UltraTech
Group of Labs

Ultratech's Accreditations:

ANSI American National Standards Institute
0685

31040/SIT

C-1376

Canada
46390-2049

NVLAP
200093-0

BSMI
SL2-IN-E-1119R

3000 Bristol Circle,
Oakville, Ontario,
Canada L6H 6G4

Tel.: (905) 829-1570
Fax.: (905) 829-8050

Website: www.ultratech-labs.com
Email: vic@ultratech-labs.com

May 11, 2006

TIMCO ENGINEERING INC.
P.O. Box 370
849 N.W. State Road 45
Newberry, Florida
USA 32669

Subject: **FCC Certification Authorization Application under FCC Part 15, Subpart C, Sec. 15.247 - Digital Modulation Transmitters operating in the frequency band 2400 - 2483.5 MHz.**

Product: **TMW11B Wireless Radio Module**
Model No.: **TMW11B**
FCC ID: **T89-TMW11B**

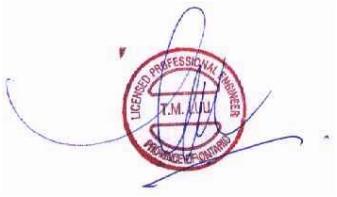
Dear Sir/Madam

As appointed agent for **Epson Canada Ltd.**, we would like to submit this application for FCC Certification of the above product. Please review all required documents uploaded to TIMCO Upload Web Site.

- Modular Transmitter Approval Request:- This application is subject to the FCC certification for a modular transceiver, please kindly refer to the Section 6.5 of the submitted test report for clarification of compliance for this modular transmitter with FCC Public Notice DA 00-1407.

If you have any queries, please do not hesitate to contact us.

Yours truly,



Tri Minh Luu, P. Eng.,
V.P., Engineering

Encl

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Email: vic@ultratech-labs.com

May 11, 2006

Epson Canada Ltd.
3771 Victoria Park
Scarborough, Ontario
Canada, M1W 3Z5

Attn.: **Mr. Dan Lehotsky**

Subject: **FCC Certification Application Testing under FCC Part 15, Subpart C, Sec. 15.247 - Digital Modulation Transmitters operating in the frequency band 2400 - 2483.5 MHz.**

Product: **TMW11B Wireless Radio Module**
Model No.: **TMW11B**
FCC ID: **T89-TMW11B**

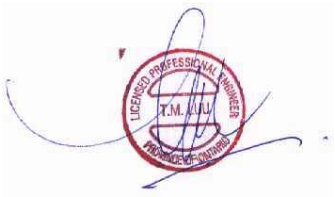
Dear Lehotsky,

The product sample, as provided by you, has been tested and found to comply with **FCC Part 15, Subpart C, Sec. 15.247 - Digital Modulation Transmitters operating in the frequency band 2400 - 2483.5 MHz.**

- Modular Transmitter Approval Request:- This application is subject to the FCC certification for a modular transceiver, please kindly refer to the Section 6.5 of the submitted test report for clarification of compliance for this modular transmitter with FCC Public Notice DA 00-1407.

Enclosed you will find copies of the engineering report. If you have any queries, please do not hesitate to contact us.

Yours truly,



Tri Minh Luu, P. Eng.,
V.P., Engineering

Encl.

ENGINEERING TEST REPORT

TMW11B Wireless Radio Module
Model No.: TMW11B

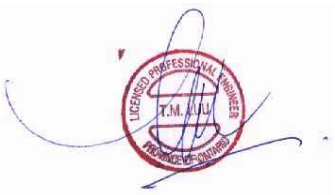
FCC ID: T89-TMW11B

Applicant: **Epson Canada Ltd.**
3771 Victoria Park
Scarborough, Ontario
Canada, M1W 3Z5

In Accordance With

FEDERAL COMMUNICATIONS COMMISSION (FCC)
PART 15, SUBPART C, SEC. 15.247
Digital Modulation Transmitters operating in the frequency band 2400 - 2483.5 MHz

UltraTech's File No.: EPS-092FCC15C

This Test report is Issued under the Authority of Tri M. Luu, Professional Engineer, Vice President of Engineering UltraTech Group of Labs Date: May 11, 2006	
Report Prepared by: Tri Luu, P.Eng. Issued Date: May 11, 2006	Tested by: Hung Trinh, RFI Technologist Test Dates: May 01-05, 2006

- *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

3000 Bristol Circle, Oakville, Ontario, Canada, L6H 6G4
Tel.: (905) 829-1570 Fax.: (905) 829-8050
Website: www.ultratech-labs.com Email: vic@ultratech-labs.com, Email: tri.luu@sympatico.ca

TABLE OF CONTENTS

- *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:	FCC Part 15, Subpart C, Section 15.247
Title	Telecommunication - Code of Federal Regulations, CFR 47, Part 15
Purpose of Test:	To gain FCC Certification Authorization for Digital Modulation Transmitters 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:	• Residential • Light-industry, Commercial • Industry
Modular Approval:	• This application is subject to the FCC certification for a modular transceiver per FCC Public Notice DA 00-1407.

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

None

1.3. NORMATIVE REFERENCES

Publication	YEAR	Title
FCC CFR Parts 0-19	Feb. 16 - 2006	Code of Federal Regulations – Telecommunication
ANSI C63.4	2004	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 EN 55022	2003-04-10 2004-10-14 2003	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
FCC Test Procedures	Mar. 23, 2005	Measurement of Digital Transmission Systems. Operating under Section 15.247
FCC Public Notice DA 00-1407	2000	Part 15 Unlicensed Modular Transmitter Approval

EXHIBIT 1. PERFORMANCE ASSESSMENT

1.1. CLIENT INFORMATION

APPLICANT:	
Name:	Epson Canada Ltd.
Address:	3771 Victoria Park Scarborough, Ontario Canada, M1W 3Z5
Contact Person:	Mr. Dan Lehotsky Phone #: 416-790-3303 Fax #: 416-495-8185 Email Address: da_lehotsky@ea.epson.com

MANUFACTURER:	
Name:	Epson Canada Ltd.
Address:	3771 Victoria Park Scarborough, Ontario Canada, M1W 3Z5
Contact Person:	Mr. Dan Lehotsky Phone #: 416-790-3303 Fax #: 416-495-8185 Email Address: da_lehotsky@ea.epson.com

1.2. 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 Ltd.
Product Name	TMW11B Wireless Radio Module
Model Name or Number	TMW11B
Serial Number	Preproduction
Type of Equipment	Digital Modulation Transmitters
Input Power Supply Type	3.3 Vdc
Primary User Functions of EUT:	Provide data communication link through air

1.3. EUT'S TECHNICAL SPECIFICATIONS

TRANSMITTER	
Equipment Type:	▪ Portable ▪ Mobile ▪ Base station (fixed use)
Intended Operating Environment:	▪ Residential ▪ Commercial, light industry & heavy industry
Power Supply Requirement:	5Vdc from an OEM product
RF Output Power Rating (Conducted):	5.6 dBm or 3.63 mili-Watts
Operating Frequency Range:	2412 – 2462 MHz
RF Output Impedance:	50 Ohms
Duty Cycle:	100% maximum
6 dB Bandwidth:	10.1 MHz
Modulation Type:	Digital Modulation • DBPSK for 1Mb/s Data Rate • QPSK for 2 Mb/s Data Rate • CCK for 11 Mb/s Data Rate
Emission Designation:	10M1GXW
Antenna Connector Type:	N/A. This antenna is a circuit board mounted antenna
Antenna Description:	Manufacturer: Taiyo Yuden Type: Circuit Board Mounted Model: AH104F245001-T Frequency Range: 2.45GHz Gain: 2 dBi

RECEVER	
Operating Frequency Range:	2412 – 2462 MHz
RF Input Impedance:	50 Ohms

1.4. LIST OF EUT'S PORTS

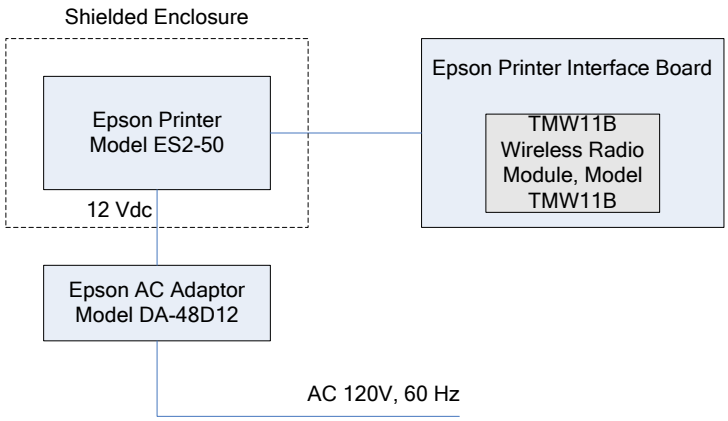
Port Number	EUT's Port Description	Number of Identical Ports	Connector Type	Cable Type (Shielded/Non-shielded)
1	I/O & DC Input Port Ports	2	Pin-header	Direct mounting to an printer interface board

1.5. 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:	Epson Printer enclosed in a metal enclosure used as a Test Jig
Brand name:	Epson
Model Name or Number:	ES2-50
FCC Certification	FCC DoC
Serial Number:	N/A
Connected to EUT's Port:	Interface board and shielded cable

1.6. TEST SETUP BLOCK DIAGRAM



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

EXHIBIT 2. EUT OPERATING CONDITIONS AND CONFIGURATIONS DURING TESTS

2.1. CLIMATE TEST CONDITIONS

The climate conditions of the test environment are as follows:

Temperature:	21°C
Humidity:	51%
Pressure:	102 kPa
Power input source:	3.3 Vdc

2.2. OPERATIONAL TEST CONDITIONS & ARRANGEMENT FOR TESTS

Operating Modes:	▪ Each of lowest, middle and highest channel frequencies transmits continuously for emissions measurements. ▪ The EUT operates in normal Direct Sequence mode for occupancy duration, and frequency separation.
Special Test Software:	▪ Special software is provided by the Applicant to select and operate the EUT at each channel frequency continuously. For example, the transmitter will be operated at each of lowest, middle and highest frequencies individually continuously during testing.
Special Hardware Used:	Epson printer and interface board
Transmitter Test Antenna:	The EUT is tested with the antenna fitted in a manner typical of normal intended use as an integral antenna equipment.

Transmitter Test Signals:	
Frequencies: ▪ 2400 - 2483.5 MHz band:	Lowest, middle and highest channel frequencies tested:
Transmitter Wanted Output Test Signals: ▪ RF Power Output (measured maximum output power): ▪ Normal Test Modulation ▪ Modulating signal source:	 ▪ 5.6 dBm ▪ DBPSK for 1Mb/s Data Rate, QPSK for 2 Mb/s Data Rate CCK for 11 Mb/s Data Rate ▪ Internal

EXHIBIT 3. SUMMARY OF TEST RESULTS

3.1. 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 Powerline Conducted Emissions were performed in UltraTech's shielded room, 16'(L) by 12'(W) by 12'(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.: IC2049-1). Last Date of Site Calibration: June. 20, 2005.

3.2. APPLICABILITY & SUMMARY OF EMC EMISSION TEST RESULTS

FCC PARAGRAPH.	TEST REQUIREMENTS	COMPLIANCE (YES/NO)
Public Notice DA 00-1407	Part 15 Unlicensed Modular Transmitter Approval	Yes
15.107 & 15.207	Class B - AC Power Conducted Emissions on Tx, Rx and standby modes	Yes
15.247(a)(2)	6dB Bandwidth of a Digital Modulation System	Yes
15.247(b) & (c)	Maximum Peak Power (Conducted)	Yes
15.247(i) & 1.1307, 1.1310, 2.1091 & 2.1093	RF Exposure Limit	Yes
15.247(d)	RF Conducted Spurious Emissions at the Transmitter Antenna Terminal	Yes
15.247(e)	Transmitted Power Density of a Digital Modulation System	Yes
15.247(d), 15.209 & 15.205	Transmitter Radiated Emissions	Yes
FCC Part 15, Sub. B, Sec. 15.109	Class B Radiated Emissions	Yes. Note 1

Note 1: A separate engineering test report for compliance with FCC Part 15, Subpart B - Class B Unintentional Radiators will be provided upon request.

3.3. MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES

None

EXHIBIT 4. MEASUREMENTS, EXAMINATIONS & TEST DATA FOR EMC EMISSIONS

4.1. TEST PROCEDURES

This section contains test results only. Details of test methods and procedures can be found in ANSI C63.4, "FCC Measurement of Digital Transmission Systems Operating under Section 15.247 - March 23, 2005", ULTR-P001-2004, ULTR-P002-2004 and ULTR-P003-2004.

4.2. 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.

4.3. 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.

4.4. ESSENTIAL/PRIMARY FUNCTIONS AS DECLARED BY THE MANUACTURER:

The essential function of the EUT is to correctly communicate data to and from radios over RF link.

4.5. UNLICENSED MODULAR TRANSMITTER APPROVAL REQUIREMENTS @ FCC PUBLIC NOTICE DA 00-1407 (JUNE 26, 2000)

In order to satisfy FCC requirements for equipment authorization for modular transmitters, the transmitters shall meet the following parameters:

	Requirements for Modular Transmitters	**Manufacturer's Clarification**	**Laboratory's Comments**
(a)	In order to be considered a transmitter module, the device must be complete RF transmitter, i.e., it must have its own reference oscillator (e.g., VCO), antenna, etc…. The only connectors to the module, if any, may be power supply and modulation/data inputs	✓ The transmitter is completed with its own reference oscillator, antenna. ✓ Only connectors provide are dc supply, data and rf ports are provided with the modular transmitter	Satisfactory
(b)	Compliance with FCC RF Exposure requirements may, in some instances, limit the output power of a module and/or the final applications in which the approved module may be employed	✓ The radio is intended for use with mobile or fixed base stations only. It complies with MPE per 2.1091 & 1.1307	Satisfactory
(c)	While the applicant for a device into which an authorized module is installed is not required to obtain a new authorization for the module, this does not preclude the possibility that some other form of authorization or testing may be required for the device (e.g., a WLAN into which the authorized module is installed still be authorized as PC peripheral, subject to the appropriate equipment authorization)	✓ The equipment under complies with FCC Part15, Subpart B, Class B – Unintentional radiators	Satisfactory
(d)	In the case of a modular transceiver, the modular approval policy only applies to the transmitter portion of such devices. Pursuant to section 15.101(b), the receiver portion will either be subject to Verification, or it will not be subject to any authorization requirements (unless if is a Scanning Receiver, in which case it is also subject to Certification, pursuant to Section 15.101(a)	✓ The equipment under complies with FCC Part15, Subpart B, Class B – Radio Receivers	Satisfactory
(e)	The holder of the grant of equipment authorization (Grantee) of the module is responsible for the compliance of the module in its final configuration, provided that the OEM, integrator, and /or end user has complied with all of the instructions provided by the Grantee which indicate installation and/or operating conditions necessary for compliance.	End-users must comply with the following instruction sated in the users' manual: ✓ Labeling requirement for equipment using this modular transmitter. ✓ RF Exposure Warning for compliance with FCC Rules 2.1091 and 1.1307 when the radio is used in a mobile or base system	Satisfactory

In order to obtain a modular transmitter approval, a cover letter requesting modular approval must be submitted and the numbered requirements identified below must be addressed in the application for equipment authorization:

	Requirements for Modular Transmitters	**Manufacturer's Clarification**	**Laboratory's Comments**
1.	The modulator transmitter must have its own RF shielding. This is intended to ensure that the module does not have to reply upon the shielding provided by the device into which it is installed in order for all modular transmitter emissions to comply with Part 15 limits. It is also intended to prevent coupling between the RF circuitry of the module and any wires or circuits in the device into which the module is installed. Such coupling may result in non-complaint operation.	✓ The modular transmitter has its own RF shielding	Satisfactory
2.	The modular transmitter must have buffered modulation/data inputs (if such inputs are provided) to ensure that the module will comply with Part 15 requirements under conditions of excessive data rates or over-modulation.	✓ The modular transmitter has buffered modulation/data inputs	Satisfactory
3.	The modular transmitter must have its own power supply regulation. This is intended to ensure that the module will comply with Part 15 requirements regardless of the design of the power supplying circuitry in the device into which the module is installed.	✓ The modular transmitter has its own power supply regulation.	Satisfactory

	Requirements for Modular Transmitters	Manufacturer's Clarification	Laboratory's Comments
4.	The modular transmitter must comply with the antenna requirements of section 15.203 and 15.204(c). The antenna must either be permanently attached or employ a "unique" antenna coupler (at all connections between the module and the antenna, including the cable). Any antenna used with the module must be approved with the module, either at the time of initial authorization or through a Class II permissive change. The "professional installation" provision of Section 15.203 may not be applied to modules.	✓ The radio complies with Rules 15.203 and 15.204(c) with permanently attached antenna.	Satisfactory
5	The modular transmitter must be tested in a stand-alone configuration, i.e., the module must not be inside another device during testing. This is intended to demonstrate that the module is capable of complying with Part 15 emission limits regardless of the device into which it is eventually installed. Unless the transmitter module will be battery powered, it must comply with the AC conducted requirements found in Section 15.207. AC or DC power lines and data input/output lines connected to the module must not contain ferrites, unless they will marketed with the module (see Section 15.27(a)). The length of these lines shall be length typical of actual use or, if that length is unknown, at least 10 centimeters to insure that there is no coupling between the case of the module and supporting equipment. Any accessories, peripherals, or support equipment connected to the module during testing shall be unmodified or commercially available (See Section 15.31(I)).	✓ The modular transmitter was tested in a stand-alone configuration	Satisfactory

4.6. COMPLIANCE WITH FCC PART 15 – GENERAL TECHNICAL REQUIREMENTS

FCC Section	FCC Rules	
15.203	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. 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: • The application (or intended use) of the EUT • The installation requirements of the EUT • The method by which the EUT will be marketed	The antenna is a trace on the printed circuit board
15.204	Provided the information for every antenna proposed for use with the EUT: (a) type (e.g. Yagi, patch, grid, dish, etc…), (b) manufacturer and model number (c) gain with reference to an isotropic radiator	N/A

