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

ELITE PROJECT: 27754

DATE TESTED: June 9, 1999

TEST PERSONNEL: Daniel E. Crowder

TEST SPECIFICATION: FCC "Code of Federal Regulations" Title 47
Part 15, Subpart C, Section 15.231

ENGINEERING TEST REPORT NO. 21794

MEASUREMENT OF RF INTERFERENCE FROM

A MODEL RF019 TRANSMITTER

FOR: Gama Electronics
Woodstock, Illinois

PURCHASE ORDER NO.: 8036

Report By:
Daniel E. Crowder

Witnessed By:
Steve Reckamp
Gama Electronics

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

ENGINEERING TEST REPORT NO. 21794

ADMINISTRATIVE DATA AND SUMMARY OF TESTS

DESCRIPTION OF TEST ITEM: Transmitter

MODEL NO: RF019 **SERIAL NO:** None Assigned

MANUFACTURER: Gama Electronics

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 9, 1999

DATE TESTED: June 9, 1999

PERSONNEL (OPERATORS, OBSERVERS, AND CO-ORDINATORS):
CUSTOMER: Steve Reckamp of Gama Electronics was present.
ELITE ELECTRONIC: Daniel E. Crowder

ELITE JOB NO.: 27754

ABSTRACT: The model RF019 315MHz Transmitter, does meet the radiated emission requirements of the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, Section 15.231 for Intentional Radiators, when tested per ANSI C63.4-1992.

The radiated emissions level closest to the limit (worst case) occurred at 310.0MHz. The emissions level at this frequency was 4.9dB within the limit. See data page 15 for more details.

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A MODEL RF019 315MHz TRANSMITTER

1.0 INTRODUCTION:

1.1 DESCRIPTION OF TEST ITEM: On June 9, 1999, a series of radio interference measurements were performed on a model RF019 315MHz 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 Gama Electronics of Woodstock, Illinois.

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 the Elite Electronic Engineering Incorporated, of Downers Grove, Illinois. The laboratory is accredited by the National

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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 55%.

2.0 TEST ITEM SETUP AND OPERATION:

2.1 POWER INPUT: The test item was powered from an internal 9VDC battery.

2.2 GROUNDING: Since the test item was powered with 9VDC through a 9VDC battery, it was ungrounded during the tests.

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.

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:

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:

4.2.2 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 12. The duty cycle factor was computed to be -18.4dB

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.

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 310.0MHz, the limit at the fundamental is 5833uV/m @ 3m and the limit on the harmonics is 583uV/m @ 3m.

In addition, emissions appearing in the Restricted Bands of Operation listed in paragraph 15.231(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.

The 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 maximization techniques.

The broadband measuring antenna was positioned at a 3 meter distance from the test item. The frequency range from 30MHz to 4000MHz was investigated using a peak detector function. The maximum levels for the vertical 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 peak detector and a broadband bi-log or double ridged waveguide 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 plots are presented on data pages 13 and 14. 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 310MHz, 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 with the following modifications - the 22k ohm resistor was replaced with a 270k ohm resistor and the 100 ohm resistor was replaced with a 470 ohm resistor. The emissions level closet to the limit (worst case) occurred at 310.0MHz. The emissions level at this frequency was 4.9dB within the limit. See data page 15 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 16. As can be seen from this data page, the transmitter met the occupied bandwidth requirements.

5.0 CONCLUSION:

It was found that the Gama Electronics model RF019 315MHz Transmitter, serial number None Assigned, as modified by Gama Electronics personnel does meet the radiated emission requirements of the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, Section 15.231 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 as operated by Gama Electronics 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.

