Measurement of RF Emissions from a Model No. LS2400T Patient Egress Monitoring Transmitter

For	Innovative Control Systems, Inc. 10125 S52nd St. Franklin, WI 53132
P.O. Number	P026238
Date Tested	November 11, 2013
Test Personnel	Richard E. King
Test Specification	FCC "Code of Federal Regulations" Title 47 Part15, Subpart C Industry Canada RSS-GEN Industry Canada RSS-210

Test Report By:

Richard E. King
EMC Engineer

Requested By:

Mark Kieckhefer, Gregg Haensgen
Innovative Control Systems, Inc.

Approved By:

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Registered Professional
Engineer of Illinois - 44894

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REVISION HISTORY

Revision	Date	Description
—	03 Dec 2013	Initial release

Measurement of RF Emissions from a Patient Egress Monitoring Transmitter, Model No. LS2400T Transmitter

1. INTRODUCTION

1.1. Scope of Tests

This report presents the results of the RF emissions measurements performed on a Patient Egress Monitoring Transmitter, Model No. LS2400T, Serial No. 3, (hereinafter referred to as the Equipment Under Test (EUT)). The EUT was designed to transmit at approximately 133 kHz using a 5 inch internal antenna. The EUT was manufactured and submitted for testing by Innovative Control Systems, Inc. located in Franklin, WI.

1.2. Purpose

The test series was performed to determine if the EUT meets the conducted and radiated RF emission requirements of the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, for Intentional Radiators and Industry Canada Radio Standards Specification, RSS-210, “Low-power License-exempt Radiocommunication Devices was performed in accordance with ANSI C63.4-2009.

1.3. Deviations, Additions and Exclusions

There were no deviations, additions to, or exclusions from the test specification during this test series.

1.4. EMC Laboratory Identification

This series of tests was performed by Elite Electronic Engineering Incorporated of Downers Grove, Illinois. The laboratory is accredited by The American Association for Laboratory Accreditation (A2LA). A2LA Certificate Number: 1786.01.

1.5. Laboratory Conditions

The temperature at the time of the test was 22.8^{o}C and the relative humidity was 20%.

2. APPLICABLE DOCUMENTS

The following documents of the exact issue designated form part of this document to the extent specified herein:

- Federal Communications Commission "Code of Federal Regulations", Title 47, Part 15, Subpart C, dated 1 October 2013
- ANSI C63.4-2009, "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"
- Industry Canada Radio Standards Specification, RSS-Gen, “General Requirements and Information for the Certification of Radiocommunication Equipment”, Issue 3, December 2010
- Industry Canada Radio Standards Specification, RSS-210, “Low-power Licence-exempt Radiocommunication Devices (All Frequency Bands): Category I Equipment”, Issue 8, December 2010

3. EUT SETUP AND OPERATION

3.1. General Description

The EUT is an Innovative Control Systems, Inc., Patient Egress Monitoring Transmitter, Model No. LS2400T. A block diagram of the EUT setup is shown as Figure 1.

3.1.1.Power Input

The EUT obtained 15V 60Hz power through 2 leads from the secondary of a Triade Co. step-down transformer, Part No.WSU150-2400-R. The primary of this transformer received 115V 60Hz power through lowpass powerline filters on the wall of the shielded enclosure. The 15VAC power from the secondary of the transformer was provided to the EUT through a 2 wire, 4 foot long unshielded cord. Each primary lead was connected through a line impedance stabilization network (LISN) which was located on the ground plane. The network complies with the requirements of Paragraph 4.1.2 of ANSI C63.4-2009.

3.1.2.Peripheral Equipment

The following peripheral equipment was submitted with the EUT:

Item	Description
LCD displays	Two Innovative Control Systems Inc. LCD Displays one LS2400D and one LS2400DNS.

3.1.3.Signal Input/Output Leads

The following interconnect cables were submitted with the EUT:

Item	Description
485 3 pin inner connect	Two - 485 3 pin inner connect wires between the LCD Displays and the transceiver.

3.1.4.Grounding

The EUT was grounded only through the third wire of its input power cord.

3.2. Software

For all tests the EUT had Firmware Version 1.4.0 loaded onto the device to provide correct load characteristics.

3.3. Operational Mode

For all tests the EUT was placed on an 80cm high non-conductive stand. The EUT was energized and configured to transmit continuously.

3.4. EUT Modifications

No modifications were required for compliance to the FCC 15.209 limits.

4. TEST FACILITY AND TEST INSTRUMENTATION

4.1. Shielded Enclosure

All tests were performed in a 32ft. x 20ft. x 18ft. hybrid ferrite-tile/anechoic absorber lined test chamber. With the exception of the floor, the reflective surfaces of the shielded chamber are lined with ferrite tiles on the walls and ceiling. Anechoic absorber material is installed over the ferrite tile. The floor of the chamber is used as the ground plane. The chamber complies with ANSI C63.4-2009 for site attenuation.

4.2. Test Instrumentation

The test instrumentation and auxiliary equipment used during the tests are listed in Table 9-1.

Conducted and radiated emission measurements were performed with a spectrum analyzer. This receiver allows measurements with the bandwidths and detector functions specified by the FCC. The receiver bandwidth was 120kHz for the 30MHz to 1000MHz radiated emissions data and 1MHz for the 1000MHz to 5000MHz radiated emissions data.

4.3. Calibration Traceability

Test equipment is maintained and calibrated on a regular basis. All calibrations are traceable to the National Institute of Standards and Technology (NIST).

