

ENGINEERING STATEMENT

For Certification of  
MIDLAND CONSUMER RADIO

Model No. FG-2  
FCC ID: MMAFG2

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-2 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 3, 2001

A. INTRODUCTION

The following data are submitted in connection with this request for type certification of the FG-2 transceiver in accordance with Part

2, Subpart J of the FCC Rules.

The FG-2 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: MMAFG2
  - 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 0.410 W

GMRS 0.492 W

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B. GENERAL INFORMATION (Cont.)

- d. Maximum power permitted under FCC Part 95 (interstitial) is 5 watts ERP. The FG-2 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: 0.69           0.62 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 0.410 W  
GMRS 0.492 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).

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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  $60\log f/3$  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

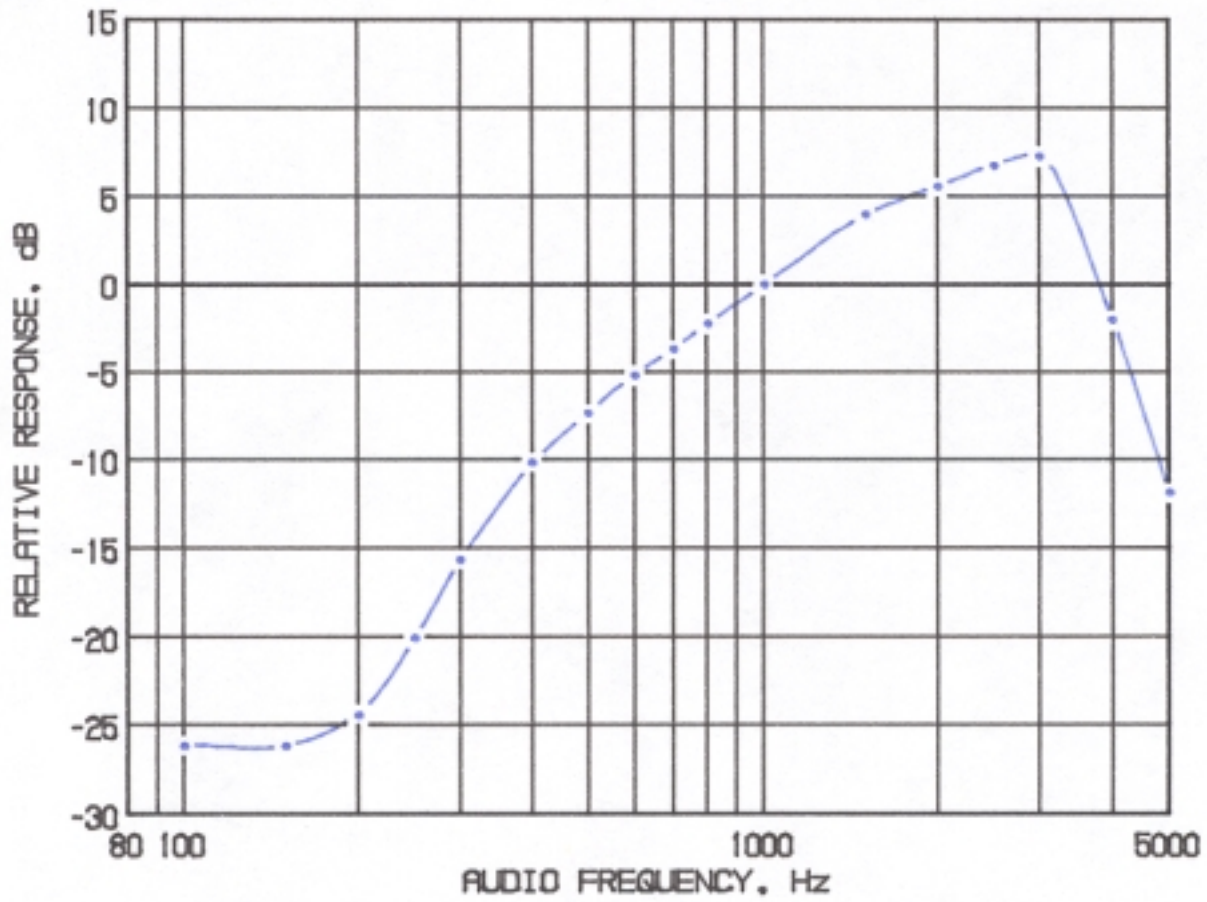
transmitter output taken with a Tektronix 494P spectrum analyzer on GMRS Channel 1. Modulation corresponded to conditions of 2.989(c)(1) and consisted of 2500 Hz tone at an input level 16 dB greater than that necessary to produce 50% modulation at 2891 Hz, the frequency of maximum response.

