ELITE ELECTRONIC ENGINEERING COMPANY
1516 CENTRE CIRCLE
DOWNERS GROVE, ILLINOIS 60515-1082

ELITE PROJECT: 27442 DATES TESTED: March 8, 1999

TEST PERSONNEL: Daniel E. Crowder

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

ENGINEERING TEST REPORT NO. 21501

MEASUREMENT OF RF INTERFERENCE FROM

A MODEL VER-1650 COM. BADGE TRANSMITTER

FOR: Versus Technology, Inc.
Traverse City, Michigan

PURCHASE ORDER NO.: RLW-00362

Report By:
Daniel E. Crowder

Witnessed By:
Robert Wiser
Versus Technology, Inc.

Approved By:
Raymond J. Klouda
Registered Professional
Engineer of Illinois - 44894

ENGINEERING TEST REPORT NO. 21501

ADMINISTRATIVE DATA AND SUMMARY OF TESTS

DESCRIPTION OF TEST ITEM: Com. Badge Transmitter

MODEL NO: VER-1650 **SERIAL NO:** None Assigned

MANUFACTURER: Versus Technology, Inc.

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 COMPANY
Radio Interference Consultants
Downers Grove, Illinois 60515

DATE RECEIVED: March 8, 1999

DATE TESTED: March 8, 1999

PERSONNEL (OPERATORS, OBSERVERS, AND CO-ORDINATORS):
CUSTOMER: Robert Wiser of Versus Technology, Inc. was present.
ELITE ELECTRONIC: Daniel E. Crowder

ELITE JOB NO.: 27442

ABSTRACT: The model VER-1650 Com. Badge 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 1301.9MHz. The emissions level at this frequency was 1.8dB within the limit. See data page 3 for more details.

ENGINEERING TEST REPORT NO. 21501

TABLE OF CONTENTS

TOTAL NUMBER OF PAGES IN THIS DOCUMENT, (INCLUDING DATA SHEETS): 17

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MEASUREMENT OF RF INTERFERENCE FROM

A MODEL VER-1650 COM. BADGE TRANSMITTER

1.0 INTRODUCTION:

1.1 DESCRIPTION OF TEST ITEM: On March 8, 1999, a series of radio interference measurements were performed on a model VER-1650 Com. Badge 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 433.0 MHz using an internal antenna, 5.2 inches long. The tests were performed for Versus Technology, Inc. of Traverse City, Michigan.

1.2 PURPOSE: The test series was performed to determine if the test item meets the 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 1997
- ANSI C63.4-1992, "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 the Elite Electronic Engineering Company, 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 20°C and the relative humidity was 25%.

2.0 TEST ITEM SETUP AND OPERATION:

2.1 POWER INPUT: The test item received 4.5 VDC from internal batteries.

2.2 GROUNDING: Since the test item was powered with 4.5VDC through a battery, it was ungrounded during the tests.

2.3 PERIPHERAL EQUIPMENT: There was no peripheral equipment.

2.4 INTERCONNECT CABLES: There were no interconnect cables.

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 433.0MHz.

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 an HP 8566B 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.

The duty cycle factor was calculated from the pulse train for the test item. A data plot was obtained to determine the duty cycle factor. The duty cycle factor was computed as the Word ON time divided by the Word period (ON time + OFF time). The duty cycle factor in dB = 20 log (Word ON/Word period). If the word period is more than 100 milliseconds, then the duty cycle would be computed on the maximum Word ON time during a 100 millisecond period.

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:

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:

4.2.2 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).

4.2.3 RESULTS: The plot of the duty cycle is shown on data page 1. The duty cycle factor was computed to be -16.5dB

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(e) 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	1,500 to 5,000*	150 to 500*

* - Linear Interpolation

For 433.0MHz, the limit at the fundamental is 4383.3uV/m @ 3m and

the limit on the harmonics below 960MHz is 438.3uV/m @ 3m. The limit of the harmonics above 960MHz is 500uV/m.

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 floor 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.

Since a quasi-peak detector requires long integration times, it is not practical to automatically sweep through the quasi-peak levels. Therefore, radiated emissions from the test item were first scanned using a peak detector and automatically plotted. The frequencies where significant emission levels were noted were then remeasured using the quasi-peak detector.

