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Electromagnetic Emissions Test Report and Application for Grant of Equipment Authorization pursuant to FCC Part 15, Subpart C Specifications for an Intentional Radiator on the PLX Devices Model: Wireless M Series

FCC ID:	RX6PLX001
GRANTEE:	PLX Devices 24180 Dawnridge Dr. Los Altos, CA. 94024
TEST SITE:	Elliott Laboratories, Inc. 684 W. Maude Avenue Sunnyvale, CA 94086
REPORT DATE:	March 30, 2004
FINAL TEST DATE:	March 19, 2004
AUTHORIZED SIGNATORY:	Mark Briggs VP of Engineering

ACCREDITED

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SCOPE

An electromagnetic emissions test has been performed on the PLX Devices model Wireless M Series pursuant to Subpart C of Part 15 of FCC Rules for intentional radiators. Conducted and radiated emissions data has been collected, reduced, and analyzed within this report in accordance with measurement guidelines set forth in ANSI C63.4-1992 as outlined in Elliott Laboratories test procedures.

The intentional radiator above has been tested in a simulated typical installation to demonstrate compliance with the relevant FCC performance and procedural standards.

Final system data was gathered in a mode that tended to maximize emissions by varying orientation of EUT, orientation of power and I/O cabling, antenna search height, and antenna polarization.

Every practical effort was made to perform an impartial test using appropriate test equipment of known calibration. All pertinent factors have been applied to reach the determination of compliance.

The test results recorded herein are based on a single type test of the PLX Devices model Wireless M Series and therefore apply only to the tested sample. The sample was selected and prepared by Paul Lowchareonkul of PLX Devices

OBJECTIVE

The primary objective of the manufacturer is compliance with Subpart C of Part 15 of FCC Rules for the radiated and conducted emissions of intentional radiators. Certification of these devices is required as a prerequisite to marketing as defined in Part 2 the FCC Rules.

Certification is a procedure where the manufacturer or a contracted laboratory makes measurements and submits the test data and technical information to the FCC. The FCC issues a grant of equipment authorization upon successful completion of their review of the submitted documents. Once the equipment authorization has been obtained, the label indicating compliance must be attached to all identical units which are subsequently manufactured.

STATEMENT OF COMPLIANCE

The tested sample of PLX Devices model Wireless M Series complied with the requirements of Subpart C of Part 15 of the FCC Rules for low power intentional radiators.

Maintenance of FCC compliance is the responsibility of the manufacturer. Any modification of the product that may result in increased emissions should be checked to ensure compliance has been maintained (i.e., printed circuit board layout changes, different line filter, different power supply, harnessing or I/O cable changes, etc.).

EMISSION TEST RESULTS

The following emissions tests were performed on the PLX Devices model Wireless M Series. The actual test results are contained in an exhibit of this report.

LIMITS OF CONDUCTED INTERFERENCE VOLTAGE

The EUT is designed to be installed in a vehicle and powered from the vehicle's battery. As the device is not intended to be powered, directly or indirectly, from an AC power source the limits of 15.207 do not apply.

LIMITS OF RADIATED INTERFERENCE FIELD STRENGTH

The EUT tested complied with the limits detailed in FCC Rules Part 15 Section 15.209.

The following measurement was extracted from the data recorded during the radiated electric field emissions scan and represents the highest amplitude emission relative to the specification limit. The actual test data and any correction factors are contained in an exhibit of this report.

Radiated Emissions - Fundamental

Frequency MHz	Level dBuV/m	Pol v/h	FCC 15.209 Limit	FCC 15.209 Margin	Detector Pk/QP/Avg	Azimuth degrees	Height meters	Comments
418.000	45.0	h	46.0	-1.0	QP	106	1.0	Note 1

Radiated Emissions - Spurious

Frequency MHz	Level dBuV/m	Pol v/h	FCC 15.209 Limit	FCC 15.209 Margin	Detector Pk/QP/Avg	Azimuth degrees	Height meters	Comments
2926.000	43.9	h	54.0	-10.1	Pk	0	1.0	Note 1

Note 1: Pk reading versus average limit

MEASUREMENT UNCERTAINTIES

ISO Guide 17025 requires that an estimate of the measurement uncertainties associated with the emissions test results be included in the report. The measurement uncertainties given below are based on a 95% confidence level and were calculated in accordance with NAMAS document NIS 81.