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:

$$(2D + 2F) \quad 2 \times 2.5 + 2 \times 3.0 = 11k0F3E$$



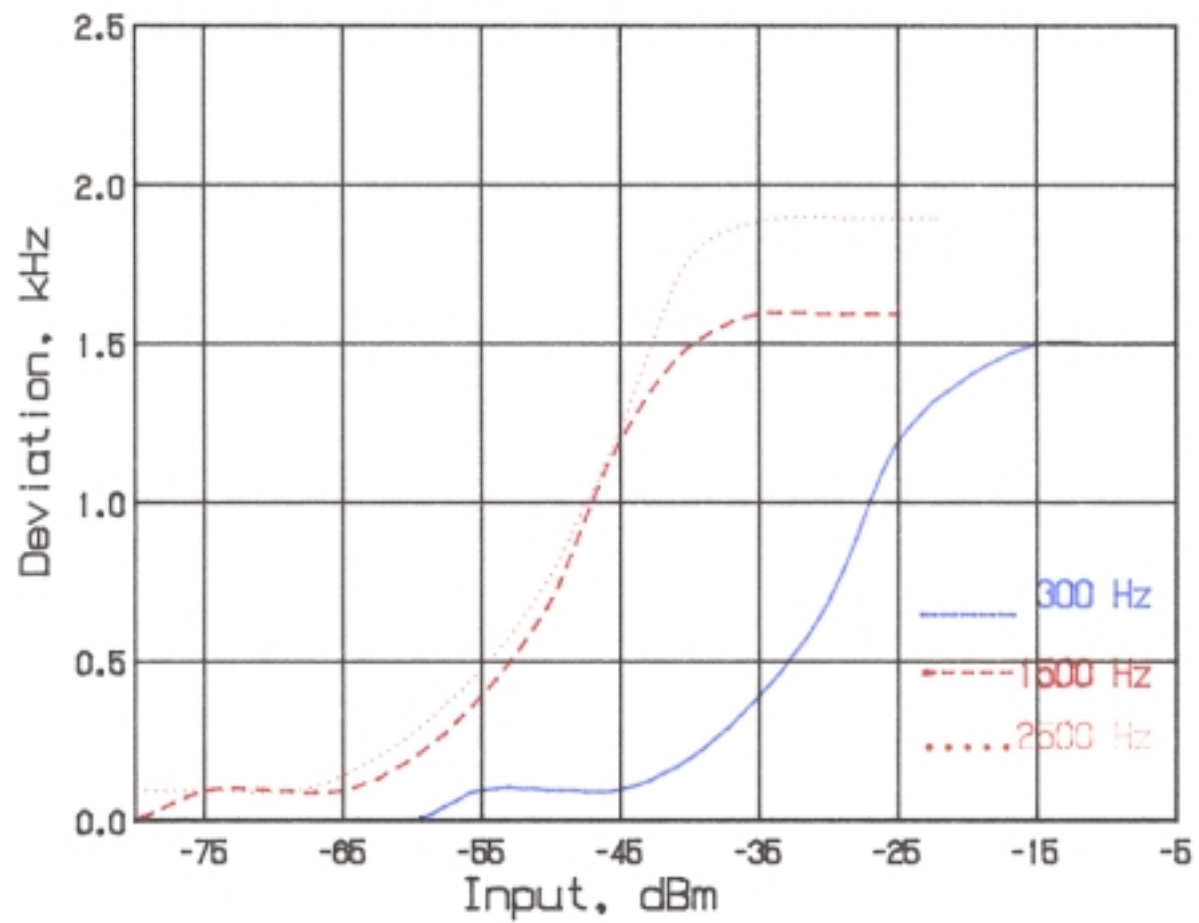
MODULATION FREQUENCY RESPONSE  
FCC ID: MMAFG2

FIGURE 1

