# Measurement of RF Interference from a Model LT8-1 Transmitter

For : Lanco, Inc.
West Chicago, IL

P.O. No. : 09130104
Date Received : September 14, 2004
Date Tested : September 14, 2004
Test Personnel : Richard E. King
Specification : FCC "Code of Federal Regulations" Title 47 Part 15, Subpart C

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**Measurement of RF Emissions from a LT8-1 transmitter**

THIS REPORT SHALL NOT BE REPRODUCED, EXCEPT IN FULL, WITHOUT THE WRITTEN APPROVAL OF ELITE ELECTRONIC ENGINEERING INCORPORATED.

## 1.0 INTRODUCTION:

**1.1 Description of Test Item -** This document represents the results of the series of radio interference measurements performed on a model LT8-1 transmitter, (hereinafter referred to as the test item). The test item was designed to transmit at approximately 315 MHz using an internal antenna. The test item was manufactured and submitted for testing by Lanco located in West Chicago, IL.

**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 C, Sections 15.231 for Intentional Radiators. 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 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 2003
- 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"

**1.5 Subcontractor 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.

**1.6 Laboratory Conditions** The temperature at the time of the test was C and the relative humidity was %.

## 2.0 TEST ITEM SETUP AND OPERATION:

The test item is a LT8-1. A block diagram of the test item setup is shown as Figure 1.

**2.1 Power Input -** The test item received +3VDC from a 3 volt battery.

**2.2 Grounding -** Since the test item was powered with +3VDC from a battery, it was ungrounded during the tests.

**2.3 Peripheral Equipment -** No peripheral equipment was submitted with the test item.

**2.4 Interconnect Cables -** No interconnect cables were submitted with the test item.

**2.5 Operational Mode -** For all tests the test item was placed on an 80cm high non-conductive stand.

The test item was energized by pressing the lower right side transmit button.

**2.6 Test Item Modifications** - No modifications were required for compliance to the FCC 15.231 requirements.

## 3.0 TEST EQUIPMENT:

**3.1 Test Equipment List** - A list of the test equipment used can be found on Table I. All equipment was calibrated per the instruction manuals supplied by the manufacturer.

**3.2 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).

**3.3 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 budgets were based on guidelines in "ISO Guide to the Expression of Uncertainty in Measurements" and NAMAS NIS81 "The Treatment of Uncertainty in EMC Measurements".

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 |

## 4.0 REQUIREMENTS, PROCEDURES AND RESULTS:

### 4.1 Powerline Conducted Emissions

**4.1.1 Requirements** – Since the test item was powered by internal batteries, no conducted emissions tests are required.

### 4.2 Duty Cycle Factor Measurements:

**4.2.1 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 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).

**4.2.2 Results:** The plot of the duty cycle is shown on data page 11. The duty cycle factor was computed to be -10.58 dB.

**4.3 Radiated Measurements**

**4.3.1 Requirements -** The test item must comply with the requirements of FCC "Code of Federal Regulations Title 47", Part 15, Subpart C, Section 15.205 et seq.

Paragraph 15.231(b) has the following radiated emission limits:

| Fundamental Frequency MHz | Field Intensity uV/m @ 3 meters | Field Strength Harmonics and Spurious @ 3 meters |
|---|---|---|
| 260 to 470 | 3,750 to 12,500* | 375 to 1,250* |

* - Linear Interpolation

For 315MHz, the limit at the fundamental is 6039.7uV/m @ 3m and the limit on the harmonics is 604uV/m @ 3m.

In addition, emissions appearing in the Restricted Bands of Operation listed in paragraph 15.205(a) shall not exceed the general requirements shown in paragraph 15.209.

**4.3.2 Procedures -** Open Area measurements were performed in a 32ft. x 20ft. x 18ft. 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.

A preliminary radiated emissions test was 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 5.0GHz 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 automatically performed over the frequency range of 30MHz to 5000MHz. Between 30MHz and 1000MHz, a bilog antenna was used as the pick-up device. A broadband double ridged waveguide antenna was used as the pick-up device for all frequencies above 1GHz. All significant broadband and narrowband signals were measured and recorded. The peak detected levels were converted to average levels using a duty cycle factor which was computed from the pulse train.

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.
(3) The measuring antenna was raised and lowered from 1 to 4 meters for each antenna polarization to maximize the readings.
(4) 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.

**4.3.3 Results -** The preliminary plots, with the test item transmitting at 315MHz, are presented on data pages 12 and 13. The plots are presented for a reference only, and are not used to determine compliance.

