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ENGINEERING STATEMENT

For Type Certification of

KODEN INTERNATIONAL, INC.

Model No. MD-3420Mk2/3441

FCC ID: HJXMRT-152

I am an Electronic Engineer, a principal in the firm of Hyak Laboratories, Inc., Springfield Virginia. My education and experience are a matter of record with the Federal Communication Commission.

Hyak Laboratories, Inc. has been authorized by Koden International, Inc. to make Type Certification measurements on the MD-3420Mk2/3441 marine radar system. These tests were made by me or under my supervision in our Springfield laboratory.

Test data required by the FCC for Type Certification are included in this report. It is submitted that the above mentioned device meets FCC requirements and Type Certification is requested.

Rowland S. Johnson

Dated: September 17, 1999

B. GENERAL INFORMATION REQUIRED FOR TYPE ACCEPTANCE (Paragraph 2.983 of the Rules) (Continued)

5. Data for 2.985 through 2.997 follow this section B.

6. (Not applicable)
7. (Not applicable)

C. RF POWER OUTPUT (Paragraph 2.985(a) of the Rules)

RF power output into a dummy load was measured with a HP X752D directional coupler, HP X382A attenuator, and HP432A power meter with HP478A thermocouple sensor.

The power meter was corrected for directional coupler attenuation and sensor calibration.

Table 1
RF Power Output

Pulse Setting	Short	Medium	Long	
Measured PRF	2202	1106	552	PPS
Pulse Length (microseconds)	0.120	0.344	0.892	uS
Average Power	0.3	0.6	0.9	W
Duty Cycle (PRF x Pulse Length)	264.2	380.4	492.3	$(x10^{-6})$
Peak Power (Ave. PWR/Duty Cycle)	1.0	1.7	1.9	kW

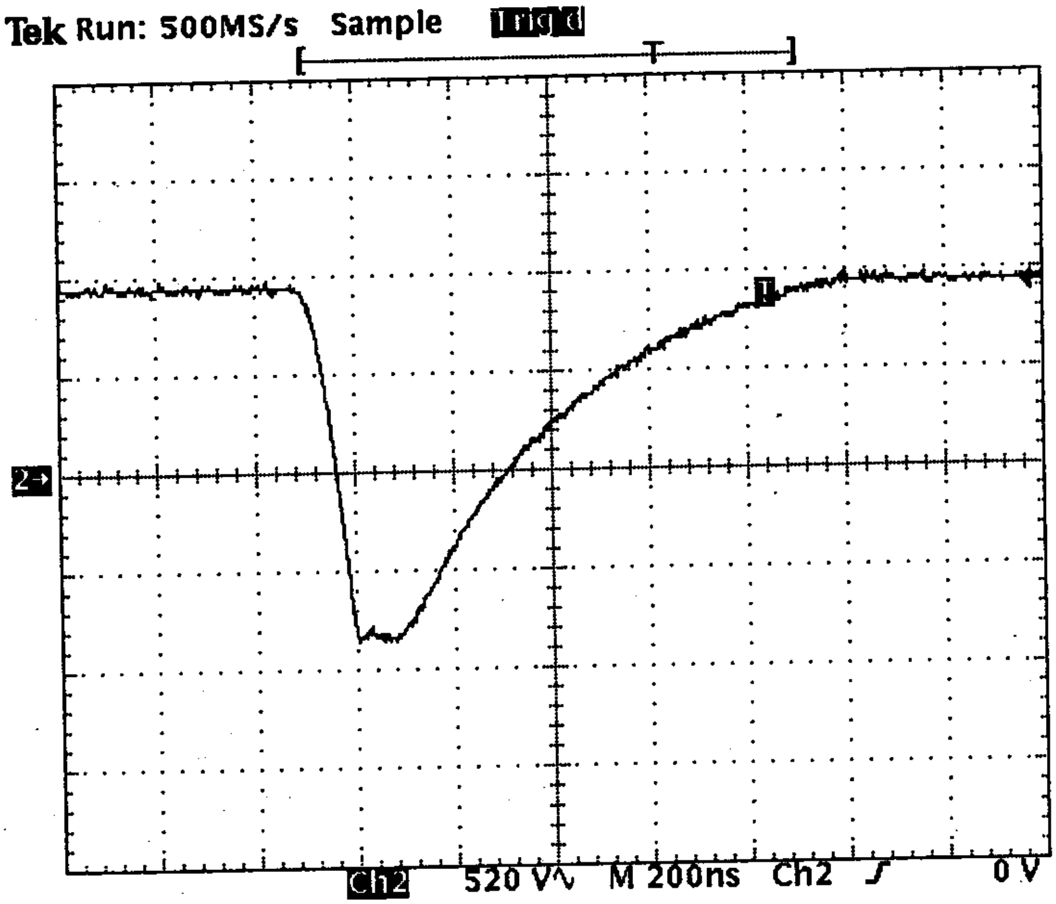
D. MODULATION CHARACTERISTICS (Paragraph 2.987 of the Rules)

