LEXMARK

LEXMARK INTERNATIONAL

TEST REPORT

for

FCC PART 15
INDUSTRY CANADA RSS-210

TRADE NAME: Proximity card Reader

REGULATORY TYPE/MODEL NUMBER: LEX-M05-001

Test Report Number: 617-EMC-2008-FCC-011108

Date: January 11, 2008

1 TABLE OF CONTENTS

2 TECHNICAL REPORT

Manufacturer of Equipment-under-test	Lexmark International, Inc.
Address of Manufacturer	740 New Circle Rd. Lexington, Kentucky 40511

Equipment Under Test	
Trade Name(s)	Lexmark
Regulatory Type/Model Number	LEX-M05-001
FCC ID	IYLLEXM05001
Industry Canada ID	2376A-M05001
Device Category	Mobile
RF Exposure Category	General Population/Uncontrolled Environment
Transmission Modes	ISO14443 A, ISO14443 B, ISO 15693
Frequency Range (MHz)	13.553 – 13.567 MHz
Designation of Emission	10K0A1D
Maximum Radiated Electric Field @ 10 meter distance	42.95 dB(μV/m))
Antenna Type	Loop antenna integrated on PCB
EUT Power Supply	Power obtained via USB interface

2.1 PURPOSE OF TESTING

The purpose of this testing was to evaluate the EUT for compliance to the FCC and Industry Canada Rules for an intentional radiator operating in the frequency range 13.553 – 13.567 MHz. The EUT is tested to the general radiated emission limits of §15.209 [3] and §2.6 [4] in lieu of §15.225 [3] and §A2.6 [3].

2.2 APPLIED STANDARDS

[1] CFR 47, Part 1.

[2] CFR 47, Part 2.

[3] CFR 47, Part 15.

[4] RSS-210, Issue 7, *Low Power License-Exempt Radiocommunication Devices (All Frequency Bands)*

[5] RSS-Gen, Issue 2, *General Requirements and Information for the Certification of Radiocommunication Equipment.*

[6] 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.*

3 SUMMARY

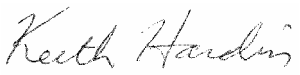
The purpose of this testing was to evaluate the EUT for compliance to the FCC and Industry Canada Rules for an intentional radiator operating in the frequency range 13.553 – 13.567 MHz. This data demonstrates that the EUT complies with these requirements.

The following is a summary of the testing documented in this report:

FCC Rules	Description of Test	Result	Page of this Report
§15.203	Antenna requirement	Compliant	6
§15.205	Restricted bands of operation	Compliant	10
§15.207	AC conducted emissions	Compliant	16
§15.209	Radiated emissions	Compliant	12

Industry Canada RSS-210 & RSS-Gen	Description of Test	Result	Page of this Report
§2.1 [4]	Bandwidth	Compliant	10
§2.6 [4]	Radiated emissions	Compliant	12
§7.1.4 [5]	Antenna requirement	Compliant	6
§7.2.2 [5]	AC conducted emissions	Compliant	16

This report has been reviewed by:

Keith Hardin  January 11, 2008

Name Signature Date

4 DESCRIPTION OF EUT

The Equipment Under Test (EUT) is a contactless card reader option for a printer. The EUT can read and write to both a 13.56 MHz contactless smart card and virtually any contact smart card. The dual interface feature, implemented on a small PCB, supports end-user environments where both contactless and contact smart card technology may be in use. The reader supports contactless smart cards with up to 424 kbps in ISO 14443 transmission. The only connection to the EUT is via a detachable USB cable. Power to the EUT is provided through this USB cable.