The final open area radiated levels, with the test item transmitting at 315MHz, are presented on data pages 14 and 15. As can be seen from the data, all emissions measured from the test item were within the specification limits. The emissions level closet to the limit (worst case) occurred at 315MHz. The emissions level at this frequency was 0.4dB under the limit. See data page 14 for details. Photographs of the test configuration which yielded the highest or worst case radiated emission levels are shown on Figure 2.

**4.4 Occupied Bandwidth Measurements**

**4.4.1 Requirement -** In accordance with paragraph 15.231(c), all emissions within 20dB of the peak amplitude level of the center frequency are required to be within a band less than 0.25% of the center frequency wide.

**4.4.2 Procedures -** The test item was placed on an 80cm high non-conductive stand. The unit was set to transmit continuously. With an antenna positioned nearby, occupied bandwidth emissions were displayed on the spectrum analyzer. The resolution bandwidth was set to 30 kHz and span was set to 2 MHz. The frequency spectrum near the fundamental was plotted.

**4.4.3 Results -** The plot of the emissions near the fundamental frequency are presented on data page 16. As can be seen from this data page, the transmitter met the occupied bandwidth requirements.

## 5.0 CONCLUSIONS:

It was determined that the Lanco LT8-1 transmitter did fully meet the radiated emission requirements of

the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, Section 15.205 et seq. for Intentional Radiators, when tested per ANSI C63.4-2003.

## 6.0 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.

## 7.0 ENDORSEMENT DISCLAIMER:

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

TABLE I: TEST EQUIPMENT LIST

ELITE ELECTRONIC ENG. INC. Page: 1

| Eq ID | Equipment Description | Manufacturer | Model No. | Serial No. | Frequency Range | Cal Date | Cal Inv | Due Date |
|---|---|---|---|---|---|---|---|---|
| Equipment Type: ACCESSORIES, MISCELLANEOUS | | | | | | | | |
| XZG2 | ATTENUATOR/SWITCH DRIVER | HEWLETT PACKARD | 11713A | 2223A01751 | --- | | N/A | |
| Equipment Type: AMPLIFIERS | | | | | | | | |
| APK2 | PREAMPLIFIER | AGILENT TECHNOL | 8449B | 3008A01595 | 1-26.5GHZ | 02/04/04 | 12 | 02/04/05 |
| Equipment Type: ANTENNAS | | | | | | | | |
| NDP0 | TUNED DIPOLE ANTENNA | EMCO | 3121C-DB3 | 311 | 140-400MHZ | 01/23/04 | 12 | 01/23/05 |
| NTA0 | BILOG ANTENNA | CHASE EMC LTD. | BILOG CBL611 | 2057 | 0.03-2GHZ | 07/12/04 | 12 | 07/12/05 |
| NWG0 | RIDGED WAVE GUIDE (DCC-MAT | AEL | H1479 | 104 | 1-12.4GHZ | 11/26/03 | 12 | 11/26/04 |
| Equipment Type: CONTROLLERS | | | | | | | | |
| CDD2 | COMPUTER | HEWLETT PACKARD | D4171A#ABA | US61654645 | --- | | N/A | |
| CMA0 | MULTI-DEVICE CONTROLLER | EMCO | 2090 | 9701-1213 | --- | | N/A | |
| Equipment Type: METERS | | | | | | | | |
| MSI1 | DIGITAL OSCILLOSCOPE (DCC- | LECROY CORP. | 9310AM | 4546 | DC-400MHZ | 06/16/04 | 12 | 06/16/05 |
| Equipment Type: RECEIVERS | | | | | | | | |
| RAC0 | SPECTRUM ANALYZER | HEWLETT PACKARD | 85660B | 2449A01117 | 100HZ-22GHZ | 02/04/04 | 12 | 02/04/05 |
| RACA | RF PRESELECTOR | HEWLETT PACKARD | 85685A | 2926A00980 | 20HZ-2GHZ | 02/03/04 | 12 | 02/03/05 |
| RAF1 | QUASIPEAK ADAPTER | HEWLETT PACKARD | 85650A | 2043A00271 | 0.01-1000MHZ | 02/03/04 | 12 | 02/03/05 |
| RAKG | RF SECTION | HEWLETT PACKARD | 85462A | 3549A00284 | 0.009-6500MHZ | 03/22/04 | 12 | 03/22/05 |
| RAKH | RF FILTER SECTION | HEWLETT PACKARD | 85460A | 3448A00324 | --- | 03/22/04 | 12 | 03/22/05 |

Cal. Interval: Listed in Months 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.