The broadband measuring antenna was positioned at a 3 meter distance from the test item. The frequency range from 30MHz to 1000MHz was investigated using a peak detector function with the bilog antenna at several heights, horizontal and vertical antenna polarization, and with several different orientations of the test item with respect to the antenna. The maximum levels for each antenna polarization were

plotted.

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 quasi-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.

4.3.3 RESULTS: The preliminary plot, with the test item transmitting at 433.0 MHz, is presented on data page 2. The plots are presented for a reference only, and are not used as official data.

The final open area radiated levels, with the test item transmitting at 433.0 MHz, are presented on data pages 3. 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 1301.9MHz. The emissions level at this frequency was 1.8dB within the limit. See data page 3 for details. Photographs of the test configuration which yielded the highest, or worst case, radiated emission levels are shown on Figure 1.

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 4. As can be seen from this data page, the transmitter met the occupied bandwidth requirements.

5.0 CONCLUSION:

It was found that the Versus Technology, Inc. model VER-1650 Com. Badge 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 Company 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 as operated by Versus Technology, Inc. personnel. 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 1: 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: ANTENNAS								
NTA0	BILOG ANTENNA	CHASE EMC LTD.	BILOG CBL611	2057	.03-2GHZ	03/18/98	12	03/18/99
NWH0	DOUBLE RIDGED WAVEGUIDE	TENSOR	4105	2081	1-12.4GHZ	08/26/98	12	08/26/99
Equipment Type: CONTROLLERS								
CDD2	COMPUTER	HEWLETT PACKARD	D4171A#A8A	SUS61654645	N/A		N/A	
Equipment Type: PRINTERS AND PLOTTERS								
HRE2	LASER JET 5P	HEWLETT PACKARD	C3150A	USHB061201	---		N/A	
Equipment Type: RECEIVERS								
RAC2	SPECTRUM ANALYZER	HEWLETT PACKARD	85660B	3638A08770	100HZ-22GHZ	10/30/98	12	10/30/99
RACC	RF PRESELECTOR	HEWLETT PACKARD	85685A	2648A00507	20HZ-2GHZ	02/01/99	12	02/01/00
RAF4	QUASIPEAK ADAPTER	HEWLETT PACKARD	85650A	2043A00320	.01-1000MHZ	02/01/99	12	02/01/00

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.

