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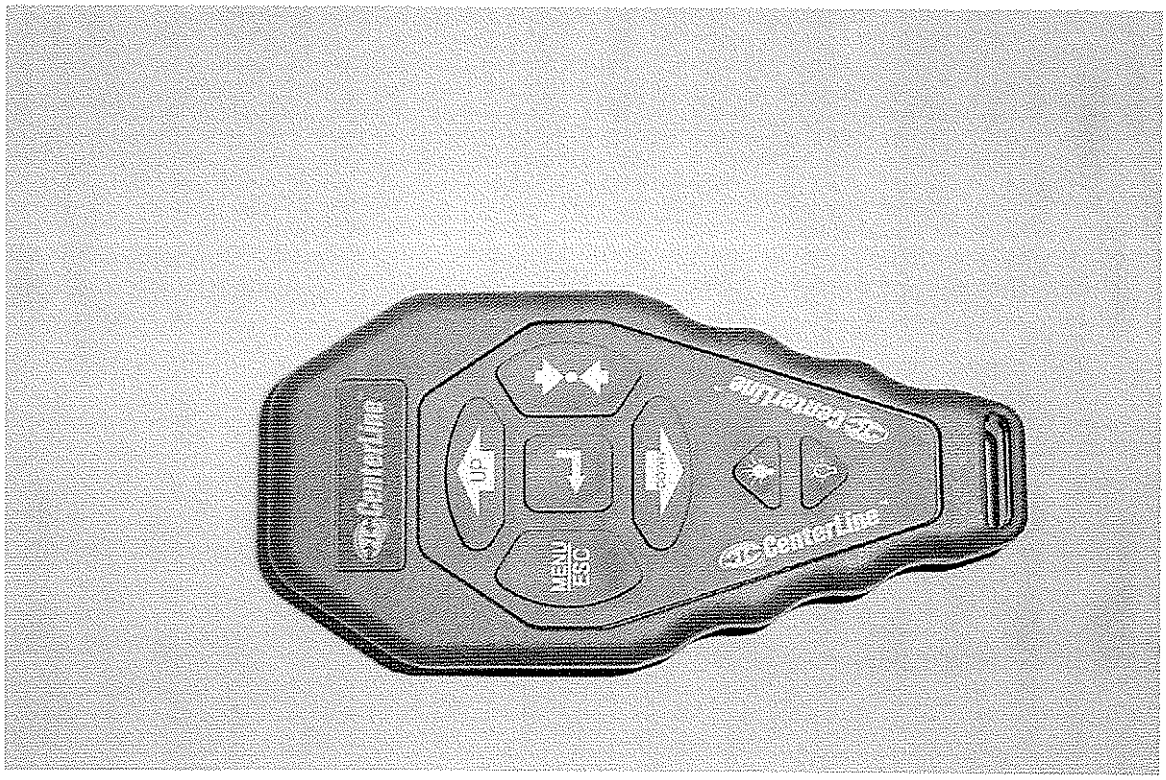
Engineering Test Report Number 31886-01



MEASUREMENT OF RF INTERFERENCE FROM A MODEL CENTERLINE TRANSMITTER

FOR: **Midwest Technologies**
2864 Old Rochester Road
Springfield, Illinois 60123

Dates Tested: February 21, 2003

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

ENGINEERING TEST REPORT NO. 31886-01

ADMINISTRATIVE DATA AND SUMMARY OF TESTS

DESCRIPTION OF TEST ITEM: Remote Control Transmitter

MODEL NO: Centerline **SERIAL NO:** None Assigned

MANUFACTURER: Midwest Technologies

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: February 21, 2003

DATE TESTED: February 21, 2003

PERSONNEL (OPERATORS, OBSERVERS, AND CO-ORDINATORS):
CUSTOMER: Steve Stone and Joe Davenport of Midwest Technologies were present.
ELITE ELECTRONIC: Mark E. Longinotti

ELITE JOB NO.: 31886

ABSTRACT: The model Centerline 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.