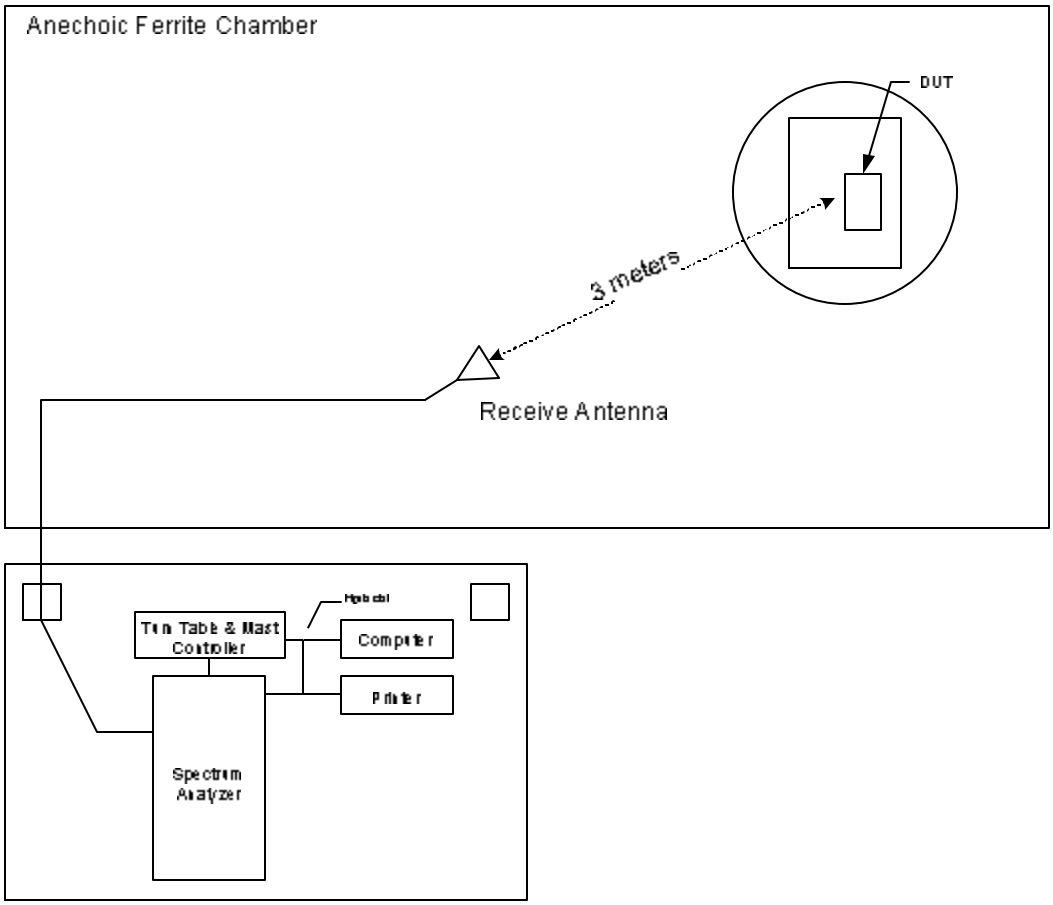
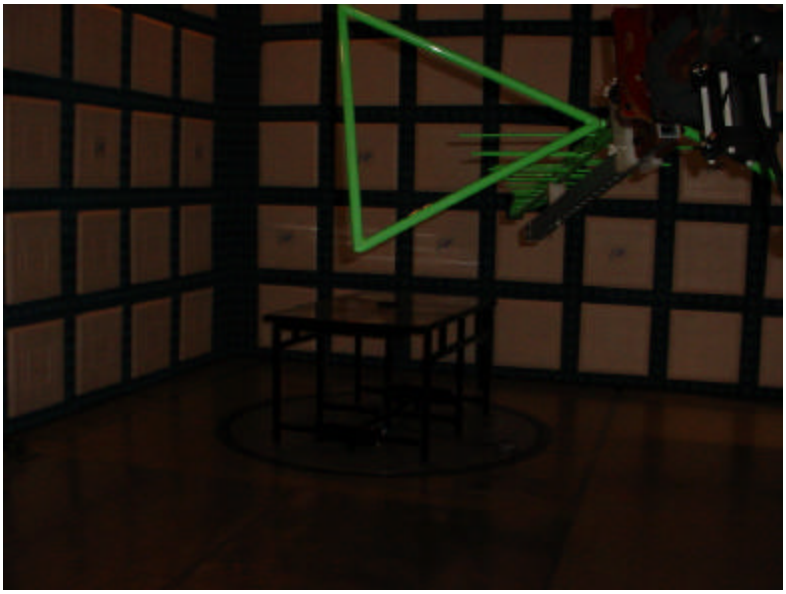
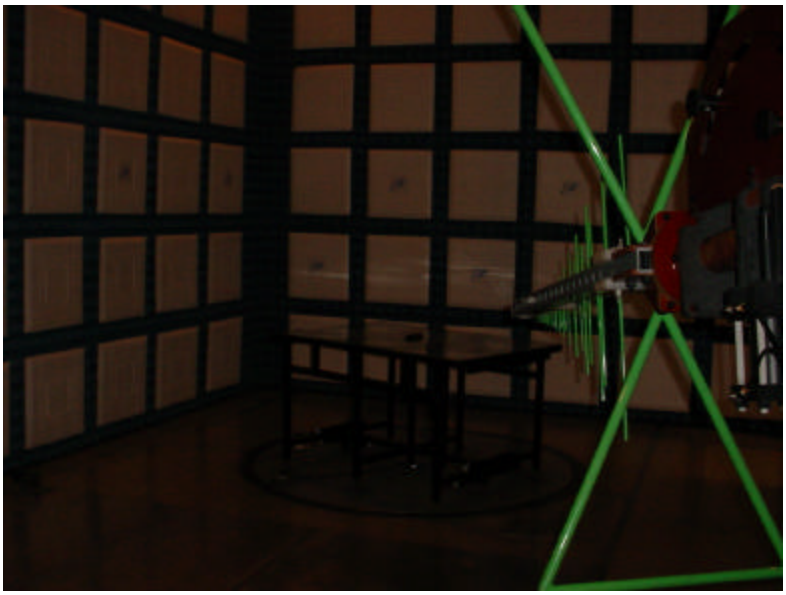



