Project 10003-10

Motorola
WTM1100

Electromagnetic Compatibility Test Report

Prepared for:

Motorola
6500 River Place Blvd. Building 7
Austin, Texas 78730

By

Professional Testing (EMI), Inc.
1601 North A.W. Grimes Blvd., Suite B
Round Rock, Texas 78665

AUGUST 6, 2009

Reviewed by

Dan Gaas
Director of Engineering

Written by

Jason Anderson
Director of Testing Services

Revision History

Revision History		
Revision Number	**Description**	**Date**
00	Initial Release	August 5 2009
01	Corrected Frequency range	August 6, 2009

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FIGURES

PHOTOGRAPHS

Certificate of Compliance

Applicant: Motorola
Applicant's Address: 6500 River Place Blvd. Building 7
Austin, Texas 78730

Model: WTM1100
Project Number: 10003-10

The **Motorola- WTM1100** was tested utilizing the following documents and found to be in compliance with the required criteria on the indicated test date.

FCC 47 CFR Part 15		
Conducted Emissions	Class B	June 30, 2009
Radiated Emissions	Class B	June 29, 2009

I, Jason Anderson, for Professional Testing (EMI), Inc., being familiar with the Electromagnetic Compatibility rules and test procedures, have reviewed the test setup, measured data and this report. I believe them to be true and accurate.

Jason Anderson
Director of Testing Services

This report has been reviewed and accepted by Motorola. The undersigned is responsible for ensuring that the Motorola WTM1100 will continue to comply with the applicable rules.

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1.0 Introduction

1.1 Scope

The purpose of the EMC testing was to determine compliance with specific emissions and immunity standards. This report describes the extent to which the Equipment Under Test (EUT) conformed to the standards to which it was tested and the manner in which that testing was conducted.

1.2 EUT Description

The WTM1100 is an IEEE 802.16e Wave 2 compliant, single-band Half Mini-PCIe wireless network adapter that operates in the 2.5 GHz spectrum for WiMax connectivity. The WTM1100 is capable of delivering up to 4Mbps UL/ 16 Mbps DL over WiMax. The WTM1100 is capable of operating with various modulation schemes and channel bandwidths. See the possible configuration table below for all modes that were tested.

Operational Modes

TX/RX	Modulation	Channel Bandwidth
Receive Only	QPSK/QAM16/QAM64	5, 10

Note: Receive Mode had a combined operational mode in which the device listened across all modes.

Note 1: For a more detailed description, please refer to the manufacturer's specifications or User's Manual.

The system tested consisted of the following:

Manufacturer & Model	**Serial #**	**Description**
Motorola WTM1100		WiMax transmitter
Remote Equipment/System Peripherals:		
Dell, Inspiron		Laptop
Dell, PA-1900-02D		Laptop Power Supply
Netgear		Ethernet Router
Cords and Cables		

Qty	Length	Type
1	1 meter	Shielded USB – Tx Module to laptop
1	1 meter	Cat 5 – Router to laptop

1.3 EUT Operation

The EUT was configured as a peripheral device with the host being a laptop computer. The host device was populated with at least two types of I/O. The EUT was placed in continuous receive mode at by a program provided by the manufacturer (RTT software test tool). The system tested consisted of the following:

1.4 Modifications to Equipment

No modifications were made to the EUT during the performance of the test program.

1.5 Applicable Documents

The following documents were used as reference for the test procedures specified herein.

ANSI C63.4	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low Voltage Electrical and Electronic Equipment.	2003
47 CFR	Part 15 – Radio Frequency Devices Subpart B -Unintentional Radiators	

2.0 Electromagnetic Emissions Testing

Professional Testing (EMI), Inc. (PTI), follows the guidelines of NIST for all uncertainty calculations, estimates and expressions thereof for EMC testing. Professional Testing has met the requirements for performing measurements on the site. All relevant accreditations are shown in Appendix E. A copy of PTI's policy for EMC Measurement Uncertainty is provided in Appendix D.

2.1 Conducted Emissions Measurements

2.1.1 Test Procedure

The EUT was configured and operated in a manner consistent with typical applications. The EUT power cord in excess of one meter was folded back and forth forming a bundle 30 to 40 cm long in the approximate center of the cable. Power supply cords for the peripheral equipment were powered from an auxiliary LISN. Excess interface cable lengths were separately bundled in a non-inductive arrangement at the approximate center of the cable with the bundle 30 to 40 centimeters in length. The conducted emissions were maximized, by varying the operating states and configuration of the EUT.

The tests were performed in a 12' x 8' RayProof modular shielded room. The EUT was placed on a non-metallic table 0.4 meters from a vertical metal reference plane and 0.8 meters from a horizontal metal reference plane. A drawing showing the test setup is given as Figure 1.

2.1.2 Test Criteria

The FCC Part 15 Class B conduction limits are given below.

Frequency (MHz)	Conducted Limits (dBuV)	
	Average	Quasi-Peak
0.15 – .50	66-56*	56 – 46*
.50 - 5	56	46
5 – 30	60	50

The tighter limit shall apply at the edge between two frequency bands.
*Decreases with the logarithm of the frequency.

2.1.3 Test Results

The conducted emissions generated by EUT were below FCC Part 15.109 Class B maximum criteria.

2.2 Radiated Emissions Measurements

Radiated emissions measurements were made at the Professional Testing Site 45, located in Austin, Texas to determine the radio frequency noise radiated from the EUT.

2.2.1 Test Procedure

The EUT was placed on a non-conductive table 0.8 meters above the ground plane. The table was centered on a motorized turntable which allows 360 degree rotation.

For frequencies less than 1GHz, a measurement antenna was positioned at a distance of 10 meters as measured from the closest point of the EUT. The radiated emissions were maximized by configuring the EUT, by rotating the EUT, and by raising and lowering the antenna from 1 to 4 meters. A Spectrum Analyzer with peak detection was used to find the maximums of the radiated emissions during the variability testing. All final measurements were taken using a Quasi-peak adapter with a measurement bandwidth of 120 kHz.

For frequencies greater than 1GHz, a measurement antenna was positioned at a constant height of 1 meter and at a distance of 3 meters from the closest point of the EUT. Average measurements were taken using a Spectrum Analyzer to find the maximums of the microwave radiated emissions.

A drawing showing the test setup is given as Figure 1.

2.2.2 Test Criteria

The FCC Part 15.109 Class B radiated limits are given below.

Frequency (MHz)	Test Distance (Meters)	Field Strength dB(μV/m)
30 to 88	10	29.5
88 to 216	10	33.0
216 to 960	10	35.5
Above 960	10	43.5

The lower limit shall apply at the transition frequency.

The FCC Part 15.109 Class B microwave radiated limits are given below.

Frequency (MHz)	Test Distance (Meters)	Field Strength dB(μV/m)
>1000	3	54

2.2.3 Test Results

The radiated emissions generated by EUT were below FCC Part 15.109 Class B maximum criteria.