4.1 EUT PHOTOS

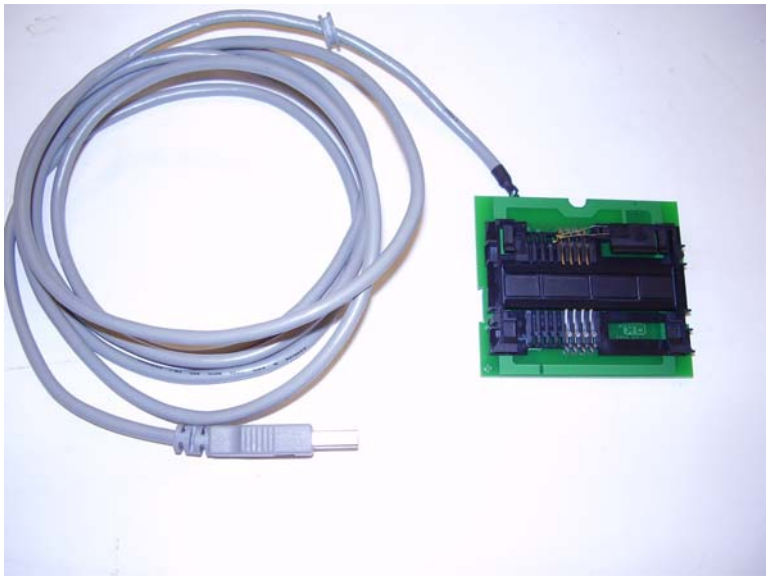


Figure 1. Top view of EUT.

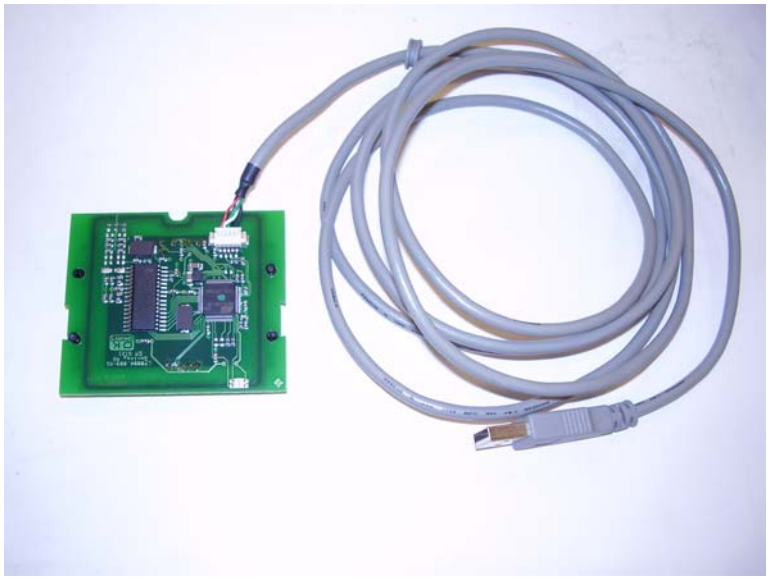


Figure 2. Back view of EUT.

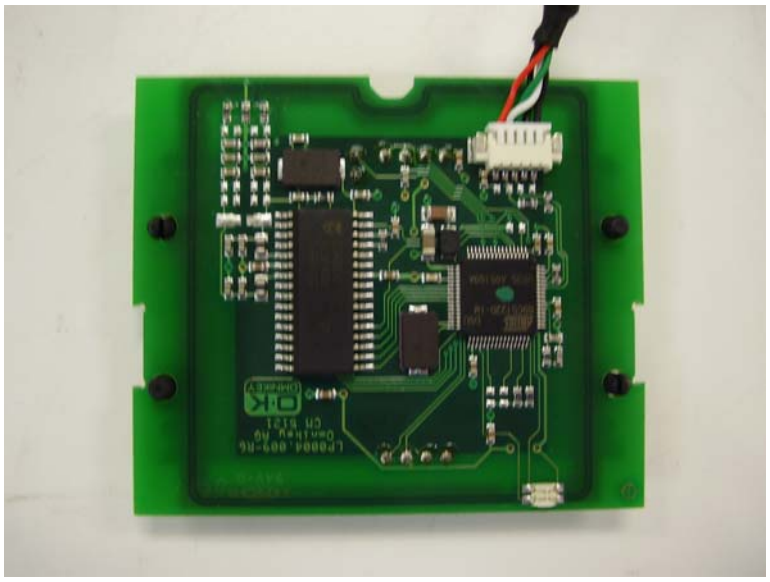


Figure 3. Close-up top view of EUT.

