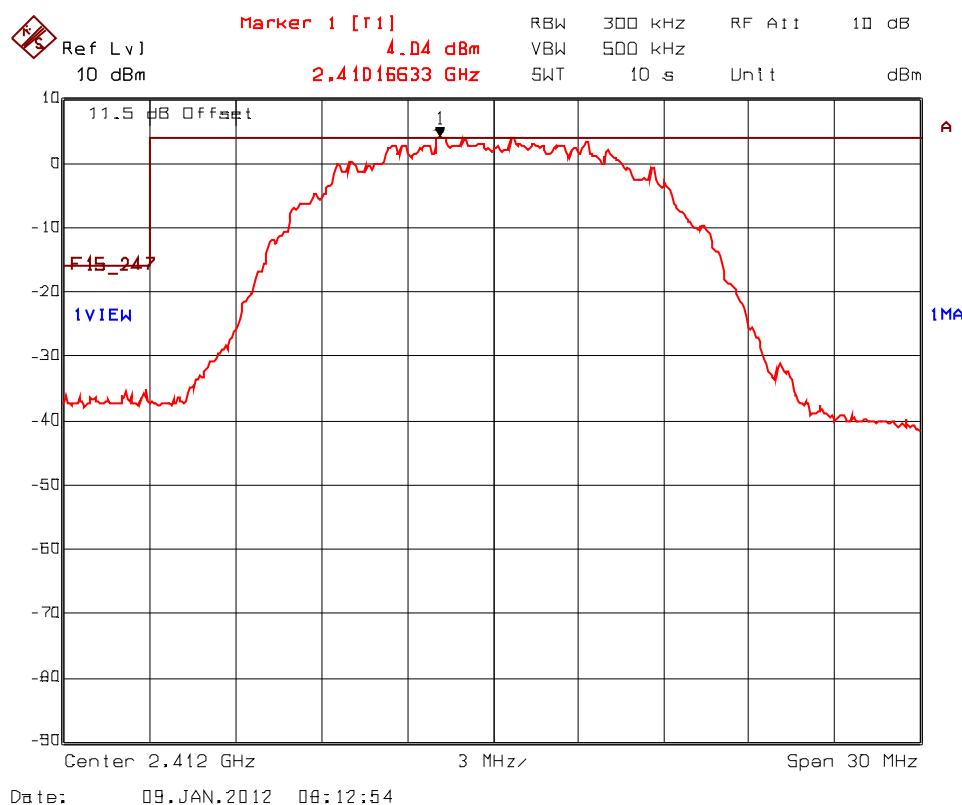
5.8.3. Test Arrangement



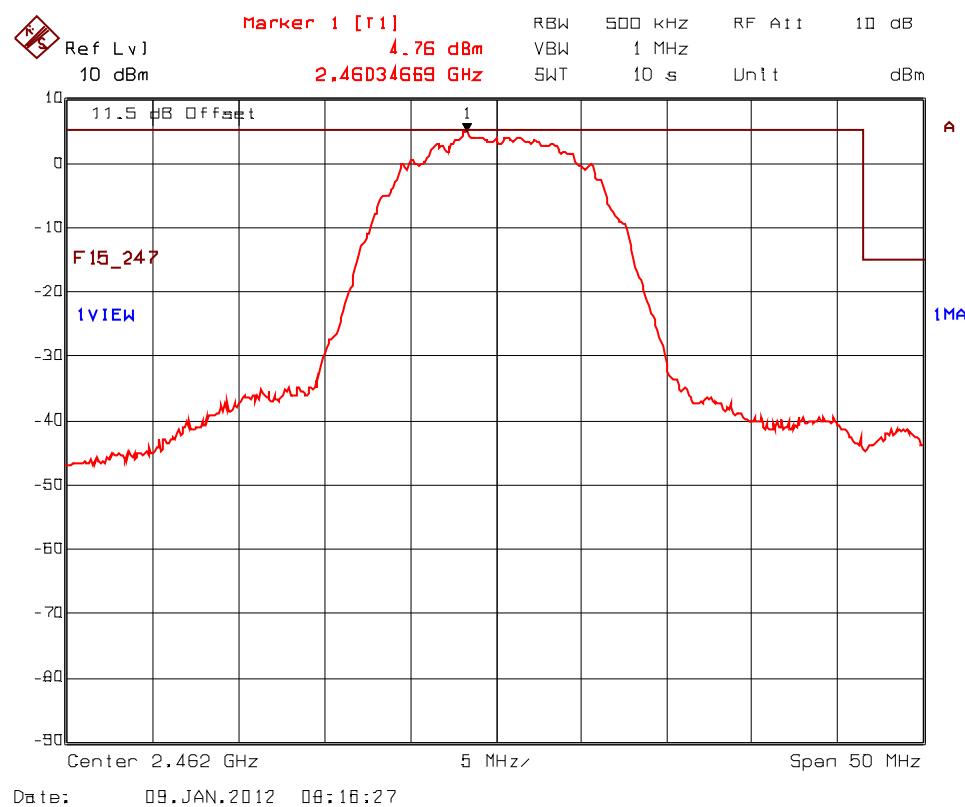
5.8.4. Test Data

5.8.4.1. Band-Edge RF Conducted Emissions

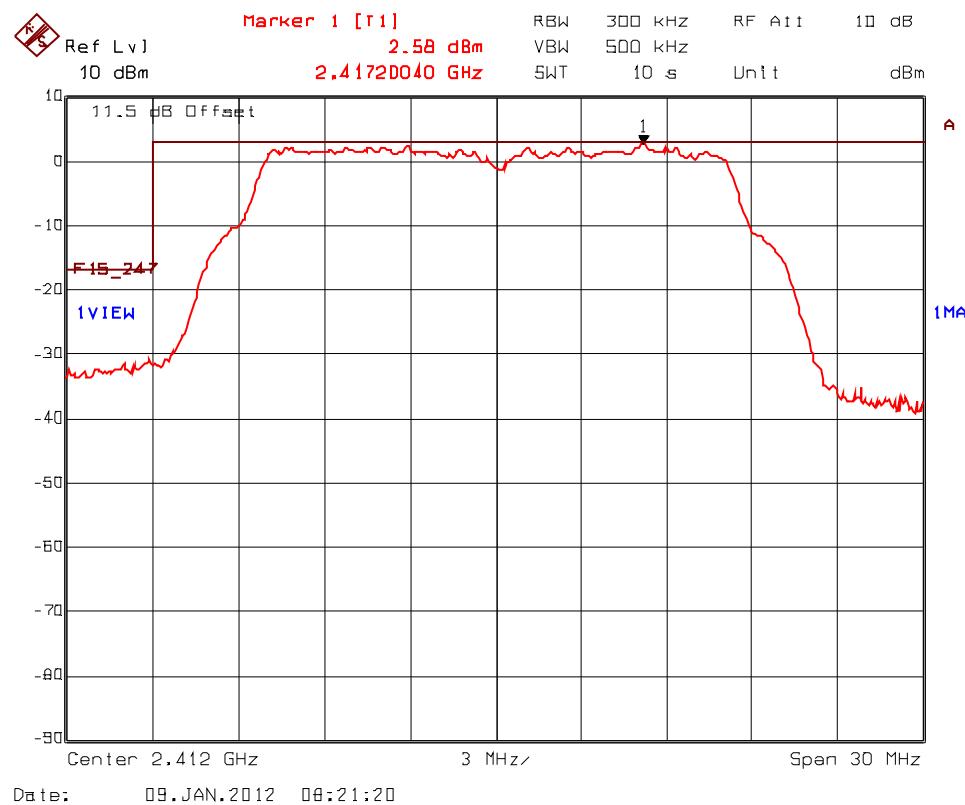
Plot 6.8.5.1.1 Band-Edge RF Conducted Emissions, 802.11b Mode
Low End of Frequency Band 2412 MHz, CCK 11 Mbps



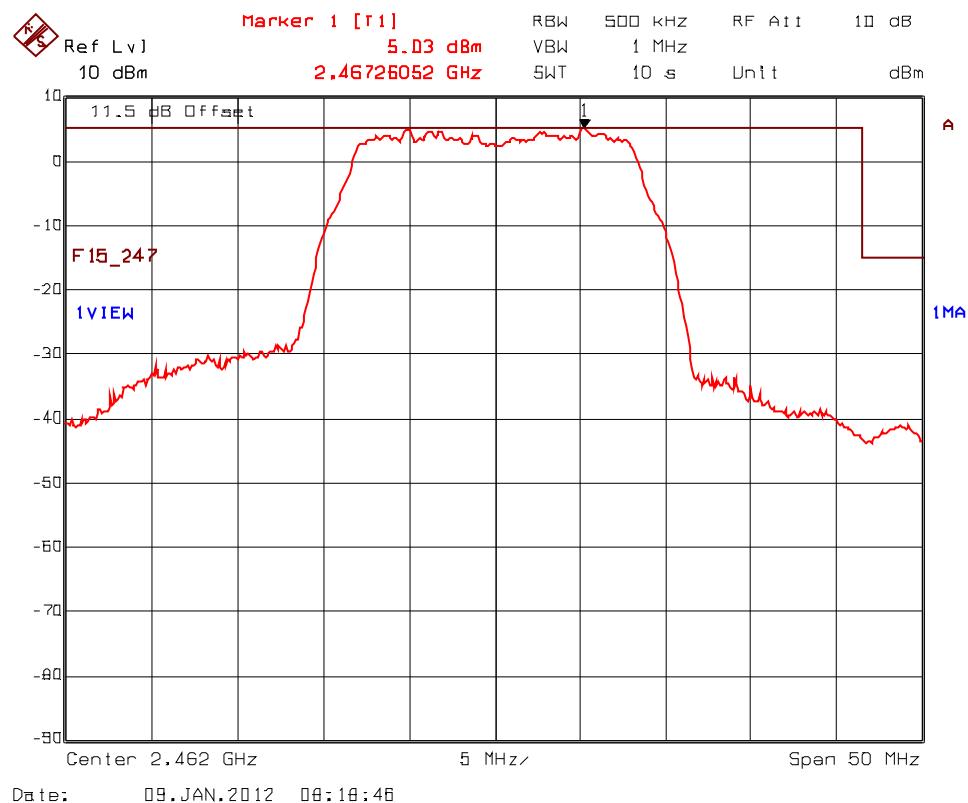
Plot 6.8.5.1.2 Band-Edge RF Conducted Emissions, 802.11b Mode
High End of Frequency Band 2462 MHz, CCK 11 Mbps



**Plot 6.8.5.1.3 Band-Edge RF Conducted Emissions, 802.11g Mode
Low End of Frequency Band 2412 MHz, 16QAM 36 Mbps**

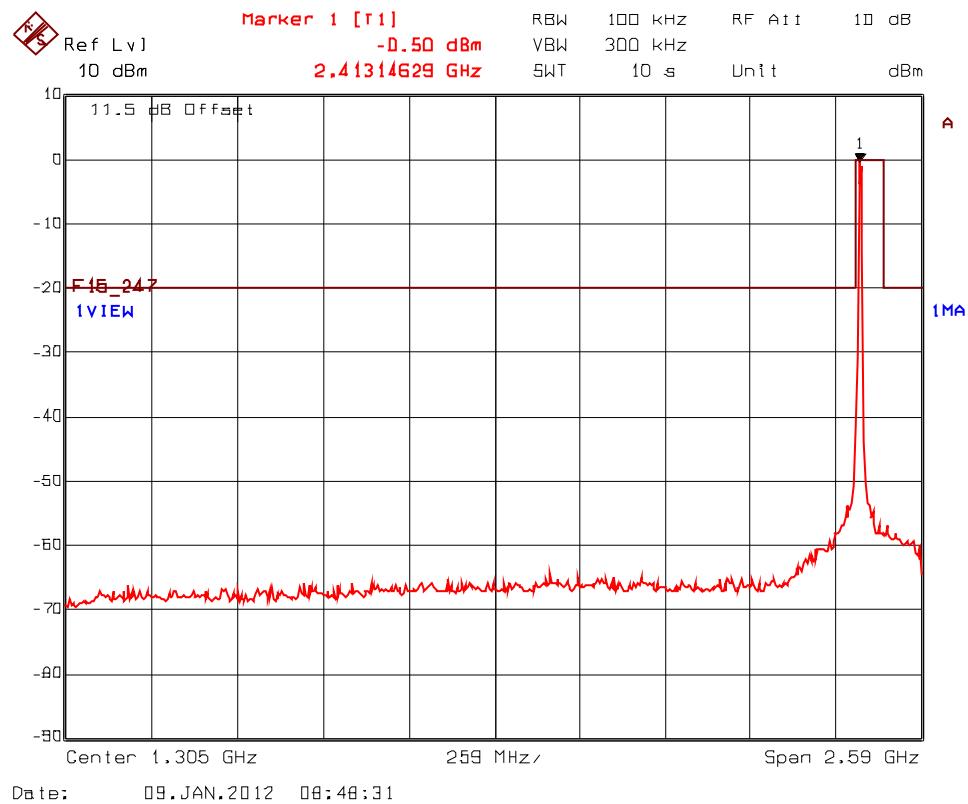


Plot 6.8.5.1.4 Band-Edge RF Conducted Emissions, 802.11g Mode
High End of Frequency Band 2462 MHz, 16QAM 36 Mbps

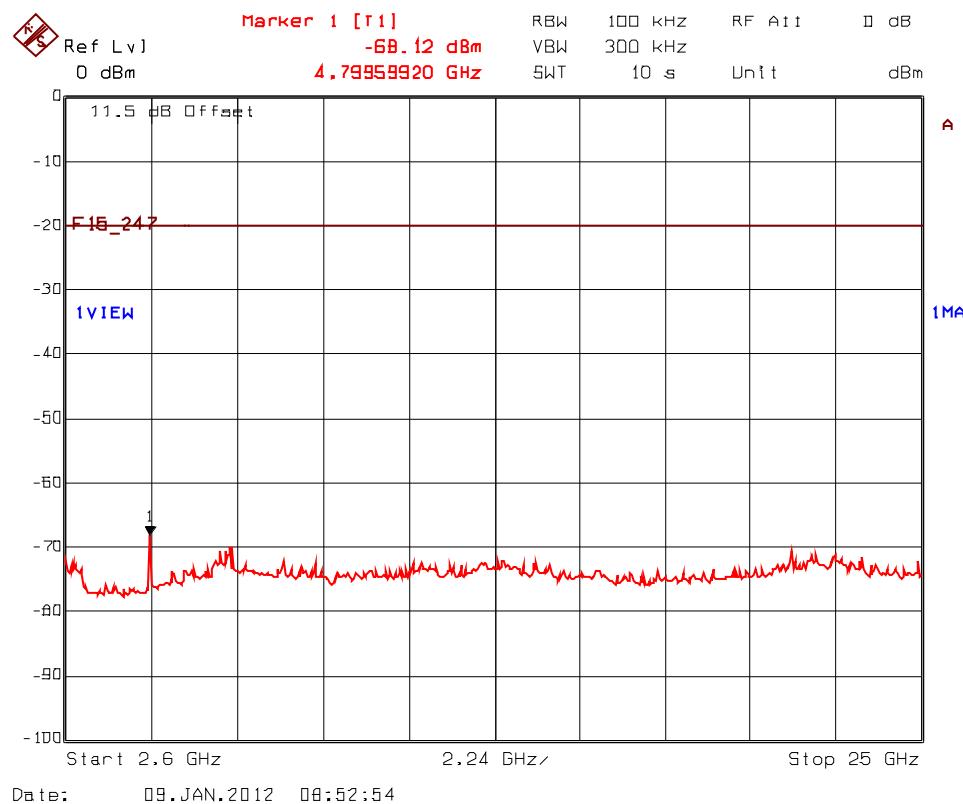


5.8.4.2. Spurious RF Conducted Emissions

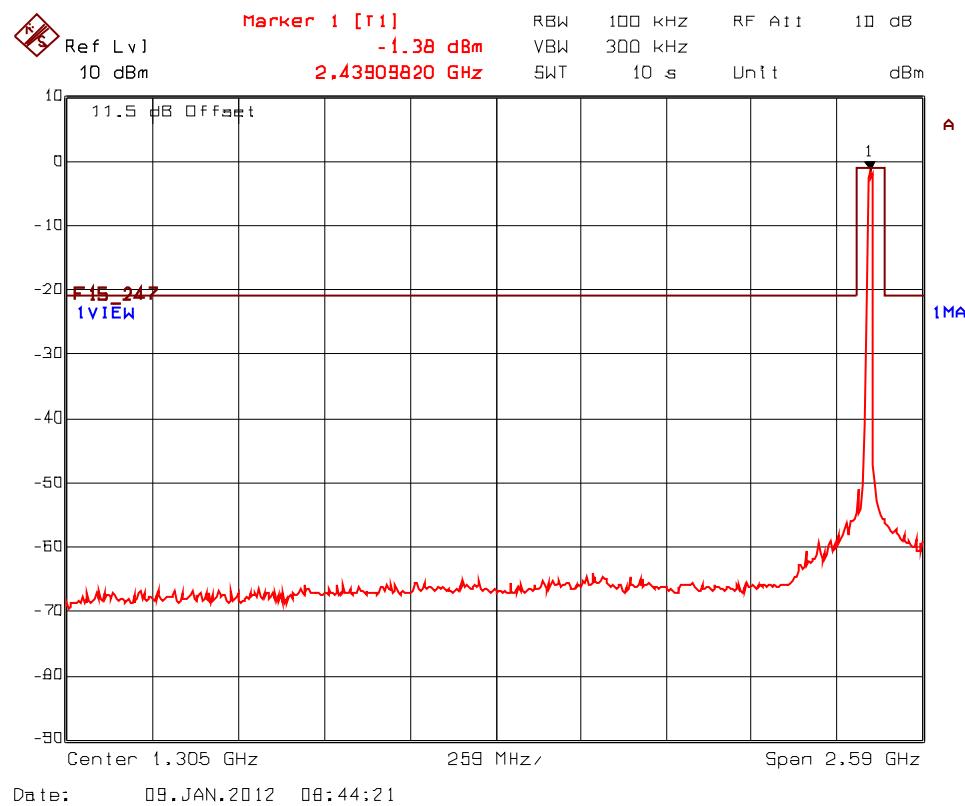
Plot 6.8.5.2.1(j) Spurious RF Conducted Emissions, 802.11b Mode
Transmitter Frequency: 2412 MHz, CCK 11 Mbps



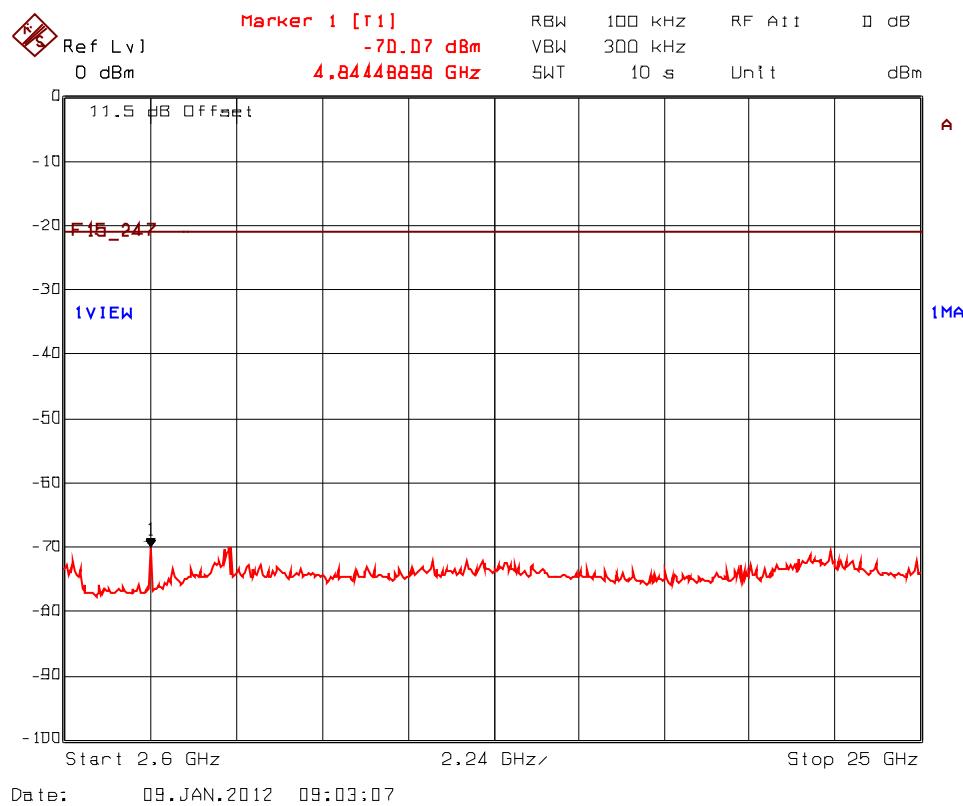
Plot 6.8.5.2.1(ii) Spurious RF Conducted Emissions, 802.11b Mode
Transmitter Frequency: 2412 MHz, CCK 11 Mbps



