Measurement of RF Interference from an Model No. ZICM2410P2 Zigbee Transceiver

For	:	California Eastern Labs
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	:	Wauconda, IL
P.O. No.	:	167361
Date Tested	:	September 14 through November 6, 2009
Test Personnel	:	Richard E King
Specification	:	FCC "Code of Federal Regulations" Title 47, Part 15, Subpart B and Subpart C, Section 15.247 for Digital Transmission Systems Operating within The band 2400-2483.5MHz Industry Canada RSS-210 Industry Canada RSS-GEN

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REVISION HISTORY

Revision	Date	Description
—	November 13, 2009	Initial release

Measurement of RF Emissions from a Model No. ZICM2410P2 Transceiver

1 INTRODUCTION

1.1 Scope of Tests

This document represents the results of the series of radio interference measurements performed on a Zigbee Transceiver, Model No. ZICM2410P2 (hereinafter referred to as the test item). Serial No 825-ES2-X3. The test item was designed to transmit and receive in the 2405MHz to 2480MHz band using an internal antenna. The test item transmitted using digital transmission system techniques. The test item was manufactured and submitted for testing by California Eastern Labs located in Wauconda, IL.

The receive portion of the test item is a super-heterodyne type receiver designed to receive in the 2405MHz to 2480MHz band. The test item contains a tuner which utilizes one local oscillator (LO) at the tuned frequency.

1.2 Purpose

The test series was performed to determine if the test item meets the conducted and radiated RF emission requirements of the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart B, Sections 15.107 and 15.109, and Subpart C, Sections15.207 and 15.247 for Intentional Radiators operating within the 2400-2483.5MHz band. Testing was performed in accordance with ANSI C63.4-2003.

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 National Institute of Standards and Technology (NIST) under the National Voluntary Laboratory Accreditation Program (NVLAP). NVLAP Lab Code: 100278-0.

1.5 Laboratory Conditions

The temperature at the time of the test was 23ºC and the relative humidity was 35%.

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 2008
- 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"
- Industry Canada RSS-210, Issue 7, September 2007, “Spectrum Management and Telecommunications Radio Standards Specification, Low-power License-exempt radio communication devices (All Frequency Bands): Category I Equipment”
- Industry Canada RSS-GEN, Issue 2, September 2007, “Spectrum Management and Telecommunications Radio Standards Specification, General Requirements and Information for the Certification of radio communication equipment”
- Public Notice 558074, “New Guidance on Measurements for Digital Transmission Systems in 15.247”

- Public Notice DA 00-705, “Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems”

3 TEST ITEM SET-UP AND OPERATION

3.1 General Description

The test item is a Zigbee Transceiver, Model No. ZICM2410P2 serial number 825-ES2-X3. A block diagram of the test item set-up is shown as Figure 1. A photograph of the test item is shown as Figure 2.

3.1.1 Power Input

The test item was powered with 3.2VDC through a 2 meter long, 2 wire unshielded power lead. The high and low leads of the input power were 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 C63.4-2001.

3.1.2 Peripheral Equipment

The test item was submitted with a twelve inch test harness connected to a test board, the test board was connected to a Sony Vaio laptop. The test board and laptop were used for programming the transceiver only and was disconnected for testing.

3.1.3 Interconnect Cables

The test item does not require or utilize interconnect cables to operate.

3.1.4 Grounding

The test item was grounded only through the return lead of the input power.

3.2 Operational Mode

The output power, 6dB bandwidth and spectral density tests were performed on a unit modified with an antenna port. All remaining tests were performed with the antenna port removed. For all tests, the test item was placed on an 80cm high non-conductive stand. The test item was energized.

For radiated emissions tests, the test item was programmed to operate in one of the following modes:

- transmit @ 2405MHz
- transmit @ 2440MHz
- transmit @ 2480MHz
- receive @ 2440MHz

3.3 Test Item Modifications

No modifications were required for compliance to the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart B, Sections 15.107 and 15.109, and Subpart C, Sections 15.207 and 15.247 requirements.

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 C63.4-2003 for site attenuation.

4.2 Test Instrumentation

The test instrumentation and auxiliary equipment used during the tests are listed in Table 9-1 Equipment List. All equipment was calibrated per the instruction manuals supplied by the manufacturer.

Conducted emission tests were performed with a spectrum analyzer in conjunction with a quasi-peak adapter. Radiated emissions were performed with a spectrum analyzer. This receiver allows measurements with the bandwidths detector functions specified by the FCC.

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

Radiated Emission 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 Transmitter

5.1.1.1 Requirements

All radio frequency voltages on the power lines of an intentional radiator shall be below the values shown below when using a quasi-peak or average detector:

CONDUCTED LIMITS FOR AN INTENTIONAL RADIATOR

Frequency MHz	RFI Voltage dBuV(QP)	RFI Voltage dBuV(Average)
0.15-0.5	66 decreasing with logarithm of frequency to 56	56 decreasing with logarithm of frequency to 46
0.5 – 5.0	56	46
5.0 – 30.0	60	50

Note 1: The lower limit shall apply at the transition frequencies.
Note 2: If the levels measured using the QP detector meet both the QP and the Average limits, the test item is considered to have met both requirements and measurements do not need to be performed using the Average detector.

5.1.1.2 Procedures

The interference on each power lead was measured by connecting the measuring equipment to the appropriate meter terminal of the LISN. The meter terminal of the LISN not under test was terminated with 50 ohms. Measurements were first made over the entire frequency range from 150kHz through 30MHz with a peak detector and the results were automatically plotted. The data thus obtained was then searched by the computer for the highest levels. Quasi-peak measurements were automatically performed at the frequencies selected from the highest peak measurements, and the results printed.

5.1.1.3 Results

The plots of the peak preliminary conducted voltage levels on each power line, with the test item transmitting at 2440MHz are presented on pages 19 and 20. The conducted emissions limits are shown as a reference. The final quasi-peak and average results are presented on pages 21 and 22. As can be seen from the data, all emissions measured from the test item were within the specification limits. Photographs of the test setup are shown in Figure 3.

5.2 Duty Cycle Factor Measurements

5.2.1 Procedures

The duty cycle factor is used to convert peak detected readings to average readings. This factor is computed from the time domain trace of the pulse modulation signal.

With the transmitter set up to transmit for maximum pulse density, the time domain trace is displayed on the spectrum analyzer. This trace is obtained by tuning the center frequency to the transmitter frequency and then setting a zero span width with 10msec/div. The amplitude settings are adjusted so that the on/off transitions clear the 4th division from the bottom of the display. The markers are set at the beginning and end of a word period. If the word period exceeds 100 msec the word period is set to 100 msec. The on-time and off-time are then measured. The on-time is total time signal level exceeds the 4th division. Off-time is time under for the word period. The duty cycle is then computed as the (On-time/ word period) where the word period = (On-time + Off-time).

5.2.2 Results

The plots of the duty cycle are shown on data page 23. The duty cycle correction factor was calculated to be -11.06 dB.

5.3 Radiated Measurements

5.3.1 Receiver

5.3.1.1 Requirements

Per 15.101(b), receivers operating above 960MHz are exempt from complying with the radiated emissions requirements of 15.109. Therefore, no radiated emissions tests were performed with the test item operating in the receive mode.

Per RSS-GEN, the search for spurious emissions shall be from the lowest frequency internally generated or used in the receiver (e.g. local oscillator, intermediate or carrier frequency), or 30 MHz, whichever is the higher, to at least 3 times the highest tune-able or local oscillator frequency, whichever is the higher, without exceeding 40 GHz.

All emanations from a receiver shall be below the levels shown on the following table:

RADIATION LIMITS FOR A RECEIVER

Frequency MHz	Distance between Test Item And Antenna in Meters	Field Strength uV/m	Field Strength dBuV/m
30-88	3	100	40
88-216	3	150	43.5
216-960	3	200	46
Above 960	3	500	54

Note: The tighter limit shall apply at the edge between the two frequency bands.

5.3.1.2 Procedure

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 C63.4-2003 for site attenuation.

a) The field strength of all emissions above 1GHz were measured using a double-ridged waveguide antenna. The waveguide antenna was positioned at a 3 meter distance from the test item. A peak detector with a resolution bandwidth of 1MHz was used on the spectrum analyzer.

b) To ensure that maximum or worst case emission levels were measured, the following steps were taken when taking all measurements:

   i) The test item was rotated so that all of its sides were exposed to the receiving antenna.

   ii) Since the measuring antenna is linearly polarized, both horizontal and vertical field components were measured.

   iii) For all radiated emissions measurements above 1GHz, if the peak reading is below the limits listed in above, no further measurements are required. If however, the peak readings exceed the limits listed above, then the emissions are re-measured using an average detector.

The measuring antenna was raised and lowered for each antenna polarization to maximize the readings.

5.3.1.3 Results

Preliminary radiated emissions plots with the test item receiving in the 2405-2480MHz band are shown on pages 24 through 27. Final receiver radiated emissions data are presented on data page 28. As can be seen from the data, all emissions measured from the test item were within the specification limits.

5.3.2 Transmitter

5.3.2.1 Requirements

Per section 15.247(d), in any 100kHz 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 100kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated emissions measurement. 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 comply with the radiated emission limits specified in §15.209(a).

Paragraph 15.209(a) has the following radiated emission limits:

Frequency MHz	Field Strength (microvolts/meter)	Measurement distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	3
30.0-88.0	100	3
88.0-216.0	150	3
216.0-960.0	200	3
Above 960	500	3

5.3.2.2 Procedures

Radiated measurements were performed in a 32ft. x 20ft. x 14ft. high shielded enclosure. 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.

Preliminary radiated emissions tests were performed to determine the emission characteristics of the test item. For the preliminary test, a broadband measuring antenna was positioned at a 3 meter distance from the test item. The entire frequency range from 30MHz to 25GHz was investigated using a peak detector function.

The final open field emission tests were then manually performed over the frequency range of 30MHz to 25GHz.

2) For all harmonics not in the restricted bands, the following procedure was used:

   a) The field strength of the fundamental was measured using a double-ridged waveguide antenna. The double-ridged waveguide antenna was positioned at a 3 meter distance from the test item. A peak detector with a resolution bandwidth of 100kHz was used on the spectrum analyzer.

   b) The field strength of all of the harmonics not in the restricted band were then measured using a double-ridged waveguide antenna. The waveguide antenna was positioned at a 3 meter distance from the test item. A peak detector with a resolution bandwidth of 100kHz was used on the spectrum analyzer.

   c) To ensure that maximum or worst case emission levels were measured, the following steps were taken when measuring the fundamental emissions and the spurious emissions:

      i) The test item was rotated so that all of its sides were exposed to the receiving antenna.

      ii) Since the measuring antenna is linearly polarized, both horizontal and vertical field components were measured.

      iii) The measuring antenna was raised and lowered for each antenna polarization to maximize the readings.

   d) All harmonics not in the restricted bands must be at least 20dB below level measured at the fundamental. However, attenuation below the general limits specified in §15.209(a) is not required.