4.4. Measurement Uncertainty

All measurements are an estimate of their true value. The measurement uncertainty characterizes, with a specified confidence level, the spread of values which may be possible for a given measurement system.

The measurement uncertainty for these tests is presented below:

Conducted Emissions Measurements		
Combined Standard Uncertainty	1.07	-1.07
Expanded Uncertainty (95% confidence)	2.1	-2.1

Radiated Emissions Measurements		
Combined Standard Uncertainty	2.26	-2.18
Expanded Uncertainty (95% confidence)	4.5	-4.4

5. TEST PROCEDURES

5.1. Powerline Conducted Emissions

5.1.1. Requirements

All radio frequency voltages on the power lines for any frequency or frequencies of an intentional radiator shall not exceed the limits in the following table:

Frequency MHz	Conducted Limit (dBuV)	
	Quasi-peak	Average
0.15 – 0.5	66 decreasing with logarithm of frequency to 56	56 decreasing with logarithm of frequency to 46
0.5 - 5	56	46
5 - 30	60	50

Note 1: The lower limit shall apply at the transition frequencies.

5.1.2. Procedures

The interference on each power lead of the EUT was measured by connecting the measuring equipment to the appropriate meter terminal of the Line Impedance Stabilization Network (LISN). The meter terminal of the LISN not under test was terminated with 50 ohms.

a) The EUT was operated in the transmit at 133 kHz mode.

b) Measurements were first made on the 120 VAC 60 Hz high line.

c) The frequency range from 150 kHz to 30 MHz was broken up into smaller frequency sub-bands.

d) Conducted emissions measurements were taken on the first frequency sub-band using a peak detector.

e) The data thus obtained was then searched by the computer for the highest levels. Any emissions levels that were within 10dB of the average limit were then measured again using both a quasi-peak detector and an average detector. (If no peak readings were within 10dB of the average limit, quasi-peak and average readings were taken on the highest emissions levels measured during the peak detector scan.)

f) Steps (d) and (e) were repeated for the remainder of the frequency sub-bands until the entire frequency range from 150kHz to 30MHz was investigated. The peak trace was automatically plotted. The plot also shows quasi-peak and average readings that were taken on discrete frequencies. A table showing the quasi-peak and average readings was also generated. This tabular data compares the quasi-peak and average conducted emissions to the applicable conducted emissions limits.

g) Steps (c) through (f) were repeated on the 120 VAC 60 Hz return line.

5.1.3.Results

The plots of the peak, quasi-peak, and average conducted voltage levels acquired from each input power line with the EUT set to transmit at 133 kHz and are shown on pages 14 and 16. The tabular quasi-peak and average results from each input power line with the EUT set to transmit at 133 kHz and are shown on pages 13 and 15. All power line conducted emissions measured from the EUT were within the specification limits.

Photographs of the test configuration which yielded the highest or worst case, conducted emission levels are shown on Figure 2.

5.2. Radiated Measurements

5.2.1.Requirements

All radio frequency voltages on the power lines for any frequency or frequencies of an intentional radiator shall not exceed the limits in the following table:

Frequency (MHz)	Field Strength (uV/m)	Measurement Distance (meters)
0.009 – 0.490	2400/F(kHz)	300
0.490 – 1.705	2400/F(kHz)	30
1.705 – 30.0	30	30

5.2.2.Procedures

All tests were performed in a 32ft. x 20ft. x 18ft. hybrid ferrite-tile/anechoic absorber lined test chamber. The walls and ceiling of the shielded chamber are lined with ferrite tiles. Anechoic absorber material is installed over the ferrite tile. The floor of the chamber is used as the ground plane. The chamber complies with ANSI C63.4-2009 for site attenuation.

The shielded enclosure prevents emissions from other sources, such as radio and TV stations from interfering with the measurements. All powerlines and signal lines entering the enclosure pass through filters on the enclosure wall. The powerline filters prevent extraneous signals from entering the enclosure on these leads.

A preliminary radiated emissions test was performed to determine the emission characteristics of the EUT. For the preliminary test, a broadband measuring antenna was positioned at a 3 meter distance from the EUT. The entire frequency range from 10kHz to 30MHz was investigated using a peak detector function. The data was then processed by the computer to calculate equivalent field intensity.

The final open field emission tests were then manually performed over the frequency range of 133kHz to 1.3MHz using an active loop antenna at a 3 meter test distance. All significant broadband and narrowband signals were measured and recorded.

To ensure that maximum or worst case, emission levels were measured, the following steps were taken:

1) The test item was rotated so that all of its sides were exposed to the receiving antenna.
2) Since the measuring antenna is linearly polarized, both horizontal and vertical field components were measured. In the vertical polarization, the active loop antenna was rotated 360 degrees about its vertical axis.
3) For hand-held or body-worn devices, the test item was rotated through three orthogonal axes to determine which orientation produces the highest emission relative to the limit.

5.2.3.Results

The preliminary plots, with the EUT transmitting at 133 kHz, are presented on data pages 17 and 18. The plots are presented for a reference only, and are not used to determine compliance.

The final radiated levels, with the test item transmitting at 133 kHz, are presented on data page 19. As can be seen from the data, all emissions measured from the EUT were within the specification limits.

Photographs of the test configuration which yielded the highest or worst case, radiated emission levels are shown on Figure 3.

6. OTHER TEST CONDITIONS

6.1. Test Personnel and Witnesses

All tests were performed by qualified personnel from Elite Electronic Engineering Incorporated. The test series was witnessed by Innovative Control Systems, Inc. personnel.

6.2. Disposition of the EUT

The EUT and all associated equipment were returned to Innovative Control Systems, Inc. upon completion of the tests.