1. Magnetron pulse input was measured with a Tektronix TDS360 digital storage oscilloscope and 6015 high voltage probe, and plotted with a HP 7550 plotter. Oscilloscope display for each pulse width are included as Figures 1a, 1b, and 1c for nominal pulse widths of 0.1, 0.3, and 0.8 microseconds respectively.

2. Graphs of occupied bandwidth for nominal pulse widths of 0.1, 0.3, and 0.8 microseconds are included as Figures 2a, 2b, and 2c respectively. The plots were made with Tektronix 494P spectrum analyzer and HP 7550 plotter coupled via the analyzer's IEEE 488 Port.

   Analysis of the plots demonstrated that 99% of the spectral density is within the allowed bandwidth as required by Section 2.989. (See Appendix A.)

MAGNETRON CONTROL PULSE



Nominal Pulse Width: 0.1 microseconds

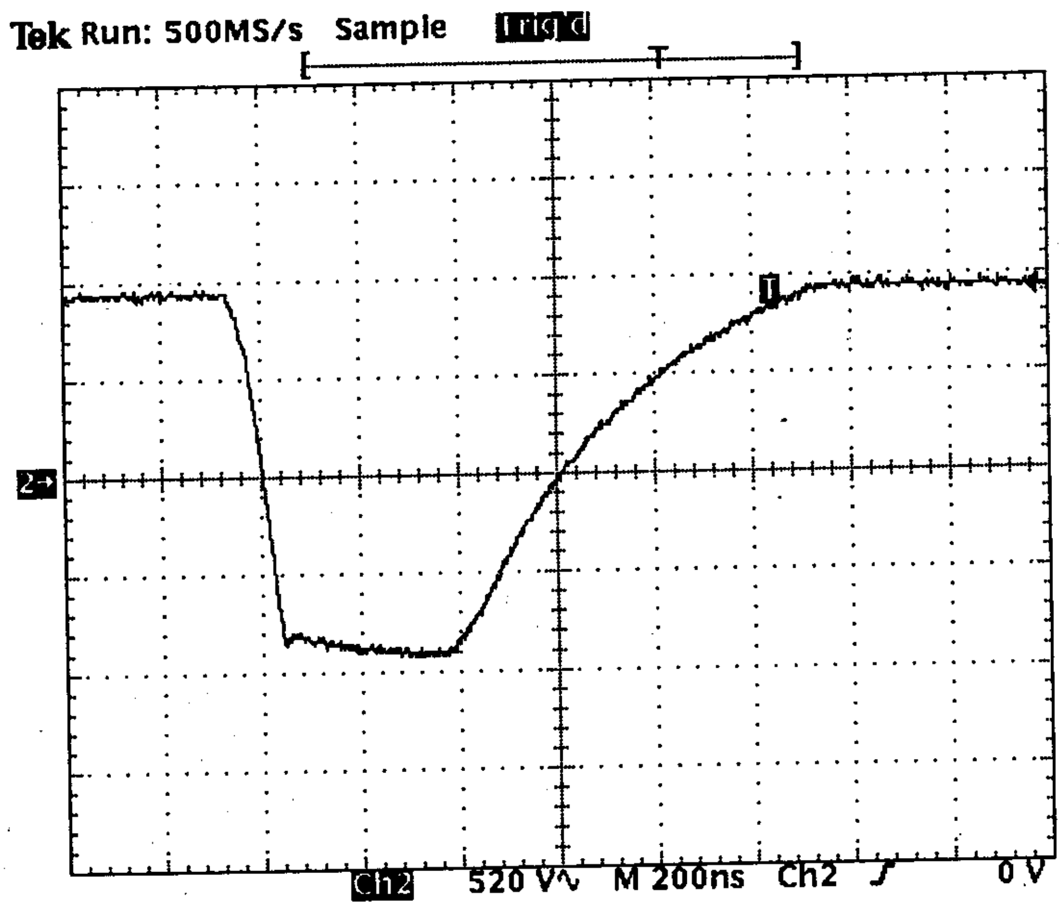
Display:

520 V per vertical division
0.2 microseconds per horizontal division

MAGNETRON CONTROL PULSE
FCC ID: HJXMRT-152

FIGURE 1a

MAGNETRON CONTROL PULSE



Nominal Pulse Width: 0.3 microseconds

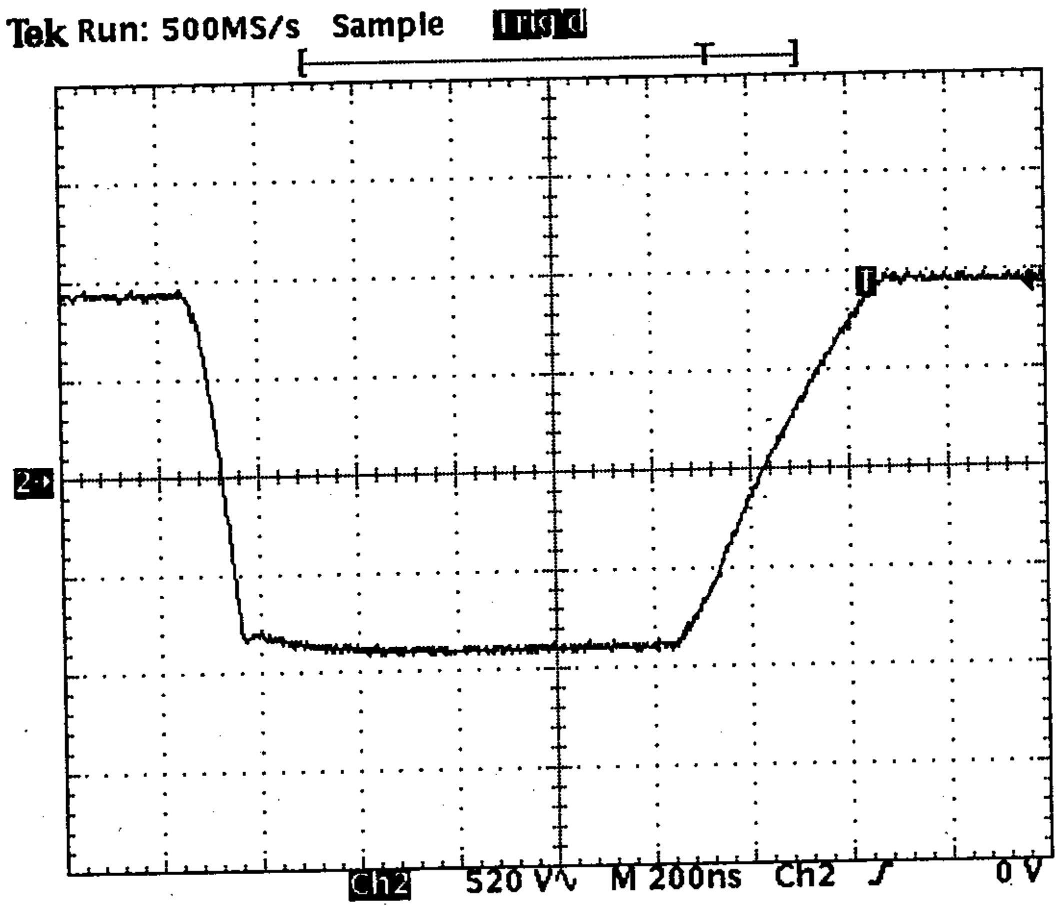
Display:

520 V per vertical division
0.2 microseconds per horizontal division

MAGNETRON CONTROL PULSE
FCC ID: HJXMRT-152

FIGURE 1b

MAGNETRON CONTROL PULSE



Nominal Pulse Width: 0.8 microseconds

Display:

520 V per vertical division
0.2 microseconds per horizontal division

MAGNETRON CONTROL PULSE
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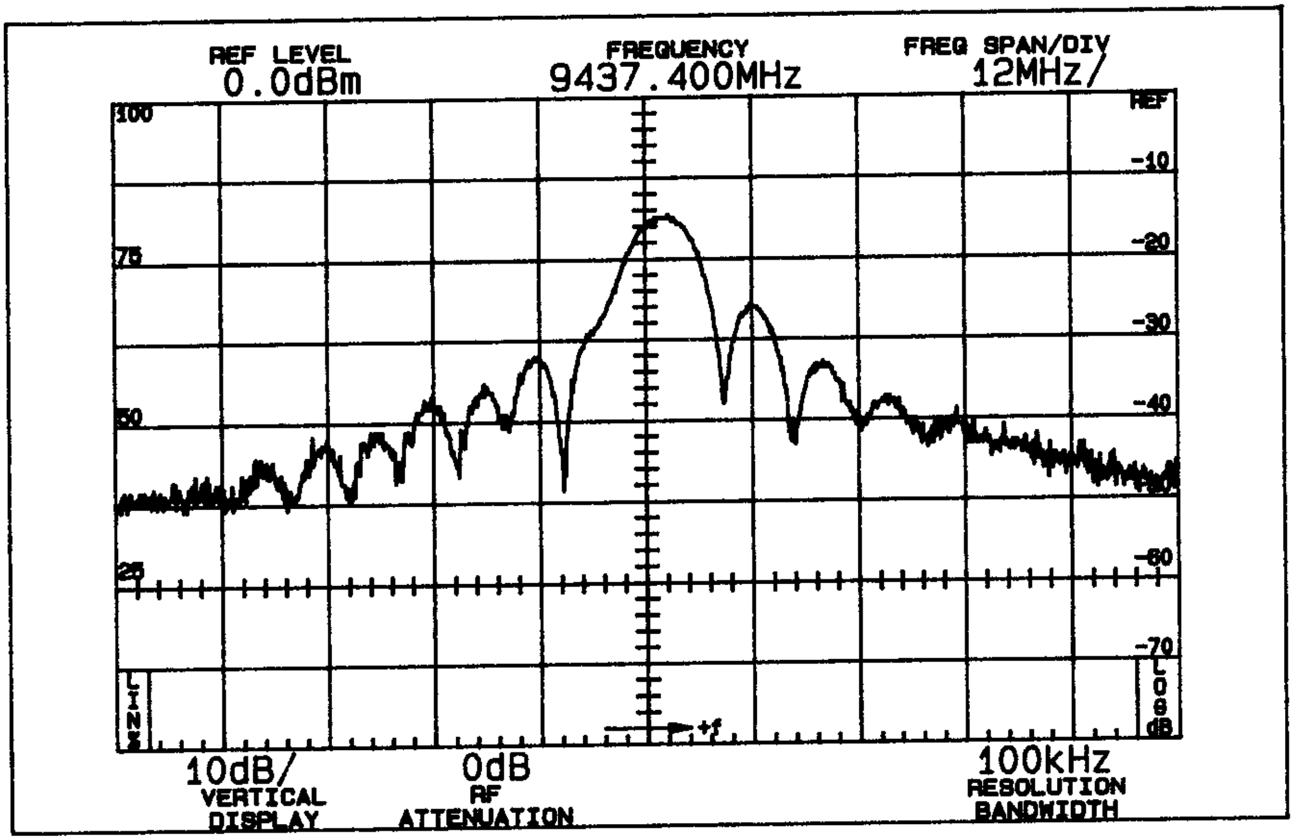
FIGURE 1c