3) For all emissions in the restricted bands, the following procedure was used:

   a) The field strength of all emissions below 1GHz were measured using a bi-log antenna. The bi-log antenna was positioned at a 3 meter distance from the test item. A peak detector with a resolution bandwidth of 100kHz was used on the spectrum analyzer.

   b) The field strength of all emissions above 1GHz were measured using a double-ridged waveguide antenna. The waveguide antenna was positioned at a 3 meter distance from the test item. A peak detector with a resolution bandwidth of 1MHz was used on the spectrum analyzer.

c) To ensure that maximum or worst case emission levels were measured, the following steps were taken when taking all measurements:

i) The test item was rotated so that all of its sides were exposed to the receiving antenna.

ii) Since the measuring antenna is linearly polarized, both horizontal and vertical field components were measured.

iii) The measuring antenna was raised and lowered for each antenna polarization to maximize the readings.

d) For all radiated emissions measurements below 1GHz, if the peak reading is below the limits listed in 15.209(a), no further measurements are required. If however, the peak readings exceed the limits listed in 15.209(a), then the emissions are re-measured using a quasi-peak detector.

e) For all radiated emissions measurements above 1GHz, measurements were taken using a 1MHz resolution bandwidth and a 10Hz video bandwidth. For pulsed emissions, these readings were corrected to average levels using a duty cycle factor which was computed from the pulse train. All average levels must comply with the limits specified in 15.209(a).

5.3.2.3 Results

Preliminary radiated emissions plots with the test item transmitting are shown on pages 29 through 52. The final radiated emissions data is presented on data pages 53 through 58. As can be seen from the data, all emissions measured from the test item were within the specification limits. Photographs of the test are shown on Figure 4.

5.4 6dB Bandwidth and 99% Bandwidth

5.4.1 Requirements

Per 15.247(a) (2), for systems using digital modulation in the 2400-2483.5MHz band, the minimum 6dB bandwidth shall be at least 500kHz.

5.4.2 Procedures

a) The test item was connected to the receiver through 50 dB of attenuation. With the modulation enabled, and the data rate set to 250kHz the test item was allowed to transmit continuously at 2405MHz.

b) The center frequency of the spectrum analyzer was set to the transmit frequency of the test item. The resolution bandwidth on the analyzer was set to 100kHz.

c) The 'Max-Hold' function of the spectrum analyzer was engaged. The analyzer was allowed to scan until the envelope of the transmitter bandwidth was defined.

d) The marker-to-peak function of the analyzer was used to set the marker to the peak of the emission. The marker-delta function was used to measure 6dB down point from the peak of the emission. The marker-delta function was reset and the marker was moved to the other side of the emission until it is even with the reference marker level. The marker-delta reading at this point is the 6dB bandwidth.

e) The analyzer's display was plotted using a 'screen dump' utility.

f) The resolution bandwidth was then reduced to 30kHz.

g) The 'Max-Hold' function of the spectrum analyzer was engaged. The analyzer was allowed to scan until the envelope of the transmitter bandwidth was defined. The 99% bandwidth function of the spectrum analyzer was then used to measure the 99% bandwidth. The measurement was recorded.

h) Steps (a) through (h) were repeated with the test item transmitting at the 500kHz data rate.

i) Steps (a) through (h) were repeated with the test item transmitting at the 1MBps data rate.

j) Steps (a) through (i) were repeated with the test item transmitting at 2440MHz.

k) Steps (a) through (i) were repeated with the test item transmitting at 2480MHz.

5.4.3 Results

The plots of the 6dB bandwidth, with the test item transmitting in both high power and low power are shown on pages 59 through 67. As can be seen from the plots, the minimum 6dB bandwidth measured was 2.18MHz which is greater than the minimum required 6dB bandwidth of 500kHz. The 99% bandwidth was measured to be 3.09MHz.

5.5 Peak Output Power

5.5.1 Requirements

Per section 15.247(b)(3), for systems using digital modulation the maximum peak output conducted power shall not be greater than 1.0W (30dBm). Per section 15.247(b) (4), this limit is based on the use of antennas with directional gains that do not exceed 6dBi. Since the limit allows for a 6dBi antenna gain, the maximum EIRP can be increased by 6dB to 4 Watt (36dBm).

5.5.2 Procedures

a) With the transmitter set to CW, the test item was allowed to transmit continuously at 2405MHz.

b) The test item was connected to the receiver through 50 dB of attenuation. The output power was measured and recorded.

c) With the modulation enabled, the test item was allowed to transmit continuously at 2405MHz.

d) A double-ridged waveguide antenna was positioned at a 3 meter distance from the test item. The output of the double-ridged waveguide antenna was connected to a spectrum analyzer.

e) The center frequency of the spectrum analyzer was set to the transmit frequency of the test item. The resolution bandwidth on the analyzer was set to 3MHz (greater than the 6dB bandwidth of the test item).

f) The test item was maximized for worst case emissions (or maximum output power) at the measuring antenna. The maximum meter reading was recorded.

g) The equivalent isotropic power was determined from the field intensity levels measured at 3 meters using substitution method. To determine the emission power, a second double ridged waveguide antenna was then set in place of the test item and connected to a calibrated signal generator. The output of the signal generator was adjusted to match the received level at the spectrum analyzer. The signal level was recorded. The reading was then corrected to compensate for cable loss and antenna gain, as required.

h) Steps (a) through (e) were repeated with the test item transmitting at 2440MHz.

i) Steps (a) through (e) were repeated with the test item transmitting at 2480MHz.

5.5.3 Results

The results are presented on pages 68 and 69. The maximum conducted output power measured from the transmitter was 18.23 dBm or 0.067W which is below the 1 Watt or 30dBm limit. The maximum EIRP measured from the transmitter was 20.1dBm or 0.102W which is below the 4 Watt or 36 dBm defacto limit.

5.6 Power Spectral Density

5.6.1 Requirements

Per section 15.247(d), for digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8dBm in any 3kHz band during any time interval of continuous transmission.

5.6.2 Procedures

a) The test item was connected to the receiver through 50 dB of attenuation.

b) With the modulation enabled, and the data rate set to 250kHz, the test item was allowed to transmit continuously at 2405MHz.

c) The center frequency of the spectrum analyzer was set to the transmit frequency of the test item. The resolution bandwidth on the analyzer was set to 3MHz (greater than the 6dB bandwidth of the test item).

d) The display line on the spectrum analyzer was set. (This level represents the 8.0dBm power spectral density level.) The resolution bandwidth (RBW) was set to 3kHz, the sweep time was set to a time equal to or greater than the span divided by 3kHz (2 MHz/3kHz = 666 seconds). The peak detector and 'Max-Hold' function was engaged.

e) The analyzer's display was plotted using a 'screen dump' utility.

l) Steps (a) through (e) were repeated with the test item transmitting at the 500kHz data rate.

m) Steps (a) through (e) were repeated with the test item transmitting at the 1MBps data rate.

n) Steps (a) through (m) were repeated with the test item transmitting at 2440MHz.

f) Steps (a) through (m) were repeated with the test item transmitting at 2480MHz.

5.6.3 Results

Data pages 70 through 72 show the power spectral density results. As can be seen from this plot, the power spectral density is less than 8dBm in a 3kHz band during any time interval of continuous transmission.

5.7 Band-edge Compliance

5.7.1 Requirements

Per section 15.247(d), the emissions at the band-edges must be at least 20dB below the highest level measured within the band but attenuation below the general limits listed in 15.209(a) is not required. In addition, the radiated emissions which fall in the restricted band beginning at 2483.5 MHz must meet the general limits of 15.209(a).

5.7.2 Procedures

a) The test item was set up inside the test chamber on a non-conductive stand.

b) A broadband measuring antenna was placed at a test distance of 3 meters from the test item.

c) The test item was set to transmit continuously at the channel closest to the low band-edge.

d) The test item was maximized for worst case emissions at the measuring antenna. The maximum meter reading was recorded.

e) To determine the band-edge compliance, the following spectrum analyzer settings were used:

   i. Span = Wide enough to capture the peak level of the emission operating on the channel closest to the band-edge, as well as any modulation products which fall outside of the authorized band of operation.

   ii. Resolution bandwidth (RBW) = 100kHz.

   iii. The 'Max-Hold' function was engaged. The analyzer was allowed to scan until the envelope of the transmitter bandwidth was defined.

   iv. The marker was set on the peak of the in-band emissions. A display line was placed 20dB down from the peak of the in-band emissions. All emissions which fall outside of the authorized band of operation must be below the 20dB down display line. (All emissions to the left of the center frequency (band-edge) must be below the display line.)

v. The analyzer's display was plotted using a 'screen dump' utility.

f) The test item was set to transmit continuously at the channel closest to the high band-edge.

g) Per Public Notice DA00-705, the Marker-Delta method of measuring band edge compliance can only be used for measuring emissions that are up to two “standard” bandwidths away form the band-edge. (Since C63.4 specifies a 1MHz resolution bandwidth for measurements above 1GHz, two “standard” bandwidths away from the band-edge would be 2MHz away from the band-edge.) Radiated emissions that are removed by more than two “standard” bandwidths must be measured in the conventional manner.

h) The highest transmit frequency used by the test item is 2480MHz. Since this is more than two “standard” bandwidths away from the band-edge, conventional radiated emissions measurements were taken at the band-edge.

i) The test item was set up in the test chamber. With the modulation enabled, the test item was allowed to transmit continuously at 2480MHz.

j) A double-ridged waveguide antenna was positioned at a 3 meter distance from the test item. The output of the double-ridged waveguide antenna was connected to a spectrum analyzer.

k) The center frequency of the spectrum analyzer was set to the band-edge (2483.5MHz). The resolution bandwidth on the analyzer was set to 1MHz.

l) The test item was maximized for worst case emissions at the measuring antenna. The video bandwidth was reduced to 10Hz and an average reading was taken.

5.7.3 Results

Page 73 shows the radiated band-edge compliance results at 2400MHz. As can be seen from the plot, the emissions at the band-edge are within the 20 dB down limits.

Page 74 shows the radiated band-edge compliance results at 2483.5MHz. As can be seen from the data, the emissions at the band-edge are within the general limits.

6 CONCLUSIONS

It was determined that the California Eastern Labs Zigbee Transceiver, Model No. ZICM2410P2, (Serial No., did fully meet the conducted and radiated emission requirements of the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart B, Sections 15.107 and 15.109 for receivers and Subpart C Sections 15.207 and 15.247 for Intentional Radiators Operating within the 2400MHz to 2483.5MHz band, when tested per ANSI C63.4-2003.

7 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 test item at the test date. Any electrical or mechanical modification made to the test item subsequent to the specified test date will serve to invalidate the data and void this certification.