4.7. AC POWERLINE CONDUCTED EMISSIONS @ FCC PART 15, SUBPART B, PARA.15.107(A) & 15.207

4.7.1. Limits

The equipment shall meet the limits of the following table:

	CLASS B LIMITS		
Test Frequency Range (MHz)	**Quasi-Peak (dBμV)**	**Average* (dBμV)**	**Measuring Bandwidth**
0.15 to 0.5	66 to 56*	56 to 46*	RBW = 9 kHz VBW ≥ 9 kHz for QP VBW = 1 Hz for Average
0.5 to 5	56	46	RBW = 9 kHz VBW ≥ 9 kHz for QP VBW = 1 Hz for Average
5 to 30	60	50	RBW = 9 kHz VBW ≥ 9 kHz for QP VBW = 1 Hz for Average

* Decreasing linearly with logarithm of frequency

4.7.2. Method of Measurements

Refer to Ultratech Test Procedures, File # ULTR P001-2004 and ANSI C63.4 for measurement methods

4.7.3. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
EMI Receiver System/Spectrum Analyzer with built-in Amplifier	Hewlett Packard	HP 8546A	3520A00248	9KHz-5.6GHz, 50 Ohms
Transient Limiter	Hewlett Packard	11947A	310701998	9 kHz – 200 MHz 10 dB attenuation
L.I.S.N.	EMCO	3825/2	89071531	9 kHz – 200 MHz 50 Ohms / 50 μH
12'x16'x12' RF Shielded Chamber	RF Shielding	…	..	…

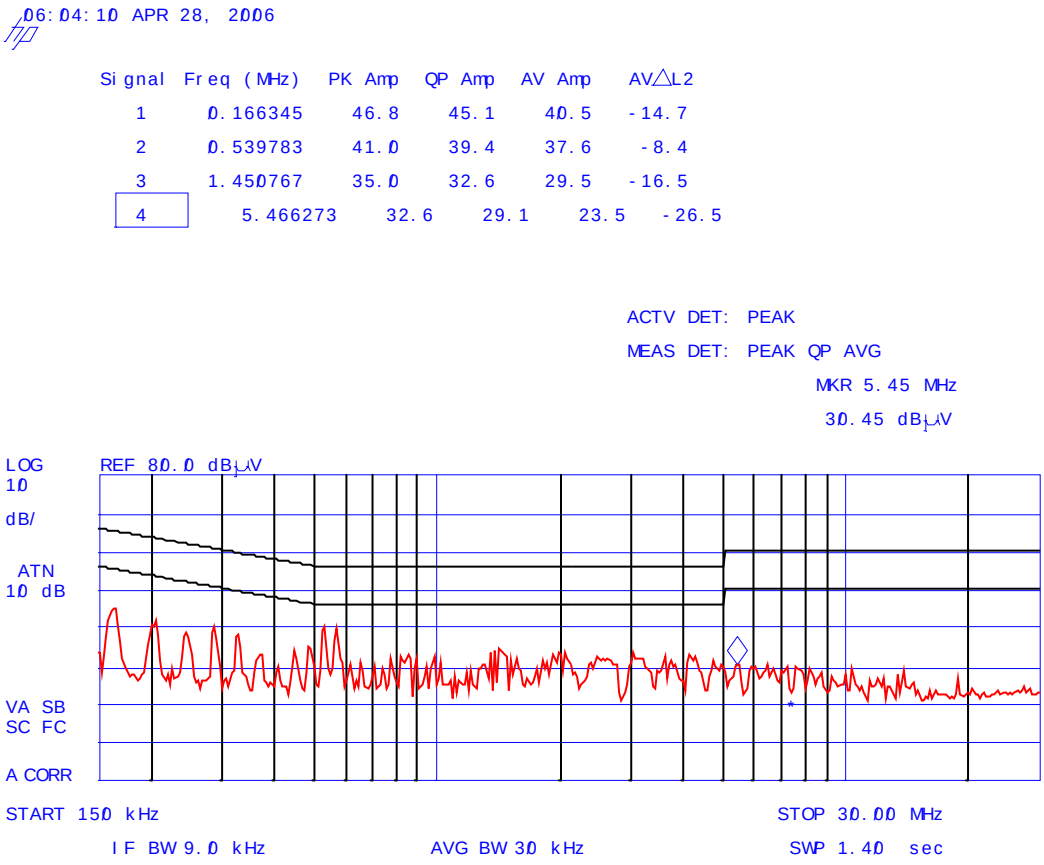
4.7.4. Photographs of Test Setup

Please refer to Photos # 1 and 2 in Annex 1 for test setup of AC Powerline Conducted Emissions

4.7.5. Test Data

Conforms. Please refer to the Plots #1 and 2 below

Plot #1: AC POWER LINE CONDUCTED EMISSIONS MEASUREMENT PLOT				
Applicant:	Detector: [X] PEAK [X] QUASI-PEAK [X] AVERAGE		Temp: 23C°	Humidity: 32%
Product:	Line Tested: Line 1	Line Voltage 120V AC	Test Tech: Hung	Test Date: 28 April 06
Model:	Standard: FCC 152.07		Transmitter Mode	



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

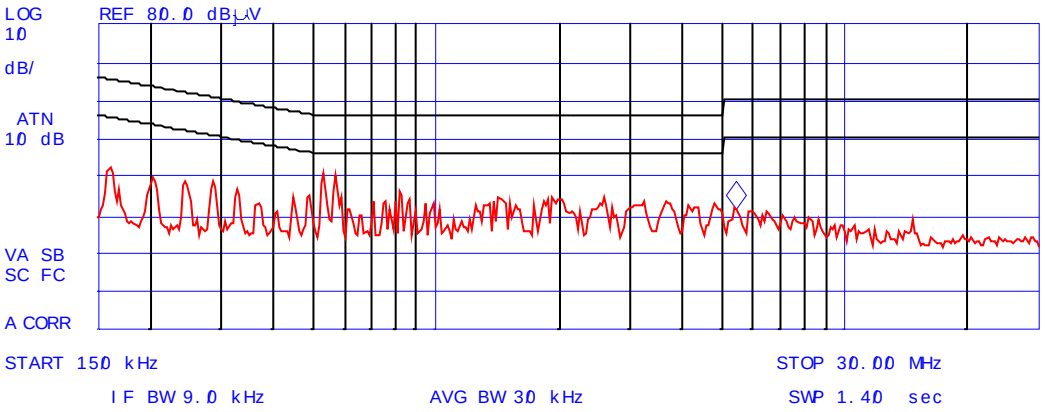
Plot #2: AC POWER LINE CONDUCTED EMISSIONS MEASUREMENT PLOT

Applicant:	Detector: [X] PEAK [X] QUASI-PEAK [X] AVERAGE		Temp: 23C°	Humidity: 32%
Product:	Line Tested: Line 2	Line Voltage 120V AC	Test Tech: Hung	Test Date: 28 April 06
Model:	Standard: FCC 152.07		Transmitter Mode	

05:59:40 APR 28, 2006

Signal	Freq (MHz)	PK Amp	QP Amp	AV Amp	AV△L2
1	0.166350	45.4	43.5	37.5	-17.8
2	0.539788	41.1	39.7	38.2	-7.8
3	1.450775	35.7	33.2	30.6	-15.4
4	5.466275	32.7	28.9	23.4	-26.6

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 5.45 MHz
31.28 dBµV



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

4.8. 6 DB BANDWIDTH @ FCC 15.247(A)(2)

4.8.1. Limits

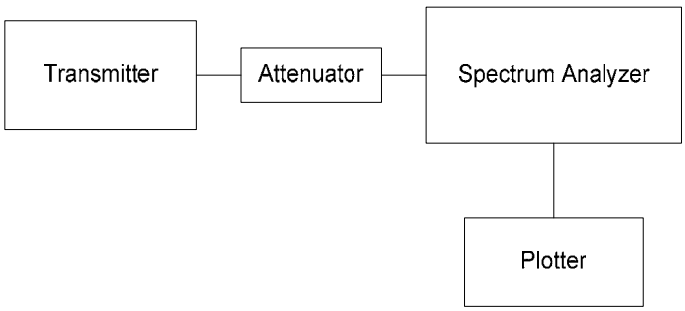
For a Digital Modulation System, the minimum 6 dB bandwidth shall be at least 500 KHz.

4.8.2. Method of Measurements

Refer to "FCC Measurement of Digital Transmission Systems Operating under Section 15.247 - March 23, 2005"

Make the measurement with the spectrum analyzer's resolution bandwidth (RBW) = 100 kHz. In order to make an accurate measurement, set the span greater than RBW. The 6 dB bandwidth must be greater than 500 kHz.

4.8.3. Test Arrangement



4.8.4. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer/ EMI Receiver	Rohde & Schawrz	FSEK20/B4/B21	834157/005	9 kHz – 40 GHz with external mixer

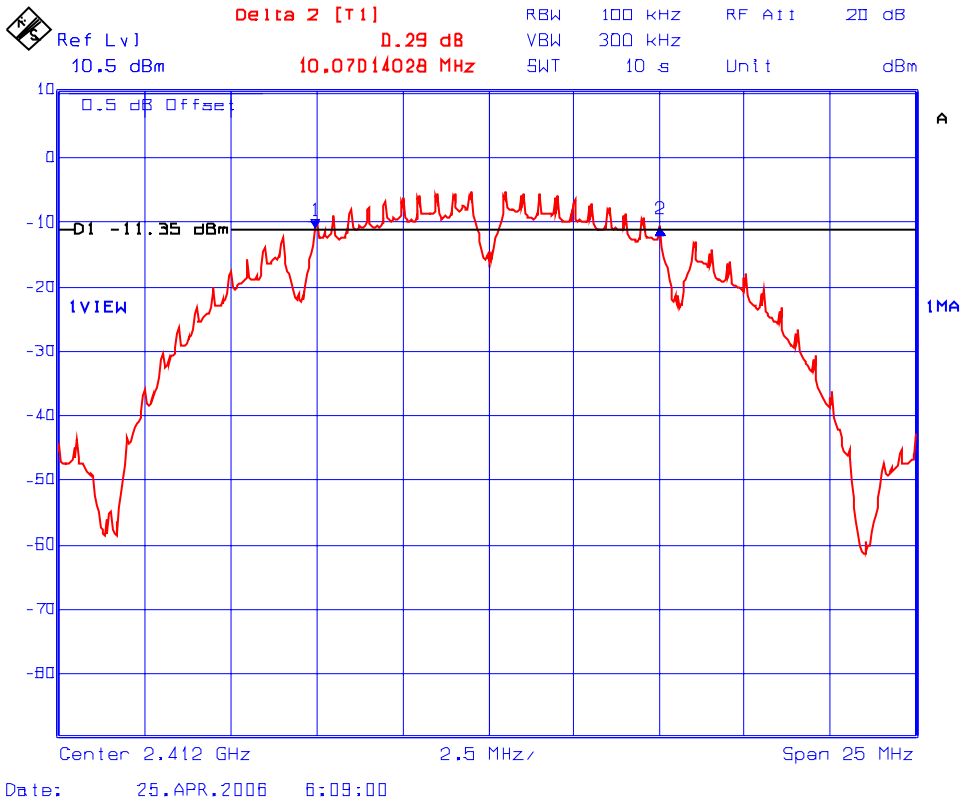
4.8.5. Test Data

CHANNEL FREQUENCY (MHz)	Modulation *	6 dB BANDWIDTH (MHz)	MINIMUM LIMIT (MHz)	PASS/FAIL
2412	DBPSK @ 1 Mbps	10.1	0.5	PASS
2437	DBPSK @ 1 Mbps	10.1	0.5	PASS
2462	DBPSK @ 1 Mbps	10.1	0.5	PASS
2412	QPSK @ 2 Mbps	10.1	0.5	PASS
2437	QPSK @ 2 Mbps	10.1	0.5	PASS
2462	QPSK @ 2 Mbps	10.1	0.5	PASS
2412	CCK @ 11 Mbps	10.1	0.5	PASS
2437	CCK @ 11 Mbps	10.6	0.5	PASS
2462	CCK @ 11 Mbps	10.1	0.5	PASS

* The 6 dB Bandwidths were found to be the same for all different modulations

Plot #3: 6 dB Bandwidth

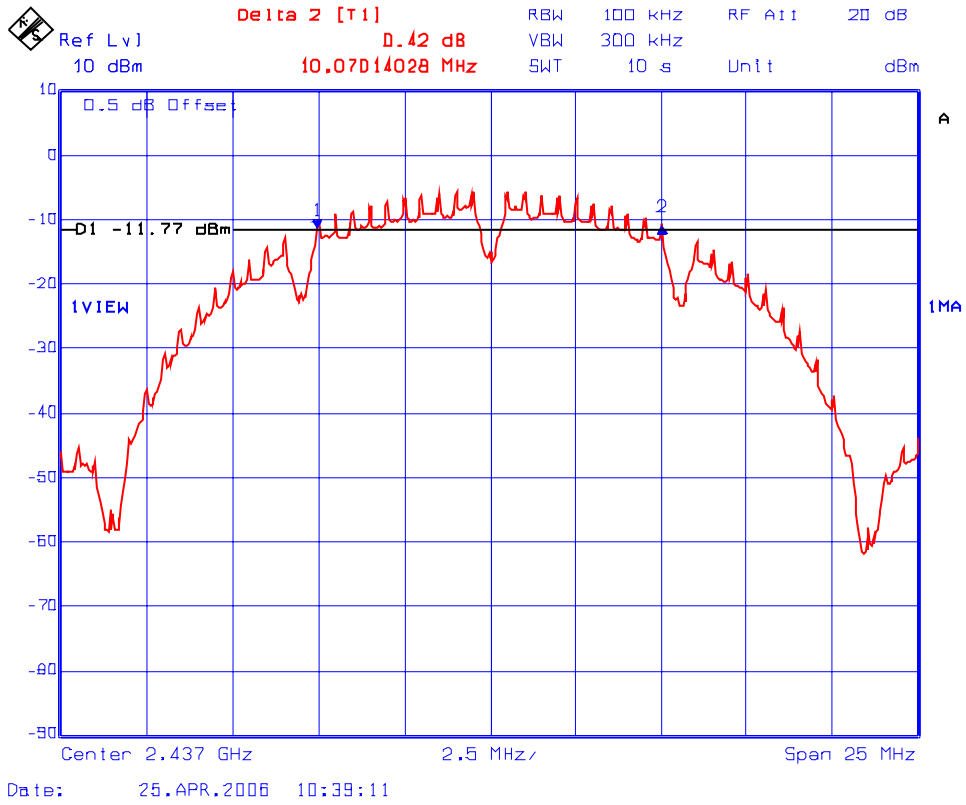
Frequency: 2412 MHz, Modulation: 802.11(b) - DBPSK, Data Rate: 1 Mbps



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

Plot #4: 6 dB Bandwidth

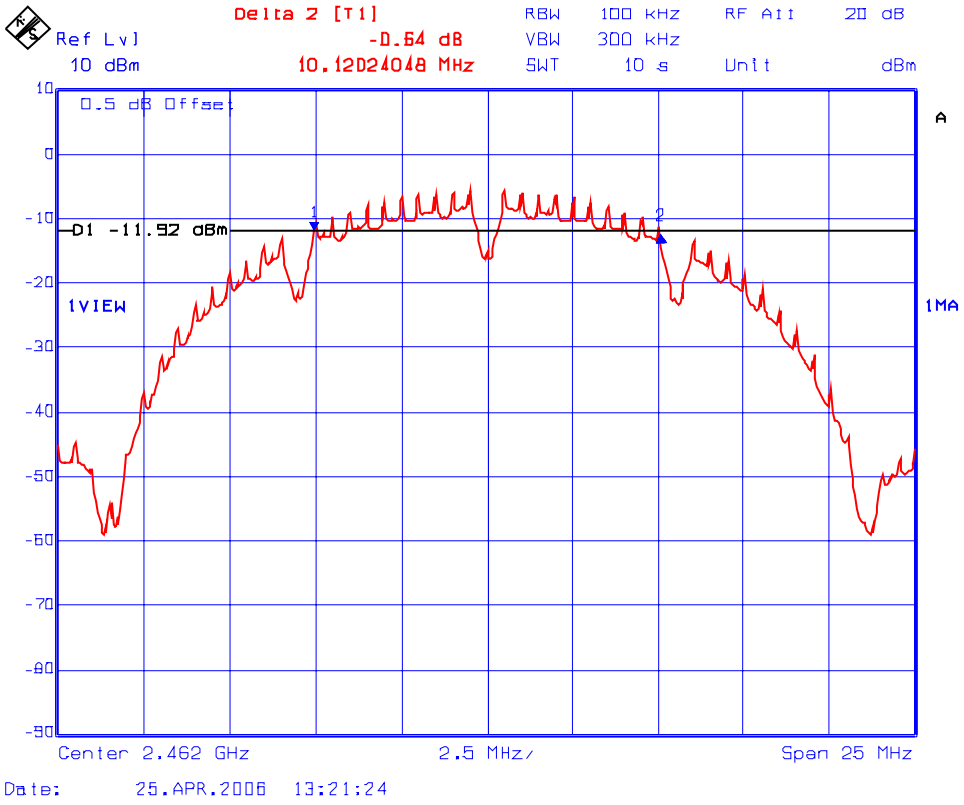
Frequency: 2437 MHz, Modulation: 802.11(b) - DBPSK, Data Rate: 1 Mbps



