

Elite Electronic Engineering, Inc.
1516 Centre Circle
Downers Grove, Illinois
(630) 495-9770
www.elitetest.com

Engineering Test Report Number 31149-01



MEASUREMENT OF RF INTERFERENCE FROM A MODEL TELEPILOT TRANSMITTER

FOR: **Telemotive Industrial Controls**
175 Wall Street
Glendale Heights, Illinois 60139-1985

Date Tested: July 1, 2002

Test Specifications: FCC "Code of Federal Regulations" Title 47
Part 15, Subpart C, Section 15.205

Elite

ENGINEERING TEST REPORT NO. 31149-01

ADMINISTRATIVE DATA AND SUMMARY OF TESTS

DESCRIPTION OF TEST ITEM: Transmitter

MODEL NO: TELEPILOT

SERIAL NO: None Assigned

MANUFACTURER: Telemotive Industrial Controls

APPLICABLE SPECIFICATIONS:

FCC "Code of Federal Regulations"
Title 47, Part 15, Subpart C

QUANTITY OF ITEMS TESTED: One (1)

TEST PERFORMED BY: ELITE ELECTRONIC ENGINEERING INCORPORATED
Radio Interference Consultants
Downers Grove, Illinois 60515

DATE RECEIVED: July 1, 2002

DATE TESTED: July 1, 2002

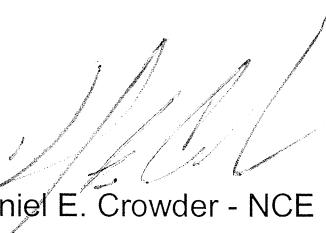
PERSONNEL (OPERATORS, OBSERVERS, AND CO-ORDINATORS):

CUSTOMER: Talmage Wesley of Telemotive Industrial Controls was present.
ELITE ELECTRONIC: Richard E. King

ELITE JOB NO.: 31149

ABSTRACT: The model TELEPILOT Transmitter, does 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 C63.4-1992.

Report By:


Daniel E. Crowder - NCE

Approved By:

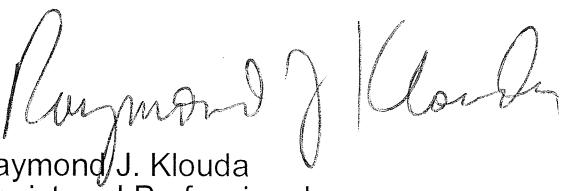

Raymond J. Klouda
Registered Professional
Engineer of Illinois - 44894

TABLE OF CONTENTS

PARAGRAPH	DESCRIPTION OF CONTENTS	PAGE NO.
1.0	INTRODUCTION	4
1.1	DESCRIPTION OF TEST ITEM	4
1.2	PURPOSE	4
1.3	DEVIATIONS, ADDITIONS AND EXCLUSIONS	4
1.4	APPLICABLE DOCUMENTS	4
1.5	SUBCONTRACTOR IDENTIFICATION	4
1.6	LABORATORY CONDITIONS	4
2.0	TEST ITEM SETUP AND OPERATION	5
2.1	POWER INPUT	5
2.2	GROUNDING	5
2.3	PERIPHERAL EQUIPMENT	5
2.4	INTERCONNECT CABLES	5
3.0	TEST EQUIPMENT	5
3.1	TEST EQUIPMENT LIST	5
3.2	CALIBRATION TRACEABILITY	6
3.3	MEASUREMENT UNCERTAINTY	6
4.0	REQUIREMENTS, PROCEDURES AND RESULTS	6
4.1	POWERLINE CONDUCTED EMISSIONS	6
4.1.1	REQUIREMENTS	6
4.2	DUTY CYCLE FACTOR MEASUREMENTS	6
4.2.1	PROCEDURES	6
4.2.2	RESULTS	7
4.3	RADIATED MEASUREMENTS	7
4.3.1	REQUIREMENTS	7
4.3.3	RESULTS	9
4.4	OCCUPIED BANDWIDTH MEASUREMENTS	9
4.4.1	REQUIREMENTS	9
4.4.2	PROCEDURES	9
4.4.3	RESULTS	9
5.0	CONCLUSION	10
6.0	CERTIFICATION	10
7.0	ENDORSEMENT DISCLAIMER	10
	TABLE I - EQUIPMENT LIST	11

