A. INTRODUCTION

The following data are submitted in connection with this request for type acceptance of the GMRS-50 transceiver in accordance with Part 2, Subpart J of the FCC Rules.

The GMRS-50 is a hand-held, battery operated, UHF, frequency modulated, 1/5 W transceiver intended for voice communications applications in the 462.5500 - 467.7250 MHz band under Part 95 in the GMRS service.

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

1. Name of applicant: Maxon America, Inc.

2. Identification of equipment: FCC ID: F3JGMRS50

   a. The equipment identification label is shown in Appendix 1.
   b. Photographs of the equipment are included in Appendix 2.

3. Quantity production is planned.

4. Technical description:

   a. 16k0F3E emission
   b. Frequency range: 462.5500-467.7250 MHz.
   c. Operating power of transmitter is fixed at the factory at 5 watts and can be programmed to a reduced power of 1 W.
   d. Maximum power permitted under FCC Part 95 (interstitial) is 5 watts ERP. The GMRS-50 fully complied with that power limitation.
   e. The dc voltage and dc currents at final amplifier:

      Collector voltage: 7.4 Vdc
      Collector current: 1.3 A

   f. Function of each active semiconductor device: See Appendix 3.
   g. Complete circuit diagram is included in Appendix 4.
   h. A draft instruction book is submitted as Appendix 5.
   i. The transmitter tune-up procedure is included in Appendix 6.
   j. A description of circuits for stabilizing frequency is included in Appendix 7.
   k. A description of circuits and devices employed for suppression of spurious radiation and for limiting modulation is included in Appendix 8.
   l. Not applicable.

B. GENERAL INFORMATION REQUIRED FOR TYPE ACCEPTANCE (Continued)

5. Data for 2.985 through 2.997 follow this section.

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

RF power output was measured with a Bird 4421 RF power meter and a Narda 765-20 attenuator as a 50 ohm dummy load. Maximum power was 5.0 watts, reduced power 0.9 W. (The transmitter was tuned by the factory according to the procedure of Exhibit 4.)

D. MODULATION CHARACTERISTICS

1. A curve showing frequency response of the transmitter is shown in Figure 1. Reference level was audio signal output from a Boonton 8220 modulation meter with one kHz deviation. Audio output was measured with a Audio Precision System One TRMS voltmeter and tracking generator.

2. Modulation limiting curves are shown in Figure 2, using a Boonton 8220 modulation meter. Signal level was established with a Audio Precision System One. The curves show compliance with paragraphs 2.987(b) and 95.633(b).

3. Figure 3 is a graph of the post-limiter low pass filter which meets the requirements of paragraph 95.633(b) in providing a roll-off of 60Logf/3 dB where f is audio frequency in kHz. Measurements were made following EIA RS-152B with an Audio Precision System One on the Boonton 8220 modulation meter audio output.

4. Occupied Bandwidth
(Paragraphs 2.989(c), 90.209(b)(4), and 95.629(a) of the Rules)

Figure 4 is a plot of the sideband envelope of the transmitter output taken with a Tektronix 494P spectrum analyzer. Modulation corresponded to conditions of 2.989(c)(1) and consisted of 2500 Hz tone at an input level 16 dB greater than that necessary to produce 50% modulation at 2623 Hz, the frequency of maximum response. Measured modulation under these conditions was 4.3 kHz.

The plot is within the limits imposed by Paragraph 90.211(h) for frequency modulation. The horizontal scale (frequency) is 10 kHz per division and the vertical scale (amplitude) is a logarithmic presentation equal to 10 dB per division.