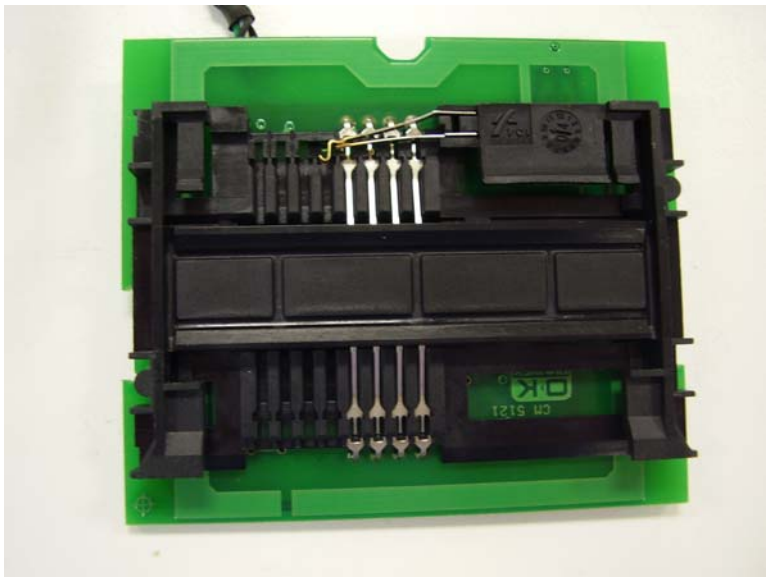


Figure 4. Close-up bottom view of EUT.

4.2 EUT ANTENNA

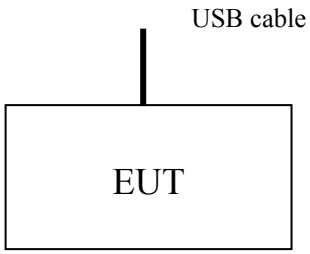
The EUT employs a planar loop antenna integrated on the printed circuit board of the EUT as shown in Figures 3 and 4. The EUT meets the requirement in [3] and [5] that no antenna other than that furnished by the responsible party can be used with the device.

4.3 EUT CLOCK FREQUENCIES

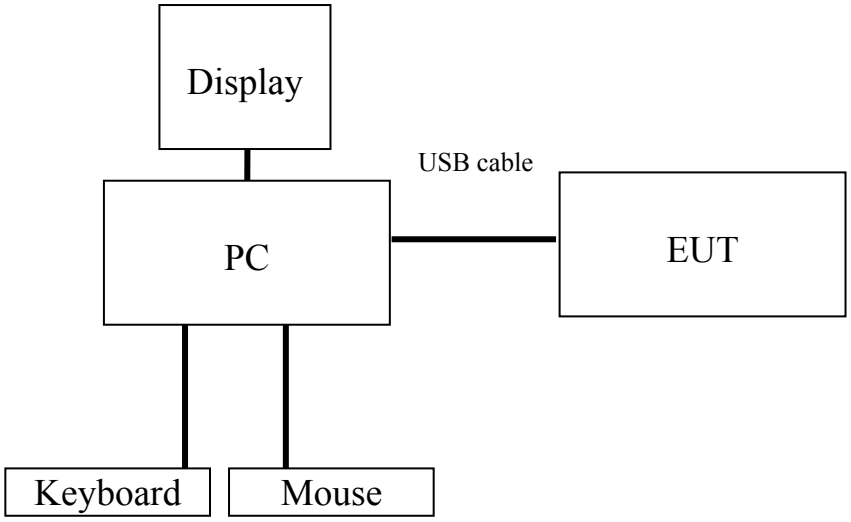
Description	Frequency (MHz)
RF Reference Clock	13.56
Digital Reference Clock	8.0

5 TEST CONFIGURATIONS

5.1 TEST SETUP FOR RADIATED EMISSIONS



5.2 TEST SETUP FOR CONDUCTED EMISSIONS



The following auxiliary equipment was used during the testing of the EUT:

