ENGINEERING STATEMENT

For Certification of

MIDLAND CONSUMER RADIO

Model No. FG-1
FCC ID: MMAFG1

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

Hyak Laboratories, Inc. has been authorized by Midland Consumer Radio to make certification measurements on the FG-1 transceiver. These tests were made by me or under my supervision in our Springfield laboratory.

Test data and documentation required by the FCC for certification are included in this report. The data verifies that the above mentioned transceiver meets FCC requirements and certification is requested.

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Rowland S. Johnson

Dated: December 21, 2001

A. INTRODUCTION

The following data are submitted in connection with this request for type certification of the FG-1 transceiver in accordance with Part

2, Subpart J of the FCC Rules.

The FG-1 is a hand-held, battery operated, UHF, frequency modulated, transceiver intended for voice communications applications under Part 95 GMRS (channels 1-7 or 15-22)* or Part 95 FRS (channels 8-14)*.

*See Appendix A for frequency assignment.

1. The unit's antenna meets 95.647, (i.e. is integral to the transmitter.

2. Except for power, the technical parameters for operating on all the channels (both FRS and GMRS) are the same as those for FRS, (i.e. 12.5 kHz bandwidth, 2.5 ppm frequency tolerance, maximum 2.5 kHz deviation, etc).

3. An informational insert is included inside the box (product package) that clearly informs the consumer (buyer/owner) when the radio is transmitting on GMRS frequencies, that operation on GMRS frequencies requires an FCC license and such operation is subject to additional rules specified in 47 CFR Part 95. (See Appendix B)

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

1. Name of applicant: Midland Consumer Radio

2. Identification of equipment: FCC ID: MMAFG1

   a. The equipment identification label is submitted as a separate exhibit.
   b. Photographs of the equipment are submitted as separate exhibits.

3. Quantity production is planned.

4. Technical description:

   a. 11k0F3E emission (FRS and GMRS)
   b. Frequency range: 462.5500-467.7125 MHz.
   c. Operating power ERP(d):
      FRS 0.45 W
      GMRS 0.54 W

B. GENERAL INFORMATION (Cont.)

   d. Maximum power permitted under FCC Part 95 (interstitial) is 5 watts ERP. The FG-1 fully complied with that power limitation.
   e. The dc voltage and dc currents at final amplifier:

	GMRS	FRS

Collector voltage:	4.4	4.4 Vdc
Collector current:	0.71	0.69 A

f. Function of each active semiconductor device: See Appendix 1.

g. Complete circuit diagram is submitted as a separate exhibit.

h. A draft instruction book is submitted as a separate exhibit.

i. The transmitter tune-up procedure is submitted as a separate exhibit.

j. A description of circuits for stabilizing frequency is included in Appendix 2.

k. A description of circuits and devices employed for suppression of spurious radiation and for limiting modulation is included in Appendix 3.

l. Not applicable.

5. Data for 2.985 through 2.997 follow this section.

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

ERP(d) by substitution: FRS 0.45 W
GMRS 0.54 W

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 an 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 an Audio Precision System One. The curves show compliance with paragraphs 2.987(b) and 95.633(b).

D. MODULATION CHARACTERISTICS (Cont.)

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 4a is a plot of the sideband envelope of the

transmitter output taken with a Tektronix 494P spectrum analyzer on GMRS Channel 1. 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 2198 Hz, the frequency of maximum response.

Figure 4b is a plot under the same conditions for FRS Channel 8.