5. Emission Designator Calculation:

(2D + 2F) 2x5.0 + 2x3.0 = 16k0F3E

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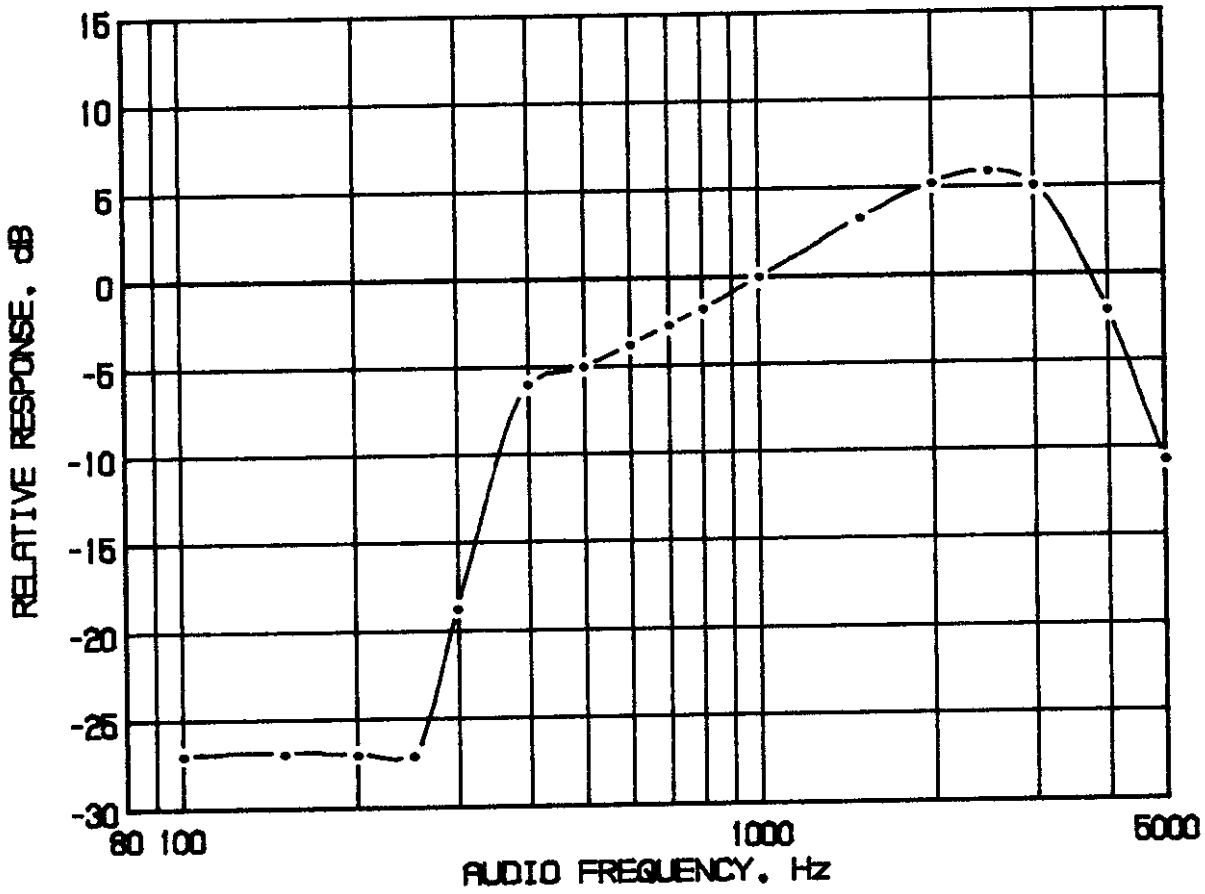
FIGURE 1