Measurement Type	Frequency Range (MHz)	Calculated Uncertainty (dB)
Conducted Emissions	0.15 to 30	± 2.4
Radiated Emissions	30 to 1000	± 3.6

EQUIPMENT UNDER TEST (EUT) DETAILS

GENERAL

The PLX Devices model Wireless M Series is a wireless data logger operating at 418MHz, which is designed to transmit data to a USB receiver. Normally, the EUT would be mounted in an automobile during operation. The EUT was, therefore, treated as tabletop equipment during testing to simulate the end-user environment. The electrical rating of the Transmitter EUT is 12VDC, 400mA.

The sample was received on March 19, 2004 and tested on March 19, 2004. The EUT consisted of the following component(s):

Manufacturer/Model/Description	Serial Number
PLX Devices M-series Transmitter	

ENCLOSURE

The Transmitter enclosure is primarily constructed of molded plastic. It measures approximately 7 cm wide by 11.4 cm deep by 2.54 cm high.

MODIFICATIONS

The transmitter was modified during testing. A series attenuator was added in the transmit signal path.

ANTENNA

The antenna connector is unique and is only provided by the manufacturer of the RF Transmitter module. It is similar in dimension to an SMA connector but has an inverted center pin. Standard SMA male and female connectors will not mate with the antenna and/or the antenna cable. The antenna can be connected directly to the rf connector or via coax extension cables. The extension cables are provided and sold exclusively by PLX Devices Inc.

SUPPORT EQUIPMENT

No support equipment was used during testing.

EUT INTERFACE PORTS

The I/O cabling configuration during emissions testing was as follows:

Port	Connected To	Cable(s)		
		Description	Shielded / Unshielded	Length(m)
12V in	DC supply		Unshielded	0.7
Oxygen Sensor	Not terminated		Unshielded	2
Data Log	Not terminated		Unshielded	2
Linear output	Not terminated		Unshielded	2

EUT OPERATION

The EUT was set to continuously transmit.

TEST SITE

GENERAL INFORMATION

Final test measurements were taken on March 19, 2004 at the Elliott Laboratories Open Area Test Site #1 located at 684 West Maude Avenue, Sunnyvale, California. The test site contains separate areas for radiated and conducted emissions testing. Pursuant to section 2.948 of the Rules, construction, calibration, and equipment data has been filed with the Commission.

The FCC recommends that ambient noise at the test site be at least 6 dB below the allowable limits. Ambient levels are below this requirement with the exception of predictable local TV, radio, and mobile communications traffic. The test site contains separate areas for radiated and conducted emissions testing. Considerable engineering effort has been expended to ensure that the facilities conform to all pertinent FCC requirements.

CONDUCTED EMISSIONS CONSIDERATIONS

Conducted emissions testing is performed in conformance with ANSI C63.4-1992. Measurements are made with the EUT connected to the public power network through a nominal, standardized RF impedance, which is provided by a line impedance stabilization network, known as a LISN. A LISN is inserted in series with each current-carrying conductor in the EUT power cord.

RADIATED EMISSIONS CONSIDERATIONS

The FCC has determined that radiation measurements made in a shielded enclosure are not suitable for determining levels of radiated emissions. Radiated measurements are performed in an open field environment. The test site is maintained free of conductive objects within the CISPR defined elliptical area incorporated in ANSI C63.4 guidelines.

MEASUREMENT INSTRUMENTATION

RECEIVER SYSTEM

An EMI receiver as specified in CISPR 16-1 is used for emissions measurements. The receivers used can measure over the frequency range of 9 kHz up to 2000 MHz. These receivers allow both ease of measurement and high accuracy to be achieved. The receivers have Peak, Average, and CISPR (Quasi-peak) detectors built into their design so no external adapters are necessary. The receiver automatically sets the required bandwidth for the CISPR detector used during measurements.