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TABLE I: TEST EQUIPMENT LIST

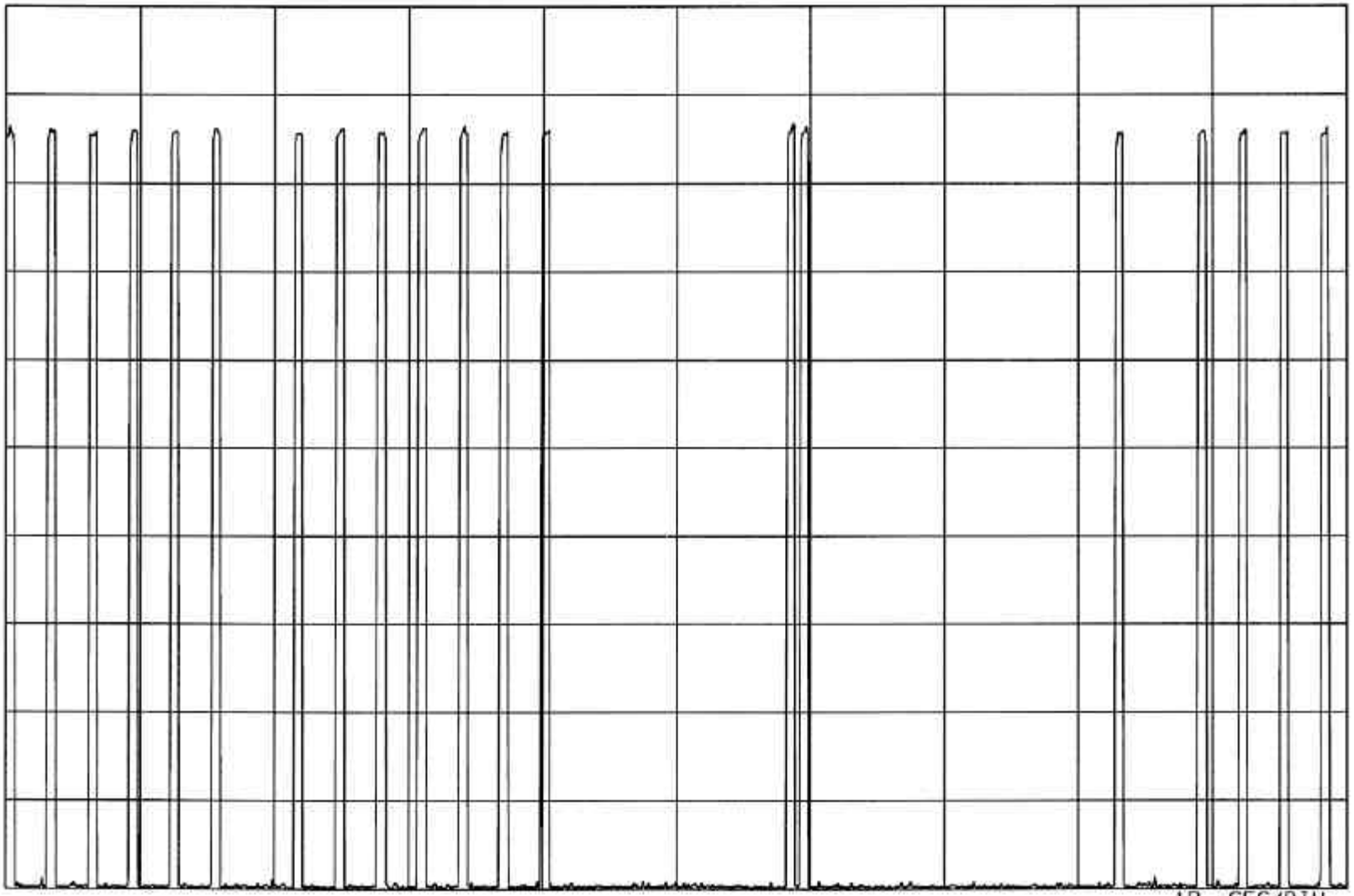
Eq ID	Equipment Description	Manufacturer	Model No.	Serial No.	Frequency Range	Cal Date	Cal Inv	Due Date
Equipment Type: ACCESSORIES, MISCELLANEOUS								
XZG0	ATTENUATOR/SWITCH DRIVER	HEWLETT PACKARD	11713A	3439A02724	---	01/29/99	N/A	
Equipment Type: AMPLIFIERS								
APK0	PRE-AMPLIFIER	HEWLETT PACKARD	8449B	3008A00662	1-26.5GHZ	01/29/99	12	01/29/00
Equipment Type: ANTENNAS								
NTA1	BILOG ANTENNA	CHASE EMC LTD.	BILOG CBL611	2054	.03-2GHZ	06/02/99	12	06/02/00
Equipment Type: CONTROLLERS								
CMA0	MULTI-DEVICE CONTROLLER	EMCO	2090	9701-1213	---		N/A	
Equipment Type: RECEIVERS								
RAC1	SPECTRUM ANALYZER	HEWLETT PACKARD	85660B	3407A08369	100HZ-22GHZ	01/26/99	12	01/26/00
RACB	RF PRESELECTOR	HEWLETT PACKARD	85685A	3506A01491	20HZ-2GHZ	01/28/99	12	01/28/00
RAF3	QUASIPEAK ADAPTER	HEWLETT PACKARD	85650A	3303A01775	0.01-1000MHZ	01/28/99	12	01/28/00

