

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

ELITE PROJECT: 27766

DATE TESTED: June 15, 1999

TEST PERSONNEL: Daniel Crowder

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

ENGINEERING TEST REPORT NO. 21873
MEASUREMENT OF RF INTERFERENCE FROM
A BUS SCAN TRANSMITTER

FOR: RTI Group Inc.
Joliet Il

PURCHASE ORDER NO.: 4970

Report By: *RICHARD E. KING*
Richard E. King

Witnessed By:
Tom Mavec
RTI Group Inc.

Approved By: *Raymond J. Klouda*
Raymond J. Klouda
Registered Professional
Engineer of Illinois -
4894/25008

ENGINEERING TEST REPORT NO. 21873

ADMINISTRATIVE DATA AND SUMMARY OF TESTS

DESCRIPTION OF TEST ITEM: Bus Scan

MODEL NO: None given

SERIAL NO: None Given

MANUFACTURER: RTI Group 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 INCORPORATED
Radio Interference Consultants
Downers Grove, Illinois 60515

DATE RECEIVED: June 14, 1999

DATE TESTED: June 15, 1999

PERSONNEL (OPERATORS, OBSERVERS, AND CO-ORDINATORS):
CUSTOMER: Tom Mavec of RTI Group Inc. was present.
ELITE ELECTRONIC: Daniel Crowder

ELITE JOB NO.: 27766

ABSTRACT: The model Bus Scan, 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 632.3MHz. The emissions level at this frequency was 2.6dB within the limit. See data page 16 for more details.

ENGINEERING TEST REPORT NO. 21873

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	5
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	7
4.2	DUTY CYCLE FACTOR MEASUREMENTS	7
	4.2.2 PROCEDURES	7
	4.2.3 RESULTS	7
4.3	RADIATED MEASUREMENTS	7
	4.3.1 REQUIREMENTS	7
	4.3.2 PROCEDURES	8
	4.3.2.1 PRELIMINARY RADIATED MEASUREMENTS	8
	4.3.2.2 FINAL RADIATED MEASUREMENTS	9
	4.3.3 RESULTS	9
4.4	OCCUPIED BANDWIDTH MEASUREMENTS	10
	4.4.1 REQUIREMENTS	10
	4.4.2 PROCEDURES	10
	4.4.3 RESULTS	10
5.0	CONCLUSION	11
6.0	CERTIFICATION	11
7.0	ENDORSEMENT DISCLAIMER	11
	TABLE I - EQUIPMENT LIST	12

TOTAL NUMBER OF PAGES IN THIS DOCUMENT,
(INCLUDING DATA SHEETS): 18

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

ENGINEERING TEST REPORT NO. 21873
MEASUREMENT OF RF INTERFERENCE FROM
A BUS SCAN TRANSMITTER

1.0 INTRODUCTION:

1.1 DESCRIPTION OF TEST ITEM: On the day of June 15, 1999, a series of radio interference measurements were performed on a Bus Scan 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 315MHz using an internal antenna. The tests were performed for RTI Group Inc. of Joliet IL.

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 1998
- 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 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 27°C and the relative humidity was 50%.

2.0 TEST ITEM SETUP AND OPERATION:

A block diagram of the test item setup is included as Figure 3.

2.1 POWER INPUT: The test item obtained 12VDC power through an external battery.

2.2 GROUNDING:

Since the test item was powered with 12V through a 12VDC battery, it was ungrounded during the tests.

2.3 PERIPHERAL EQUIPMENT: The test item was not submitted with peripheral equipment.

2.4 INTERCONNECT CABLES: The test item was not submitted with interconnect cables.

2.5 OPERATIONAL MODE: For all tests the test item equipment was placed on a 80cm high non-conductive stand. The test item was operated in the transmit mode. This mode was achieved by energizing the test item and pressing the transmit button. The tests were performed with the test item operating at 315MHz.