The radiated emissions level closest to the limit (worst case) occurred at 433.9MHz. The emissions level at this frequency was 0.2dB within the limit. See data page 16 for more details.

Report By:

Mark E. Longinotti
NARTE® Certified
EMC Test Engineer

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	5
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
4.3.2	PROCEDURES	7
4.3.3	RESULTS	8
4.4	OCCUPIED BANDWIDTH MEASUREMENTS	8
4.4.1	REQUIREMENTS	8
4.4.2	PROCEDURES	8
4.4.3	RESULTS	9
5.0	CONCLUSION	9
6.0	CERTIFICATION	9
7.0	ENDORSEMENT DISCLAIMER	9
TABLE I - EQUIPMENT LIST		10

TOTAL NUMBER OF PAGES IN THIS DOCUMENT, (INCLUDING DATA SHEETS): 16

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 presents the results of a series of radio interference measurements performed on a model Centerline Transmitter, (hereinafter referred to as the test item). No serial number was assigned to the test item. The test item was designed to transmit at approximately 433.9MHz using an internal antenna. The tests were performed for Midwest Technologies of Springfield, 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 22°C and the relative humidity was 14%.

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 4.5VDC through three (3) "AA" batteries.

2.2 GROUNDING: Since the test item was powered with 4.5VDC through a 4.5VDC 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: The were no interconnect cables submitted with the test item.

2.5 OPERATIONAL MODE: For all tests the test item was energized and placed on a 80cm high non-conductive stand.

For all tests, the test item's transmit button was held down thereby setting the unit to transmit continuously. The transmitting mechanism automatically deactivated when released. The battery voltage was periodically checked to ensure proper operation at maximum level. The tests were performed with the test item operating at 433.9MHz.

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 120kHz 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: The plot of the duty cycle is shown on data page 13. The duty cycle factor was computed to be -6.5 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 433.9MHz, the limit at the fundamental is 10997.0uV/m @ 3m and the limit on the harmonics is 1099.7uV/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 bi-log 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.

   (e) 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 433.9MHz, are presented on data page 14. 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 433.9MHz, are presented on data page 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 433.9MHz. The emissions level at this frequency was 0.2dB within the limit. See data page 16 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 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 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 CONCLUSION:

It was found that the Midwest Technologies model Centerline Transmitter, does meet the conducted and 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.

TABLE I: TEST EQUIPMENT LIST

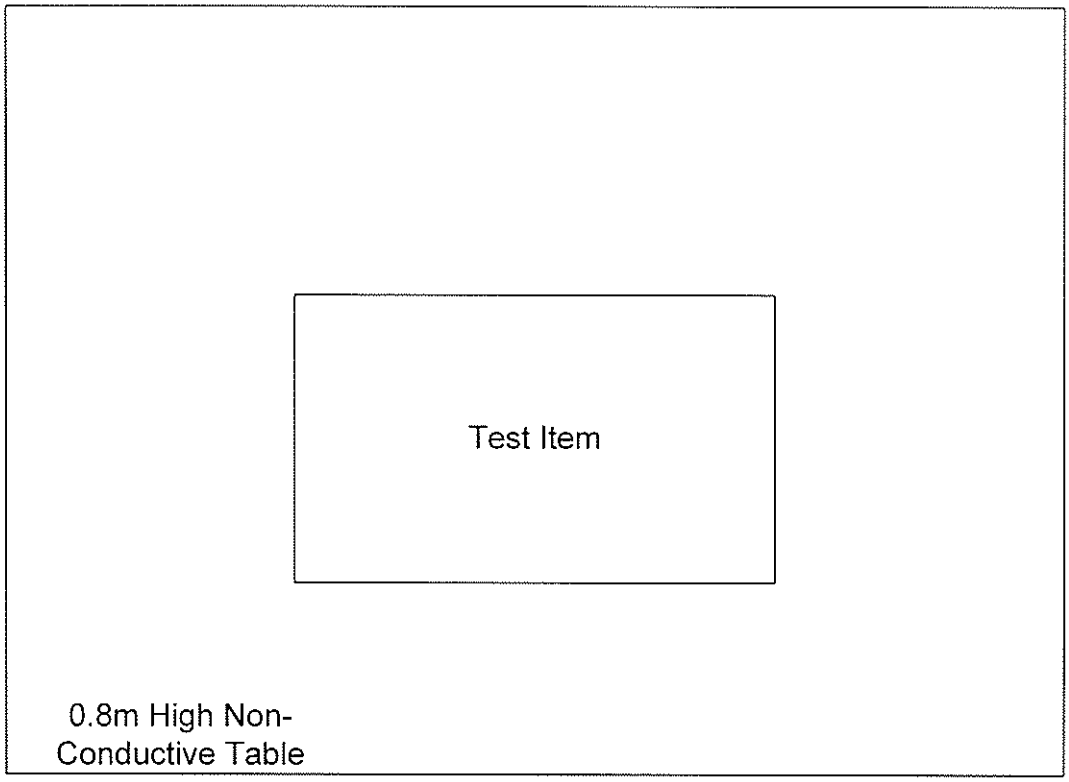
ELITE ELECTRONIC ENG. INC.