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FIGURE 2

AUDIO LIMITER CHARACTERISTICS



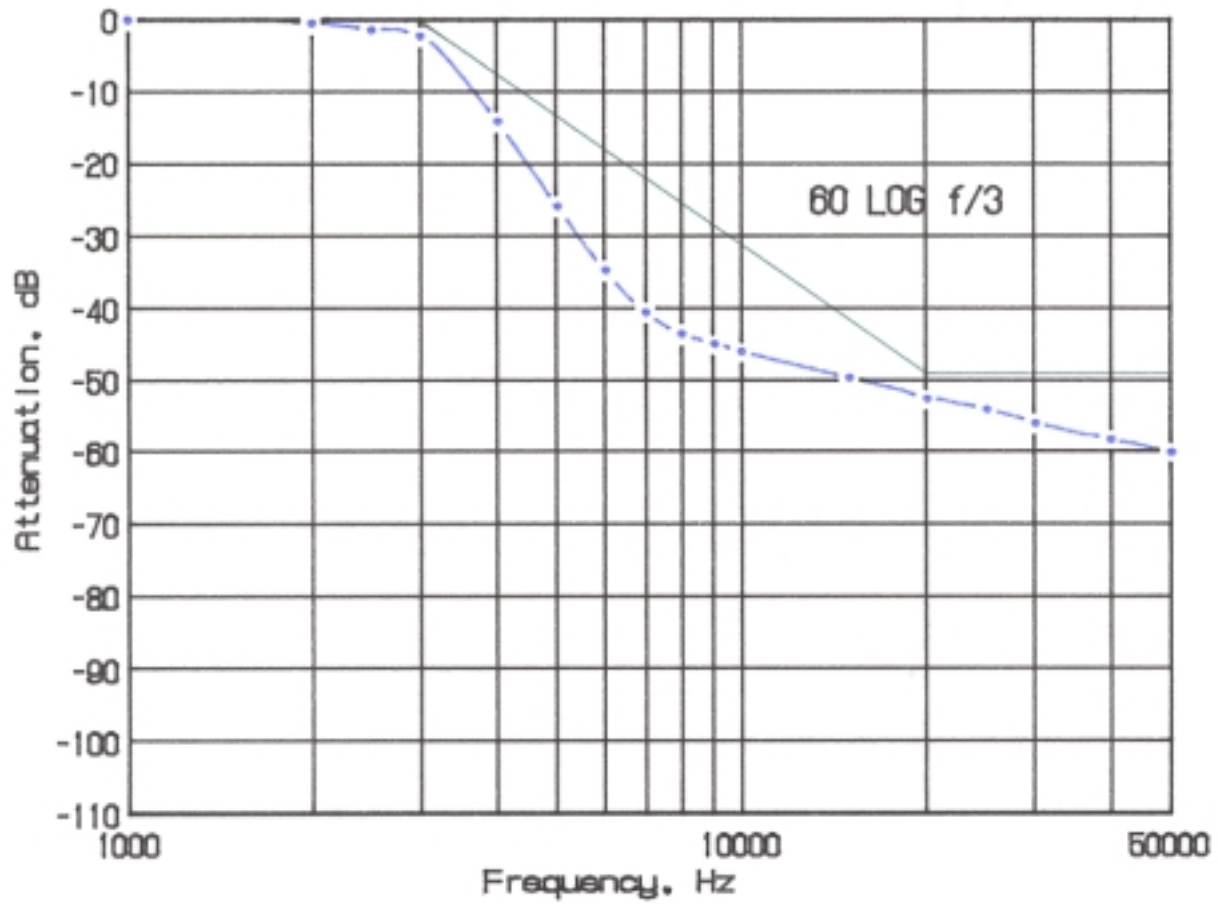
AUDIO LIMITER CHARACTERISTICS  
FCC ID: MMAFG2

FIGURE 2

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FIGURE 3

