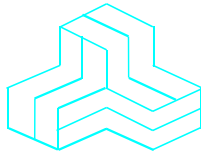


ENGINEERING TEST REPORT



XBee
Model No.: XB24

FCC ID: OUR-XBEE

Applicant:

MaxStream, Inc.
355 South 520 West Suite 180
Lindon, UT 84058

In Accordance With

Federal Communications Commission (FCC)
Part 15, Subpart C, Section 15.247
Digital Modulation Systems (DTS) Operating in 2400 – 2483.5 MHz Band

UltraTech's File No.: MXS-056F15C247C2PC

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



Date: May 17, 2007

Report Prepared by: Dan Huynh

Tested by: Mr. Hung Trinh, EMI/RFI Technician

Issued Date: May 17, 2007

Test Dates: April 17-29, 2007

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

UltraTech

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TABLE OF CONTENTS

EXHIBIT 1.	SUBMITTAL CHECK LIST	1
EXHIBIT 2.	INTRODUCTION.....	2
2.1.	SCOPE	2
2.2.	RELATED SUBMITTAL(S)/GRANT(S).....	2
2.3.	NORMATIVE REFERENCES	3
EXHIBIT 3.	PERFORMANCE ASSESSMENT	4
3.1.	CLIENT INFORMATION	4
3.2.	EQUIPMENT UNDER TEST (EUT) INFORMATION	4
3.3.	EUT'S TECHNICAL SPECIFICATIONS	5
3.4.	ASSOCIATED ANTENNA DESCRIPTION	5
3.5.	LIST OF EUT'S PORTS.....	6
3.6.	ANCILLARY EQUIPMENT	6
EXHIBIT 4.	EUT OPERATING CONDITIONS AND CONFIGURATIONS DURING TESTS.....	7
4.1.	CLIMATE TEST CONDITIONS	7
4.2.	OPERATIONAL TEST CONDITIONS & ARRANGEMENT FOR TESTS	7
EXHIBIT 5.	SUMMARY OF TEST RESULTS.....	8
5.1.	LOCATION OF TESTS	8
5.2.	APPLICABILITY & SUMMARY OF EMC EMISSION TEST RESULTS	8
5.3.	MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES	8
EXHIBIT 6.	MEASUREMENTS, EXAMINATIONS & TEST DATA FOR EMC EMISSIONS.....	9
6.1.	TEST PROCEDURES	9
6.2.	MEASUREMENT UNCERTAINTIES	9
6.3.	MEASUREMENT EQUIPMENT USED	9
6.4.	ESSENTIAL/PRIMARY FUNCTIONS AS DECLARED BY THE MANUFACTURER.....	9
6.5.	AC POWER LINE CONDUCTED EMISSIONS [§15.207(a)]	10
6.6.	OCCUPIED BANDWIDTH [§ 15.247(a)(2)]	14
6.7.	PEAK CONDUCTED OUTPUT POWER - DTS [§ 15.247(b)(3)]	21
6.8.	TRANSMITTER BAND-EDGE & SPURIOUS CONDUCTED EMISSIONS [§ 15.247(d)].....	25
6.9.	TRANSMITTER SPURIOUS RADIATED EMISSIONS AT 3 METERS [§§ 15.247(d), 15.209 & 15.205]	34
6.10.	POWER SPECTRAL DENSITY [§ 15.247(e)]	54
6.11.	RF EXPOSURE REQUIRMENTS [§§ 15.247(e)(i), 1.1310 & 2.1091].....	58
EXHIBIT 7.	MEASUREMENT UNCERTAINTY.....	60
7.1.	LINE CONDUCTED EMISSION MEASUREMENT UNCERTAINTY.....	60
7.2.	RADIATED EMISSION MEASUREMENT UNCERTAINTY	61

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File #: MXS-056F15C247C2PC

May 17, 2007

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EXHIBIT 1. SUBMITTAL CHECK LIST

Annex No.	Exhibit Type	Description of Contents	Quality Check (OK)
--	Test Report	<ul style="list-style-type: none">Exhibit 1: Submittal check listsExhibit 2: IntroductionExhibit 3: Performance AssessmentExhibit 4: EUT Operation and Configuration during TestsExhibit 5: Summary of test ResultsExhibit 6: Measurement DataExhibit 7: Measurement Uncertainty	OK
1	Test Setup Photos	<ul style="list-style-type: none">AC Conducted Emissions Setup PhotosRadiated Emissions Setup Photos	OK
2	External EUT Photos	--	--
3	Internal EUT Photos	--	--
4	Cover Letters	<ul style="list-style-type: none">Letter from Ultratech for Certification RequestLetter from the Applicant to appoint Ultratech to act as an agentLetter from the Applicant to request for Confidentiality Filing	OK
5	Attestation Statements	--	--
6	ID Label/Location Info	--	--
7	Block Diagrams	Block Diagram	OK
8	Schematic Diagrams	Schematics	OK
9	Parts List/Tune Up Info	Parts List	OK
10	Operational Description	Operation Description	OK
11	RF Exposure Info	MPE Evaluation, see section 6.11 in this Test Report for details.	OK
12	Users Manual	XBee OEM RF Module – Product Manual	OK

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File #: MXS-056F15C247C2PC

May 17, 2007

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EXHIBIT 2. INTRODUCTION

2.1. SCOPE

Reference:	FCC Part 15, Subpart C, Section 15.247
Title:	Code of Federal Regulations (CFR), Title 47 – Telecommunication, Part 15
Purpose of Test:	<p>Class II Permissive Changes application for equipment certification of Digital Modulation Systems (DTS) Transmitter Operating in the Frequency Band 2400-2483.5 MHz.</p> <p>The changes made in the MaxStream XBee module are as follows:</p> <ol style="list-style-type: none">1. The principal semiconductor content of the module consisted of a microcontroller and an RF chip. The semiconductor manufacturer has merged the microcontroller and RF chip into a single integrated package.2. The circuit layout was modified to remove the wiring between the two chips and connect the single chip package to the module pins.3. The circuit layout was changed to connect the radio portion of the single chip to antenna. Components were adjusted to match the RF stage of the radio to the antenna
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:	<p>[x] Commercial, industrial or business environment</p> <p>[x] Residential environment</p>

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

None.

2.3. NORMATIVE REFERENCES

Publication	Year	Title
47 CFR Parts 0-19	2006	Code of Federal Regulations – Telecommunication
ANSI C63.4	2003	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
CISPR 22 CISPR 22 +A1 EN 55022	2003-04-10 2004-10-14 2003	Information Technology Equipment - Radio Disturbance Characteristics – Limits and Methods of Measurement
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
KDB Publication No. 558074	2005	Guidance on Measurements for Digital Transmission Systems (47 CFR 15.247)
FCC Public Notice DA 00-1407	2000	Part 15 Unlicensed Modular Transmitter Approval

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File #: MXS-056F15C247C2PC

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EXHIBIT 3. PERFORMANCE ASSESSMENT

3.1. CLIENT INFORMATION

APPLICANT	
Name:	MaxStream, Inc.
Address:	355 South 520 West Suite 180 Lindon, UT 84058 USA
Contact Person:	Mr. David Steed Phone #: (801) 765-9885 Fax #: (801) 765-9895 Email Address: davids@maxstream.net

MANUFACTURER	
Name:	MaxStream, Inc.
Address:	355 South 520 West Suite 180 Lindon, UT 84058 USA
Contact Person:	Mr. David Steed Phone #: (801) 765-9885 Fax #: (801) 765-9895 Email Address: davids@maxstream.net

3.2. EQUIPMENT UNDER TEST (EUT) INFORMATION

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

Brand Name:	MaxStream, Inc.
Product Name:	XBee
Model Name or Number:	XB24
Serial Number:	Test Sample
Type of Equipment:	Digital Modulation Transmitter
Input Power Supply Type:	2.8 Vdc – 3.4 Vdc Hewlett Packard DC Power Supply Model: E3615A S/N: KR61303416
Primary User Functions of EUT:	Wireless modem

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3.3. EUT'S TECHNICAL SPECIFICATIONS

TRANSMITTER	
Equipment Type:	<ul style="list-style-type: none">• Mobile• Base Station (fixed use)
Intended Operating Environment:	<ul style="list-style-type: none">• Commercial, industrial or business• Residential
Power Supply Requirement:	2.8 – 3.4 Vdc
RF Output Power Rating:	1 mW (0 dBm)
Operating Frequency Range:	2405 – 2480 MHz
RF Output Impedance:	50 Ohms
Channel Spacing:	5 MHz
Duty Cycle:	100%
6 dB bandwidth:	1.611MHz
Modulation Type:	QPSK
Oscillator Frequencies:	16 MHz
Antenna Connector Type:	<ul style="list-style-type: none">• Integral• Unique connector (IPX or U.FL)

3.4. ASSOCIATED ANTENNA DESCRIPTION

The highest gain antenna from each type of antenna was selected for testing to represent the worst case. The following antennas were selected for testing in this Class II Permissive Change filing:

1. D-Link Omni-directional Antenna (P/N: A24-F15NF; Max. Antenna Gain: 15 dBi)
2. Maxrad Yagi Antenna (P/N: A24-Y18NF; Max. Antenna Gain: 15 dBi)
3. ARC Panel Antenna (P/N: A24-P19NF; Max. Antenna Gain: 19 dBi)

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May 17, 2007

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3.5. LIST OF EUT'S PORTS

Port Number	EUT's Port Description	Number of Identical Ports	Connector Type	Cable Type (Shielded/Non-shielded)
1	RF IN/OUT Port	1	U.FL or IPX	Shielded
2	DC Supply & I/O Port	1	Pin Header	No cable, direct connection

3.6. 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:	Test Jig Board
Brand name:	MaxStream
Model Name or Number:	N/A
Serial Number:	N/A
Connected to EUT's Port:	Module pin signals

EXHIBIT 4. EUT OPERATING CONDITIONS AND CONFIGURATIONS DURING TESTS

4.1. CLIMATE TEST CONDITIONS

The climate conditions of the test environment are as follows:

Temperature:	21°C
Humidity:	51%
Pressure:	102 kPa
Power input source:	2.8 – 3.4 Vdc

4.2. 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 could be tested outside of the enclosure using Maxstream Test Jig Board connected to EUT.
Transmitter Test Antenna:	The EUT is tested with the antenna fitted in a manner typical of normal intended use as an integral / non-integral antenna equipment as described with the test results.

Transmitter Test Signals	
Frequency Band(s):	2405 – 2480 MHz
Frequency(ies) Tested: (Near lowest, near middle & near highest frequencies in the frequency range of operation.)	2405 MHz, 2440 MHz and 2480 MHz
RF Power Output: (measured maximum output power at antenna terminals)	-0.13dBm (0.001W)
Normal Test Modulation:	QPSK
Modulating Signal Source:	Internal

EXHIBIT 5. SUMMARY OF TEST RESULTS

5.1. LOCATION OF TESTS

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

- AC Power Line Conducted Emissions were performed in UltraTech's shielded room, 24'(L) by 16'(W) by 8'(H).
- Radiated Emissions were performed at the Ultratech's 3-10 TDK Semi-Anechoic Chamber situated in the Town of Oakville, province of Ontario. This test site been calibrated in accordance with ANSI C63.4, and found to be in compliance with the requirements of Sec. 2.948 of the FCC Rules. The descriptions and site measurement data of the Oakville 3-10 TDK Semi-Anechoic Chamber has been filed with FCC office (FCC File No.: 31040/SIT 1300B3) and Industry Canada office (Industry Canada Site No.: 2049A-2, Expiry Date: July 4, 2008).

5.2. APPLICABILITY & SUMMARY OF EMC EMISSION TEST RESULTS

FCC Section(s)	Test Requirements	Compliance (Yes/No)
15.203	Antenna requirements	Yes*
15.207(a)	AC 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
The digital circuit portion of the EUT has been tested and verified to comply with FCC Part 15, Subpart B, Class B Digital Devices. The engineering test report is available upon request.		

* The EUT complies with the requirement, it employs a unique (non-standard) antenna connector (IPX or U.FL), for all external antennas proposed for use with the EUT.

5.3. MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES

None.

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File #: MXS-056F15C247C2PC

May 17, 2007

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EXHIBIT 6. MEASUREMENTS, EXAMINATIONS & TEST DATA FOR EMC EMISSIONS

6.1. 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.

6.2. 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.

6.3. MEASUREMENT EQUIPMENT USED

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

6.4. ESSENTIAL/PRIMARY FUNCTIONS AS DECLARED BY THE MANUFACTURER

Wireless modem.

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

6.5.1. Limit(s)

The equipment shall meet the limits of the following table:

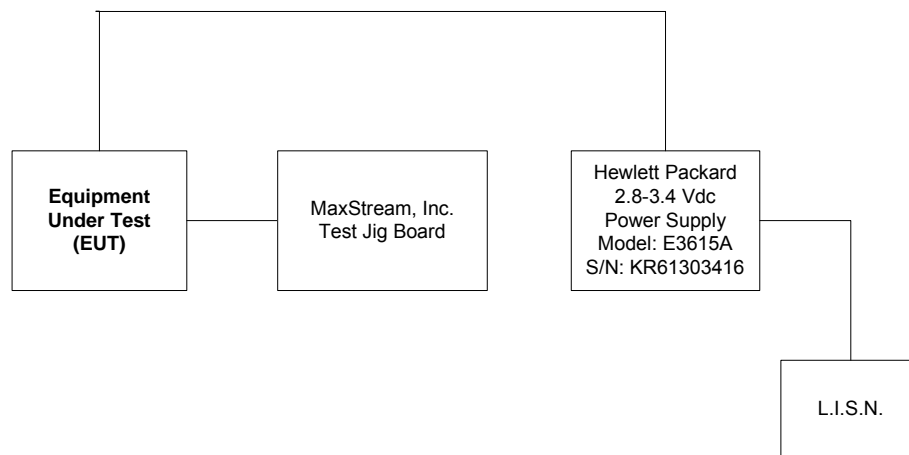
Frequency of emission (MHz)	Conducted Limits (dB μ V)		Measuring Bandwidth
	Quasi-peak	Average	
0.15–0.5	66 to 56*	56 to 46*	RBW = 9 kHz
0.5–5	56	46	VBW \geq 9 kHz for QP
5–30	60	50	VBW = 1 Hz for Average

*Decreases linearly with the logarithm of the frequency

6.5.2. Method of Measurements

ANSI C63.4

6.5.3. Test Arrangement



6.5.4. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer/ EMI Receiver	Hewlett Packard	HP 8593EM	3412A00103	9 kHz – 26.5 GHz
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 μ H
24'(L) x 16'(W) x 8'(H) RF Shielded Chamber	Braden Shielding

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File #: MXS-056F15C247C2PC

May 17, 2007

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6.5.5. Test Data

Frequency (MHz)	RF Level (dBμV)	Receiver Detector (P/QP/AVG)	QP Limit (dBuV)	AVG Limit (dBuV)	Margin (dB)	Pass/ Fail	Line Tested
0.153438	58.1	QP	65.8	55.8	-7.7	Pass	Positive
0.153438	44.9	AVG	65.8	55.8	-10.9	Pass	Positive
0.474819	40.2	QP	56.4	46.4	-16.2	Pass	Positive
0.474819	32.8	AVG	56.4	46.4	-13.6	Pass	Positive
13.647088	36.1	QP	60.0	50.0	-23.9	Pass	Positive
13.647088	31.8	AVG	60.0	50.0	-18.2	Pass	Positive
0.150550	58.4	QP	66.0	56.0	-7.6	Pass	Negative
0.150550	44.8	AVG	66.0	56.0	-11.2	Pass	Negative
0.507938	40.1	QP	56.0	46.0	-15.9	Pass	Negative
0.507938	30.2	AVG	56.0	46.0	-15.8	Pass	Negative
9.462488	39.4	QP	60.0	50.0	-20.6	Pass	Negative
9.462488	35.4	AVG	60.0	50.0	-14.6	Pass	Negative
13.565600	36.7	QP	60.0	50.0	-23.3	Pass	Negative
13.565600	32.5	AVG	60.0	50.0	-17.5	Pass	Negative

Note: See the following test data plots for details.