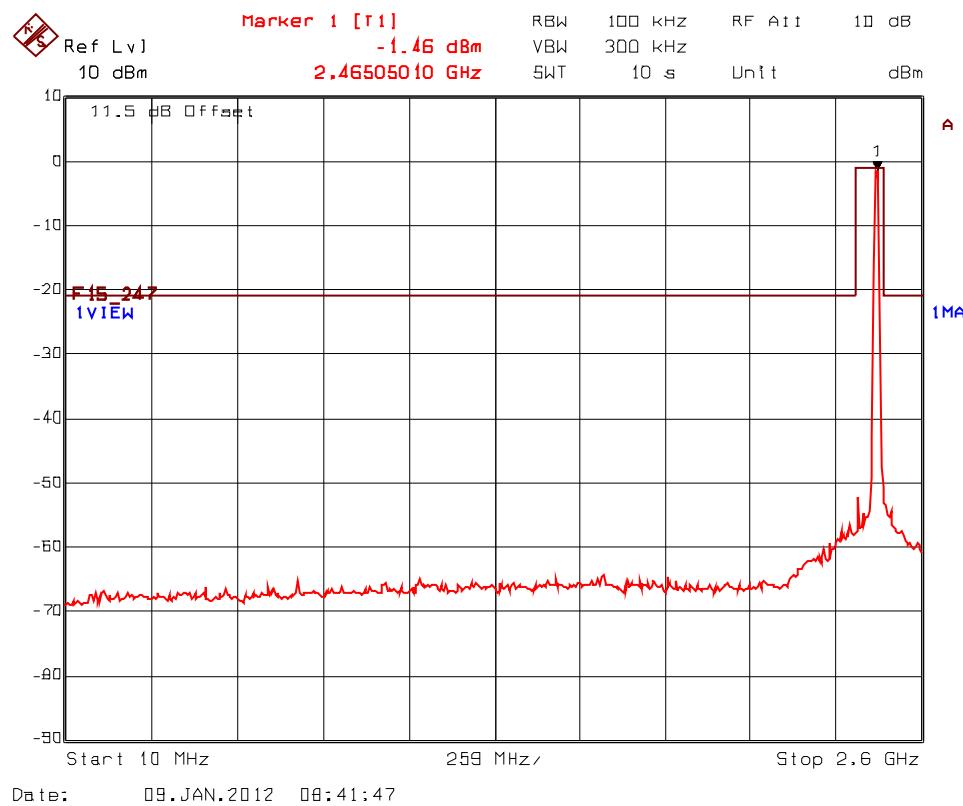
Plot 6.8.5.2.2(i) Spurious RF Conducted Emissions, 802.11b Mode
Transmitter Frequency: 2437 MHz, CCK 11 Mbps



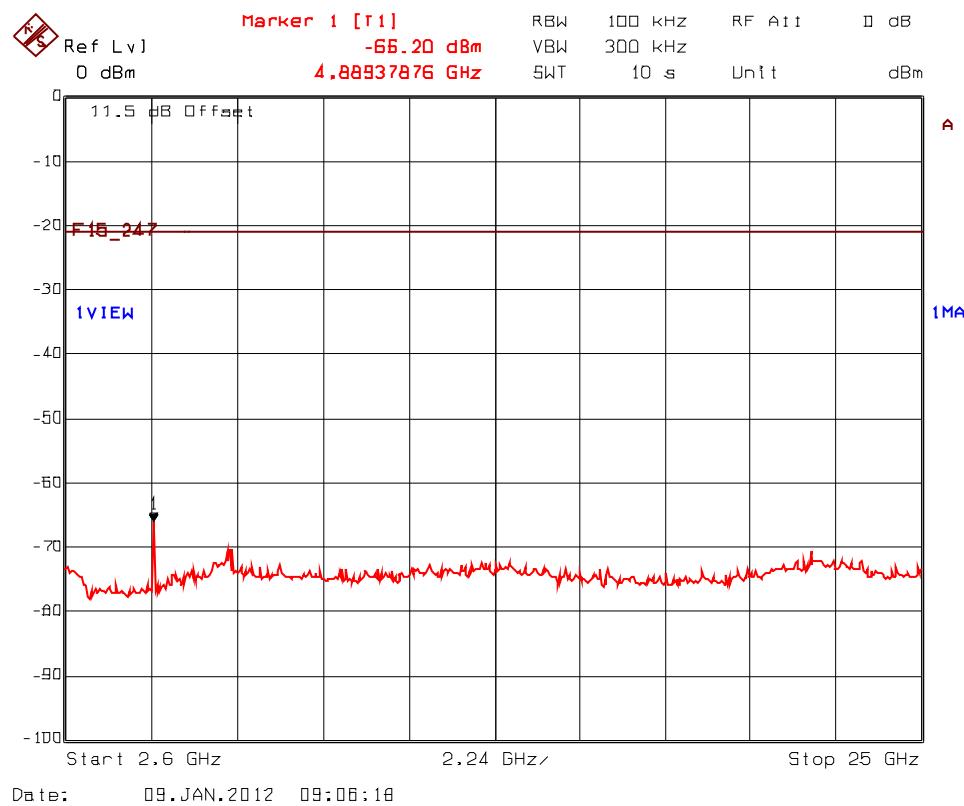
Plot 6.8.5.2.2(ii) Spurious RF Conducted Emissions, 802.11b Mode
Transmitter Frequency: 2437 MHz, CCK 11 Mbps



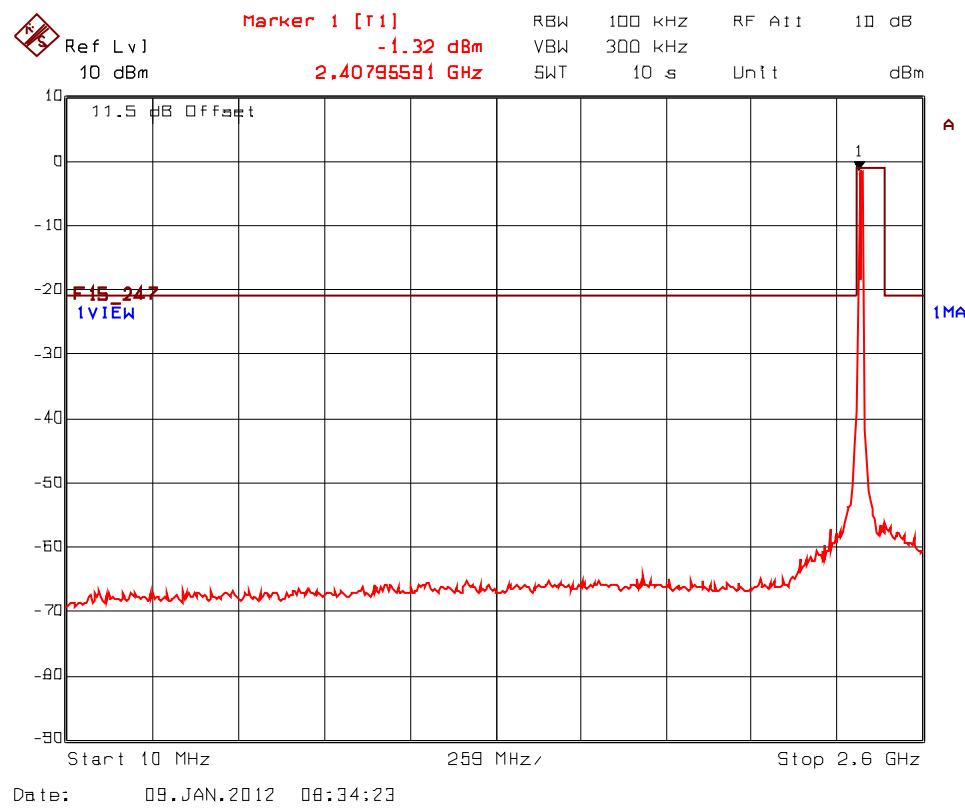
Plot 6.8.5.2.3(i) Spurious RF Conducted Emissions, 802.11b Mode
Transmitter Frequency: 2462 MHz, CCK 11 Mbps



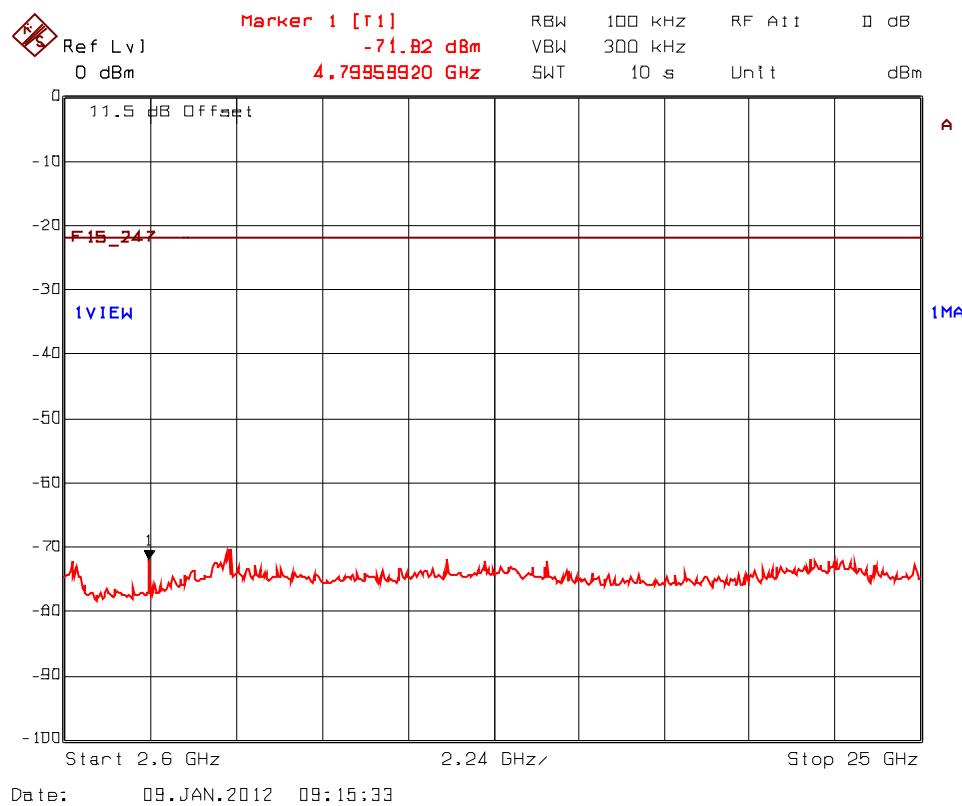
Plot 6.8.5.2.3(ii) Spurious RF Conducted Emissions, 802.11b Mode
Transmitter Frequency: 2462 MHz, CCK 11 Mbps



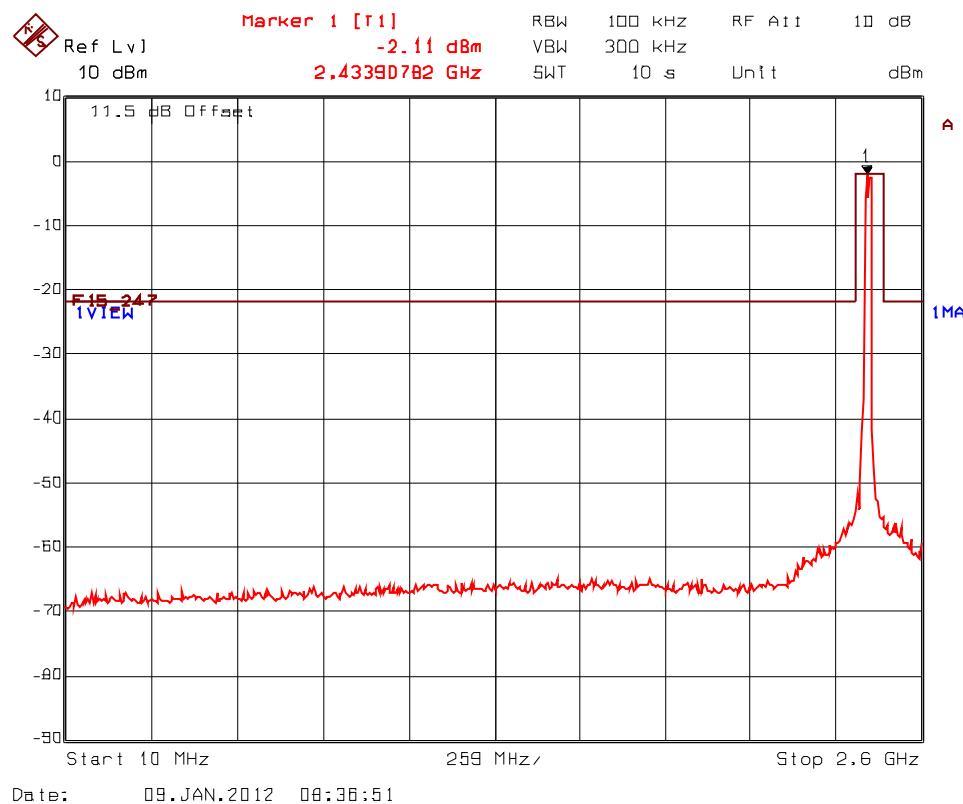
Plot 6.8.5.2.4(i) Spurious RF Conducted Emissions, 802.11g Mode
Transmitter Frequency: 2412 MHz, 16QAM 36 Mbps



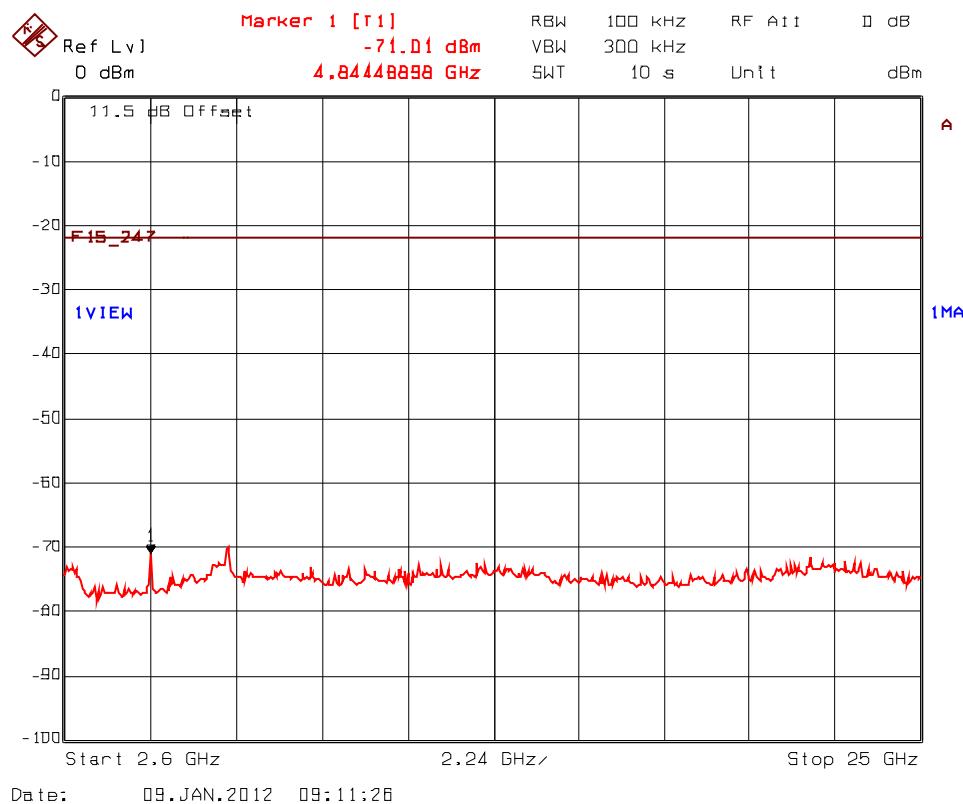
Plot 6.8.5.2.4(ii) Spurious RF Conducted Emissions, 802.11g Mode
Transmitter Frequency: 2412 MHz, 16QAM 36 Mbps



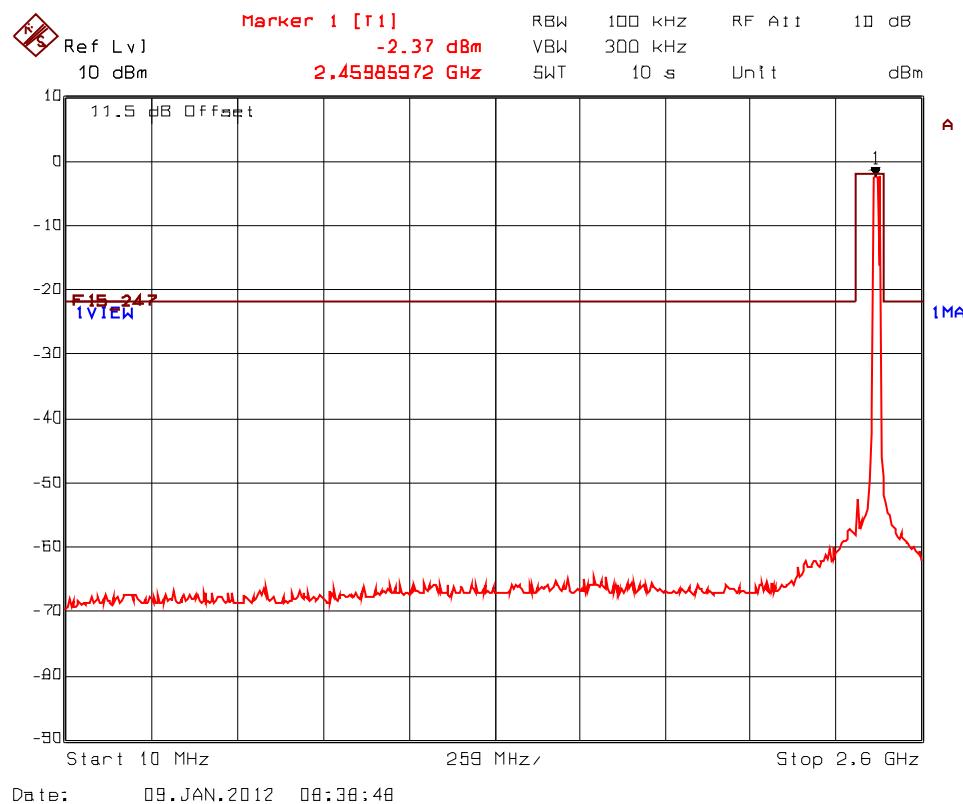
Plot 6.8.5.2.5(i) Spurious RF Conducted Emissions, 802.11g Mode
Transmitter Frequency: 2437 MHz, 16QAM 36 Mbps



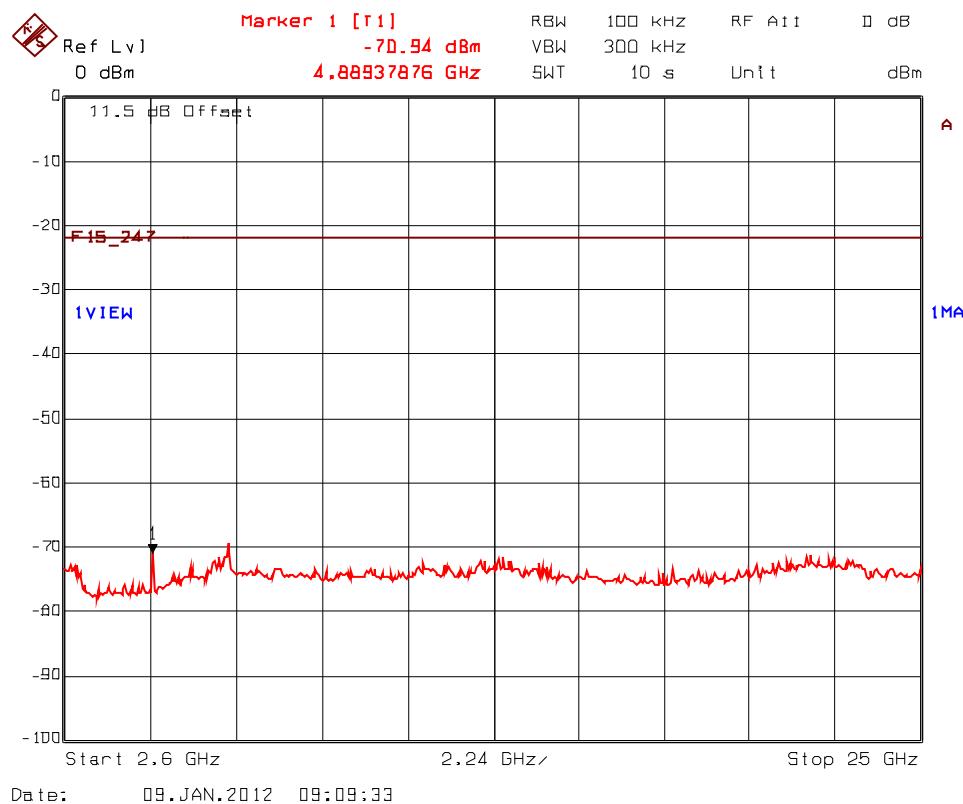
Plot 6.8.5.2.5(ii) Spurious RF Conducted Emissions, 802.11g Mode
Transmitter Frequency: 2437 MHz, 16QAM 36 Mbps



Plot 6.8.5.2.6(i) Spurious RF Conducted Emissions, 802.11g Mode
Transmitter Frequency: 2462 MHz, 16QAM 36 Mbps



Plot 6.8.5.2.6(ii) Spurious RF Conducted Emissions, 802.11g Mode
Transmitter Frequency: 2462 MHz, 16QAM 36 Mbps



5.9. TRANSMITTER SPURIOUS RADIATED EMISSIONS AT 3 METERS [§§ 15.247(d), 15.209 & 15.205]

5.9.1. 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. Attenuation below the general limits specified in Section 15.209(a) is not required. 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)).