Appendix A Test Setup Figures

Figure 1: Conducted Emissions Test Setup

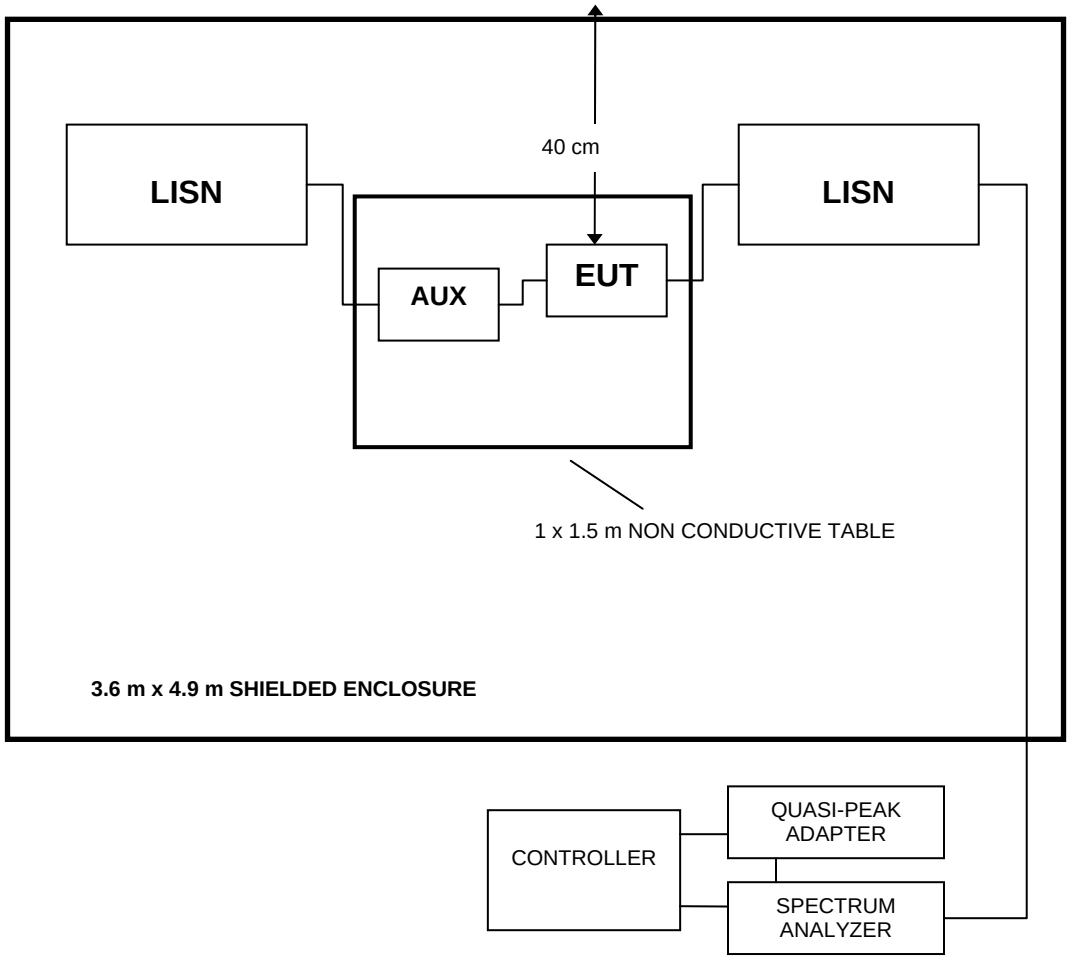
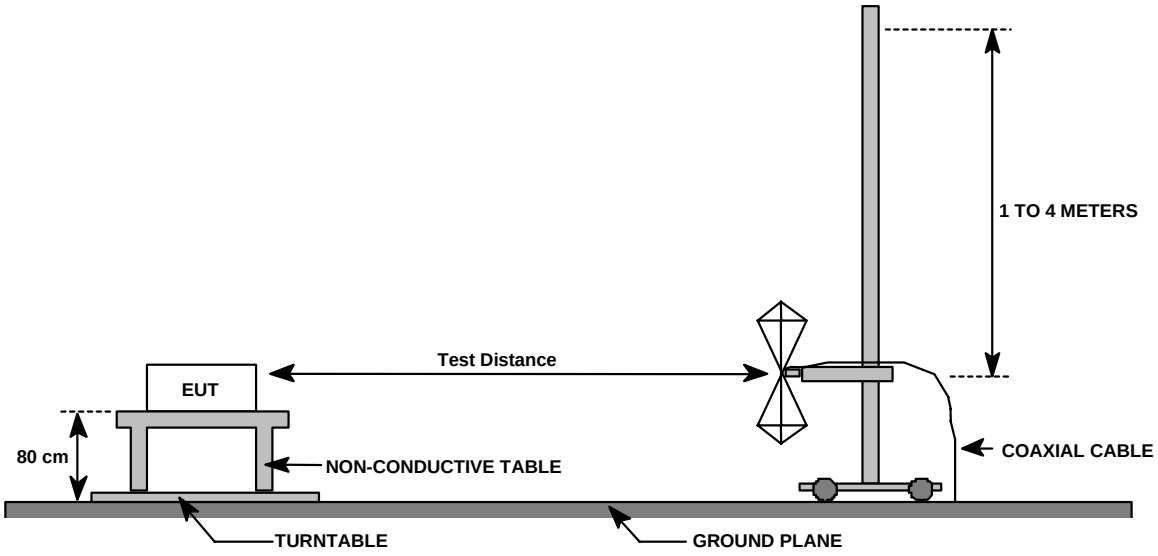


Figure 2: Radiated Emissions Test Setup



Appendix B Emissions Test Equipment & Data Sheets

Receive Spurious Conducted Emissions Data Sheet

Measurement Parameters

150 kHz to 30 MHz

PROJECT #	DATE	CLASS	DISTANCE	COUPLING	RBW	VBW	DETECTOR
10003-10	June 30, 2009	B	N/A	LISN	9 kHz	100 kHz	Quasi-Peak/Average

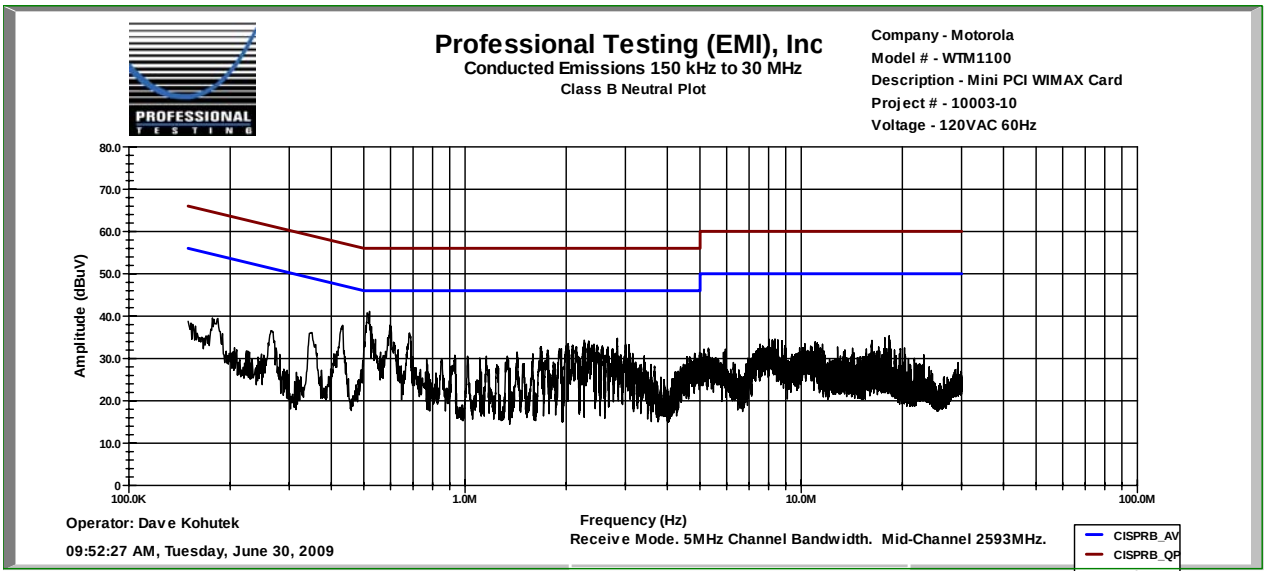
Test Equipment

Asset #	Manufacturer	Model #	Description	Calibration Due
1281	HP	85650A	Quasi-peak Adapter	January 05, 2010
0045	HP	85662A	Spectrum Analyzer Display	NCR
1284	HP	8568B	Spectrum Analyzer	January 05, 2010
1037	PTI	PTI-ALF1	Attenuator, Limiter, Filter	June 2, 2010
1185	Emco	3825/2	Line Impedance Stabilization Network	September 13, 2009
0081	ELGAR	1751SL	AC Power Supply	NCR
1683	TESEQ	T800	ISN	November 24, 2009
1173	PTI	100KHz HPF	High Pass Filter	January 26, 2010