Eq ID	Equipment Description	Manufacturer	Model No.	Serial No.	Frequency Range	Cal Date	Cal Inv	Due Date
Equipment Type: ACCESSORIES, MISCELLANEOUS								
XZG3	ATTENUATOR/SWITCH DRIVER	HEWLETT PACKARD	11713A	2421A03059	---		N/A	
Equipment Type: AMPLIFIERS								
APK3	PREAMPLIFIER	AGILENT TECHNOL	8449B	3008A01593	1-26.5GHZ	05/09/02	12	05/09/03
Equipment Type: ANTENNAS								
NTAO	BILOG ANTENNA	CHASE EMC LTD.	BILOG CBL611	2057	0.03-2GHZ	06/25/02	12	06/25/03
NWFO	RIDGED WAVE GUIDE	EMCO	3105	2035	1-12.4GHZ	11/03/02	12	11/03/03
Equipment Type: CONTROLLERS								
CDD2	COMPUTER	HEWLETT PACKARD	D4171A#ABA	US61654645	---		N/A	
CMAO	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								
RAC2	SPECTRUM ANALYZER	HEWLETT PACKARD	85660B	3638A08770	100HZ-22GHZ	02/10/03	12	02/10/04
RACD	RF PRESELECTOR	HEWLETT PACKARD	85685A	3010A01205	20HZ-2GHZ	02/10/03	12	02/10/04
RAF4	QUASIPEAK ADAPTER	HEWLETT PACKARD	85650A	2043A00320	0.01-1000MHZ	02/10/03	12	02/10/04
RAKI	RF SECTION	HEWLETT PACKARD	85462A	3411A00181	0.009-6500MHZ	02/07/03	12	02/07/04
RAKJ	RF FILTER SECTION	HEWLETT PACKARD	85460A	3330A00154	---	02/07/03	12	02/07/04