7. CONCLUSIONS

It was determined that the Innovative Control Systems, Inc. Patient Egress Monitoring Transmitter, Model No. LS2400T, Serial No. 3, did fully meet the conducted and radiated emission requirements of the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, for Intentional Radiators and Industry Canada Radio Standards Specification, RSS-210, “Low-power License-exempt Radiocommunication Devices.

8. CERTIFICATION

Elite Electronic Engineering Incorporated certifies that the information contained in this report was obtained under conditions which meet or exceed those specified in the test specifications.

The data presented in this test report pertains to the EUT at the test date as operated by Innovative Control Systems, Inc. personnel. Any electrical or mechanical modification made to the EUT subsequent to the specified test date will serve to invalidate the data and void this certification.

This report must not be used to claim product endorsement by NVLAP or any agency of the US Government.

9. EQUIPMENT LIST

Table 9-1 Equipment List

Eq ID	Equipment Description	Manufacturer	Model No.	Serial No.	Frequency Range	Cal Date	Due Date
CDX8	COMPUTER	ELITE	WORKSTATION			N/A	
GRB0	1MHZ, LISN SIGNAL CHECKER	ELITE	LISNCHKR1M	1	1MHZ	1/9/2013	1/9/2014
MDA0	MULTIMETER (R. KING)	FLUKE CORPORATION	26	72120781	I;VDC;VAC;R	3/18/2013	3/18/2014
MEA2	MICRO-OHM METER	KEITHLEY	580	674866	10UOHM-200KOHM	11/19/2013	11/19/2014
NLS1	24" ACTIVE LOOP ANTENNA	EMCO	6502	8903-2329	0.01-30MHZ	6/20/2013	6/20/2014
NTA3	BILOG ANTENNA	TESEQ	6112D	28040	25-1000MHz	2/15/2013	2/15/2014
NWQ1	DOUBLE RIDGED WAVEGUIDE ANTENNA	ETS-LINDGREN	3117	66655	1GHZ-18GHZ	3/18/2013	3/18/2014
PLF2	CISPR16 50UH LISN	ELITE	CISPR16/70A	002	.15-30MHz	6/25/2013	6/25/2014
PLF4	CISPR16 50UH LISN	ELITE	CISPR16/70A	003	.15-30MHz	6/25/2013	6/25/2014
RAKI	RF SECTION	HEWLETT PACKARD	85462A	3411A00181	0.009-6500MHZ	3/15/2013	3/15/2014
RAKJ	RF FILTER SECTION	HEWLETT PACKARD	85460A	3330A00154	---	3/15/2013	3/15/2014
RBA1	EMI TEST RECEIVER	ROHDE & SCHWARZ	ESIB26	100146	20HZ-26.5GHZ	3/4/2013	3/4/2014
SMAF	POWER SUPPLY	MASTECH	HY3020EX	1012	30 Volt, 20 Amp	NOTE 1	
T1N3	10DB 20W ATTENUATOR	NARDA	766-10	---	DC-4GHZ	8/8/2013	8/8/2014
VBR8	CISPR EN FCC CE VOLTAGE.exe						
WQB0	RE_8546A						
XLT9	5W, 50 OHM TERMINATION	JFW INDUSTRIES	50T-052	010	DC-2GHZ	1/9/2013	1/9/2014

I/O: Initial Only
N/A: Not Applicable
Note 1: For the purpose of this test, the equipment was calibrated over the specified frequency range, pulse rate, or modulation prior to the test or monitored by a calibrated instrument.