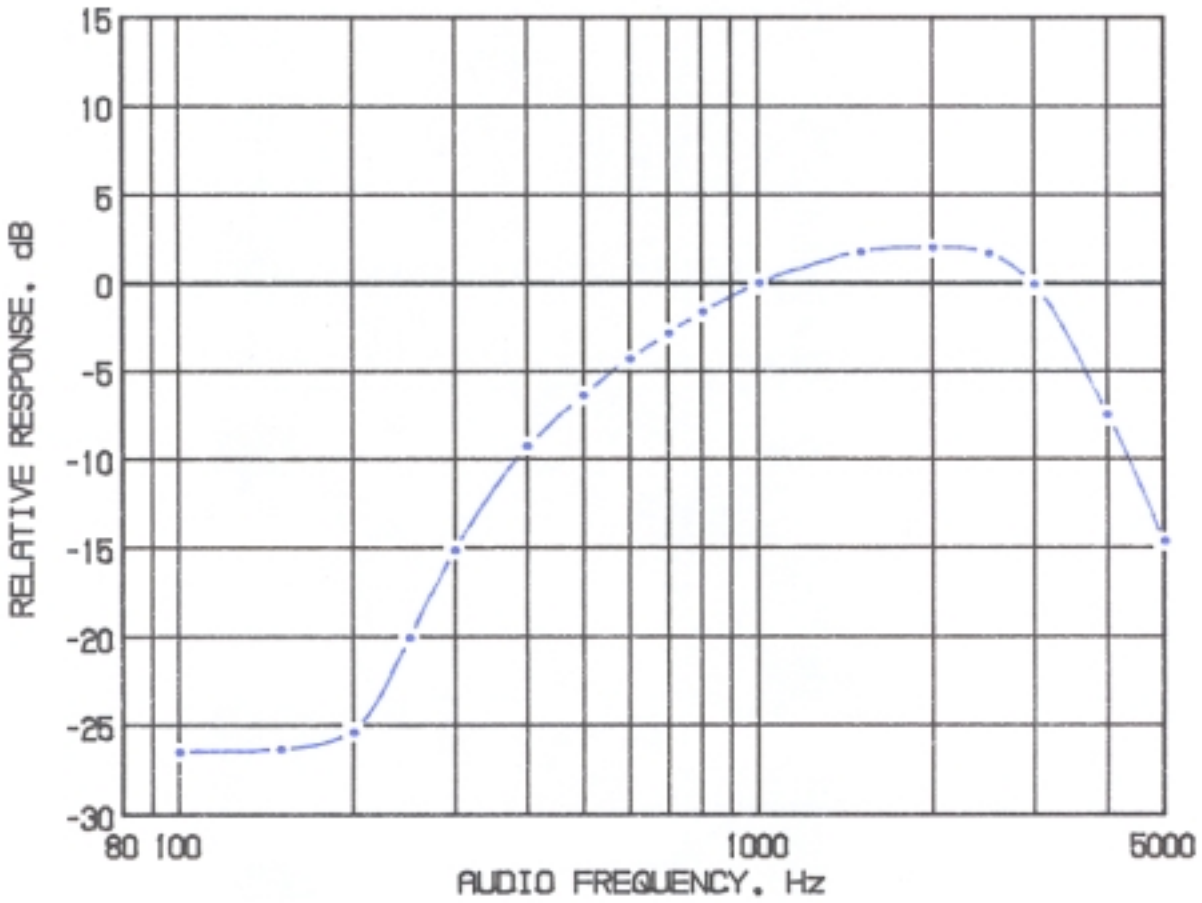
The plots are within the limits imposed by Part 95 for frequency modulation. The horizontal scale (frequency) is 10 kHz per division and the vertical scale (amplitude) is a logarithmic presentation equal to 10 dB per division.