MODULATION FREQUENCY RESPONSE

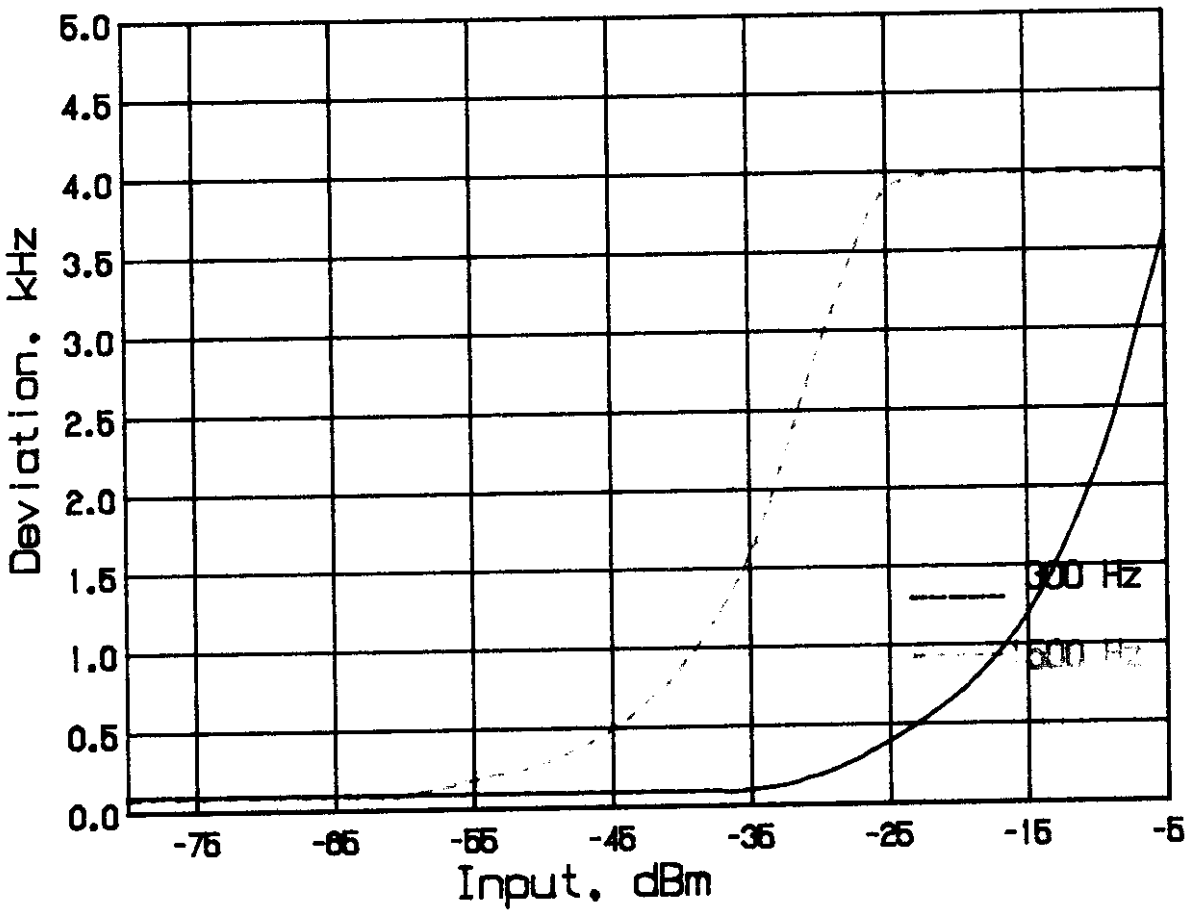


MODULATION FREQUENCY RESPONSE
FCC ID: F3JGMRS50

FIGURE 1

FIGURE 2

AUDIO LIMITER CHARACTERISTICS

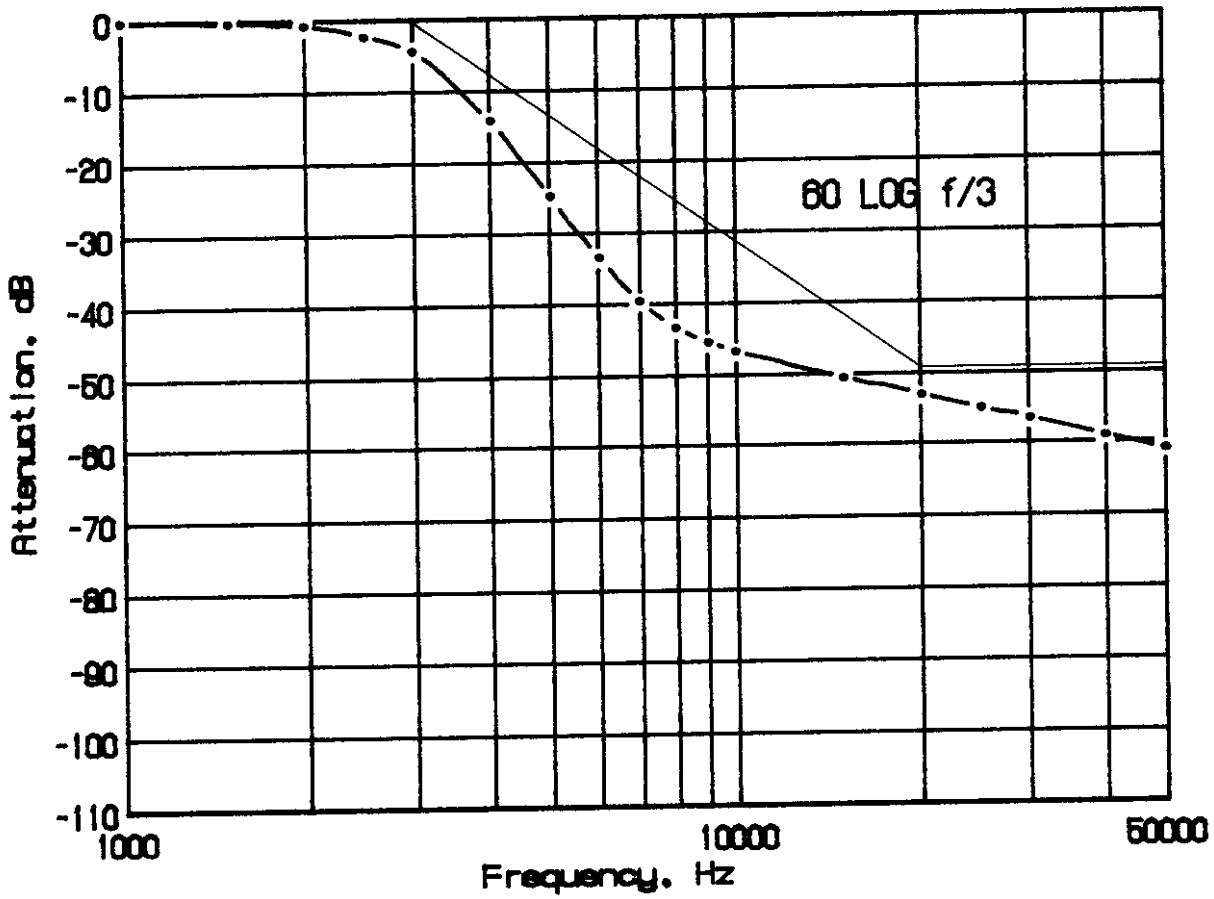


AUDIO LIMITER CHARACTERISTICS
FCC ID: F3JGMRS50

FIGURE 2

FIGURE 3