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



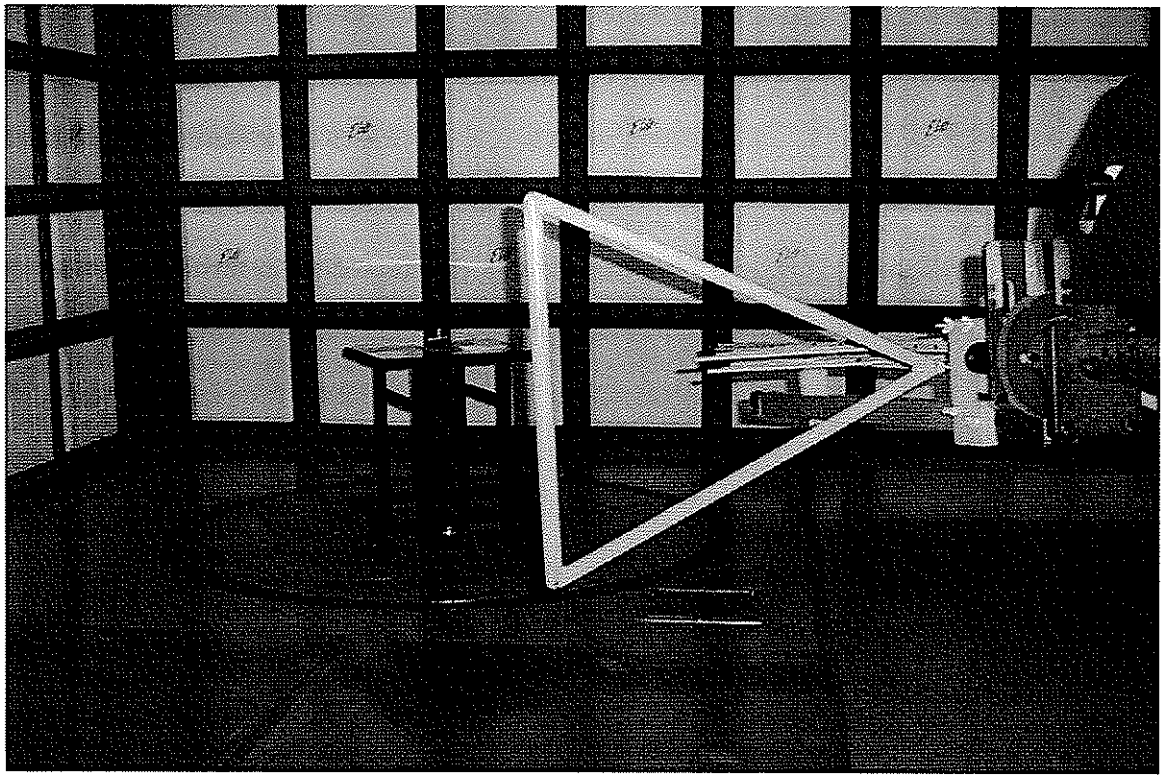


FIGURE 2a - TEST SETUP FOR HIGHEST RADIATED EMISSIONS MEASUREMENT HORIZONTAL POLARITY