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 85462A spectrum analyzer. The spectrum analyzer peak detected readings were converted to average readings using a duty

ETR No. 21873

DATA PAGE

SPECIFICATION : FCC PART 15C (REV OCT 1, 94) TRANSMITTER OPEN FIELD DATA
 MANUFACTURER : RTI
 MODEL : BUS SCAN
 S/N : NONE ASSIGNED
 TEST DATE : 15 Jun 1999
 NOTES : MOD UNIT
 TEST ANTENNA : ROBERTS DIPOLE & DRWG ANTENNAS

FREQUENCY MHz	ANT POL	MIR RDG dBuV	CBL FAC dB	ANT FAC dB	DUTY CYCLE dB	TOTAL dBuV/m @3m	TOTAL uV/m @3m	LIMIT uV/m @3m	NOTES
316.10	H	49.8	.7	18.8	-12.8	56.6	673.7	6087.5	
316.10	V	44.5	.7	18.8	-12.8	51.3	366.0	6087.5	
632.30	H	37.8	1.2	24.1	-12.8	50.3	326.9	608.8	
632.30	V	40.6	1.2	24.1	-12.8	53.1	451.3	608.8	
948.70	H	16.0	1.5	28.5	-12.8	33.2	45.7	608.8	
948.70	V	14.7	1.5	28.5	-12.8	31.9	39.4	608.8	
1264.80	H	16.7	1.8	24.5	-12.8	30.2	32.3	608.8	
1264.80	V	18.1	1.8	24.5	-12.8	31.6	37.9	608.8	
1580.80	H	7.2	2.0	25.5	-12.8	21.9	12.4	500.0	*
1580.80	V	8.3	2.0	25.5	-12.8	23.0	14.1	500.0	*
1897.00	H	10.0	2.2	27.1	-12.8	26.4	20.9	608.8	
1897.00	V	9.5	2.2	27.1	-12.8	25.9	19.8	608.8	
2213.40	H	20.0	2.4	28.2	-12.8	37.7	77.1	500.0	*
2213.40	V	17.7	2.4	28.2	-12.8	35.4	59.1	500.0	*
2529.20	H	20.6	2.6	29.1	-12.8	39.5	94.2	608.8	
2529.20	V	16.7	2.6	29.1	-12.8	35.6	60.1	608.8	
2845.30	V	20.6	2.7	30.4	-12.8	41.0	111.8	500.0	*
2845.30	H	20.0	2.7	30.4	-12.8	40.4	104.3	500.0	*
3161.40	H	20.1	2.9	31.5	-12.8	41.8	122.9	608.8	
3161.40	V	21.6	2.9	31.5	-12.8	43.3	146.0	608.8	

* DENOTES A FREQUENCY CONFLICT WITH RESTRICTED BANDS

checked by:



D. CROWDER

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 18. The duty cycle factor was computed to be -12.77 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 6087.5uV/m @ 3m and the limit on the harmonics is 608.8uV/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:

4.3.2.1 PRELIMINARY RADIATED MEASUREMENTS: All preliminary tests were performed in a 17ft. x 14ft. x 8ft. 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.

The broadband measuring antenna was positioned at a 1 meter distance from the test item. The entire frequency range from 30MHz to 4.0GHz was investigated using a peak detector function. The data was then processed by the computer to equivalent field intensity at 3 meters using linear extrapolation. A -9.5dB ($-9.5\text{dB} = 20 * \text{Log}(1\text{m}/3\text{m})$) distance correction factor has automatically been applied to the plotted emissions data to allow a direct comparison of the data obtained at 1 meter with the emissions limit at the 3 meter specification distance.

4.3.2.2 FINAL RADIATED MEASUREMENTS: The Final open field measurements were manually performed at Elite's open field test site located in Downers Grove, Illinois. The open field test site is located in a clear area and is equipped with a 1/4-inch wire mesh

ground plane. The facility complies with the test site criteria in ANSI C63.4-1992.

Measurements were performed at a test distance of 3 meters using a peak detector. The peak detected levels were converted to average levels using a duty cycle factor which was computed from the pulse train.