AUDIO LOW PASS FILTER RESPONSE

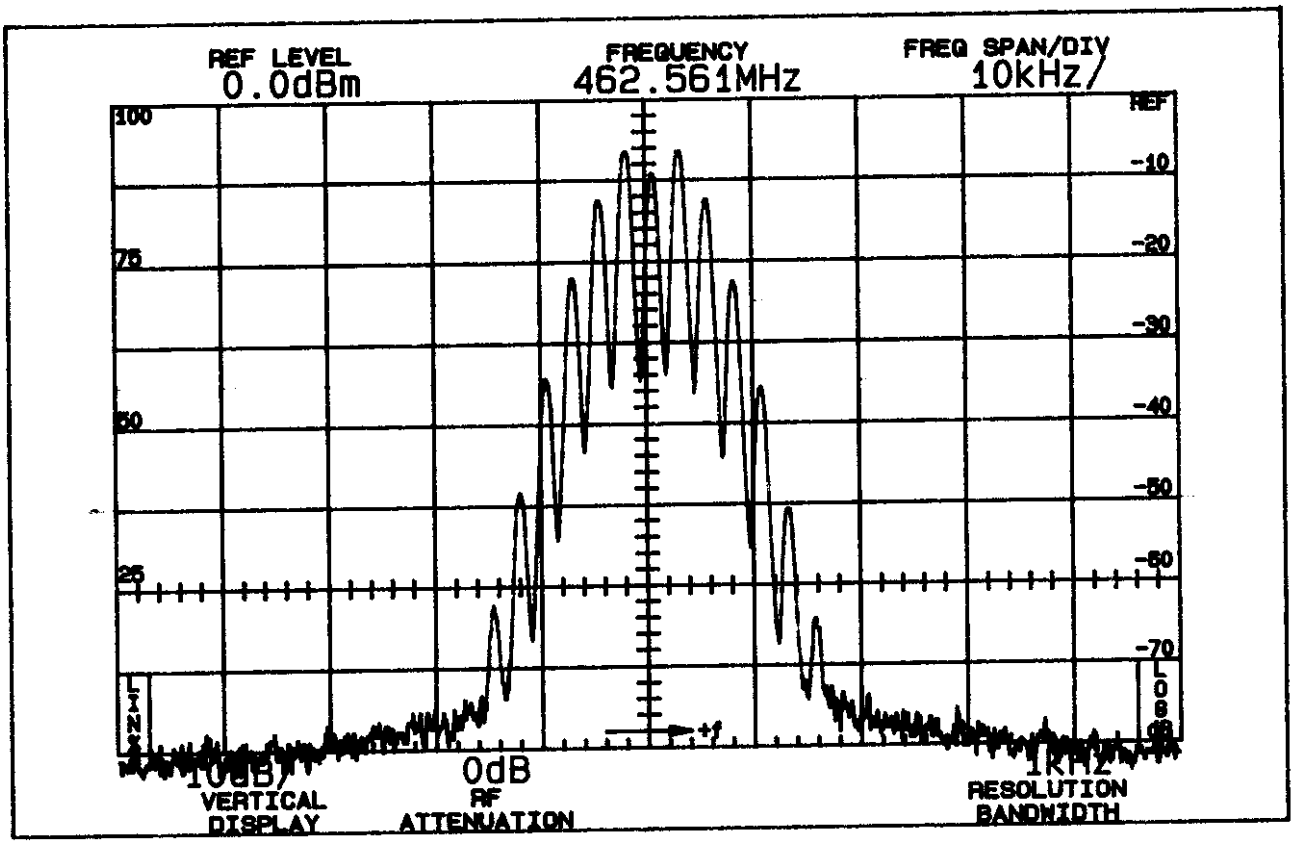


AUDIO LOW PASS FILTER RESPONSE
FCC ID: F3JGMRS50

FIGURE 3

FIGURE 4a

OCCUPIED BANDWIDTH



	ATTENUATION IN dB BELOW MEAN OUTPUT POWER Required
On any frequency more than 50% up to and including 100% of the authorized bandwidth, 20 kHz (10-20 kHz)	25
On any frequency more than 100%, up to and including 250% of the authorized bandwidth (20-50 kHz)	35
On any frequency removed from the assigned frequency by more than 250% of the authorized bandwidth (over 50 kHz)	43+10LogP = 46 (P = 5.0 W)