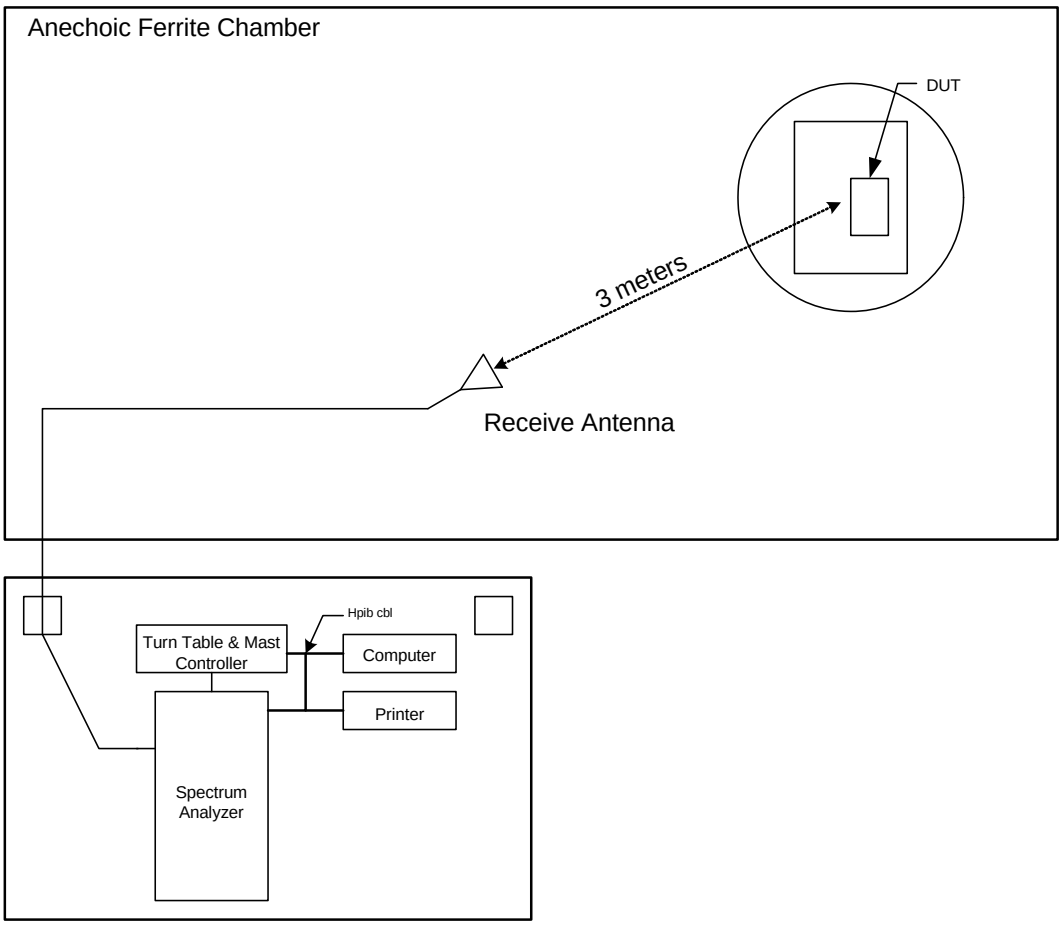
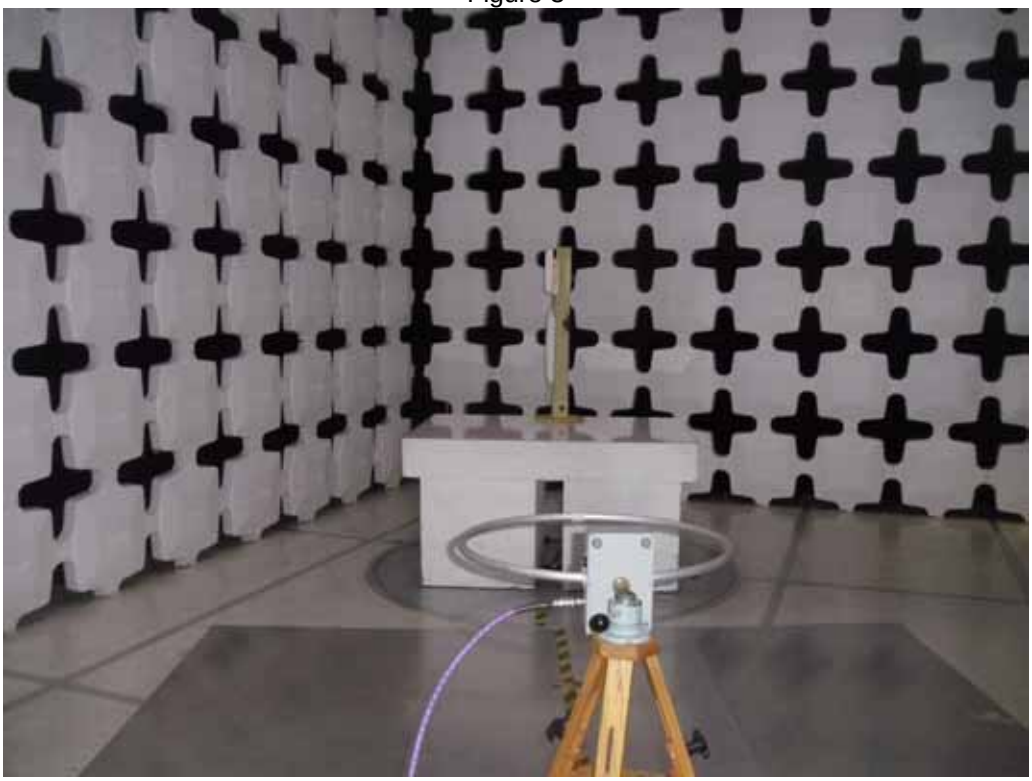


FIGURE 1 BLOCKDIAGRAM OF TEST SETUP

Figure 2

Test Setup for Conducted Emissions

Figure 3



Test Setup for Radiated Emissions, Up to 30MHz – Horizontal Polarization

Test Setup for Radiated Emissions, Up to 30MHz – Vertical Polarization

FCC Part 15 Subpart B Conducted Emissions Test

Significant Emissions Data

VB** 02/09/2011

Manufacturer	:	INNOVATIVE CONTROL SYSTEM INC
Model	:	LS2400T
DUT Revision	:	
Serial Number	:	3
DUT Mode	:	Tx @ 133 kHz
Line Tested	:	L1
Scan Step Time [ms]	:	30
Meas. Threshold [dB]	:	-10
Notes	:	
Test Engineer	:	R. King
Limit	:	Class B
Test Date	:	Nov 21, 2013 01:12:00 PM
Data Filter	:	Up to 80 maximum levels detected with 6 dB level excursion threshold over 10 dB margin below limit