The final open field emission tests were performed over the frequency range of the fundamental through the 10th harmonic. A tuned dipole antenna was used over the frequency range of 30MHz to 1GHz. Above 1GHz a double ridged waveguide antenna was used.

All significant broadband and narrowband signals were measured and recorded.

To ensure that maximum emission levels were measured, the following steps were taken:

- 1) Measurements were made using a peak detector and a tuned dipole 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: An initial test showed emissions were not within the specification limits. The test item was modified by adding a 5.1V zener diode. The preliminary plots, with the test item transmitting at 315MHz, are presented on data pages 14 and 15. The plots of data from 30MHz to 4000MHz represent composite maximum peak readings of multiple antenna heights and multiple orientations of the

test item. 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 315MHz, are presented on data page 16. 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 632.3MHz. The emissions level at this frequency was 2.6dB 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 Figures 1 and 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 17. As can be seen from this data page, the transmitter met the occupied bandwidth requirements.

5.0 CONCLUSION:

It was found that the RTI Group Inc. Bus Scan Transmitter, with the modifications in place does meet the radiated emission

requirements of the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C. 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. 21873

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: ACCESSORIES, MISCELLANEOUS								
XZG1	ATTENUATOR/SWITCH DRIVER	HEWLETT PACKARD	11713A	3439A02724	---		N/A	
Equipment Type: AMPLIFIERS								
APK1	PRE-AMPLIFIER	HEWLETT PACKARD	8449B	3008A01243	1-26.5GHZ	03/04/99	12	03/04/00
Equipment Type: ANTENNAS								
NDP1	TUNED DIPOLE ANTENNA	EMCO	3121C-DB3	313	140-400MHZ	10/07/98	12	10/07/99
NDQ1	TUNED DIPOLE ANTENNA	EMCO	3121C-DB4	313	400-1000MHZ	10/07/98	12	10/07/99
NWH0	DOUBLE RIDGED WAVEGUIDE	TENSOR	4105	2081	1-12.4GHZ	08/26/98	12	08/26/99
Equipment Type: CONTROLLERS								
CDG4	COMPUTER	HEWLETT PACKARD	D7949T	US91606067	---		N/A	
Equipment Type: RECEIVERS								
RACD	RF PRESELECTOR	HEWLETT PACKARD	85685A	3010A01205	20HZ-2GHZ	01/29/99	12	01/29/00
RAE4	SPECTRUM ANALYZER	HEWLETT PACKARD	8566B	3638A08788	100HZ-22GHZ	12/21/98	12	12/21/99

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 3 BLOCK DIAGRAM OF THE TEST ITEM SETUP.