A:\STEXP7SN.OBM

OCCUPIED BANDWIDTH

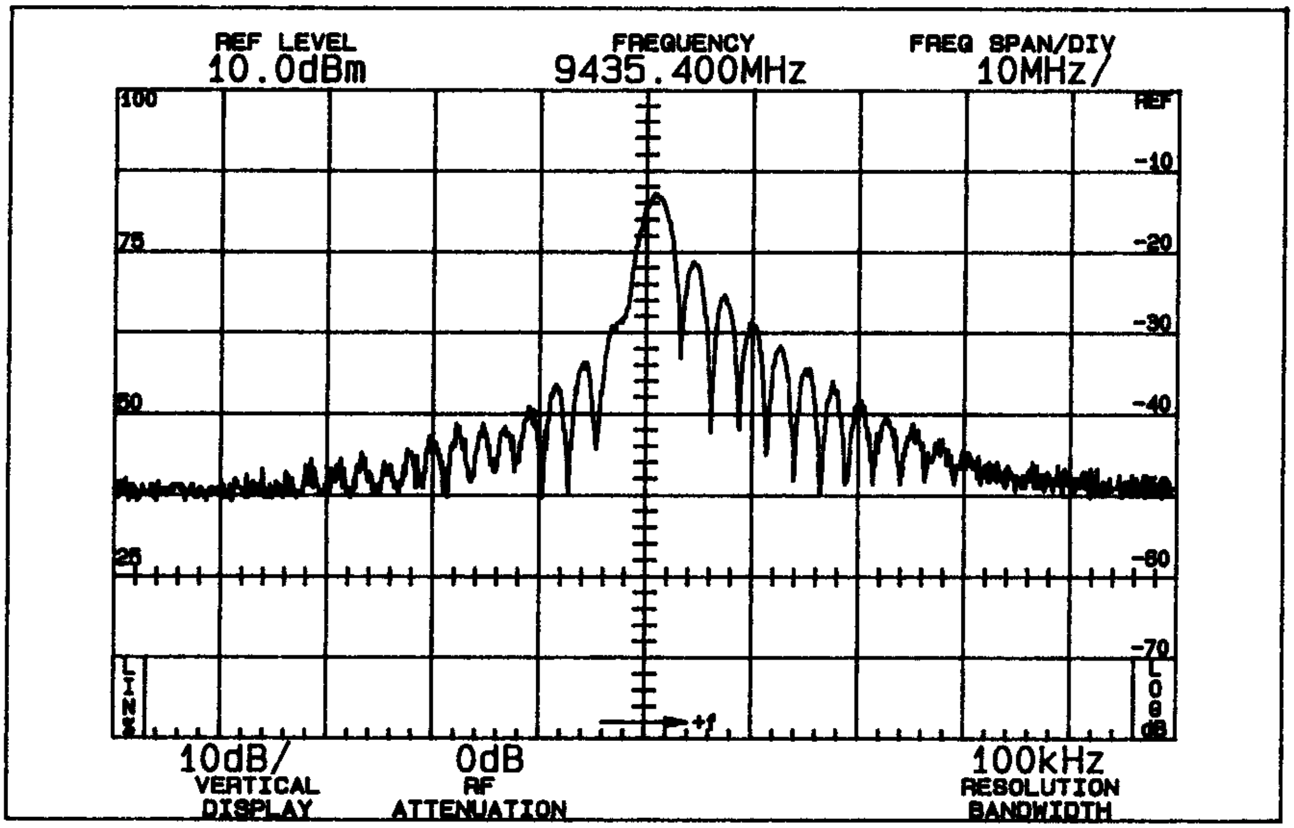


(Nominal Pulsewidth 0.1 microseconds, PRF 2202 Hz)

OCCUPIED BANDWIDTH
FCC ID: HJXMRT-152

FIGURE 2a (Short Pulse)