Description	Manufacturer	Model
Personal Computer	Dell	Dimension C521
LCD	Dell	E177FPb

6 CABLE INFORMATION

Cables used for testing included the following:

Cable Description	Cable Length (meters)	Ferrites	Shield Status
USB cable from PC to EUT	2	No	Shielded

7 TESTING & MEASUREMENT EQUIPMENT

Description	Manufacturer	Model Number	Serial Number	Calibration Due Date
EMI receiver	Rhode & Schwarz	ESI7	100092	4/9/09
EMI receiver	Rhode & Schwarz	ESIB7	100093	12/14/08
EMI receiver	Rhode & Schwarz	ESIB40	1112950683	10/18/09
EMI receiver	Rhode & Schwarz	ESIB40	100148	4/26/09
EMI receiver	Rhode & Schwarz	ESCI	100346	7/30/08
EMI receiver	Rhode & Schwarz	ESCI	100347	7/18/09
Bi-Log antenna	Chase	CBL6111C	2459	9/21/08
Bi-Log antenna	Chase	CBL6111C	2460	10/2/08
Loop antenna (9 kHz - 30 MHz)	Rhode & Schwarz	HFH 2Z2	881056/074	10/18/08
LISN	Rhode & Schwarz	ESH2-Z5	848765/017	8/2/09
LISN	Rhode & Schwarz	ESH2-Z5	890484/012	8/30/09

8 TEST RESULTS

8.1 BANDWIDTH OF EMISSION

Criteria for Bandwidth of Emission: The nominal bandwidth shall be such that the fundamental modulation products lie totally within the the bands listed in Tables 2, 3, 4, and 5 of [4] and do not fall inside the restricted bands of operation listed in [3] and [4].

Test Procedure for Bandwidth of Emission: The EUT was located in a semi-anechoic chamber. A receive antenna was located 3 meters from the EUT and connected directly to the input of the spectrum analyzer via a coaxial cable. The resolution and video bandwidths of the analyzer were set to 100 Hz and 300 Hz, respectively. The frequency span was set to 5 kHz so that the entire channel of operation could be displayed on the spectrum analyzer. The integrated bandwidth measurement function of the spectrum analyzer was used to measure the 99% bandwidth of the transmitted signal

The EUT was tested in both the standby mode and while actively reading from a proximity card. The highest bandwidth measured for all modes is reported.

Results for Bandwidth of Emission: See Figure 5 for results. The 99% bandwidth measured was 240.48 Hz.