Section 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
10.495–0.505	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	2655–2900	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.			

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

²Above 38.6

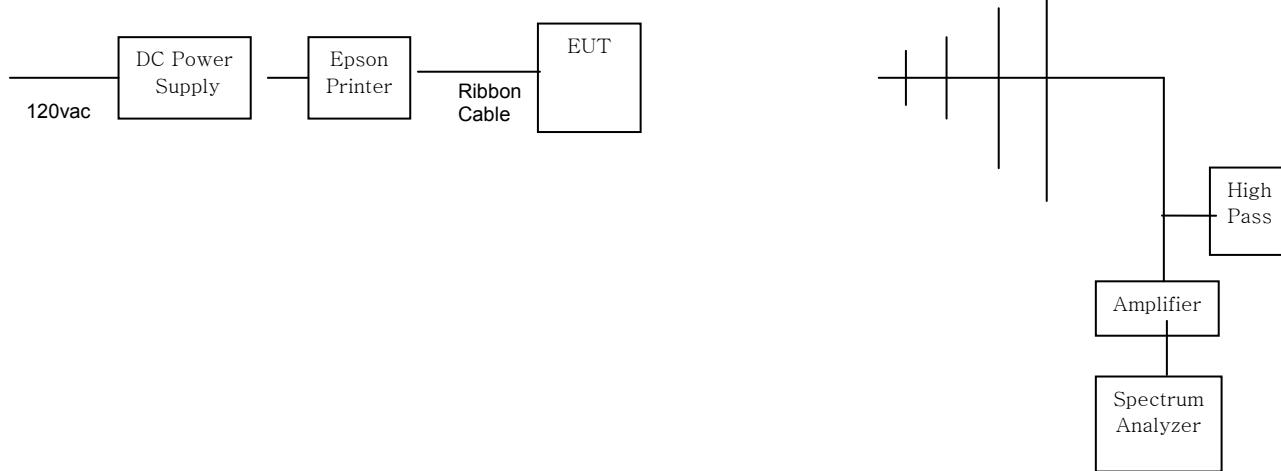
Section 15.209(a) -- Field Strength Limits within Restricted Frequency Bands --

Frequency (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
0.009 - 0.490	2,400 / F (kHz)	300
0.490 - 1.705	24,000 / 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

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



5.9.4. Test Data

Remarks:

- All spurious emissions that are in excess of 20 dB below the specified limit shall be recorded.
- EUT is tested in all three orthogonal positions.
- Both 802.11b & 802.11g Modulations with highest power levels yielded the same result as tabulated below.

5.9.4.1. Transmitter Radiated Spurious Emissions

Transmitter Radiated Spurious Emissions							
Frequency (MHz)	RF Peak Level (dB μ V/m)	RF Avg Level (dB μ V/m)	Antenna Plane (H/V)	Limit 15.209 (dB μ V/m)	Limit 15.247 (dB μ V/m)	Margin (dB)	Pass/Fail
2412	107.63	--	V	--	--	--	--
2412	110.43	--	H	--	--	--	--
4824	49.16	38.32	V	54.0	87.6	-15.7	Pass*
4824	48.41	37.27	H	54.0	87.6	-16.7	Pass*
9648	58.18	50.08	V	54.0	87.6	-37.5	Pass
9648	57.68	48.60	H	54.0	87.6	-39.0	Pass

* Emission within the restricted frequency bands.

Fundamental Frequency: 2437 MHz Test Frequency Range: 30 MHz – 25 GHz							
Frequency (MHz)	RF Peak Level (dB μ V/m)	RF Avg Level (dB μ V/m)	Antenna Plane (H/V)	Limit 15.209 (dB μ V/m)	Limit 15.247 (dB μ V/m)	Margin (dB)	Pass/Fail
2437	107.05	--	V	--	--	--	--
2437	100.84	--	H	--	--	--	--
4874	48.24	35.88	V	54.0	87.1	-18.1	Pass*
4874	48.80	38.11	H	54.0	87.1	-15.9	Pass*
9748	58.55	50.52	V	54.0	87.1	-36.6	Pass
9748	57.84	50.85	H	54.0	87.1	-36.2	Pass

* Emission within the restricted frequency bands.

Fundamental Frequency: 2462 MHz Test Frequency Range: 30 MHz – 25 GHz							
Frequency (MHz)	RF Peak Level (dB μ V/m)	RF Avg Level (dB μ V/m)	Antenna Plane (H/V)	Limit 15.209 (dB μ V/m)	Limit 15.247 (dB μ V/m)	Margin (dB)	Pass/Fail
2462	107.18	--	V	--	--	--	--
2462	111.92	--	H	--	--	--	--
4924	48.39	37.04	V	54.0	87.1	-17.0	Pass*
4924	48.61	39.38	H	54.0	87.1	-14.6	Pass*
9848	58.41	51.89	V	54.0	87.1	-35.2	Pass
9848	58.71	52.87	H	54.0	87.1	-34.2	Pass

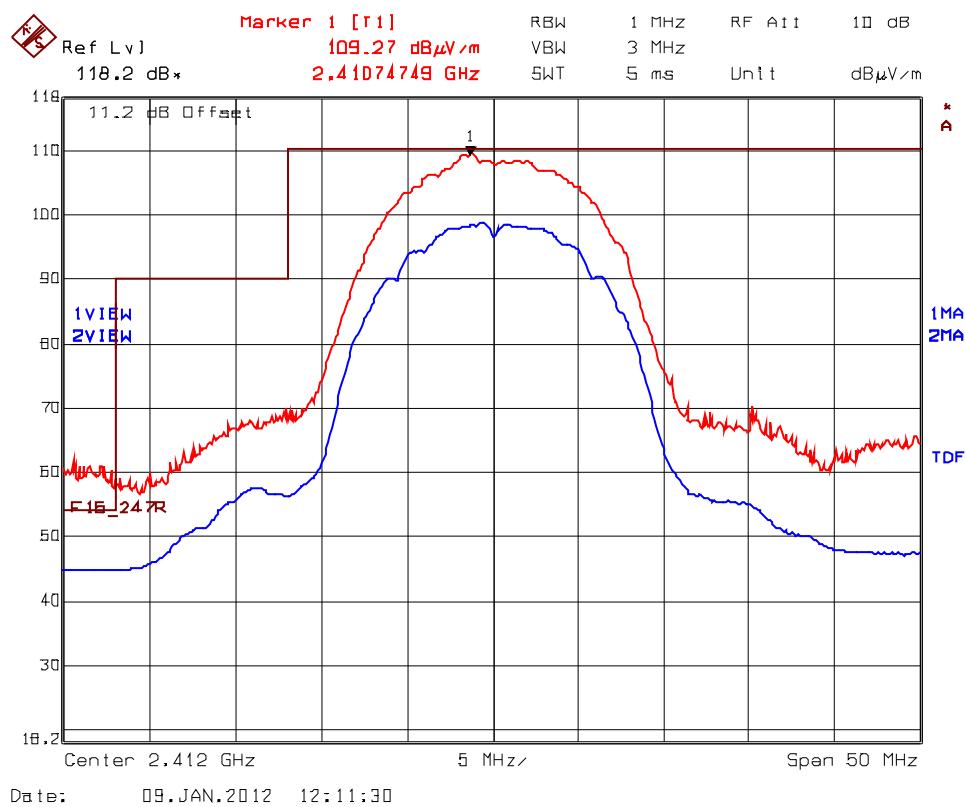
* Emission within the restricted frequency bands.

See the following test data plots for band-edge emissions.

802.11b mode, 11 Mbps data rate, CCK:

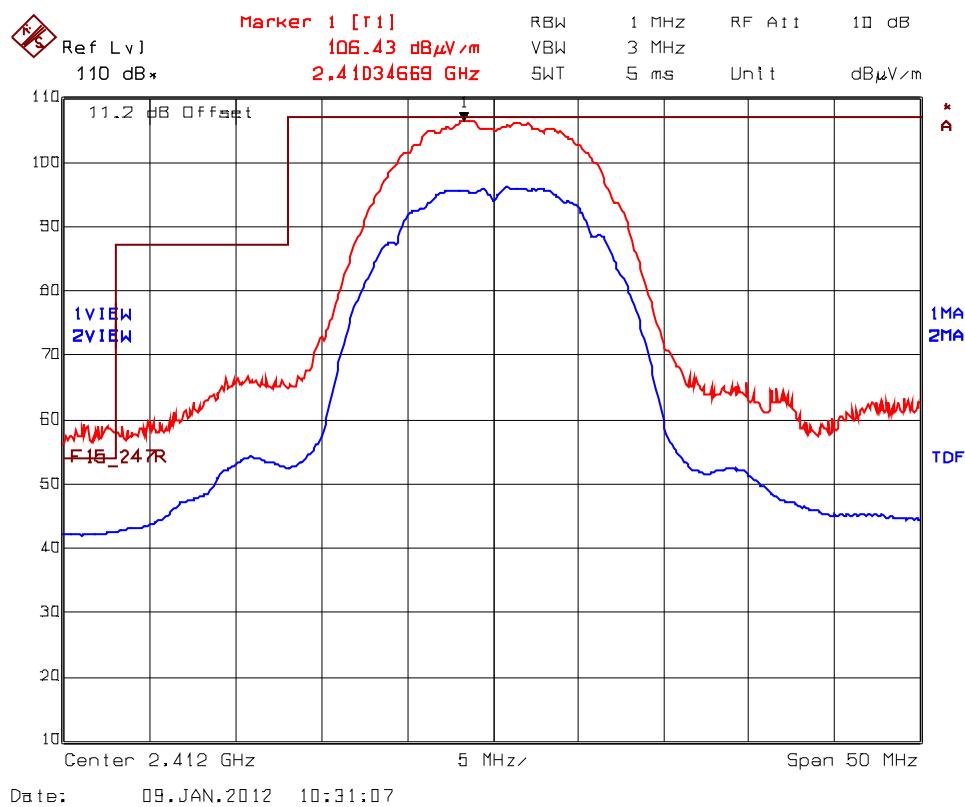
Plot 6.9.5.1.1 Band-Edge RF Radiated Emissions @ 3 m
Low End of Frequency Band; Test Frequency: 2412 MHz
Rx Antenna Orientation: Horizontal

Trace 1: RBW= 1 MHz, VBW= 3 MHz; Trace 2: RBW= 1 MHz, VBW= 10 Hz



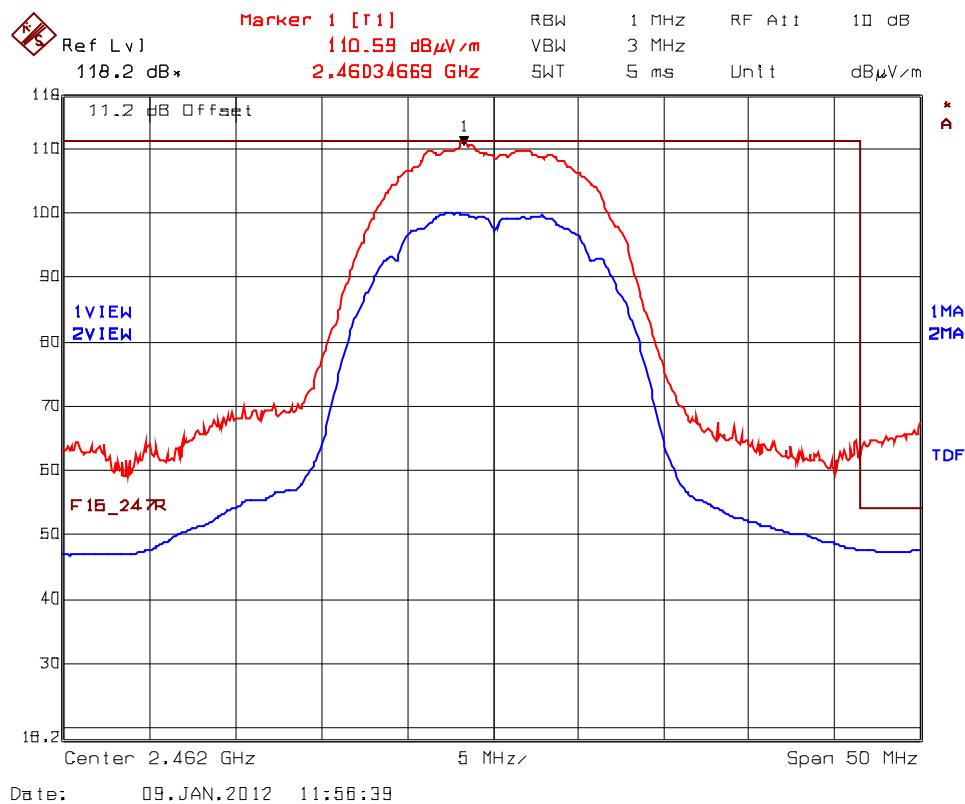
Plot 6.9.5.1.2 Band-Edge RF Radiated Emissions @ 3 m
Low End of Frequency Band; Test Frequency: 2412 MHz
Rx Antenna Orientation: Vertical

Trace 1: RBW= 1 MHz, VBW= 3 MHz; Trace 2: RBW= 1 MHz, VBW= 10 Hz



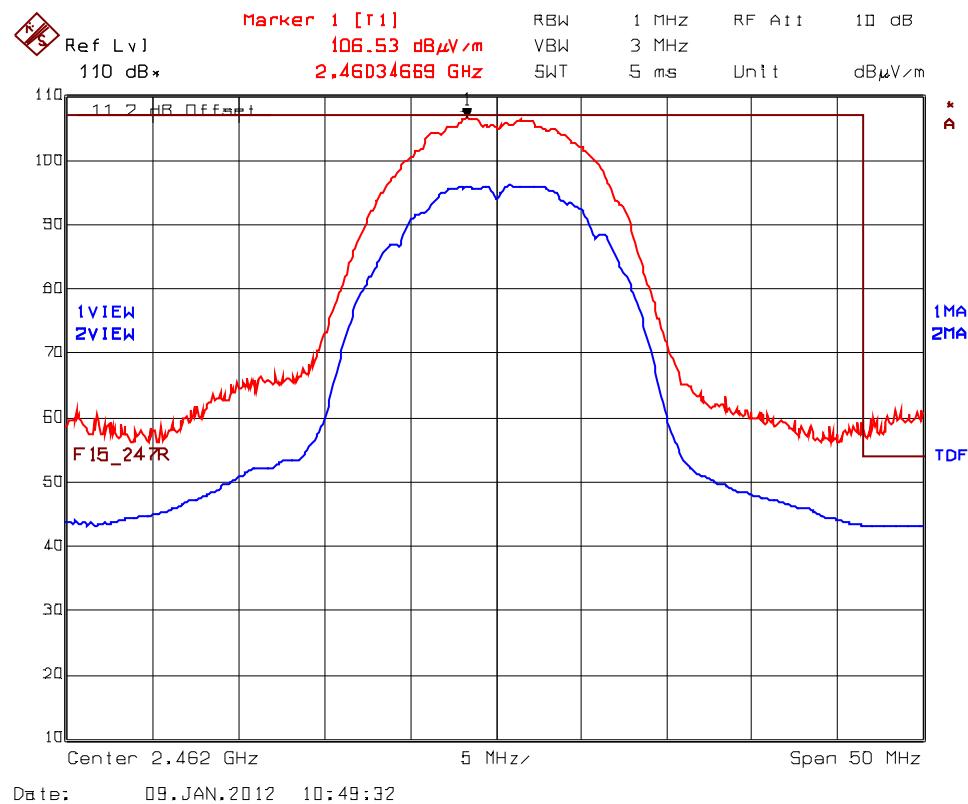
Plot 6.9.5.1.3 Band-Edge RF Radiated Emissions @ 3 m
High End of Frequency Band; Test Frequency: 2462 MHz
Rx Antenna Orientation: Horizontal

Trace 1: RBW= 1 MHz, VBW= 3 MHz; Trace 2: RBW= 1 MHz, VBW= 10 Hz



Plot 6.9.5.1.4 Band-Edge RF Radiated Emissions @ 3 m
High End of Frequency Band; Test Frequency: 2462 MHz
Rx Antenna Orientation: Vertical

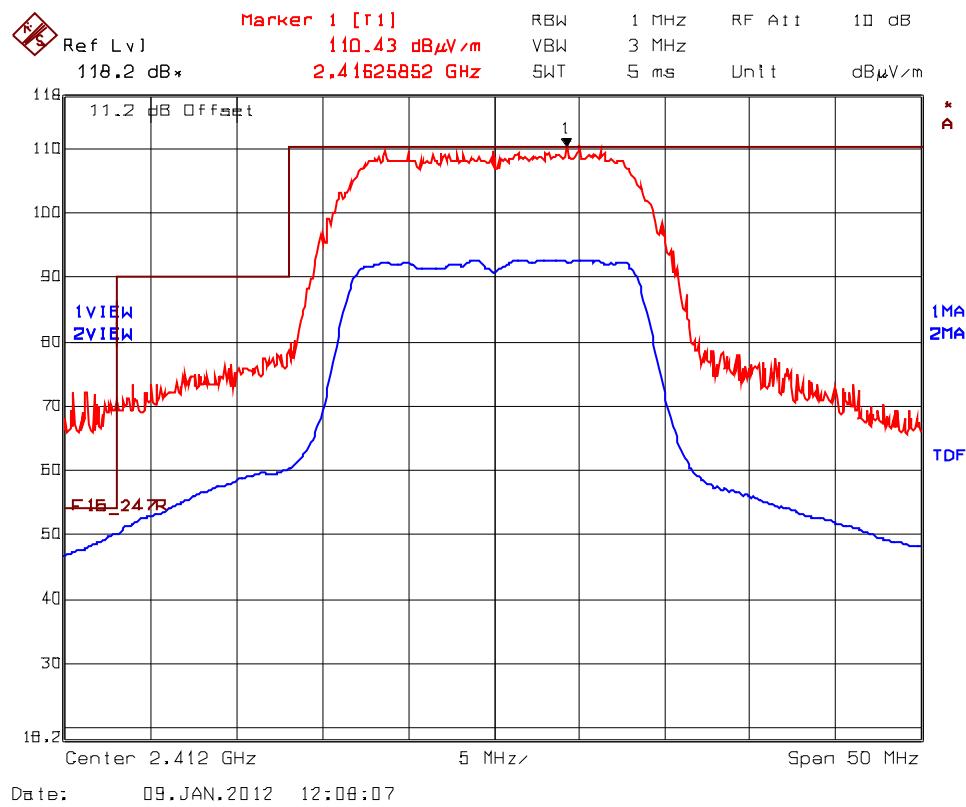
Trace 1: RBW= 1 MHz, VBW= 3 MHz; Trace 2: RBW= 1 MHz, VBW= 10 Hz