AUDIO LOW PASS FILTER RESPONSE



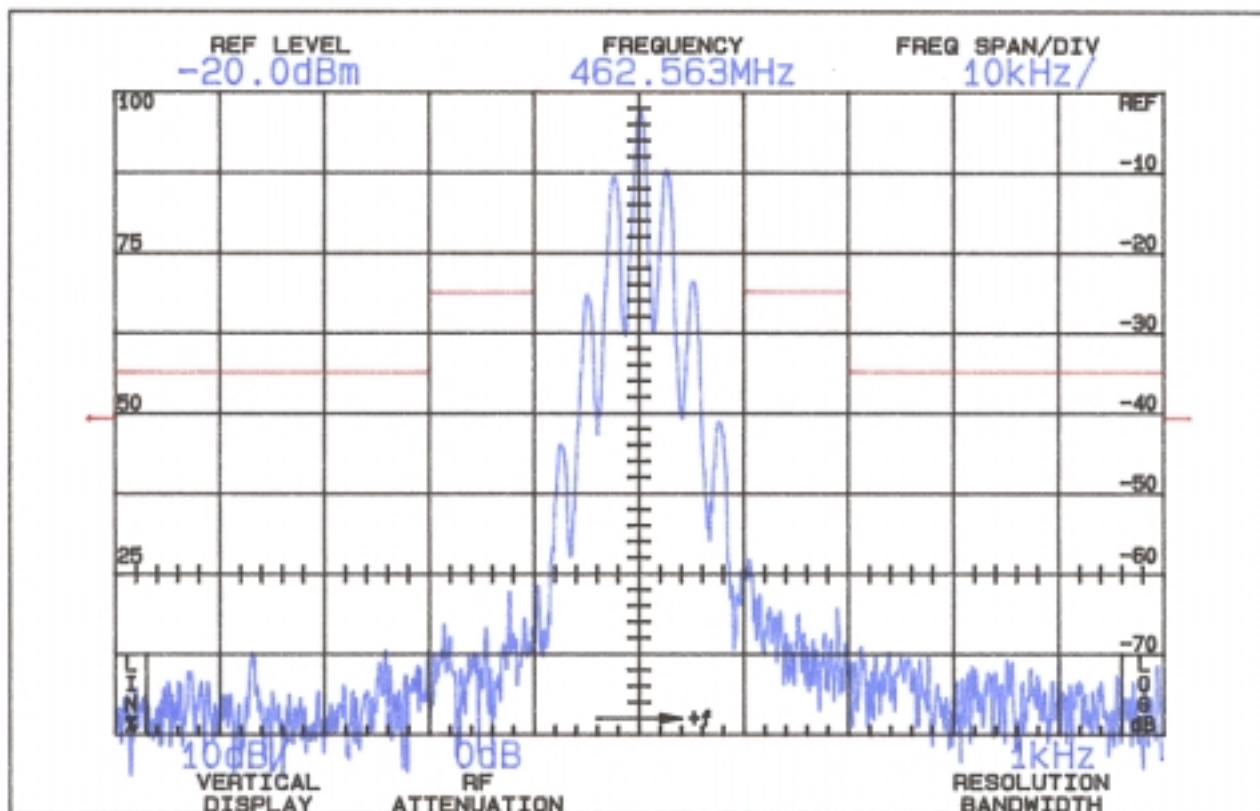
AUDIO LOW PASS FILTER RESPONSE  
FCC ID: MMAFG2

FIGURE 3

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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)