Receive Mode 5 MHz Channel Bandwidth Mid Channel 2593 MHz

(Neutral)

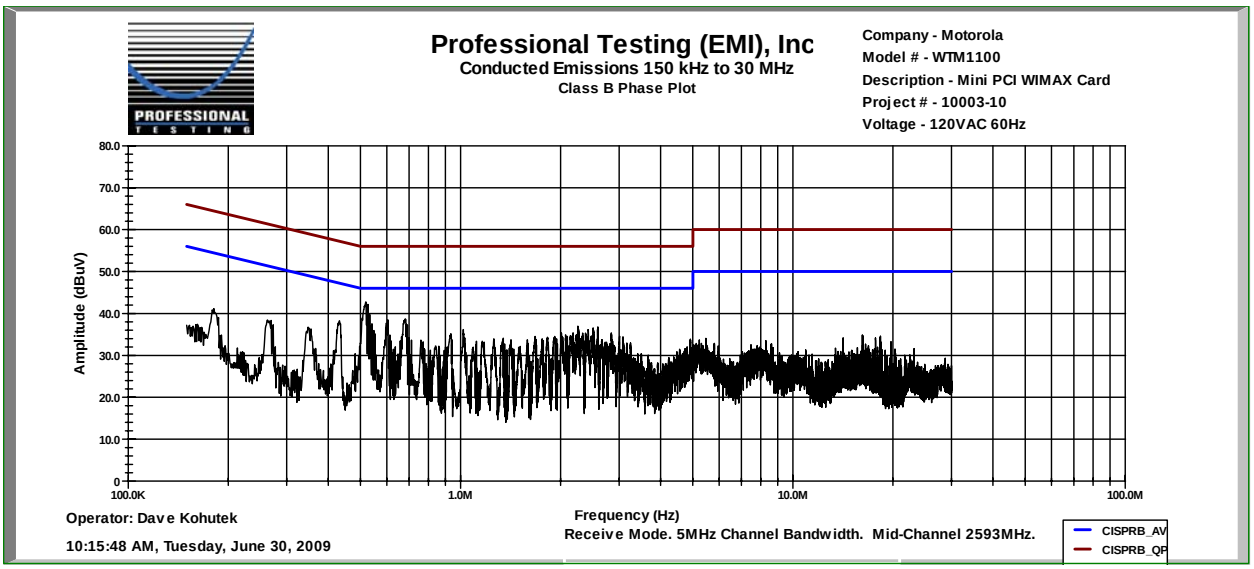
Frequency Reading (MHz)	Quasi-peak Reading (dBuV)	Average Reading (dBuV)	Quasi-peak Limit (dBuV)	Quasi-peak Margin (dB)	Average Limit (dBuV)	Average Margin (dB)
0.1806	36.8	33.7	65.1	-28.3	55.1	-21.4
0.43147	38.0	34.4	58.0	-20.0	48.0	-13.5
0.51622	39.9	36.7	56.0	-16.1	46.0	-9.3
0.51706	40.1	37.5	56.0	-15.9	46.0	-8.5
0.59662	35.8	33.7	56.0	-20.2	46.0	-12.3
8.04075	32.5	23.6	60.0	-27.5	50.0	-26.4
8.20435	32.1	25.6	60.0	-27.9	50.0	-24.4
8.28933	32.3	24.1	60.0	-27.7	50.0	-25.9
17.7101	33.6	29.5	60.0	-26.4	50.0	-20.5
18.2568	34.0	30.2	60.0	-26.0	50.0	-19.8



RESULT = PASS

Receive Mode 5 MHz Channel Bandwidth Mid Channel 2593 MHz (Phase)

Frequency Reading (MHz)	Quasi-peak Reading (dBuV)	Average Reading (dBuV)	Quasi-peak Limit (dBuV)	Quasi-peak Margin (dB)	Average Limit (dBuV)	Average Margin (dB)
0.50456	41.4	39.5	56.0	-14.6	46.0	-6.5
0.50535	42.1	39.3	56.0	-13.9	46.0	-6.7
0.50572	42.0	39.6	56.0	-14.0	46.0	-6.4
0.51865	41.0	39.1	56.0	-15.0	46.0	-6.9
0.67424	37.6	34.3	56.0	-18.4	46.0	-11.7
5.48333	31.6	24.3	60.0	-28.4	50.0	-25.7
14.1672	28.6	23.4	60.0	-31.4	50.0	-26.6
16.182	31.8	27.4	60.0	-28.2	50.0	-22.6
16.2449	32.9	29.1	60.0	-27.1	50.0	-20.9
18.3202	32.6	28.1	60.0	-27.4	50.0	-21.9

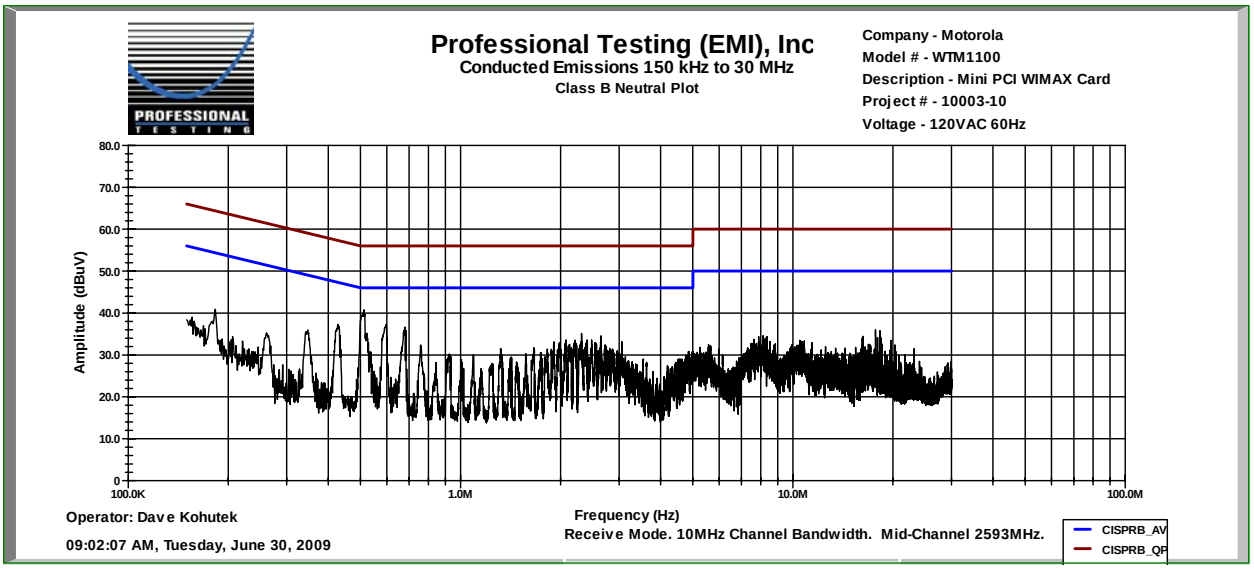


RESULT = PASS

Receive Mode 10 MHz Channel Bandwidth Mid Channel 2593 MHz

(Neutral)