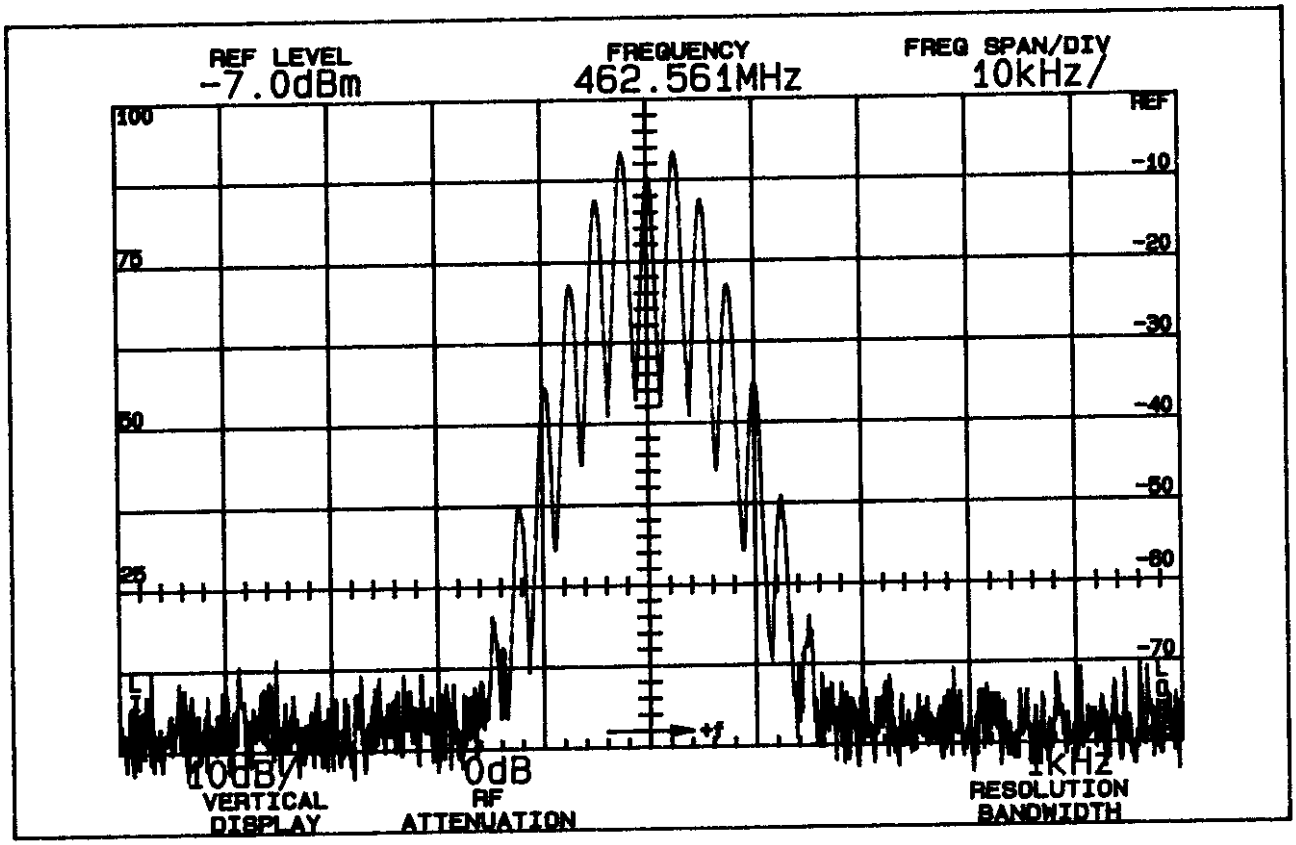
OCCUPIED BANDWIDTH
FCC ID: F3JGMRS50

FIGURE 4a (5 W)