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File #: MXS-056F15C247C2PC

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Plot 6.5.5.1 Power Line Conducted Emissions
Line Voltage: 3.4VDC
Line Tested: Positive

hp

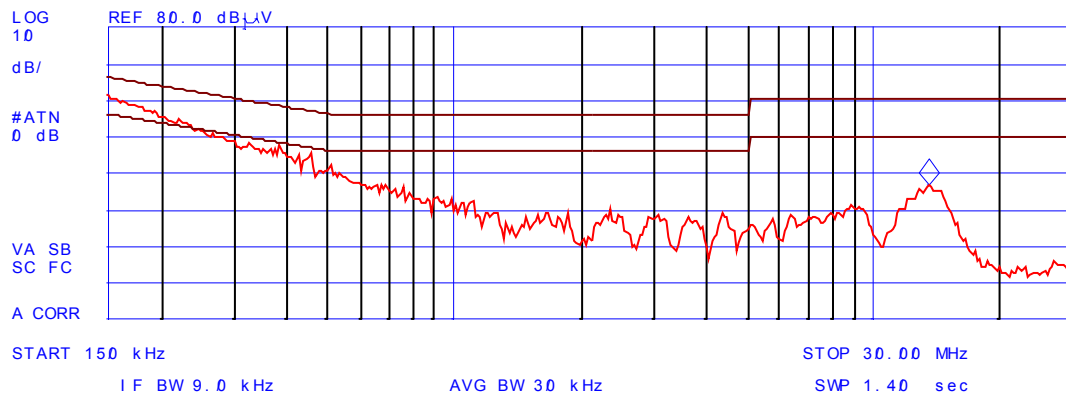
Signal	Freq (MHz)	PK Amp	QP Amp	AV Amp	QP Δ L1
1	0.153438	61.1	58.1	44.9	-7.7
2	0.474819	44.8	40.2	32.8	-16.3
3	13.647088	38.7	36.1	31.8	-23.9

ACTV DET: PEAK

MEAS DET: PEAK QP AVG

MKR 13.59 MHz

36.60 dB μ V



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May 17, 2007

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Plot 6.5.5.2 Power Line Conducted Emissions
Line Voltage: 3.4 VDC
Line Tested: Negative

hp

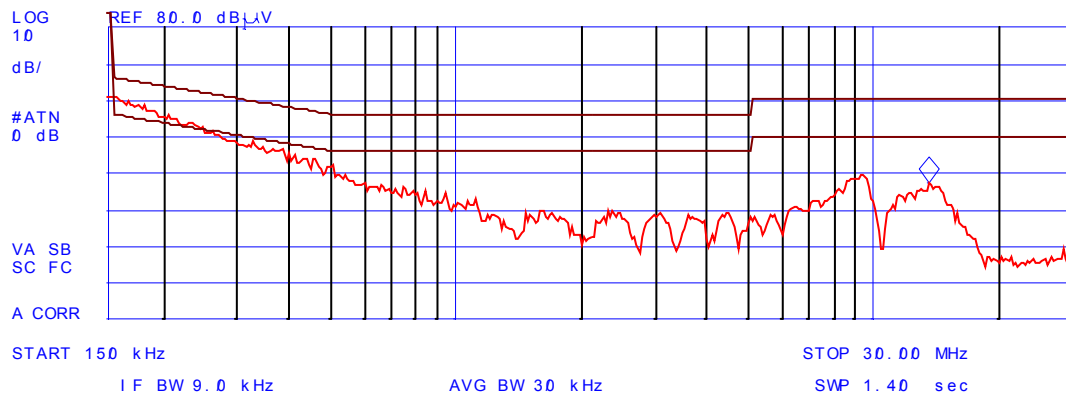
Signal	Freq (MHz)	PK Amp	QP Amp	AV Amp	QP Δ L1
1	0.150550	61.2	58.4	44.8	-7.6
2	0.507938	44.4	40.1	30.2	-15.9
3	9.462488	41.4	39.4	35.4	-20.6
4	13.565600	39.2	36.7	32.5	-23.3

ACTV DET: PEAK

MEAS DET: PEAK QP AVG

MKR 13.55 MHz

37.28 dB μ V



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May 17, 2007

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

6.6.1. Limit(s)

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

6.6.2. Method of Measurements

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

6.6.3. Test Arrangement



6.6.4. Test Equipment List

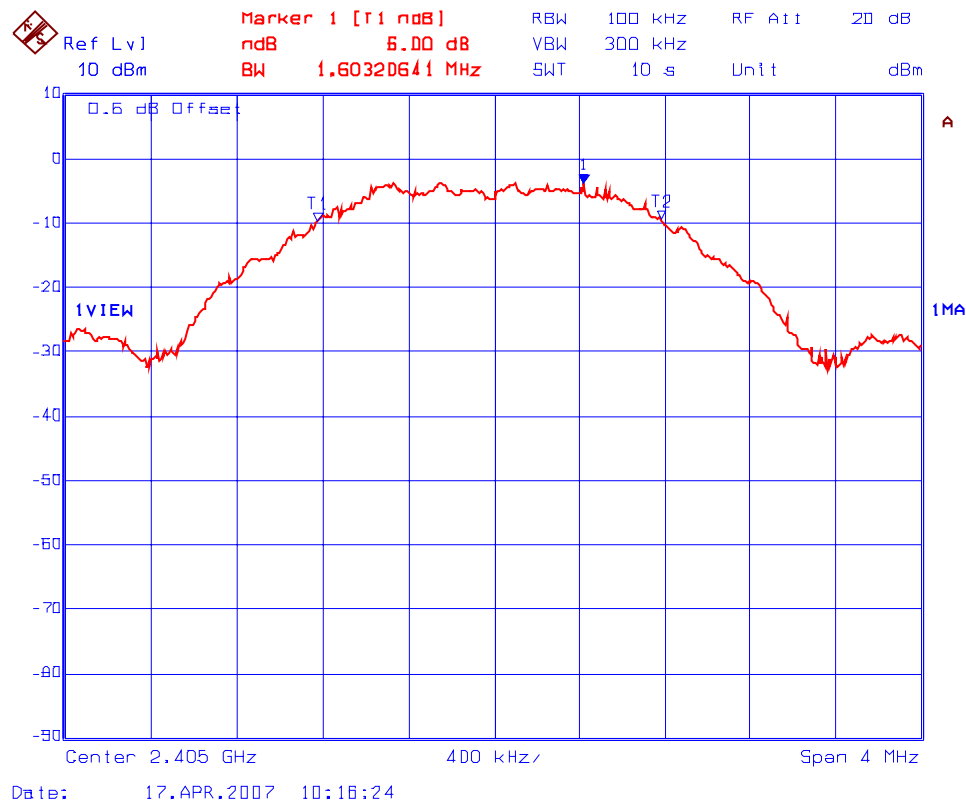
Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer	Rhode & Schwarz	FSEK20/B4/B21	834157/005	9 kHz- 40 GHz

6.6.5. Test Data

Frequency (MHz)	6 dB Bandwidth (MHz)	99% Occupied Bandwidth (MHz)
2405	1.603	2.349
2440	1.595	2.365
2480	1.611	2.357

See the following plots for detailed measurements.

Plot 6.6.5.1 6 dB Bandwidth
Frequency: 2405 MHz



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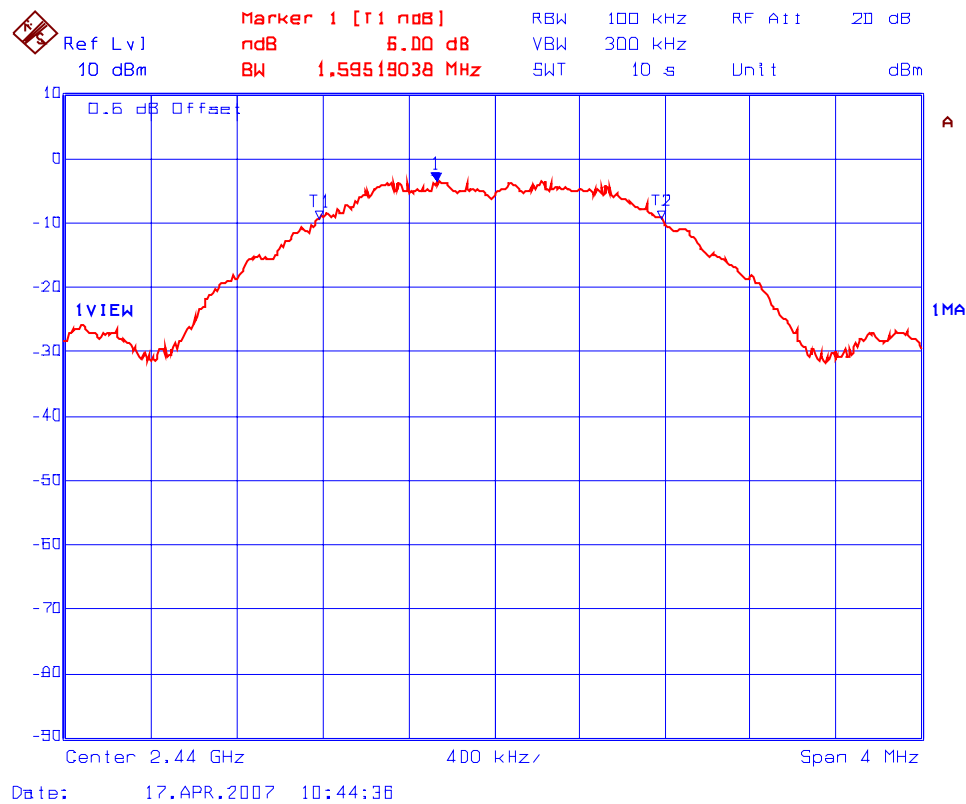
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Plot 6.6.5.2 6 dB Bandwidth
Frequency: 2440 MHz



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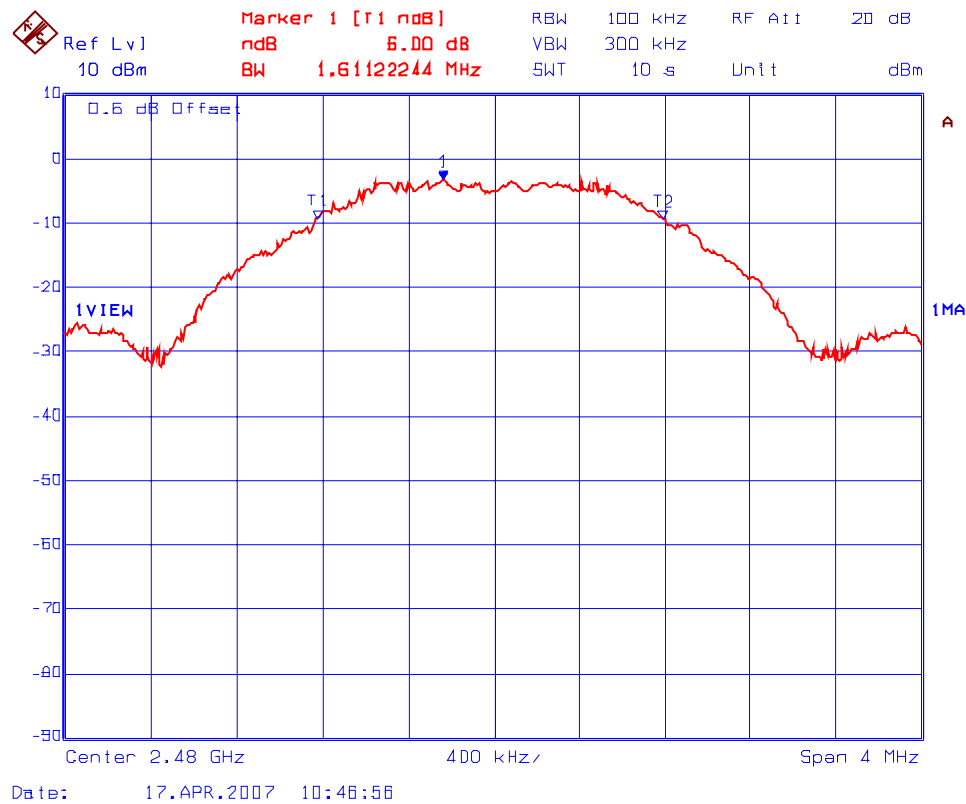
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Plot 6.6.5.3 6 dB Bandwidth
Frequency: 2480 MHz



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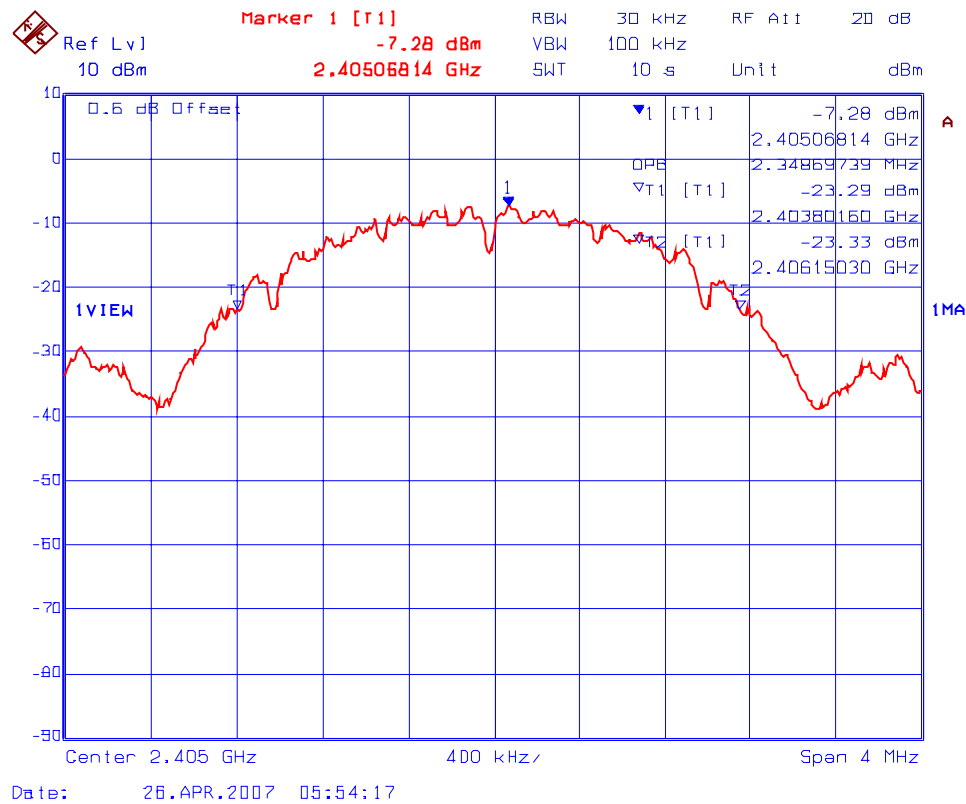
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Plot 6.6.5.4 99% Occupied Bandwidth
Frequency: 2405 MHz