8 ENDORSEMENT DISCLAIMER

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
APK4	PREAMPLIFIER OPT H02	HEWLETT PACKARD	8449B	3008A00329	1-26.5GHZ	4/6/2009	4/6/2010
APW0	PREAMPLIFIER	PLANAR ELECTRONICS	PE2-30-20G20R6C	PL2926/0646	20GHZ-26.5GHZ	12/16/2008	12/16/2009
APW3	PREAMPLIFIER	PLANAR ELECTRONICS	PE2-35-120-5R0-1(	PL2924	1GHZ-20GHZ	12/16/2008	12/16/2009
GRE0	SIGNAL GENERATOR	AGILENT TECHNOLOGIES	E4438C	MY42083127	250KHZ-6GHZ	1/12/2009	1/12/2010
NHG1	STANDARD GAIN HORN ANTENNA	NARDA	638	---	18-26.5GHZ	NOTE 1	
NTA0	BILOG ANTENNA	CHASE EMC LTD.	BILOG CBL6112	2057	0.03-2GHZ	11/14/2008	11/14/2009
NWF0	RIDGED WAVE GUIDE	EMCO	3105	2035	1-12.4GHZ	10/25/2008	11/25/2009
NWH0	RIDGED WAVE GUIDE	TENSOR	4105	2081	1-12.4GHZ	8/11/2009	8/11/2010
NWI0	RIDGED WAVE GUIDE	AEL	H1498	153	2-18GHZ	10/25/2008	11/25/2009
NWI1	RIDGED WAVE GUIDE	AEL	H1498	154	2-18GHZ	10/25/2008	11/25/2009
PLL9	50UH LISN 462D	ELITE ELECTRONIC ENG	462D/70A	010	0.01-400MHZ	3/5/2009	3/5/2010
PLLA	50UH LISN 462D	ELITE ELECTRONIC ENG	462D/70A	011	0.01-400MHZ	3/5/2009	3/5/2010
RACA	RF PRESELECTOR	HEWLETT PACKARD	85685A	2926A00980	20HZ-2GHZ	2/20/2009	2/20/2010
RACE	RF PRESELECTOR	HEWLETT PACKARD	85685A	3010A01194	20HZ-2GHZ	12	
RAF5	QUASIPEAK ADAPTOR	HEWLETT PACKARD	85650A	2043A00151	0.01-1000MHZ	2/20/2009	2/20/2010
RBB0	EMI TEST RECEIVER 20HZ TO 40 (	ROHDE & SCHWARZ	ESIB40	100250	20 HZ TO 40GHZ	3/11/2009	3/11/2010
T1EE	10DB 25W ATTENUATOR	WEINSCHEL	46-10-34	BN2321	DC-18GHZ	12/4/2008	12/4/2009
XLJ1	5W, 50 OHM TERMINATION	JFW INDUSTRIES	50T-052	2	DC-2GHZ	8/24/2009	8/24/2010
XOB2	ADAPTER	HEWLETT PACKARD	K281C,012	09407	18-26.5GHZ	NOTE 1	
XZG4	ATTENUATOR/SWITCH DRIVER	HEWLETT PACKARD	11713A	2223A01683	---	N/A	

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.