5. Emission Designator Calculation:

(2D + 2F) 2x2.5 + 2x3.0 = 11k0F3E

FIGURE 1

MODULATION FREQUENCY RESPONSE

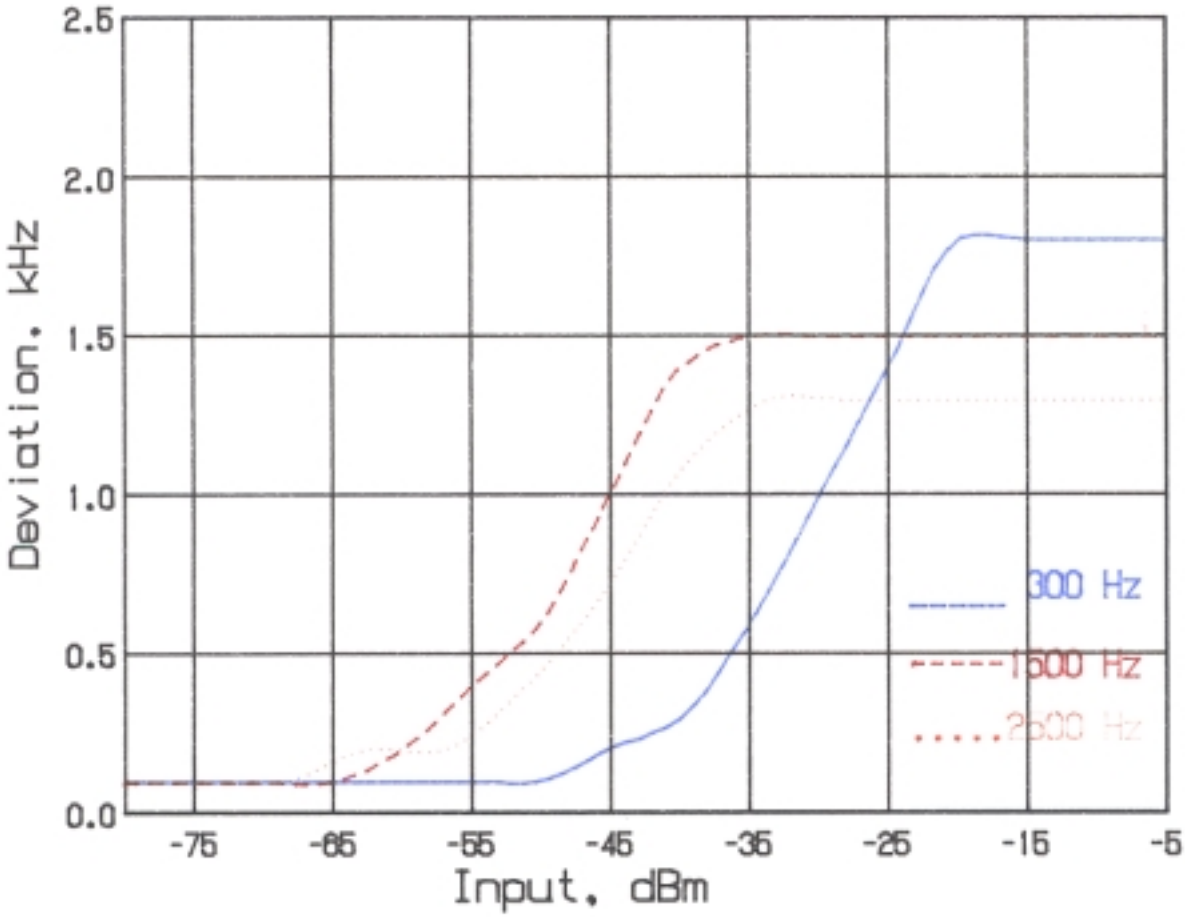


MODULATION FREQUENCY RESPONSE
FCC ID: MMAFG1

FIGURE 1

FIGURE 2

AUDIO LIMITER CHARACTERISTICS

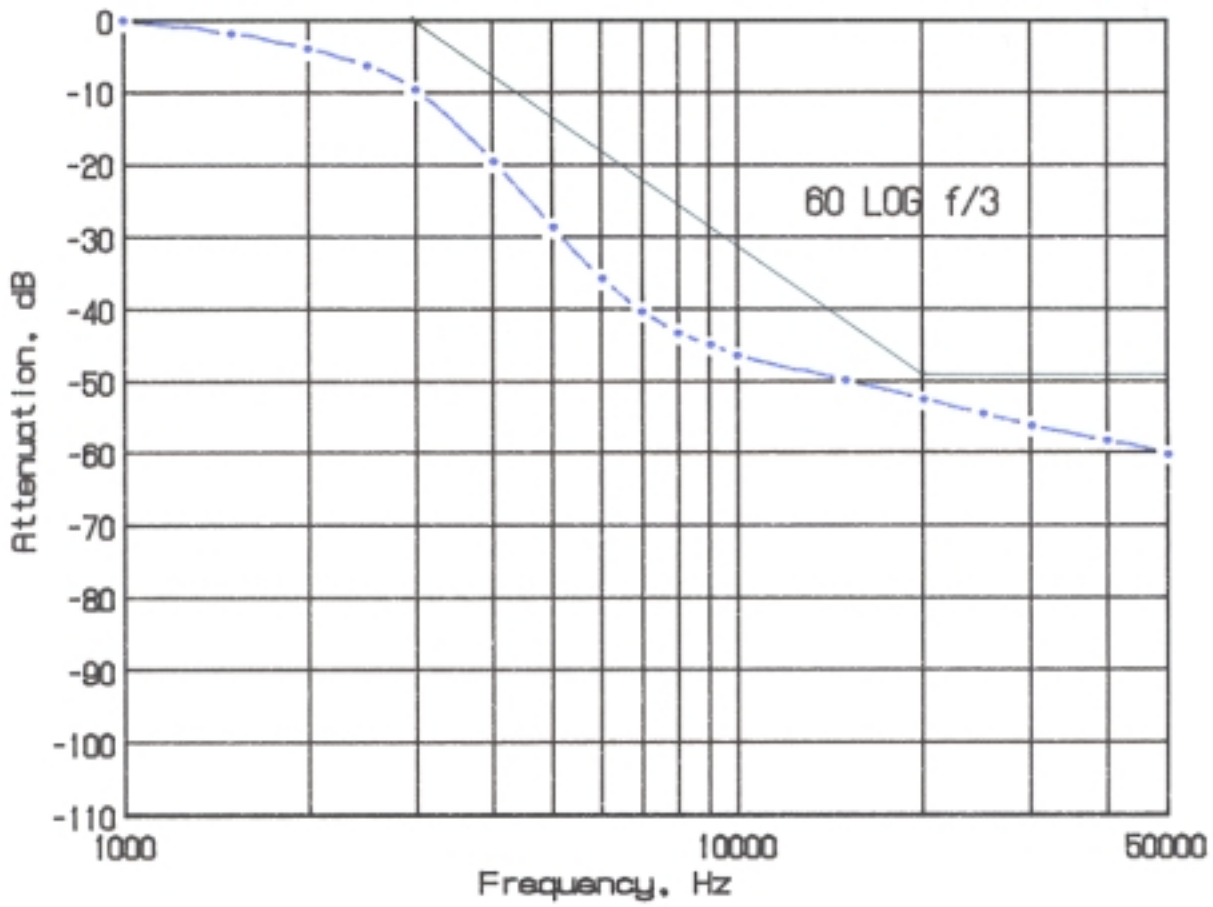