802.11g mode, 36 Mbps data rate, 16QAM:

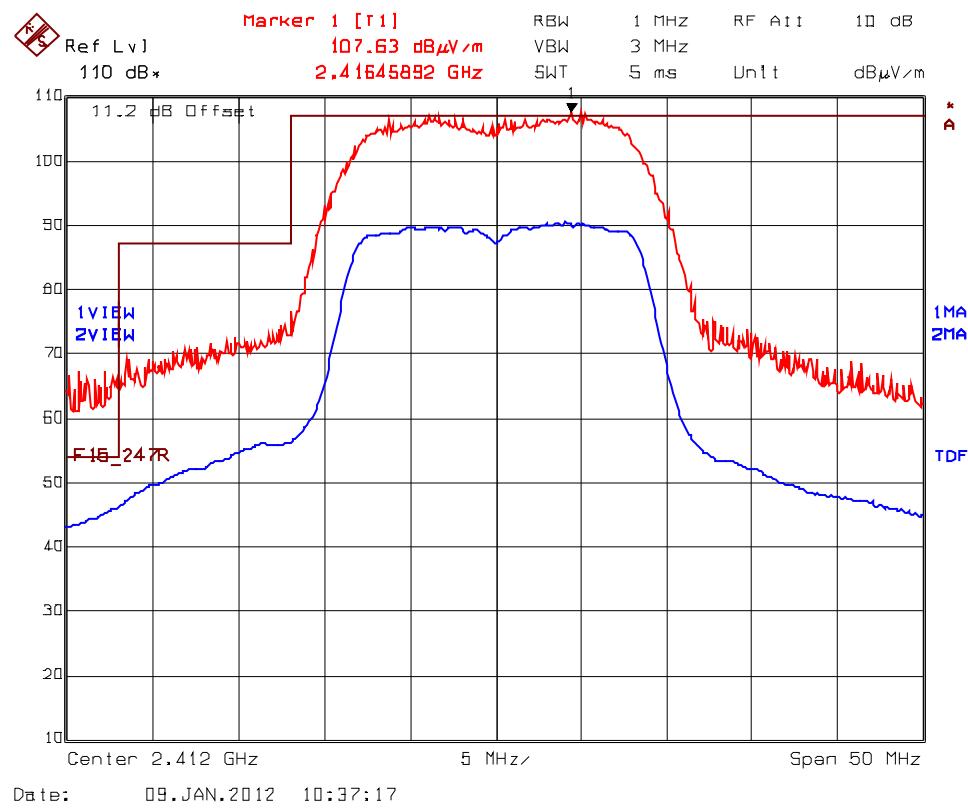
Plot 6.9.5.1.5 Band-Edge RF Radiated Emissions @ 3 m
Low End of Frequency Band; Test Frequency: 2412 MHz
Rx Antenna Orientation: Horizontal

Trace 1: RBW= 1 MHz, VBW= 3 MHz; Trace 2: RBW= 1 MHz, VBW= 10 Hz



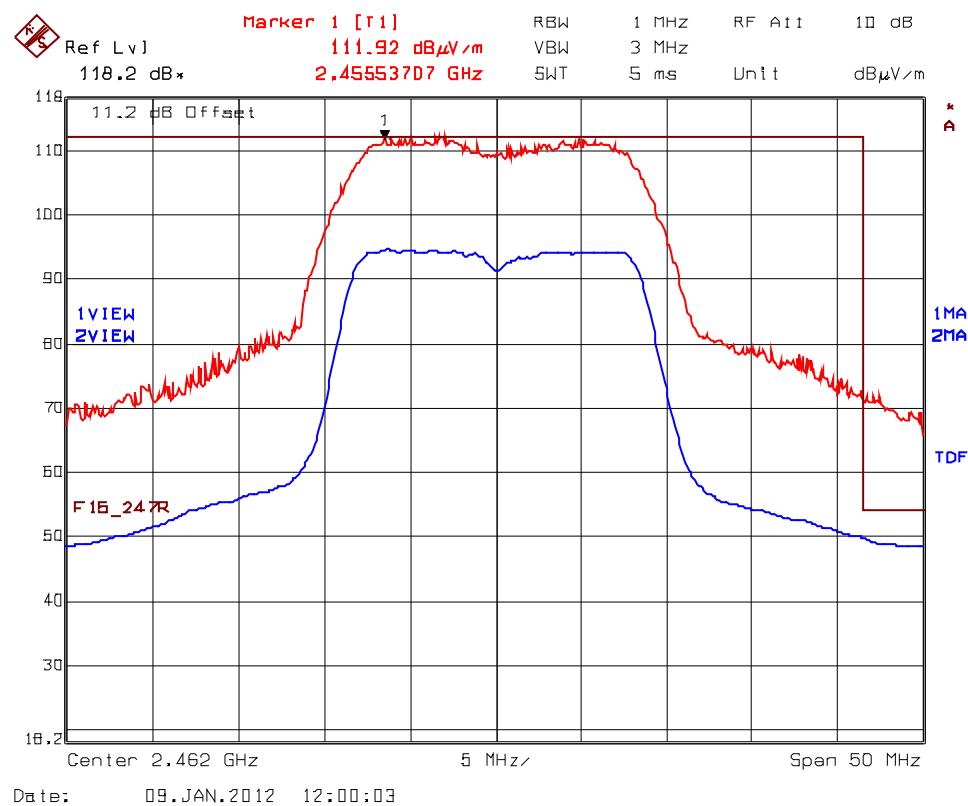
Plot 6.9.5.1.6 Band-Edge RF Radiated Emissions @ 3 m
Low End of Frequency Band; Test Frequency: 2412 MHz
Rx Antenna Orientation: Vertical

Trace 1: RBW= 1 MHz, VBW= 3 MHz; Trace 2: RBW= 1 MHz, VBW= 10 Hz



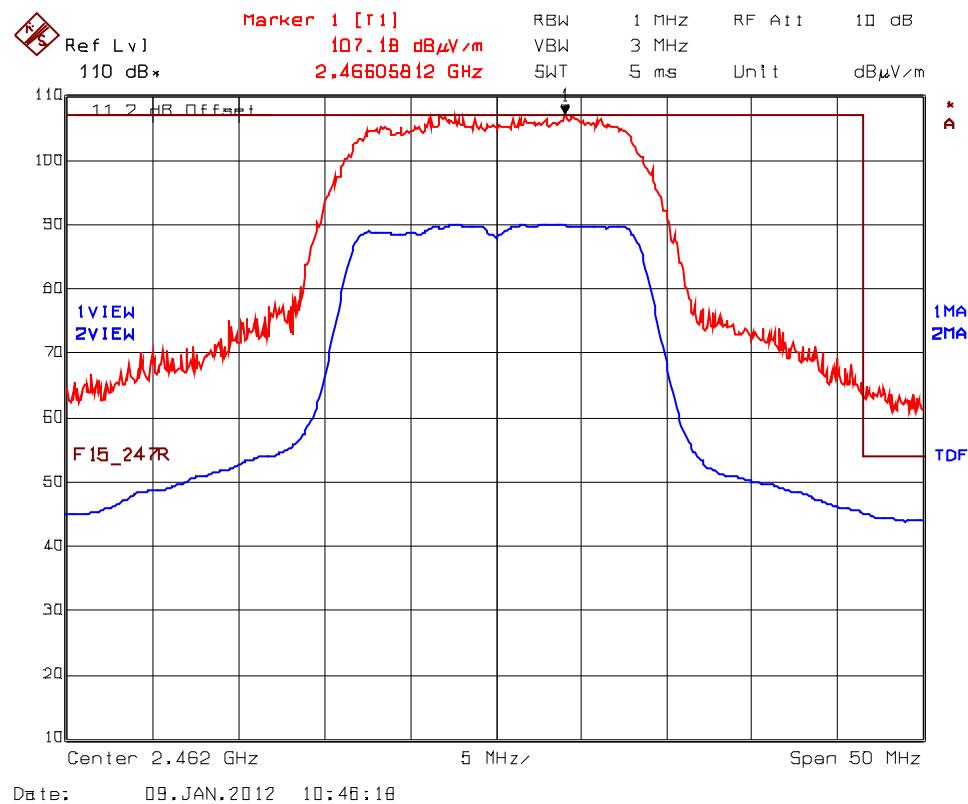
Plot 6.9.5.1.7 Band-Edge RF Radiated Emissions @ 3 m
High End of Frequency Band; Test Frequency: 2462 MHz
Rx Antenna Orientation: Horizontal

Trace 1: RBW= 1 MHz, VBW= 3 MHz; Trace 2: RBW= 1 MHz, VBW= 10 Hz



Plot 6.9.5.1.8 Band-Edge RF Radiated Emissions @ 3 m
High End of Frequency Band; Test Frequency: 2462 MHz
Rx Antenna Orientation: Vertical

Trace 1: RBW= 1 MHz, VBW= 3 MHz; Trace 2: RBW= 1 MHz, VBW= 10 Hz



5.10. POWER SPECTRAL DENSITY [§ 15.247(e)]

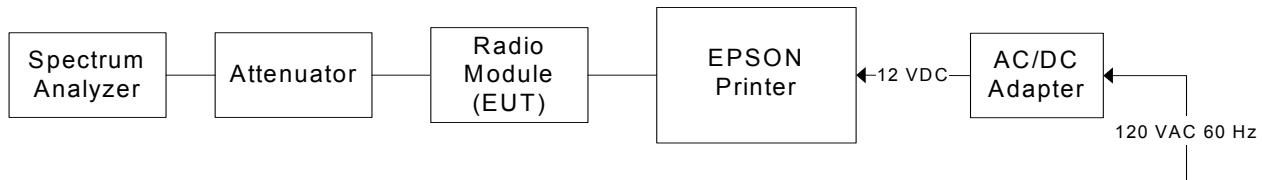
5.10.1. Limit(s)

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

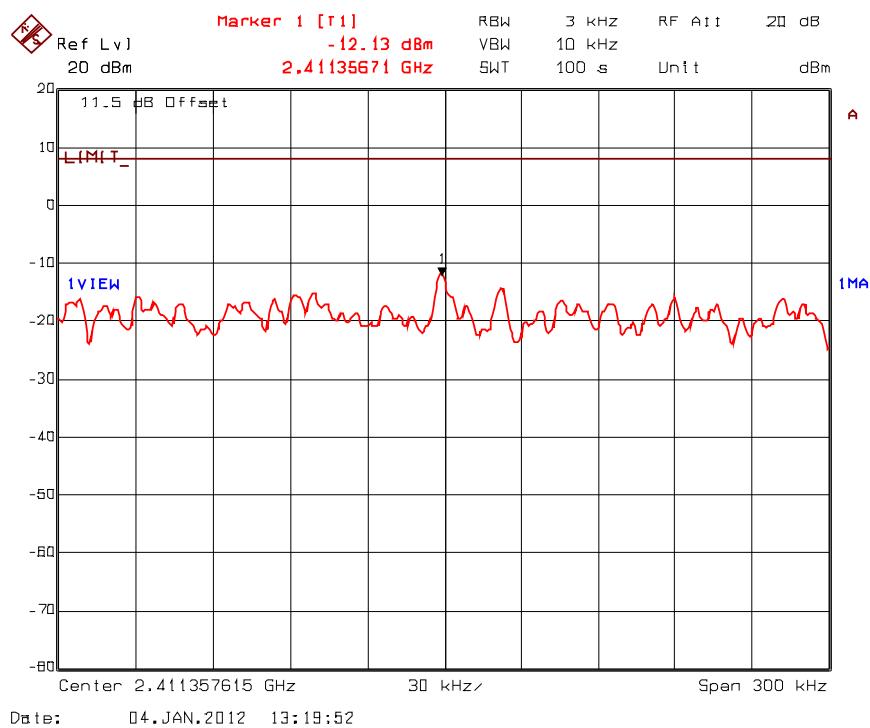
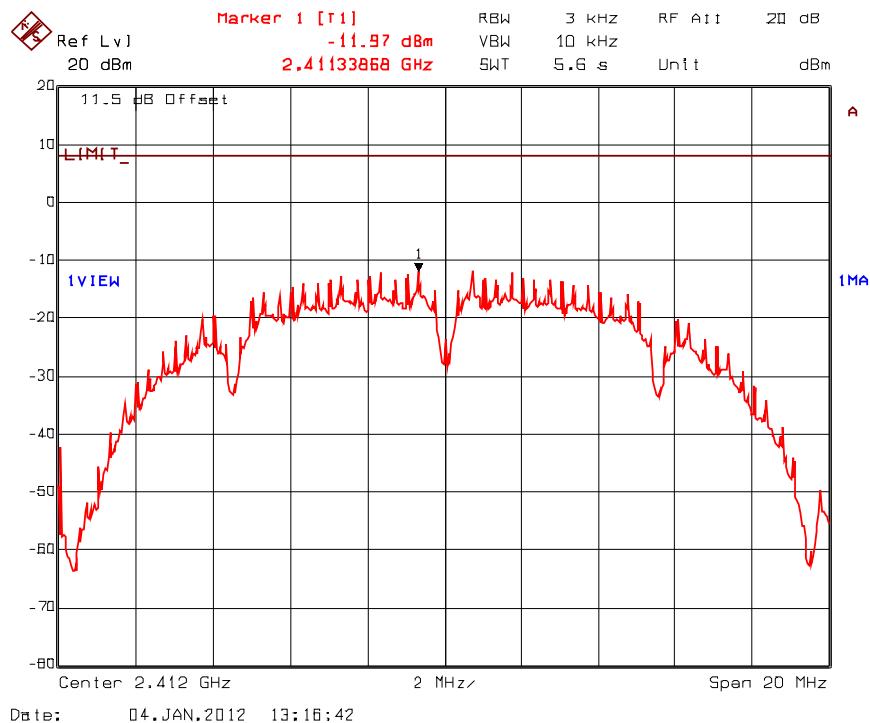
- Measurement method: Power spectral density (PSD) Option 1.

Data Rate (Mbps)	Modulation	Channel 1 2412 MHz (dBm)	Channel 7 2437 MHz (dBm)	Channel 11 2462 MHz (dBm)
802.11b				
1	DBPSK	-12.13	-12.87	-12.84
2	DQPSK	-13.62	-14.69	-14.98
11	CCK	-13.54	-13.96	-14.09
802.11g				
9	BPSK	-14.27	-15.97	-14.96
18	QPSK	-12.97	-13.28	-13.78
36	16-QAM	-11.04	-11.68	-11.68
54	64-QAM	-10.71	-11.06	-11.03

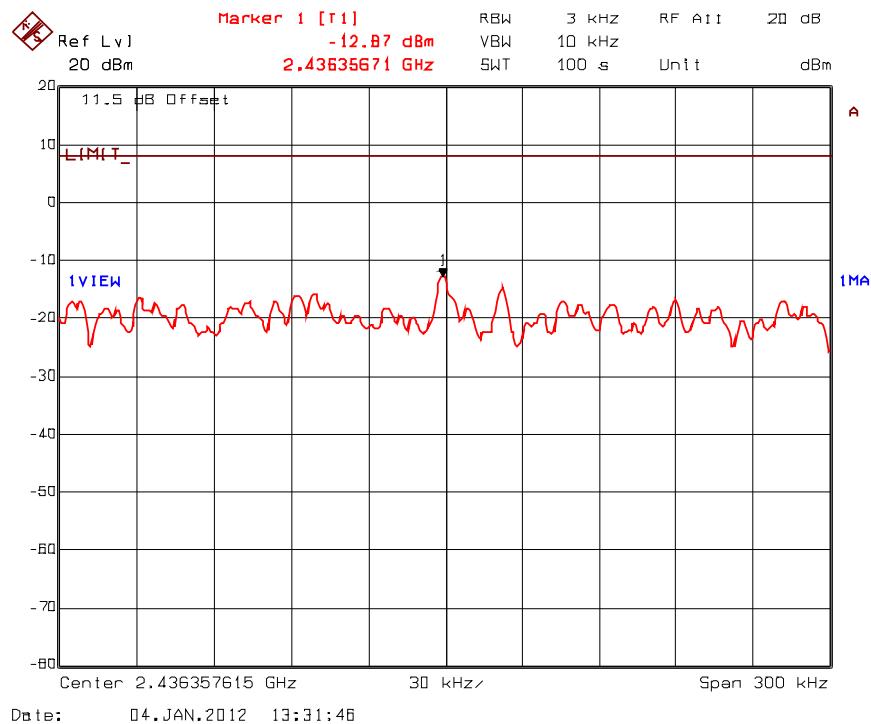
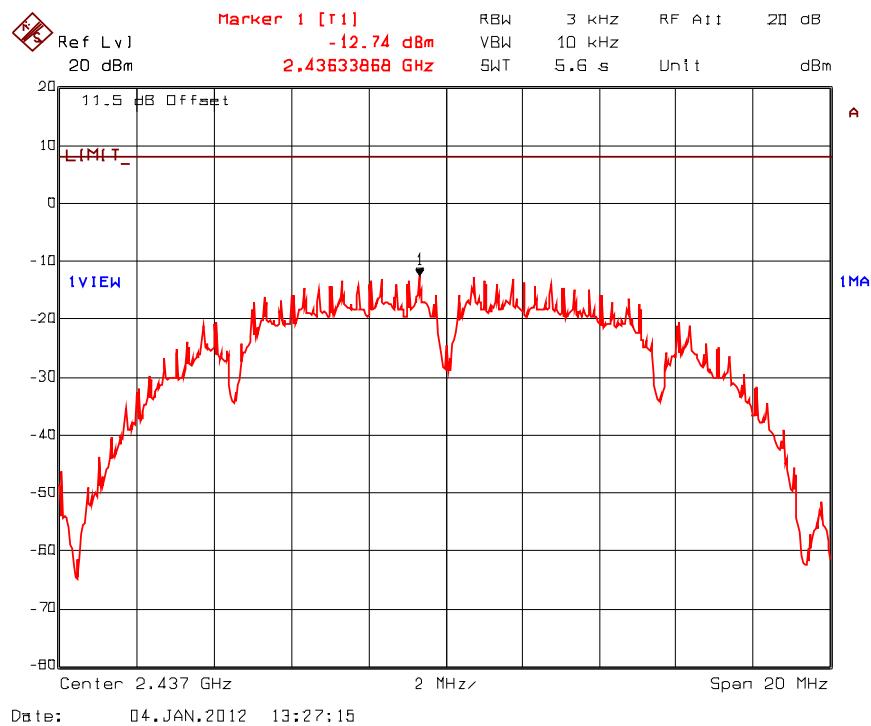
*See the following plots for measurement details.