FIGURE 1 BLOCKDIAGRAM OF TEST SETUP

Figure 2

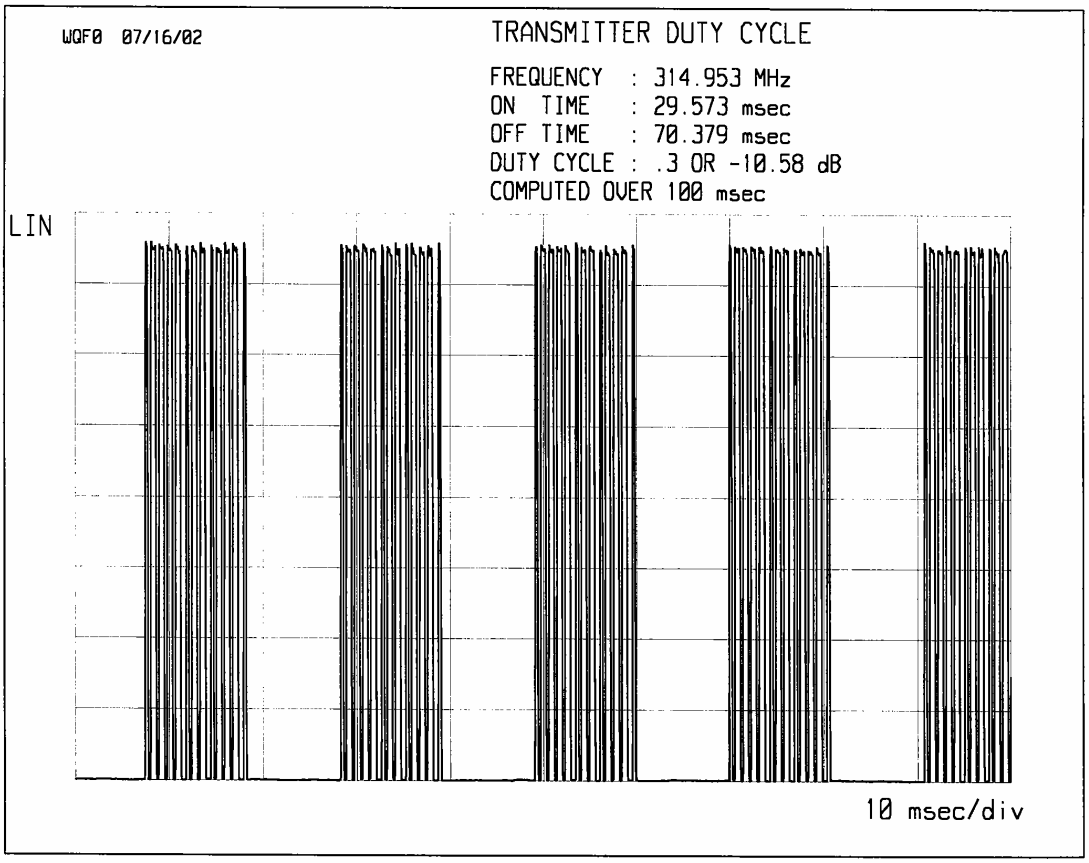


Test Setup for Worst Case Emissions Horizontal Polarity



Test Setup for Worst Case Emissions Vertical Polarity

ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Il 60515