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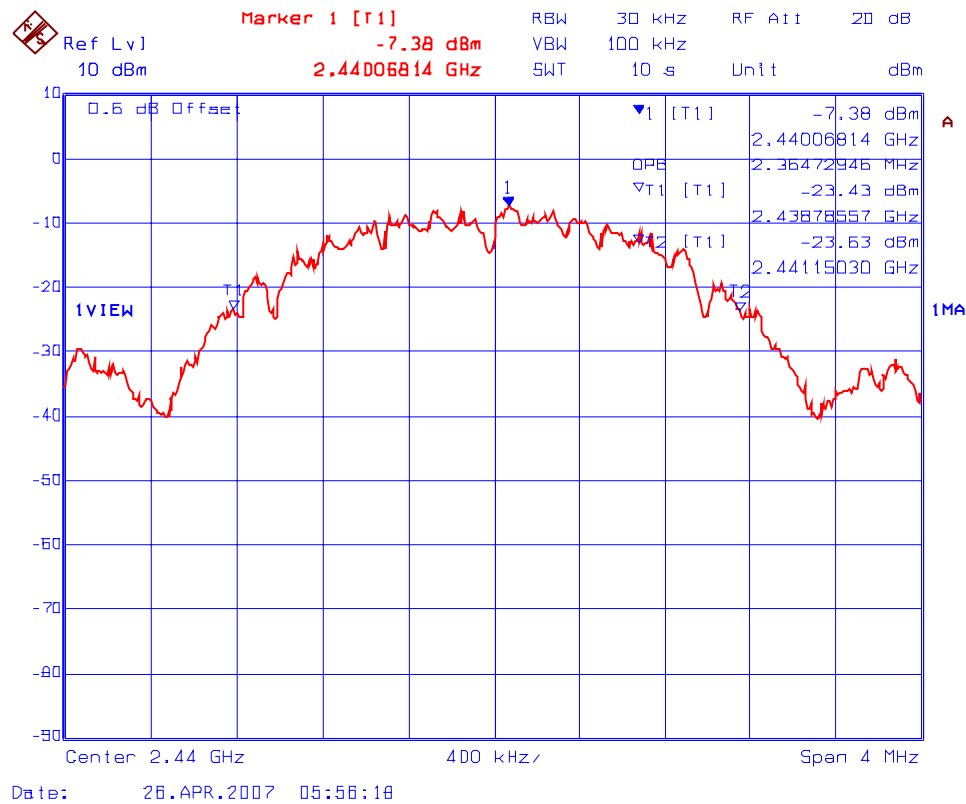
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4
Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: yic@ultratech-labs.com, Website: <http://www.ultratech-labs.com>

File #: MXS-056F15C247C2PC

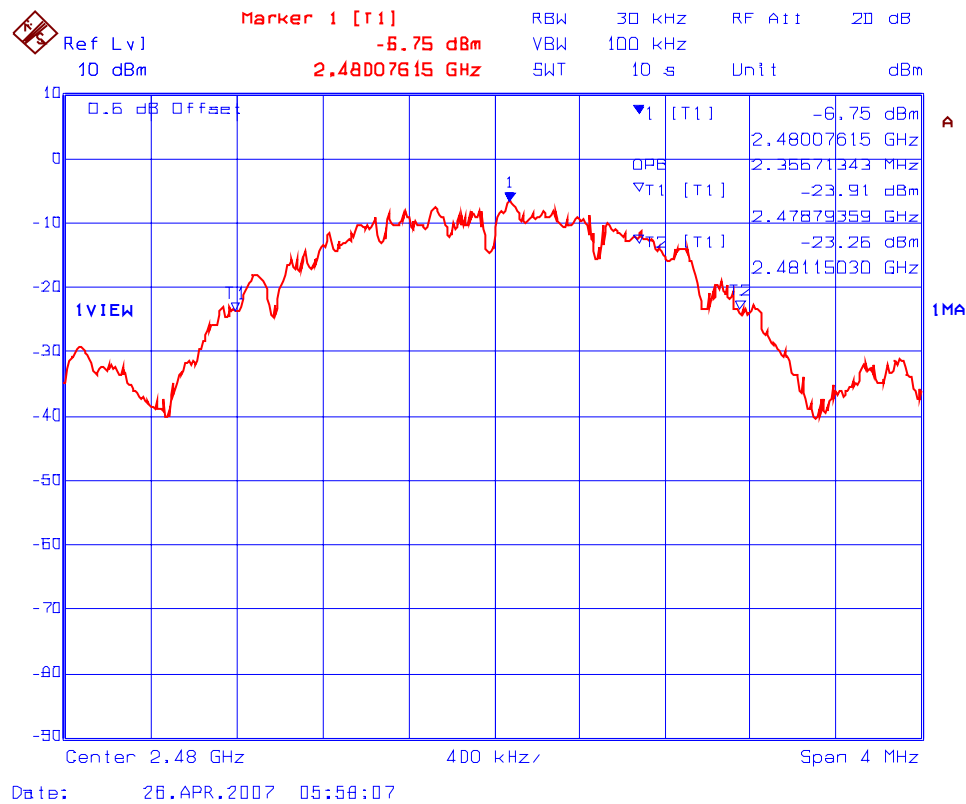
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All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

Plot 6.6.5.5 99% Occupied Bandwidth
Frequency: 2440 MHz



Plot 6.6.5.6 99% Occupied Bandwidth
 Frequency: 2480 MHz



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

6.7.1. 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.

§15.247(b)(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.

6.7.2. Method of Measurements & Test Arrangement

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

6.7.3. Test Arrangement



6.7.4. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer	Rhode & Schwarz	FSEK20/B4/B21	834157/005	9 kHz- 40 GHz

6.7.5. Test Data

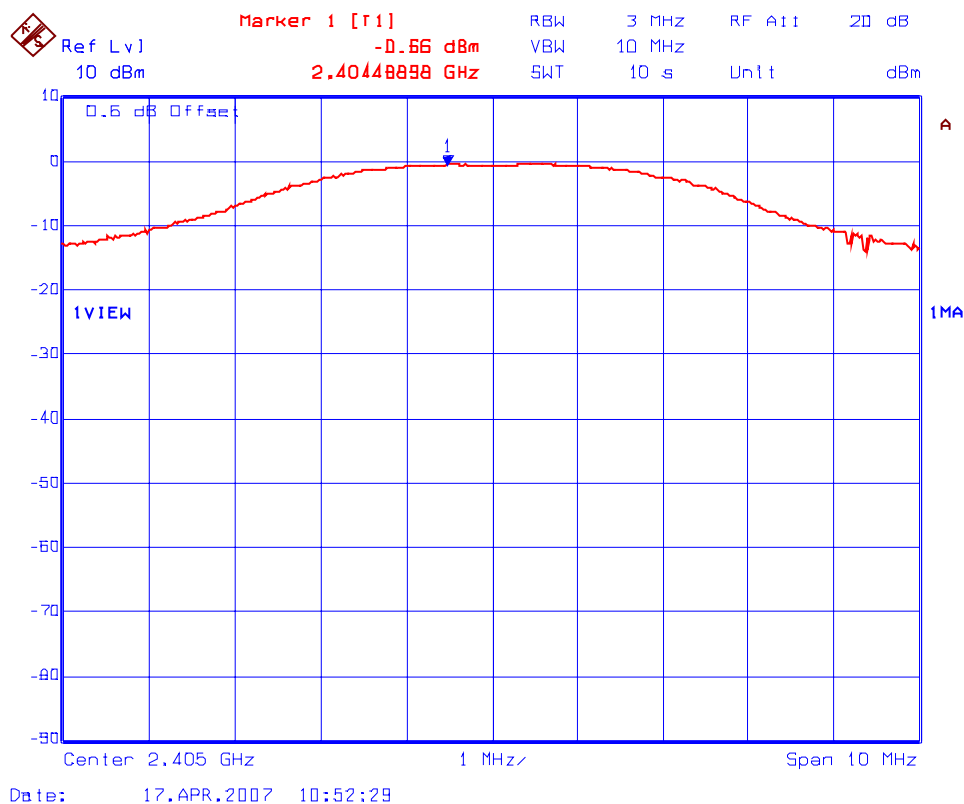
Frequency (MHz)	Peak Conducted Power (dBm)	Peak EIRP ^(Note 1, 2) (dBm)	Peak Conducted Power Limit (dBm)	EIRP Limit (dBm)
2405	-0.66	18.34	30	36
2440	-0.54	18.46	30	36
2480	-0.13	18.87	30	36

Note 1: The Peak EIRP is calculated as the sum of Peak Conducted Power in dBm and antenna gain of EUT in dBi.

Note 2: The maximum antenna gain to be used with the EUT is 19 dBi.

See the following plots for details.

Plot 6.7.5.1 Peak Conducted Output Power
Frequency: 2405 MHz



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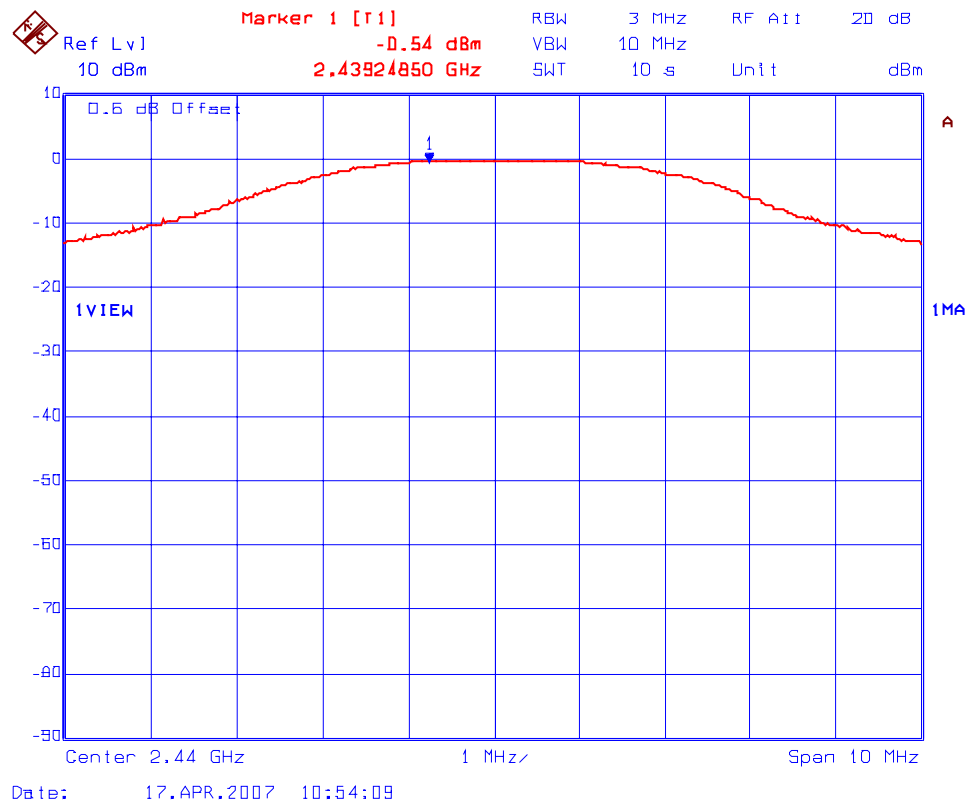
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Plot 6.7.5.2 Peak Conducted Output Power
Frequency: 2440 MHz



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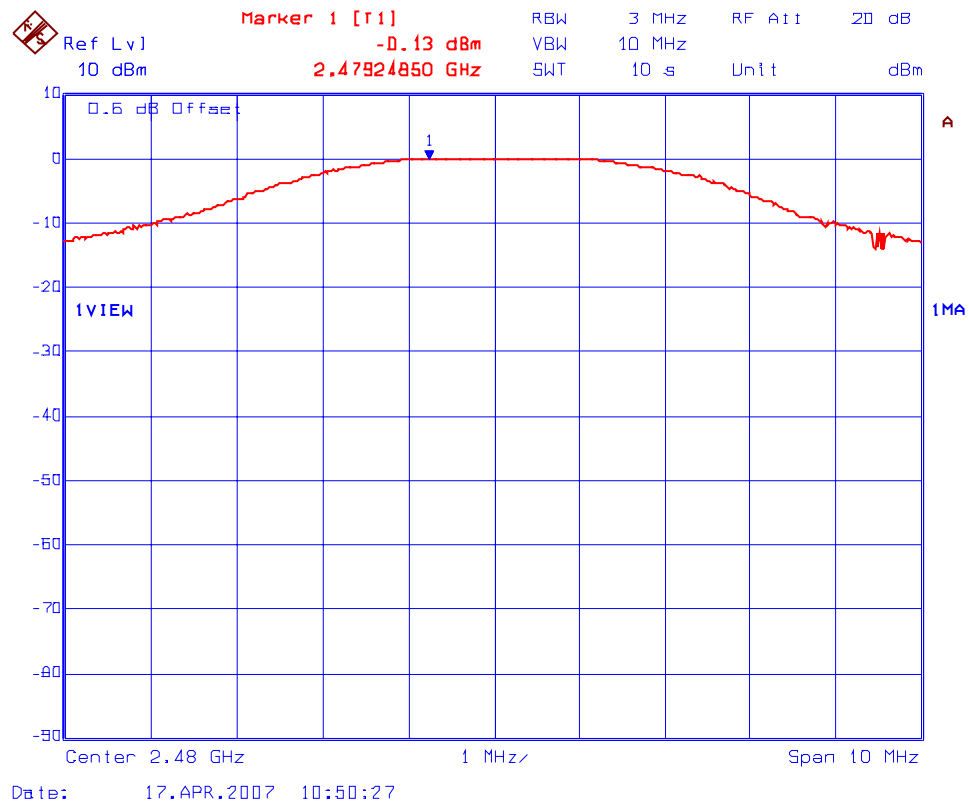
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4
Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: yic@ultratech-labs.com, Website: <http://www.ultratech-labs.com>

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Plot 6.7.5.3 Peak Conducted Output Power
Frequency: 2480 MHz



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

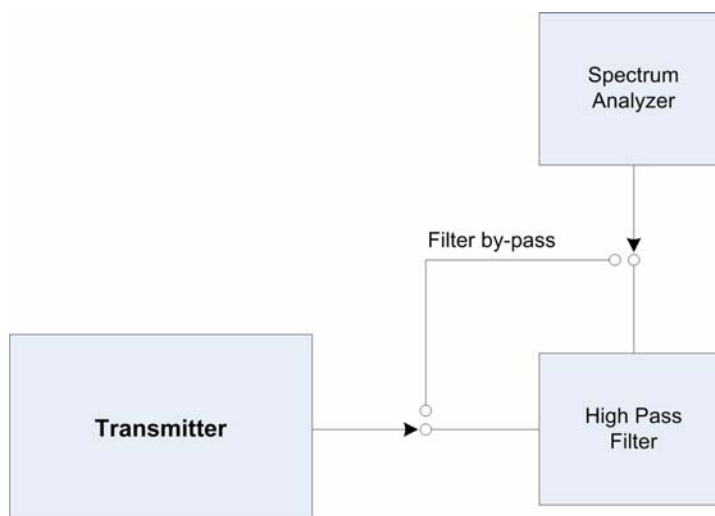
6.8.1. Limit(s)

§ 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.