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

Plot #5: 6 dB Bandwidth

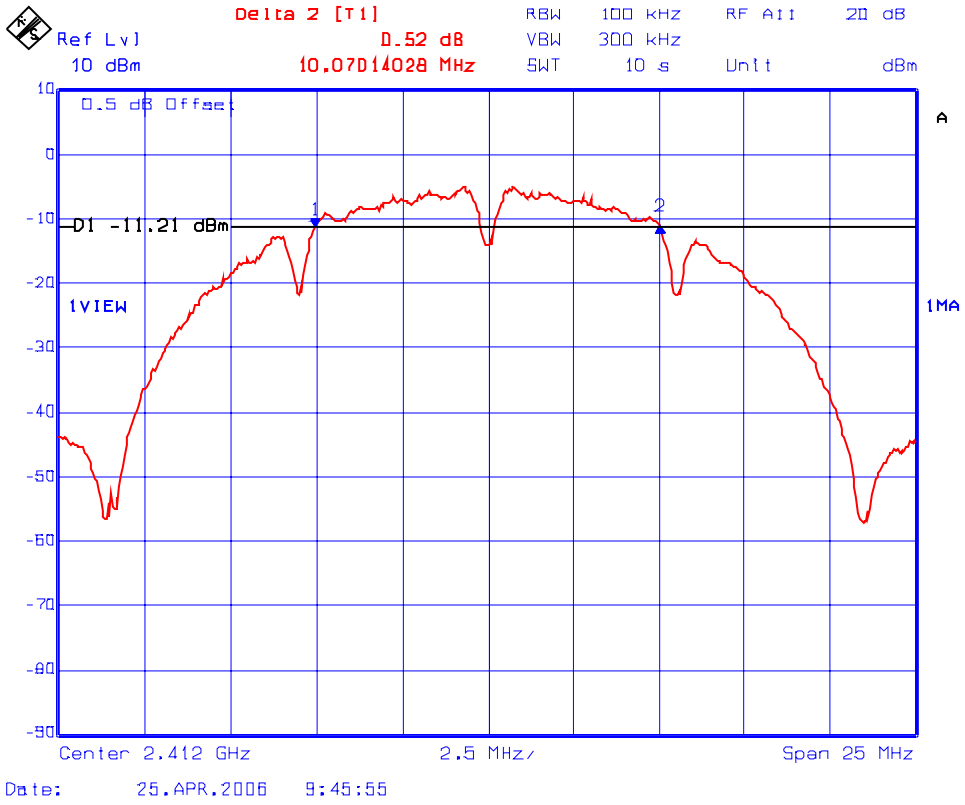
Frequency: 2462 MHz, Modulation: 802.11(b) - DBPSK, Data Rate: 1 Mbps



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

Plot #6: 6 dB Bandwidth

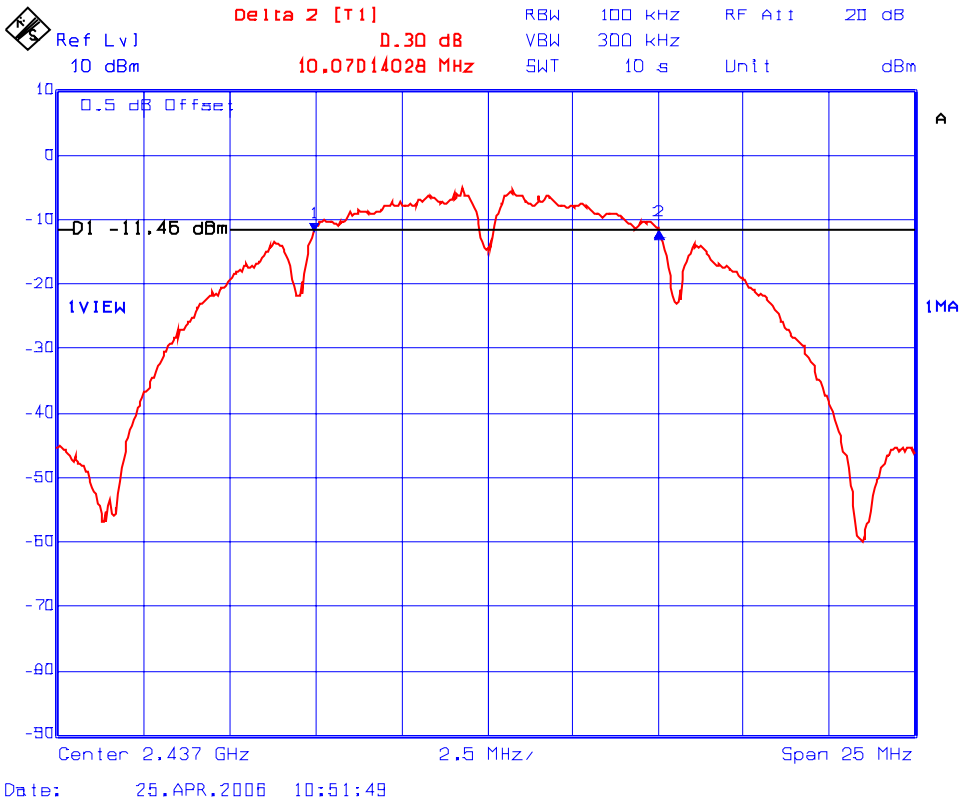
Frequency: 2412 MHz, Modulation: 802.11(b) - QPSK, Data Rate: 2 Mbps



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

Plot #7: 6 dB Bandwidth

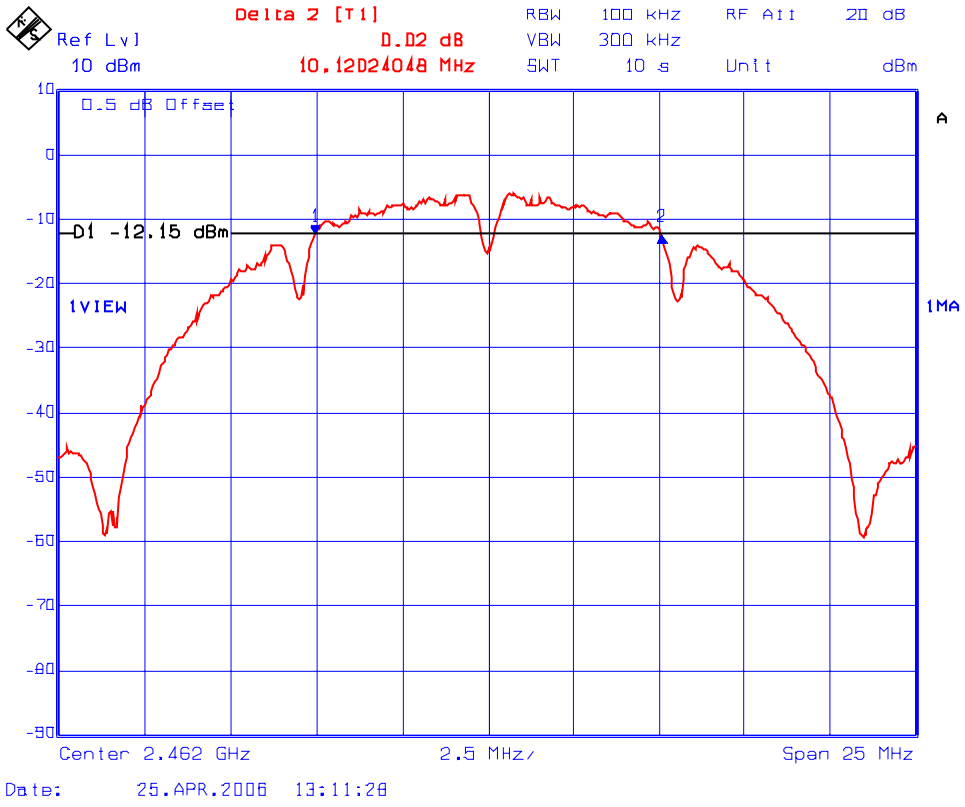
Frequency: 2437 MHz, Modulation: 802.11(b) - QPSK, Data Rate: 2 Mbps



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

Plot #8: 6 dB Bandwidth

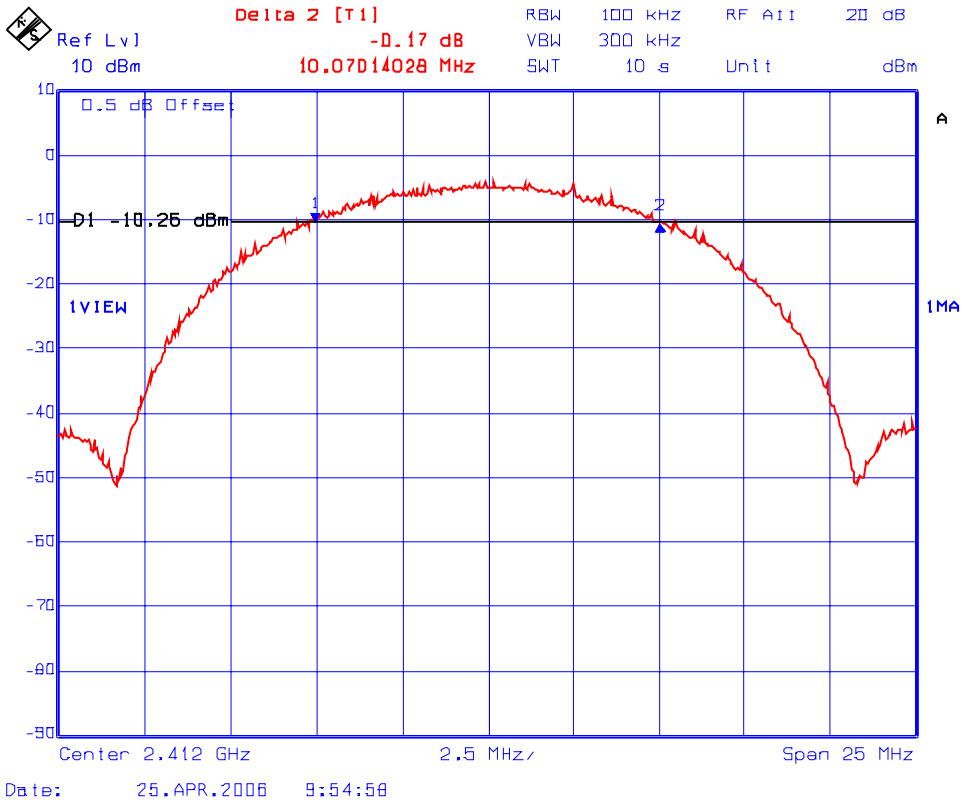
Frequency: 2462 MHz, Modulation: 802.11(b) - QPSK, Data Rate: 2 Mbps



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

Plot #9: 6 dB Bandwidth

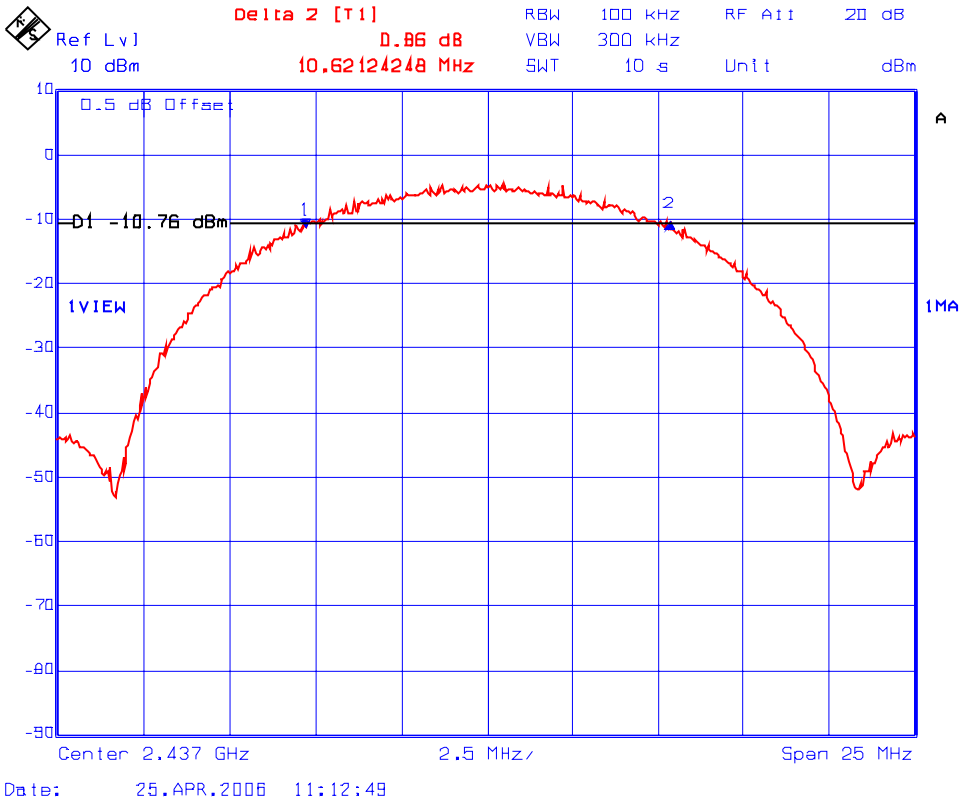
Frequency: 2412 MHz, Modulation: 802.11(b) - CCK, Data Rate: 11 Mbps



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

Plot #9: 6 dB Bandwidth

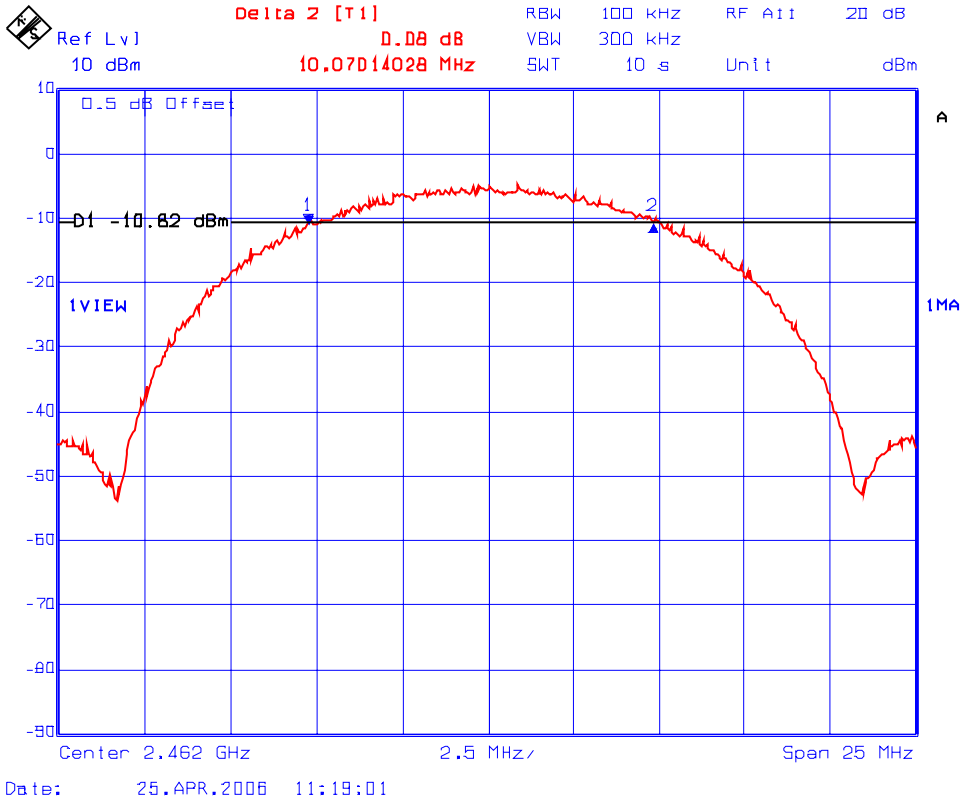
Frequency: 2437 MHz, Modulation: 802.11(b) - CCK, Data Rate: 11 Mbps



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

Plot #10: 6 dB Bandwidth

Frequency: 2462 MHz, Modulation: 802.11(b) - CCK, Data Rate: 11 Mbps



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

4.9. OUTPUT POWER (CONDUCTED) @ FCC 15.247(B)&(C)

4.9.1. 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.

(4) The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

FCC 15.247(c): Operation with directional antenna gains greater than 6 dBi.

(1) Fixed point-to-point operation:

(i) Systems operating in the 2400-2483.5 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum conducted output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

(iii) Fixed, point-to-point operation, as used in paragraphs (c)(4)(i) and (c)(4)(ii) of this section, excludes the use of point-to-multipoint systems, omnidirectional applications, and multiple co-located intentional radiators transmitting the same information. The operator of the spread spectrum or digitally modulated intentional radiator or, if the equipment is professionally installed, the installer is responsible for ensuring that the system is used exclusively for fixed, point-to-point operations. The instruction manual furnished with the intentional radiator shall contain language in the installation instructions informing the operator and the installer of this responsibility.

(2) In addition to the provisions in paragraphs (b)(1), (b)(3), (b)(4) and (c)(1)(i) of this section, transmitters operating in the 2400-2483.5 MHz band that emit multiple directional beams, simultaneously or sequentially, for the purpose of directing signals to individual receivers or to groups of receivers provided the emissions comply with the following:

(i) Different information must be transmitted to each receiver.

(ii) If the transmitter employs an antenna system that emits multiple directional beams but does not do emit multiple directional beams simultaneously, the total output power conducted to the array or arrays that comprise the device, i.e., the sum of the power supplied to all antennas, antenna elements, staves, etc. and summed across all carriers or frequency channels, shall not exceed the limit specified in paragraph (b)(1) or (b)(3) of this section, as applicable. However, the total conducted output power shall be reduced by 1 dB below the specified limits for each 3 dB that the directional gain of the antenna/antenna array exceeds 6 dBi. The directional antenna gain shall be computed as follows:

(A) The directional gain shall be calculated as the sum of 10 log number of array elements or staves) plus the directional gain of the element or stave having the highest gain.

(B) A lower value for the directional gain than that calculated in paragraph (c)(2)(ii)(A) of this section will be accepted if sufficient evidence is presented, e.g., due to shading of the array or coherence loss in the beamforming.

(ii) If a transmitter employs an antenna that operates simultaneously on multiple directional beams using the same or different frequency channels, the power supplied to each emission beam is subject to the ower limit specified in paragraph (c)(2)(ii) of this section. If transmitted beams overlap, the power shall be reduced to ensure that their aggregate power does not exceed the limit specified in paragraph (c)(2)(ii) of this section. In addition, the aggregate power transmitted simultaneously on all beams shall not exceed the limit specified in paragraph (c)(2)(ii) of this section by more than 8 dB.

(iii) Transmitters that emit a single directional beam shall operate under the provisions of paragraph (c)(1) of this section.