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.

ELITE ELECTRONIC ENGINEERING Co.

Downers Grove, Il 60515



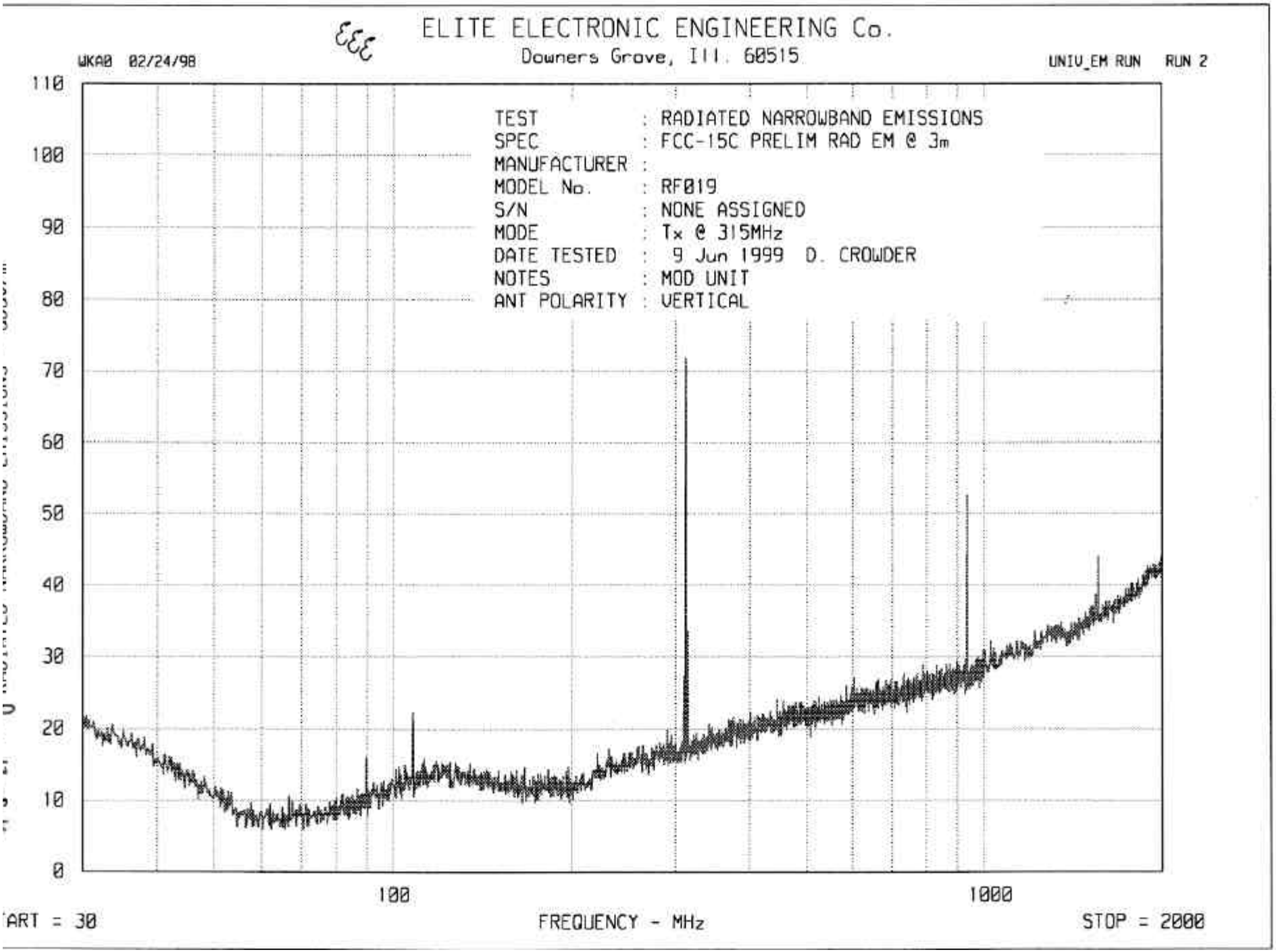
TRANSMITTER DUTY CYCLE

FREQUENCY: 310.6016 MHz
ON TIME : 12.188 mSEC
OFF TIME : 87.812 mSEC
DUTY CYCLE = .12 or -18.42 dB
COMPUTED OVER 100 mSEC

MANUFACTURER : GAMA ELECTRONICS
MODEL : RF019 315MHz TRANSMITTER
S/N : NONE ASSIGNED
TEST DATE : 9 Jun 1999
NOTES :

Dec 12 of 16

ETR 21744


ELITE ELECTRONIC ENGINEERING Co.
Downers Grove, Ill. 60515
WKA0 02/24/98
UNIV_EM RUN RUN 2
TEST : RADIATED NARROWBAND EMISSIONS
SPEC : FCC-15C PRELIM RAD EM @ 3m
MANUFACTURER :
MODEL No. : RF019
S/N : NONE ASSIGNED
MODE : Tx @ 315MHz
DATE TESTED : 9 Jun 1999 D. CROWDER
NOTES : MOD UNIT
ANT POLARITY : VERTICAL
110
100
90
80
70
60
50
40
30
20
10
0
100
1000
ART = 30
FREQUENCY - MHz
STOP = 2000