For measurements above the frequency range of the receivers, a spectrum analyzer is utilized because it provides visibility of the entire spectrum along with the precision and versatility required to support engineering analysis. Average measurements above 1000MHz are performed on the spectrum analyzer using the linear-average method with a resolution bandwidth of 1 MHz and a video bandwidth of 10 Hz.

INSTRUMENT CONTROL COMPUTER

The receivers utilize either a Rohde & Schwarz EZM Spectrum Monitor/Controller or contain an internal Spectrum Monitor/Controller to view and convert the receiver measurements to the field strength at an antenna or voltage developed at the LISN measurement port, which is then compared directly with the appropriate specification limit. This provides faster, more accurate readings by performing the conversions described under Sample Calculations within the Test Procedures section of this report. Results are printed in a graphic and/or tabular format, as appropriate. A personal computer is used to record all measurements made with the receivers.

The Spectrum Monitor provides a visual display of the signal being measured. In addition, the controller or a personal computer run automated data collection programs which control the receivers. This provides added accuracy since all site correction factors, such as cable loss and antenna factors are added automatically.

LINE IMPEDANCE STABILIZATION NETWORK (LISN)

Line conducted measurements utilize a fifty microhenry Line Impedance Stabilization Network as the monitoring point. The LISN used also contains a 250 uH CISPR adapter. This network provides for calibrated radio frequency noise measurements by the design of the internal low pass and high pass filters on the EUT and measurement ports, respectively.

FILTERS/ATTENUATORS

External filters and precision attenuators are often connected between the receiving antenna or LISN and the receiver. This eliminates saturation effects and non-linear operation due to high amplitude transient events.

ANTENNAS

A biconical antenna is used to cover the range from 30 MHz to 300 MHz and a log periodic antenna is utilized from 300 MHz to 1000 MHz. Narrowband tuned dipole antennas are used over the entire 30 to 1000 MHz range for precision measurements of field strength. Above 1000 MHz, a horn antenna is used. The antenna calibration factors are included in site factors programmed into the test receivers.

ANTENNA MAST AND EQUIPMENT TURNTABLE

The antennas used to measure the radiated electric field strength are mounted on a non-conductive antenna mast equipped with a motor-drive to vary the antenna height.

ANSI C63.4 specifies that the test height above ground for table mounted devices shall be 80 centimeters. Floor mounted equipment shall be placed on the ground plane if the device is normally used on a conductive floor or separated from the ground plane by insulating material from 3 to 12 mm if the device is normally used on a non-conductive floor. During radiated measurements, the EUT is positioned on a motorized turntable in conformance with this requirement.

INSTRUMENT CALIBRATION

All test equipment is regularly checked to ensure that performance is maintained in accordance with the manufacturer's specifications. All antennas are calibrated at regular intervals with respect to tuned half-wave dipoles. An exhibit of this report contains the list of test equipment used and calibration information.

TEST PROCEDURES

EUT AND CABLE PLACEMENT

The FCC requires that interconnecting cables be connected to the available ports of the unit and that the placement of the unit and the attached cables simulate the worst case orientation that can be expected from a typical installation, so far as practicable. To this end, the position of the unit and associated cabling is varied within the guidelines of ANSI C63.4, and the worst case orientation is used for final measurements.

CONDUCTED EMISSIONS

Conducted emissions are measured at the plug end of the power cord supplied with the EUT. Excess power cord length is wrapped in a bundle between 30 and 40 centimeters in length near the center of the cord. Preliminary measurements are made to determine the highest amplitude emission relative to the specification limit for all the modes of operation. Placement of system components and varying of cable positions are performed in each mode. A final peak mode scan is then performed in the position and mode for which the highest emission was noted on all current carrying conductors of the power cord.

RADIATED EMISSIONS

Radiated emissions measurements are performed in two phases as well. A preliminary scan of emissions is conducted in which all significant EUT frequencies are identified with the system in a nominal configuration. At least two scans are performed from 30 MHz up to the frequency required by the regulation specified on page 1. One or more of these is with the antenna polarized vertically while the one or more of these is with the antenna polarized horizontally. During the preliminary scans, the EUT is rotated through 360°, the antenna height is varied and cable positions are varied to determine the highest emission relative to the limit.