4.9.2. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer/ EMI Receiver	Rohde & Schawrz	FSEK20/B4/B21	834157/005	9 kHz – 40 GHz with external mixer
RF Signal Generator	Hewlett Packard	HP 83752B	3610A00457	0.01 – 20 GHz
67297 RF Detector (Diode Detector)	Herotex	DZ122-553	63400	..
Storage Oscilloscope	Philips	PM3320A	ST9907959	--

4.9.3. Method of Measurements

Refer to "FCC Measurement of Digital Transmission Systems Operating under Section 15.247 - March 23, 2005"

This is an RF conducted test. Use a direct connection between the antenna port of the transmitter and the spectrum analyzer, through suitable attenuation. Power Output Option 1 is a peak measurement. Power Output Option 2 is the same procedure used for UNII output power measurements. Either option can be used for DTS devices.

Power Output Option 1:

Set the RBW greater than 6 dB bandwidth of the emission or use a peak power meter.

4.9.4. Test Data

Method of Output Power Measurements:

Option #1, Method #1:	Total Peak Power using Peak Power Meter

Modulation: 802.11b – BPSK @ 1 Mbps

Transmitter Channel	Frequency (MHz)	Total Peak Power @ Antenna Port (dBm)	Antenna Gain G (dBi)	Total Peak EIRP (dBm)	Limit of Peak Power @ Antenna Port (dBm)	Limit of Total Peak EIRP (dBm)
Lowest	2412	5.6	2.0	7.6	30.0	34.0
Middle	2437	5.2	2.0	7.2	30.0	34.0
Highest	2462	5.1	2.0	7.1	30.0	34.0

Modulation: 802.11b – QPSK @ 2 Mbps

Transmitter Channel	Frequency (MHz)	Total Peak Power @ Antenna Port (dBm)	Antenna Gain G (dBi)	Total Peak EIRP (dBm)	Limit of Peak Power @ Antenna Port (dBm)	Limit of Total Peak EIRP (dBm)
Lowest	2412	5.6	2.0	7.6	30.0	34.0
Middle	2437	5.2	2.0	7.2	30.0	34.0
Highest	2462	5.1	2.0	7.1	30.0	34.0

Modulation: 802.11b – CCK @ 11 Mbps

Transmitter Channel	Frequency (MHz)	Total Peak Power @ Antenna Port (dBm)	Antenna Gain G (dBi)	Total Peak EIRP (dBm)	Limit of Peak Power @ Antenna Port (dBm)	Limit of Total Peak EIRP (dBm)
Lowest	2412	5.6	2.0	7.6	30.0	34.0
Middle	2437	5.2	2.0	7.2	30.0	34.0
Highest	2462	5.1	2.0	7.1	30.0	34.0

4.10. RF EXPOSURE REQUIRMENTS @ FCC 15.247(I), 1.1307(B)(1)

4.10.1. Limits

- **FCC 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).
- **FCC 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).

LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm^2)	Average Time (minutes)
(A) Limits for Occupational/Control Exposures				
1500-100,000	...	...	5	6
(B) Limits for General Population/Uncontrolled Exposure				
1500-100,000	...	...	1.0	30

F = Frequency in MHz

4.10.2. Method of Measurements

Refer to FCC @ 1.1310, 2.1091

- Spread spectrum transmitters operating under section 15.247 are categorically 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)(5), 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.

- In order to demonstrate compliance with MPE requirements (see Section 2.1091), the following information is typically needed:

(1) Calculation that estimates the minimum separation distance (20 cm or more) between an antenna and persons required to satisfy power density limits defined for free space.
(2) Antenna installation and device operating instructions for installers (professional/unskilled users), and the parties responsible for ensuring compliance with the RF exposure requirement
(3) Any caution statements and/or warning labels that are necessary in order to comply with the exposure limits
(4) Any other RF exposure related issues that may affect MPE compliance

Calculation Method of RF Safety Distance:

$S = PG/4\Pi r^2 = EIRP/4\Pi r^2$

Where: P: power input to the antenna in mW
EIRP: Equivalent (effective) isotropic radiated power.
S: power density mW/cm^2
G: numeric gain of antenna relative to isotropic radiator
r: distance to centre of radiation in cm

FCC radio frequency exposure limits may be exceeded at distances closer than r cm from the antenna of this device

$r = \sqrt{PG/4\Pi S}$

FCC radio frequency exposure limits may not be exceeded at distances closer than r cm from the antenna of this device

- 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., an 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 a SAR evaluation be performed, as provided for in Section 1.1307(d)

4.10.3. Test Data

Frequency (MHz)	MaximumConducted Peak Power at the Antenna Terminal (dBm)	Maximum Antenna Gain (dBi)	Maximum Measured Total EIRP (dBm)	Laboratory's Recommended Minimum RF Safety Distance r (cm)
2412	5.6	2.0	7.6	0.68

Note 1: **RF EXPOSURE DISTANCE LIMITS:** $r = (PG/4\Pi S)^{1/2} = (EIRP/4\Pi S)^{1/2}$
Limits for General Population/Uncontrolled Exposure: $S = 1.0\ mW/cm^2$

Evaluation of RF Exposure Compliance Requirements	
RF Exposure Requirements	**Compliance with FCC Rules**
Minimum calculated separation distance between antenna and persons required: 0.68 cm	Manufacturer' instruction for separation distance between antenna and persons required: 20 cm.
Antenna installation and device operating instructions for installers (professional/unskilled users), and the parties responsible for ensuring compliance with the RF exposure requirement	N/A
Caution statements and/or warning labels that are necessary in order to comply with the exposure limits	N/A
Any other RF exposure related issues that may affect MPE compliance	N/A

4.11. TRANSMITTER BAND-EDGE & SPURIOUS EMISSIONS (CONDUCTED), FCC CFR 47, PARA. 15.247(D)

4.11.1. Limits

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)).

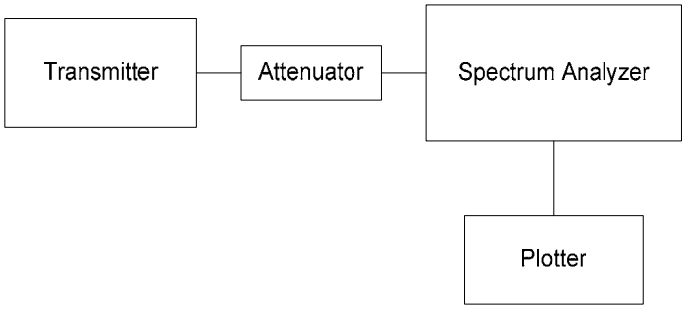
4.11.2. Method of Measurements

Refer to "FCC Measurement of Digital Transmission Systems Operating under Section 15.247 - March 23, 2005"

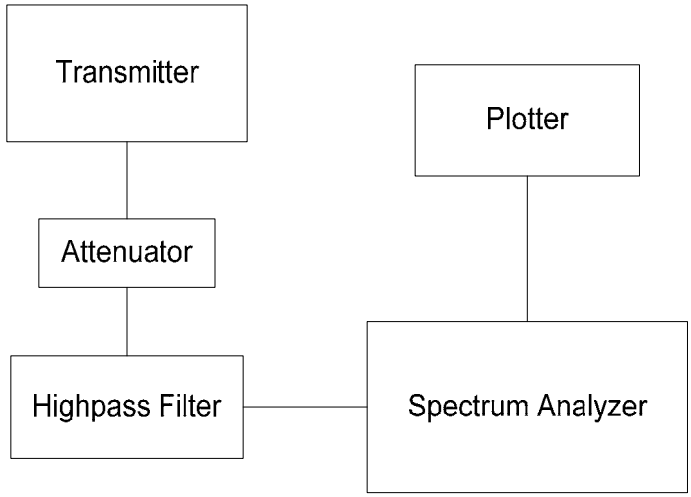
RF antenna conducted test: Set RBW = 100 kHz, Video bandwidth (VBW) > RBW, scan up through 10th harmonic. All harmonics/spurs must be at least 20 dB down from the highest emission level within the authorized band *as measured with a 100 kHz RBW.*

4.11.3. Test Arrangement

For Conducted Band-edge Emissions Measurements



For Conducted Spurious Emissions Measurements



4.11.4. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer/ EMI Receiver	Rohde & Schawrz	FSEK20/B4/B21	834157/005	9 kHz – 40 GHz with external mixer

4.11.5. Test Data

4.11.5.1. Conducted Band-edge Spurious Emissions

Please refer to Plots # 11 to 16 for detailed measurements of band-edge conducted emissions.

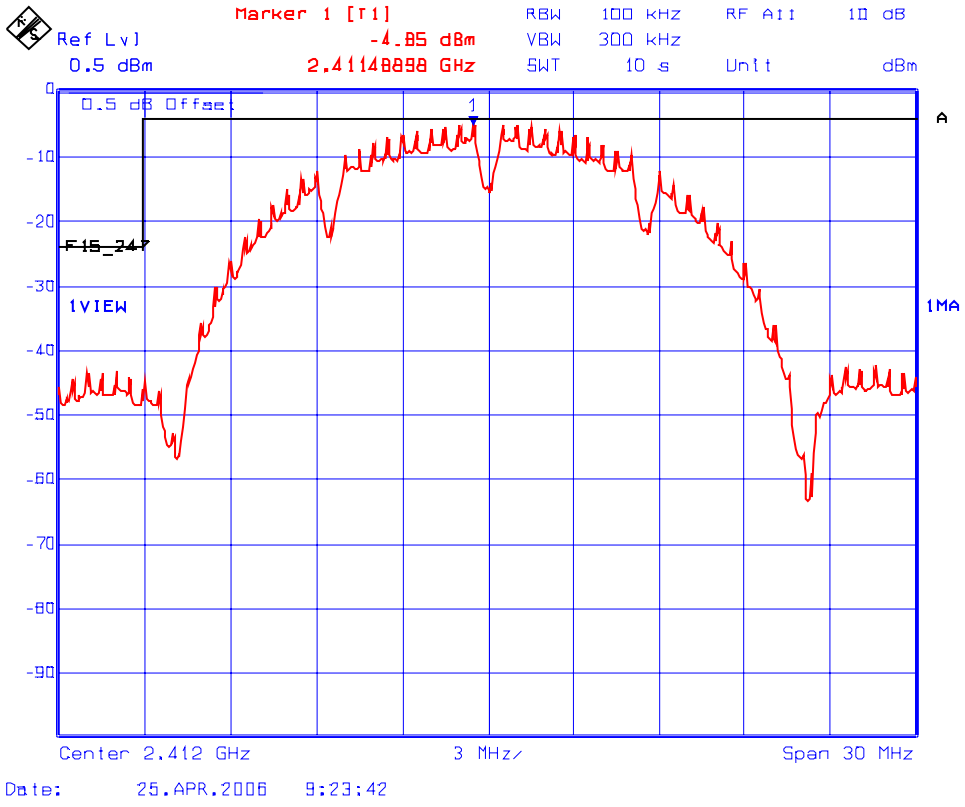
4.11.5.2. Conducted Spurious Emissions

Conforms. Please refer to Plots # 17(a)(b) to 19(a)(b) for test data

Remark: As we observed, the output power, 6 dB Bandwidth and Band-edge emissions are the same with all different modulations. Therefore, the conducted emissions with in Plots 17(a)(b) to 19 (a)(b) with CCK @ 11 Mbps will be tested and represent for all.

Plot # 11: Band-edge Conducted Emissions

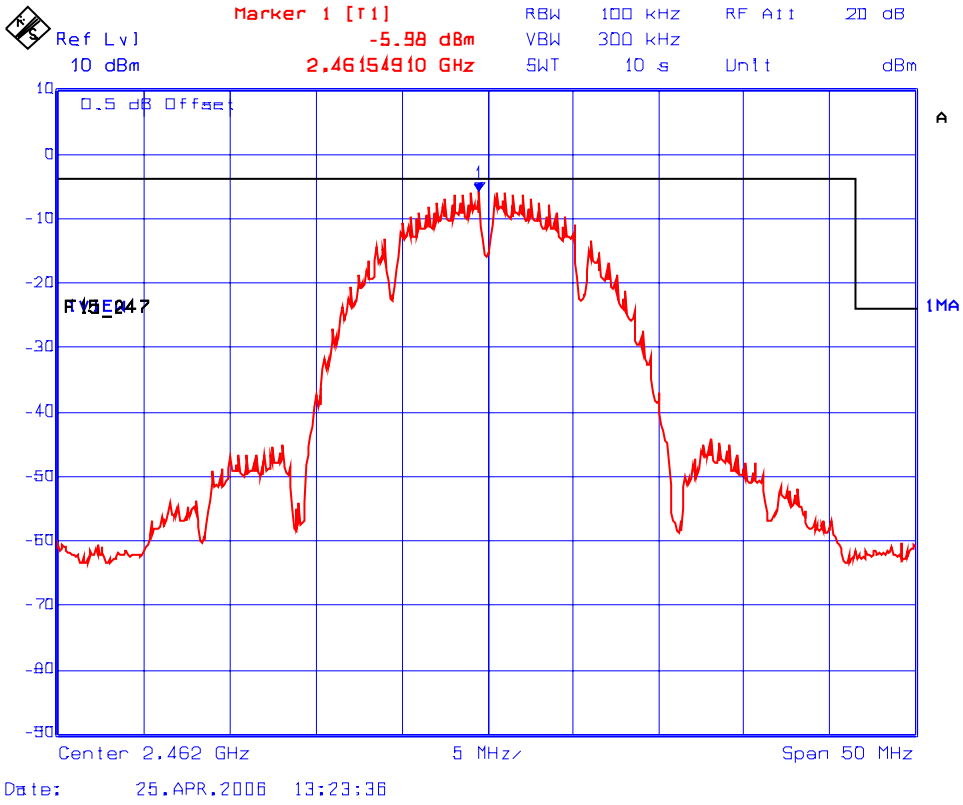
Lowest Frequency: 2412 MHz, Modulation: 802.11(b) - BPSK, Data Rate: 1 Mbps



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

Plot # 12: Band-edge Conducted Emissions

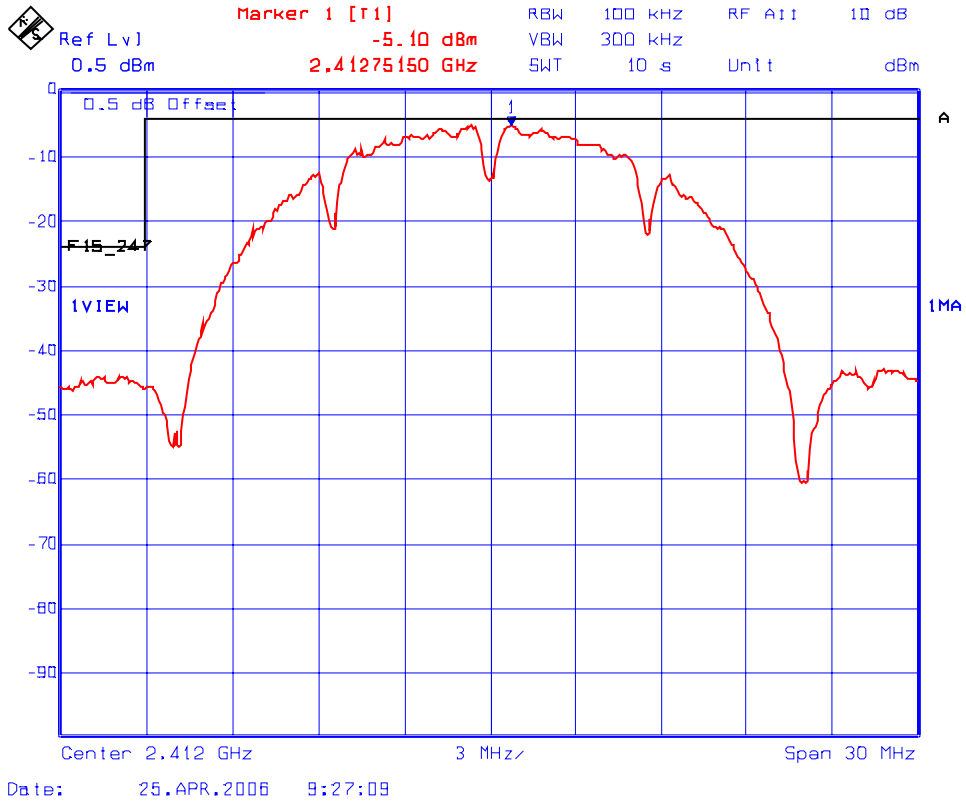
Highest Frequency: 2462 MHz, Modulation: 802.11(b) - BPSK, Data Rate: 1 Mbps



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

Plot # 13: Band-edge Conducted Emissions

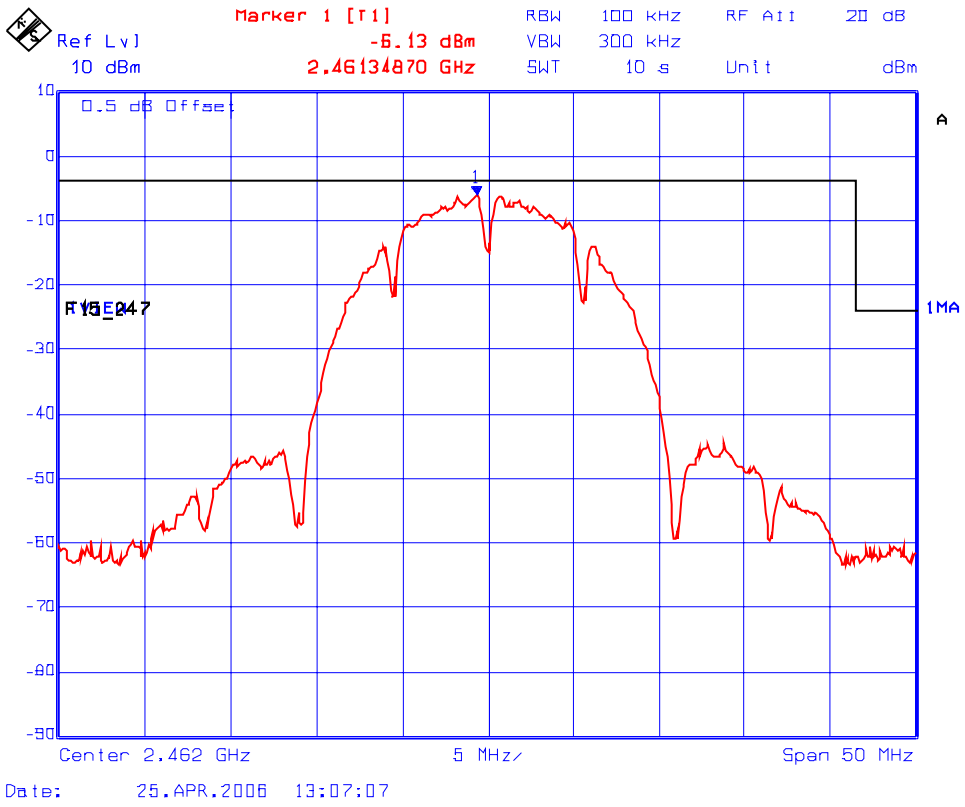
Lowest Frequency: 2412 MHz, Modulation: 802.11(b) - QPSK, Data Rate: 2 Mbps