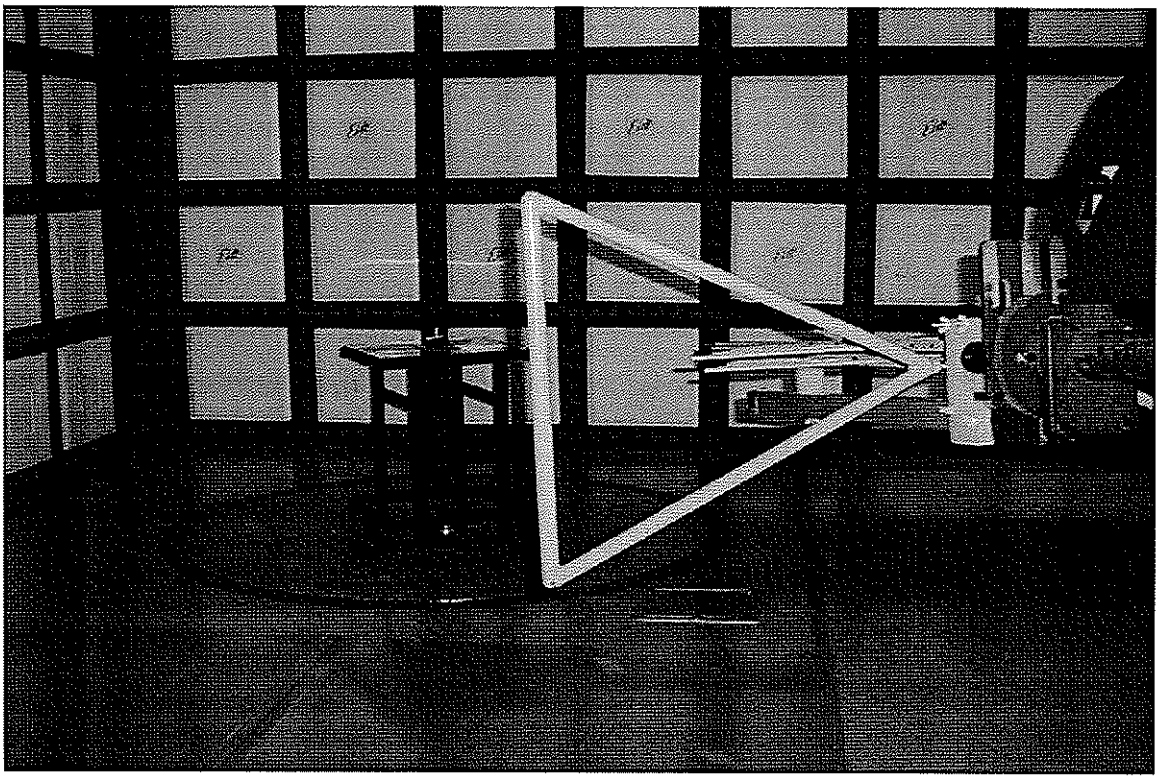


FIGURE 2b - TEST SETUP FOR HIGHEST RADIATED EMISSIONS MEASUREMENT VERTICAL POLARITY

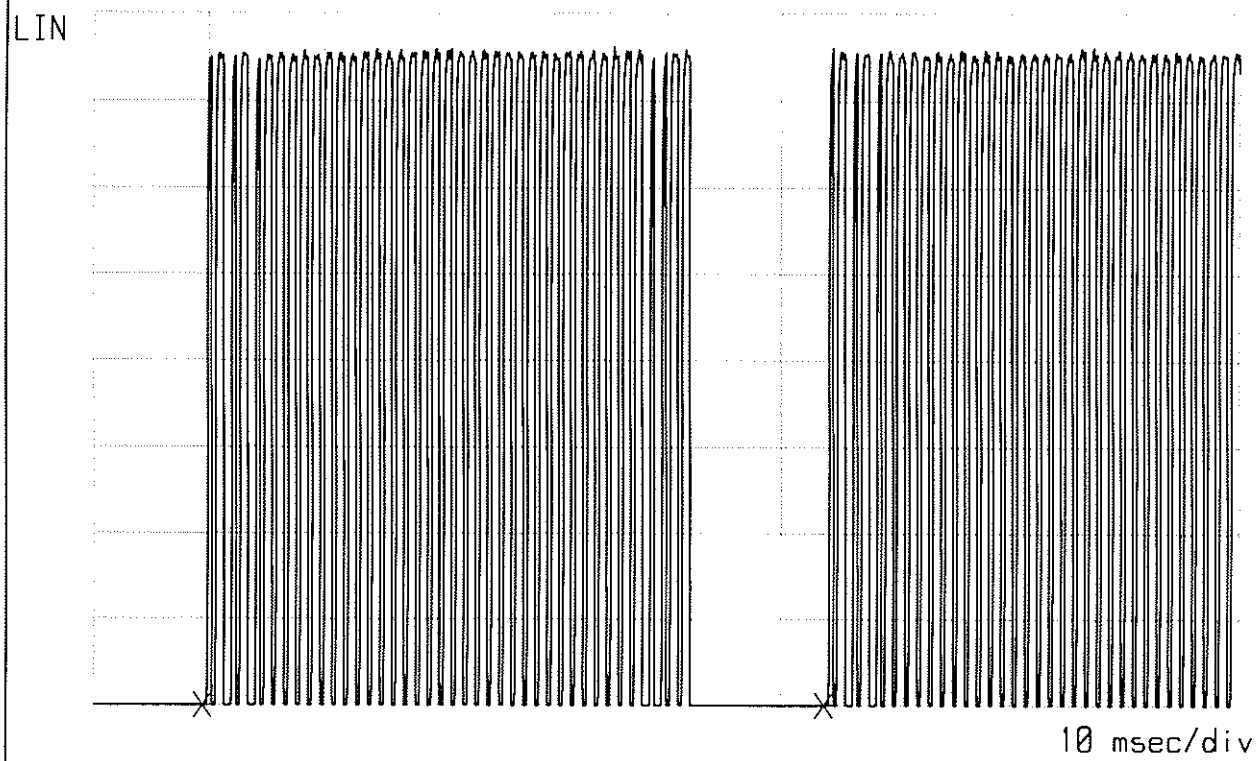
ELITE ELECTRONIC ENGINEERING Inc.