Frequency Reading (MHz)	Quasi-peak Reading (dBuV)	Average Reading (dBuV)	Quasi-peak Limit (dBuV)	Quasi-peak Margin (dB)	Average Limit (dBuV)	Average Margin (dB)
0.17778	36.8	33.6	65.2	-28.4	55.2	-21.6
0.42957	37.1	33.3	58.0	-20.9	48.0	-14.7
0.50791	39.7	36.5	56.0	-16.3	46.0	-9.5
0.59394	36.4	33.5	56.0	-19.6	46.0	-12.5
0.67377	34.7	31.7	56.0	-21.3	46.0	-14.3
7.91047	31.4	22.9	60.0	-28.6	50.0	-27.1
8.15945	31.8	24.1	60.0	-28.2	50.0	-25.9
8.32973	31.7	25.1	60.0	-28.3	50.0	-24.9
17.7092	33.6	29.7	60.0	-26.4	50.0	-20.3
18.2588	34.0	30.2	60.0	-26.0	50.0	-19.8



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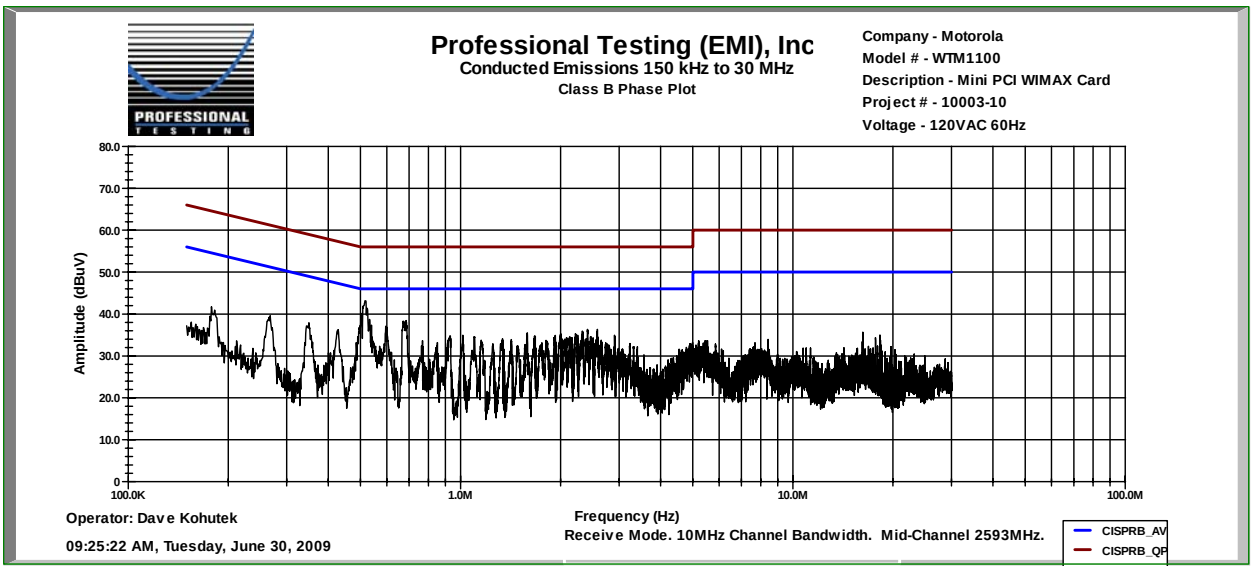
Receive Mode 10 MHz Channel Bandwidth Mid Channel 2593 MHz (Phase)

Frequency Reading (MHz)	Quasi-peak Reading (dBuV)	Average Reading (dBuV)	Quasi-peak Limit (dBuV)	Quasi-peak Margin (dB)	Average Limit (dBuV)	Average Margin (dB)
0.17933	38.8	35.7	65.2	-26.3	55.2	-19.5
0.26477	36.8	34.3	62.7	-26.0	52.7	-18.4
0.34637	35.7	33.9	60.4	-24.7	50.4	-16.5
0.51429	41.5	39.2	56.0	-14.5	46.0	-6.8
0.67449	37.4	34.6	56.0	-18.6	46.0	-11.4
5.22932	30.4	23.8	60.0	-29.6	50.0	-26.2
8.43583	31.0	22.4	60.0	-29.0	50.0	-27.6
16.242	32.9	28.8	60.0	-27.1	50.0	-21.2
17.7096	33.1	29.2	60.0	-26.9	50.0	-20.8
18.2607	34.0	29.8	60.0	-26.0	50.0	-20.2



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Receive Spurious Radiated Emissions Data Sheet

Measurement Parameters

30 MHz to 1000 MHz

PROJECT #	DATE	CLASS	DISTANCE	ANTENNA	RBW	VBW	DETECTOR
10003-10	June 29, 2009	B	10 m	Bicon | Log	120 kHz	300 kHz	Peak/Quasi-Peak

1 GHz to 10 GHz

PROJECT #	DATE	CLASS	DISTANCE	ANTENNA	RBW	VBW	DETECTOR
10003-10	June 29, 2009	B	3 m	Horn	1 MHz	1 MHz	Peak/Avg.

Test Equipment

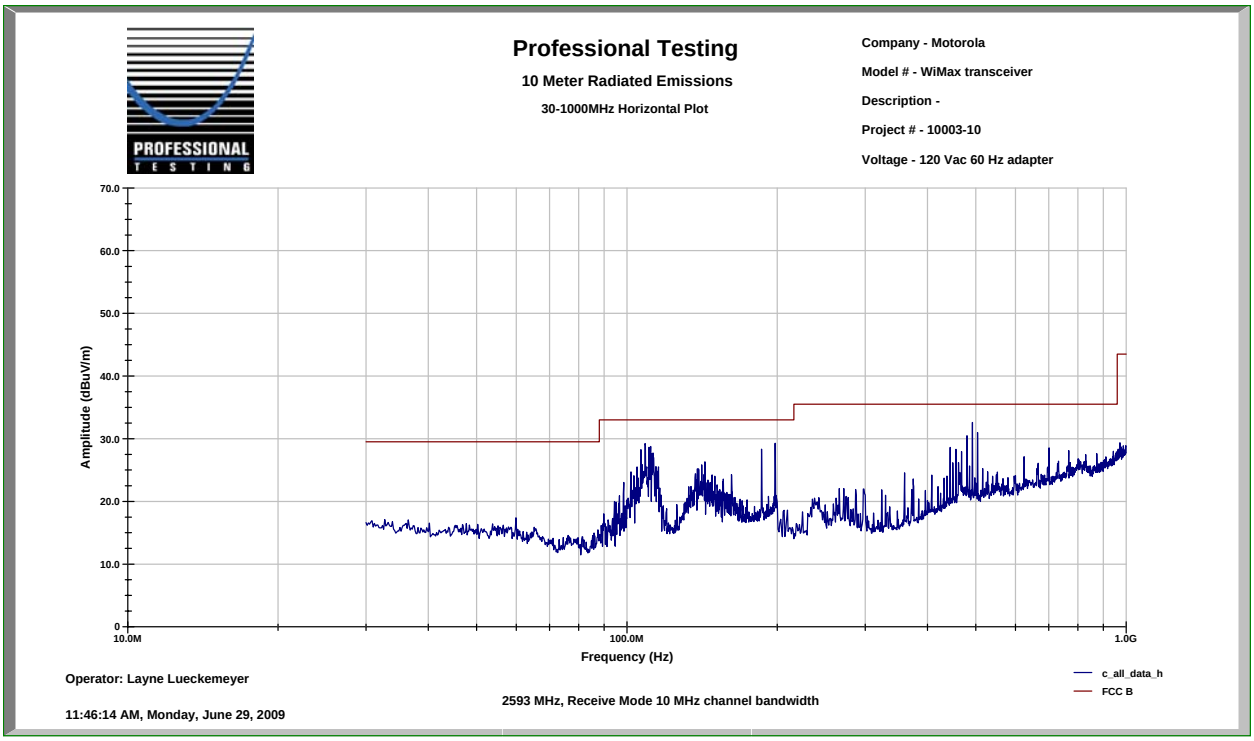
Asset #	Manufacturer	Model #	Description	Calibration Due
1277	HP	85650A	Quasi-peak Adapter (high band)	October 21, 2009
1273	HP	85662A	Spectrum Analyzer Display (high band)	NCR
0084	HP	8566B	Spectrum Analyzer (high band)	February 23, 2010
1035	HP	85685A	RF Preselector (high band)	January 29, 2010
1279	HP	85650A	Quasi-peak Adapter (low band)	August 1, 2009
1148	HP	85662A	Spectrum Analyzer Display (low band)	NCR
1129	HP	8568B	Spectrum Analyzer (low band)	August 1, 2009
0238	HP	85685A	RF Preselector (low band)	July 16, 2010
1414	HP	8447D	RF Preamplifier	June 22, 2010
1497	Emco	3108	Biconical Antenna	April 16, 2010
1486	Emco	3147	Log Periodic Dipole Array Antenna	April 16, 2010
C026	none	none	Coaxial Cable (low band)	July 27, 2010
C027	none	none	Coaxial Cable (high band)	July 27, 2010