$$43 + 10 \log P = 40$$

$$(P = 0.492 \text{ W})$$

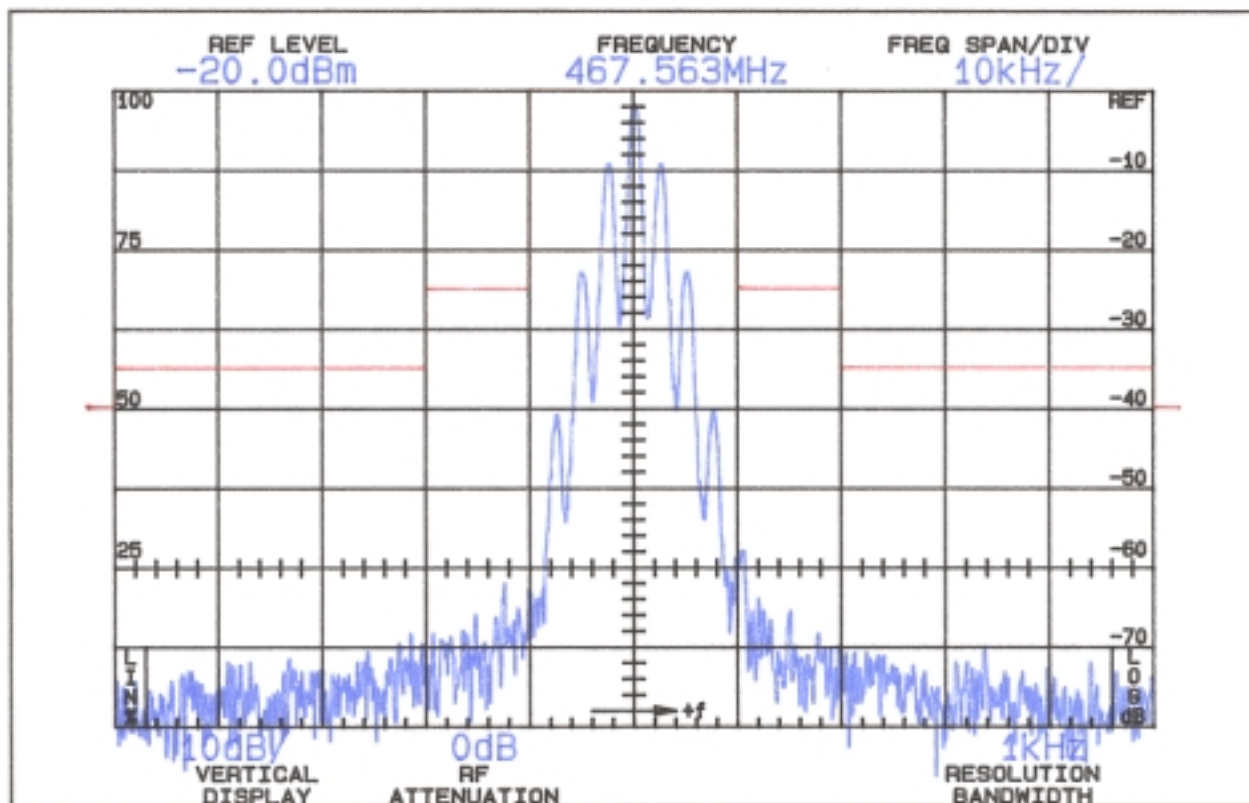
OCCUPIED BANDWIDTH  
FCC ID: MMAFG2

FIGURE 4a, (GMRS)

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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)

$$43 + 10 \log P = 39$$

$$(P = 0.410 \text{ W})$$

OCCUPIED BANDWIDTH  
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FIGURE 4b, (FRS)

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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-2 were made by substitution with a Tektronix 494P spectrum analyzer using Singer DM-105A calibrated test antennae for the measurements to 1 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

| <u>Frequency</u><br><u>MHz</u> | <u>dB Below</u><br><u>Carrier</u><br><u>Reference</u> <sup>1</sup> |
|--------------------------------|--|
| 462.563                        | 0  |
| 1850.250                       | 59V  |

Required:  $43 + 10\text{Log}(0.492) = 40$

TABLE 2b  
TRANSMITTER RADIATED SPURIOUS  
467.5625 MHz, 4.5 Vdc, FRS, Channel 8

| <u>Frequency</u><br><u>MHz</u> | <u>dB Below</u><br><u>Carrier</u><br><u>Reference</u> <sup>1</sup> |
|--------------------------------|--|
| 467.563                        | 0  |
| 1870.250                       | 59V  |
| 2337.813                       | 59V  |

Required:  $43 + \text{Log}(0.410) = 39$

<sup>1</sup>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  $\pm 2^\circ$  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

| <u>Temperature, °C</u> | <u>Output_Frequency,_MHz</u> | <u>p.p.m.</u> |
|------------------------|------------------------------|---------------|
| -30.1                  | 462.562184                   | -0.7          |
| -20.3                  | 462.563069                   | 1.2           |
| -10.1                  | 462.563411                   | 2.0           |
| 0.4                    | 462.563295                   | 1.7           |
| 10.9                   | 462.563046                   | 1.2           |
| 20.1                   | 462.562614                   | 0.2           |
| 30.4                   | 462.562186                   | -0.7          |
| 40.1                   | 462.561898                   | -1.3          |
| 50.1                   | 462.561983                   | -1.1          |

|                          |                   |
|--------------------------|-------------------|
| Maximum frequency error: | 462.563411        |
|                          | <u>462.562500</u> |
|                          | + .000911 MHz     |

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

|            |                |
|------------|----------------|
| High Limit | 462.563656 MHz |
| Low Limit  | 462.561344 MHz |

