

Nemko Test Report: 132354-1TRFWL

Applicant: Imation Corp.
1 Imation Way
Oakdale, MN 55128-3414
United States

Apparatus: WR700TX Wireless Transmitter

FCC ID: PB4WR700TX

In Accordance With: FCC Part 15 Subpart C, 15.247
FHSS System and Digitally Modulated Radiators
902–928 MHz, 2400–2483.5 MHz, 5725–5850 MHz

Authorized By: 
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Date: September 9, 2009

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Section 1 : Report Summary

These tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with Part 15, Subpart C. Radiated tests were conducted in accordance with ANSI C63.4-2003.

The assessment summary is as follows:

Apparatus Assessed:	WR700TX Wireless Transmitter
Specification:	FCC Part 15 Subpart C, 15.247
Compliance Status:	Complies
Exclusions:	None
Non-compliances:	None
Report Release History:	Original Release
Test Location:	Nemko Canada Inc. 303 River Road Ottawa, Ontario K1V 1H2
Registration Number:	176392 (3 m Semi-Anechoic Chamber)
Tests Performed By:	Kevin Ma, Wireless/EMC Specialist
Test Dates:	August 25 to August 27, 2009

Note that the results contained in this report relate only to the items tested and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.

This test report has been completed in accordance with the requirements of ISO/IEC 17025. All results contain in this report are within Nemko Canada's ISO/IEC 17025 accreditation.

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Section 2 : Equipment Under Test

2.1 Identification of Equipment Under Test (EUT)

The following information identifies the EUT under test:

Type of Equipment:	Wireless transmitter
Brand Name:	TDK LoR
Model Name or Number:	WR700TX
Serial Number:	N/A
Nemko Sample Number:	1
FCC ID:	PB4WR700TX
Date of Receipt:	August 25, 2009

2.2 Accessories

No accessories were used to exercise the EUT during testing.

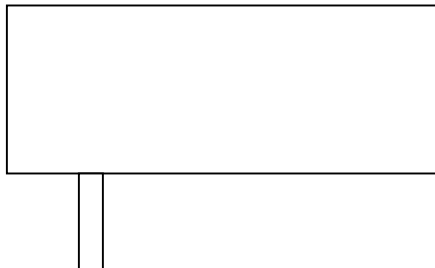
2.3 EUT Description

Portable transceiver operates at 2.4–2.4835 GHz ISM band.

2.4 Technical Specifications of the EUT

Operating Band:	2400–2483.5 MHz
Operating Frequency:	2403–2478 MHz
Modulation:	MSK
Occupied Bandwidth:	1.64 MHz
Emission Designator:	1M64G1D
Channel Number:	16
Antenna Data:	Ceramic chip antenna 2.1 dBi
Power Supply Requirements:	3 VDC 2x “AAA” type Batteries

2.5 EUT Setup diagram



2.6 Operation of the EUT during testing

The EUT has been controlled from PC to transmit constantly at the low, mid and high channel.

2.7 Modifications incorporated in the EUT

There were no modifications performed to the EUT during this assessment.

Section 3 : Test Conditions

3.1 Specifications

The apparatus was assessed against the following specifications:

FCC Part 15 Subpart C, 15.247

FHSS System and Digitally Modulated Radiators

902–928 MHz, 2400–2483.5 MHz, 5725–5850 MHz

3.2 Deviations From Laboratory Test Procedures

No deviations were made from laboratory test procedures.

3.3 Test Environment

All tests were performed under the following environmental conditions:

Temperature range	:	15–30 °C
Humidity range	:	20–75 %
Pressure range	:	86–106 kPa
Power supply range	:	±5 % of rated voltages

3.4 Measurement Uncertainty

Nemko Canada measurement uncertainty has been calculated using guidance of UKAS LAB 34:2003 and TIA-603-B Nov 7, 2002. All calculations have been performed to provide a confidence level of 95 % and can be found in Nemko Canada document MU-003.