Asset #	Manufacturer	Model #	Description	Calibration Due
0582	EMCO	3115	Ridge Guide Antenna	September 30, 2009
1529	Miteq	Antenna Mounted	Microwave Preamplifier (preamp 1)	July 17, 2010
0084	HP	8566B	Spectrum Analyzer	February 23, 2010
1273	HP	85662A	Spectrum Analyzer Display	NCR
1530	Miteq	None	Microwave Preamplifier (preamp 2)	July 17, 2010
C030	None	None	Coaxial Cable (MRE band)	July 27, 2010

Receive Mode Mid Channel (2593 MHz) 10 MHz Channel Bandwidth

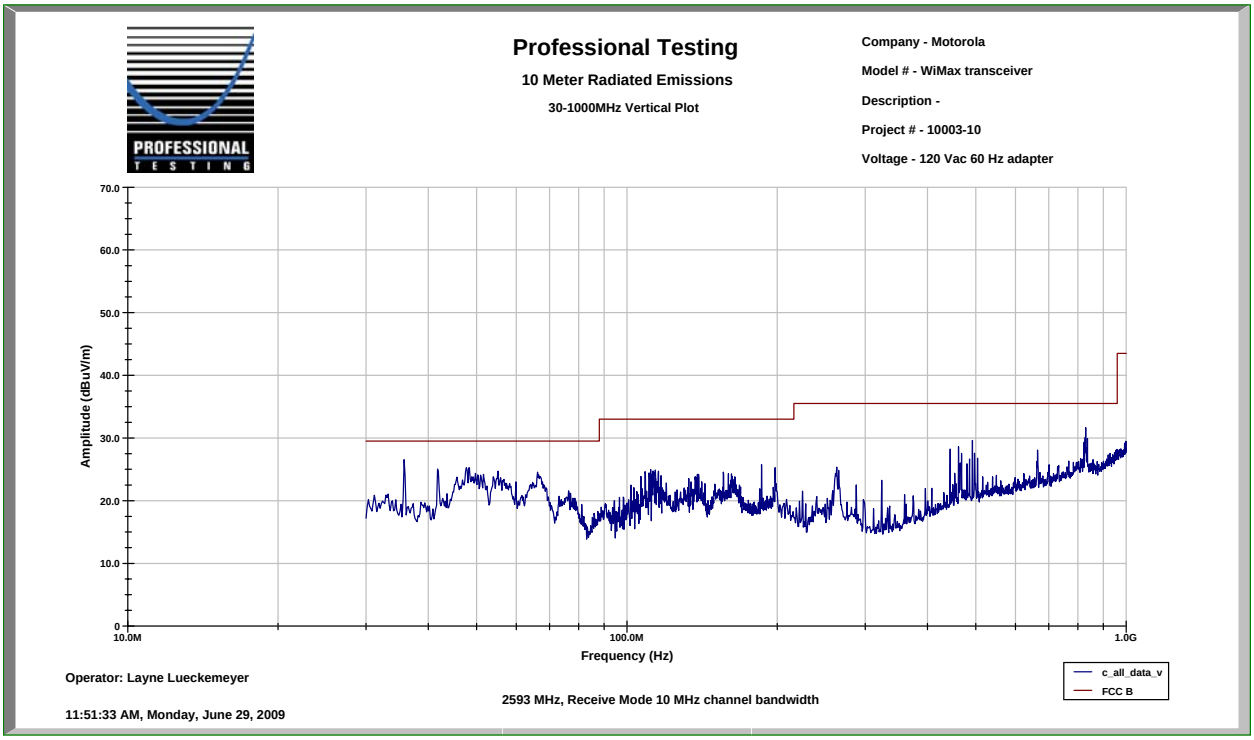
30 MHz – 1 GHz Horizontal

Frequency (MHz)	EUT Direction (degrees)	Antenna Elevation (Meters)	Recorded Level (dBuV)	Amplifier Gain (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector Function
108.7	90	4	44.1	25.9	9.8	1.2	29.2	33	-3.8	Peak
198.1	180	4	39.3	25.5	13.6	1.8	29.3	33	-3.7	Peak
492	90	3	46.9	36.6	19.0	3.4	32.6	35.5	-2.9	Peak



Receive Mode Mid Channel (2593 MHz) 10 MHz Channel Bandwidth
30 MHz – 1 GHz Vertical

Frequency (MHz)	EUT Direction (degrees)	Antenna Elevation (Meters)	Recorded Level (dBuV)	Amplifier Gain (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector Function
35.8	0	1	39.3	26.0	12.8	0.5	26.5	29.5	-3.0	Peak
492	270	1	43.9	36.6	19.0	3.4	29.6	35.5	-5.9	Peak
829.6	180	1	40.7	36.6	23.0	4.7	31.7	35.5	-3.8	Peak



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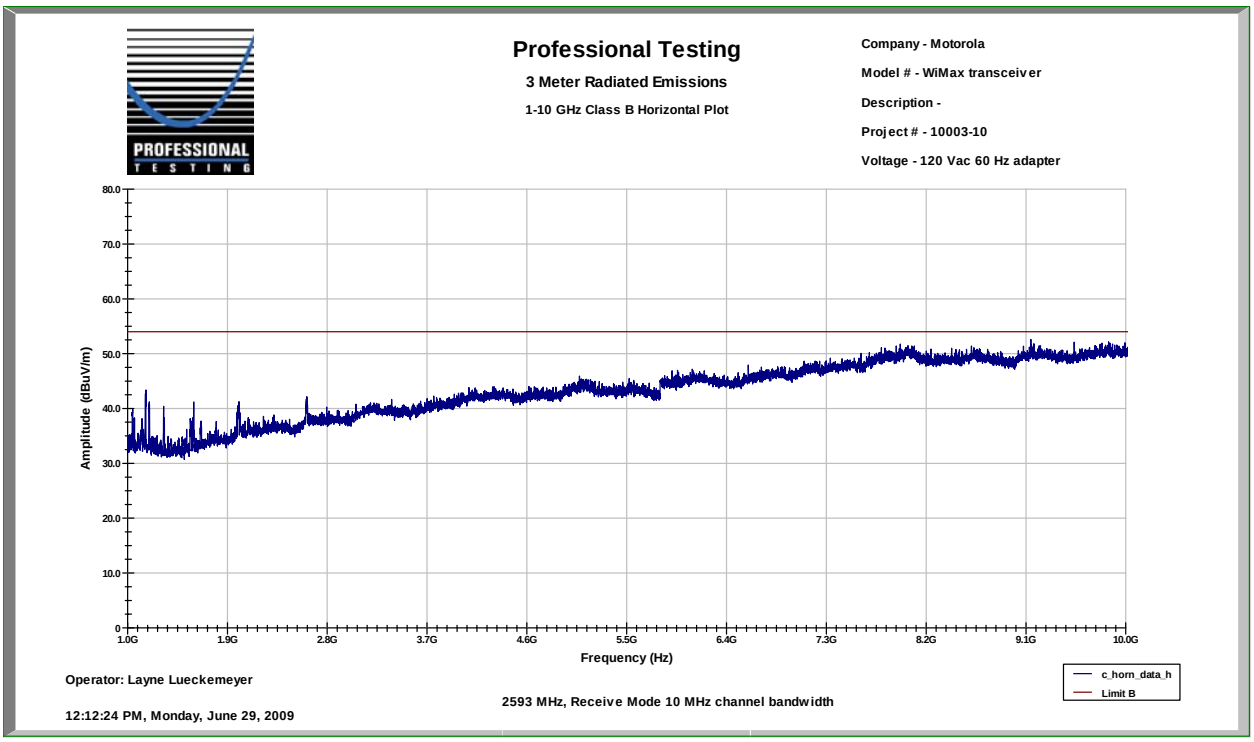
Receive Mode Mid Channel (2593 MHz) 10 MHz Channel Bandwidth