A: \MAXBOLD.DBM

FIGURE 4b

OCCUPIED BANDWIDTH



	ATTENUATION IN dB BELOW MEAN OUTPUT POWER Required
On any frequency more than 50% up to and including 100% of the authorized bandwidth, 20 kHz (10-20 kHz)	25
On any frequency more than 100%, up to and including 250% of the authorized bandwidth (20-50 kHz)	35
On any frequency removed from the assigned frequency by more than 250% of the authorized bandwidth (over 50 kHz)	43+10LogP = 46 (P = 0.9 W)

OCCUPIED BANDWIDTH
FCC ID: F3JGMRS50

FIGURE 4b (0.9 W)

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

The GMRS-50 transmitter was tested for spurious emissions at the antenna terminals while the equipment was modulated with a 2500 Hz signal, 16 dB above minimum input signal for 50% (2.5 kHz deviation) modulation at 2623 Hz, the frequency of highest sensitivity.

Measurements were made with Tektronix 494P spectrum analyzer coupled to the transmitter output terminal through Narda 765-20 microwave power attenuator.

During the tests, the transmitter was terminated in the 50 ohm attenuator. Power was monitored on a Bird 43 Thru-Line wattmeter; dc supply was 7.5 volts throughout the tests.

Spurious emissions were measured throughout the RF spectrum from 12.8 MHz (lowest frequency generated in the transmitter) to 4.7 GHz. Any emissions that were between the required attenuation and the noise floor of the spectrum analyzer were recorded. Data are shown in Table 1.

TABLE 1

TRANSMITTER CONDUCTED SPURIOUS
462.562 MHz, 7.5 Vdc, 0.9 and 5 W

Spurious Frequency MHz	dB Below Carrier Reference	
	5 W	0.9 W
925.123	66	69
1387.685	>100	>100
1850.246	>100	>100
2312.808	>100	>100
2775.369	>100	>100
3237.930	>100	>100
3700.492	>100	>100
4163.055	>100	>100
4625.615	>100	>100
Required: 43+10Log(P)	50	43

All other emissions from 12.8 MHz to 4.7 GHz were 20 dB or more below FCC limit.

F. DESCRIPTION OF MEASUREMENT FACILITIES

A description of the Hyak Laboratories' radiation test facility is a matter of record with the FCC. The facility was approved for radiation measurements from 25 to 1000 MHz on October 1, 1976 and is currently listed as an acceptable site.

G. FIELD STRENGTH MEASUREMENTS OF SPURIOUS RADIATION

Field intensity measurements of radiated spurious emissions from the GMRS-50 were made with a Tektronix 494P spectrum analyzer using Singer DM-105A calibrated test antennae for the measurements to 1 GHz, and EMCO 3115 horn above 1 GHz. The transmitter and dummy load were located in an open field 3 meters from the test antenna. Supply voltage was a power supply with a terminal voltage under load of 7.5 Vdc. Output power was 5.0 watts at the 462.562 MHz operating frequency. The transmitter and test antennae were arranged to maximize pickup. Both vertical and horizontal test antenna polarization were employed.

Reference level for the spurious radiations was taken as an ideal dipole excited by 5 watts, the 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 this case $E = \frac{(49.2 \times 5)^{1/2}}{3} = 5.2$ V/m

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

5.2 volts/meter $= 5.2 \times 10^6$ uV/m

dBu/m $= 20 \log_{10} (5.2 \times 10)^6$

$= 134$ dBu/m

Since 1 uV/m $= -107$ dBm, the reference becomes

$134 - 107 = 27$ dBm

The measurement system was capable of detecting signals 90 dB or more below the reference level. Measurements were made from the lowest frequency generated within the unit (12.8 MHz), to 10 times operating frequency, 4.7 GHz. Data after application of antenna factors and line loss corrections are shown in Table 2.

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

TABLE 2

TRANSMITTER CABINET RADIATED SPURIOUS
462.562 MHz, 7.5 Vdc, 5 watts

Frequency MHz	dB Below Carrier Reference[1]
925.125	70H
1387.688	75V*
1850.250	65H
2312.813	89H*
2775.375	83H*
3237.938	79V*
3700.500	73H*
4163.063	66V
4625.625	66H

Required: 43+10Log(5.0) = 50

[1]Worst-case polarization, H-Horizontal, V-Vertical.