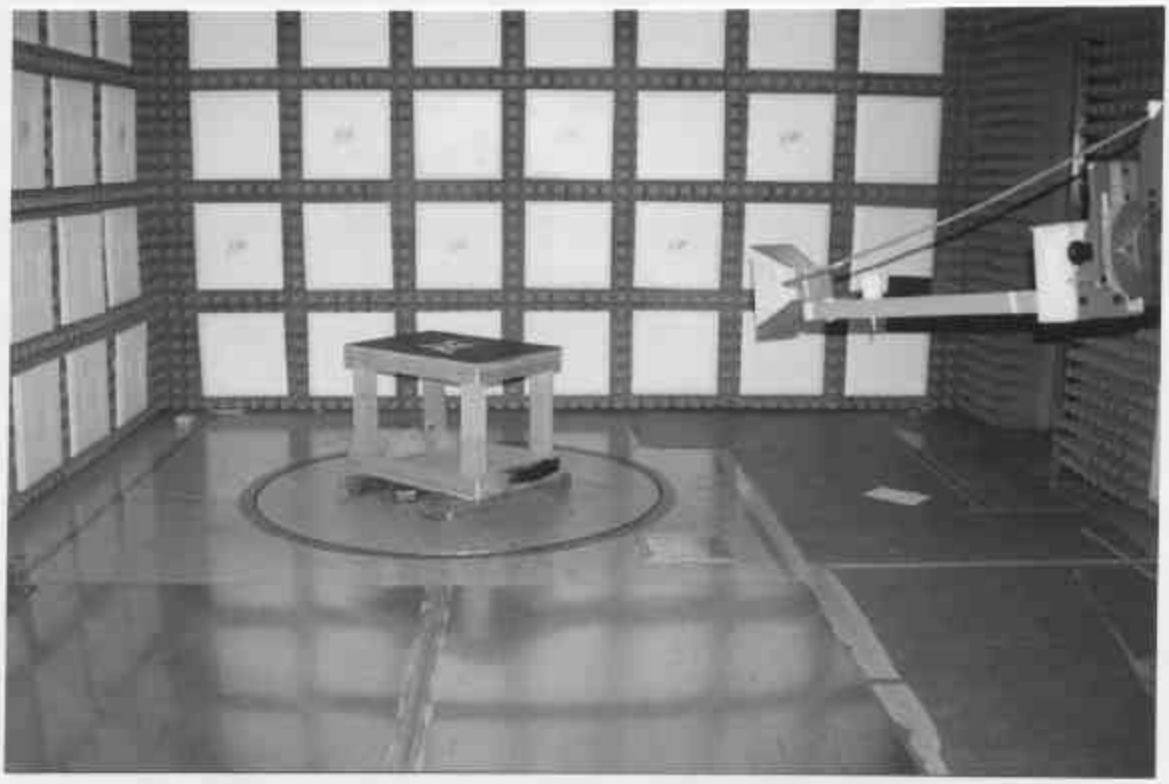
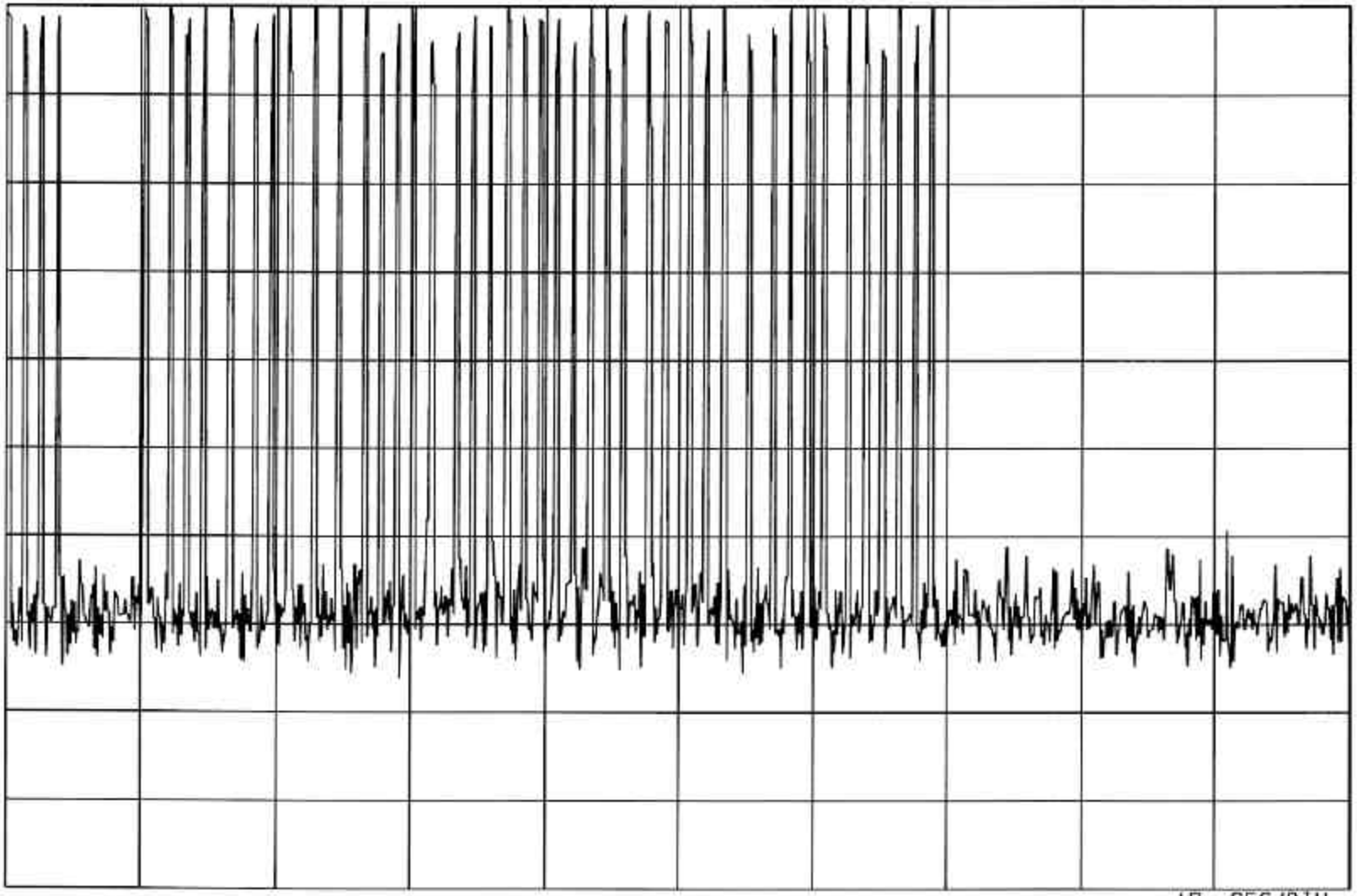