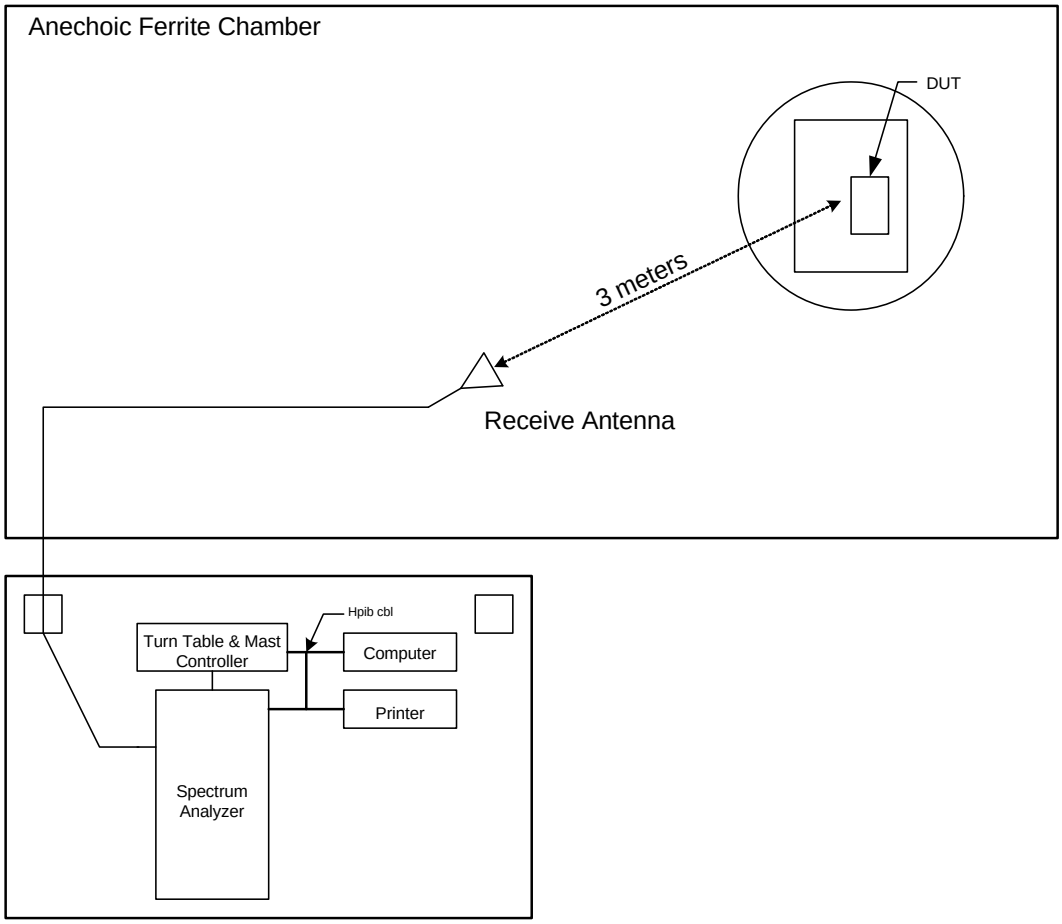


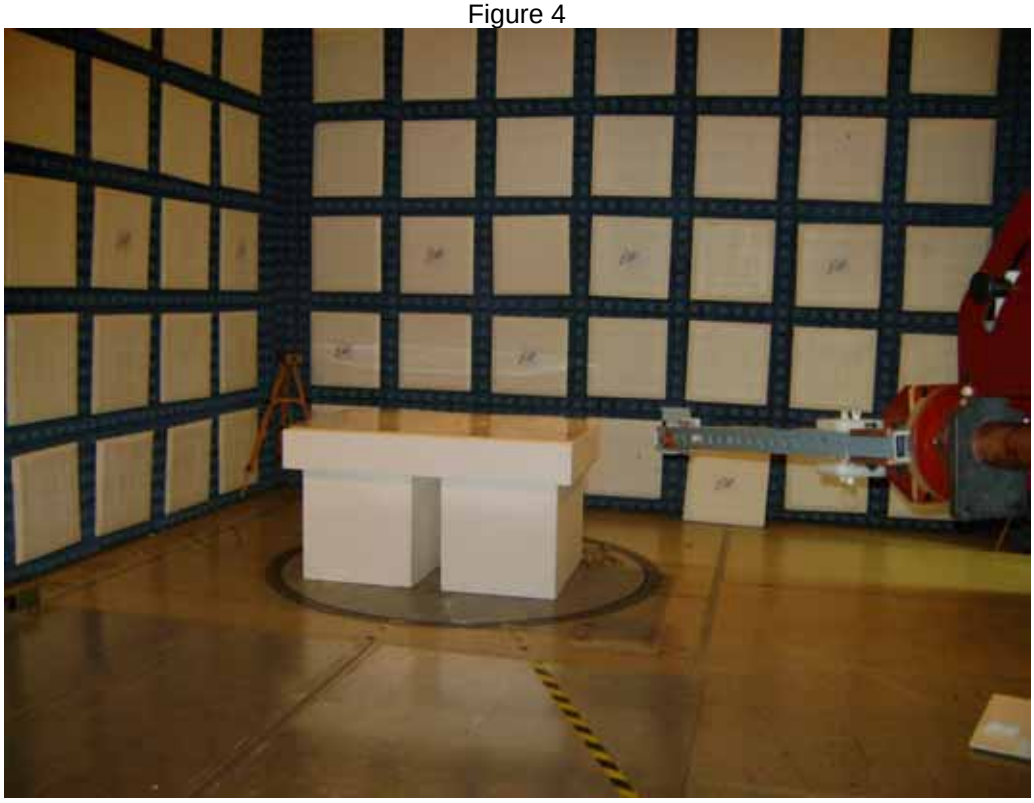
FIGURE 1 BLOCKDIAGRAM OF TEST SETUP

Figure 3

Test Setup for Conducted Emissions

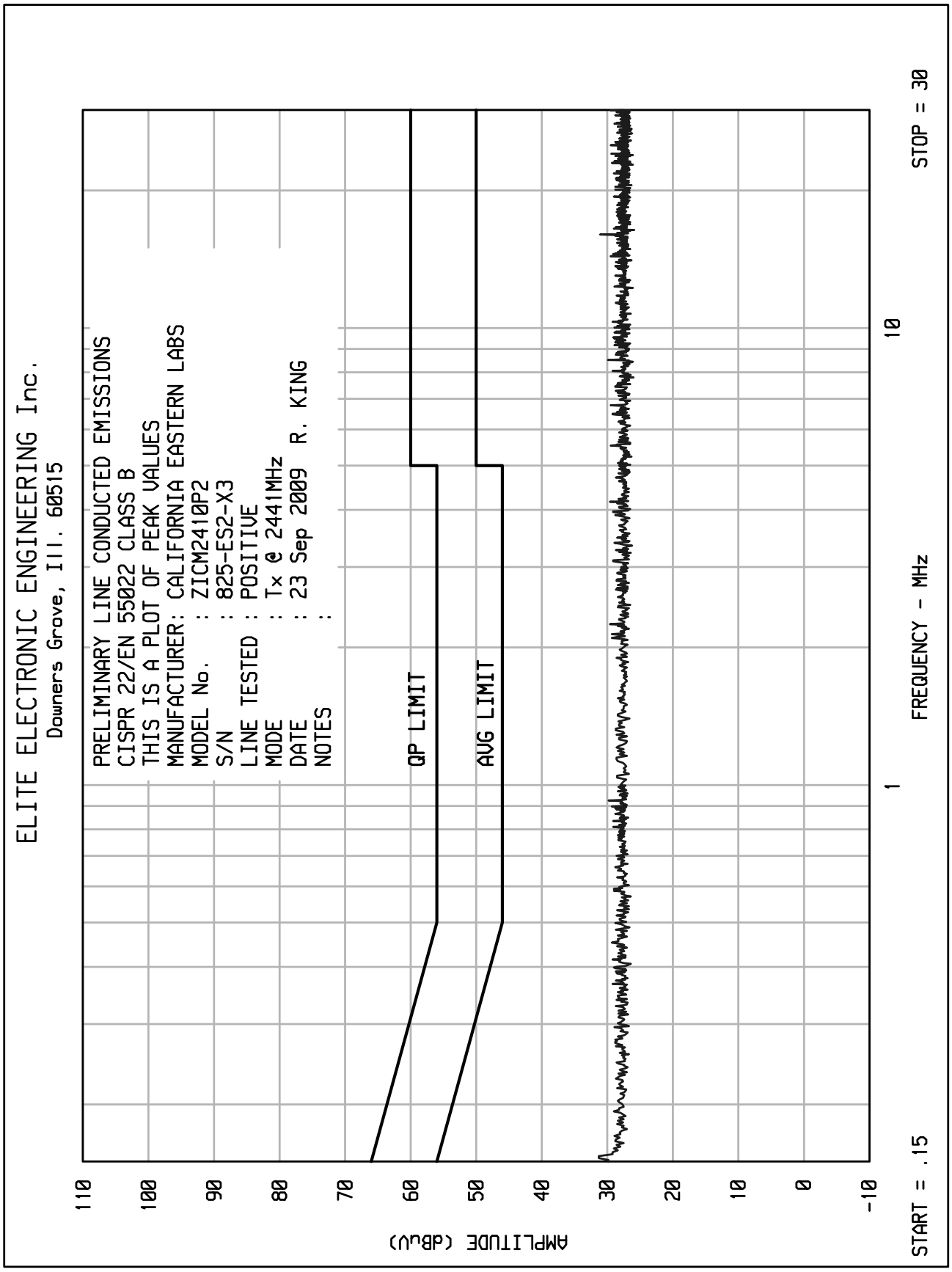
Test Setup for Conducted Emissions

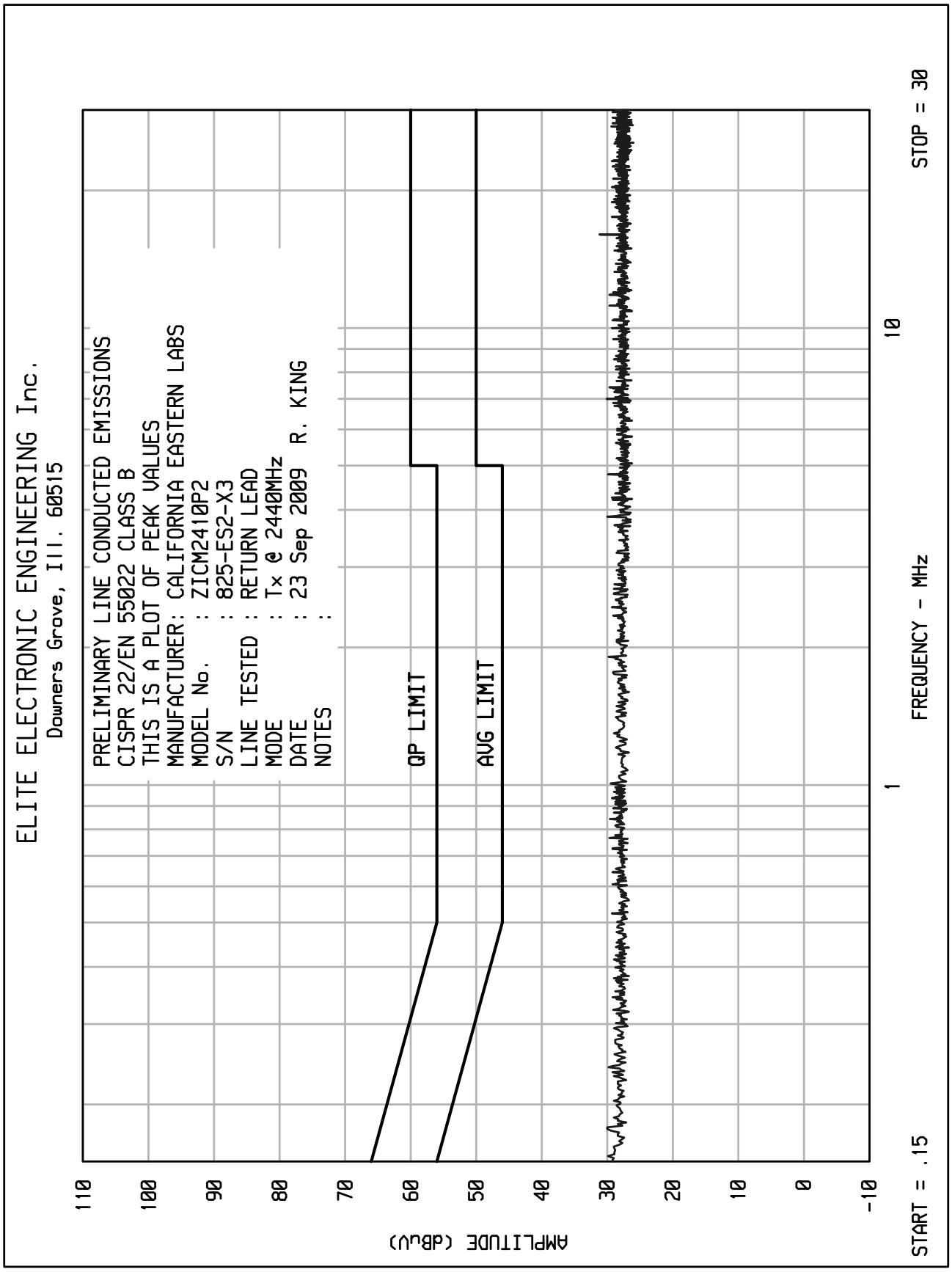
Figure 4



Test Setup for Radiated Emissions – 2GHz to 18GHz, Horizontal Polarization

Test Setup for Radiated Emissions – 2GHz to 18GHz, Vertical Polarization


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
PRELIMINARY LINE CONDUCTED EMISSIONS
CISPR 22/EN 55022 CLASS B
THIS IS A PLOT OF PEAK VALUES
MANUFACTURER: CALIFORNIA EASTERN LABS
MODEL No. : ZICM2410P2
S/N : 825-ES2-X3
LINE TESTED : POSITIVE
MODE : Tx @ 2441MHz
DATE : 23 Sep 2009 R. KING
NOTES : :
QP LIMIT
AVG LIMIT
AMPLITUDE (dBuV)
110
100
90
80
70
60
50
40
30
20
10
0
-10
START = .15
1
10
STOP = 30
FREQUENCY - MHz


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
PRELIMINARY LINE CONDUCTED EMISSIONS
CISPR 22/EN 55022 CLASS B
THIS IS A PLOT OF PEAK VALUES
MANUFACTURER: CALIFORNIA EASTERN LABS
MODEL No. : ZICM2410P2
S/N : 825-ES2-X3
LINE TESTED : RETURN LEAD
MODE : Tx @ 2440MHz
DATE : 23 Sep 2009 R. KING
NOTES : :
QP LIMIT
AVG LIMIT
AMPLITUDE (dBuV)
110
100
90
80
70
60
50
40
30
20
10
0
-10
START = .15
1
10
STOP = 30
FREQUENCY - MHz

ELITE ELECTRONIC ENGINEERING CO.

MANUFACTURER : CALIFORNIA EASTERN LABS
MODEL : ZICM2410P2
S/N : 825-ES2-X3
SPECIFICATION : CISPR 22/EN 55022 CLASS B
TEST : LINE CONDUCTED EMISSIONS
LINE TESTED : POSITIVE LEAD
MODE : Tx @ 2440MHz
DATE : 23 Sep 2009
NOTES :
RECEIVER : HP 8566 w/ HP85650A QP ADAPTOR
VALUES MEASURED WITH QP DETECTOR USING 9kHz BANDWIDTH

FREQUENCY MHz	METER RDG. dBuV	QP LIMIT dBuV	AVG RDG dBuV	AVG LIMIT dBuV	NOTES
.150	28.7	66.0		56.0	
.451	26.1	56.9		46.9	
.807	26.1	56.0		46.0	
1.312	25.9	56.0		46.0	
2.882	25.8	56.0		46.0	
4.442	25.8	56.0		46.0	
6.299	25.4	60.0		50.0	
8.201	25.4	60.0		50.0	
11.633	25.3	60.0		50.0	
14.738	25.4	60.0		50.0	
17.788	25.4	60.0		50.0	
21.438	25.4	60.0		50.0	
24.839	25.4	60.0		50.0	
27.318	25.4	60.0		50.0	

Checked BY Richard E. King :

Richard E. King

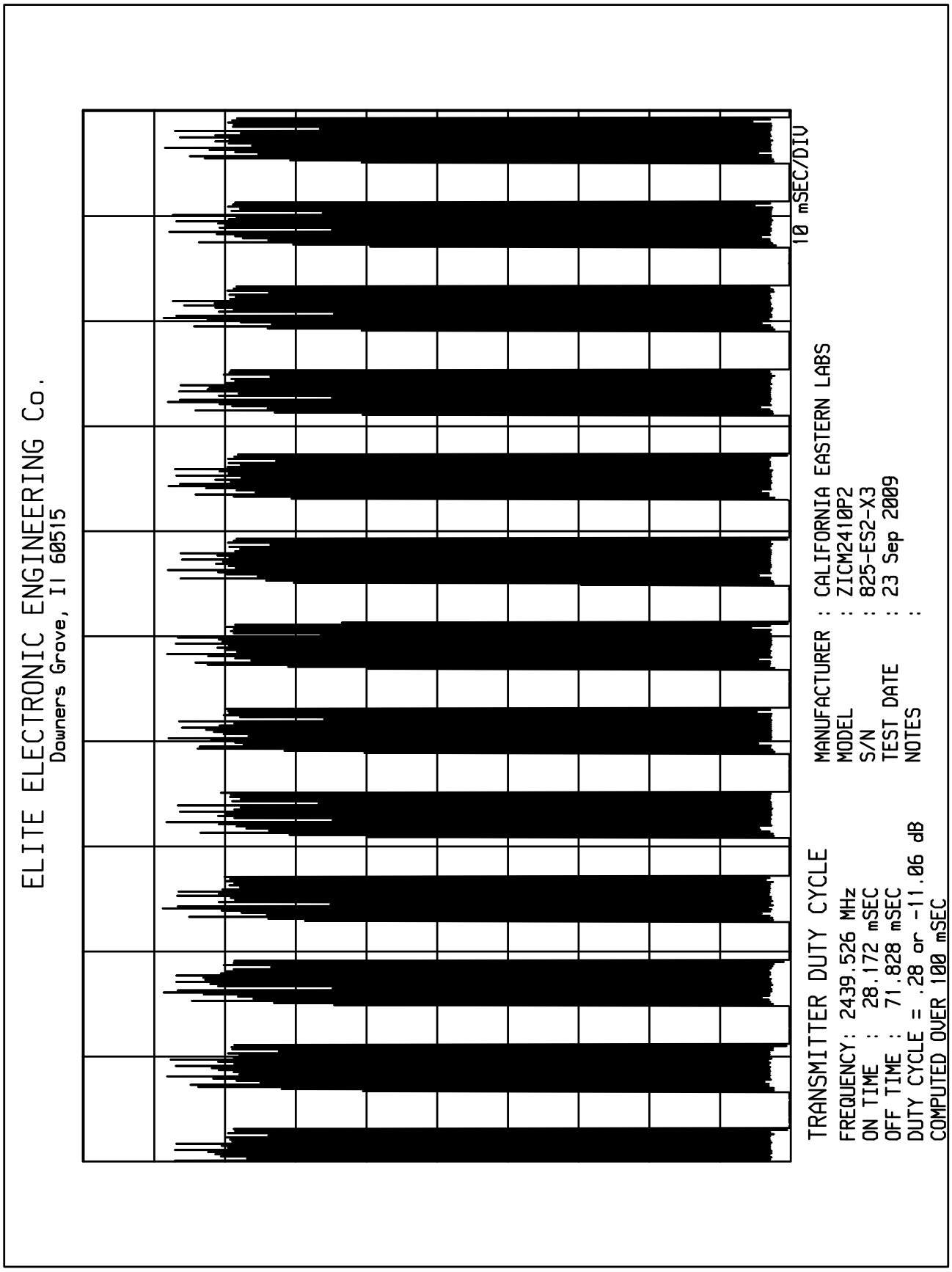
ELITE ELECTRONIC ENGINEERING CO.