AUDIO LIMITER CHARACTERISTICS
FCC ID: MMAFG1

FIGURE 2

FIGURE 3

AUDIO LOW PASS FILTER RESPONSE

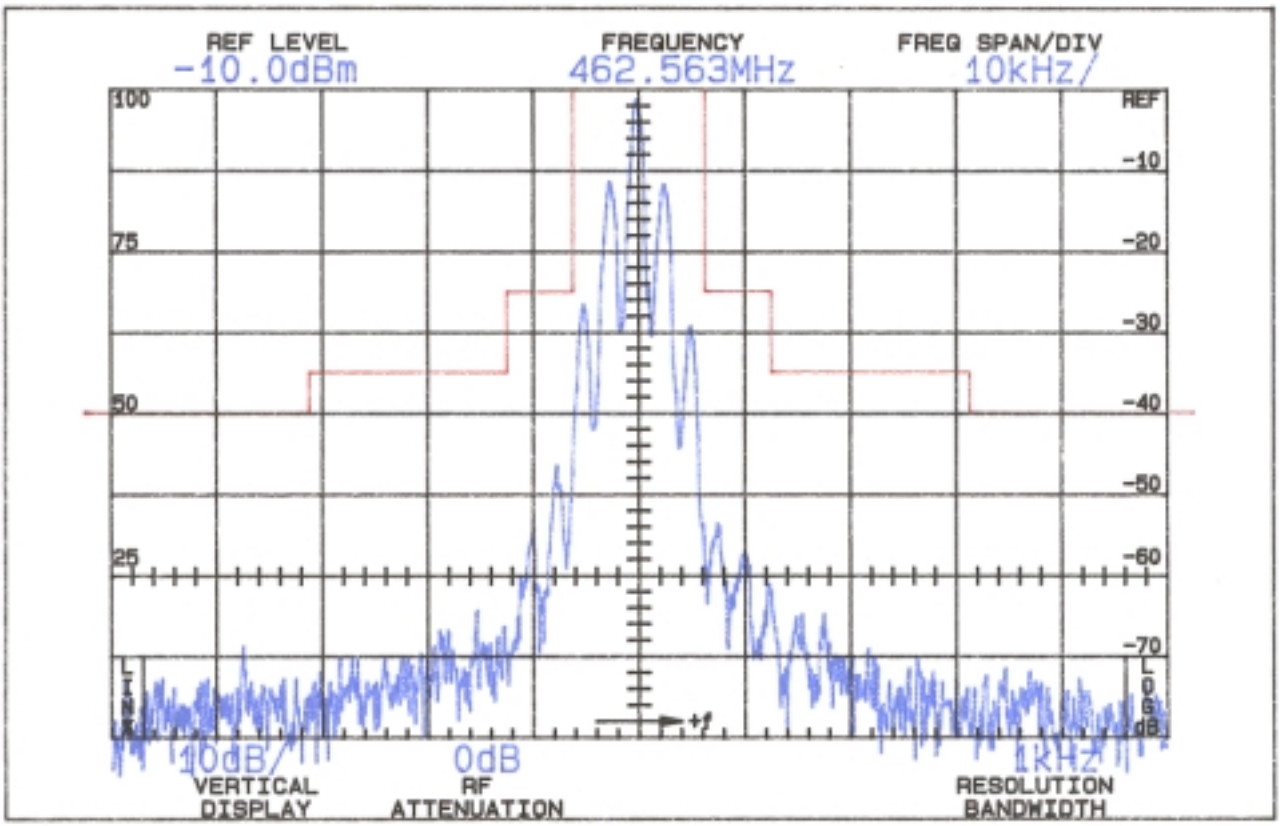


AUDIO LOW PASS FILTER RESPONSE
FCC ID: MMAFG1

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 25
authorized bandwidth, 20 kHz
(10-20 kHz)