FIGURE 1A TEST SETUP FOR RADIATED EMISSIONS MEASUREMENTS
MAXIMIZED FOR MEASUREMENT OF WORST CASE EMISSIONS
HORIZONTAL POLARIZATION

FIGURE 1B TEST SETUP FOR RADIATED EMISSIONS MEASUREMENTS
MAXIMIZED FOR MEASUREMENT OF WORST CASE EMISSIONS
VERTICAL POLARIZATION

ELITE ELECTRONIC ENGINEERING Co.
Downers Grove, Il 60515



10 mSEC/DIV

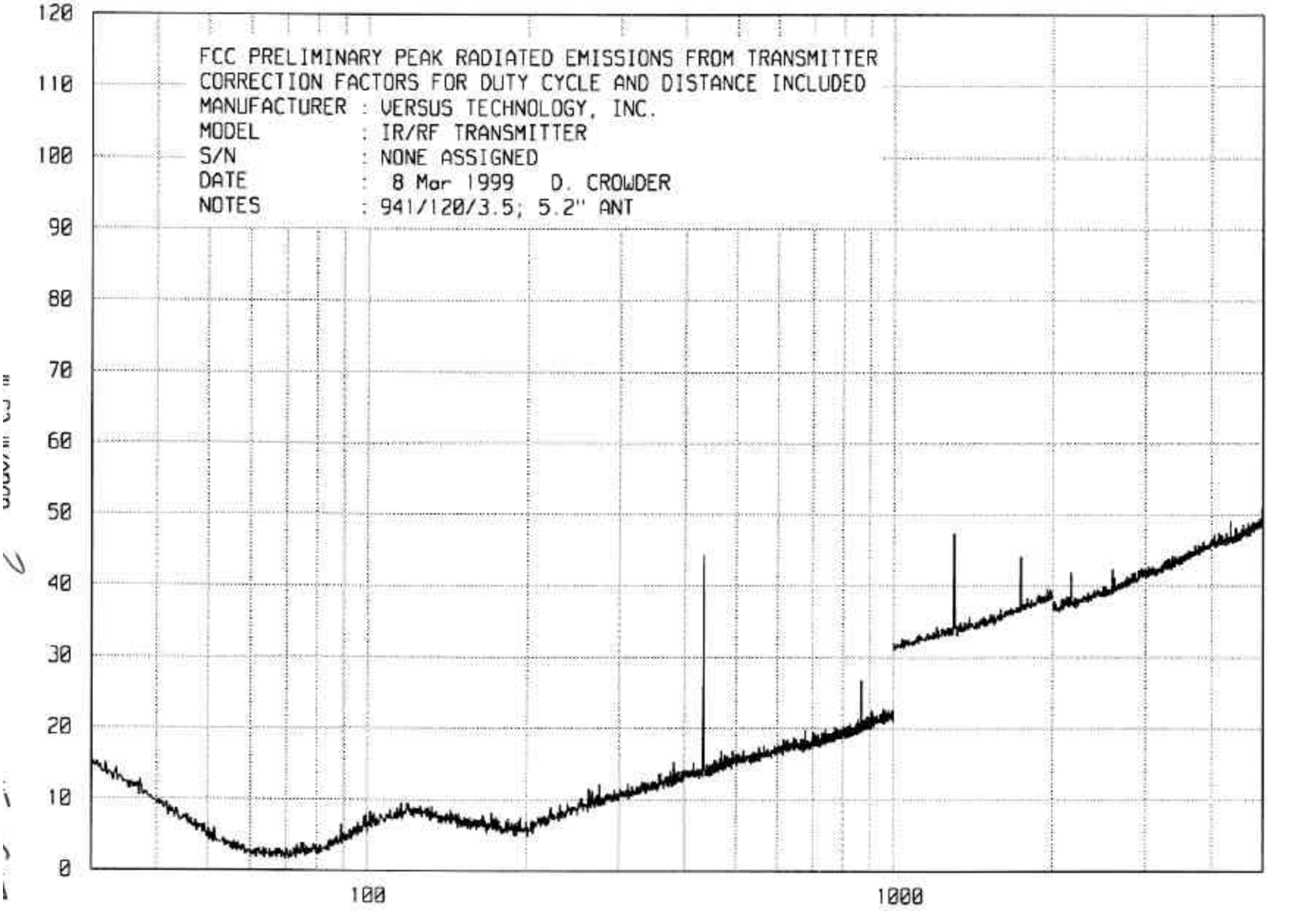
TRANSMITTER DUTY CYCLE

FREQUENCY: 433.9996 MHz
ON TIME : 14.885 mSEC
OFF TIME : 85.115 mSEC
DUTY CYCLE = .15 or -16.48 dB
COMPUTED OVER 100 mSEC

MANUFACTURER : VERSUS TECHNOLOGY, INC.
MODEL : IR/RF TRANSMITTER
S/N : NONE ASSIGNED
TEST DATE : 8 Mar 1999
NOTES : 941/120/3.5