**TOTAL NUMBER OF PAGES IN THIS DOCUMENT,
(INCLUDING DATA SHEETS): 28**

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

MEASUREMENT OF RF INTERFERENCE FROM
A MODEL TELEPILOT TRANSMITTER

1.0 INTRODUCTION:

1.1 DESCRIPTION OF TEST ITEM: This document presents the results of a series of radio interference measurements performed on a model TELEPILOT Transmitter, (hereinafter referred to as the test item). No serial number was assigned to the test item. The test item was designed to transmit in the frequency range of 433.1MHz to 450MHz using an internal antenna. The tests were performed for Telemotive Industrial Controls of Elmhurst, Illinois.

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 for Intentional Radiators. Testing was performed in accordance with ANSI C63.4-1992.

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 2001
- ANSI C63.4-2001, "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 24°C and the relative humidity was 58%.

2.0 TEST ITEM SETUP AND OPERATION:

A block diagram of the test item setup is included as Figure 1.

2.1 POWER INPUT: The test item was powered with 3VDC through a 3VDC battery.

2.2 GROUNDING: Since the test item was powered with 3VDC through a 3VDC battery, it was ungrounded during the tests.

2.3 PERIPHERAL EQUIPMENT: There was no peripheral equipment submitted with the test item.

2.4 INTERCONNECT CABLES: There were no interconnect cables submitted with the test item.

2.5 OPERATIONAL MODE: For all tests the test item was placed on a 80cm high non-conductive stand. The test item was energized. For all tests, the test item was programmed to transmit continuously. Transmission was verified by observation of an LED which was lit whenever the transmitter was enabled. The transmitting mechanism automatically deactivated when released. The battery voltage was periodically checked to ensure proper operation at maximum level. The tests were performed separately with the test item operating at 433.1MHz, 439.8MHz and 450.0MHz.

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.

The fundamental, harmonics and spurious emissions were measured with a spectrum analyzer. The spectrum analyzer peak detected readings were converted to average readings using a duty cycle factor. All measurements were taken with the resolution and video bandwidth of the measuring instrument adjusted to 100kHz below 1GHz and 1MHz above 1GHz.

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 were performed.

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 setting are adjusted so that the on/off transitions clear the 4th division from the bottom of the display. The markers are set at 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: Plots of the duty cycles at each frequency are shown on data pages 14 through 16. Data pages 14 and 15 are duty cycles for normal transmitting system. The frequency range of 449.5MHz to 450.0MHz is dedicated to the series 9000 system. Data page 16 is the duty cycle for the series 9000 system.

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 433.1MHz, the limit at the fundamental is 10962.5uV/m @ 3m and the limit on the harmonics is 1096.3uV/m @ 3m.

For 439.8MHz, the limit at the fundamental is 11241.7uV/m @ 3m and the limit on the harmonics is 1124.2uV/m @ 3m.

For 450.0MHz, the limit at the fundamental is 11666.7uV/m @ 3m and the limit on the harmonics is 1166.7uV/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: 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 1992 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.

Preliminary radiated emissions measurements were first performed using a peak detector and automatically plotted. The frequencies where significant emission levels were noted were then remeasured.

With the broadband measuring antennas positioned at a 3 meter distance from the test item, the frequency range from 30MHz to 5GHz was investigated using a peak detector function with the antennas set for vertical polarization.