6.8.2. Method of Measurements

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

6.8.3. Test Arrangement



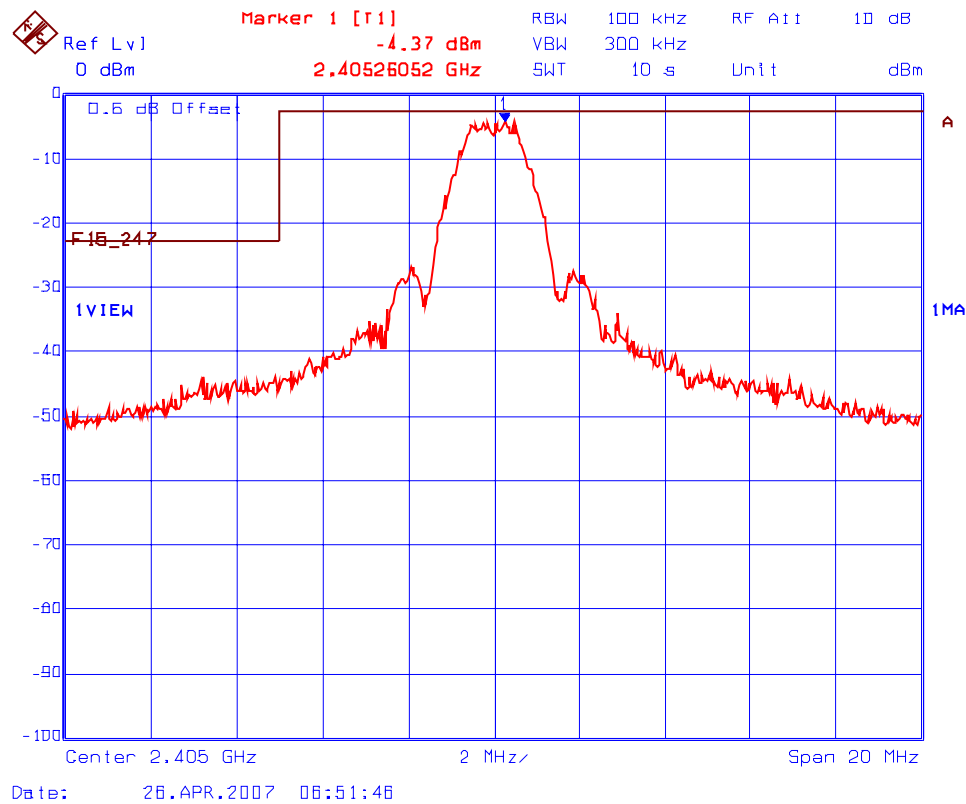
6.8.4. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer	Rhode & Schwarz	FSEK20/B4/B21	834157/005	9 kHz – 40 GHz
High Pass Filter	K & L	11SH10-4000T12000	4	3dB cutoff at 4 GHz

6.8.5. Test Data

6.8.5.1. Band-Edge RF Conducted Emissions

Plot 6.8.5.1.1 Band-Edge RF Conducted Emissions
Low End of Frequency Band



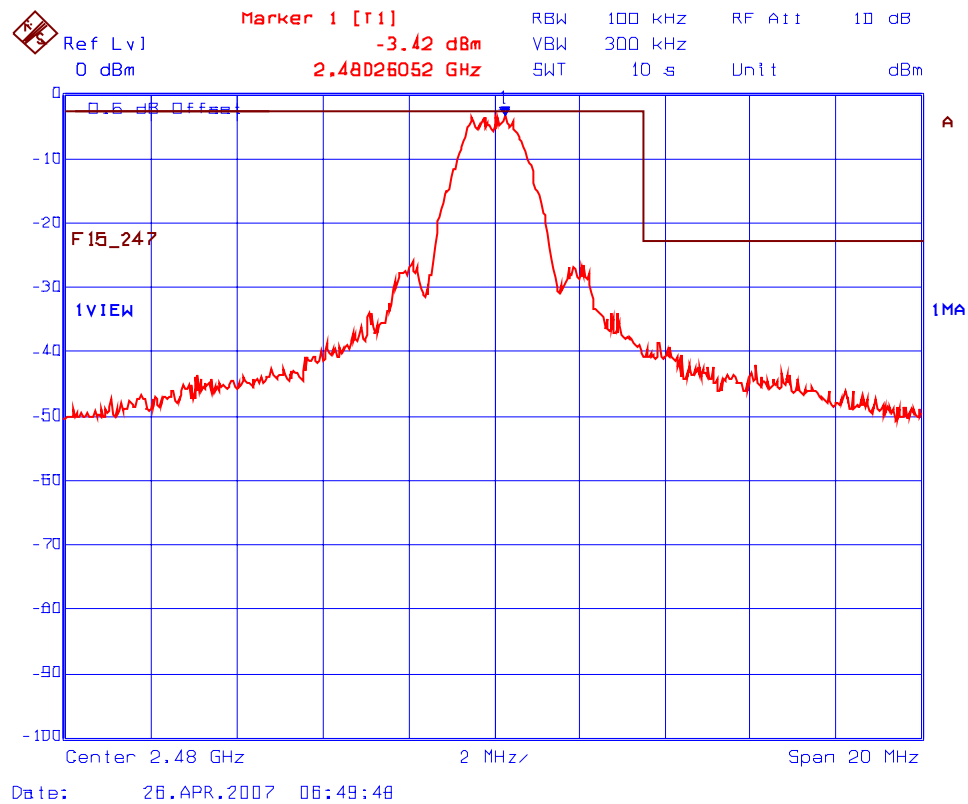
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**Plot 6.8.5.1.2 Band-Edge RF Conducted Emissions
High End of Frequency Band**



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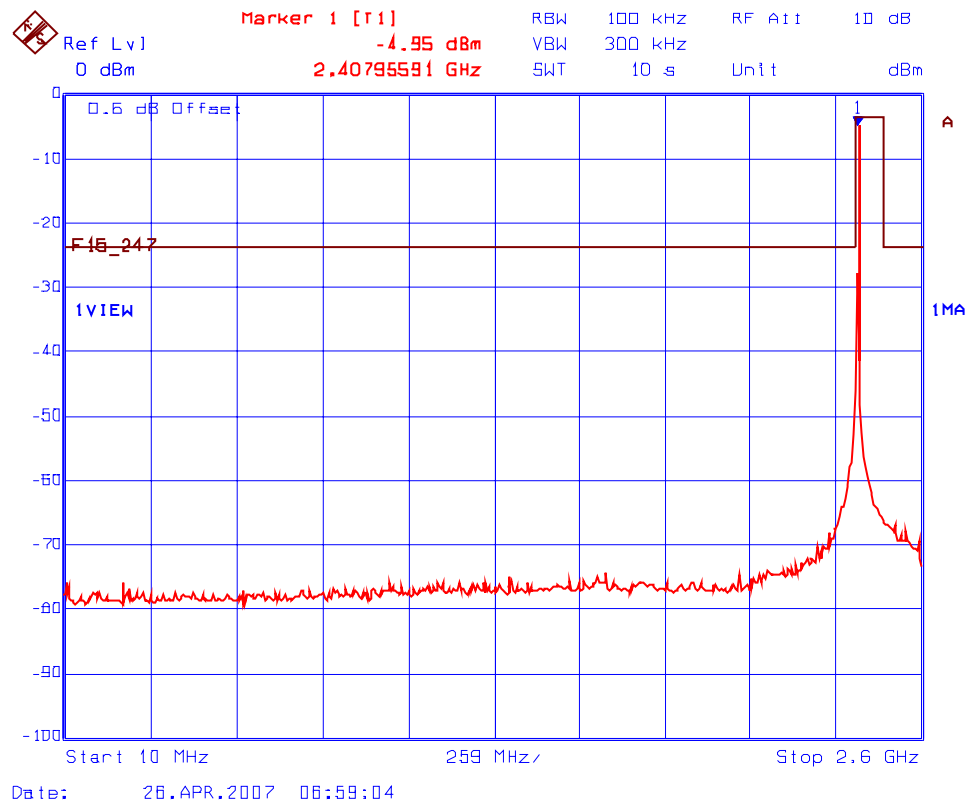
File #: MXS-056F15C247C2PC

May 17, 2007

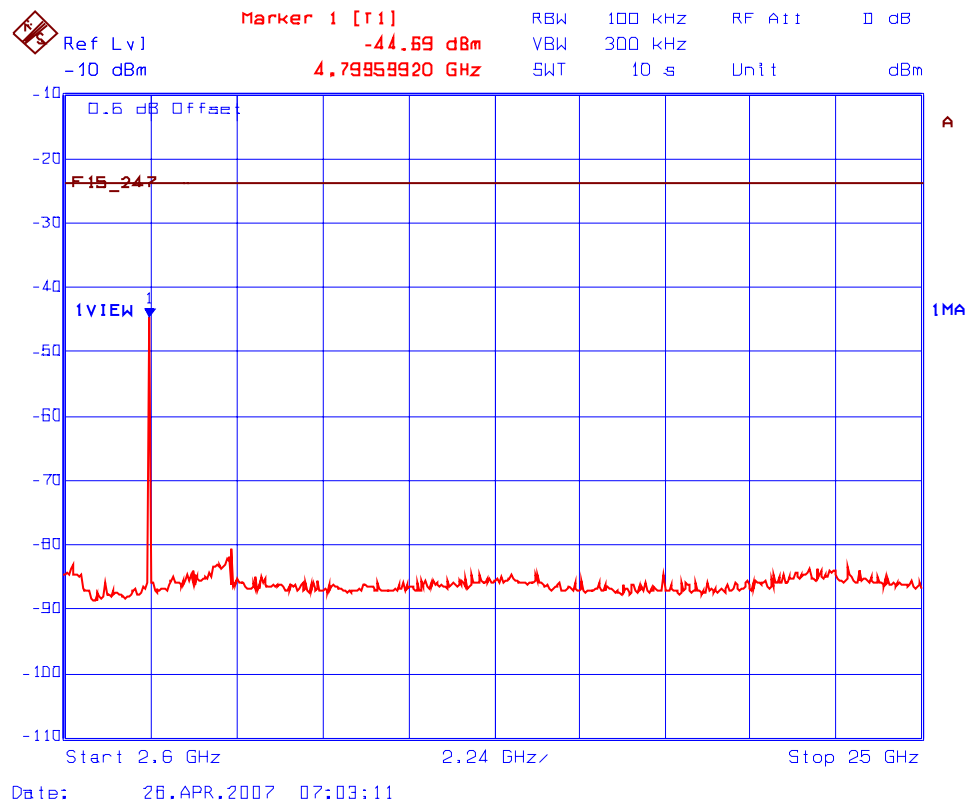
All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

6.8.5.2. Spurious RF Conducted Emissions

Plot 6.8.5.2.1 Spurious RF Conducted Emissions
Transmitter Frequency: 2405 MHz



Plot 6.8.5.2.2 Spurious RF Conducted Emissions
Transmitter Frequency: 2405 MHz



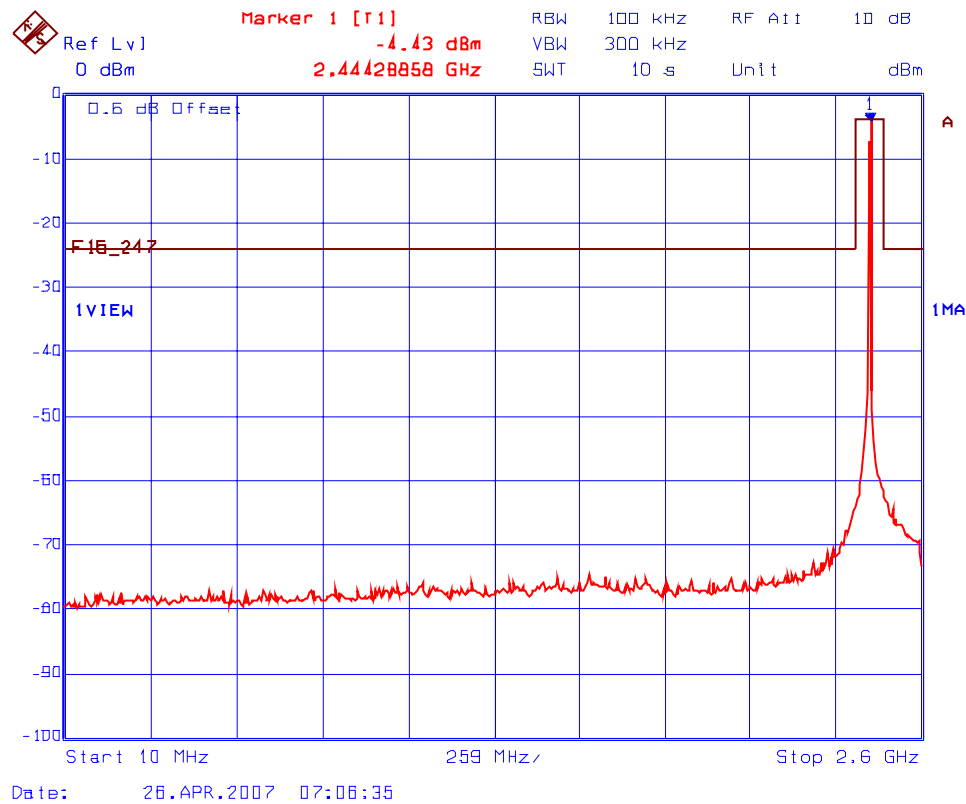
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Plot 6.8.5.2.3 Spurious RF Conducted Emissions
Transmitter Frequency: 2440 MHz



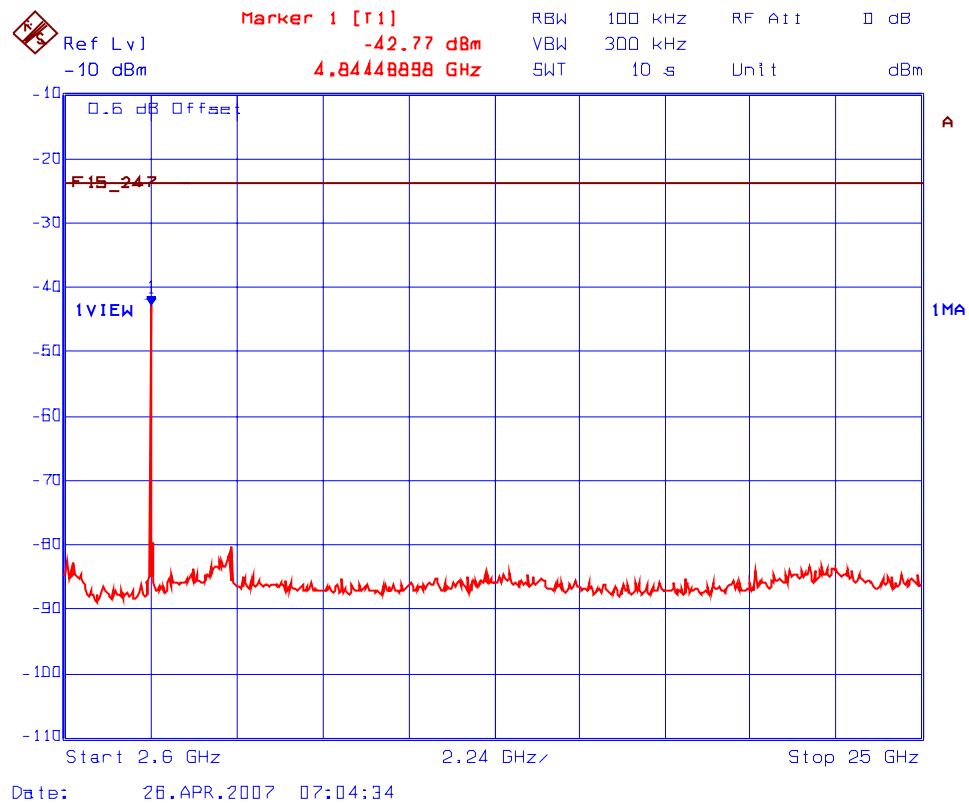
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Plot 6.8.5.2.4 Spurious RF Conducted Emissions
Transmitter Frequency: 2440 MHz



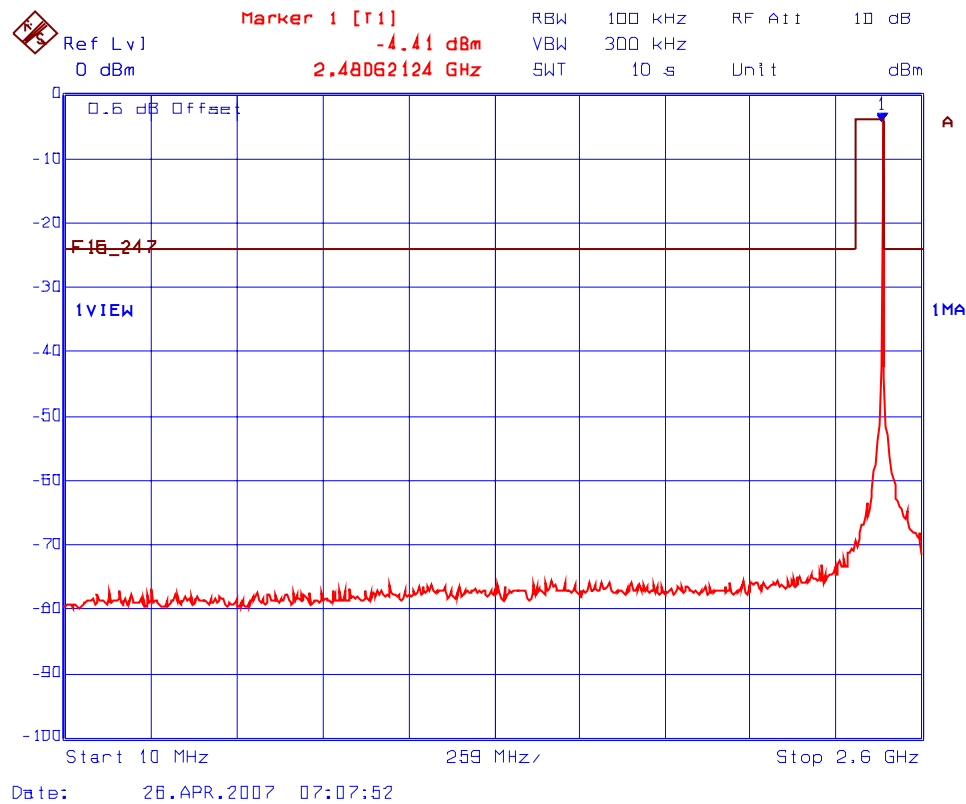
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Plot 6.8.5.2.5 Spurious RF Conducted Emissions
Transmitter Frequency: 2480 MHz