ETR 21501

ELITE ELECTRONIC ENGINEERING Co.
Downers Grove, Ill. 60515



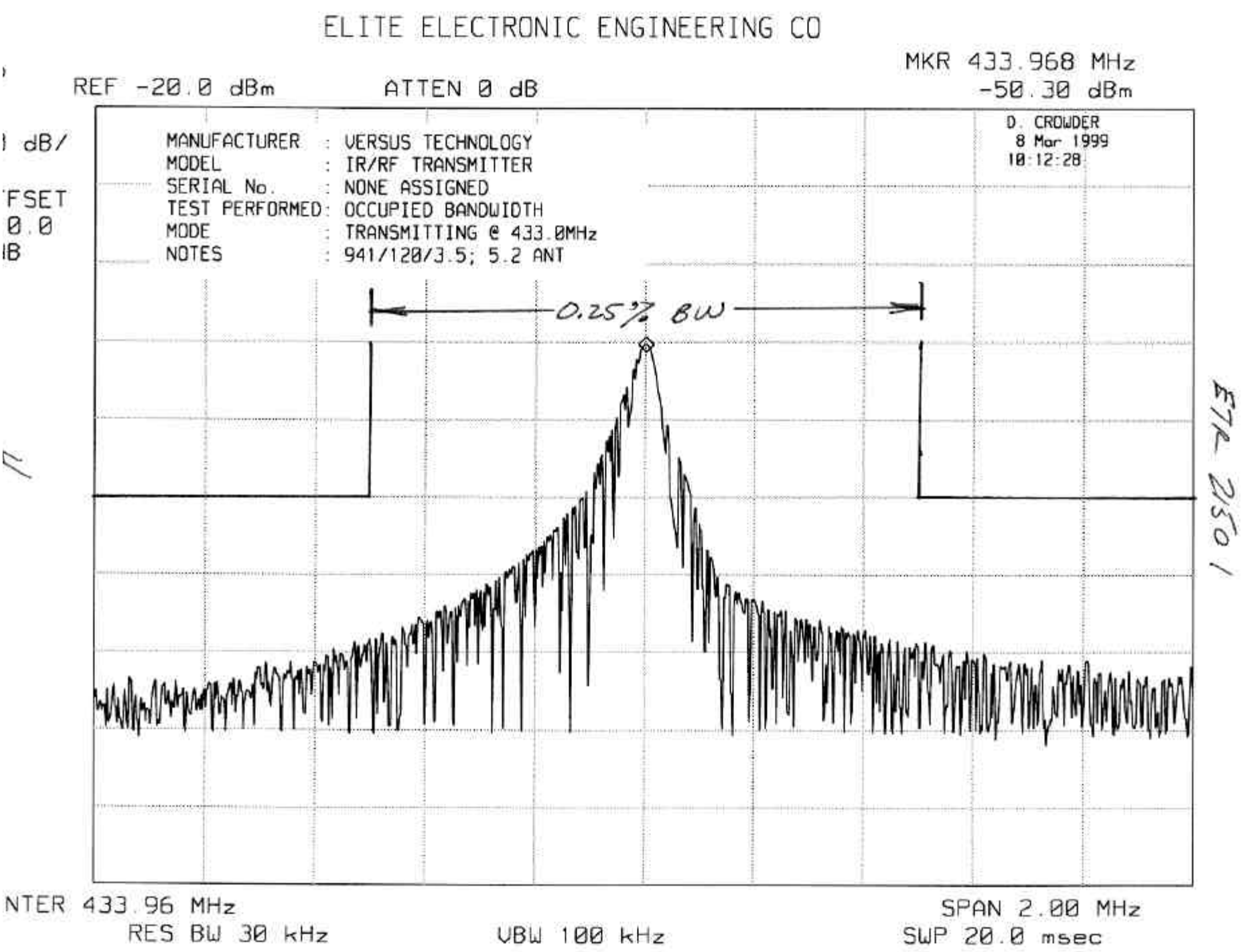
ETE 2150

ENGINEERING TEST REPORT NO. 21501
ELITE ELECTRONIC ENGINEERING, INC.

MANUFACTURER : VERSUS TECHNOLOGY, INC.
MODEL : IR/RF TRANSMITTER
S/N : NONE ASSINGED
SPECIFICATION : FCC-15C OPEN FIELD RADIATED EMISSIONS @ 3m
DATE : MARCH 8, 1999
NOTES : 941/120/3.5; 5.2" ANTENNA

FREQ. (MHz)	ANT POL	MTR RDG (dBuV)	ANT FAC dB	CABLE FAC dB	DUTY CYCLE dB	TOTAL dBuV/m	TOTAL uV/m	LIMIT uV/m
433.0	H	61.9	16.6	2.4	-16.5	64.4	1657.4	4383.3
	V	48.0	16.6	2.4	-16.5	50.5	334.5	4383.3
867.9	H	23.2	21.6	3.7	-16.5	32.0	39.9	438.3
	V	24.5	21.6	3.7	-16.5	33.3	46.3	438.3
1301.9	H	40.0	25.1	3.6	-16.5	52.2	406.8	500
	V	36.7	25.1	3.6	-16.5	48.9	278.2	500
1735.9	H	29.7	26.7	4.1	-16.5	44.0	158.2	500
	V	28.4	26.7	4.1	-16.5	42.7	136.2	500
2169.8	H	28.1	28.1	4.7	-16.5	44.3	164.5	500