On any frequency more than 100%,
up to and including 250% of the 35
authorized bandwidth (20-50 kHz)

On any frequency removed from
the assigned frequency by more
than 250% of the authorized
bandwidth (over 50 kHz)

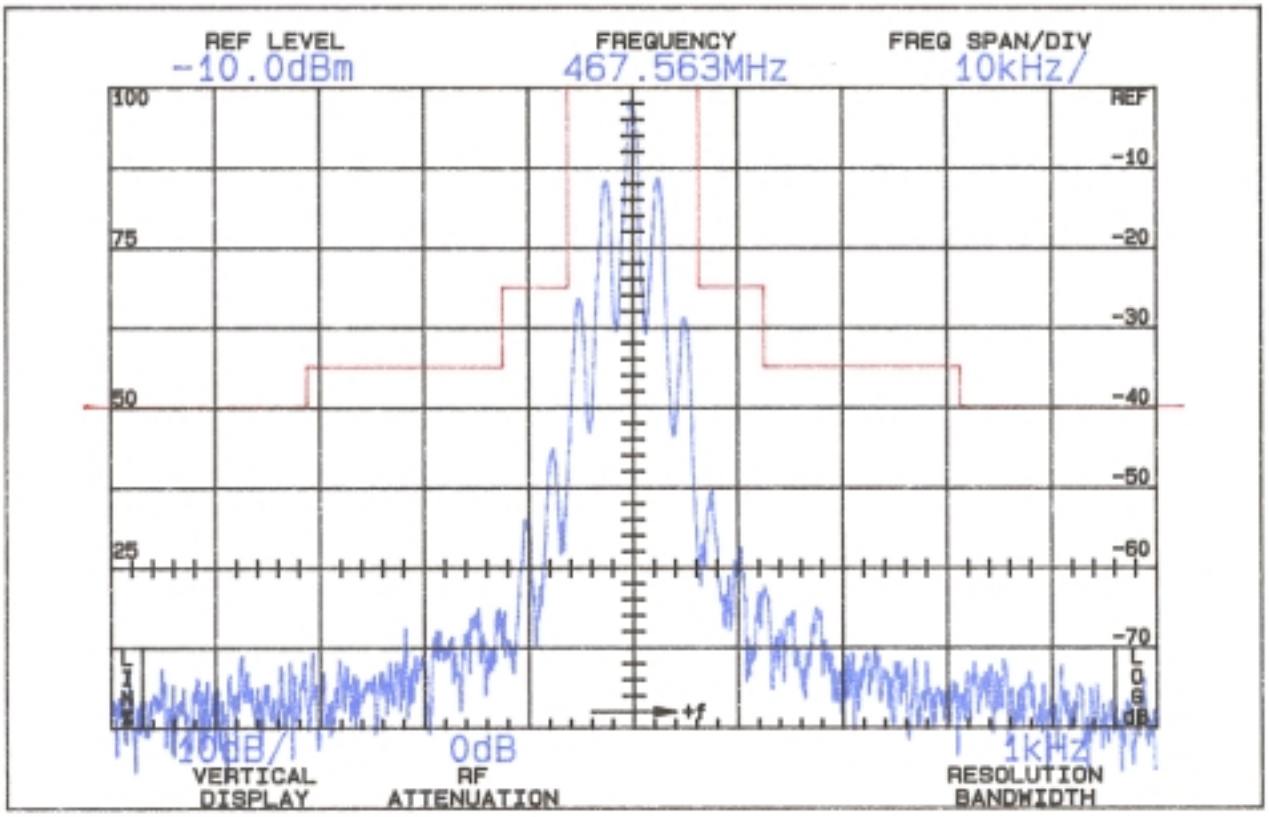
43+10LogP = 40
(P = 0.54 W)