OCCUPIED BANDWIDTH

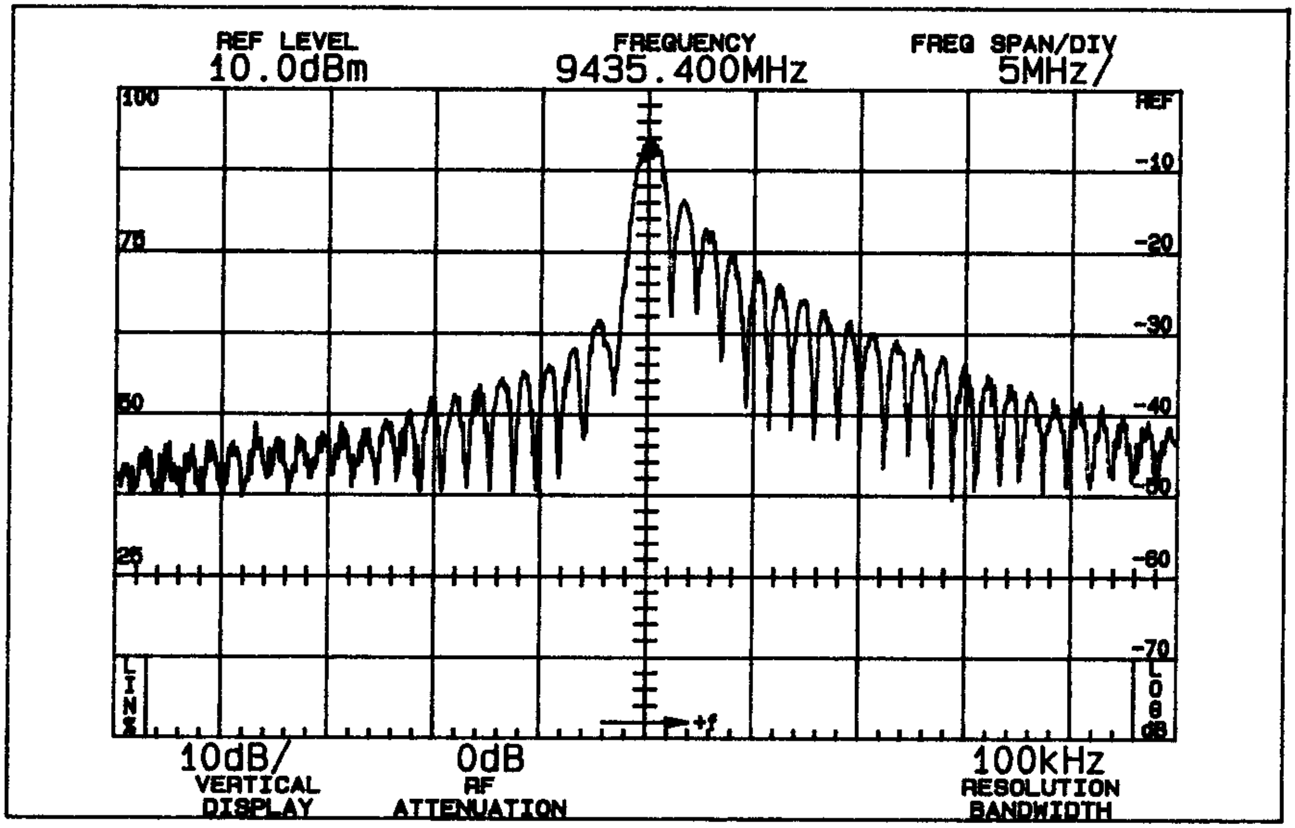


(Nominal Pulsewidth 0.3 microseconds, PRF 1106 Hz)

OCCUPIED BANDWIDTH
FCC ID: HJXMRT-152

FIGURE 2b (Medium Pulse)

OCCUPIED BANDWIDTH



(Nominal Pulsewidth 0.8 microseconds, PRF 552 Hz)

OCCUPIED BANDWIDTH
FCC ID: HJXMRT-152

FIGURE 2c (Long Pulse)

D. SPURIOUS EMISSIONS AT THE ANTENNA TERMINALS
(Paragraph 2.991 of the Rules)

The MD-3420Mk2/3441 transmitter was tested for spurious emissions while the equipment was modulated with nominal pulsewidths of 0.1, 0.3 and 0.8 microseconds.

Measurements were made with a Tektronix 494P spectrum analyzer coupled to the transmitter output waveguide through a directional coupler. During the tests, the transmitter was terminated in a 50 ohm X-band load. Supply voltage was maintained at 13.8 Vdc throughout the test.

Spurious emissions were measured throughout the RF spectrum from 100 MHz to 40 GHz. Any emissions that were between the required attenuation and the noise floor of the spectrum analyzer were recorded. Data are shown in Table 2.