MANUFACTURER : LANCO
MODEL : LT8-1
S/N : NONE ASSIGNED
NOTES : HIGHEST PWR
DATE : 14 Sep 2004 08:06:13 R. KING

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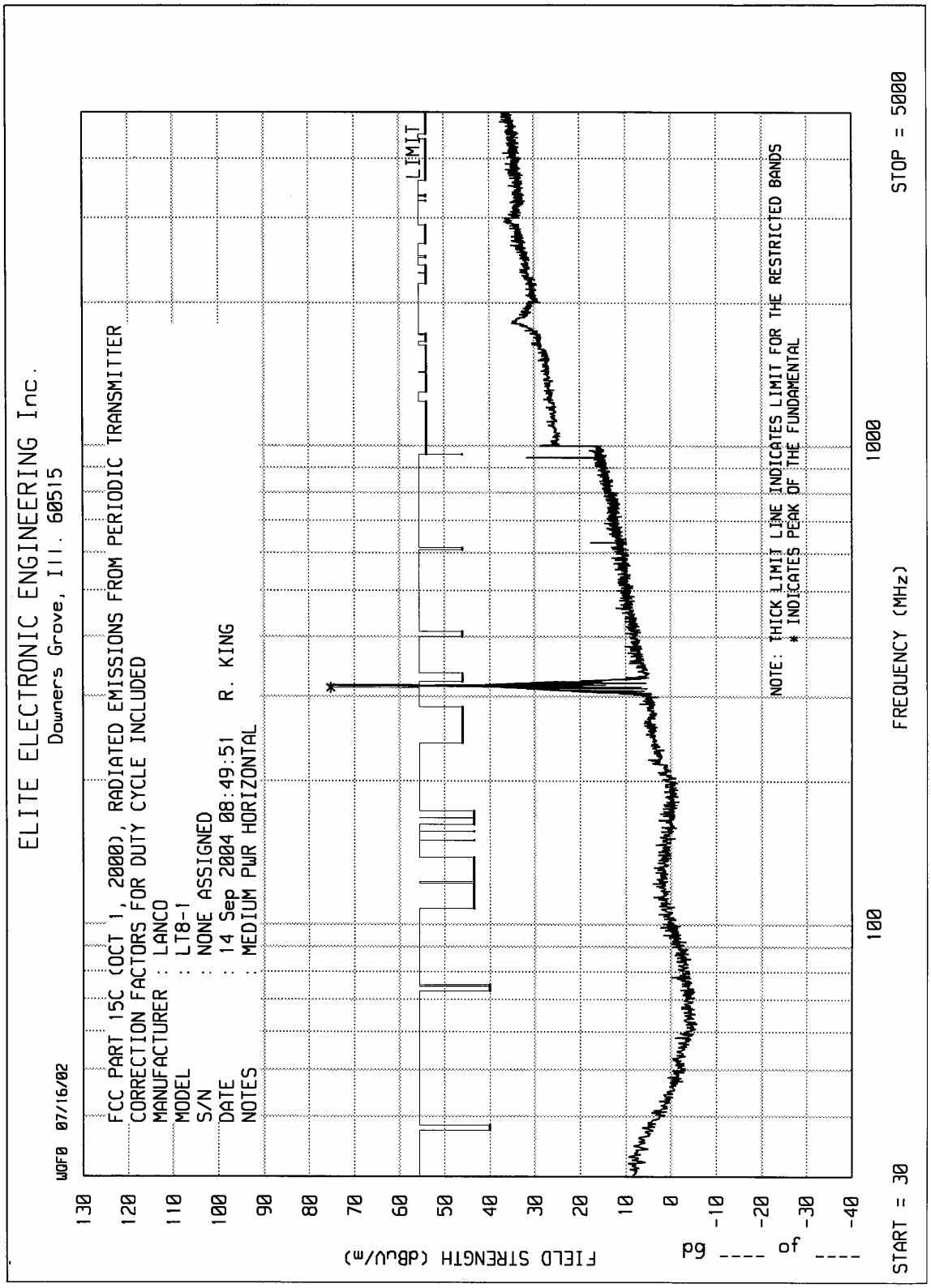
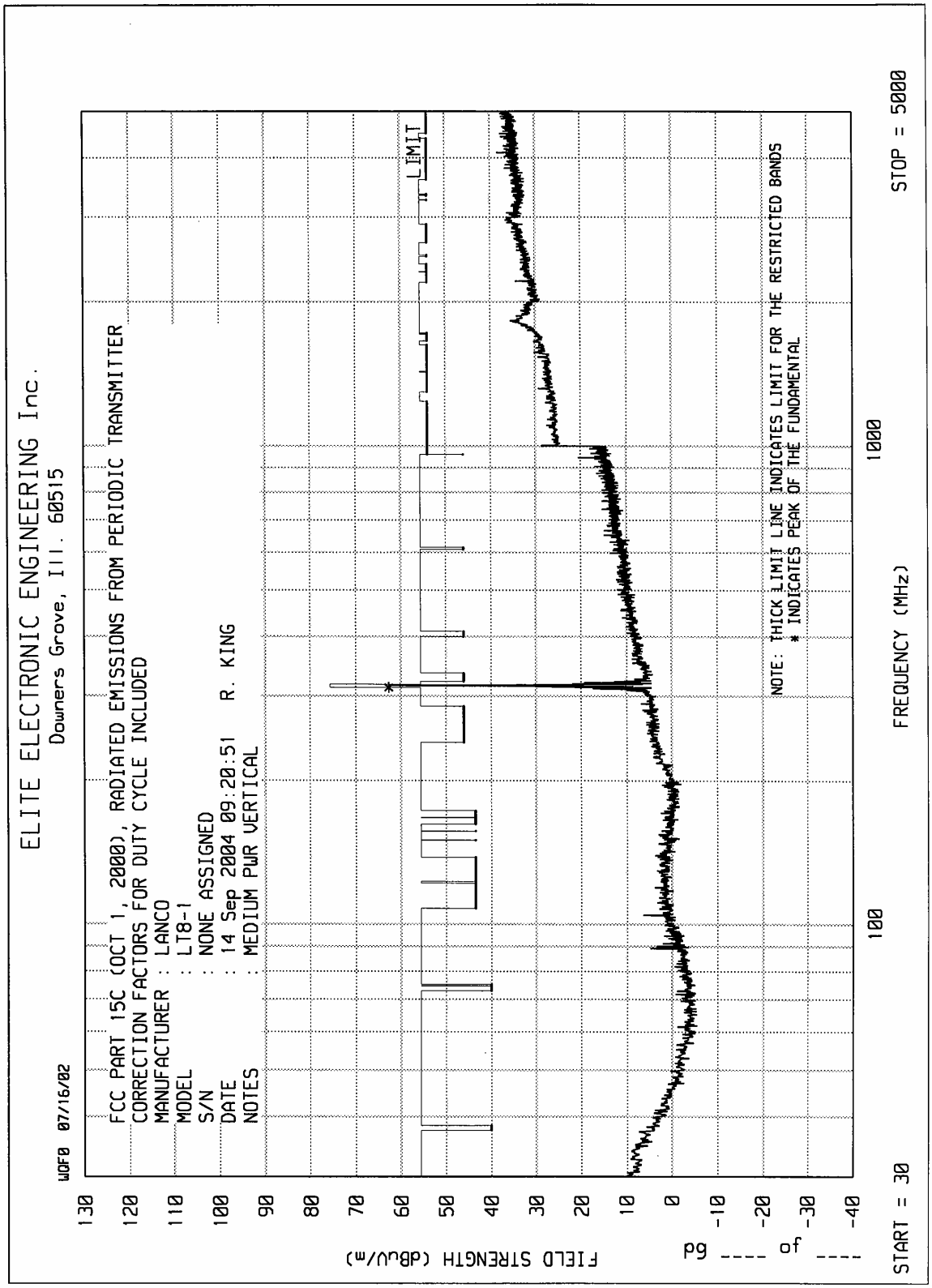

ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
WOFB 07/16/02
FCC PART 15C (OCT 1, 2000), RADIATED EMISSIONS FROM PERIODIC TRANSMITTER
CORRECTION FACTORS FOR DUTY CYCLE INCLUDED
MANUFACTURER : LANCO
MODEL : LT8-1
S/N : NONE ASSIGNED
DATE : 14 Sep 2004 08:49:51 R. KING
NOTES : MEDIUM PWR HORIZONTAL
LIMIT
NOTE: THICK LIMIT LINE INDICATES LIMIT FOR THE RESTRICTED BANDS
* INDICATES PEAK OF THE FUNDAMENTAL
FIELD STRENGTH (dBuV/m)
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
pg ---- of ----
START = 30
100
1000
STOP = 5000
FREQUENCY (MHz)


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
FCC PART 15C (OCT 1, 2000), RADIATED EMISSIONS FROM PERIODIC TRANSMITTER
CORRECTION FACTORS FOR DUTY CYCLE INCLUDED
MANUFACTURER : LANCO
MODEL : LT8-1
S/N : NONE ASSIGNED
DATE : 14 Sep 2004 09:20:51 R. KING
NOTES : MEDIUM PWR VERTICAL
WOFB 07/16/02
LIMIT
NOTE: THICK LIMIT LINE INDICATES LIMIT FOR THE RESTRICTED BANDS
* INDICATES PEAK OF THE FUNDAMENTAL
FIELD STRENGTH (dBuV/m)
FREQUENCY (MHz)
START = 30
100
1000
STOP = 5000
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
pg ---- of ----