OCCUPIED BANDWIDTH
FCC ID: MMAFG1

FIGURE 4a, (GMRS)

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 25
authorized bandwidth, 20 kHz
(10-20 kHz)

On any frequency more than 100%,
up to and including 250% of the 35
authorized bandwidth (20-50 kHz)

On any frequency removed from
the assigned frequency by more
than 250% of the authorized
bandwidth (over 50 kHz)

43+10LogP = 39
(P = 0.45 W)

OCCUPIED BANDWIDTH
FCC ID: MMAFG1

FIGURE 4b, (FRS)

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

Not Applicable, integral antenna.

F. MEASUREMENTS OF SPURIOUS RADIATION

Measurement of radiated spurious emissions from the FG-1 were made by substitution with a Tektronix 494P spectrum analyzer using Singer DM-105A calibrated test antennae for the measurements to l GHz, Polarad CA-L, CA-S, CA-M and/or EMCO 3115. 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 4.5 Vdc. The transmitter and test antennae were arranged to maximize pickup. Both vertical and horizontal test antenna polarization were employed.

TABLE 2a

TRANSMITTER RADIATED SPURIOUS
462.5625 MHz, 4.5 Vdc, GMRS, Channel 1

Frequency MHz	dB Below Carrier Reference[1]
462.563	0
925.125	44V
1387.688	61V
1850.250	55V
2312.813	47V
2775.375	51H
3237.938	56H
3700.500	55H
4163.063	57H
4625.625	59V

Required: 43+10Log(0.54) = 40

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

All other spurious from 21.5 MHz to 4.7 GHz were 20 dB or more below FCC limit.

TABLE 2b

TRANSMITTER RADIATED SPURIOUS
467.5625 MHz, 4.5 Vdc, FRS, Channel 8

Frequency MHz	dB Below Carrier Reference[1]

467.565	0
935.130	54V
1402.695	57V
1870.260	62V
2337.825	55H
2805.390	57H

Required: 43+Log(0.45) = 39

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

All other spurious from 21.5 MHz to 4.7 GHz were 20 dB or more below FCC limit.

G. 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. Primary supply was 4.5 volts. Frequency was measured with a HP 5385A digital frequency counter. Measurements were made at 462.5625 MHz. No transient keying effects were observed.

TABLE 3

462.5625 MHz, 4.5 V Nominal

Temperature, °C	Output_Frequency,_MHz	p.p.m.
-29.4	462.561386	-2.4
-20.4	462.562119	-0.8
-10.2	462.562959	1.0
- 1.4	462.563251	1.6
9.9	462.563052	1.2

19.7	462.562379	-0.3
31.2	462.561870	-1.4
40.1	462.561570	-2.0
50.4	462.561621	-1.9

Maximum frequency error: 462.561570
462.562500

- .000930 MHz

FCC Part 95 specifies .00025% or a maximum of ± .001156 MHz, which corresponds to:

High Limit	462.563656 MHz
Low Limit	462.561344 MHz

H. 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 4.5 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 °C ambient.

TABLE 4

462.5625 MHz, 20°C, 4.5 V Nominal

%	Supply_Voltage	Output_Frequency,_MHz	p.p.m.
115	5.2	462.562701	0.4
110	5.0	462.562614	0.2
105	4.7	462.562497	0.0
100	4.5	462.562379	-0.3

95	4.3	462.562272	-0.5
90	4.1	462.562186	-0.7
85	3.8	462.562115	-0.8
*	3.6	462.562063	0.5

Maximum frequency error: 462.562115
462.562500

*MFR rated battery endpoint. - .000385 MHz
**Processor shut-down.