Downers Grove, Il 60515

WQF0 07/16/02

TRANSMITTER DUTY CYCLE

FREQUENCY : 433.927 MHz
ON TIME : 25.636 msec
OFF TIME : 28.565 msec
DUTY CYCLE : .47 OR -6.5 dB
COMPUTED OVER 1 DATA WORD

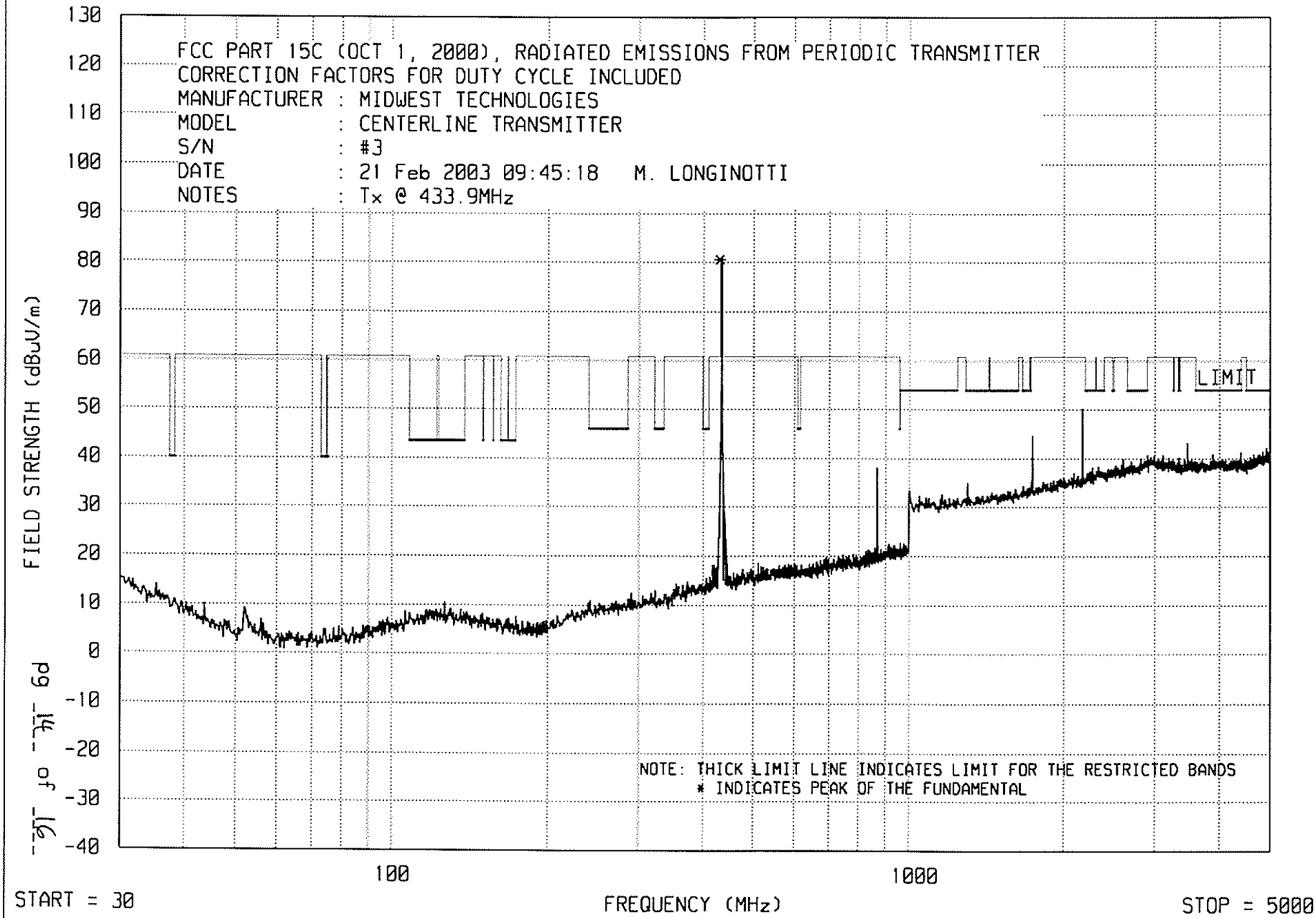


MANUFACTURER : MIDWEST TECHNOLOGIES
MODEL : CENTERLINE TRANSMITTER
S/N : #3
NOTES : Tx @ 433.9MHz
DATE : 21 Feb 2003 09:45:18 M. LONGINOTTI

ELITE ELECTRONIC ENGINEERING Inc.

Downers Grove, Ill. 60515

WQF0 07/16/02



HARMONIC AND EXCESSIVE EMISSIONS FROM TRANSMITTER

SPECIFICATION : FCC PART 15C (OCT 1, 2000)
MANUFACTURER : MIDWEST TECHNOLOGIES
MODEL : CENTERLINE TRANSMITTER
S/N : #3
DATE : 21 Feb 2003 09:45:18 M. LONGINOTTI
NOTES : Tx @ 433.9MHz
DUTY CYCLE : -6.5 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.	433.9	68.4	12.2	80.6	10703.2	10997.0	-.2	NO
2	867.9	20.4	17.7	38.1	80.2	1099.7	-22.7	NO
3	1301.8	12.5	22.6	35.1	56.6	500.0	-18.9	YES
4	1735.7	20.4	24.2	44.7	171.0	1099.7	-16.2	NO
5	2169.6	24.0	26.2	50.2	324.7	1099.7	-10.6	NO
6	2603.6	11.9	28.0	39.9	99.2	1099.7	-20.9	NO
7	3037.5	10.8	29.3	40.1	100.9	1099.7	-20.8	NO
8	3471.4	13.3	29.9	43.2	144.9	1099.7	-17.6	NO
9	3905.3	9.4	30.5	39.9	99.0	500.0	-14.1	YES
10	4339.3	8.5	30.8	39.3	92.3	500.0	-14.7	YES

Checked By: Mark E Longinotti

ELITE ELECTRONIC ENGINEERING Inc.