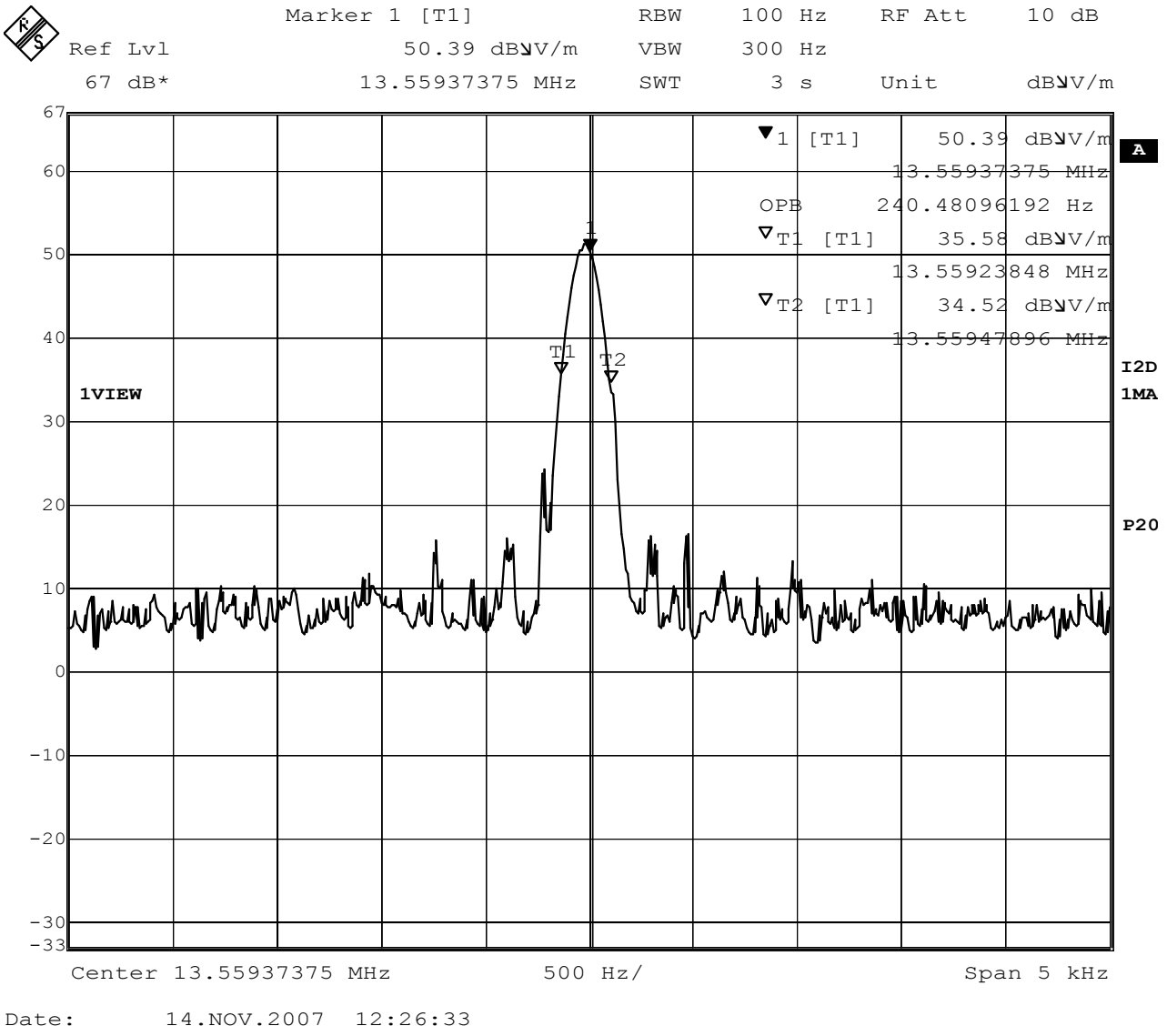


Figure 5. Bandwidth of emission (99% Bandwidth).

8.2 RADIATED EMISSIONS

Criteria for Radiated Emissions: The radiated emissions of the transmitter shall not exceed the values in Table 1.

Frequency Range (MHz)	Limit (dB(μV/m))	Measurement Distance (m)
1.705 - 30	29.5	30
30 - 88	40	3
88 - 216	43.5	3
216 - 960	46	3
960 - 1000	54	3
Above 1000	54 (average detector) 74 (peak detector)	3

Table 1. Limits for radiated emissions.

Test Procedure for Radiated Emissions: Radiated emissions were measured in Lexmark's 10 meter and 3/5 meter semi-anechoic chambers. These facilities are registered with the FCC (registration number 949691 for 10 meter chamber and 991141 for 3/5 meter chamber) and Industry Canada (site number 2376A-1 for 10 meter chamber and 2376A-3 for 3/5 meter chamber).

The EUT configuration shown in Section 5.1 was placed atop a 0.8 meter high wooden table with a rectangular surface measuring 1.5m x 1.0m. The test setup is shown in Figures 6 and 7. The host PC was located outside of the chamber for this testing; only the EUT was located inside the chamber.

For measurements below 30 MHz, a calibrated loop antenna was used. The antenna was located 10 meters from the EUT with a height of the center of the loop antenna at 1 meter. The axis of the antenna was rotated to maximize the emissions. A CISPR quasi-peak detector is used for measurements below 30 MHz except in the frequency ranges of 9 – 90 kHz and 110 – 490 kHz where an average detector is used.