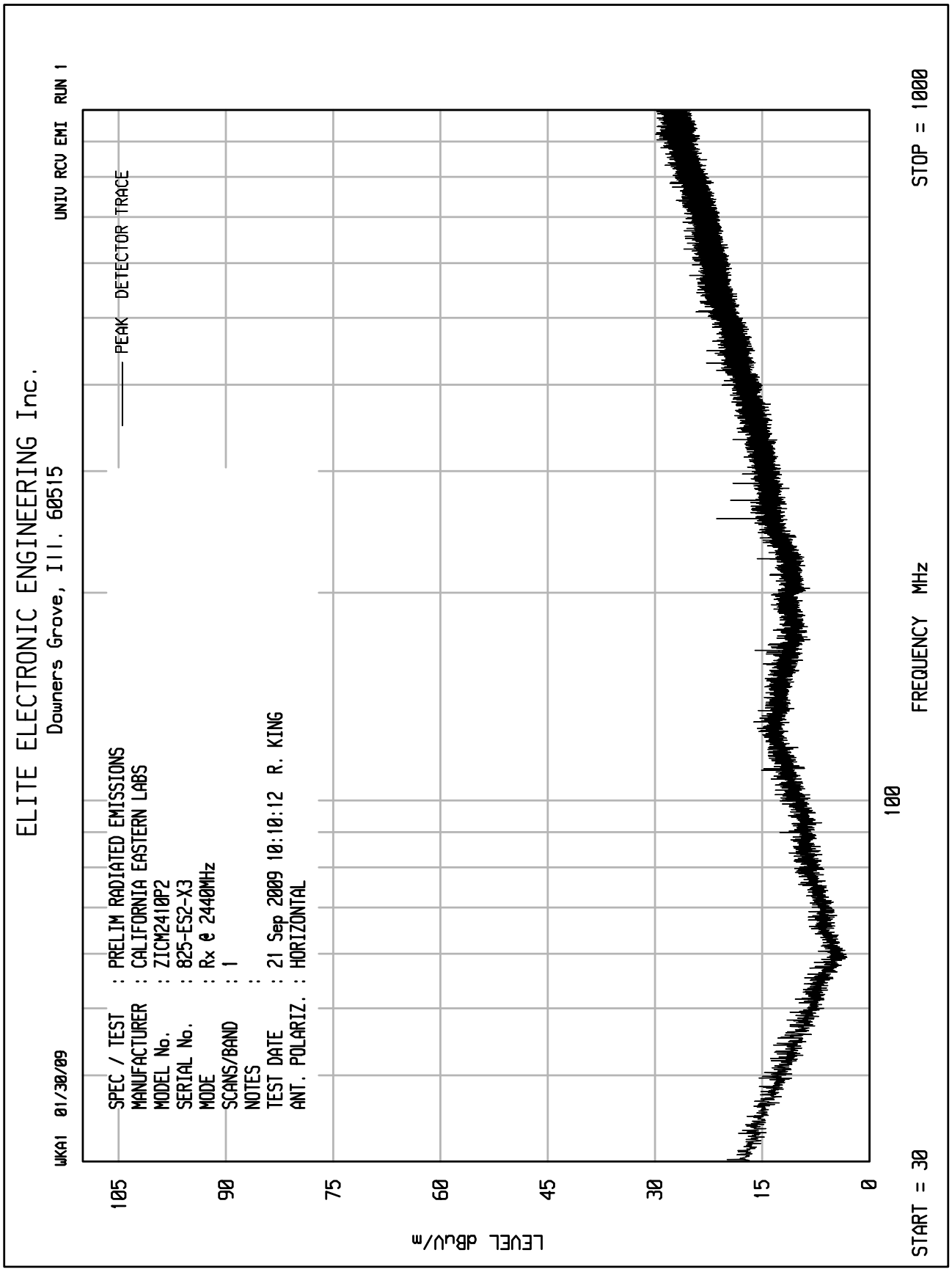
MANUFACTURER : CALIFORNIA EASTERN LABS
MODEL : ZICM2410P2
S/N : 825-ES2-X3
SPECIFICATION : CISPR 22/EN 55022 CLASS B
TEST : LINE CONDUCTED EMISSIONS
LINE TESTED : RETURN LEAD
MODE : Tx @ 2440MHz
DATE : 23 Sep 2009
NOTES :
RECEIVER : HP 8566 w/ HP85650A QP ADAPTOR
VALUES MEASURED WITH QP DETECTOR USING 9kHz BANDWIDTH

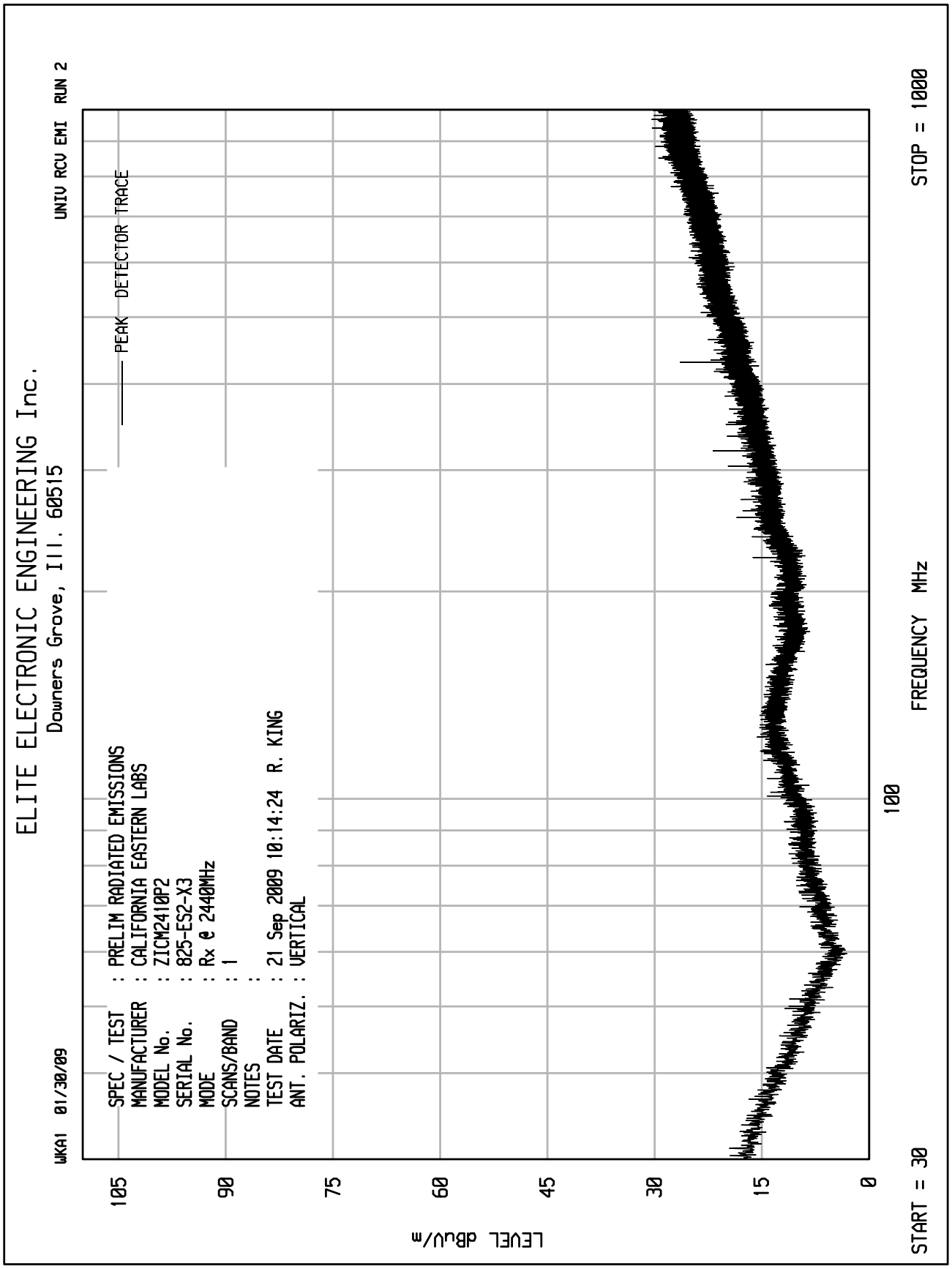
FREQUENCY MHz	METER RDG. dBuV	QP LIMIT dBuV	AVG RDG dBuV	AVG LIMIT dBuV	NOTES
.333	26.9	59.4		49.4	
.512	27.1	56.0		46.0	
.833	25.8	56.0		46.0	
1.894	26.0	56.0		46.0	
2.437	25.8	56.0		46.0	
4.697	25.8	56.0		46.0	
6.951	25.4	60.0		50.0	
8.498	25.3	60.0		50.0	
11.773	25.4	60.0		50.0	
14.733	25.4	60.0		50.0	
18.808	25.4	60.0		50.0	
21.788	25.4	60.0		50.0	
23.653	25.4	60.0		50.0	
27.583	25.4	60.0		50.0	

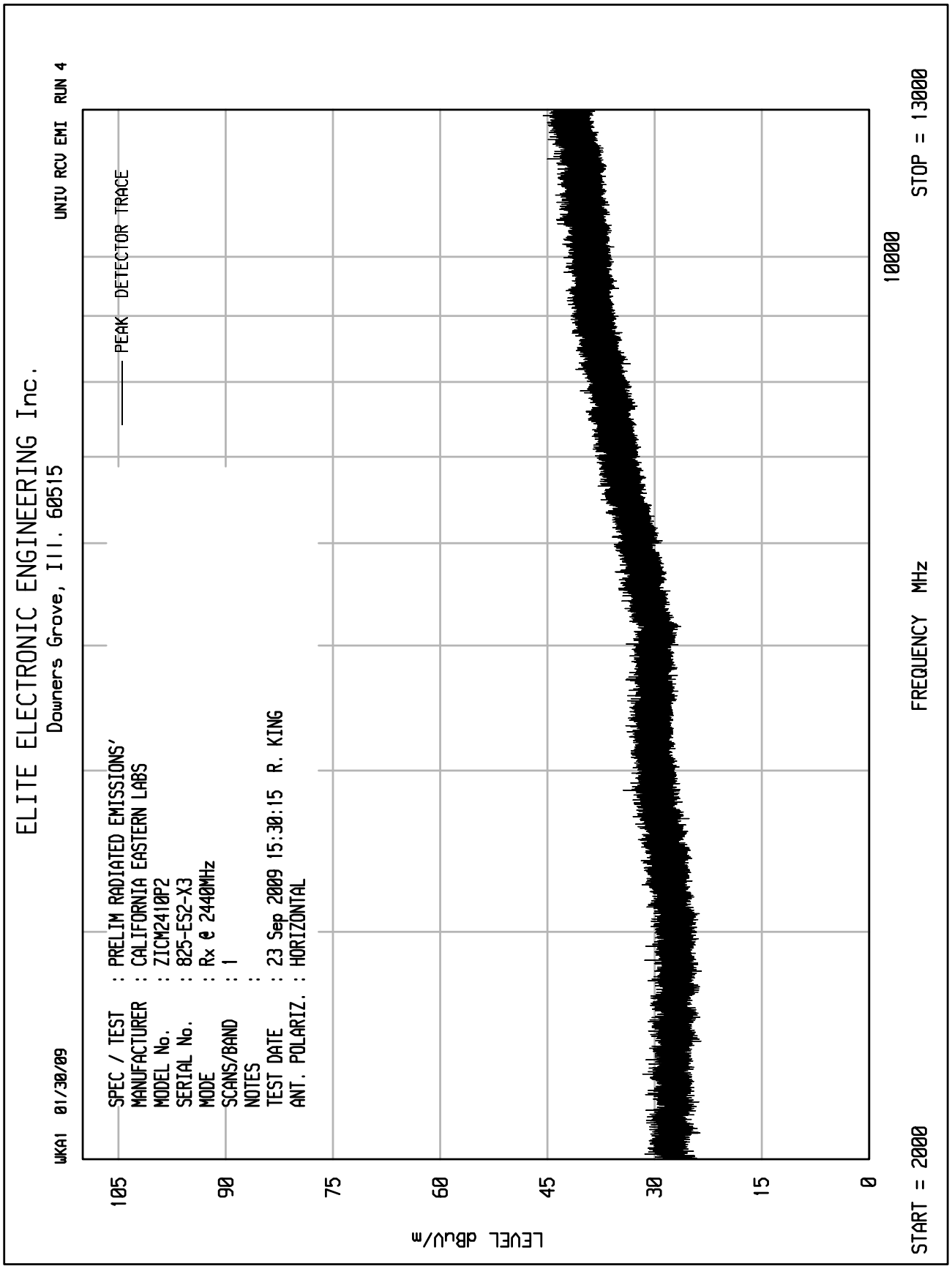
Checked BY Richard E. King :