hp

REF 87.0 dBuV ATTEN 0 dB

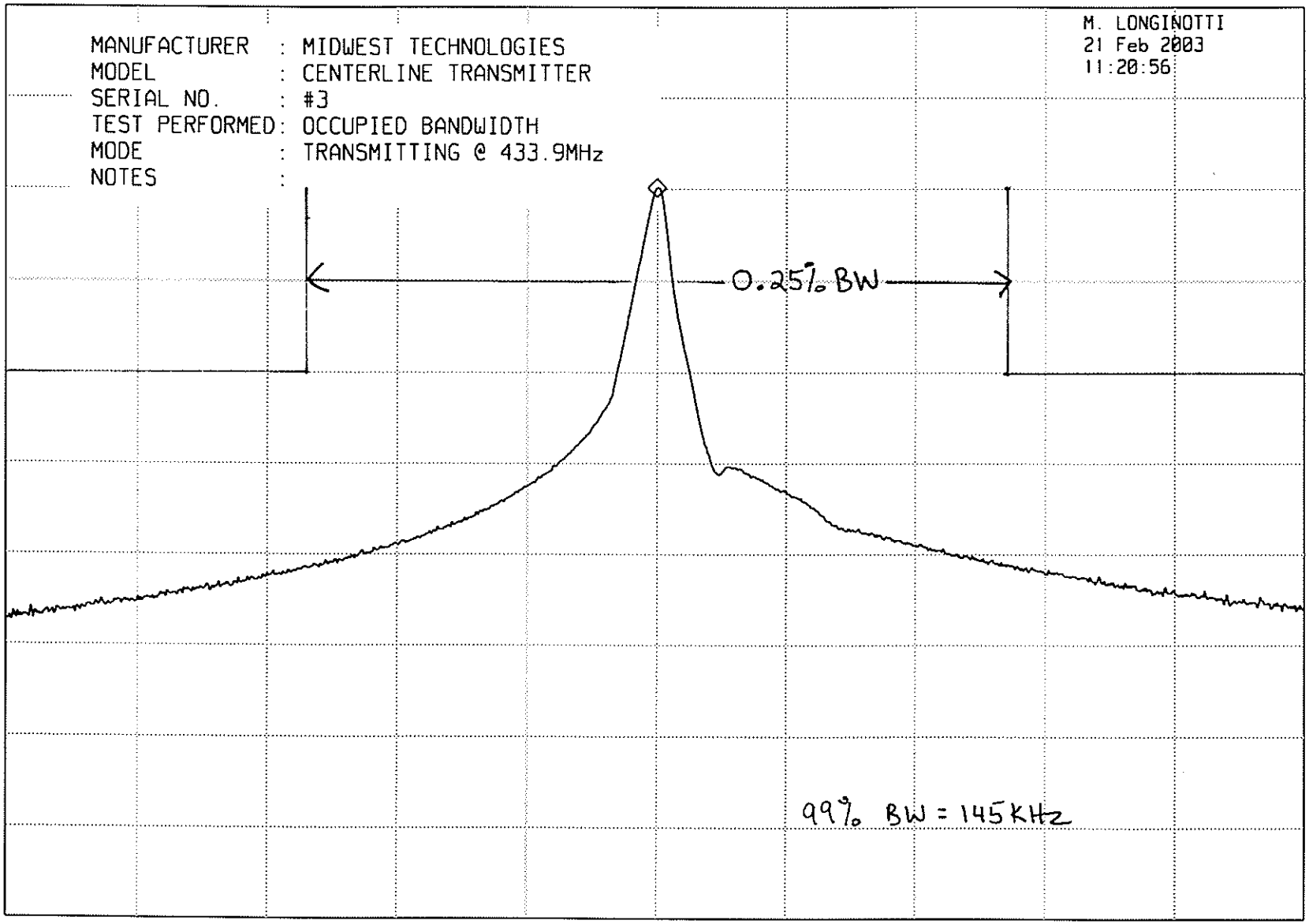
MKR 433.926 MHz
67.20 dBuV

10 dB/

OFFSET
-10.0
dB

MANUFACTURER : MIDWEST TECHNOLOGIES
MODEL : CENTERLINE TRANSMITTER
SERIAL NO. : #3
TEST PERFORMED: OCCUPIED BANDWIDTH
MODE : TRANSMITTING @ 433.9MHz
NOTES :

M. LONGINOTTI
21 Feb 2003
11:20:56



CENTER 433.92 MHz
RES BW 30 kHz(i) VBW 300 kHz

SPAN 2.00 MHz
SWP 20.0 msec

pg. 16 of 16