3.5 Test Equipment

Equipment	Manufacturer	Model No.	Asset/Serial No.	Cal. Date	Next Cal.
3 m EMI Test Chamber	TDK	SAC-3	FA002047	May 06/09	May 06/10
Bilog	Sunol	JB3	FA002108	Jan. 27/09	Jan. 27/10
Flush Mount Turntable	Sunol	FM2022	FA002082	NCR	NCR
Controller	Sunol	SC104V	FA002060	NCR	NCR
Mast	Sunol	TLT2	FA002061	NCR	NCR
International Power Supply	California Inst.	3001i	FA001021	Jan. 13/09	Jan. 13/10
Receiver/Spectrum Analyzer	Rohde & Schwarz	ESU 26	FA002043	Dec. 16/08	Dec. 16/09
Horn Antenna #2	EMCO	3115	FA000825	Jan. 21/09	Jan. 21/10
1 – 18 GHz Amplifier	JCA	JCA118-503	FA002091	Oct 2/08	Oct 2/09
Receiver/Spectrum Analyzer	Rohde & Schwarz	ESU 40	FA002071	Nov. 25/08	Nov. 25/09
Horn 18 – 26.5 GHz	Electro-Metrics	SH-50/60-1	FA000479	COU	COU
18.0 – 26.0 GHz Amplifier	NARDA	BBS-1826N612	FA001550	COU	COU
Frequency Counter	HP	5352B	FA001915	Jan 08/09	Jan 08/10
Multimeter	Fluke	16	FA001831	Jan 13/09	Jan 13/10
Attenuator	Narda	776B-20	FA001153	COU	COU

COU – Calibrate on Use

NCR – No Calibration Required

Section 4 : Results Summary

This section contains the following:

FCC Part 15 Subpart C : Test Results

The column headed 'Required' indicates whether the associated clauses were invoked for the apparatus under test. The following abbreviations are used:

N No : not applicable / not relevant.

Y Yes : Mandatory i.e. the apparatus shall conform to these tests.

N/T Not Tested, mandatory but not assessed. (See Report Summary)

4.1 FCC Part 15 Subpart C : Test Results

Part 15	Test Description	Required	Result
15.31(e)	Variation of power supply	N	PASS
15.207(a)	Powerline Conducted Emissions	N	
15.209(a)	Radiated Emissions within Restricted Bands	Y	
15.247(a)(1)	Frequency hopping systems	N	PASS
15.247(a)(1)(i)	Frequency hopping systems operating in the 902–928 MHz band	N	
15.247(a)(1)(ii)	Frequency hopping systems operating in the 5725–5850 MHz band	N	
15.247(a)(1)(iii)	Frequency hopping systems operating in the 2400–2483.5 MHz band	N	PASS
15.247(a)(2)	Minimum 6 dB Bandwidth	Y	
15.247(b)(1)	Maximum peak output power of Frequency hopping systems operating in the 2400–2483.5 MHz band and 5725–5850 MHz band	N	
15.247(b)(2)	Maximum peak output power of Frequency hopping systems operating in the 902–928 MHz band	N	PASS
15.247(b)(3)	Maximum peak output power of systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands	Y	
15.247(b)(4)	Maximum peak output power	Y	
15.247(c)(1)	Fixed point-to-point Operation with directional antenna gains greater than 6 dBi	N	PASS
15.247(c)(2)	Transmitters operating in the 2400–2483.5 MHz band that emit multiple directional beams	N	
15.247(d)	Radiated Emissions Not in Restricted Bands	Y	
15.247(e)	Power Spectral Density for Digitally Modulated Devices	Y	PASS
15.247(f)	Time of Occupancy for Hybrid Systems	N	

Appendix A : Test Results

Clause 15.209(a) Radiated Emissions within Restricted Bands

Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Field Strength		Measurement Distance (meters)
	($\mu\text{V/m}$)	($\text{dB}\mu\text{V/m}$)	
0.009–0.490	2400/F	$67.6-20\log(F)$	300
0.490–1.705	24000/F	$87.6-20\log(F)$	30
1.705–30.0	30	29.5	30
30–88	100	40.0	3
88–216	150	43.5	3
216–960	200	46.0	3
Above 960	500	54.0	3

Note: F = fundamental frequency in kHz

Test Results: Pass

Additional Observations:

The Spectrum was searched from 30 MHz to the 10th Harmonic.

These results apply to emissions found in the restricted bands defined in FCC Part 15 Subpart C, 15.205.