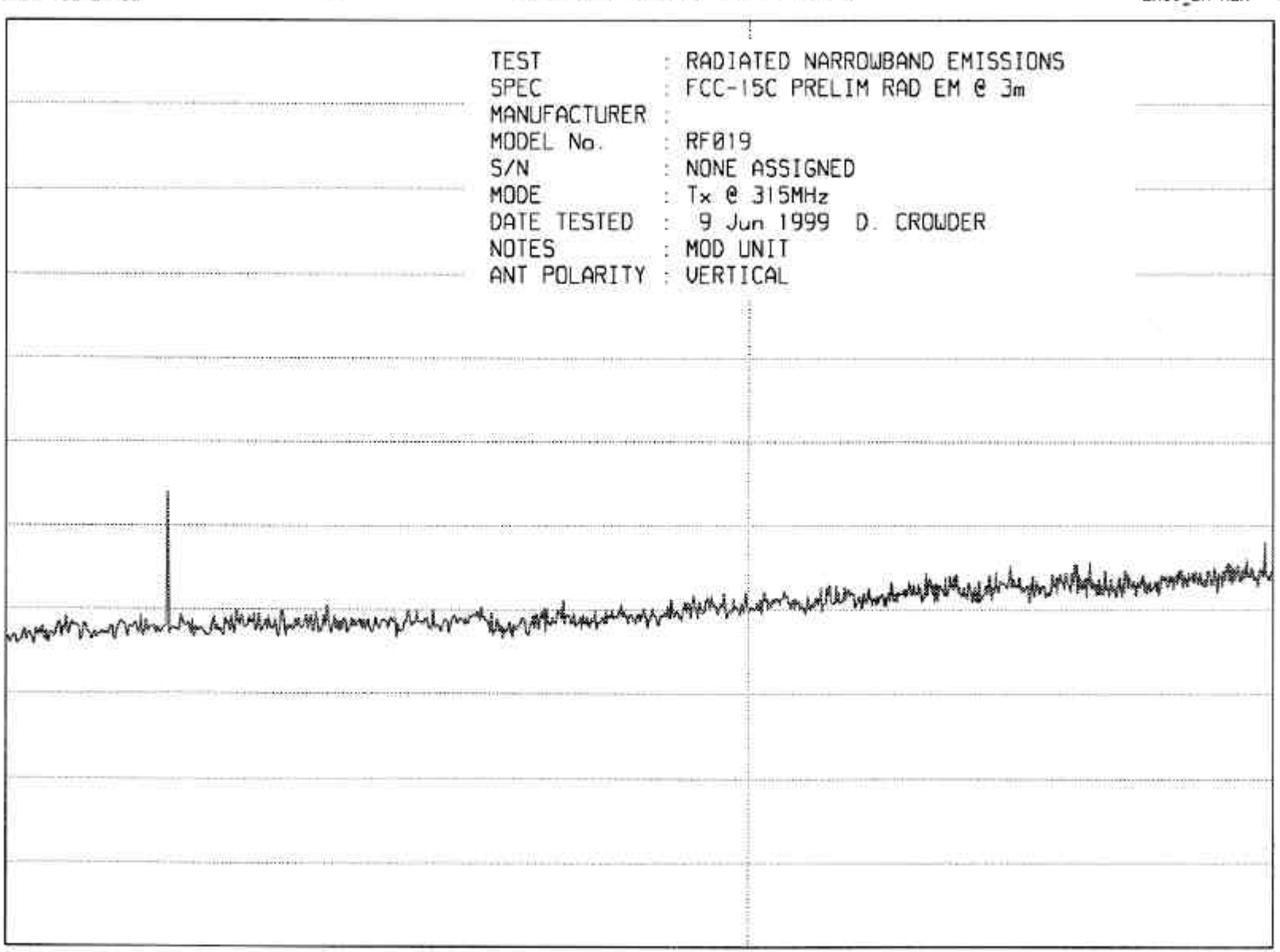
STP 21794

ELITE ELECTRONIC ENGINEERING Co.

Downers Grove, Ill. 60515

WKAB 02/24/98

UNIV_EM RUN RUN 1



START = 2000

FREQUENCY - MHz

STOP = 4000

ETR 21794

ETR No. 21794
DATA PAGE

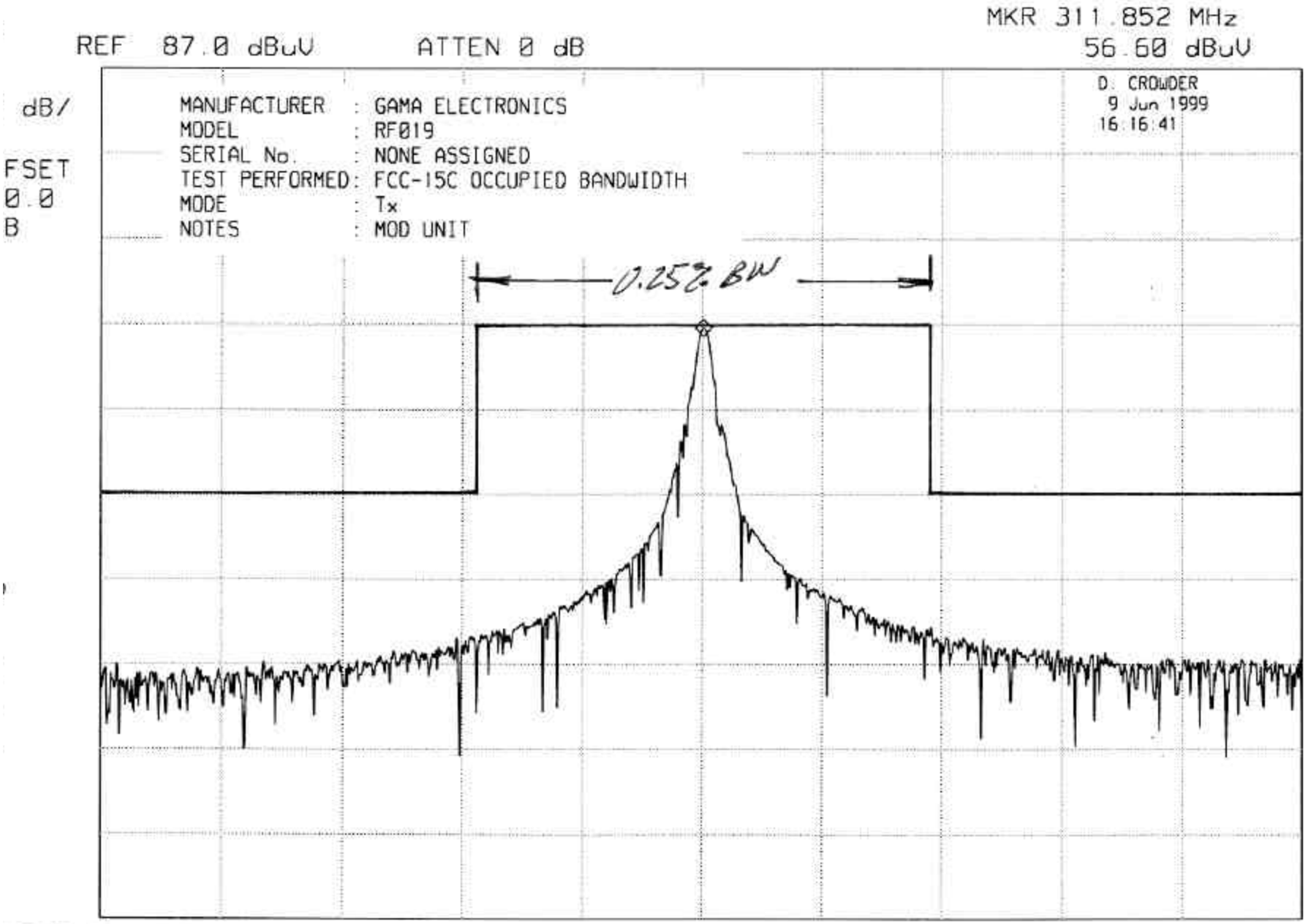
SPECIFICATION : FCC PART 15C(REV OCT 1, 94) TRANSMITTER OPEN FIELD DATA
MANUFACTURER : GAMA ELECTRONICS
MODEL : RF019
S/N : NONE ASSIGNED
TEST DATE : 9 Jun 1999
NOTES : 22k-270k & 100-470
TEST ANTENNA : CHASE BI-LOG & DRWG ANTENNAS