802.11b mode:

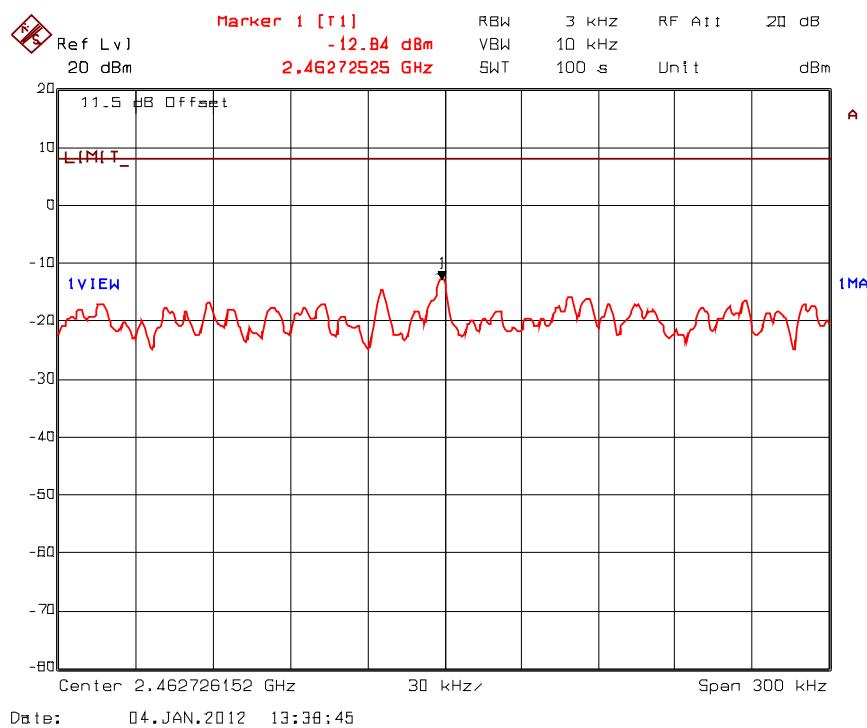
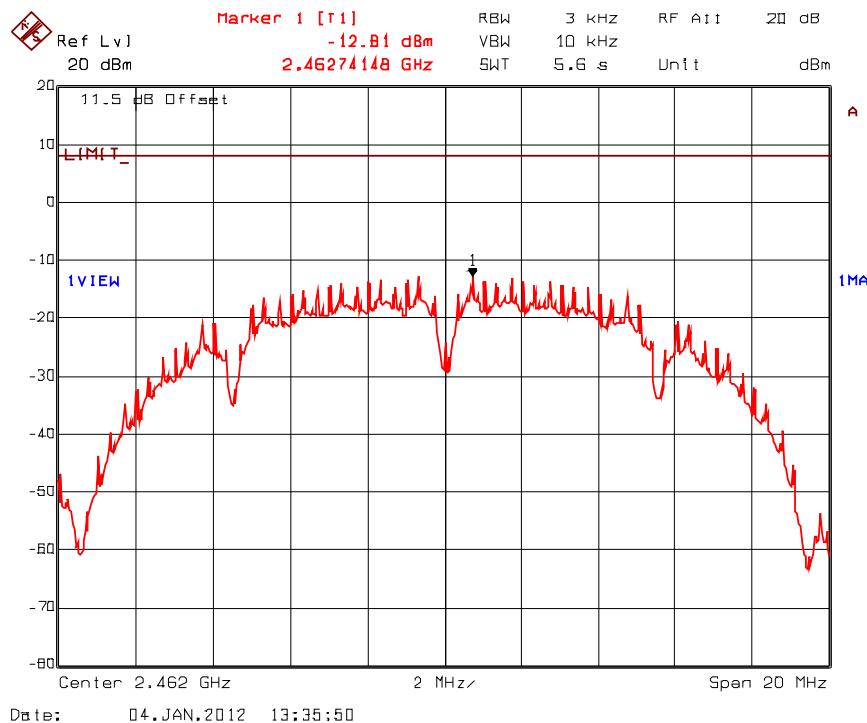
Plot 6.10.5.1 Power Spectral Density
 Frequency: 2412 MHz, Modulation: DBPSK at 1 Mbps



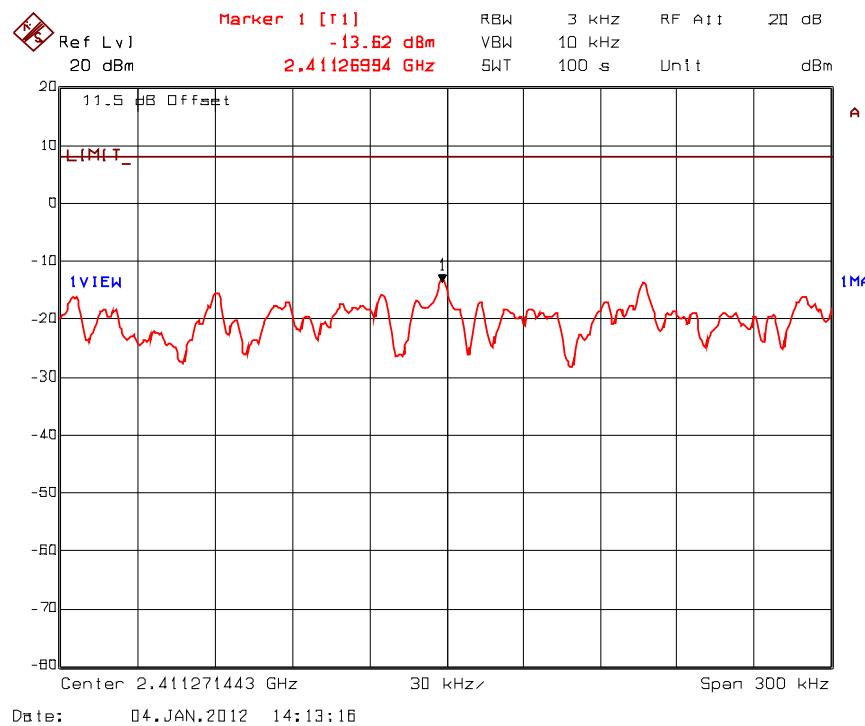
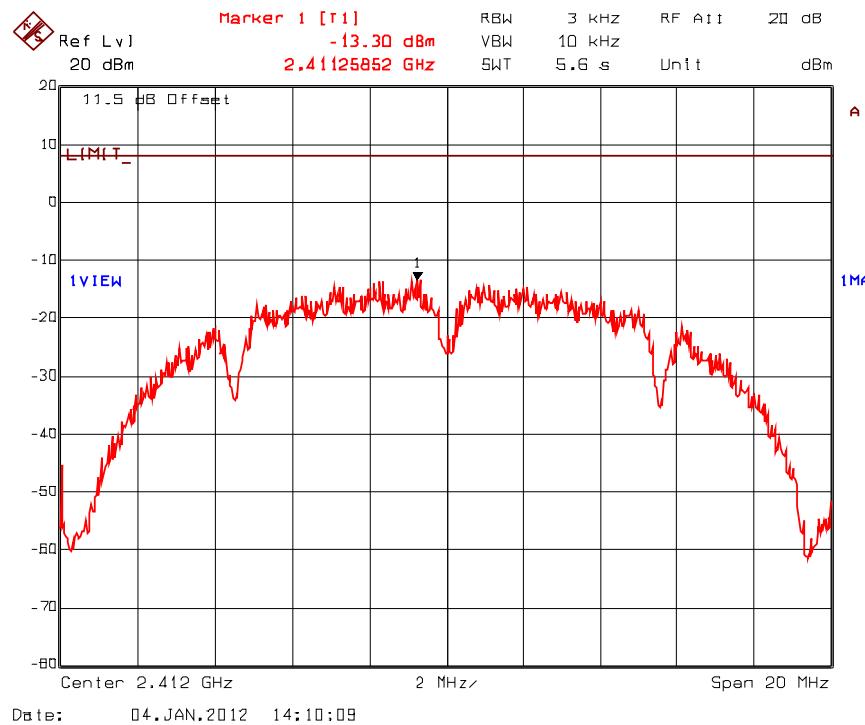
Plot 6.10.5.2 Power Spectral Density
Frequency: 2437 MHz, Modulation: DBPSK at 1 Mbps



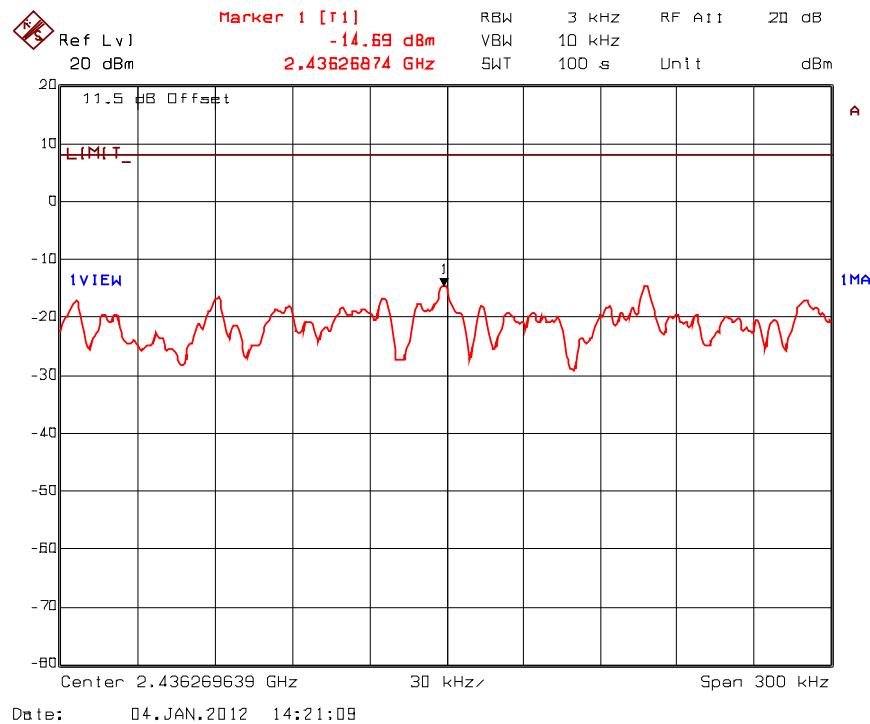
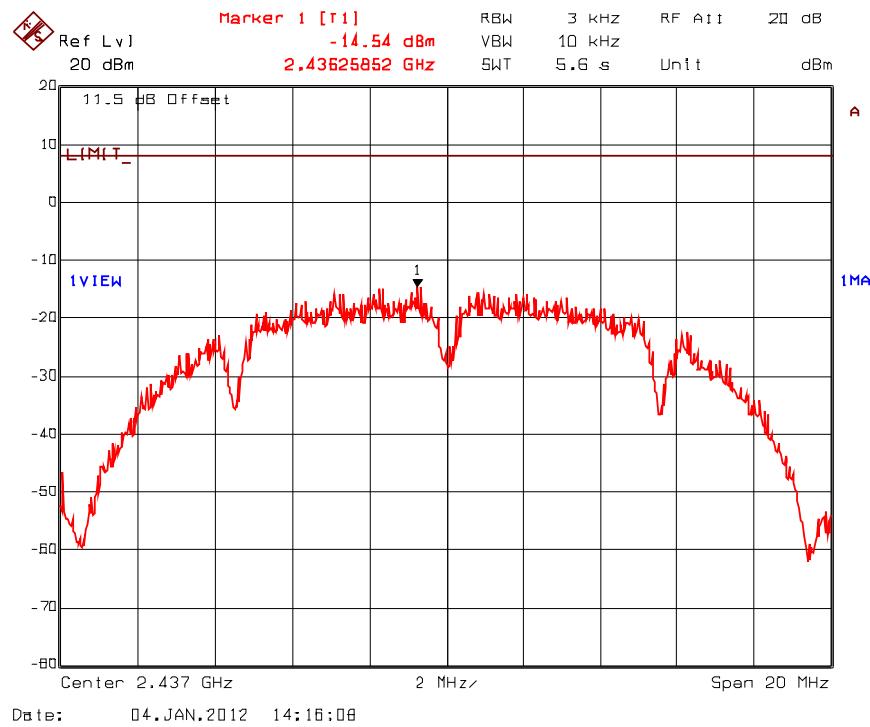
Plot 6.10.5.3 Power Spectral Density
 Frequency: 2462 MHz, Modulation: DBPSK at 1 Mbps



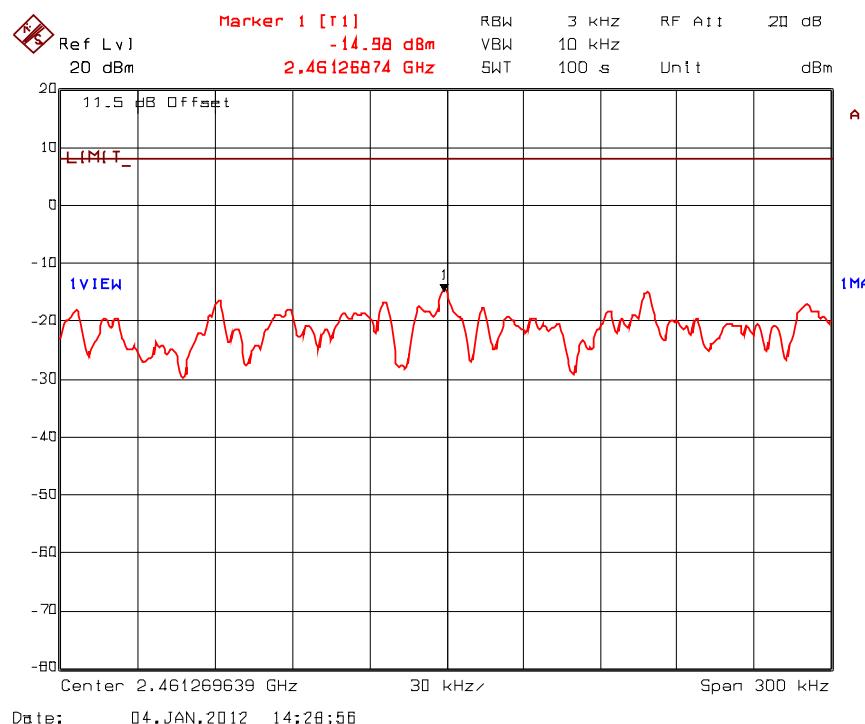
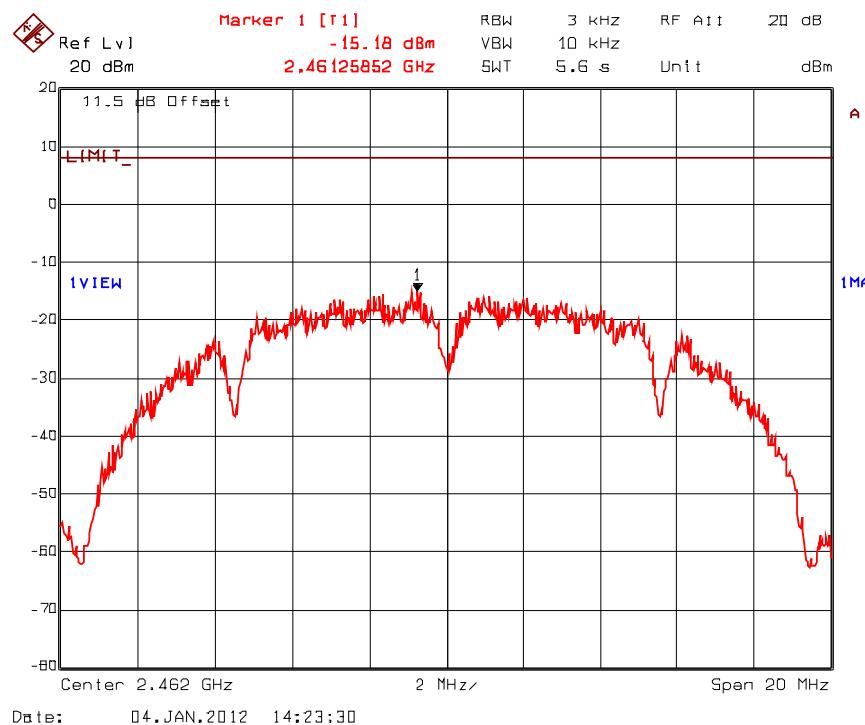
Plot 6.10.5.4 Power Spectral Density
Frequency: 2412 MHz, Modulation: DQPSK at 2 Mbps



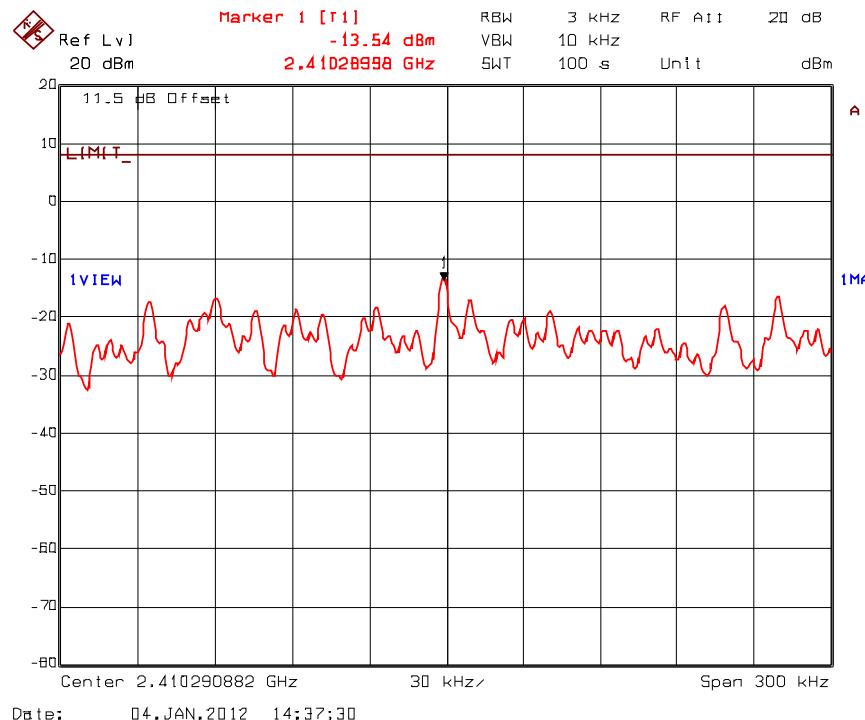
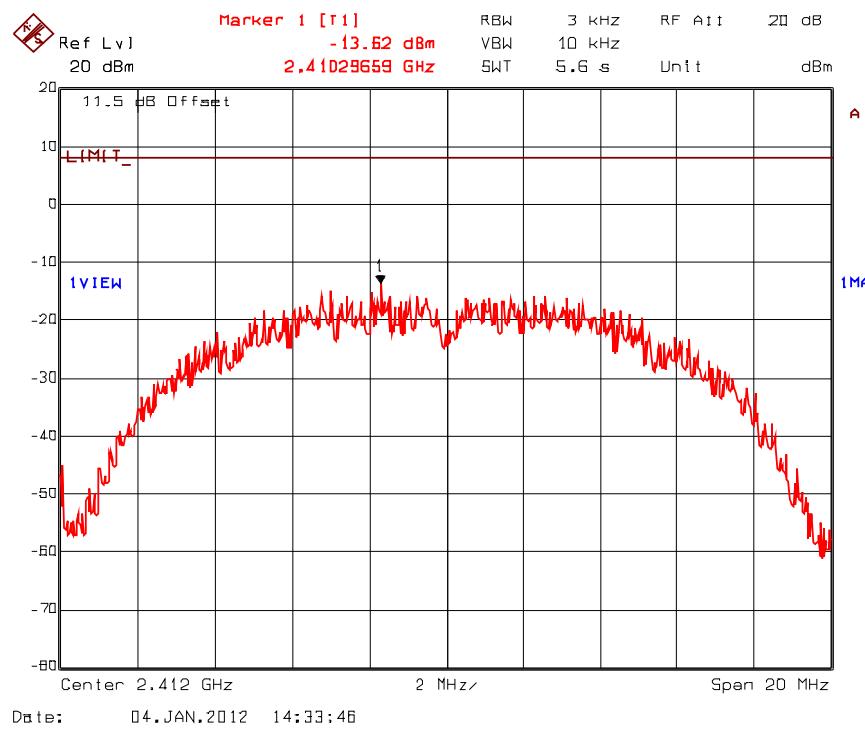
Plot 6.10.5.5 Power Spectral Density
Frequency: 2437 MHz, Modulation: DQPSK at 2 Mbps