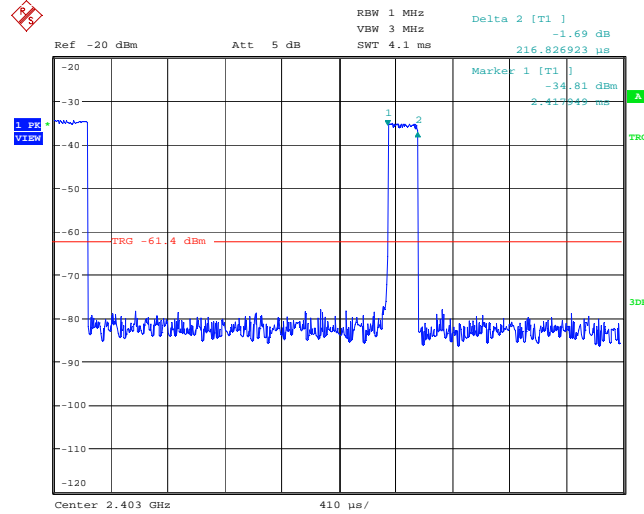
All measurements were performed at the distance of 3 m. Peak detector was used with 100 kHz RBW/300 kHz VBW below 1 GHz and 1 MHz/3 MHz RBW/VBW above 1 GHz. Fresh batteries were used throughout all tests.

The EUT was measured on three orthogonal axis.

Channel	Freq. MHz	Pol.	Peak Field Strength $\text{dB}\mu\text{V/m}$	Peak Limit $\text{dB}\mu\text{V/m}$	Margin dB	Average Factor dB	Average Field Strength $\text{dB}\mu\text{V/m}$	Average Limit $\text{dB}\mu\text{V/m}$	Margin dB
0	4805.2	V	54.3	74.00	19.7	-19.30	35.0	54.00	19.0
0	4805.2	H	55.5	74.00	18.5	-19.30	36.2	54.00	17.8
7	4875.6	V	57.9	74.00	16.1	-19.30	38.6	54.00	15.4
7	4875.6	H	55.7	74.00	18.3	-19.30	36.4	54.00	17.6
15	4957.2	V	55.0	74.00	19.0	-19.30	36.7	54.00	17.3
15	4957.2	H	58.8	74.00	15.2	-19.30	39.5	54.00	14.5

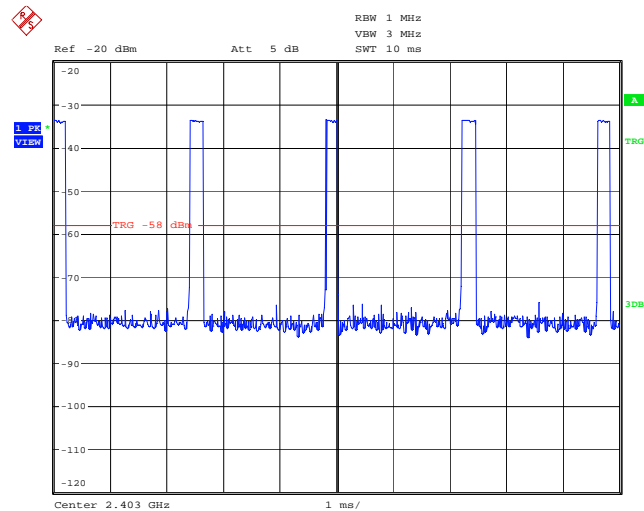
Note: Antenna Factor, cable loss and amplifier gain are included in the Peak Field Strength result.