HARMONIC AND EXCESSIVE EMISSIONS FROM TRANSMITTER

SPECIFICATION : FCC PART 15C (OCT 1, 2000)
MANUFACTURER : LANCO
MODEL : LT8-1
S/N : NONE ASSIGNED
DATE : 14 Sep 2004 08:49:51 R. KING
NOTES : MEDIUM PWR HORIZONTAL
DUTY CYCLE : -10.58 dB
TOTAL FAC. = ANTENNA + CABLE + DUTY CYCLE FAC. + EXT. ATTENUATION (dB)

| HARM. INDEX | FREQ MHz | METER READING dBuV | TOTAL FACTOR dB | TOTAL dBuV/m @3m | TOTAL uV/m @3m | LIMIT uV/m @3m | EMI.-LIM MARGIN dB | RESTR. BAND |
|---|---|---|---|---|---|---|---|---|
| FUND. | 315.0 | 69.8 | 5.4 | 75.2 | 5756.8 | 6039.7 | -.4 | NO |
| 2 | 629.9 | 6.4 | 11.2 | 17.6 | 7.6 | 604.0 | -38.0 | NO |
| 3 | 944.9 | 17.3 | 14.4 | 31.7 | 38.7 | 604.0 | -23.9 | NO |
| 4 | 1259.8 | 9.9 | 18.1 | 28.0 | 25.0 | 604.0 | -27.7 | NO |
| 5 | 1574.8 | 10.0 | 19.1 | 29.1 | 28.5 | 500.0 | -24.9 | YES |
| 6 | 1889.7 | 12.6 | 20.7 | 33.3 | 46.3 | 604.0 | -22.3 | NO |
| 7 | 2204.7 | 9.3 | 22.2 | 31.5 | 37.6 | 500.0 | -22.5 | YES |
| 8 | 2519.6 | 9.6 | 23.6 | 33.2 | 45.7 | 604.0 | -22.4 | NO |
| 9 | 2834.6 | 9.1 | 25.1 | 34.2 | 51.4 | 500.0 | -19.8 | YES |
| 10 | 3149.5 | 9.0 | 25.8 | 34.8 | 55.0 | 604.0 | -20.8 | NO |