Final radiated emissions were performed on all significant broadband and narrowband emissions found in the preliminary sweeps using the following methods:

- 1) Measurements were made using a peak detector and a broadband antenna.
- 2) To ensure that maximum, or worst case, emission levels were measured, the following steps were taken:
 - (a) The test item was rotated so that all of its sides were exposed to the receiving antenna.
 - (b) Since the measuring antenna is linearly polarized, both horizontal and vertical field components were measured.
 - (c) The measuring antenna was raised and lowered from 1 to 4 meters for each antenna polarization to maximize the readings.
 - (d) The fundamental through the 10th harmonic of the transmit frequency were measured.

Since the test item can transmit over the range 430MHz to 450.0MHz, it was tested at three frequencies, one near the bottom of the frequency range (433.1MHz), one in the middle of the

frequency range (439.8MHz) and one near the top of the frequency range (450.0MHz).

4.3.3 RESULTS: The preliminary plots, with the test item transmitting at 433.1MHz, are presented on data pages 17 and 18. The preliminary plots, with the test item transmitting at 439.8MHz, are presented on data pages 19 and 20. The preliminary plots, with the test item transmitting at 450.0MHz, are presented on data pages 21 and 22. 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 433.1MHz, is presented on data page 23. The final open area radiated levels, with the test item transmitting at 439.8MHz, is presented on data page 24. The final open area radiated levels, with the test item transmitting at 450.0MHz, is presented on data page 25. As can be seen from the data, all emissions measured from the test item were within the specification limits. 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 REQUIREMENTS: 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 plots of the emissions near the fundamental frequency are presented on data pages 26 through 28. As can be seen from these data pages, the transmitter met the occupied bandwidth requirements.

5.0 CONCLUSION:

It was found that the Telemotive Industrial Controls model TELEPILOT Transmitter, does 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 C63.4-1992.

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 specification.

The data presented in this test report pertains only 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.