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## 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  $\pm 15\%$  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

| <u>%</u> | <u>Supply_Voltage</u> | <u>Output_Frequency,_MHz</u> | <u>p.p.m.</u> |
|----------|-----------------------|------------------------------|---------------|
| 115      | 5.2                   | 462.562785                   | 0.6           |
| 110      | 5.0                   | 462.562691                   | 0.9           |
| 105      | 4.7                   | 462.562644                   | 1.0           |
| 100      | 4.5                   | 462.562614                   | 1.0           |
| 95       | 4.3                   | 462.562365                   | 0.9           |
| 90       | 4.1                   | **                           | N/A           |
| 85       | 3.8                   | **                           | N/A           |
| *        | 3.6                   | **                           | N/A           |

Maximum frequency error: 462.562785  
462.562500

\*MFR rated battery endpoint. + .000285 MHz

\*\*Processor shut-down.

FCC Part 95 specifies .00025% or a maximum of  $\pm 0.001156$  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 FG2 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 FG2. 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 FG2. 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](http://www.fcc.gov)

## APPENDIX 1

### FUNCTION OF DEVICES

## SEMICONDUCTORS AND FUNCTIONS

|     |         |                  |
|-----|---------|------------------|
| QF1 | 2SC4226 | RX/TX VCO BUFFER |
|-----|---------|------------------|

|     |                |                                 |
|-----|----------------|---------------------------------|
| QV1 | KRC104S        | RX/TX VCO SWITCHING             |
| QV2 | 2SC4226        | O.S.C                           |
| QR1 | 2SC4226        | RX RF AMP.                      |
| QR2 | 2SC4226        | 1'ST MIXER                      |
| QR3 | KTC3880S       | 1'ST IF AMP.                    |
| QR5 | KTC3875S       | CTCSS DET.                      |
| QR6 | KTA1504ST1(G)  | AUDIO PATH SWITCH               |
| QT1 | 2SC4226        | TX BUFFER                       |
| QT2 | 2SC4226        | TX POWER DRIVE AMP.             |
| QT3 | DRF1401        | TX POWER FINAL AMP.             |
| QF2 | KRC104S        | TX SWITCH                       |
| QS1 | KRA105S        | RX B+ SWITCHING                 |
| QS2 | KRA105S        | RX P/S SWITCHING                |
| QS3 | KRA105S        | TX B+ SWITCHING                 |
| QS4 | KRC104S        | TX B+ SWITCHING                 |
| QS5 | KRA105S        | VOX OUT SWITCHING               |
| QS7 | KRA101S        | PTT DETECTOR                    |
| QS8 | KRA105S        | LCD BACK LIGHT SWITCHING        |
|     |                |                                 |
| IC1 | DBL5018V       | 2'ND MIXER, IF, AND FM DETECTOR |
| IC2 | NJM2070        | AUDIO POWER AMP.                |
| IC3 | S3C728X27-QZR8 | CPU                             |
| IC4 | TB31202FN      | PLL FREQUENCY SYSTHEISIZER      |
| IC5 | TK71330        | REGULATOR                       |
| IC6 | LM324          | PRE-EMPHASIS AND 300Hz HPF      |
| IC7 | 24WC02J        | EEPROM                          |
| IC8 | LM324          | CTCSS LOWPASS FILTER            |
| IC9 | LM324          | DE-EMPHASIS AND 300Hz HPF       |

## APPENDIX 2

### CIRCUITS AND DEVICES TO STABILIZE FREQUENCY

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

At the reference oscillator, the 21.250 MHz TCXO of the TCXO-1 is connected to the pin 10,11 of the IC4 to oscillate the frequency of 21.250 MHz. The TCXO (21.250 MHz) is the temperature compensation circuit to maintain the frequency within the allowable error range even under a low temperature of -30.

The phase detector send 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 referenced frequency, the phase detector sends out the output power in positive pulse. If the oscillation frequency of the VCO is high, phase detector send out can maintain the frequency set.

CIRCUITS AND DEVICES TO  
STABILIZE FREQUENCY, etc.  
FCC ID: MMAFG2

APPENDIX 2

APPENDIX 3

CIRCUITS AND DEVICES TO  
SUPPRESS SPURIOUS EMISSIONS, ETC.

The transmitted signal of approximately 7 mW, combined at the driver TR is supplied to the base of the QT2 amplifier. the transmitted

signal amplified to 0.5 W 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 LT7.

CIRCUITS AND DEVICES TO  
SUPPRESS SPURIOUS EMISSIONS, etc.  
FCC ID: MMAFG2

APPENDIX 3