A speaker is provided in the receiver to aid in discriminating between EUT and ambient emissions. Other methods used during the preliminary scan for EUT emissions involve scanning with near field magnetic loops, monitoring I/O cables with RF current clamps, and cycling power to the EUT.

Final maximization is a phase in which the highest amplitude emissions identified in the spectral search are viewed while the EUT azimuth angle is varied from 0 to 360 degrees relative to the receiving antenna. The azimuth which results in the highest emission is then maintained while varying the antenna height from one to four meters. The result is the identification of the highest amplitude for each of the highest peaks. Each recorded level is corrected in the receiver using appropriate factors for cables, connectors, antennas, and preamplifier gain. Emissions which have values close to the specification limit may also be measured with a tuned dipole antenna to determine compliance.

SPECIFICATION LIMITS AND SAMPLE CALCULATIONS

The limits for conducted emissions are given in units of microvolts, and the limits for radiated emissions are given in units of microvolts per meter at a specified test distance. Data is measured in the logarithmic form of decibels relative to one microvolt, or dB microvolts (dBuV). For radiated emissions, the measured data is converted to the field strength at the antenna in dB microvolts per meter (dBuV/m). The results are then converted to the linear forms of uV and uV/m for comparison to published specifications.

For reference, converting the specification limits from linear to decibel form is accomplished by taking the base ten logarithm, then multiplying by 20. These limits in both linear and logarithmic form are as follows:

CONDUCTED EMISSIONS SPECIFICATION LIMITS, SECTION 15.207

Frequency (MHz)	Average Limit (dBuV)	Quasi Peak Limit (dBuV)
0.150 to 0.500	Linear decrease on logarithmic frequency axis between 56.0 and 46.0	Linear decrease on logarithmic frequency axis between 66.0 and 56.0
0.500 to 5.000	46.0	56.0
5.000 to 30.000	50.0	60.0

RADIATED EMISSIONS SPECIFICATION LIMITS, SECTION 15.209

Frequency Range (MHz)	Limit (uV/m @ 3m)	Limit (dBuV/m @ 3m)
0.009-0.490	$2400/F_{KHz}$ @ 300m	$67.6-20*\log_{10}(F_{KHz})$ @ 300m
0.490-1.705	$24000/F_{KHz}$ @ 30m	$87.6-20*\log_{10}(F_{KHz})$ @ 30m
1.705 to 30	30 @ 30m	29.5 @ 30m
30 to 88	100	40
88 to 216	150	43.5
216 to 960	200	46.0
Above 960	500	54.0

SAMPLE CALCULATIONS - CONDUCTED EMISSIONS

Receiver readings are compared directly to the conducted emissions specification limit (decibel form) as follows:

$$R_r - S = M$$

where:

R_r = Receiver Reading in dBuV

S = Specification Limit in dBuV

M = Margin to Specification in +/- dB

SAMPLE CALCULATIONS - RADIATED EMISSIONS

Receiver readings are compared directly to the specification limit (decibel form). The receiver internally corrects for cable loss, preamplifier gain, and antenna factor. The calculations are in the reverse direction of the actual signal flow, thus cable loss is added and the amplifier gain is subtracted. The Antenna Factor converts the voltage at the antenna coaxial connector to the field strength at the antenna elements. A distance factor, when used for electric field measurements, is calculated by using the following formula:

$$F_d = 20*LOG_{10} (D_m/D_s)$$

where:

F_d = Distance Factor in dB

D_m = Measurement Distance in meters

D_s = Specification Distance in meters

Measurement Distance is the distance at which the measurements were taken and Specification Distance is the distance at which the specification limits are based. The antenna factor converts the voltage at the antenna coaxial connector to the field strength at the antenna elements.