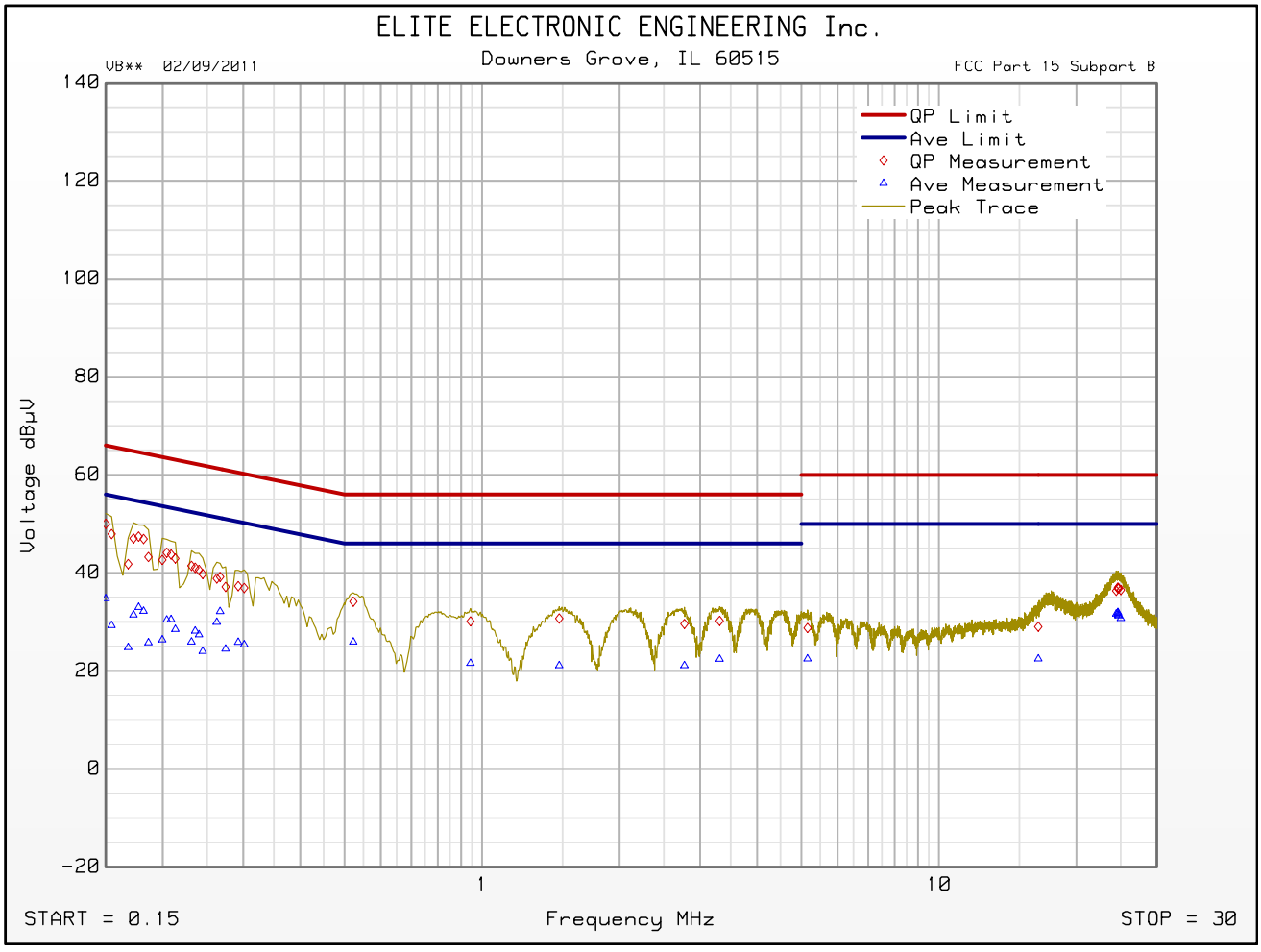
Freq MHz	Quasi-peak Level dBµV	Quasi-peak Limit dBµV	Excessive Quasi-peak Emissions	Average Level dBµV	Average Limit dBµV	Excessive Average Emissions
0.150	50.0	66.0		34.8	56.0	
0.293	37.3	60.5		25.9	50.5	
0.523	34.1	56.0		25.9	46.0	
0.943	30.1	56.0		21.6	46.0	
1.475	30.7	56.0		21.1	46.0	
2.772	29.6	56.0		21.1	46.0	
3.311	30.2	56.0		22.4	46.0	
5.158	28.8	60.0		22.5	50.0	
16.502	29.0	60.0		22.5	50.0	
24.656	37.0	60.0		31.9	50.0	

FCC Part 15 Subpart B Conducted Emissions Test

Cumulative Data

VB** 02/09/2011

Manufacturer	:	INNOVATIVE CONTROL SYSTEM INC
Model	:	LS2400T
DUT Revision	:	
Serial Number	:	3
DUT Mode	:	Tx @ 133 kHz
Line Tested	:	L1
Scan Step Time [ms]	:	30
Meas. Threshold [dB]	:	-10
Notes	:	
Test Engineer	:	R. King
Limit	:	Class B
Test Date	:	Nov 21, 2013 01:12:00 PM



Emissions Meet QP Limit
Emissions Meet Ave Limit

FCC Part 15 Subpart B Conducted Emissions Test

Significant Emissions Data

VB** 02/09/2011

Manufacturer	:	INNOVATIVE CONTROL SYSTEM INC
Model	:	LS2400T
DUT Revision	:	
Serial Number	:	3
DUT Mode	:	Tx @ 133 kHz
Line Tested	:	L2
Scan Step Time [ms]	:	30
Meas. Threshold [dB]	:	-10
Notes	:	
Test Engineer	:	R. King
Limit	:	Class B
Test Date	:	Nov 21, 2013 01:18:15 PM
Data Filter	:	Up to 80 maximum levels detected with 6 dB level excursion threshold over 10 dB margin below limit