*Reference data only, more than 20 dB below FCC limit.

All other spurious from 12.8 MHz to 4.7 GHz were 20 dB or more below FCC limit.

H. FREQUENCY STABILITY
(Paragraph 2.995(a)(2) and 95.621(b) of the Rules)

Measurement of frequency stability versus temperature was made at temperatures from -30°C to +50°C. At each temperature, the unit 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. Test temperature was sequenced in the order shown in Table 3, starting with -30°C.

A Thermotron S1.2 temperature chamber was used. Temperature was monitored with a Keithley 871 digital temperature probe. The transmitter output stage was terminated in a dummy load. Primary supply was 7.5 volts. Frequency was measured with a HP 5385A digital frequency counter connected to the transmitter through a power attenuator. Measurements were made at 462.562 MHz. No transient keying effects were observed.

TABLE 3

462.562 MHz, 7.5 V Nominal, 5 watts

Temperature, °C	Output Frequency, MHz	p.p.m.
-29.5	462.562370	-0.3
-19.6	462.562331	-0.4
- 9.9	462.562472	-0.1
0.3	462.562623	0.3
9.8	462.562676	0.4
20.3	462.562564	0.1
30.0	462.562443	-0.1
40.3	462.562382	-0.3
49.8	462.562679	0.4
Maximum frequency error:	462.562679	
	462.562500	
	+ .000179 MHz	

FCC Rule 95.621(b) specifies .0005% or a maximum of ± .002313 MHz, which corresponds to:

High Limit	462.564813 MHz
Low Limit	462.560187 MHz

I. FREQUENCY STABILITY AS A FUNCTION OF SUPPLY VOLTAGE (Paragraph 2.995(d)(2) of the Rules)

Oscillator frequency as a function of power supply voltage was measured with a HP 5385A digital frequency counter as supply voltage provided by an HP 6264B variable dc power supply was varied from ±15% above the nominal 7.5 volt rating to below the battery end point. A Keithley 197 digital voltmeter was used to measure supply voltage at transmitter primary input terminals. Measurements were made at 20 ^{o}C ambient.

TABLE 4

462.562 MHz, 20^{o}C, 7.5 V Nominal, 5.0 watts

%	Supply Voltage	Output Frequency, MHz	p.p.m.
115	8.63	462.562623	0.3
110	8.25	462.562601	0.2
105	7.88	462.562582	0.2
100	7.50	462.562564	0.1
95	7.13	462.562558	0.1
90	6.75	462.562553	0.1
85	6.38	462.562547	0.1
*	6.00	462.562544	0.1

Maximum frequency error: 462.562623
462.562500

*Low Battery Indicator Threshold + .000123 MHz

FCC Rule 95.621(b) specifies .0005% or a maximum of ± .002313 MHz, corresponding to:

High Limit 462.564813 MHz
Low Limit 462.560187 MHz

APPENDIX 3

FUNCTION OF DEVICES
GMRS-50

Reference	Type	Function
Q503	BLT52	Final Amplifier
Q502	BLT50	Driver
Q501	MMBR951	Pre Driver
Q17	BFR92A	Intermediate Driver
Q16	BFR92A	VCO Buffer
Q203	2SC5084	Charge Pump TX
Q202	2SC5084	VCO Oscillator TX
Q5	KRA104S	Lock Detector
D9	ND433G	Hybrid Ring Mixer
IC2	MC14519F	Phase Lock Loop
IC5	MC3361	FM IF IC
IC6	LM386N3	Audio Amplifier
IC409	HD4074818P	Microprocessor
IC408	93C56	Program Personality EEPROM
IC410	KIA-324F	Limiter/Low Pass Filter