ETR 21873

ETP 21873

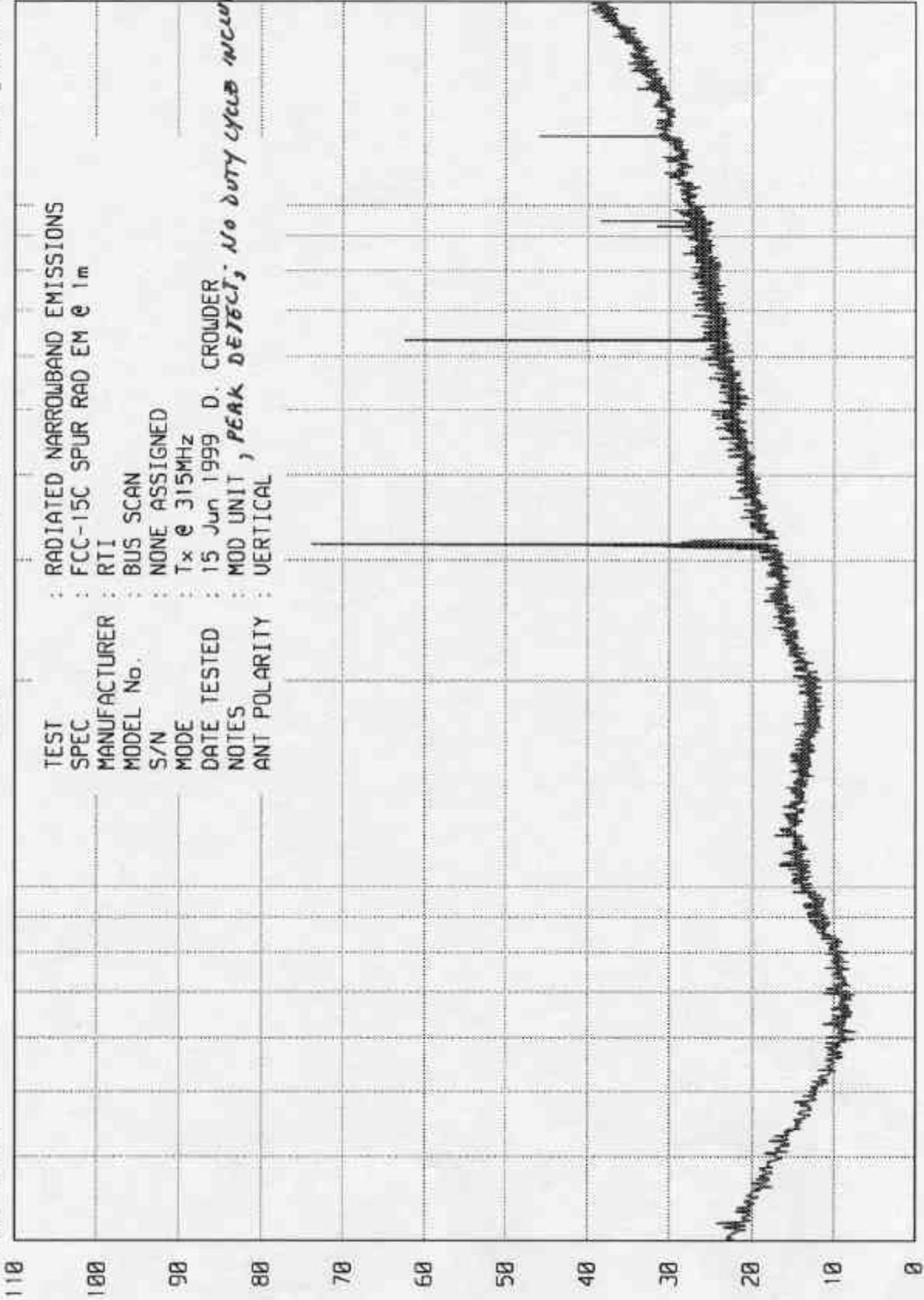
ELITE ELECTRONIC ENGINEERING Co.
Downers Grove, Ill. 60515

LJK08 82/24/98

UNITU_EM RUN RUN 1

EE

TEST : RADIATED NARROWBAND EMISSIONS
 SPEC : FCC-15C SPUR RAD EM @ 1m
 MANUFACTURER : RTI
 MODEL No. : BUS SCAN
 S/N : NONE ASSIGNED
 MODE : Tx @ 315MHz
 DATE TESTED : 15 Jun 1999 D. CROWDER
 NOTES : MOD UNIT, *PEAK DETECT; No DUTY CYCLES INCLUDED*
 ANT POLARITY : VERTICAL