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

Plot # 14: Band-edge Conducted Emissions

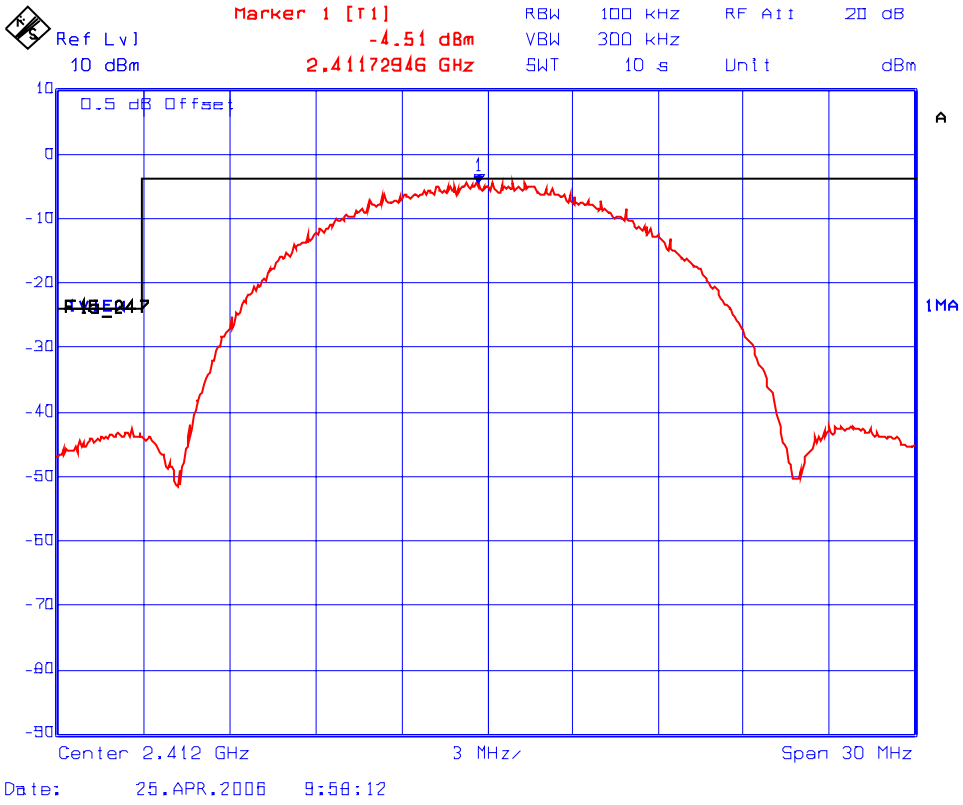
Highest Frequency: 2462 MHz, Modulation: 802.11(b) - QPSK, Data Rate: 2 Mbps



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

Plot # 15: Band-edge Conducted Emissions

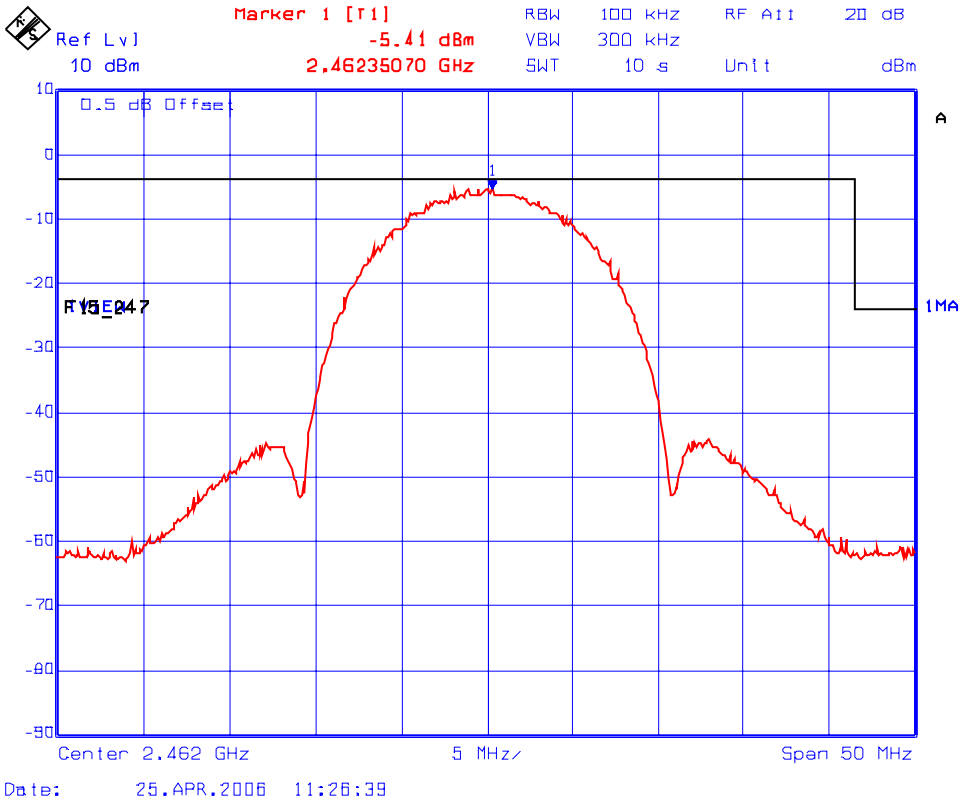
Lowest Frequency: 2412 MHz, Modulation: 802.11(b) - CCK, Data Rate: 11 Mbps



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

Plot # 16: Band-edge Conducted Emissions

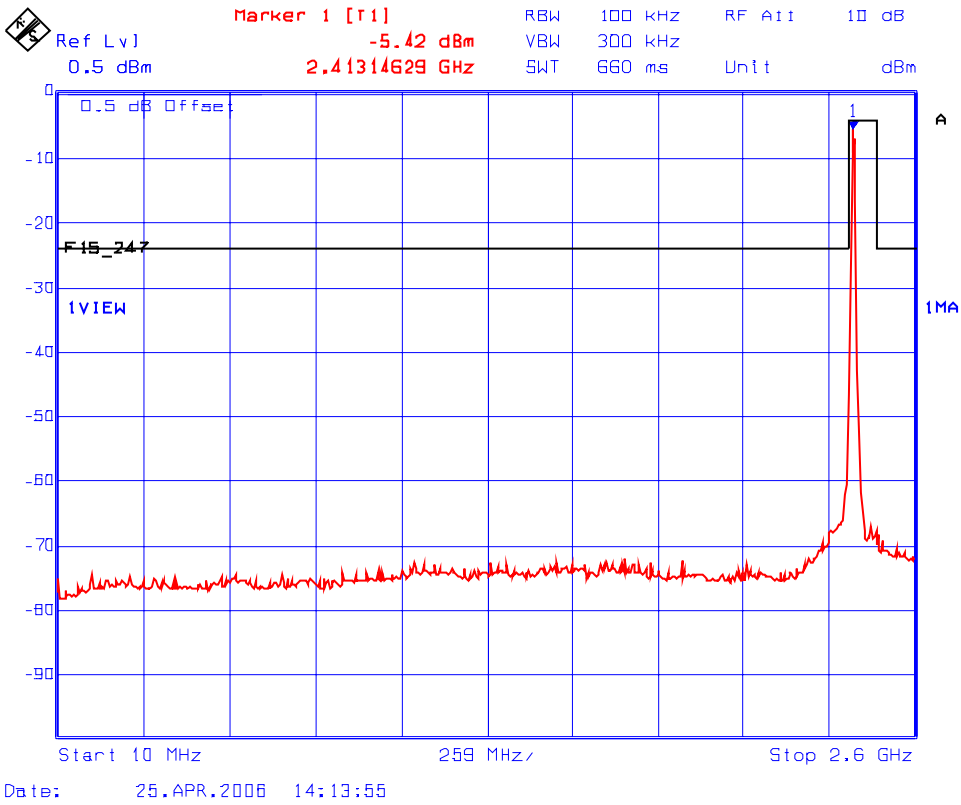
Highest Frequency: 2462 MHz, Modulation: 802.11(b) - CCK, Data Rate: 11 Mbps



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

Plot # 17(a): Band-edge Conducted Emissions
Highest Frequency: 2412 MHz, Modulations: 802.11(b) - CCK, Data Rate: 11 Mbps

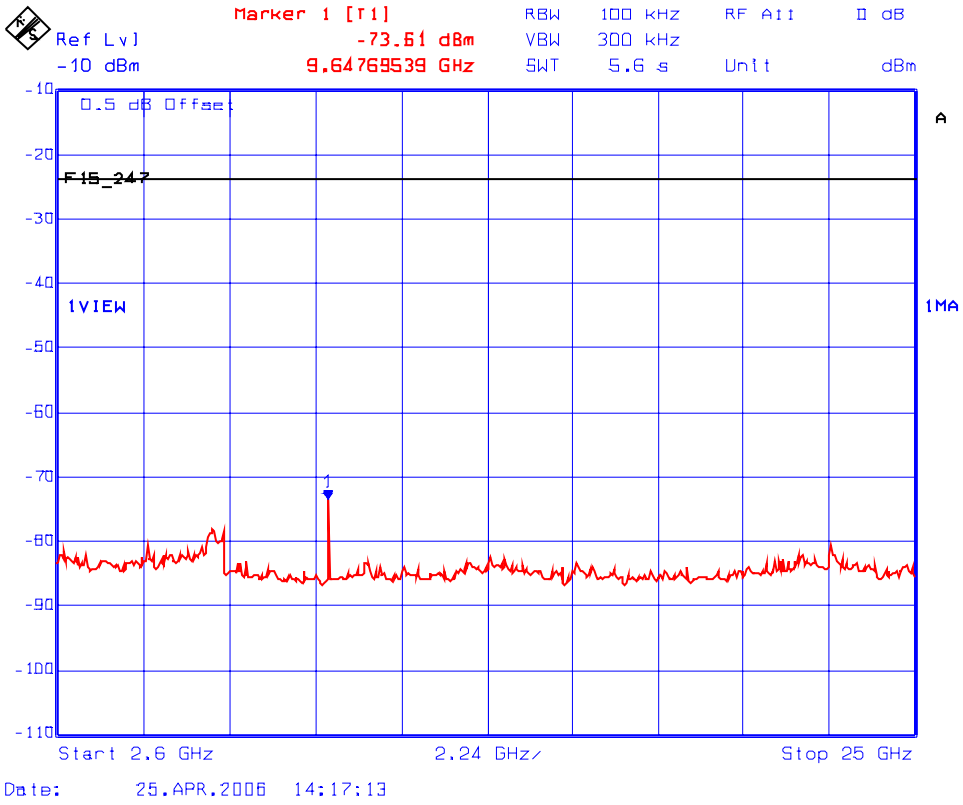
Note: Prescans show that the conducted emissions with modulations of BPSK @ 1Mbps and QPSK @ 2 Mbps are same as that of CCK @ 11 Mpbs



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

Plot # 17(b): Band-edge Conducted Emissions
Highest Frequency: 2412 MHz, Modulations: 802.11(b) - CCK, Data Rate: 11 Mbps

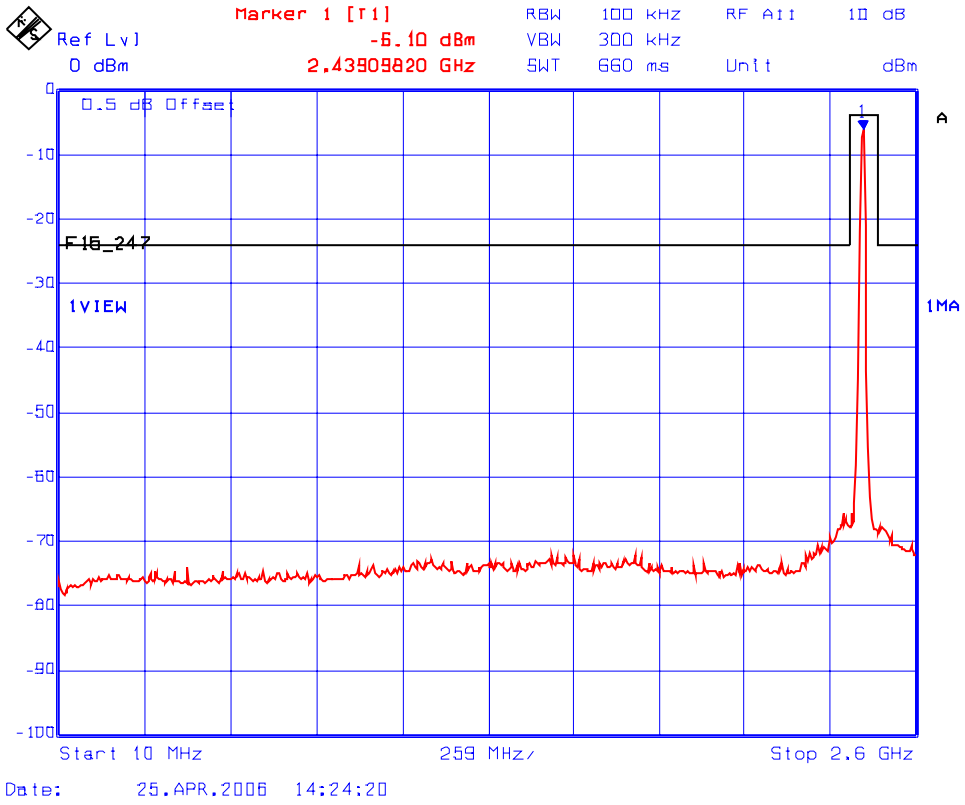
Note: Prescans show that the conducted emissions with modulations of BPSK @ 1Mbps and QPSK @ 2 Mbps are same as that of CCK @ 11 Mpbs



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

Plot # 18(a): Band-edge Conducted Emissions
Highest Frequency: 2437 MHz, Modulations: 802.11(b) - CCK, Data Rate: 11 Mbps

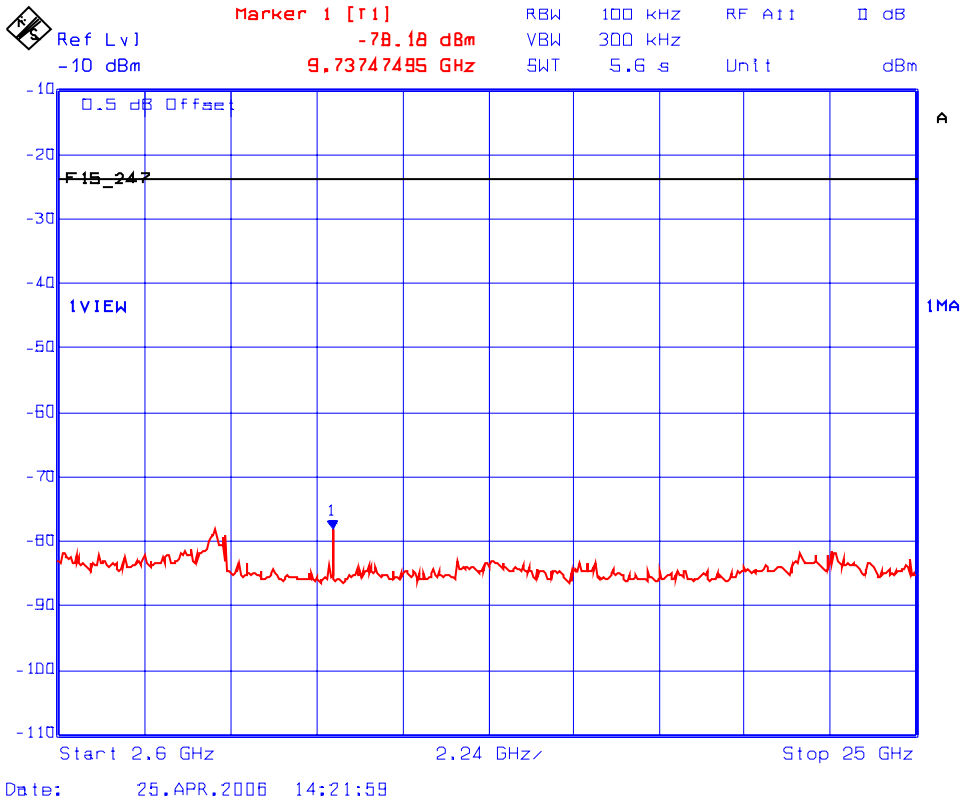
Note: Prescans show that the conducted emissions with modulations of BPSK @ 1Mbps and QPSK @ 2 Mbps are same as that of CCK @ 11 Mpbs



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

Plot # 18(b): Band-edge Conducted Emissions
Highest Frequency: 2437 MHz, Modulations: 802.11(b) - CCK, Data Rate: 11 Mbps