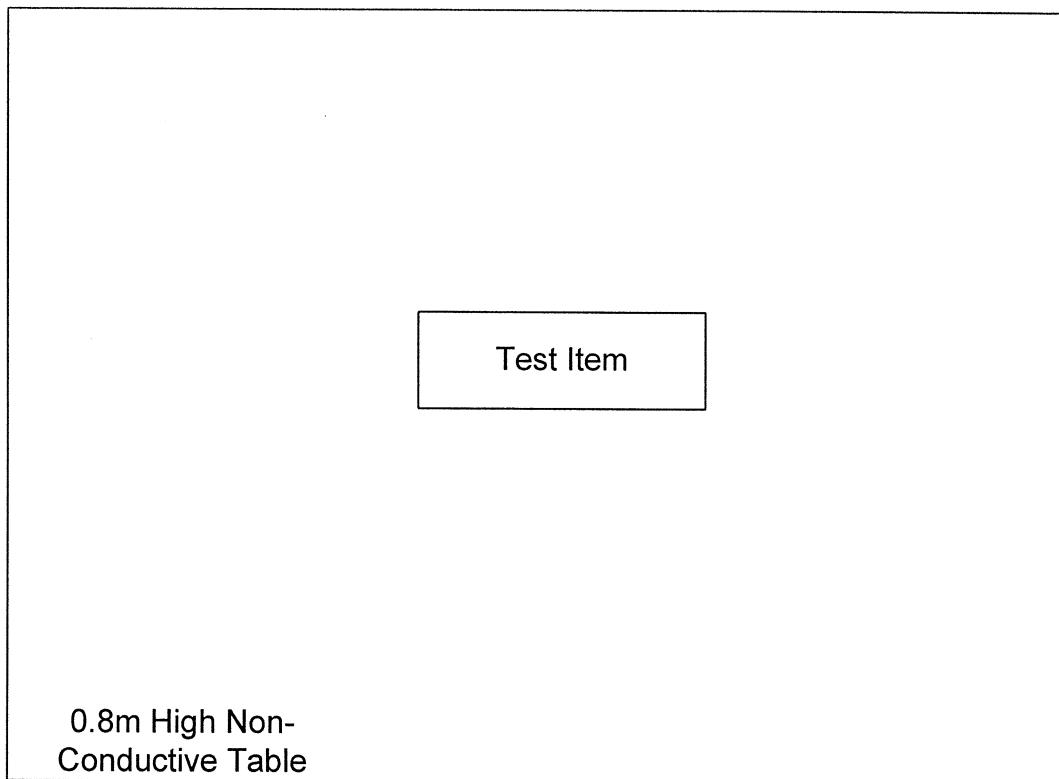
ENGINEERING TEST REPORT NO. 31149-01

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								
XZG0	ATTENUATOR/SWITCH DRIVER	HEWLETT PACKARD	11713A	3439A02724	---			N/A
Equipment Type: AMPLIFIERS								
APKO	PRE-AMPLIFIER	HEWLETT PACKARD	8449B	3008A00662	1-26.5GHZ	02/22/02	12	02/22/03
Equipment Type: ANTENNAS								
NDQ1	TUNED DIPOLE ANTENNA	EMCO	3121C-DB4	313	400-1000MHZ	01/10/02	12	01/10/03
NWHO	RIDGED WAVE GUIDE	TENSOR	4105	2081	1-12.4GHZ	08/03/01	12	08/03/02
Equipment Type: CONTROLLERS								
CDD2	COMPUTER	HEWLETT PACKARD	D4171A#ABA	US61654645	---			N/A
CMA0	MULTI-DEVICE CONTROLLER	EMCO	2090	9701-1213	---			N/A
Equipment Type: PRINTERS AND PLOTTERS								
HRE1	LASER JET 5P	HEWLETT PACKARD	C3150A	USHB061052	---			N/A
Equipment Type: RECEIVERS								
RAC1	SPECTRUM ANALYZER	HEWLETT PACKARD	85660B	3407A08369	100HZ-22GHZ	01/18/02	12	01/18/03
RACB	RF PRESELECTOR	HEWLETT PACKARD	85685A	3506A01491	20HZ-2GHZ	01/18/02	12	01/18/03
RAF3	QUASIPEAK ADAPTER	HEWLETT PACKARD	85650A	3303A01775	0.01-1000MHZ	01/18/02	12	01/18/03

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 - Block Diagram of Test Item