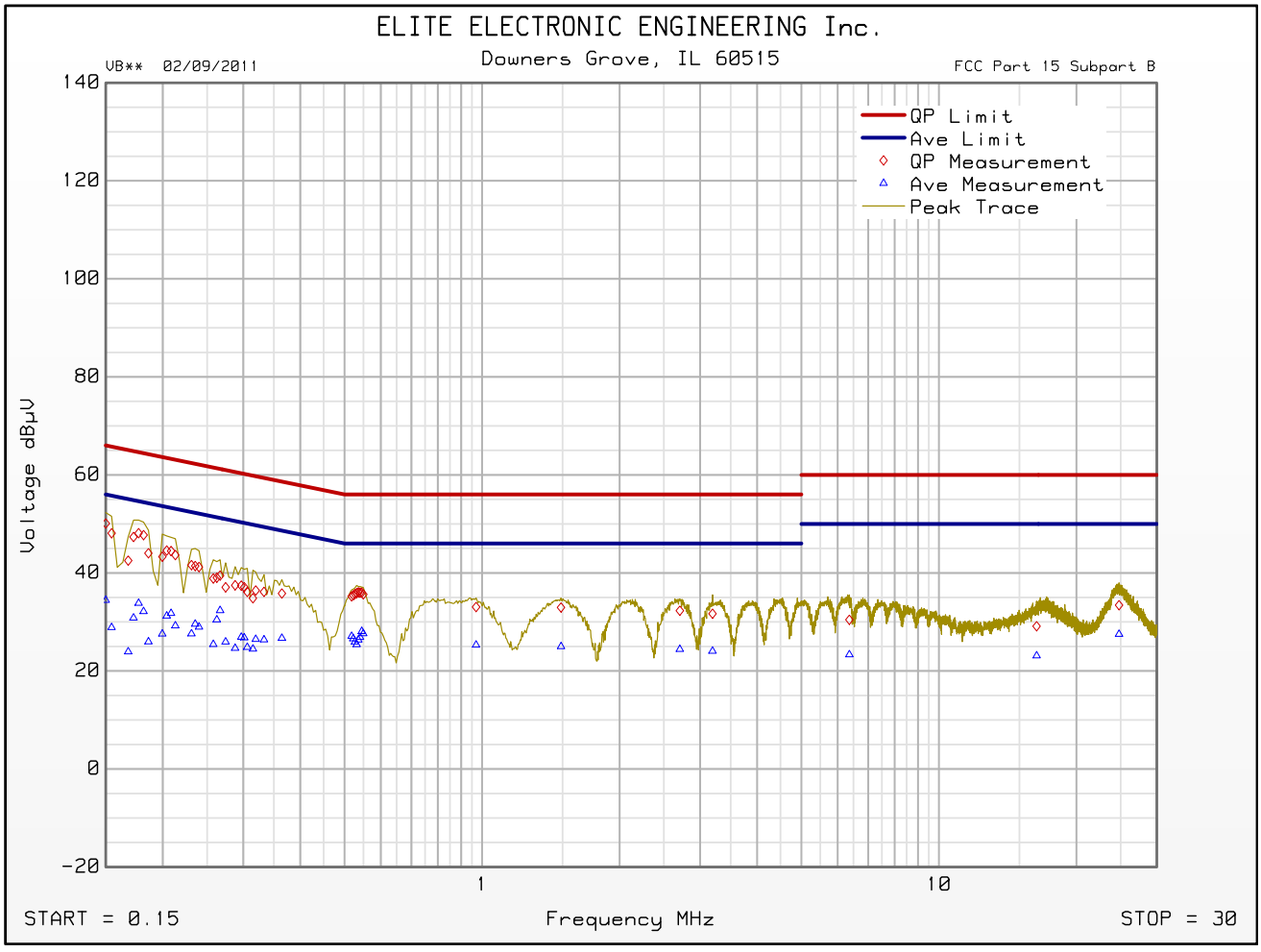
Freq MHz	Quasi-peak Level dBµV	Quasi-peak Limit dBµV	Excessive Quasi-peak Emissions	Average Level dBµV	Average Limit dBµV	Excessive Average Emissions
0.150	50.1	66.0		34.4	56.0	
0.365	35.8	58.6		26.7	48.6	
0.536	36.0	56.0		26.3	46.0	
0.970	33.1	56.0		25.3	46.0	
1.489	33.0	56.0		25.0	46.0	
2.709	32.3	56.0		24.4	46.0	
3.194	31.7	56.0		24.1	46.0	
6.368	30.4	60.0		23.3	50.0	
16.362	29.1	60.0		23.1	50.0	
24.796	33.4	60.0		27.5	50.0	