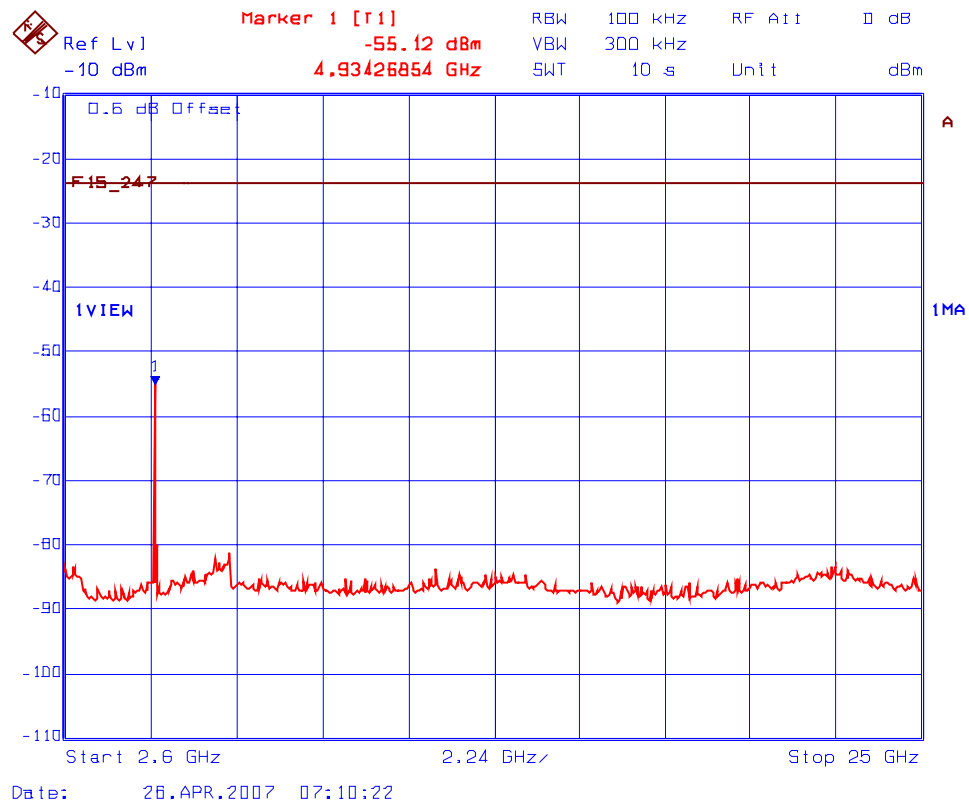
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Plot 6.8.5.2.6 Spurious RF Conducted Emissions
Transmitter Frequency: 2480 MHz



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

6.9.1. 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
¹ 0.495–0.505	16.69475–16.69525	608–614	5.35–5.46
2.1735–2.1905	16.80425–16.80475	960–1240	7.25–7.75
4.125–4.128	25.5–25.67	1300–1427	8.025–8.5
4.17725–4.17775	37.5–38.25	1435–1626.5	9.0–9.2
4.20725–4.20775	73–74.6	1645.5–1646.5	9.3–9.5
6.215–6.218	74.8–75.2	1660–1710	10.6–12.7
6.26775–6.26825	108–121.94	1718.8–1722.2	13.25–13.4
6.31175–6.31225	123–138	2200–2300	14.47–14.5
8.291–8.294	149.9–150.05	2310–2390	15.35–16.2
8.362–8.366	156.52475–156.52525	2483.5–2500	17.7–21.4
8.37625–8.38675	156.7–156.9	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			

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

² Above 38.6

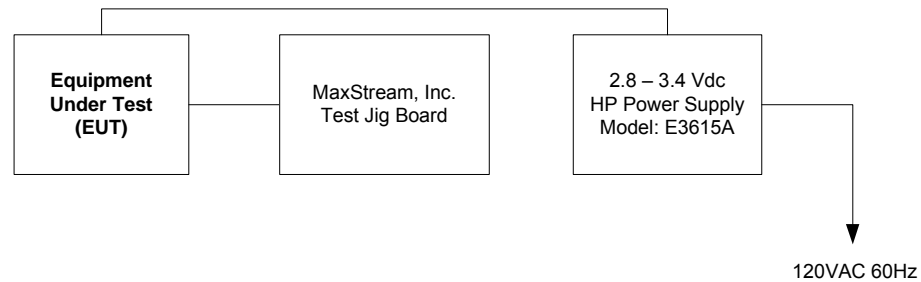
Section 15.209(a) -- Field Strength Limits within Restricted Frequency Bands --

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

6.9.2. Method of Measurements

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

6.9.3. Test Arrangement



6.9.4. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer	Rhode & Schwarz	FSEK20/B4/B21	834157/005	9kHz – 40GHz
Microwave Amplifier	Hewlett Packard	8449B	3008A00769	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	1007	18 GHz – 26.5 GHz

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6.9.5. Test Data

Remarks:

- All spurious emissions that are in excess of 20 dB below the specified limit shall be recorded.
- The following test results are the worst-case measurements.
- Band-edges compliance condition: EUT connected to antennas via antenna feedline must have a minimum cable loss as specified in the test configurations and the following table.

Antenna Type	Antenna Gain (dBi)	Minimum Required Cable Loss (dB)
DLink Omni-directional	15	5.7
Maxrad Yagi	15	7.9
ARC Panel	19	12

6.9.5.1. EUT with DLink Omni-directional Antenna (15 dBi gain with minimum cable loss of 5.7 dB)

Fundamental Frequency: 2405 MHz

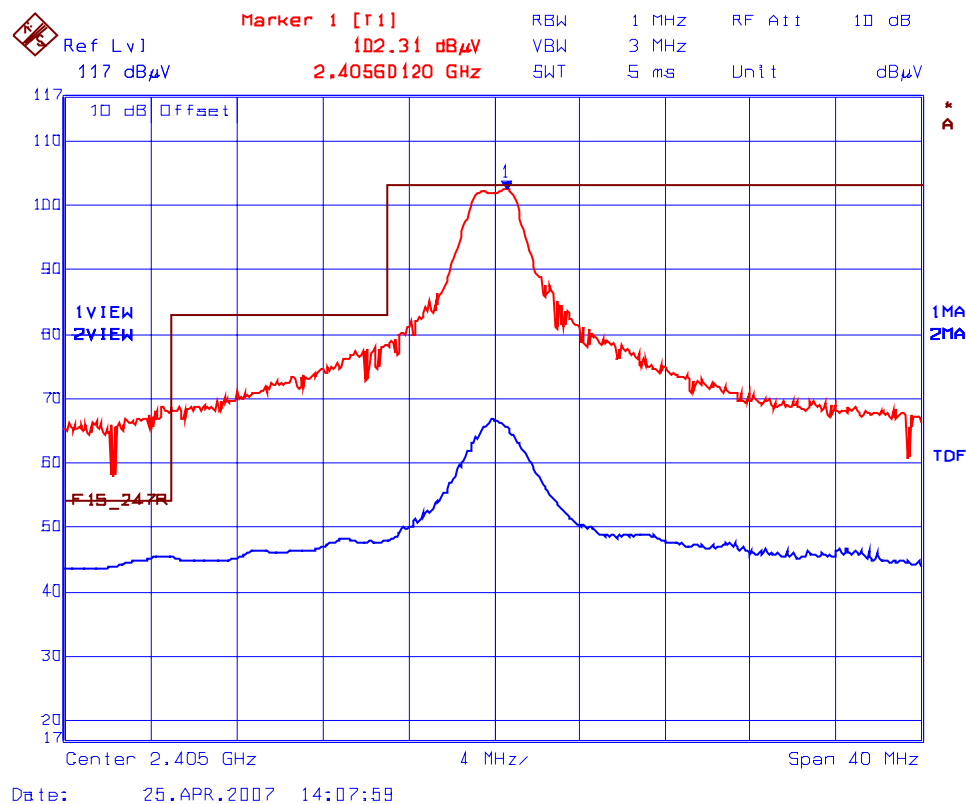
Frequency Test Range: 30 MHz – 25 GHz

Frequency (MHz)	RF Peak Level (dBμV/m)	RF Avg Level (dBμV/m)	Antenna Plane (H/V)	Limit 15.209 (dBμV/m)	Limit 15.247 (dBμV/m)	Margin (dB)	Pass/Fail
2405	102.41	--	V	--	--	--	--
2405	102.31	--	H	--	--	--	--
4810	58.19	41.15	V	54.0	82.4	-12.9	Pass*
4810	58.92	41.59	H	54.0	82.4	-12.4	Pass*

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

* Emission within the restricted frequency bands.

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



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

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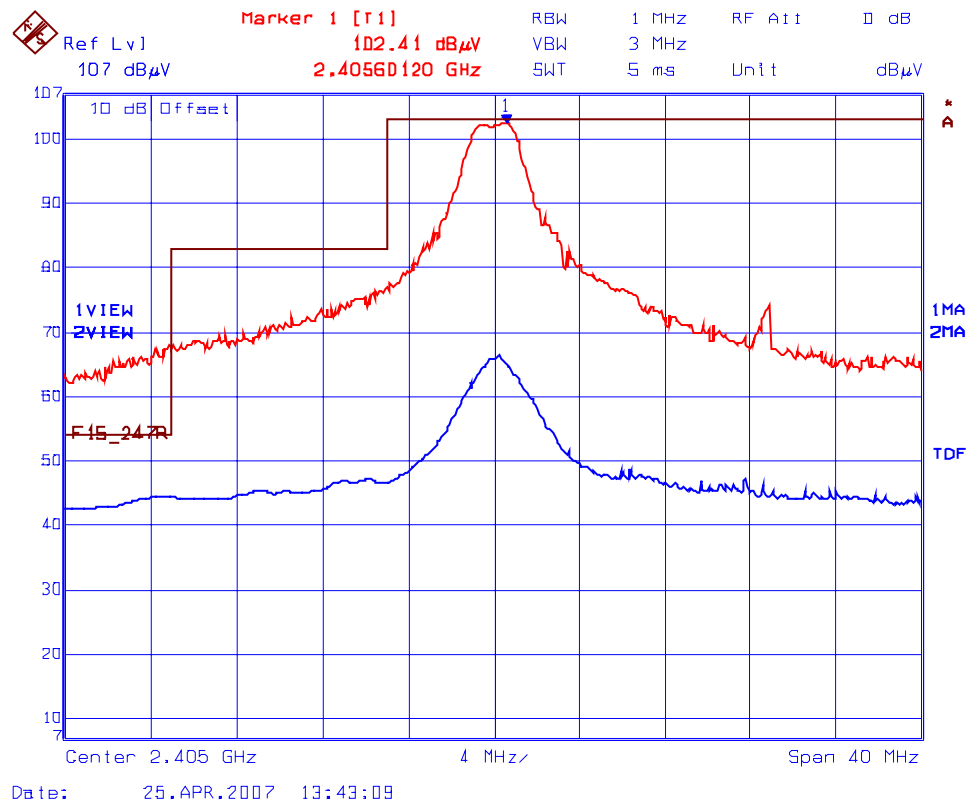
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4
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Plot 6.9.5.1.2 Band-Edge RF Radiated Emissions @ 3 m
Low End of Frequency Band
Rx Antenna Orientation: Vertical



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

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May 17, 2007

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

Fundamental Frequency: 2440 MHz
Frequency Test 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
2440	102.98	--	V	--	--	--	--
2440	103.60	--	H	--	--	--	--
4880	58.34	41.11	V	54.0	83.6	-12.9	Pass*
4880	59.75	42.04	H	54.0	83.6	-12.0	Pass*

* Emission within the restricted frequency bands.

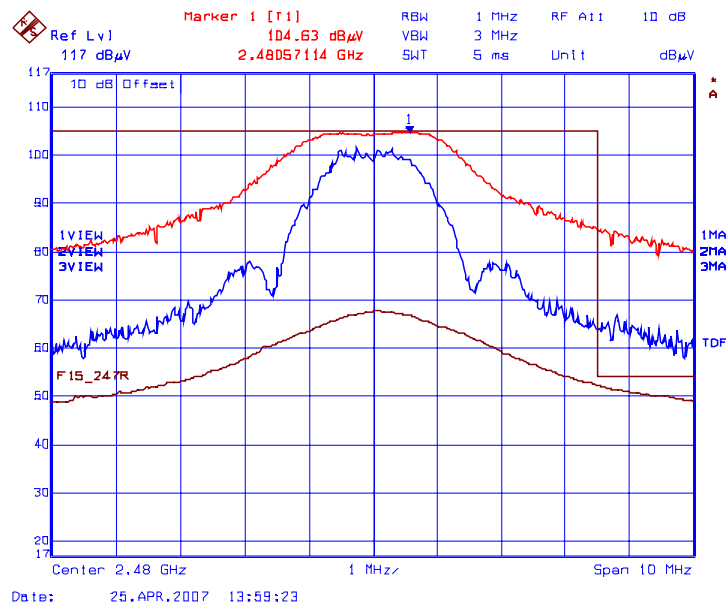
Fundamental Frequency: 2480 MHz
Frequency Test Range: 30 MHz – 25 GHz

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
2480	106.23	--	V	--	--	--	--
2480	104.63	--	H	--	--	--	--
4960	56.67	40.95	V	54.0	86.2	-13.1	Pass*
4960	59.79	41.95	H	54.0	86.2	-12.1	Pass*

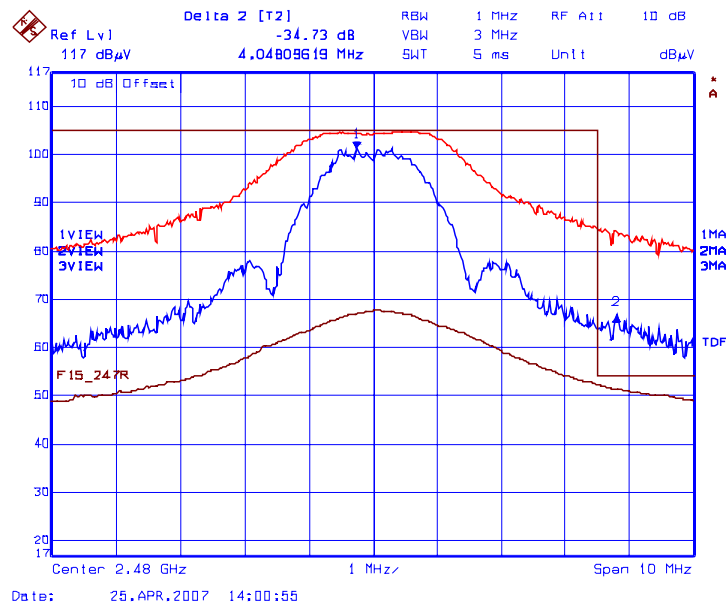
See the following test data plots for band-edge emissions.

* Emission within the restricted frequency bands.