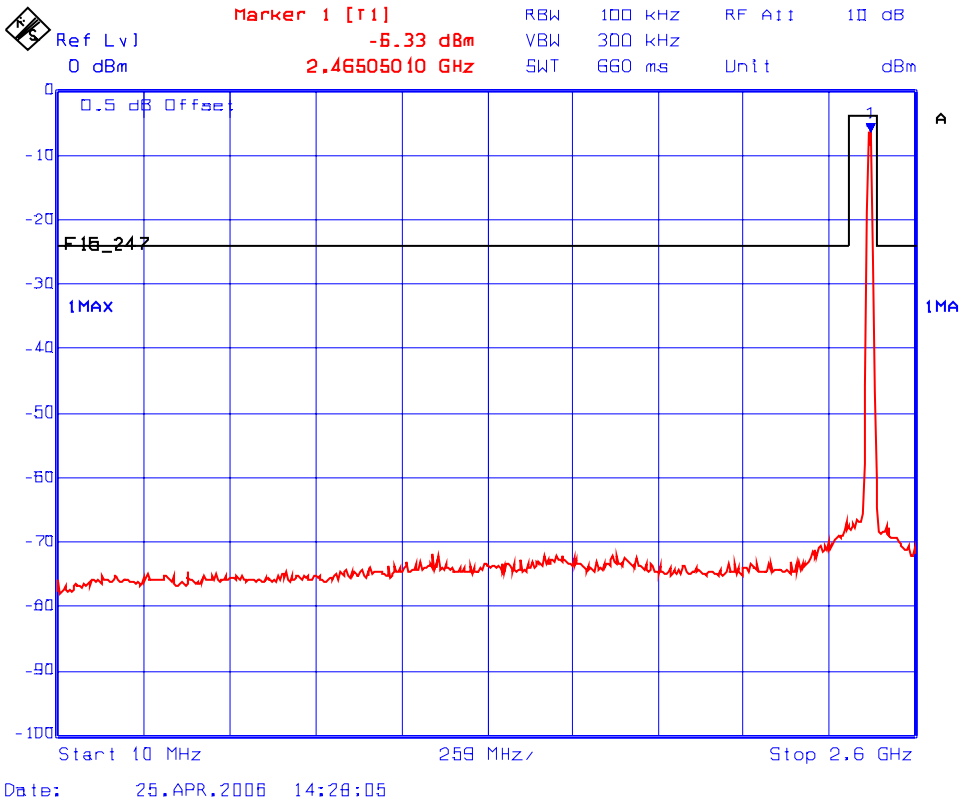
Note: Prescans show that the conducted emissions with modulations of BPSK @ 1Mbps and QPSK @ 2 Mbps are same as that of CCK @ 11 Mpbs



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

Plot # 19(a): Band-edge Conducted Emissions
Highest Frequency: 2462 MHz, Modulations: 802.11(b) - CCK, Data Rate: 11 Mbps

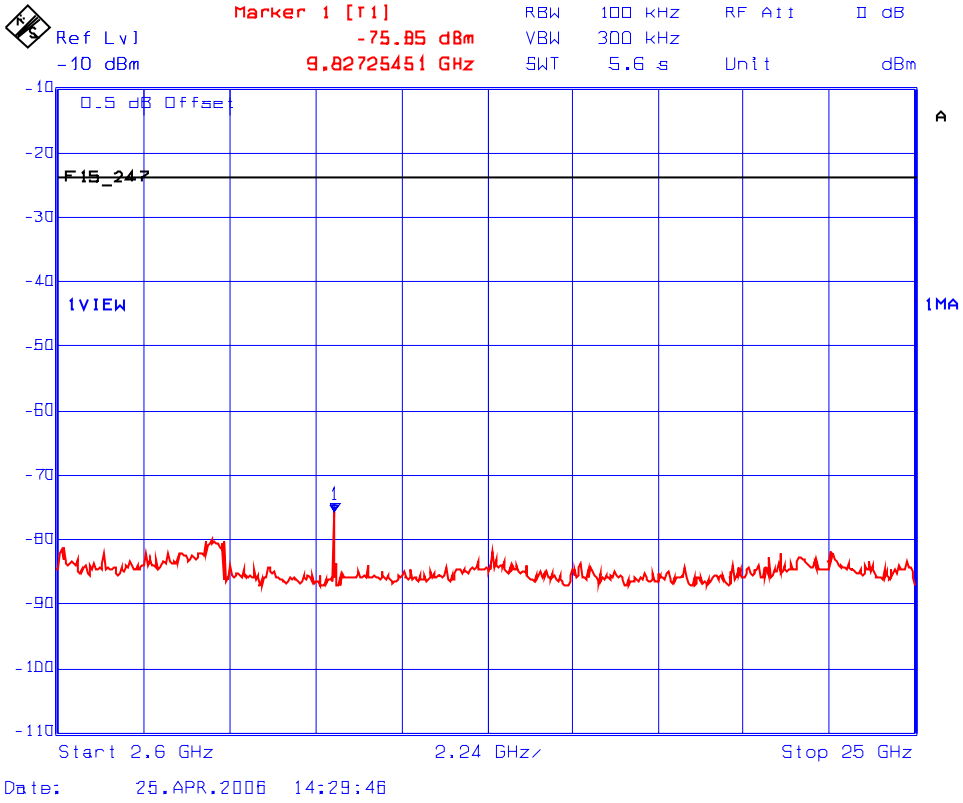
Note: Prescans show that the conducted emissions with modulations of BPSK @ 1Mbps and QPSK @ 2 Mbps are same as that of CCK @ 11 Mpbs



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

Plot # 19(b): Band-edge Conducted Emissions
Highest Frequency: 2462 MHz, Modulations: 802.11(b) - CCK, Data Rate: 11 Mbps

Note: Prescans show that the conducted emissions with modulations of BPSK @ 1Mbps and QPSK @ 2 Mbps are same as that of CCK @ 11 Mpbs



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

4.12. TRANSMITTED POWER DENSITY OF A DIGITAL MODULATION SYSTEM, FCC CFR 47, PARA. 15.247(E)

4.12.1. Limits

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. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

4.12.2. Method of Measurements

Refer to "FCC Measurement of Digital Transmission Systems Operating under Section 15.247 - March 23, 2005"

The same method of determining the conducted output power shall be used to determine the power spectral density. If a peak output power is measured, then a peak power spectral density measurement is required. If an average output power is measured, then an average power spectral density measurement should be used. Use PSD Option 1 if Power output Option 1 was used. Use PSD Option 2 if power output Option 2 was used.

PSD Option 1:

Locate and zoom in on emission peak(s) within the passband. Set RBW = 3 kHz, VBW > RBW, sweep= (SPAN/3 kHz) e.g., for a span of 1.5 MHz, the sweep should be 1.5 x 106 ÷ 3 x103 = 500 seconds. The peak level measured must be no greater than + 8 dBm. If external attenuation is used, don't forget to add this value to the reading. Use the following guidelines for modifying the power spectral density measurement procedure when necessary.

- For devices with spectrum line spacing greater than 3 kHz no change is required.
- For devices with spectrum line spacing equal to or less than 3 kHz, the resolution bandwidth must be reduced below 3 kHz until the individual lines in the are resolved. The measurement data must then be normalized to 3 kHz by summing the power of all the individual spectral lines within a 3kHz band power units) to determine compliance.
- If the spectrum line spacing cannot be resolved on the available spectrum the noise density function on most modern conventional spectrum analyzers directly measure the noise power density normalized to a 1 Hz noise power bandwidth. Add 35 dB for correction to 3 kHz.
- Should all the above fail or any controversy develop regarding accuracy measurement, the FCC Laboratory will use the HP 89440A Vector Signal for final measurement unless a clear showing can be made for a further alternate.

PSD Option 2:

Locate and zoom in on emission peak(s) within the passband.

- Set RBW = 3 kHz.
- Set VBW > 9 kHz.
- Set Sweep time to Automatic
- Use a peak detector. A sample detector mode can be used only if the following can be achieved with automatic sweep time and adjusting the bin width.
  1. Bin width (i.e., span/number of points in spectrum display) < 0.5
  2. The transmission pulse or sequence of pulses remains at maximum transmit power throughout each of the 100 sweeps of averaging the interval between pulses is not included in any of the sweeps sweeps should occur during one transmission, or each sweep gated occur during a transmission).

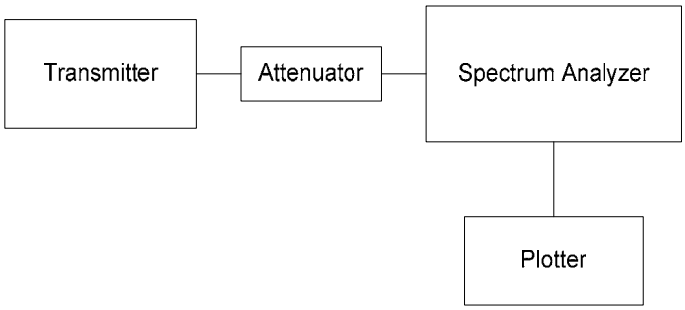
  Note: If condition 2 cannot be achieved, then PSD Option 1 (peak on max hold) must be used and trace averaging cannot be used.

- Use a video trigger with the trigger level set to enable triggering only on power pulses. Transmitter must operate at full control power for entire every sweep. If the device transmits continuously, with no off intervals reduced power intervals, the trigger may be set to "free run".

- Trace average 100 traces in power averaging mode. Do not use video averaging mode.

Note: Some analyzers will automatically select sample mode when trace averaging is selected. If a peak detector is used, then peak detector must be

4.12.3. Test Arrangement



4.12.4. Test Equipment List

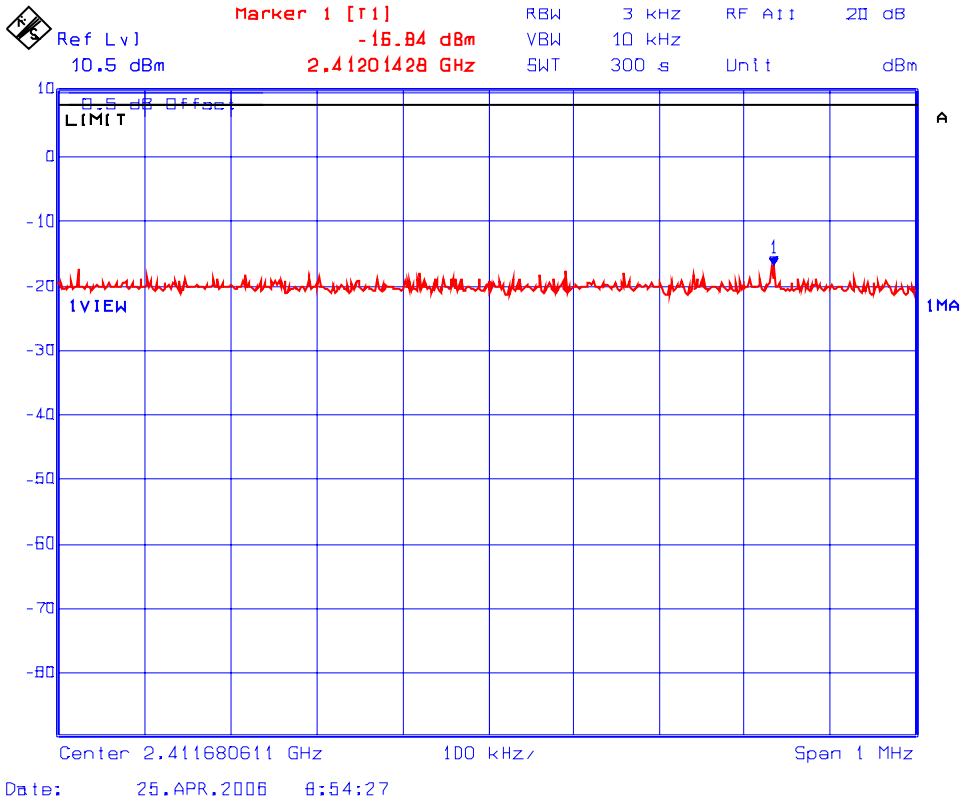
Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer/ EMI Receiver	Rohde & Schawrz	FSEK20/B4/B21	834157/005	9 kHz – 40 GHz with external mixer

4.12.5. Test Data

Test Method:	FCC Measurement of Digital Transmission Systems Operating under Section 15.247 - March 23, 2005: • PSD Option 1

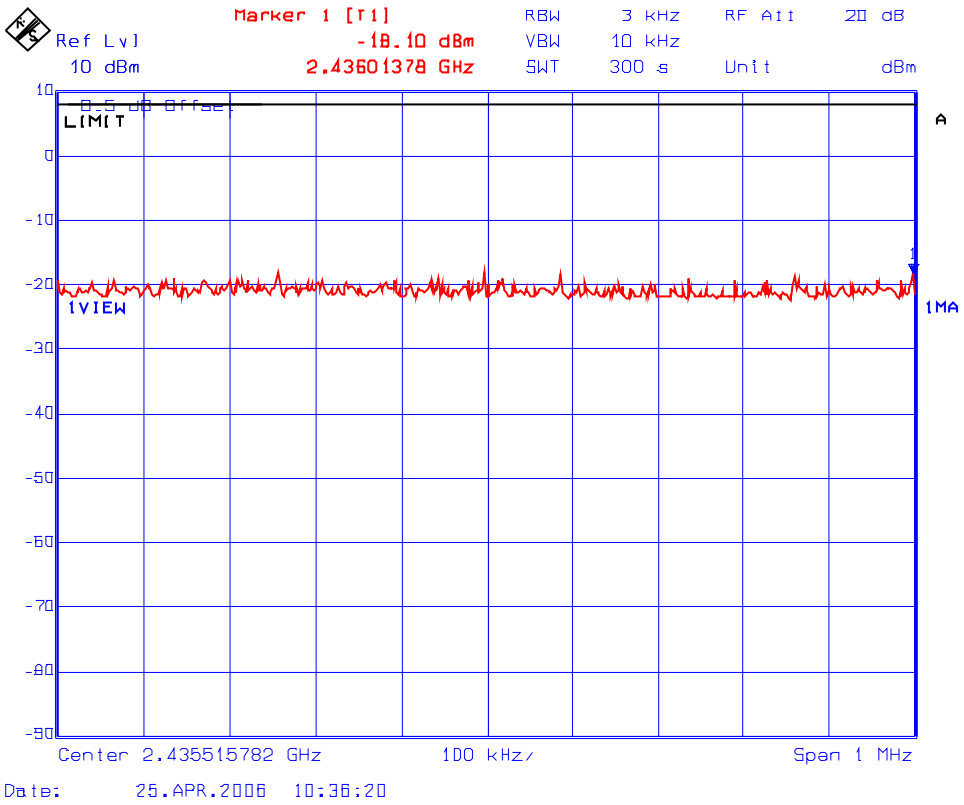
Conforms. Please refer to Plots # 20 to 28 for details of measurement data

Plot # 20: Power Density in 3 kHz BW
Frequency: 2412 MHz, Modulations: 802.11(b) - BPSK, Data Rate: 1 Mbps



Plot # 21: Power Density in 3 kHz BW

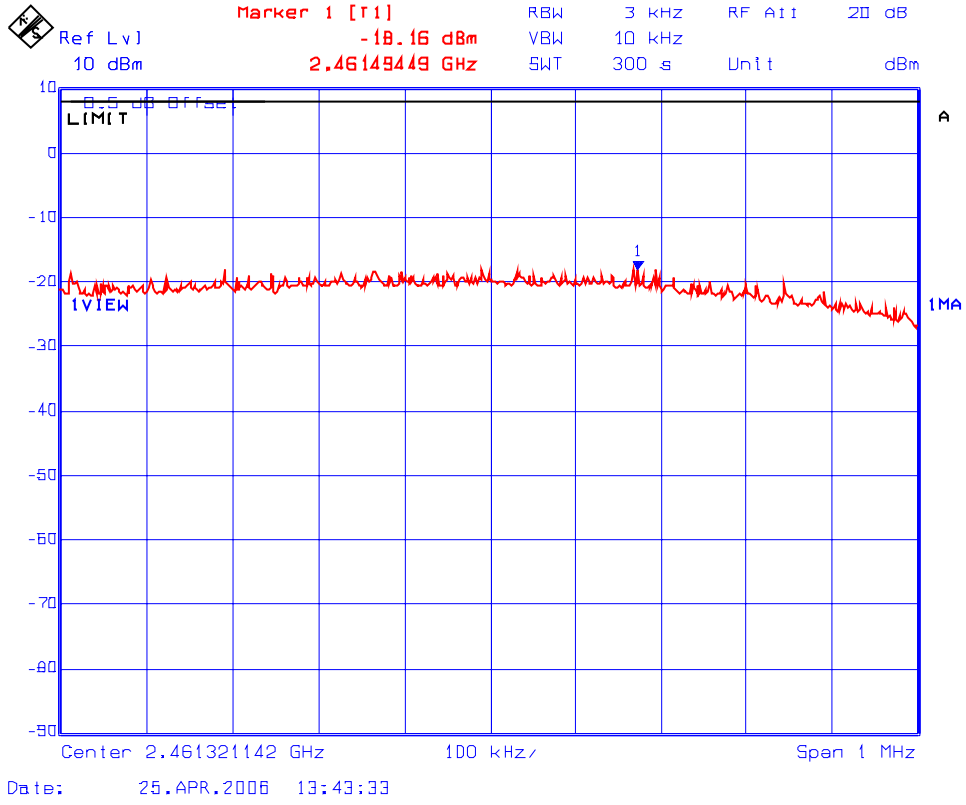
Frequency: 2437 MHz, Modulations: 802.11(b) - BPSK, Data Rate: 1 Mbps