100

1000

ART = 30

FREQUENCY - MHz

STOP = 2000

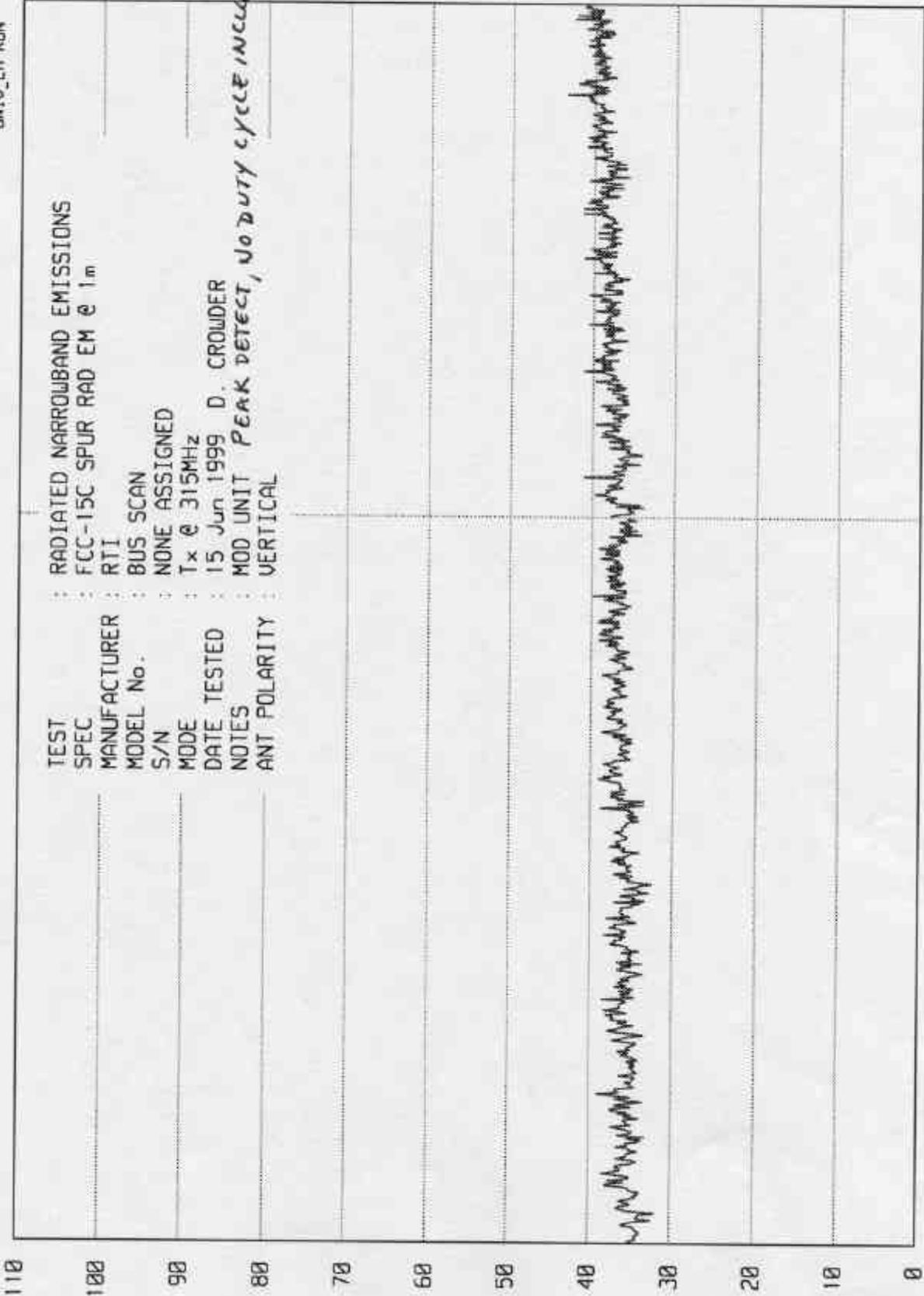
ETR 21873

ELITE ELECTRONIC ENGINEERING Co.

Downers Grove, Ill. 60515

UKAB 02/24/98

UNITU_EM RUN RUN 2



TEST : RADIATED NARROWBAND EMISSIONS
 SPEC : FCC-15C SPUR RAD EM @ 1m
 MANUFACTURER : RTI
 MODEL No. : BUS SCAN
 S/N : NONE ASSIGNED
 MODE : Tx @ 315MHz
 DATE TESTED : 15 Jun 1999 D. CROWDER
 NOTES : MOD UNIT PEAK DETECT, NO DUTY CYCLE INCLUDED
 ANT POLARITY : VERTICAL