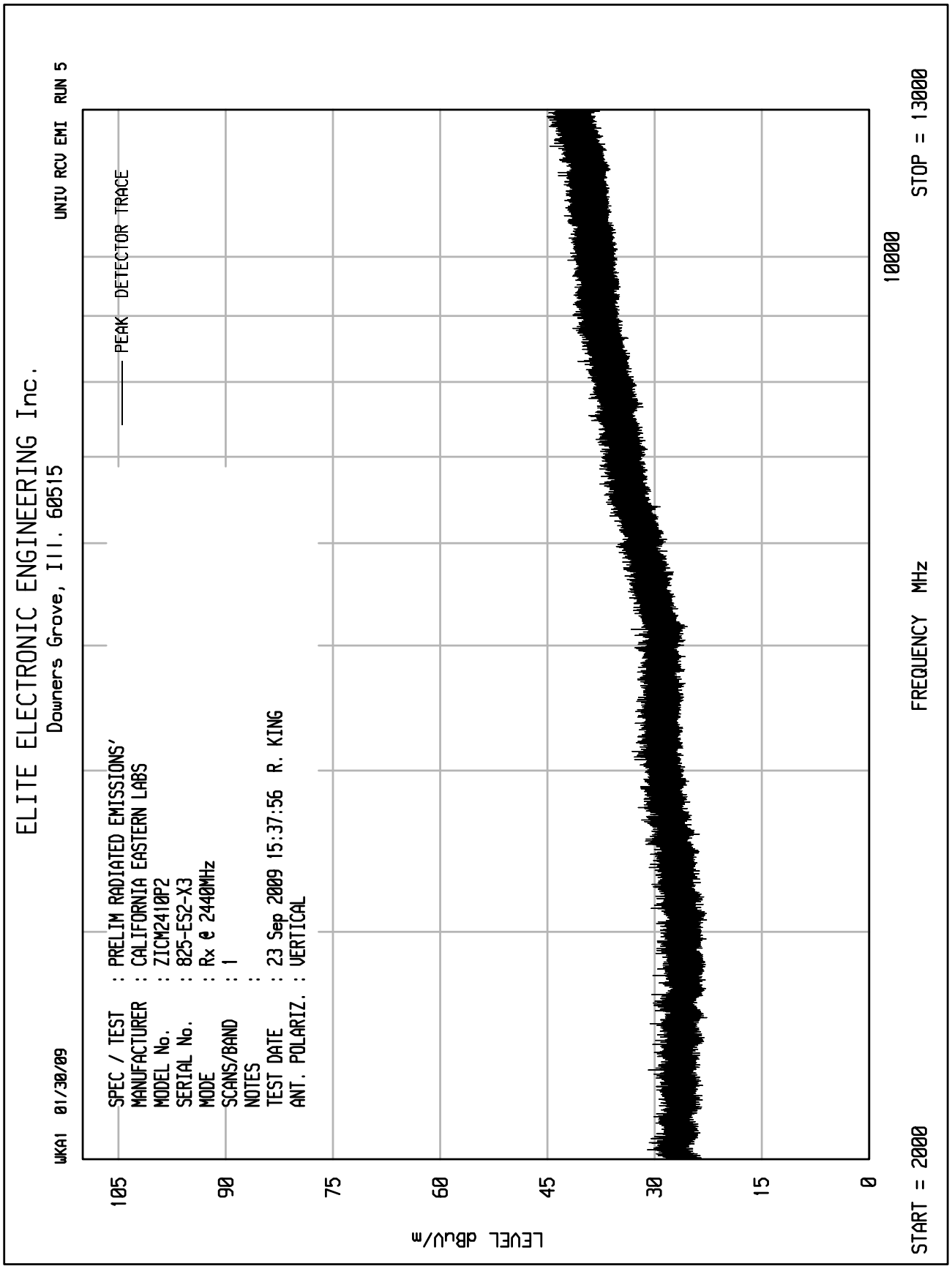
Richard E. King


ELITE ELECTRONIC ENGINEERING Co.
Downers Grove, Il 60515
10 mSEC/DIV
TRANSMITTER DUTY CYCLE
FREQUENCY: 2439.526 MHz
ON TIME : 28.172 mSEC
OFF TIME : 71.828 mSEC
DUTY CYCLE = .28 or -11.06 dB
COMPUTED OVER 100 mSEC
MANUFACTURER : CALIFORNIA EASTERN LABS
MODEL : ZICM2410P2
S/N : 825-ES2-X3
TEST DATE : 23 Sep 2009
NOTES : :


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 1
WKA1 01/30/09
SPEC / TEST : PRELIM RADIATED EMISSIONS
MANUFACTURER : CALIFORNIA EASTERN LABS
MODEL No. : ZICM2410P2
SERIAL No. : 825-ES2-X3
MODE : Rx @ 2440MHz
SCANS/BAND : 1
NOTES : :
TEST DATE : 21 Sep 2009 10:10:12 R. KING
ANT. POLARIZ. : HORIZONTAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
105
90
75
60
45
30
15
0
START = 30
100
FREQUENCY MHz
STOP = 1000


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 2
WKA1 01/30/09
SPEC / TEST : PRELIM RADIATED EMISSIONS
MANUFACTURER : CALIFORNIA EASTERN LABS
MODEL No. : ZICM2410P2
SERIAL No. : 825-ES2-X3
MODE : Rx @ 2440MHz
SCANS/BAND : 1
NOTES :
TEST DATE : 21 Sep 2009 10:14:24 R. KING
ANT. POLARIZ. : VERTICAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
105
90
75
60
45
30
15
0
START = 30
100
FREQUENCY MHz
STOP = 1000


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 4
WKA1 01/30/09
SPEC / TEST : PRELIM RADIATED EMISSIONS'
MANUFACTURER : CALIFORNIA EASTERN LABS
MODEL No. : ZICM2410P2
SERIAL No. : 825-ES2-X3
MODE : Rx @ 2440MHz
SCANS/BAND : 1
NOTES :
TEST DATE : 23 Sep 2009 15:30:15 R. KING
ANT. POLARIZ. : HORIZONTAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
105
90
75
60
45
30
15
0
START = 2000
10000
STOP = 13000
FREQUENCY MHz


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 5
WKA1 01/30/09
SPEC / TEST : PRELIM RADIATED EMISSIONS'
MANUFACTURER : CALIFORNIA EASTERN LABS
MODEL No. : ZICM2410P2
SERIAL No. : 825-ES2-X3
MODE : Rx @ 2440MHz
SCANS/BAND : 1
NOTES :
TEST DATE : 23 Sep 2009 15:37:56 R. KING
ANT. POLARIZ. : VERTICAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
105
90
75
60
45
30
15
0
START = 2000
10000
STOP = 13000
FREQUENCY MHz

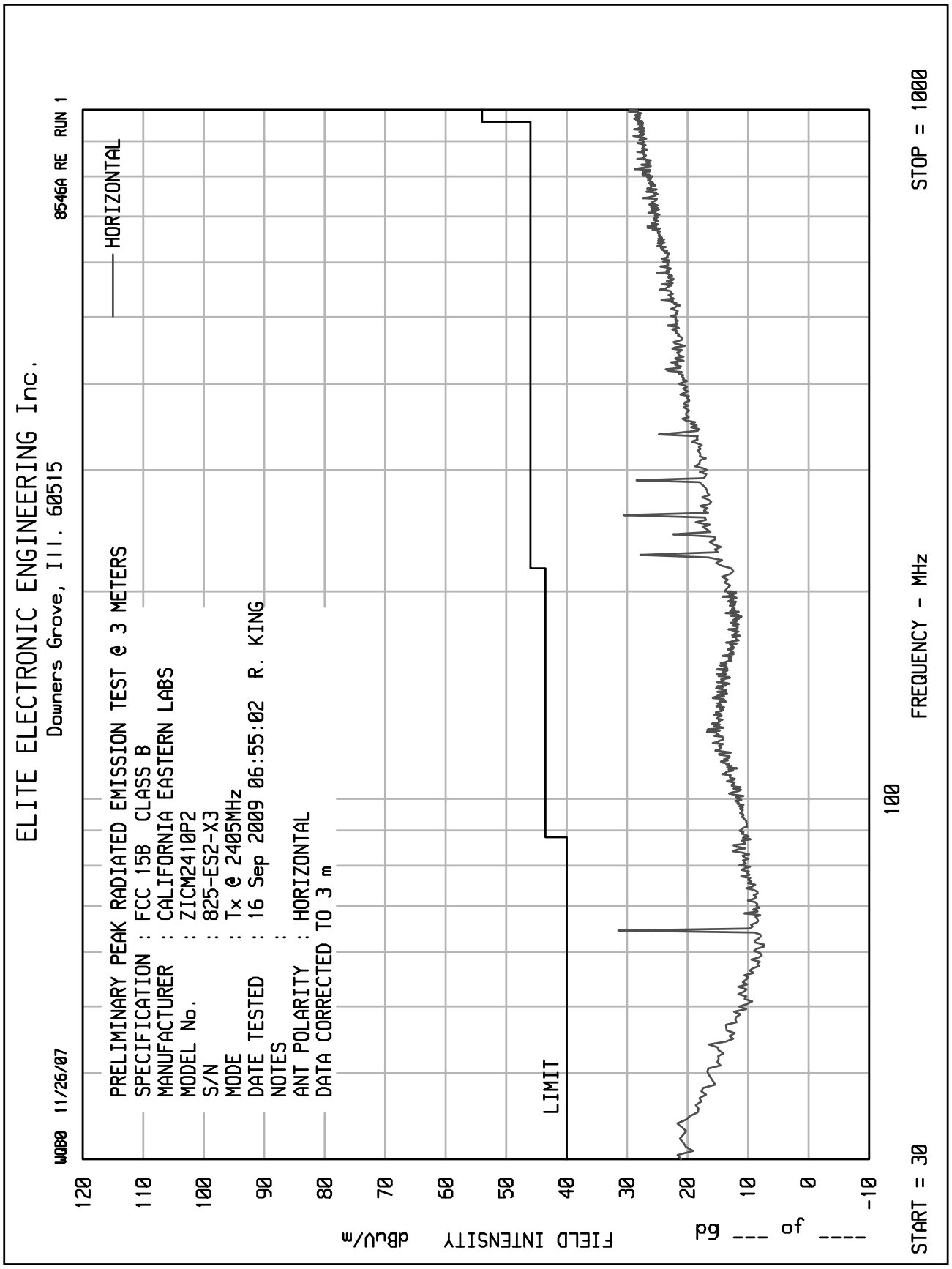
Manufacturer : California Eastern Labs
Test Item : Zigbee Transceiver
Model No. : ZICM2410P2
Test Specification : Industry Canada Radiated Receiver Emissions
Date : September 14 through 25, 2009
Mode : Receive @ 2440MHz
Test Distance : 3 meters
Notes : none