FCC Part 15 Subpart B Conducted Emissions Test

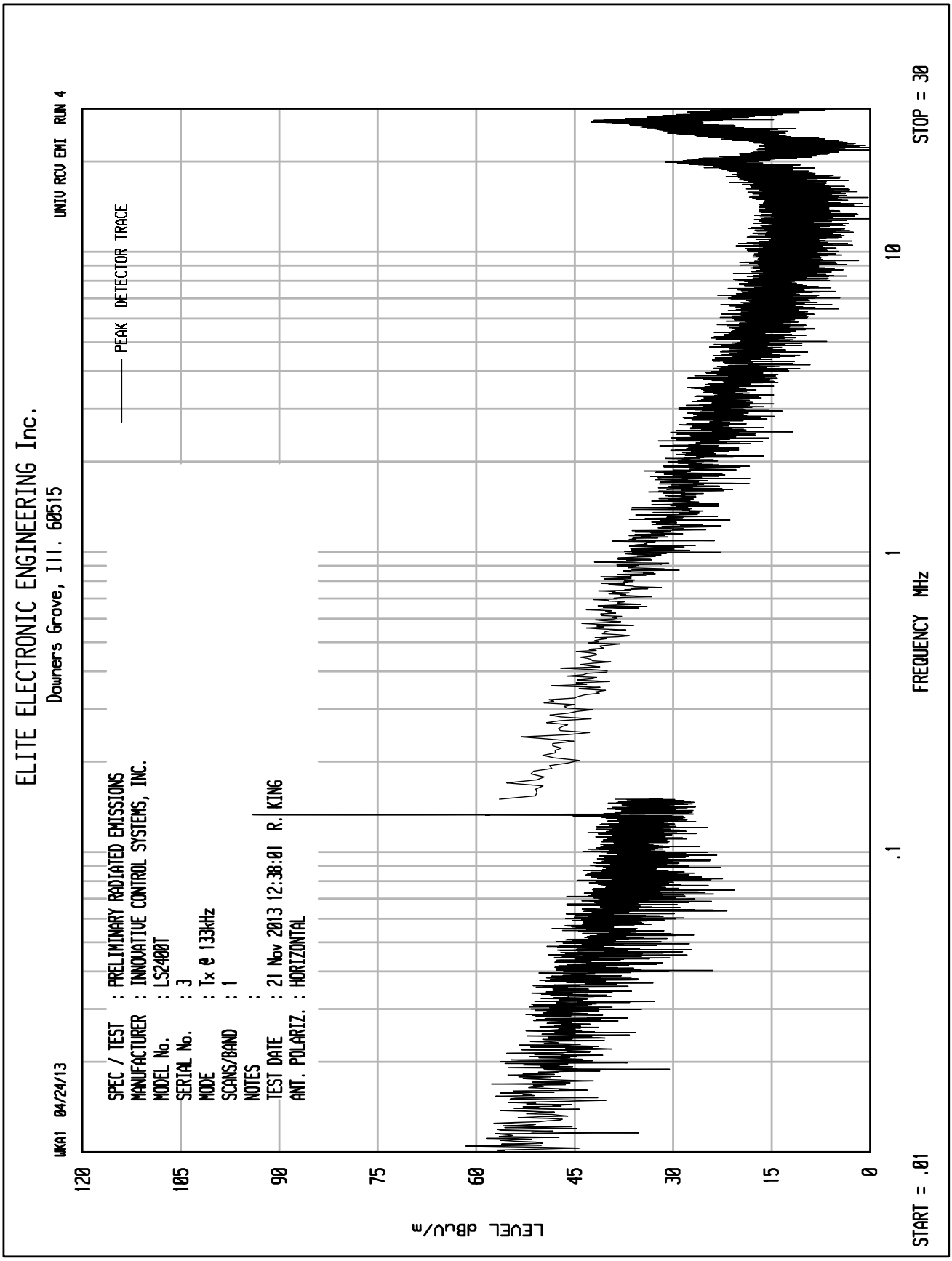
Cumulative Data

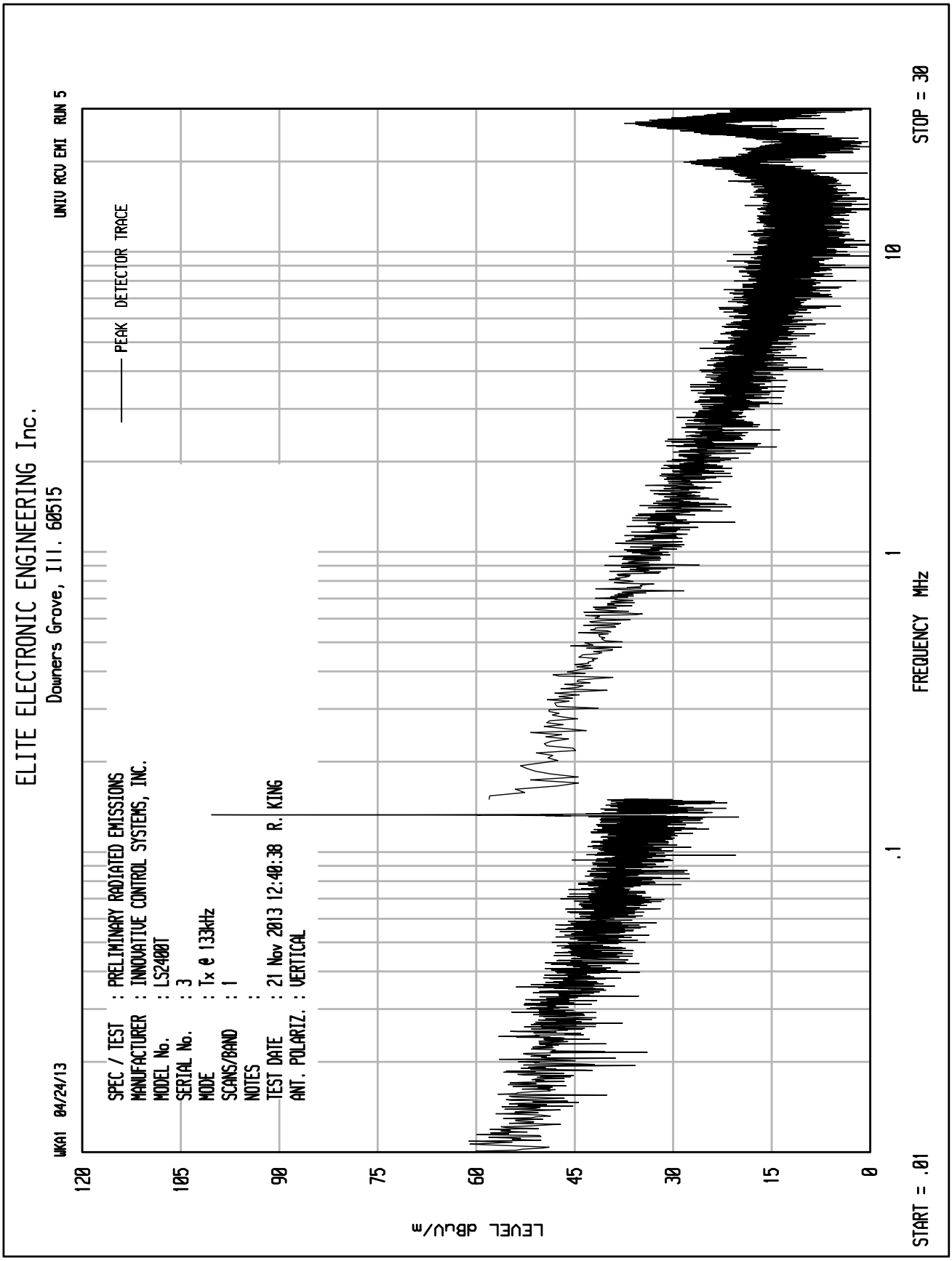
VB** 02/09/2011

Manufacturer	:	INNOVATIVE CONTROL SYSTEM INC
Model	:	LS2400T
DUT Revision	:	
Serial Number	:	3
DUT Mode	:	Tx @ 133 kHz
Line Tested	:	L2
Scan Step Time [ms]	:	30
Meas. Threshold [dB]	:	-10
Notes	:	
Test Engineer	:	R. King
Limit	:	Class B
Test Date	:	Nov 21, 2013 01:18:15 PM



Emissions Meet QP Limit
Emissions Meet Ave Limit


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 4
WKA1 04/24/13
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : INNOVATIVE CONTROL SYSTEMS, INC.
MODEL No. : LS2400T
SERIAL No. : 3
MODE : Tx @ 133kHz
SCANS/BAND : 1
NOTES :
TEST DATE : 21 Nov 2013 12:38:01 R. KING
ANT. POLARIZ. : HORIZONTAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
START = .01
.1
1
10
STOP = 30
FREQUENCY MHz


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 5
WKA1 04/24/13
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : INNOVATIVE CONTROL SYSTEMS, INC.
MODEL No. : LS2400T
SERIAL No. : 3
MODE : Tx @ 133kHz
SCANS/BAND : 1
NOTES :
TEST DATE : 21 Nov 2013 12:40:38 R. KING
ANT. POLARIZ. : VERTICAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
START = .01
.1
1
10
STOP = 30
FREQUENCY MHz

MANUFACTURER : Innovative Control Systems, Inc.
MODEL : LS2400T
SPECIFICATION : FCC-15C Radiated Emissions
DATE : 11/21/2013
NOTES :