PART = 2000

FREQUENCY - MHz

STOP = 4000

ETR No. 21873
DATA PAGE

SPECIFICATION : FCC PART 15C (REV OCT 1, 94) TRANSMITTER OPEN FIELD DATA
 MANUFACTURER : RTI
 MODEL : BUS SCAN
 S/N : NONE ASSIGNED
 TEST DATE : 15 Jun 1999
 NOTES : MOD UNIT
 TEST ANTENNA : ROBERTS DIPOLE & DRWG ANTENNAS

FREQUENCY MHz	ANT POL	MIR RDG dBuV	CBL FAC dB	ANT FAC dB	DUTY CYCLE dB	TOTAL dBuV/m @3m	TOTAL uV/m @3m	LIMIT uV/m @3m	NOTES
316.10	H	49.8	.7	18.8	-12.8	56.6	673.7	6087.5	
316.10	V	44.5	.7	18.8	-12.8	51.3	366.0	6087.5	
632.30	H	37.8	1.2	24.1	-12.8	50.3	326.9	608.8	
632.30	V	40.6	1.2	24.1	-12.8	53.1	451.3	608.8	
948.70	H	16.0	1.5	28.5	-12.8	33.2	45.7	608.8	
948.70	V	14.7	1.5	28.5	-12.8	31.9	39.4	608.8	
1264.80	H	16.7	1.8	24.5	-12.8	30.2	32.3	608.8	
1264.80	V	18.1	1.8	24.5	-12.8	31.6	37.9	608.8	
1580.80	H	7.2	2.0	25.5	-12.8	21.9	12.4	500.0	*
1580.80	V	8.3	2.0	25.5	-12.8	23.0	14.1	500.0	*
1897.00	H	10.0	2.2	27.1	-12.8	26.4	20.9	608.8	
1897.00	V	9.5	2.2	27.1	-12.8	25.9	19.8	608.8	
2213.40	H	20.0	2.4	28.2	-12.8	37.7	77.1	500.0	*
2213.40	V	17.7	2.4	28.2	-12.8	35.4	59.1	500.0	*
2529.20	H	20.6	2.6	29.1	-12.8	39.5	94.2	608.8	
2529.20	V	16.7	2.6	29.1	-12.8	35.6	60.1	608.8	
2845.30	V	20.6	2.7	30.4	-12.8	41.0	111.8	500.0	*
2845.30	H	20.0	2.7	30.4	-12.8	40.4	104.3	500.0	*
3161.40	H	20.1	2.9	31.5	-12.8	41.8	122.9	608.8	
3161.40	V	21.6	2.9	31.5	-12.8	43.3	146.0	608.8	