Since the limits in Table 1 for emissions below 30 MHz are specified at 30 meters, and measurements were made at 10 meters, the limit is translated to 10 meters by using a $1/r^2$ relationship, or 40 dB/decade. With this, the limit at 10 meters is given as:

$$Limit_{10meters} = Limit_{30meters} + 20\log\left((30/10)^2\right)$$

For measurement of emissions in the frequency range 30 – 1000 MHz, a bilog antenna was used. The receiving antenna was connected to a spectrum analyzer and with the spectrum analyzer in peak hold mode, the EUT configuration was rotated continuously and the antenna scanned from 1 - 4 meters in height. After obtaining a plot of the peak emissions, those emissions close to the limit were investigated using the quasi-peak detector.

The EUT was tested in both the standby mode and while actively reading from a contactless card. At the fundamental operating frequency of the EUT, the maximum radiated electric field was

measured with the AC voltage of the host PC set to a nominal voltage of 117VAC/60Hz (V_{nom}), 99.5VAC/60Hz (85% V_{nom}) and 134.6VAC/60Hz (115% V_{nom}).

Results for Radiated Emissions: Tables 2 - 9 contain data on the radiated emissions of significant amplitude from the EUT configuration shown in Section 5.1. The frequency range from 16 – 1000 MHz was investigated for spurious emissions. This data indicates that the EUT met the requirements for radiated emissions.

Frequency (MHz)	Factor (dB(1/m))	Amplitude (dB(μV/m))	Limit (dB(μV/m))	Margin (dB)
13.56	20.84	42.66	48.58	5.92
27.12	22.67	26.65	48.58	21.93

Table 2. Radiated emissions below 30 MHz; standby mode; $V = V_{nom}$.

Frequency (MHz)	Factor (dB(1/m))	Amplitude (dB(μV/m))	Limit (dB(μV/m))	Margin (dB)
13.56	20.84	34.83	48.58	13.75
27.12	22.67	27.73	48.58	20.85

Table 3. Radiated emissions below 30 MHz; actively communicating with card; $V = V_{nom}$.

Frequency (MHz)	Factor (dB(1/m))	Amplitude (dB(μV/m))	Limit (dB(μV/m))	Margin (dB)
13.56	20.84	42.94	48.58	5.64

Table 4. Field strength at fundamental; standby mode; $V = 85\% V_{nom}$.

Frequency (MHz)	Factor (dB(1/m))	Amplitude (dB(μV/m))	Limit (dB(μV/m))	Margin (dB)
13.56	20.84	34.74	48.58	13.84

Table 5. Field strength at fundamental; actively communicating with card; $V = 85\% V_{nom}$.

Frequency (MHz)	Factor (dB(1/m))	Amplitude (dB(μV/m))	Limit (dB(μV/m))	Margin (dB)
13.56	20.84	42.95	48.58	5.63

Table 6. Field strength at fundamental; standby mode; $V = 115\% V_{nom}$.

Frequency (MHz)	Factor (dB(1/m))	Amplitude (dB(μV/m))	Limit (dB(μV/m))	Margin (dB)
13.56	20.84	34.64	48.58	13.94

Table 7. Field strength at fundamental; actively communicating with card; $V = 115\% V_{nom}$.

Frequency (MHz)	Polarity	Cable Loss (dB)	Antenna Factor (dB(1/m))	Amplitude (dB(μV/m))	Limit (dB(μV/m))	Margin (dB)
34.519	V	-28.17	16.48	27.99	40	12.01
96.019	V	-27.4	9.31	31.19	43.5	12.31
167.998	V	-26.78	9.76	31.30	43.5	12.2
352.553	V	-25.51	14.56	37.38	46	8.62
379.656	V	-25.31	15.11	38.46	46	7.54
447.464	V	-25.06	17.11	39.36	46	6.64

Table 8. Results for radiated emissions 30 - 1000 MHz; standby mode.

Frequency (MHz)	Polarity	Cable Loss (dB)	Antenna Factor (dB(1/m))	Amplitude (dB(μV/m))	Limit (dB(μV/m))	Margin (dB)
34.399	V	-28.18	16.49	27.76	40	12.24
94.925	V	-27.41	9.26	30.50	43.5	13
311.868	V	-25.76	13.45	31.70	46	14.3
352.543	V	-25.51	14.56	36.16	46	9.84
379.656	V	-25.31	15.11	37.92	46	8.08
447.474	V	-25.06	17.11	36.91	46	9.09

Table 9. Results for radiated emissions 30 – 1000 MHz; actively communicating with card.