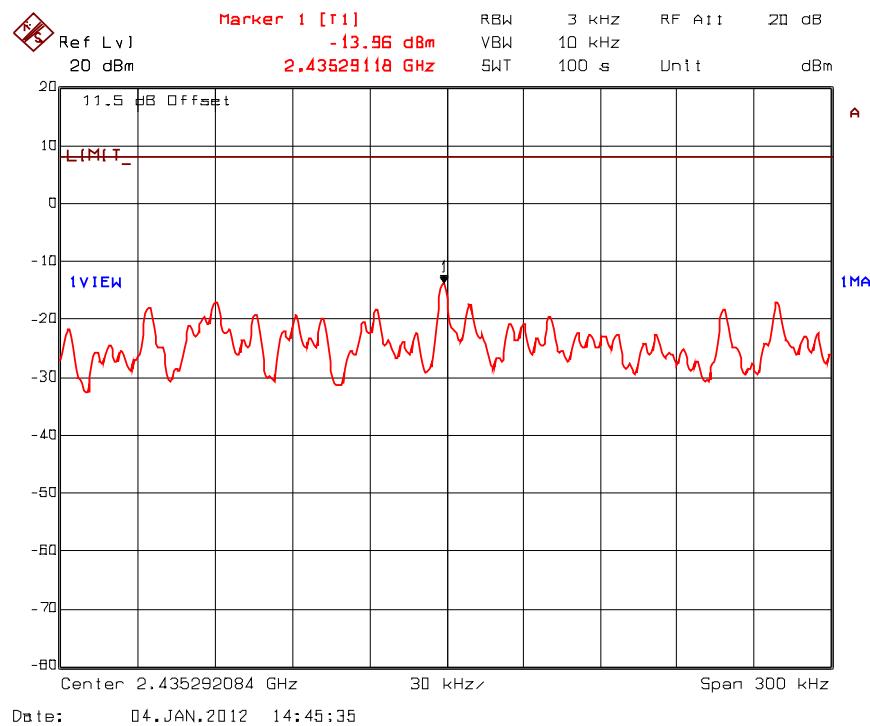
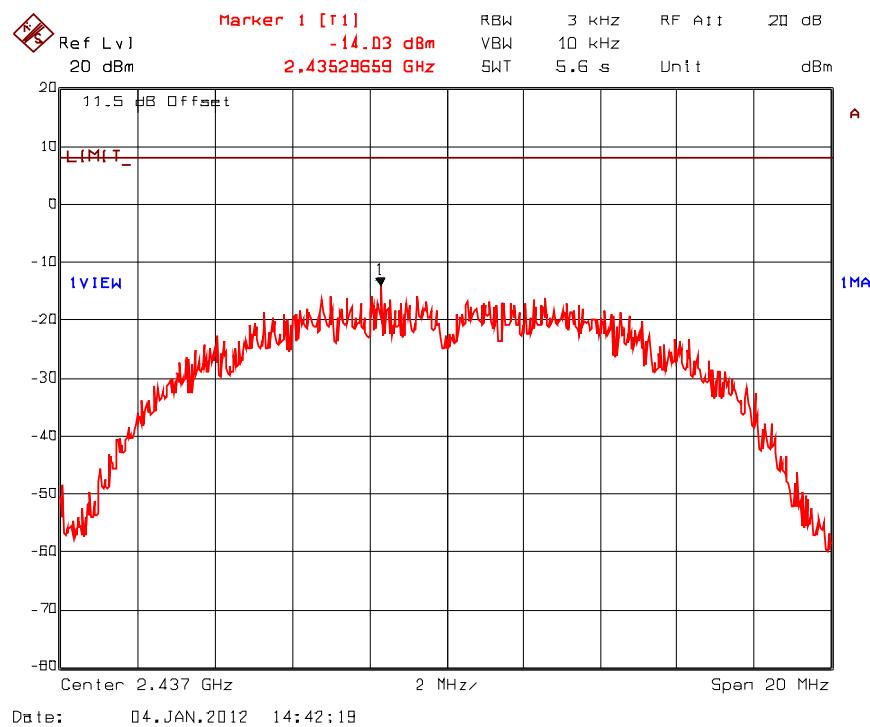
Plot 6.10.5.6 Power Spectral Density
Frequency: 2462 MHz, Modulation: DQPSK at 2 Mbps



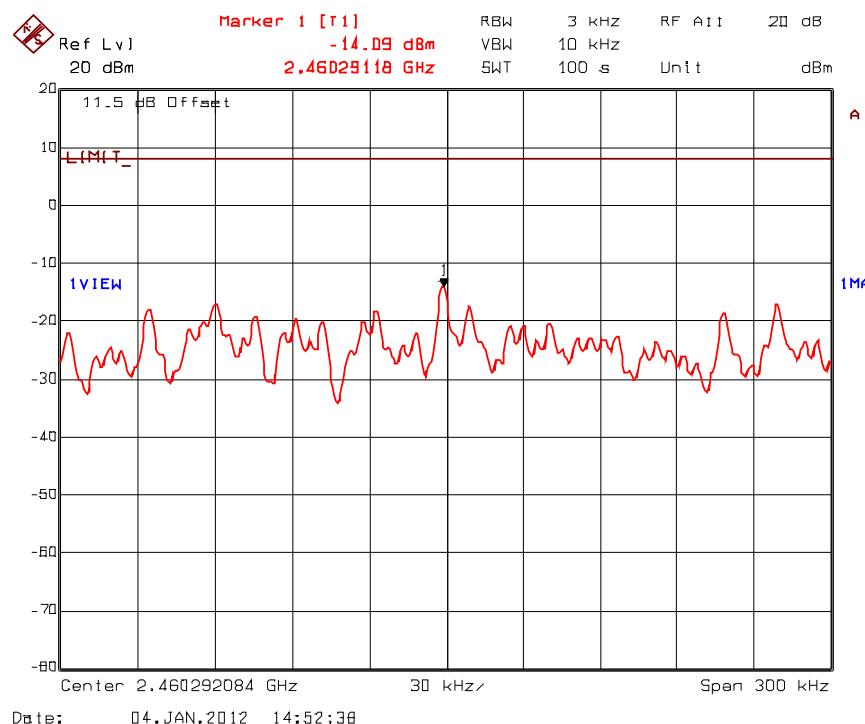
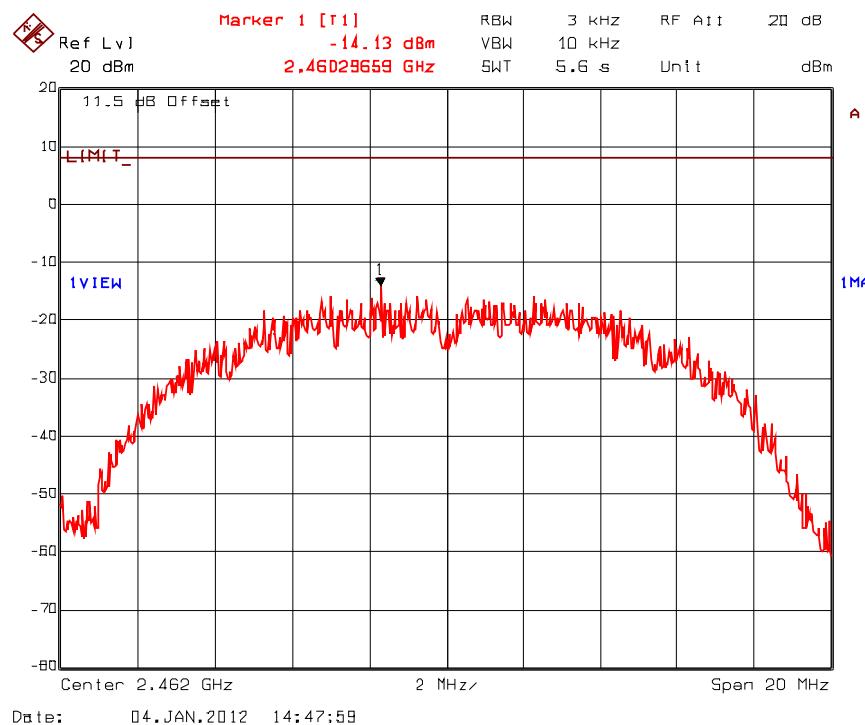
Plot 6.10.5.7 Power Spectral Density
Frequency: 2412 MHz, Modulation: CCK at 11 Mbps



Plot 6.10.5.8 Power Spectral Density
Frequency: 2437 MHz, Modulation: CCK at 11 Mbps

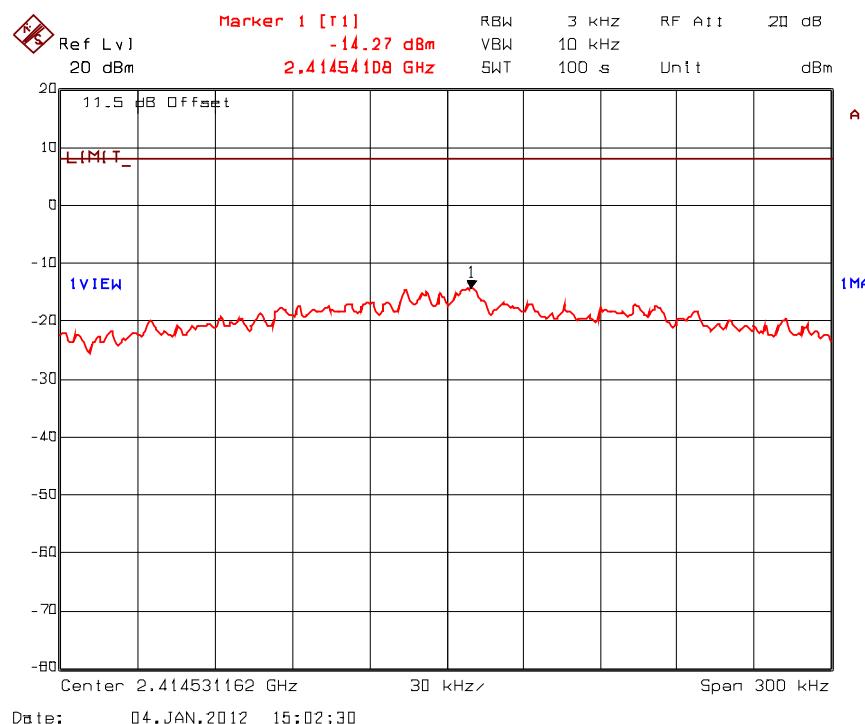
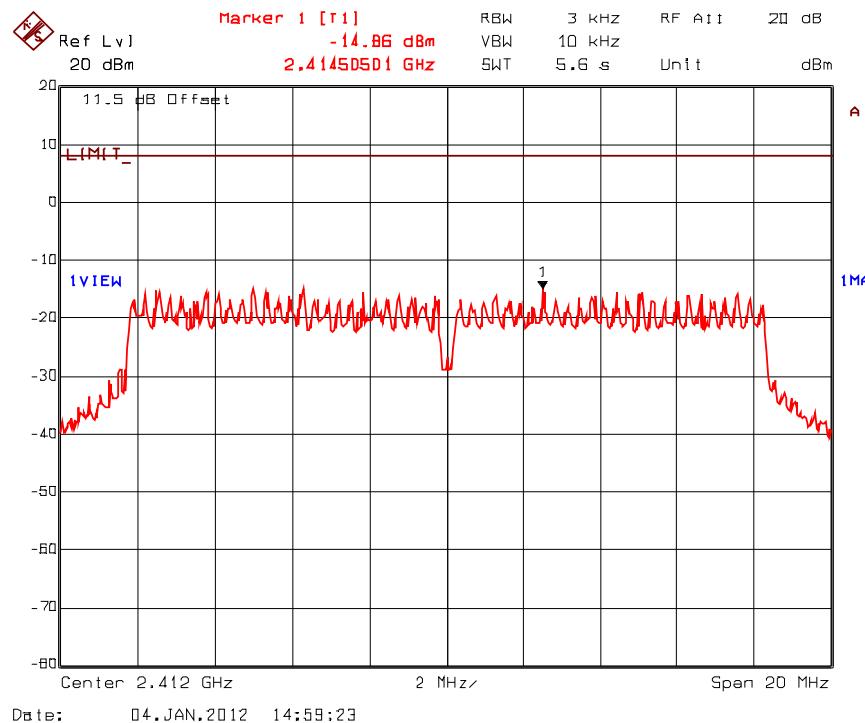


Plot 6.10.5.9 Power Spectral Density
Frequency: 2462 MHz, Modulation: CCK at 11 Mbps

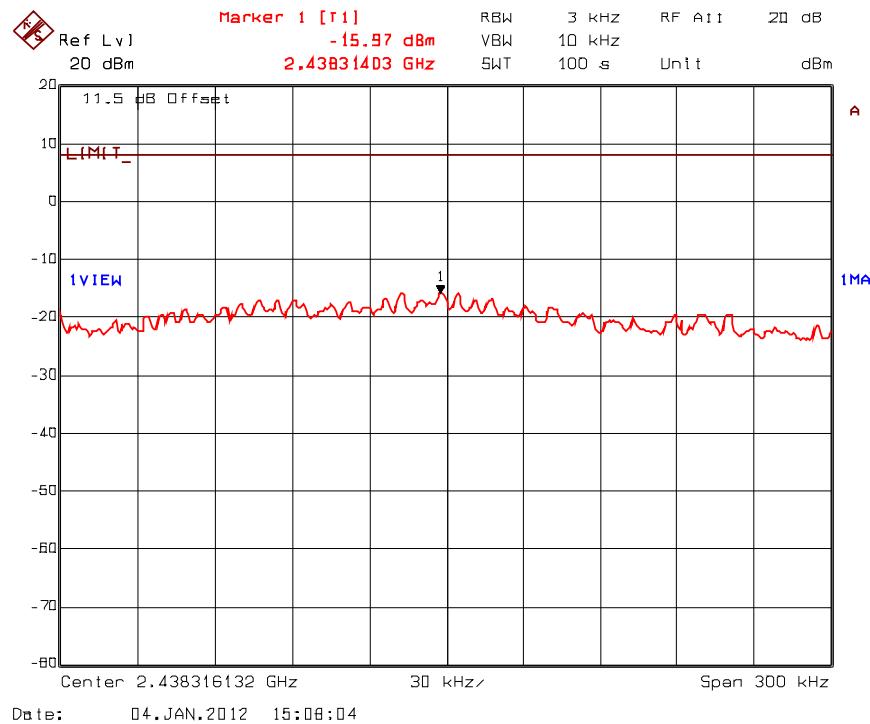
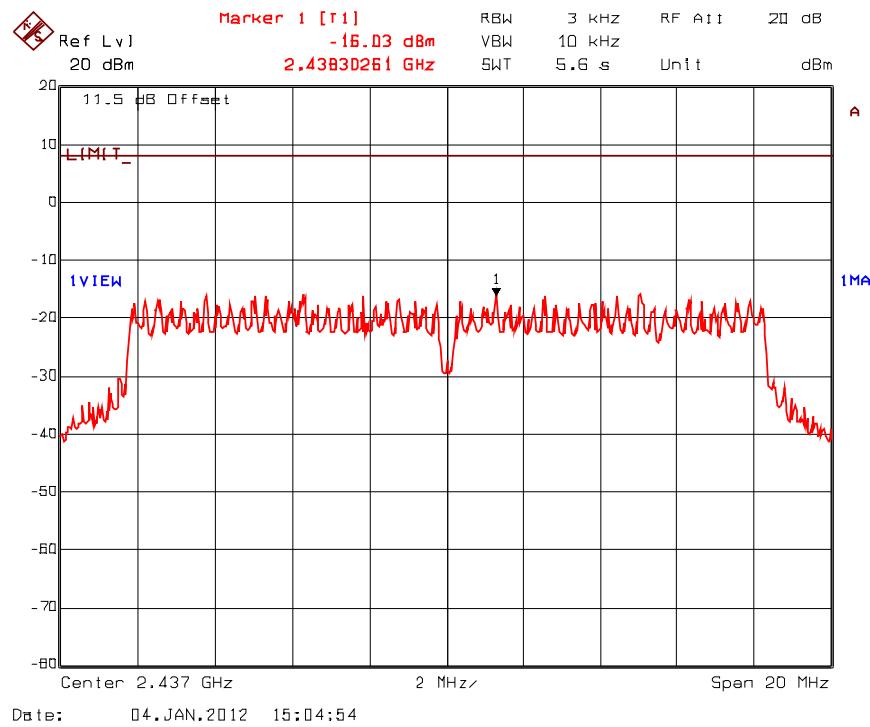


802.11g mode:

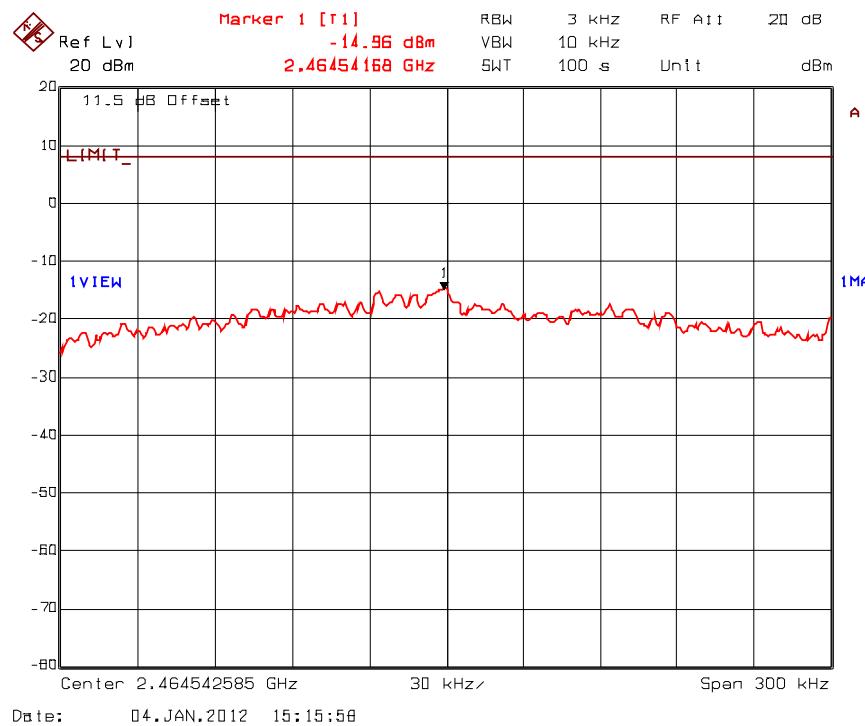
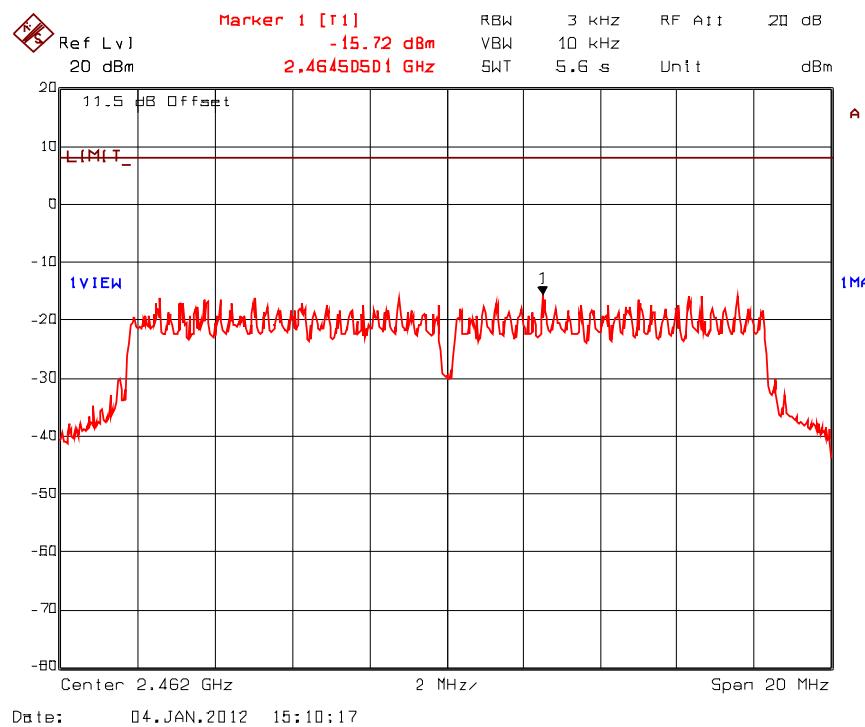
Plot 6.10.5.10 Power Spectral Density
Frequency: 2412 MHz, Modulation: BPSK at 9 Mbps