Plot 6.9.5.1.3(a) Band-Edge RF Radiated Emissions @ 3 m
Upper End of Frequency Band; Rx Antenna Orientation: Horizontal



Plot 6.9.5.1.3(b) Band-Edge RF Radiated Emissions @ 3 m
Upper End of Frequency Band; Rx Antenna Orientation: Horizontal



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

Trace 2: RBW = 100 kHz, VBW = 300 kHz, Delta (Peak to Band-Edge): 34.73 dB

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

Band-Edge Level at 2483.5 MHz: $104.63 \text{ dB}\mu\text{V/m} - 34.73 \text{ dB} = 69.90 \text{ dB}\mu\text{V/m}$,

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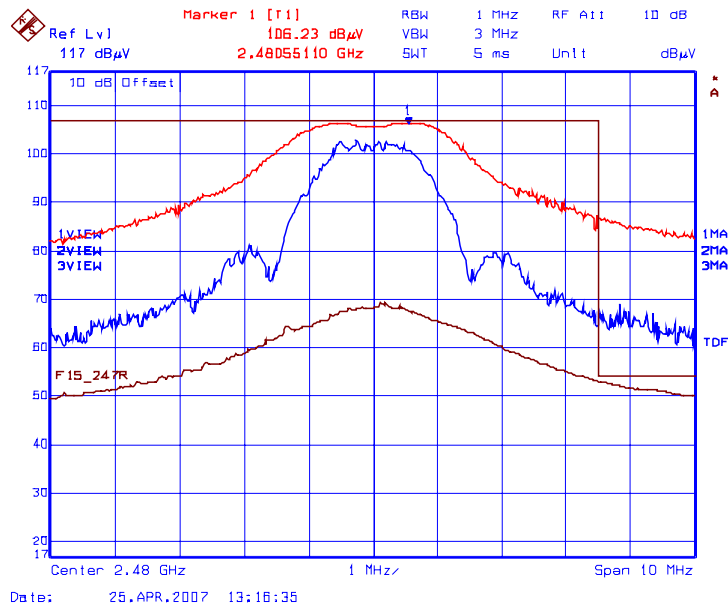
Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: <http://www.ultratech-labs.com>

File #: MXS-056F15C247C2PC

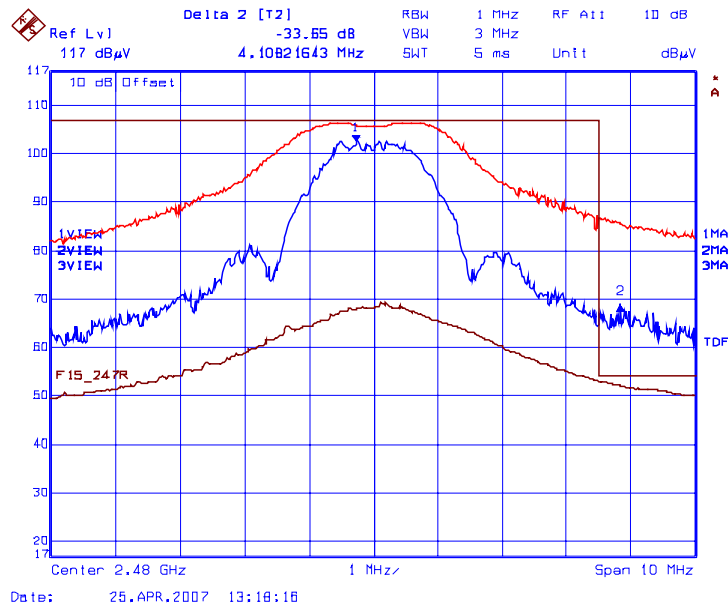
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Plot 6.9.5.1.4(a) Band-Edge RF Radiated Emissions @ 3 m
Upper End of Frequency Band; Rx Antenna Orientation: Vertical



Plot 6.9.5.1.4(b) Band-Edge RF Radiated Emissions @ 3 m
Upper End of Frequency Band; Rx Antenna Orientation: Vertical



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

Trace 2: RBW = 100 kHz, VBW = 300 kHz, Delta (Peak to Band-Edge): 33.65 dB

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

Band-Edge Level at 2483.5 MHz: $106.23 \text{ dB}\mu\text{V/m} - 33.65 \text{ dB} = 72.58 \text{ dB}\mu\text{V/m}$

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6.9.5.2. EUT with Maxrad Yagi Antenna (15 dBi gain with minimum cable loss of 7.9 dB)

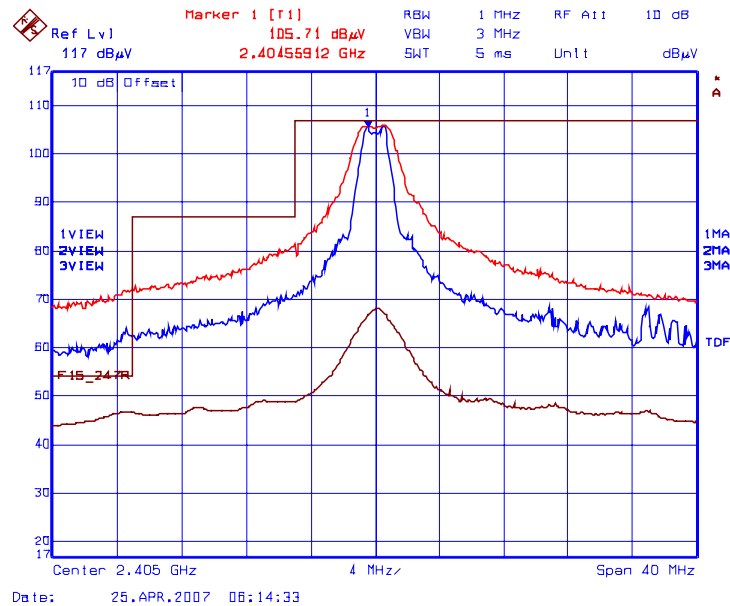
Fundamental Frequency: 2405 MHz
Frequency Test Range: 30 MHz – 25 GHz

Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit 15.247 (dBµV/m)	Margin (dB)	Pass/Fail
2405	105.54	--	V	--	--	--	--
2405	105.71	--	H	--	--	--	--
4810	54.60	39.25	V	54.0	85.7	-14.8	Pass*
4810	53.39	38.86	H	54.0	85.7	-15.1	Pass*

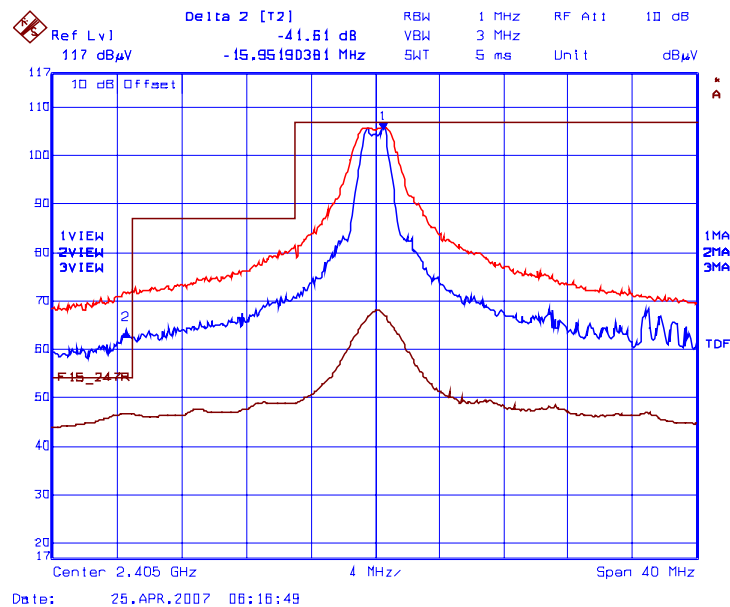
See the following test data plots for band-edge emissions.

* Emission within the restricted frequency bands.

Plot 6.9.5.2.1(a) Band-Edge RF Radiated Emissions @ 3 m
Low End of Frequency Band; Rx Antenna Orientation: Horizontal



Plot 6.9.5.2.1(b) Band-Edge RF Radiated Emissions @ 3 m
Low End of Frequency Band; Rx Antenna Orientation: Horizontal



Trace 1: RBW = 1 MHz, VBW = 3 MHz
Trace 2: RBW = 300 kHz, VBW = 1 MHz, Delta (Peak to Band-Edge): 41.61 dB
Trace 3: RBW = 1 MHz, VBW = 10 Hz
Band-Edge Level at 2390 MHz: 105.71 dBμV/m – 41.61 dB = 64.10 dBμV/m

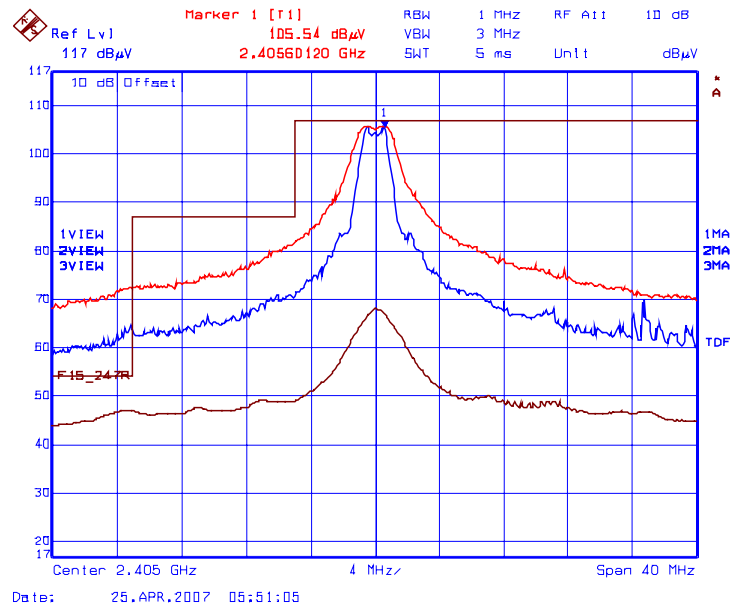
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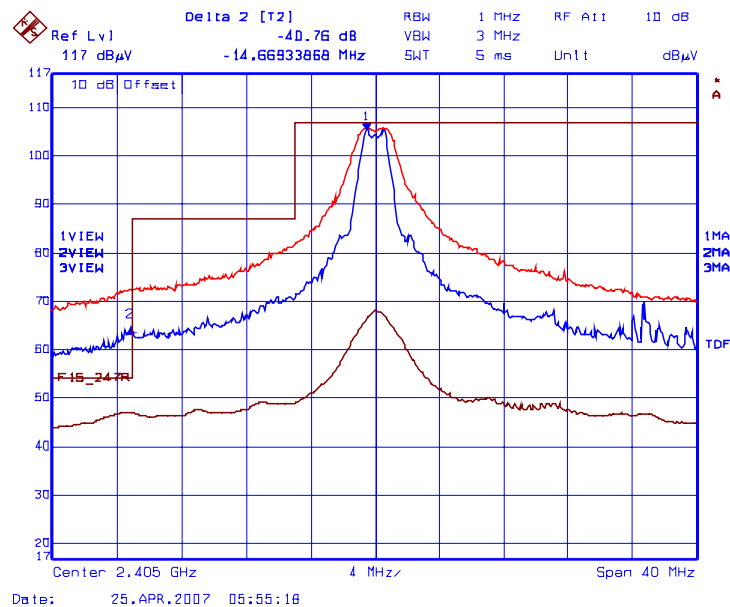
File #: MXS-056F15C247C2PC
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Plot 6.9.5.2.2(a) Band-Edge RF Radiated Emissions @ 3 m
Low End of Frequency Band; Rx Antenna Orientation: Vertical



Plot 6.9.5.2.2(b) Band-Edge RF Radiated Emissions @ 3 m
Low End of Frequency Band; Rx Antenna Orientation: Vertical



Trace 1: RBW = 1 MHz, VBW = 3 MHz
Trace 2: RBW = 300 kHz, VBW = 1 MHz, Delta (Peak to Band-Edge): 40.76 dB
Trace 3: RBW = 1 MHz, VBW = 10 Hz
Band-Edge Level at 2390 MHz: $105.54 \text{ dB}\mu\text{V/m} - 40.76 \text{ dB} = 64.78 \text{ dB}\mu\text{V/m}$

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Fundamental Frequency: 2440 MHz
Frequency Test Range: 30 MHz – 25 GHz

Frequency (MHz)	RF Peak Level (dBμV/m)	RF Avg Level (dBμV/m)	Antenna Plane (H/V)	Limit 15.209 (dBμV/m)	Limit 15.247 (dBμV/m)	Margin (dB)	Pass/Fail
2440	106.21	--	V	--	--	--	--
2440	106.40	--	H	--	--	--	--
4880	57.19	40.60	V	54.0	86.4	-13.4	Pass*
4880	54.64	39.73	H	54.0	86.4	-14.3	Pass*

* Emission within the restricted frequency bands.

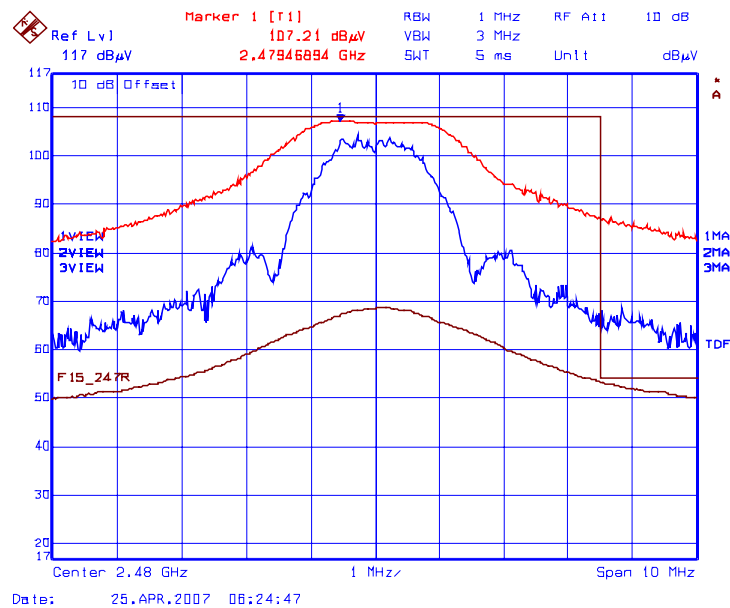
Fundamental Frequency: 2480 MHz
Frequency Test Range: 30 MHz – 25 GHz

Frequency (MHz)	RF Peak Level (dBμV/m)	RF Avg Level (dBμV/m)	Antenna Plane (H/V)	Limit 15.209 (dBμV/m)	Limit 15.247 (dBμV/m)	Margin (dB)	Pass/Fail
2480	106.73	--	V	--	--	--	--
2480	107.21	--	H	--	--	--	--
4960	55.86	40.03	V	54.0	87.2	-14.0	Pass*
4960	53.91	39.41	H	54.0	87.2	-14.6	Pass*

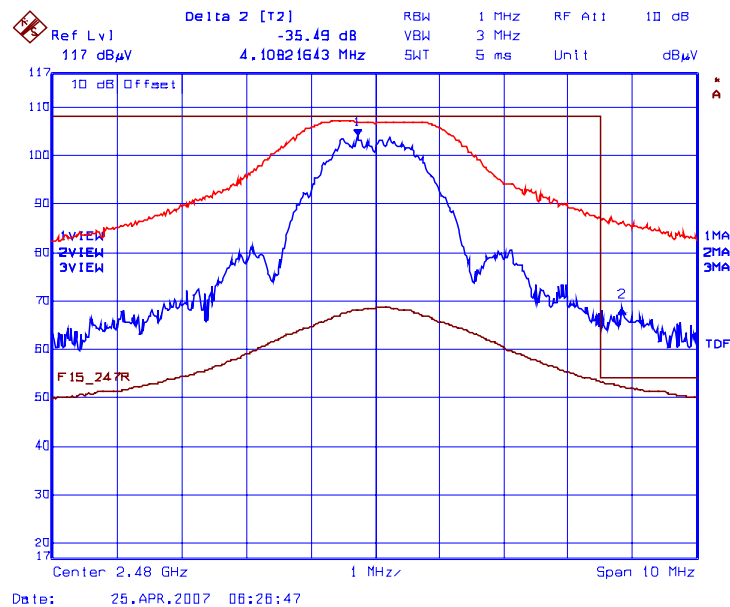
See the following test data plots for band-edge emissions.

* Emission within the restricted frequency bands.