1 GHz – 10 GHz Horizontal

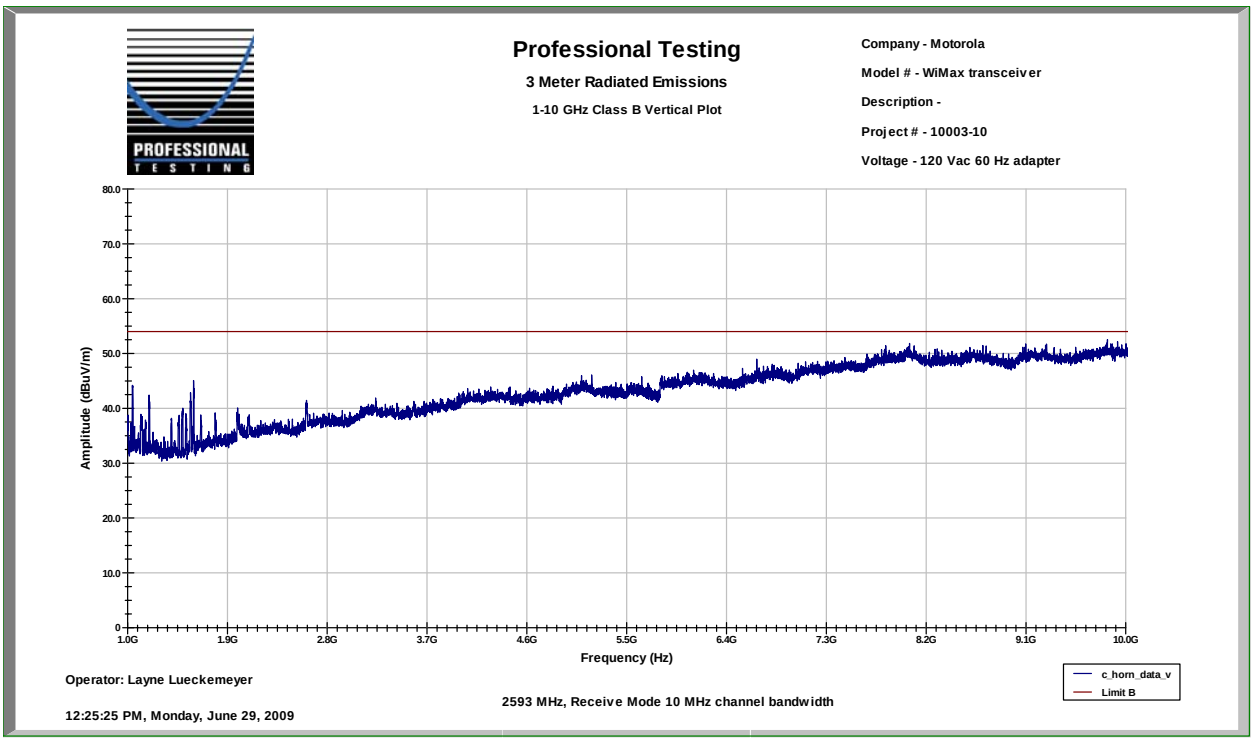
Frequency (MHz)	EUT Direction (degrees)	Antenna Elevation (Meters)	Recorded Level (dBuV)	Amplifier Gain (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector Function
1164	max	1	70.6	55.4	24.1	4.0	43.4	54	-10.6	Peak
1596	max	1	66.5	55.3	25.7	4.3	41.2	54	-12.8	Peak
2616	max	1	63.3	54.8	28.9	4.9	42.2	54	-11.8	Peak



Receive Mode Mid Channel (2593 MHz) 10 MHz Channel Bandwidth

1 GHz – 10 GHz Vertical

Frequency (MHz)	EUT Direction (degrees)	Antenna Elevation (Meters)	Recorded Level (dBuV)	Amplifier Gain (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector Function
1046	max	1	71.8	55.4	23.7	3.9	44.1	54	-9.9	Peak
1193	max	1	69.5	55.4	24.2	4.1	42.4	54	-11.6	Peak
1595	max	1	70.4	55.3	25.7	4.3	45.1	54	-8.9	Peak



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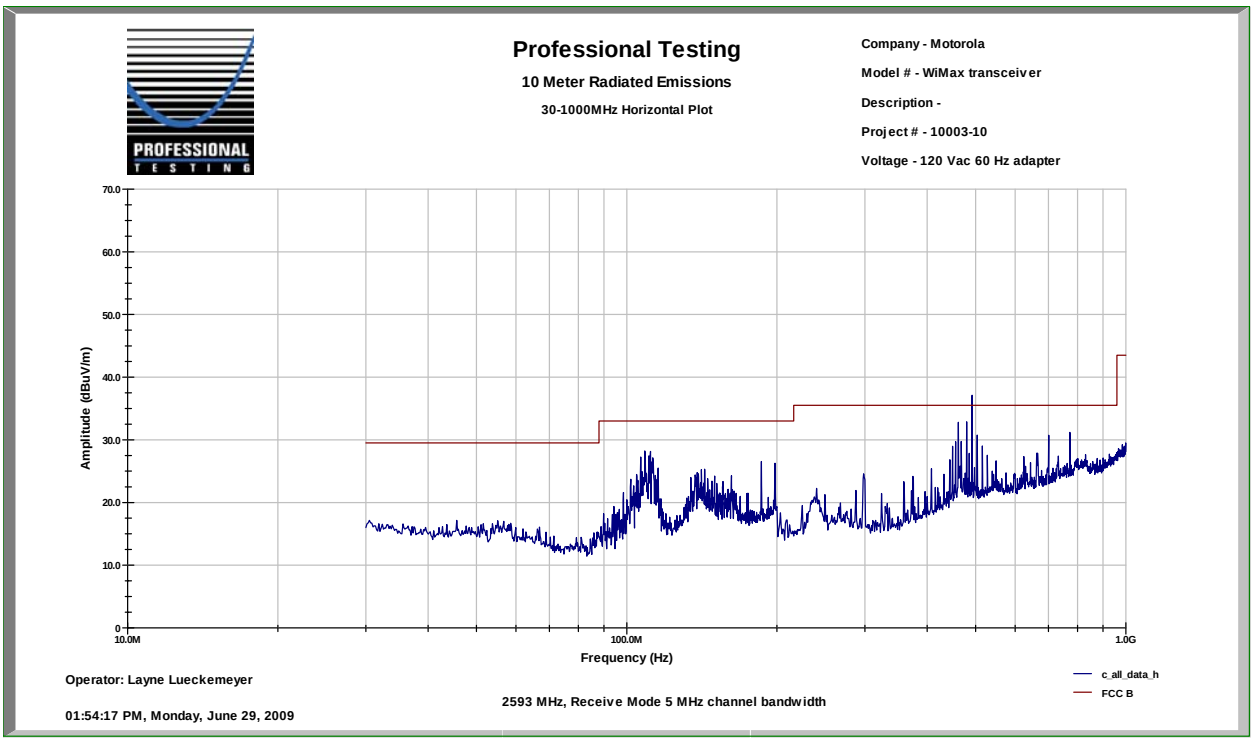
Receive Mode Mid Channel (2593 MHz) 5 MHz Channel Bandwidth