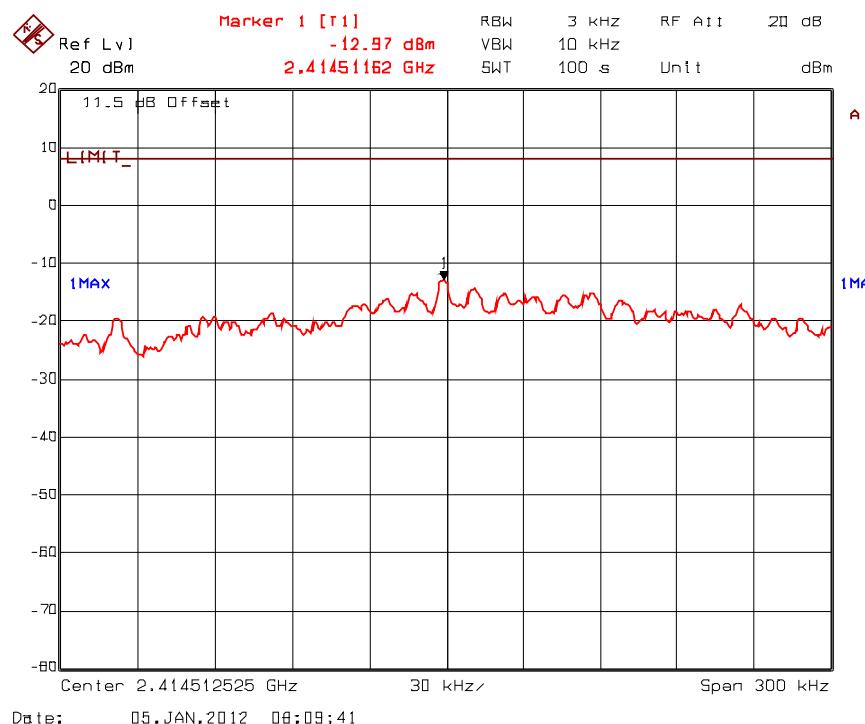
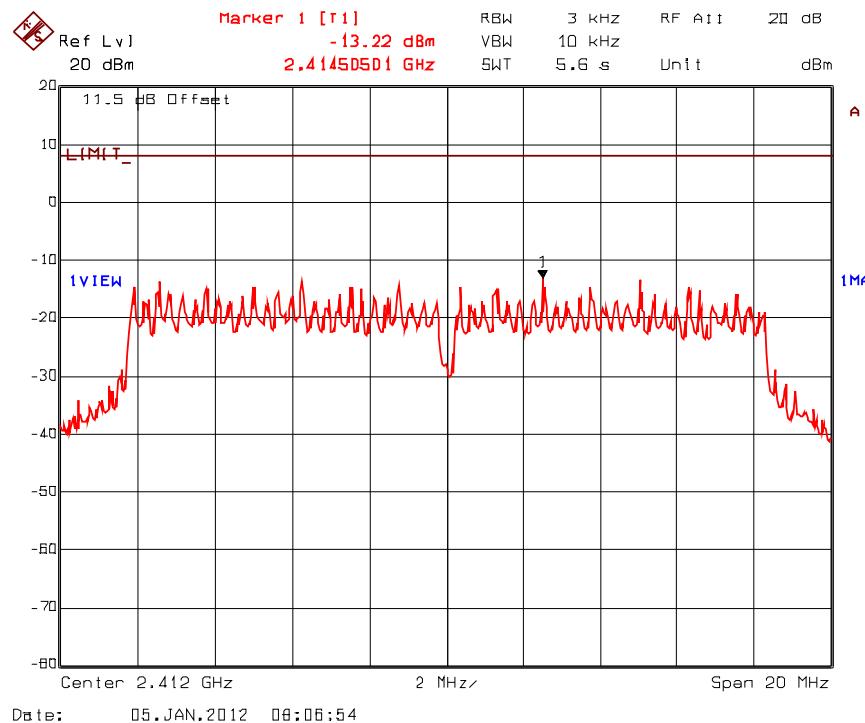
Plot 6.10.5.11 Power Spectral Density
Frequency: 2437 MHz, Modulation: BPSK at 9 Mbps



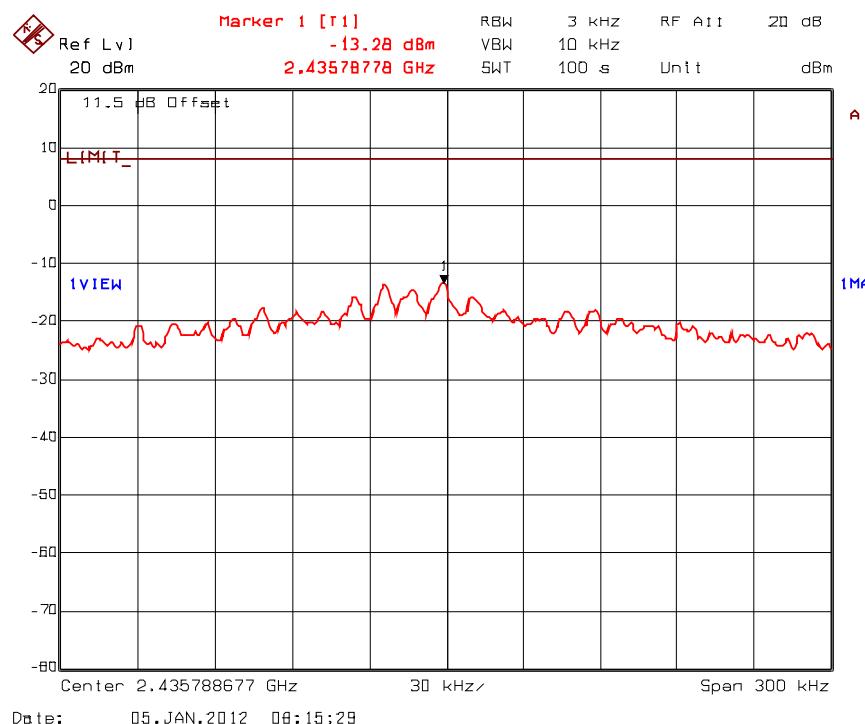
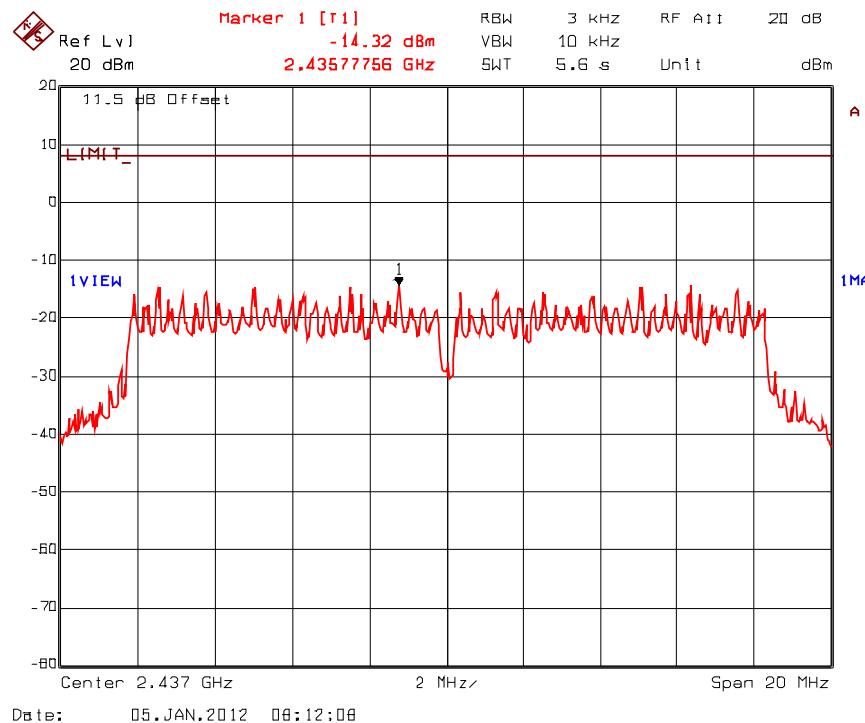
Plot 6.10.5.12 Power Spectral Density
Frequency: 2462 MHz, Modulation: BPSK at 9 Mbps



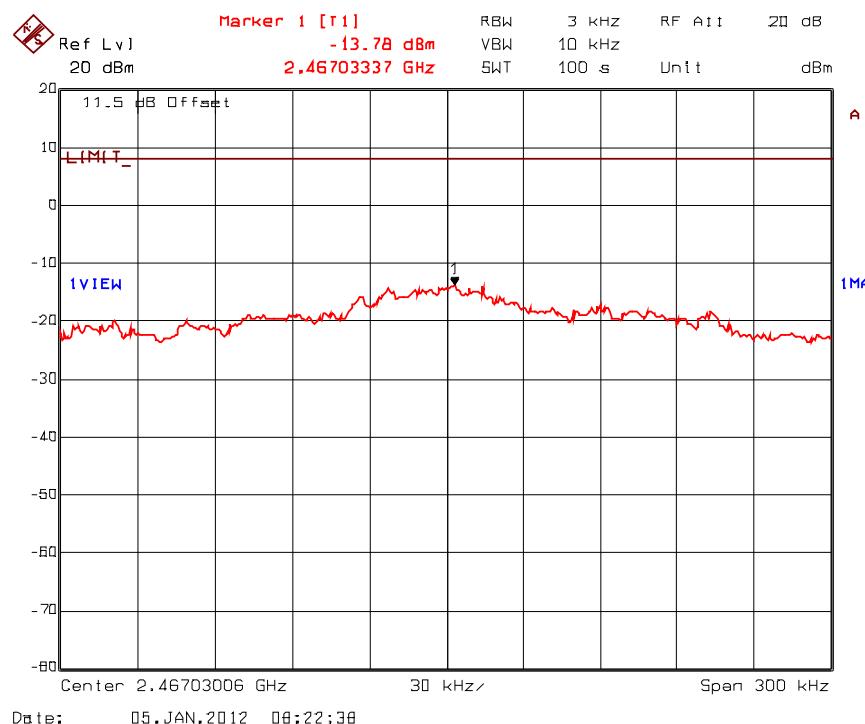
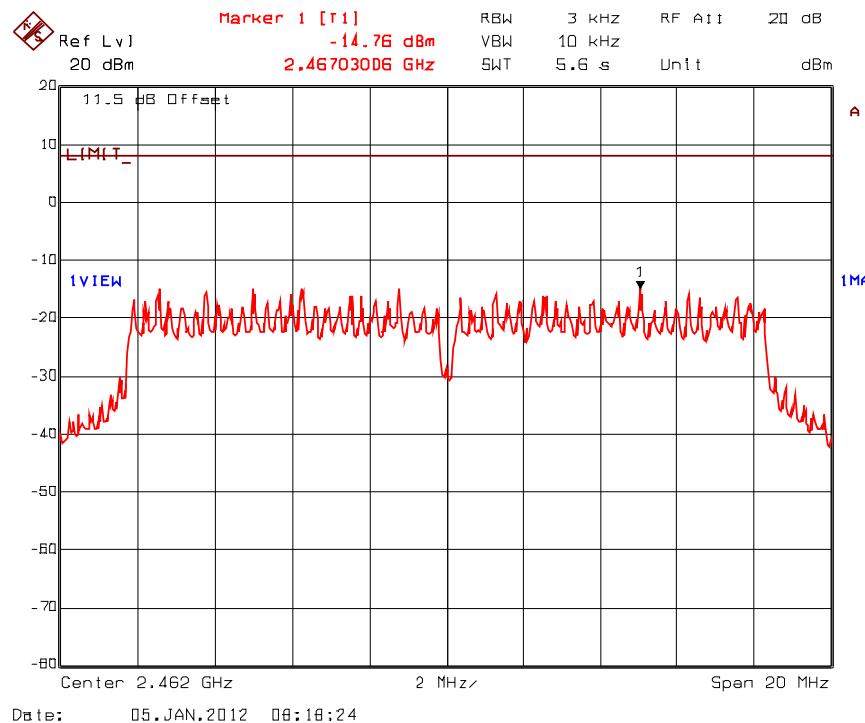
Plot 6.10.5.13 Power Spectral Density
Frequency: 2412 MHz, Modulation: QPSK at 18 Mbps



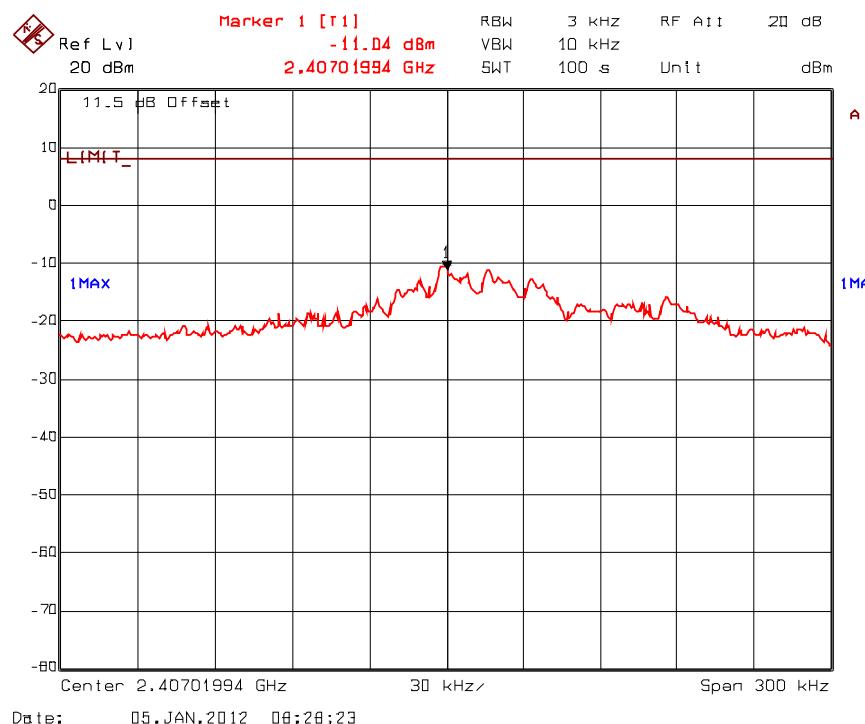
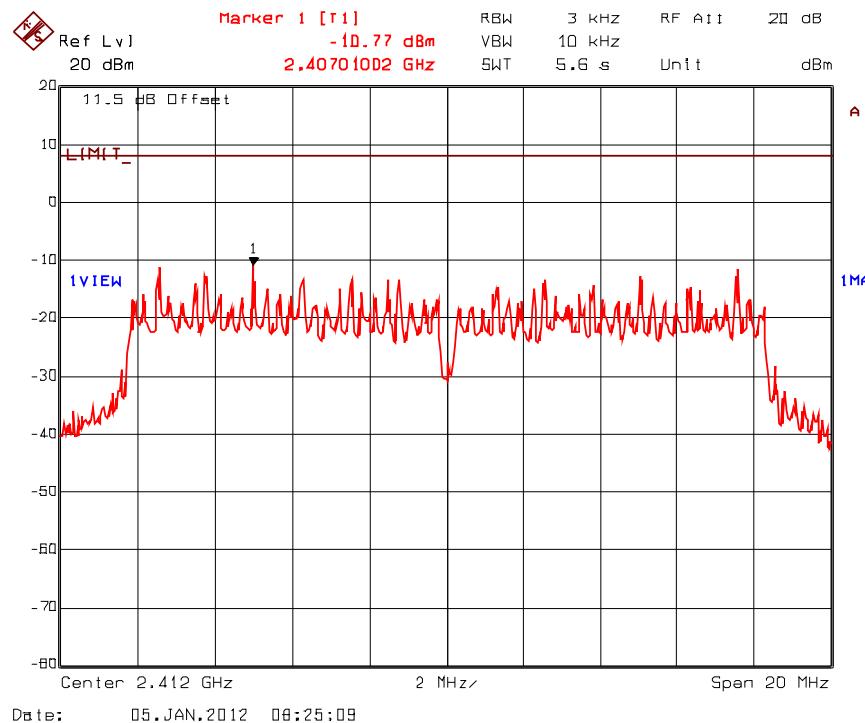
Plot 6.10.5.14 Power Spectral Density
Frequency: 2437 MHz, Modulation: QPSK at 18 Mbps



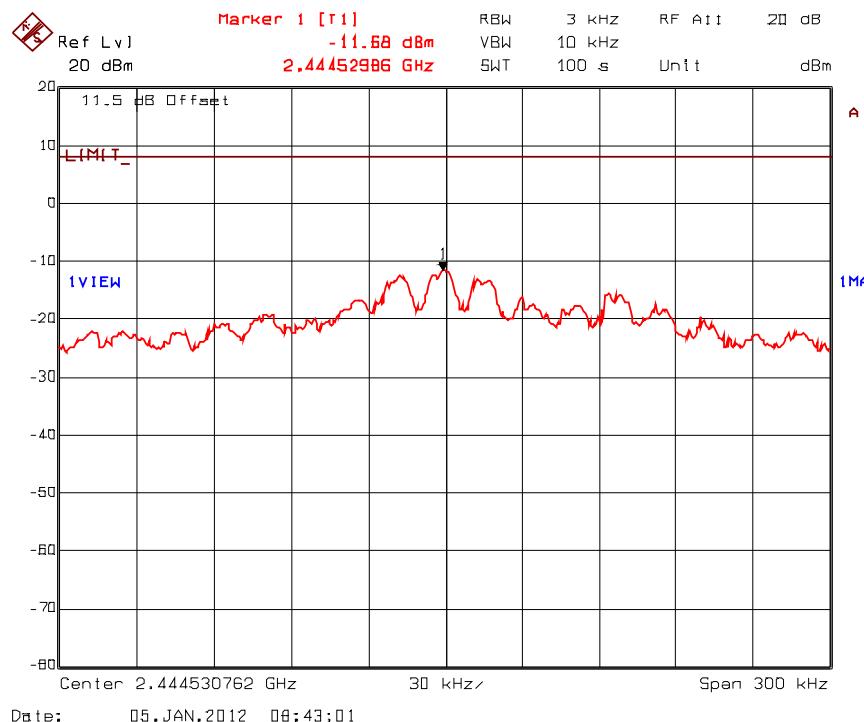
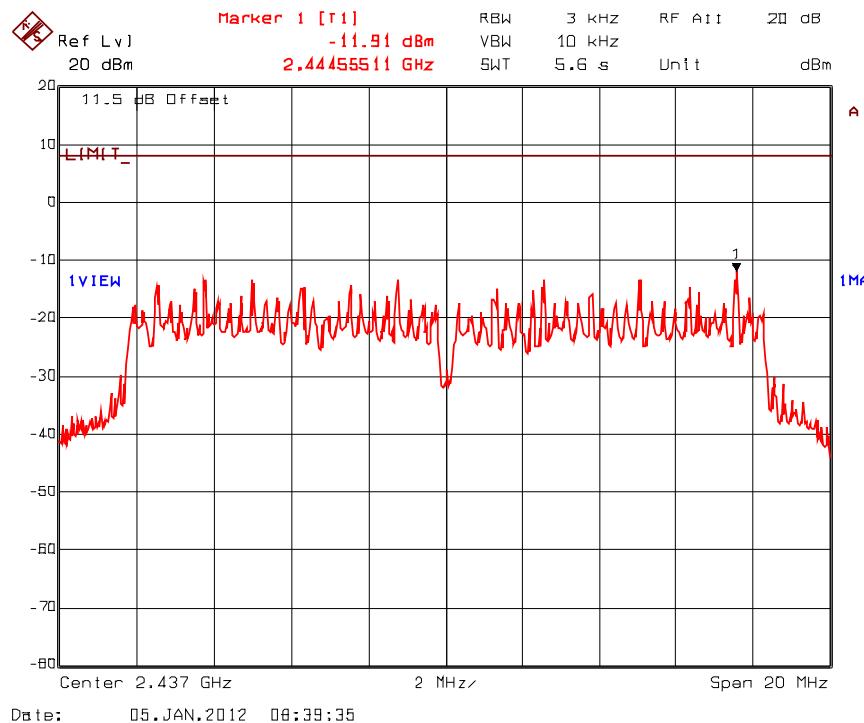
Plot 6.10.5.15 Power Spectral Density
Frequency: 2462 MHz, Modulation: QPSK at 18 Mbps