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

Plot # 22: Power Density in 3 kHz BW

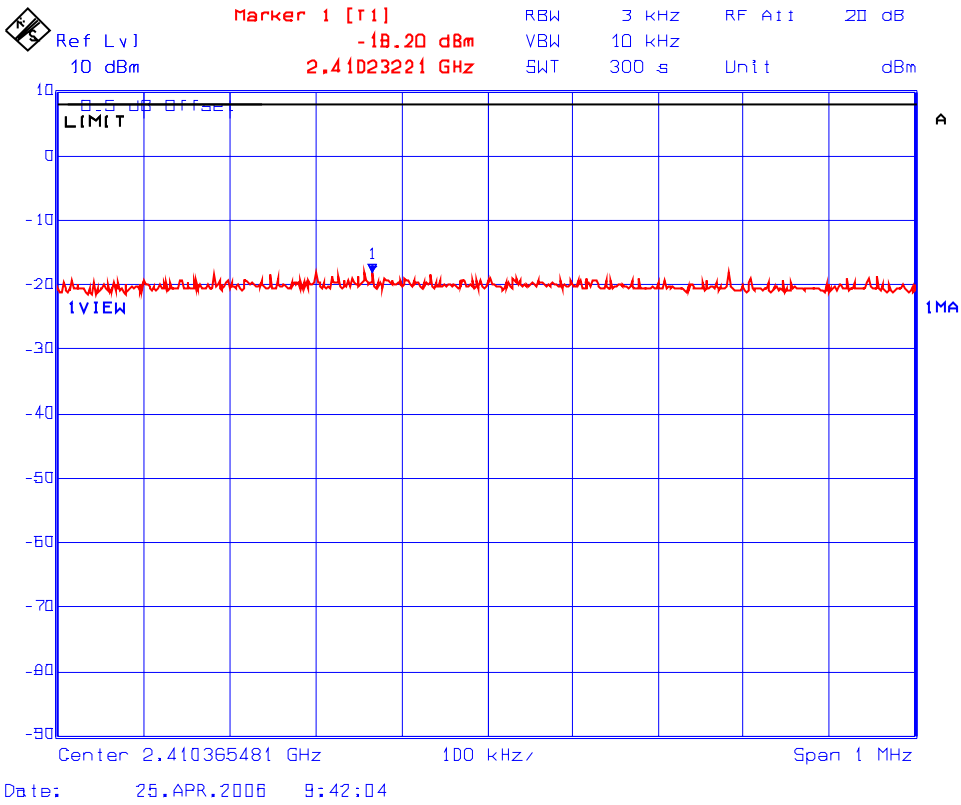
Frequency: 2462 MHz, Modulations: 802.11(b) - BPSK, Data Rate: 1 Mbps



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

Plot # 23: Power Density in 3 kHz BW

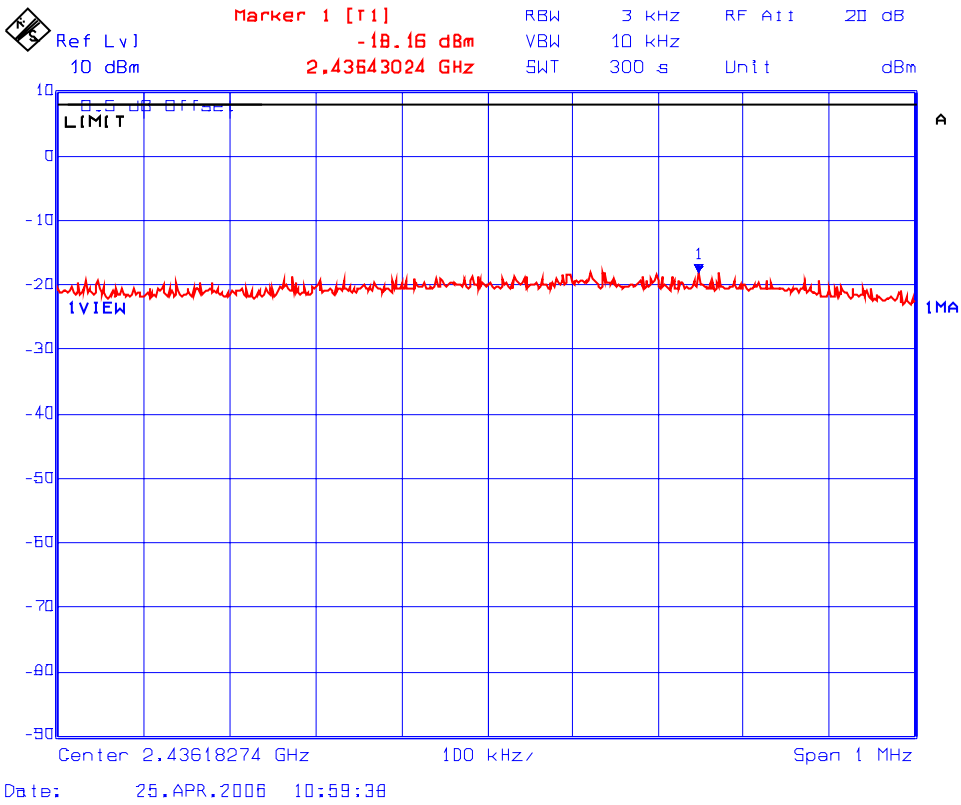
Frequency: 2412 MHz, Modulations: 802.11(b) - QPSK, Data Rate: 1 Mbps



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

Plot # 24: Power Density in 3 kHz BW

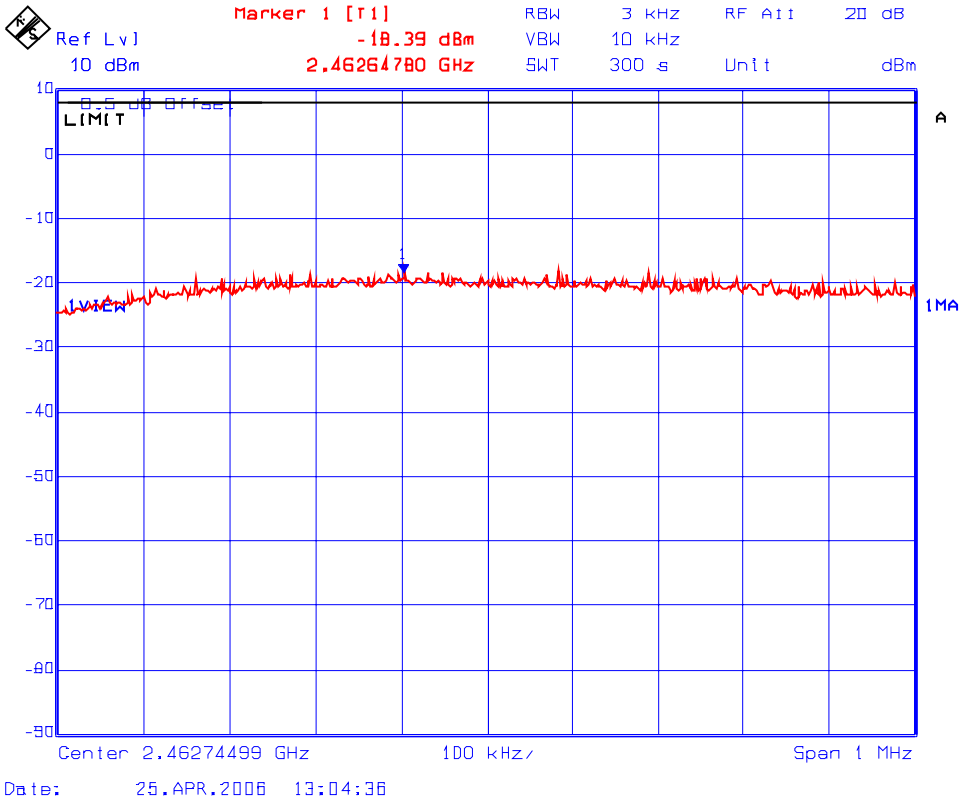
Frequency: 2437 MHz, Modulations: 802.11(b) - QPSK, Data Rate: 1 Mbps



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

Plot # 25: Power Density in 3 kHz BW

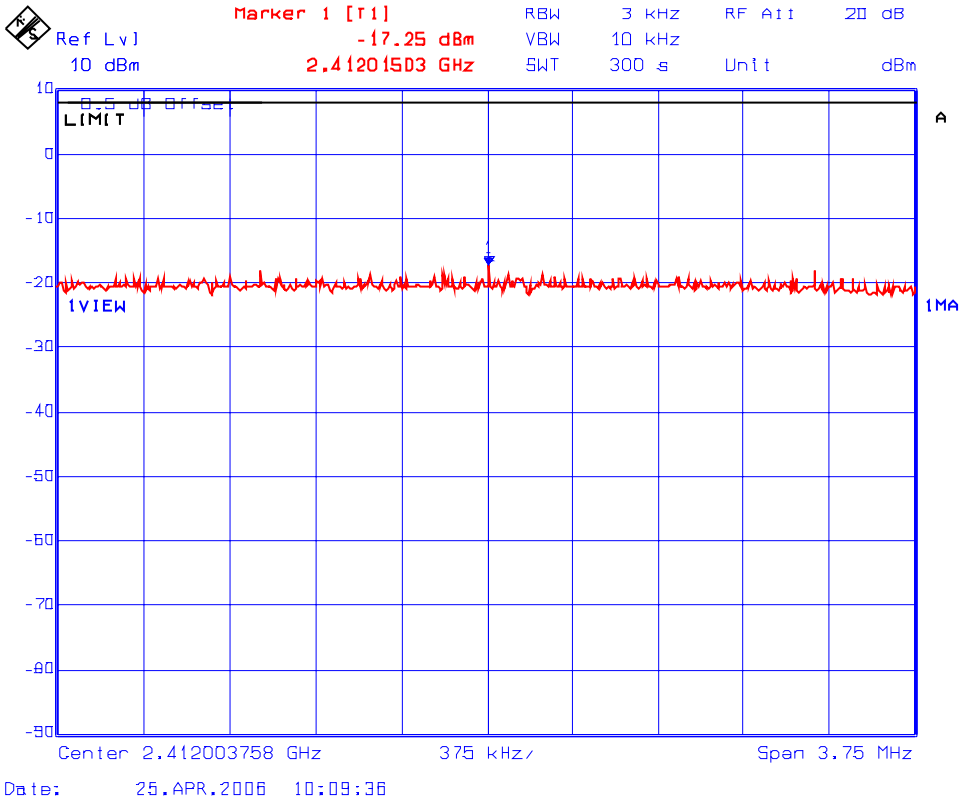
Frequency: 2462 MHz, Modulations: 802.11(b) - QPSK, Data Rate: 1 Mbps



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

Plot # 26: Power Density in 3 kHz BW

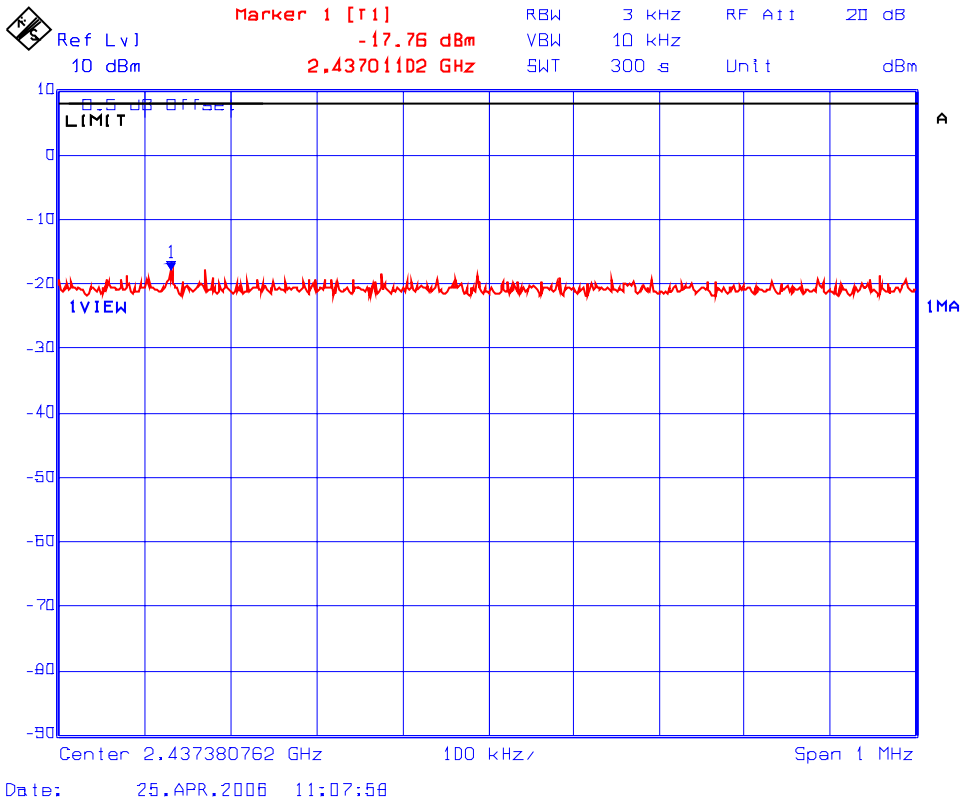
Frequency: 2412 MHz, Modulations: 802.11(b) - CCK, Data Rate: 11 Mbps



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

Plot # 27: Power Density in 3 kHz BW

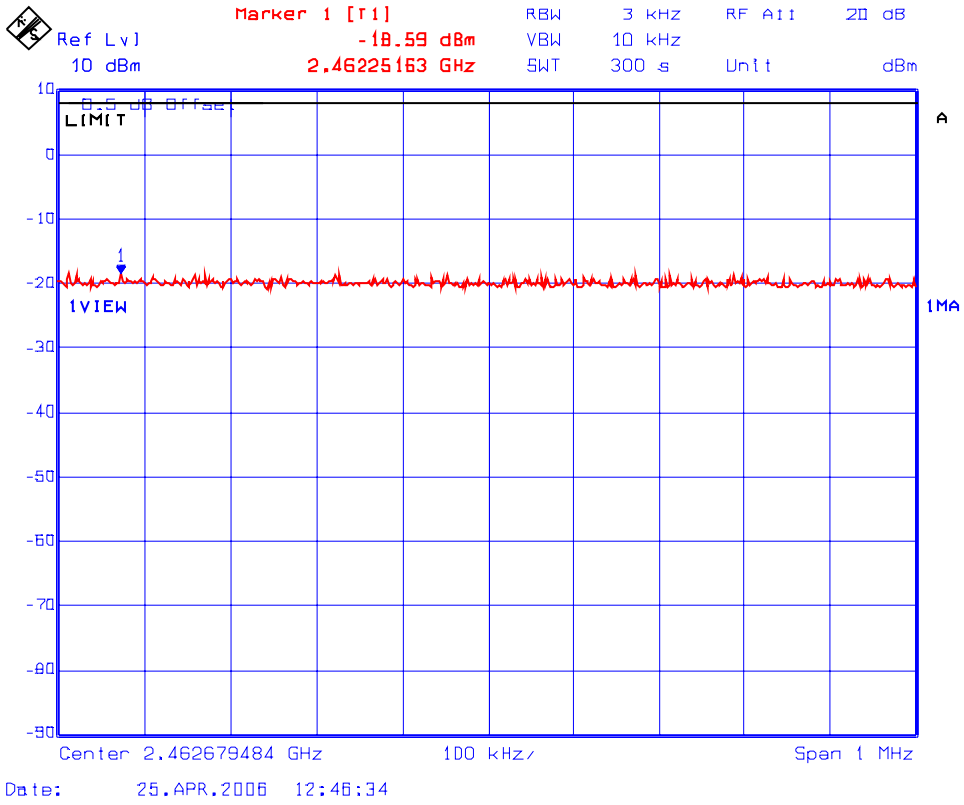
Frequency: 2437 MHz, Modulations: 802.11(b) - CCK, Data Rate: 11 Mbps



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

Plot # 28: Power Density in 3 kHz BW

Frequency: 2462 MHz, Modulations: 802.11(b) - CCK, Data Rate: 11 Mbps



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

4.13. TRANSMITTER BAND-EDGE & SPURIOUS EMISSIONS (RADIATED @ 3 METERS), FCC CFR 47, PARA. 15.247(D), 15.209 & 15.205

4.13.1. Limits

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. Attenuation below the general limits specified in § 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in § 15.205(a), must also comply with the radiated emission limits specified in § 15.209(a) (see § 15.205(c)).

Remarks:

- Applies to harmonics/spurious emissions that fall in the restricted bands listed in Section 15.205. The maximum permitted average field strength is listed in Section 15.209.
- **@ FCC CFR 47, Para. 15.237(c)** - The emission limits as specified above are based on measurement instrument employing an average detector. The provisions in **@15.35** for limiting peak emissions apply.

FCC CFR 47, Part 15, Subpart C, Para. 15.205(a) - Restricted Frequency Bands

MHz	MHz	MHz	GHz
0.090 - 0.110	162.0125 - 167.17	2310 - 2390	9.3 - 9.5
0.49 – 0.51	167.72 - 173.2	2483.5 - 2500	10.6 - 12.7
2.1735 - 2.1905	240 - 285	2655 - 2900	13.25 - 13.4
8.362 - 8.366	322 - 335.4	3260 - 3267	14.47 - 14.5
13.36 - 13.41	399.9 - 410	3332 - 3339	14.35 - 16.2
25.5 – 25.67	608 - 614	3345.8 - 3358	17.7 - 21.4
37.5 – 38.25	960 - 1240	3600 - 4400	22.01 - 23.12
73 - 75.4	1300 - 1427	4500 - 5250	23.6 - 24.0
108 – 121.94	1435 - 1626.5	5350 - 5460	31.2 - 31.8
123 – 138	1660 - 1710	7250 - 7750	36.43 - 36.5
149.9 – 150.05	1718.8 - 1722.2	8025 - 8500	Above 38.6
156.7 – 156.9	2200 - 2300	9000 - 9200	

FCC CFR 47, Part 15, Subpart C, Para. 15.209(a)
-- Field Strength Limits within Restricted Frequency Bands --

FREQUENCY (MHz)	FIELD STRENGTH LIMITS (microvolts/m)	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

4.13.2. Method of Measurements

Refer to "FCC Measurement of Digital Transmission Systems Operating under Section 15.247 - March 23, 2005" and Ultratech Test Procedures, File # ULTR P003-2004 and ANSI C63.4 for measurement methods

Radiated emission test: Applies to harmonics/spurs that fall in the restricted bands listed in Section 15.205. The maximum permitted average field strength is listed in Section 15.209. A pre-amp (and possibly a high-pass filter) is necessary for this measurement. For measurements above 1 GHz, set RBW = 1MHz, VBW = 10 Hz, Sweep: Auto. If the emission is pulsed, modify the unit for continuous operation; use the settings shown above, then correct the reading by subtracting the peak-average correction factor, derived from the appropriate duty cycle calculation. See Section 15.35(b) and (c).

4.13.3. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer/ EMI Receiver	Rohde & Schawrz	FSEK20/B4/B21	834157/005	9 kHz – 40 GHz with external mixer
Microwave Amplifier	Hewlett Packard	HP 83017A		1 GHz to 26.5 GHz
Biconilog Antenna	EMCO	3143	1029	20 MHz to 2 GHz
Horn Antenna	EMCO	3155	9701-5061	1 GHz – 18 GHz
Horn Antenna	EMCO	3160-09	..	18 GHz – 26.5 GHz

4.13.4. Photographs of Test Setup

Refer to the Photographs #3 to #5 in Annex 1 for setup and arrangement of equipment under tests and its ancillary equipment.