Duty Cycle: Transmission On Time



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Transmission within 10 ms

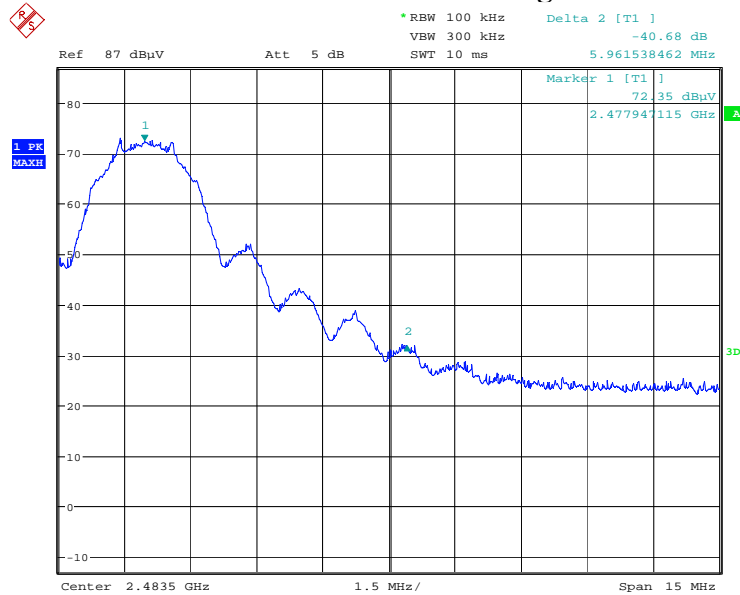


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T_{ON} (μs)	Maximum Number of pulses within 10 ms	Maximum Number of pulses within 100 ms	T_{ON} (ms) within 100 ms	Average factor (dB)
216.83	5	50	10.84	-19.30

Duty Cycle Correction (Average Factor) = $20 \log_{10}(T_{ON} / 100 \text{ ms}) =$
 $20 \log_{10}(10.84 \text{ ms} / 100 \text{ ms}) = -19.30 \text{ dB}$

Delta Marker Measurement for 2.4835 GHz Band Edge



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Measured Field Strength for High Channel in 1 MHz RBW = 99.24 dBμV/m

Delta Marker = -40.68 dB

Therefore, Peak Field Strength = 99.24 dBμV/m - 40.68dB = 58.56 dBμV/m

Limit = 74 dBμV/m

Average Field Strength = 58.56 dBμV/m - 19.30 dB (Duty Cycle) = 39.26 dBμV/m

Limit = 54 dBμV/m

Peak Field Strength (dBμV/m)	Peak Field Strength Limit (dBμV/m)	Margin (dB)
58.56	74.00	15.44
Average Field Strength (dBμV/m)	Average Field Strength Limit (dBμV/m)	Margin (dB)
39.26	54.00	14.74

Clause 15.247(a)(2) Minimum 6 dB Bandwidth

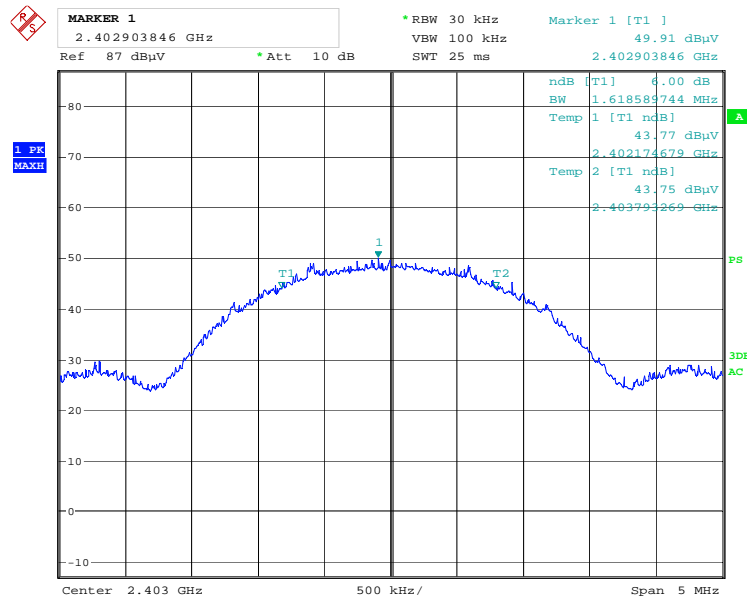
Systems using digital modulation techniques may operate in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

Test Results: Pass

6 dB Bandwidth:

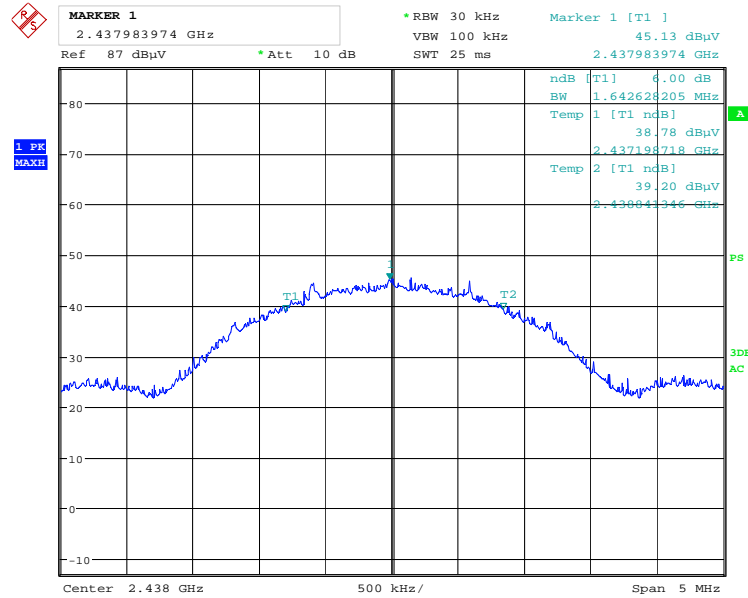
Channel	6 dB BW, MHz	Limit, MHz	Margin, MHz
Low	1.619	0.5	1.119
Mid	1.643	0.5	1.143
High	1.619	0.5	1.119

6 dB BW on Low channel:



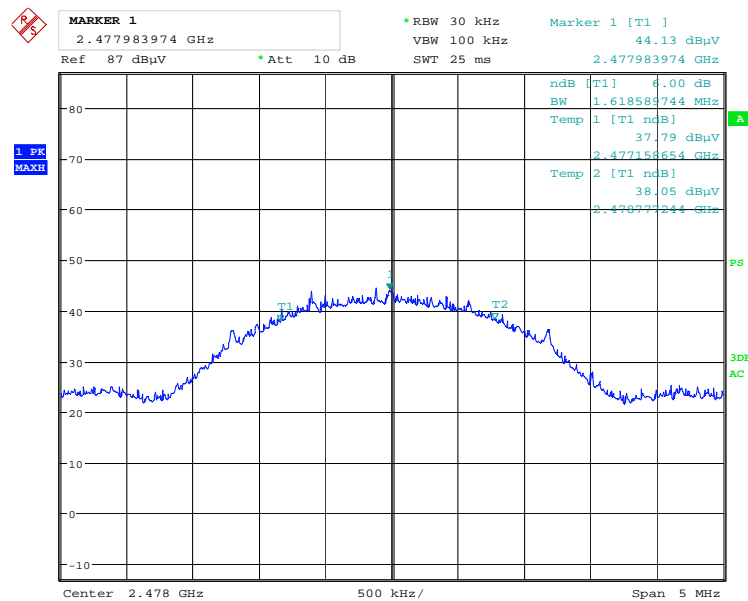
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6 dB BW on Mid channel:



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6 dB BW on High channel:



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Clause 15.247(b)(3) Maximum peak output power of systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands

For systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands: 1 W. As an alternative to a peak power measurement, compliance with the 1 W 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 signalling 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.

Clause 15.247(b)(4) Maximum peak output power

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.

Test Results: Pass

The output power tested radiated using peak detector of the spectrum analyzer and 10 MHz/10 MHz of RBW/VBW at the distance of 3 meter.

Fresh batteries were used throughout all tests.

Radiated Output Power:

Chan.	Freq. MHz	Pol.	Ant. Type	Peak Field Strength dBμV/m	Conducted Output power dBm	Conducted Power Limit dBm	Margin dB
0	2403.0	V	Horn	97.22	-0.11	30.00	30.11
0	2403.0	H	Horn	99.17	1.84	30.00	28.16
7	2438.0	V	Horn	95.27	-2.06	30.00	32.06
7	2438.0	H	Horn	97.74	0.41	30.00	29.59
15	2478.0	V	Horn	98.87	1.54	30.00	28.46
15	2478.0	H	Horn	99.72	2.41	30.00	27.59

$$E \text{ (V/m)} = \frac{10^{(FS/20)}}{1 \times 10^6} = \left(10^{\left(\frac{99.72}{20} \right)} \right) \times 10^{-6} = 0.097 \text{ V/m}$$

$$G \text{ (numeric)} = 10^{(Ag/10)} = 10^{\left(\frac{2.1}{10} \right)} = 1.62$$

$$P \text{ (W)} = \frac{E^2 R^2}{30G} = 0.001742 \text{ W} = 1.742 \text{ mW}$$

FS = Field Strength (dBμV/m)