30 MHz – 1 GHz Horizontal

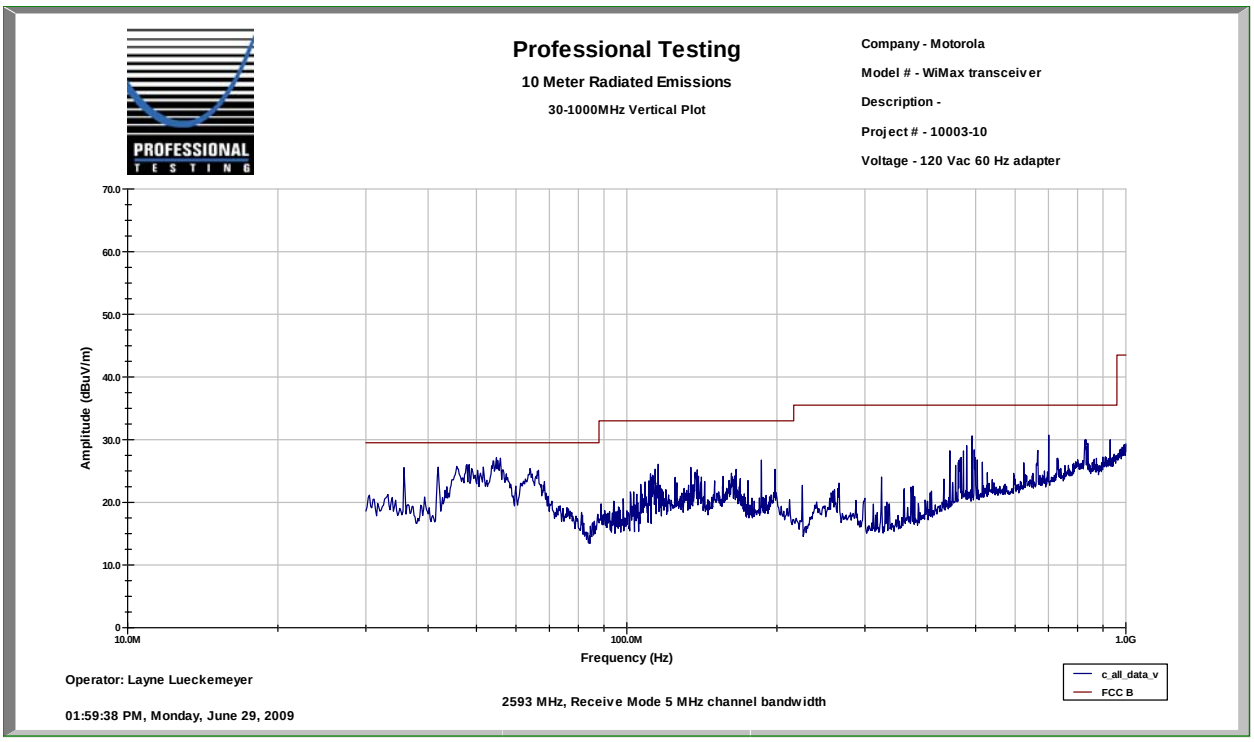
Frequency (MHz)	EUT Direction (degrees)	Antenna Elevation (Meters)	Recorded Level (dBuV)	Amplifier Gain (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector Function
108.7	90	4	44.1	25.9	9.8	1.2	29.2	33	-3.8	Peak
198.1	90	4	36.3	25.5	13.6	1.8	26.3	33	-6.7	Peak
492	180	3	48.7	36.6	19.0	3.4	34.4	35.5	-1.1	Quasi-Peak



Receive Mode Mid Channel (2593 MHz) 5 MHz Channel Bandwidth

30 MHz – 1 GHz Vertical

Frequency (MHz)	EUT Direction (degrees)	Antenna Elevation (Meters)	Recorded Level (dBuV)	Amplifier Gain (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector Function
35.8	90	1	38.3	26.0	12.8	0.5	25.5	29.5	-4.0	Peak
492	0	1	44.9	36.6	19.0	3.4	30.6	35.5	-4.9	Peak
700.8	90	1	42.3	36.6	20.6	4.4	30.7	35.5	-4.8	Peak



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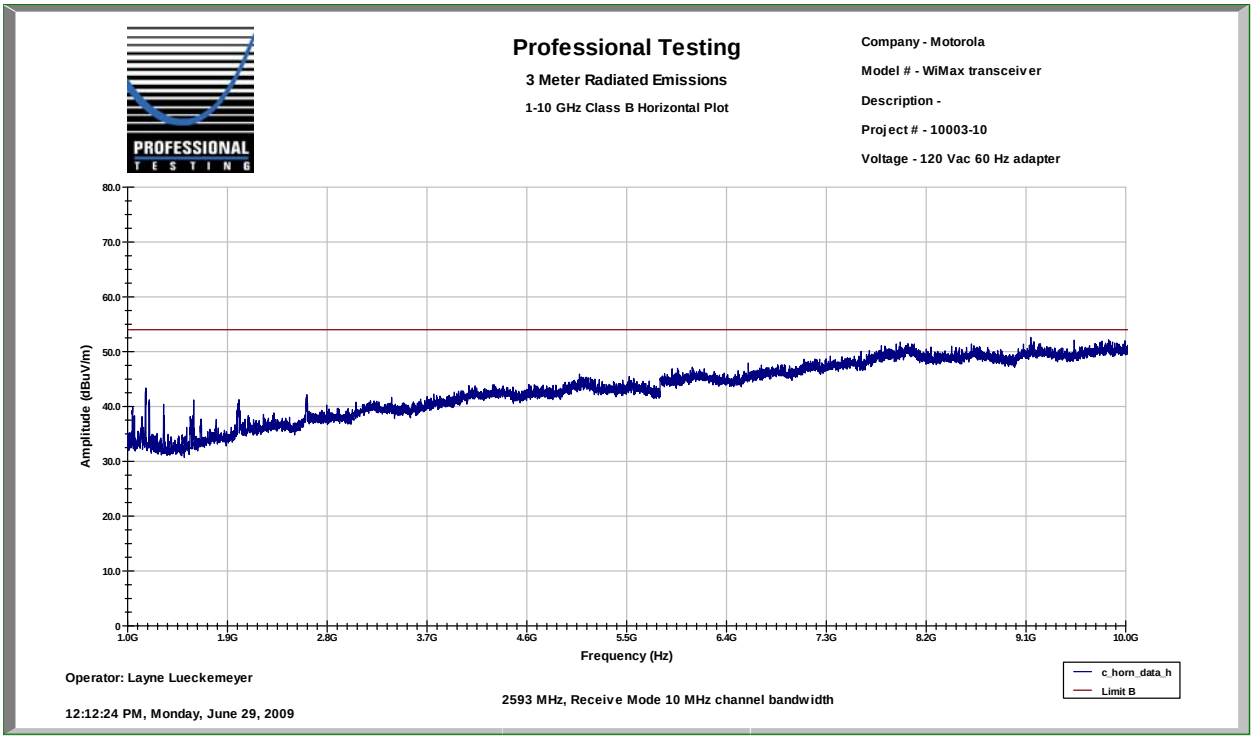
Receive Mode Mid Channel (2593 MHz) 5 MHz Channel Bandwidth