FCC Part 95 specifies .00025% or a maximum of ±.001156 MHz, corresponding to:

High Limit	462.563656 MHz
Low Limit	462.561344 MHz

APPENDIX A

CHANNEL ASSIGNMENT

GMRS Channels:

CH1: 462.5625 MHz
CH2: 462.5875 MHz
CH3: 462.6125 MHz
CH4: 462.6375 MHz
CH5: 462.6625 MHz

CH6: 462.6875 MHz
CH7: 462.7125 MHz

CH15: 462.5500 MHz
CH16: 462.5750 MHz
CH17: 462.6000 MHz
CH18: 462.6250 MHz
CH19: 462.6500 MHz
CH20: 462.6750 MHz
CH21: 462.7000 MHz
CH22: 462.7250 MHz

FRS Channels:

CH8: 467.5625 MHz
CH9: 467.5875 MHz
CH10: 467.6125 MHz
CH11: 467.6375 MHz
CH12: 467.6625 MHz
CH13: 467.6875 MHz
CH14: 467.7125 MHz

APPENDIX B

FCC LICENCE REQUIREMENT

IMPORTANT NOTICE
FCC LICENCE REQUIRED

The FG1 operates on GMRS (General Mobile Radio Service) frequencies which require an FCC (Federal Communications Commission) license. Information on how to apply for a license is included in the owner's manual. A user must be licensed prior to operating on channels 1 – 7 or 15 –22, which comprise the GMRS channels of the FG1. Serious penalties could result

for unlicensed use of GMRS channels, in violation of FCC rules, as stipulated in the Communications Act's Sections 501 and 502 (amended).

Licensed users will be issued a call sign by the FCC which should be used for station identification when operating the FG1. GMRS users should also cooperate by engaging in permissible transmissions only, avoiding channel interference with other GMRS users, and being prudent with the length of their transmission time.

Questions regarding the license application should be directed to the FCC at 1-888-CALL FCC. Additional information is available on the FCC's website at www.fcc.gov

APPENDIX 1

FUNCTION OF DEVICES

Reference	Type	Description

QT1	2SC4226	TX Buffer
QT2	2SC4226	TX Power Drive Amp
QT3	DRF1401	TX Power Final Amp
QT4	KRC104S	RX B+ Switching at TX
QV2	2SC4226	O.S.C.
IC2	NJM2070	Audio Power Amp
IC3	S3C728X27-QZR8	CPU
IC4	TB31202FN	PLL Frequency Synthesizer
IC6	DBL358	Pre-Emphasis and Mic Amp
IC7	24WC02J	EEPROM

APPENDIX 2

CIRCUITS AND DEVICES TO STABILIZE FREQUENCY

The PLL synthesizer of the FG-1 consists of the signal loop PLL circuit with the reference of 6.25 kHz. The IC4 PLL IC includes all the functions such as the reference oscillator, the driver, the phase detector, the lock detector, and the programmable divider.

At the reference oscillator, the 21.25 MHz X3 of the TCXO is connected to the pin 11 of the IC4 to oscillate the frequency of 21.25 MHz. The TCXO (21.25 MHz) is the temperature compensation circuit to maintain the frequency within the allowable error range even under a low temperature of $-30^{o}C$.

The phase detector sends out the output power to the loop filter through 3 pin of the IC4. If the oscillation frequency of the VCO is low compared to the reference frequency, the phase detector sends out the output power in positive pulse. If the oscillation frequency of the VCO is high, phase detector sends out the output power in negative pulse. Therefore, the VCO can maintain the frequency set.

CIRCUITS AND DEVICES TO
STABILIZE FREQUENCY, etc.
FCC ID: MMAFG1

APPENDIX 2
APPENDIX 3

CIRCUITS AND DEVICES TO
SUPPRESS SPURIOUS EMISSIONS, ETC.

TX Power (QT3)

The transmitted signal of approximately 7 mW, combined at the PLL module is supplied to the base of the QT3 amplifier. The transmitted signal amplified to 0.5 watts here passes the TX LPF of the 2nd characteristic of the LT4 and the LT5, and RX/TX switching takes place by the DT2. After this, the signal is provided to the antenna the TX LPF of the 1st characteristics, consisted of the LT6.

Limiter, LP Filter (IC6)

The voice signal input from the microphone is pre-emphasized at the IC6A. The signal, which comes out of the DM1, is limited to a certain amplitude for the voice signal not to exceed the allowable bandwidth assigned for transmission.