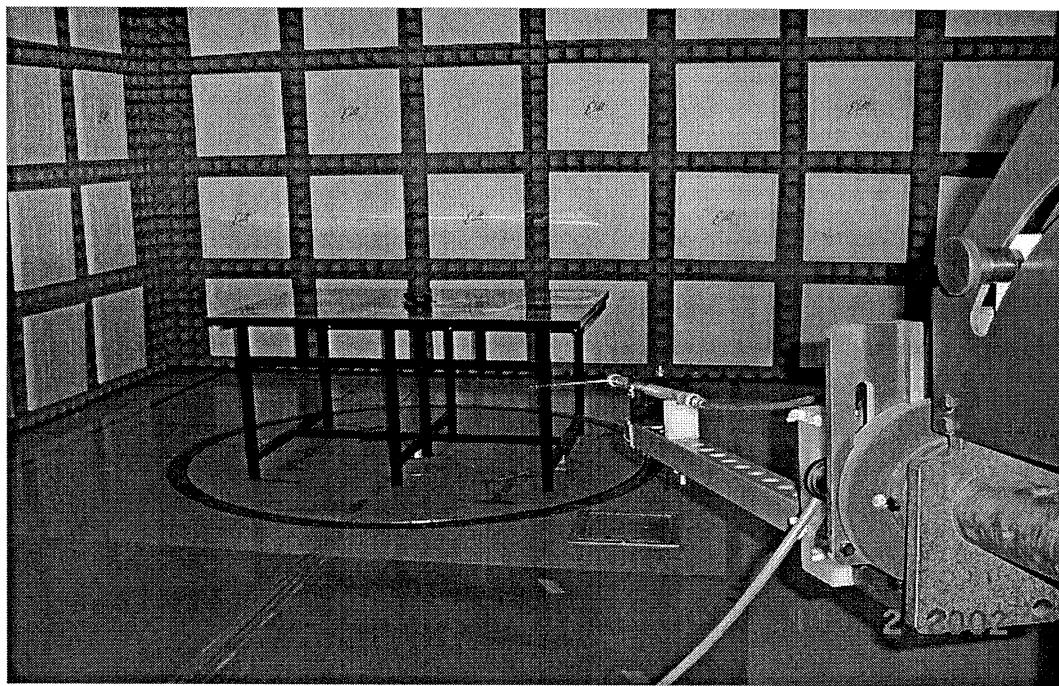


FIGURE 2a - TEST SETUP FOR HIGHEST RADIATED EMISSIONS MEASUREMENT
HORIZONTAL POLARITY

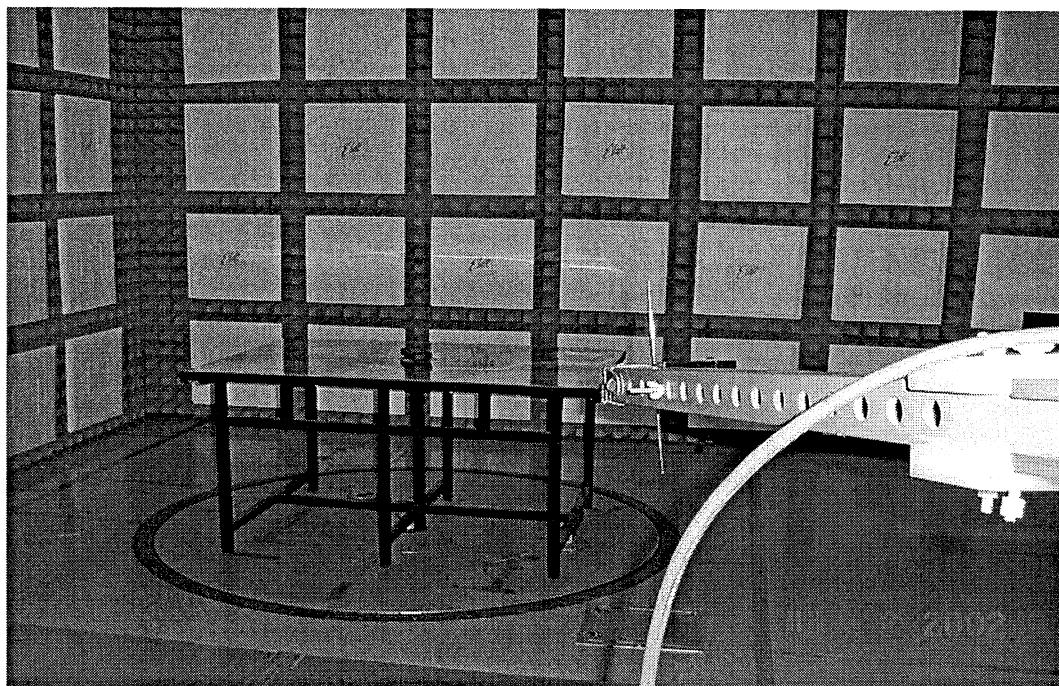
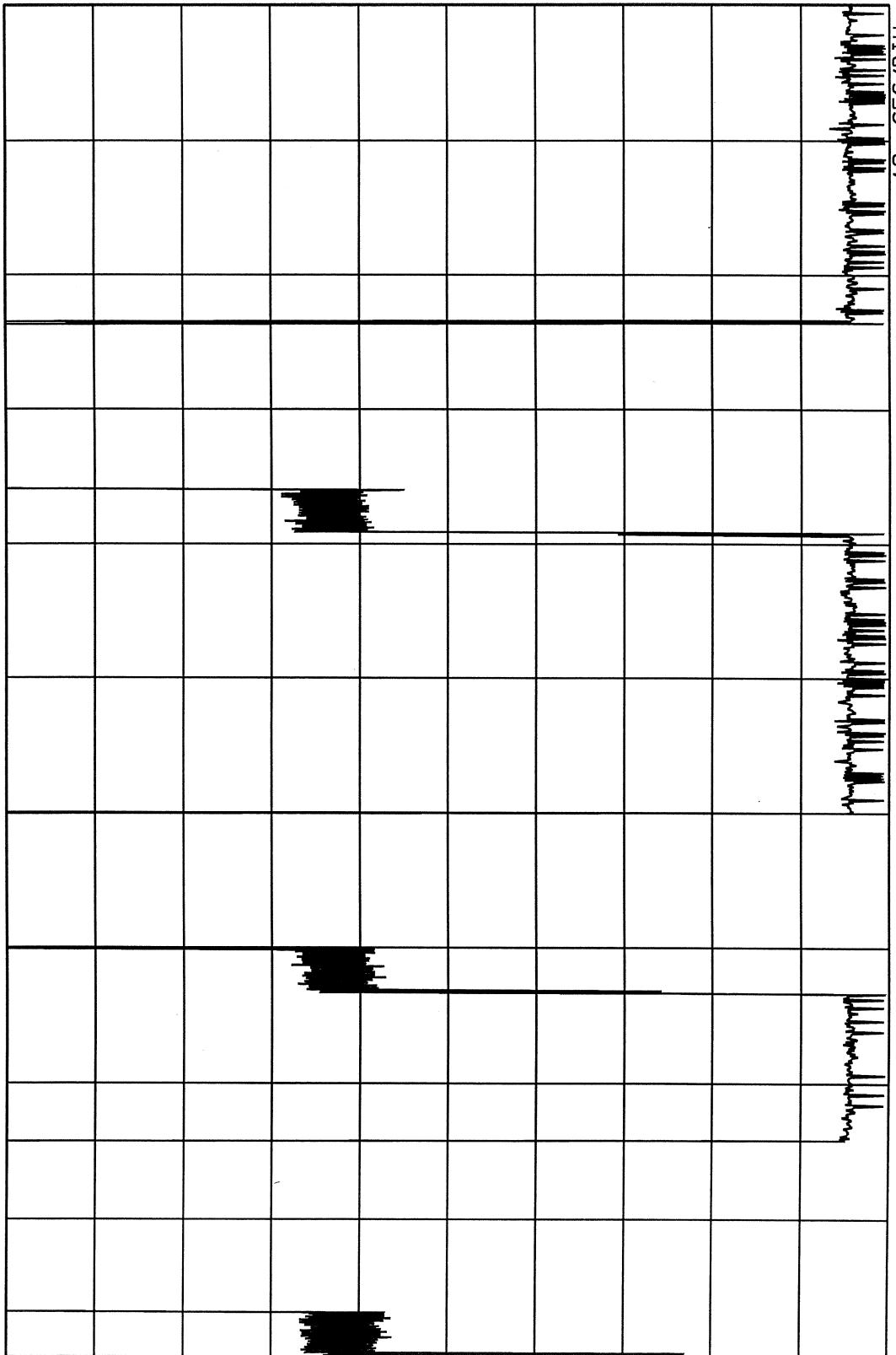


FIGURE 2b - TEST SETUP FOR HIGHEST RADIATED EMISSIONS MEASUREMENT
VERTICAL POLARITY

ETR 3119-01

ELITE ELECTRONIC ENGINEERING Co.
Downers Grove, IL 60515



TRANSMITTER DUTY CYCLE
FREQUENCY : 433.8437 MHz
ON TIME : 44.356 msec
OFF TIME : 55.644 msec
DUTY CYCLE = .44 or -7.13 dB
COMPUTED OVER 100 msec

MANUFACTURER : TELEMOTIVE
MODEL : TELEPILOT V1.0
S/N : NONE ASSIGNED
TEST DATE : 2 Jul 2002
NOTES : INCLUDES 9000 SYSTEMS