* DENOTES A FREQUENCY CONFLICT WITH RESTRICTED BANDS

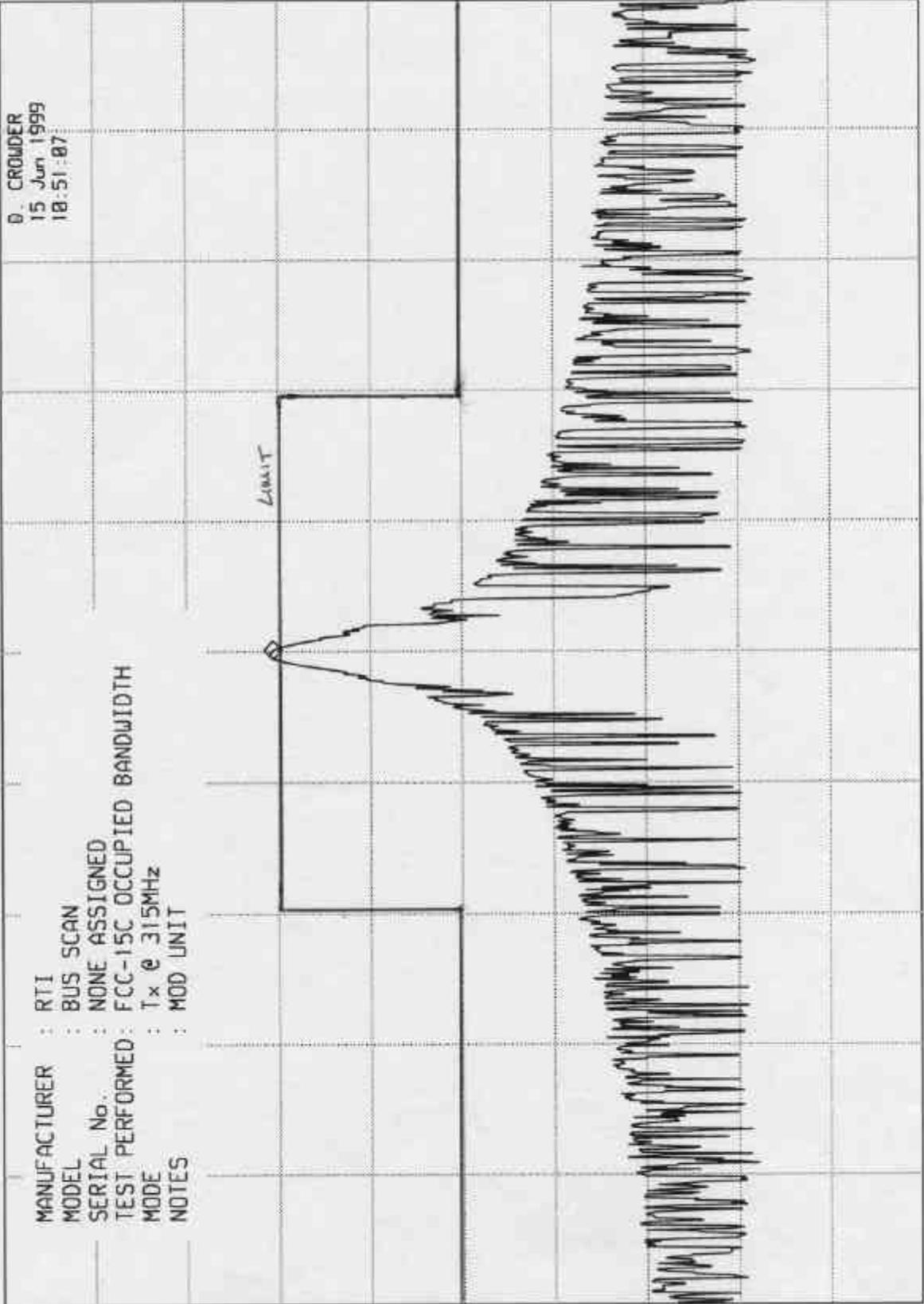
checked by:


D. CROWDER

ELITE ELECTRONIC ENGINEERING CO

MKR 316.310 MHz
47.60 dBuV

REF 77.0 dBuV ATTN 0 dB



MANUFACTURER : RTI
 MODEL : BUS SCAN
 SERIAL No. : NONE ASSIGNED
 TEST PERFORMED : FCC-15C OCCUPIED BANDWIDTH
 MODE : Tx @ 315MHz
 NOTES : MOD UNIT