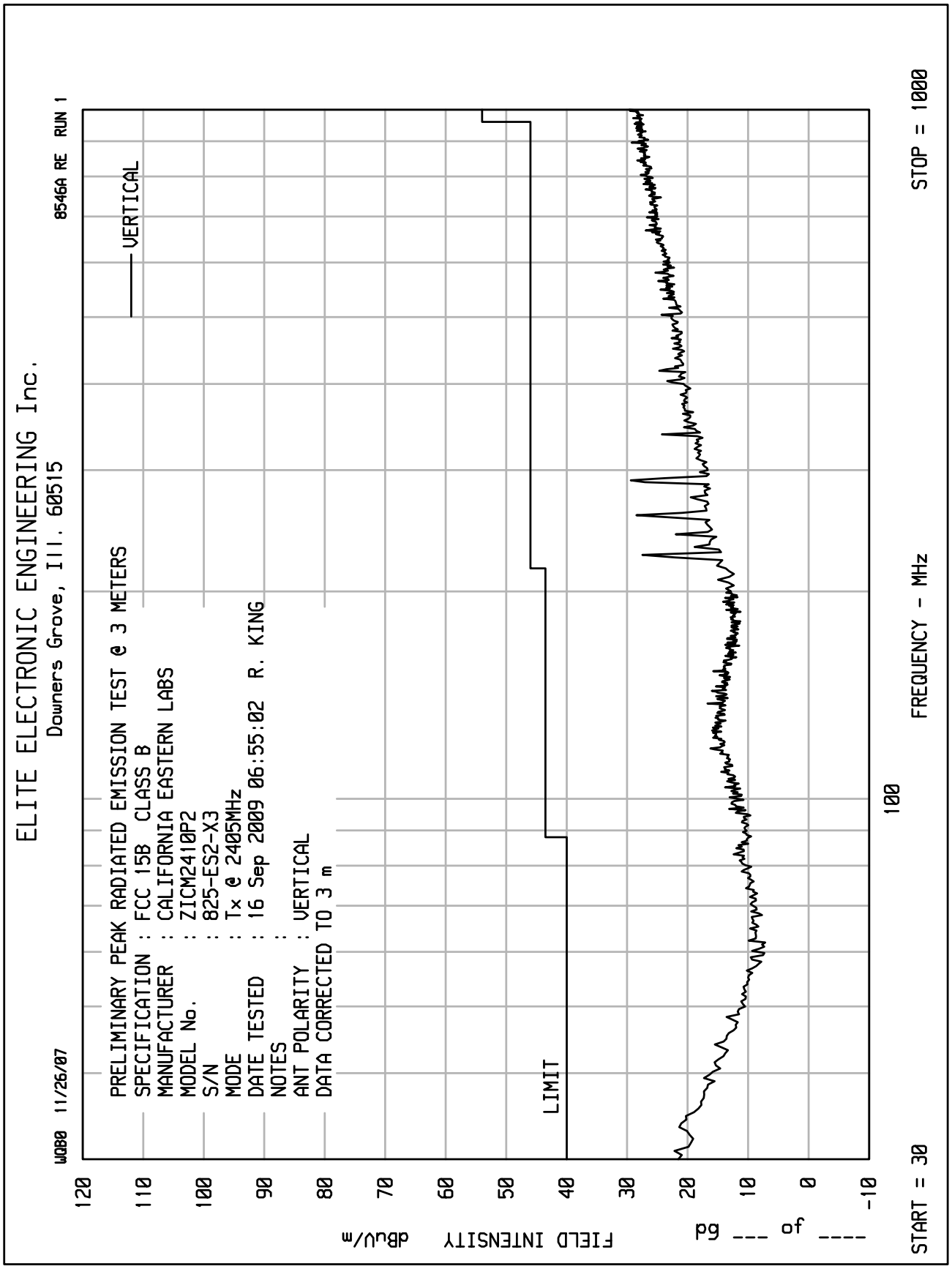
Total = Meter Reading + Cable Loss + Antenna Factor + Preamp Gain

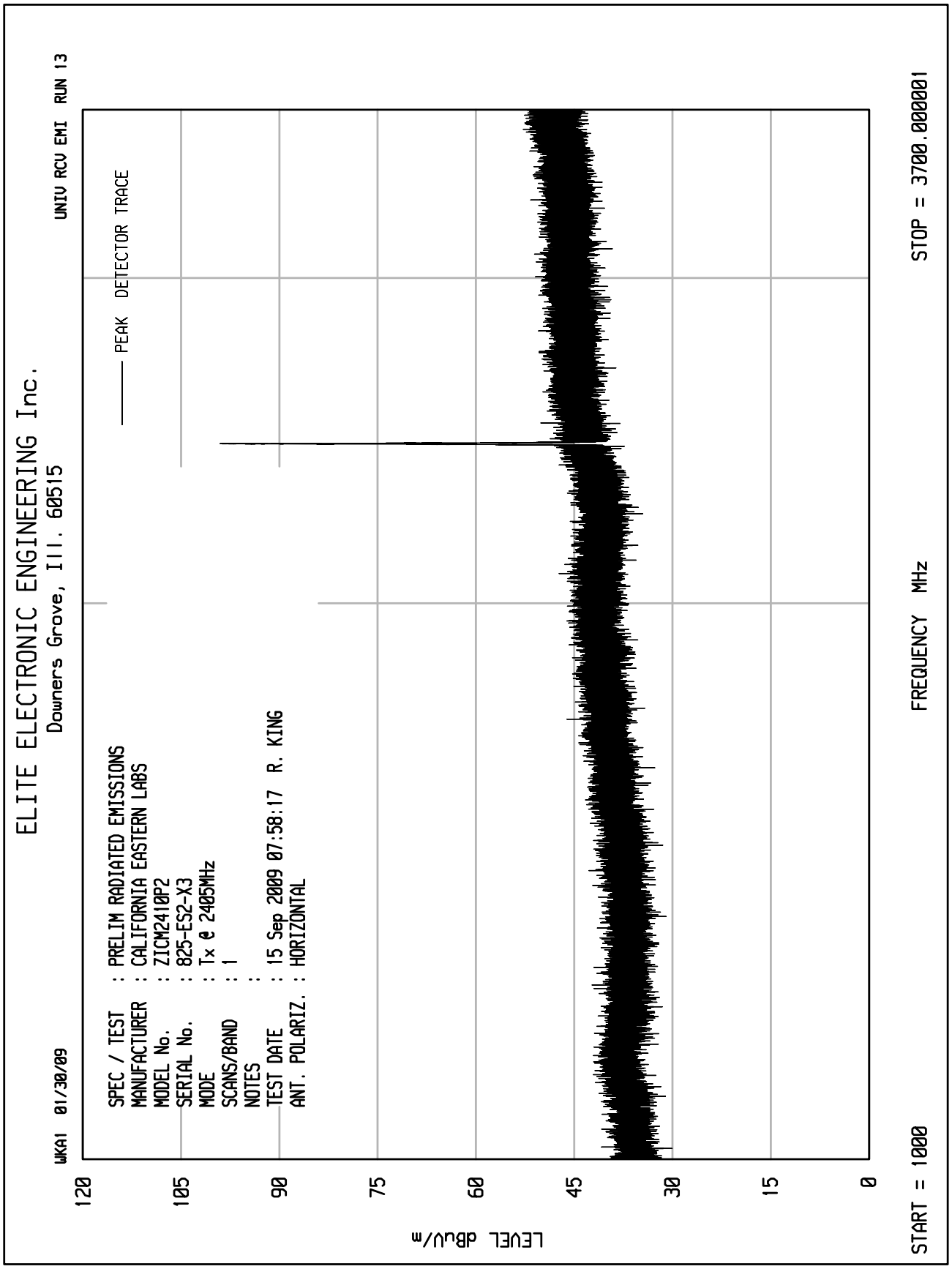
Freq (MHz)	Ant Pol	Meter Reading (dBuV)	Ambient	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Total dBuV/m at 3 M	Total uV/m at 3M	Limit uV/m at 3M	Margin (dB)
2440.0	H	44.4	*	3.8	30.4	-40.3	38.4	82.9	500	-15.6
2440.0	V	44.3	*	3.8	30.4	-40.3	38.2	81.7	500	-15.7
4880.0	H	41.7	*	5.7	33.8	-40.1	41.1	113.7	500	-12.9
4880.0	V	41.7	*	5.7	33.8	-40.1	41.2	114.4	500	-12.8
7320.0	H	42.1	*	7.7	37.8	-39.8	47.8	244.6	500	-6.2
7320.0	V	43.1	*	7.7	37.8	-39.8	48.8	273.9	500	-5.2

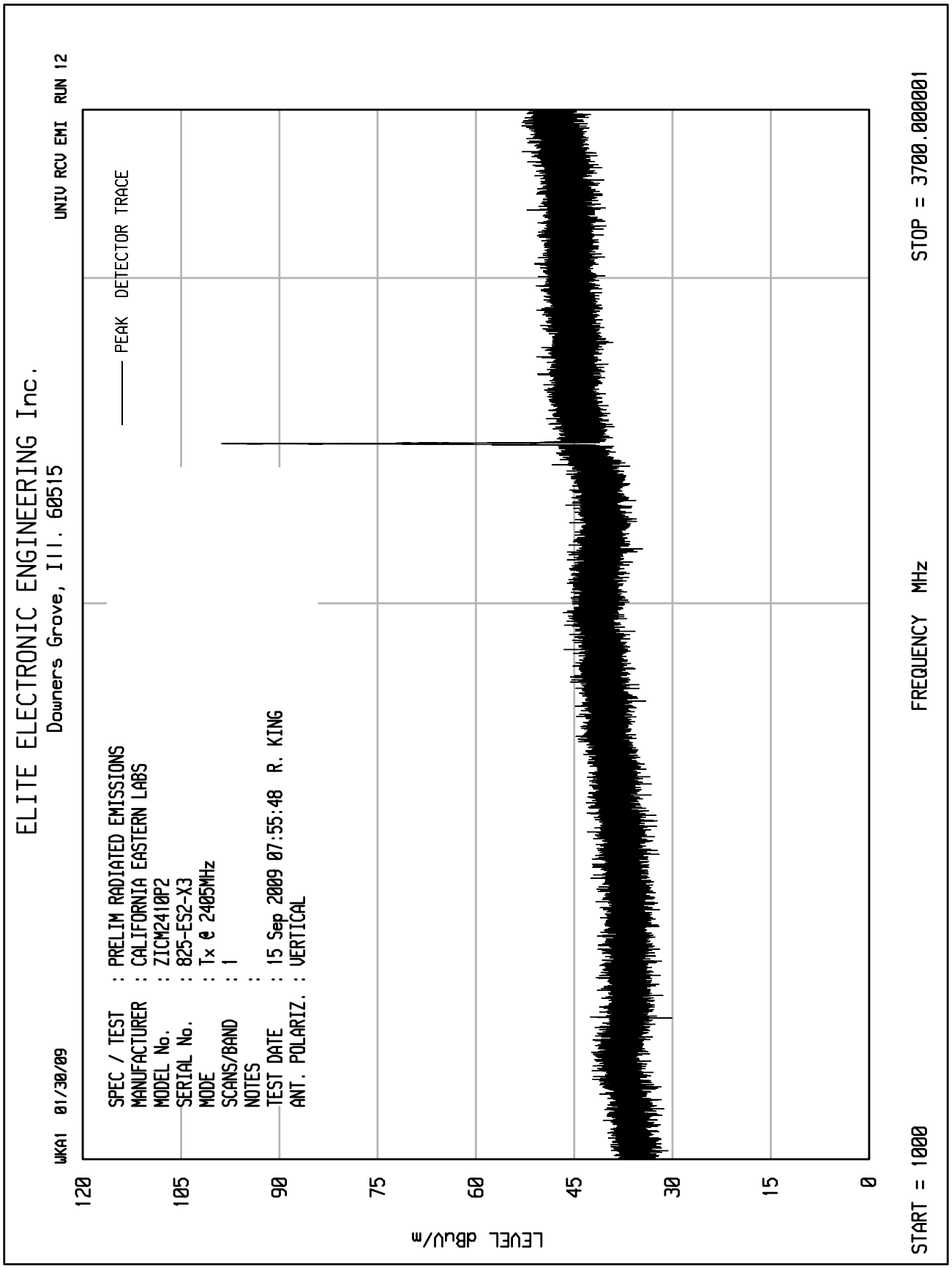
Checked BY Richard E. King :