	V	25.1	28.1	4.7	-16.5	41.3	116.4	500
2603.8	H	28.5	29.1	5.2	-16.5	46.3	207.0	500
	V	22.9	29.1	5.2	-16.5	40.7	108.6	500
3037.8	H	22.7	30.7	5.7	-16.5	42.6	135.5	500
	V	21.3	30.7	5.7	-16.5	41.2	115.4	500
3471.8	H	21.2	31.8	6.3	-16.5	42.8	138.2	500
	V	21.9	31.8	6.3	-16.5	43.5	149.8	500
3905.7	H	21.8	32.8	6.8	-16.5	44.9	176.2	500
	V	21.8	32.8	6.8	-16.5	44.9	176.2	500
4339.7	H	22.5	32.7	7.4	-16.5	46.1	201.4	500
	V	21.8	32.7	7.4	-16.5	45.4	185.8	500

CHECKED BY: JEL


ELITE ELECTRONIC ENGINEERING CO
MKR 433.968 MHz
-50.30 dBm
REF -20.0 dBm
ATTEN 0 dB
D. CROWDER
8 Mar 1999
10:12:28
MANUFACTURER : VERSUS TECHNOLOGY
MODEL : IR/RF TRANSMITTER
SERIAL No. : NONE ASSIGNED
TEST PERFORMED: OCCUPIED BANDWIDTH
MODE : TRANSMITTING @ 433.0MHz
NOTES : 941/120/3.5; 5.2 ANT
0.25% BW
FTR 2150 1
NTER 433.96 MHz
SPAN 2.00 MHz
RES BW 30 kHz
VBW 100 kHz
SWP 20.0 msec