Figure 6. Test configuration for radiated emissions (front view).

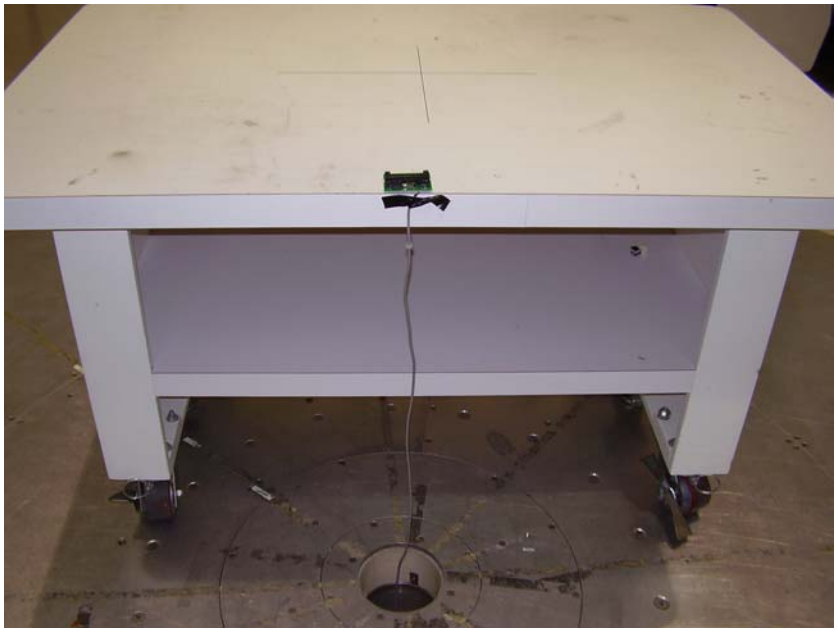


Figure 7. Test configuration for radiated emissions (back view).

8.3 AC CONDUCTED EMISSIONS

Criteria for AC Conducted Emissions: The emissions conducted onto the AC power line by the EUT shall not exceed the values in Table 10.

Frequency Range (MHz)	Quasi-peak Limit (dB(μV))	Average Limit (dB(μV))
0.15 - 0.5	66 to 56	56 to 46
0.5 - 5	56	46
5 - 30	60	50

Table 10. Limits for conducted emissions.

Test Procedure for AC Conducted Emissions: The test configuration shown Section 5.2 was used for this testing. Conducted emissions testing was performed in an 18 ft. x 18 ft. all-welded shielded room located at Lexmark International's EMC test facilities. As shown in Figures 8 and 9, the EUT was placed atop a 0.8 meter high wooden table with a rectangular surface measuring 1.5m x 1.0m. The back edges of all devices were located 40 cm from the metal wall of the shielded room. The AC line cord of the host PC was plugged into the LISN (Line Impedance Stabilization Network) with the excess of the PC line cord length bundled in the center. The USB cable was draped down from the rear of the EUT and PC, but hung no closer than 40 cm to the floor (ground plane). The excess of this cable was serpentined to form a bundle 30-40 cm in length, with the overall length of the cable not to exceed 1.0 meter in length

For this testing, the loop antenna was disconnected and the RF output terminated with two 150Ω resistors as allowed in Section 13.2 of [6]. This is accomplished by replacing 0Ω resistors on the board with 150Ω resistors. The EUT was operated in a constant transmit mode.

Results for AC Conducted Emissions: Table 11 contains the emissions with the highest amplitudes for the EUT. The EUT met the requirements for conducted emissions given in Table 10.