D. CROWDER
 15 Jun 1999
 18:51:07

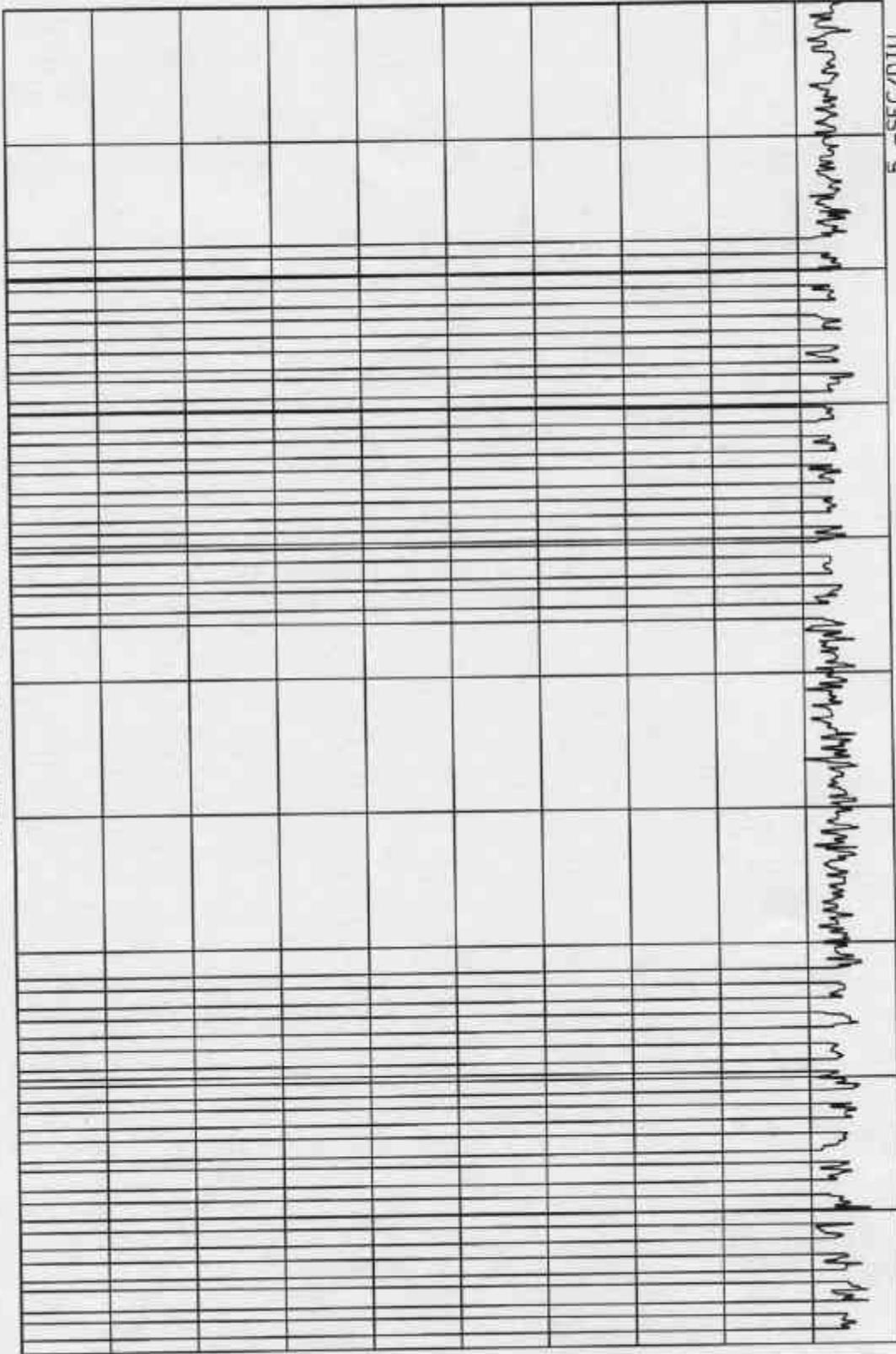
dB/
 FSET
 0.0
 B

ETR 21873

NTER 316.31 MHz SPAN 2.00 MHz
 RES BW 30 kHz VBW 100 kHz SWP 20.0 msec

ETL 21873

ELITE ELECTRONIC ENGINEERING Co.
Downer's Grove, IL 60515



5 mSEC/DIV

TRANSMITTER DUTY CYCLE
 FREQUENCY : 316.3129 MHz
 ON TIME : 6.244 mSEC
 OFF TIME : 28.779 mSEC
 DUTY CYCLE = .23 or -12.77 dB
 COMPUTED OVER 1 DATA WORD

MANUFACTURER : RTI
 MODEL : BUS SZAN
 S/N : NONE ASSIGNED
 TEST DATE : 15 Jun 1999
 NOTES :

Disc 18 of 18