Ag = Antenna gain (dBi)

E = Measured Value (V/m)

R = Measurement distance (m)

G = Antenna Gain (numeric)

P = Output power (W)

$$\text{Output Power (dBm)} = 10 \times \log(\text{Output Power (mW)}) = 10 \times \log(1.742) = 2.41 \text{ dBm}$$

Conducted Output Power Limit = 30 dBm

EIRP: Conducted Output power + antenna Gain = 2.41 + 2.1 = 4.51 dBm.

EIRP limit = 36 dBm.

Clause 15.247(d) Radiated Emissions Not in Restricted Bands

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 §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)).

Test Results: Pass

Additional Observations:

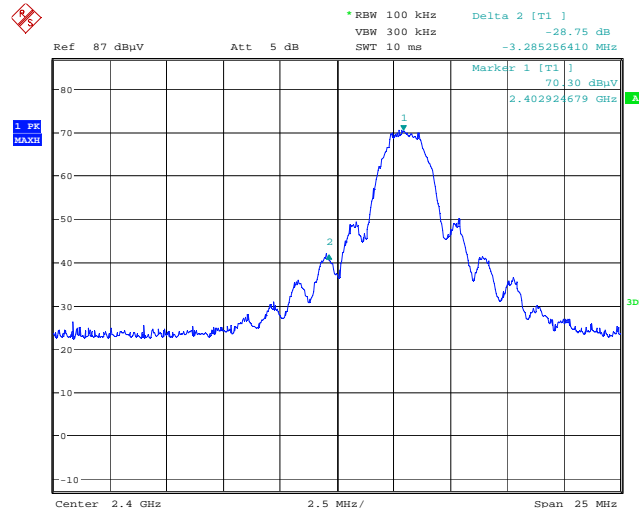
The Spectrum was searched from 30 MHz to the 10th Harmonic.

These results apply to emissions found not in the restricted bands defined in FCC Part 15 Subpart C, 15.205.

Fresh batteries were used throughout all tests.

No emissions were found less than 20 dB below the fundamental emission with 100 kHz RBW/300 kHz VBW.

Lower Band Edge:



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Clause 15.247(e) Power Spectral Density for Digitally Modulated Devices

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.

Test Results: Pass

Channel	Freq. MHz	Peak Field Strength dBμV/m/3 kHz	Conducted spectral Density dBm/3 kHz	Spectral Density Limit dBm/3 kHz	Margin dB
0	2403	84.19	-13.14	8.00	21.14
7	2438	83.27	-14.06	8.00	22.06
15	2478	85.50	-11.82	8.00	19.82

Sample calculation for High channel:

$$E \text{ (V/m/3 kHz)} = \frac{10^{(FS/20)}}{1 \times 10^6} = 0.018836 \text{ V/m/3 kHz}$$

$$G \text{ (numeric)} = 10^{(Ag/10)} = 10^{\left(\frac{2.1}{10}\right)} = 1.62$$

$$P \text{ (W/3 kHz)} = \frac{E^2 R^2}{30G} = 0.0000657 \text{ W/3 kHz} = 0.0657 \text{ mW/3 kHz}$$

FS = Field Strength (dBμV/m/3 kHz)

Ag = Antenna gain (dBi)

E = Measured Value (V/m/3 kHz)

R = Measurement distance (m)

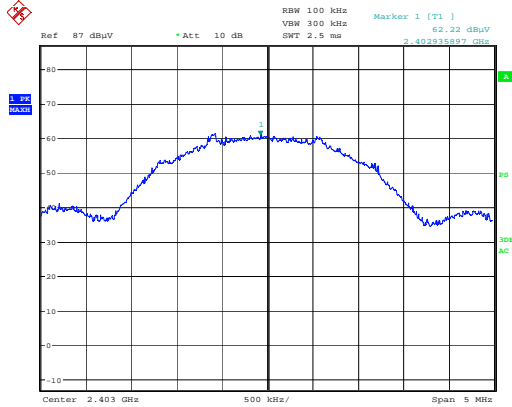
G = Antenna Gain (numeric)