Frequency (MHz)	Line	Correction Factors (dB)	Quasi-peak Amplitude (dB(μV))	Quasi-peak Limit (dB(μV))	Quasi-peak Margin (dB)	Average Amplitude (dB(μV))	Average Limit (dB(μV))	Average Margin (dB)
13.428	P	11.36	45.08	60	14.92	42.6	50	7.4
13.612	P	11.37	43.67	60	16.33	40.4	50	9.6
17.208	P	11.61	43.97	60	16.03	40.66	50	9.34
16.631	N	11.57	42.32	60	17.68	38.86	50	11.14
13.56	P	11.37	37.04	60	22.96	30.84	50	19.16
13.56	N	11.37	36.08	60	23.92	29.83	50	20.17
27.12	N	12.25	45.98	60	14.02	41.18	50	8.82

Table 11. Results for AC conducted emissions.

Figure 8. Test configuration for transmitter conducted emissions (front view).

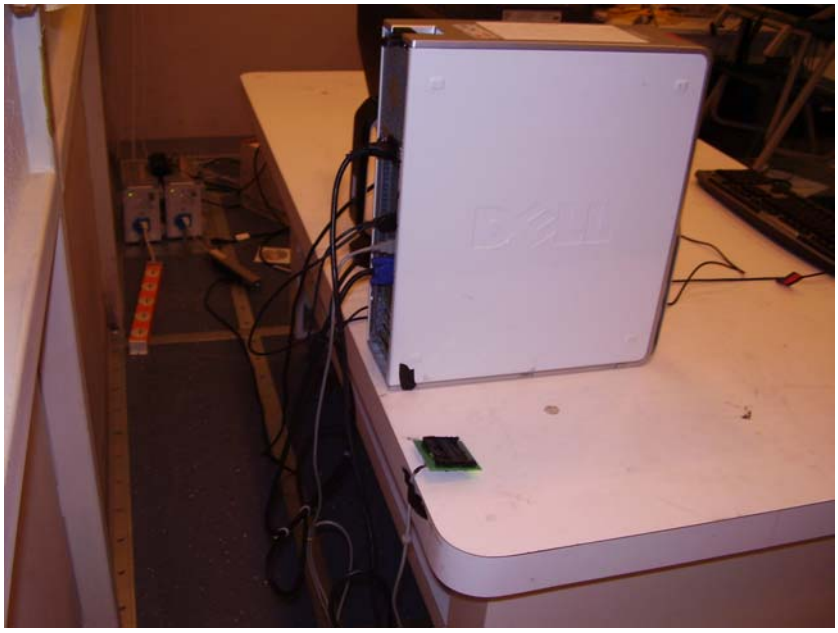


Figure 9. Test configuration for transmitter conducted emissions (side view).

8.4 MAXIMUM PERMISSIBLE EXPOSURE CALCULATIONS

Test Procedure for Maximum Permissable Exposure: Using the values of the maximum radiated electric field measurements previously reported in this report and assuming a $1/r^2$ rolloff of the electric field, the distance from the EUT where the electric field equals the maximum allowed in [1] is calculated.

Per §1.1310 of the FCC Rules [1], the limit for the category of general population/uncontrolled exposure in the frequency range of 1.34 – 30 MHz is:

$$E_{\lim it} = \frac{824}{f_{MHz}} V/m$$

Assuming a $1/r^2$ (40 dB/decade) rolloff of the electric field, the equation describing the electric field at any distance r relative to the field value E_{10m} measured at a 10 meter distance is the following:

$$E = E_{10m} + 20\log\left(\left(\frac{10}{r}\right)^2\right)$$

Setting the value of the electric field equal to the limit yields the following equation:

$$E_{\lim it} = E_{10m} + 20\log\left(\left(\frac{10}{r}\right)^2\right)$$

where the value of the distance r can be determined so that the equation is satisfied. The value of r that satisfies this equation is found to be 15 mm.

It is expected that due to the nature of the EUT and how it will be installed, the user will be located at least 20 cm from the EUT.

Criteria for Maximum Permissable Exposure: Per §1.1310 of the FCC Rules, the limit of radiation exposure for a device operating at a frequency of 13.56 MHz under the Limits for General Population/Uncontrolled Exposure is 155.67 dB(μV/m). The electric field radiated by the EUT was below this value for separation distances of 20 cm or greater.

NOTE:

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2. **reproduced, except in full.**