Plot 6.9.5.2.3(a) Band-Edge RF Radiated Emissions @ 3
Upper End of Frequency Band; Rx Antenna Orientation: Horizontal



Plot 6.9.5.2.3(b) Band-Edge RF Radiated Emissions @ 3
Upper End of Frequency Band; Rx Antenna Orientation: Horizontal



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

Trace 2: RBW = 100 kHz, VBW = 300 kHz, Delta (Peak to Band-Edge): 35.49 dB

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

Band-Edge Level at 2483.5 MHz: 107.21 dBμV/m – 35.49 dB = 71.72 dBμV/m,

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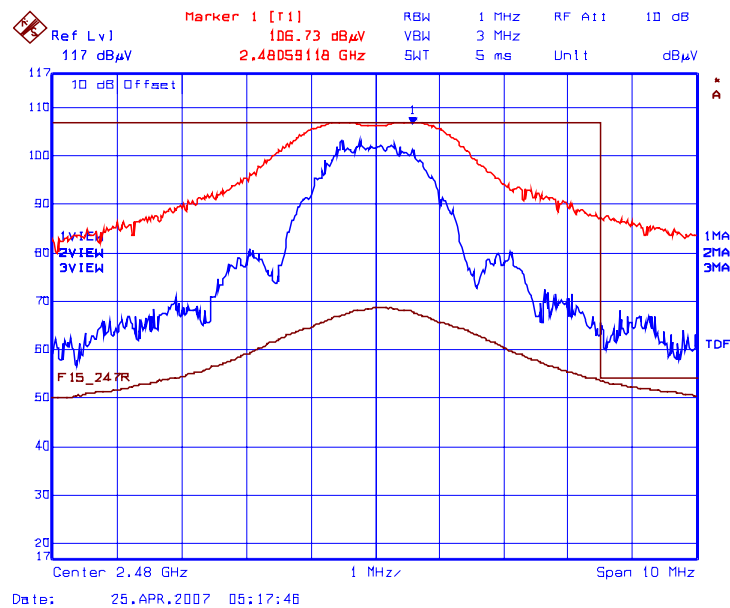
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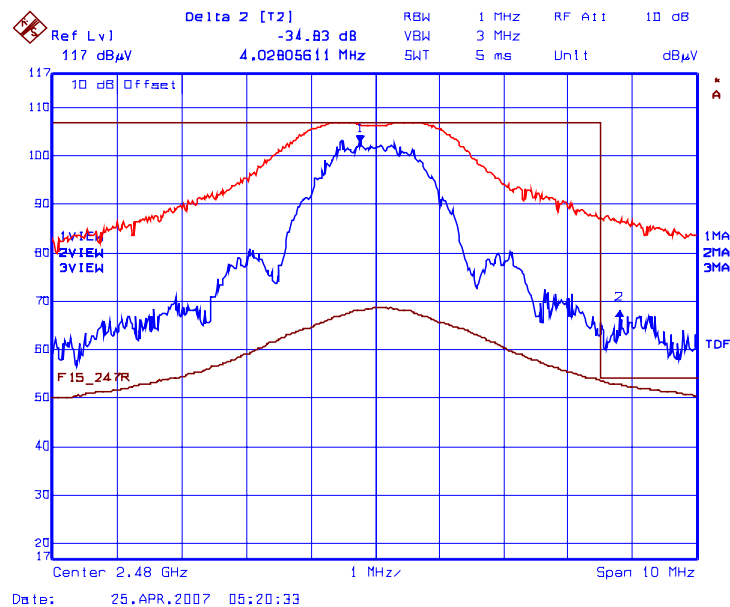
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Plot 6.9.5.2.4(a) Band-Edge RF Radiated Emissions @ 3 m
Upper End of Frequency Band; Rx Antenna Orientation: Vertical



Plot 6.9.5.2.4(b) Band-Edge RF Radiated Emissions @ 3 m
Upper End of Frequency Band; Rx Antenna Orientation: Vertical



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

Trace 2: RBW = 100 kHz, VBW = 300 kHz, Delta (Peak to Band-Edge): 34.83 dB

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

Band-Edge Level at 2483.5 MHz: $106.73 \text{ dB}\mu\text{V/m} - 34.83 \text{ dB} = 71.90 \text{ dB}\mu\text{V/m}$

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6.9.5.3. EUT with ARC Panel Antenna (19 dBi gain with minimum cable loss of 12 dB)

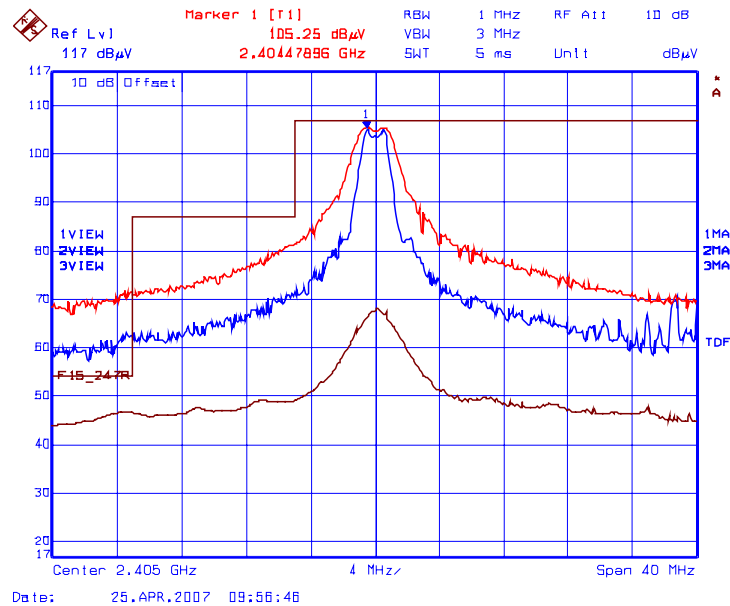
Fundamental Frequency: 2405 MHz
Frequency Test Range: 30 MHz – 25 GHz

Frequency (MHz)	RF Peak Level (dBμV/m)	RF Avg Level (dBμV/m)	Antenna Plane (H/V)	Limit 15.209 (dBμV/m)	Limit 15.247 (dBμV/m)	Margin (dB)	Pass/Fail
2405	106.27	--	V	--	--	--	--
2405	105.25	--	H	--	--	--	--
4810	54.48	38.06	V	54.0	86.3	-15.9	Pass*
4810	54.29	38.83	H	54.0	86.3	-15.2	Pass*

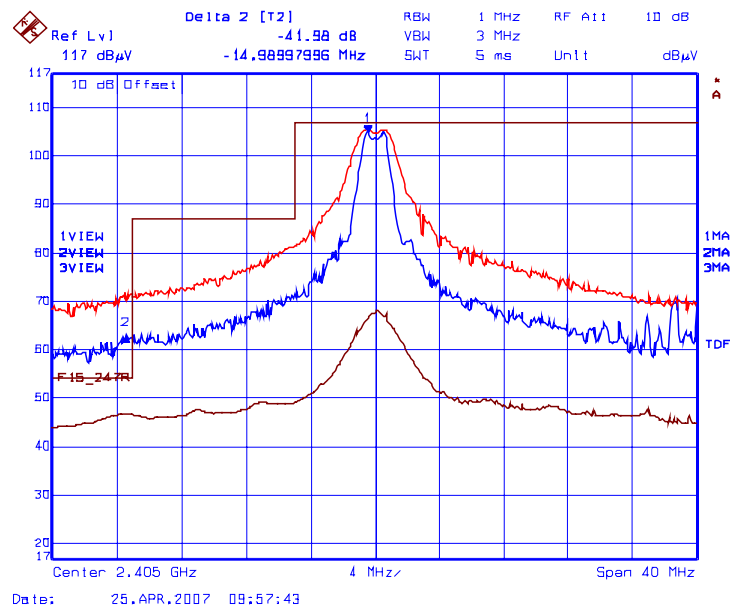
See the following test data plots for band-edge emissions.

* Emission within the restricted frequency bands.

Plot 6.9.5.3.1(a) Band-Edge RF Radiated Emissions @ 3 m
Low End of Frequency Band; Rx Antenna Orientation: Horizontal



Plot 6.9.5.3.1(b) Band-Edge RF Radiated Emissions @ 3 m
Low End of Frequency Band; Rx Antenna Orientation: Horizontal



Trace 1: RBW = 1 MHz, VBW = 3 MHz
Trace 2: RBW = 300 kHz, VBW = 1 MHz, Delta (Peak to Band-Edge): 41.98 dB
Trace 3: RBW = 1 MHz, VBW = 10 Hz
Band-Edge Level at 2390 MHz: $105.25 \text{ dB}\mu\text{V/m} - 41.98 \text{ dB} = 63.27 \text{ dB}\mu\text{V/m}$

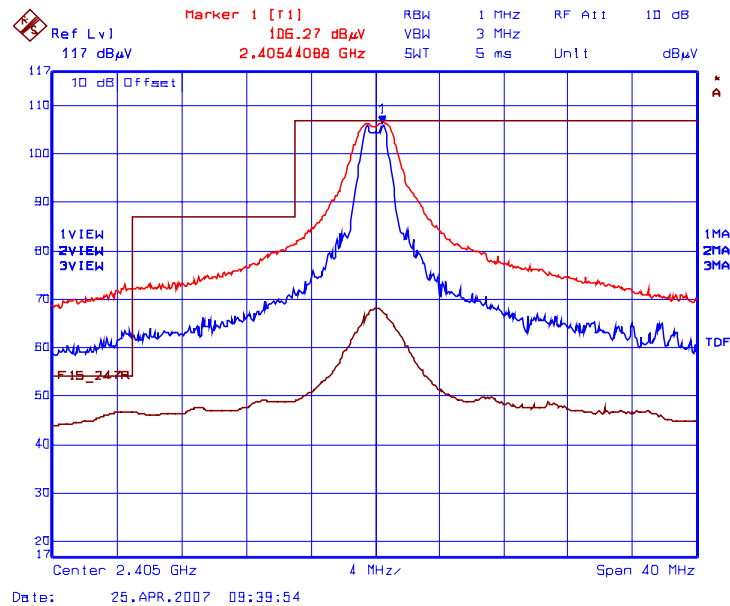
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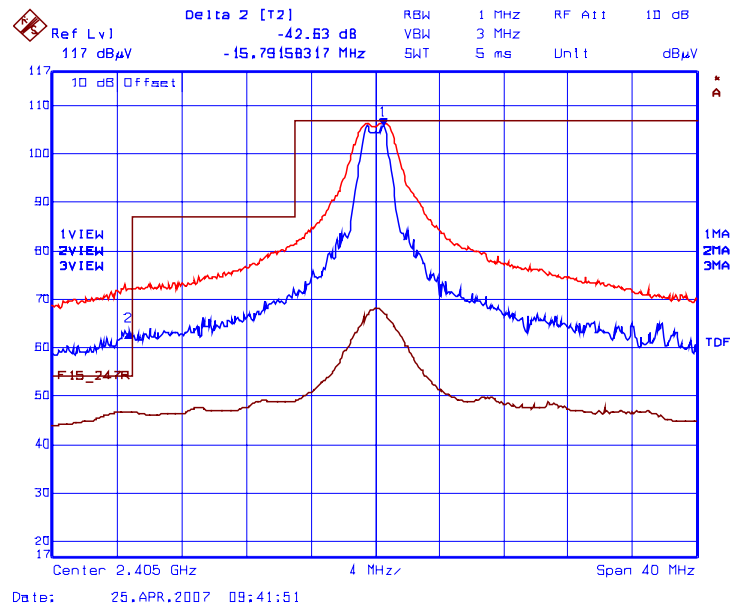
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Plot 6.9.5.3.2(a) Band-Edge RF Radiated Emissions @ 3 m
Low End of Frequency Band; Rx Antenna Orientation: Vertical



Plot 6.9.5.3.2(b) Band-Edge RF Radiated Emissions @ 3 m
Low End of Frequency Band; Rx Antenna Orientation: Vertical



Trace 1: RBW = 1 MHz, VBW = 3 MHz
Trace 2: RBW = 300 kHz, VBW = 1 MHz, Delta (Peak to Band-Edge): 42.63 dB
Trace 3: RBW = 1 MHz, VBW = 10 Hz
Band-Edge Level at 2390 MHz: $106.27 \text{ dB}\mu\text{V/m} - 42.63 \text{ dB} = 63.64 \text{ dB}\mu\text{V/m}$

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Fundamental Frequency: 2440 MHz
Frequency Test Range: 30 MHz – 25 GHz

Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit 15.247 (dBµV/m)	Margin (dB)	Pass/Fail
2440	106.90	--	V	--	--	--	--
2440	106.69	--	H	--	--	--	--
4880	55.38	39.12	V	54.0	86.9	-14.9	Pass*
4880	55.08	39.50	H	54.0	86.9	-14.5	Pass*

* Emission within the restricted frequency bands.

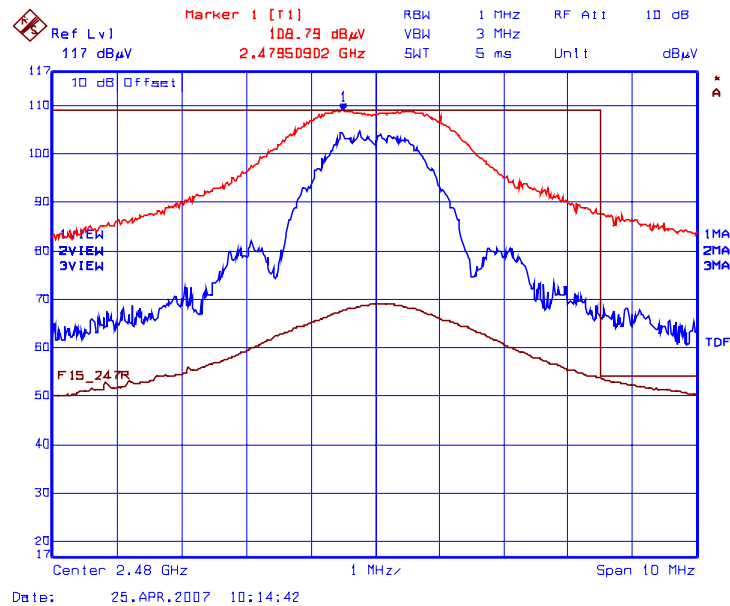
Fundamental Frequency: 2480 MHz
Frequency Test Range: 30 MHz – 25 GHz

Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit 15.247 (dBµV/m)	Margin (dB)	Pass/Fail
2480	107.59	--	V	--	--	--	--
2480	108.79	--	H	--	--	--	--
4960	55.16	39.24	V	54.0	88.8	-14.8	Pass*
4960	54.34	38.78	H	54.0	88.8	-15.2	Pass*

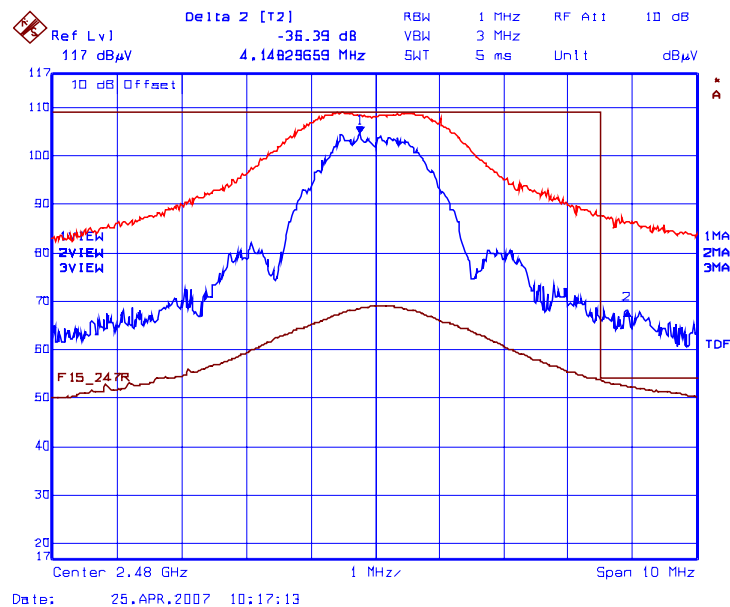
See the following test data plots for band-edge emissions.

* Emission within the restricted frequency bands.