P = Spectral power Density (W/3 kHz)

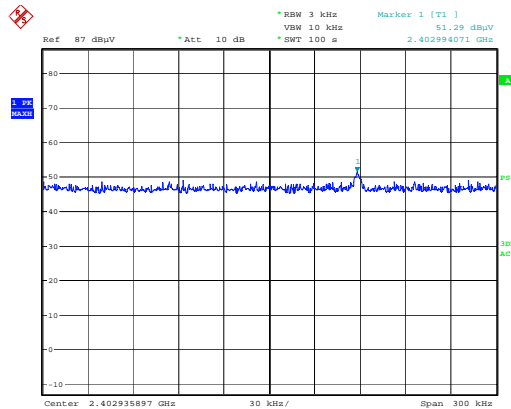
$$\text{Spectral Power Density (dBm/3 kHz)} = 10 \times \log(0.0657) = -11.82 \text{ dBm/3 kHz}$$

Note: Fresh batteries were used throughout all tests.

Power Spectral Density on Low channel:

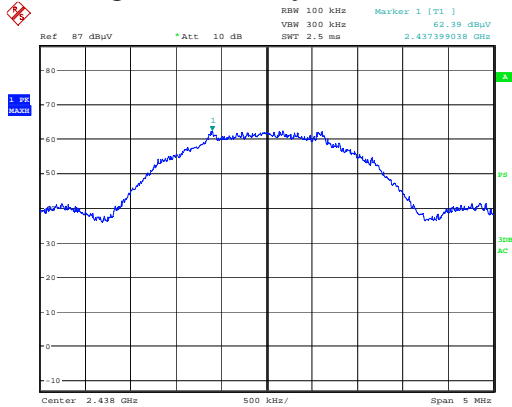


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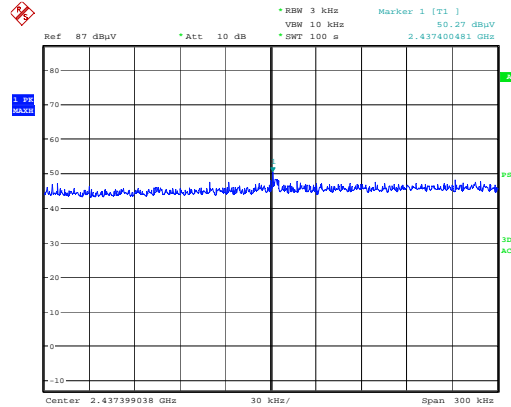


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Power Spectral Density on Mid channel:

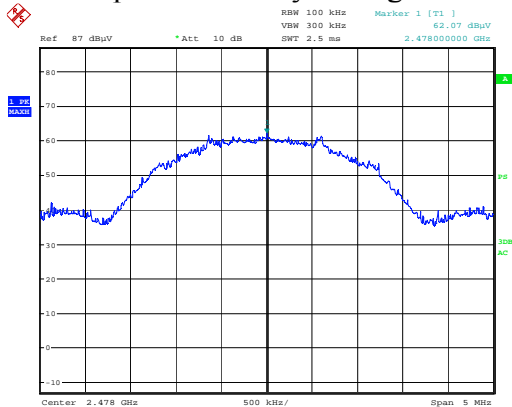


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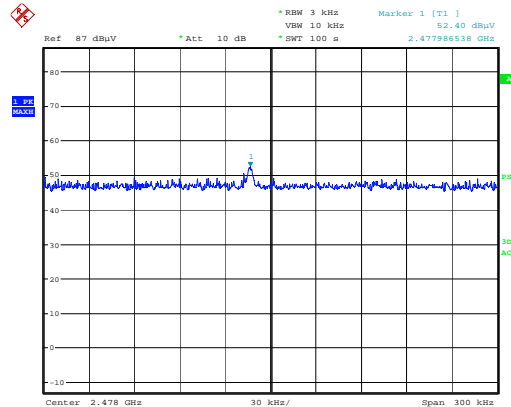


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Power Spectral Density on High channel:



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Date: 27.AUG.2009 12:14:28

Appendix B : Setup Photographs

Spurious Emissions Setup:



Appendix C : Block Diagram of Test Setups

Radiated Emissions above 30 MHz Test Site