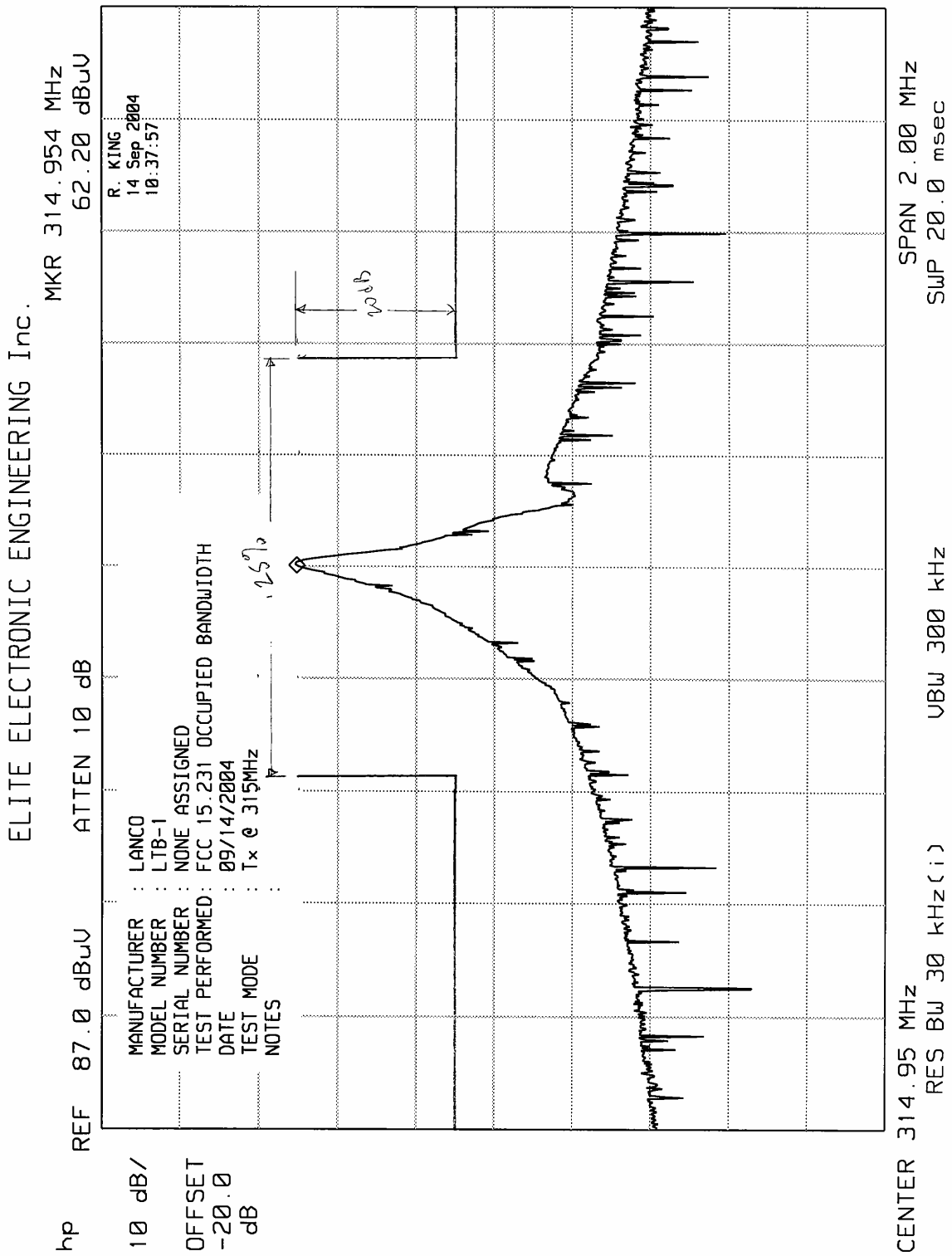
pg ____ of ____

HARMONIC AND EXCESSIVE EMISSIONS FROM TRANSMITTER

SPECIFICATION : FCC PART 15C (OCT 1, 2000)
MANUFACTURER : LANCO
MODEL : LT8-1
S/N : NONE ASSIGNED
DATE : 14 Sep 2004 09:20:51 R. KING
NOTES : MEDIUM PWR VERTICAL
DUTY CYCLE : -10.58 dB
TOTAL FAC. = ANTENNA + CABLE + DUTY CYCLE FAC. + EXT. ATTENUATION (dB)

| HARM. INDEX | FREQ MHz | METER READING dBuV | TOTAL FACTOR dB | TOTAL dBuV/m @3m | TOTAL uV/m @3m | LIMIT uV/m @3m | EMI.-LIM MARGIN dB | RESTR. BAND |
|---|---|---|---|---|---|---|---|---|
| FUND. | 315.0 | 57.3 | 5.4 | 62.6 | 1354.2 | 6039.7 | -13.0 | NO |
| 2 | 629.9 | 2.3 | 11.2 | 13.5 | 4.7 | 604.0 | -42.2 | NO |
| 3 | 944.9 | 6.1 | 14.4 | 20.5 | 10.6 | 604.0 | -35.1 | NO |
| 4 | 1259.8 | 9.3 | 18.1 | 27.5 | 23.6 | 604.0 | -28.2 | NO |
| 5 | 1574.8 | 11.2 | 19.1 | 30.3 | 32.6 | 500.0 | -23.7 | YES |
| 6 | 1889.7 | 12.2 | 20.7 | 32.9 | 44.1 | 604.0 | -22.7 | NO |
| 7 | 2204.7 | 12.1 | 22.2 | 34.4 | 52.3 | 500.0 | -19.6 | YES |
| 8 | 2519.6 | 9.0 | 23.7 | 32.7 | 43.2 | 604.0 | -22.9 | NO |
| 9 | 2834.6 | 10.0 | 25.1 | 35.1 | 56.6 | 500.0 | -18.9 | YES |
| 10 | 3149.5 | 8.9 | 25.8 | 34.7 | 54.3 | 604.0 | -20.9 | NO |

pg ____ of ____


hp
REF 87.0 dBuV
ATTEN 10 dB
MKR 314.954 MHz
62.20 dBuV
10 dB/
OFFSET
-20.0
dB
ELITE ELECTRONIC ENGINEERING Inc.
MANUFACTURER : LANCO
MODEL NUMBER : LTB-1
SERIAL NUMBER : NONE ASSIGNED
TEST PERFORMED : FCC 15.231 OCCUPIED BANDWIDTH
DATE : 09/14/2004
TEST MODE : Tx @ 315MHz
NOTES :
R. KING
14 Sep 2004
10:37:57
20db
.25%
CENTER 314.95 MHz
RES BW 30 kHz(i)
VBW 300 kHz
SPAN 2.00 MHz
SWP 20.0 msec