Plot 6.9.5.3.3(a) Band-Edge RF Radiated Emissions @ 3 m
Upper End of Frequency Band; Rx Antenna Orientation: Horizontal



Plot 6.9.5.3.3(b) Band-Edge RF Radiated Emissions @ 3 m
Upper End of Frequency Band; Rx Antenna Orientation: Horizontal



Trace 1: RBW = 1 MHz, VBW = 3 MHz
Trace 2: RBW = 300 kHz, VBW = 1 MHz, Delta (Peak to Band-Edge): 36.39 dB
Trace 3: RBW = 1 MHz, VBW = 10 Hz
Band-Edge Level at 2483.5 MHz: 108.79 dBμV/m – 36.39 dB = 72.40 dBμV/m

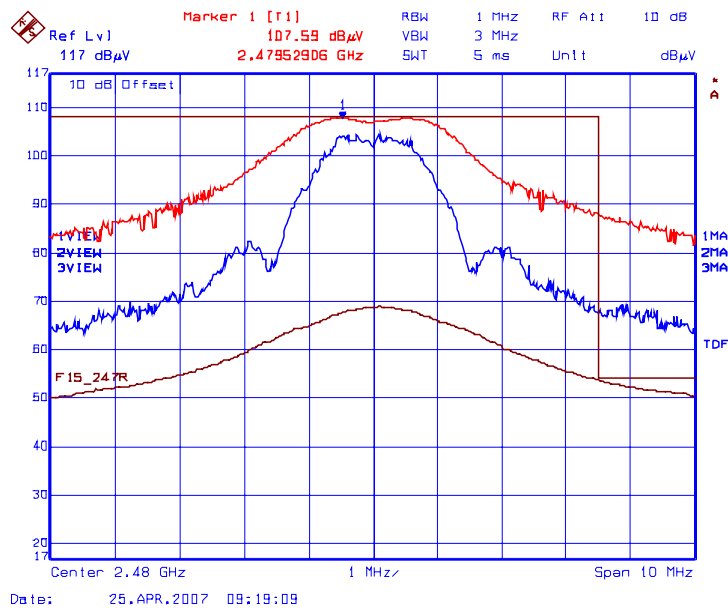
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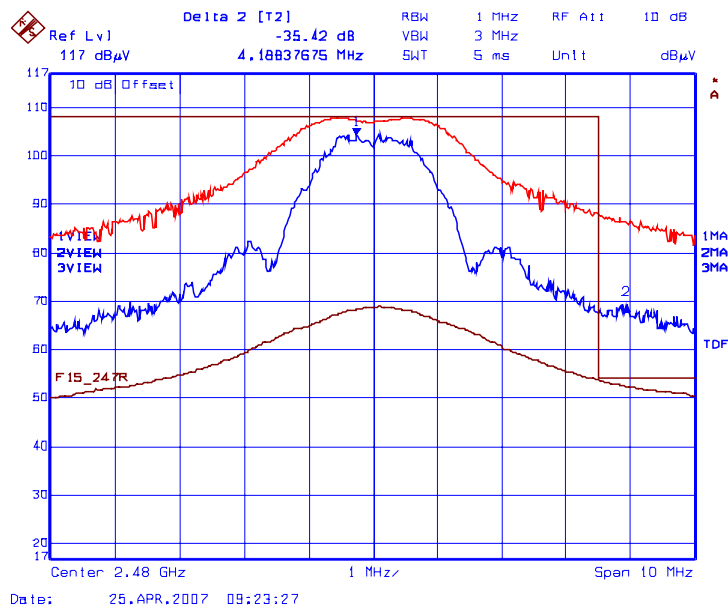
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Plot 6.9.5.3.4(a) Band-Edge RF Radiated Emissions @ 3 m
Upper End of Frequency Band; Rx Antenna Orientation: Vertical



Plot 6.9.5.3.4(b) Band-Edge RF Radiated Emissions @ 3 m
Upper End of Frequency Band; Rx Antenna Orientation: Vertical



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

Trace 2: RBW = 100 kHz, VBW = 300 kHz, Delta (Peak to Band-Edge): 35.42 dB

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

Band-Edge Level at 2483.5 MHz: $107.59 \text{ dB}\mu\text{V/m} - 35.42 \text{ dB} = 72.17 \text{ dB}\mu\text{V/m}$

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

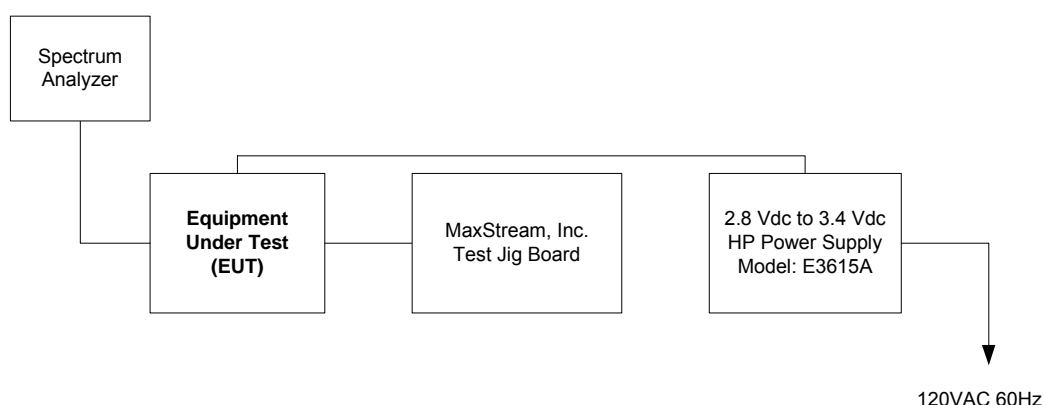
6.10.1. Limit(s)

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.

6.10.2. Method of Measurements

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

6.10.3. Test Arrangement



6.10.4. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer	Rhode & Schwarz	FSEK20/B4/B21	834157/005	9 kHz- 40 GHz

6.10.5. Test Data

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

Frequency (MHz)	*PSD in 3 kHz BW (dBm)	Limit (dBm)	Margin (dB)	Comments (Pass/Fail)
2405	-14.29	8	-22.29	Pass
2440	-13.95	8	-21.95	Pass
2480	-13.38	8	-21.38	Pass

*See the following plots for measurement details.

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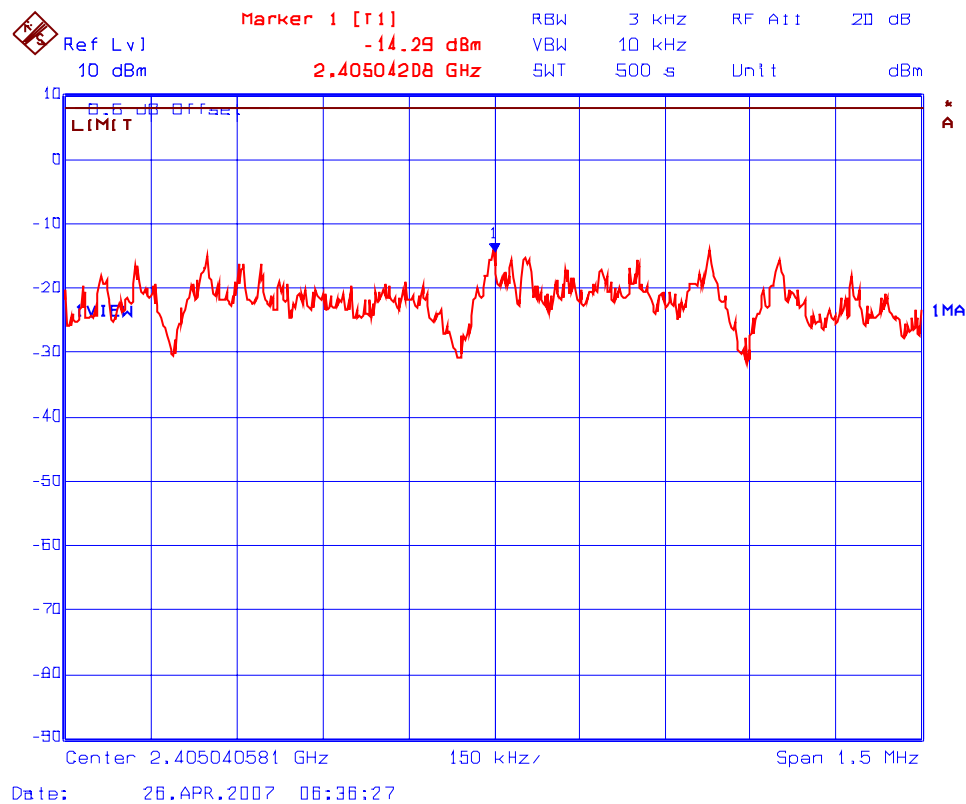
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Plot 6.10.5.1 Power Spectral Density
Frequency: 2405 MHz



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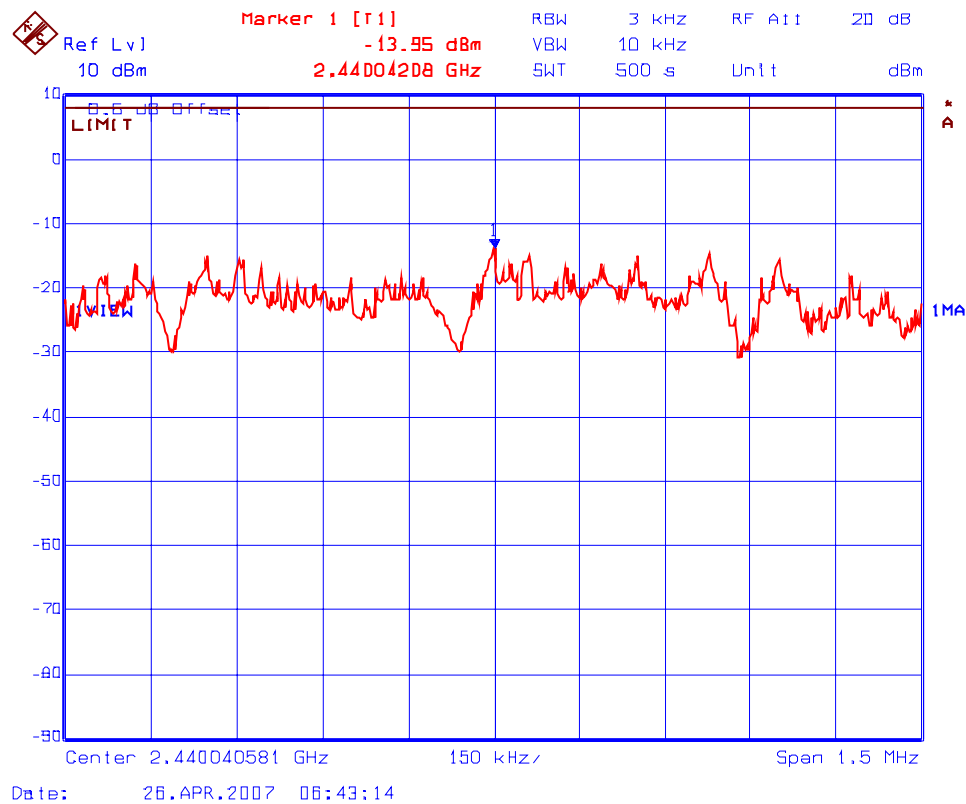
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Plot 6.10.5.2 Power Spectral Density
Frequency: 2440 MHz



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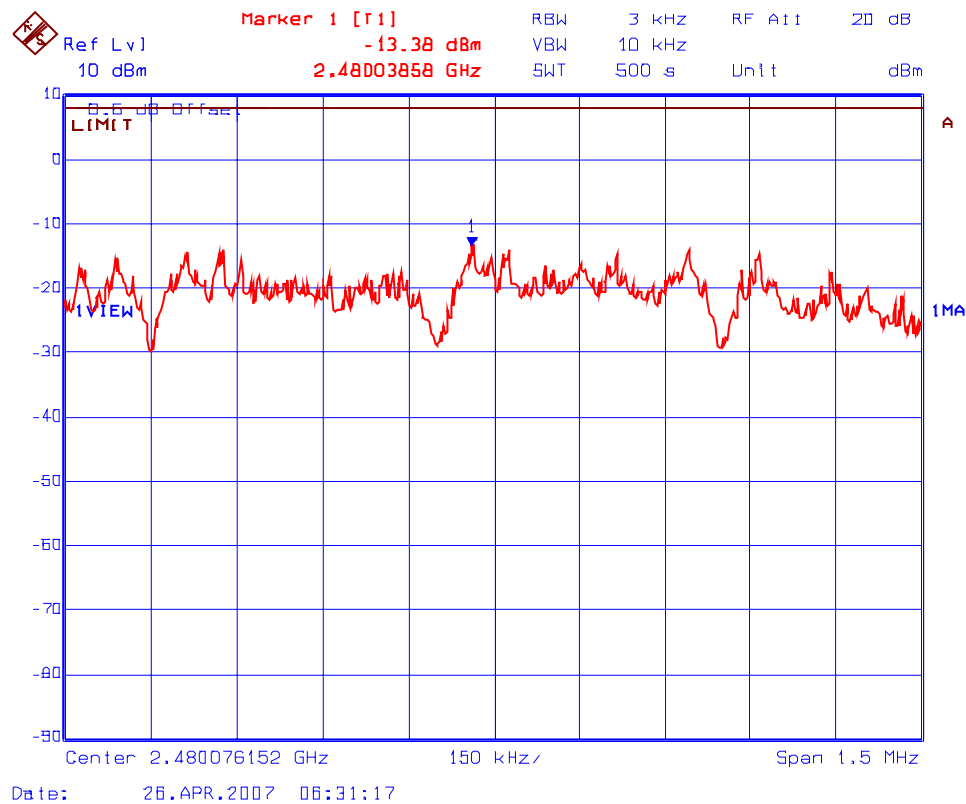
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Plot 6.10.5.3 Power Spectral Density
Frequency: 2480 MHz



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6.11. RF EXPOSURE REQUIRMENTS [§§ 15.247(e)(i), 1.1310 & 2.1091]

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.

6.11.1. Method of Measurements

Refer to Sections 1.1310, 2.1091

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/cm²
G: numeric gain of antenna relative to isotropic radiator
r: distance to centre of radiation in cm

$$r = \sqrt{EIRP/4\pi S}$$

6.11.2. RF Evaluation

Evaluation of RF Exposure Compliance Requirements	
RF Exposure Requirements	Compliance with FCC Rules
Minimum calculated separation distance between antenna and persons required: *2.5 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	Antenna installation and device operating instructions shall be provided to installers to maintain and ensure compliance with RF exposure requirements.
Caution statements and/or warning labels that are necessary in order to comply with the exposure limits	Refer to User's Manual for RF Exposure Information.
Any other RF exposure related issues that may affect MPE compliance	None.

*The minimum separation distance between the antenna and bodies of users are calculated using the following formula:

$$\text{RF EXPOSURE DISTANCE LIMITS: } r = (PG/4\pi S)^{1/2} = (EIRP/4\pi S)^{1/2}$$

$$S = 1.0 \text{ mW/cm}^2$$

$$EIRP = 19 \text{ dBm} = 10^{19/10} \text{ mW max. (Worst Case)}$$

$$r = (EIRP/4\pi S)^{1/2} = (10^{19/10} / 4\pi(1.0))^{1/2} = 2.5 \text{ cm}$$

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EXHIBIT 7. MEASUREMENT UNCERTAINTY

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

7.1. LINE CONDUCTED EMISSION MEASUREMENT UNCERTAINTY

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

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

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

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

7.2. RADIATED EMISSION MEASUREMENT UNCERTAINTY

CONTRIBUTION (Radiated Emissions)	PROBABILITY DISTRIBUTION	UNCERTAINTY (\pm dB)	
		3 m	10 m
Antenna Factor Calibration	Normal (k=2)	± 1.0	± 1.0
Cable Loss Calibration	Normal (k=2)	± 0.3	± 0.5
EMI Receiver specification	Rectangular	± 1.5	± 1.5
Antenna Directivity	Rectangular	± 0.5	± 0.5
Antenna factor variation with height	Rectangular	± 2.0	± 0.5
Antenna phase center variation	Rectangular	0.0	± 0.2
Antenna factor frequency interpolation	Rectangular	± 0.25	± 0.25
Measurement distance variation	Rectangular	± 0.6	± 0.4
Site imperfections	Rectangular	± 2.0	± 2.0
Mismatch: Receiver VRC $\Gamma_1 = 0.2$ Antenna VRC $\Gamma_R = 0.67$ (Bi) 0.3 (Lp) Uncertainty limits $20\log(1+\Gamma_1\Gamma_R)$	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:

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