FREQUENCY MHz	ANT POL	MTR RDG dBuV	CBL FAC dB	ANT FAC dB	DUTY CYCLE dB	TOTAL dBuV/m @3m	TOTAL uV/m @3m	LIMIT uV/m @3m	NOTE
310.00	H	72.6	1.9	14.3	-18.4	70.4	3293.4	5833.3	
310.00	V	58.3	1.9	14.3	-18.4	56.1	634.8	5833.3	
621.30	H	38.0	3.0	19.6	-18.4	42.2	129.1	583.3	
621.30	V	30.4	3.0	19.6	-18.4	34.6	53.8	583.3	
932.00	H	39.2	3.8	22.1	-18.4	46.7	217.5	583.3	
932.00	V	31.3	3.8	22.1	-18.4	38.8	87.6	583.3	
1242.60	H	37.2	4.8	24.9	-18.4	48.6	268.5	583.3	
1242.60	V	37.3	4.8	24.9	-18.4	48.7	271.6	583.3	
1553.30	H	18.0	5.7	25.9	-18.4	31.2	36.2	500.0	*
1553.30	V	18.9	5.7	25.9	-18.4	32.1	40.2	500.0	*
1863.90	H	16.6	6.5	27.2	-18.4	31.8	39.1	583.3	
1863.90	V	16.1	6.5	27.2	-18.4	31.3	36.9	583.3	
2174.60	H	12.6	7.1	28.1	-18.4	29.3	29.3	583.3	
2174.60	V	14.2	7.1	28.1	-18.4	30.9	35.3	583.3	
2485.20	H	11.1	7.6	28.7	-18.4	29.0	28.1	500.0	*
2485.20	V	8.8	7.6	28.7	-18.4	26.7	21.6	500.0	*
2795.90	H	6.4	8.1	29.9	-18.4	25.9	19.8	500.0	*
2795.90	V	6.6	8.1	29.9	-18.4	26.1	20.3	500.0	*
3106.50	H	6.8	8.6	30.9	-18.4	27.9	24.9	583.3	
3106.50	V	6.9	8.6	30.9	-18.4	28.0	25.2	583.3	

* DENOTES A FREQUENCY CONFLICT WITH RESTRICTED BANDS

checked by: D. CROWDER

ELITE ELECTRONIC ENGINEERING CO



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