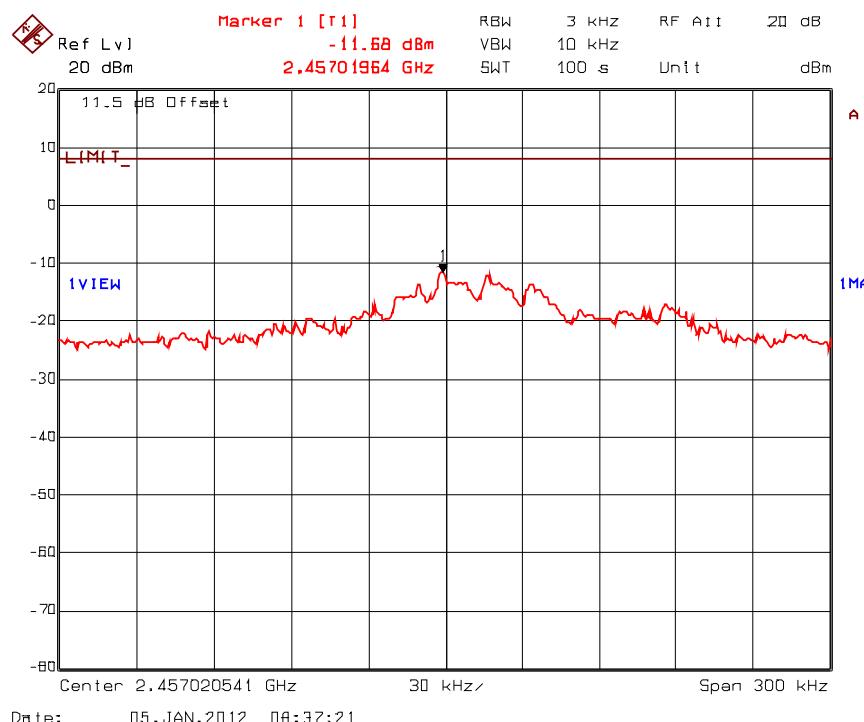
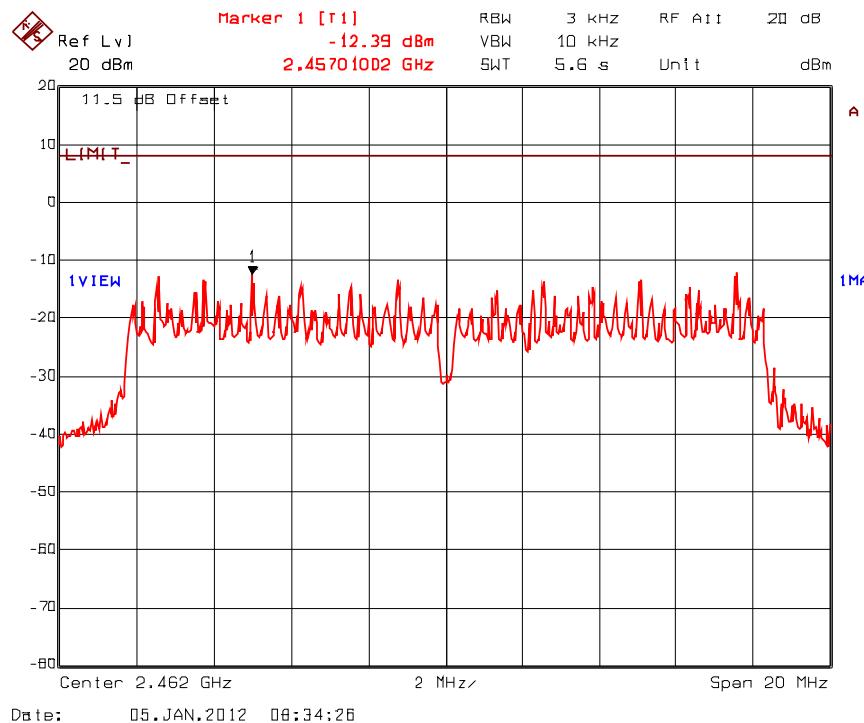
Plot 6.10.5.16 Power Spectral Density
Frequency: 2412 MHz, Modulation: 16-QAM at 36 Mbps



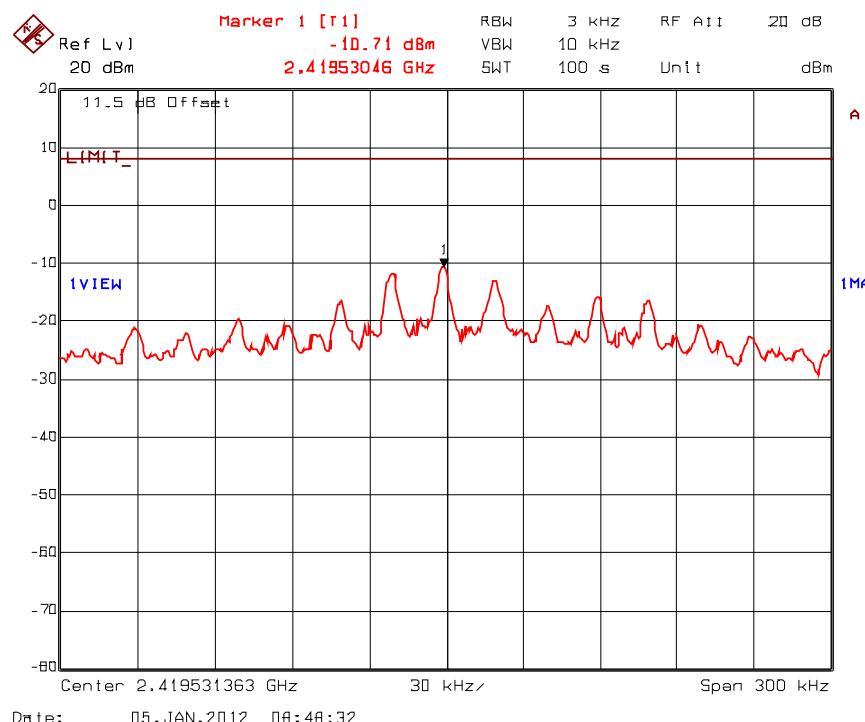
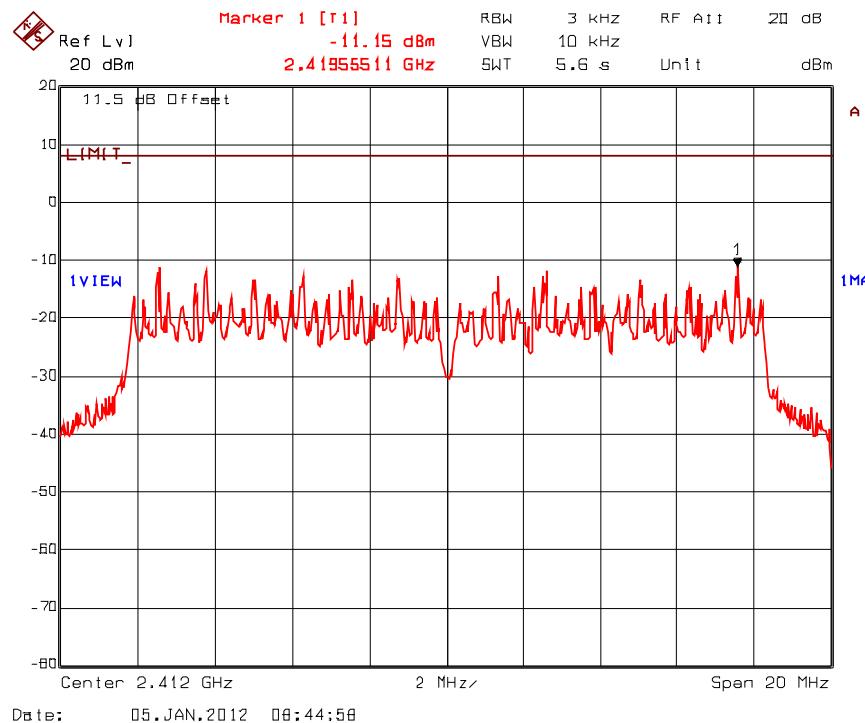
Plot 6.10.5.17 Power Spectral Density
Frequency: 2437 MHz, Modulation: 16-QAM at 36 Mbps



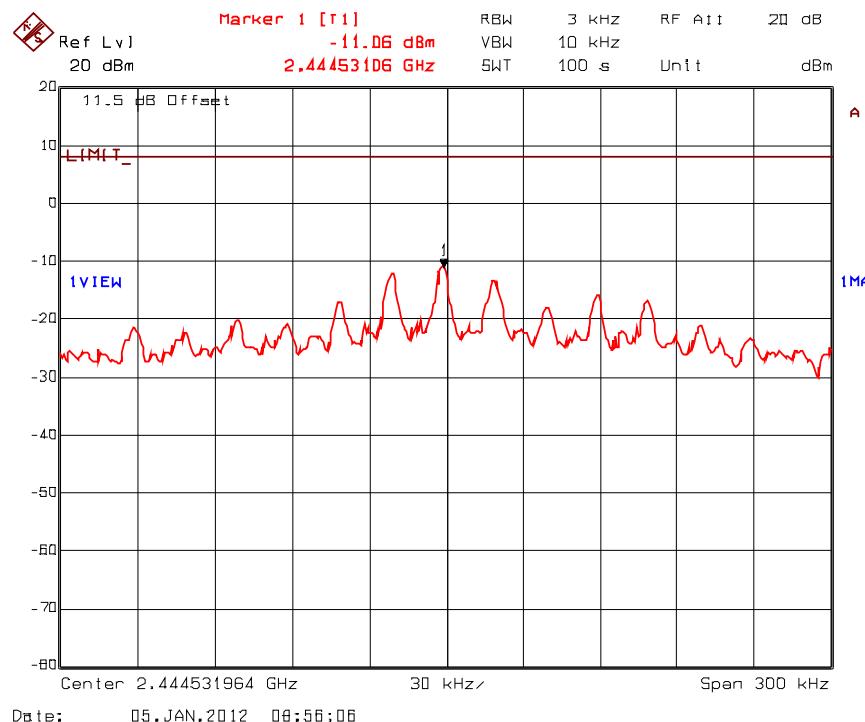
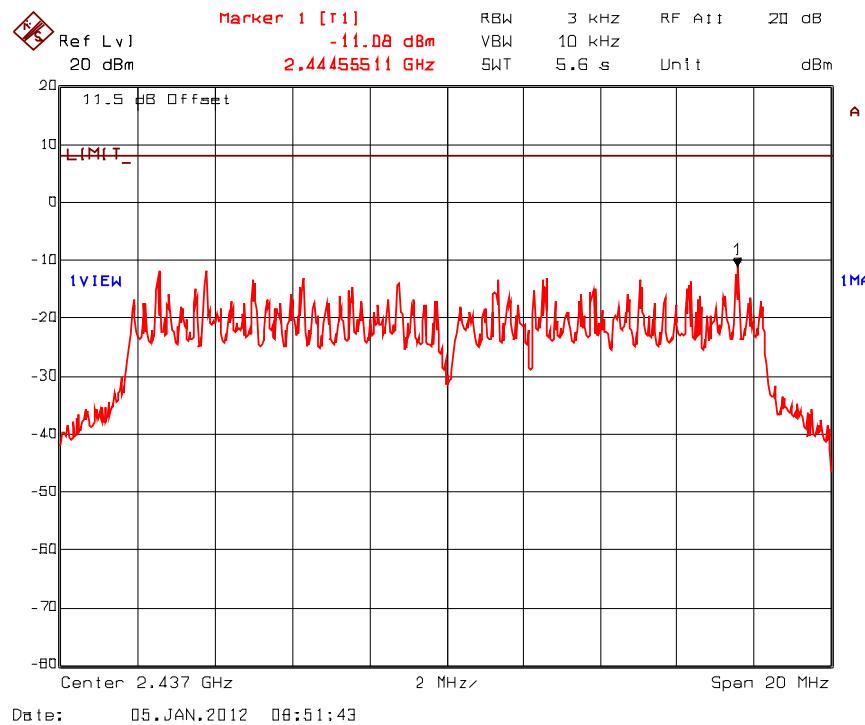
Plot 6.10.5.18 Power Spectral Density
Frequency: 2462 MHz, Modulation: 16-QAM at 36 Mbps



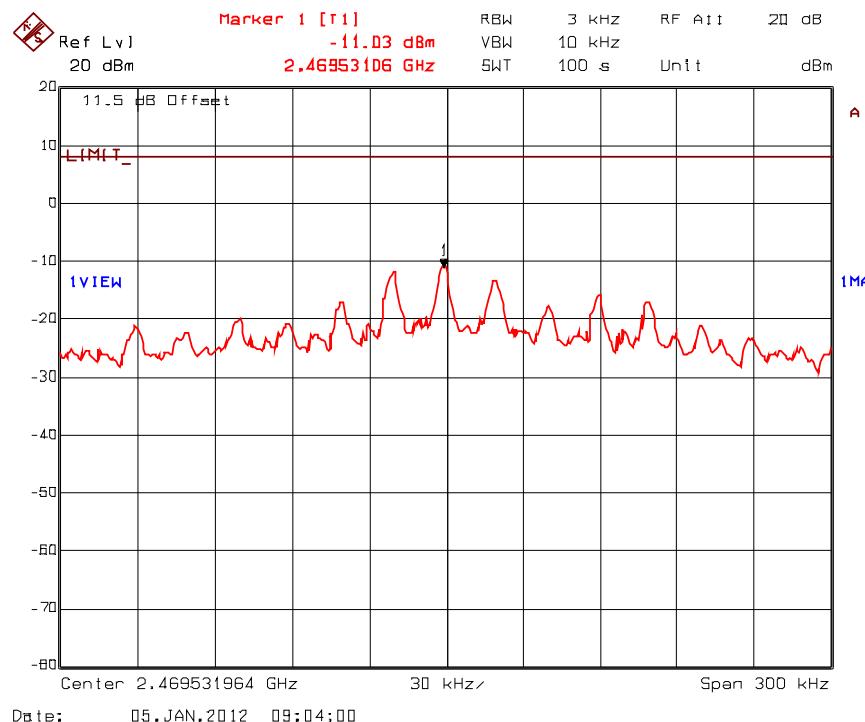
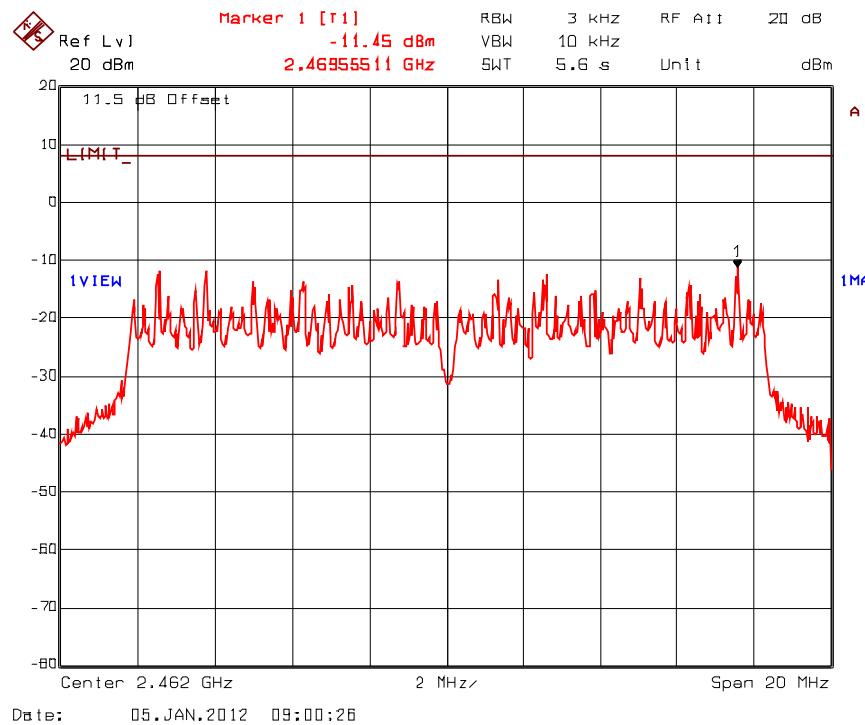
Plot 6.10.5.19 Power Spectral Density
Frequency: 2412 MHz, Modulation: 64-QAM at 54 Mbps



Plot 6.10.5.20 Power Spectral Density
Frequency: 2437 MHz, Modulation: 64-QAM at 54 Mbps



Plot 6.10.5.21 Power Spectral Density
Frequency: 2462 MHz, Modulation: 64-QAM at 54 Mbps



5.11. RF EXPOSURE REQUIREMENTS [§§ 15.247(i), 1.1307(b)(1) & 2.1093]

The criteria listed in the following table shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation.

FCC 47 CFR § 1.1310:

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.

5.11.1. 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).

5.11.2. RF Evaluation

This device is categorically excluded from routine environmental evaluation for RF Exposure requirement as per section 2.1093.

This module may be used in portable exposure conditions with no restrictions on host platforms when the source-based time-averaged output power is $\leq 60/f_{(\text{GHz})}$ mW as per 2(a)(1) of FCC KDB 447498 v04.

Measured Maximum source-based time-averaged output Power is = 10.67 dBm or 11.67 mW

SAR is not required as average power (11.67mW) is well below the threshold value of 24 mW.

$$\begin{aligned}\text{Threshold Value} &= [60/f(\text{GHz})] \text{ mW} \\ &= (60/2.5) \text{ mW} \\ &= 24 \text{ mW}\end{aligned}$$

EXHIBIT 6. TEST EQUIPMENT LIST

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range	Cal. Due Date
Spectrum Analyzer	Rohde & Schwarz	FSEK30	100077	20 Hz – 40 GHz	27 Sep 2012
Spectrum Analyzer	Rohde & Schwarz	ESU40	100037	20 Hz – 40 GHz	15 Mar 2012
RF Amplifier	Hewlett Packard	84498	3008A00769	1 – 26.5 GHz	1 Dec 2012
RF Amplifier	AH System	PAM-0118	225	20 MHz – 18 GHz	15 Mar 2012
High Pass Filter	K & L	11SH10-4000/T12000	4	Cut off 2.4 GHz	Cal. on use
Horn Antenna	Emco	3155	6570	1 – 18 GHz	22 Feb 2012
Biconi-Log Antenna	Emco	3142C	00034792	26 – 3000 MHz	26 April 2012
Signal Generator	Hewlett Packard	8648C	3443U00391	100 kHz – 3200 MHz	14 Dec, 2012
Power Divider	Mini-Circuits	15542	0235	DC – 18 GHz	Cal. on use
Attenuator	Narda	4768-20	-	DC – 40 GHz	Cal. on use
Spectrum Analyzer	Hewlett Packard	HP8593EM	3710A00223	9 kHz – 22 GHz	25 April 2012
LISN	EMCO	3825/2	8907-1531	10 kHz – 100 MHz	30 Mar 2012
Attenuator	Pasternack	PE7010-20	-	-	18 Jan 2012
Horn Antenna	Emco	3160-09	00118385	18 – 26.5 GHz	30 May 2012

EXHIBIT 7. MEASUREMENT UNCERTAINTY

The measurement uncertainties stated were calculated in accordance with the requirements of CISPR 16-4-2 @ IEC:2003 and JCGM 100:2008 (GUM 1995) – Guide to the Expression of Uncertainty in Measurement.

7.1. LINE CONDUCTED EMISSION MEASUREMENT UNCERTAINTY

	Line Conducted Emission Measurement Uncertainty (150 kHz – 30 MHz):	Measured	Limit
u_c	Combined standard uncertainty: $u_c(y) = \sqrt{\sum_{i=1}^m u_i^2(y)}$	± 1.57	± 1.8
U	Expanded uncertainty U: $U = 2u_c(y)$	± 3.14	± 3.6

7.2. RADIATED EMISSION MEASUREMENT UNCERTAINTY

	Radiated Emission Measurement Uncertainty @ 3m, Horizontal (30-1000 MHz):	Measured	Limit
u_c	Combined standard uncertainty: $u_c(y) = \sqrt{\sum_{i=1}^m u_i^2(y)}$	± 2.15	± 2.6
U	Expanded uncertainty U: $U = 2u_c(y)$	± 4.30	± 5.2

	Radiated Emission Measurement Uncertainty @ 3m, Vertical (30-1000 MHz):	Measured	Limit
u_c	Combined standard uncertainty: $u_c(y) = \sqrt{\sum_{i=1}^m u_i^2(y)}$	± 2.39	± 2.6
U	Expanded uncertainty U: $U = 2u_c(y)$	± 4.78	± 5.2

	Radiated Emission Measurement Uncertainty @ 3 m, Horizontal & Vertical (1 – 18 GHz):	Measured	Limit
u_c	Combined standard uncertainty: $u_c(y) = \sqrt{\sum_{i=1}^m u_i^2(y)}$	± 1.87	Under consideration
U	Expanded uncertainty U: $U = 2u_c(y)$	± 3.75	Under consideration