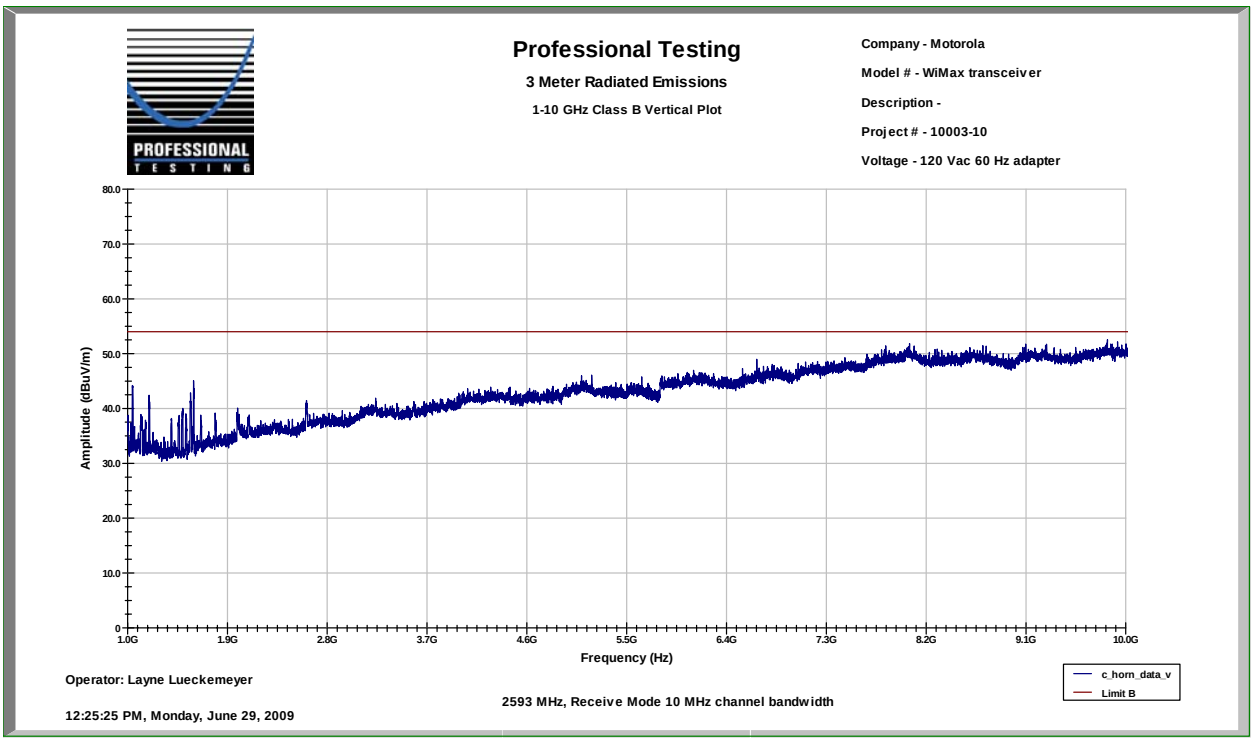
1 GHz – 10 GHz Horizontal

Frequency (MHz)	EUT Direction (degrees)	Antenna Elevation (Meters)	Recorded Level (dBuV)	Amplifier Gain (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector Function
1164	max	1	67.4	55.4	24.1	4.0	40.2	54	-13.8	Peak
1596	max	1	67.6	55.3	25.7	4.3	42.3	54	-11.7	Peak
2616	max	1	62.4	54.8	28.9	4.9	41.3	54	-12.7	Peak



Receive Mode Mid Channel (2593 MHz) 5 MHz Channel Bandwidth
1 GHz – 10 GHz Vertical

Frequency (MHz)	EUT Direction (degrees)	Antenna Elevation (Meters)	Recorded Level (dBuV)	Amplifier Gain (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector Function
1046	max	1	71.5	55.4	23.7	3.9	43.8	54	-10.2	Peak
1193	max	1	67.1	55.4	24.2	4.1	40.0	54	-14.0	Peak
1589	max	1	70.3	55.3	25.6	4.3	45.0	54	-9.0	Peak



RESULT = PASS

Appendix D Policy, Rationale and Evaluation of EMC Measurement Uncertainty

All uncertainty calculations, estimates and expressions thereof shall be in accordance with NIST policy. Since PTI operates in accordance with NIST (NVLAP) Handbook 150-11:2007, all instrumentation having an effect on the accuracy or validity of tests shall be periodically calibrated or verified traceable to national standards by a competent calibration laboratory. The certificates of calibration or verification on this instrumentation shall include estimates of uncertainty as required by NIST Handbook 150-11.

1. Rationale and Summary of Expanded Uncertainty.

Each piece of instrumentation at PTI that is used in making measurements for determining conformance to a standard (or limit), shall be assessed to evaluate its contribution to the overall uncertainty of the measurement in which it is used. The assessment of each item will be based on either a type A evaluation or a type B evaluation. Most of the evaluations will be type B, since they will be based on the manufacture's statements or specifications of the calibration tolerances, or uncertainty will be stated along with a brief rationale for the type of evaluation and the resulting stated uncertainties.

The individual uncertainties included in the combined standard uncertainty for a specific test result will depend on the configuration in which the item of instrumentation is used. The combination will always be based on the law of propagation of uncertainty. Any systematic effects will be accommodated by including their uncertainties, in the calculation of the combined standard uncertainty; except that if the direction and amount of the systematic effect cannot be determined and separated from its uncertainty, the whole effect will be treated as uncertainty and combined along with the other elements of the test setup.

Type A evaluations of standard uncertainty will usually be based on calculating the standard deviation of the mean of a series of independent observations, but may be based on a least-squares curve fit or the analysis of variance for unusual situations. Type B evaluations of standard uncertainty will usually be based on manufacturer's specifications, data provided in calibration reports, and experience. The type of probability distribution used (normal, rectangular, a-priori, or u-shaped) will be stated for each Type B evaluation.

In the evaluation of the uncertainty of each type of measurement, the uncertainty caused by the operator will be estimated. One notable operator contribution to measurement uncertainty is the manipulation of cables to maximize the measured values of radiated emissions. The operator contribution to measurement uncertainty is evaluated by having several operators independently repeat the same test. This results in a Type A evaluation of operator-contributed measurement uncertainty.

A summary of the expanded uncertainties of PTI measurements if shown is Table 1. These are the worst-case uncertainties considering all operative influence factors.

Table 1: Summary of Measurement Uncertainties for Site 45

Type of Measurement	Frequency Range	Meas. Dist.	Expanded Uncertainty U, dB (k=2)
Mains Conducted Emissions	150 kHz to 30 MHz	N/A	2.9
Telecom Conducted Emissions	150 kHz to 30 MHz	N/A	2.8
Radiated Emissions	30 to 1000 MHz	10 m	4.8
	1 to 18 GHz	10 m	5.7

Appendix E Accreditations

Laboratory Accreditation

NVLAP accreditation to ISO/IEC 17025:2005 with the following Scope of Accreditation: Lab code 200062-0.

- ANSI C63.4 (2003) with FCC Method 47 CFR Part 15, Subpart A

Agency Testing Approvals / Registration

- Federal Communications Commission (FCC) Type 2.948 listed test firm for measuring devices subject to certification under Parts 15 & 18.