The margin of a given emission peak relative to the limit is calculated as follows:

$$R_c = R_r + F_d$$

and

$$M = R_c - L_s$$

where:

R_r = Receiver Reading in dBuV/m

F_d = Distance Factor in dB

R_c = Corrected Reading in dBuV/m

L_s = Specification Limit in dBuV/m

M = Margin in dB Relative to Spec

EXHIBIT 1: Test Equipment Calibration Data

1 Page

Radiated Emissions, 30 - 6,500 MHz And Conducted Emissions, 19-Mar-04
Engineer: Chris Byleckie

Manufacturer	Description	Model #	Asset #	Cal Due
EMCO	Horn Antenna, D. Ridge 1-18GHz	3115	487	24-Apr-04
Hewlett Packard	EMC Spectrum Analyzer 9kHz - 6.5GHz	8595EM	780	26-Feb-05
EMCO	Biconical Antenna, 30-300 MHz	3110B	801	13-May-04
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	870	12-Jan-05
Rohde & Schwarz	Test Receiver, 9kHz-2750MHz	ESCS 30	1337	05-Jan-05
EMCO	Log Periodic Antenna, 0.2-2 GHz	3148	1347	28-Oct-04

EXHIBIT 2: Test Data Log Sheets

ELECTROMAGNETIC EMISSIONS

TEST LOG SHEETS

AND

MEASUREMENT DATA

T54885 5 Pages

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EMC Test Data

Client:	PLX Devices	Job Number:	J54871
Model:	Wireless M Series	T-Log Number:	T54885
		Account Manager:	Rob Holt
Contact:	Paul Lo		
Emissions Spec:	FCC 15209	Class:	B
Immunity Spec:	-	Environment:	-

EMC Test Data

For The

PLX Devices

Model

Wireless M Series

Date of Last Test: 3/19/2004

Client:	PLX Devices	Job Number:	J54871
Model:	Wireless M Series	T-Log Number:	T54885
		Account Manager:	Rob Holt
Contact:	Paul Lo		
Emissions Spec:	FCC 15209	Class:	B
Immunity Spec:	-	Environment:	-

EUT INFORMATION

General Description

The EUT is a wireless data logger operating at 418MHz which is designed to transmit data to a USB receiver. Normally, the EUT would be mounted in an automobile during operation. The EUT was, therefore, treated as table-top equipment during testing to simulate the end-user environment. The electrical rating of the Transmitter EUT is 12VDC, 400mA. The USB receiver gets its power from the host computer.

Equipment Under Test

Manufacturer	Model	Description	Serial Number	FCC ID
PLX Devices		Transmitter	-	
PLX Devices		Receiver	-	

Other EUT Details

The EUT was tested with the following antenna: Linx technologies ANT-418-CW-RH

EUT Enclosure

The EUT enclosure is primarily constructed of molded plastic. It measures approximately 7 cm wide by 11.4 cm deep by 2.54 cm high.

Modification History

Mod. #	Test	Date	Modification
1	Radiated Emissions (Tx)	3/19/2004	Attenuation circuit added toansmit path

Modifications applied are assumed to be used on subsequent tests unless otherwise stated as a further modification.

Client:	PLX Devices	Job Number:	J54871
Model:	Wireless M Series	T-Log Number:	T54885
		Account Manager:	Rob Holt
Contact:	Paul Lo		
Emissions Spec:	FCC 15209	Class:	B
Immunity Spec:	-	Environment:	-

Test Configuration #2 - Transmitter

Local Support Equipment

Manufacturer	Model	Description	Serial Number	FCC ID
Power Designs	6150D	Power Supply	902072	

Remote Support Equipment

Manufacturer	Model	Description	Serial Number	FCC ID
None				

Interface Cabling and Ports

		Cable(s)		
Port	Connected To	Description	Shielded or Unshielded	Length(m)
DC in	Power supply	2 wire	Unshielded	1
Oxygen Sensor	Not terminated		Unshielded	2
Data Log	Not terminated		Unshielded	2
Linear output	Not terminated		Unshielded	2

EUT Operation During Emissions

The EUT was continously transmitting at 418MHz

Client:	PLX Devices	Job Number:	J54871
Model:	Wireless M Series	T-Log Number:	T54885
		Account Manager:	Rob Holt
Contact:	Paul Lo		
Spec:	FCC 15209	Class:	B

Radiated Emissions

Test Specifics

Objective: The objective of this test session is to perform final qualification testing of the EUT with respect to the specification listed above.