Freq. (MHz)	Ant Pol	Meter Reading (dBuV)	Ambient	BL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Dist. Corr. (dB)	Total (dBuV/m)	Total (uV/m)	Limit (uV/m)	Specified Test Distance (meters)	Margin (dB)
0.133	H	84.4		0.0	10.4	0.0	-80.0	14.8	5.49252	18.0	300.0	-10.3
0.133	V	93.8		0.0	10.4	0.0	-80.0	24.2	16.26565	18.0	300.0	-0.9
0.266	H	45.6		0.0	10.3	0.0	-80.0	-24.1	0.06238	9.0	300.0	-43.2
0.266	V	49.9		0.0	10.3	0.0	-80.0	-19.8	0.10222	9.0	300.0	-38.9
0.399	H	41.5		0.0	10.3	0.0	-80.0	-28.2	0.03873	6.0	300.0	-43.8
0.399	V	41.4	*	0.0	10.3	0.0	-80.0	-28.3	0.03855	6.0	300.0	-43.9
0.532	H	38.5	*	0.0	10.5	0.0	-40.0	9.0	2.81838	45.1	30.0	-24.1
0.532	V	37.7	*	0.0	10.5	0.0	-40.0	8.2	2.56744	45.1	30.0	-24.9
0.665	H	36.3	*	0.0	10.5	0.0	-40.0	6.8	2.18776	36.1	30.0	-24.3
0.665	V	35.9	*	0.0	10.5	0.0	-40.0	6.4	2.08689	36.1	30.0	-24.8
0.798	H	34.2	*	0.0	10.6	0.0	-40.0	4.8	1.74545	30.1	30.0	-24.7
0.798	V	34.2	*	0.0	10.6	0.0	-40.0	4.8	1.73943	30.1	30.0	-24.8
0.931	H	32.9	*	0.0	10.7	0.0	-40.0	3.5	1.50277	25.8	30.0	-24.7
0.931	V	33.1	*	0.0	10.7	0.0	-40.0	3.7	1.53778	25.8	30.0	-24.5
1.064	H	31.8	*	0.0	10.7	0.0	-40.0	2.4	1.32124	22.6	30.0	-24.6
1.064	V	31.3	*	0.0	10.7	0.0	-40.0	2.0	1.25309	22.6	30.0	-25.1
1.197	H	30.1	*	0.0	10.8	0.0	-40.0	0.9	1.10571	20.1	30.0	-25.2
1.197	V	30.2	*	0.0	10.8	0.0	-40.0	1.0	1.11594	20.1	30.0	-25.1
1.330	H	30.1	*	0.0	10.8	0.0	-40.0	1.0	1.12126	18.0	30.0	-24.1
1.330	V	30.3	*	0.0	10.8	0.0	-40.0	1.1	1.13948	18.0	30.0	-24.0

Checked BY Richard E. King :

Richard E. King