4.13.5. Test Data

Note: Since the rf output power, 6 dB bandwidth and conducted band-edge and spurious emissions are the same for all modulations, the band-edge radiated emissions are only needed to be performed with CCK @ 11 Mbps to represent for all.

4.13.5.1. Transmitter Radiated Band-edge Spurious Emissions

Conforms. Please refer to Plots # 29(a)(b) to 30(a)(b) for detailed measurements of band-edge conducted emissions.

Remarks for Plots of Transmitter Radiated Band-edge Emisisons:

In making radiated band-edge measurements, there can be a problem obtaining meaningful data since a measurement instrument that is tuned to a band-edge frequency may also capture some in-band signals when using the resolution bandwidth (RBW) required by measurement procedure ANSI C63.4-1992 (hereafter C63.4). In an effort to compensate for this problem, we have developed the following technique for determining band-edge compliance.

STEP 1) Perform an in-band field strength measurement of the fundamental emission using the RBW and detector function required by C63.4 and our Rules for the frequency being measured. For example, for transmitters operating above 1 GHz, use a 1 MHz RBW, a 1 MHz VBW, and a peak detector (as required by Section 15.35). Repeat the measurement with an average detector (i.e., 1 MHz RBW with 10 Hz VBW). Note: For pulsed emissions, other factors must be included. Please contact the FCC Lab for details if the emission under investigation is pulsed. Also, please note that radiated measurements of the fundamental emission of a transmitter operating under 15.247 are not normally required, but they are necessary in connection with this procedure.

** Note: Trace 1 (Red) is peak measurement with RBW= 1 MHz, VBW= 3 MHz, Detector

STEP 2) Choose a spectrum analyzer span that encompasses both the peak of the fundamental emission and the band-edge emission under investigation. Set the analyzer RBW to 1% of the total span (but never less than 30 kHz) with a video bandwidth equal to or greater than the RBW. Record the peak levels of the fundamental emission and the relevant band-edge emission (i.e., run several sweeps in peak hold mode). Observe the stored trace and measure the amplitude delta between the peak of the fundamental and the peak of the band-edge emission. This is not a field strength measurement, it is only a relative measurement to determine the amount by which the emission drops at the band-edge relative to the highest fundamental emission level.

** Note: Trace 2 (Blue): is a measurement with RBW= 500 kHz = 1% of Total Span (50MHz), VBW= 1 MHz,
the Delta is a difference between the peaks of Trace 1 (Red) and the relevant band-edge emission of the Trace 2 (Blue).

STEP 4) The above "delta" measurement technique may be used for measuring emissions that are up to two "standard" bandwidths away from the band-edge, where a "standard" bandwidth is the bandwidth specified by C63.4 for the frequency being measured. For example, for band-edge measurements in the restricted band that begins at 2483.5 MHz, C63.4 specifies a measurement bandwidth of at least 1 MHz. Therefore you may use the "delta" technique for measuring emissions up to 2 MHz removed from the band-edge. Radiated emissions that are removed by more than two “standard” bandwidths must be measured in the conventional manner.

4.13.5.2. Transmitter Radiated Spurious Emissions

4.13.5.2.1. Lowest Frequency (2412 MHz) – Modulation: 802.11b – CCK @ 11Mbps

FREQUENCY (MHz)	RF PEAK LEVEL (dBuV/m)	RF AVG LEVEL (dBuV/m)	ANTENNA PLANE (H/V)	LIMIT 15.209 (dBuV/m)	LIMIT 15.247 (dBuV/m)	MARGIN (dB)	PASS/ FAIL
2412	101.3	N/A	V	N/A	N/A	N/A	PASS
2412	103.2	N/A	H	N/A	N/A	N/A	PASS
4824	55.8	44.8	V	N/A	83.2	-38.4	PASS
4824	55.2	44.4	H	N/A	83.2	-38.8	PASS
The emissions were scanned from 30 MHz to 25 GHz and all emissions less 40 dB below the limits were recorded.							

4.13.5.2.2. Lowest Frequency (2437 MHz) – Modulation: 802.11b – CCK @ 11Mbps

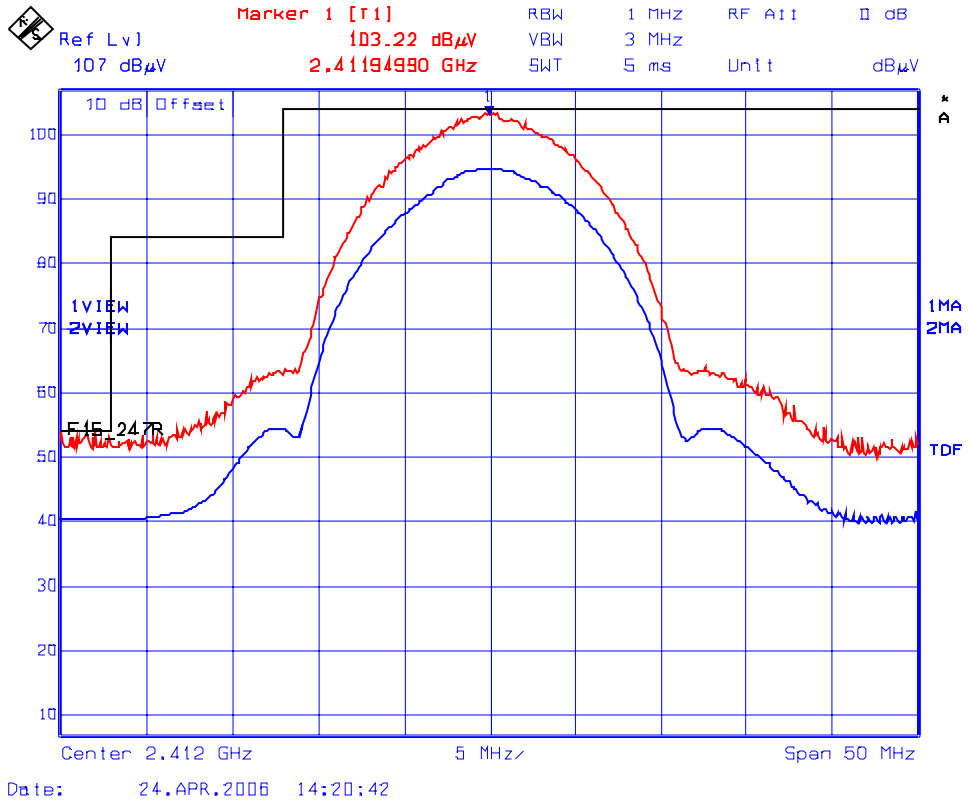
FREQUENCY (MHz)	RF PEAK LEVEL (dBuV/m)	RF AVG LEVEL (dBuV/m)	ANTENNA PLANE (H/V)	LIMIT 15.209 (dBuV/m)	LIMIT 15.247 (dBuV/m)	MARGIN (dB)	PASS/ FAIL
2437	101.5	N/A	V	N/A	N/A	N/A	PASS
2437	102.2	N/A	H	N/A	N/A	N/A	PASS
4874	55.9	44.4	V	N/A	82.2	-37.8	PASS
4874	55.6	44.2	H	N/A	82.2	-38.0	PASS
The emissions were scanned from 30 MHz to 25 GHz and all emissions less 40 dB below the limits were recorded.							

4.13.5.2.3. Lowest Frequency (2437 MHz) – Modulation: 802.11b – CCK @ 11Mbps

Power FREQUENCY (MHz)	RF PEAK LEVEL (dBuV/m)	RF AVG LEVEL (dBuV/m)	ANTENNA PLANE (H/V)	LIMIT 15.209 (dBuV/m)	LIMIT 15.247 (dBuV/m)	MARGIN (dB)	PASS/ FAIL
2462	102.4	N/A	V	N/A	N/A	N/A	PASS
2462	102.2	N/A	H	N/A	N/A	N/A	PASS
4924	55.4	44.1	V	N/A	82.2	-38.1	PASS
4924	55.3	43.1	H	N/A	82.2	-39.1	PASS
The emissions were scanned from 30 MHz to 25 GHz and all emissions less 40 dB below the limits were recorded.							

Plot # 29(a): Band-edge Radiated Emissions – Horizontal Polarization
Lower Frequency: 2412 MHz, Modulations: 802.11(b) - CCK, Data Rate: 11 Mbps

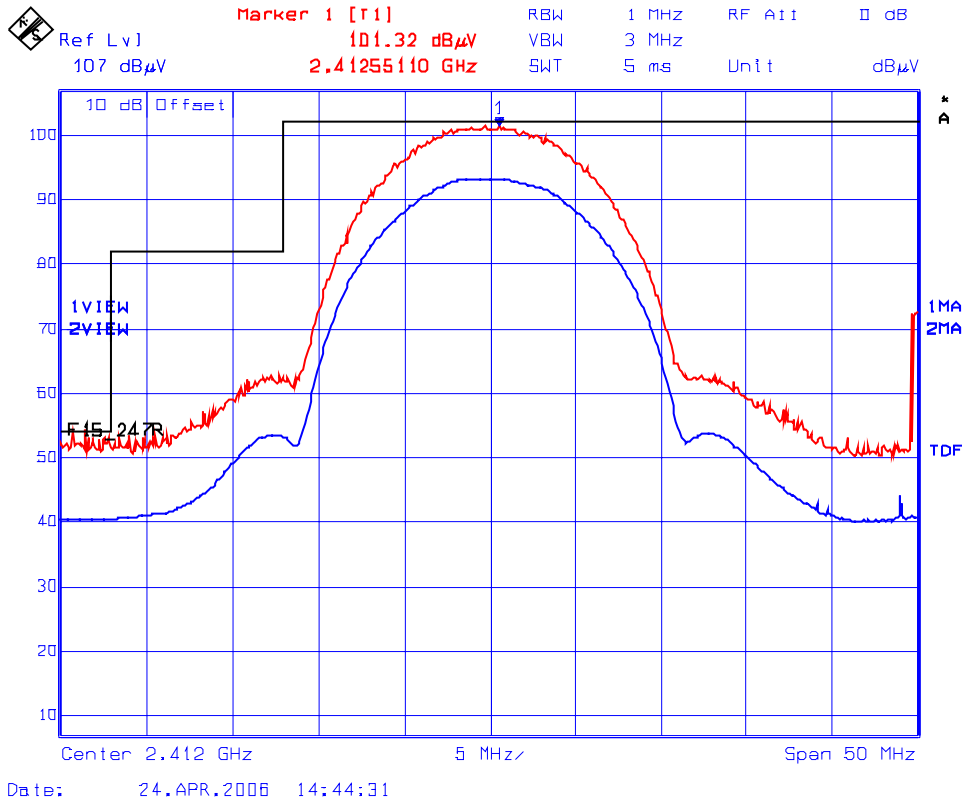
Remarks:
(1) Trace 1 (Red) is peak measurement with RBW= 1 MHz, VBW= 3 MHz, Detector
(2) Trace 2 (Blue): is a measurement with RBW= 500 kHz = 1% of Total Span (50MHz), VBW= 1 MHz.



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

Plot # 29(b): Band-edge Radiated Emissions – Vertical Polarization
Lower Frequency: 2412 MHz, Modulations: 802.11(b) - CCK, Data Rate: 11 Mbps

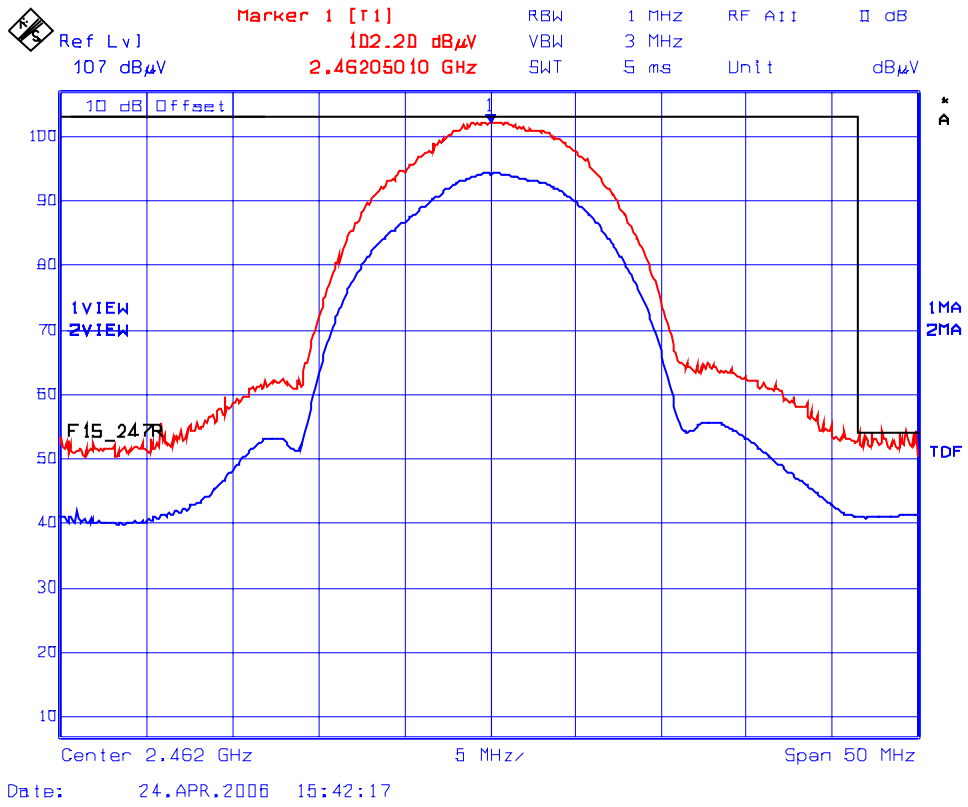
Remarks:
(1) Trace 1 (Red) is peak measurement with RBW= 1 MHz, VBW= 3 MHz, Detector
(2) Trace 2 (Blue): is a measurement with RBW= 500 kHz = 1% of Total Span (50MHz), VBW= 1 MHz.



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

Plot # 30(a): Band-edge Radiated Emissions – Horizontal Polarization
Upper Frequency: 2462 MHz, Modulations: 802.11(b) - CCK, Data Rate: 11 Mbps

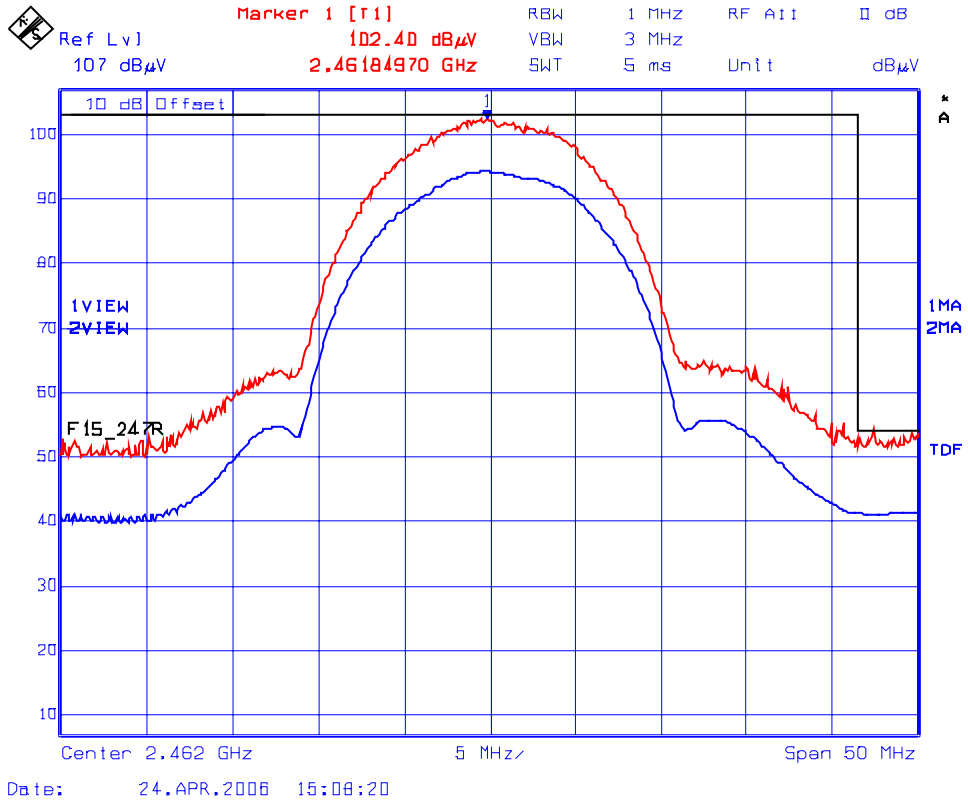
Remarks:
(1) Trace 1 (Red) is peak measurement with RBW= 1 MHz, VBW= 3 MHz, Detector
(2) Trace 2 (Blue): is a measurement with RBW= 500 kHz = 1% of Total Span (50MHz), VBW= 1 MHz.



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

Plot # 30(b): Band-edge Radiated Emissions – Vertical Polarization
Upper Frequency: 2462 MHz, Modulations: 802.11(b) - CCK, Data Rate: 11 Mbps

Remarks:
(1) Trace 1 (Red) is peak measurement with RBW= 1 MHz, VBW= 3 MHz, Detector
(2) Trace 2 (Blue): is a measurement with RBW= 500 kHz = 1% of Total Span (50MHz), VBW= 1 MHz.



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

EXHIBIT 5. MEASUREMENT UNCERTAINTY

The measurement uncertainties stated were calculated in accordance with the requirements of NIST Technical Note 1297 and LAB 34

5.1. 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 kHz) 0.2 (30 MHz) Uncertainty limits 20Log(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:

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

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

5.2. 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 Γ_1 = 0.2 Antenna VRC Γ_R = 0.67(Bi) 0.3 (Lp) Uncertainty limits 20Log(1±$\Gamma_1\Gamma_R$)	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:

$U = 2u_c(y) = 2x(+2.19) = +4.38$ dB And $U = 2u_c(y) = 2x(-2.21) = -4.42$ dB