Date of Test: 3/19/2004
Test Engineer: Chris Byleckie
Test Location: SVOATS #1

Config. Used: 2
Config Change: None
EUT Voltage: 12VDC

General Test Configuration

The EUT and all local support equipment were located on the turntable for radiated emissions testing.

Unless otherwise specified, the measurement antenna was located 10 meters from the EUT for the measurement range 30 - 1000 MHz and 3m from the EUT for the frequency range 1 - 10 GHz.

Ambient Conditions:

Temperature: 17 °C
Rel. Humidity: 72 %

Summary of Results

Run #	Test Performed	Limit	Result	Margin
1	RE, 418 MHz, Fundamnetal	15.209	Pass	-1.0dB @ 418.000MHz
2	RE, 30 - 5000MHz, Spurious Emissions	15.209	Pass	-10.1dB @ 2926.0MHz

Modifications Made During Testing:

No modifications were made to the EUT during testing

Deviations From The Standard

No deviations were made from the requirements of the standard.

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EMC Test Data

Client:	PLX Devices	Job Number:	J54871
Model:	Wireless M Series	T-Log Number:	T54885
		Account Manager:	Rob Holt
Contact:	Paul Lo		
Spec:	FCC 15209	Class:	B

Run #1: Fundamental Emissions, 418 MHz

Frequency	Level	Pol	15.209		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
418.000	45.0	h	46.0	-1.0	QP	106	1.0	
418.000	44.2	v	46.0	-1.8	QP	296	1.0	

Run #2: 30-5000MHz, Spurious Emissions

Frequency	Level	Pol	15.209		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2926.000	43.9	h	54.0	-10.1	Pk	0	1.0	Pk reading versus average limit
2926.000	43.4	v	54.0	-10.6	Pk	0	1.0	Pk reading versus average limit
2508.000	39.5	v	54.0	-14.5	Pk	0	1.0	Pk reading versus average limit
2508.000	38.9	h	54.0	-15.1	Pk	0	1.0	Pk reading versus average limit
2090.000	37.9	v	54.0	-16.1	Pk	0	1.0	Pk reading versus average limit
2090.000	37.1	h	54.0	-16.9	Pk	0	1.0	Pk reading versus average limit
1672.000	32.5	v	54.0	-21.5	Pk	0	1.0	Pk reading versus average limit
1254.000	32.5	v	54.0	-21.5	Pk	0	1.0	Pk reading versus average limit
836.000	24.3	v	46.0	-21.7	QP	0	1.0	
836.000	24.1	h	46.0	-21.9	QP	0	1.5	
1672.000	31.9	h	54.0	-22.1	Pk	0	1.0	Pk reading versus average limit
1254.000	29.5	h	54.0	-24.5	Pk	0	1.0	Pk reading versus average limit

Note - all signals above 2GHz were at the noise floor of the measurement instrumentation when measured at 3m. No signals were observed above 3GHz. Measurements below 1GHz were made using a QP detector (120kHz bandwidth). Above 1GHz measurements were made using peak detector (RBW=VBW =1MHz).
The EUT was tested in the orientation that will be used when the device is installed in a vehicle, with the antenna held vertically in test fixture.

EXHIBIT 3: Test Configuration Photographs

Uploaded as A Separate Attachment

EXHIBIT 4: Proposed FCC ID Label & Label Location

Uploaded as A Separate Attachment

EXHIBIT 5: Detailed Photographs of PLX Devices Model Wireless M Series

External and Internal Photographs Uploaded as
Separate Attachments

EXHIBIT 6: Operator's Manual for PLX Devices Model Wireless M Series

Uploaded as A Separate Attachment

EXHIBIT 7: Block Diagram of PLX Devices Model Wireless M Series

Uploaded as A Separate Attachment

EXHIBIT 8: Schematic Diagrams for PLX Devices Model Wireless M Series

Uploaded as A Separate Attachment

EXHIBIT 9: Theory of Operation for PLX Devices Model Wireless M Series

Uploaded as A Separate Attachment