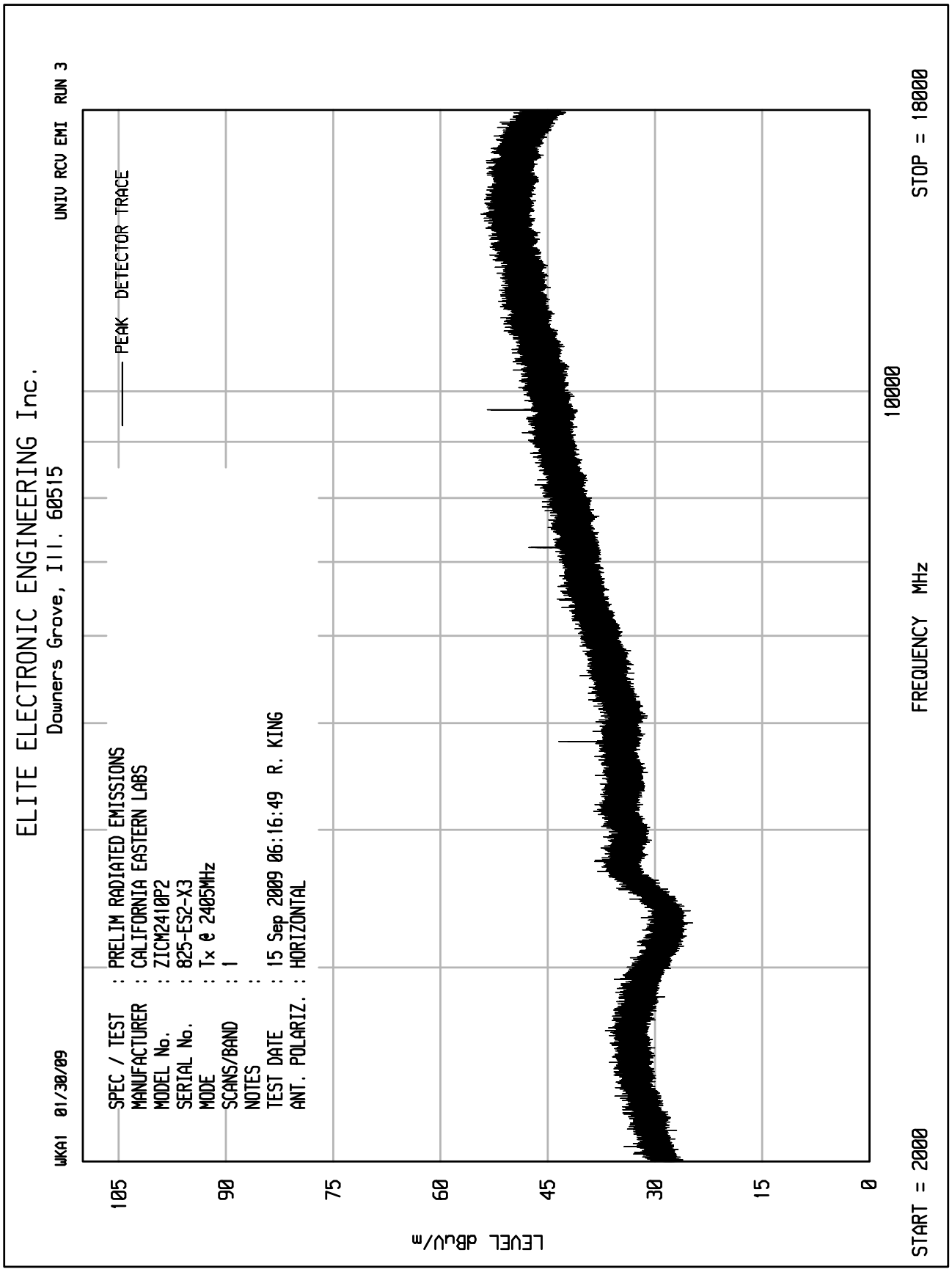
Richard E. King

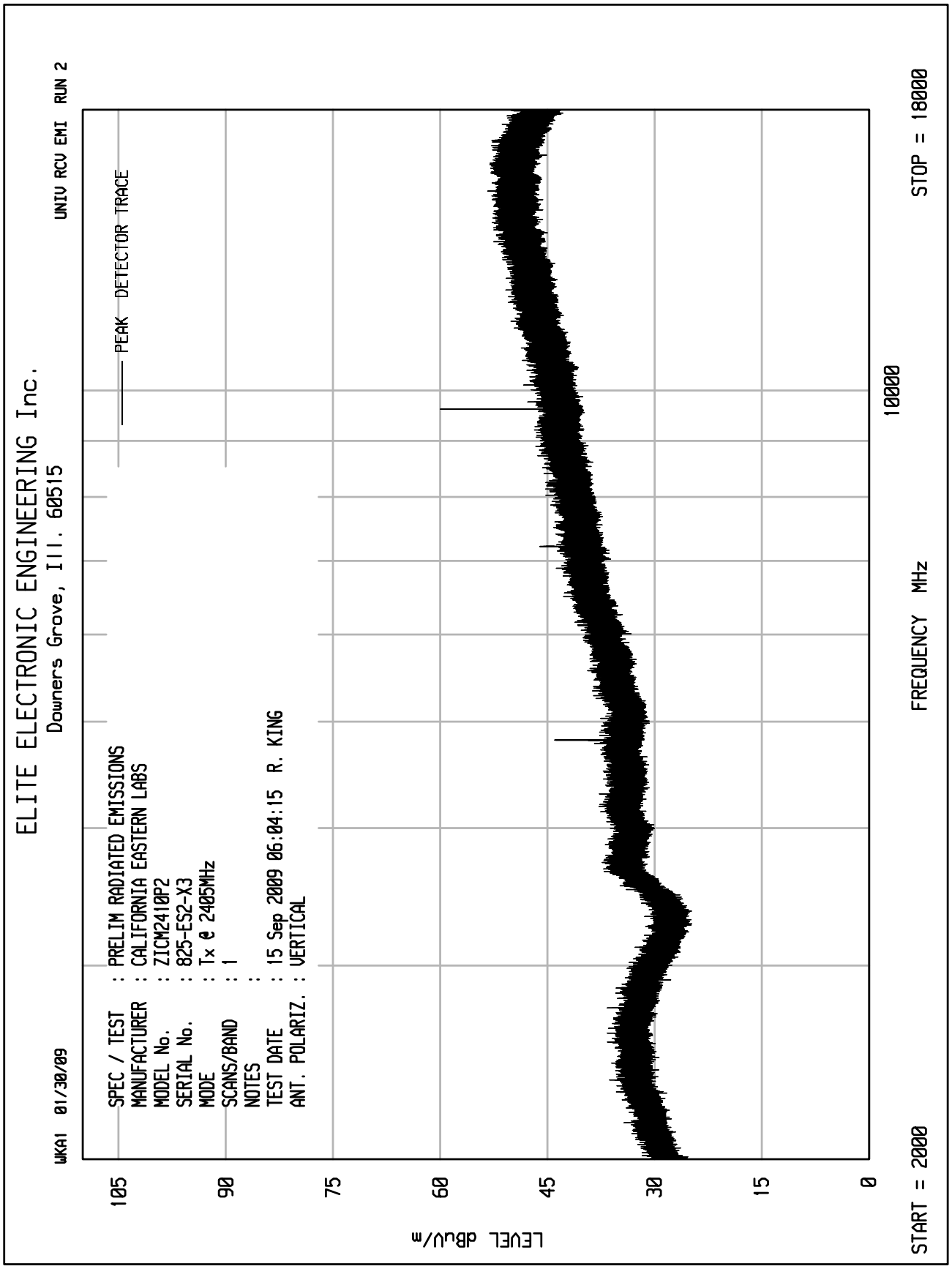

ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
8546A RE RUN 1
WQ80 11/26/07
PRELIMINARY PEAK RADIATED EMISSION TEST @ 3 METERS
SPECIFICATION : FCC 15B CLASS B
MANUFACTURER : CALIFORNIA EASTERN LABS
MODEL No. : ZICM2410P2
S/N : 825-ES2-X3
MODE : Tx @ 2405MHz
DATE TESTED : 16 Sep 2009 06:55:02 R. KING
NOTES : :
ANT POLARITY : HORIZONTAL
DATA CORRECTED TO 3 m
HORIZONTAL
LIMIT
FIELD INTENSITY dBuV/m
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
START = 30
100
FREQUENCY - MHz
STOP = 1000
pg --- of ----


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
8546A RE RUN 1
WQ80 11/26/07
PRELIMINARY PEAK RADIATED EMISSION TEST @ 3 METERS
SPECIFICATION : FCC 15B CLASS B
MANUFACTURER : CALIFORNIA EASTERN LABS
MODEL No. : ZICM2410P2
S/N : 825-ES2-X3
MODE : Tx @ 2405MHz
DATE TESTED : 16 Sep 2009 06:55:02 R. KING
NOTES : :
ANT POLARITY : VERTICAL
DATA CORRECTED TO 3 m
VERTICAL
LIMIT
FIELD INTENSITY dBuV/m
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
START = 30
100
FREQUENCY - MHz
STOP = 1000
pg --- of ----


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 13
WKA1 01/30/09
SPEC / TEST : PRELIM RADIATED EMISSIONS
MANUFACTURER : CALIFORNIA EASTERN LABS
MODEL No. : ZICM2410P2
SERIAL No. : 825-ES2-X3
MODE : Tx @ 2405MHz
SCANS/BAND : 1
NOTES :
TEST DATE : 15 Sep 2009 07:58:17 R. KING
ANT. POLARIZ. : HORIZONTAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
START = 1000
FREQUENCY MHz
STOP = 3700.000001


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 12
WKA1 01/30/09
SPEC / TEST : PRELIM RADIATED EMISSIONS
MANUFACTURER : CALIFORNIA EASTERN LABS
MODEL No. : ZICM2410P2
SERIAL No. : 825-ES2-X3
MODE : Tx @ 2405MHz
SCANS/BAND : 1
NOTES :
TEST DATE : 15 Sep 2009 07:55:48 R. KING
ANT. POLARIZ. : VERTICAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
START = 1000
FREQUENCY MHz
STOP = 3700.000001


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 3
WKA1 01/30/09
SPEC / TEST : PRELIM RADIATED EMISSIONS
MANUFACTURER : CALIFORNIA EASTERN LABS
MODEL No. : ZICM2410P2
SERIAL No. : 825-ES2-X3
MODE : Tx @ 2405MHz
SCANS/BAND : 1
NOTES :
TEST DATE : 15 Sep 2009 06:16:49 R. KING
ANT. POLARIZ. : HORIZONTAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
105
90
75
60
45
30
15
0
START = 2000
10000
STOP = 18000
FREQUENCY MHz


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 2
WKA1 01/30/09
SPEC / TEST : PRELIM RADIATED EMISSIONS
MANUFACTURER : CALIFORNIA EASTERN LABS
MODEL No. : ZICM2410P2
SERIAL No. : 825-ES2-X3
MODE : Tx @ 2405MHz
SCANS/BAND : 1
NOTES :
TEST DATE : 15 Sep 2009 06:04:15 R. KING
ANT. POLARIZ. : VERTICAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
105
90
75
60
45
30
15
0
START = 2000
10000
STOP = 18000
FREQUENCY MHz