Table 2

TRANSMITTER CONDUCTED SPURIOUS

FREQUENCY	dBc for each nominal pulsewidth			
	0.1	0.3	0.8	(uS)
100 MHz to 40 GHz	*	*	*	
Average power (P)	0.3	0.6	0.9	(W)
Required Attenuation				
43 + 10LogP	38	41	43	(dB)

*No signals were observed above analyzer noise floors: (100 kHz RBW to 1 GHz, then 1 MHz RBW)

100 KHz	- 1.8 GHz	-98 dBm	5.4 GHz	- 18 GHz	-70 dBm
1.7 GHz	- 5.5 GHz	-83 dBm	15 GHz	- 21 GHz	-65 dBm
3.0 GHz	- 7.1 GHz	-83 dBm	21 GH	- 40 GHz	-50 dBm

E. FIELD STRENGTH MEASUREMENTS OF SPURIOUS RADIATION
(Paragraph 2.993(a), (b) (2) of the Rules)

Field intensity measurements of radiated spurious emissions were made with a Tektronix 494P spectrum analyzer using Singer DM-105A calibrated test antennas below 1 GHz, Polarad CA-L Horn from 1 to 2.4 GHz, AEL H1498 double-ridged horn from 2 to 18 GHZ, and Emco 3116 horn to 40 GHz. The transmitter and dummy load were located on a open field site 3 meters from the test antenna. The transmitter and test antennas were arranged to maximize pickup. Both vertical and horizontal test antenna polarization were employed.

G. FIELD STRENGTH MEASUREMENTS (continued)

Reference level for the spurious radiation was taken as an ideal dipole excited by 0.9 watts, the maximum average output power of the transmitter according to the following relationship:*

$$E = \frac{(49.2P_t)^{1/2}}{R}$$

Where E = electric field intensity in volts/meter

P_t = transmitter power in watts

R = distance in meters

for the case $$E = \frac{(49.2 \times 0.9)^{1/2}}{3} = 2.2 \text{ V/M}$$

Since the spectrum analyzer is calibrated in decibels above one milliwatt (dBm), a conversion, for convenience, was made from dBu to dBm:

2.2 volts/meter $= 2.2 \times 10^6$ uV/m

dBu/m $= 20 \text{ Log}_{10}(2.2 \times 10^6)$

$= 127$ dBu/m

Since 1 uV/m = −107 dBm, the reference becomes:

127 − 107 = 20 dBm

The measurement system was capable of detecting signals 50 dB or more below the reference level. Measurements were made from 100 MHz to 40 GHz.

No spurious emissions were observed.

*Reference Data for Radio Engineers, Fourth Edition, International Telephone and Telegraph Corporation, p. 676

H. FREQUENCY STABILITY AS A FUNCTION OF TEMPERATURE (Paragraph 2.995 (2) of the Rules)

Measurement of frequency stability versus temperature was made at temperatures from -20°C to 50 °C. At each temperature, the frequency determining circuitry of the transmitter was exposed to test chamber ambient a minimum of 60 minutes after indicated chamber temperature ambient had stabilized to within ±2° of the desired test temperature. Following the 1 hour soak at each temperature, the unit was turned on, keyed and frequency measured within 2 minutes.

The transmitter output stage was terminated with a dummy load. Primary supply was 13.8 Vdc. Frequency was measured with the spectrum analyzer in the frequency counter mode.

Data are shown in Table 3.

TABLE 3

Temperature, °C	Output Frequency, GHz
-21.2	9.4331
-10.4	9.4346
0.2	9.4350
10.3	9.4358
22.4	9.4354
30.4	9.4357
42.3	9.4352
49.9	9.4363

Maximum excursion of the transmitter was 9.4331 and 9.4363 GHz for the temperature extremes. FCC Rule 80.209(b) specifies 1.5/T MHz to upper and lower limits of the authorized frequency band, where "T" is pulse duration in microseconds.

For the equipment tested, the authorized frequency band is 9300-9500 MHz, and worst-case 1.5T is 15 MHz (0.1 microsecond pulse duration on the minimum range position).

I. FREQUENCY STABILITY AS A FUNCTION OF SUPPLY VOLTAGE (Paragraph 2.995(d)(1) of the Rules)

Oscillator frequency as a function of power supply voltage was measured with the Tektronix 494P spectrum analyzer as supply voltage was varied ±15% from the nominal 13.8 Vdc volt rating. A Keithley 177 digital voltmeter was used to measure supply voltage at transmitter primary input terminals. Measurements were made at 20°C ambient.

I. FREQUENCY STABILITY AS A FUNCTION OF SUPPLY VOLTAGE (Continued)

TABLE 4

Supply Voltage	Frequency, GHz
15.87	9.4351
15.18	9.4354
14.49	9.4353
13.80	9.4354
13.11	9.4350
12.42	9.4355
11.73	9.4354